Chapter 5

Supply, Demand and Water Budget

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Chapter 5. Supply, Demand, and Water Budget

5.1 Introduction

The purpose of this chapter is to create a common understanding of historic[1] and future water supply and demand conditions and to describe the Imperial Region water budget. This chapter:

- Documents the available Colorado River supply and the reliability of the
- Reports historic demand and evaluates forecasted water demand
- Identifies gaps between available supply and forecasted future demand, and impacts that may arise from gaps and/or changing water use patterns
- Describes IID's water budget to explain how the imported Colorado River supply is distributed and used within the Imperial Region

A description of the historic and future water supply is presented first. This is followed by a presentation of the current and forecasted future demands.

The Imperial IRWMP describes how the Colorado River supply can be managed by IID to meet forecasted demands. This chapter provides a regional water supply evaluation that is consistent with the requirements of California Water Code 2.10.[2] It describes the total projected water supplies available during normal, single dry, and multiple dry water years during the planning horizon from 2010 to 2050 and documents IID's water supply availability to meet forecasted demands.

The chapter includes identification of IID water supply entitlements, water rights, water service contracts, and agreements related to the Colorado River water. This includes the historical consumptive use of water by IID.[3] Future demands were forecasted based on adopted city and county general plans or specific land use plans. The chapter identifies potential challenges in meeting the demand with the available supply.

5.1.1 *Intended Use for the IRWMP*

Historic demand and available supplies establish the existing condition, including water projects and facilities, water management and land use plans, water use demands, and supply/demand imbalance.

[1] The IRWMP Planning Grant Agreement's Scope of Work requires "Quantification of current demands and forecast of future demands…" However, for purposes of the Imperial IRWMP, *current* will be referred to as *historic*.
[2] This chapter is prepared to be consistent with the intent of the CWC Section 2.10, Water Supply Planning to Support Existing and Planned Future Use10910, §10910-10915.
[3] Throughout this document, net consumptive use is per USBR Colorado River Accounting and Water Use (Decree Accounting) at Imperial Dam – not with any other accounting. Under QSA and USBR Decree Accounting: Net consumptive use is the amount of water less transfers (from 2,978,223 AF in 2003 to a projected 2,613,800 AF in 2026 and thereafter) as measured at Imperial Dam; total annual quantified amount of IID Colorado River water rights is 3,100,000 AF as described in Section 5.2.7.

The chapter compares available supply, including planned facilities and other known conditions that could influence the supply, and forecasted future demands to identify any future supply/demand imbalance assuming no other actions are taken. This chapter documents changes in water use as a result of implementation of IID Efficiency Conservation Definite Plan (Definite Plan) and System Conservation Plan (SCP), even though implementation of the Definite Plan and SCP are outside of the scope of the IRWMP. (Section 6.0)

In the language of CDWR in the California Water Plan (CWP) and the IRWMP Guidelines, RMSs are projects, programs, and policies that local agencies can integrate to solve problems. The Imperial Water Forum[4] (Water Forum) can integrate and combine resources management to configure alternative solutions that can then be compared to select a preferred alternative. Chapter 6 summarizes the CDWR resource management strategies that were reviewed by the Water Forum and Chapters 7 through 11 discusses CDWR RMSs and how they can be tailored to the specific conditions in the Imperial Region, including Water Forum findings and recommendations to further shape how specific alternatives could be configured. Chapter 12 provides information related to the capital project program and policy alternatives, and approaches for financing such alternatives and Chapters 13 and 14 provide information related to the IRWMP Implementation Plan, Measuring Plan Performance, and Data Management.

5.1.2 Other Intended Uses

CDWR requires discussion of how the IRWMP is related to local land use planning and to local water planning.[5] This chapter provides a standardized description and assessment of the Imperial Region's Colorado River water supply that can be used to update other plans, including UWMPs, city or county General Plans, and local lead agency Water Supply Assessments (Appendix J).

Information presented in the water supply availability section is intended to prevent misinterpretation of IID's Colorado River water supply entitlements, contracts and agreements, and to document the availability and reliability of the Colorado River supply. This section is consistent with the information needed for the preparation of a Determination of Wholesale Water Sustainability (Sustainability Report) completed by IID when a project proponent submits a Request for Water Determination as summarized in Appendix J.

5.2 Regional Surface Water (Colorado River) Supply Availability

Detailed description of the existing supply is presented to document baseline Colorado River water supply conditions and future supply availability and reliability assumptions. It documents the Region's historical water rights to the Colorado River and how the Law of the River, Quantification Settlement Agreement and Related Agreements (QSA/Transfer Agreements), and federal contract operating policies influence the availability and reliability of the Region's water supply. The Colorado River entitlement is

[4] Water Forum. "Imperial IRWMP Mission, Goals and Objectives" p 1. Rev. Jun 2011. <http://imperialirwmp.org/20100824%20WF%20GoalsObjectives_rev_16June2011.pdf>
[5] CDWR Guidelines, Appendix C – Guidance for IRWM Plan Standards

held by IID, and the senior water rights are highly reliable and relatively stable compared to more junior water right holders on the Colorado River, even in dry or multiple dry years.

Even with a relatively stable and known water supply entitlement, under the terms of the QSA/Transfer Agreements, supply reliability may be an issue due to variations in annual agricultural demand. Understanding how supply and demand is related is important for: 1) identifying problems and potential impacts, 2) developing solutions to manage the supply, and 3) avoiding impacts to present day water users and/or the environment. This chapter discusses how the variation, largely in agricultural demand, can result in supply and demand imbalances (overruns) or in underruns. Overrun conditions result when water is diverted in excess of IID's Colorado River entitlement. Underrun conditions occur when less water is diverted than IID's net consumptive use amount as per the 2003 Colorado River Water Delivery Agreement (CRWDA) Exhibit B, Column 13.

5.2.1 Colorado River and Other Water Supply

The Imperial Valley depends solely on the Colorado River for surface water supply. IID imports raw water from the Colorado River and distributes it primarily for agricultural use (95.5 percent of total 2011 delivery).[6] The remaining supply (4.5 percent) is distributed to the Valley's seven municipalities, one private water company, and two community water systems for treatment to potable standards and distribution as domestic water, and to industrial users. Rainfall is less than three inches per year and does not currently contribute to IID's water delivery, although at times it does increase or reduce agricultural water demand. [7] Groundwater in the Imperial Valley is of poor quality and is generally unsuitable for domestic or irrigation purposes, though some is pumped for industrial (geothermal) use. In addition, to avoid agricultural root zone contamination, tile drains are used to dewater the root zone and drain these waters into the Salton Sea.

5.2.2 Colorado River Water Rights

IID's rights to appropriate Colorado River water are long-standing. Beginning in 1885, a number of individuals, as well as the California Development Company, made a series of appropriations of Colorado River water under California law for use in the Imperial Valley. Pursuant to then-existing California laws, these appropriations were initiated by the posting of public notices for approximately 7 million acre-feet per year (MAFY) at the point of diversion and recording such notices in the office of the county recorder. The individual appropriations were subsequently assigned to the California Development Company, whose entire assets, including its water rights, were later bought by the Southern Pacific Company. On June 22, 1916, the Southern Pacific Company conveyed all of its water rights to IID.

IID's predecessor water right holder made reasonable progress in putting their pre-1914 appropriative water rights to beneficial use. By 1929, the beneficial was 424,145 acres out of the Imperial Valley's approximately one million irrigable acres.

[6] IID Water Information System (WIS), Water Balance
[7] One inch of rainfall across the IID irrigated area results in a reduction of about 50 KAF in net consumptive use.

Colorado River water rights are governed by numerous compacts, state and federal laws, court decisions and decrees, contracts, and regulatory guidelines collectively known as the "Law of the River." Together, these documents allocate the water, regulate land use, and manage the Colorado River water supply among the seven basin states and Mexico. The following legal and regulatory documents are among those that have significant bearing on IID.

5.2.2.1 Colorado River Compact (1921)

With the authorization of their legislatures and at the urging of the federal government, representatives from the seven Colorado River basin states began negotiations regarding the distribution of water from the Colorado River in 1921. In November 1922, an interstate agreement, the Colorado River Compact, was signed by the representatives giving each basin perpetual rights to annual apportionments of 7.5 MAFY of Colorado River water.

5.2.2.2 Boulder Canyon Project Act (1928)

Pursuant to the provisions of the Boulder Canyon Project Act which Congress authorized in 1928, the California Limitation Act, and the Secretary's contracts with the California water users, California was apportioned 4.4 MAFY out of the lower basin allocation of 7.5 MAFY, plus 50 percent of any available surplus water. Further apportionment of California's share of Colorado River water was made by the Secretary entering contracts with California right holders. The Secretary entered into a permanent service water delivery contract with IID on December 1, 1932. The District undertook to pay the cost of the works (Imperial Dam and the All American Canal) and to include within itself certain public lands of the United States and other specific lands. The United States undertook to deliver to the Imperial Dam the water that would be carried by the new canal to the various lands to be served by it. IID's contract with the Secretary incorporated the provisions of the Seven-Party Agreement. IID's contract has no termination date; it is a contract for permanent water service.

5.2.2.3 California Seven-Party Agreement (1931)

On November 5, 1930, the Secretary of the Interior requested the California Division of Water Resources to recommend a proper method of apportioning the water that California was entitled to receive under the 1922 Colorado River Compact and the Boulder Canyon Project Act. Thereafter, a number of users and prospective users of Colorado River water entered into the Seven-Party Agreement on August 18, 1931. The California Seven-Party Agreement (condensed and summarized in Table 5-1) states the following:

> *The Division of Water Resources to, in all respects, recognize said apportionments and priorities in all matters relating to State authority and to recommend the [apportionment and priority provisions] to the Secretary of the Interior of the United States for insertion in any and all contracts for water made by him pursuant to the terms of the* ***Boulder Canyon Project Act****.*

Table 5-1. Seven-Party Agreement for Apportionments and Priorities[8]

Priority Order	Description	Annual Apportionment (Acre-feet)	Annual Present Perfected Rights (PPRs) (Acre-feet)
1	Palo Verde Irrigation District – for use exclusively on a gross area of 104,500 acres of land within and adjoining the district	3,850,000	**219,790** (or consumptive use for 33,604 acres)
2	Yuma Project (Reservation District) – for use on California Division, not exceeding 25,000 acres of land		**38,270** (or consumptive use for 6,294 acres)
3a	Imperial Irrigation District - for use on lands served by All American Canal in Imperial and Coachella Valleys		**2,600,000** (or consumptive use for 424,145 acres) - (IID only)
3b	Palo Verde Irrigation District – for use exclusively on an additional 16,000 acres of mesa lands		
4	Metropolitan Water District and/or City of Los Angeles and/or others – for use by themselves and/or others on Southern California coastal plain	550,000	
	Subtotal	4,400,000	
5a	Metropolitan Water District and/or City of Los Angeles and/or others on coastal plain	550,000	
5b	City and County of San Diego	112,000	
6a	Imperial Irrigation District - lands served by the All American Canal (AAC) in Imperial and Coachella Valleys	300,000	
6b	Palo Verde Irrigation District – for exclusive use on 16,000 acres of mesa lands		
	Total	5,362,000	
7	California Agricultural Use - Colorado River Basin lands in California	All remaining available water	

As a result of the Seven-Party Agreement, IID agreed to limit its California pre-1914 appropriative water rights in quantity and priority to the apportionments and priorities contained in the Seven-Party Agreement.

5.2.3 IID State Applications and Permits

Following execution of the Seven-Party Agreement, IID filed eight applications (Table 5-1) with the California Division of Water Rights between 1933 and 1936 to appropriate water pursuant to the California Water Commission Act. These applications each reserved the pre-1914 appropriative rights. However, the applications also incorporated the terms of the Seven-Party Agreement, thus incorporating the apportionment and priority parameters of the Seven-Party Agreement into IID's

[8] IID. "2010 Annual Water Report" < http://www.iid.com/Modules/ShowDocument.aspx?documentid=5057>. p 14.

appropriative applications. Permits were granted on the applications in 1950. A summary of issued permits is shown in Table 5-2.

Table 5-2. Issued Permits Summary

Permit	AFY	Place of Diversion	Purpose of Use
7643	7,239,680	Imperial Dam	Irrigation and domestic
7649	5,791,744	Imperial Dam	Power-related
7648	4,343,808	Imperial Dam	Power-related
7647	5,791,744	Imperial Dam	Power-related
7646	5,791,744	Imperial Dam	Power-related
7645	5,791,744	Imperial Dam	Power-related
7644	9,411,584	Imperial Dam	Power-related
7651	1,447,936	Imperial Dam	Power-related

5.2.4 Subordination by Coachella Valley Water District

CVWD was formed in 1918 to protect and conserve local water sources. At the time IID entered into its contract with the Secretary of the Interior, it was anticipated that the lands to be served with Colorado River water in the Coachella Valley to the north would also become a part of IID. However, Coachella farmers eventually decided that they preferred to have their own delivery contract with the Secretary, and an action was brought by the Coachella Valley Water District (CVWD) to protest IID's court validation of the 1932 IID water service and repayment contract with the Secretary of the Interior. In 1934, IID and CVWD executed a compromise agreement that paved the way for CVWD to have its own contract with the Secretary, but which provided that CVWD would subordinate its Colorado River entitlement, in perpetuity, to IID's entitlement. In other words, within the third, sixth, and seventh priority order (Table 5-1), as set forth in the Seven-Party Agreement and the various California water delivery contracts, IID's water use takes precedence over CVWD's use. As a practical matter, under the third priority, CVWD receives what is left over from the 3.85 MAFY after, Palo Verde Irrigation District, Yuma Project, and IID uses are deducted.

In summary, IID has senior water rights to the Colorado River established under state law, when California is limited to 4.4 MAFY, in the amount of 3.85 MAFY minus the amounts used by Priorities 1 and 2. Priorities 1 and 2 are not fixed quantities and have ranged from 364,817 AFY to 602,181 AFY over the last 25 years.[9]

5.2.5 IID Present Perfected Rights and AZ v. CA US Supreme Court Decision (1964, 1979)

The term "present perfected rights" first appeared in the Colorado River Compact executed on November 24, 1922. The Compact provided that present perfected rights to the beneficial use of waters

[9] "East Brawley Geothermal Development Project SB 610 Water Supply Assessment Review" letter, February 12, 2009, p. 15, and calculations from Derek Dessert, Design Development & Engineering, as emailed to Anisa Devine, June 2012.

of the Colorado River system are unimpaired by this Compact. The Boulder Canyon Project Act Section 6, effective on June 25, 1929, recognized and protected these rights by providing that "the dam and reservoir ... shall be used; second, for irrigation and domestic uses and satisfaction of present perfected rights in pursuance of Article VIII of said Colorado River Compact ..." Pursuant to the terms of the Boulder Canyon Project Act, California's 4.4 MAFY of mainstream water was to be used to satisfy "any rights which existed on December 21, 1928." Such rights included present perfected rights within IID's pre-1914 state-law appropriative rights.

Although the United States Supreme Court in Arizona v. California defined "perfected right" and "present perfected rights" in its 1964 Decree, IID's present perfected rights were not quantified until the Supreme Court issued a Supplemental Decree in 1979. That Supplemental Decree defined IID's present perfected rights as a right to Colorado River water:

> *In annual quantities not to exceed (i) 2,600,000 acre-feet of diversions from the mainstream or (ii) the consumptive use required for irrigation of 424,145 acres and for the satisfaction of related uses, whichever of (i) or (ii) is less, with a priority date of 1901.*

IID's present perfected rights are very important because Article II(B)(3) of the Supreme Court Decree provides that in any year in which there is less than 7.5 MAF of mainstream water available for release for consumptive use in Arizona, California, and Nevada, the Secretary of the Interior shall first provide for the satisfaction of present perfected rights in the order of their priority dates without regard to state lines before imposing shortage cutbacks on other junior water right holders.

5.2.6 Colorado River Basin Project Act (1968)

In 1968, Congress authorized various water development projects in both the upper and lower basins, including the Central Arizona Project (CAP). Under the Colorado River Basin Act of 1968, priority was given to California's apportionment over the CAP water supply in times of shortage. Also under the act, the Secretary was directed to prepare long-range criteria for the Colorado River reservoir system in consultation with the Colorado River Basin states.

5.2.7 Quantification Settlement Agreement and Related Agreements (2003)

Due to completion of a large portion of the CAP infrastructure in 1994, creation of the Arizona Water Banking Authority in 1996, and the growth of Las Vegas in the 1990s, California encountered increasing pressure to live within its Priority 1-4 rights under the Law of the River. After years of negotiating among Colorado River Compact States and affected California water delivery agencies, the Quantification Settlement Agreement and Related Agreements (QSA/Transfer Agreements) and associated documents were signed by the Secretary of Interior, IID, CVWD, MWD, the SDCWA, and other affected parties on October 10, 2003. With execution of the QSA/Transfer Agreements, IID's consumptive uses were capped at 3,100,000 acre-feet (3.1 MAF) per year for the 45-year term of the IID/SDCWA transfer agreement, with possible extension for an additional 30 years. Under the terms of the QSA, the Secretary of the Interior shall deliver IID's Priority 3(a) consumptive use entitlement under the Colorado River Water Delivery Agreement, pursuant to Exhibit A (Table 5-1) and Exhibit B (Table 5-5), as follows:

Table 5-3. Delivery of Priority 3(a) Consumptive Use Entitlement to IID (CRWDA Exhibit A)[10]

Delivered to (entity):	At (point of diversion):	Amount not to exceed (AFY):
CVWD	Imperial Dam	103,000
MWD[1]	Lake Havasu	110,000*
SDCWA[2]	Lake Havasu	56,200
SDCWA[3]	Lake Havasu	200,000
SLR[4]	see note 4	see note 4
Misc. & Indian PPRs[5]	Current points of delivery	11,500
For benefit of MWD/SDCWA[6]	Lake Havasu	145,000
IID	Imperial Dam	Remainder
IID's Priority 3(a) Total		3,100,000

* By IID/MWD agreement, the 1988 IID/MWD transfer was fixed at 105 KAFY, beginning in calendar year 2007.
[1]Agreement for Implementation of a Water Conservation Program and Use of Conserved Water, dated Dec 22, 1988; Approval Agreement, dated Dec 19, 1989. Of amount identified: up to 90 KAFY to MWD and 20 KAFY to CVWD.
[2]Water conserved from construction of a new lined canal parallel to the AAC from Pilot Knob to Drop 3.
[3]Agreement for Transfer of Conserved Water, dated Apr 29, 1998, as amended. As set forth in Exhibit B (Table 5-4), delivery amounts shall be 205 KAF in calendar year 2021 and 202.5 KAF in calendar year 2022.
[4]Water conserved from AAC lining project and made available for benefit of San Luis Rey Settlement Parties under applicable provisions of PL 100-675, as amended. Quantity may vary, not to exceed 16.0 KAFY, as may the point of diversion, subject to the terms of the Allocation Agreement.
[5]Water to be delivered to misc. and Indian PPRs identified in the Decree in Arizona v. California, as supplemented. Delivery of water will be to current points of delivery unless modified in accordance with applicable law.
[6]As provided in CRWDA subsection 4(g).

The annual water limit imposed by the QSA/Transfer Agreements (CRWDA Exhibit B, Table 5-4) creates complicated accounting for both IID and the USBR and is still evolving. Data included herein represents IID's effort to consolidate USBR and IID numbers in a simplified annual format. As IID works with the USBR to develop consolidated accounting formats, the presentation of these values is likely to be refined and updated. The 3.1 MAF annual cap and water conservation and transfer programs present unique challenges as data prior to 2003 cannot always be compared or averaged with pre-QSA data absent additional data rectification or benchmarking.

As a result of the QSA/Transfer Agreements, IID will be able to more efficiently deliver Colorado River water within the Imperial Valley. Imperial Valley agricultural water users will be able to more efficiently use their irrigation water; thus, preserving Imperial Valley agricultural output while reducing their use of Colorado River water. The on-farm program will compensate local participants for the conserved water. USBR will not challenge reasonable and beneficial use under the 43 C.F.R. Part 417 as long as IID

[10] Secretary of the Interior. "Exhibit A of the Colorado River Water Delivery Agreement (CRWDA)" <http://www.usbr.gov/lc/region/g4000/crwda/crwda.pdf>

participates in the QSA/Transfer Agreements; thus, the Imperial Valley will be able to rely on the senior rights to a large volume of Colorado that IID possesses.

In short, the QSA/Transfer Agreements ensure that IID will receive Colorado River water as scheduled in the Colorado River Water Delivery Agreement, Exhibit B (Table 5-5) and provide the means to allow IID and the customers it serves to elevate their Colorado River water use to efficient 21st Century standards and ensure the continued availability of this precious supply.

5.2.7.1 QSA Impacts on Water Supply

The impact of the QSA/Transfer Agreements on the water supply in the Region is the limitation of Colorado River water available for delivery by IID to its customers. IID has agreed to 45 years of large-scale water conservation, increasing from 120,000 AFY in 2003, to 408,000 AFY (303,000 AFY in year 24 of the QSA/Transfer Agreements (2026), shown in Table 5-5, plus 105,000 AFY to MWD under the 1988 Agreement) plus miscellaneous PPRs of 11.5000 AFY of water (at Imperial Dam). From 2026 through 2047, the IID QSA/Transfer Agreements reduction is stabilized. These conserved amounts are to be transferred to urban areas in the Colorado River and Southern Coast Regions of California. These transfers are to be achieved while working within an annual cap of 3.1 MAF of Colorado River water and without reducing agricultural productivity; thereby increasing productive water use. Under the terms of the QSA/Transfer Agreements, IID is also to deliver mitigation water to Salton Sea in calendar years 2003-2017. Mitigation is being implemented to address impacts throughout the region with particular focus on the Salton Sea.

Table 5-5 presents the amounts and those who will receive the conserved water by fallowing and efficiency practices from 2003 through 2017 in order to provide mitigation water to the Salton Sea. From 2018 on, all of the transferred water can be from efficiency conservation, should IID and the customers it serves decide to follow that course.

Table 5-4. IID Net Consumptive Use (KAF, CRWDA Exhibit B)

CRWDA: Federal QSA Exhibit B: IID Quantification and Transfers, as of 2011 (KAF)[1]

Col 1	2	3	4	5	6	7	8	9	10	11
	IID Priority 3a									
		IID Reductions								
Year	IID Priority 3a Quantified Amount	1988 MWD Transfer[2]	SDCWA Transfer	AAC Lining	Salton Sea Mitigation SDCWA Transfer	Intra-Priority 3 CVWD Transfer	MWD Transfer w\ Salton Sea Restoration	Misc. PPRs	IID Total Reduction (Σ Cols 3 -9)[3]	**IID Net Consumptive Use Amount** (Col 2 - 10)
2003	3,100	105.1	10	0	0	0	0	11.5	126.6	2973.4
2004	3,100	101.9	20	0	15	0	0	11.5	148.4	2951.6
2005	3,100	101.9	30	0	15	0	0	11.5	158.4	2941.6
2006	3,100	101.1	40	0	20	0	0	11.5	172.6	2927.4
2007	3,100	105	50	0	25	0	0	11.5	191.5	2908.5
2008	3,100	105	50	67.7	26	4.0	0	11.5	264.2	2835.8
2009	3,100	105	60	67.7	30	8.	0	11.5	282.2	2817.8
2010	3,100	105	70	67.7	33.8	6.0	0	11.5	294.8	2805.2
2011	3,100	105	63.3	67.7	0	16	0	11.5	263.5	2836.5
2012	3,100	105	90	67.7	45	21	100	11.5	440.2	2,659.8
2013	3,100	105	100	67.7	70	26	100	11.5	480.2	2,619.8
2014	3,100	105	100	67.7	90	31	100	11.5	505.2	2,594.8
2015	3,100	105	100	67.7	110	36	100	11.5	530.2	2,569.8
2016	3,100	105	100	67.7	130	41	100	11.5	555.2	2,544.8
2017	3,100	105	100	67.7	150	45	91	11.5	570.2	2,529.8
2018	3,100	105	130	67.7	0	63	0	11.5	377.2	2,722.8
2019	3,100	105	160	67.7	0	68	0	11.5	412.2	2,687.8
2020	3,100	105	193	67.7	0	73	0	11.5	450.2	2,649.8
2021	3,100	105	205	67.7	0	78	0	11.5	467.2	2,632.8
2022	3,100	105	203	67.7	0	83	0	11.5	470.2	2,629.8
2023	3,100	105	200	67.7	0	88	0	11.5	472.2	2,627.8
2024	3,100	105	200	67.7	0	93	0	11.5	477.2	2,622.8
2025	3,100	105	200	67.7	0	98	0	11.5	482.2	2,617.8
2026	3,100	105	200	67.7	0	103	0	11.5	487.2	2,612.8
2027	3,100	105	200	67.7	0	103	0	11.5	487.2	2,612.8
2028	3,100	105	200	67.7	0	103	0	11.5	487.2	2,612.8
'29-37	3,100	105	200	67.7	0	103	0	11.5	487.2	2,612.8
'38-47[4]	3,100	105	200	67.7	0	103	0	11.5	487.2	2,612.8
'48-77[5]	3,100	105	200	67.7	0	100	0	11.5	484.2	2,615.8

Notes:

[1] Information conveyed in this figure is volume at Imperial Dam from USBR Colorado River Water Delivery Agreement (CRWDA) Exhibit B; however, IID has adjusted the 1988 MWD Transfer values for 2003 through 2006 to reflect actual values and the values for 2007 - 2077 to reflect the new IID/MWD agreement. IID Total Reduction and IID Net Consumptive Use Amount have been recalculated to reflect these changes.

