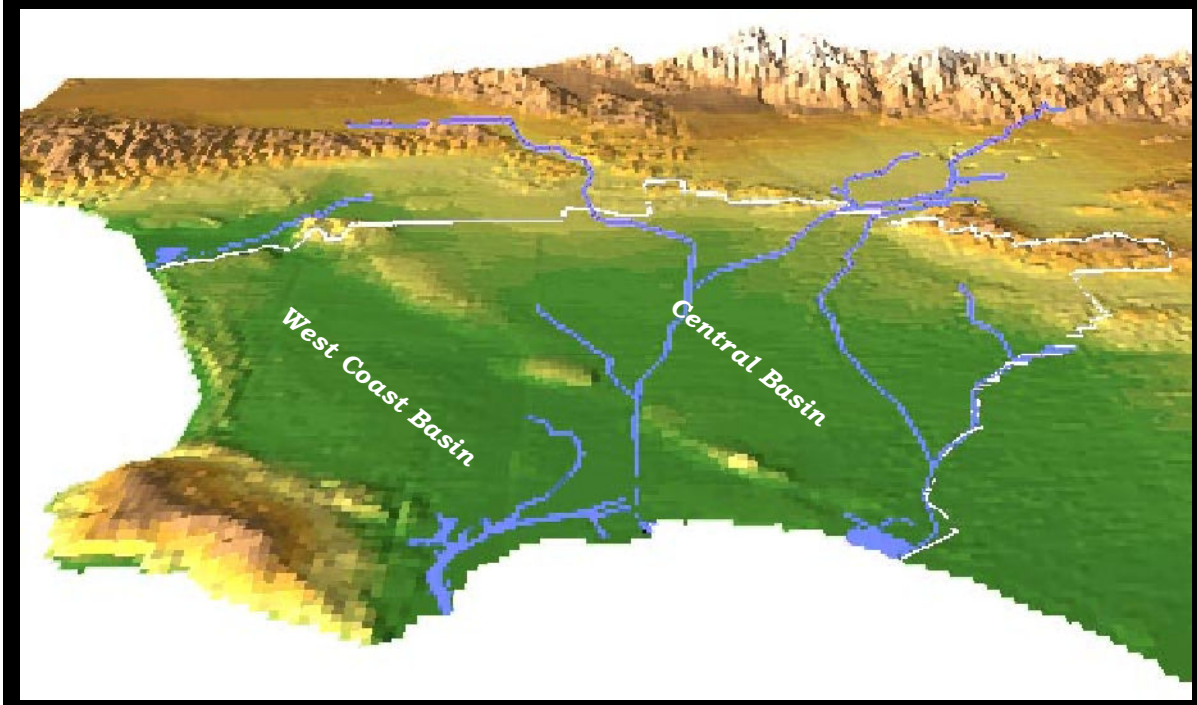

Engineering Survey and Report

2019

WRD

WATER REPLENISHMENT DISTRICT
OF SOUTHERN CALIFORNIA

March 6, 2019

Water Replenishment District
Of Southern California

ENGINEERING SURVEY AND REPORT, 2019
March 6, 2019

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Professional Certification

This Engineering Survey and Report has been prepared under the direct supervision of the California Professional Geologist whose signature appears below. This individual certifies that the information contained in the report has been prepared in accordance with the generally accepted principles and practices of his profession.

Theodore A. Johnson, PG, CHG
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GLOSSARY OF ACRONYMS

ABP	Alamitos Barrier Project
AF	Acre-Feet (equivalent to 325,851 gallons)
AFY	Acre-Feet per Year
APA	Allowed Pumping Allocation
ARC	Albert Robles Center for Water Recycling and Environmental Learning
AWTF	Advanced Water Treatment Facility
BAC	Budget Advisory Committee
BOS	Bureau of Sanitation (City of Los Angeles Dept. of Public Works)
CASGEM	California Statewide Groundwater Elevation Monitoring
CB	Central Basin
CBMWD	Central Basin Municipal Water District
CBWCB	Central Basin and West Coast Basin
CDPH	California Department of Public Health (now Division of Drinking Water)
CEC	Constituents of Emerging Concern
CEQA	California Environmental Quality Act
CIP	Capital Improvement Program
CMMS	Computer Maintenance Management System
CPI	Consumer Price Index
DAC	Disadvantaged Community
DDW	State Water Resources Control Board – Division of Drinking Water (formerly CDPH)
DGBP	Dominguez Gap Barrier Project
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EIR	Environmental Impact Report
EPA	U.S. Environmental Protection Agency
ESR	Engineering Survey and Report
FY	Fiscal Year (July 1 – June 30)
GIS	Geographic Information System
GRIP	Groundwater Reliability Improvement Project (now known as ARC)
IRWMP	Integrated Regional Water Management Plan
LACDHS	Los Angeles County Department of Health Services
LACDPW	Los Angeles County Department of Public Works (Flood Control)
LACFCD	Los Angeles County Flood Control District
LADWP	City of Los Angeles Department of Water and Power
LBWD	City of Long Beach Water Department
LBWRP	Long Beach Water Reclamation Plant

MAR	Managed Aquifer Recharge
Met	Metropolitan Water District of Southern California (aka "MWD")
MCL	Maximum Contaminant Level
MF	Microfiltration
MGD	Million Gallons per Day
msl	Mean Sea Level
MWD	Metropolitan Water District of Southern California (aka "Met")
NDMA	N-Nitrosodimethylamine
ppb	Parts Per Billion, equivalent to micrograms per liter (µg/L)
ppm	Parts Per Million, equivalent to milligrams per liter (mg/L)
PWRP	Pomona Water Reclamation Plant
RA	Replenishment Assessment
RGWMP	Regional Groundwater Monitoring Program
RO	Reverse Osmosis
RWQCB	Regional Water Quality Control Board (Los Angeles Region)
SAT	Soil Aquifer Treatment
SCADA	Supervisory Control and Data Acquisition
SDLAC	Sanitation Districts of Los Angeles County
SDWP	Safe Drinking Water Program
SGVMWD	San Gabriel Valley Municipal Water District
SJCWRP	San Jose Creek Water Reclamation Plant
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TITP	Terminal Island Treatment Plant
USGS	United States Geological Survey
USGVMWD	Upper San Gabriel Valley Municipal Water District
UVAOP	Ultraviolet Light Advanced Oxidation Processes
VOC	Volatile Organic Compounds
WBMWD	West Basin Municipal Water District
WCB	West Coast Basin
WCBBP	West Coast Basin Barrier Project
WIN	Water Independence Now program
WNOU	Whittier Narrows Operable Unit
WNWRP	Whittier Narrows Water Reclamation Plant
WRD	Water Replenishment District of Southern California
WRP	Water Reclamation Plant
WY	Water Year (October 1 – September 30)

BOARD SUMMARY

District Staff is pleased to present this 2018 Engineering Survey and Report (ESR). It was prepared pursuant to the California Water Code, Section 60300 et seq. and determines the past, current, and ensuing year groundwater conditions in the Central Basin and West Coast Basin (CBWCB). The report contains information on groundwater production, annual and accumulated overdraft, water levels, quantity, source, and cost of replenishment water, and a discussion of necessary projects and programs to protect and preserve the groundwater resources of the basins.

The ESR provides the Board of Directors with the necessary information to justify the setting of a replenishment assessment (RA) for the ensuing fiscal year (FY) (July 1 through June 30) to purchase replenishment water and to fund projects and programs related to groundwater replenishment and groundwater quality over the ensuing water year (WY) (October 1 through September 30).

The following is a summary of the ESR elements required by the Water Code, and **Plates 1**, **2** and **3** provide illustrations of pumping and groundwater conditions for the previous WY 2017/18.

1. Groundwater Production

- Adjudicated Amount: 281,835.25 acre-feet (AF)
- Previous Water Year (2017/18): 220,697 AF
- Current Water Year (2018/19): 217,300.00 AF (estimated)
- Ensuing Water Year (2019/20): 217,300.00 AF (estimated)

2. Annual Overdraft

- Previous Water Year: 171,482 AF
- Current Water Year: 72,100 AF (estimated)
- Ensuing Water Year: 72,100 AF (estimated)

3. Accumulated Overdraft

- Previous Water Year: 828,665 AF
- Current Water Year: 806,900 AF (estimated)

4. Groundwater Levels

WY 2017/18 had below normal precipitation resulting in an overall water level decline in the CBWCB. Although WRD continued artificial replenishment with recycled and imported water, there was insufficient rainfall to makeup the overdraft. Water levels in the Montebello Forebay dropped up to 34 feet. However in the West Coast Basin, water levels generally rose due to reduction in pumping and continued injection at the seawater barriers. Throughout the WRD Service Area, a total of 80,243 acre feet were removed from storage bringing the accumulated overdraft to 828,665 AF which is only 71,335 AF above the Board-adopted minimum groundwater quantity.

In the current WY 2018/19, through the time of this writing the year has been a wet one, with precipitation 150% of normal so far. Water levels in the Montebello Forebay have been rising as a result, and are over 5 feet higher than the start of the WY in October 2018. And WRD has placed an order for 8,000 AF of imported water for spreading and is maximizing recycled water. Therefore,

because the current and projected groundwater levels in the CBWCB are within historic ranges, the District anticipates that there will continue to be sufficient supplies of safe and reliable groundwater to meet the demands of the pumpers in our service area in the current and ensuing years. Details of the groundwater levels in the CBWCB are described in Chapter 3.

5. Quantity of Replenishment Water Required in the Ensuing Year

The District determines replenishment water needs based on averages from a long-term (30 year) hydrologic record and computer models, meaning extremely wet years and extremely dry years in addition to average precipitation years are accounted for in deriving the average replenishment needs. Other considerations by the Board are also incorporated into replenishment water needs. The District's Water Independence Now (WIN) initiative has been successful to build and/or have permitted the recharge facilities it uses to replenish the groundwater basins with 100% recycled water instead of imported water. As these facilities secure the recycled water they need for full operations, the amount of imported water will approach near zero. Chapter 4 details the quantity of water that WRD plans to purchase in the ensuing year. A summary is as follows:

- Spreading Water: 72,400 AF (61,000 AF tertiary recycled; 10,000 AF advanced treated recycled at ARC, zero imported; 1,400 Whittier Narrows Operable Unit water – considered Local Water)
- Seawater Barrier Water: 29,000 AF (9,500 AF imported; 19,500 AF recycled)
- In-Lieu Program Water: 0 AF (suspended due to lack of MWD seasonal water)
- Total Water: 101,400 AF

6. Source of Replenishment Water

The sources of replenishment water to the District for the ensuing year are detailed in Chapter 4, and include recycled water and imported water. A summary follows:

- Recycled Water: Tertiary water for spreading is available from the Sanitation Districts of Los Angeles County (SDLAC). Advanced-treated recycled water for the West Coast Basin Barrier Project (WCBBP) is available from the West Basin Municipal Water District. Advanced-treated recycled water for the Dominguez Gap Barrier Project (DGBP) is available from the City of Los Angeles. Advanced-treated recycled water for the Alamitos Barrier Project (ABP) is available from WRD's Leo J. Vander Lans Water Treatment Facility. Advanced-treated recycled water for the Montebello Forebay (spreading grounds and injection wells) is available from WRD's Albert Robles Center for Water Recycling and Environmental Learning (ARC), formerly known as the Groundwater Reliability Improvement Project (GRIP).
- Imported Water: Raw river water (untreated) Tier 1 is assumed to be available for spreading from MWD and its member agencies if desired by WRD. For the seawater barrier wells, treated potable imported water Tier 1 is assumed to be available as needed for the WCBBP and DGBP from the West Basin Municipal Water District (WBMWD), and for the ABP from the City of Long Beach.

7. Cost of Replenishment Water

WRD has estimated it will need 101,400 AF of replenishment water in the ensuing year to help overcome the annual overdraft. WRD purchases replenishment water from MWD member agencies and recycled water providers. These agencies set the price for the replenishment water that WRD buys for the spreading grounds, seawater barrier injection wells, and In-Lieu water when available. The

cost for replenishment water is a direct pass-through from WRD to the water suppliers on WRD's replenishment assessment. The cost for source water for WRD's projects (Leo J. Vander Lans and ARC) are included in the operations and maintenance budgets for those projects and therefore not included on **Table 2**.

Using currently available information, the estimated cost of water to WRD for the ensuing year is $40,227,727, which is a 3.8% increase from the previous year. **Tables 1 and 2** provide a detailed breakdown of the water amounts and estimated costs.

The water cost are for water purchases only and do not include the additional costs for projects and programs related to water replenishment and water quality matters. These projects and programs are presented in Chapter 5, although their costs are presented in separate District materials, including budget workshops, Finance Committee meetings, Board of Directors' meetings, Budget Advisory Committee (BAC) meetings, and other public meetings and workshops. The Board of Directors will combine the cost of water with the cost of all other necessary District operations in considering the rate for the ensuing year Replenishment Assessment (RA), which they will adopt on or before the second Tuesday in May in accordance with the Water Code.

8. Projects and Programs

A list of the projects and programs in which WRD is involved related to groundwater replenishment and the protection and preservation of groundwater quality is shown on **Table 3**. Funds are required to finance these projects and programs. Sections 60221, 60230 and 60224 of the Water Code authorize the WRD to undertake a wide range of capital projects and other programs aimed at enhancing groundwater replenishment and improving groundwater quality.

These projects and programs address any existing or potential problems related to the basins' groundwater, and may extend beyond the District's boundaries if the threat of contamination is outside those boundaries. The programs span all phases of planning, design, and construction and are financed by the collection of a replenishment assessment. A more detailed description of each project and program is presented in Chapter 5 of the report.

9. Conclusions

Based upon the information presented in the ESR, a replenishment assessment is necessary in the ensuing year to purchase replenishment water and to finance projects and programs to perform replenishment and water quality activities. These actions will ensure sufficient supplies of high quality groundwater within the District for the benefit of the residents and businesses in the Central Basin and West Coast Basin.

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CHAPTER 1 - INTRODUCTION

Purpose of the Engineering Survey & Report

To facilitate the Board of Directors' decisions and actions, the Water Replenishment District Act requires that an engineering survey and report (ESR) be prepared each year. This ***Engineering Survey and Report 2019*** is in conformity with the requirements of Section 60300 et seq. of the Water Replenishment District Act and presents the necessary information on which the Board of Directors can declare whether funds shall be raised to purchase water for replenishment during the ensuing year, as well as to finance projects and programs aimed at accomplishing groundwater replenishment. With the information in this ESR, the Board can also declare whether funds shall be collected to remove contaminants from the groundwater supplies or to exercise any other power under Section 60224 of the California Water Code. The information presented in this report along with the District's strategic planning and budget preparation presents the necessary information on which the Board of Directors can base the establishment of a replenishment assessment for the ensuing fiscal year (FY) effective July 1, 2019 through June 30, 2020.

Scope of Engineering Survey & Report

This report contains specific information outlined in Chapter I, Part 6 of Division 18 of the Water Code (the Water Replenishment District Act, § 60300 and § 60301). The following is a brief description of the contents of this report:

1) a discussion of groundwater production within the District (Chapter 2);

2) an evaluation of groundwater conditions within the District, including estimates of the annual overdraft, the accumulated overdraft, changes in water levels, and the effects of water level fluctuations on the groundwater resources (Chapter 3);

3) an appraisal of the quantity, availability, and cost of replenishment water required for the ensuing water year (Chapter 4); and

4) a description of current and proposed programs and projects to accomplish replenishment goals and to protect and preserve high quality groundwater supplies within the District (Chapter 5).

Schedule for Setting the Replenishment Assessment

The following actions are required by the Water Code to set the Replenishment Assessment:

1) *The Board shall order the preparation of the ESR no later than the second Tuesday in February each year (see Section 60300).*
2) *The Board shall declare by resolution whether funds shall be collected to purchase replenishment water and to fund projects and programs related to replenishment and/or water quality activities on or before the second Tuesday in March each year and after the ESR has been completed (see Section 60305).*
3) *A Public Hearing will be held for the purpose of determining whether District costs will be paid for by a replenishment assessment. The Public Hearing will be opened on the second Tuesday in April and may be adjourned from time to time but will be completed by the first Tuesday in May (see Sections 60306 and 60307).*
4) *The Board by resolution shall levy a replenishment assessment for the ensuing fiscal year no later than the second Tuesday in May (see Sections 60315, 60316 and 60317).*

Although dates specified in the Water Code refer generally to 'on or before certain Tuesdays', Section 60043 also states that "*Whenever any act is required to be done or proceeding taken on or set for a particular day or day of the week in any month, the act may be done or proceeding set for and acted upon a day of the month otherwise specified for a regular meeting of the board"*. Therefore, there is flexibility as to the actual dates when Board actions are taken regarding the ESR, adopting resolutions, conducting public hearings, and the setting of the replenishment assessment.

The ESR is completed on or before the second Tuesday in March of each year to comply with the Water Code and to provide the Board with the necessary information to determine whether a replenishment assessment will be needed in the ensuing year to purchase replenishment water and to fund projects and programs related to water quality and replenishment activities. However, in the subsequent months leading up to the adoption of the replenishment assessment in April or May, new information may be received that affects the findings presented in the March ESR. The final information used by the Board of Directors when they adopt the replenishment assessment is reflected in an updated ESR that is published after adoption of the replenishment assessment in April or May.

CHAPTER 2 - GROUNDWATER PRODUCTION

Adjudication and Demand

Prior to the adjudication of groundwater rights in the early 1960s, annual groundwater production (pumping) reached levels as high as 259,400 acre feet (AF) in the Central Basin (CB) and 94,100 AF in the West Coast Basin (WCB). This total of 353,500 AF was more than double the natural safe yield of the basins (173,400 AF) as determined by the California Department of Water Resources in 1962. Due to this serious overdraft, water levels declined, groundwater was lost from storage, and seawater intruded into the coastal aquifers. To remedy this problem, the courts adjudicated the two basins to put a limit on pumping. The West Coast Basin adjudication was set at 64,468.25 acre-feet per year (AFY). The Central Basin "Allowed Pumping Allocation" (APA) was set at 217,367 AFY. Therefore, the current amount allowed to be pumped from both basins is 281,835.25 AFY, plus any carryover or stored water, or other provisions as described at the end of this Section or in the Judgments.

The adjudicated pumping amounts were set higher than the natural replenishment amounts, creating an annual deficit known as the "Annual Overdraft". WRD is enabled under the California Water Code to purchase and recharge additional water to make up this annual overdraft, which is known as artificial replenishment or managed aquifer recharge (MAR). WRD has the authority to levy a replenishment assessment on all pumping within the District to raise the monies necessary to purchase or manufacture the artificial replenishment water and to fund projects and programs necessary for replenishment and groundwater quality activities.

Groundwater Production

Under the terms of Section 60326.1 of the Water Replenishment District Act, each groundwater producer must submit a report to the District summarizing their monthly production activities (quarterly for smaller producers). The information from these reports is the basis by which each producer pays the replenishment assessment.

Previous Water Year:

Per the Water Code, WRD tracks and reports on groundwater production (pumping) on a water year (WY) basis covering the time frame of October 1 - September 30 of each year. In the previous WY (2017/18), total pumping in both basins was 220,696.55 AF, including 188,515.28 AF in the CB and 32,181.27 AF in the WCB. Because the adjudicated rights are 281,835.25 AF, there were about 61,139 AF of available rights that were not pumped in the previous WY, although many of these unpumped rights were allowed to carry over into the current WY or converted into storage.

Plate 1 illustrates the groundwater production in the CBWCB during the previous WY and **Table E** presents the historical pumping amounts.

Current Water Year:

For the first three months of the current WY (October through December, 2018), groundwater production was 50,989AF (43,970 AF in the CB and 7,019 AF in the WCB). This is 3,679 AF less than the same period of the year earlier (-6.7%). Because these numbers represent only the first 3 months of the WY, they are difficult to use to forecast through the rest of the year. However, based on conversations with the Central Basin and West Coast Basin Watermaster Administrative Body and a review of the FY pumping to date, the early forecast is for total pumping for the entire WY to be 217,300 AF (188,000 AF in the CB and 29,300 AF in the WCB).

Ensuing Water Year:

To estimate production for the ensuing year, recent averages are typically used in addition to knowledge of changing conditions that might affect pumping. Actual pumping patterns can vary considerably throughout the year based on a pumper's individual operational needs, water demands, water well maintenance, conservation efforts and hydrology. In the 2015/16 WY, pumping was significantly reduced due to the State's fifth year of drought that resulted in mandated water reductions and public awareness for conservation efforts and the shutdown of some wells due to operational issues. This led to the lowest pumping amounts the District has seen in over 20 years. Although the drought was declared over by the California Governor for 2016/17 due to a wet year, 2017/18 was dry again, and although the current year 2018/19 has been wet so far, it has not yet reached an average annual amount. Groundwater pumping has picked up from the recent lows, but conservation efforts are expected to continue. Therefore, recent averages may not be indicative of future pumping.

To estimate the ensuing year's groundwater pumping, WRD has made a forecast based on the current year's anticipated pumping plus expected additional or reduced pumping from discussions with purveyors. Based on this information, at this time WRD is estimating the ensuing WY pumping to be the same as the current year's forecast, or 217,300 AF. Of this amount, 188,000 AF is estimated for the CB and 29,300 AF for the WCB.

Table 1 shows the groundwater production amounts for the previous, current, and ensuing WYs.

Measurement of Production

With few exceptions, meters installed and maintained by the individual producer measure the groundwater production from their wells. Through periodic testing by Watermaster (Water Rights Panel) to verify the accuracy of individual meters, corrective measures are taken when necessary. The production of the few wells that are not metered is estimated on the basis of electrical energy consumed by individual pump motors or other reasonable means.

Carryover and Drought Provisions

The carryover of unused pumping rights in any given year influences the actual amount of production for the ensuing year. The Central Basin Judgment allowed carryover for the ensuing year is 60% of the allotted pumping right. The West Coast Basin Judgment allowed carryover is 100% of allotted pumping rights. In both the Central Basin and West Coast Basin, the amount of carryover is reduced by the quantity of water held in a pumper's storage account, but in no event is carryover less than 20% of the allotted pumping right. These provisions of the Judgments extend the flexibility with which the pumpers can operate.

During emergency or drought conditions, WRD can allow under certain conditions an additional 27,000 AF of extractions for a four-month period (17,000 for CB and 10,000 for WCB). This provision has yet to be exercised but offers the potential use of an additional 7.8% pumping in the CB and 15% in the WCB.

