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ORANGE COUNTY WATER DISTRICT

ORANGE COUNTY'S GROUNDWATER AUTHORITY

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MICHAEL R. MARKUS, P.E., D.WRE

July 12, 2018

Ms. Hope Smythe
Executive Officer
California Regional Water Quality Control Board, Santa Ana Region
3737 Main Street, Suite 500
Riverside, CA 92501

Re: June 21, 2018 California Coastkeeper Alliance Letter

Dear Ms. Smythe:

Orange County Water District (OCWD; District) recently became aware of a June 21, 2018 letter from Sean Bothwell – Policy Director of the California Coastkeeper Alliance regarding the proposed Huntington Beach Poseidon Resources Ocean Desalination project. Three technical reports were enclosed with the letter discussing the proposed project.

The District wanted to make you aware that the James Fryer report "A Review of Water Demand Forecasts for the Orange County Water District" does not include the latest future water demand projection information currently being used by OCWD. The District's current future water demand projections are 447,000 acre-feet per year and not 525,079 acre-feet per year as indicated in the Fryer report. Attachments A and B to this letter as summarized below provide supporting documentation.

- Attachment A - September 6, 2016 OCWD staff report – Page 2 of the staff report shows an assessment of future projected water supplies and the 447,000 acre-feet per year water demand projection. The staff report also documents the methodology used for the projection.
- Attachment B - 2016-17 Engineers Report of the Groundwater Conditions, Water Supply and Basin Utilization in the OCWD – Page 24 of this document again shows the 447,000 acre-feet per year water demand projection.

Please call or email Mr. John Kennedy at (714) 378-3304 or JKennedy@ocwd.com if you have any further questions.

Sincerely,

Michael R. Markus, P.E., D.WRE, BCEE, F.ASCE
General Manager

PO Box 8300
Fountain Valley, CA 92728-8300

18700 Ward Street
Fountain Valley, CA 92708

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AGENDA ITEM SUBMITTAL

Meeting Date: September 7, 2016

To: Board of Directors

From: Mike Markus

Staff Contact: J. Kennedy

Budgeted: N/A
Budgeted Amount: N/A
Cost Estimate: N/A
Funding Source: N/A
Program/Line Item No.: N/A
General Counsel Approval: N/A
Engineers/Feasibility Report: N/A
CEQA Compliance: N/A

Subject: METROPOLITAN WATER DISTRICT LOS ANGELES COUNTY CITY OF CARSON INDIRECT POTABLE REUSE PROJECT

SUMMARY

The Metropolitan Water District (MWD) is studying the feasibility of constructing a GWRS type project in partnership with Los Angeles County Sanitation District in the City of Carson. The District, via the construction of necessary pipelines, could receive 65,000 acre-feet per year of water from the project to recharge the groundwater basin. An OCWD resolution of support for the project was adopted in January 2016. As previously requested by Board members, a MWD representative, John Bednarski, will provide a project update and presentation.

Attachment(s):

- November 2015 MWD staff report describing the project and study
- Presentation provided to MWD Engineering and Operations Committee on August 15, 2016

RECOMMENDATION

Informational

BACKGROUND AND ANALYSIS

The Los Angeles County Joint Water Pollution Control Plant in the City of Carson currently treats approximately 270 million gallons of day of wastewater to secondary standards before it is discharged through outfall tunnels to the Pacific Ocean. MWD is working with the Los Angeles County Sanitation District to potentially construct a GWRS indirect potable reuse (IPR) type project at the Carson plant to purify and create up to 150 million gallons per day of new water supplies to be used to replenish local groundwater basins in Southern California.

MWD staff is working to complete a feasibility report for the project by December 2016 for consideration by the MWD Board. MWD has indicated the District via a contract could receive 65,000 acre-feet per year of water to recharge the groundwater basin.

The quality of this water would be high, similar to GWRS water, with a low total dissolved solids concentration. It also appears the water would have reliability similar to GWRS and would not be subject to the MWD Allocation process during drought cycles.

- GWRS is expanded from 103,000 to 134,000 acre-feet per year.

- Miscellaneous supplies are the IRWD Michelson and OCWD GAP purple pipe reclamation projects. These two projects currently provide about 20,000 acre-feet per year of water supply.

- MWD Untreated and/or Carson Indirect Potable Reuse (IPR) project. OCWD originally committed to take a total of 650,000 acre-feet of MWD untreated full service water over a ten year period (65,000 acre-feet per year). This commitment ends in December 2024. MWD would want the District to contractually commitment to taking a similar amount of water from the Carson IPR project in-lieu of the original 65,000 acre-feet per year commitment to purchase untreated full service water.

- MWD Treated water to Producers is calculated as the difference between total water demands of 447,000 acre-feet per year and the total of the other supply sources. Over the past 30 years the average amount of treated imported water provided by the MWD to the 19 OCWD Groundwater Producers is 136,000 acre-feet per year.

PRIOR BOARD ACTIONS

January 2016 – Approved resolution of support for the MWD IPR project

ORANGE COUNTY WATER DISTRICT

SINCE 1933

2016 - 2017 Engineer's Report on the Groundwater Conditions, Water Supply and Basin Utilization in the Orange County Water District

2016-2017

ENGINEER'S REPORT ON

GROUNDWATER CONDITIONS,

WATER SUPPLY AND BASIN UTILIZATION

IN THE

ORANGE COUNTY WATER DISTRICT

FEBRUARY 2018

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MICHAEL R. MARKUS, P.E., D.WRE

February 21, 2018

Michael R. Markus
General Manager
Orange County Water District
Post Office Box 8300
Fountain Valley, CA 92728-8300

Dear Mr. Markus:

In accordance with Section 26 of the District Act, the 2016-2017 Engineer's Report on the Groundwater Conditions, Water Supply and Basin Utilization in the District is hereby submitted.

Precipitation for the water year July 1, 2016 through June 30, 2017 within the District's boundaries averaged 18.0 inches, which was one hundred thirty four percent of the long-term average rainfall. The average discharge of Santa Ana River flow past Prado Dam for the water year was measured to be 197,011 acre-feet which represented eighty seven percent of the 30-year average flow. Flow past the District's spreading grounds (including any flow from the Santiago Creek) that was lost to the Pacific Ocean totaled 67,933 acre-feet.

Total water demands within the District for the 2016-2017 water year were 388,851 acre-feet (excluding water used for groundwater replenishment and barrier maintenance). Supplemental water used for groundwater replenishment and barrier maintenance during the water year totaled 51,648 acre-feet (excludes any available In-Lieu Program water). Groundwater production within the basin for the water year totaled 301,637 acre-feet (includes any available In-Lieu Program water) which was a nine percent increase from the prior water year.

The accumulated basin overdraft decreased from 379,000 acre-feet on June 30, 2016 to 328,000 acre-feet on June 30, 2017 using the three-layer approach and the new benchmark for full-basin conditions. Under the provisions of Section 27 of the District Act, a portion of the Replenishment Assessment for the 2018-2019 water year could be equal to an amount necessary to purchase up to 189,000 acre-feet of replenishment water.

Very truly yours,

Chris S. Olsen
Director of Engineering

Lo Tan
Senior Engineer

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EXECUTIVE SUMMARY

Total water demands within Orange County Water District (OCWD) were 388,851 acre-feet (AF) for the 2016-17 water year (beginning on July 1, 2016 and ending on June 30, 2017). Groundwater production for the water year totaled 301,637 AF including any available In-Lieu Program water. The use of supplemental water in OCWD's service area during the 2016-17 water year totaled 120,229 AF of which 68,581 AF resulted from the direct use by water agencies and districts and 51,648 AF were used for the purpose of groundwater replenishment and maintenance of seawater intrusion control barriers.

For the water year which ended on June 30, 2017, the "annual overdraft" (annual basin storage decrease without supplemental replenishment water) was 98,000 AF. The accumulated overdraft decreased from 379,000 AF on June 30, 2016 to 328,000 AF on June 30, 2017. Precipitation within the basin was 134 percent of the long-term average during the water year, totaling 18.00 inches.

Based on the groundwater basin conditions for the water year ending on June 30, 2017, OCWD may purchase up to 189,000 AF of water for groundwater replenishment during the ensuing water year, beginning on July 1, 2018, pursuant to the District Act.

ACKNOWLEDGMENTS

A number of public and private entities contributed data used in this report including:

City of Anaheim
City of Buena Park
East Orange County Water District
City of Fountain Valley
City of Fullerton
City of Garden Grove
Golden State Water Company
City of Huntington Beach
Irvine Ranch Water District
City of La Palma
Mesa Water District
Metropolitan Water District of Southern California
Municipal Water District of Orange County
City of Newport Beach
City of Orange
County of Orange, Public Works Department
Orange County Sanitation District
City of Santa Ana
Santa Ana Watershed Project Authority
City of Seal Beach
Serrano Water District
City of Tustin
United States Geological Survey
City of Westminster
Yorba Linda Water District

The cooperation received from all agencies is gratefully acknowledged.

This report is based on the 2016-17 Basic Data Report which is placed on file at the office of OCWD in Fountain Valley.

GLOSSARY OF ACRONYMS

AF	Acre-feet
ARTIC	Anaheim Regional Transportation Intermodal Center
AWPF	Advanced Water Purification Facility
BEA	Basin Equity Assessment
BPP	Basin Production Percentage
CPTP	Coastal Pumping Transfer Program
CUP	Conjunctive Use Program
DRWF	Dyer Road Well Field
GAP	Green Acres Project
GWRS	Groundwater Replenishment System
IDP	Irvine Desalter Project
IRWD	Irvine Ranch Water District
MF	Microfiltration
mg/L	Milligrams per Liter
MBI	Mid-Basin Injection
MGD	Million Gallons per Day
MSL	Mean Sea Level
MWD	Metropolitan Water District of Southern California
MWDOC	Municipal Water District of Orange County
NO_3	Nitrate
O&M	Operation and Maintenance
OCSD	Orange County Sanitation District
OCWD	Orange County Water District
RA	Replenishment Assessment
RO	Reverse Osmosis
RTS	Readiness-to-Serve
SAR	Santa Ana River
SWP	State Water Project
TDS	Total Dissolved Solids
UV	Ultraviolet
WRD	Water Replenishment District of Southern California
WSM	Basin Water Supply Management Program

PART I: GROUNDWATER CONDITIONS

Section 25 of the OCWD Act requires that OCWD order an annual investigation to report on the groundwater conditions within the District's boundaries. A summary of the groundwater conditions for the water year covering July 1, 2016 to June 30, 2017 is as follows.

GROUNDWATER CONDITIONS
2016-17 SUMMARY OF FINDINGS

1. Groundwater production (including the In-Lieu Program) totaled 301,637 acre-feet (AF) for the 2016-17 water year.

2. Groundwater stored in the basin increased by 51,000 AF for the 2016-17 water year.

3. Accumulated Overdraft[1] on June 30, 2017 was 328,000 AF.[2]

4. Annual Overdraft was 98,000 AF for the 2016-17 water year.

5. Average Annual Overdraft[3] for the immediate past five water years (2012-13 through 2016-17) was 156,000 AF.

6. Projected Annual Overdraft[3] for the current 2017-18 water year is 201,000 AF.

7. Projected Annual Overdraft[3] for the ensuing 2018-19 water year is 164,000 AF.

8. Projected Accumulated Overdraft[2] on June 30, 2018 is 287,000 AF.

9. Under the provisions of Section 27 of the District Act, a portion of the 2018-19 Replenishment Assessment (RA) could be equal to an amount necessary to purchase up to 189,000 AF of replenishment water.[4]

[1] *Accumulated overdraft was calculated using OCWD's three-layer storage change methodology adopted on March 21, 2007 and the associated new benchmark for full-basin conditions. Water year 2005-06 was the first year this methodology was used. Additional explanation can be found in the report on "Evaluation of Orange County Groundwater Basin Storage and Operational Strategy" by OCWD in 2007.*

[2] *Water from the Metropolitan Water District of Southern California Long-Term Groundwater Storage Program was included as part of the total stored water in determining the basin's accumulated overdraft.*

[3] *Annual overdraft is defined in the District Act as "the quantity, determined by the Board of Directors, by which the production of groundwater supplies within said District during the water year exceeds the natural replenishment of such groundwater supplies in such water year."*

[4] *Determined by adding the five-year annual overdraft (156,000 AF) to one-tenth of the accumulated overdraft (328,000 AF) which results in the following:*
156,000 AF + [(328,000 AF) x 0.10] = 188,800 AF (or 189,000 AF when rounded).

BASIN HYDROLOGY

Groundwater conditions in the Orange County groundwater basin are influenced by the natural hydrologic conditions of rainfall, capture and recharge of Santa Ana River (SAR) and Santiago Creek stream flows, natural infiltration of surface water, and the transmissive capacity of the basin. The basin is also influenced by groundwater extraction and injection through wells, use of imported water for groundwater replenishment, wastewater reclamation and water conservation efforts and activities throughout OCWD's service area.