[2] By IID and MWD agreement, the 1988 IID/MWD transfer has been fixed at 105 KAFY, starting in 2007.

[3] Reductions include conservation for 1988 IID/MWD Agreement Transfer, IID/SDCWA Transfer, AAC Lining (amount may vary); SDCWA Transfer Mitigation, additional MWD Transfer w/Salton Sea Restoration (amount may vary), and Misc. PPRs and allow for Conditional Interim Surplus Agreement Backfill (amount may vary). Amounts in this table are independent of increases and reductions as allowed under the Inadvertent Overrun and Payback Policy. NOTE: Shaded columns represent amounts that might vary.

[4] Assumes SDCWA does not elect termination in year 35.

Assumes SDCWA and IID mutually consent to renewal term of 30 years.

Source: QSA CRWDA Exhibit B p 13 <http://www.usbr.gov/lc/region/g4000/QSA/crwda.pdf>

Table 5-5. IID Conserved Water Delivery, KAF (from CRWDA Exhibit B)

		Delivery to:					
QSA Year	Calendar Year	MWD	SDCWA	Salton Sea Mitigation (SDCWA)	CVWD*	MWD	Total Delivery
1	2003	110	10	5	0	0	120
2	2004	110	20	10	0	0	130
3	2005	110	30	15	0	0	140
4	2006	110	40	20	0	0	150
5	2007	105	50	25	0	0	155
6	2008	105	50	25	4	0	159
7	2009	105	60	30	8	0	173
8	2010	105	70	35	12	0	187
9	2011	105	80	40	16	0	201
10	2012	105	90	45	21	0	216
11	2013	105	100	70	26	0	231
12	2014	105	100	90	31	0	236
13	2015	105	100	110	36	0	241
14	2016	105	100	130	41	0	246
15	2017	105	100	150	45	0	250
16	2018	105	130		63	0	298
17	2019	105	160		68	0	333
18	2020	105	192.5		73	2.5	373
19	2021	105	205		78	5.0	393
20	2022	105	202.5		83	2.5	393
21	2023	105	200		88	0	393
22	2024	105	200		93	0	398
23	2025	105	200		98	0	403
24	2026	105	200		103	0	408
25	2027	105	200		103	0	408
26	2028	105	200		103	0	408
27-45	2029-2047[1]	105	200		103	0	408
46-75	2048-2077[2]	105	200		50	0	355

*or MWD if CVWD declines to acquire
[1] Assumes SDCWA does not elect termination in year 35 when its wheeling agreement with MWD ends.
[2] Assumes SDCWA and IID mutually consent to renewal term of 30 years.
Source: <http://www.usbr.gov/lc/region/g4000/QSA/crwda.pdf>

Table 5-6. Compromise IID QSA Delivery Schedule (KAF)

	Delivery for Transfer			Conservation Practice			
1	2	3	4	5	6	7	8
Year	to SDCWA	to CVWD	Total Transfer (Col 2+3) or (Col 5+6)	Efficiency for Delivery	Fallowing for Delivery	Fallowing for Mitigation	Total Fallowing (Col 6+7)
2003	10	0	10	0	10	5	15
2004	20	0	20	0	20	10	30
2005	30	0	30	0	30	15	45
2006	40	0	40	0	40	20	60
2007	50	0	50	0	50	25	75
2008	50	4	54	4	50	25	75
2009	60	8	68	8	60	30	90
2010	70	12	82	12	70	35	105
2011	80	16	96	16	80	40	120
2012	90	21	111	21	90	45	135
2013	100	26	126	46	80	70	150
2014	100	31	131	71	60	90	150
2015	100	36	136	96	40	110	150
2016	100	41	141	121	20	130	150
2017	100	45	145	145	0	150	150
Total	**1000**	**240**	**1240**	**540**	**700**	**800**	**1500**

Source: "QSA by and among IID, MWD, and CVWD, Exhibit C." p 39 of 44. 10 Oct 2010, volumes at Imperial Dam. <http://www.iid.com/Modules/ShowDocument.aspx?documentid=882>

5.2.8 Other Colorado River Operating Policies and Agreements

A number of other federal operating policies could affect IID diversions, deliveries and operations, and influence the reliability of the Imperial Valley's Colorado River supply under different hydrologic conditions.

5.2.8.1 2003 Colorado River Water Delivery Agreement (CRWDA)

As part of QSA/Transfer Agreements among California and federal agencies, the Colorado River Water Delivery Agreement: Federal QSA for purposes of Section 5(b) Interim Surplus Guidelines (CRWDA) was entered into among the Secretary of the Interior, IID, CVWD, MWD and SDCWA.[11] This agreement involves the federal government because of the change in place of use to the MWD Colorado River Aqueduct.

The CRWDA assists California in meeting the goals of the California 4.4 Plan by quantifying for a specific term of years the deliveries under certain Colorado River entitlements within shared priorities, so that transfers may occur. In particular, for the term of the CRWDA, quantification of priority 3(a) was

[11] <http://www.usbr.gov/lc/region/g4000/crwda/crwda.pdf>

effected through caps on water deliveries to IID (consumptive use of 3.1 million acre-feet per year) and CVWD (consumptive use of 330,000 acre-feet per year). Quantification of priority 6(a) was effected through quantifying consumptive use amounts to be made available in order of priority to MWD (38,000 acre-feet per year), IID (63,000 acre-feet per year), and CVWD (119,000 acre-feet per year) with the provision that any additional water available to priority 6(a) be delivered under IID's and CVWD's existing water delivery contract with the Secretary. The CRWDA provides that the underlying water delivery contract with the Secretary remain in full force and effect. (*Colorado River Documents 2008*, Chapter 6, pages 6-12 and 6-13)

The CRWDA also provides a source of water to effect a San Luis Rey Indian Water rights settlement. Additionally, the CRWDA satisfies the requirement of the 2001 Interim Surplus Guidelines (ISGs) that a QSA be adopted as a prerequisite to the interim surplus determination by the Secretary in the ISG.

The Inadvertent Overrun Payback Policy, adopted by the Secretary contemporaneously with the execution of the CRWDA, provides additional flexibility to Colorado River management and applies to entitlement holders in the Lower Division States.[12] The IOPP defines inadvertent overruns as "Colorado River water diverted, pumped, or received by an entitlement holder of the Lower Division States that is in excess of the water users' entitlement for the year." In the event of an overrun, the IOPP provides a structure to payback the overrun for that year.

5.2.8.2 1970 Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs

These Operating Criteria control operation of the Colorado River reservoirs in compliance with requirements set forth in the Colorado River Compact of 1922, the United States-Mexico Water Treaty of 1944, the Colorado River Storage Project Act of 1956, the Boulder Canyon Projects Act (Lake Mead) and the Colorado River Basin Project Act (Upper Basin Reservoirs) of 1968, and other applicable federal laws.[13] Under these Operating Criteria, the Secretary of the Interior makes annual determinations published in the USBR Annual Operating Plan for Colorado River Reservoirs (discussed below) regarding the release of Colorado River water for deliveries to the Lower Basin States. A requirement to equalize active storage between Lake Powell and Lake Mead when there is sufficient storage in the Upper Basin is included in these operating criteria.

5.2.8.3 Annual Operating Plan (AOP) for Colorado River Reservoirs

Annual operating plans are developed in accordance with Section 602 of the Colorado River Basin Project Act (Public Law 90-537); the Criteria for Coordinated Long-Range Operations of Colorado River Reservoirs Pursuant to the Colorado River Basin Project Act of 1968, as amended, promulgated by the Secretary of the Interior; and Section 1804(c)(3) of the Grand Canyon Protection Act (Public Law 102-

[12] 2003 Inadvertent Overrun and Payback Policy
<http://www.usbr.gov/lc/region/g4000/4200Rpts/DecreeRpt/2006/agreements/IOPP.pdf>
[13] USBR website: The Law of the River, visit for these Operating Criteria and other agreements
<http://www.usbr.gov/lc/region/g1000/lawofrvr.html>

575)[14]. As part of the AOP process, the Secretary makes determinations regarding the availability of Colorado River water for deliveries to the Lower Basin States, including when normal, surplus, and shortage conditions occur on the lower portion of the Colorado River.

5.2.8.4 2007 Interim Guidelines for Lower Basin Shortages

The circumstances that triggered the need for the 2007 guidelines is described by the USBR, as follows,

The Colorado River Upper Basin experienced a protracted multi-year drought which began in October 1999 and ended in 2010. In the summer of 1999, Lake Powell was essentially full with reservoir storage at 97 percent of capacity. However, it became evident with precipitation totals at only 30 percent of average for October, November, and December that the stage was set for the low runoff that occurred in 2000.

In the late 1990s, inflow to Lake Powell was above average and the lake stayed full from 1995 through 1999. As late as September 1999, Lake Powell was still 95 percent full. Inflow into Lake Powell from water years 2000 through 2004 was about half of what is considered average. The 2002 inflow was the lowest recorded since Lake Powell began filling in 1963. However, by August 2011, unregulated inflow volume to Lake Powell in July was 279 percent of average.

Table 5-7. Unregulated Inflow to Lake Powell, Percent of Historic Average, 2000-2010

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
62%	59%	25%	51%	49%	105%	73%	68%	102%	88%	73%

Source: USBR website: Drought In the Upper Colorado River Basin

Whether a drought exists is determined by comparison with normal hydrology for an area. Normal is defined as a long-term average of annual precipitation data, which may include droughts and extremely wet periods. No single year will ever be normal due to the complexity of weather patterns. Because the occurrence of a drought affects this average, the definition of normal for the American Southwest, will be altered for the next several decades.[15]

In the midst of the drought period, USBR developed the 2007 Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead with consensus from the Basin States (Figure 5-1), which selected the Preferred Alternative[16] as the new basis for USBR's determination that it best meets all aspects of the purpose and need for the federal action. The Preferred Alternative highlighted the:

1. Need to remain in place for the extended period of the interim Guidelines
2. Desirability of the alternative based on the facilitated consensus recommendation from the Basin States

[14] For the AOPs, visit <http://www.usbr.gov/lc/region/g4000/aop/>
[15] USBR. "Drought in the Upper Colorado River Basin." August 2011. <http://www.usbr.gov/uc/feature/drought.html>
[16] USBR. "Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead." [ROD Dec 13, 2007]. <http://www.usbr.gov/lc/region/programs/strategies.html>

3. Likely durability of the mechanisms adopted in the Preferred Alternative in light of the extraordinary efforts that the Basin States and water users have undertaken to develop implementing agreements that will facilitate the water management tools (shortage sharing, forbearance, and conservation efforts) identified in the Preferred Alternative
4. Range of elements in the alternative that will enhance the Secretary's ability to manage the Colorado River reservoirs in a manner that recognizes the inherent tradeoffs between water delivery and water storage.

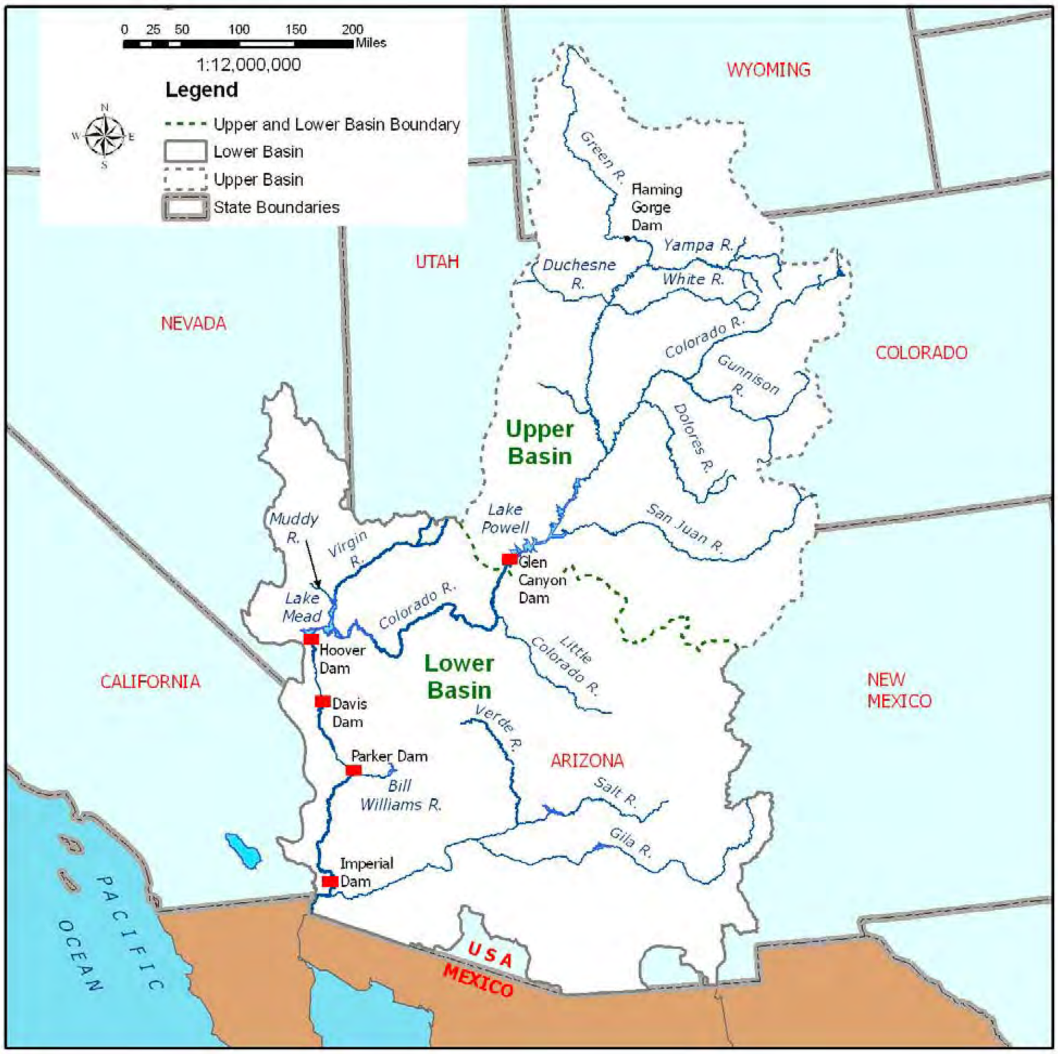

Figure 5-1. Major Reservoir Storage Facilities and Basin Location Map.

Source: Final EIS – Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead

Importantly for the long-term stable management of the Colorado River, adoption of this decision activates a legal agreement among the Basin States that contains a critically important provision: the Basin States have agreed to mandatory consultation provisions to address future controversies on the Colorado River through consultation and negotiation, as a requirement, before resorting to litigation. With respect to the various interests, positions and views of each of the seven Basin States, this provision adds an important new element to the modern evolution of the legal framework for the prudent management of the Colorado River.

In June 2007, the USBR announced that a preferred alternative for Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations of Lake Powell and Lake Mead (Preferred Alternative) had been determined.[17] The Preferred Alternative, based on the Basin States consensus alternative and an alternative submitted by the environmental interests called "Conservation Before Shortage," was comprised of four key operational elements. These four key elements of the Preferred Alternative which would guide operations of Lake Powell and Lake Mead through 2026 are:

1. Shortage strategy for Lake Mead and Lower Division states: The Preferred Alternative proposed discrete levels of shortage volumes associated with Lake Mead elevations to conserve reservoir storage and provide water users and managers in the Lower Basin with greater certainty to know when, and by how much, water deliveries will be reduced during low reservoir conditions.
2. Coordinated operations of Lake Powell and Lake Mead: The Preferred Alternative proposed a fully coordinated operation of the reservoirs to minimize shortages in the Lower Basin and to avoid risk of curtailments of water use in the Upper Basin.
3. Mechanism for storage and delivery of conserved water in Lake Mead: The Preferred Alternative proposed the Intentionally Created Surplus (ICS) mechanism to provide for the creation, accounting, and delivery of conserved system and non-system water thereby promoting water conservation in the Lower Basin. Credits for Colorado River or non-Colorado River water that has been conserved by users in the Lower Basin creating an ICS would be made available for release from Lake Mead at a later time. The total amount of credits would be 2.1 MAF, but this amount could be increased up to 4.2 MAF in future years.
4. Modifying and extending elements of the Interim Surplus Guidelines, which determine conditions under which surplus water is made available for use within the Lower Division states. These modifications eliminate the most liberal surplus conditions thereby leaving more water in storage to reduce the severity of future shortages.

The time span to 2026 provides an opportunity to gain operating experience for the management of Lake Powell and Lake Mead and to improve the basis for making additional future operational decisions, whether during the interim period or thereafter.

[17] USGR website: <http://www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=17341>. The description of the preferred alternative is available on Reclamation's Lower Colorado Region web site, at <http://www.usbr.gov/lc/region/programs/strategies/documents.html>.

Figure 5-2 shows how the coordinated operation element allows for the adjustment of Lake Powell releases to respond to low reservoir storage conditions in either Lake Powell or Lake Mead. The ICS water conservation mechanism encourages efficient use and management of Colorado River water, and enhances conservation opportunities in the Lower Basin and the retention of water in Lake Mead.

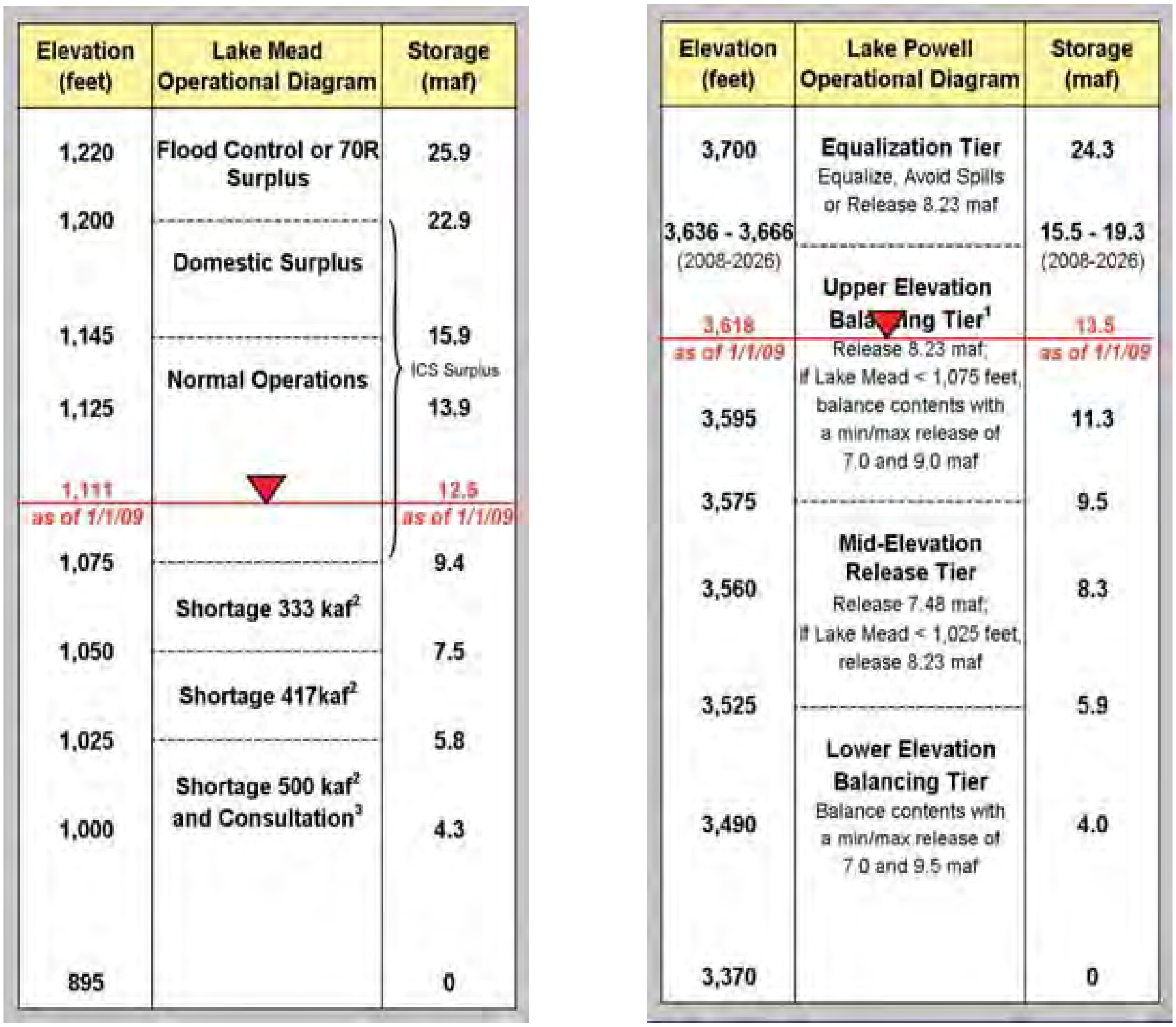

Figure 5-2. Prescribed Operations and Lake Powell and Lake Mead in the Interim Guidelines

[1] Subject to April adjustments that may result in balancing releases or releases according to the Equalization Tier

[2] These are amounts of shortage (i.e., reduced deliveries in the United States)

[3] If Lake Mead falls below elevation 1,025 feet, USDOI will initiate efforts to develop additional guidelines for shortages at lower Lake Mead elevations.

Source:< http://wwa.colorado.edu/IWCS/archive/IWCS_2009_Jan_feature2.pdf >

5.2.8.5 Annual 417 Process

Pursuant to the Code of Federal Regulations Title 43 Part 417 (43 CFR part 417), prior to the beginning of each calendar year, USBR consults, as appropriate, with holders of Boulder Canyon Project Act Section 5 contracts (Contractors) for the delivery of water. IID is one such Contractor. Under these consultations, USBR makes recommendations related to water conservation measures and operating practices in the diversion, delivery, distribution, and use of Colorado River water as stated by USBR in the following the following excerpt:

> *The Regional Director or his (sic) representative will, prior to the beginning of each calendar year, arrange for and conduct such consultations with each Contractor as the Regional Director may deem appropriate as to the making by the Regional Director of annual recommendations relating to water conservation measures and operating practices in the diversion, delivery, distribution and use of Colorado River water, and to the making by the Regional Director of annual determinations of each Contractor's estimated water requirements for the ensuing calendar year to the end that deliveries of Colorado River water to each Contractor will not exceed those reasonably required for beneficial use under the respective Boulder Canyon Project Act contract or other authorization for use of Colorado River water.*[18]

5.3 GROUNDWATER SUPPLY

The Salton Basin, which is comprised of the broad region draining directly into the Salton Sea, lies within the Salton Trough of southern California. The Salton Trough as shown in Figure 5-3 is the dominant feature of the Colorado Desert geomorphic province of California. The Basin is about 130 miles long and up to 70 miles wide, and is generally considered the northwesterly landward extension of the Gulf of California (Loeltz et al., 1975).

While the Salton Trough extends to the Gulf of California; the Salton Trough is a concave desert basin that descends to 235 feet (72 m) below sea level at the Salton Sea. The earth's thin crust in the region, and the proximity of hot magma beneath it, relates to the Imperial Valley's location at the top end of a fault in which tectonic plates are moving apart from one another to form the Gulf of California.