The Central Basin Judgment also contains an additional Drought Carryover provision available to all Central Basin water rights holders after a declaration of a Water Emergency by the WRD Board of Directors. The Drought Carryover allows water rights holders to carryover an additional 35% of their APA (or 35 AF, whichever is larger) beyond the annual carryover described above during the period the Declared Water Emergency is in effect.

The intent of the action is to prevent further degradation of the groundwater basins by helping to restore groundwater levels and improving the water supply in the aquifers by providing an incentive to groundwater producers in the Central Basin to reduce pumping for a particular period of time.

A Declared Water Emergency is defined in the Central Basin Judgment as:

> *"A period commencing with the adoption of a resolution of the Board of Directors of the Central and West Basin Water Replenishment District* [renamed Water Replenishment District of Southern California] *declaring that conditions within the Central Basin relating to natural and imported supplies of water are such that, without implementation of the water emergency provisions of this Judgment, the water resources of the Central Basin risk degradation. In making such declaration, the Board of Directors shall consider any information and requests provided by water producers, purveyors and other affected entities and may, for that purpose, hold a public hearing in advance of such declaration. A Declared Water Emergency shall extend for one (1) year following such resolution, unless sooner ended by similar resolution."*

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CHAPTER 3 - GROUNDWATER CONDITIONS

Introduction

The California Water Code Section 60300 requires WRD to determine annually in the ESR the following items related to groundwater conditions in CBWCB:

1) Total groundwater production for the previous WY and estimates for the current and ensuing WYs;

2) The Annual Overdraft for the previous WY and estimates for the current and ensuing WYs;

3) The Accumulated Overdraft for previous WY and an estimate for the current WY;

4) Changes in groundwater levels (pressure levels or piezometric heights) within the District and the effects these changes have on groundwater supplies within the District; and

5) An estimate of the quantity, source, and cost of water available for replenishment during the ensuing WY;

To meet these requirements, WRD's hydrogeologists and engineers closely monitor and collect data to manage the groundwater resources of the District throughout the year. They track groundwater levels from WRD's network of specialized monitoring wells and from groundwater producers' production wells. They utilize computer models developed by the United States Geological Survey (USGS) and others to provide parameters for data analysis and to simulate groundwater conditions and predict future conditions. They use their geographic information system (GIS) and database management system to store, analyze, map, and report on the information required for the ESR. They work closely with the Los Angeles County Department of Public Works (LACDPW) on spreading grounds and seawater barrier wells to determine current and future operational impacts to groundwater supplies. They work closely with the Metropolitan Water District of Southern California (MWD or Met), the local MWD member agencies, and the Sanitation Districts of Los Angeles County (SDLAC) on the current and future availability of replenishment water. They also work with regulators on replenishment criteria for water quality and recycled water use, and with the groundwater pumpers, the pumpers' Technical Advisory Committee (TAC), the Budget Advisory Committee (BAC), and other stakeholders to discuss the current and future groundwater conditions and beneficial projects and programs within the District and neighboring basins.

The information on Annual Overdraft, Accumulated Overdraft, water levels, and change in storage are discussed in the remainder of this chapter. Groundwater production was previously discussed in Chapter 2. The estimated quantity, source, and cost of replenishment water will be discussed in Chapter 4. Projects and programs are discussed in Chapter 5.

Annual Overdraft

Section 60022 of the Water Replenishment District Act defines Annual Overdraft as "*...the amount...by which the quantity of groundwater removed by any natural or artificial means from the groundwater supplies within such replenishment district during the water year exceeds the quantity of non-saline water replaced therein by the replenishment of such groundwater supplies in such water year by any natural or artificial means other than replenishment under the provisions of Part 6 of this act or by any other governmental agency or entity.*" (Part 6 of the Act pertains to water that WRD purchases for replenishment). Therefore, the Annual Overdraft equals the natural inflows to basins (not including WRD purchased water) minus all of the outflows (mostly pumping). There is an Annual

Overdraft almost every year for the simple fact that the groundwater extractions typically exceed the natural inflows into the groundwater basins. It has been one of the District's main responsibilities since its formation in 1959 to help make up this Annual Overdraft by purchasing or producing artificial replenishment water to recharge the aquifers and supplement natural recharge.

To determine the Annual Overdraft for the previous WY, WRD determines the inflows and outflows of the CBWCB. In the previous WY 2017/18, natural inflows (storm water capture, areal recharge, and net groundwater underflow) were quite low due to a dry year and totaled only 49,215 AF. Total pumping in the basins was 220,697 AF. The Annual Overdraft is the total outflows that exceed the natural inflows, or 171,482 AF.

For the current and ensuing WY estimates for Annual Overdraft, the concept of "Average Annual Groundwater Deficiency" is utilized. The Average Annual Groundwater Deficiency is the long-term average of natural inflows minus total outflows and represents the long term average deficit in the basins. The development of the USGS/WRD computer model derived these long term average inflow and outflow terms. **Table 4** presents this information, which concluded that the Average Annual Groundwater Deficiency is 105,385 AFY. Values for the Average Annual Groundwater Deficiency are based on the 30-year average inflows and outflows as calculated by the computer model which was built to simulate groundwater conditions from October 1970 through September 2000. Long-term average inflows are influenced by the amount of precipitation falling on the District as well as for storm water capture at the spreading grounds. **Table 5** and **Figure A** show the historical precipitation amounts in the District. Current measurements are utilized from LACDPW Precipitation Station #383 (Imperial Yard) located in unincorporated County land near the cities of South Gate, Downey, and Lynwood.

The calculation of the Average Annual Groundwater Deficiency represents that, in general, WRD needs to replenish about 105,385 AFY assuming long-term average conditions over that 30 year period for the water balance to reach equilibrium, the overall change in storage to equal zero, and groundwater levels to remain relatively constant. To estimate the current and ensuing year Annual Overdraft, adjustments are made to the Average Annual Groundwater Deficiency for any expected deviations in the current and ensuing water years. **Table 6** presents these adjustments and the calculation of the Annual Overdraft. For the current and ensuing water years, the Annual Overdraft is estimated at 72,100 AF.

Accumulated Overdraft

Section 60023 of the Water Replenishment District Act defines *"Accumulated Overdraft"* as "*...the aggregate amount…by which the quantity of ground water removed by any natural or artificial means from the groundwater supplies…during all preceding water years shall have exceeded the quantity of non-saline water replaced therein by the replenishment of such ground water supplies in such water years by any natural or artificial means…"*

In connection with the preparation of Bulletin No. 104-Appendix A (1961), the DWR estimated that the historically utilized storage (Accumulated Overdraft) between 1904 and 1957[1] was 1,080,000 AF (780,000 in CB, 300,000 in WCB). Much of this storage removal was from the forebay areas (Montebello Forebay and Los Angeles Forebay), where aquifers are merged, unconfined and serve as the "headwaters" to the confined pressure aquifers. Storage loss from the confined and completely full, deeper aquifers was minimal in comparison or was replaced by seawater intrusion, which cannot be accounted for under the language of the Water Code since it is considered saline water.

[1] DWR Bulletin 104-A did not refer to the ending year for the storage determination. WRD has assumed it to be the year 1957, as this is the end year for their detailed storage analysis presented in Bulletin 104-B – Safe Yield Determination.

The goal of groundwater basin management by WRD is to ensure a sufficient supply of safe and reliable groundwater in the basins for annual use by the pumpers, to keep a sufficient supply in storage for times of drought when imported water supplies may be curtailed for several consecutive years as well as to keep suitable room available in the basins to receive natural water replenishment in very wet years.

To compute the Accumulated Overdraft since this initial amount of 1,080,000 AF, WRD takes each consecutive year's Annual Overdraft and replenishment activities and determines the change in storage. It adds to or subtracts from the corresponding value from the Accumulated Overdraft. Since the base level, the aggregate excess of extractions over recharge has been reduced due to the artificial replenishment activities by LACDPW and WRD at the spreading grounds and seawater barrier wells and the reduction of pumping established by the adjudications and by WRD's In-Lieu Program. The Accumulated Overdraft at the end of the previous WY was determined to be 828,665 AF. For the current year, the Accumulated Overdraft will be 806,900 AF (estimated).

Table 7 presents information for the previous and current Accumulated Overdraft estimate. The annual changes in storage are presented on **Table 8**.

Groundwater Levels

A groundwater elevation contour map representing water levels within the District in fall 2018 (end of the WY) was prepared for this report and is presented as **Plate 2**. The data for the map were collected from wells that are screened in the deeper basin aquifers where the majority of groundwater pumping occurs. These deeper aquifers include the Upper San Pedro Formation aquifers, including the Lynwood, Silverado, and Sunnyside. Water level data was obtained from WRD's network of monitoring wells and from groundwater production wells that are screened in the deeper aquifers.

As can be seen on **Plate 2**, groundwater elevations range from a high of about 150 feet above mean sea level (msl) in the northeast portion of the basin, above the spreading grounds in the Whittier Narrows, to a low of about 110 feet below mean sea level (msl) in the Long Beach area. With the exception of the Montebello Forebay, and along the West Coast Basin Barrier Project, the majority of groundwater levels in the District remain below sea level (red colored contour lines on **Plate 2**), which is why continued injection at the seawater barriers is needed to prevent saltwater intrusion.

Plate 2 also shows the location of the key wells used for long-term water level data. These long-term hydrographs have been presented in the ESR for years, and provide a consistent basis from which to compare changing water levels. A discussion of water levels observed in the key wells is presented below.

Los Angeles Forebay

The Los Angeles Forebay occupies the westerly portion of the Central Basin Non-Pressure Area. Historically a recharge area for the Los Angeles River, this forebay's natural recharge capability has been substantially reduced since the river channel was lined and open areas paved over. Recharge is now limited to deep percolation of precipitation in limited areas, In-Lieu replenishment when available, subsurface inflow from the Montebello Forebay, the northern portion of the Central Basin outside of WRD's boundary, and the San Fernando Valley through the Los Angeles Narrows.

Key well #2778 (2S/13W-10A01) represents the water level conditions of the Los Angeles Forebay (see **Figure B**). The water level high was observed in 1938 at an elevation of approximately 70 feet above msl and by 1962 water levels had fallen nearly 180 feet to an elevation of 109 ft below msl due to basin over-pumping and lack of sufficient natural recharge. Since then, basin adjudication and managed aquifer recharge by WRD and others have improved water levels in this area. At the end of WY 2017/18, groundwater levels were at an elevation of 22.2 feet below msl, which is only 0.4 feet

higher from the previous year. Other parts of the Los Angeles Forebay fell. The average water level change throughout the entire Los Angeles Forebay over the WY based on WRD's GIS analysis was a 2.2 foot drop.

Montebello Forebay

The Montebello Forebay lies in the northeastern portion of the Central Basin and connects with the San Gabriel Basin to the north through the Whittier Narrows. The Rio Hondo and San Gabriel River coastal spreading grounds (often collectively called the "Montebello Forebay Spreading Grounds") provide a substantial amount of recharge water to the CBWCB since the aquifers there are unconfined and allow easy infiltration of surface water impounded at the spreading grounds to the deeper groundwater.

Three key wells help describe the groundwater level conditions in the Montebello Forebay, a northern well, a middle well, and a southeastern well (**Plate 2**). The historic water levels in these three key wells are discussed below:

- Well Pico1_4 (2S/11W-18C07) is in the northern part of the Montebello Forebay. The upper chart on **Figure C** shows the water levels for this well. Historic water levels at this well or its predecessors have ranged from a high elevation of 164.7 feet above mean sea level in April 1944 to a low of 42.8 feet above msl in December 1957. At the end of WY 2017/18, groundwater levels in this well were at an elevation of 81.43 feet above msl and were 33.5 feet lower than the previous year due to the dry winter/spring.

- Well 1601T (2S/12W-24M08) is centrally located between the Rio Hondo and San Gabriel coastal spreading grounds. This well is monitored weekly to assess water levels in the middle of the forebay. The center chart on **Figure C** shows the water levels for this well. The historic water level high was observed in 1942 at an elevation of 137.8 feet above mean sea level, but by 1957 it had fallen 117 feet to an all-time low elevation of 20.9 feet above msl due to basin over-pumping and insufficient natural recharge. As described above for the Los Angeles Forebay, adjudication of pumping rights and managed aquifer recharge helped restore water levels in the Montebello Forebay. At the end of WY 2017/18, groundwater levels in this well were at an elevation of 60.0 feet above msl and were 19.5 feet lower than the previous year.

- Well 1615P (3S/12W-01A06) is located downgradient and southeast of the spreading grounds near the southern end of the Montebello Forebay. Water level responses in this well are typically less pronounced than the other two wells because it is further away from the spreading grounds and the recharge activities that occur there. The lower chart on **Figure C** shows the water level history for this well. The historic water level high was observed in 1947 at an elevation of 113.6 feet above mean sea level but by 1957 had dropped 102 feet to an all-time low elevation of 11.4 feet above msl. Since then, water levels have recovered. At the end of WY 2017/18, groundwater levels were at an elevation of 42.0 feet above msl and were 6 feet lower than the previous year.

The average water level change throughout the entire Montebello Forebay during the previous WY was a fall of 15.0 feet due to the dry year.

Central Basin Pressure Area

The District monitors long term key wells 906D (4S/13W-12K01) and 460K (4S/12W-28H09) which represent the conditions of the pressurized groundwater levels in the Central Basin Pressure Area. The hydrographs for these two wells are shown on **Figure D**.

Groundwater highs were observed in these wells in 1935 when they began to continually drop over 110 feet until their lows in 1961 due to the over-pumping and insufficient natural recharge.

Groundwater levels recovered substantially during the early 1960s as a result of replenishment operations and reduced pumping. Between 1995 and 2007 there were 100-foot swings in water levels each year between winter and summer caused by pumping pattern changes by some of the Central Basin producers who operate with more groundwater in the summer months and less groundwater in the winter months, and took advantage of the MWD and WRD In-Lieu programs. From May 2007 to March 2011 the In-Lieu water was not available, so pumping remained more constant throughout those years and water levels remain low. Since then, In-Lieu with the City of Long Beach has occurred on several occasions, with resulting water levels rising as the pumps go off.

At the end of WY 2017/18, groundwater levels in well 906D were at an elevation of 69.95 ft below msl and were 6.7 feet higher than the previous year. Water levels in well 460K were at an elevation of 92.7 ft below msl and were 6.0 feet lower than the previous year. The average water levels change throughout the entire Central Basin Pressure Area during the previous WY was a drop of 5.0 feet.

West Coast Basin

The West Coast Basin is adjacent to the Central Basin along the Newport-Inglewood Uplift, which is a series of discontinuous, sub-parallel hills and faults that act as a partial barrier to groundwater flow. Groundwater moves across the uplift based on water levels on both sides and the "tightness" (hydraulic conductivity) of the uplift along its various reaches, both horizontally and vertically. Like the Central Basin Pressure Area, most of the aquifers used for water supply are confined aquifers and therefore do not respond rapidly to precipitation events, but instead to changes in pumping patterns or seawater barrier well injection rates.

Figure E shows the hydrographs of key well Wilmington1_3 and well Lawndale1_4. These two wells represent the general conditions of the water levels in the West Coast Basin. In 1955, the control of groundwater extractions in the West Coast Basin resulted in stabilizing and reversal of the declining water levels in the center of the basin whereas at the eastern end near the Dominguez Gap Barrier water levels continued to decline until about 1971, when a recovery began due mostly to the startup of the Dominguez Gap Barrier Project.

At the end of the previous WY 2017/18, water levels in well Lawndale1_4 were at an elevation of 4.19 ft below msl and were 5.0 feet higher than the previous year. Water levels in well Wilmington1_3 were at an elevation of 29.37 ft below msl and were 11.8 feet higher than the previous year. Over the entire West Coast Basin during the previous WY, the average water level change was a rise of 3.4 feet.

Whittier Area

The Whittier Area is in the northeastern-most portion of the Central Basin and historically has not been used for significant water supplies due to poor natural water quality conditions (high total dissolved solids concentrations) and low production rates. Some minor pumping does occur towards the western end. Because of this, WRD does not maintain long term hydrographs for this area, but does track current groundwater levels from its recently constructed monitoring wells. Over the past WY, the groundwater levels fell 6.5 feet on average in the Whittier Area.

Plate 3 shows the water level changes over the entire WRD Service area for the previous WY.

Because of the below normal precipitation, WY 2017/18 saw a net drop in groundwater levels of 4 feet, although in some areas rises of up to nearly 12 feet were observed and declines of over 33 feet were also observed (**Plate 3**).

In the current WY 2018/19, through the time of this writing the year has been a wet one, with precipitation 150% of normal so far. Water levels in the Montebello Forebay have been rising as a result, and are over 5 feet higher than the start of the WY in October 2018. Additionally, WRD has

placed an order for 8,000 AF of imported water for spreading and is maximizing recycled water. Therefore, because the current and projected groundwater levels in the CBWCB are within historic ranges, the District anticipates that there will continue to be sufficient supplies of safe and reliable groundwater to meet the demands of the pumpers in our service area in the current and ensuing years.

Change in Storage

The District determines the annual change in groundwater storage by comparing water levels from one year to the next, and factoring in the storage coefficients of the major aquifer layers. Rising groundwater means there is an increase in the amount of groundwater in storage whereas a drop in groundwater levels means there is a decrease from storage. Using groundwater elevation data collected from WRD's monitoring well network and selected production wells, the District constructs a groundwater level change map showing water level differences from one year to the next (**Plate 3**). The data from this map are converted to grids in the District's GIS and multiplied by the storage coefficient value grids for the aquifer layers as obtained from the USGS calibrated Modflow computer model of the District. This calculation produces the change in storage value for the previous WY.

Performing this analysis determines that in WY 2017/18 there was a decrease in storage in the basins of 80,243 AF. Most of this storage decrease was observed in the Montebello Forebay, which saw an overall water level drop of 15 feet. **Table 8** provides the historical groundwater storage changes in the CBWCB. Based on the wet year in the current WY, it is expected that the groundwater basins will gain water in storage this year.

Optimum and Minimum Groundwater Quantity

In response to a 2002 State audit of the District's activities, the Board of Directors adopted an Optimum and Minimum Quantity for groundwater amounts in the CBWCB. The Optimum Quantity is based on the Accumulated Overdraft (AOD) concept described in the Water Code and this ESR. The historic maximum groundwater drawdown due to over pumping reported in the CBWCB between 1904 and 1957 was 1,080,000 AF. This is defined as the historic maximum AOD. As pumping eased and artificial replenishment occurred, more water was put back into the basins and the AOD was reduced resulting in rising water levels.

After considerable analysis and discussion, the Board of Directors on June 18, 2003 adopted an Optimum Quantity of groundwater in the WRD service area at an AOD of 400,000 AF and a Minimum Quantity of an AOD of 900,000 AF. Several years later, additional reviews were conducted to update the Optimum Quantity to recognize the need for groundwater storage space within the District. On April 19, 2006 the WRD Board of Directors revised the Optimum Quantity to an AOD of 612,000 AF. This value was based on an extensive review of over 70 years of water level fluctuations in the District and recognizing that in WY 1999/2000 groundwater amounts were at an acceptable quantity to sustain the adjudicated pumping rights in the basins. The AOD at that time was 611,900 AF (rounded to 612,000 AF), and therefore was set by the Board of Directors as the Optimum Quantity. The Minimum Quantity was not modified and therefore remains at an AOD of 900,000 AF.

The Board of Directors on April 19, 2006 also adopted a policy to make up the Optimum Quantity should it fall too low. The policy is as follows:

> *An Accumulated Overdraft greater than the Optimum Quantity is a deficit. WRD will make up the deficit within a 20 year period as decided by the Board on an annual basis. If the deficit is within 5 percent of the Optimum Quantity, then no action needs to be taken to allow for natural replenishment to makeup the deficit.*

The Accumulated Overdraft at the end of WY 2017/18 was 828,665 AF, or 71,335 AF above the Minimum Quantity of AOD = 900,000 AF.

CHAPTER 4 - GROUNDWATER REPLENISHMENT: QUANTITIES, AVAILABILITY, AND COSTS

As discussed in the previous chapter, the CBWCB have an annual overdraft because more groundwater is pumped out than is typically replaced by natural means. The District purchases supplemental water (artificial replenishment water) each year to help offset this overdraft through managed aquifer recharge. The purchased water enters the groundwater basins at the Montebello Forebay spreading grounds, at the seawater barrier injection wells, and through the District's In-Lieu Program. The purpose of this Chapter is to determine the quantities of water needed to offset the overdraft in the ensuing WY, the anticipated cost for that water, and the expected availability of that water.

Sources of Replenishment Water

The District currently has available to it recycled and imported water sources for use as artificial replenishment water. These two sources are described below:

- **Recycled Water**: Recycled water is wastewater from the sewer systems that is reclaimed and purified through extensive treatment at water reclamation plants (WRPs). The water is treated to high quality standards so that it can be reused safely, and offsets the need to use more expensive and sometimes less available imported water. Some agencies and businesses use recycled water for non-potable purposes, such as for irrigation of parks, golf courses, and street medians, or for industrial purposes (known as "purple-pipe projects"). WRD has successfully used recycled water for groundwater recharge since 1962. In semi-arid areas such as Southern California where groundwater and imported water are in short supply, recycled water has proven to be a safe and reliable additional resource to supplement the water supply. Recycled water is used at the spreading grounds and the seawater barrier injection wells. Although recycled water is high quality, relatively low cost, and a reliable supply all year long, the District may be limited by regulatory agencies in the amount it can use for replenishment at any given replenishment facility. Therefore, imported water is also used for recharge as needed, although the ultimate goal of WRD is to be independent from imported water for groundwater replenishment under its Water Independence Now (WIN) initiative.

- **Imported Water**: River water originating in northern California (State Water Project and Los Angeles Aqueduct) and from western states (the Colorado River) is imported into Southern California through canals and aqueducts by the Metropolitan Water District of Southern California (MWD or Met) and the City of Los Angeles Department of Water and Power (LADWP). MWD sells this water as-is (untreated raw river water) or after it treats the water to potable standards to their member agencies for multiple uses, including municipal, industrial, and groundwater recharge. WRD uses raw imported water from the State Water Project at the spreading grounds (Colorado River water is currently not available to WRD due to potential invasive Quagga Mussel issues) and uses treated potable water for injection at the seawater barrier wells and the In-Lieu program. Because of treatment and transportation costs, imported water is the most expensive type for groundwater replenishment. Prior to October 2011, MWD offered seasonally-available discounted water that could be purchased for replenishment. In turn for the discount, it was considered by MWD to be interruptible and they could stop deliveries at any time. But due to a lack of surplus supplies caused by drought and other factors, MWD has eliminated offering this type of discounted interruptible water. Instead, replenishment agencies such as WRD must now purchase what is known as "Tier 1" or "Tier 2" water from MWD member agencies for spreading and In-Lieu. This water is at a higher price and relies on available allocation from the member agency. But, this Tier 1 or Tier 2 water is supposed to be firm delivery (not interruptible), although

during extreme droughts MWD can implement a water supply allocation to reduce sales of imported water. The seawater barrier injection water has been Tier 1 treated water for decades and has to date not been interrupted by MWD.

