Water Replenishment District of Southern California

Engineering Survey and Report

2017

March 2, 2017

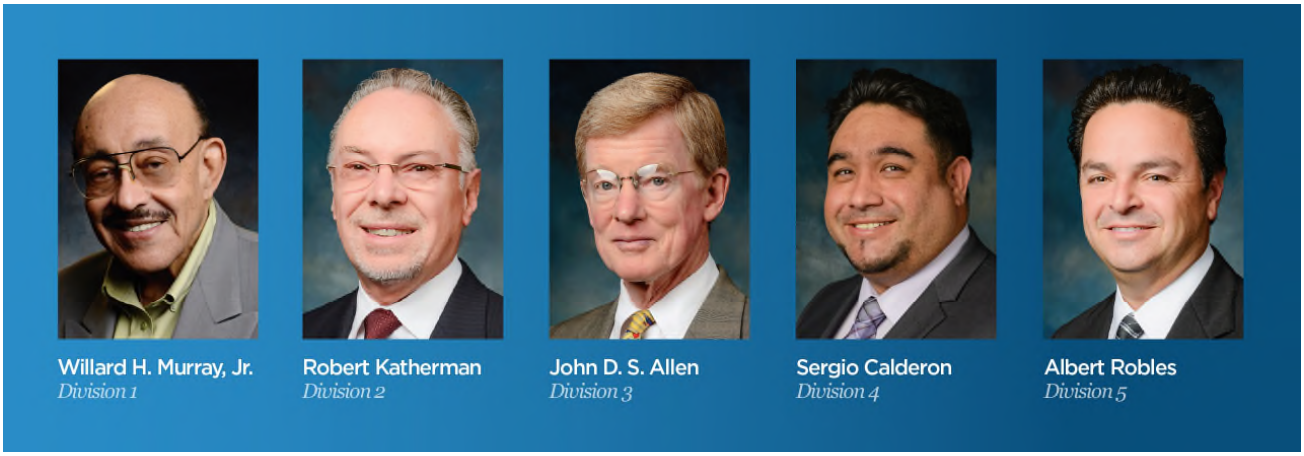
Updated:
April 27, 2017

WRD
WATER REPLENISHMENT DISTRICT
OF SOUTHERN CALIFORNIA

Water Replenishment District
Of Southern California

ENGINEERING SURVEY AND REPORT, 2017
Updated April 27, 2017

Board of Directors



Management Staff

Robb Whitaker, PE	General Manager
Ken Ortega, PE	Assistant General Manager
Ted Johnson, PG/CHG	Chief Hydrogeologist
Scott Ota, CPA	Chief Financial Officer
H. Francisco Leal	Interim District Counsel

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
Chief Hydrogeologist

PROFESSIONAL GEOLOGIST
THEODORE A. JOHNSON
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CERTIFIED HYDROGEOLOGIST
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WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

MEMORANDUM

DATE: APRIL 27, 2017

TO: INTERESTED PARTIES

FROM: ROBB WHITAKER, GENERAL MANAGER

SUBJECT: UPDATED 2017 ENGINEERING SURVEY AND REPORT

The Water Replenishment District of Southern California ("WRD" or "District") is the groundwater management agency responsible for safe and reliable groundwater in the Central Basin and West Coast Basin in southern coastal Los Angeles County. Groundwater constitutes nearly 50% of the total water demand used by the 4 million residents and businesses in the 43 cities in the WRD service area.

On March 2, 2017, WRD completed an Engineering Survey and Report ("ESR") as required by the California Water Code (Section 60300) to present information on the past, current, and anticipated future conditions in the two groundwater basins within the District's service area. Information is presented on groundwater pumping, groundwater conditions (water levels, overdraft, changes in storage), projects related to groundwater supply and quality, and the amount, sources, and cost of replenishment water needed to balance the annual pumping overdraft.

According to Water Code Section 60305, the ESR must be completed by March of each year. However, the annual Replenishment Assessment ("RA") on groundwater production is not typically adopted until April or May of each year. During the time frame between the March ESR and the adoption of the RA, new and updated information is sometimes received that results in necessary edits to the ESR after adoption of the RA. To document any changes, the District publishes an updated ESR following adoption of the RA. This April 27, 2017 ESR updates and replaces the earlier March 2, 2017 report and contains the latest information on replenishment water sources and costs within the District.