The water year beginning on July 1, 2016, yielded an average of 18.00 inches of rainfall within OCWD's boundaries, which is approximately 134 percent of the long-term annual average of 13.40 inches. Rainfall data within OCWD's boundaries was provided by the Orange County Public Works Department for precipitation stations number 5, 61, 88, 96, 121, 163, 165, 169, 173, 219 and 229. The previous water year (2015-16) had rainfall equaling 8.40 inches. The average annual rainfall in the OCWD service area for the five-year period (from July 1, 2012 through June 30, 2017) was 9.05 inches, and below-average rainfall in the watershed tends to lead to lower flows in the SAR reaching Orange County. Stream flow in the SAR measured downstream of Prado Dam for the water year 2016-17 totaled 197,011 AF which was approximately 87 percent of the 30-year flow average of 225,233 AF.

GROUNDWATER PRODUCTION

Groundwater production from wells within OCWD for the 2016-17 water year totaled 301,637 AF (excluding In-Lieu Program water, MWD Groundwater Storage Program extractions, and any groundwater used for the Talbert Barrier): 300,048 AF for non-irrigation and 1,589 AF for irrigation uses. The term "irrigation" used in the District Act and herein refers to irrigation for agricultural, horticultural or floricultural crops and for pasture grown for commercial purposes.

OCWD's In-Lieu Program replaces groundwater supplies with imported water to reduce groundwater pumping. During the 2016-17 water year, In-Lieu Program water was not available for purchase from MWD. Annual groundwater production and In-Lieu quantities within OCWD for the period 1967-68 through 2016-17 are presented in Figure 1 and Table 1.

Groundwater production for 2016-17 for the major groundwater producers is summarized in Appendix 1. Groundwater production for all producers exceeding 25 AF per year for non-irrigation and irrigation purposes is presented in Appendices 2 and 3, respectively.

FIGURE 1. Groundwater Production

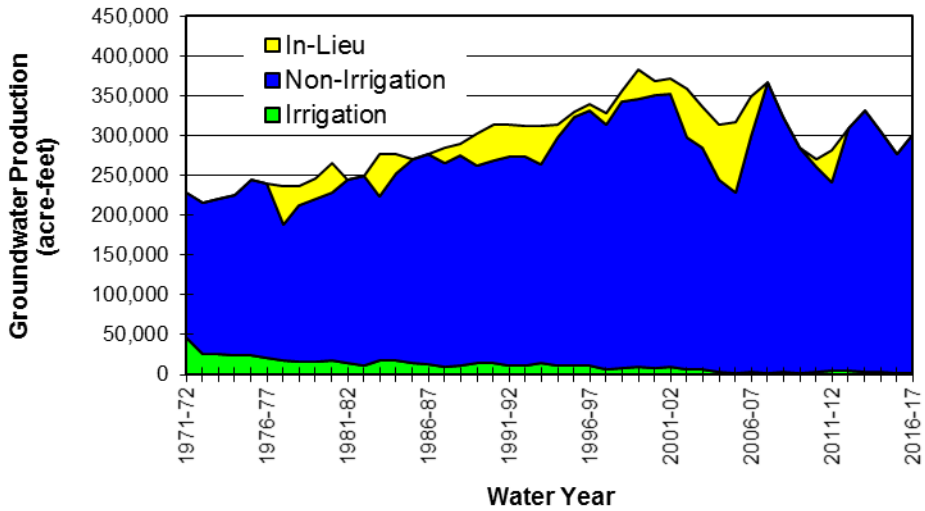


TABLE 1. Historical Groundwater Production Within OCWD

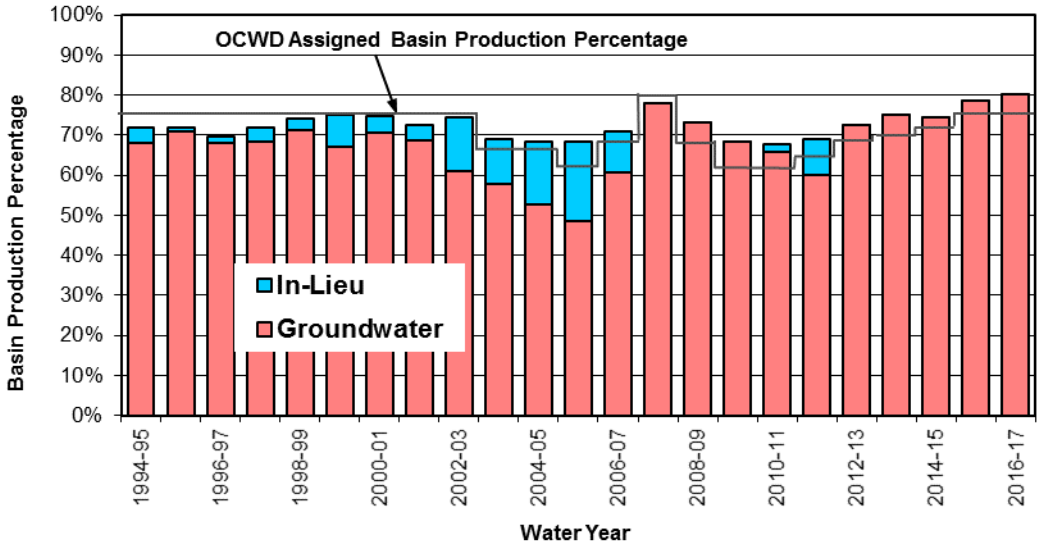
Water Year Jul 1-Jun 30	Groundwater Production (AF)	In-Lieu Program (AF)	Water Year Jul 1-Jun 30	Groundwater Production (AF)	In-Lieu Program (AF)
1967-68	193,656	-	1992-93	273,587	38,900
1968-69	178,798	-	1993-94	264,159	48,134
1969-70	194,379	-	1994-95	298,217	15,622
1970-71	203,923	-	1995-96	324,111	5,542
1971-72	229,048	-	1996-97	331,406	7,883
1972-73	214,983	-	1997-98	313,805	15,096
1973-74	218,863	-	1998-99	342,823	13,352
1974-75	225,597	-	1999-00	345,362	38,007
1975-76	245,456	-	2000-01	350,385	18,640
1976-77	243,511	-	2001-02	352,113	19,473
1977-78	188,407	48,290	2002-03	297,191	61,463
1978-79	213,290	23,792	2003-04	284,621	52,168
1979-80	221,453	24,861	2004-05	244,370	69,617
1980-81	228,943	36,373	2005-06	228,159	89,216
1981-82	244,184	-	2006-07	299,118	50,740
1982-83	249,548	-	2007-08	366,185	-
1983-84	223,207	52,822	2008-09	324,147	-
1984-85	252,070	25,198	2009-10	285,575	-
1985-86	270,932	-	2010-11	259,861	10,435
1986-87	276,354	-	2011-12	241,082	40,564
1987-88	265,226	18,856	2012-13	309,295	-
1988-89	275,077	15,022	2013-14	330,782	-
1989-90	261,190	38,961	2014-15	305,259	-
1990-91	266,745	44,588	2015-16	277,090	-
1991-92	271,224	39,789	2016-17	301,637	-

BASIN PRODUCTION PERCENTAGE

The Basin Production Percentage (BPP) is defined in the District Act as "…*the ratio that all water to be produced from groundwater supplies within the district bears to all water to be produced by persons and operators within the district from supplemental sources as well as from groundwater within the district.*" The BPP applies only to water producers that utilize more than 25 AF of groundwater per water year. Water producers that use 25 AF or less from the groundwater basin are excluded from the production percentage limitation.

The BPP for the 2016-17 water year was established at 75.0 percent by the OCWD Board of Directors. The overall BPP achieved within OCWD for non-irrigation use in the 2016-17 water year was 80.3 percent. The achieved pumping is greater than 75.0 percent primarily due to additional extraction from several water quality projects that are given a Basin Equity Assessment (BEA) exemption to pump groundwater above the BPP. The production percentage achieved by each major producer for non-irrigation use is presented in Appendix 1. Historical assigned and achieved BPPs are illustrated below in Figure 2.

FIGURE 2. Groundwater BPP



GROUNDWATER LEVELS

Groundwater levels in the Orange County groundwater basin are shown on Plate 1. Groundwater level data used to prepare this plate were collected during late June and early July 2017 from over 500 production and monitoring wells screened within the

principal aquifer system (approximately 300 to 1,200 feet deep), from which over 90% of basin pumping occurs. The groundwater elevation contours range from 30 to 90 feet below mean sea level in the coastal area of the basin due to pumping. A general indicator of changing basin levels is the location of the zero (0) mean sea level (MSL) elevation contour each year (MSL elevations are referenced to Vertical Datum NGVD 29). The zero MSL contour moved slightly seaward (ranging from 0.1 to 0.8 miles) when compared to its alignment the prior year, indicating an increase in groundwater levels in the Principal aquifer system from June 2016 to June 2017.

Plate 2 shows the change in groundwater levels from June 2016 to June 2017 for the Principal aquifer system. In the Principal aquifer, groundwater levels rose throughout most of the groundwater basin, except in the Irvine Sub-basin where they remained stable.

Key well groundwater elevation trends throughout the groundwater basin are illustrated in Plate 3.

Below is a general overview of the change in groundwater levels from June 2016 to June 2017 for the three primary aquifer systems of the basin.

Shallow Aquifer Groundwater Levels:

In the shallow aquifer, groundwater levels rose throughout most of the basin from June 2016 to June 2017 except for a very small decline in the Irvine Sub-basin and a localized decline of 5 to 10 feet immediately adjacent to the SAR in the vicinity of the OCWD recharge facilities in Anaheim and a localized decline of 5 feet around Burris Basin.

The localized decline along the managed portion of the SAR was due to reduced recharge in the Off-River channel in May and June of 2017 coinciding with the annual water level measurement in late June. Recharge in the Off-River channel during May and June of 2017 was only 10% of what it was for those two months of the prior year due to OCWD construction activities (weir pond improvements and new trash racks near Imperial Highway). During construction, managed recharge within the SAR was intentionally constrained to the far southern side of the channel.

Shallow aquifer groundwater levels were also approximately 5 feet lower in a small localized area immediately surrounding Burris Basin, likely due to June 2017 recharge in that facility being only about half of what it was in June 2016.

In the Irvine Sub-basin, Shallow aquifer groundwater levels remained unchanged in some areas and nominally declined less than 2 feet in other areas.

With the exception of along the SAR as mentioned above, Shallow aquifer groundwater levels rose approximately 10 to 15 feet in the Anaheim Forebay in the general vicinity of

the OCWD recharge facilities and as much as 20 feet surrounding new La Palma Basin which went into service in November 2016. In the Fullerton area farther west of the OCWD recharge facilities, Shallow aquifer groundwater levels rose 5 to 10 feet.

In the Orange Forebay area, Shallow aquifer groundwater levels rose 10 to 20 feet but more than 30 feet immediately surrounding the Santiago Basins, likely due to additional managed recharge there in June 2017 as compared to June 2016 but also due to increased incidental recharge from the adjacent mountain-front area. The increased incidental recharge appeared to have a more pronounced effect in the Santiago area as compared to the Irvine Sub-basin described above likely because of the large drainage area of upper Santiago Creek that funnels down through Santiago Canyon.

The groundwater level rise was only 2 to 3 feet throughout most of the Pressure area (i.e., in the central portion of the basin), the coastal area, and in the west Orange County area near the boundary with Los Angeles County.

In the Talbert Barrier area, Shallow aquifer groundwater levels remained approximately the same from June 2016 to June 2017, likely due to both barrier injection and coastal groundwater production being relatively unchanged. Barrier injection operations were able to maintain protective groundwater elevations sufficiently above mean sea level seaward of the barrier for the majority of water year 2016-17 to prevent seawater intrusion.

Principal Aquifer Groundwater Levels:

In the Principal aquifer, groundwater levels rose approximately 10 to 15 feet throughout most of the basin, but similar to the Shallow aquifer, declined approximately 5 feet in the vicinity of the SAR near the OCWD recharge facilities in Anaheim and also declined slightly in some portions of Irvine, Santa Ana, Tustin, and the Newport Mesa area.

Throughout most of the Irvine Sub-basin, Principal aquifer groundwater levels declined approximately 5 feet, except in the vicinity of the Irvine Desalter Project wells where groundwater levels rose approximately 5 feet. The gradual decline in Principal aquifer groundwater levels in the Irvine area was somewhat less this year than in the prior five drought years.

Just west of the Irvine Sub-basin, Principal aquifer groundwater levels declined 5 to 10 feet due to pumping from a new City of Tustin production well T-ED. There were also a couple localized areas having a small groundwater level decline in Santa Ana and in the Newport Mesa area, likely due to temporal variations in pumping relative to the prior water year.

For the majority of the basin, the moderate rise of 10 to 15 feet in Principal aquifer

groundwater levels overshadowed these isolated areas with mild declines. Principal aquifer groundwater levels rose approximately 20 feet in the immediate vicinity of new La Palma Basin in Anaheim, similar to the rise in the Shallow aquifer and confirming the unimpeded hydraulic connection between the Shallow and Principal aquifers in this area. Principal aquifer groundwater levels rose a maximum of 40 feet surrounding the Santiago Basins in the Orange Forebay area similar to what was described for the Shallow aquifer.

