

2020-2021 Engineer's Report on the Groundwater Conditions, Water Supply and Basin Utilization in the Orange County Water District

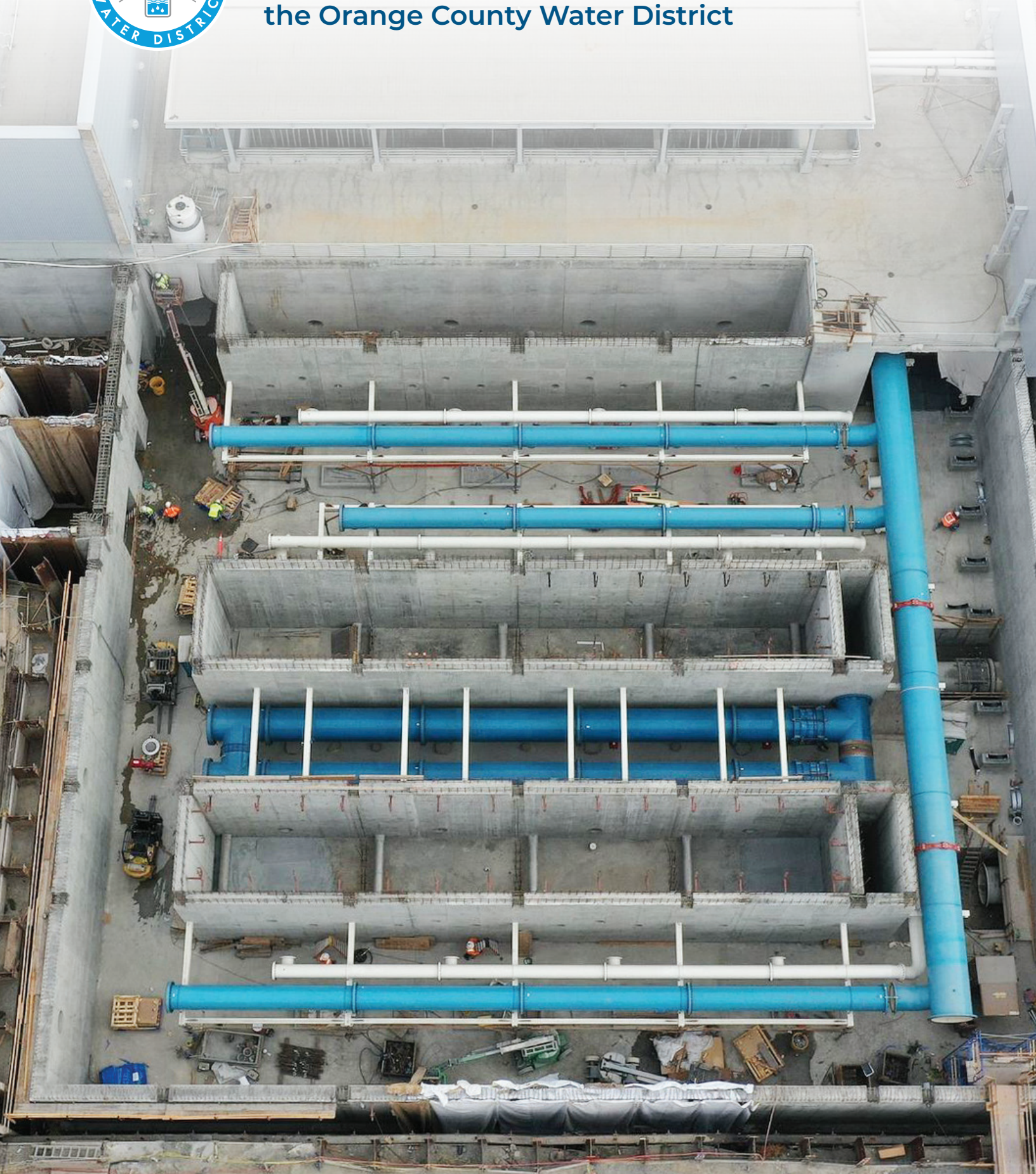


Photo Cover:

***Construction of Additional Microfiltration for the
Groundwater Replenishment System Final Expansion***

2020-2021

ENGINEER'S REPORT ON

GROUNDWATER CONDITIONS,

WATER SUPPLY AND BASIN UTILIZATION

IN THE

ORANGE COUNTY WATER DISTRICT

FEBRUARY 2022

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February 16, 2022

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 2020-2021 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, 2020 through June 30, 2021 within the District's boundaries averaged 5.01 inches, which was thirty eight 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 100,900 acre-feet which represented forty four 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 1,218 acre-feet.

Total water demands within the District for the water year 2020-2021 were 406,992 acre-feet (excluding water used for groundwater replenishment and barrier maintenance). The use of supplemental water in the District's service area during the water year totaled 105,159 acre-feet. Groundwater production within the basin for the water year totaled 281,793 acre-feet which was a decrease of 1.7 percent from the prior water year.

The accumulated basin overdraft increased from 200,000 acre-feet on June 30, 2020 to 248,000 acre-feet on June 30, 2021 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 ensuing 2022-2023 water year could be equal to an amount necessary to purchase up to 151,000 acre-feet of replenishment water.

Truly yours,

Chris S. Olsen
Director of Engineering

Lo Tan
Principal Engineer

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EXECUTIVE SUMMARY

Total water demands within Orange County Water District (OCWD) were 406,992 acre-feet (AF) for the 2020-21 water year (beginning on July 1, 2020 and ending on June 30, 2021). Groundwater production for the water year totaled 281,793 AF including any available In-Lieu Program water. The use of supplemental water in OCWD's service area during the 2020-21 water year totaled 105,159 AF of which 102,524 AF resulted from the direct use by water agencies and districts and 2,635 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, 2021, the "annual overdraft" (annual basin storage decrease without supplemental replenishment water) was 149,800 AF. The accumulated overdraft increased from 200,000 AF on June 30, 2020 to 248,000 AF on June 30, 2021. Precipitation within the basin was thirty eight percent of the long-term average during the water year, totaling 5.01 inches.

Based on the groundwater basin conditions for the water year ending on June 30, 2021, OCWD may purchase up to 151,000 AF of water for groundwater replenishment during the ensuing water year, beginning on July 1, 2022, 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 2020-21 Basic Data Report which is placed on file at the office of OCWD in Fountain Valley.

GLOSSARY OF ACRONYMS

AF	Acre-Feet
AWPF	Advanced Water Purification Facility
BEA	Basin Equity Assessment
BPP	Basin Production Percentage
CPTP	Coastal Pumping Transfer Program
CUP	Conjunctive Use Program
EOS	Extraordinary Supply
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
OC San	Orange County Sanitation District
OCWD	Orange County Water District
PFAS	per- and polyfluoroalkyl substances
RA	Replenishment Assessment
RO	Reverse Osmosis
RTS	Readiness-to-Serve
SAR	Santa Ana River
SARCCUP	Santa Ana River Conservation and Conjunctive Use Program
SBVMWD	San Bernardino Valley Municipal Water District
SPW	State Project Water
TDS	Total Dissolved Solids
UV	Ultraviolet
WRD	Water Replenishment District of Southern California

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, 2020 to June 30, 2021 is as follows.

GROUNDWATER CONDITIONS 2020-21 SUMMARY OF FINDINGS

1. Groundwater production (including the In-Lieu Program water) totaled 281,793 acre-feet (AF) for the 2020-21 water year.
2. Groundwater stored in the basin decreased by 48,000 AF for the 2020-21 water year.
3. Accumulated Overdraft¹ on June 30, 2021 was 248,000 AF.²
4. Annual Overdraft was 149,800 AF for the 2020-21 water year.
5. Average Annual Overdraft³ for the immediate past five water years (2016-17 through 2020-21) was 126,000 AF.
6. Projected Annual Overdraft³ for the current 2021-22 water year is 98,000 AF.
7. Projected Annual Overdraft³ for the ensuing 2022-23 water year is 112,000 AF.
8. Projected Accumulated Overdraft² on June 30, 2022 is 226,000 AF.
9. Under the provisions of Section 27 of the District Act, a portion of the 2022-23 Replenishment Assessment (RA) could be equal to an amount necessary to purchase up to 151,000 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 average annual overdraft (126,000 AF) to one-tenth of the accumulated overdraft (248,000 AF) which results in the following:
 $126,000 \text{ AF} + [(248,000 \text{ AF}) \times 0.10] = 150,800 \text{ AF}$ (or 151,000 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, 2020, yielded an average of 5.01 inches of rainfall within OCWD's boundaries, which is approximately thirty eight 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. The rainfall for the previous water year (2019-20) was 13.38 inches. The average annual rainfall in the OCWD service area for the five-year period (from July 1, 2016 through June 30, 2021) was 12.35 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 2020-21 totaled 100,900 AF which was approximately 44 percent of the 30-year flow average of 228,299 AF.