Updated information includes the following:

- On April 27, 2017, the WRD Board of Directors adopted the 2017/2018 Fiscal Year budget, which lowered the estimated ensuing year pumping amount from 228,000 AF as presented in the March ESR to 217,300 acre feet (AF). This reduction was based upon discussions with groundwater producers, who anticipated lower production amounts from continued

conservation efforts and use of more surface water due to surpluses in the coming year. The adjusted pumping amount has been incorporated into this updated ESR.

- Also at the April 27, 2017 Board of Directors meeting, the adopted budget included a reduction in the anticipated cost of replenishment water to account for an increased amount of recycled water for the spreading grounds (63,000 AF) and a corresponding decrease in the amount of the more expensive imported water for the spreading grounds (8,000 AF). This brought the water replenishment costs down from $42.6 million to $39.7 million, a reduction of $2.9 million. The revised water purchase estimates have been incorporated into the updated ESR.

- No other significant changes were made to the report.

On April 27, 2017, the WRD Board of Directors adopted the 2017/2018 RA at $318 per AF of groundwater pumped within the WRD Service area, which is a 7.1% increase from the current rate of $297. The increase is related to the reduction in groundwater pumping within the District with a resulting reduction in necessary revenues, even with a lowering of water purchase costs. This rate was recommended by the District's Budget Advisory Committee, an independent group of seven members from the groundwater pumping community who review the District's proposed budget in detail and makes recommendations to the Board of Directors. The new RA will go into effect July 1, 2017 and will be in effect through June 30, 2018.

My staff and I welcome any comments or questions you may have regarding this updated ESR. Additional copies are available by calling the District at (562) 921-5521 or by downloading it from our web site at http://www.wrd.org. Thank you for your continued interest in groundwater conditions in the WRD Service Area.

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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
BAC	Budget Advisory Committee
BoS	Bureau of Sanitation (City of Los Angeles Dept. of Public Works)
CB	Central Basin
CBMWD	Central Basin Municipal Water District
CDPH	California Department of Public Health (now Division of Drinking Water)
CEC	Constituents of Emerging Concern
CEQA	California Environmental Quality Act
CHG	California Certified Hydrogeologist
CIP	Capital Improvement Program
CPI	Consumer Price Index
CBWCB	Central Basin and West Coast Basin
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)
GAC	Granular Activated Carbon
GIS	Geographic Information System
GRIP	Groundwater Reliability Improvement Project
IRWMP	Integrated Regional Water Management Plan
LACDHS	Los Angeles County Department of Health Services
LACDPW	Los Angeles County Department of Public Works (Flood Control)
LADWP	City of Los Angeles Department of Water and Power
LBWD	City of Long Beach Water Department
MAR	Managed Aquifer Recharge
Met	Metropolitan Water District of Southern California (aka “MWD”)
MCL	Maximum Contaminant Level
MF	Microfiltration
MFI	Modified Fouling Index

mgd	Million Gallons per Day
MOU	Memorandum of Understanding
msl	Mean Sea Level
MWD	Metropolitan Water District of Southern California (aka "Met")
NDMA	N-Nitrosodimethylamine
O&M	Operations and Maintenance
PG	California Professional Geologist
ppb	Parts Per Billion, equivalent to micrograms per liter (µg/L)
ppm	Parts Per Million, equivalent to milligrams per liter (mg/L)
PRC	Program Review Committee
PWRP	Pomona Water Reclamation Plant
RA	Replenishment Assessment
RO	Reverse Osmosis
RTS	Readiness-to-Serve Charge
RWQCB	Regional Water Quality Control Board
SAT	Soil Aquifer Treatment
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
TAC	Technical Advisory Committee
TITP	Terminal Island Treatment Plant
USGS	United States Geological Survey
USGVMWD	Upper San Gabriel Valley Municipal Water District
UV	Ultraviolet Light Treatment
VOC	Volatile Organic Compound
WAS	Water Augmentation Study
WBMWD	West Basin Municipal Water District
WCB	West Coast Basin
WCBBP	West Coast Basin Barrier Project
WIN	Water Independence Now program
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 updated 2017 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 from the Water Code, and **Plates 1**, **2** and **3** provide illustrations of pumping and groundwater conditions for the previous WY 2015/16.