Principal aquifer groundwater levels rose approximately 5 to 8 feet throughout the western portion of the basin (e.g., Buena Park, Garden Grove, Westminster, Huntington Beach, Los Alamitos, and Seal Beach) and less than 5 feet farther west across the county line in the Cerritos and Long Beach areas. The lesser rise in Principal aquifer groundwater levels in the Cerritos/Long Beach area relative to west-central Orange County indicated that the gradient towards Los Angeles County was slightly steeper in June 2017 than in June 2016 and thus the groundwater outflow during water year 2016-17 was likely higher than the prior water year. Simulations using the OCWD basin model indicated a 10% increase in the outflow to Los Angeles County relative to the prior water year.

In the immediate vicinity of the west end of the Talbert Barrier in Huntington Beach, Principal aquifer groundwater levels rose 20 to 30 feet, which was more than double the rise throughout the greater coastal area. This larger rise was relatively localized and likely due to increased Talbert Barrier injection into the lower Principal aquifer (Main aquifer) for replenishing the basin as compared to the prior year when barrier injection was more prioritized into the shallower aquifer zones susceptible to seawater intrusion during the drought and lower basin conditions.

Slightly to the northeast of the Talbert Barrier, Principal aquifer groundwater levels in the Irvine Ranch Water District (IRWD) Dyer Road Well Field (DRWF) area rose only 5 feet or less from June 2016 to June 2017.

Deep Aquifer Groundwater Levels:

In the deep aquifer, groundwater level changes from June 2016 to June 2017 were very similar to those in the Principal aquifer but more subtle in most areas. Deep aquifer groundwater levels rose 5 to 10 feet throughout most of the Forebay area and rose 3 to 5 feet throughout most of the Pressure area of the basin.

In the Irvine Sub-basin, Deep aquifer groundwater levels declined 5 feet or less in the western portion but rose by 5 feet or less in the northeast portion closer to the Santa Ana Mountains, possibly due to increased subsurface incidental recharge occurring at depth resulting from above-average rainfall.

Similar to the western portion of the basin, Deep aquifer groundwater levels farther west in the Central Basin in the Cerritos and Long Beach areas also rose approximately 3 to 5

feet. The equivalent rise on both sides of the county line indicated no significant change in the gradient towards LA County and thus groundwater outflow across the county line in the Deep aquifer during water year 2016-17 was likely relatively similar to the prior water year, supported by OCWD basin model simulations indicating an insignificant increase of less than 2%.

COASTAL GROUNDWATER CONDITIONS

The coastal portion of the groundwater basin, essentially that area within five miles of the coast, is sensitive to seawater intrusion potential and seasonal effects on production well capacity due to lower groundwater levels. Coastal groundwater levels are affected by groundwater production, overall groundwater storage in the basin, and, to a somewhat lesser extent, injection at the Talbert and Alamitos barriers.

Coastal groundwater production for water year 2016-17 totaled 95,168 AF (includes Fountain Valley, Huntington Beach, IRWD DRWF and Deep Aquifer Treatment System wells, Mesa Water, Newport Beach, OCWD deep wells in Fountain Valley, Seal Beach, and Westminster). Total coastal groundwater production for water year 2016-17 was approximately the same as the prior water year despite a basin-wide 6.2% increase in total demand and an unchanged BPP of 75%. A slight pumping increase by most coastal producers during water year 2016-17 was offset by reduced pumping from Huntington Beach and Westminster. Westminster's pumping was higher the prior water year due to over-pumping for the MWD CUP program. Mesa Water nearly doubled their colored water pumping (wells MCWD-6 and MCWD-11) during water year 2016-17 but partially offset this increase by reducing their clear water pumping. The Coastal Pumping Transfer Program was not continued during water year 2016-17.

Talbert Barrier injection totaled 33,255 AF for water year 2016-17, representing a decrease of 5.6% from the prior water year. The decrease was primarily due to lower injection in February, March, and April of 2017 stemming from the wet winter in which coastal pumping was reduced and coastal groundwater levels rose markedly. As such, the higher groundwater conditions reduced the amount of injection necessary to maintain protective elevations seaward of the barrier.

A key OCWD monitoring well M26 is located near Adams Avenue seaward of the barrier. Shallow aquifer groundwater levels were maintained at or slightly above protective elevations of approximately 3 feet above MSL during water year 2016-17, with the exception of a brief period in September 2016 due to a three-day shutdown of the GWRS, after which groundwater elevations quickly recovered back to protective elevations at M26. The low coastal pumping amounts in the winter/spring of water year 2016-17 corresponded to lower Talbert Barrier injection those same months, illustrating the connection between coastal pumping and the amount of barrier injection required to stably maintain groundwater levels at or slightly above protective elevations seaward of

the barrier at key well M26.

Monthly groundwater production in the coastal area had slightly more seasonal fluctuation in water year 2016-17 than the prior water year but was similar to previous years. Coastal production reached a high of approximately 10,000 AF in August 2016 and a low of approximately 5,400 AF in February 2017.

As with prior years, pumping from the IRWD Dyer Road Well Field followed a typical demand curve during water year 2016-17, while pumping from the IRWD Deep Aquifer Treatment System (colored water) wells was nearly constant year-round. In contrast, pumping from Mesa Water wells 6 and 11 into Mesa's colored water treatment plant (Mesa Water Reliability Facility) was somewhat seasonally variable with reduced pumping from December 2016 through March 2017. Pumping from the Mesa Water clear wells was more stable with only a slight reduction during the winter months of water year 2016-17. Huntington Beach pumping also followed a typical demand curve during water year 2016-17 with considerably lower pumping during the winter and early spring months when demand was especially low due to the wet winter.

At the Alamitos Barrier, the OCWD portion of injection totaled 1,166 AF for water year 2016-17, representing 51% less than the prior water year. Barrier injection was lower during water year 2016-17 due to higher groundwater levels stemming from the wet winter but also due to well drilling and construction activities for the Alamitos Barrier Improvement Project in which existing injection wells adjacent to the well drilling had to be taken off-line. The injection total included all sources of water (67% imported and 33% recycled for water year 2016-17) but only represents OCWD's share, which is less than half of the total injection based on the location of the barrier wells that lie within both Los Angeles and Orange counties. A supply goal of Alamitos Barrier injection has been an approximately 50/50 blend of imported and recycled water. However, the recycled portion was lower the last four years because of Leo J. Van der Lans treatment plant shutdowns related to plant operational issues and wastewater supply interruptions from the Los Angeles County Sanitation District's Long Beach treatment plant.

ANNUAL OVERDRAFT

Annual groundwater basin overdraft, as defined in the District Act, is the quantity, determined by the Board of Directors, by which the production of groundwater supplies within the District during the water year exceeds the natural replenishment of such groundwater supplies in such water year. This difference between extraction and replenishment can be estimated by determining the change in volume of groundwater in storage that would have occurred had supplemental and recycled water not been used for any groundwater recharge purpose, including seawater intrusion protection, advanced water reclamation and the In-Lieu Program.

For the 2016-17 water year, it is estimated that the volume of groundwater in storage increased by 51,000 AF. Approximately 149,000 AF of water was supplied to the basin as follows: 1) directly from the percolation or injection of purchased imported water from the Colorado River and State Water Project (SWP), 2) use of recycled water to supplement purchased imported water in the Alamitos seawater intrusion barrier, and 3) use of GWRS recycled water for basin replenishment. Therefore, the annual overdraft was 98,000 AF for the 2016-17 water year. For the five-year period from July 1, 2012 to June 30, 2017, an annual average of approximately 126,000 AF of supplemental water and recycled water was percolated or injected into the underground basin for replenishment or used directly in place of pumping groundwater (i.e., In-Lieu Program). The average annual overdraft during the same five-year period was approximately 156,000 AF.

GROUNDWATER BASIN ACCUMULATED OVERDRAFT

The accumulated overdraft, as defined in the District Act, is the quantity of water needed to be replaced at OCWD's intake area to prevent landward movement of ocean water into the fresh groundwater body. Landward movement of ocean water can be prevented if groundwater levels near the coast are several feet above sea level. Groundwater levels along the coast are related to the volume of water stored in the intake area, water pumped from the entire basin and the pattern or location of pumping. However, the Talbert and Alamitos seawater intrusion control projects have been implemented to prevent landward movement of ocean water into the fresh groundwater body. Due to the operation of seawater intrusion barrier facilities, there is no longer a direct correlation between accumulated overdraft and controlling seawater intrusion. These facilities allow greater utilization of the storage capacity of the groundwater basin. OCWD is also dedicated to maximizing its replenishment capabilities by actively negotiating with the U.S. Army Corps of Engineers to increase its water conservation program behind Prado Dam and implementing a Long-Term Facilities Plan to evaluate cost-effective improvements to its groundwater recharge capabilities.

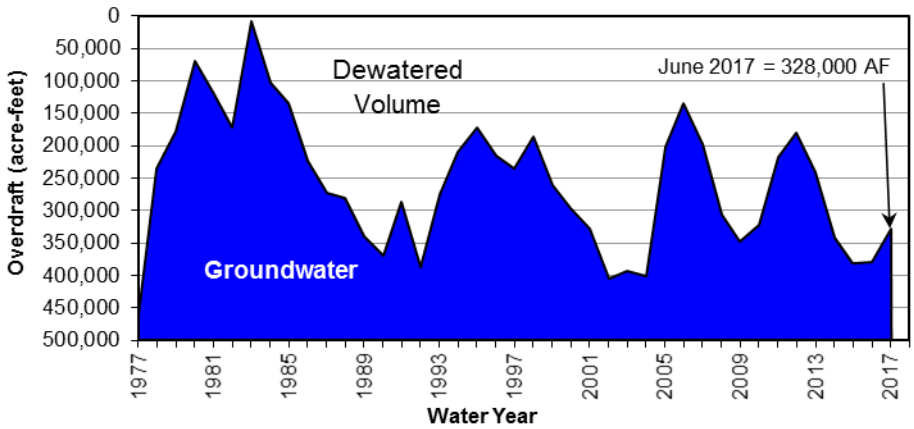
In February 2007, OCWD staff completed a report entitled "Evaluation of Orange County Groundwater Basin Storage and Operational Strategy." This report presented a new methodology that had been developed, tested, and documented for calculating accumulated overdraft and storage change based on a three-aquifer layer approach. Furthermore, the report provided the basis for calculating accumulated overdraft using a new full-basin benchmark that was developed for each of the three aquifer layers, which in effect replaces the traditional single-layer full benchmark of 1969.

The annual analysis of basin storage change and accumulated overdraft for water year 2016-17 has been completed. Based on the three-layer methodology, an accumulated overdraft of 328,000 AF was calculated for the water year ending June 30, 2017. The accumulated overdraft for the prior water year ending June 30, 2016 was 379,000 AF (also calculated using the three-layer storage method). Therefore, an annual increase of 51,000

AF (reported earlier herein this report) in stored groundwater was calculated as the difference between the June 2016 and June 2017 accumulated overdrafts.

Figure 3 shows the accumulated basin overdraft quantities for the period 1977 through 2017.

FIGURE 3. Accumulated Basin Overdraft



The accumulated overdraft for the current water year ending on June 30, 2018 is projected to be 287,000 AF. The annual overdraft is estimated to be 201,000 AF. This quantity is based on assumed annual groundwater production of approximately 321,000 AF for the current water year (including groundwater pumping within the BPP, In-Lieu Program water, groundwater pumped above the BPP from water quality improvement projects and MWD Groundwater Storage Program extractions) and that natural replenishment (including captured SAR flows and incidental recharge) is estimated to be approximately 120,000 AF for the basin under below-average rainfall conditions. In addition, GWRS production is projected to reach 103,000 AF.

Projected annual overdraft for the ensuing water year (2018-19) is estimated to be 164,000 AF. This estimate is based on the assumption that total annual groundwater production for the ensuing water year will be 322,000 AF, a figure that is based upon an assumed BPP of 77 percent and includes 22,000 AF of production above the BPP from water quality improvement projects (discussed further in the subsequent section entitled Recommended Basin Production Percentage). The natural replenishment is estimated to be 158,000 AF (average of last five years) under below-average rainfall conditions, and the GWRS production is projected to be 103,000 AF.

OCWD, MWD, the Municipal Water District of Orange County (MWDOC) and participating producers approved the funding agreement for the MWD Long-Term

Groundwater Storage Program on June 25, 2003. This conjunctive use program (also informally referred to as MWD CUP) provides for MWD to store up to 66,000 AF in the OCWD groundwater basin to be pumped (less basin losses) by participating producers in place of receiving imported supplies during water shortage events. A compensation package from MWD was included in the agreement to build eight new groundwater production wells, improvements to the seawater intrusion barrier, construction of the Diemer Bypass Pipeline and an annual administrative fee. The preferred means to store water in the MWD storage account has been through the In-Lieu deliveries to participating groundwater producers. Water into the MWD storage account has also been conducted through direct replenishment utilizing OCWD Forebay recharge basins. In any event, the water stored or extracted by MWD is considered as MWD supply and not groundwater production. During water year 2016-17, 1,556 AF were stored into the MWD Cyclic account via OCWD's recharge basins. The annual quantities and cumulative totals of MWD water stored since the inception of the program are shown in Appendix 4. It is important to note that the reported quantities do not include pumping extractions from the account or basin losses.