GROUNDWATER PRODUCTION

Groundwater production from wells within OCWD for the 2020-21 water year totaled 281,793 AF (excluding In-Lieu Program water, MWD Groundwater Storage Program extractions, and any groundwater used for the Talbert Barrier): 281,043 AF for non-irrigation and 750 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 2020-21 water year, the In-Lieu Program water was not available for purchase from MWD. Historical data on the annual groundwater production and In-Lieu quantities within OCWD are shown in Figure 1. Table 1 summarizes the annual groundwater production and In-Lieu Program water for the period of 1971-72 through 2020-21.

Groundwater production and In-Lieu Program quantities for 2020-21 for the major groundwater producers are summarized in Appendix 1. The groundwater production for all producers exceeding 25 AF per year for non-irrigation and irrigation purposes are presented in Appendices 2 and 3, respectively.

FIGURE 1. Groundwater Production

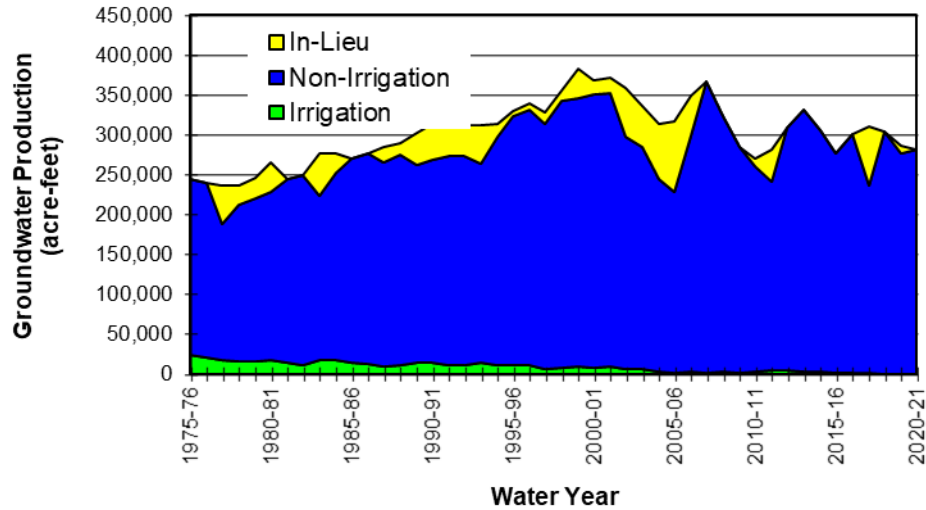


TABLE 1. Historical Groundwater Production Within OCWD

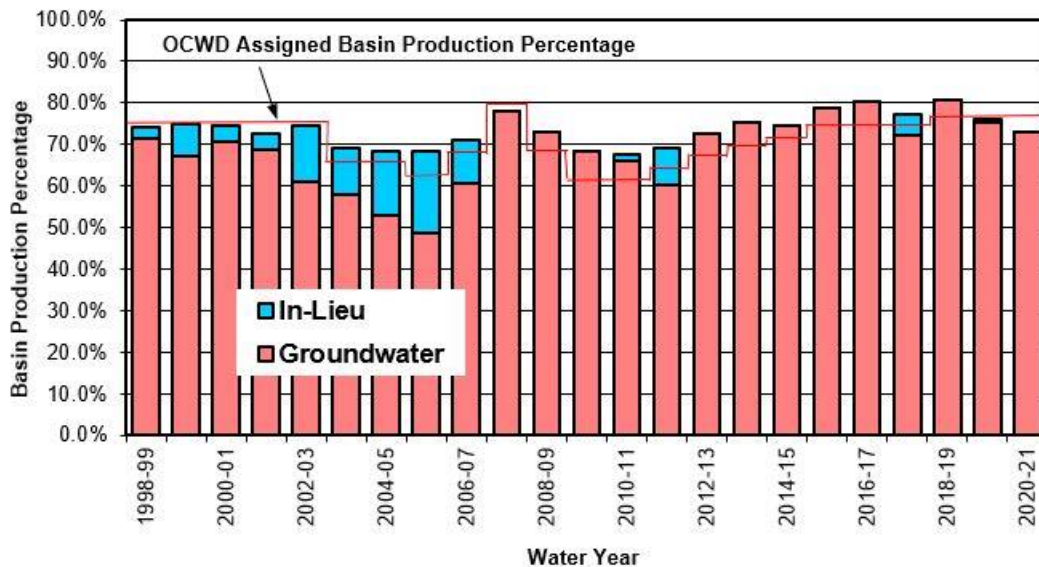
Water Year Jul 1-Jun 30	Groundwater Production (AF)	In-Lieu Program (AF)	Water Year Jul 1-Jun 30	Groundwater Production (AF)	In-Lieu Program (AF)
1971-72	229,048	-	1996-97	331,406	7,883
1972-73	214,983	-	1997-98	313,805	15,096
1973-74	218,863	-	1998-99	342,823	13,352
1974-75	225,597	-	1999-00	345,362	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	-	2002-03	297,191	61,463
1978-79	213,290	48,290	2003-04	284,621	52,168
1979-80	221,453	23,792	2004-05	244,370	69,617
1980-81	228,943	24,861	2005-06	228,159	89,216
1981-82	244,184	36,373	2006-07	299,118	50,740
1982-83	249,548	-	2007-08	366,185	-
1983-84	223,207	-	2008-09	324,147	-
1984-85	252,070	52,822	2009-10	285,575	-
1985-86	270,932	25,198	2010-11	259,861	10,435
1986-87	276,354	-	2011-12	241,082	40,564
1987-88	265,226	-	2012-13	309,295	-
1988-89	275,077	18,856	2013-14	330,782	-
1989-90	261,190	15,022	2014-15	305,259	-
1990-91	266,745	38,961	2015-16	277,090	-
1991-92	271,224	44,588	2016-17	301,637	-
1992-93	273,587	39,789	2017-18	236,916	73,108
1993-94	264,159	38,900	2018-19	303,496	-
1994-95	298,217	48,134	2019-20	277,195	9,355
1995-96	324,111	5,542	2020-21	281,793	-

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 2020-21 water year was established at 77.0 percent by the OCWD Board of Directors. The overall BPP achieved within OCWD for non-irrigation use in the 2020-21 water year was 73.1 percent. The achieved pumping is less than 77.0 percent primarily due to the water quality impacts of per- and polyfluoroalkyl substances (PFAS). 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 2021 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 10 to 80 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 landward (ranging from 0.04 to 1.80 miles) when compared to its alignment of the prior year, indicating a decrease in groundwater levels in the principal aquifer system from June 2020 to June 2021.

Plate 1 also shows the relatively large depression in groundwater levels in the southern Santa Ana and northern Costa Mesa area due to the large concentration of production wells in this area. Groundwater levels are 40 to 50 feet lower than the surrounding areas. The potential impacts of this pumping depression include increased seawater intrusion and low well water levels which have been mitigated by OCWD's basin management programs including the Talbert seawater barrier expansion, the Groundwater Replenishment System (GWRS) and the mid-basin injection (MBI) wells. However, should groundwater production in this area substantially increase or groundwater elevations continue to decrease, the potential negative impacts should be evaluated in advance as they could, at least, partially offset the mitigative benefits of the aforementioned basin management programs.

Plate 2 shows the change in groundwater levels from June 2019 to June 2020 for the principal aquifer system. In the principal aquifer, groundwater levels generally declined by approximately 10 to 20 feet throughout most of the groundwater basin, except in the vicinity of OCWD's recharge facilities at Santiago basins in Orange where groundwater levels declined by 20 to 60 feet.

Plate 3 shows the groundwater elevation trends within the principal aquifer since 1980 at four key well locations across the groundwater basin. In the pressure area of the basin at key wells GG-16 and COS-PLAZ, seasonal groundwater level fluctuations are noticeably larger than at AM-14 and IDM-3 located in the Anaheim and Irvine Forebay areas, respectively. All four key well locations show an increased water level response during or immediately following high-recharge wet periods such as 2005-06, 2011-12, and 2018-19, but the response is largest at AM-14 due to its proximity to OCWD's spreading grounds.