1. Groundwater Production

- Adjudicated Amount: 281,835.25 acre-feet (AF)
- Previous Water Year (2015/16): 214,867 AF
- Current Water Year (2016/17): 216,700 AF (estimated)
- Ensuing Water Year (2017/18): 217,300 AF (estimated)

2. Annual Overdraft

- Previous Water Year: 110,600 AF
- Current Water Year: 61,500 AF (estimated)
- Ensuing Water Year: 82,800 AF (estimated)

3. Accumulated Overdraft

- Previous Water Year: 832,822 AF
- Current Water Year: 761,700 AF (estimated)

4. Groundwater Levels

Because of the fifth year of drought and below normal precipitation, WY 2015/16 saw a net loss of groundwater storage of 500 AF. However, this is not a significant amount and the basins were nearly balanced due to the reduction of pumping from the State-mandated water use restrictions and conservation measures, and the aggressive replenishment of recycled water and imported water by WRD to help make-up for the lack of natural replenishment.

Groundwater levels in the WRD service area over the previous WY ending September 30, 2016 fell on average only 1 foot, with the Montebello Forebay seeing a rise of 0.6 foot, the Los Angeles Forebay a drop of 2.6 feet, the Whittier Area a drop of 2.2 feet, the Central Basin Pressure Area a drop of 0.6 foot and the West Coast Basin a rise of 1 foot.

In the current WY 2016/17, through this writing the District has received over 15 inches of precipitation, which exceeds its normal full year amount of 13.9 inches causing groundwater levels to

rise significantly. In addition, WRD has been purchasing imported water and recycled water for additional recharge. As a result, water levels in the Montebello Forebay have risen nearly 40 feet and are within 20 feet of the pre-drought 2011 levels. The final determination of the WY 2016/17 change in storage will be calculated at the end of the WY in September. 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. Chapter 4 details the quantity of water that WRD plans to purchase in the ensuing year. A summary is as follows:

- Spreading Water: 71,000 AF (63,000 recycled; 8,000 imported)
- Seawater Barrier Water: 30,600 AF (4,140 AF imported; 26,460 AF recycled)
- In-Lieu Program Water: 0 AF (suspended due to lack of MWD seasonal water)
- Total Water: 101,600 AF

6. Source of Replenishment Water

The sources of replenishment water to the District for the ensuing year are detailed in Chapter 4. Discounted replenishment water from MWD has not been available for In-Lieu or spreading since October 2011. MWD has not adopted a new replenishment program or replenishment rate so for now WRD budgets for the more available and expensive Tier 1 water. In the current WY, the WRD is planning on purchasing 43,000 AF of Tier 1 water for replenishment; 16,000 AF for the regular annual purchase plus 27,000 AF of makeup water from previous years when the imported water was not available. For the ensuing year, it is currently assumed that Tier 1 water will be available. A summary of all of the sources of replenishment water available to WRD is as 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.

- Imported Water: Raw river water (untreated) Tier 1 is assumed to be available for spreading from MWD and its member agencies. For the seawater barrier wells, treated potable imported water Tier 1 is assumed to be available 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 101,600 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.

Using currently available information, the estimated cost of water to WRD for the ensuing year is $39,736,939. **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 per 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 basin's 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.

On April 27, 2017, the WRD Board of Directors adopted the 2017/2018 RA at $318 per acre foot (AF) of groundwater pumped within the WRD Service area, which is a 7.1% increase from the current rate of $297. This rate was the recommended rate by the District's Budget Advisory Committee, an independent group of seven members from the groundwater pumping community who review the District's proposed budget in detail and makes recommendations to the Board of Directors. The new RA will go into effect July 1, 2017 and will be in effect through June 30, 2018.

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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 2017*** 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 effective July 1, 2017 through June 30, 2018.

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 code refer generally to 'on or before certain Tuesdays', the Water Code (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 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 late April or May, new information is normally received that affects the findings presented in the March ESR. This new information is typically related to the amount of water and price that WRD expects to pay for replenishment water in the ensuing year. The final information used by the Board when they adopt the replenishment assessment is reflected in an updated ESR that is published after adoption of the replenishment assessment in late April or May. This report reflects the updated information.

On April 27, 2017, the WRD Board of Directors adopted the 2017/2018 RA at $318 per acre foot (AF) of groundwater pumped within the WRD Service area, which is a 7.1% increase from the current rate of $297. This rate was the recommended rate by the District's Budget Advisory Committee, an independent group of seven members from the groundwater pumping community who review the District's proposed budget in detail and makes recommendations to the Board of Directors. The new RA will go into effect July 1, 2017 and will be in effect through June 30, 2018.