Recommended Quantities of Replenishment Water

With the information presented in the preceding chapters regarding the pumping demands in the CBWCB, annual and accumulated overdraft, and the overall condition of the groundwater basins, WRD can estimate its projected need for replenishment water in the ensuing year.

Spreading

Groundwater recharge through surface spreading occurs intentionally in the Montebello Forebay Spreading Grounds adjacent to the Rio Hondo and the San Gabriel River, within the unlined portion of the San Gabriel River, and incidental recharge behind the Whittier Narrows Dam in the Whittier Narrows Reservoir. Owned by the Los Angeles County Flood Control District (LACFCD) and operated by the Los Angeles County Department of Public Works (LACDPW), they were originally constructed in 1938 for flood control and conservation of local storm water, but have been used since the 1950s to replenish the basins with imported water and since 1962 with recycled water.

The District currently uses recycled water that has gone through tertiary treatment for its spreading needs. Since tertiary recycled water is a high quality, less expensive, and available year-round source of replenishment water, the District maximizes its use within established regulatory limits. These limits are discussed below under "Expected Availability of Replenishment Water". The District has historically targeted 50,000 AFY of tertiary recycled water for spreading to meet regulatory limits. However, with the recent modifications to the District's permit to allow 45% tertiary recycled water over a running 10-year average (see below under Expected Availability of Replenishment Water), the District can now target higher amounts as long as sufficient dilution water is available from storm water and imported water. For the ensuing year, WRD is planning on 61,000 AF of tertiary recycled water for spreading.

The District has also completed its Albert Robles Center for Water Recycling and Environmental Learning (ARC - formerly known as the Groundwater Replenishment Improvement Project or GRIP) in 2019, which will use the tertiary recycled water as source water and provide additional treatment including ultrafiltration, reverse osmosis (RO), and ultraviolet advanced oxidation processes (UVAOP) to improve overall water quality. The advanced treated water will either be used for spreading and/or direct injection into the aquifers. The District anticipates 10,000 AF of ARC water in the ensuing year. This total of 71,000 AF of recycled water eliminates the need for imported water.

In addition, under an agreement with the Main San Gabriel Basin Watermaster related to the Whittier Narrows Operable Unit (WNOU), which is a groundwater containment and cleanup project to protect Central Basin from receiving contaminated groundwater originating in the Main San Gabriel Basin, any groundwater pumped out from the WNOU project that is discharged to lakes or rivers that then overflows into Central Basin and is lost from Main San Gabriel Basin, WRD will reimburse the Main San Gabriel Basin Watermaster for the cost of that water. The water that WRD receives is considered "Local Water" as it originated in San Gabriel Valley and is not imported water from MWD. This effort is necessary to protect Central Basin from receiving contaminated groundwater. This is a short-term agreement until the WNOU water is instead put to a beneficial use such as a drinking water source to Main San Gabriel Basin customers. For the ensuing year, the District estimates 1,400 AF of WNOU water.

Table 9 presents the anticipated imported water replenishment needs at the spreading grounds.

Injection

Another way of replenishing the groundwater supply is to inject water at the three seawater intrusion barriers owned and operated by the LACDPW, including the West Coast Basin Barrier, Dominguez Gap Barrier, and Alamitos Barrier. Although the primary purpose of the barriers is for seawater intrusion control, groundwater replenishment also occurs as the freshwater is injected into the CBWCB aquifers and then moves inland towards pumping wells.

To determine the amount of barrier water needed for the ensuing year, WRD under an Agreement with LACDPW gets annual estimates from the expected demand at the barriers. WRD reviews these estimates, reviews recent 5-year averages of actual injection amounts, and makes adjustments as necessary. For the ensuing year, WRD estimates the West Coast Basin Barrier Project will require 17,000 AF. Based on recent operations, WRD estimates that 75% (12,750 AF) will be recycled water from WBMWD's Edward C. Little Water Recycling Facility and 25% (4,250 AF) will be Tier 1 treated imported water from WBMWD. For the Dominguez Gap Barrier Project, a total of 7,500 AF is expected to be needed. Based on recent operations, WRD estimates that 60% (4,500 AF) will be recycled water from the City of Los Angeles' Terminal Island Treatment Plant and 40% (3,000 AF) will be Tier 1 treated imported water from WBMWD. For the Alamitos Barrier Project, a total of 4,500 AF is expected to be required by WRD (does not include barrier water purchased by Orange County Water District for their side of the barrier), which includes 50% (2,250 AF) of advanced treated recycled water from the District's Leo J. Vander Lans Water Treatment Facility and 50% (2,250 AF) of Tier 1 treated imported water from the City of Long Beach.

The total barrier demand for WRD in the ensuing year is estimated at 29,000 AF, including 9,500 AF imported water (33%) and 19,500 AF of recycled water (67%) (See **Table 9)**.

In-Lieu Replenishment Water

The basic premise of WRD's In-Lieu Program is to offset the pumping in the basin to lower the annual overdraft and reduce the artificial replenishment needs. It helps provide an alternate means of replenishing the groundwater supply by encouraging basin pumpers to purchase imported water when available instead of pumping groundwater. This can help raise water levels in areas that are otherwise more difficult to address. MWD has ceased providing seasonally discounted water for the In-Lieu program since 2011, so WRD's program has been put on hold with the exception of a few localized projects with the City of Long Beach. For the ensuing year, WRD is not budgeting for the In-Lieu program, although may consider new programs if opportunities arise.

Expected Availability of Replenishment Water

The availability of water supplies for the ensuing WY has been taken into account when determining how funds should be raised. If a particular resource is expected to be unavailable during a given year, money can still be raised to fund the purchase of that quantity of water in a succeeding year.

Recycled Water

Recycled water is reliable all year round but its use for recharge is capped by regulatory limits. The current limits for tertiary recycled water spreading in the Montebello Forebay are established by the Los Angeles Regional Water Quality Control Board (RWQCB) and are detailed in Order No. 91-100 adopted on September 9, 1991 with amendments on April 2, 2009 under Order No. R4-2009-0048 and June 4, 2013 (letter approval from RWQCB Executive Officer). On April 10, 2014, under Order No. R4-2009-0048-A-01, the RWQCB approved a request by WRD to increase the allowable percentage of recycled water to be recharged at the Montebello Forebay spreading grounds from 35% to 45% over a 10-year running average. This major action will allow continued use of historic amounts of recycled water for longer periods of time should extended droughts return like the 2011-2016 five year

drought, and might allow for additional recycled water for recharge should normal to wet hydrologic conditions return. This will allow WRD to continue to maximize use of recycled water for groundwater recharge as part of its WIN initiative.

The Sanitation Districts of Los Angeles County (SDLAC) provides the recycled water to WRD for spreading by LACDPW. This water comes from the Whittier Narrows Water Reclamation Plant (WNWRP), San Jose Creek Water Reclamation Plant (SJCWRP), and Pomona Water Reclamation Plant (PWRP). For planning purposes, the District assumes purchasing 61,000 AF of tertiary recycled water in the ensuing year and 10,000 AF of additional water for the ARC facility (formerly named GRIP). This total of 71,000 AF of recycled water eliminates the need for imported water at the spreading grounds, so long as the recycled water remains available.

Recycled water for injection into the seawater barrier wells comes from different agencies depending on the specific barrier. At the WCBBP, the water is provided by WBMWD's Edward C. Little Water Recycling Facility. Per regulatory limits, this resource can provide up to 100% recycled water to the Barrier, or up to 17,000 AFY.

Recycled water for the DGBP is available from the City of Los Angeles' Terminal Island Treatment Plant (Harbor Recycled Water Project). In 2016 the plant was permitted by the Los Angeles Regional Water Quality Control Board to provide the barrier with 100% recycled water.

Recycled water for the ABP is available from WRD's Leo J. Vander Lans Water Treatment Facility. This treatment plant was permitted to provide up to 100% of the barrier with recycled water in 2014.

Although the three barriers are permitted for 100% recycled water, they have not yet met that target due to planned and unplanned operational issues and source water availability. Therefore, for the near term, WRD will continue to budget for some amount of imported water at the barriers until 100% recycled water becomes reliable.

Imported Water

Since October 2011, MWD terminated its discounted replenishment water program which the District utilized since 1959, and has not yet offered a new replenishment program. Replenishment agencies must rely on the more expensive Tier 1 water if it is available from MWD-member agencies, or pay the higher priced Tier 2 water if Tier 1 water is unavailable. Over the past few years, WRD has budgeted for untreated (raw) Tier 1 water for the spreading grounds and the treated Tier 1 water for the In-Lieu program. However, for 2019 for the first time in its history, WRD will not budget for any imported water at the spreading grounds since it anticipates being able to meet the full demand of 71,000 AF with recycled water (61,000 AF tertiary water and 10,000 AF advanced treated recycled water from ARC, assuming the source water is available).

For the imported water used for injection at the seawater barrier wells, the District obtains the water from MWD member agencies including WMBWD and the City of Long Beach. This water will be available in the ensuing year.

Projected Cost of Replenishment Water

WRD has estimated it will need 101,400 AF of replenishment water in the ensuing year to help overcome the annual overdraft. WRD purchases replenishment water from MWD member agencies and recycled water providers. These agencies set the price for the replenishment water that WRD buys for the spreading grounds, seawater barrier injection wells, and In-Lieu water when available. The cost for replenishment water is a direct pass-through from WRD to the water suppliers on WRD's replenishment assessment. For the recycled water source water to feed the ARC project and the Leo

J. Vander Lans facility, the cost of that source water is part of the separate operations budget and are not part of the water purchase budget which is shown on **Table 2**.

Using currently available information and estimates for the cost of replenishment water to WRD in the ensuing year, the estimated cost of water is $40,227,727, which is a 3.8% increase from the previous year. **Tables 1 and 2** provide a detailed breakdown of these costs.

These estimated costs are for water purchases only and do not include the additional costs for projects and programs related to water replenishment and water quality. These projects and programs are presented in Chapter 5. The costs for these projects and programs are discussed separately in District budget workshops, Finance Committee meetings, Board of Directors' meetings, Budget Advisory Committee (BAC) meetings, and other public meetings and combined with these water costs before the Board adopts the Replenishment Assessment (RA) for the ensuing Fiscal Year.

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CHAPTER 5 - PROJECTS AND PROGRAMS

California Water Code Sections 60220 through 60226 describe the broad purposes and powers of the District to perform any acts necessary to replenish, protect, and preserve the groundwater supplies of the District. In order to meet its statutory responsibilities, WRD has instituted numerous projects and programs in a continuing effort to effectively manage groundwater replenishment and groundwater quality in the Central Basin and West Coast Basin (CBWCB). These projects and programs include activities that enhance the replenishment program, increase the reliability of the groundwater resources, improve and protect groundwater quality, and ensure that the groundwater supplies are suitable for beneficial uses.

These projects and programs have had a positive influence on the basins, and WRD anticipates continuing these activities into the ensuing year. The following is a discussion of the projects and programs that WRD intends to continue or initiate during the ensuing year.

001 – Leo J. Vander Lans Water Treatment Facility Project

The Leo J. Vander Lans Advanced Wastewater Treatment Facility (AWTF) provides advanced treated recycled water to the Alamitos Seawater Intrusion Barrier. Source water to the facility consists of tertiary-treated municipal wastewater provided by the Sanitation Districts of Los Angeles County Long Beach Water Reclamation Plant (LBWRP). Source water is treated using a multi-barrier treatment process consisting of microfiltration (MF), reverse osmosis (RO) and ultraviolet advanced oxidation processes (UVAOP). The facility's operations permit was approved by the Los Angeles Regional Water Quality Control Board and operations began in October 2005. Finish product water is delivered to the Alamitos Barrier to offset the use of imported water, thus improving the reliability and quality of water supplying the barrier. The AWTF has been producing approximately 3 million gallons per day (MGD) of highly purified, potable quality water for delivery to the barrier. Presently the Long Beach Water Department (LBWD) is responsible for the operations and maintenance of the AWTF under contract with WRD.

The facility was expanded in early 2015 to increase the capacity to 8 MGD, with the operations permit amended by the RWQCB for expanded facility. Expansion of the treatment facility provided a number of unique enhancements to optimize operations. These enhancements included (1) a third-stage RO system to increase recovery from the original 85% to 92.5%; and (2) a recovery MF system that captures the primary MF waste and treats it through a two-step treatment process consisting of dissolve air flotation and secondary MF. With these process enhancements, the facility has been expanded to achieve enhanced production while minimizing the cost associated with brine disposal.

The facility has faced a series of scheduled extended shutdowns over the past two years, with an additional shutdown planned for the next fiscal year. These shutdowns are a result of infrastructure improvements at the LBWRP. During these periods, this will provide an opportunity to address much needed repairs and enhancements to facility equipment and infrastructure. WRD is also actively engaged with the LBWD to establish a new water purchase agreement which will serve to guarantee future sustainable water supplies to the AWTF. Operational costs for the coming fiscal year will include operations and maintenance, groundwater monitoring at the barrier and improvements aimed at optimizing current and future facility operations. This program is funded 100% from the Replenishment Fund.

002 – Robert W. Goldsworthy Desalter Project

The Robert W. Goldsworthy Desalter (also known as the Torrance Desalter) was commissioned in 2002. Located within the City of Torrance, the facility utilizes reverse osmosis (RO) membrane technology to desalt brackish groundwater in the Torrance area that was stranded inland of the West Coast Basin Barrier after it was placed into operation in the 1950s. The Torrance Desalter was originally designed with a production capacity of 2,200 AFY of potable quality water for delivery to the City's distribution system. The City of Torrance is responsible for operations and maintenance of the treatment plant under contract with WRD.

The facility underwent a significant expansion to increase production to a total capacity of 4,800 AFY. Completed in December 2017, this included the addition of one RO system, two new source water wells, and associated conveyance pipelines and pump stations. The overlying purpose of this expansion project is to provide additional remediation of the groundwater quality within the basin for beneficial use. Project costs were funded through WRD's Capital Improvement Program and grants. Expected costs for the coming fiscal year will include continued capital improvements as well as increased operation and maintenance costs associated with operations of the expanded facility.

During this next fiscal year, WRD will continue to exploring additional efforts toward groundwater remediation, which extends beyond the City of Torrance boundaries, through the utilization of its Regional Brackish Water Program. This program assembles the City of Torrance, the Technical Advisory Committee and stakeholders to assess the future of the saline plume removal in the West Coast Basin. This project is funded 100% from the Clean Water Fund.

004 – Recycled Water Program

Recycled water (aka reclaimed municipal wastewater) has been successfully used for groundwater recharge by WRD since 1962. Recycled water provides a reliable source of high-quality water for surface spreading in the Montebello Forebay and for injection at the seawater intrusion barriers. In light of the recurring drought conditions in California and uncertainties about future water availability and growing cost of imported water supplies, recycled water has become increasingly vital as a replenishment source.

In order to ensure that the use of recycled water for groundwater recharge remains a safe and reliable practice, WRD participates in various research and monitoring activities, proactively contributes to the regulatory and legislative development processes, and engages in information exchange and dialogue with regulatory agencies and other recycled water users. The District continues to closely coordinate with the Sanitation Districts of Los Angeles County (SDLAC), which produces the recycled water used for surface spreading in the Montebello Forebay, on permit compliance activities, including groundwater monitoring, assessment, and reporting. Many monitoring and production wells are sampled frequently by WRD staff, and the results are reported to the regulatory agencies.

In addition to compliance monitoring and sampling associated with the spreading grounds, WRD is partnering with others to more fully investigate the effectiveness of soil aquifer treatment (SAT) during groundwater recharge. WRD completed a research project with the Colorado School of Mines to evaluate the impact on SAT from using different blends of tertiary recycled water and fully advanced treated recycled water. The results of the study indicated that the SAT system can tolerate a wide range of blend ratios, including with only fully advanced treated recycled water with short duration, and can still demonstrate effective treatment performance. The District has also participated

in researches in characterizing the percolation process and quantifying the filtering and purifying properties of the underlying soil with respect to constituents of concern, such as nitrogen, total organic carbon, and chemicals of emerging concern (CECs). The District continues to be vigilant in monitoring research on the occurrence, significance, attenuation, and removal of CECs, including pharmaceuticals, endocrine disruptors, and personal care products, in anticipation of the amendment to the Recycled Water Policy.

Recycled water is also injected into the Los Angeles County Department of Public Works' three seawater intrusion barriers located along the Coast of Los Angeles County (Alamitos, West Coast, and Dominguez Gap barriers). Highly purified recycled water used for injection at the Alamitos Barrier is produced at WRD's Leo J. Vander Lans Water Treatment Facility. The recycled water for the Dominguez Gap Barrier is generated at the City of Los Angeles' Terminal Island Water Reclamation Plant/Advanced Water Purification Facility. And the recycled water for the West Coast Barrier is produced at the West Basin Municipal Water District's Edward C. Little Water Recycling Facility. Extensive recycled water monitoring and regular groundwater modeling are performed to ensure that the treatment plants are operating as intended and that the injected water is making a positive contribution to the groundwater basins. All three barrier projects are in various phases of expanding the recycled water produced in the barrier operations, with the ultimate goal of completely phasing out the potable water used at the barriers. All three barriers are currently permitted for 100% recycled water recharge, with activities being performed to have the treatment plants consistently and reliably provide that amount by late 2018.

Projects under this program help to improve the reliability and utilization of an available local resource, i.e. locally produced recycled water. This resource is used to help maintain the integrity of the basins and improve replenishment capabilities. This program is funded 100% from the Replenishment Fund.

005 – Groundwater Resources Planning Program

The Groundwater Resources Planning Program was instituted to evaluate basin management issues and to provide a means of assessing project impacts in the District's service area. Prior to moving forward with a prospective project, an extensive evaluation is undertaken. Within the Groundwater Resources Planning Program, new projects and programs are analyzed based on benefits to overall basin management. This analysis includes performing an economic evaluation to compare estimated costs with anticipated benefits. As part of this evaluation process, all capital projects are brought to the District's Technical Advisory Committee for review and recommendation. The culmination of this review and evaluation process is the adoption of the Five - Year Capital Improvement Program (CIP) by the District's Board of Directors.

Conceptual projects identified in the District's Groundwater Basins Master Plan will continue to be evaluated through pumper workshops and/or focused meetings with basin stakeholders and prospective project proponents. These workshops and meetings, facilitated by District staff, will further the development of available groundwater resources to reduce the region's demand for imported water.

Also, District staff will continue to monitor state and federal funding programs to determine applicability to the District's list of prospective projects described within the CIP. The District will continue its participation in the various Greater Los Angeles County Region's Integrated Regional Water Management Plan (IRWMP) stakeholder committees. Collaborative development of the

region's IRWMP is a requirement for entities to secure grant funding under Proposition 1 that was passed in November 2014.

Projects under the Groundwater Resources Planning Program serve to improve replenishment operations and general basin management. This program is funded 100% through the Replenishment Fund.

006 – Groundwater Quality Program

This program is an ongoing effort to address water quality issues that affect WRD projects and the pumpers' facilities. The District monitors and evaluates the impacts of proposed, pending and recently promulgated drinking water regulations and legislation. The District assesses the justification and reasoning used to draft these proposals and, if warranted, joins in coordinated efforts with other interested agencies to resolve concerns during the early phases of the regulatory and/or legislative process.

Annually, the District offers a groundwater quality workshop to water purveyors. At the workshop, industry experts and regulators provide information on the latest water quality regulations, state of the groundwater in the local basins, information on the cutting edge technology for contaminant removal or well rehabilitation, and other topics that are of key interest to the District's water purveyors. The annual workshop also gives a comprehensive overview of the resources provided under the District's Groundwater Quality Program.

The District continually evaluates compliance with current and anticipated water quality regulations in production wells, monitoring wells, and spreading/injection waters of the basins. WRD proactively investigates any potential non-compliance situations to confirm or determine the causes of noncompliance, develops recommended courses of action and estimates their associated costs to address the problem, and implements the best alternative to achieve compliance.

Effective January 1, 2007, the District initiated performance of the Title 22 Groundwater Monitoring Program. The program involves working with participating pumpers to comply with regulatory requirements for well water monitoring, including: (1) scheduling the collection and analysis of samples for Title 22 compliance required by the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) and special sampling such as the Unregulated Contaminant Monitoring Rule required by the United States Environmental Protection Agency (EPA); (2) coordinating the submittal of results to the SWRCB DDW; and 3) preparing the annual Consumer Confidence Reports for the pumpers. This program is available to pumpers who choose to participate and agree to reimburse the District the actual monitoring costs, including District staff time in administering the program. The District presently has 22 pumpers/participants in this program, which involves a total of 83 wells.

In recent years, new Chemicals of Emerging Concern (CECs) have been identified nationwide as potentially impacting surface water and groundwater. CECs can be broadly defined as any synthetic or naturally occurring chemical or any microorganism that is not commonly monitored in the environment but has been recently detected in the environment. CECs such as pharmaceuticals and personal care products, perfluorinated compounds, polybrominated diphenyl ethers, and others may pose a potential threat to water resources. Their detection in the environment does not necessarily mean that they pose a health threat at their measured concentrations. WRD is actively monitoring surface spreading and injection activities for water quality constituents, including many CECs. In addition, the District supports research evaluating CEC removals using innovative treatment technologies.