REPLENISHMENT RECOMMENDATION

Section 27(b) of the District Act states the following:

"*The total of the replenishment assessment levied in any year shall not exceed an amount of money found to be necessary to purchase sufficient water to replenish the average annual overdraft for the immediate past five water years plus an additional amount of water sufficient to eliminate over a period of not less than 10 years nor more than 20 years, the accumulated overdraft, plus an amount of money to pay the costs of initiating, carrying on, and completing any of the powers, projects and purposes for which this district is organized.*"

Based upon Section 27(b), that portion of the RA that is used for water purchases for the ensuing water year 2018-19 is limited to the amount needed to purchase 189,000 AF as calculated below:

Five-year (7/1/2012 through 6/30/2017) Average Annual Overdraft*	= 156,000 AF
Accumulated Overdraft (End of Water Year 2016-17)	= 328,000 AF
Assumed Time Period to Eliminate Accumulated Overdraft	= 10 years
Potential Water Purchase Amount: 156,000 AF + (328,000 AF/10 years)	= 188,800 AF (use 189,000 AF)

**Referred to as the Average Annual Overdraft in Section 27(b) of the District Act.*

Table 2 presents the proposed 2018-19 budget for water purchases, which shows the proposed quantity of purchased water (80,000 AF) being significantly less than the prescribed limit of 189,000 AF as allowed for under the provisions of Section 27(b) of the District Act.

TABLE 2. 2018-19 Budget for Water Purchases

Water Source	AF	Rate ($/AF)*	Total Cost ($)
Alamitos Barrier	2,000	$1,148.00	$ 2,296,000
Payment for 100,000 AF In-Lieu Water	13,000	$695.00	$ 9,035,000
MWD Untreated Non-interruptible Water	65,000	$713.00	$46,345,000
Water Purchases Sub-total	80,000	—	$57,676,000
Applicable Charges			**Total Cost ($)**
MWDOC Surcharge	—	—	$ 499,002
MWD/MWDOC Capacity Charge	—	—	$ 900,000
MWD/MWDOC RTS Charge	—	—	$ 2,500,000
Additional Charges Sub-total	—	—	$ 3,899,002
TOTAL WATER PURCHASES COST	80,000	—	$61,575,002

* Rates include required MWDOC Capacity and Readiness to Serve (RTS) charges where appropriate.

RECOMMENDED BASIN PRODUCTION PERCENTAGE

In December 2002, OCWD approved a basin management approach for determining the BPP for future water years. The management approach is based upon the development of a base amount of groundwater production the basin can annually sustain utilizing dependable water supplies OCWD expects to receive. It is a policy for OCWD to provide an estimate of the BPP each January for the following fiscal year to assist the groundwater producers in the preparation of their annual budgets.

A BPP of 77 percent is currently being proposed for the ensuing water year 2018-19. Analysis of the groundwater basin's projected accumulated overdraft, the available supplies to the basin (assuming below-average hydrology) and the projected pumping demands indicate that this level of pumping could potentially be sustained for 2018-19 without detriment to the basin.

A BPP of 77 percent corresponds to approximately 322,000 AF of groundwater production which includes 22,000 AF of groundwater production above the BPP to account for several groundwater quality enhancement projects (see description below).

In order to achieve water quality objectives in the groundwater basin, it is estimated for the ensuing water year 2018-19 that additional production of approximately 22,000 AF (above the BPP) will be undertaken by the City of Tustin, City of Garden Grove, Mesa Water District and IRWD. These agencies need the additional pumping allowance in order to accommodate groundwater quality improvement projects. As in prior years, production above the BPP from these projects would be partially or fully exempt from the BEA as a result of the benefit provided to the basin by removing poor-quality groundwater and treating it for beneficial use.

In March 2018, staff will review with the OCWD Board of Directors the basis and the assumptions made for the proposed BPP and receive any direction on the matter. In April 2018, staff will again apprise the OCWD Board of Directors on the status of the aforementioned conditions. If the estimates of basin supplies in the current or ensuing year are substantially different than those contained in the respective conditions, a revised BPP may then be recommended.

The proposed BPP is calculated as follows:

$$\text{Numerator} = \boxed{\begin{array}{c}\text{Groundwater}\\ \text{Projected to}\\ \text{be Produced}\\ \text{322,000 AF}\end{array}} - \boxed{\begin{array}{c}\text{Water Quality}\\ \text{BEA Exempt}\\ \text{Pumping Above}\\ \text{BPP}\\ \text{22,000 AF}\end{array}} = \text{300,000 AF}$$

$$\text{Denominator} = \boxed{\begin{array}{c}\text{Groundwater}\\ \text{Production}\\ \text{322,000 AF}\end{array}} + \boxed{\begin{array}{c}\text{Supplemental}\\ \text{(Imported and}\\ \text{Santiago Creek}\\ \text{Native Water)}\\ \text{68,000 AF}\end{array}} = \text{390,000 AF}$$

$$\text{BPP} = \frac{\text{Groundwater}}{\begin{array}{c}\text{Groundwater}\\ \text{Plus}\\ \text{Supplemental}\end{array}} = \frac{\text{Numerator}}{\text{Denominator}} = \frac{\text{300,000 AF}}{\text{390,000 AF}} = \text{77 \%}$$

PART II: WATER SUPPLY AND BASIN UTILIZATION

Section 31.5 of the District Act requires an investigation and annual report setting forth the following information related to water supply and basin utilization within the OCWD service area, together with other information as OCWD may desire:

WATER SUPPLY AND BASIN UTILIZATION
2016-17 SUMMARY OF FINDINGS

1. Water usage from all supplemental sources and non-local water sources (if any) totaled 120,229 AF for the 2016-17 water year including any available In-Lieu Program water (none for 2016-17).

2. Water usage from recycled water produced from within OCWD including the GWRS totaled 115,501 AF for the 2016-17 water year.

3. Water demands within OCWD totaled 388,851 AF for the 2016-17 water year.

4. Estimated demands for groundwater for the ensuing 2018-19 water year are 322,000 AF.

SUPPLEMENTAL WATER

Supplemental water is used by water agencies within OCWD's boundary to augment groundwater supplies in satisfying their user demands and by OCWD to recharge the groundwater basin. Supplemental water, as defined in Section 31.5 of the District Act, is any water that originates from outside the SAR watershed (comprised of an area of 2,081 square miles) with the exception of water that originates within the portion of the Santiago Creek watershed that lies upstream of Villa Park Dam which is counted as supplemental water. It is important to note that the Santiago Creek watershed lies entirely within the SAR watershed. Sources of supplemental water typically include imported deliveries from MWD and diversions from Irvine Lake/Santiago Reservoir (i.e., Santiago Creek) that are conveyed to users within OCWD boundaries. MWD deliveries originate from either the Colorado River or the SWP. In addition, supplemental water would also include deliveries from within the SAR watershed that involve water exchanges (i.e., releasing a quantity of water that originates from within the SAR watershed while importing an equal quantity of supplemental water to replace it).

Non-local waters are defined, for the purposes of this report, as waters purchased from agencies outside of OCWD's boundary for use within OCWD. Non-local waters include al water deliveries to OCWD where the water source is located within the SAR watershed. Water deliveries to OCWD from the Arlington Desalter in Riverside and the San Bernardino Valley Municipal Water District's High Groundwater Mitigation Project are considered non-local waters. Both projects involve pumping (and treatment in Arlington's case) and release of groundwater from the SAR upstream groundwater basins to OCWD via the SAR for groundwater replenishment at OCWD Forebay recharge facilities. For the purpose of being consistent with previous Engineer's Reports and to present information in a concise manner, non-local water deliveries that are purchased and used by OCWD for groundwater replenishment are included in the supplemental water totals in this report. However, while accounted for in the supplemental water totals in this Engineer's Report for convenience and consistency purposes, these non-local waters are not supplemental sources of water as defined in Section 31.5 of the District Act because the non-local waters originate within the SAR watershed. These non-local water deliveries are not included in the accounting of supplemental sources that address water demands within OCWD as shown in Table 5.

Recycled wastewater produced and used within OCWD is considered, for the purposes of this report, as neither non-local water nor supplemental water (sometimes referred to as neutral water). Therefore, recycled water that originates from within OCWD is reported separately from supplemental water totals. However, recycled water used in the Alamitos Barrier is supplied by Water Replenishment District of Southern California (WRD) and originated from outside the SAR watershed, and, as such, is categorized as supplemental water.

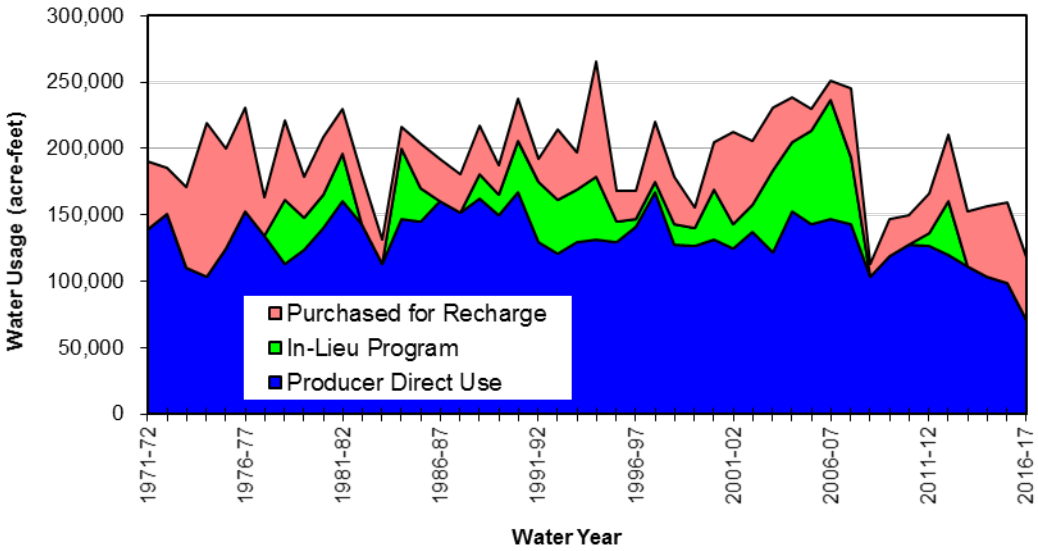
Water agencies utilizing supplemental water are listed in Appendix 1. As summarized in Table 3, the use of supplemental water in OCWD's service area during the 2016-17 water year totaled 120,229 AF of which 68,581 AF resulted from the direct use by water agencies and districts and 51,648 AF (including any available In-Lieu Program water) were used for groundwater replenishment purposes. The supplemental water used by water agencies included 68,581 AF for municipal and industrial use and zero AF for agricultural purposes. Historical supplemental water usage is illustrated in Figure 4. The GWRS delivered recycled water to OCWD Forebay recharge basins and the Talbert seawater intrusion barrier throughout the 2016-17 water year. A breakdown of non-local water purchases by OCWD for 1997-98 through 2016-17 is presented in Appendix 4.

TABLE 3. 2016-17 Supplemental Water Usage

Direct Agency Use	**AF**
Imported Water[1]	66,385
Santiago Creek Native Water	2,196
Subtotal	**68,581**
Groundwater Replenishment (Purchased)	**AF**
In-Lieu Program[2]	0
Forebay Recharge[3]	50,474
Alamitos Barrier[4]	1,166
Talbert Barrier	8
Subtotal	**51,648**
TOTAL	**120,229**

[1]Includes extractions from MWD Groundwater Storage Program.
[2]Any amount reported herein includes water received by OCWD's groundwater producers as In-Lieu water.
[3]Full service rate untreated water.
[4]Total amount combines imported and recycled water deliveries.

FIGURE 4. Historical Supplemental Water Usage



Recycled water use within OCWD is presented in Table 4 (excluding WRD-supplied recycled water to the Alamitos Barrier because this water is categorized as supplemental water and already included in the total amount reported in Table 3). The major uses of recycled water are groundwater replenishment (including Kraemer, Miller, Miraloma and La Palma recharge basins and Talbert Barrier injection wells) and supply water for irrigation and industrial users.

TABLE 4. 2016-17 Recycled Water Usage

Groundwater Replenishment	Water Usage (AF)
GWRS AWPF (for Talbert Barrier)	33,247
GWRS AWPF (for Recharge Basins)[1]	62,058
GWRS AWPF (for Mid-Basin Injection)	1,563
Subtotal	**96,868**
Irrigation	**Water Usage (AF)**
IRWD[2]	15,067
OCWD (Green Acres Project)[3]	3,566
Subtotal	**18,633**
TOTAL	**115,501**

[1]Includes 92 AF of GWRS recycled water delivered to City of Anaheim Canyon Power Plant and Anaheim Regional Transportation Intermodal Center (ARTIC).
[2]Recycled water used within the portion of OCWD that lies within IRWD's boundaries (excludes OCWD/IRWD intertie water deliveries to the Green Acres Project).
[3]Excludes deliveries to the Orange County Sanitation District and includes IRWD/OCWD Intertie deliveries to the Green Acres Project.

AVAILABILITY OF SUPPLEMENTAL REPLENISHMENT WATER

MWD provided untreated full service water supplies to its groundwater-basin agencies during the water year 2016-17 as a result of a normal allocation of State Project Water and above-normal rainfall condition. The availability of supplemental water from MWD to recharge the groundwater basin in the ensuing water year is uncertain at this time as MWD may or may not receive a normal allocation of State Project Water.