CHAPTER 2 - GROUNDWATER PRODUCTION

Adjudication and Demand

Prior to the adjudication of groundwater rights in the early 1960s, annual production (pumping) reached levels as high as 259,400 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.

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 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 (2015/16), California was in its fifth year of serious drought, and the State required cutbacks in water use. That, along with additional conservation and other reasons for reduction in pumping by some purveyors, the groundwater production in 2015/16 was significantly lower than pre-drought averages and less than originally forecast. Total WY pumping in both basins totaled 214,867 AF, which was 16,133 AF less than the 231,000 AF anticipated at the start of the WY. In the CB, groundwater extractions totaled 184,018 AF and WCB totaled 30,849 AF. Because the adjudicated rights are 281,835.25 AF, there were about 66,968 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, 2016), groundwater production was 50,697 AF (44,282 AF in the CB and 6,415 AF in the WCB). This is 1,612 AF less than the same period of the year earlier (-3%). 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 Basin Watermaster Administrative Body and a review of the fiscal year to date pumping, the early forecast for total pumping for the entire WY is 216,700 AF (189,200 AF in the CB and 27,500 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 previous year, 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 the past two years. Therefore, recent averages may not be indicative of future pumping, especially since the current WY has above normal precipitation and the State is considering officially ending the drought declaration.

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 analysis, WRD is estimating the ensuing WY pumping at 217,300 AF. For the purposes of this ESR and replenishment assessment determinations, the 217,300 AF projection is Staff's best estimate at this time. Of this amount, 189,500 AF in estimated for the CB and 27,800 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 required 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 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 Engineering Survey and Report ("ESR") the following items related to groundwater conditions in the Central Basin and West Coast Basin ("CBWCB"):

1) Total groundwater production for the previous water year ("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 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 2015/16, natural inflows (storm water capture, areal recharge, and net groundwater underflow) totaled 104,316 AF and WRD added 110,051 AF of supplemental recharge water (imported and recycled) at the seawater barrier wells and spreading grounds. Total natural and artificial inflows, therefore, equaled 214,367 AF. Total pumping in the basins was 214,867 AF. The Annual Overdraft is the natural inflows minus total outflows, or 110,551 AF (rounded to 110,600 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 ran 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 year, the Annual Overdraft is estimated at 61,500 AF (lower than usual because of the wet year and reduced pumping) and for the ensuing year 82,800 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 the high WY of 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,

[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.

which cannot be accounted for under the language of the Water Code since it is considered saline water.

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 832,822 AF. For the current year, the Accumulated Overdraft is forecast to improve to 761,700 AF due to the above normal precipitation, the reduction in pumping, and the purchase of extra imported water for spreading (makeup water from previous years when it was not available). This could change if hydrology or pumping patterns or planned artificial replenishment activities vary considerably in the near future.

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 2016 (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 105 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.

<u>Los Angeles Forebay</u>

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 2015/16, groundwater levels were at an elevation of 22.6 feet below msl and were 0.6 feet lower than the previous year. The average water level change throughout the entire Los Angeles Forebay based on WRD's GIS analysis was a drop of 2.6 feet.

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 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 2015/16, groundwater levels in this well were at an elevation of 86.6 feet above msl and were 7.6 feet higher than the previous year.

- Well 1601T (2S/12W-24M08) is centrally located between the Rio Hondo and San Gabriel 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 2015/16, groundwater levels in this well were at an elevation of 61.7 feet above msl and were 5.8 feet higher than the previous year. So far in the current WY, water levels have risen nearly 40 feet due to above normal precipitation and imported water purchased by WRD for spreading.

- 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 from the spreading grounds and the recharge that occurs 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 2015/16, groundwater levels were at an elevation of 40.1 feet above msl and were 1.4 feet lower than the previous year.

The average water level change throughout the entire Montebello Forebay during the previous WY was a rise of 0.6 feet.

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, and falling when the pumps come on.

At the end of WY 2015/16, groundwater levels in well 906D were at an elevation of 59.1ft below msl and were 4.9 feet higher than the previous year. Water levels in well 460K were at an elevation of 90.9 ft below msl and were 5.7 feet higher than the previous year. The average water levels change throughout the entire Central Basin Pressure Area during the previous WY was a drop of 0.6 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 patters 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 2015/16, water levels in well Lawndale1_4 were at an elevation of 4.2 ft below msl and were 4.0 feet higher than the previous year. Water levels in well Wilmington1_3 were at an elevation of 43.4 ft below msl and were 2.4 feet lower than the previous year. Over the entire West Coast Basin during the previous WY, the average water level change was a rise of 1 foot.