Groundwater storage capacity of the Region has been estimated at approximately 14 MAF of water (CDWR, 1975). Groundwater in the Imperial Region can be discussed in terms of three principal physiographic and hydrologic areas: (1) Imperial Valley (irrigated area), (2) West Mesa, and (3) East Mesa. IID, as water wholesaler, does not derive any of its supplies from groundwater. Groundwater TDS in the Region ranges from hundreds to an extreme of up to tens of thousands of milligrams per liter (ppm). Imperial Valley groundwater is of generally poor quality and is unsuitable for domestic or irrigation use due to high levels of total dissolved solids (TDS), fluoride concentration, and boron concentration. Groundwater in the West Mesa comes from a sole source aquifer of good quality. East Mesa groundwater is largely undeveloped and quality varies, however, the USBR operates the Lower Colorado River Water Supply Project along the All American Canal, which operates as follows:

> *Under a May 22, 1992 contract with Reclamation, IID and CVWD have agreed to exchange a portion of their rights to divert water from the Colorado River for an equivalent quantity and quality of groundwater ("exchange water") to be*

[18] 43 CFR, Subtitle B, Ch. I §417.2. 10–1–07 Edition. "Procedural Methods for Implementing Colorado River Water Conservation Measures with Lower Basin Contractors and Others."<http://www.usbr.gov/cio/im/rules/docs/43%20CFR%20417.pdf>

withdrawn from a well field located in the Sand Hills along the All-American Canal in Imperial County. IID and CVWD would reduce their diversions from the Colorado River in an amount equal to the volume of groundwater discharged into the All-American Canal up to a maximum of 10,000 acre-feet per year. An amount of Colorado River water equal to the amount of water that would have otherwise been diverted by IID and CVWD would be made available for beneficial consumptive use by Project beneficiaries. The Project facilities are being developed in stages: Stage 1 has a capacity to provide 5,000 acre-feet of exchange water per year. Stage 1 was declared substantially complete on October 1, 1996, and was officially turned over to the IID for operation and maintenance on January 1, 2000.[19]

Figure 5-3. Map of the Salton Basin in Southern California[20]

Source: Ground Water Availability within the Salton Sea Basin: A Final Report, Lawrence Livermore Laboratory, Jan. 2008

5.3.1 Imperial Valley (Central Irrigated Area)

Imperial Valley is located in the central portion of the Imperial Region. Imperial Valley lies south of the Salton Sea, north of the U.S./Mexico International Border, and generally in the 500,000 acre irrigated

[19] Source: Lower Colorado River Water Supply Act of 1986. <www.crb.ca.gov/083101_3_QA1_rv.doc>

[20] Red dashed is the sea level elevation contour within the Salton Trough. The shaded area corresponds to the watershed basin, 8360 mi^2 (21,700 km^2) in area. Imported water aqueducts are shown in purple. The thick gray line indicates the lined portion of the Coachella Canal.

area between the Westside Main and East Highline canals. Studies of groundwater conditions in the Imperial Valley focus exclusively on the upper 1,000 feet of water-bearing strata; however, data is limited owing to the fact that groundwater in the upper 300 feet of this area is generally of poor quality (saline) and well yields are quite low. In addition, historically there has been little need to investigate and develop the groundwater in the Imperial Valley due to the availability and relatively higher quality of imported Colorado River water.

5.3.2 West Mesa

Located in the southwestern portion of the Imperial Region, West Mesa consists of gently southwest to northeasterly sloping, non-irrigated desert land that lies to the south and east of the Salton Sea, west of the Imperial Valley and east of the Coyote and Jacumba Mountains. With a saturated thickness of about 400 feet and an average depth to groundwater of approximately 100 feet, the aquifer is generally homogenous and of a more coarse-grained nature than the Imperial Valley area. Thus, the data do not indicate separate water-bearing zones or intervening aquitards of any regional significance. Groundwater and surface water flow mimics the topography.

The area includes portions of several relatively small groundwater subbasins for which little direct information is known. The exception to this is the Ocotillo/Coyote Wells Subbasin, for which studies on both the quality and quantity of available groundwater exist (Bookman-Edmonston, 1996; Bookman-Edmonston, 2004; and U.S. Gypsum Final EIR/EIS). Project studies show the sustainable and sole reliance on the Ocotillo-Coyote Wells Groundwater Basin, which was designated a sole source aquifer by the U.S. Environmental Protection Agency in 1996.[21] As a result of this designation, new projects relying on and overlying the Ocotillo-Coyote Wells Groundwater Basin shall be based on safe yield consideration and resource constraints to protect correlative rights of overlying users.

5.3.3 East Mesa

East Mesa is located in the southeastern portion of the Imperial Region, and is described as the broad area that lies that lies to the south and east of the Salton Sea, east of IID's East Highline Canal and to west of the Sand Hills Fault.[22] That is, East Mesa is roughly bordered by East Highline Canal on the west, Coachella Canal on the east and the All American Canal on the south. East Mesa, a non-irrigated alluvial surface that slopes gently northwest towards the Salton Sea, is covered with thin veneers of wind-blown sand. The East Mesa aquifer is chiefly unconfined, homogenous, and composed of coarse-grained deposits of gravels, sands, silts, and silty clays that are thought to be deposited by the Colorado River during the Pliocene era, 5 million to 1.6 million years ago. Available aquifer storage within East Mesa lying between the East Highline Canal and the Coachella Canal is estimated to be one million acre-feet (USBR, 1988). Much of the groundwater in East Mesa was replenished as a result of the Coachella Canal.

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[21] 61 FR 47752, September 10, 1996; or see <ftp://ftp.co.imperial.ca.us/icpds/eir/usg/final/17revisions-sect3.pdf>.
[22] The Sand Hills Fault (also named Algodones Fault), an easterly splay of the San Andreas Fault system, is mapped as bordering the east side of the Sand Hills (Loeltz et. al., 1975).

5.3.4 Groundwater Recharge from the Coachella Canal

The 123 mile-long Coachella Canal was completed in 1948. Prior to the Coachella Canal completion in 1948, imported water was not available to the Coachella Valley. The first water deliveries took place in 1949. In the 1960s, CVWD and Desert Water Agency became State Water Project (SWP) contractors. Together, the two agencies use their entitlement to SWP water to replenish the western Coachella Valley aquifer using the Whitewater Spreading Area, Coachella Valley's largest groundwater recharge facility. The combined entitlement is the third largest among SWP contractors. Since 1973, CVWD and DWA have replenished more than 2.5 MAF of imported water at this site. Previously, the water districts relied on rain and snow melt from nearby mountains to naturally replenish the aquifer at the location.[23]

In December 2006, CVWD celebrated completion of a two-year Coachella Canal lining project, the construction of a 34.8-mile concrete waterway to replace two remaining earthen sections of the original canal. The other sections of the 123-mile canal were either lined when built or in the 1980s to conserve water. The latest project conserves net of 26,000 acre-feet of Colorado River water annually that previously seeped into the rugged desert terrain.[24] Opportunities for groundwater development, storage, and conjunctive management are discussed in Chapter 7. Material in Appendix P is being held for the East Mesa GWMP element and will not be part of the IRWMP until it is updated early next year.

5.4 RELIABILITY OF COLORADO RIVER SURFACE WATER SUPPLIES

As discussed under the Law of the River in Section 5.2.2 (above), IID has significant historical legal protections in place to maintain its Priority 3(a) water right to consumptive use of 3.1 MAF per year under the QSA/Transfer Agreements and its Priority 6(a) to 300 KAF per year. IID's present perfected right of 2.6 MAF per year makes the supply very reliable in terms of IID's ability to provide water to the service area even in dry years (as defined by elevations in Lake Mead under the 2007 Interim Guidelines for Lower Basin Shortages) as present perfected rights are the last to be reduced in time of drought. However, given the terms of IID's Priority 3(a) quantification (Table 5-5), even with this level of reliability, IID has begun experiencing years with a supply/demand imbalance (overrun) resulting from fluctuations in agricultural use. This is expected to be exacerbated if municipal (residential, commercial, and urban industrial) and industrial (renewable energy) demands increase as forecasted.

The reliability and certainty of IID's ability to deliver Colorado River water and to meet its customers' demands are governed by a number of factors as briefly summarized below (a link follows each bulleted item for a detailed discussion found in Section 5.2.2):

1. In years with normal or average Colorado River flows and adequate reservoir storage in Lakes Powell and Mead, IID's allocation will remain capped at 3.1 MAF.[25] (Section 5.2.7)

[23] <http://www.cvwd.org/about/wherewater.php>
[24] <http://www.cvwd.org/news/newsarchive/2006_11_20_Canalliningdedication.pdf>
[25] 2012 IID Approved Diversion is 2,817,798 AF. p 2. <http://www.usbr.gov/lc/region/g4000/hourly/forecast12.pdf>

2. In years with surplus flows of more than 7.5 MAF in the Lower Basin (triggered by elevation of Lake Mead), the Seven-Party Agreement and the QSA/Transfer Agreements provide for diversions above 4.4 MAF for use in California. The likelihood of surplus flows in the Colorado River has been diminished by increased Colorado River water use by Nevada and Arizona and by the 11-year drought (1999-2010) in the Colorado River watershed that resulted in historically low levels in Lake Mead. (Section 5.2.5)
3. Even in drought years, with Lower Colorado River flows less than 7.5 MAF Lees Ferry, existing laws and agreements provide security that IID will receive its annual present perfected right of 2.6 MAF and its overall annual water allocation of 3.1 MAF. However, should levels in Lake Mead fall below 1075 feet (critical shortage), other agreements take effect.[26](Section 5.2.5)

IID's protections are based on the following:

1. 1885 California water right, based on reasonable and beneficial use annually of approximately 7 MAF conveyed to IID on June 22, 1916. (Section 5.2.2)
2. 1922 Colorado River Compact requires the Upper Basin states to ensure the annual supply of 7.5 MAF at Lees Ferry for use by the Lower Basin states (actually stated as 75 MAF over 10 years). Thus, it is the responsibility of the Upper Basin states to provide the full Lower Basin allocation, even in drought years and even if the 10-year running average annual water supply of the river is less than 15.0 MAF. (Section 5.2.2.1)
3. 1931 Seven-Party Agreement provides a schedule of apportionments and priorities. (Section 5.2.5)
4. In 1931, as a result of the Seven Party Agreement, IID agreed to limit its California pre-1914 appropriative water rights in quantity and priority to the apportionments and priorities contained in the Agreement. (Section 5.2.2.3)
5. 1964 Supreme Court decree in California v. Arizona defined the present perfected rights on the Colorado River and set IID's at 2.6 MAF annually because that was the annual quantity historically diverted by IID and used to irrigate 424,145 acres. (Section 5.2.5)
6. 1968 Colorado River Basin Project Act states that all deliveries to the Central Arizona Project (CAP) and all other post-1968 water deliveries are subordinate to pre-existing Colorado River water rights in the Lower Basin, regardless of each state's allocations under the 1928 Boulder Canyon Project Act. (Section 5.2.5)
7. 1979 Supplemental Decree in *Arizona v. California* retains IID's present perfected rights to use of Colorado River water. If water supply shortages occur along the Colorado River, IID's present perfected rights must be satisfied prior to the satisfaction of any non-perfected rights, regardless of state lines and federal agreements. (Section 5.2.5)

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[26] Water levels in Lake Mead averaged 1093.26 feet for the month of October 2010, before beginning to rise. By December 2012, the average level had risen to 1132.83 feet. Since filling of Lake Mead, average level is 1173 feet. <http://www.usbr.gov/lc/region/g4000/hourly/mead-elv.html>

8. 2007 *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* provide that shortages in Lake Mead storage (decreasing water levels in the reservoir) will prompt reductions in the annual deliveries to Arizona and Nevada but that California will remain at 4.4 MAF per year.[27]

If California's annual consumptive use remains at 4.4 MAF, then IID deliveries should likewise remain at the levels described in CRWDA Exhibit B (Table 5-5), decreasing form just over 2.97 MAF in 2003 to 2.53 in 2017 (due to required Salton Sea mitigation flow), then increasing in 2018 to just over 2.7 MAF; and declining again until the reduction is stabilized in 2026 at just over 2.6 MAF per year. This reduction in net consumptive use is to be achieved through conservation efficiency practices; thereby, retaining the productivity of the agricultural system and meeting the demand of the existing MCI users, allowing for 3.1 MAF in net annual consumptive use. Values given are volume at Imperial Dam (IID Priority 3(a) Amount equals IID net consumptive use plus IID reductions for QSA transfers and the AAC Lining).[28]

Furthermore, IID has significant historical legal protections in place to maintain its annual Priority 3(a) right to 3.1 MAF of Colorado River water even during periods of lower flow in the Colorado River. These protections are described above in Section 5.2.

5.4.1 Colorado River Historical Annual Flow

Starting in the early 1940s, information about the long-term climate and hydrologic conditions of the Colorado River Basin has been greatly expanded through analysis of tree ring data. These efforts have enabled researchers to reconstruct the annual flows of the Colorado River back to the 1500s and even back to the mid-700s. This new information allows water resource planners and managers to compare the twentieth century gage flow record to the multi-century long-term record.

Table 5-8 summarizes the findings of the most relevant studies to date. The results of tree ring reconstruction studies indicate that the long-term (multi-century) average annual flow of the Colorado River is between 13 MAF and 14 MAF, as shown in Table 5-8. An equally important observation of the tree ring reconstruction efforts has been identification of prolonged drought periods where high flows are absent for over 50 years. Figure 5-4 and Figure 5-5 are graphs of various reconstructions for 1500 to 2000 AD, and from 800 to 2000 AD, respectively.

[27] USBR. "Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead*." 2007.* < http://www.usbr.gov/lc/region/programs/strategies/documents.html>
[28] USBR "Colorado River Water Delivery Agreement. 10 Oct 2003. <http://www.usbr.gov/lc/region/g4000/QSA/crwda.pdf>

Table 5-8. Tree Ring Reconstructions of Annual Colorado River Flow, MAFY, 1490-2005

Study	Calibration Period	Gage Data Source	Chronology Type	Regression Approach	Variance Explained	Reconstruction Period	Long-Term Average Flow (MAFY)
Stockton and Jacoby, 1976	1899-1961	Hely, 1969	Standard	PCA with lagged predictors	0.75	1512-1961	14.2
	1914-1961	Hely, 1969			0.78	1512-1962	13.9
		UCRSFIG, 1971			0.87	1511-1961	13.0
		Average of Above			--	1520-1961	13.4
Michaelson et al., 1990	1906-1962	Simulated flows	Residual	Best subsets	0.83	1568-1962	13.8
Hidalgo et al., 2000	1914-1962	USBR	Standard	Alt. PCA with lagged predictors	0.82	1493-1962	13.0
Woodhouse et al., 2006	1906-1995	USBR	Residual	Stepwise	0.81	1490-1997	14.7
			Standard	Stepwise	0.84		14.5
			Residual	PCA	0.72		14.6
			Standard	PCA	0.77		14.1
Meko et al., 2007	1906-2003	USBR	Residual	2-Step Regression with PCA	0.60	762-2003	14.7
	1906-2002				0.74	1182-2002	
	1906-2002				0.77	1365-2002	
	1906-2004				0.57	1473-2005	

Chronology Type: Standard chronologies contain low order autocorrelation related to biological persistence; residual chronologies have been pre-whitened and contain no low order autocorrelation.
Regression Approach: Principal Component Analysis (PCA) is principal regression procedure. Best subsets are multiple linear regressions using Mallow's Cp to select best subset. Alternative PCA used an algorithm to find the best subset of predictors on which to perform PCA for regression. Stepwise is forward stepwise regression.
UCRSFIG: Upper Colorado Region State-Federal Interagency Group
Source: USBR, 2007

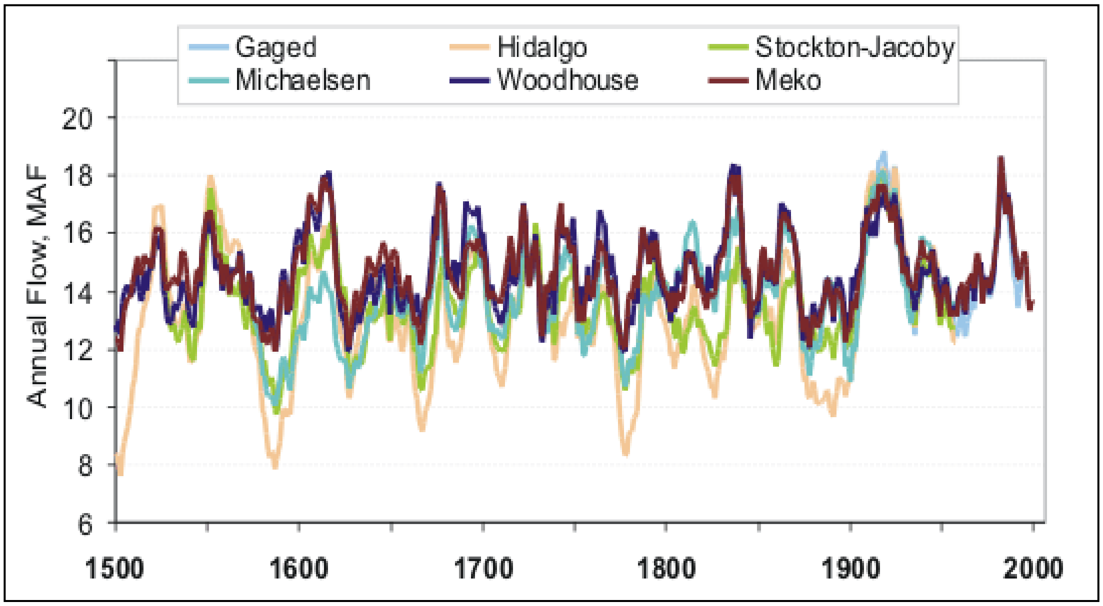

Figure 5-4. Tree Ring Reconstructed Annual Flows of the Colorado River, 1500-2000 AD

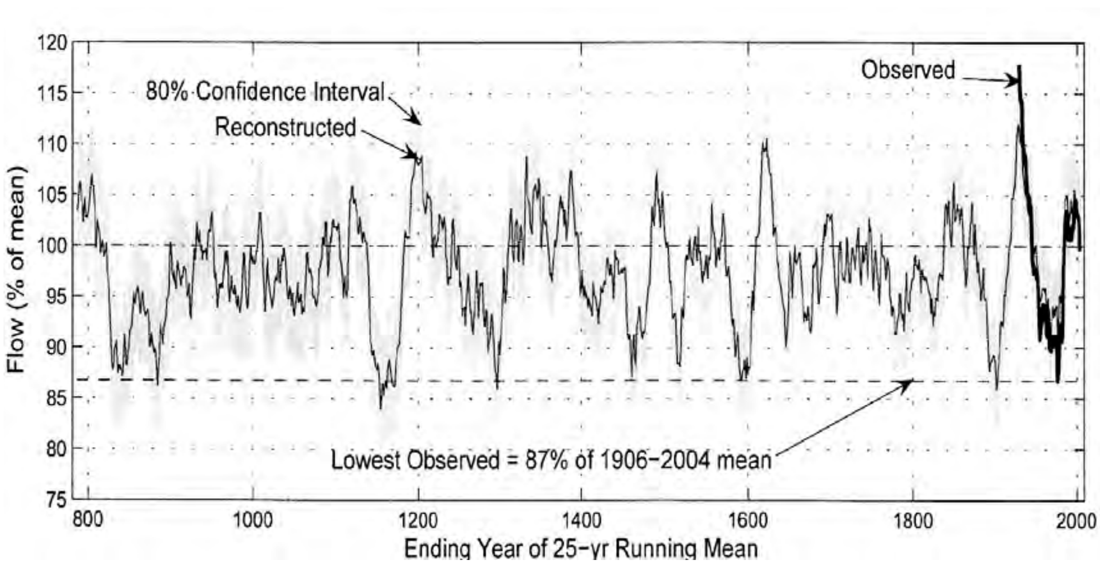

Figure 5-5. Tree Ring Reconstructed Annual Flows of the Colorado River, 800-2000 AD

5.4.2 Historical Data on the Colorado River Water Supply

Colorado River flow at Lees Ferry has been gauged since 1921. By removing reservoir and diversion effects, the USBR has created a "natural flow" record for this site. The long-term (1906 to 2004) annual average natural flow is estimated to be about 15.1 MAF based on the gauge record. The annual natural flow record is shown in Figure 5-6 and Figure 5-7. A few important points can be noted from the natural flow record:

1. The period of 1906 to 1930 and prior was the gauge record available when many of the Colorado River compacts were drafted. This period had a 10-year running average annual flow of about 17.0 MAF, which is higher than most other periods in the gauge record.
2. From 1934 to 1984, the 10-year running annual average was almost always less than 15 MAFY, meaning that the 1922 Compact annual apportionment of 7.5 MAF each to the Upper and Lower Basins could not have been fully satisfied for most of this 50-year period.
3. Annual allocations from the Colorado River total 16.5 MAF, divided as 7.5 MAF each to the Upper and Lower Basins, and 1.5 MAF to Mexico. Long-term average natural flows from the gauge record are less than these total allocations.

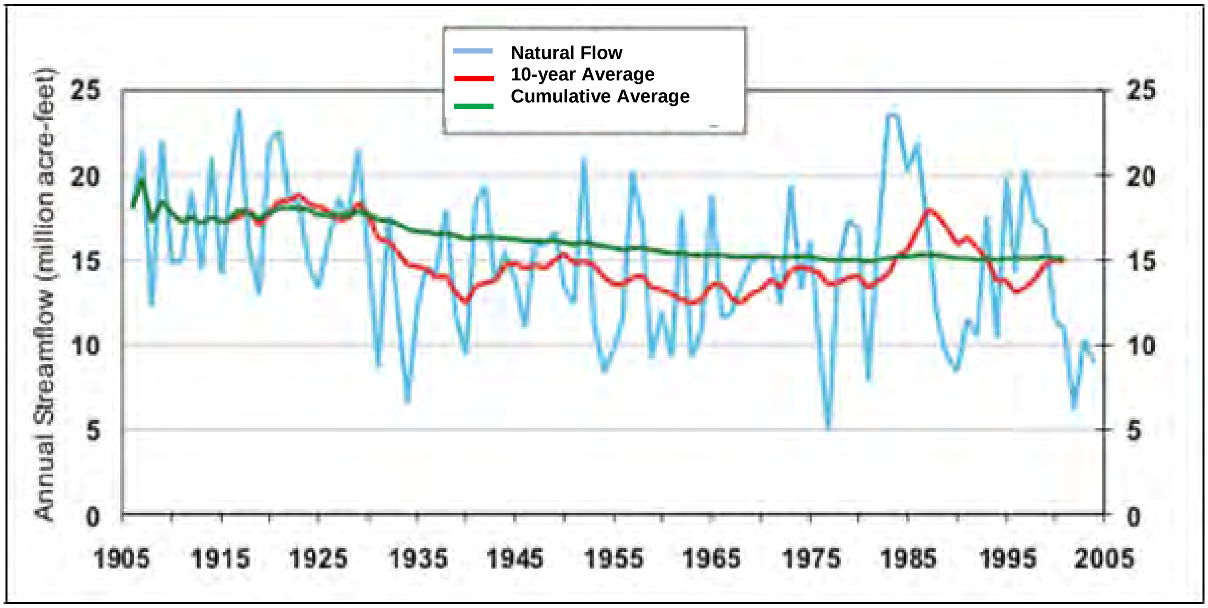

Figure 5-6. Annual Streamflows of Colorado River at Lees Ferry, 1905-2005

Source: USGS

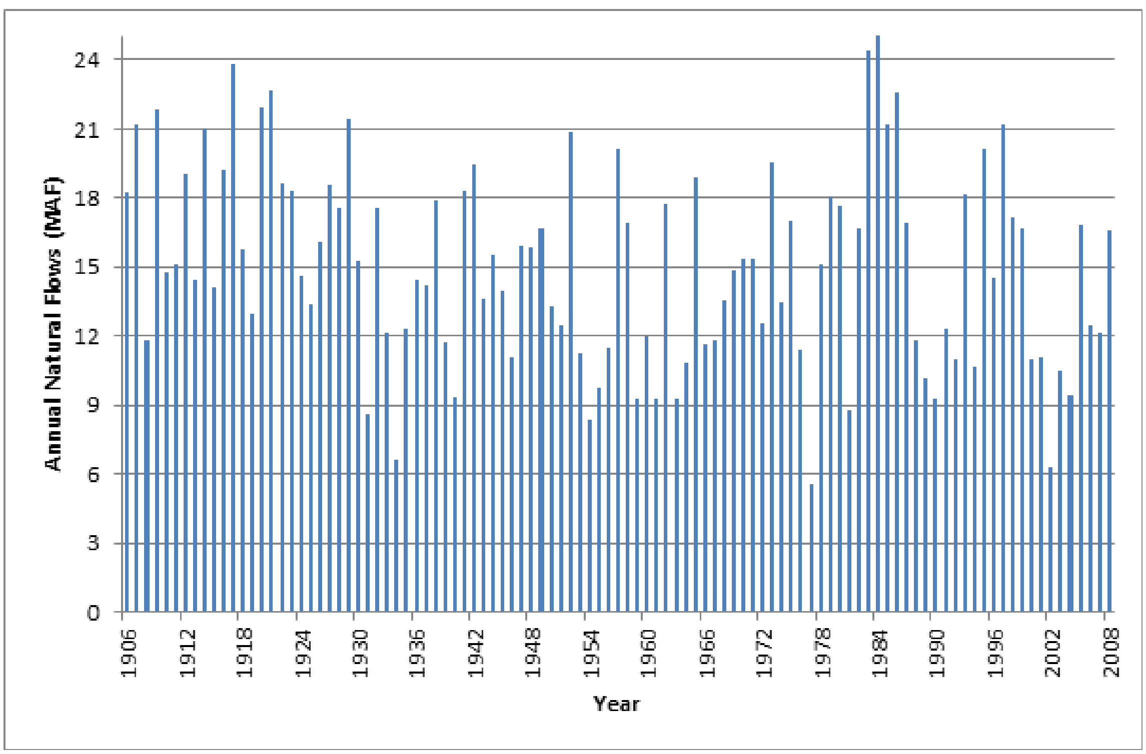

Figure 5-7. Annual Natural Flows of Colorado River at Lees Ferry, 1906-2008

Source: USGS

The variation in recent natural flows, displayed in Figure 5-7 indicates the role and importance of storage on the Colorado River. Lake Mead reservoir elevations, also provided by the USBR, are shown in Figure 5-8 for 1939 to 2011.