The storage decrease of 48,000 AF resulted from a moderate decline in groundwater levels throughout most of the basin from June 2020 to June 2021. In the shallow aquifer, groundwater levels declined approximately 10 to 25 feet in the Anaheim and Orange Forebay areas surrounding the OCWD recharge facilities, 5 to 10 feet in the greater Anaheim/Fullerton Forebay area, and less than 5 feet in the pressure area of the basin. Shallow aquifer groundwater levels near the Talbert Barrier remained stable at or above protective elevations for seawater intrusion control.

In the principal aquifer, groundwater levels declined from June 2020 to June 2021 by as much as 40 to 65 feet immediately surrounding Santiago basin resulting from a lack of

recharge due to PFAS water quality issues and a dry year. Principal aquifer groundwater levels at Santiago basin dropped significantly more than in the shallow aquifer which was presumed to be dry by June 2021 based on the observed dry ports at OCWD monitoring wells. Principal aquifer groundwater levels declined 10 to 20 feet around the recharge facilities in the Anaheim Forebay as well as throughout the central portion of the basin and declined 20 to 30 feet in Santa Ana near the Irvine Ranch Water District (IRWD) Dyer Road Well Field. In the Irvine sub-basin, principal aquifer groundwater levels dropped 20 to 40 feet surrounding the IRWD Irvine Desalter Project (IDP) wells with a lesser decline of 10 to 20 feet in the rest of the Irvine sub-basin. A smaller decline of 5 to 10 feet was observed in the Costa Mesa area.

In the deep aquifer, groundwater levels dropped throughout the basin from June 2020 to June 2021. The groundwater levels decreased by as much as 30 to 55 feet immediately surrounding Santiago Basin, 20 to 30 feet surrounding the IRWD IDP wells in the Irvine sub-basin, 10 to 20 feet throughout the greater Anaheim/Orange Forebay area as well as the central portion of the basin, and 5 to 10 feet in the Tustin area and the southwest portion of the Irvine sub-basin.

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 2020-21 water year, it is estimated that the volume of groundwater in storage decreased by 48,000 AF. Approximately 101,800 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, 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 149,800 AF for the 2020-21 water year. For the five-year period from July 1, 2016 to June 30, 2021, an annual average of approximately 152,200 AF of supplemental water and recycled water as 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 126,000 AF.

GROUNDWATER BASIN ACCUMULATED OVERDRAFT

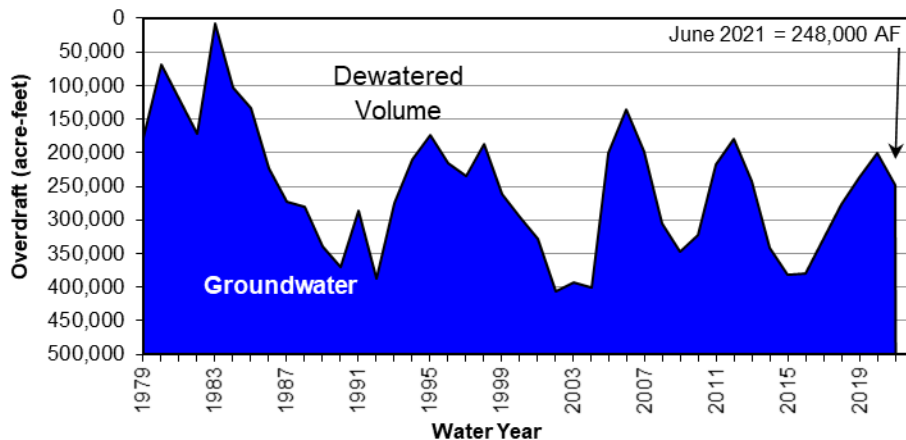
The accumulated overdraft, as defined in the District Act, is the quantity of water needed to be replaced at OCWD's intake area to prevent landward movement of ocean water into the fresh groundwater body. Landward movement of ocean water can be prevented if groundwater levels near the coast are several 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 2020-21 has been completed. Based on the three-layer methodology, an accumulated overdraft of 248,000 AF was calculated for the water year ending on June 30, 2021. The accumulated overdraft for the prior water year ending on June 30, 2020 was 200,000 AF (also calculated using the three-layer storage method). Therefore, an annual increase of 48,000 AF (reported earlier herein this report) was calculated as the difference between the June 2020 and June 2021 accumulated overdrafts.

Figure 3 shows the accumulated basin overdraft quantities for the period 1979 through 2021.

FIGURE 3. Accumulated Basin Overdraft



The accumulated overdraft for the current water year ending on June 30, 2022 is projected to be 226,000 AF. The projected annual overdraft is estimated to be 98,000 AF. This quantity is based on assumed annual groundwater production of approximately 281,000 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 183,000 AF for the basin under average rainfall conditions. In addition, GWRS production is projected to reach 97,000 AF.

Projected annual overdraft for the ensuing water year 2022-23 is estimated to be 112,000 AF. This estimate is based on the assumption that the total annual groundwater production for the ensuing water year will be 295,000 AF, a figure that is based upon an assumed BPP of 77 percent and includes 20,000 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 183,000 AF (average of last five years) under average rainfall conditions, and the GWRS production is projected to be 110,000 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. There was no MWD CUP water stored or extracted in water year 2020-21 and the balance remains zero AF in the MWD CUP account at the end of the water year. 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.

In April 2019, OCWD established the Santa Ana Conservation and Conjunctive Use Program (SARCCUP) water bank in the OCWD groundwater basin. The SARCCUP water bank can contain up to 36,000 AF of water to be used during dry years, as determined by OCWD. Sources of water for the bank include imported water and surplus State Project Water (SPW) from San Bernardino Valley Municipal Water District (SBVMWD). The SBVMWD, a SPW contractor, and MWD have an agreement in which surplus SPW purchased by MWD is made available to OCWD and other SARCCUP agencies for storage in the multiple water banks in the SAR watershed. Surplus SPW purchased from MWD can be considered Extraordinary Supply (EOS) water which can be used during years when MWD reduces imported supplies via an allocation process. For accounting purposes, two types of water will be tracked in the SARCCUP water bank. The first is imported water, which is designated as local water and can be used in dry years as determined by OCWD. The second is the EOS water which is surplus SPW. The EOS water can be used during dry years or during allocation years.

The SARCCUP water bank was financed by a \$55M Proposition 84 Integrated Regional Water Management grant from the Department of Water Resources and local matching funds from participating agencies including OCWD, SBVMWD, Inland Empire Utilities Agency, Western Municipal Water District and Eastern Municipal Water District. During the 2020-21 water year, 2,000 AF of SARCCUP water were placed in the groundwater basins upstream of Prado Dam.

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 2022-23 is limited to the amount needed to purchase 151,000 AF as calculated below:

Five-year (7/1/2016 through 6/30/2021) Average Annual Overdraft* = 126,000 AF
 Accumulated Overdraft (End of Water Year 2020-21) = 248,000 AF
 Assumed Time Period to Eliminate Accumulated Overdraft = 10 years
 Potential Water Purchase Amount: 126,000 AF + (248,000 AF/10 years) = 150,800 AF (use 151,000 AF)

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

Table 2 presents the proposed 2022-23 water budget expenses, which shows the proposed quantity of purchased water (3,000 AF) being significantly less than the prescribed limit of 151,000 AF as allowed for under the provisions of Section 27(b) of the District Act.

TABLE 2. 2022-23 Water Budget Expenses

Water Source	Amount (AF)	Unit Cost (\$/AF)	Total Cost (\$)
Alamitos Barrier	3,000	\$1,331.50	\$ 3,994,500
MWD Untreated Full-Service Water	<u>0</u>	\$843.50	<u>\$ 0</u>
Water Purchases Sub-total	3,000	—	\$ 3,994,500
Applicable Charges			Total Cost (\$)
MWD Readiness to Serve Charge	—	—	\$ 3,162,000
MWDOC Groundwater Charge	—	—	\$ 335,000
MWD Capacity Charge	—	—	\$ 700,000
Total Expenses			\$ 8,191,500

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.