WRD's service area contains a large and diverse industrial and commercial base. Consequently, many potential groundwater contamination sources exist within District boundaries. Examples of potential contamination sources include leaking underground storage tanks, petroleum pipeline leaks at refineries and petrochemical plants, and discharges from dry cleaning facilities, auto repair shops, metal works facilities, and others. Such contamination sources may pose a threat to the drinking water aquifers. Accordingly, WRD established its Groundwater Contamination Prevention Program as a key component of the Groundwater Quality Program in an effort to minimize or eliminate threats to groundwater supplies. The Groundwater Contamination Prevention Program includes several ongoing efforts:

- Central Basin and West Coast Basin (CBWCB) Groundwater Contamination Forum: More than 10 years ago, WRD established this data-sharing and discussion forum with key stakeholders including the EPA, the California Department of Toxic Substances Control (DTSC), the RWQCB, the SWRCB DDW, the United States Geological Survey (USGS), and various cities and purveyors. Stakeholders drafted and signed a Memorandum of Understanding agreeing to meet regularly and share data on contaminated groundwater sites within the District. WRD acts as the meeting coordinator and data repository/distributor, helping stakeholders to characterize the extent of contamination to identify potential pathways for contaminants in shallow aquifers to reach deeper drinking water aquifers and develop optimal methods for remediating contaminated groundwater.

- With the cooperation and support of all stakeholders in the Groundwater Contamination Forum, WRD developed a list of high-priority contaminated groundwater sites located within the District. This list is a living document, subject to cleanup and closure of sites, as well as discovery of new sites warranting further attention. Currently, the list includes 46 sites across the CBWCB. WRD works with the lead regulatory agencies for each of these sites to keep abreast of their status, offer data collection, review and recommendations as needed, and facilitate progress in site characterization and cleanup.

- In 2012, WRD formed the Los Angeles Forebay Groundwater Task Force to coordinate and align regulators and water purveyors/agencies to collaboratively address groundwater contamination in the Los Angeles Forebay that is a threat to drinking water resources. The Task Force members currently include WRD, DTSC, EPA, RWQCB, SWRCB DDW, USGS, City of Vernon, City of Los Angeles and others. WRD and DTSC are investigating and collecting data to assess the extent of regional volatile organic compound and perchlorate plumes and find the source(s) of this contamination. In March 2017, WRD was awarded Prop 1 grant funds to remediate a perchlorate "hot spot" located in the City of Vernon. The data generated during the groundwater remediation project will be utilized to identify responsible party(ies) and seek cost recovery through the DTSC. WRD initiated work in 2018.

WRD remains committed to projects seeking opportunities and innovative project concepts to enhance capture and recharge of local stormwater runoff in order to augment local groundwater resources, as follows:

- In 2012, the District partnered with the City of Los Angeles Bureau of Sanitation (the lead applicant) to pursue Proposition 84 funding (Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006) to implement a portion of the concept design to increase stormwater infiltration and to assist the City of Los Angeles in its compliance with total maximum daily load (water quality-related) requirements. The project area is located in the City of Los Angeles south of the 10 freeway and east of the 110 freeway. The

stormwater capture/infiltration measures were installed on 19 residential properties within the City of Los Angeles and included dry wells, rain gardens, continuous deflective separation (CDS) system for trash and sediment removal, and infiltration gallery. The combined watershed of all proposed stormwater infiltration projects is approximately 220 acres with mixed land uses. In 2013, the City was awarded $2,939,361 by the State Water Resources Control Board to construct and monitor the project. Known as the "Broadway Neighborhood Stormwater Greenway (Broadway) Project, this project was completed in June 2016 and is currently operating.

WRD continues to do work involving additional investigations at well sites known to have contaminated water, continued monitoring of water quality regulations and proposals affecting production and replenishment operations, further characterization of contaminant migration into the deeper aquifers, and monitoring and expediting cleanup activities at contaminated sites. The work under this program is related to water quality and cleanup efforts; 100% of it is funded from the Clean Water Fund.

010 – Geographic Information System (GIS)

The District maintains an extensive in-house database and Geographic Information System (GIS). The database includes water level and water quality data for WRD's service area with information drawn not only from the District's Regional Groundwater Monitoring Program and permit compliance monitoring, but also from water quality data obtained from the DDW. The system requires continuous update and maintenance but serves as a powerful tool for understanding basin characteristics and overall basin health.

The GIS is used to provide better planning and basin management. It is used to organize and store an extensive database of spatial information, including well locations. The GIS allows the spatial data to relate to the water level data, water quality information, well construction data, production data, aquifer locations, and computer model files which are stored in a regularly updated SQL database, assuring accurate and timely data output. In the coming year, this information will be further integrated with readily available data from other state and federal agencies, as well as other District departments. Staff uses the system daily for project support and database management. Specific information is available upon request to any District pumper or stakeholder and can be delivered through the preparation of maps, tables, reports, or in other compatible formats. Additionally, the District has made its web-based Interactive Well Search tool available to the public. This web site provides these users with limited access to WRD's water quality and production database. In the 2018/19 FY and WY, the site was upgraded to increase performance, functionality and improve access.

District staff will continue to streamline and refine the existing data management system and ensure its compatibility with the District's asset management system, which is currently under development. As part of the streamlining of the data, staff will work closely with other District departments to evaluate and implement updates to the District's existing system to facilitate the seamless transfer of data and access to that data. Additionally, District staff will continue the development of applications to more efficiently manage and report groundwater production information. Continued use, upkeep, and maintenance of the GIS are planned for the coming year. The use of the system supports both replenishment activities and groundwater quality efforts. Accordingly, the cost for this program is equally split between the Replenishment and Clean Water Funds.

011 – Regional Groundwater Monitoring Program

WRD has been monitoring groundwater quality and water levels in the CBWCB for nearly 60 years. The Regional Groundwater Monitoring Program (RGWMP) provides for the collection of basic information used for groundwater basin management including groundwater level data and water quality data. The RGWMP utilizes a network of 331 WRD and USGS-installed monitoring wells at 59 locations throughout the District, supplemented by data from groundwater production wells operated by the water purveyors. The information generated by this program is stored in the District's GIS and provides the basis to better understand the dynamic groundwater system in the Central Basin and West Coast Basin. WRD hydrogeologists and engineers provide the in-house capability to collect, analyze and report on new and historical groundwater data.

Water quality samples from the monitoring wells are collected once or twice a year and analyzed for numerous common constituents such as general minerals, volatile organic compounds, metals, and general physical properties, as well as "special study constituents" such as 1,2,3-trichloropropane, pharmaceuticals and personal care products, explosives such as HMX, RDX, and TNT, and other chemicals of emerging concern on a case by case basis. Water levels are measured in most monitoring wells with automatic data loggers every six hours, while water levels in all monitoring wells are manually measured by field staff a minimum of four times per year. On an annual basis, staff prepares the Regional Groundwater Monitoring Report that documents groundwater level and groundwater quality conditions each water year throughout the District. This report is distributed to the WRD stakeholders and is also available on the District's website. The RGWMP also generates the data required for the District's Salt and Nutrient Management Plan and California Statewide Groundwater Elevation Monitoring (CASGEM) program. In 2011, the National Groundwater Associated presented WRD with the "2011 Groundwater Protection Project Award" in recognition of the regional groundwater monitoring program.

WRD is also the designated groundwater monitoring entity for the CBWCB under the State of California's CASGEM program. WRD collects water level data from 28 of its nested monitoring wells and uploads it to the State's CASGEM website on a regular basis for seasonal and long-term water level trend tracking. Public access to the CASGEM website is at www.water.ca.gov/groundwater/casgem.

Ongoing work by WRD involves continuous field activities including quarterly, semi-annual, and annual data collection, well and equipment maintenance, and annual reporting activities. Work associated with the RGWMP also supports activities relating to both replenishment and water quality projects. The program is funded 50% each from the Replenishment and Clean Water Funds.

012 – Safe Drinking Water Program

WRD's Safe Drinking Water Program (SDWP) has operated since 1991 and is intended to promote the cleanup of groundwater resources at specific well locations. Through the installation of wellhead treatment facilities at existing production wells, the District removes contaminants from the underground supply and delivers the extracted water for potable purposes. Projects implemented through this program are accomplished in collaboration with well owners.

One component of the program focuses on the removal of volatile organic compounds (VOCs) and offers financial assistance for the design, equipment and installation at the selected treatment facility. Another component offers zero-interest loans for secondary constituents of concern that affect a specific production well. The capital costs of wellhead treatment facilities range from

$800,000 to over $2,000,000. Due to financial constraints, the initial cost is generally prohibitive to most pumpers. Financial assistance through the District's SDWP makes project implementation much more feasible.

There are several projects in various stages of implementation and new candidates for participation are under evaluation. Three projects for VOC removal are currently under construction and scheduled for completion by May 2019. A total of 16 facilities have been completed and are online and one facility has successfully completed removal of the contamination and no longer needs to treat. While continued funding of this program is anticipated for next year, the District has revised the guidelines of the SDWP to place a greater priority on projects involving VOC contamination or other anthropogenic (man-made) constituents, now classified as Priority A Projects. Treatment projects for naturally-occurring constituents are classified as Priority B Projects and funded as a secondary priority, on a case-by-case basis and only if program monies are still available during the fiscal year. While such projects are of interest to WRD, availability of funding for them will not be determined until after the budget process is completed.

The District recently revised the Safe Drinking Water Program to include a revolving fund plan for Priority B Projects and implementation of a revitalization plan to maximize program participation. The Safe Drinking Water Program now includes a third component, the Disadvantage Communities (DAC) Outreach Assistance Program, which will provide assistance to water systems in Disadvantaged areas with applying for State funding. There are currently 11 participants in the DAC Outreach Assistance Program. Through the District's program, four of the participants have received at total of $3.1 million in State funding for their projects and the remaining seven participants are awaiting final approval.

Projects under the SDWP involve the treatment of contaminated groundwater for subsequent beneficial use. This water quality improvement assists in meeting the District's groundwater cleanup objectives. Funding for the costs of the program is drawn wholly from the Clean Water Fund.

018 – Dominguez Gap Barrier Recycled Water Injection

This Project involves the delivery of recycled water from the City of Los Angeles Department of Public Works - Bureau of Sanitation (BOS) Terminal Island Water Reclamation Plant/Advanced Water Treatment Facility (AWTF) to the Dominguez Gap Barrier Project (DGBP). Delivery of recycled water to the barrier commenced in February 2006.

Prior to injection at the barrier, the recycled water produced at the AWTF undergoes advanced treatment processes including microfiltration, reverse osmosis, and chlorination. The DGBP was originally permitted by RWQCB in conjunction with DDW for up to 5 MGD of recycled water and 50% recycled water contribution (meaning recycled water may not exceed 50% of the total injected volume with the remainder consisting of potable water). In 2016, the permit was revised to allow up to 12 MGD of 100% recycled water to the DGBP. Water quality requirements, including turbidity and modified fouling index, must also be satisfied to minimize potential fouling of DGBP injection wells owned and operated by the County of Los Angeles Department of Public Works.

While BOS is responsible for the treatment and the water quality monitoring of the recycled water at the AWTF and LADWP for the delivery of the recycled water to the DGBP, WRD performs the groundwater monitoring and modeling aspects for compliance purposes at the request of BOS and LADWP. WRD measures and tracks groundwater levels and quality conditions, evaluates potential impact of recycled water on groundwater, and identifies potential problems at monitoring wells before recycled water arrives at any downgradient drinking water wells. In addition, WRD performed an

extensive tracer study from the start of recycled water injection in February 2006 through fall 2010 to determine the extent of travel and movement of the recycled water through the aquifers. The tracer study confirmed that after injection, adequate mixing and further blending of recycled water with diluent water occurs in the ground and that groundwater samples collected were representative of the recycled water blend.

In December 2018, WRD entered into a 30-year recycled water purchase agreement with LADWP to deliver 7.5 mgd of advanced treated to the DGBP with the ability to expand up to 9.5 mgd to meet other needs of the District. This agreement included the expansion of the existing infrastructure to include a Second Barrier Connection and a Potable Water Backup System. WRD will be working with LADWP to get these improvements installed.

Recycled water use at the seawater intrusion barriers in Los Angeles County improves the reliability of a supply in continuous demand. Traditionally, water purchases for the barriers have been viewed as a replenishment function. Therefore, this program is funded 100% through the Replenishment Fund.

023 – Replenishment Operations

WRD actively monitors the operation and maintenance practices at the LACDPW-owned and operated spreading grounds and seawater barriers within the District. Optimizing replenishment opportunities is fundamentally important to WRD, in part because imported and recycled water deliveries directly affect the District's annual budget. Consequently, the District seeks to ensure that the conservation of stormwater is maximized, and that imported and recycled water replenishment is optimized.

Due to the high cost and susceptibility of imported water to drought and environmental concerns, WRD is working on its Water Independence Now (WIN) initiative to eventually become independent from imported water for groundwater recharge. By maximizing the use of recycled water and stormwater, the amount of imported water needed can eventually be reduced or eliminated, thereby providing the groundwater basins with full replenishment needs through locally-derived water.

WRD coordinates regular meetings with LACDPW, MWD, SDLAC, and other water interests to discuss replenishment water availability, spreading grounds operations, barrier operations, scheduling of replenishment deliveries, seawater barrier improvements, upcoming maintenance activities, and facility outages or shutdowns. The District tracks groundwater levels in the Montebello Forebay weekly to assess general basin conditions and determine the level of artificial replenishment needed. WRD also monitors the amount of recycled water used at the spreading grounds and seawater barriers to maximize use while complying with pertinent regulatory limits. While improvements undertaken in recent years by LACDPW/WRD (e.g., expansion of Whittier Narrows Conservation Pool, installation of rubber dams on San Gabriel River, Interconnection Pipeline, and recycled water diversion structures) have considerably increased the stormwater portion of WRD's supply portfolio, the potential for further increasing the use of stormwater for groundwater augmentation remains significant, and WRD will work to enhance storm water capture and replenishment.

The District plans to continue working with the LACDPW on several design projects for the Rio Hondo and San Gabriel coastal spreading grounds with the goal of increasing the volume of storm water and recycled water conserved. The District is continually looking for opportunities to work with the LACDPW on improvement projects at the recharge facilities. Several potential projects have been identified and are being further evaluated to determine if they should be pursued. This fiscal year the District plans to continue working with the LACDPW to maximize the use of the turnout structures and increase the volume of recycled water conserved as well as using of the Montebello Forebay

Spreading Grounds Operation Model to evaluate and prioritize future improvement projects. The District will also install new groundwater monitoring wells in the Montebello Forebay in order to maintain regulatory compliance with the recycled water use requirements.

The District plans to continue partnering with the LACDPW to co-fund enhancements to the Interconnection Pipeline and associated pump station at the Montebello Forebay Spreading Grounds. As its name implies, the Replenishment Operations Program deals primarily with replenishment issues and therefore its costs are borne 100% through the Replenishment Fund.

025 – Hydrogeology Program

This program accounts for the projects and programs related to hydrogeologic investigations of the District and surrounding areas to ensure safe and reliable groundwater. Work performed under this program includes the preparation of the annual Engineering Survey and Report, which incorporates the calculation and determination of annual overdraft, accumulated overdraft, changes in storage, pumping amounts, and replenishment water availability into a document to help the District assess its replenishment needs and costs in the ensuing year. Extensive amounts of data are compiled and analyzed by staff to determine these values. Maps are created showing water levels in the basins and production patterns and amounts.

An ongoing effort at the District to better characterize the hydrogeologic conditions across the Central and West Coast Basins is called the "Hydrogeologic Conceptual Model". This long-term project being performed in cooperation with the USGS involves compiling and interpreting the extensive amounts of data generated during drilling and logging of the WRD/USGS monitoring wells and collected from historical information for production wells and oil wells within the District. The ultimate goal of this project is to develop a new geologic framework model based on sequence stratigraphy as a basis for the new conceptual model, and incorporate the information into WRD's database, GIS, and models to generate aquifer surfaces and cross-sections for comparison with historical interpretations of basin hydrogeology. The final geologic framework conceptual model will significantly improve the understanding of the aquifer depths, extents and thicknesses throughout the District and will assist staff, pumpers and stakeholders with planning for groundwater resource projects such as new well drilling, storage opportunities or modeling. The data will also be made available on WRD's website to be used as a reference source for hydrogeologic interpretations and to fill project-related data requests.

The geologic framework conceptual model is being incorporated into a new USGS numerical flow model. The updates to the numerical model are being performed based on the new information gleaned from the additional aquifer-specific WRD monitoring wells and the extensive groundwater monitoring that the District has performed since then to identify trends in groundwater levels. The new model will also include refining the original model’s resolution to 1/8-mile square cells versus the previous model’s 1/2 - mile cells, and creating at least 12 vertical layers to simulate groundwater flow in the various aquifers versus the previous model’s 4 layers. The model has also been converted to the newest version of Modflow known as Unstructured Grids (USG), which allows better simulation of groundwater flow in the complex geology of the Central and West Coast Basins. Time frames for model calculation will improve from annual measurements to quarterly. All of these upgrades will lead to a much improved groundwater modeling simulator for the District’s future management efforts. This model is a significant analytical tool utilized by WRD to determine basin benefits and impacts of changes proposed in the management of the Central Basin and West Coast Basin. It is anticipated that this model will be completed and published in mid to late 2019, with a subsequent conversion to the Modflow 6 platform.

Hydrogeologic analysis is also needed for projects associated with groundwater quality concerns and specific cleanup projects. Staff work may include investigative surveys, data research, and oversight of specific project studies. Such efforts are used to relate water quality concerns with potential impact to basin resources. An example of this type of staff work is the District's Well Profiling Program. The District assists pumpers in evaluating drinking water supply well contamination. Services may include existing data collection and review and field tasks such as spinner logging and depth-discrete sampling. WRD's evaluation helps pumpers to determine the best course of action; e.g., sealing off a particular screened interval of a well, wellhead treatment, or well destruction.

Salt / Nutrient Management Plans are a State requirement for all groundwater basins throughout California. The Plans are required as part of the Recycled Water Policy issued by the State Water Resources Control Board (SWRCB) and effective as of May 14, 2009. As stated in the Policy, its purpose is to "establish uniform requirements for recycled water use and to develop sustainable water supplies throughout the state". The SWRCB therefore "supports and encourages every region…to develop a Salt / Nutrient Management Plan by 2014". WRD along with other stakeholders completed the SNMP in 2014 and the Regional Water Quality Control Board adopted a Basin Plan Amendment to incorporate the SNMP in February 2015. Follow up work will be to monitor the salt and nutrient concentrations in the District over time, and compare results to the model predictions in the SNMP.

Modeling of groundwater flow and movement of injected recycled water at the Alamitos and Dominguez Gap seawater barriers are also included in this program. These efforts are required under permits for the recycled water injection.

In 2019, the WRD will replace Central Basin MWD, City of Long Beach, and City of Compton, as the Lower Area Plaintiff under the Long Beach Judgment. In 1959, the Long Beach Board of Water Commissioners filed a lawsuit in Los Angeles County Superior Court against numerous parties in the San Gabriel Basin to determine the rights of the various parties to the water flow from the San Gabriel River. Central Basin MWD and the City of Compton joined the case in Long Beach's support shortly thereafter. The WRD was not yet formed when the case was filed and therefore not part of the original lawsuit. After several years of court proceedings and negotiations, judgment was entered in 1965, allocating the San Gabriel River's flow between the Upper Area and the Lower Area, with Whittier Narrows established as the dividing line between the Upper and Lower Areas. The Judgment, commonly referred to as the "Long Beach Judgment", entitles the Lower Area to receive a long-term average of 98,415 acre-feet per year of water from the San Gabriel River system, which can be adjusted from time to time based on hydrology.

Because WRD is the groundwater manager for the Lower Area and benefits from the water provided under the Judgment, the three plaintiffs in 2018 agreed that it was more appropriate for WRD to replace Central Basin MWD, Long Beach and Compton as the sole plaintiff to represent the Lower Area and take on the Lower Area's responsibilities under the Judgment. WRD agreed and submitted the appropriate paperwork to the Court to make the switch official in 2019.

The Hydrogeology Program addresses both groundwater replenishment objectives and groundwater quality matters. The cost of the program is evenly split between the Replenishment and Clean Water Funds.

033 – Albert Robles Center for Water Recycling and Environmental Learning (ARC)

The WRD continues to make substantial progress on completing its Albert Robles Center for Water Recycling and Environmental Learning (ARC), formerly known as the Groundwater Reliability

Improvement Project (GRIP) Advanced Water Treatment Facility (AWTF). Once finished, ARC will offset the current use of imported water at the spreading grounds by providing up to 10,000 AFY of advanced treated recycled water for groundwater recharge, and due to its high quality, free up an additional 11,000 AFY of tertiary recycled water and thus, fully offsetting the need for imported water at the spreading grounds. The primary goals of ARC are to:

- Provide a sustainable and reliable supply for replenishing the Basins;
- Protect and improve groundwater quality;
- Minimize the environmental/energy footprint of any option or options selected;
- Comply with pertinent regulatory requirements employing an institutionally feasible approach;
- Minimize cost to agencies using groundwater; and
- Engage stakeholders in the decision-making process.

Using tertiary recycled water supplied by the SDLAC's San Jose Creek Water Reclamation Plant, the ARC AWTF will produce 10,000 AFY of highly treated recycled water for groundwater recharge in the Montebello Forebay. Specifically, the advanced treated water will be diverted to both the San Gabriel and Rio Hondo spreading basins via two (2) turnout/diversion structures that were constructed by WRD in 2016. In addition, the water also will be injected using three (3) new supplemental recharge wells that have been installed at the ARC facility.

In 2016, the WRD, commenced both design and construction-related activities for its ARC Design-Build and Transitional Operations project using a Progressive Design-Build project delivery means and method. Design and construction activities continued throughout 2018 and the ARC AWTF is scheduled to go online in Spring 2019. In 2018, the Title 22 Engineering Report was completed and the final permit to operate the new AWTF was adopted by the Los Angeles Regional Water Quality Control Board. The project is being funded from a combination of 2015 Bond Proceeds, California State Revolving Fund (SRF) Loan and Grant Proceeds, SRF, United States Bureau of Reclamation Title XVI Grant, and a River's and Mountains Conservancy Grant, respectively.

This resource is used to improve replenishment capabilities and is thus funded 100% from the Replenishment Fund.

038 – Engineering Program

The Engineering Department provides technical planning, engineering, program management, environmental review, construction management, and hands-on support on capital improvement projects ranging from concept development through planning, engineering design, entitlement, project management, and construction inspections. The Engineering Department is also responsible for developing, updating, and managing the five-year capital improvement program (CIP) and its related projects. The Engineering Department prepares and/or oversees the preparation of plans, specifications and engineer's estimates of probable construction costs, and/or prepares requests for interest/proposals/qualifications for professional engineering consultation and construction management services depending on the size and specific needs of the project.