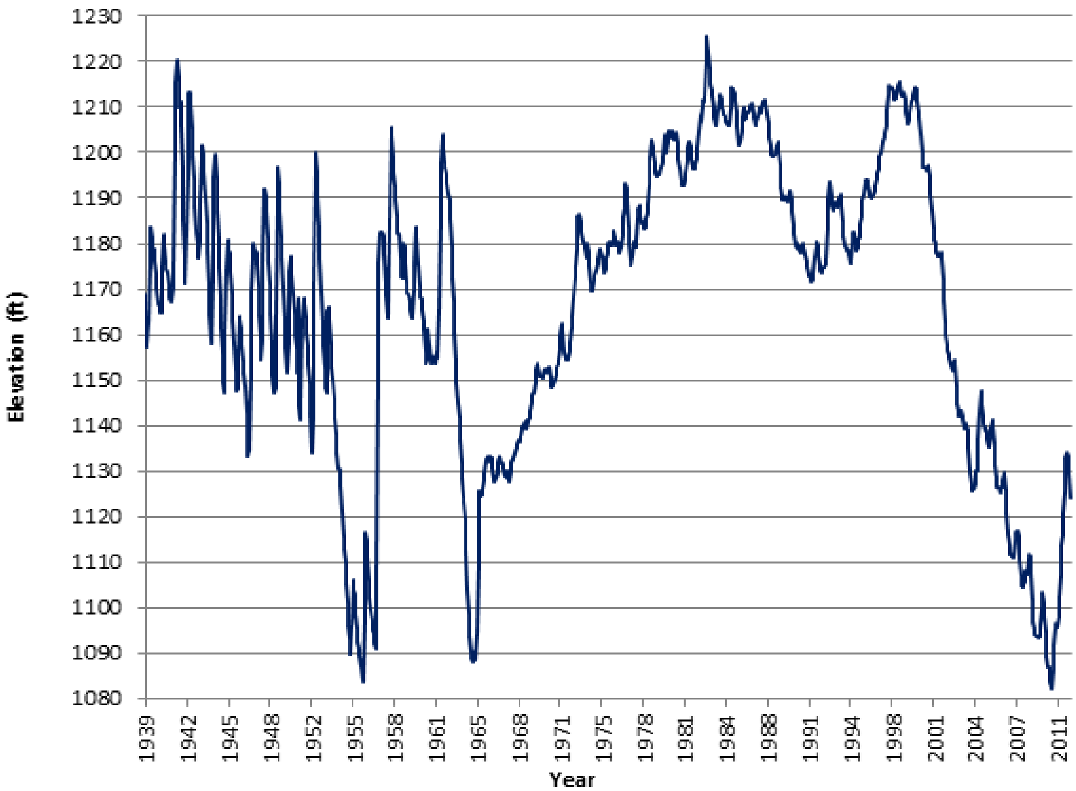

Figure 5-8. Lake Mead Reservoir Elevation, 1939-2011

Source: <http://www.usbr.gov/lc/region/g4000/hourly/mead-elv.html>

5.4.3 Future of Colorado River Supplies

Studies by scientists at the Scripps Institution of Oceanography at the University of California at San Diego indicate that climate change scenarios predict a decrease in annual runoff from the watershed to the Colorado River of about 400,000 acre feet of water 40 percent of the time by 2025. That's equivalent to the amount of water needed to supply 400,000 to 800,000 households or around 80,000 acres of irrigated agriculture in the desert southwest.

Read more: <http://trib.com/news/state-and-regional/article_55cf4396-d8af-5b09-aca7-4abb17cb32b4.html>

Under this scenario, the Colorado River would be able to provide all of its allocated water only 10 to 40 percent of the time. The USBR, using a different set of calculations, reached a similar prediction; that by 2050, the Colorado River could run short 58 to 73 percent of the time (meet allocated flows 27 percent to 42 percent of the time). These findings are significant because decreased supplies on the Colorado River would affect the water and energy supply for both of millions of people and hundreds of thousands of acres of irrigated farmland that supply up to 25 percent of the nation’s winter vegetables as well as a myriad of other crops.

Several studies since 1979 have looked at potential impacts that changes in average temperature and precipitation might have on the flow of the Colorado River. Table 5-9 provides a brief summary of some relevant studies that include hydrological models and statistical analyses. However, it is to be borne in mind that, while over time, results of global climate models have improved, they are not necessarily more accurate than scenario results based on temperature and precipitation inputs into statistical hydrologic regression analyses. Similarly, hydrologic models can capture many of the processes that affect basin runoff, but their complexity harbors uncertainty and error.

The general conclusion from the model results shown in Table 5-9 is that the average annual runoff (flow) of the Colorado River could decrease by 1 MAF to 3 MAF (6 percent to 20 percent) in the next few decades as a result of changes in regional temperature and precipitation. In terms of water rights, this should not impact IID's Priority 3(a) right to a quantified amount of 3.1 MAFY of Colorado River water as reported at Imperial Dam.

Table 5-9. Studies of Climate Change Impacts on Colorado River Streamflow

Study	Climate Variable Source	Runoff Generation Technique	Results				
			Temperature Change (°C)	**Precipitation Change (%)**	**Runoff Change (%)**	**Annual Runoff (MAF)**	**Notes**
Stockton and Boggess, 1979	Scenario: 4 scenarios on +/-2C temp change and +/- 10% change in precipitation	Empirical, Langbein (1949) historical runoff-temperature-precipitation relationships	+2.0	-10	-33	10	
			+2.0	+10	-33	10	
			+2.0	+10	+50	23	
			+2.0	-10	0	15	
Revelle and Waggoner, 1983	Scenario: Any combination of temperature and precipitation changes can be accommodated in the regression equation	Statistical Regression on Upper Basin historical temp and precipitation based on period 1931-1976	+2.0	-10	-40	9	Regression explains 73% of variance gage flow record
			+2.0	0	-29	11	
			0.0	-10	-11	13	
Nash and Gleick, 1991, 1993	10 Scenarios / GCM Simulations from 3 models	National Weather Service River Forecasting System (NWS-RFS) Hydrology Model	+2.0	-10	-20	12	(52 results, range 33% to +19%)
			+2.0	0	+4 to +12	14	
Christensen et al., 2004	GCM simulations from PCM for 3 time periods, "Business as Usual" future emissions and a control run (no additional emissions)	Variable Infiltration Capacity (VIC) Hydrology Model	+0.5	-1	-10	14	(Control)
			+1.0	-3	-14	13	(2010-2039)
			+1.7	-6	-18	12	(2040-2069)
			+2.4	-3	-17	12	(2070-2098)
Hoerling and Eischeid, 2008	GCM results from IPCC Fourth Assessment Report, "Business as Usual" emissions	Statistical regression on Palmer Drought Severity Index (PDSI) using data from 1895-1989	+1.4	0	-33	10	(2006-2030)
			+2.8	0	-45	8	(2035-2060)
Christensen and Lettenmaier, 2008	GCM results from IPCC Fourth Assessment Report, emission scenarios A2 (high) and B1 (low), for 3 time periods	Variable Infiltration Capacity (VIC) Hydrology Model	+1.2	-1	0	15	(A2, 2040-2069)
			+2.6	-2	-6	14	(A2, 2040-2069)
			+4.4	-2	-11	13	(A2, 2070-2099)
			+1.3	+1	0	15	(B1, 2010-2039)
			+2.1	-1	-7	14	(B1, 2040-2069)
			+2.7	-1	-8	14	(B1, 2070-2099)

Source: Udall, 2007

5.5 IMPERIAL REGION WATER DEMAND

Climate change predictions for the Imperial Region were derived by analyzing global climate model (GCM) simulations of past and future climate. Six future climatologies of precipitation, temperature, wind and evapotranspiration in Imperial Region were analyzed to assess the magnitude of predicted climate change. These climatologies are described in more detail in Appendix O. The six climatologies are comprised of three different future greenhouse gas emission scenarios that were simulated using two different GCMs. The results indicate that for the Imperial Region there is more variation in magnitude of future changes between the two GCMs than there is among future emission scenarios. Thus, future climate studies should focus on using more GCMs to capture a full range of variability.

All climate model runs predict increases in temperature, with greater increases in minimum temperatures (2 percent to 14 percent) than in maximum temperatures (1 percent to 5 percent). The largest predicted increases in minimum temperatures occur in the winter and fall. Seasonal patterns of increase in maximum temperature are less consistent across model runs. The narrowing of the range of daily temperatures impacts both wind speed and evapotranspiration. Predicted changes in wind range from decreases of 3 percent to increases of 2 percent. While most model runs predicted small increases in evapotranspiration of less than 4 percent, a few predict evapotranspiration decreases, likely due to decreases in wind speed. However, all model runs consistently predict higher evapotranspiration rates in the summer.

The predicted warming will impact crop development and water use, since plants have different water requirements at each growth stage. Growing degree day (GDD) is used as the primary measure for assessing plant development under the influence of heat. GDD is computed by summing mean daily temperatures in excess of 46°F, up to a daily temperature maximum of 90°F. GDD is accumulated from the beginning of the season and is used to predict key growth benchmarks such as flowering and maturity. The analysis shows an increase in the GDD for all seasons with large increases of up to 19 percent in winter and spring by 2050. The results indicate that crop water use is likely to increase if cropping patterns remain unchanged.

Predictions of change in precipitation are less consistent across the six model runs with the largest inconsistencies occurring for fall and summer. Predicted changes in summer rainfall vary between -12 percent and +24 percent while fall rainfall changes of -21 percent to +28 percent are predicted. However, a majority of model runs predict winter precipitation to increase between 3 percent and 19 percent while spring precipitation is predicted to decrease from 15 percent to 30 percent.

While the predicted changes would make for improved winter growing conditions with warmer temperatures, the shift from spring to winter precipitation increases the chances of precipitation during the winter harvest season could damage crops just prior to harvest. Excessive summer heat could lead to seed germination problems, sunburn and lower yields. Increased temperatures throughout the year could lead to alterations in crop growth and water use patterns. Hotter summers could also increase water demand and power consumption for domestic and industrial cooling with associated increases in power generation emissions.

Farmers are sure to respond to weather changes that impact quality and economic value of crop yields; their response may include changing cropping calendars, type and amount of crop planted, etc. These changes would in turn impact water consumption patterns. However, with its 24/7 delivery schedule, these types of changes in demand patterns can be accommodated by IID.

5.6 Greenhouse Gas Emissions Related to Water Services

In the process of transporting, treating or pumping of water, power is expended. Emissions associated with water related activities are attributed to this electricity use. Appendix O presents the GHG analysis for the Imperial Region. The analysis is intended to provide metrics to compute emissions from each type of energy intensive water related activity that presently occurs or is expected to occur due to implementation of IRWMP project alternatives.[29] Energy intensities of water related operations can be multiplied by emissions generated per unit of energy used to obtain the carbon dioxide equivalent (CO_2e) emissions for processing the water.

As of April 2012, water-energy intensity (the amount of energy required to process a million gallons of water) in the Imperial Region is estimated at 3067 kWh/MG for wastewater treatment, 800 kWh/MG for potable water treatment, 314 kWh/MG for non-irrigation agricultural operations, and 1228 kWh/MG for recycling water. Colorado River water is transported by gravity from Imperial Dam to the Region, and IID generates hydropower along the All American Canal. Therefore, a minus 304 kWh/MG water-energy intensity is associated with water deliveries to the Imperial Region. There are no desalination plants or groundwater banks operating in the Imperial Region. However, typical water-energy intensities from other regions indicate that 2840 kWh/MG is required for water desalination while groundwater pumping requires 2410 kWh/MG. For 2008, IID reported an emissions factor of 1270.9 lbs of CO_2e/MWh of electrical energy generated (excluding exports) or purchased and used within the service area. Net emissions from all water-related activities are negative (-4,926 metric tons of CO_2e emissions) since avoided emissions benefits for hydropower energy generation exceed total emissions from power use in the water sector in the region.

Four project alternatives for creating 100 KAF annually of new water to supplement IID's Colorado River water supply were evaluated in terms of their impacts on greenhouse gases emissions: groundwater banking, recycling wastewater, retiring agricultural land and desalination. The water-energy intensities and electricity emission factors presented above are used in the computations. The results of the project alternatives analysis are presented below:

1. Groundwater banking of underruns yielding of 100 KAF annually runs would cause an increase of about 45,280 metric tons of CO2e in water-related emissions.

[29] Does not include Definite Plan or System Conservation Plan project activity, which is outside the scope of the IRWMP.

2. Recycling projects yielding 100 KAF annually of wastewater would increase emissions by 23,070 metric tons of CO2e.
3. Retirement of agricultural land to obtain 100 KAF annually of water would result in an overall emissions reduction of about 5,907 metric tons of CO2e, excluding reductions in indirect fuel emissions from farm equipment operations and live-cycle emissions from products such as insecticides and fertilizers.
4. Desalination projects yielding 100 KAF annually would lead to an increase of about 53,356 metric tons of CO2e.

Geothermal energy generation cannot be considered as a separate alternative for reducing water use. Geothermal energy is considered a likely future water user as there are plans to develop the resource. Emissions from use of water in geothermal energy generation are between 0.68 lbs CO_2e /AF and 0.85 lbs CO_2e /AF. Use of 100 KAFY of water for geothermal energy generation would lead to an emissions increase of between 30 metric tons of CO_2e and 38 metric tons of CO_2e.

An analysis of transportation-related and energy generation emissions in the Imperial Region was performed to provide context to the scale of the water-related emissions. The analysis shows that for 2010, energy generation emissions from the net electrical energy delivered and used within IID amounted to 2.022 million metric tons of CO_2e while emissions from fossil-fuel use in transportation amounted to 1.376 million metric tons CO_2e. Even desalination, which is the highest emitting 100 KAFY water project alternative, would contribute less than 4 percent of either the energy generation or transportation-related emissions. The water project alternatives in the Imperial Region will therefore have minimal climate mitigation impacts.

5.7 HISTORIC AND FUTURE WATER DEMANDS METHODOLOGY

Colorado River water use in the Imperial Valley is under terms and conditions of the QSA/Transfer Agreements described above in Section 5.7 and below in Section 5.10. Under the QSA/Transfer Agreements efficiency conservation measures are to be implanted and operated to transfer water historically used in the Imperial Region out of the region to urban areas in Southern California. Agricultural water consumptive use is to remain the same unless there is permanent irrigated land retirement as a result of planned land use changes consistent with the Imperial County General Plan, when agricultural lands are annexed to an incorporated city consistent with prevailing city general plans, or when a solar voltaic development is granted a Conditional Use Permit by Imperial County. As has been the case historically, annual agricultural demands are expected to vary year-to-year based on commodity markets, rainfall, temporary or long-term fallowing and other factors.

Changes in agricultural use due to the QSA/Transfer Agreements, although described herein, are out of scope for the Imperial IRWMP, because they are the result of years of negotiation, and have been agreed to and signed by California and non-California water agencies, the state of California and the federal government. Potential changes in use by agriculture due to urban and/or solar voltaic development are considered below and in Chapter 11 and 12.

Non-agricultural water demands include Municipal, Commercial, and Industrial (MCI) and environmental water demands. Non-agricultural water demands are anticipated to increase over the IRWMP planning horizon (2010 to 2050) from those in the baseline year of 2004. Historic non-agricultural demands are documented in this section to identify baseline conditions from which to calculate municipal water conservation requirements using methods in the 20x2020 Water Conservation Plan (CDWR, 2010). CDWR guidelines define the methodology for forecasting MCI demand and for calculating the 20 percent conservation goal to be achieved by the year 2020. Future MCI demands were forecasted consistent with CDWR methods. Multiple future MCI demand scenarios were developed based on population growth associated with adopted land use plans and for future demands with conservation and without conservation. These are presented in Appendix D Historical and Future Municipal, Commercial, and Industrial Water Demands.

This section summarizes the historical and future non-agricultural water use, which are presented in detail in Appendix D. This section summarizes the data, methods and assumptions used for forecasting demands both with and without water conservation for areas within and outside of the Imperial Valley, which comprises the IID water service area.

5.7.1 Data, Methods, and Assumptions

California legislation that shapes CDWR requirements for establishing baseline conditions, forecasting future water demands, and calculating MCI conservation saving goals include:

- CDWR methods for 20x2020 Water Conservation Plan, Water Conservation Act of 2009[30]
- CDWR Urban Water Management Plan (UWMP) Guidelines[31]

The updated methodologies were provided by CDWR in the 2010 Urban Water Management Plan Guidebook (Final) and in the Methodologies for Calculating Baseline Compliance Urban Per Capita Water Use Requirements Report (Water Conservation Act of 2009) (CDWR, 2011) to be adhered to when preparing urban water management plans. CDWR methods were used to forecast future demands, meet state requirements and ensure consistency between the Imperial IRWMP and UWMPs prepared by the cities in the Imperial Region. Appendix D technical analysis included:

1. Evaluating historic population, land use data, and water supply data
2. Establishing unit water requirements and assumptions
3. Acre-feet per capita per year (AFCY) or gallons per capita per day (GPCD) for population-based forecast
4. Acre-feet per acre (AF/AC) or gallons per acre (Gal/AC) of water use for land use-based forecast
5. Forecasting water use based on population forecasts

[30] Steinberg. “Senate Bill SBx7-7 Water Conservation Act of 2009.” <http://www.water.ca.gov/wateruseefficiency/sb7/>
[31] CDWR. “Guidebook to Assist Urban Water Suppliers to Prepare a 2010 Urban Water Management Plan.” Mar 2011. <http://www.water.ca.gov/urbanwatermanagement/docs/2010FinalUWMPGuidebook_linked.pdf>

6. Forecasting water use based on land use plans
7. Evaluating water conservation goals and assumptions
8. Evaluating potential unit water requirements for renewable energy (geothermal and solar thermal) and developing assumptions for this use category
9. Comparing approaches and defining future MCI demand assumptions for the Imperial IRWMP

5.7.2 Water Use Sectors

This demand analysis presents historic and forecasted water demands for non-agricultural water use. The IID 2009 Regulations for Equitable Distribution Plan (EDP) defines non-agricultural water as, "Water used for municipal needs (domestic, commercial, and urban industrial), industrial needs (geothermal, solar, and thermal), feed lots, dairies (and fish farms), or Environmental Resources Water" (p3). The MCI water demand for each city is included in a single IID wholesale account number. Future water demands for the renewable energy industry were calculated and evaluated separately since they represent the largest potential future increase.

5.7.3 Historic Population and Demographic Data

Population data from the Imperial Valley Association of Governments (IVAG) and California Department of Finance (CDOF) were used to forecast demand in five-year increments (CDWR, 2011). Table 5-10 and Figure 5-9 show the 2000 through 2009 population for the cities in the Imperial Valley.

Table 5-10. Forecasted Imperial Valley Cities Population , 2000-2009

Community	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Brawley	21,980	21,760	21,531	21,609	21,852	21,934	22,037	22,314	22,593	23,342
Calexico	27,340	28,274	30,423	32,093	33,630	35,113	36,230	37,095	37,978	38,827
Calipatria	7,314	7,514	7,538	7,552	7,606	7,636	7,601	7,595	7,566	7,685
El Centro	38,126	37,773	37,661	37,664	37,876	38,966	39,797	39,476	40,081	41,241
Holtville	5,597	5,545	5,490	5,462	5,411	5,356	5,283	5,359	5,396	5,487
Imperial	7,714	7,855	8,033	8,784	9,423	9,470	11,406	12,580	13,444	13,878
Westmorland	2,114	2,093	2,071	2,060	2,043	2,203	2,170	2,168	2,185	2,221
Total	**110,185**	**110,814**	**112,747**	**115,224**	**117,841**	**120,678**	**124,524**	**126,587**	**129,243**	**132,684**

Source: US Census, Population Estimates, Incorporated Places and Minor Civil Divisions, All Place: 2000 to 2009, California.

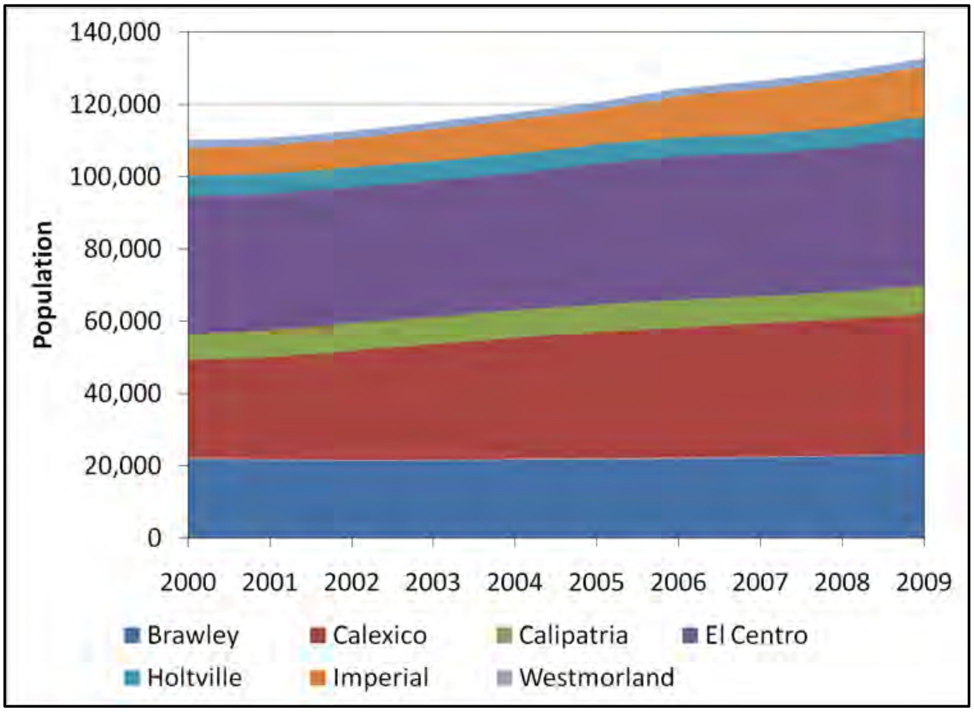

Figure 5-9. Imperial Valley Cities Population, 2000-2009

Table 5-11 provides 2000 census population, housing units, average household size, land area, and population and household density data for Imperial Valley cities. Unincorporated communities make up about 12 percent of the population within the Imperial Region. Population estimates for unincorporated communities in the Imperial Region for 2006 were used.

Table 5-11. Demographic Data for Imperial Valley Cities , 2000

Community	Population[1]	Housing Units	Average Household Size	Land Area[2] (Acres)	Population per Acre	Housing Unit per Acre
Brawley	21,980	7,038	3.1	2,686	8.2	2.6
Calexico	27,340	6,983	3.9	3,188	8.6	2.2
Calipatria	7,314	961	7.6	467	15.7	2.1
El Centro	38,126	12,263	3.1	5,050	7.5	2.4
Holtville	5,597	1,617	3.5	525	10.7	3.1
Imperial	7,714	2,385	3.2	964	8.0	2.5
Westmorland	2,114	677	3.1	189	11.2	3.6
Total	**110,185**	**31,924**		**13,069**		
Weighted Average			**3.6**			**8.4**

[1]Population Estimates, Incorporated Places and Minor Civil Divisions, All Place: 2000 to 2009, California.
[2]County of Imperial – Imperial County General Plan, 2006
Source: US 2000 Census

5.7.4 Future Population

Based on IVAG historical data, average annual growth rate for incorporated municipal areas within the Imperial Valley for 2010 to 2035 is forecasted as 2.4 percent. Using this rate and historical population data presented in Table 5-10, the population forecast was extended to 2050. Based on SCAG household forecasts for Imperial County, average annual growth rate of unincorporated areas within the Imperial Region for 2010 to 2035 was estimated to be 3.8 percent.[32] This growth rate was used to extend the unincorporated 2006 populations to the year 2050. Table 5-12 and Figure 5-10 present 2010 and forecasted population data for the Imperial Region.