The BPP does not restrict the amount of groundwater that a groundwater producer may pump; but a groundwater producer must pay the basin equity assessment (BEA) on any groundwater production (other than BEA-exempt groundwater) above the BPP. The BEA is set at an amount so that groundwater production above the BPP cost the same amount as imported supplemental water. If groundwater producers produced groundwater significantly above the BPP, this additional groundwater production could increase the annual overdraft (and, over time, increase the accumulated overdraft), with potential

detriments to the basin, including seawater intrusion. Substantial groundwater production significantly above the BPP could also impair OCWD's ability to manage the groundwater basin for sustainable groundwater production. The OCWD Act provides regulatory powers to OCWD that can be exercised by OCWD, including the setting of basin production limitations and surcharges, and mid-year modifications to the BPP, BEA, and production limitations/surcharges, to address potential production of significant quantities of groundwater above the BPP. The OCWD Board of Directors may approve a surcharge, in an amount to be determined in its discretion, for production by a producer in excess of any production limitation.

A BPP of 77 percent is currently being proposed for the ensuing water year 2022-23. 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 2022-23 without detriment to the basin. Under normal conditions, the annual groundwater production could reach 315,000 AF. However, it is anticipated that the groundwater production for the ensuing water year 2022-23 will decrease to approximately 295,000 AF due to the water quality impacts of PFAS. Because of the State Division of Drinking Water setting of a Response Level of 10 parts per trillion for perfluorooctanic acid and 40 parts per trillion for perfluorooctane sulfonic acid, OCWD anticipates that up to 70 production wells could be shutdown until water treatment systems can be installed.

In order to achieve water quality objectives in the groundwater basin, it is estimated for the ensuing water year 2022-23 that additional production of approximately 20,000 AF (above the BPP) will be undertaken by the City of Tustin, City of Huntington Beach, 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 2022, 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 2022, 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.

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 2020-21 SUMMARY OF FINDINGS

1. Water usage from all supplemental sources and non-local water sources (if any) totaled 105,159 AF for the 2020-21 water year.
2. Water usage from recycled water produced from within OCWD including the GWRS totaled 121,875 AF for the 2020-21 water year.
3. Water demands within OCWD totaled 406,992 AF for the 2020-21 water year.
4. Estimated demands for groundwater for the ensuing 2022-23 water year are 295,000 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 that portion of that watershed on and along Santiago Creek upstream of the downstream toe of the slope of the Villa Park Flood Control 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 all 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 2020-21 water year totaled 105,159 AF of which 102,524 AF resulted from the direct use by water agencies and districts and 2,635 AF were used for groundwater replenishment purposes. The supplemental water used by water agencies included 99,596 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 2020-21 water year. A breakdown of non-local water purchases by OCWD from water years 2001-2002 through 2020-21 is presented in Appendix 4.

TABLE 3. 2020-21 Supplemental Water Usage

Direct Agency Use	AF
Imported Water ¹	99,596
Santiago Creek Native Water	2,928
Subtotal	102,524
Groundwater Replenishment (Purchased)	AF
In-Lieu Program ²	0
Forebay Recharge ³	0
Alamitos Barrier ⁴	2,618
Talbert Barrier	17
Subtotal	2,635
TOTAL	105,159

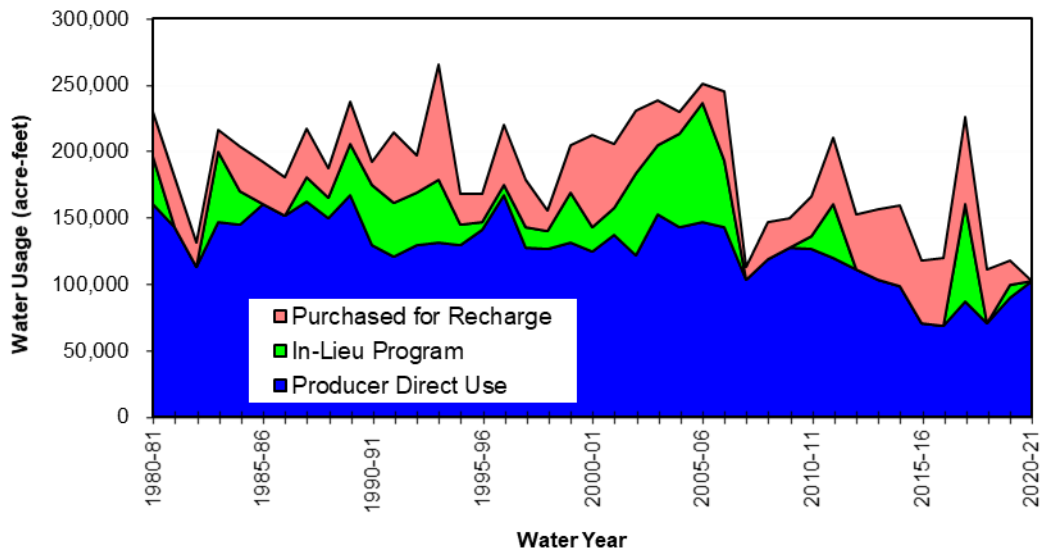
¹Includes any extractions from MWD Groundwater Storage Program.

²Any amount reported herein includes water received by OCWD’s groundwater producers as In-Lieu water.

³Full service rate untreated water.

⁴Total 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. 2020-21 Recycled Water Usage

Groundwater Replenishment		Water Usage (AF)
GWRS AWPf (for Talbert Barrier)		27,113
GWRS AWPf (for Recharge Basins) ¹		61,479
GWRS AWPf (for Mid-Basin Injection)		10,608
Subtotal		99,200
Irrigation		Water Usage (AF)
IRWD ²		18,360
OCWD (Green Acres Project) ³		4,315
Subtotal		22,675
TOTAL		121,875

¹Includes 61 AF of GWRS recycled water delivered to City of Anaheim Canyon Power Plant and Anaheim Regional Transportation Intermodal Center.

²Recycled water used within the portion of OCWD that lies within IRWD's boundaries (excludes OCWD/IRWD intertie water deliveries to the Green Acres Project).

³Excludes deliveries to the Orange County Sanitation District and includes IRWD/OCWD Intertie deliveries to the Green Acres Project.

AVAILABILITY OF SUPPLEMENTAL REPLENISHMENT WATER

MWD's untreated full-service water supplies for any groundwater-basin agencies were available during the water year 2020-21 as a result of its allocation of State Project Water and normal rainfall conditions. Supplemental water from MWD to recharge the groundwater basin is available in the current water year and is expected to be available in the ensuing water year 2022-23. OCWD is not planning to purchase untreated full-service water to recharge its groundwater basin in the ensuing water year 2022-23 due to the expected decrease in groundwater production caused by the PFAS water quality issue.

WATER DEMANDS

During the 2020-21 water year, the total water demands within OCWD's service area were 406,992 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.

Water demands for 2020-21 and projected water demands for 2021-22 and 2022-23 are summarized in Table 5. The water demands for the current year 2021-22 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 water demands. The water demands for the ensuing year 2022-23 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-water¹	Imported Water^{2,3}	Santiago Creek Native Water³	Recycled Water⁴	Total⁶
2020-21					
Non-Irrigation	281,043	99,596	2,928	-	383,567
Irrigation	750	0	-	22,675	23,425
Total	281,793	99,596	2,928	22,675	406,992
2021-22 (Current Year)⁵					
Non-Irrigation	280,200	93,100	2,900	-	376,200
Irrigation	800	-	-	23,000	23,800
Total	281,000	93,100	2,900	23,000	400,000
2022-23 (Ensuing Year)⁵					
Non-Irrigation	294,200	79,200	2,800	-	376,200
Irrigation	800	-	-	23,000	23,800
Total	295,000	79,200	2,800	23,000	400,000

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 Orange County Sanitation District'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.

The GWRS is an advanced wastewater reclamation project jointly-funded by OCWD and the Orange County Sanitation District (OC San). 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 advanced oxidation process of ultraviolet (UV) light in combination with hydrogen peroxide. For the water year 2020-21, the GWRS treated wastewater from the OC San to drinking water standards and delivered 99,200 AF of purified water for direct injection into the Talbert seawater intrusion barrier and percolation into the OCWD groundwater basin via recharge basins and MBI well.

For water year 2020-21, 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 22,675 AF.

WRD operates the Alamitos Barrier Recycled Water Project, known as the Leo J. Vander Lans Water Treatment Facility that has a design capacity of 8 MGD; however, its historical production is typically 3 MGD. 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 advanced oxidation process of UV light and hydrogen peroxide. 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 throughout the water year 2020-21 and supplied 1,498.5 AF of purified recycled water to OCWD's portion of the Alamitos Barrier, which represented 57.3 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.