WATER DEMANDS

During the 2016-17 water year, the total water demands within OCWD's service area were 388,851 AF. Total demands include the use of groundwater, MWD In-Lieu Program water, supplemental sources (including imported water and Santiago Creek native water) and recycled water (which is not included within supplemental sources if originating within the SAR watershed). Total demands exclude any groundwater, supplemental water and recycled water (such as the GWRS recycled water) used by OCWD for groundwater recharge and water conservation credits given to groundwater producers for their conservation efforts.

Water demands for 2016-17 and projected water demands for 2017-18 and 2018-19 are summarized in Table 5. The water demands for the current year 2016-17 were determined by assessing the data that is presently available for the first half of the water year and projecting that data to develop the total annual demands. The water demands for the ensuing year 2018-19 are based on the projections provided by the retail water agencies within OCWD's service area. Long-term projections are presented in Figure 5.

TABLE 5. Water Demands Within OCWD

	Ground-water[1]	Imported Water[2,3]	Santiago Creek Native Water[3]	Recycled Water[4]	Total[6]
2016-17					
Non-Irrigation	300,048	66,385	2,196	-	368,629
Irrigation	1,589	-	-	18,633	20,222
Total	**301,637**	**66,385**	**2,196**	**18,633**	**388,851**
2017-18 (Current Year)[5]					
Non-Irrigation	319,400	51,800	2,200	-	373,400
Irrigation	1,600	-	-	19,000	20,600
Total	**321,000**	**51,800**	**2,200**	**19,000**	**394,000**
2018-19 (Ensuing Year)[5]					
Non-Irrigation	320,300	66,000	2,000	-	388,300
Irrigation	1,700	-	-	20,000	21,700
Total	**322,000**	**66,000**	**2,000**	**20,000**	**410,000**

[1] *Includes In-Lieu Program water, if available. Also includes groundwater pumped under water quality improvement agreements entered into between OCWD and certain producers pursuant to Section 38.1 of the District Act where the produced groundwater is exempted from payment of all or a portion of the BEA. The BEA-exempt groundwater is deducted from the projection of total groundwater used to calculate the BPP.*

[2] *Excludes water conservation credits and imported water used for groundwater replenishment.*

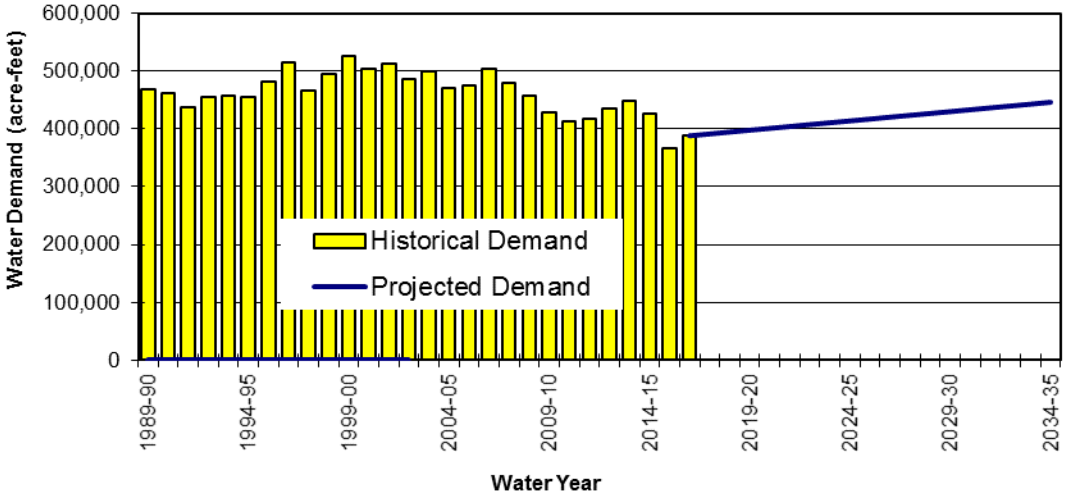
[3] *"Imported Water" and "Santiago Creek Native Water" are both counted as supplemental water.*

[4] *Excludes GWRS recycled water recharged into the groundwater basin. Includes recycled water from IRWD and OCWD's Green Acres Project (excluding OCSD's usage).*

[5] *Water demands are estimated by OCWD assuming average hydrology.*

[6] *Includes all groundwater and non-groundwater sources, and is greater than the amount of supplemental sources used in the calculation of BPP. For purposes of this table, supplemental water is calculated as the sum of Imported Water and Santiago Creek Native Water, and does not include Recycled Water.*

FIGURE 5. Water Demand Projections



WATER DEMAND FORECAST

OCWD participates with MWDOC and retail groundwater producers to predict future demands in OCWD's service area. Each groundwater producer projected its total water demands to the year 2035. These projections include the effect of local water conservation efforts. Figure 5 illustrates the historical and the projected water demands for OCWD's service area to the year 2035.

Population within OCWD's service area is expected to increase from the current 2.28 million people (based on Census 2010 demographic data) to approximately 2.6 million people by the year 2035. This population growth is expected to increase water demands from the current 388,851 AF per year to 447,000 AF per year in 2035 (a water demand projection that takes into consideration future water conservation savings). In an effort to support increasing water demands, OCWD will look to increase basin production by operating the existing GWRS, maximizing the current AWPF production capacity, capturing more SAR storm flows, expanding the production of GWRS to its ultimate capacity (with the assumption that additional wastewater flows are available), purchasing imported supplies for groundwater recharge whenever supplies are available, developing other local recycled water supplies for replenishment purposes, developing ocean desalination water supplies, and expanding recharge facilities.

ADVANCED WASTEWATER RECLAMATION

Groundwater, supplemental water and local surface water have historically been the primary water sources within OCWD. In recent decades, wastewater reclamation has increasingly become a significant source of additional water. Purified recycled water has

been produced by OCWD for use as injection water in the Talbert Barrier and as percolation water in Kraemer, Miller, Miraloma and La Palma recharge basins. OCWD and IRWD also recycle wastewater at their respective treatment plants for irrigation and industrial uses.

The GWRS is an advanced wastewater reclamation project jointly-funded by OCWD and the Orange County Sanitation District (OCSD). The project was operational in January 2008. The advanced treatment processes utilized in the GWRS consist of microfiltration (MF) followed by reverse osmosis (RO) membranes and ultraviolet (UV) light disinfection in combination with hydrogen peroxide. For water year 2016-17, the GWRS treated wastewater from the OCSD to drinking water standards and delivered 96,868 AF of purified water for direct injection into the Talbert seawater intrusion barrier and percolation into the OCWD groundwater basin via recharge basins and mid-basin injection (MBI) well.

For water year 2016-17, OCWD and IRWD recycled water deliveries for landscape irrigation and industrial uses in Fountain Valley, Costa Mesa, Huntington Beach, Newport Beach, Santa Ana and IRWD's service area within OCWD totaled 18,633 AF.

WRD operates a 3-MGD Alamitos Barrier Recycled Water Project, known as the Leo J. Vander Lans Water Treatment Facility. This project supplies highly treated recycled water to the Alamitos Barrier. The Leo J. Vander Lans advanced wastewater treatment facility located in Long Beach utilizes the treatment processes of MF, RO and UV light disinfection. Currently undergoing an expansion to 8 MGD, this project is ultimately intended to replace most of the imported water used to supply the Alamitos Barrier with purified recycled water. The project operated for twelve months during the water year 2016-17 and supplied 383 AF of purified recycled water to the Alamitos Barrier, which represented 33 percent of the barrier's supply that OCWD is responsible for payment. Recycled water deliveries from the Leo J. Vander Lans plant to the Orange County portion of the Alamitos Barrier are classified as supplemental water because this recycled water originates from outside the SAR watershed. It is noteworthy to mention that the Leo J. Vander Lans Water Treatment Facility is presently under expansion in an effort to increase its treatment capacity.

WATER QUALITY

OCWD maintains a comprehensive groundwater protection policy that includes water quality monitoring, removal of contaminants, regulatory agency support, toxic residuals removal and hazardous waste management. In addition, OCWD provides water quality information to regulatory agencies, other water agencies and the general public. In order to meet the current and future water quality testing requirements, OCWD operates the Advanced Water Quality Assurance Laboratory at the Fountain Valley campus. The laboratory houses approximately 30 chemists and laboratory technicians, 12 water quality

monitoring personnel and all the analytical instruments that are needed to perform more than 400,000 analyses of approximately 20,000 water samples taken each water year. The laboratory supports the extensive water quality testing requirements for the GWRS.

When blended together by the major agencies within OCWD's service area, the blended groundwater (without treatment) and treated supplemental water for 2016-17 was determined to have a flow-weighted average of 461 milligrams per liter (mg/L) of total dissolved solids (TDS) which is less than the average TDS concentration of 489 mg/L reported for the prior year (2015-16). The average groundwater TDS concentration for the basin for 2016-17 was 459 mg/L (compared to 449 mg/L reported for 2015-16), ranging from a low of 222 mg/L in coastal areas (such as Seal Beach) to a high of approximately 721 mg/L in certain inland areas.

Average concentrations of TDS, nitrate (NO_3) and hardness for groundwater and groundwater combined with supplemental water supplied by agencies within OCWD's service area during the 2016-17 water year are summarized in Table 6. These concentrations were determined from groundwater and supplemental water analyses and from production reports submitted to and filed with OCWD by each water agency. The City of Tustin and IRWD have active groundwater treatment projects that help to reduce certain constituents reported in Table 6 in their groundwater supply prior to service to their customers (see note 6 for detailed explanation).

WATER RESOURCES DATA

A summary of water resources data within OCWD for the 2016-17 water year and the previous water year (2015-16) is included in Appendix 5.

TABLE 6. 2016-17 Water Quality Summary

City/Agency	Groundwater[1,7]			Delivered Blend[1,2,7]		
	TDS[3]	NO_3-N[4]	Hard-ness[5]	TDS[3]	NO_3-N[4]	Hard-ness[5]
Anaheim	593	2.7	328	565	2.2	300
Buena Park	415	1.5	258	426	1.2	245
East Orange County Water District	588	3.7	344	557	2.8	306
Fountain Valley	382	1.4	264	384	1.4	262
Fullerton	488	2.4	246	483	1.8	234
Garden Grove	545	3.7	328	537	3.4	314
Golden State Water Company	409	1.7	229	421	1.4	223
Huntington Beach	423	0.9	238	443	0.6	221
Irvine Ranch Water District[6]	345*	0.9*	128*	348*	0.8*	130*
La Palma	308	ND[8]	142	362	ND[8]	162
Mesa Water District	365	0.3	98	367	0.3	99
Newport Beach	270	1.6	127	320	1.3	145
Orange	482	2.2	281	480	2.0	270
Santa Ana	395	2.2	240	413	1.8	230
Seal Beach	222	ND[8]	83	296	ND[8]	118
Serrano Water District	721	2.0	378	699	1.6	366
Tustin[6]	684*	6.8*	364*	660*	6.1*	346*
Westminster	360	1.4	228	386	1.1	221
Yorba Linda Water District	688	1.9	338	622	1.4	296
Weighted Average[7]	**459**	**2.0**	**242**	**461**	**1.7**	**234**

[1] *All groundwater results (alone or blend) are for untreated groundwater (see note 6 below). Units are reported in mg/L.*

[2] *Delivered blend includes untreated groundwater and treated imported MWD water (i.e., blend of Colorado River water and State Project water as measured at the MWD Diemer Plant), except Serrano Water District, which blends with treated Santiago Reservoir water. Units are reported in mg/L. Annual average water qualities for MWD and Santiago Reservoir (Irvine Lake) for 2016-17 are as follows:*

MWD Water Quality			Santiago Reservoir Water Quality		
TDS	=	*468 mg/L*	*TDS*	=	*635 mg/L*
$N0_3$-N	=	*0.3 mg/L*	*$N0_3$-N*	=	*0.4 mg/L*
Hardness (as $CaCO_3$)	=	*200 mg/L*	*Hardness (as $CaCO_3$)*	=	*334 mg/L*

[3] *Secondary Drinking Water Standards for TDS are as follows:*

500 mg/L = recommended limit
1,000 mg/L = upper limit

[4] *Primary Drinking Water Standard for nitrate NO_3-N (i.e., nitrate expressed as nitrogen) is 10 mg/L.*

[5] *Hardness is reported as mg/L of $CaCO_3$. General classifications of hard and soft water are within the following concentration ranges:*

0-75 mg/L	=	*soft*	*150-300 mg/L*	=	*hard*
75-150 mg/L	=	*moderately hard*	*300 and up mg/L*	=	*very hard*

[6] *Agencies with active groundwater quality improvement projects that treat for one or more of the constituents listed in the table. The results shown herein for "groundwater" and "delivered blend" reflect results from untreated groundwater. Water quality constituents that are marked with an asterisk (*) are reduced prior to delivery to customers.*

[7] *All water quality results are flow-weighted averages based on groundwater and imported water delivered to each agency.*

[8] *ND = not detected. Nitrate (expressed as NO_3-N) analytical detection limit for OCWD Advanced Water Quality Assurance Laboratory is 0.1 mg/L.*

PART III: WATER PRODUCTION COSTS FOR ENSUING WATER YEAR (2018-19)

Section 31.5 of the District Act requires that costs of producing groundwater and obtaining supplemental water be evaluated annually. These costs vary for each groundwater producer and depend on many factors. Although these variations in cost are recognized, it is necessary for the purpose of this report to arrive at figures representing the average cost of producing groundwater and purchasing supplemental water.