Table 5-12. Imperial Region Population, 2010-2050

	2010	2015	2020	2025	2030	2035	2040	2045	2050
Within IID Water Service Area									
Brawley	30,705	36,206	41,707	45,852	49,996	52,266	58,274	64,972	72,441
Calexico	41,653	47,764	53,874	58,751	63,628	65,905	73,481	81,927	91,344
Calipatria[1]	4,381	4,992	5,602	5,997	6,392	6,515	7,264	8,099	9,030
El Centro	45,003	51,406	57,808	62,257	66,705	68,836	76,749	85,571	95,407
Holtville	5,939	6,305	6,671	6,937	7,202	7,309	8,149	9,086	10,130
Imperial	12,321	14,956	17,591	18,783	19,974	20,543	22,904	25,537	28,473
Westmorland	2,846	3,245	3,644	3,934	4,223	4,367	4,869	5,429	6,053
Heber	3,601	4,339	5,228	6,300	7,591	9,147	11,023	13,282	16,005
Seeley	1,957	2,358	2,841	3,424	4,126	4,972	5,991	7,219	8,699
Niland	1,377	1,660	2,000	2,410	2,904	3,499	4,217	5,081	6,122
Calipatria – CDCR[2]	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180	4,180
Centinela – CDCR[2]	5,110	5,110	5,110	5,110	5,110	5,110	5,110	5,110	5,110
NAF El Centro[3]	1,692	1,787	1,888	1,994	2,106	2,224	2,349	2,481	2,621
Specific Plan Area[4]	876	1,753	2,629	3,505	4,382	5,258	6,134	7,011	7,887
Total	**161,641**	**186,061**	**210,773**	**229,434**	**248,519**	**260,131**	**290,694**	**324,985**	**363,502**
Outside of IID Water Service Area									
West Mesa									
Ocotillo/Nomirage[4]	268	312	359	409	463	520	582	648	720
Specific Plan Area[5]	24	47	71	95	118	142	166	189	213
East Mesa	-	-	-	-	-	-	-	-	-
Region Total	**162,272**	**186,759**	**211,542**	**230,277**	**249,439**	**261,132**	**291,781**	**326,161**	**364,774**

[1]Reported IVAG population minus Calipatria CA Department of Corrections and Rehabilitation (CDCR) population.
[2]CDCR, no growth is expected for the Department of Corrections and Rehabilitation institutions.
[3]Average seasonal values, interpolated at 11% increase over 10 years (provided by William Kagele, Water Program Manager, NAF El Centro).
[4] Population estimates extrapolated from Ocotillo/Coyote Wells Hydrology and Groundwater Modeling Study.
[5] Unless specifically given, population estimates based on Specific Plan land use changes and demographic values assumes linear growth from 2005 to 2050.
Source: IID. "2009 SDI Apportionment" – EDP Class data Muni IVAG_CA D of CHG v31.xls

[32] SCAG County Population Forecasts. <http://eltoroairport.org/issues/population.html>

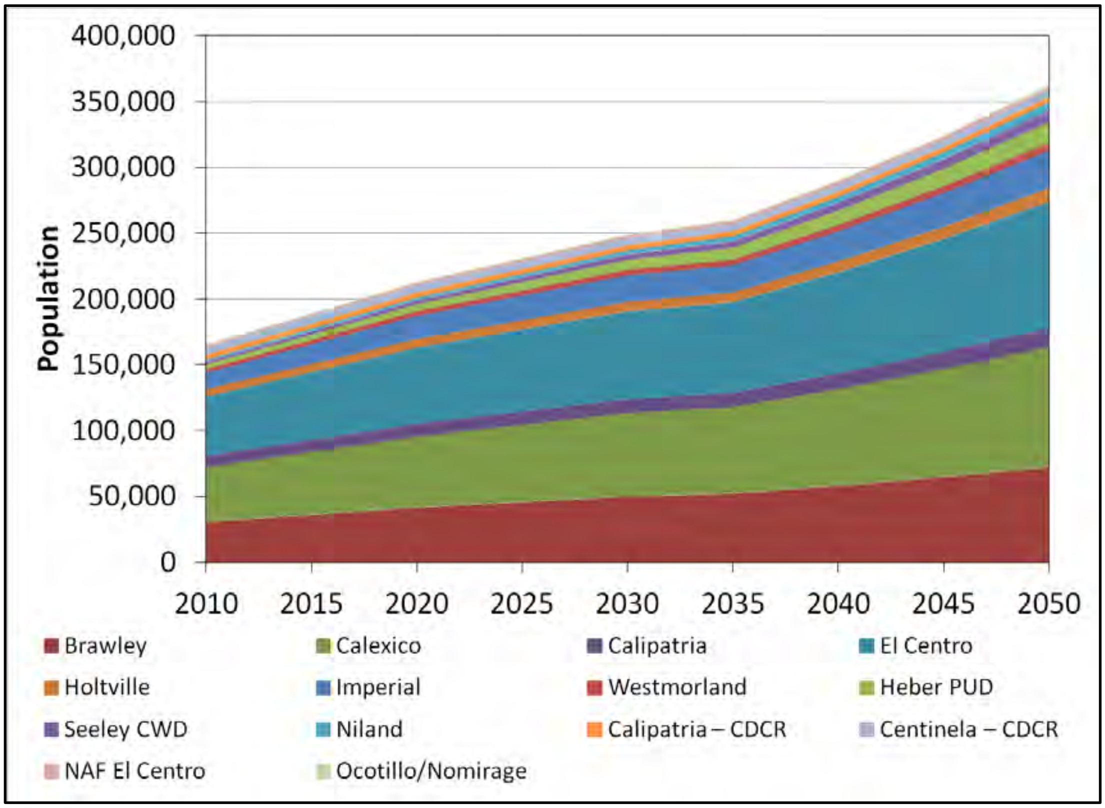

Figure 5-10.Imperial Region Population, 2010-2050

5.7.5 Per Capita Water Demand

Table 5-13 lists the daily per capita municipal demand in gallons per day (GPD) and acre-feet per year (AFY) for the urban areas within the Imperial Valley. Values in Table 5-13 were calculated using total water demand values in the 2005 UWMP for Brawley, Calexico, and Imperial; the 2010 UWMP for El Centro; and 2005 IVAG population estimates. The IID Definite Plan recommends that future municipal water use should be estimated as the water demand in 2006 plus 0.26 AFCY (250 GPCD) for the population difference between 2006 and a future year.

Table 5-13. Per Capita Municipal Demand for Imperial Valley Cities

Imperial Valley Cities	AFY	GPD
Brawley	0.34	301
Calexico	0.17	154
El Centro	0.22	194
Holtville	0.22	196
Imperial	0.25	220
Westmorland	0.26	236
Heber	0.19	171
Calipatria/Niland	0.28	251
Seeley	0.15	133
Population Weighted Average	0.23	205

5.7.6 Future Land Use

GIS land use maps were produced based on city and county General Plans and land use diagrams (GEI, 2011).[33] Full build-out of the area is assumed to be the year 2050. Table 5-14 and Figure 5-11 shows expected municipal land use within the Imperial Region through 2050. Build-out of the spheres-of-influence would result in a nearly 450 percent increase in municipal land use by the year 2050. Outside of the Imperial Valley there is one Specific Plan that has received a Conditional Use Permit: Coyote Wells/Wind Zero Specific Plan, which includes 943 acres.

Table 5-14. Imperial Region Developed Land Use Area, 2005-2050

	Developed Municipal Area (Acres)									
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Brawley	2,686	4,193	5,699	7,207	8,714	10,218	11,725	13,231	14,738	16,244
El Centro	5,050	6,576	8,105	9,631	11,158	12,685	14,213	15,739	17,267	18,794
Calexico	3,188	3,893	4,599	5,303	6,008	6,714	7,419	8,124	8,829	9,534
Imperial	964	2,084	3,206	4,326	5,445	6,565	7,685	8,805	9,925	11,045
Calipatria	467	1,651	2,837	4,021	5,206	6,389	7,574	8,758	9,943	11,127
Holtville	525	1,160	1,794	2,428	3,063	3,698	4,333	4,967	5,602	6,236
Westmorland	189	416	646	873	1,101	1,329	1,557	1,785	2,013	2,241
Heber	91	201	312	421	531	641	751	861	971	1,081
Seeley	92	202	313	424	534	645	756	866	977	1,088
NAF El Centro	2,734	2,734	2,734	2,734	2,734	2,734	2,734	2,734	2,734	2,734
Specific Plan Area	0	862	1,724	2,586	3,448	4,311	5,173	6,035	6,897	7,759
Total	**15,986**	**23,972**	**31,969**	**39,954**	**47,942**	**55,929**	**63,920**	**71,905**	**79,896**	**87,883**

Source: Extracted from AutoCAD files provided by Imperial County Planning Department, LAFCO and City of Calexico; Heber and Seeley area estimated.

[33] Appendix D, Historical and Future Municipal, Commercial, and Industrial Water Demands

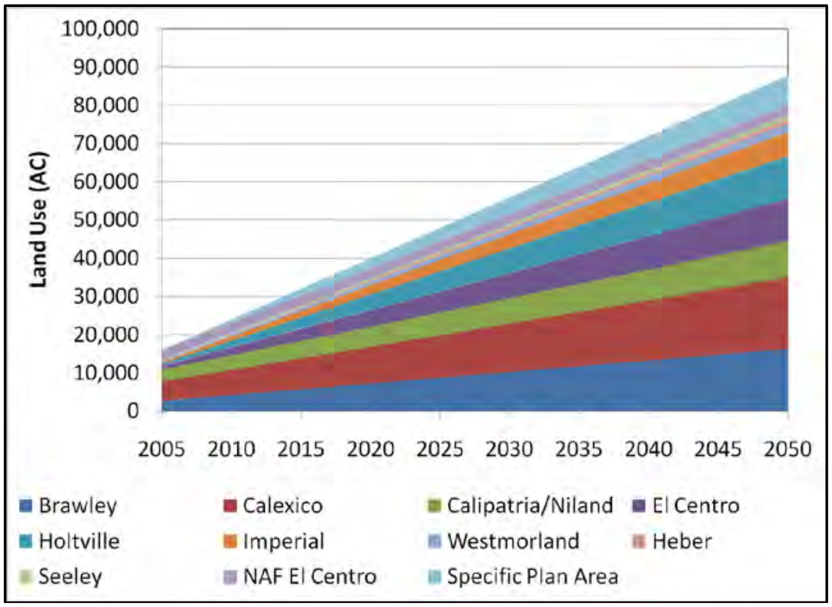

Figure 5-11. Imperial Region Urban Land Use 2005-2050

Use of water for cooling purposes at renewable plants is potentially the largest future MCI demand. Planned land use changes for renewable energy projects (geothermal/ solar thermal) would occur on land designated as open space (agricultural land and/or natural habitat) based on the land use policies of Imperial County and of the USBLM, which oversees the majority of land in federal ownership in the Imperial Region. Where and when such growth may occur is subject to market forces and proposals from private renewable energy project development interests.

5.8 HISTORIC[34] NON-AGRICULTURAL DEMANDS

5.8.1 Municipal (Domestic Commercial and Urban Industrial)

Municipal water demand historically accounts for approximately 3 percent of IID's delivered Colorado River water, by 2029 that had risen to 4.5% and it is expected that municipal water demand will continue to increase as the population grows. Figure 5-12 and Table 5-15 provide a summary of IID municipal water deliveries in million gallons per day (MGD) from 2000 to 2009 (based on water sales). Other small municipal deliveries do not significantly impact the volume of delivery.

[34] The IRWMP Planning Grant Agreement's Scope of Work requires "Quantification of current demands and forecast of future demands…" However, for purposes of the Imperial IRWMP, *current* will be referred to as *existing* or *historic*.

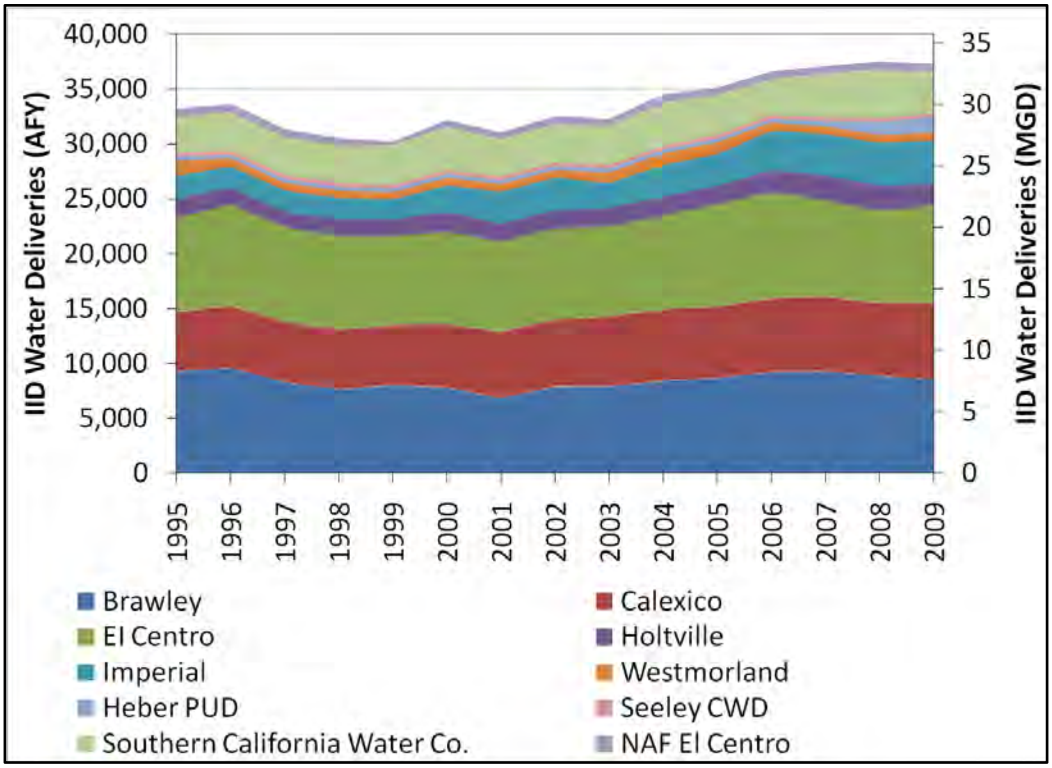

Figure 5-12. IID Municipal Water Deliveries, 2000-2009

5.8.2 Historic Industrial (Renewable Energy) Demand

Table 5-16 provides a summary of the water use for renewable energy plants for both construction and operations in and around the Imperial Region. This information is from the California Energy Commission website and information submitted during the review and approval process for plants located in the Imperial Region or other similar desert environments. From Table 5-16, the total water use in the Imperial Region for geothermal and solar thermal energy is approximately 32 KAF annually. It is assumed for planning purposes that the water demand for other renewable energy sources is relatively small when compared to geothermal and solar thermal energy. As such, water demand for these other renewable energy sources was assumed to be included in the geothermal and solar thermal build-out demand.

Table 5-15. Historical Imperial Valley MCI Water Deliveries, 2000-2009

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Acre-Feet Per Year										
Brawley	7,804	6,830	7,885	7,898	8,442	8,662	9,225	9,280	8,887	8,544
Calexico	5,766	6,048	6,097	6,382	6,506	6,522	6,709	6,833	6,623	6,954
El Centro	8,436	8,202	8,340	8,174	8,549	9,306	9,678	8,756	8,381	8,868
Holtville	1,795	1,666	1,625	1,718	1,700	1,693	1,983	2,260	2,304	1,971
Imperial	2,406	2,886	2,988	2,268	2,885	2,883	3,643	3,786	3,905	3,995
Westmorland	719	721	707	959	1,073	1,099	713	714	730	724
Heber PUD	362	358	341	385	355	352	344	503	1,193	1,415
Seeley County WD	345	348	338	345	346	342	346	346	351	350
So. CA Water Co.[1]	3,974	3,420	3,539	3,522	3,982	3,591	3,301	3,927	4,441	3,744
NAF El Centro	592	610	686	655	694	682	685	690	713	761
Total	**32,199**	**31,089**	**32,546**	**32,306**	**34,533**	**35,132**	**36,627**	**37,095**	**37,527**	**37,325**
Million Gallons Per Day										
Brawley	6.97	6.10	7.04	7.05	7.54	7.73	8.24	8.28	7.93	7.63
Calexico	5.15	5.40	5.44	5.70	5.81	5.82	5.99	6.10	5.91	6.21
El Centro	7.53	7.32	7.45	7.30	7.63	8.31	8.64	7.82	7.48	7.92
Holtville	1.60	1.49	1.45	1.53	1.52	1.51	1.77	2.02	2.06	1.76
Imperial	2.15	2.58	2.67	2.02	2.58	2.57	3.25	3.38	3.49	3.57
Westmorland	0.64	0.64	0.63	0.86	0.96	0.98	0.64	0.64	0.65	0.65
Heber PUD	0.32	0.32	0.30	0.34	0.32	0.31	0.31	0.45	1.07	1.26
Seeley County WD	0.31	0.31	0.30	0.31	0.31	0.31	0.31	0.31	0.31	0.31
So. CA Water Co.[1]	3.55	3.05	3.16	3.14	3.56	3.21	2.95	3.51	3.96	3.34
NAF El Centro	0.53	0.54	0.61	0.58	0.62	0.61	0.61	0.62	0.64	0.68
Total	**28.75**	**27.75**	**29.06**	**28.84**	**30.83**	**31.36**	**32.70**	**33.12**	**33.50**	**33.32**

[1] Southern California Water Co. (now Golden State Water Company) provides water to Calipatria, Niland, Calipatria CDCR, and Centinela CDCR
Source: Imperial Irrigation District Water Department

Table 5-16. Historic and Estimated Water Demand by Imperial Valley Renewable Energy Plants

Power Plant Owner	Plant Name	Type	Capacity (MW Net)	IID Water Use (AFY)	AFY/MW	IID Water Use (MGD)	MGD/MW
CalEnergy	Salton Sea 1 & Salton Sea 2	Dual Flash	10 17	9.9[1,2]	0.4	0.01	0.0004
	Salton Sea 3 & Salton Sea 4	Dual Flash	50 40	399 [1, 2]	4.4	0.36	0.0039
	Salton Sea 5	Dual Flash	49	1200[2]	24.5	1.07	0.0219
	Del Ranch	Dual Flash	42	948[2]	22.6	0.85	0.0202
	Vulcan	Dual Flash	38	164[2]	4.3	0.15	0.0038
	Leathers	Dual Flash	42	1354_2	32.2	1.21	0.0287
	Elmore	Dual Flash	42	1910[2]	45.5	1.71	0.0406
	CE Turbo	Single Flash	10	0_2	0	0.00	0.0000
	Black Rock 1,2,3 (Proposed)	Single Flash	195	483 Est.	2.5	0.43	0.0022
	Black Rock 4,5,6 (Proposed)	Single Flash	195	483 Est.[2]	2.5	0.43	0.0022
Catalyst Hannon Armstrong Renewables	Hudson Ranch 1	Dual Flash	50	850 Est.	17	0.76	0.0152
	Hudson Ranch 2	Dual Flash	80	850 Est.	17	0.76	0.0152
ORMAT	Ormesa 1	Binary	38	1665	43.8	1.49	0.0391
	Ormesa 1E	Binary	8	923	115.4	0.82	0.1030
	Ormesa 1H	Binary	12	1040	86.7	0.93	0.0774
	Ormesa 2	Binary	18	1993	110.7	1.73	0.0988
	GEM 2	Dual Flash	22	-	-	-	-
	GEM 3	Dual Flash	18	-	-	-	-
Heber KGRA (Ormat)	Heber 1	Dual Flash/ Binary	52	1156	22.2	1.03	0.0198
	Heber 2	Binary	48	3663	76.3	3.27	0.0681
Brawley KGRA (Ormat)	North Brawley (Construction)	Binary	80	6600 Est.	132.3	5.89	0.1180
	East Brawley (Proposed)	Binary	80	5500 Est.	110.2	5500	4.91
Brawley KGRA (RAM)	Ram East Brawley	Dual Flash	50	800 Est.	16	0.71	0.0143

[1] Combined meter
[2] Past 10-year average use from IID delivery gate record.

5.9 Future Non-Agricultural Demands

Future water demand in the EDP is categorized into four main groups: municipal (domestic, commercial, and urban industrial) (MCI); industrial (geothermal, solar, thermal energy); feedlots, dairies, and fisheries; and environmental resources.

5.9.1 Municipal (Domestic, Commercial, and Urban Industrial) Demand

Three methods were used to calculate and compare municipal (residential, commercial, and urban industrial) water demands:[35]

Method 1: Supply/Demand Imbalance Apportionment (2009 Regulations for Equitable Distribution Plan)
Method 2: Per Capita Demand Model
Method 3: Land Use Demand Model

Application of these three methods for forecasting future municipal demands is described in Appendix D. The results of Method 2, Per Capita Demand Model, were selected for use in the IRWMP and are discussed below.

The per capita demand model (Method 2) was developed using the demand per capita per day for 2005, a distribution of the municipal demand to the different types of water use, and the population estimates. Table 5-17 and Figure 5-13 present the municipal demand using the per capita demand model. Municipal demand for the Imperial Valley is expected to increase to 83 KAF annually (over 120 percent) by the year 2050 and to 244 AF (75 percent increase) outside the IID water service area.

Using the population-weighted average water use of 0.23 AFY and 205 MGD and the land use demographics in Table 5-17 the expected Per Capita Model municipal water demand represents a total urban land use increase of about 24,000 acres by the year 2050 for the Imperial Region.

Table 5-17. Future Imperial Region Municipal Water Demand 2005-2050

	Forecasted Demand (AFY)									
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Within IID Water Service Area										
Brawley	8,415	10,440	12,310	14,180	15,590	16,999	17,770	19,813	22,091	24,630
Calexico	6,202	7,081	8,120	9,159	9,988	10,817	11,204	12,492	13,928	15,529
Calipatria	968	1,227	1,398	1,569	1,679	1,790	1,824	2,034	2,268	2,528
El Centro	9,017	9,779	11,171	12,562	13,529	14,496	14,959	16,678	18,595	20,733
Holtville	1,275	1,307	1,387	1,468	1,526	1,584	1,608	1,793	1,999	2,229
Imperial	2,462	3,080	3,739	4,398	4,696	4,994	5,136	5,726	6,384	7,118
Westmorland	626	740	844	947	1,023	1,098	1,135	1,266	1,411	1,574
Heber PUD	547	684	824	993	1,197	1,442	1,738	2,094	2,524	3,041
Seeley County WD	235	294	354	426	514	619	746	899	1,083	1,305
Niland	308	386	465	560	675	813	980	1,181	1,423	1,714
Calipatria – CDCR	961	961	961	961	961	961	961	961	961	961
Centinela – CDCR	1,175	1,175	1,175	1,175	1,175	1,175	1,175	1,175	1,175	1,175
NAF El Centro	368	389	411	434	459	484	512	540	571	603
Imperial Valley Total	**30,617**	**37,543**	**43,159**	**48,833**	**53,011**	**57,272**	**59,748**	**66,652**	**74,412**	**83,139**
Outside IID Water Service Area										
Ocotillo/Nomirage	130	140	150	161	172	184	198	212	227	244

Per Capita Demand Model

[35] Calculation details are provided in Historical and Future Demand Forecast (GEI, 2011), Appendix D Per Capita Model Water Demand Calculations, and Appendix D Municipal Water Demand Conservation Calculations.

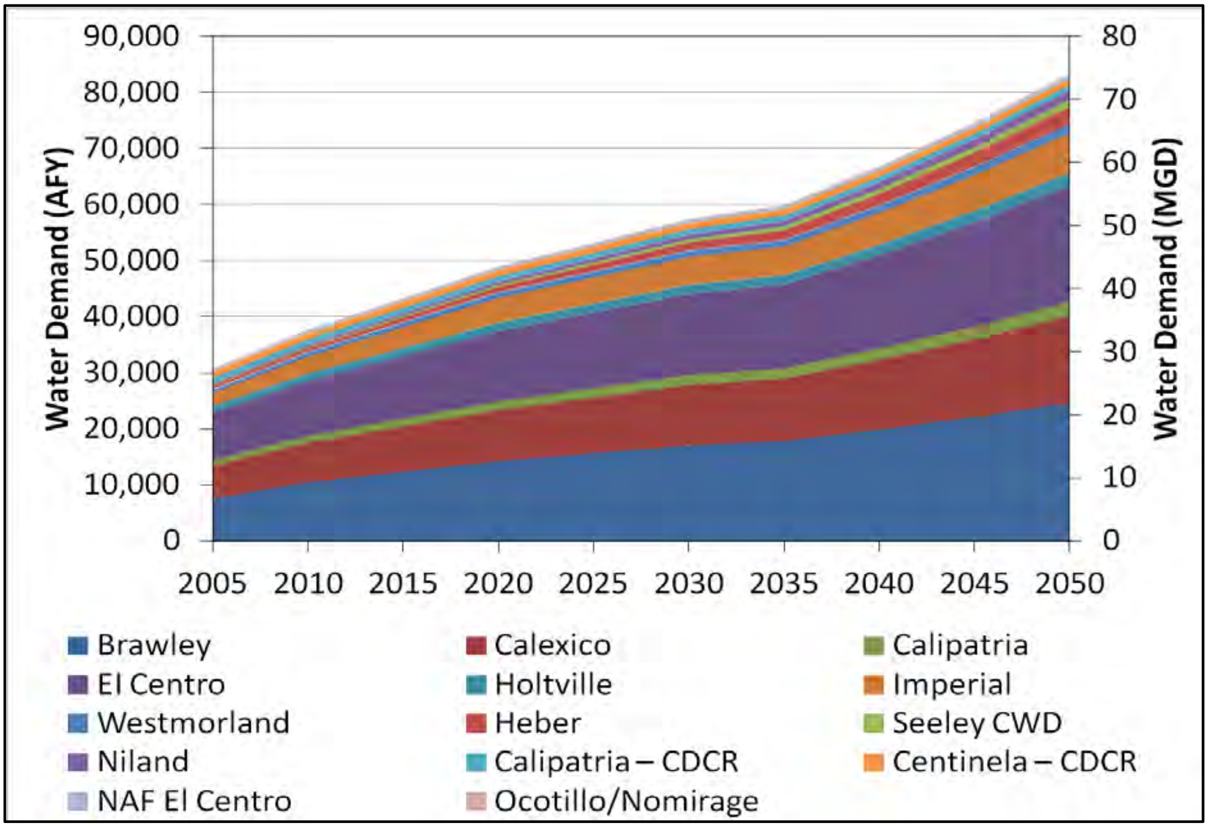

Figure 5-13. Forecasted Imperial Region Municipal Water Demand, Per Capita Demand Model

Conservation estimates were calculated using the Methodologies for Calculating Baseline and Compliance Urban Per Capita Water Use (CDWR, 2011). Table 5-18 shows baseline and a regional average target municipal water demand with 20 percent per capita water demand conservation by the year 2020, using the methods prescribed by CDWR. Table 5-19 and Figure 5-14 show future municipal water demand using the per capita demand model, with and without conservation.