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) 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. Over the past WY, the groundwater levels fell on average 2.2 feet in the Whittier Area.

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

Because of the fifth year of drought and below normal precipitation, WY 2015/16 saw a net loss of groundwater storage of 500 AF. However, this is a small amount and the basins were nearly balanced due to the reduction of pumping from the State-mandated water use restrictions and conservation measures, and the aggressive replenishment of recycled water and imported water by WRD to help make-up for the lack of natural replenishment. Groundwater levels in the WRD service area fell on average only 1.2 foot during the previous WY, which resulted in only the small storage loss.

In the current WY 2016/17, through this writing the District has received over 15 inches of precipitation, which exceeds its normal full year amount of 13.9 inches causing groundwater levels to rise significantly. In addition, WRD has been purchasing imported water and recycled water for additional recharge. As a result, water levels in the Montebello Forebay have risen nearly 40 feet and are within 20 feet of the pre-drought levels last seen in May 2011. Because the current groundwater levels in the CBWCB are within historic ranges and the anticipated replenishment activities by WRD will continue as planned, 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 in 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 Geographic Information System (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.

As discussed above, in WY 2015/16 there was a slight decrease in water levels in the District (1.2 feet), although rises occurred in some areas and drops in others. The result was a net decrease in groundwater storage of 500 AF, which is nearly a balanced basin. **Table 8** provides the historical groundwater storage changes in the CBWCB. Based on the groundwater recharge occurring in the current WY due to above normal precipitation and the imported and recycled water being purchased by WRD, it is expected that the groundwater basins will gain storage in the current WY.

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 1999/00 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 2015/16 was 832,822 AF, or 220,800 AF below the Optimum Quantity. Based on the groundwater recharge occurring in the current WY due to above normal precipitation and the imported and recycled water being purchased by WRD, it is expected that the AOD will be reduced and be closer to the Optimum Quantity by the end of the WY.

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

As discussed in the previous chapter, the Central Basin and West Coast Basin ("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 water year ("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 ("WRP"s). 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 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 (DWP). MWD sells this water as-is (untreated raw river water) or after treatment into potable water 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 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 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 behind the Whittier Narrows Dam in the Whittier Narrows Reservoir. Owned 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.

Since 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 recycled water for spreading to meet regulatory limits. However, with the recent modifications to the District's permit to allow 45% recycled water over a running 10-year average (see below under Expected Availability of Replenishment Water), the District can now target 55,000 AFY of recycled water as long as sufficient dilution water is available from storm water and imported water. However, for the ensuing year, and based on recent amounts, the District is targeting 63,000 AF for WY 2017/18.

Additional replenishment water is needed beyond the recycled water and will have to come from imported water until the District's Groundwater Reliability Improvement Project (GRIP) project is completed. In 2003, the WRD Board adopted the long term average of 27,600 AFY of imported water to purchase for spreading. This value was based on long-term (30 year) averages of the overall water budget of the basins using the USGS computer model. The 2003 ESR discusses the derivation of this value in more detail.

Since that time, the District has invested in cooperative projects with the LACDPW to capture more storm water and to lessen the need for imported water as part of WRD's WIN initiative. Improvements to the Whittier Narrows Conservation Pool are expected to conserve an additional 3,000 AFY of storm water on average. Two new rubber dams were built in the San Gabriel River near Valley Boulevard and are expected to conserve an additional 3,600 AFY on average. And with the revisions to the recycled water permit discussed in the previous paragraph, 5,000 additional AF of recycled water can be planned thus lowering imported water by 5,000 AFY. Therefore, the new Long Term Average for imported spreading demands is 16,000 AFY. However, due to recent improvements in recycled water deliveries and a wet winter to allow dilution credits, the District will target only 8,000 AF of imported water for the ensuing year. .