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 Philip L. Anthony Water Quality Laboratory at the Fountain Valley campus. The laboratory houses approximately 31 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 2020-21 was determined to have a flow-weighted average of 450 milligrams per liter (mg/L) of total

dissolved solids (TDS) which is higher than the average TDS concentration of 427 mg/L reported for the prior year (2019-20). The average groundwater TDS concentration for the basin for 2020-21 was 406 mg/L (compared to 429 mg/L reported for 2019-20), ranging from a low of 237 mg/L in coastal areas (such as Seal Beach) to a high of approximately 679 mg/L in certain inland areas.

Average concentrations of TDS, nitrate (NO₃) and hardness for groundwater and groundwater combined with supplemental water supplied by agencies within OCWD's service area during the 2020-21 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 2020-21 water year and the previous water year (2019-20) is included in Appendix 5.

TABLE 6. 2020-21 Water Quality Summary

City/Agency	Groundwater ^{1,7}			Delivered Blend ^{1,2,7}		
	TDS ³	NO ₃ -N ⁴	Hardness ⁵	TDS ³	NO ₃ -N ⁴	Hardness ⁵
Anaheim	510	2.1	310	550	0.7	270
Buena Park	436	1.9	267	451	1.7	266
East Orange County Water District	528	2.7	341	562	0.4	262
Fountain Valley	342	1.0	200	342	1.0	200
Fullerton	426	2.0	242	465	1.5	246
Garden Grove	532	3.6	329	539	2.8	312
Golden State Water Company	397	1.5	234	450	1.1	241
Huntington Beach	323	0.5	177	358	0.4	188
Irvine Ranch Water District ⁶	325*	0.7*	115*	340*	0.7*	124*
La Palma	299	ND ⁸	139	299	ND ⁸	139
Mesa Water District	321	0.5	112	322	0.5	113
Newport Beach	289	1.2	153	301	1.2	158
Orange	429	2.2	248	462	1.7	250
Santa Ana	408	2.1	247	444	1.6	249
Seal Beach	237	ND ⁸	70	340	ND ⁸	128
Serrano Water District	0 ⁹	0 ⁹	0 ⁹	624	ND ⁸	374
Tustin ⁶	642*	5.5*	360*	627*	4.4*	340*
Westminster	366	1.8	230	366	1.8	230
Yorba Linda Water District	679	1.2	325	625	0.7	292
Weighted Average⁷	406	1.6	218	450	1.2	229

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 2020-21 are as follows:

<u>MWD Water Quality</u>	<u>Santiago Reservoir Water Quality</u>
TDS = 565 mg/L	TDS = 624 mg/L
NO ₃ -N = 0.8 mg/L	NO ₃ -N = 0.05 mg/L
Hardness (as CaCO ₃) = 256 mg/L	Hardness (as CaCO ₃) = 374 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 NO₃-N (i.e., nitrate expressed as nitrogen) is 10 mg/L.

⁵ Hardness is reported as mg/L of CaCO₃. General classifications of hard and soft water are within the following concentration ranges:

0-75 mg/L = soft
75-150 mg/L = moderately hard
150-300 mg/L = 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 NO₃-N) analytical detection limit for OCWD Philip L. Anthony Water Quality Laboratory is 0.1 mg/L.

⁹ This agency did not pump groundwater in 2020-21.

PART III: WATER PRODUCTION COSTS FOR ENSUING WATER YEAR (2022-23)

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 (2022-23) WATER PRODUCTION COSTS SUMMARY OF FINDINGS

1. Cost for producing water from the groundwater basin within OCWD including a replenishment assessment for 2022-23 is estimated to be \$833.00 per acre-foot.
2. Cost of treated, non-interruptible supplemental water for 2022-23 is estimated to be \$1,277.50 per acre-foot.

GROUNDWATER PRODUCTION COSTS FOR NON-IRRIGATION USE

Cost for producing an acre-foot of groundwater in the ensuing 2022-23 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 2021. The capital cost component was derived using the current capital cost of a typical production well (including design and construction costs) financed with an annual interest rate of five percent and amortized over a 30-year repayment period. Appendix 6 contains several of the key design characteristics for a typical production well. The OCWD RA used in the determination of groundwater production cost is the approved RA for 2022-23.

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 2022-23 water year is estimated to be \$833 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 \$76 per AF. Operation and maintenance (O&M) costs ranged from \$5 to \$432 per acre-foot with a median cost of approximately \$74 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 49 percent.

TABLE 7. Estimated 2022-23 Groundwater Production Costs

Cost Item	Non-Irrigation Use	
	Annual Cost (\$)	Cost per AF (\$/AF)
Energy	197,600	76 ²
RA	1,450,800	558 ³
Capital	325,000 ^{1,4}	125 ^{1,4}
O&M	192,400	74 ²
Total Cost to Producers	2,165,800	833

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 Approved and adopted RA for 2022-23.
⁴ Assuming \$5,000,000 capital cost (including design and construction) with an interest rate of five percent amortized over a 30-year period and excluding cost of land purchase.

COST OF SUPPLEMENTAL WATER

Supplemental water is supplied to OCWD’s service area by MWD. MWD delivers both treated and untreated water as either an uninterruptible 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 2022-23 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 2022-23 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 2022-23 Supplemental Water Cost¹

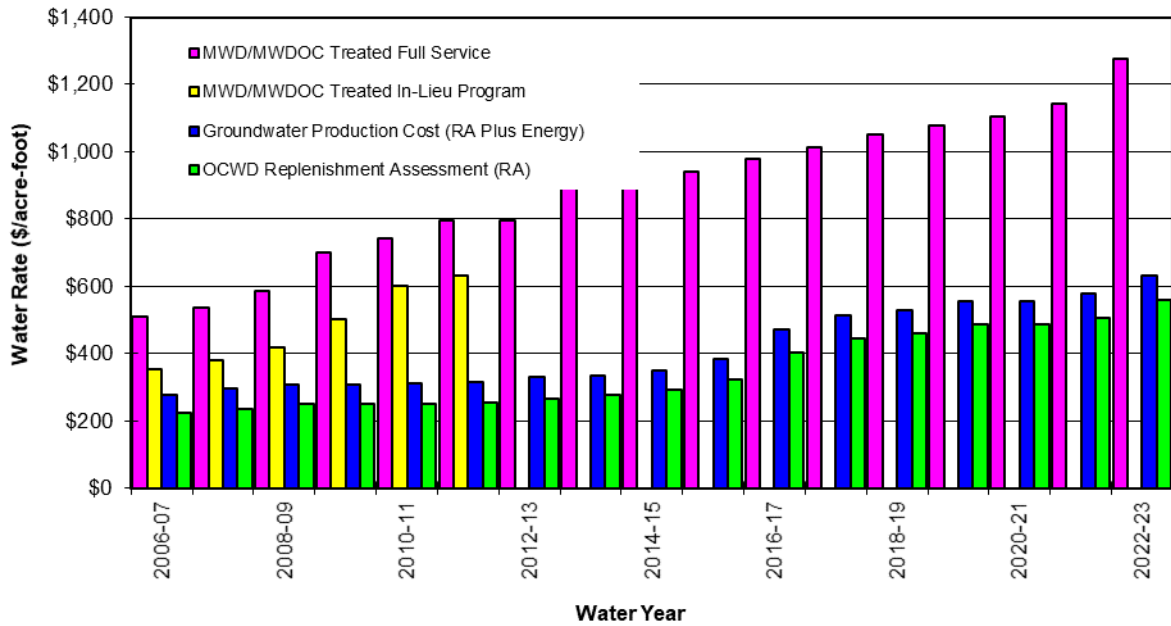
Rate and Charge Components	Treated Water Rate (\$/AF)
Firm Deliveries	Full Service Water
MWD Supply Rate (MWDOC Melded Rate)	285.50
MWD System Access Rate	381.00
MWD System Power Rate	177.00
MWD Treatment Surcharge	354.00
MWD RTS and Capacity Charges ²	<u>80.00</u>
Total	1,277.50

¹ Rates are an average of calendar year 2022 and calendar year 2023. 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. 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.