The Engineering Department receives and reviews public bids and provides recommendations to various committees and the Board of Directors to award contracts. The Engineering Department also applies, secures, and administers/manages grants from various, Federal, State, and Local organizations to supplement funds allocated by WRD.

The Engineering Department provides and oversees project planning and environmental review/entitlement services for its CIP projects. The Engineering Department also monitors

construction work in progress, reviews/approves progress pay estimates, and provides quality assurance/quality control oversight services on approved projects to ensure compliance with Board goals and objectives.

The Engineering Program is intended to provide a mechanism for engineering staff to plan and further develop alternatives for potential capital improvement projects. Not all CIP project concepts develop into multi-year capital improvement program projects, and more often than not require many months of advanced planning and concept development before being capitalized. The Engineering Program deals primarily with replenishment issues and therefore its costs are borne by the Replenishment Fund until such time as alternative capital improvement program funding is identified.

039 – Supervisory Control and Data Acquisition (SCADA)

The Supervisory Control and Data Acquisition (SCADA) System project includes the development of a SCADA System Master Plan, which was completed in May 2016 in order to establish comprehensive standards for the District's entire SCADA system infrastructure, a communications network between all of the District's operating facilities, and a system-wide network security program. The SCADA System Master Plan is currently being implemented to create a master SCADA system that will meet the expanding needs of the District, as related to the implementation of ongoing and recently completed construction projects including the expansion of the Goldsworthy Desalter, the two turnout structures at the Montebello Forebay Spreading Grounds, and the new ARC AWTF (formerly named GRIP). Eventually, a fully integrated and standardized master SCADA system will be established and all of WRD's operating facilities will be displayed and/or controlled at the Centralized Information System that was recently established at the District's offices in Lakewood, California.

This project supports both replenishment activities and groundwater quality efforts. Accordingly, the cost for this program is equally split between the Replenishment and Clean Water Funds.

040 – Computerized Maintenance Management System (CMMS) and Asset Management

In recent years, District assets have expanded to greater than $200 million, and will continue to grow as new projects are implemented, including the newest treatment plant (ARC AWTF) and Field Operations & Storage Annex. An enterprise asset management plan was developed to facilitate more effective management across all District assets. A core component of this management plan is the Computerized Maintenance Management System (CMMS). This system consists of an electronic database of all District assets which is utilized to generate electronic work orders in response to maintenance-related issues, including reactionary and preventative maintenance-related work. The CMMS system tracks work performance to verify that maintenance is being performed as needed to ensure proper operations. The system was fully implemented at the Leo J. Vander Lans treatment plant in 2018, with rollout at the remaining treatment facilities and District headquarters to follow. An additional effort was launched in 2018 that will be utilized by both Operations and Finance Department. This program will work in conjunction with the CMMS to track the condition of District assets. Tracking the condition and associated risk of asset failure will assist when planning capital replacements and move the District toward achieving a high level of service. The enterprise asset management program is currently funded 100% from the Replenishment fund.

043 – Regional Brackish Water Reclamation Program Feasibility Study

Within the West Coast Basin a significant plume (approx. 600,000 acre feet) of high Total Dissolved Solids (TDS) has been trapped due to seawater intrusion and the implementation of the West Coast Seawater Intrusion Barrier. WRD began the Regional Brackish Water Reclamation Program (Program) through the Groundwater Basin's Master Plan to evaluate ways to remediate the basin.

WRD has now initiated a regional planning effort to evaluate the feasibility of remediating the high TDS plume with six additional stakeholders (Stakeholder Group) who pump and wholesale potable water within the basin. A Feasibility Study has been identified as the first step to determining how to remediate this plume to allow for future groundwater use within the basin.

The Feasibility Study will evaluate potential siting and technologies for brackish water reclamation facilities within the plume with maximum remediation benefit and the most efficient life cycle cost. At the end of this Feasibility Study WRD and the Stakeholder Group anticipate proceeding forward with partnership agreements determining project specific responsibility followed by CEQA and permitting for the recommended project(s).

Once completed, the benefits of this program will include recovering an impaired groundwater resource and putting to beneficial use the available space to store water. In addition, local users will decrease their reliance on imported water, further "drought proofing" local communities and the region. This project supports both replenishment activities and groundwater quality efforts. Accordingly, the cost for this program is equally split between the Replenishment and Clean Water Funds.

044 – Pipeline Projects

Pipelines to connect the District's various assets are currently under the planning phase and may become a critical resource for the District in the future. Currently, WRD is evaluating pipelines to provide additional source water to the Leo J. Vander Lans Water Treatment Facility (LVL). Historically, LVL has encountered challenges with reliable source water for continuous plant operation. LVL currently receives source water from the Long Beach Water Reclamation Facility (LBWRF), owned and operated by the Sanitation Districts of Los Angeles County (LACSD), which has been undergoing a series of planned shutdowns for various facility improvement. WRD is evaluating options to diversify source water with an end goal of improved and continuous operation of LVL. One of these alternatives that is under evaluation is utilizing existing allocations from the Los Coyotes Water Reclamation Facility (LCWRF), owned and operated by LACSD, to provide an alternate source water supply to LVL via a new pipeline project.

The Los Coyotes pipeline project study is included in the five-year capital improvement program (CIP) and is currently funded under the 2018 bond issuance with debt payments attributed to the Replenishment fund.

045 – Joint Los Angeles Basin Replenishment and Extraction Master Plan

WRD and Los Angeles Department of Water and Power (LADWP) are working collaboratively to investigate potential future opportunities for sustainable extraction and replenishment of groundwater

from the West and Central groundwater basins. LADWP has access to the Hyperion Water Reclamation Plant (WRP) as a potential source of replenishment water (supply equaling ~200 million gallons per day) and shares WRD's goal of increased local sustainability through utilization of all available recycled water in the Los Angeles Basin. The two agencies have partnered on a Master Plan effort to identify all feasible assets within the greater Los Angeles area within the following categories:

- Sustainable recycled water supplies available;
- Locations, infrastructure and treatment to get new recycled water into the ground; and
- Locations, infrastructure and treatment to get new water out of the ground.

In early 2019, the two agencies formalized the Master Plan effort with a cost-sharing Memorandum of Agreement and the procurement of professional services to begin evaluation of available assets, potential project opportunities, and funding and outreach strategies. The plan is scheduled to be completed in January of 2020 and will result in implementable preferred project alternatives.

This project is an initiative to improve replenishment flexibility and therefore its costs are being borne by the Replenishment Fund until final projects are determined and alternative CIP funding is identified.

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TABLES

Table 1

GROUNDWATER CONDITIONS AND REPLENISHMENT SUMMARY

	WATER YEAR Oct 1 - Sep 30		
	2017/18	*2018/19 (a)*	*2019/20 (a)*
Total Groundwater Production	220,697 AF	217,300 AF	217,300 AF
Annual Overdraft	(171,482) AF	(72,100) AF	(72,100) AF
Accumulated Overdraft	(828,665) AF	(806,900) AF	

Quantity Required for Artificial Replenishment for the Ensuing Year		
Spreading		
Imported for Spreading in Montebello Forebay	-	AF
Recycled for Spreading in Montebello Forebay	71,000	
Whittier Narrows Operable Unit Spreading Water (Local Water)	1,400	
Subtotal Spreading	72,400	
Injection		
Alamitos Seawater Barrier Imported Water (WRD side only)	2,250	
Alamitos Seawater Barrier Recycled Water (WRD side only)	2,250	
Dominguez Gap Seawater Barrier Imported Water	3,000	
Dominguez Barrier Seawater Barrer Recycled Water	4,500	
West Coast Seawater Barrier Imported Water	4,250	
West Coast Seawater Barrier Recycled Water	12,750	
Subtotal Injection	29,000	
In-lieu (b) Subtotal In-lieu	-	
Total	**101,400**	AF

(a) Estimated values

(b) In-Lieu Program currently not established for ensuing year

Table 2

QUANTITY AND COST OF REPLENISHMENT WATER FOR THE ENSUING YEAR

Summary - All Water

Item	Quantity (AF)	Total Cost
Spreading - Tier 1 Untreated Imported	0	$ 342,396
Spreading - Recycled (tertiary spreading)	61,000	$ 7,760,000
Spreading - Recycled (GRIP/ARC AWTF)*	10,000	$ -
Spreading - Whittier Narrows Operable Unit	1,400	$ 1,192,800
Alamitos Barrier - Imported	2,250	$ 2,778,318
Alamitos Barrier - Recycled*	2,250	$ -
Dominguez Barrier - Imported	3,000	$ 4,435,432.88
Dominguez Barrier - Recycled	4,500	$ 4,774,500
West Coast Barrier - Imported up to 17kaf barrier total	4,250	$ 6,283,529.92
West Coast Barrier - Imported over 17kaf	0	$ -
West Coast Barrier - Recycled	12,750	$ 12,660,750
In-Lieu MWD Member	0	$ -
In-Lieu WBMWD Customer	0	$ -
TOTAL	**101,400**	**$ 40,227,727**

Detailed Breakout of Water Costs and Surcharges to WRD

Imported Water

Item	Quantity	Oct-Dec	Jan-Jun	Jul-Sep	Melded	Total
CBMWD						
MWD Untreated Tier 1 - Spreading ($/af)	0	$ 731	$ 755	$ 755	$ 749	$ -
MWD RTS ($/month)	12	$ 22,333	$ 22,333	$ 22,333	$ 22,333	$ 267,996
CBMWD Administrative Surcharge ($/af)	0	$ 70	$ 70	$ 70	$ 70	$ -
CBMWD Water Service Charge ($/month)	12	$ 6,200	$ 6,200	$ 6,200	$ 6,200	$ 74,400
Total to CBMWD						**$ 342,396**
LBWD						
MWD Treated Tier 1 - Alamitos Barrier ($/af)	2,250	$ 1,050	$ 1,078	$ 1,078	$ 1,071	$ 2,409,750
MWD Capacity Charge ($/cfs/month)	7.7	$ 717	$ 733	$ 733	$ 729	$ 67,068
LBWD RTS ($/af)	2,250	$ 127	$ 127	$ 133	$ 129	$ 290,250
LBWD Administrative Surcharge ($/af)	2,250	$ 5	$ 5	$ 5	$ 5	$ 11,250
Total to LBWD						**$ 2,778,318**
WBMWD						
MWD Treated Tier 1-DG/WC Barriers ($/af)	7,250	$ 1,050	$ 1,078	$ 1,078	$ 1,071	$ 7,764,750
MWD RTS ($/af)	7,250	$ 98	$ 103	$ 103	$ 102	$ 739,500
MWD Capacity Charge ($/cfs/month)	46.8	$ 600	$ 630	$ 630	$ 623	$ 349,877
WBMWD Administrative Surcharge ($/af)	7,250	$ 237	$ 237	$ 249	$ 240	$ 1,740,000
WBMWD Fixed Service Charge ($/month)	12	$ 10,149	$ 10,149	$ 11,164	$ 10,403	$ 124,836
Total to West Basin MWD						**$ 10,718,963**
MSGBWM						
Whittier Narrows Operable Unit Water ($/af)	1,400	$ 834	$ 858	$ 858	$ 852	**$ 1,192,800**
IN-LIEU						
MWD Member Agency ($/af)	0	-	-	-		No IL Program
WBMWD Member Agency ($/af)	0	-	-	-		No IL Program
Total for In-Lieu Payments						$ -

Recycled Water

Item	Quantity	Oct-Dec	Jan-Jun	Jul-Sep	Melded	Total
LADWP						
Recycled Water for Dominguez Barrier ($/af)	4,500	$ 1,053	$ 1,053	$ 1,085	$ 1,061	$ 4,774,500
Total to LADWP						**$ 4,774,500**
SDLAC						
Tertiary Water - WN, SJC, Pomona ($/af) ≤50k	50,000	$ 63	$ 63	$ 71	$ 65	$ 3,250,000
Tertiary Water - WN, SJC, Pomona ($/af) >50k	11,000	$ 410	$ 410	$ 410	$ 410	$ 4,510,000
Tertiary Water for GRIP AWTF*	10,000	$ -	$ -	$ -	$ -	$ -
Total to SDLAC						**$ 7,760,000**
WBMWD						
WBMWD Recycled Water Rate (S/af)	12,750	$ 973	$ 973	$ 1,051	$ 993	$ 12,660,750
Total to WBMWD						**$ 12,660,750**
LBWD						
Source Water for Vander Lans Plant ($/af)*	2,250	$ -	$ -	$ -	$ -	$ -
Total to WRD						$ -
TOTAL	**101,400**					**$ 40,227,727**

* Cost of source water covered under that project's separate operations budget

Updated 2/7/2019

Table 3

WRD PROJECTS AND PROGRAMS

PROJECT / PROGRAM		DISTRICT FUNCTION	
		Replenishment	Clean Water
001	Leo J. Vander Lans Water Treatment Facility Project	100%	
002	Robert W. Goldsworthy Desalter Project		100%
004	Recycled Water Program	100%	
005	Groundwater Resources Planning Program	100%	
006	Groundwater Quality Program		100%
010	Geographic Information System (GIS)	50%	50%
011	Regional Groundwater Monitoring Program	50%	50%
012	Safe Drinking Water Program		100%
018	Dominguez Gap Barrier Recycled Water Injection	100%	
023	Replenishment Operations	100%	
025	Hydrogeology Program	50%	50%
033	Albert Robles Center for Water Recycling and Environmental Learning (ARC) (formerly named GRIP)	100%	0%
038	Engineering Program	50%	50%
039	Supervisory Control And Data Acquisition (SCADA)	50%	50%
040	Computerized Maintenance Management System (CMMS) and Asset Management	50%	50%
043	Regional Brackish Water Reclamation Program Feasibility Study	50%	50%
044	Pipeline Projects	100%	
045	Joint Los Angeles Basin Replenishment and Extraction Master Plan	100%	

Table 4

30-YEAR AVERAGE GROUNDWATER BALANCE FROM USGS AND WRD REGIONAL MODEL

INFLOWS	Average AFY	OUTFLOWS	Average AFY
Natural Inflows:		**Artificial Outflows:**	
Local water conserved at spreading grounds [1]	48,825	Pumping	250,590
Interior and mountain front recharge	47,900		
Net underflow from adjacent basins [2]	48,480		
Subtotal Natural Inflows:	145,205		
Artificial Inflows:			
Imported and recycled spreading [3]	74,075		
Barrier injection water [4]	34,600		
Subtotal Artificial Inflows:	108,675		
Total Inflows:	**253,880**	**Total Outflows:**	**250,590**

Average Annual Groundwater Deficiency (afy) = Natural Inflows - Total Outflows = (105,385)

[1] includes stormwater and base flow water captured and recharged at the spreading grounds

[2] does not include average of 7,100 afy of seawater intrusion, which can not be considered as replenishment per the water code

[3] includes all imported purchased, all recycled purchased, and Pomona Plant (free) recycled water.

[4] includes all injected water at the three barrier systems, including all of Alamitos Barrier. Model value may differ slightly from actual purchases.

Description of the model can be found in USGS, 2003, Geohydrology, Geochemistry, and Ground-Water Simulation - Optimization of the Central and West Coast Basins, Los Angeles County, California; Water Resources Investigation Report 03-4065 by Reichard, E.G., Land, M., Crawford, S.M., Johnson, T., Everett, R.R., Kulshan, T.V., Ponti, D.J., Halford, K.J., Johnson, T.A., Paybins, K.S., and Nishikawa, T.

Table 5

Annual Rainfall in the WRD Service Area

Water Year	Inches	Water Year	Inches	Water Year	Inches	Water Year	Inches
1925-26	12.63	1950-51	8.27	1975-76	9.55	2000-01	14.98
1926-27	16.92	1951-52	24.68	1976-77	11.23	2001-02	2.52
1927-28	11.97	1952-53	10.53	1977-78	33.85	2002-03	19.89
1928-29	11.52	1953-54	12.33	1978-79	18.68	2003-04	7.73
1929-30	10.84	1954-55	11.84	1979-80	28.29	2004-05	23.43
1930-31	10.45	1955-56	13.97	1980-81	8.74	2005-06	11.36
1931-32	14.52	1956-57	9.89	1981-82	13.41	2006-07	1.95
1932-33	10.02	1957-58	24.65	1982-83	30.3	2007-08	17.11
1933-34	11.1	1958-59	6.68	1983-84	11.96	2008-09	9.49
1934-35	21.94	1959-60	9.84	1984-85	12.44	2009-10	13.02
1935-36	9.65	1960-61	4.3	1985-86	19.47	2010-11	17.73
1936-37	22.11	1961-62	18.46	1986-87	6.49	2011-12	8.84
1937-38	21.75	1962-63	10.9	1987-88	11.47	2012-13	6.19
1938-39	18.69	1963-64	6.86	1988-89	7.82	2013-14	5.23
1939-40	12.81	1964-65	13.27	1989-90	7.87	2014-15	9.43
1940-41	34.21	1965-66	17.02	1990-91	12.22	2015-16	7.46
1941-42	14.66	1966-67	17.78	1991-92	16.07	2016-17	18.77
1942-43	17.91	1967-68	11.46	1992-93	26.55	2017-18	4.29
1943-44	17.89	1968-69	22.33	1993-94	9.26		
1944-45	11.25	1969-70	7.52	1994-95	26.82		
1945-46	10.31	1970-71	11.45	1995-96	10.68		
1946-47	15.24	1971-72	6.4	1996-97	13.95		
1947-48	8.62	1972-73	18.57	1997-98	32.47		
1948-49	9.04	1973-74	14.51	1998-99	7.29		
1949-50	10.14	1974-75	15.01	1999-00	9.21		

Period of Record	93 years
Running 93 Year Average	13.9 inches
Minimum	1.95 inches
Maximum	34.21 inches

Table 6

ANNUAL OVERDRAFT CALCULATION

for Current and Ensuing Water Years (in acre-feet)*

Item	WATER YEAR 2018/19	WATER YEAR 2019/20
Average Annual Groundwater Deficiency (from Table 4)	(105,385)	(105,385)
Adjustments/Variances to AAGD		
(1) Local Water at Spreading Grounds[(a)]	0 [(d)]	0 [(d)]
(2) Precipitation, mountain front recharge, applied water[(a)]	0 [(d)]	0 [(d)]
(3) Subsurface inflow[(b)]	0 [(d)]	0 [(d)]
(4) Groundwater Extractions[(c)]	(33,300) [(d)]	(33,300) [(d)]
ANNUAL OVERDRAFT [AAGD+(1)+(2)+(3)-(4)]	(72,100)	(72,100)

** Previous Year Annual Overdraft is derived in Chapter III*

(a) Difference between actual and model average. Positive value indicates increased recharge.

(b) Difference between annual model value and average model value. Positive value indicates increased inflow. Does not include seawater intrusion inflow

(c) Difference between actual and model average. Positive value indicates increased pumpage.

(d) Estimated Values. A value of zero indicates average year was assumed.

Table 7

ACCUMULATED OVERDRAFT CALCULATION (in acre-feet)

Accumulated Overdraft at End of Previous Water Year	(828,665)
Estimated Annual Overdraft for Current Year	(72,100)
Subtotal without artificial replenishment	(900,765)
Planned Artificial Replenishment for Current Year	
Imported and WNOU* Water Purchased for Spreading	9,400
Recycled Water Purchased for Spreading	57,500
Imported and Recycled Water Purchased for Barrier Wells	27,000
WRD Replenishment Subtotal	93,900
PROJECTED ACCUMULATED OVERDRAFT FOR CURRENT WATER YEAR	**(806,900)**

* WNOU = Whittier Narrows Operable Unit Water Purchased for Spreading

Table 8

CHANGES IN GROUNDWATER STORAGE

WATER YEAR	ANNUAL CHANGE IN STORAGE (AF)	CUMULATIVE CHANGE IN STORAGE (AF)
1961-62	88,500	88,500
1962-63	(11,100)	77,400
1963-64	10,300	87,700
1964-65	35,200	122,900
1965-66	21,100	144,000
1966-67	21,400	165,400
1967-68	11,400	176,800
1968-69	(7,500)	169,300
1969-70	(800)	168,500
1970-71	(3,400)	165,100
1971-72	(50,600)	114,500
1972-73	34,800	149,300
1973-74	(2,400)	146,900
1974-75	(14,100)	132,800
1975-76	(40,200)	92,600
1976-77	(32,900)	59,700
1977-78	88,600	148,300
1978-79	30,100	178,400
1979-80	(1,100)	177,300
1980-81	17,100	194,400
1981-82	18,400	212,800
1982-83	46,800	259,600
1983-84	(22,400)	237,200
1984-85	(9,600)	227,600
1985-86	10,600	238,200
1986-87	4,000	242,200
1987-88	(11,700)	230,500
1988-89	10,400	240,900
1989-90	13,600	254,500
1990-91	28,400	282,900
1991-92	1,600	284,500
1992-93	45,800	330,300
1993-94	(28,500)	301,800
1994-95	19,400	321,200
1995-96	12,500	333,700
1996-97	15,700	349,400
1997-98	16,700	366,100
1998-99	(80,200)	285,900
1999-00	(30,000)	255,900
2000-01	(400)	255,500
2001-02	(36,500)	219,000
2002-03	(10,500)	208,500
2003-04	(43,000)	165,500
2004-05	89,100	254,600
2005-06	12,000	266,600
2006-07	(59,000)	207,600
2007-08	(41,600)	166,000
2008-09	(51,500)	114,500
2009-10	27,000	141,500
2010-11	110,000	251,500
2011-12	(73,200)	178,300
2012-13	(68,000)	110,300
2013-14	(62,100)	48,200
2014-15	(12,700)	35,500
2015-16	(500)	35,000
2016-17	84,400	119,400
2017-18	(80,243)	39,157
2018-19	-	-
2019-20	-	-
2020-21	-	-
2021-22	-	-
2022-23	-	-
2023-24	-	-
2024-25	-	-
2025-26	-	-
2026-27	-	-
2027-28	-	-
2028-29	-	-
2029-30	-	-
2030-31	-	-
2031-32	-	-
2032-33	-	-

Note: Numbers in parentheses represent negative values.