ENSUING WATER YEAR (2018-19) WATER PRODUCTION COSTS SUMMARY OF FINDINGS

1. Cost for producing water from the groundwater basin within OCWD including a replenishment assessment for 2018-19 is estimated to be $666.00 per acre-foot.

2. Cost of treated, non-interruptible supplemental water for 2018-19 is estimated to be $1,112.50 per acre-foot.

GROUNDWATER PRODUCTION COSTS FOR NON-IRRIGATION USE

Cost for producing an acre-foot of groundwater in the ensuing 2018-19 water year has been estimated for a potable water well for a large groundwater producer (i.e., a city water department, water district) in OCWD's service area. Operations and maintenance (O&M) and energy costs were determined using the cost information provided by nineteen large groundwater producers from a survey conducted by OCWD in fall 2017. The capital cost component was derived using the available actual project cost data for eight production wells constructed in 2008 under the MWD Long-Term Groundwater Storage Program and adjusted to present values using Engineering News-Record Construction Cost Index. Appendix 6 contains several of the key design characteristics for eight wells that were constructed under the MWD's program. The OCWD RA used in the determination of groundwater production cost is the proposed RA for 2018-19.

The estimated cost for groundwater production for a large groundwater producing entity such as a city water department or a water district is presented in Table 7. The total cost to produce an acre-foot of groundwater within OCWD in the ensuing 2018-19 water year is estimated to be $666 per acre-foot. Based on the responses to the aforementioned survey, the flow-weighted average (based upon the quantity of groundwater pumped) for energy cost equaled $67 per AF. Operation and Maintenance (O&M) costs ranged from $32 to $279 per acre-foot with a median cost of approximately $72 per acre-foot. Elements that influence these costs include load factors and variations in groundwater levels. Recently drilled wells are generally deeper than those drilled decades ago. From the aforementioned survey, the average load factor which indicates the percent-of-use of an extraction facility equaled 50 percent.

TABLE 7. Estimated 2018-19 Groundwater Production Costs

Cost Item	Non-Irrigation Use	
	Annual Cost ($)	Cost per AF ($/AF)
Energy	174,200[1]	67[2]
RA	1,201,200[1]	462[3]
Capital	169,000[4]	65[4]
O&M	187,200[1]	72[2]
Total Cost to Producers	1,731,600	666

[1] *Based upon an annual average production of 2,600 AF per production well.*
[2] *Based on survey of major agencies within OCWD's service area, non-irrigation groundwater users.*
[3] *Proposed RA for 2018-19.*
[4] *Based on 2008 average cost for design and construction of a production well (excluding land cost) under the MWD Long-Term Groundwater Storage Program (cost amortized over 30 years at 5 percent interest) and adjusted to 2017 dollars using Engineering News-Record Construction Cost Index for Los Angeles area. Typical design parameters are listed in Appendix 6.*

COST OF SUPPLEMENTAL WATER

Supplemental water is supplied to OCWD's service area by MWD. MWD delivers both treated and untreated water as either a non-interruptible supply or an interruptible supply. As a result, there are several categories of water available from MWD. The categories most applicable for purposes of this report are 1) uninterruptible (i.e., firm) treated water, which is referred to as "full service water," and 2) uninterruptible untreated water. Treated water is purchased and used directly by various groundwater producers for municipal and industrial purposes, while untreated water is purchased and recharged into the basin by OCWD to support higher groundwater production. Table 8 shows the estimated cost for the MWD uninterruptible treated water (full service water) cost for the ensuing 2018-19 water year. Figure 6 illustrates the historical supplemental water costs along with the historical groundwater production costs. A comparison of estimated costs for groundwater versus supplemental water (non-irrigation use) during the ensuing water year 2018-19 is summarized in Table 9 and also in Figure 6. Values used in Figure 6 are presented in tabular form in Appendix 7.

TABLE 8. Estimated 2018-19 Supplemental Water Cost[1]

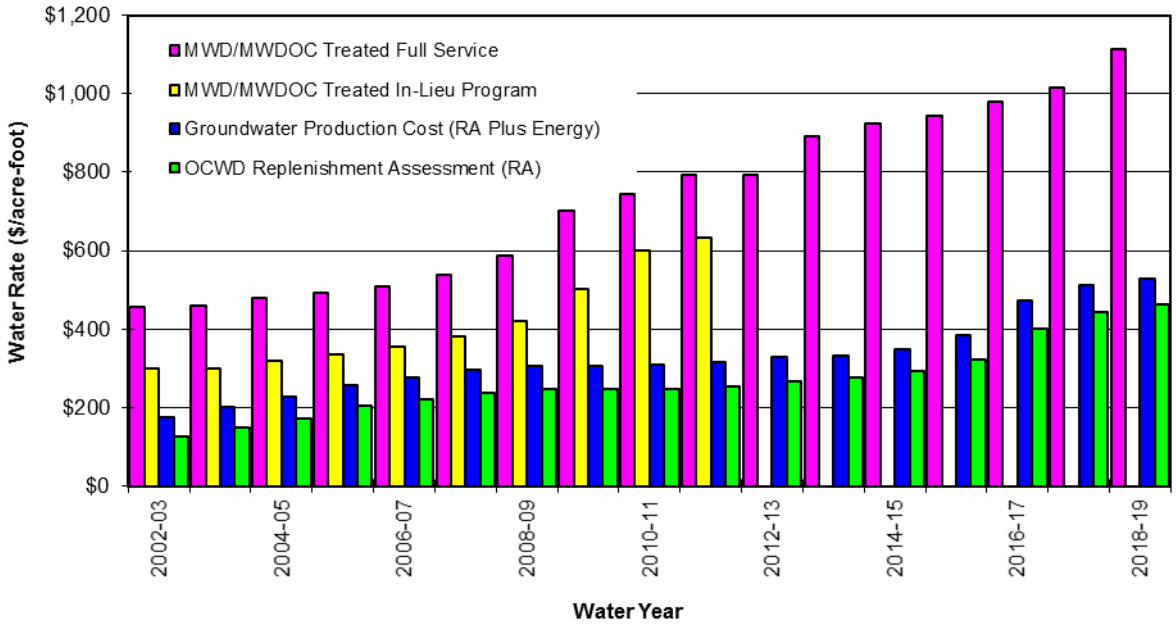
Rate and Charge Components	Treated Water Rate ($/AF)
Firm Deliveries	**Full Service Water**
MWD Supply Rate (MWDOC Melded Rate)	209.00
MWD System Access Rate	312.50
MWD System Power Rate	129.50
MWD Water Stewardship Rate	62.00
MWD Treatment Surcharge	319.50
MWD RTS and Capacity Charges[2]	80.00
Total	**1,112.50**

[1] *Rates are an average of calendar year 2018 and proposed calendar year 2019. Supplemental water costs for MWD's member agencies (i.e., Anaheim, Fullerton and Santa Ana) are not reported herein due to the variability among these agencies on water supply allocations between MWD's Tier 1 and Tier 2.*

[2] *Readiness-to-Serve (RTS) and Capacity Charges have been converted to an approximate cost per acre-foot, but are not normally reported in terms of unit cost.*

Cost components for supplemental treated and untreated water are listed in Table 8. Beyond the normally expected water supply, treatment and power charges, there are several other charges. The System Access charge is for costs associated with the conveyance and distribution system, including capital and O&M costs. The Water Stewardship charge is used to support MWD's financial commitment to conservation,

FIGURE 6. Adopted and Projected Water Rates for Non-Irrigation Use[1]



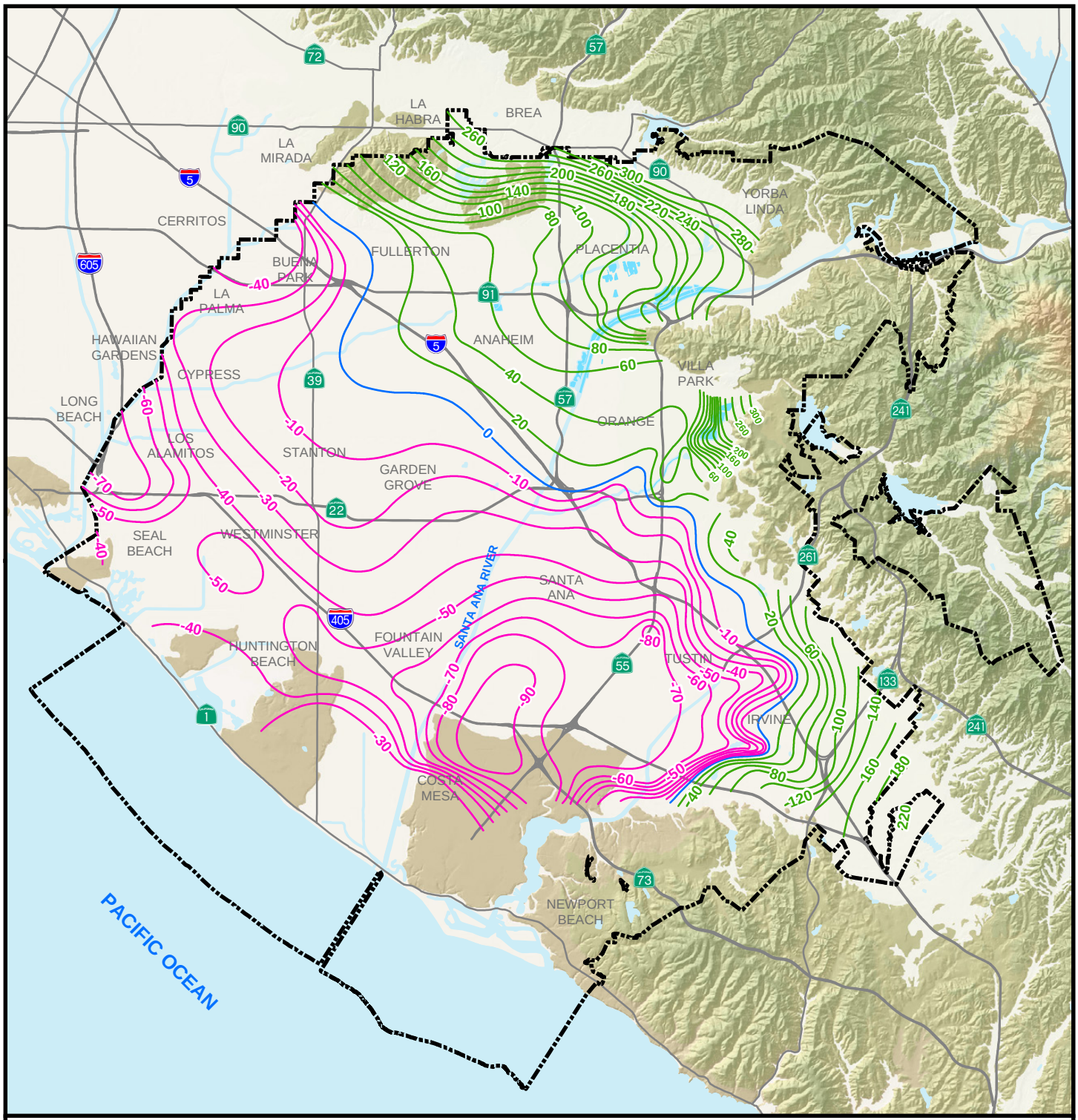
[1] *Refer to Appendix 7 for actual values used in Figure 6.*

TABLE 9. Estimated 2018-19 Water Production Cost Comparison

Non-Irrigation Use	Groundwater Cost ($/AF)	Supplemental Water Cost ($/AF)
Fixed Cost	65.00[1]	1,112.50[3]
Variable Cost	601.00[2]	-[3]
Total	**666.00**	**1,112.50**

[1] *Capital cost.*
[2] *Cost for energy, O&M and proposed RA.*
[3] *Delineation of fixed and variable costs is not available.*

water recycling, groundwater recovery and other water management programs approved by MWD. MWD uses the Capacity Charge to recover its cost for use of peaking capacity within its distribution system. The RTS charge is to recover MWD's cost associated with providing standby and peak conveyance capacity and system emergency storage capacity.