With conservation, the Imperial Region is forecasted to have municipal water demand of 10,219 AFY (9.12 MGD) less than it would have without conservation in the year 2050 based on CDWR methods.

Table 5-18. Baseline and Target Municipal Water Demand Rates

	Baseline	2015 Interim Target (10% Demand Reduction)	2020 Target (20% Demand Reduction)
AFCY	0.25	0.23	0.20
GPCD	224	201	179

Per Capita Demand Model

Table 5-19. Imperial Region Municipal Water Demand with and without Conservation, 2005-2050

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Without Conservation										
AFY	30,747	37,682	43,309	48,993	53,183	57,456	59,946	66,864	74,639	83,383
MGD	27.45	33.64	38.66	43.74	47.48	51.29	53.52	59.69	66.63	74.44
With Conservation										
AFY	30,747	37,682	42,141	42,430	46,187	50,031	52,376	58,523	65,419	73,164
MGD	27.45	33.64	37.62	37.88	41.23	44.66	46.76	52.25	58.40	65.32

Per Capita Demand Model

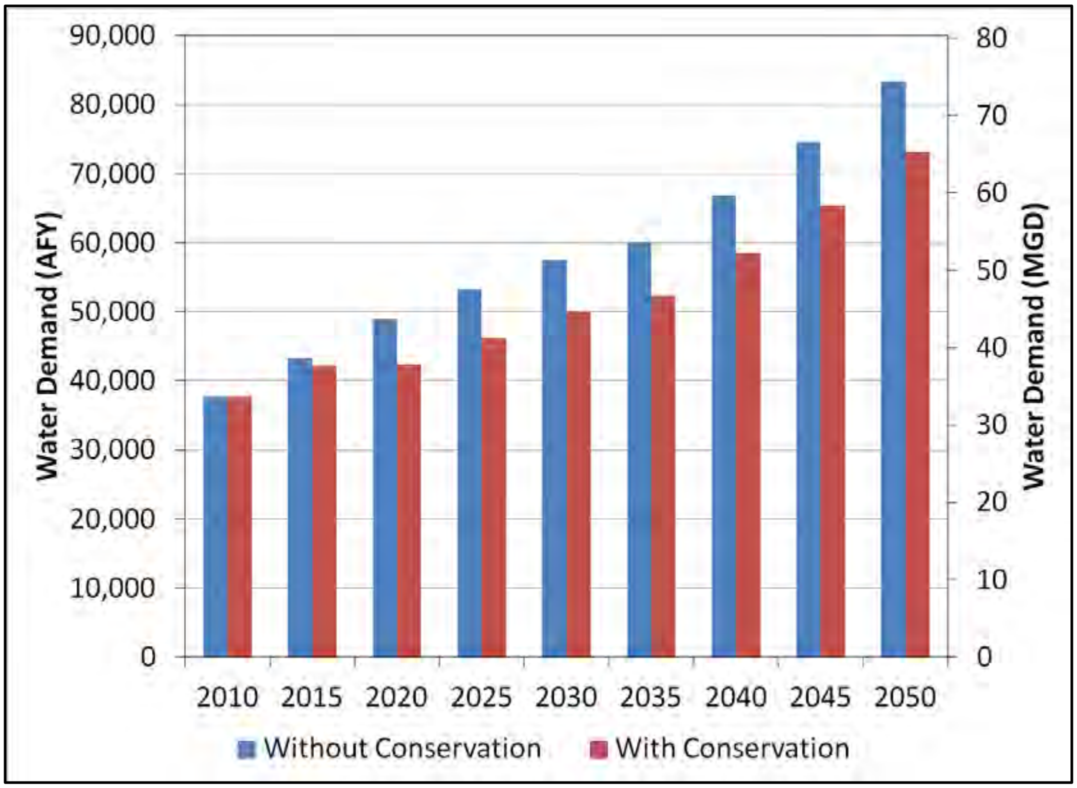

Figure 5-14. Forecasted Imperial Region Municipal Water Demand, with and without Conservation

Table 5-20. Imperial Region Industrial (Renewable Energy and Other) Water Use, 2005-2050 (AFY)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Without Conservation (AFY)										
Geothermal and Solar Thermal	31,931	48,383	64,835	81,287	97,739	114,192	130,644	147,096	163,548	180,000
Other Industrial	7,859	7,859	7,859	7,859	7,859	7,859	7,859	7,859	7,859	7,859
Total	**39,790**	**56,242**	**72,694**	**89,146**	**105,598**	**122,051**	**138,503**	**154,955**	**171,407**	**187,859**
With Conservation (AFY)										
Geothermal and Solar Thermal	31,931	48,383	58,352	65,030	78,192	91,353	104,515	117,677	130,838	144,000
Other Industrial	7,859	7,859	7,466	7,073	7,073	7,073	7,073	7,073	7,073	7,073
Total	**39,790**	**56,242**	**65,818**	**72,103**	**85,265**	**98,426**	**111,588**	**124,750**	**137,911**	**151,073**

Per Capita Demand Model

5.9.2 Industrial (Renewable Energy) Demand

Industrial water users outside municipal areas are governed by the same terms as renewable energy in the 2009 Regulations for EDP. For 1997 through 2008, average water demand for industrial uses in the Imperial Region was 7,092 AFY (6.33 MGD). Outside of Imperial Valley, the U.S. Gypsum Company, working in West Mesa estimates a baseline groundwater demand of 767 AFY (0.68 MGD, according to the Ocotillo/Coyote Wells Hydrology and Groundwater Modeling Study (GEI Consultants, Inc., 2004). For planning purposes, it was assumed that the historic water demand will remain around 8 KAF annually going into the future. According to the 20x2020 Water Conservation Plan, industrial water use reduction is to be 5 percent by the year 2015 and 10 percent reduction by the year 2020.

Solar mirror or photovoltaic industries, which are to be developed in the Imperial Region, typically do not require as much water as agricultural users since water is used only for washing the mirrors and dust control. However, solar thermoelectric plants require use of water for cooling. Solar thermoelectric water use varies with the cooling technology with demand similar to binary geothermal plants.[36]

Imperial Region water for flash geothermal and solar thermal plants ranges from 2 to 40 acre-feet per megawatt-hour (AF/MWh), averaging 15 AF/MWh. The binary geothermal plants listed in Table 5-15 all employ or propose to employ wet cooling, and demand ranges from 43 to 132 AF/MWh, averaging 96 AF/MWh. According to the Geothermal Energy Association (GEA, 2010), geothermal plants use 5 gallons per megawatt hour (74 AF/MWh) of fresh water, while binary air-cooled plants use no fresh water (Kagal, 2007). A recent article in IEEE Spectrum provided water use estimates for binary and flash systems in the Salton Sea geothermal area using surface water as Binary: 4,463 Gal/MWh (120 AFY), Flash: 361 Gal/MWh (9.7 AFY) (Adde, 2010).

Table 5-21 and Figure 5-15 show the forecasted water demand for geothermal and solar thermal and other industrial water through 2050. Geothermal and solar thermal water demand for 2005 in Table 5-

[36] Appendix D, Historical and Future Municipal, Commercial, and Industrial Water Demands, Attachment D Solar and Geothermal Energy Water Use Technical Memorandum

21 is based on values in Figure 5-15 (converted to MGD). The Imperial County General Plan estimates that at full build-out, water demand for renewable energy plants will be 180,000 AFY (161 MGD).

Table 5-21. Forecasted Imperial Region Industrial Water Demand, 2005-2050 (MGD)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Without Conservation (MGD)										
Geothermal and Solar Thermal	28.51	43.19	57.88	72.57	87.26	101.94	116.63	131.32	146.01	160.69
Industrial	7.02	7.02	7.02	7.02	7.02	7.02	7.02	7.02	7.02	7.02
Total	**35.52**	**50.21**	**64.90**	**79.58**	**94.27**	**108.96**	**123.65**	**138.33**	**153.02**	**167.71**
With Conservation (MGD)										
Geothermal and Solar Thermal	28.51	43.19	52.09	58.05	69.81	81.56	93.31	105.06	116.81	128.56
Industrial	7.02	7.02	6.67	6.31	6.31	6.31	6.31	6.31	6.31	6.31
Total	**35.52**	**50.21**	**58.76**	**64.37**	**76.12**	**87.87**	**99.62**	**111.37**	**123.12**	**134.87**

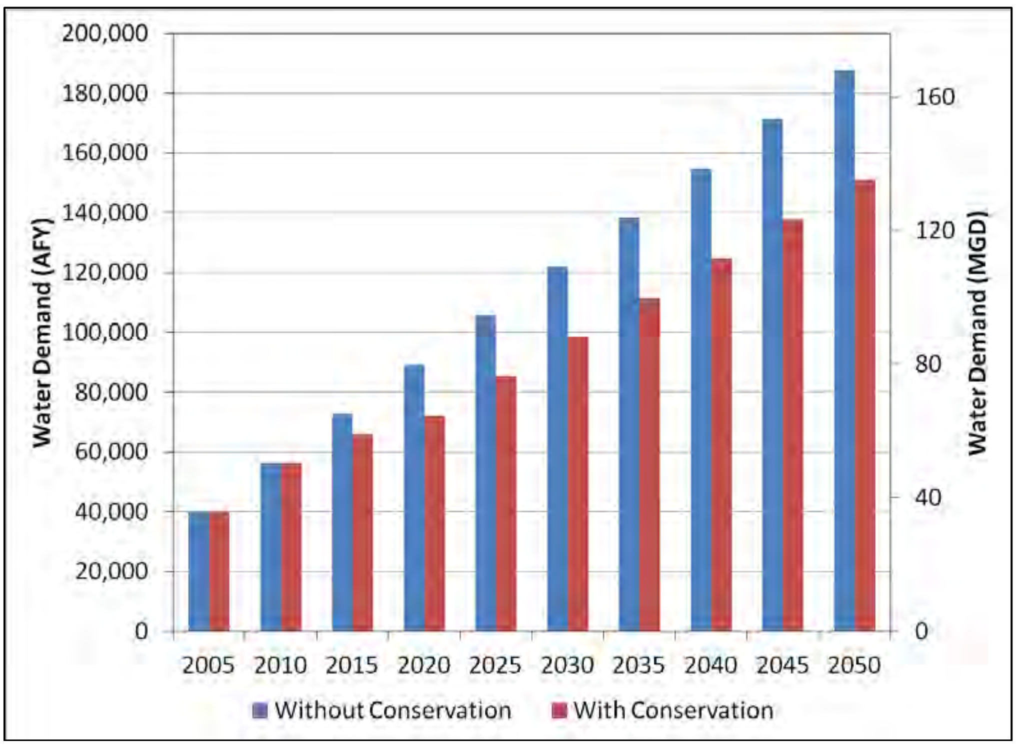

Figure 5-15. Forecasted Imperial Region Industrial Water Demand, 2005-2050

With conservation, the Imperial Region can expect an industrial water demand of 36,786 AFY (32.84 MGD) less than without conservation in the year 2050.

5.9.3 Forecasted Feedlots/Dairies and Fisheries Demand

The 1997 to 2008 adjusted annual average water use by feedlots and dairies was 20,000 AFY (17.85 MGD). Under the 2009 EDP Regulations, future use by feedlots and dairies is based on past use and other considerations. It is assumed that future feedlot, dairy, and fishery water demand will remain unchanged from the 1998 to 2008 average. The 20x2020 Water Conservation Plan only addresses potable water use. Therefore, 20 percent reduction in water use is not calculated for feedlots' and dairies' water demand.

5.9.4 Environmental Resources Demand

Environmental resources water is needed for the QSA/Transfer Agreements. A total of 960 acres of freshwater marsh habitat will be constructed. The water demand for the habitat is 6 AF/AC per year (1.96 MG/AC per year), and it must be equivalent to the Colorado River water quality. The marsh complex is designed as a flow-through system, and small volumes of water are discharged to IID's drain system. Additional mitigation efforts may include a 2,000 acre saline habitat complex (does not use freshwater); up to 100 acres of native tree habitat to mitigate for impacts to tamarisk scrub vegetation (will use approximately 500 AFY or 0.45 MGD of fresh water); and desert mitigation (which has no water demand). 2009 Regulations for EDP includes 1,500 AF (489 MG) annually for environmental resources water. Using the marsh complex development schedule, water demand for 320 acres should be 1,920 AFY (1.72 MGD) and this grows to 5,760 AFY (5.14 MGD) by October 2019. With a fully developed tamarisk mitigation area, the environmental resource water requirement should be 6,010 AFY (5.36 MGD) by 2020.

5.9.5 Cumulative Future Non-Agricultural Demand

Table 5-22illustrates with and without conservation future non-agricultural water demands for the Imperial Region in five-year increments from 2005 through 2050. Without conservation, the total future water demand for non-agricultural uses in the Imperial Region is estimated to be 302 KAF annually (1,076 MGD) in the year 2050. With conservation the total future water demand for the Imperial Region is estimated to be 255 KAF annually (957 MGD). Cumulative future water demand for non-agricultural uses within and outside the Imperial Valley from the year 2005 to the year 2050 is summarized below in Table 5-22 and Table 5-23.

Table 5-22. Future Non-Agricultural Water Demand within IID Water Service Area, 2005-2050 (AFY)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Without Conservation										
Municipal	30,617	37,543	43,159	48,833	53,011	57,272	59,748	66,652	74,412	83,139
Geothermal	31,931	48,383	64,835	81,287	97,739	114,192	130,644	147,096	163,548	180,000
Other Industrial	7,092	7,092	7,092	7,092	7,092	7,092	7,092	7,092	7,092	7,092
Feedlots/Dairies	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Envr Resources	0	3,840	7,930	12,020	12,020	12,020	12,020	12,020	12,020	12,020
Total	**89,640**	**116,858**	**143,016**	**169,232**	**189,862**	**210,576**	**229,504**	**252,860**	**277,072**	**302,251**
With Conservation										
Municipal	30,617	37,543	41,984	42,275	46,018	49,846	52,175	58,305	65,183	72,909
Geothermal	31,931	48,383	58,352	65,030	78,192	91,353	104,515	117,677	130,838	144,000
Other Industrial	7,092	7,092	6,699	6,306	6,306	6,306	6,306	6,306	6,306	6,306
Feedlots/Dairies	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Envr Resources	0	3,840	7,930	12,020	12,020	12,020	12,020	12,020	12,020	12,020
Total	**89,640**	**116,858**	**134,964**	**145,631**	**162,536**	**179,525**	**195,016**	**214,308**	**234,347**	**255,235**

Note: Future geothermal demand is based on an assumed 20% conservation savings to meet the state 20 X 2020 goal and use of best management practices.

Table 5-23. Future Non-Agricultural Water Demand outside IID Water Service Area, 2005-2050 (AFY)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Without Conservation										
Municipal[1]	130	147	164	182	201	221	241	262	285	309
Industrial	767	767	767	767	767	767	767	767	767	767
Total	**897**	**914**	**931**	**949**	**968**	**988**	**1,008**	**1,029**	**1,052**	**1,076**
With Conservation										
Municipal[1]	130	147	170	172	192	213	235	258	282	307
Industrial	767	767	729	690	690	690	690	690	690	690
Total	**897**	**914**	**899**	**862**	**882**	**904**	**926**	**949**	**972**	**997**

[1] Includes Coyote Wells/Wind Zero expected water use, which, as of May 2012, Wind Zero is no longer to be developed.

Table 5-24 and Table 5-25 show baseline demand (2005), and forecasted water demand (2050) with and without conservation, for five non-agricultural water demand categories. For the 2050 forecasted non-agricultural water use, a 47,016 AF conservation reduction is included for within the IID service area and a 78 AF conservation reduction for outside the IID water service area. The planning period is from 2010 to 2050.

Factors that could potentially affect future non-agricultural water demands include:

- Imperial Region economic conditions
- Population growth
- Land use changes
- Renewable energy development policies
- Climate change

Table 5-24. Non-Agricultural Water Demand in and outside IID Water Service Area, 2005 and 2050 (AFY)

	2005	2050			
	Baseline	**Without Conservation**	**With Conservation**	**Use Reduction**	**Percent Reduction**
Within IID Water Service Area					
Municipal	30,617	83,139	72,909	10,231	3.28
Geothermal/Solar Thermal	31,931	180,000	144,000	36,000	5.56
Industrial	7,092	7,092	6,306	786	2.93
Feedlots/Dairies	20,000	20,000	20,000	-	-
Environmental Resources	0	12,020	12,020	-	-
Total	**89,640**	**302,251**	**255,235**	**47,016**	**4.22**
Outside IID Water Service Area					
Municipal	130	309	307	1	0.12
Industrial	767	767	690	77	2.63
Total	**897**	**1,076**	**997**	**78**	**1.88**

Table 5-25. Non-Agricultural Water Demand in and outside IID Water Service Area, 2005, 2050, (MGD)

	2005	2050			
	Baseline	**Without Conservation**	**With Conservation**	**Use Reduction**	**% Reduction**
Within IID Water Service Area					
Municipal	27.31	74.16	65.03	9.13	3.28
Geothermal/Solar Thermal	28.48	160.69	128.45	32.11	5.56
Industrial	6.33	6.33	5.63	0.70	2.93
Feedlots/Dairies	17.84	17.84	17.84	-	-
Environmental Resources	0.00	10.72	10.72	-	-
Total	**79.96**	**269.61**	**227.67**	**41.94**	**4.22**
Outside IID Water Service Area					
Municipal	0.12	0.28	0.27	0.00	0.12
Industrial	0.68	0.68	0.62	0.07	2.63
Total	**0.80**	**0.96**	**0.89**	**0.07**	**1.88**

5.10 OVERVIEW OF THE IMPERIAL REGION COLORADO RIVER WATER SUPPLY PORTFOLIO

The Imperial Region Water Supply Portfolio consists of Colorado River water assets managed held in trust by the Imperial irrigation District for use by residents of the Imperial Valley. The region also has developed groundwater assets in the West Mesa used by the town of Ocotillo and by U.S. Gypsum in Plaster City. In the East Mesa, there is one center pivot operation as well as some farming between the East Highline and Coachella canals from near Calipatria north to the end of the East Highline Canal. IID supplies water to the users between the canals, but it is not delivered with IID infrastructure. That land is included in the IID Crop Report. There is also the Lower Colorado Well Supply Project operated by USBR which is located in the Sand Hills along the All American Canal.

As described in Section 5.2.7, under the terms of the QSA/Transfer Agreements, IID's Priority 3(a) right to consumptive use of Colorado River water has been quantified at 3.1 MAF annually, with IID net consumptive use reduced from 3.1 MAF annually by the volume of transfers to urban areas out of Imperial Region, Salton Sea mitigation and water conserved by the All American Canal Lining Project (values are consumptive use volumes at Imperial Dam). These conserved waters will be made available to South Coast and Colorado Region urban users through 2037, when SDCWA's wheeling agreement with MWD ends; or through 2047, after which SDCWA and IID will have to mutually consent to renewal for the term of 30 years. The transfer schedule is described in the Colorado River Water Delivery Agreement Exhibit B.[37] However some modifications are already in place; for an overview of the transfer and IID reductions schedule as of 2010 (Table 5-5).

Undeveloped assets that could be added to the Imperial Region's water portfolio include Colorado River water banking in the East Mesa and/or storage in the Coachella Valley IRWM Region, desalination of IID drain water or brackish groundwater in the Imperial Valley or East Mesa, recycling of municipal wastewater; and/or reapportionment of water from agriculture to municipal and industrial consumptive use through a change in land use (e.g., urban development, fallowing, solar photovoltaic project) or conservation efficiency practices.

Pre-QSA Imperial Region Colorado River water use (1987 -2003) is shown in Figure 5-18; projected water use through 2047 is shown in Figure 5-19, and Figures 5-20 to 5-22 show the projected water use and the impact of possible projects and policies to meet future demand. Note that none of these tables show the impact of payback requirements for inadvertent overruns.

Figure 5-16 illustrates the historic distribution and use of Colorado River in the Imperial Valley (volumes prior to QSA implementation). The figure shows that just over half of the imported Colorado water went to agricultural consumptive use and that about one-third flowed to the Salton Sea, primarily as tailwater, tilewater, and operational spill discharged into IID drains. The figure also shows that , historically, a relatively constant portion of water was consumed by MCI uses; indicates the inception

[37] USBR website: "Colorado River Water Delivery Agreement." Exhibit B, p 13 of 14. <http://www.usbr.gov/lc/region/g4000/QSA/crwda.pdf>

and ramping up of the IID/MWD efficiency transfer, a conservation program designed to generate water for transfer by improving IID's system infrastructure and operations.

Implementation of the QSA/Transfer Agreements affects the Regional Water Supply in a number of ways as shown in Figure 5-17**.** The major changes are phased introduction of agricultural water conservation programs that are similar to the efficiency transfer program to MWD described above. These programs are intended to conserve water for transfer to SDCWA and CVWD through improvements in on-farm and irrigation system efficiency including lining of the All American Canal (AAC). The net impact of the agricultural efficiency programs is to support transfers while maintaining crop production in the District. As the conservation programs are being implemented, various land fallowing programs are also introduced to aid in meeting transfer commitments and to partially compensate for reduced flows of tailwater and operational spill to the Salton Sea that result from improvements in irrigation efficiency. The fallowing programs are scheduled to end in 2017 while the SDCWA/CVWD efficiency transfer will continue to expand until 2025. Beginning in 2026, transfer agreements instituted under the QSA will be fully mature and are anticipated to continue at a constant level until 2047.

The linchpin of the Imperial IRWMP is to identify 100,000 AFY of water that can be managed to meet MCI and environmental water demands within IID's service area, with 50,000 AFY to be identified by no later than 2010, and the balance to be defined by 2040.

Managing the current 3.1 MAFY Water Supply Portfolio to meet this goal can be accomplished by different methods, including:

1. Expanding the size of the Portfolio.
2. Preventing or recapturing water leaving the Region.
3. Reapportioning of water within the Portfolio.

As shown in Figure 5-18, expanding the Portfolio could include actions such as developing local groundwater. Preventing or recapturing water leaving the Portfolio would also result in more water for local use and could include desalination of drain water or recycling municipal wastewater. Both drain water and municipal wastewater flow to the Salton Sea and are no longer available for other beneficial use within IID's service area. This is shown conceptually in 0.

Reapportioning water within the current Portfolio is shown conceptually in Figure 5-20. The volume of water needed for future MCI uses would come from reapportioning water from existing uses to new uses, either through conservation, or by reducing water consumed by one use and making this water available for a different use.

Reallocation would occur under a mechanism to be used within IID to account for changes in the place or type of water use. A process to manage reallocation is needed to protect legal users of water, and to ensure that there is a net economic benefit to IID's service area.

The following notes apply to Figure 5-18 through Figure 5-21.

Figure Notes: Categories of water consumption are from measured and otherwise calculated record an IID Water Balance spreadsheet (1987-1996) and in IID's WIS for all later years. Layering of the categories in the figures provides a road map of Imperial Valley uses of Colorado River water and their changes both in the past and in the future. The broader purpose of the figures is to visually describe the time-series of Table 5-5, "IID Conserved Water Delivery, KAF (CRWDA Exhibit B)." The following describes each of the categories and references the applicable subsections of Chapter 5.