FIGURE 6. Adopted and Projected Water Rates for Non-Irrigation Use¹



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

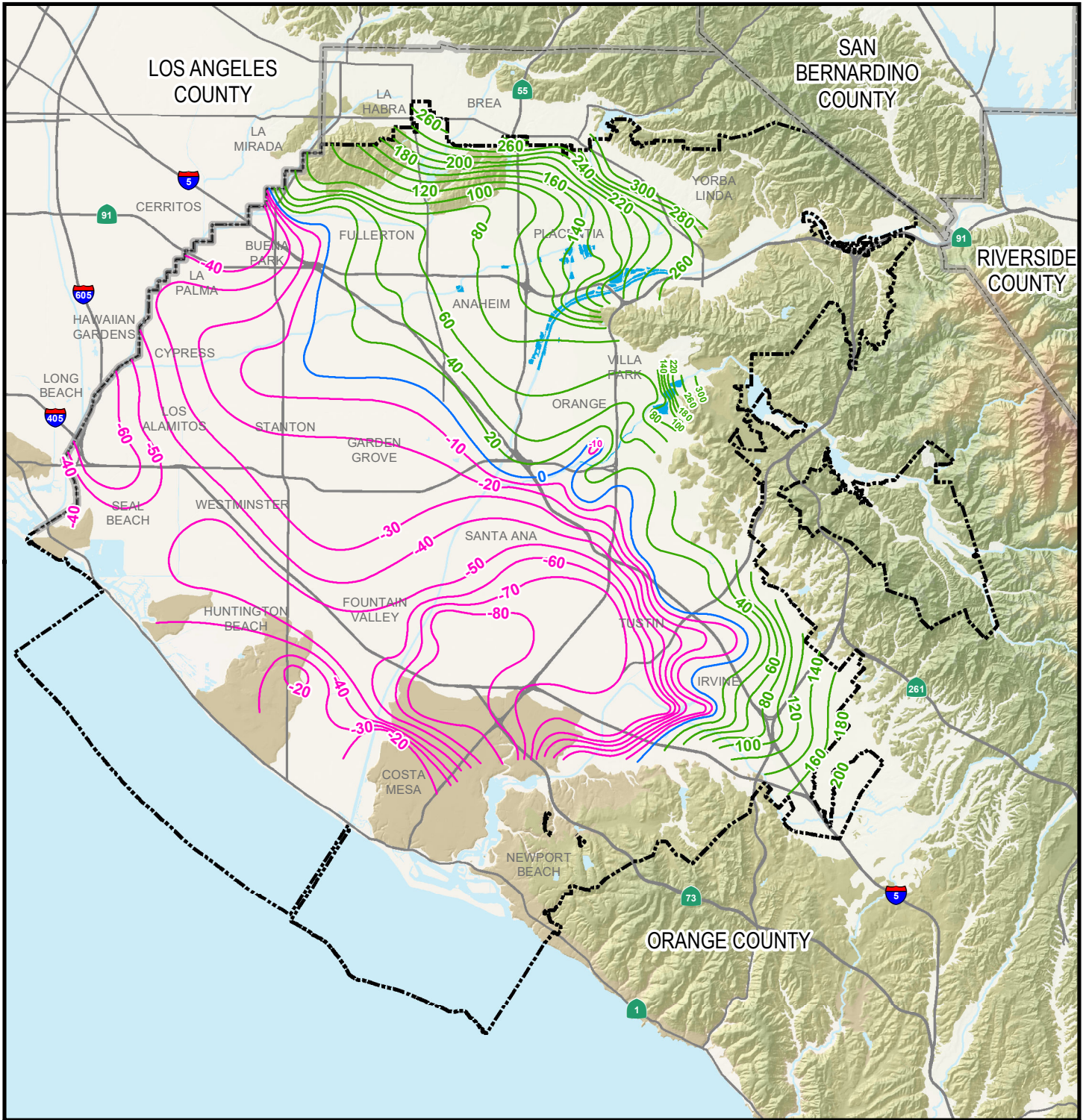
TABLE 9. Estimated 2022-23 Water Production Cost Comparison

Non-Irrigation Use	Groundwater Cost (\$/AF)	Supplemental Water Cost (\$/AF)
Fixed Cost	125.00 ¹	1,277.50 ³
Variable Cost	708.00 ²	_ ³
Total	833.00	1,277.50

¹ Capital cost.

² Cost for energy, O&M and proposed RA.

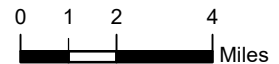
³ Delineation of fixed and variable costs is not available.



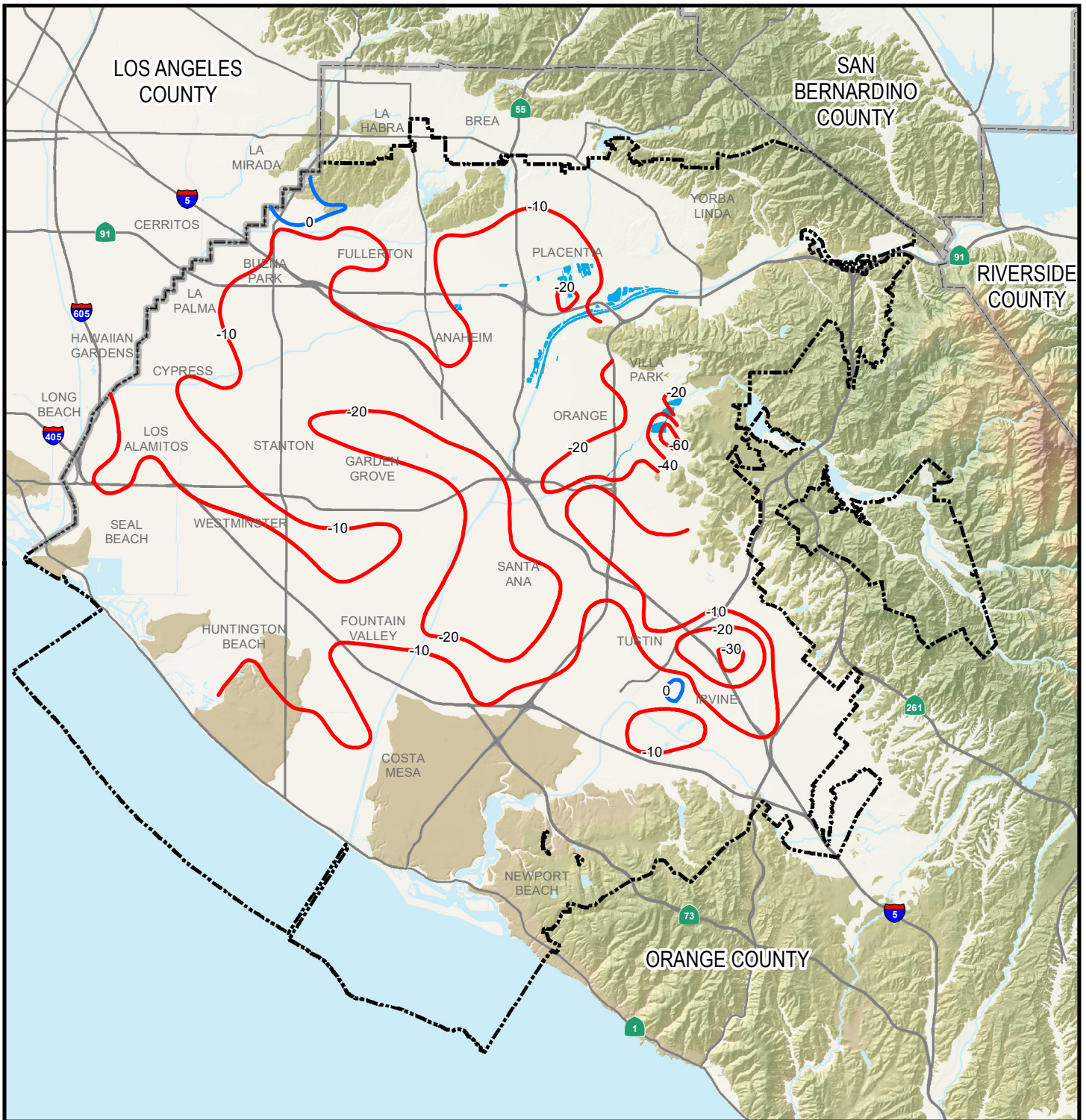
Estimated Groundwater Elevations within the Principal Aquifer Feet above Mean Sea Level* (ft MSL)

- -80 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 2021**



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




Estimated Groundwater Elevation Changes within the Principal Aquifer (Feet)