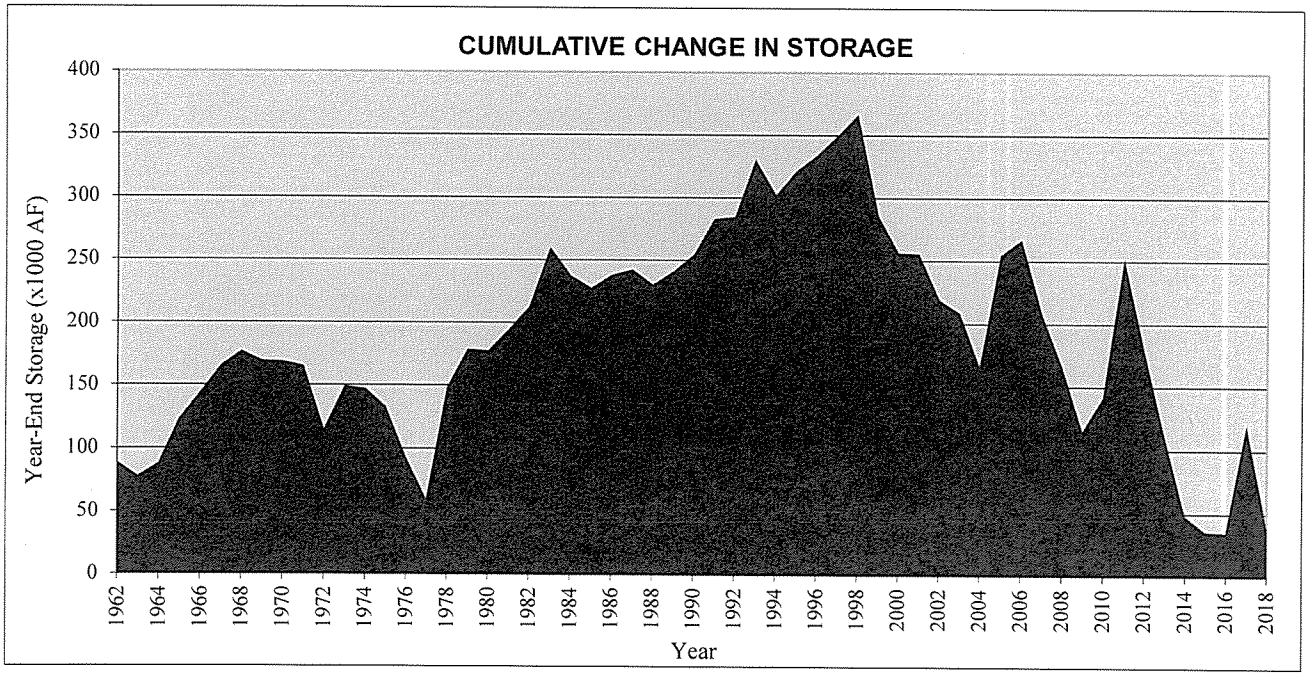


Table 9

QUANTITY OF WATER REQUIRED FOR ARTIFICIAL REPLENISHMENT

WATER TYPE	AMOUNT (AF)
Long Term Average for Imported Spreading (updated, see below)*	-
Tertiary Recycled Water for Spreading (WRD Purchases)	61,000
Recycled Water for ARC**	10,000
Total Spreading	**71,000**
West Coast Barrier - Imported	4,250
West Coast Barrier - Recycled	12,750
Dominguez Gap - Imported	3,000
Dominguez Gap - Recycled	4,500
Alamitos Barrier - Imported - WRD portion only	2,250
Alamitos Barrier - Recycled - WRD portion only	2,250
Total Barriers	**29,000**
In-Lieu Central Basin	0
In-Lieu West Coast Basin	0
Total In-Lieu	**0**
Total Water Purchase Estimate for Ensuing Year	**100,000**
Other Actions (Whittier Narrows Operable Unit Water for Spreading)	1,400
Total Water Purchase Estimate for Ensuing Year	**101,400**

* - Derivation of new Long Term Imported Spreading Requirement is possible due to new projects that will capture more storm/recycled water for conservation, and thus less imported needs:

** ARC = Albert Robles Center for Water Recycling and Environmental Learning (formerly GRIP)

1. Long Term Average of 27,600 af defined in 2003 ESR
2. Minus 3,000 afy for increasing Whittier Narrows Conservation Pool
3. Minus 3,600 afy for two new rubber dams on San Gabriel River
4. Minus 5,000 afy of imported due to 5,000 afy increase in recyled based on new averaging period effective 2013
5. Minus 10,000 afy water for ARC
6. Minus 6,000 af of more tertiary water
7. Equals new Long Term Average of 0 afy imported spreading

HISTORICAL AMOUNTS OF WATER RECHARGED IN THE MONTEBELLO FOREBAY SPREADING GROUNDS [a]

(in acre-feet)

WATER YEAR	Imported Water			Recycled Water				Local Water	Make-up Water			TOTAL
	LACFCD or Other	WRD	TOTAL	Whittier WRP	San Jose Creek WRP	Pomona WRP	TOTAL	Stormwater and River Baseflow	USGVMWD & SGVMWD	CBMWD	TOTAL	
1959-60	80,900		80,900				-	20,064			-	100,964
1960-61	80,800	67,000	147,800				-	9,118			-	156,918
1961-62	39,500	168,622	208,122	1,178			1,178	39,548			-	248,848
1962-63	4,800	75,790	80,590	12,405			12,405	14,565			-	107,560
1963-64	-	104,900	104,900	13,258			13,258	9,992			-	128,150
1964-65	75,500	84,670	160,170	14,528			14,528	13,097			-	187,795
1965-66	67,800	53,900	121,700	15,056			15,056	45,754	6,500		6,500	189,010
1966-67	74,100	10,200	84,300	16,223			16,223	59,820	-		-	160,343
1967-68	66,600	28,800	95,400	18,275			18,275	39,760	-		-	153,435
1968-69	12,500	5,300	17,800	13,877			13,877	119,395	-		-	151,072
1969-70	25,800	43,100	68,900	17,158			17,158	52,917	-		-	138,975
1970-71	46,700	25,400	72,100	19,494		3,232	22,726	44,757	-		-	139,583
1971-72	-	34,400	34,400	17,543		4,456	21,999	17,688	-		-	74,087
1972-73	-	71,947	71,947	13,622	8,327	5,937	27,886	45,077	-	20,000	20,000	164,910
1973-74	-	68,237	68,237	13,385	7,064	3,003	23,452	29,171	-	23,921	23,921	144,781
1974-75	-	71,900	71,900	14,650	6,549	5,592	26,791	29,665	-	-	-	128,356
1975-76	-	50,800	50,800	12,394	9,062	6,231	27,687	22,073	-	-	-	100,560
1976-77	-	9,300	9,300	10,158	12,705	6,496	29,359	19,252	14,500	6,900	21,400	79,311
1977-78	-	39,900	39,900	13,104	5,997	6,621	25,722	147,317	7,800	-	7,800	220,739
1978-79	-	65,300	65,300	10,716	11,741	6,403	28,860	68,859	-	-	-	163,019
1979-80	-	10,200	10,200	14,568	9,815	5,023	29,406	106,820	10,900	-	10,900	157,326
1980-81	3,300	28,700	32,000	11,464	14,645	5,613	31,722	50,590	31,500	-	31,500	145,812
1981-82	-	4,600	4,600	14,133	15,285	4,634	34,052	47,930	30,900	-	30,900	117,482
1982-83	-	2,000	2,000	12,818	4,217	5,735	22,770	126,076	8,900	-	8,900	159,746
1983-84	-	1,500	1,500	13,194	14,590	4,457	32,241	60,710	20,800	-	20,800	115,251
1984-85	-	40,600	40,600	12,905	14,093	4,380	31,378	39,099	-	-	-	111,077
1985-86	-	21,500	21,500	13,827	11,487	3,965	29,279	66,966	-	-	-	117,745
1986-87	-	49,200	49,200	15,280	20,041	2,655	37,976	27,613	-	6,500	6,500	121,289
1987-88	-	23,300	23,300	14,585	27,182	1,582	43,349	50,068	5,800	-	5,800	122,517
1988-89	-	50,300	50,300	13,830	33,327	2,616	49,773	17,096	6,500	-	6,500	123,669
1989-90	-	52,700	52,700	15,043	33,498	1,568	50,109	9,388	13,600	-	13,600	125,797
1990-91	-	56,300	56,300	13,841	38,603	1,420	53,864	35,717	100	-	100	145,981
1991-92	-	43,100	43,100	12,620	31,326	2,957	46,903	136,357	-	-	-	226,360
1992-93	-	16,561	16,561	11,026	29,811	8,027	48,864	147,699	-	-	-	213,124
1993-94	-	20,411	20,411	10,249	40,768	2,965	53,981	55,896	-	-	-	130,288
1994-95	-	21,837	21,837	10,642	18,431	4,228	33,300	100,578	-	-	-	155,715
1995-96	-	18,012	18,012	9,971	40,922	2,969	53,862	62,920	-	-	-	134,794
1996-97	-	22,738	22,738	9,850	36,977	3,132	49,959	58,262	-	-	-	130,959
1997-98	-	952	952	8,378	26,483	2,156	37,017	96,706	-	-	-	134,675
1998-99	-	-	-	10,968	34,782	1,451	47,201	32,013	-	-	-	79,214
1999-00	-	45,037	45,037	8,950	30,481	3,839	43,270	20,607	-	-	-	108,914
2000-01	-	23,451	23,451	8,253	35,165	2,925	46,343	39,725	-	-	-	109,519
2001-02	-	41,268	41,268	8,474	50,194	1,928	60,596	18,607 [c]	-	-	-	120,471
2002-03	-	17,297	17,297	5,156	35,320	2,320	42,796	63,271 [d]	-	-	-	123,364
2003-04	-	27,520	27,520 [e]	8,195	34,033	2,697	44,925	30,467	-	-	-	102,912
2004-05	-	25,296	25,296 [e]	6,741	20,547	2,215	29,503	148,674	-	-	-	203,473
2005-06	-	33,229	33,229	8,868	30,180	2,973	42,022	60,377	-	-	-	135,628
2006-07	-	40,214	40,214	7,334	34,823	2,882	45,039	11,495	-	-	-	96,748
2007-08	1,510	-	1,510 [b]	6,212	29,131	4,424	39,767	54,518	-	-	-	95,795
2008-09	-	-	-	5,202	29,999	4,410	39,611	35,348	-	-	-	74,959
2009-10	-	26,286	26,286	5,431	45,538	4,762	55,731	35,398	-	-	-	117,415
2010-11	-	37,315	37,315	7,576	24,323	5,231	37,131	113,295	-	-	-	187,741
2011-12	-	-	-	7,558	43,479	4,760	55,797	36,155	-	-	-	91,952
2012-13	-	-	-	7,004	47,207	4,933	59,145	6,048	-	-	-	65,193
2013-14	-	-	-	7,733	43,556	4,357	55,646	0	-	-	-	55,646
2014-15	-	18,515	18,515	4,811	35,737	3,802	44,349	15,892	-	-	-	78,757
2015-16	-	23,961	23,961	6,480	48,529	2,802	57,811	14,183 [f]	-	-	-	95,956
2016-17	-	32,693	32,693	6,956	47,761	3,350	58,067	70,027 [g]	-	-	-	160,786
2017-18	-	9,792	9,792	6,351	46,324	4,015	56,689	5,125 [h]	-	-	-	71,606
TOTAL	**579,810**	**1,965,850**	**2,545,660**	**629,501**	**1,270,055**	**188,124**	**2,087,680**	**2,955,607**	**157,800**	**57,321**	**215,121**	**7,804,067**

(a) Includes the Rio Hondo Spreading Grounds, Whitter Narrows Conservation Pool, San Gabriel Spreading Grounds and unlined San Gabriel River below Station F263.

(b) CBMWD purchased 1,510 af of imported water for spreading for Downey, Lakewood, and Cerritos.

(c) Includes 1,607 af of EPA extracted groundwater from WNOU considered lower area reaplenishment water paid for by WRD in 2003.

(d) Includes 5,069 af of EPA extracted groundwater from WNOU considered lower area replenishment water paid for by WRD in June 2005.

(e) Includes 13,000 af of water banked by Long Beach under a storage agreement with WRD (792 af 02/03, 12,210 af 3/04).

(f) Includes 206 af of DTSC extracted groundwater from WNOU considered lower area replenishment water paid for by WRD in 2017.

(g) Includes 1400 af of DTSC extracted groundwater from WNOU considered lower area replenishment water paid for by WRD in 2018.

*(h) Includes **** af of DTSC extracted groundwater from WNOU considered lower area replenishment water paid for by WRD in 2019.*

HISTORICAL AMOUNTS OF WATER PURCHASED FOR INJECTION

(in acre-feet)

Water Year	West Coast Barrier (a)			Dominguez Gap Barrier (b)			Alamitos Barrier							TOTAL
							WRD			OCWD			Total	
	Imported	Recycled	Total	Imported	Recycled	Total	Imported	Recycled	Total	Imported	Recycled	Total		
1959-60	3,700		3,700											3,700
1960-61	4,420		4,420											4,420
1961-62	4,460		4,460											4,460
1962-63	4,150		4,150											4,150
1963-64	10,450		10,450											10,450
1964-65	33,020		33,020				2,760		2,760	200		200	2,960	35,980
1965-66	44,390		44,390				3,370		3,370	350		350	3,720	48,110
1966-67	43,060		43,060				3,390		3,390	490		490	3,880	46,940
1967-68	39,580		39,580				4,210		4,210	740		740	4,950	44,530
1968-69	36,420		36,420				4,310		4,310	950		950	5,260	41,680
1969-70	29,460		29,460				3,760		3,760	720		720	4,480	33,940
1970-71	29,870		29,870	2,200		2,200	3,310		3,310	822		822	4,132	36,202
1971-72	26,490		26,490	9,550		9,550	4,060		4,060	936		936	4,996	41,036
1972-73	28,150		28,150	8,470		8,470	4,300		4,300	883		883	5,183	41,803
1973-74	27,540		27,540	7,830		7,830	6,140		6,140	1,148		1,148	7,288	42,658
1974-75	26,430		26,430	5,160		5,160	4,440		4,440	716		716	5,156	36,746
1975-76	35,220		35,220	4,940		4,940	4,090		4,090	565		565	4,655	44,815
1976-77	34,260		34,260	9,280		9,280	4,890		4,890	885		885	5,775	49,315
1977-78	29,640		29,640	5,740		5,740	4,020		4,020	831		831	4,851	40,231
1978-79	23,720		23,720	5,660		5,660	4,220		4,220	898		898	5,118	34,498
1979-80	28,630		28,630	4,470		4,470	3,560		3,560	575		575	4,135	37,235
1980-81	26,350		26,350	3,550		3,550	3,940		3,940	524		524	4,464	34,364
1981-82	24,640		24,640	4,720		4,720	4,540		4,540	394		394	4,934	34,294
1982-83	33,950		33,950	6,020		6,020	3,270		3,270	1,943		1,943	5,213	45,183
1983-84	28,000		28,000	7,640		7,640	2,440		2,440	1,402		1,402	3,842	39,482
1984-85	25,210		25,210	7,470		7,470	3,400		3,400	1,446		1,446	4,846	37,526
1985-86	20,260		20,260	6,160		6,160	3,410		3,410	1,863		1,863	5,273	31,693
1986-87	26,030		26,030	6,230		6,230	4,170		4,170	2,754		2,754	6,924	39,184
1987-88	24,270		24,270	7,050		7,050	3,990		3,990	2,173		2,173	6,163	37,483
1988-89	22,740		22,740	5,220		5,220	3,900		3,900	2,173		2,173	6,073	34,033
1989-90	20,279		20,279	5,736		5,736	4,110		4,110	1,929		1,929	6,039	32,054
1990-91	16,039		16,039	7,756		7,756	4,096		4,096	1,799		1,799	5,895	29,690
1991-92	22,180		22,180	6,894		6,894	4,172		4,172	1,552		1,552	5,724	34,798
1992-93	21,516		21,516	4,910		4,910	3,350		3,350	1,565		1,565	4,915	31,341
1993-94	15,482		15,482	5,524		5,524	2,794		2,794	1,309		1,309	4,103	25,109
1994-95	14,237	1,480	15,717	4,989		4,989	2,883		2,883	890		890	3,773	24,479
1995-96	12,426	4,170	16,596	5,107		5,107	3,760		3,760	2,010		2,010	5,770	27,473
1996-97	11,372	6,241	17,613	5,886		5,886	3,854		3,854	1,750		1,750	5,604	29,103
1997-98	8,173	8,306	16,479	3,771		3,771	3,677		3,677	1,504		1,504	5,181	25,431
1998-99	10,125	6,973	17,097	4,483		4,483	4,012		4,012	1,689		1,689	5,700	27,280
1999-00	11,172	7,460	18,632	6,010		6,010	4,028		4,028	1,707		1,707	5,735	30,377
2000-01	13,988	6,838	20,826	3,923		3,923	3,710		3,710	1,964		1,964	5,674	30,423
2001-02	12,724	7,276	20,000	5,459		5,459	3,961		3,961	2,232		2,232	6,193	31,652
2002-03	10,419	6,192	16,611	8,056		8,056	3,445		3,445	1,197		1,197	4,642	29,309
2003-04	9,304	3,669	12,973	6,089		6,089	3,876		3,876	2,092		2,092	5,968	25,030
2004-05	4,548	3,920	8,468	8,557		8,557	2,870		2,870	1,685		1,685	4,555	21,580
2005-06	5,997	4,249	10,246	7,259	1,450	8,709	1,042	921	1,963	330	254	584	2,547	21,502
2006-07	4,373	10,960	15,333	5,510	1,733	7,243	1,568	219	1,787	543	165	708	2,495	25,071
2007-08	3,662	10,954	14,616	4,468	2,452	6,920	3,467	1,284	4,751	1,283	475	1,758	6,509	28,045
2008-09	7,178	6,434	13,612	4,550	2,414	6,964	4,145	1,275	5,420	1,518	535	2,053	7,473	28,049
2009-10	9,661	7,620	17,281	5,495	2,037	7,532	2,596	1,775	4,371	659	470	1,129	5,500	30,313
2010-11	7,466	7,440	14,906	3,929	2,363	6,292	1,968	1,482	3,450	638	875	1,513	4,963	26,161
2011-12	3,651	6,682	10,333	4,646	103	4,749	1,785	1,527	3,312	814	678	1,492	4,804	19,886
2012-13	9,095	7,761	16,856	2,973	2,170	5,143	2,639	1,309	3,948	1,145	537	1,683	5,631	27,630
2013-14	5,464	13,399	18,863	4,088	3,902	7,990	4,125	286	4,410	2,398	191	2,588	6,999	33,852
2014-15	2,426	12,670	15,096	3,368	4,173	7,541	4,219	502	4,721	1,817	233	2,050	6,771	29,408
2015-16	1,520	12,820	14,340	3,102	3,350	6,452	3,483	982	4,465	1,814	462	2,276	6,741	27,533
2016-17	4,106	13,215	17,321	3,660	944	4,604	3,326	1,428	4,754	713	292	1,005	5,759	27,684
2017-18	2,492	12,309	14,801	3,786	3,064	6,850	2,988	119	3,106	1,013	23	1,036	4,142	25,793
TOTAL	1,055,585	189,037	1,244,622	267,344	30,155	297,499	193,838	13,108	206,946	67,939	5,190	73,129	280,075	1,822,196

(a) Prior to 10/1/71, water was purchased by the State, West Basin Water Association, local water interests, Zone II of the LA County Flood Control District and WRD. After 10/1/71, all purchases have been by WRD

(b) In 1970-71, purchases were shared by WRD and Zone II. After 10/1/71, all purchases have been by WRD

HISTORICAL AMOUNTS OF THE IN-LIEU PROGRAM

(in acre-feet)

WATER YEAR	CENTRAL BASIN	WEST COAST BASIN	TOTAL
1965-66	-	745	745
1966-67	-	851	851
1967-68	-	850	850
1968-69	-	850	850
1969-70	-	900	900
1970-71	-	881	881
1971-72	-	756	756
1972-73	-	901	901
1973-74	-	901	901
1974-75	-	400	400
1975-76	-	400	400
1976-77	-	400	400
1977-78	11,316	4,815	16,131
1978-79	9,723	8,655	18,378
1979-80	10,628	4,333	14,961
FISCAL YEAR			
1980-81	17,617	6,206	23,823
1981-82	14,050	4,833	18,883
1982-83	13,813	5,939	19,752
1983-84	29,216	12,524	41,740
1984-85	23,246	13,594	36,840
1985-86	15,505	10,627	26,132
1986-87	16,205	12,997	29,202
1987-88	15,518	12,893	28,411
1988-89	11,356	14,069	25,425
1989-90	16,858	12,293	29,151
1990-91	11,886	10,153	22,039
1991-92	13,000	6,104	19,104
1992-93	37,652	15,654	53,306
1993-94	83,488	26,093	109,581
1994-95	32,904	17,994	50,898
1995-96	37,517	13,816	51,333
1996-97	34,547	4,847	39,394
1997-98	22,995	7,335	30,330
1998-99	13,213	10,303	23,516
1999-00	18,799	3,479	22,278
2000-01	18,364	2,817	21,181
2001-02	11,931	8,789	20,720
2002-03	6,866	4,339	11,205
2003-04	-	-	-
2004-05	6,000	1,804	7,804
2005-06	7,475	2,414	9,889
2006-07	5,779	3,485	9,264
2007-08	-	-	-
2008-09	-	-	-
2009-10	-	-	-
2010-11	6,724	-	6,724
2011-12	7,815	-	7,815
2012-13	2,180	-	2,180
2013-14	4,371	-	4,371
2014-15	12,723	-	12,723
2015-16	-	-	-
2016-17	-	-	-
2017-18	-	-	-
TOTAL	601,281	272,040	873,321

Table C

HISTORICAL AMOUNTS OF REPLENISHMENT WATER FOR CENTRAL AND WEST COAST BASINS

(in acre-feet)