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 estimated 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 17,200 AF, of which the majority (15,480 AF) will be advanced treated recycled water from WBMWD's Edward C. Little Water Recycling Facility and the remaining 1,720 AF will be Tier 1 treated imported water. For the Dominguez Gap Barrier Project, a total of 8,000 AF is expected to be needed, of which 7,200 AF will be advanced treated recycled water from the City of Los Angeles' Terminal Island Treatment Plant and 800AF will be Tier 1 treated imported water. For the Alamitos Barrier Project, a total of 5,400 AF will be required by WRD (does not include barrier water purchased by Orange County Water District for their side of the barrier), which includes 3,780 AF of advanced treated recycled water from the expanded Leo J. Vander Lans Water Treatment Facility plant and 1,620 AF of Tier 1 treated imported water.

The total barrier demand for WRD in the ensuing year is estimated at 30,600 AF, including 4,140 AF imported water (14%) and 26,460 AF of recycled water (86%) (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 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 63,000 AF of recycled water in the ensuing year, although this amount can vary based on percentage limits and availability of the recycled water and the spreading grounds.

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, under their relatively new Phase V construction improvements.

Recycled water for the DGBP is typically available from the City of Los Angeles' Terminal Island Treatment Plant (Harbor Recycled Water Project). The plant in 2016 was permitted by the Los Angeles Regional Water Quality Control Board to provide the barrier with 100% recycled water. As plant improvements come online, it is expected to ramp up to 100% recycled water in the near future.

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. However, due to some temporary operational constraints and the shutting down of the plant for a period of time, it has not yet been able to provide 100% recycled water to the barrier. It is expected to ramp up to that amount in the future.

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.

For the imported water used for injection at the seawater barrier wells, the District has paid the treated Tier 1 rate for decades to ensure availability. Because of the increasing price of Tier 1 water, the District is looking at ways to reduce costs, including full use of recycled water. All three barriers are expected to be operating at or near 100% recycled water by 2018.

Projected Cost of Replenishment Water

WRD has estimated it will need 101,600 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.

Using currently available information and estimates for the cost of replenishment water to WRD in the ensuing year, the estimated cost of water is $39,736,939. **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) on or before the second Tuesday in May.

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 Water Treatment Facility provides advanced treated recycled water to the Alamitos Seawater Intrusion Barrier. The facility receives tertiary-treated water from the Sanitation Districts and provides the advanced treatment through a process train that includes microfiltration (MF), reverse-osmosis (RO), and ultraviolet light (UV). The facility's operations permit was approved by the Los Angeles Regional Water Quality Control Board ("RWQCB") on September 1, 2005, and the replenishment operations of this facility started in October 2005. The product water has since been discharging to the barrier to replace up to 50% of the potable imported water formerly used, thereby improving the reliability and quality of the water supply to the barrier. The plant has been producing 3 million gallons a day ("MGD") for delivery to the barrier. The Long Beach Water Department ("LBWD") is responsible for operation and maintenance of the treatment plant 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 the expanded facility. It is capable of providing up to 100% of the barrier demand with advanced treated recycled water, thereby eliminating altogether the need for imported water. The facility expansion added unique treatment process enhancements to reduce the facility's waste generations. The process enhancements include (1) a third-stage RO to increase recovery from the original 85% to 92.5%; and (2) a MF backwash waste treatment system that recovers approximately 95% of the backwash waste stream through dissolve air flotation (DAF) treatment and a follow-up polishing MF. With these process enhancements, the facility has been expanded to almost triple the production capacity without any increases in waste generations.

The District is currently conducting an engineering study to optimize the seawater barrier and LVLWTF Operations. The goal of this study is to optimize operational and flow equalization strategies to allow consistent and stable 24/7 operations with minimum shutdowns.

Expected costs for the coming year will involve operation and maintenance of the plant, groundwater monitoring at the barrier, and improvements to optimize facility operations based on the engineering study. The primary purpose of this project is to maintain the integrity of the Barrier and provide a more reliable means of replenishing the basins through injection. This program is funded 100% from the Replenishment Fund.

002 – Robert W. Goldsworthy Desalter Project

The Robert W. Goldsworthy Desalter has been operating since 2002 to remove brackish groundwater from a saline plume in the Torrance area that was stranded inland of the West Coast Basin Barrier after the barrier was put into operation in the 1950s and 1960s. The production well and desalting facility are located within the City of Torrance (City), and the product water is delivered for potable use to the City's distribution system. The treatment plan capacity is about 2,200 AFY. The City is responsible for operation and maintenance of the treatment plant under contract with WRD.