1. MCI, Recreation, and Environmental Consumptive Use – Water delivered to retail suppliers for potable domestic, commercial and urban use and irrigation of urban and recreation areas; untreated water for other recreational uses (Section 5.9.5) and for environmental use for QSA/Transfer Agreements mitigation (Section 5.9.4).
2. Agricultural CU – Irrigation water consumed to meet crop evapotranspiration requirements (Section 5.2.1).
3. Fallowing to SDCWA – See "SDCWA, SWRCB, and SS Mitigation Fallowing Programs End" below.
4. SWRCB Fallowing to Salton Sea – See "SDCWA, SWRCB, and SS Mitigation Fallowing Programs End" below.
5. AAC Seepage – Amount of water seeping from the All American Canal less IID return credits for flow diverted to the AAC that returns downstream to the Colorado River.
6. AAC Lining to SDCWA – Water conserved for delivery to SDCWA (Table 5-2).
7. SDCWA/CVWD Efficiency Transfer –Water from IID system and on-farm efficiency conservation for delivery to SDCWA and to CVWD (Section 0).
8. MWD Efficiency Transfer– Water conserved from system efficiency for delivery to MWD (1988 Agreement, projects completed Sept 1998) (Section 5.2.1).
9. Drain and River Evap and ET – Water that evaporates from IID's open channel system and that is used by plant life along the conveyance pathways.
10. Fallowing to Salton Sea – See "SDCWA, SWRCB, and SS Mitigation Fallowing Programs End" below.
11. MCI, Recr & Envr to Salton Sea – Return flow from non-agricultural uses to the Salton Sea (e.g., Treated wastewater and irrigation/drainage/environmental runoff).
12. Operational Spill to Salton Sea –IID discharge from main canals and laterals which flows via the drainage system via the rivers to the Salton Sea or directly to Salton Sea (Section 0).
13. Tilewater to Salton Sea – Irrigation (leaching) water captured by tile drains underlying farmed land that is discharged to IIDs drainage system via the rivers to the Salton Sea or directly to Salton Sea. (Section 5.2.1).
14. Tailwater to Salton Sea – Agricultural irrigation surface runoff from the ends (tails) of fields that discharges to IID drainage system, rivers and ultimately the Salton Sea (Section 0).
15. IID QSA Reduction Stabilized – Under the QSA/Transfer Agreements IID agreed to 45 years of water transfers to urban areas outside of the Imperial Region; for years 2026-2047, that amount remains constant (Section 5.2.7.1).
16. SDCWA, SWRCB, and SS Mitigation Fallowing Programs End – Water conserved by fallowing agricultural lands to provide flows to the Salton Sea to meet SWRCB Salton Sea mitigation requirements (2003-2017), and for delivery to SDCWA (2003-2016) (Section 5.2.7.1).
17. Forecasted Amounts – Quantified amounts closely tied to CRWDA Appendix B (Table 5-5).
18. Underruns/Overruns – IID Net Consumptive Use at Imperial Dam (USBR Decree Accounting report) for a given year is less than (underrun) or exceeds (overrun) the IID Priority 3(a) Quantified Amount of 3.1 MAF. IID Net Consumptive Use equals all Imperial Valley use of Colorado River water plus the volume of water

transferred out of the region, including AAC Lining to SDCWA and Other Water (e.g., ICS, IOPP, LCRWSP well field pumpage) , plus the volume of AAC seepage and other flow that is not accounted by USBR as IID return flow credit. (Section 5.2)

19. IID Quantified Net CU (2012-2047) – IID Quantified Priority 3(a) Amount less the sum of water transferred out of the region, including AAC Lining to SDCWA, Other Programs, and AAC seepage and other flow that accounted by USBR as IID return flow credit.
20. Other Programs – Water conserved by IID that is credited to such programs as ICS, IOPP, and LCRWSP well field pumpage.
21. IID Priority 3(a) Quantified Amount (3.1 MAF) – Water to be accounted to IID Net CU at Imperial Dam in a calendar year for the term of the QSA/Transfer Agreements. (Section 5.2.7.1)

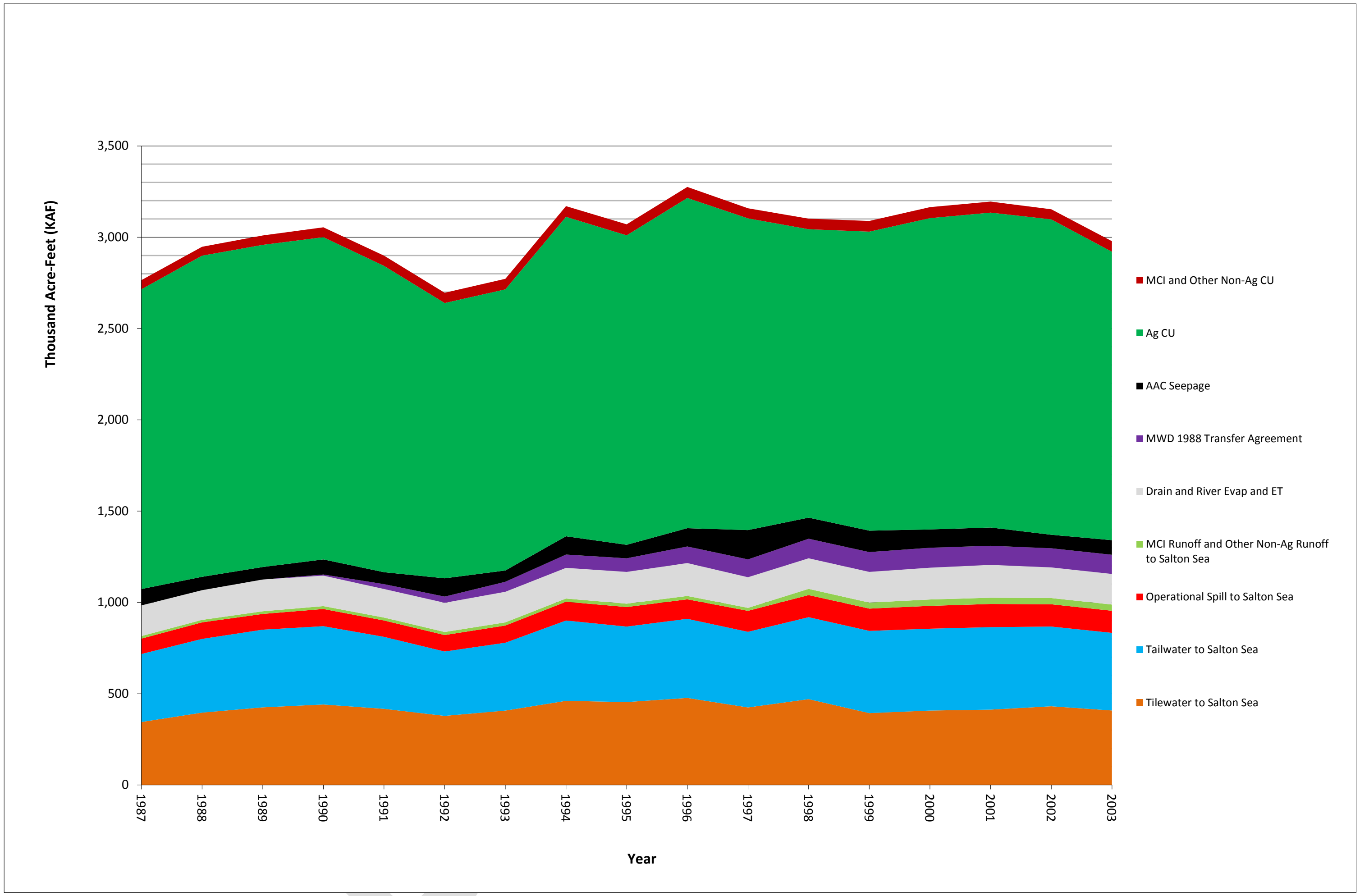

Figure 5-16. Pre-QSA Water Supply Portfolio

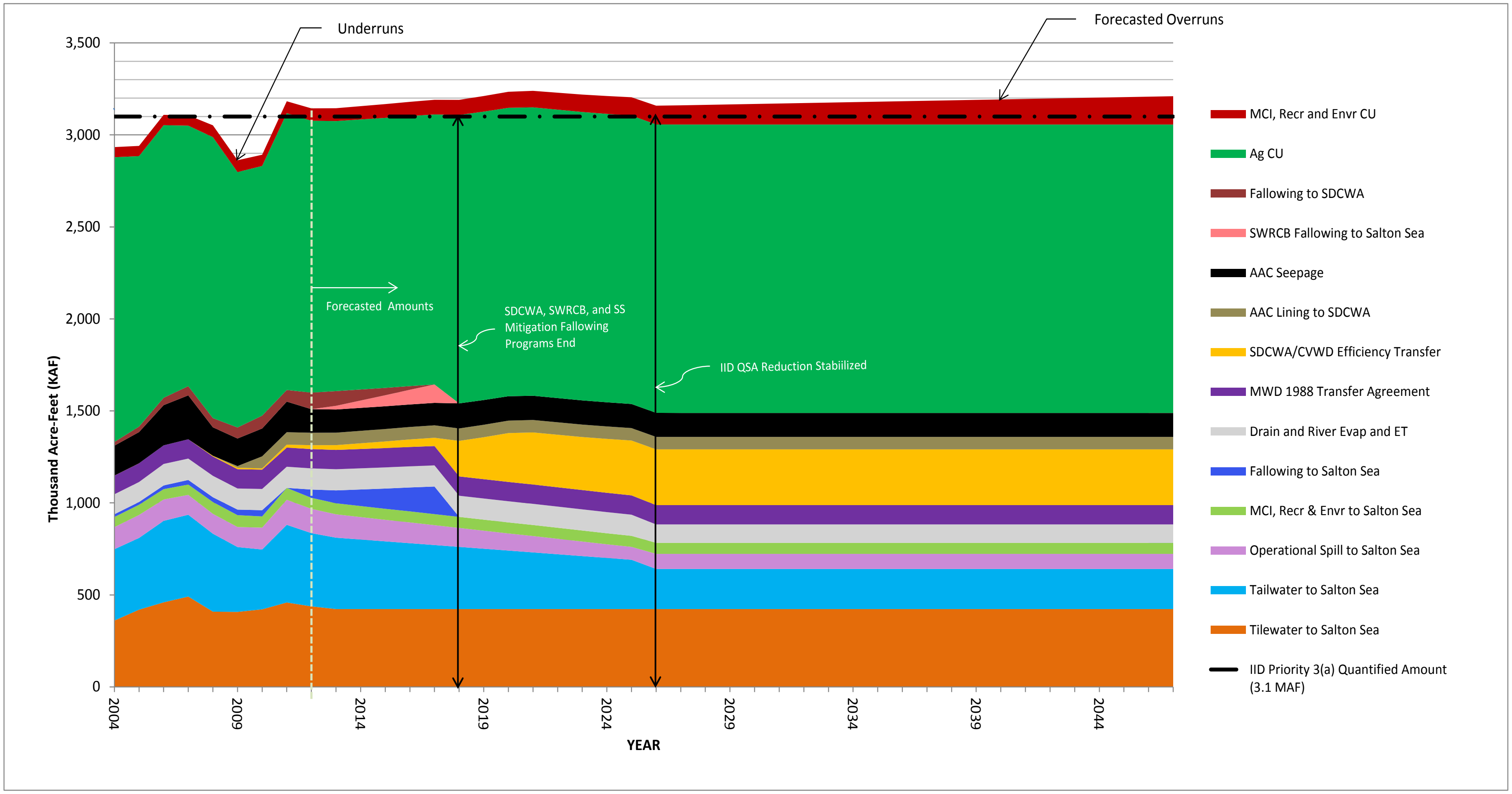

Figure 5-17. Future Water Supply Portfolio with the QSA/Transfer Agreements

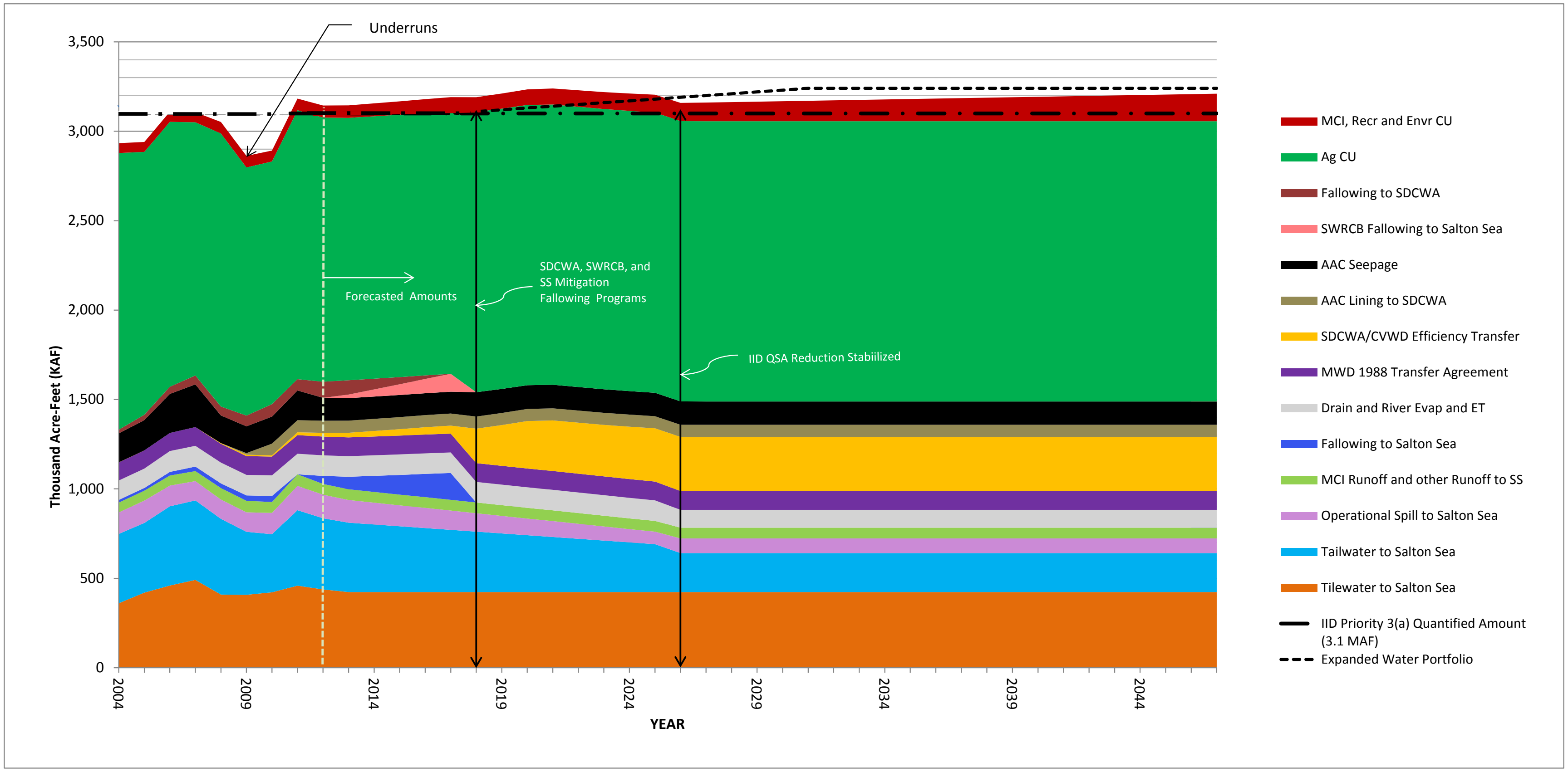

Figure 5-18. Expanding the Size of the Water Supply Portfolio (Groundwater)

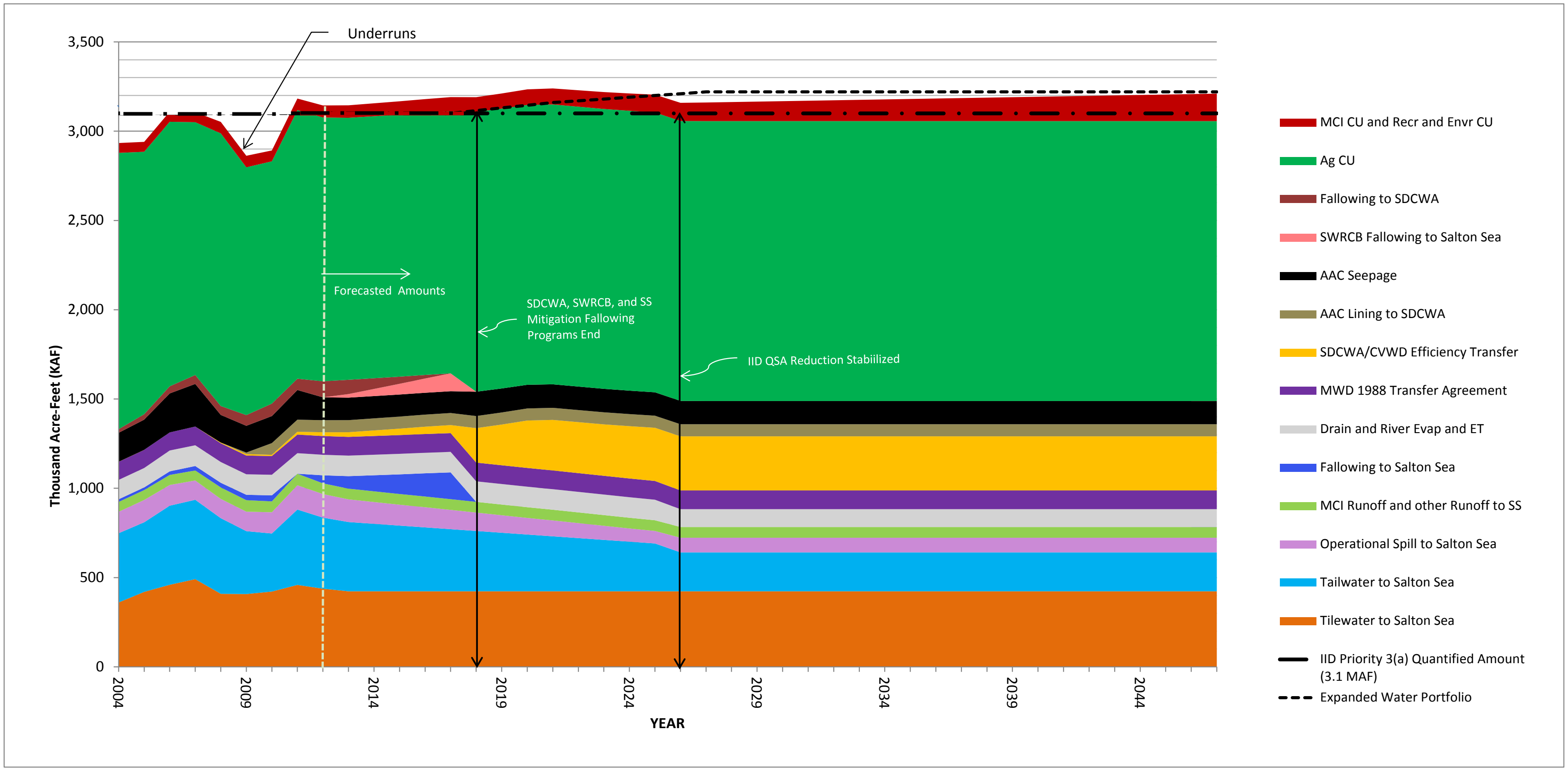

Figure 5-19. Expanding the Water Supply Portfolio (Drain Desalination and MCI Recycling)

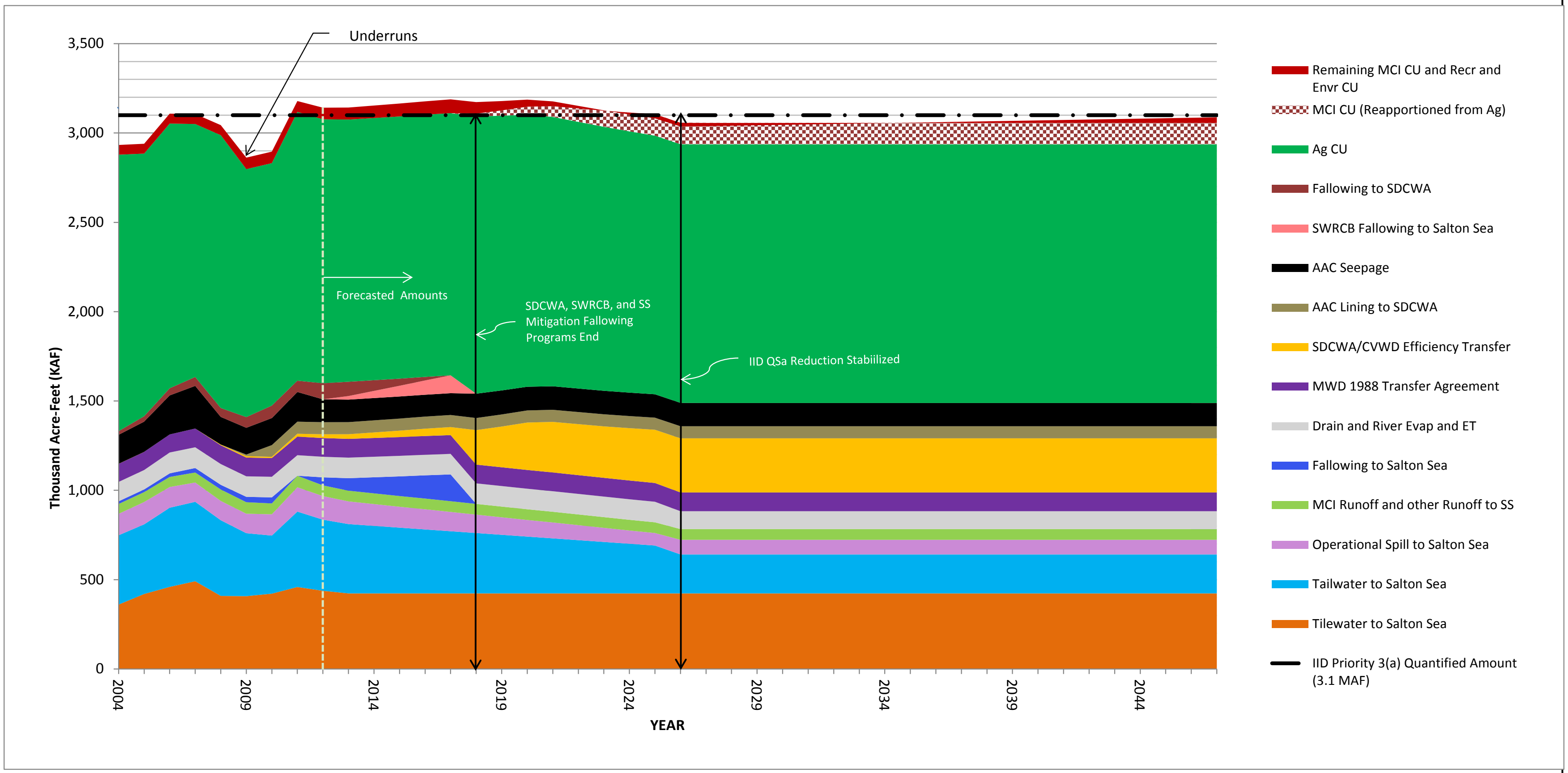

Figure 5-20. Reapportionment of the Water Portfolio (Ag to MCI)

5.10.1 Imperial Valley Demand Variability

Historically, Imperial Valley agricultural demands vary from year to year as a result of changes in markets and cropping patterns and other factors. Historically, weather has been consistent and has not affected agricultural demand, except that an inch of rainfall throughout the IID water service area reduces net consumptive use at Imperial Dam by about 50 KAFY and raises the level of the Salton Sea.

Quantification of IID's Priority 3(a) right at 3,100 KAFY and the consequent reduction of IID's net consumptive use as measured at Imperial Dam are part of an effort to reduce California's annual consumptive use of Colorado River water to match its right of 4,400 KAFY (plus 50 percent of any declared surplus). However, quantification does not change the underlying conditions that cause year-to-year fluctuations in irrigation demand. To deal with these fluctuations, the IID board adopted the 2009 Regulations for Equitable Distribution Plan (EDP) to help match IID net consumptive use to the quantified amount in years when demand is forecast to exceed supply. However, even with the EDP in place, IID diversions are occasionally expected to result in inadvertent overruns (net consumptive use greater than the quantified amount for the calendar year) or under-runs (net consumptive use less than the quantified amount). Overruns have to be paid back by extraordinary conservation in future years, because they represent the right of the junior right holder (MWD); and, since IID has no off-river storage or groundwater banking facilities, IID underruns (use less than the quantified amount) go to MWD.

Figure 5-21 shows IID net consumptive use of Colorado River water according to USBR Decree Account records for 1970 through 2011. From 2003 through 2047, the QSA/Transfer Agreements projected net consumptive use by IID is shown, adapted from CRWDA Exhibit B.

IID's historical net consumptive use, shown seen in Figure 5-21, is representative of the historic variability in agricultural consumptive use, since IID's MCI consumptive is small relative to agriculture and historically has been fairly consistent. Historic variations in agricultural water demand are similar in magnitude to the 408 KAFY of transfers called for in the QSA/Transfer Agreements. For example, agricultural water demands for 1970-2003 varied from a low of 2,555 KAFY to a high of 3,172 KAFY, a variation of 617 KAFY. The greatest variation from one year to the next was 326 KAF, while several 2-year variations have been in excess of 300 KAF. With a quantified cap, IID has a highly variable demand and a fixed supply that can lead to the supply/imbalances described above (overruns and under-runs); however, with implementation of the EDP, these variations are expected to be greatly reduced.