WATER YEAR	MONTEBELLO FOREBAY SPREADING WATER					INJECTION WATER*			IN-LIEU	TOTAL
	IMPORTED WATER	RECYCLED WATER	LOCAL WATER	MAKEUP WATER	TOTAL	IMPORTED WATER	RECYCLED WATER	TOTAL	TOTAL	
1959-60	80,900	-	20,064	-	100,964	3,700	-	3,700		104,664
1960-61	147,800	-	9,118	-	156,918	4,420	-	4,420		161,338
1961-62	208,122	1,178	39,548	-	248,848	4,460	-	4,460		253,308
1962-63	80,590	12,405	14,565	-	107,560	4,150	-	4,150		111,710
1963-64	104,900	13,258	9,992	-	128,150	10,450	-	10,450		138,600
1964-65	160,170	14,528	13,097	-	187,795	35,780	-	35,780		223,575
1965-66	121,700	15,056	45,754	6,500	189,010	47,760	-	47,760	745	237,515
1966-67	84,300	16,223	59,820	-	160,343	46,450	-	46,450	851	207,644
1967-68	95,400	18,275	39,760	-	153,435	43,790	-	43,790	850	198,075
1968-69	17,800	13,877	119,395	-	151,072	40,730	-	40,730	850	192,652
1969-70	68,900	17,158	52,917	-	138,975	33,220	-	33,220	900	173,095
1970-71	72,100	22,726	44,757	-	139,583	35,380	-	35,380	881	175,844
1971-72	34,400	21,999	17,688	-	74,087	40,100	-	40,100	756	114,943
1972-73	71,947	27,886	45,077	20,000	164,910	40,920	-	40,920	901	206,731
1973-74	68,237	23,452	29,171	23,921	144,781	41,510	-	41,510	901	187,192
1974-75	71,900	26,791	29,665	-	128,356	36,030	-	36,030	400	164,786
1975-76	50,800	27,687	22,073	-	100,560	44,250	-	44,250	400	145,210
1976-77	9,300	29,359	19,252	21,400	79,311	48,430	-	48,430	400	128,141
1977-78	39,900	25,722	147,317	7,800	220,739	39,400	-	39,400	16,131	276,270
1978-79	65,300	28,860	68,859	-	163,019	33,600	-	33,600	18,378	214,997
1979-80	10,200	29,406	106,820	10,900	157,326	36,660	-	36,660	14,961	208,947
1980-81	32,000	31,722	50,590	31,500	145,812	33,840	-	33,840	23,823	203,475
1981-82	4,600	34,052	47,930	30,900	117,482	33,900	-	33,900	18,883	170,265
1982-83	2,000	22,770	126,076	8,900	159,746	43,240	-	43,240	19,752	222,738
1983-84	1,500	32,241	60,710	20,800	115,251	38,080	-	38,080	41,740	195,071
1984-85	40,600	31,378	39,099	-	111,077	36,080	-	36,080	36,840	183,997
1985-86	21,500	29,279	66,966	-	117,745	29,830	-	29,830	26,132	173,707
1986-87	49,200	37,976	27,613	6,500	121,289	36,430	-	36,430	29,202	186,921
1987-88	23,300	43,349	50,068	5,800	122,517	35,310	-	35,310	28,411	186,238
1988-89	50,300	49,773	17,096	6,500	123,669	31,860	-	31,860	25,425	180,954
1989-90	52,700	50,109	9,388	13,600	125,797	30,125	-	30,125	29,151	185,073
1990-91	56,300	53,864	35,717	100	145,981	27,891	-	27,891	22,039	195,911
1991-92	43,100	46,903	136,357	-	226,360	33,246	-	33,246	19,104	278,710
1992-93	16,561	48,864	147,699	-	213,124	29,776	-	29,776	53,306	296,206
1993-94	20,411	53,981	55,896	-	130,288	23,800	-	23,800	109,581	263,669
1994-95	21,837	33,300	100,578	-	155,715	22,109	1,480	23,589	50,898	230,202
1995-96	18,012	53,862	62,920	-	134,794	21,293	4,170	25,463	51,333	211,590
1996-97	22,738	49,959	58,262	-	130,959	21,112	6,241	27,353	39,394	197,706
1997-98	952	37,017	96,706	-	134,675	15,621	8,306	23,927	30,330	188,932
1998-99	-	47,201	32,013	-	79,214	18,619	6,973	25,591	23,516	128,321
1999-00	45,037	43,270	20,607	-	108,914	21,210	7,460	28,670	22,278	159,862
2000-01	23,451	46,343	39,725	-	109,519	21,621	6,838	28,459	21,181	159,159
2001-02	41,268	60,596	18,607	-	120,471	22,144	7,276	29,420	20,720	170,611
2002-03	17,297	42,796	63,271	-	123,364	21,920	6,192	28,112	11,205	162,681
2003-04	27,520	44,925	30,467	-	102,912	19,269	3,669	22,938	-	125,850
2004-05	25,296	29,503	148,674	-	203,473	15,975	3,920	19,895	7,804	231,172
2005-06	33,229	42,022	60,377	-	135,628	14,298	6,620	20,918	9,889	166,435
2006-07	40,214	45,039	11,495	-	96,748	11,451	12,912	24,363	9,264	130,375
2007-08	1,510	39,767	54,518	-	95,795	11,597	14,690	26,287	-	122,082
2008-09	-	39,611	35,348	-	74,959	15,873	10,123	25,996	-	100,955
2009-10	26,286	55,731	35,398	-	117,415	17,752	11,432	29,184	-	146,599
2010-11	37,315	37,131	113,295	-	187,741	13,363	11,285	24,648	6,724	219,113
2011-12	-	55,797	36,155	-	91,952	10,082	8,312	18,394	7,815	118,161
2012-13	-	59,145	6,048	-	65,193	14,707	11,240	25,947	2,180	93,320
2013-14	-	55,646	-	-	55,646	13,677	17,587	31,263	4,371	91,280
2014-15	18,515	44,349	15,892	-	78,757	10,013	17,345	27,358	12,723	118,838
2015-16	23,961	57,811	14,183	-	95,956	8,105	17,152	25,257	-	121,213
2016-17	32,693	58,067	70,027	-	160,786	11,092	15,587	26,679	-	187,465
2017-18	9,792	56,689	5,125	-	71,606	9,266	15,492	24,758	-	96,364
TOTAL	**2,545,660**	**2,087,680**	**2,955,607**	**215,121**	**7,804,067**	**1,516,767**	**232,300**	**1,749,067**	**873,321**	**10,426,455**

** Does not include Alamitos Barrier water purchased by the Orange County Water District for the Orange County Basin*

HISTORICAL AMOUNTS OF GROUNDWATER PRODUCTION*

(in acre-feet)

WATER YEAR	CENTRAL BASIN	WEST COAST BASIN	TOTAL
1960-61	292,500	61,900	354,400
1961-62	275,800	59,100	334,900
1962-63	225,400	59,100	284,500
1963-64	219,100	61,300	280,400
1964-65	211,600	59,800	271,400
1965-66	222,800	60,800	283,600
1966-67	206,700	62,300	269,000
1967-68	220,100	61,600	281,700
1968-69	213,800	61,600	275,400
1969-70	222,200	62,600	284,800
1970-71	211,600	60,900	272,500
1971-72	216,100	64,800	280,900
1972-73	205,600	60,300	265,900
1973-74	211,300	55,000	266,300
1974-75	213,100	56,700	269,800
1975-76	215,300	59,400	274,700
1976-77	211,500	59,800	271,300
1977-78	196,600	58,300	254,900
1978-79	207,000	58,000	265,000
1979-80	209,500	57,100	266,600
1980-81	211,915	57,711	269,626
1981-82	202,587	61,874	264,461
1982-83	194,548	57,542	252,090
1983-84	196,660	51,930	248,590
1984-85	193,085	52,746	245,831
1985-86	195,972	53,362	249,334
1986-87	196,660	48,026	244,686
1987-88	194,704	43,837	238,541
1988-89	200,207	44,323	244,530
1989-90	197,621	48,047	245,668
1990-91	187,040	53,660	240,700
1991-92	196,400	56,318	252,718
1992-93	150,495	40,241	190,736
1993-94	156,565	41,826	198,392
1994-95	180,269	41,729	221,998
1995-96	182,413	52,222	234,636
1996-97	187,561	52,576	240,137
1997-98	188,305	51,859	240,164
1998-99	204,441	51,926	256,367
1999-00	198,483	53,599	252,082
2000-01	195,361	53,870	249,231
2001-02	200,168	50,063	250,231
2002-03	190,268	51,946	242,214
2003-04	200,365	48,013	248,378
2004-05	188,783	41,297	230,079
2005-06	191,123	36,808	227,931
2006-07	198,249	37,659	235,908
2007-08	206,296	38,472	244,768
2008-09	197,663	45,538	243,201
2009-10	197,390	44,013	241,403
2010-11	170,630	44,480	215,109
2011-12	195,820	45,597	241,417
2012-13	196,414	42,253	238,667
2013-14	199,549	42,502	242,051
2014-15	173,865	36,328	210,193
2015-16	184,016	30,849	214,865
2016-17	183,265	29,425	212,690
2017-18	188,515	32,181	220,697
TOTAL	**11,681,271**	**2,967,048**	**14,648,319**

* Numbers sometimes updated when pumping adjustments are required

HISTORICAL AMOUNTS OF DIRECT WATER USE IN THE WRD SERVICE AREA *

(all values in acre-feet)

YEAR	GROUNDWATER PRODUCTION	IMPORTED WATER FOR DIRECT USE**	RECLAIMED WATER FOR DIRECT USE**	TOTAL WATER	PERCENT GROUNDWATER
1960-61	354,400	196,800		551,200	64%
1961-62	334,900	193,000		527,900	63%
1962-63	284,500	237,739		522,239	54%
1963-64	280,400	261,961		542,361	52%
1964-65	271,400	291,659		563,059	48%
1965-66	283,600	258,774		542,374	52%
1966-67	269,000	283,882		552,882	49%
1967-68	281,700	342,111		623,811	45%
1968-69	275,400	343,125		618,525	45%
1969-70	284,800	401,151		685,951	42%
1970-71	272,500	390,428		662,928	41%
1971-72	280,900	418,215		699,115	40%
1972-73	265,900	423,952		689,852	39%
1973-74	266,300	390,906		657,206	41%
1974-75	269,800	364,437		634,237	43%
1975-76	274,700	386,601		661,301	42%
1976-77	271,300	331,744		603,044	45%
1977-78	254,900	366,273		621,173	41%
1978-79	265,000	329,195	100	594,295	45%
1979-80	266,600	391,481	200	658,281	40%
1980-81	269,626	258,493	300	528,419	51%
1981-82	264,461	290,329	300	555,090	48%
1982-83	252,090	356,640	400	609,130	41%
1983-84	248,590	386,334	1,800	636,724	39%
1984-85	245,831	402,371	2,000	650,202	38%
1985-86	249,334	395,050	2,400	646,784	39%
1986-87	244,686	437,916	2,300	684,902	36%
1987-88	238,541	441,240	3,500	683,281	35%
1988-89	244,530	430,805	5,300	680,635	36%
1989-90	245,668	417,471	5,900	669,039	37%
1990-91	240,700	457,647	5,000	703,347	34%
1991-92	252,718	369,178	4,900	626,796	40%
1992-93	190,736	357,440	824	549,000	35%
1993-94	198,392	458,617	3,413	660,422	30%
1994-95	221,998	412,492	6,076	640,566	35%
1995-96	234,636	404,335	15,195	654,166	36%
1996-97	240,137	412,856	19,984	672,977	36%
1997-98	240,164	356,671	18,719	615,554	39%
1998-99	256,367	371,164	23,429	650,960	39%
1999-00	252,082	391,385	26,050	669,516	38%
2000-01	249,231	370,568	25,836	645,636	39%
2001-02	250,231	381,333	31,404	662,967	38%
2002-03	242,214	402,200	32,085	676,500	36%
2003-04	248,378	405,400	32,691	686,469	36%
2004-05	230,079	345,689	30,189	605,957	38%
2005-06	227,931	350,834	30,918	609,683	37%
2006-07	235,908	364,371	32,795	633,074	37%
2007-08	244,768	336,167	33,991	614,926	40%
2008-09	243,201	304,720	35,501	583,422	42%
2009-10	241,403	266,778	35,750	543,932	44%
2010-11	215,109	269,992	32,098	517,199	42%
2011-12	241,417	272,496	35,607	549,520	44%
2012-13	238,667	290,700	37,433	566,801	42%
2013-14	242,051	289,439	42,939	574,429	42%
2014-15	210,193	279,342	35,670	525,205	40%
2015-16	214,865	215,653	35,323	465,841	46%
2016-17	212,693	230,834	37,155	480,682	44%
2017-18	220,697	252,911	36,863	510,471	43%
TOTAL	**14,648,322**	**20,041,297**	**762,340**	**35,451,959**	**41%**

** - Does not include any replenishment water, as this Table relects direct use of water by people/industry/agriculture*

*** - All values reviewed and updated in the 2018 ESR by removing replenishment water and reviewing Watermaster reports*

FIGURES

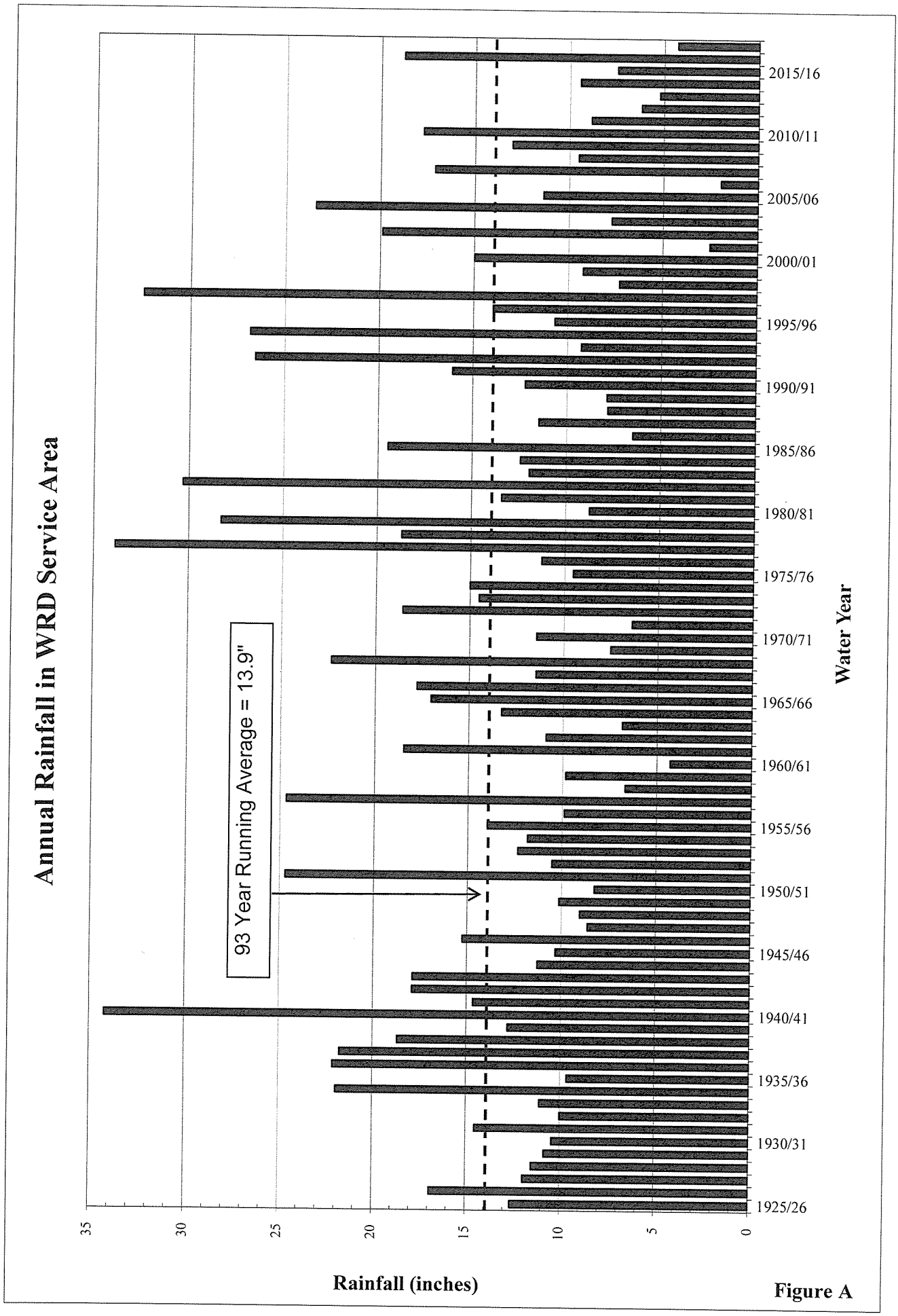
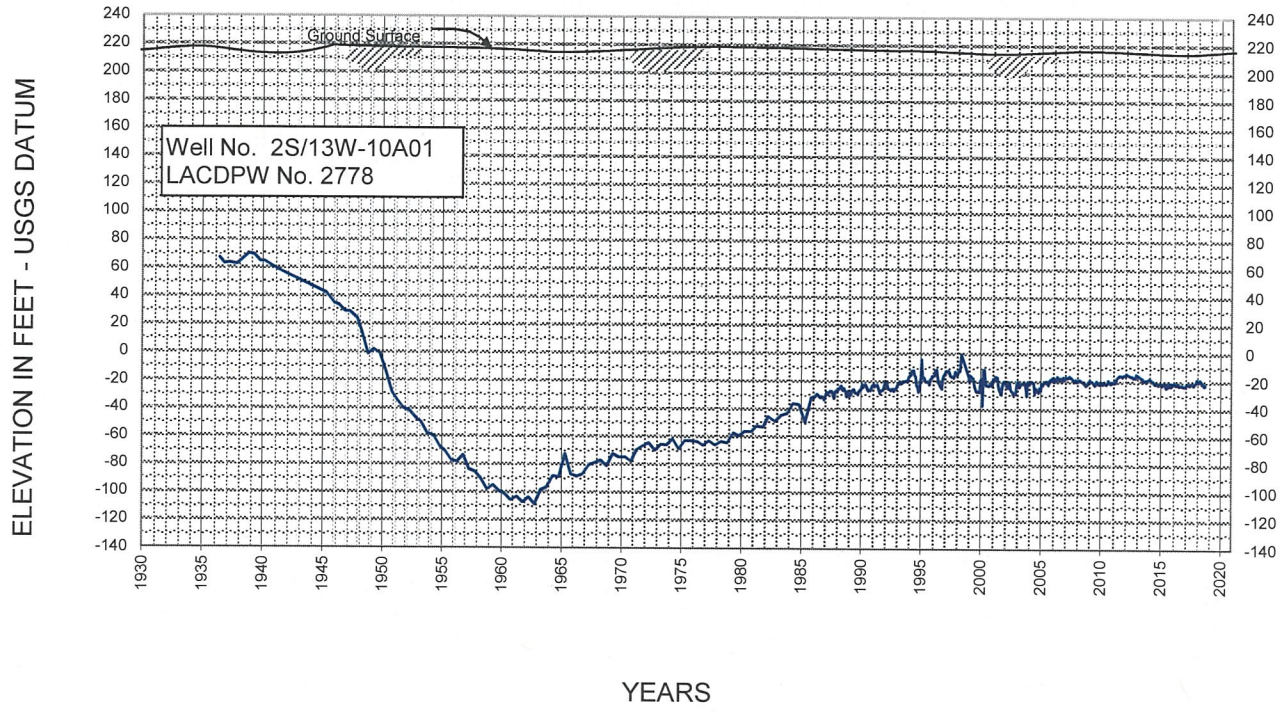
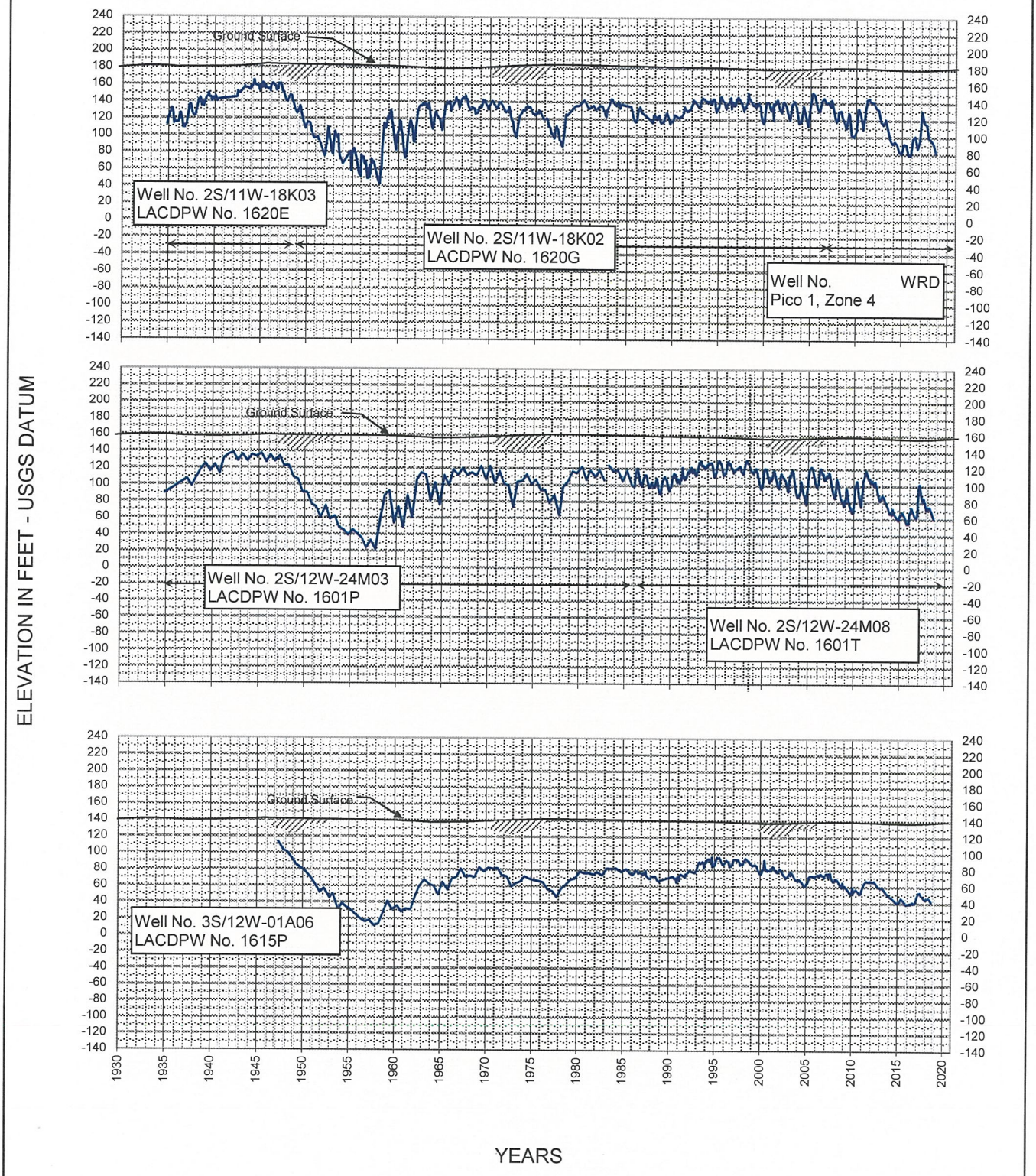