The District started construction for expanding the Goldsworthy Desalter in January 2016 and expects to complete the construction in summer 2017. The expansion project includes an increase of treatment capacity to a total 4,800 AFY, the addition of two new source water wells, and associated conveyance pipelines and pump stations. The purpose of the desalter expansion is directly related to remediating degraded groundwater quality and costs will be funded through WRD's Capital Improvement Program. Expected costs for the coming year will involve capital improvements for the plant expansion as well as operation and maintenance of the plant. The major upcoming activities involve completing the startup testing of the expanded Desalter and the follow-up first year operations.

Additional measures may be necessary in the future to fully contain and remediate the saline plume, which extends outside of the Torrance area. WRD is conducting a water master plan on the West Coast Basin for long-term solutions to this problem. The District continues to work with the City of Torrance Municipal Water Department, the pumpers' Technical Advisory Committee, and other stakeholders on the future of the saline plume removal in the West Coast Basin.

004 – Recycled Water Program

Recycled water or 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 increasing 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. A recent research conducted at the test basin adjacent to the spreading grounds augmented past research efforts by characterizing the percolation process and by 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.

Three separate groundwater tracer studies were performed in 2003-2005, 2005-2006, and 2010-2011 for the purpose of tracking and verifying the movement of recycled water from the spreading grounds by testing the monitoring wells and the production wells. Results showed that the depth rather than the horizontal distance from the recharge ponds is the key factor influencing arrival times of recycled water to wells. Travel time to deeper wells is greater than to shallower wells, even if the deeper wells are located much closer to the spreading grounds than shallower wells. In some cases, WRD made modifications to wells to seal off their shallow perforations so that the wells would only produce from the deeper aquifers. Tracer tests conducted subsequent to well modification demonstrated an increased travel time compared to earlier results. These efforts, in addition to periodic studies assessing health effects and toxicological issues, are necessary to provide continued assurances that the use of recycled water for groundwater recharge remains safe and compliant with all regulatory standards.

In response to the prolonged drought, WRD worked closely with the regulatory agencies to allow a greater amount of recycled water to be used for spreading at the Montebello Forebay Spreading Grounds, through an amendment of the existing permit in 2014. This amendment allows WRD to continue to utilize recycled water even when storm water and imported water become scarce or unavailable. As required by the permit amendment, WRD will implement additional monitoring when the recycled water contribution reaches forty percent. In addition, WRD, in concert with other stakeholders, worked closely with the State Water Resources Control Board's Division of Drinking Water (DDW; formerly, California Department of Public Health) to review, update, and help shape the regulations on groundwater recharge using recycled water, which became effective in June 2014. As required by the 2014 groundwater recharge regulations, WRD and SDLAC prepared and submitted for approval by DDW a comprehensive report assessing the compliance of the Montebello Forebay Groundwater Recharge Project with the various requirements of the 2014 regulations.

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 Districts' 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 for 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 provided that percentage by 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 extensive 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 (Plan) will be further evaluated through series of pumper workshops and focused meetings with basin stakeholders and prospective project proponents. These workshops and meetings, facilitated by District staff, will further the development of available groundwater storage to reduce the region's demand for imported water.

Under this program, District staff will continue to monitor state and federal funding programs to determine applicability to the District's list of prospective projects. In the coming year, the District will continue participation in Integrated Regional Water Management Planning ("IRWMP") for Greater Los Angeles County. Collaborative development of the region's IRWM plan 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 assumed responsibility for the Central Basin 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 ("UCMR") 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 ("MOU") 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 48 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 2016, WRD submitted a Prop 1 grant application 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 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 228 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, water level data, water quality information, well construction data, production data, aquifer locations, and computer model files. 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 selected users. This web site provides these users with limited access to WRD's water quality and production database.

District staff will continue to streamline and refine the existing data management system and website 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 over 50 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 over 320 WRD and USGS-installed monitoring wells at over 58 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 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" on a case by case basis such as perchlorate, n-nitrosodimethylamine ("NDMA"), hexavalent chromium, 1,4-dioxane, 1,2,3-trichloropropane, pharmaceuticals and personal care products, and other chemicals of emerging concern. Water levels are measured in most monitoring wells with automatic data loggers daily, while water levels in all monitoring wells are 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 and semi-annual data collection, well and equipment maintenance, and annual reporting activities. Work associated with the Regional Groundwater Monitoring Program 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 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 approaching the construction phase. 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 7 participants in the DAC Outreach Assistance Program. Through the District's program, one of the participants has received State funding for their project and the remaining six 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 (DGB). 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 DGB injection project was originally permitted by LARWQCB 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 DGB. Water quality requirements, including turbidity and modified fouling index (MFI), must also be satisfied to minimize potential fouling of DGB 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 DGB, 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.