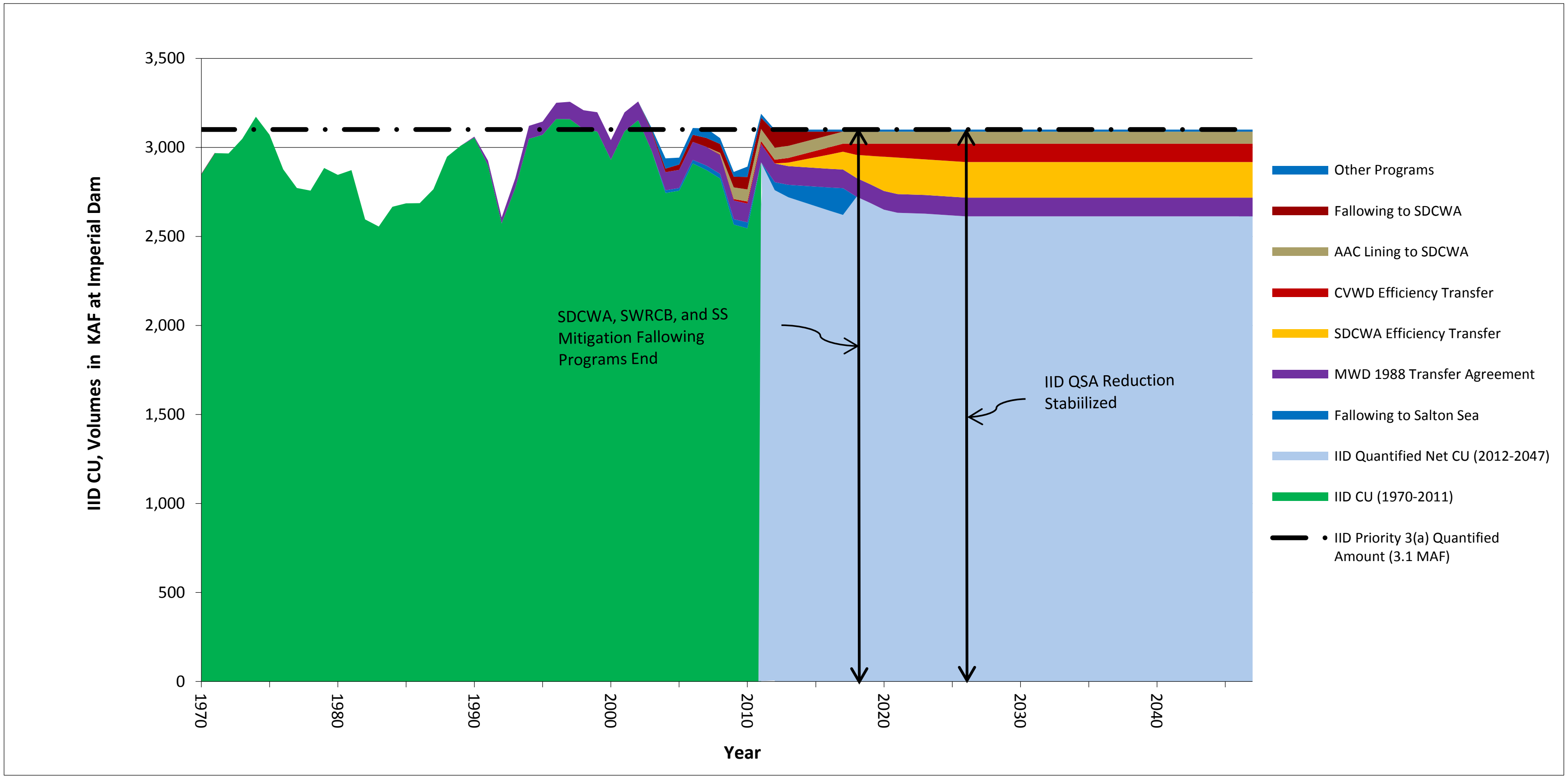

Figure 5-21. IID Colorado River Net Consumptive Use (1970-2008, USBR Decree Accounting) and Projected Net Consumptive Use (2003-2027, CRWDA Exhibit B)

Prior to implementation of the QSA/Transfer Agreements, Imperial Valley water users receiving Colorado River water from IID were part of a demand-based system. In any given year, each farmer made choices regarding what crop to plant and how much acreage to plant based on economics rather than water supply. Under the amended EDP, the amount of water available to users is to be restricted in years for which the board declares a supply/demand imbalance. In such years, a fixed volume per acre is to be apportioned for agricultural water along with various stipulations for other uses, see below. The EDP provides some flexibility for agricultural users to use more than the fixed allocation by participating in the District Water Exchange, which is described below. Even with the Equitable Distribution Plan in place, an overrun or under run can occur.

IID has established an Equitable Distribution Plan and implementing regulations, together referred to as the Equitable Distribution Program, that are designed to provide for the distribution of water in any year when expected demand for water is likely to exceed expected supply.[38] Under EDP Regulations, a fixed volume of water is to be apportioned to six types of water users: municipal; industrial; feed lots, dairies and fish farms; environmental resources water; agricultural lands, and non-agricultural users.[39] Through the District Water Exchange, agricultural water users would be able to participate in the sale and purchase of water.

[38] See IID website: Equitable Distribution <http://www.iid.com/Water/EquitableDistribution>
[39] The WIS-based IID Water Balance was modified in spring 2012 to include these six types of use.

As part of the EDP, a District Water Exchange is established so that agricultural water users can sell and buy water. This provides flexibility for some agricultural water users to obtain water in addition to their straight line apportionment.

The annual calculations of IID's net consumptive use water supply and other transfer obligations are illustrated on Figure 5-21 are a modified version of CRWDA/Federal QSA Exhibit B, (Table **5-5**). The annual record of IID's water deliveries, conservation efforts, and water transfers are tracked through a series of water budgets described in the next section.

5.11 IID PROVISIONAL WATER BUDGET, 2006-2011

In 1998, IID agreed to a water transfer to SDCWA that would start in 2003, ramp up to 205 KAF in 2021 and stabilize at 200 KAF annually through 2047, the remainder of the agreement. The water for delivery to SDCWA is being generated according to an agreed upon schedule, first by fallowing and then through efficiency conservation. In October 2003, provisions of the IID/SDCWA transfer agreement were incorporated into the QSA/Transfer Agreement which also includes transfers to MWD, CVWD, AAC Lining to SDCWA, and for Miscellaneous PPRs. For 2026 - 2047, the total amount of reduction in use by Imperial Valley residents would reach nearly 420 KAF annually.

Water for these transfers is to be generated through fallowing (2003-2017) as well as efficiency conservation for transfer to CVWD starting in 2008 and efficiency conservation for transfer to SDCWA starting in 2012/13. The efficiency measures include improvements to IID's system infrastructures and operations and improvements in on-farm irrigation practices. The IID Efficiency Conservation Definite Plan was prepared in 2007 to provide a roadmap for meeting these near- and long-term conservation obligations.

IID's water balance is designed to track water movement, conservation and use – into, through and out of the IID water service area. Figure 5-22 is a water balance schematic of IID inflows and outflows, and flow through the water service area. The water balance schematic provides an overview of accounting centers (primary systems) and elements for each. IID's Oracle-based Water Information System (WIS) is the tool used to track and record the input and contains algorithms for making the calculations is presented in the provisional water budgets for the primary systems (Accounting Centers). Volumes reported for the elements are in thousands of acre-feet (KAF) measured or calculated for the IID water service area, and are not reconciled to USBR reported consumptive use (CU) at Imperial Dam. The reported annual values for All American Canal Seepage (which is an estimate of total All American Canal seepage less IID return flow credits at the Colorado River) is used to reconcile IID service area elements with USBR Decree Accounting on an annual basis.

Table 5-27 through Table 5-34 present WIS IID provisional water budgets for calendar years 2006 to 2010 for the following primary systems (Accounting Centers):

1. Inflows and Outflows Water Budget, Table 5-27
2. Consumptive Use Water Budget, Table 5-28
3. Delivery System Water Budget, Table 5-29
4. Agricultural Water Budget, Table 5-30
5. Non-Agricultural Water Budget, Table 5-31
6. Environmental Water Budget, Table 5-32
7. Recreation Water Budget, Table 5-33
8. Drainage System Water Budget, Table 5-34

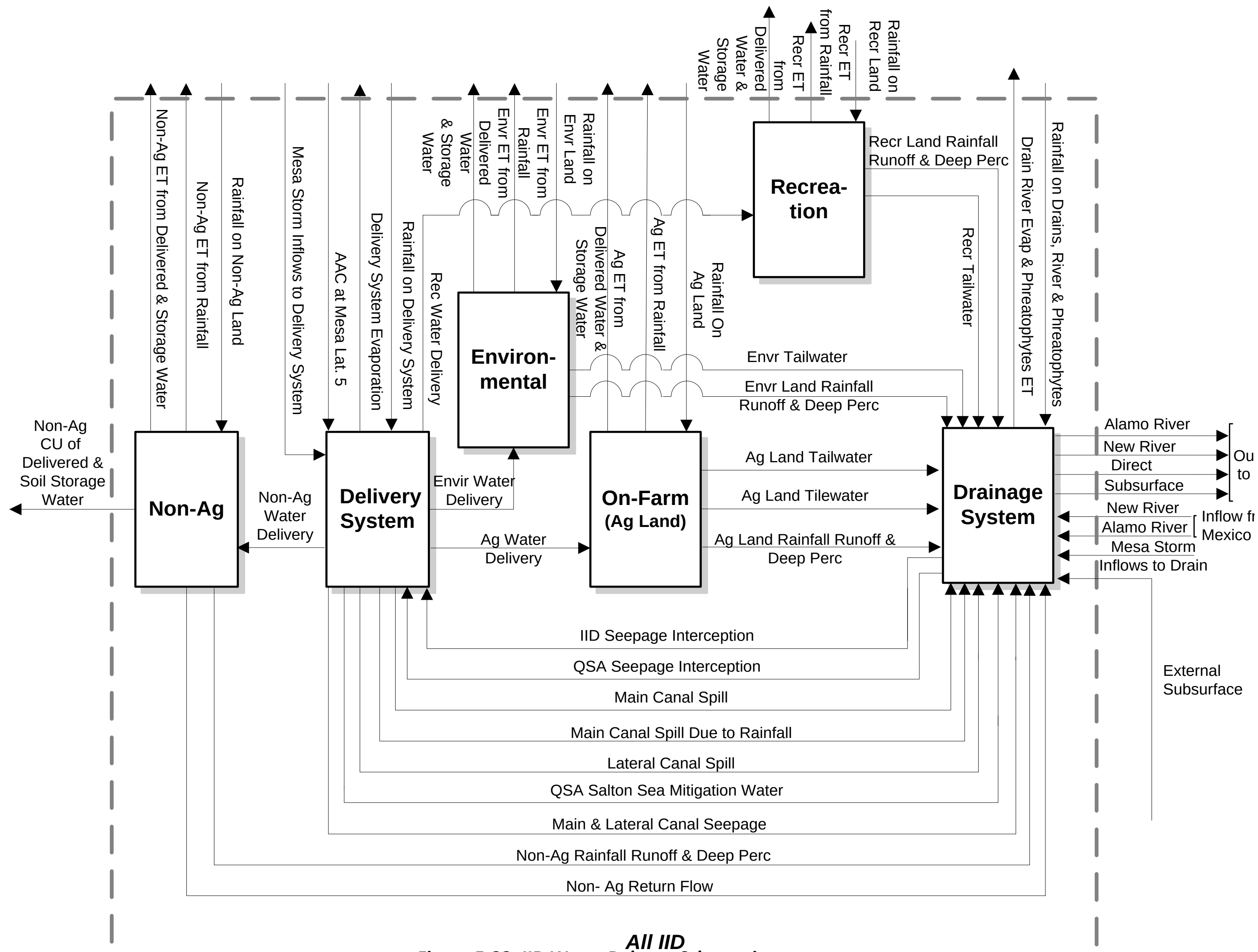

Figure 5-22. IID Water Balance Schematic

Source: Bryan P. Thoreson, Davids Engineering, Inc.

5.11.1 IID AAC Flows Downstream of Pilot Knob Provisional Water Budget

Table 5-26 is IID's provisional water budget in the AAC just downstream of Pilot Knob.

Table 5-26. IID AAC Flows Downstream of Pilot Knob Provisional Water Budget, 2006-2011 (KAF)

Accounting Center	Year[1]					
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
IID AAC Flows Downstream of Pilot Knob						
IID AAC at Pilot Knob (Station 1117)	2906	2867	2820	2564	2530	2797
Salton Sea Mitigation, AAC at PK (Station 1117)	0	23	26	30	80	0
Brock Reservoir Outlet to AAC (Station 2192)	n/a	n/a	n/a	0	11	115
Total IID AAC Flow Downstream of Pilot Knob	**2906**	**2890**	**2846**	**2595**	**2621**	**2912**

[1] Volumes reported for the elements are measured or calculated for the IID water service area and are not reconciled to USBR reported CU at Imperial Dam.

5.11.2 Inflows and Outflows Water Budget

Table 5-27 is IID's inflow and outflow provisional water budget that tracks major flow paths into IID's service area and outflows from the service area.

Table 5-27. IID Inflows and Outflows Provisional Water Budget, 2006-2011 (KAF)

Accounting Center	Year[1]					
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
Total Inflows						
All American Canal at Mesa Lateral 5	2,690	2,660	2,761	2,547	2,580	2,872
Alamo River Flow from Mexico	1	0	1	1	1	1
New River Flow from Mexico	113	90	86	80	90	82
Total Rainfall	20	65	63	30	172	95
Mesa Storm Inflows to Drain	1	4	4	2	10	5
Mesa Storm Inflows to Delivery System	0	0	2	1	6	2
External Subsurface Inflows	20	20	20	20	20	20
Total Inflows	**2,844**	**2,839**	**2,936**	**2,681**	**2,880**	**3,077**
Total Outflows						
Alamo River Flow to Salton Sea	613	608	583	523	587	612
New River Flow to Salton Sea	422	415	402	378	415	393
Direct-to-Sea Drain Flow	73	104	108	103	109	108
Subsurface Flow to Salton Sea	1	1	1	1	1	1
Total Consumptive Uses and Change in Soil Storage	1,734	1,711	1,842	1,676	1,768	1,964
Total Outflows	**2,844**	**2,839**	**2,936**	**2,681**	**2,880**	**3,077**

[1] Volumes reported for the elements are measured or calculated for the IID water service area and are not reconciled to USBR reported CU at Imperial Dam.

5.11.3 IID Consumptive Use Provisional Water Budget

Table 5-28 is IID's consumptive use provisional water budget that tracks total agricultural water use within the IID water system.

Table 5-28. IID Consumptive Use Provisional Water Budget, 2006-2011 (KAF)

Accounting Center	Year[1]					
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
Consumptive Use						
Delivery System Evaporation	25	24	25	24	24	25
Ag ET from Delivered Water & Soil Water Storage	1,522	1,466	1,577	1,448	1,427	1,677
Ag ET from Rainfall	16	45	51	24	116	69
Non-Ag CU of Delivered Water	56	56	64	64	61	66
Non-Ag ET from Rainfall	2	8	8	4	21	11
Environmental ET from Delivered Water & Stored Soil Water	0	0	0	0	2	3
Environmental ET from Rainfall	0	0	0	0	0	0
Recreation ET from Delivered Water & Stored Soil Water	20	20	25	20	23	19
Recreation ET from Rainfall	0	1	1	0	2	1
Drain Evaporation & Phreatophytes ET	73	72	73	72	72	74
River Evaporation & Phreatophytes ET	19	19	19	19	19	20
Total Consumptive Use	**1,734**	**1,711**	**1,842**	**1,676**	**1,768**	**1,964**
Minor differences between "Total Consumptive Uses and Change in Soil Storage" are likely due to rounding in various accounting centers.						

[1] Volumes reported for the elements are measured or calculated for the IID water service area and are not reconciled to USBR reported CU at Imperial Dam.

5.11.4 IID Delivery System Provisional Water Budget

Table 5-29 summarizes inflows to outflows from IID's delivery system. Note that "Ag Water Delivery, closure term," the largest component of the Delivery System Outflows, is composed of two elements, measured ag water deliveries and unaccounted canal water.

Table 5-29. IID Delivery System Provisional Water Budget, 2006-2011 (KAF)

Accounting Center	Year[1]					
	2006	2007	2008	2009	2010	2011
Delivery System Inflows						
All American Canal at Mesa Lateral 5	2,690	2,660	2,761	2,547	2,580	2,872
QSA Seepage Interception	0	0	7	21	7	26
IID Seepage Interception	12	11	11	10	8	7
Mesa Storm Inflows to Delivery System	0	0	0	0	1	1
Rainfall on Delivery System	0	0	2	1	6	2
Total Delivery System Inflows	**2,702**	**2,672**	**2,781**	**2,579**	**2,603**	**2,907**
Delivery System Outflows						
Ag Water Delivery, closure term	2,334	2,290	2,382	2,183	2,142	2,508
Non-Ag Water Delivery	92	92	106	105	104	107
Environmental Water Delivery	0	0	0	0	2	3
Recreation Water Delivery	37	38	37	32	38	34
Canal Seepage	98	97	97	96	94	93
Main Canal Spill	2	2	2	2	2	4
Lateral Canal Spill	0	0	2	1	6	2
QSA Salton Sea Mitigation Water	114	106	106	107	116	132
Delivery System Evaporation	0	22	25	29	73	0
Total Delivery System Outflows	**25**	**24**	**25**	**24**	**24**	**25**
Total Delivery System Outflows						
Ag Water Delivery	2,319	2,377	2,411	2,244	2,212	2,529
Unaccounted Canal Water	15	-87	-29	-62	-70	-22
Unaccounted Canal Water Percent	0.65	-3.79	-1.22	-2.82	-3.29	-0.86
Note: "Unaccounted Canal Water" equals "Ag Water Delivery, closure term" (considered most accurate) minus "Ag Water Delivery (TPS)"						

[1] Volumes reported for the elements are measured or calculated for the IID water service area and are not reconciled to USBR reported CU at Imperial Dam.

5.11.5 IID Agricultural Provisional Water Budget

The agricultural water budget, shown in Table 5-30, represents predominate flow paths for IID water in terms of delivery, consumptive use, and drainage to the Salton Sea.

Table 5-30. IID Agricultural Provisional Water Budget, 2006-2011 (KAF)

Accounting Center	Year[1]					
	2006	2007	2008	2009	2010	2011
Ag Water (On-Farm) Inflows						
Ag Water Delivery, closure term	2,334	2,290	2,382	2,183	2,142	2,508
Rainfall on Ag Land	16	52	51	24	140	77
Total Ag Water (On-Farm) Inflows	**2,350**	**2,342**	**2,433**	**2,207**	**2,282**	**2,585**
Ag Water (On-Farm) Outflows						
Ag ET from Delivered Water & Soil Water Storage	1,522	1,466	1,577	1,448	1,427	1,677
Ag ET from Rainfall	16	45	51	24	116	69
Ag Land Tilewater	416	435	400	400	411	438
Ag Land Tailwater	397	389	405	335	304	393
Ag Land Rainfall Runoff & Deep Percolation	0	8	0	0	23	8
Total Ag Water (On-Farm) Outflows	**2,350**	**2,342**	**2,433**	**2,207**	**2,282**	**2,585**

[1] Volumes reported for the elements are measured or calculated for the IID water service area and are not reconciled to USBR reported CU at Imperial Dam.

5.11.6 IID Non-Agricultural Provisional Water Budget

The non-agricultural IID water budget includes flow paths that involve inflows to non-ag uses and outflows from these uses. Comparison of the volumes presented in Table 5-30 and Table 5-31 show both the relative magnitude of ag and non-ag uses and the variability of these uses during the period between 2006 and 2010.

Table 5-31. IID Non-Agricultural Provisional Water Budget, 2006-2011 (KAF)

Accounting Center	Year[1]					
	2006	2007	2008	2009	2010	2011
Non-Ag (MCI) Inflows						
Non-Ag Water Delivery	92	92	106	105	104	107
Rainfall on Non-Ag Land	3	10	9	4	25	14
Total Non-Ag (MCI) Inflows	**95**	**102**	**115**	**110**	**128**	**121**
Non-Ag (MCI) Outflows						
Non-Ag CU of Delivered Water	56	56	64	64	61	66
Non-Ag ET from Rainfall	2	8	8	4	21	11
Non-Ag Return Flow	35	35	41	40	40	41
Non-Ag Land Rainfall Runoff & Deep Perc.	1	3	3	1	7	4
Total Non-Ag (MCI) Outflows	**95**	**102**	**115**	**110**	**128**	**121**

[1] Volumes reported for the elements are measured or calculated for the IID water service area and are not reconciled to USBR reported CU at Imperial Dam.

5.11.7 IID Environmental Provisional Water Budget

Table 5-32 presents the environmental water budget. The element of note here is the commencement of the delivery of Environmental Mitigation Water in 2010.

Table 5-32. IID Environmental Provisional Water Budget, 2006-2011 (KAF)

Accounting Center	Year[1]					
	2006	2007	2008	2009	2010	2011
Environmental Inflows						
Environmental Water Delivery	613	608	583	523	587	612
Rainfall on Environmental Land	422	415	402	378	415	393
Total Environmental Inflows	**73**	**104**	**108**	**103**	**109**	**108**
Environmental Outflows						
Environmental ET from Delivered Water & Stored Soil Water	0	0	0	0	2	3
Environmental ET from Rainfall	0	0	0	0	0	0
Environmental Tailwater	0	0	0	0	0	0
Environmental Land Rainfall Runoff & Deep Percolation	0	0	0	0	0	0
Total Environmental Outflows	**0**	**0**	**0**	**0**	**3**	**3**

[1] Volumes reported for the elements are measured or calculated for the IID water service area and are not reconciled to USBR reported CU at Imperial Dam.

5.11.8 IIID Recreation Provisional Water Budget

Table 5-33 presents IID's recreation water budget. This is a small component of the overall water budget that displays little variation from year to year.

Table 5-33. IID Recreation Provisional Water Budget, 2006-2011 (KAF)

Accounting Center	Year[1]					
	2006	2007	2008	2009	2010	2011
Recreation Inflows						
Recreation Water Delivery	37	38	37	32	38	34
Rainfall on Recreation Land	0	1	1	0	3	1
Total Recreation Inflows	**37**	**38**	**38**	**33**	**41**	**35**
Recreation Outflows						
Recreation ET from Delivered Water & Stored Soil Water	20	20	25	20	23	19
Recreation ET from Rainfall	0	1	1	0	2	1
Recreation Tailwater	17	18	13	12	15	15
Recreation Land Rainfall Runoff & Deep Percolation	0	0	0	0	1	0
Total Recreation Outflows	**37**	**38**	**38**	**33**	**41**	**35**

[1] Volumes reported for the elements are measured or calculated for the IID water service area and are not reconciled to USBR reported CU at Imperial Dam.

5.11.9 IID Drainage System Provisional Water Budget

The drainage water system within IID's service area is complex because of the large number of flow paths that are included in both the inflow and outflow sections of the budget.

Table 5-34. IID Drainage System Provisional Water Budget, 2006-2011 (KAF)

Accounting Center	Year[1]					
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
Drainage System Inflows						
Alamo River Flow from Mexico	1	0	1	1	1	1
New River Flow from Mexico	113	90	86	80	90	82
Mesa Storm Inflows	1	4	4	2	10	5
External Subsurface Inflows	20	20	20	20	20	20
Main Canal Spill	2	2	2	2	2	4
Main Canal Spill Due to Rainfall	0	0	2	1	6	2
Lateral Canal Spill	114	106	106	107	116	132
Canal Seepage	98	97	97	96	94	93
QSA Salton Sea Mitigation Water	0	22	25	29	73	0
Non-Ag Return Flow to IID Drains	35	35	41	40	40	41
Ag Land Rainfall Runoff & Deep Percolation	0	8	0	0	23	8
Non-Ag Land Rainfall Runoff & Deep Percolation	1	3	3	1	7	4
Environmental Land Rainfall Runoff & Deep Percolation	0	0	0	0	0	0
Recreation Land Rainfall Runoff & Deep Percolation	0	0	0	0	1	0
Rainfall on Drains and Phreatophytes	0	1	1	1	3	2
Rainfall on Rivers and Phreatophytes	0	0	0	0	1	0
Ag Land Tilewater	416	435	400	400	411	438
Ag Land Tailwater	397	389	405	335	304	393
Environmental Tailwater	0	0	0	0	0	0
Recreation Tailwater	17	18	13	12	15	15
Total Drainage System Inflows	**1,215**	**1,231**	**1,204**	**1,127**	**1,218**	**1,240**
Drainage System Outflows						
Alamo River Flow to Salton Sea	613	608	583	523	587	612
New River Flow to Salton Sea	422	415	402	378	415	393
Direct-to-Sea Drain Flow	73	104	108	103	109	108
Subsurface Flow to Salton Sea	1	1	1	1	1	1
Drain Evaporation & Phreatophytes ET	73	72	73	72	72	74
River Evaporation & Phreatophytes ET	19	19	19	19	19	20
QSA Seepage Interception	0	0	7	21	7	26
IID Seepage Interception	12	11	11	10	8	7
Total Drainage System Outflows	**1,215**	**1,231**	**1,204**	**1,127**	**1,218**	**1,240**

[1] Volumes reported for the elements are measured or calculated for the IID water service area and are not reconciled to USBR reported CU at Imperial Dam.

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