Annual Rainfall in WRD Service Area
93 Year Running Average = 13.9"
Rainfall (inches)
Water Year
35
30
25
20
15
10
5
0
2015/16
2010/11
2005/06
2000/01
1995/96
1990/91
1985/86
1980/81
1975/76
1970/71
1965/66
1960/61
1955/56
1950/51
1945/46
1940/41
1935/36
1930/31
1925/26

Figure A



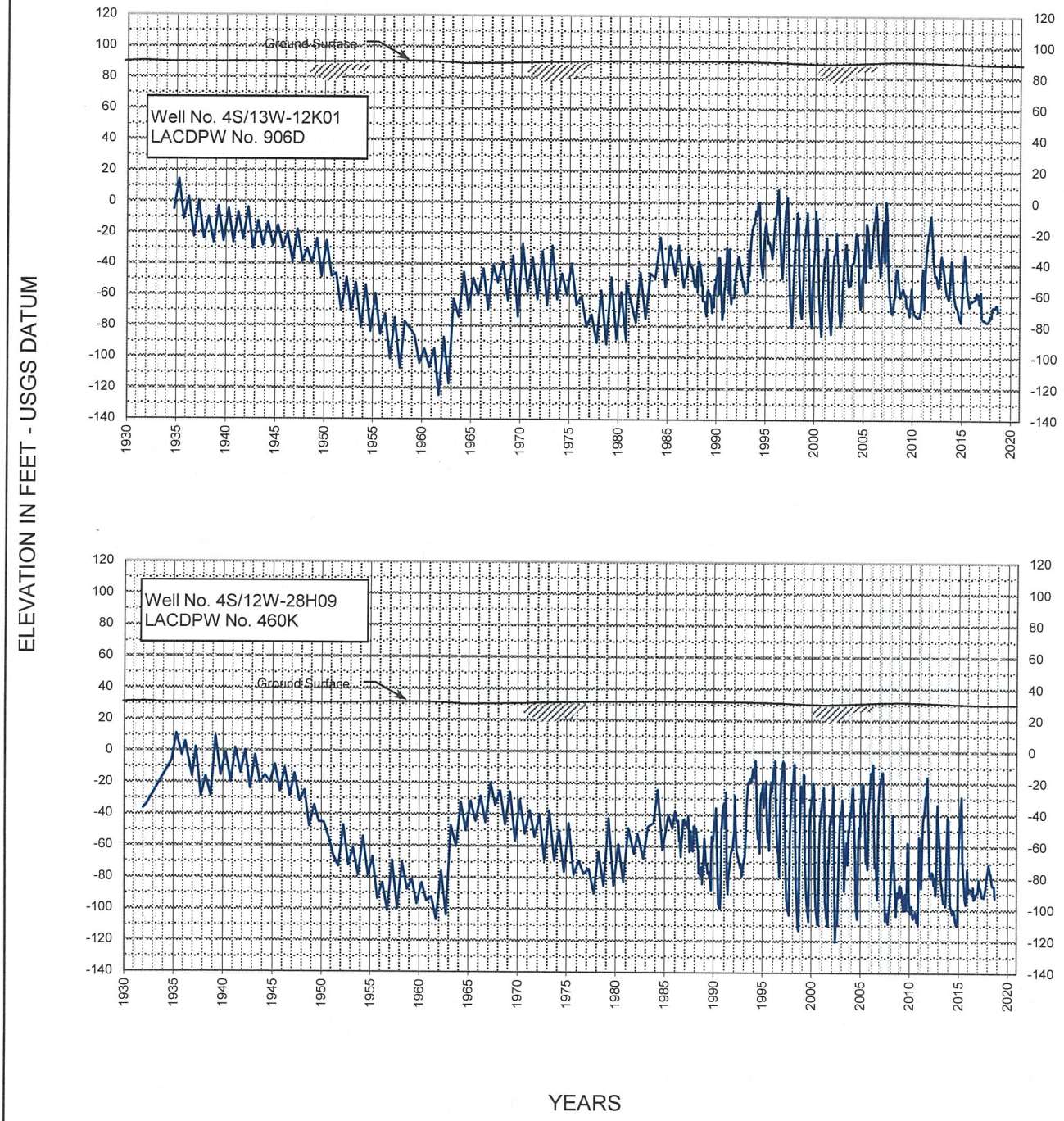
FLUCTUATION OF WATER LEVELS IN THE LOS ANGELES FOREBAY

Figure B



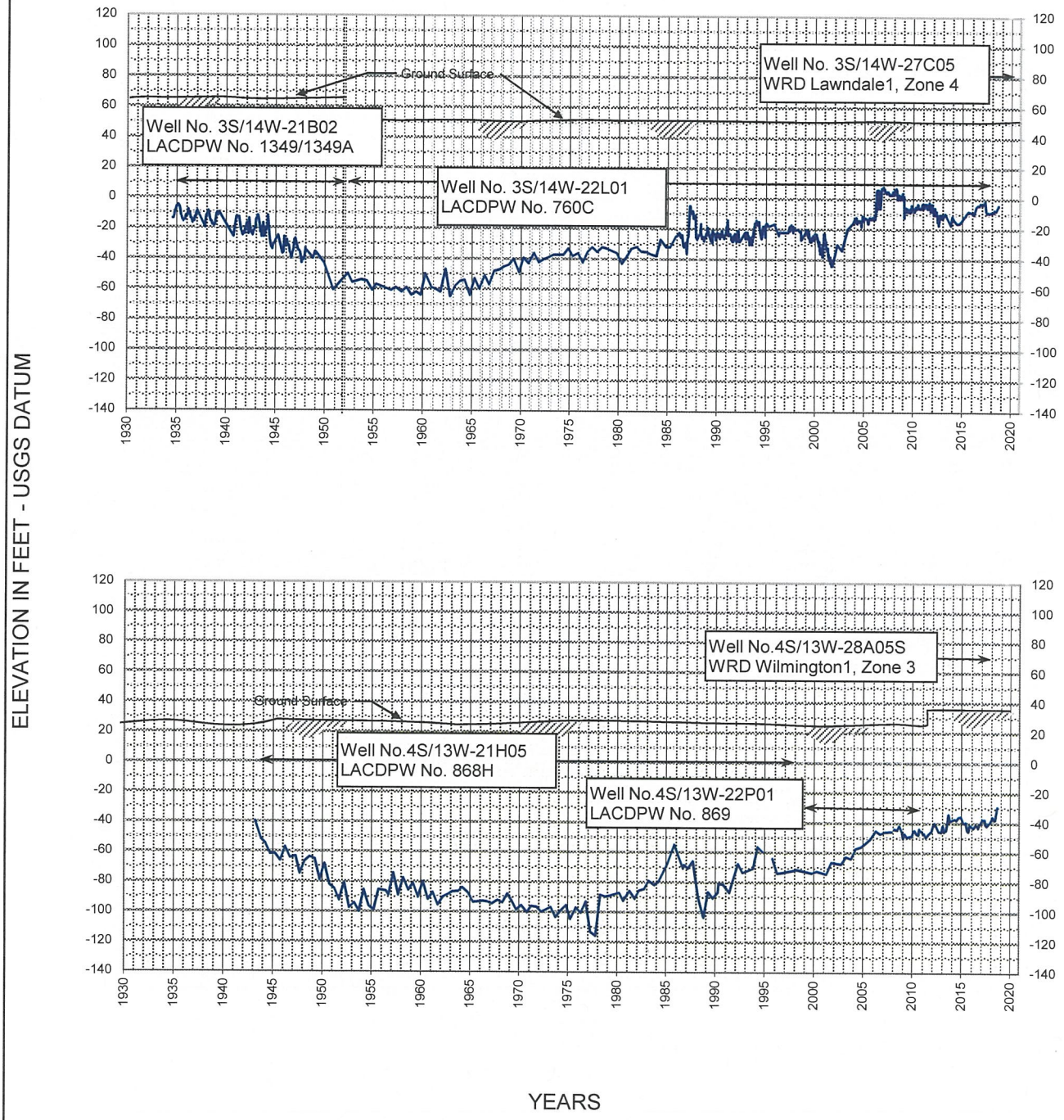
FLUCTUATION OF WATER LEVELS IN THE MONTEBELLO FOREBAY

Figure C



FLUCTUATION OF WATER LEVELS IN THE CENTRAL BASIN PRESSURE AREA

Figure D



FLUCTUATION OF WATER LEVELS IN THE WEST COAST BASIN

Figure E

PLATES

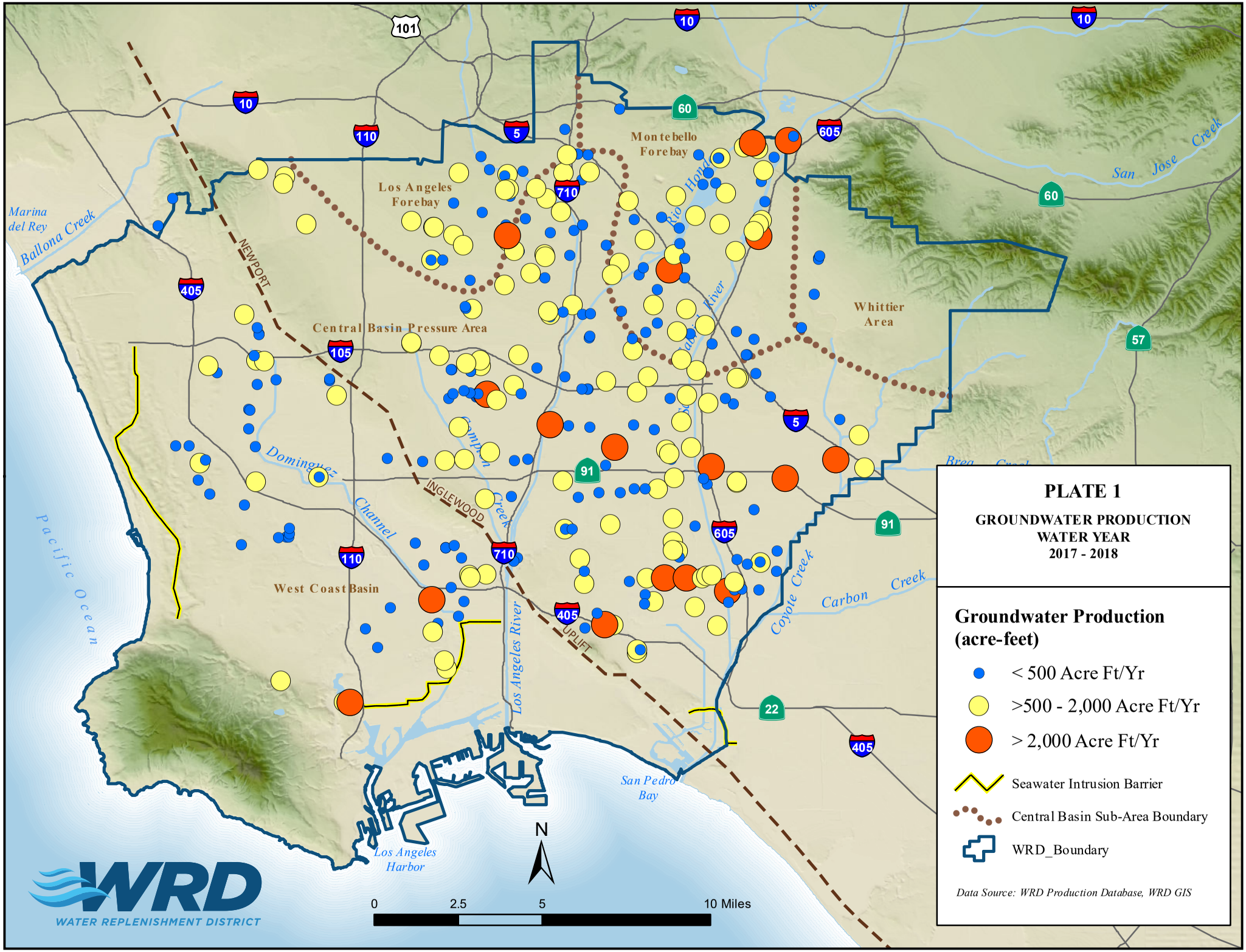


PLATE 1
GROUNDWATER PRODUCTION
WATER YEAR
2017 - 2018
Groundwater Production
(acre-feet)
< 500 Acre Ft/Yr
>500 - 2,000 Acre Ft/Yr
> 2,000 Acre Ft/Yr
Seawater Intrusion Barrier
Central Basin Sub-Area Boundary
WRD_Boundary
Data Source: WRD Production Database, WRD GIS
Montebello Forebay
Los Angeles Forebay
Central Basin Pressure Area
West Coast Basin
Whittier Area
Rio Hondo
San Gabriel River
Los Angeles River
Compton Creek
Dominguez Channel
Coyote Creek
Carbon Creek
San Jose Creek
Brea Creek
Marina del Rey
Ballona Creek
Pacific Ocean
San Pedro Bay
Los Angeles Harbor
NEWPORT
INGLEWOOD
UPLIFT
N
0
2.5
5
10 Miles
WRD
WATER REPLENISHMENT DISTRICT

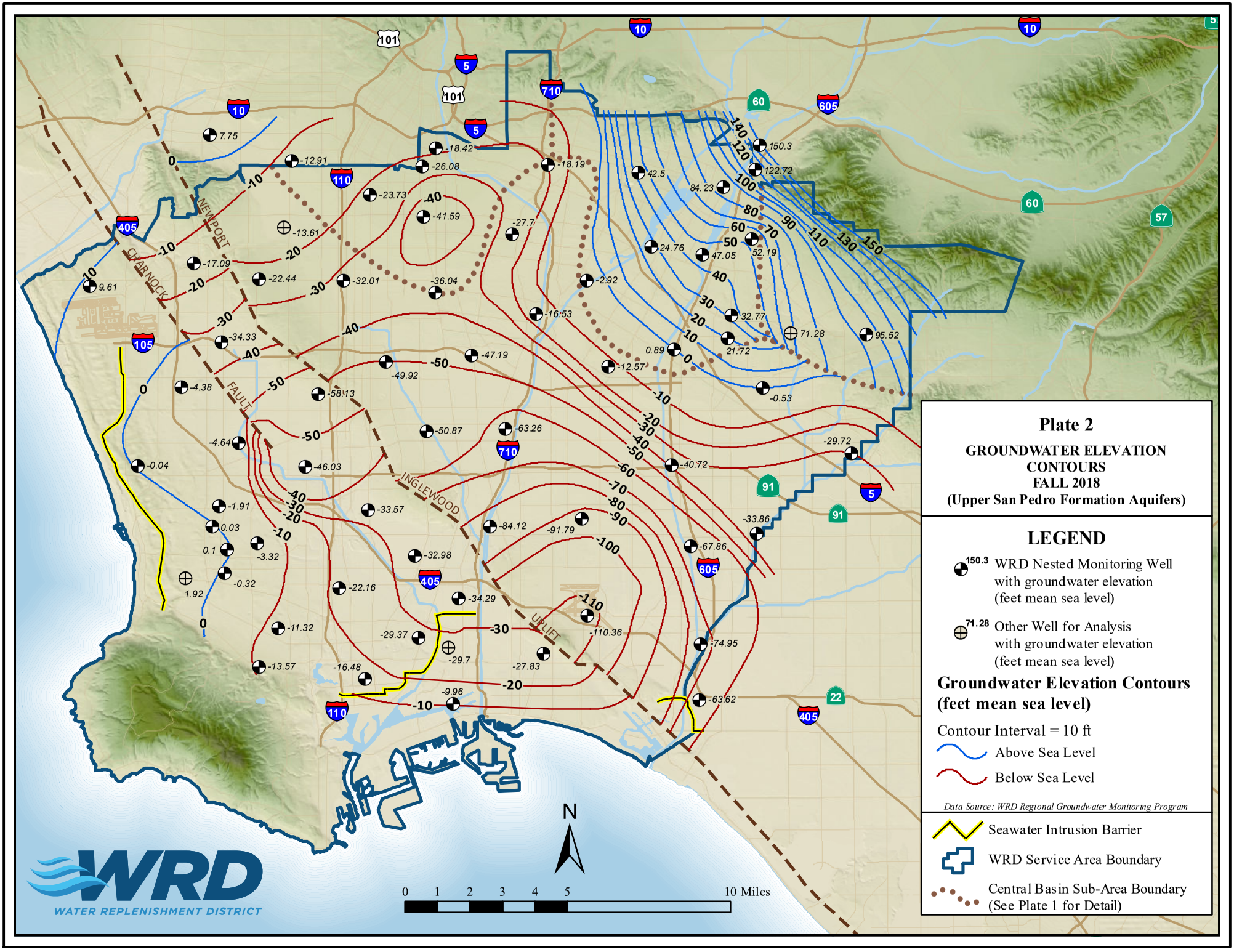


Plate 2
GROUNDWATER ELEVATION CONTOURS
FALL 2018
(Upper San Pedro Formation Aquifers)
LEGEND
150.3 WRD Nested Monitoring Well with groundwater elevation (feet mean sea level)
71.28 Other Well for Analysis with groundwater elevation (feet mean sea level)
Groundwater Elevation Contours (feet mean sea level)
Contour Interval = 10 ft
Above Sea Level
Below Sea Level
Data Source: WRD Regional Groundwater Monitoring Program
Seawater Intrusion Barrier
WRD Service Area Boundary
Central Basin Sub-Area Boundary (See Plate 1 for Detail)
NEWPORT
CHARNOCK
FAULT
INGLEWOOD
UPLIFT
N
0 1 2 3 4 5 10 Miles
WRD
WATER REPLENISHMENT DISTRICT

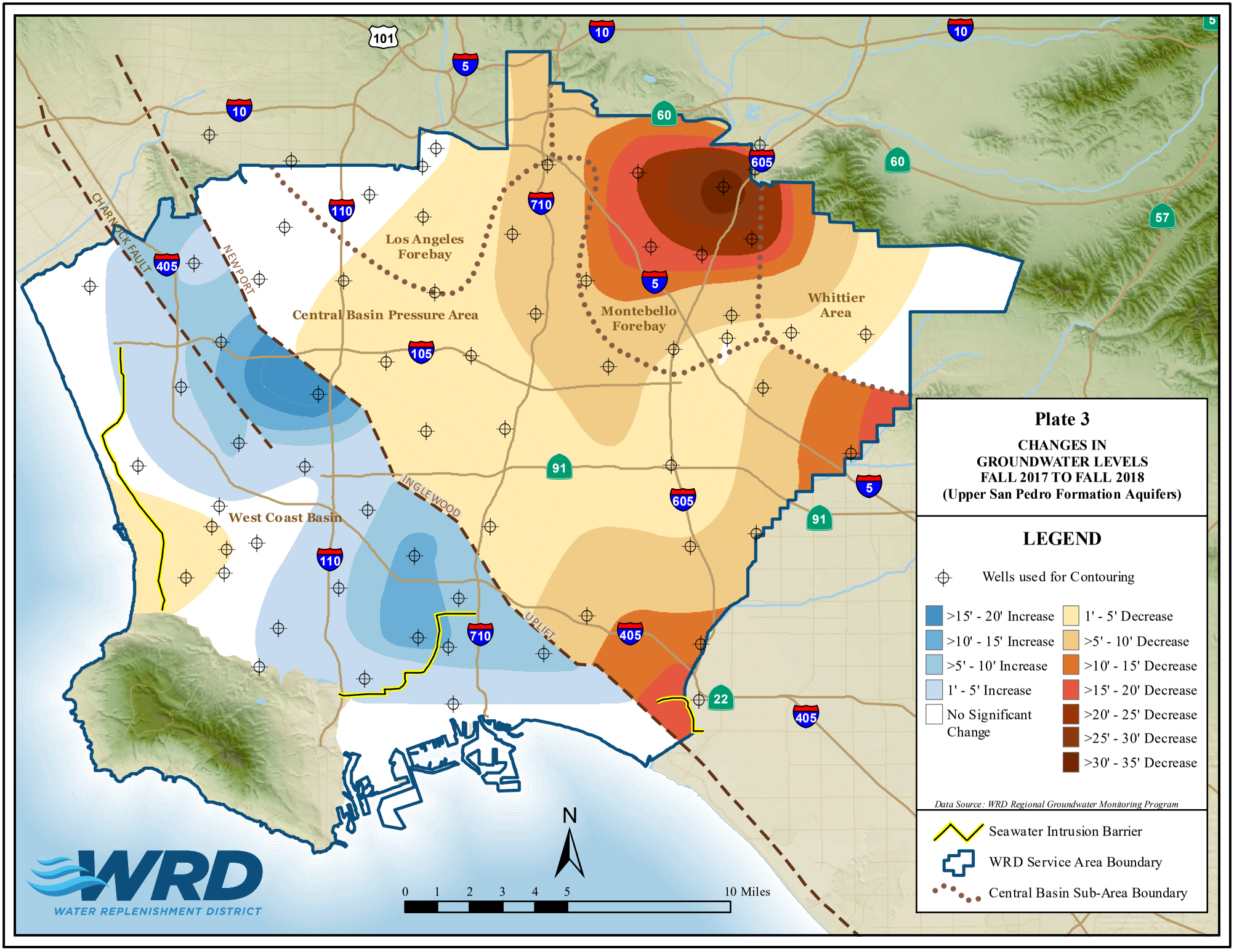


Plate 3
CHANGES IN
GROUNDWATER LEVELS
FALL 2017 TO FALL 2018
(Upper San Pedro Formation Aquifers)
LEGEND
Wells used for Contouring
>15' - 20' Increase
>10' - 15' Increase
>5' - 10' Increase
1' - 5' Increase
No Significant Change
1' - 5' Decrease
>5' - 10' Decrease
>10' - 15' Decrease
>15' - 20' Decrease
>20' - 25' Decrease
>25' - 30' Decrease
>30' - 35' Decrease
Data Source: WRD Regional Groundwater Monitoring Program
Seawater Intrusion Barrier
WRD Service Area Boundary
Central Basin Sub-Area Boundary
Los Angeles Forebay
Central Basin Pressure Area
Montebello Forebay
Whittier Area
West Coast Basin
CHARNOCK FAULT
NEWPORT
INGLEWOOD
UPLIFT
N
0 1 2 3 4 5 10 Miles
WRD
WATER REPLENISHMENT DISTRICT