Estimated Groundwater Elevations Within The Principal Aquifer Feet above Mean Sea Level* (ft MSL)

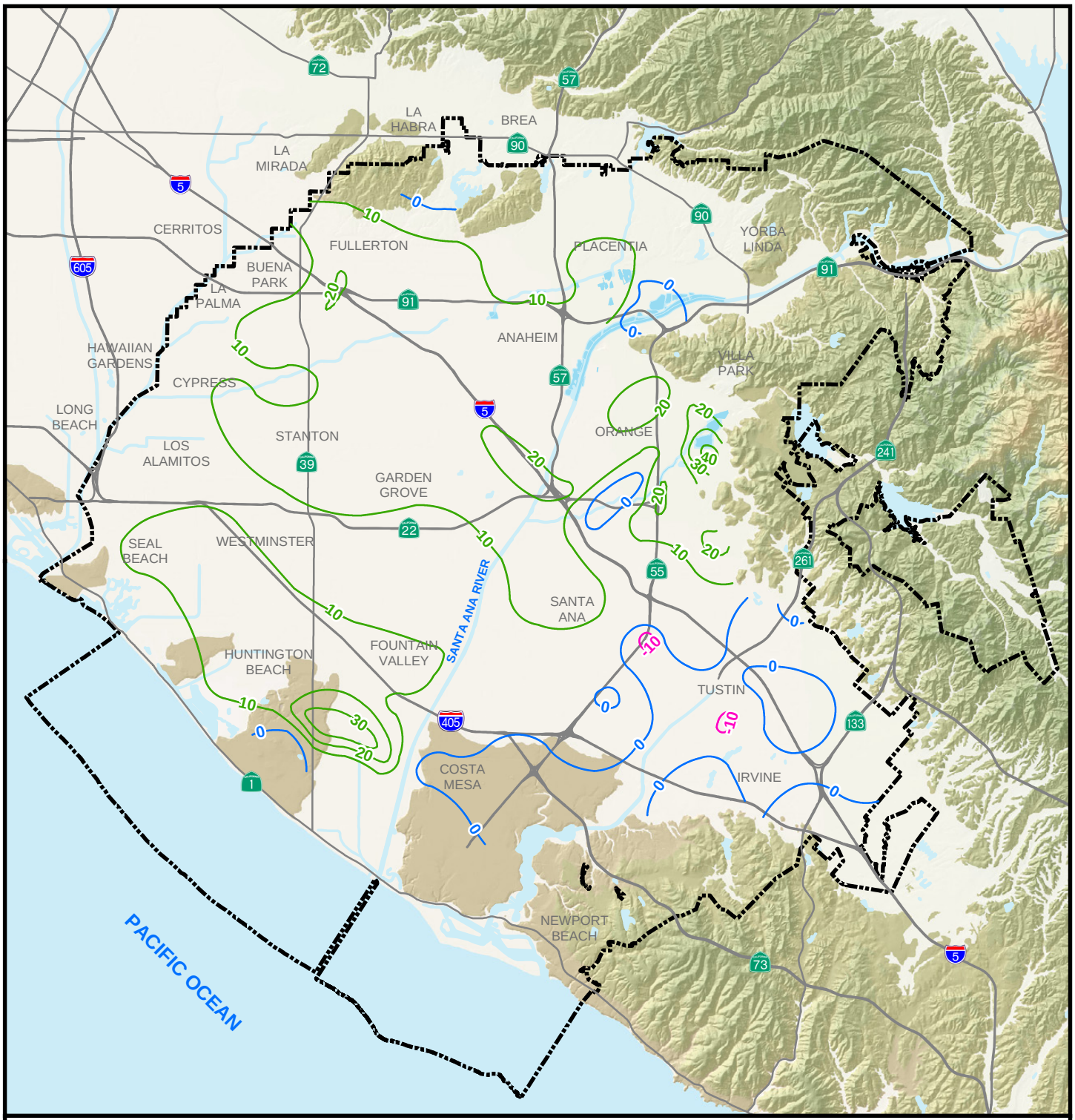
- -90 to -10
- 0
- 20 to 300
- Recharge Facility Areas
- Freeways / Highways
- Rivers / Streams
- Orange County Water District
- Water Bodies

PLATE 1
GROUNDWATER CONTOUR MAP
JUNE 2017

0 1 2 4 Miles

N W E S

***NOTE: MSL elevations are referenced to Vertical Datum NGVD 29**



Estimated Groundwater Elevation Changes Within The Principal Aquifer (Feet)

- -10
- 0
- 10 to 40
- Recharge Facility Areas
- Freeways / Highways
- Rivers / Streams
- Orange County Water District
- Water Bodies

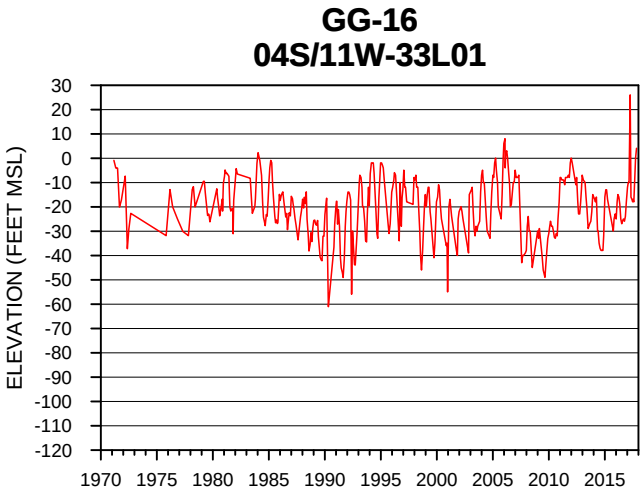
PLATE 2
CHANGE IN GROUNDWATER LEVEL FROM JUNE 2016 TO JUNE 2017

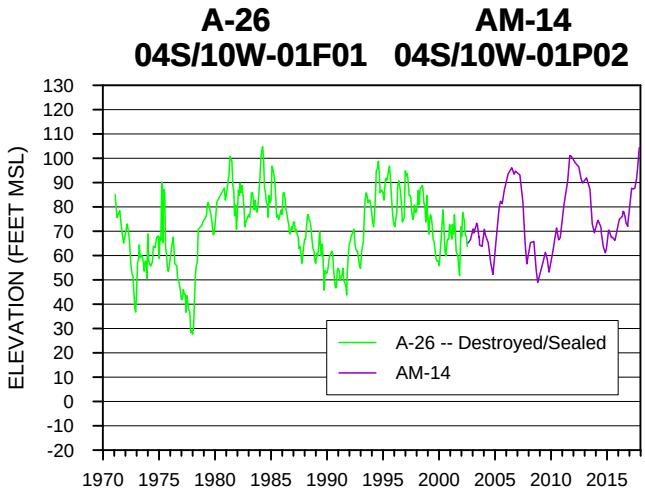
0 1 2 4 Miles

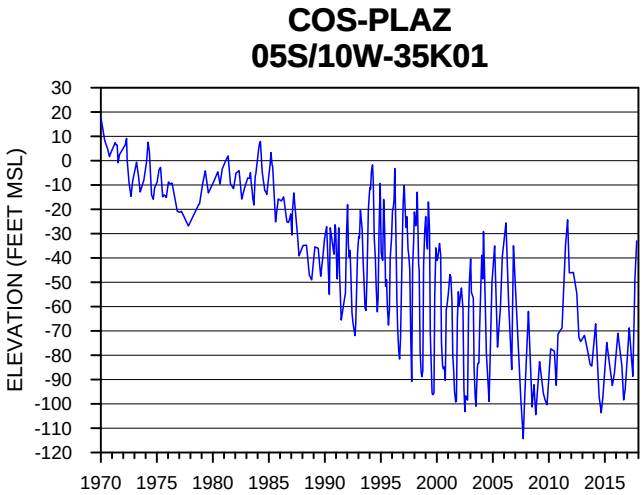
N W E S

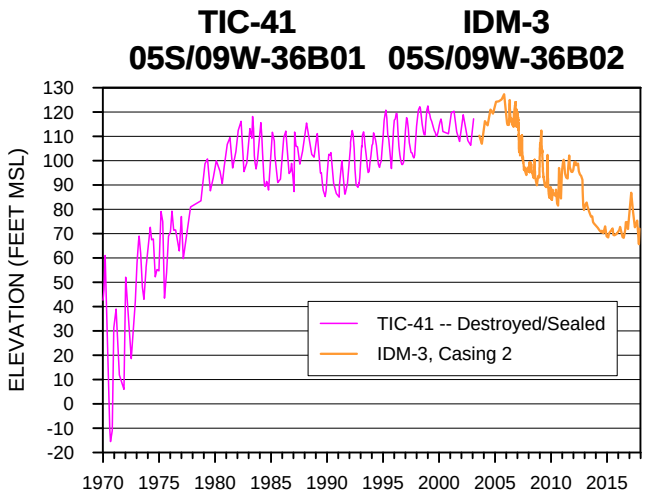
PLATE 3
KEY WELL GROUNDWATER ELEVATION TRENDS

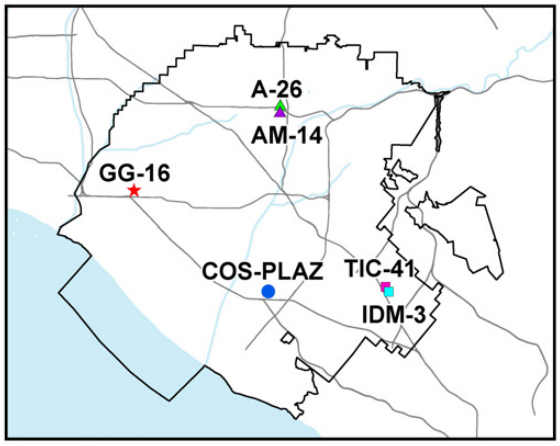
Measured water level elevations
in feet relative to mean sea level











APPENDIX 1. 2016-17 Water Production Data

Groundwater Producer	Groundwater (AF)				Supplemental Water (AF)				Grand Total (AF)	Actual BPP Non-Irrigation [1] Only
	Non-Irrigation [1]		Irrigation Pumping	Total	Non-Irrigation		Irrigation Deliveries	Total		
	Pumping	In-Lieu [2]			Deliveries	Conservation Credit [3]				
Anaheim, City of [7]	44,067.3	-	-	44,067.3	12,797.0	250.4	-	13,047.4	57,114.7	77.2%
Buena Park, City of [7]	9,741.2	-	-	9,741.2	2,607.0	29.3	-	2,636.3	12,377.5	78.7%
East Orange County Water District	548.0	-	-	548.0	190.0	3.6	-	193.6	741.6	73.9%
County of Orange	132.6	-	-	132.6	75.4	-	-	75.4	208.0	63.8%
Fountain Valley, City of	7,860.0	-	-	7,860.0	200.7	31.9	-	232.6	8,092.6	97.1%
Fullerton, City of	17,934.9	-	8.3	17,943.2	6,471.4	44.5	-	6,515.9	24,459.1	73.4%
Garden Grove, City of [4, 7]	20,074.4	-	-	20,074.4	2,294.2	62.4	-	2,356.6	22,431.0	89.5%
Golden State Water Company [7]	18,295.4	-	-	18,295.4	4,652.0	119.1	-	4,771.1	23,066.5	79.3%
Huntington Beach, City of	14,517.9	-	-	14,517.9	11,296.6	123.5	-	11,420.1	25,938.0	56.0%
Irvine Ranch Water District [4, 5]	48,291.3	-	748.6	49,039.9	1,103.3	1,501.5	-	2,604.8	51,644.7	94.9%
La Palma, City of	1,400.4	-	-	1,400.4	651.2	9.4	-	660.6	2,061.0	67.9%
Mesa Water District [4]	16,184.6	-	-	16,184.6	297.5	59.7	-	357.2	16,541.8	97.8%
Newport Beach, City of	10,007.7	-	-	10,007.7	3,316.9	30.4	-	3,347.3	13,355.0	74.9%
Orange, City of [5]	22,265.7	-	-	22,265.7	3,719.9	90.6	-	3,810.5	26,076.2	85.4%
Orange County Water District [6]	145.8	-	-	145.8	-	-	-	0.0	145.8	100.0%
Santa Ana, City of [7]	25,094.8	-	-	25,094.8	8,210.8	83.5	-	8,294.3	33,389.1	75.2%
Seal Beach, City of	2,244.2	-	-	2,244.2	972.0	7.6	-	979.6	3,223.8	69.6%
Serrano Water District [5]	1,884.7	-	-	1,884.7	647.0	5.1	-	652.1	2,536.8	74.3%
Tustin, City of [4]	9,031.3	-	-	9,031.3	1,106.3	55.4	-	1,161.7	10,193.0	88.6%
Westminster, City of [7]	7,862.9	-	-	7,862.9	2,602.0	55.5	-	2,657.5	10,520.4	74.7%
Yorba Linda Water District [7]	12,506.1	-	3.9	12,510.0	5,369.7	50.3	-	5,420.0	17,930.0	69.8%
Total Major Groundwater Producers	290,091.2	0.0	760.8	290,852.0	68,580.9	2,613.7	0.0	71,194.6	362,046.6	80.3%
Other Producers	8,096.5	-	828.8	8,925.3	0.0	0.0	0.0	0.0	8,925.3	
Exempt Well Production	1,860.1	-	-	1,860.1	0.0	0.0	0.0	0.0	1,860.1	
Total Amount	300,047.8	0.0	1,589.6	301,637.4	68,580.9	2,613.7	0.0	71,194.6	372,832.0	
Basin Production Percentage (includes non-irrigation deliveries, but excludes water conservation credits)										**80.9%**

[1] *Water classed as being used for purposes other than commercial agriculture.*

[2] *Imported MWD water purchased for domestic use to offset groundwater pumping.*

[3] *Accounts for only those credits allowed for under the program initiated on September 20, 1995.*

[4] *Agencies that participate in a groundwater water quality improvement project.*

[5] *Agencies that can receive Santiago Creek native water above Villa Park Dam that are conveyed to users within OCWD. Such water, if delivered, is included within the classification of "Supplemental Water"*