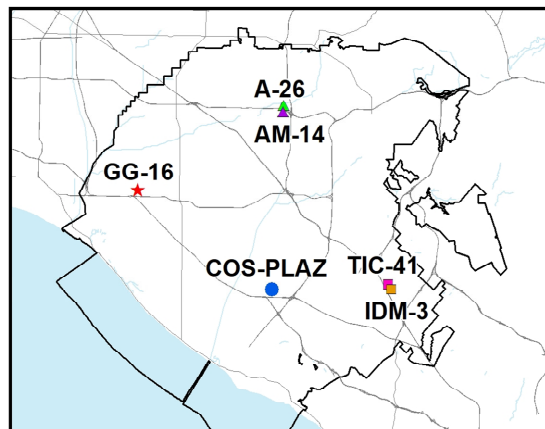
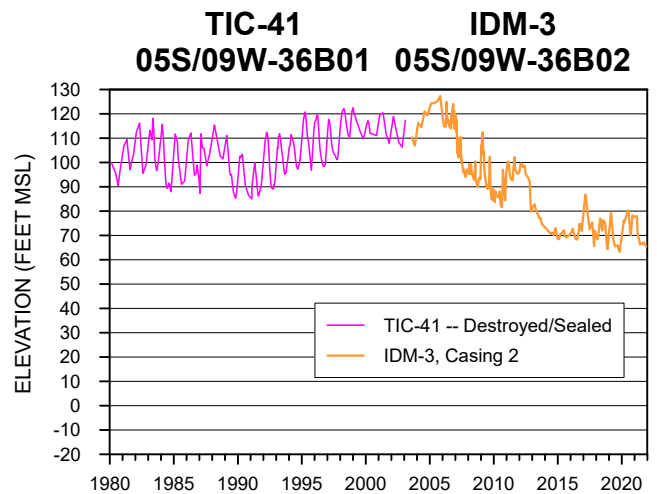
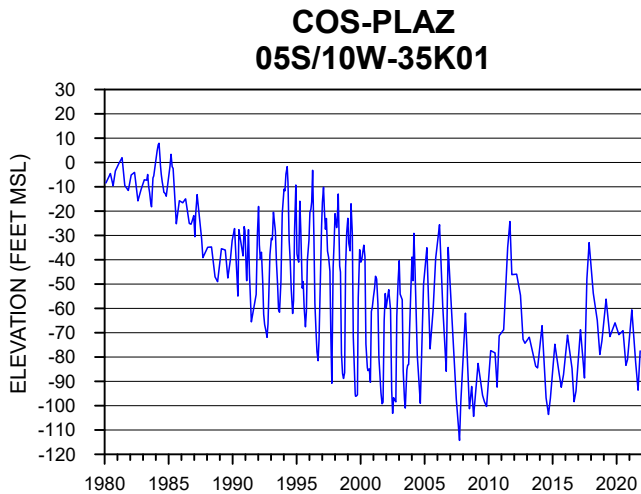
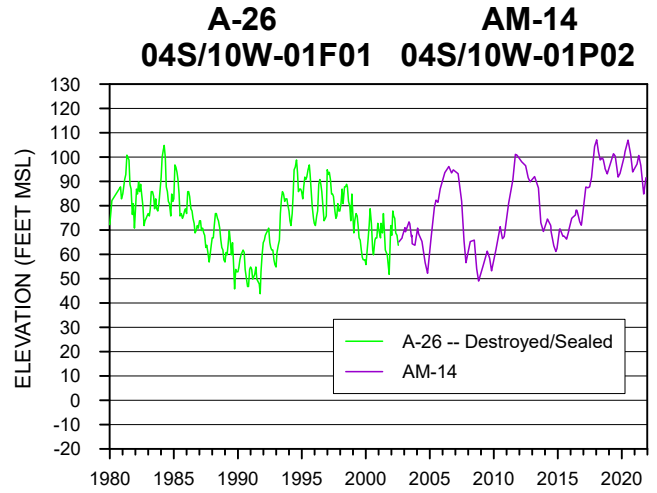
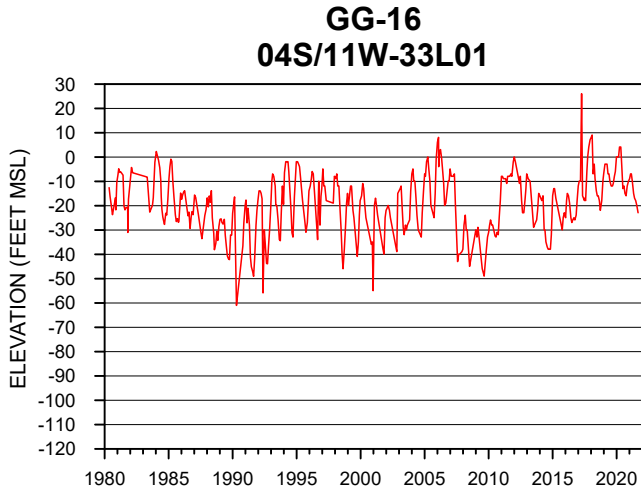
- -60 to -10
- 0
- Recharge Facility Areas
- Freeways / Highways
- Rivers / Streams
- Orange County Water District
- Water Bodies

**PLATE 2
CHANGE IN GROUNDWATER LEVEL
FROM JUNE 2020 TO JUNE 2021**



PLATE 3 KEY WELL GROUNDWATER ELEVATION TRENDS IN THE PRINCIPAL AQUIFER

 Measured water level elevations
in feet relative to mean sea level



APPENDIX 1. 2020-21 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 Deliveries	Irrigation Deliveries	Total		
	Pumping	In-Lieu ²							
Anaheim, City of ⁶	15,531.3	-	-	15,531.3	41,963.90	-	41,963.9	57,495.2	27.0%
Buena Park, City of ⁶	11,845.8	-	-	11,845.8	1,474.70	-	1,474.7	13,320.5	88.9%
East Orange County Water District	71.1	-	-	71.1	912.2	-	912.2	983.3	7.2%
County of Orange	173.7	-	-	173.7	167.3	-	167.3	341.0	50.9%
Fountain Valley, City of	9,209.3	-	-	9,209.3	0	-	0.0	9,209.3	100.0%
Fullerton, City of	17,633.2	-	-	17,633.2	6,946.9	-	6,946.9	24,580.1	71.7%
Garden Grove, City of ^{3,6}	17,846.5	-	-	17,846.5	5,317.8	-	5,317.8	23,164.3	77.0%
Golden State Water Company ⁶	16,937.6	-	-	16,937.6	7,726.6	-	7,726.6	24,664.2	68.7%
Huntington Beach, City of	23,753.6	-	-	23,753.6	4,040.1	-	4,040.1	27,793.7	85.5%
Irvine Ranch Water District ^{3,4}	47,171.4	-	-	47,171.4	2,822.6	-	2,822.6	49,994.0	94.4%
La Palma, City of	1,989.9	-	-	1,989.9	0.3	-	0.3	1,990.2	100.0%
Mesa Water District ³	16,550.8	-	-	16,550.8	66.4	-	66.4	16,617.2	99.6%
Newport Beach, City of	14,311.4	-	-	14,311.4	676.0	-	676.0	14,987.4	95.5%
Orange, City of ⁴	20,964.6	-	-	20,964.6	6,802.4	-	6,802.4	27,767.0	75.5%
Orange County Water District ⁵	1,591.4	-	-	1,591.4	0	-	0.0	1,591.4	100.0%
Santa Ana, City of ⁶	26,104.5	-	-	26,104.5	7,737.6	-	7,737.6	33,842.1	77.1%
Seal Beach, City of	2,342.5	-	-	2,342.5	1,068.8	-	1,068.8	3,411.3	68.7%
Serrano Water District ⁴	4.4	-	-	4.4	2,831.7	-	2,831.7	2,836.1	0.2%
Tustin, City of ³	9,014.0	-	-	9,014.0	2,241.3	-	2,241.3	11,255.3	80.1%
Westminster, City of ⁶	10,992.7	-	-	10,992.7	0	-	0.0	10,992.7	100.0%
Yorba Linda Water District ⁶	10,752.6	-	-	10,752.6	9,727.20	-	9,727.2	20,479.8	52.5%
Total Major Groundwater Producers	274,792.3	0.0	0.0	274,792.3	102,523.8	0.0	102,523.8	377,316.1	72.8%
Other Producers	6,250.8	-	749.4	7,000.2	-	-	-	7,000.2	
Exempt Well Production	-	-	-	-	-	-	-	-	
Total Amount	281,043.1	0.0	749.4	281,792.5	102,523.8	0.0	102,523.8	384,316.3	
Basin Production Percentage Overall									73.1%

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 Agencies that participate in a groundwater water quality improvement project.