[6] *Groundwater quantity reported herein is that quantity used by OCWD for purposes other than seawater intrusion barrier maintenance.*

[7] *These agencies participated in the MWD Long-Term Groundwater Storage Program for which groundwater was extracted and accounted for as supplemental water.*

APPENDIX 2. 2016-17 Groundwater Production — Non-Irrigation Use Production Over 25 Acre-feet

PRODUCER	AF	PRODUCER	AF
Alta Vista Country Club	390.8	Mesa Water District	16,184.6
Anaheim Cemetery	48.0	Midway City Mutual Water Company	139.7
Anaheim, City of	44,067.3	Mile Square Golf Course	95.1
Buena Park, City of	9,741.2	Navy Golf Course	496.0
Canyon RV Park	121.5	Newport Beach Golf Course	111.6
Coca Cola North America	214.7	Newport Beach, City of	10,007.7
County of Orange	132.6	Orange County Cemetery District	74.6
Donovan Golf Course Management	235.2	Orange County Water District	145.8
DS Services of America, Inc.	386.1	Orange, City of	22,265.7
East Orange County Water District	548.0	Page Avenue Mutual Water Company	37.6
Eastlake Village HOA	73.1	R.J. Noble Company	35.5
Eastside Water Association	185.0	Riverview Golf	183.0
Fairhaven Memorial Park	123.3	Santa Ana Country Club	280.2
Forest Lawn Memorial Park	56.2	Santa Ana, City of	25,094.8
Fountain Valley, City of	7,860.0	Seal Beach, City of	2,244.2
Fullerton, City of	17,934.9	Sequoia Management Services, LL	557.7
Garden Grove, City of	20,074.4	Serrano Water District	1,884.7
Golden State Water Company	18,295.4	South Coast Shores HOA c/o Optima	50.1
Hargis and Associates, Inc.	61.6	South Midway City Water Company	72.6
Huntington Beach, City of	14,517.9	The Boeing Company	247.1
Hynes Estates, Inc.	55.0	The Good Shepherd Cemetery	60.2
Irvine Ranch Water District	48,291.3	The Lakes Master Association	40.1
Knott's Berry Farm	267.0	Tustin, City of	9,031.3
La Palma, City of	1,400.4	Westminster, City of	7,862.9
Laguna Beach County Water District	1,843.1	Westminster Memorial Park	289.7
Lockheed Martin Corporation	33.0	Yorba Linda Country Club	368.4
Los Alamitos Race Course	299.5	Yorba Linda Water District	12,506.4
Melrose Abbey Funeral Center	46.6		
Mesa Verde Country Club	333.3	**Total**	**298,003.4**

APPENDIX 3. 2016-17 Groundwater Production — Irrigation Use Production Over 25 Acre-feet

PRODUCER	AF
Berumen Farms, Inc.	35.6
F.S. Nursery c/o Southern CA Edison	37.6
Irvine Ranch Water District	748.6
Neff Ranch, LTD	60.2
Orange County Produce	570.3
Village Nurseries	79.5
Total	**1,531.8**

APPENDIX 4. Non - Local Water Purchased by OCWD for Water Years 1997-98 through 2016-17

	Water Exchange		Talbert Barrier		Forebay Recharge			In-Lieu Program		Basin	SAR Upstream GW Projects		TOTAL
	Western Mun. WD	Alamitos Barrier	FV[1] OC32A	MCWD OC44B	Forebay Recharge	CUP[2] Recharge	Cyclic Program	CUP[2] In-Lieu	In-Lieu	WSM Program[3]	Arlington Desalter	SBVMWD	
Water Year	Purch. AF	Purch. AF	Purch. AF	Purch. AF	Purch. AF	Delivery AF	Delivery AF	Delivery AF	Purch. AF	Purch. AF	Purch. AF	Purch. AF	Purch. AF
1997-98	701.8	1,613.8	-	-	19,029.4	-	-	-	-	27,674.9	2,516.9	-	51,536.8
1998-99	996.1	1,493.6	-	-	10,371.5	-	-	-	-	13,351.9	2,351.3	-	28,564.4
1999-00	-	1,873.6	-	-	28,478.1	-	-	-	24,726.0	13,280.8	4,994.6	-	73,353.1
2000-01	-	1,672.5	941.7	-	59,138.4	-	-	-	11,191.0	7,449.0	5,177.9	2,787.6	88,358.1
2001-02	2,990.3	2,282.2	2,673.0	-	30,092.6	-	-	-	19,472.4	-	5,819.8	4,296.4	67,626.7
2002-03	3,471.4	1,448.7	1,540.1	-	35,755.1	-	-	-	25,631.0	35,832.0	4,924.7	-	108,603.0
2003-04	3,605.0	1,938.3	1,703.3	3,380.6	14,832.0	2,462.7	-	2,479.6	49,688.8	-	4,087.3	-	84,177.6
2004-05	-	1,914.9	2,451.8	8,368.6	3,810.8	-	-	15,021.1	54,596.1	-	567.5	-	86,730.8
2005-06	-	833.0[4]	1,079.9	5,431.1	7,256.7	-	-	15,452.9	73,763.1[5]	-	-	-	103,816.7
2006-07	1,745.0	534.1[4]	143.9	7,394.7	42,173.0	-	-	14,427.3	36,313.0	-	227.6	-	102,958.6
2007-08	2,882.4	1,505.7[4]	-	4,581.4	-	-	-	-	-	-	1,266.6	-	10,236.1
2008-09	3,663.5	2,094.2[4]	-	4,140.3	18,100.0	-	-	-	-	-	428.2	-	28,426.2
2009-10	-	1,321.9[4]	-	176.9	20,535.7	-	-	-	-	-	106.2	-	22,140.7
2010-11	-	1,689.1[4]	-	100.5	11,038.6	16,500.0	-	-	10,435.4	-	-	-	39,763.6
2011-12	-	1,198.7[4]	-	1.9	41,230.8	7,709.6	-	9,719.9	30,843.6	-	-	-	90,704.5
2012-13	-	1,721.8[4]	-	3.7	24,356.1	15,570.8	-	-	-	-	-	-	41,652.4
2013-14	-	2,370.2[4]	-	6.2	50,700.5	-	-	-	-	-	-	-	53,076.9
2014-15	-	2,236.3[4]	-	17.7	48,616.8	-	-	-	-	-	-	-	60,870.8[6]
2015-16	-	2,398.9[4]	-	7.0	45,118.0	-	-	-	-	-	-	-	47,523.9
2016-17	-	1,166.1[4]	-	7.8	48,918.1	-	1,556.4	-	-	-	-	-	51,648.4
Total	20,055.5	33,307.6	10,533.7	33,618.4	559,552.2	43,799.5	1,556.4	57,100.8	336,660.4	97,588.6	32,468.6	7,084.0	1,241,769.3[6]

[1] Includes only imported water and excludes groundwater deliveries from Fountain Valley to OCWD.

[2] CUP is the multi-agency conjunctive use program (known as the MWD Long-Term Groundwater Storage Program or MWD CUP). Basin losses are not taken into account.

[3] Known as Basin Water Supply Management Program (WSM) water. WSM program was terminated on December 31, 2003.

[4] Includes both MWD imported deliveries and supplemental recycled water deliveries.

[5] Includes 16,000 AF of 2005-06 MWD Supplemental Storage Program (i.e., "Super In-Lieu") water that was received as In-Lieu by the groundwater producers.

[6] Includes purchase of 10,000 AF of stored water from MWD CUP storage account at full-service untreated water rate in water year 2014-15.

APPENDIX 5. 2016-17 Water Resources Summary

	2016-2017 Water Year (AF)	2015-2016 Water Year (AF)	Change from last year to this year
SUMMARY OF BASIN CONDITIONS			
BASIN SUPPLIES			
Water Purchases from MWD (excludes In-Lieu)	48,918	45,118	3,800
Water into MWD Storage Account (excludes In-Lieu)	1,556	0	1,556
SAR and Santiago Creek Flows[1]	206,616	113,203	93,413
GWRS AWPF Water to Forebay Recharge Basins	61,965	65,229	(3,264)
GWRS AWPF Water to Mid-Basin Injection	1,563	1,579	(16)
GWRS AWPF Water to Talbert Barrier	33,247	35,226	(1,979)
Imported Water to Talbert Barrier (OC-44 & Fountain Valley)	8	7	1
Alamitos Barrier	1,166	2,399	(1,233)
Incidental Recharge	68,822	36,401	32,421
Evaporation from Recharge Facilities	(3,292)	(3,250)	(42)
SAR Flow Lost to Pacific Ocean	(67,933)	(610)	(67,323)
Total Groundwater Recharge	**352,637**	**295,302**	**57,335**
WATER PRODUCTION			
Groundwater Production	301,637	277,090	24,547
MWD Storage Program Extractions	0	16,212	(16,212)
Total Groundwater Production	**301,637**	**293,302**	**8,335**
BASIN STATUS			
Change in Groundwater Storage	51,000	2,000	49,000
Change in Groundwater Storage excluding MWD Stored Water	49,444	18,212	31,232
Accumulated Overdraft (AOD)	(328,000)	(379,000)	51,000
AOD without MWD Storage Program Water	(329,730)	(379,177)	49,447
IN-LIEU WATER			
OCWD In-Lieu Purchases	0	0	0
MWD In-Lieu Storage	0	0	0
Total In-Lieu	0	0	0
OTHER KEY INFORMATION			
1. Imported Deliveries to Producers (less MWD withdrawal)[2]	70,295	54,413	15,882
2. Total Dissolved Solids of SAR below Prado Dam (mg/L)	724	578	(515)
3. Total Nitrogen of SAR below Prado Dam (mg/L)	3.8	3.8	(5,233)
4. Total GWRS AWPF Production[3]	96,868	102,101	(1,155)
5. Green Acres Project	3,566	4,081	146
6. Base Flow of Santa Ana River	67,946	69,101	0
7. Year-end Storage behind Prado Dam	0	5	(5)
8. Year-end Storage in Recharge Facilities	14,597	10,841	3,756
9. Total Artificial Recharge (percolation plus barriers)	283,815	258,902	24,913
10. Rainfall Measured at OCWD Field Headquarters (inches)	19.68	8.47	11
11. Annual Mean Temperature at Santa Ana Fire Station (°F)	71.1	68.3	3

[1] *Accounts for storage to/from recharge facilities.*
[2] *Santiago Creek Native and In-Lieu water are included (excludes imported water used for groundwater replenishment).*
[3] *Total includes deliveries to recharge basins, Talbert Barrier, MBI, Anaheim Canyon Power Plant and ARTIC.*

APPENDIX 6. Typical Groundwater Extraction Facility Characteristics

PARAMETER	CHARACTERISTICS
Water System Pressure	62 psi
Load (Use) Factor	63%
Design Flow Rate	2,563 gpm
Annual Production	2,600 AF
Bowl Efficiency (minimum)	84%
Motor Horsepower	325 hp
Type Motor	Electric
Well Casing Diameters	16 – 20 inches
Type of Pump	Vertical Turbine
Depth of Well	1,052 feet
Depth of Bowls	278 feet
Total Dynamic Head	325 feet
Estimated Life	30 years
Annual Cost of Facilities[1]	$169,000

[1] 2017 cost was based on a 2008 cost with an interest rate of 5 percent amortized over a 30-year period and excluding the cost for land. The 2008 cost was adjusted to 2017 dollars using Engineering News-Record Construction Cost Index for Los Angeles area.

APPENDIX 7. Values Used in Figure 6 For Water Rates for Non-Irrigation Use

Water Year	RA ($/AF)	Estimated Groundwater Production Cost[1,2] ($/AF)	MWD Treated Interruptible Rate (In-Lieu Program)[2,3] ($/AF)	MWD Treated Non-Interruptible Rate (Full Service)[2,3] ($/AF)
1985-86	32	85	181	225
1986-87	32	91	187	231
1987-88	32	91	187	231
1988-89	42	105	187	231
1989-90	45	119	136	231
1990-91	48	91	137	232
1991-92	51	100	156	263
1992-93	60	116	206	325
1993-94	67.5	124	257	389
1994-95	88	145	279	416
1995-96	85	140	294	440
1996-97	88	140	303	448
1997-98	91	141	303	455
1998-99	94	143	303	458
1999-00	100	150	303	459
2000-01	107	150	303	459
2001-02	117	162	303	459
2002-03	127	176	299	455
2003-04	149	203	301	460
2004-05	172	229	318	479
2005-06	205	258	337	494
2006-07	223	278	354	510
2007-08	237	296	382	538
2008-09	249	307	420	586
2009-10	249	308	501[4]	701
2010-11	249	310	602[4]	744
2011-12	254	315	633[4]	794
2012-13	266	330	-[5]	794
2013-14	276	334	-[5]	890
2014-15	294	349	-[5]	923
2015-16	322	386	-[5]	942
2016-17	402	473	-[5]	979
2017-18	445	513	-[5]	1,015
2018-19	462	529	-[5]	1,112[4]

[1] *Includes RA plus energy cost to produce groundwater.*
[2] *Rate is rounded.*
[3] *Rate is proposed.*
[4] *Rate is estimated.*
[5] *This rate is no longer available because MWD terminated the Replenishment Program.*