⁴ Agencies that receive Santiago Creek native water above Villa Park Dam which are conveyed to users within OCWD. Such water, if delivered, is included within the classification of "Supplemental Water"

⁵ Groundwater quantity reported herein is that quantity used by OCWD for purposes other than seawater intrusion barrier maintenance.

⁶ These agencies participated in the MWD Long-Term Groundwater Storage Program for which groundwater was extracted and accounted for as supplemental water.

**APPENDIX 2. 2020-21 Groundwater Production —
Non-Irrigation Use Production Over 25 Acre-feet**

PRODUCER	AF	PRODUCER	AF
Alta Vista Country Club	153.50	Mesa Verde Country Club	427.30
Anaheim Cemetery	44.10	Mesa Water District	16,550.80
Anaheim, City of	15,531.30	Midway City Mutual Water Company	155.20
Billy Casper Golf	313.90	Mile Square Golf Course	114.20
Buena Park, City of	11,845.80	Navy Golf Course	511.60
Canyon RV Park	128.80	Newport Beach Golf Course	105.90
Coca Cola North America	92.00	Newport Beach, City of	14,311.40
Cottonwood Church	40.30	Old Ranch Country Club	523.00
County of Orange	173.70	Orange County Water District	1,591.41
DS Services of America, Inc.	351.80	Orange, City of	20,964.60
East Orange County Water District	71.10	Page Avenue Mutual Water Company	62.20
Eastlake Village HOA	91.70	Riverview Golf	226.40
Eastside Water Association	234.50	Santa Ana Cemetery	57.70
Fairhaven Memorial Park	155.00	Santa Ana Country Club	274.90
Fountain Valley, City of	9,209.30	Santa Ana, City of	26,104.50
Fullerton, City of	17,633.20	Seal Beach, City of	2,342.54
Garden Grove, City of	17,846.50	SMCM Water Co.	83.80
Golden State Water Company	16,937.60	The Boeing Company	118.70
Hargis and Associates, Inc.	67.2	The Good Shepherd Cemetery	74.90
Huntington Beach, City of	23,753.58	The Lakes Master Association	95.10
Hynes Estates, Inc.	91.00	Tustin, City of	9,014.00
Irvine Ranch Water District	47,171.40	Westminster Memorial Park	25.20
Knott's Berry Farm	206.10	Westminster, City of	10,992.70
La Palma, City of	1,989.90	Yorba Linda Country Club	380.80
Laguna Beach County Water District	551.15	Yorba Linda Water District	10,752.57
Lockheed Martin Corp.	30.80		
Los Alamitos Race Course	273.40	Total	280,850.05

**APPENDIX 3. 2020-21 Groundwater Production —
Irrigation Use Production Over 25 Acre-feet**

PRODUCER	AF
Neff Ranch, LTD	53.7
Orange County Produce	540.4
Treesap Farms, LLC	131.3
Total	725.4

**APPENDIX 4. Non - Local Water Purchased by OCWD for
Water Years 2001-2002 through 2020-21**

	Water Exchange	Alamitos Barrier	Talbert Barrier		Forebay Recharge		In-Lieu Program		SARCCUP	SAR Upstream Groundwater Projects		TOTAL
	Western Mun. WD		FV ¹	Mesa WD	Forebay Recharge	CUP ² Recharge	CUP ² In-Lieu	In-Lieu	Water Bank ³	Arlington Desalter	SBVMWD	
Water Year	Purch. AF	Purch. AF	Purch. AF	Purch. AF	Purchase AF	Delivery AF	Delivery AF	Purch. AF	Delivery AF	Purch. AF	Purch. AF	Delivery and Purchase AF
	2001-02	2,990.3	2,282.2	2,673.0	-	30,092.6	-	-	19,472.4	-	5,819.8	4,296.4
2002-03	3,471.4	1,448.7	1,540.1	-	35,755.1	-	-	25,631.0	-	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	-	-	-	-	-	-	50,092.0
2017-18	-	912.2 ⁴	-	18.4	66,113.5	-	-	73,108.6	-	-	-	140,152.7
2018-19	-	2,015.2 ⁴	-	20.1	40,344.9	-	-	-	-	-	-	42,380.2
2019-20	-	2,100.0 ⁴	-	2.0	18,098.2	-	-	9,354.7	-	-	-	29,554.9
2020-21	-	2,617.6 ⁴	1.3	15.7	-	-	-	-	2,000.0	-	-	4,634.6
Total	18,357.6	34,299.1	9,593.3	33,674.6	567,091.4	42,243.1	57,100.8	383,155.4	2,000.0	17,427.9	4,296.4	1,179,239.6⁶

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 excluded.

³ Both EOS and imported water from MWD will be tracked in the SARCCUP water bank.

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. 2020-21 Water Resources Summary

	2020-2021 Water Year (AF)	2019-2020 Water Year (AF)	Change from last year to this year
SUMMARY OF BASIN CONDITIONS			
BASIN SUPPLIES			
Water Purchases from MWD (excludes In-Lieu)	0	18,098	-18,098
Water into MWD Storage Account (excludes In-Lieu)	0	0	0
SAR & Santiago Creek Flows ¹	117,452	179,455	-62,003
GWRS AWPf Water to Forebay Recharge Basins	61,418	70,133	-8,714
GWRS AWPf Water to Mid-Basin Injection	10,608	3,722	6,886
GWRS AWPf Water to Talbert Barrier	27,113	23,777	3,336
Imported Water to Talbert Barrier (OC-44 & Fountain Valley)	17	2	15
Alamitos Barrier	2,618	2,100	518
Incidental Recharge	19,051	41,362	-22,311
Evaporation from Recharge Facilities	-3,266	-3,363	97
SAR Flow Lost to Ocean	<u>-1,218</u>	<u>-22,093</u>	<u>20,875</u>
Total Groundwater Recharge	233,793	313,280	(31,216)
WATER PRODUCTION			
Groundwater Production	281,793	277,195	4,598
MWD Storage Program Extractions	<u>0</u>	<u>0</u>	<u>0</u>
Total Groundwater Production	281,793	277,195	4,598
BASIN STATUS			
Change in Groundwater Storage	-48,000	36,000	-84,000
Change in Groundwater Storage excluding MWD Stored Water	-48,000	36,000	-84,000
Accumulated Overdraft (AOD)	248,000	200,000	48,000
AOD without MWD Storage Program Water	248,000	200,000	48,000
IN-LIEU WATER			
OCWD In-Lieu Purchases	0	9,355	9,355
MWD In-Lieu Storage	<u>0</u>	<u>0</u>	<u>0</u>
Total In-Lieu	0	9,355	9,355
OTHER KEY INFORMATION			
1. Total Dissolved Solids of SAR below Prado Dam (mg/L)	680	530	150
2. Total Nitrogen of SAR below Prado Dam (mg/L)	3.0	1.0	2.0
3. Total GWRS AWPf Production ²	99,200	97,719	1,481
4. Green Acres Project	4,315	4,206	109
5. Base Flow of Santa Ana River	76,391	77,984	-62
6. Year-end Storage behind Prado Dam	1	1,482	-1,481
7. Year-end Storage in Recharge Facilities	8,660	15,739	-7,079
8. Total Artificial Recharge (percolation plus barriers)	214,742	271,833	-57,091
9. Rainfall Measured at OCWD Field Headquarters (inches)	6.0	14.0	-8.0
10. Annual Mean Temperature at Santa Ana Fire Station (°F)	67.0	67.0	0

¹ Accounts for storage to/from recharge facilities.

² Total includes deliveries to recharge basins, Talbert Barrier, MBI, Anaheim Canyon Power Plant and Anaheim Regional Transportation Intermodal Center.

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	\$325,000

¹ Assuming \$5,000,000 capital cost (including design and construction) with an interest rate of five percent amortized over a 30-year period and excluding the cost for land purchase.

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 Uninterruptible Rate (Full Service) ^{2,3} (\$/AF)
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	1,050
2019-20	487	557	.5	1,078
2020-21	487	555	.5	1,104
2021-22	509	581	.5	1,143
2022-23	558	633	.5	1,277.5 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.