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. Currently, the District needs about 20,140 AF of imported water for recharge; 16,000 AF for spreading and 4,140 AF for injection at the seawater barriers. 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. Working with the Army Corps of Engineers and LACDPW on additional improvements to the Whittier Narrows Conservation Pool will allow capture of more stormwater, as will development of Montebello Forebay projects to lower the water table through increased pumping and delivery downgradient to free up underground space to capture more storm water and/or recycled water. WRD has submitted a request to the Army Corps of Engineers for a temporary deviation for the Whittier Narrows Conservation Pool to increase the operational water surface elevation (WSE) from 201.6 feet to 205 feet for three years beginning WY 2015-16. During this period, WRD will pursue a permanent Army Corps of Engineers operational change from WSE 201.6 feet to WSE 205 feet.

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 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. During this past fiscal year, the District completed the preparation of the Montebello Forebay Spreading Grounds Operation Model (MFSGOM). The model allows assesses alternative operating scenarios that could further enhance recharge at the spreading ground including the additional infrastructure improvements. 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 MFSGOM to evaluate and prioritize future improvement projects.

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. In 2013, WRD obtained extensive seismic reflection data which is being analyzed along with other seismic reflection data obtained by the USGS to help fill in gaps in the geologic structure. 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. The seismic reflection data licensed by WRD in 2013 will also be incorporated into the model. 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 2017.

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 September 2014, California enacted the Sustainable Groundwater Management Act (the Act or SGMA). The Act formally recognizes groundwater as an integral part of the state's water supply and provides a framework for managing groundwater in a sustainable way throughout the State of California. Adjudicated basins including the Central Basin and West Coast Basin are exempt from many of the SGMA requirements and are only required to submit annual reports to comply with the Act. However, there are some areas outside the adjudicated Central Basin that still reside with the

geologic boundary of the Central Basin as defined by DWR in Bulletin 118. These areas are referred to as "fringe areas" and must comply with SGMA. In 2016, WRD worked closely with key stakeholders in the region in preparing and submitting an "alternative analysis" describing how groundwater is sustainably managed within the entire Central Basin. The key stakeholder group included participants from City of Beverly Hills, City of Culver City, the City of Los Angeles Department of Water and Power, and Golden State Water Company. The analysis was also prepared in consultation with other stakeholders including DWR, Los Angeles County Department of Public Works, and the Central Basin Watermaster. DWR is currently reviewing the submittal and should provide any comments or approve of the alternative analysis in early to mid 2017.

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 – Groundwater Reliability Improvement Program ("GRIP")

The WRD continues to make substantial progress on completing its Groundwater Reliability Improvement Project (GRIP) Advanced Water Treatment Facility (AWTF). Once finished, GRIP will offset the current use of imported water at the spreading grounds by providing up to 21,000 AFY of recharge using reliable alternative supply sources (recycled water) for replenishment via the Montebello Forebay. The primary goals of GRIP are to:

- Provide a sustainable and reliable supply for replenishing the Basins;
- Protect 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 ground water; and
- Engage stakeholders in the decision making process.

The GRIP AWTF will provide 10,000 AFY of highly treated recycled water to the Montebello Forebay. The additional 11,000 AFY of 21,000 AFY to be provided as part of the GRIP will come directly from tertiary treated recycled water from the SDLAC's San Jose Creek Water Reclamation Plant and diverted to both the San Gabriel and Rio Hondo Spreading Basins via two (2) new Turnout diversion structures that were completed and operational in 2016.

Last year, the WRD completed its procurement process to select its GRIP AWATF Design-Build and Transitional Operator entity. Design and construction activities commenced midyear and will continue through the projects scheduled completion in mid-2018. In addition, the Final Draft Title 22 Engineering Report was submitted to both the Division of Drinking Water and Regional Water Quality Control Board for review, approval, and eventual permitting. The project is being funded from a combination of 2015 Bond Proceeds, California State Revolving Fund (SRF) Loan Proceeds, SRF and River's and Mountains Conservancy Grants, respectively

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

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 proposed and ongoing construction projects including the expansion of the Robert W. Goldsworthy Desalter (Goldsworthy Desalter), the two turnout structures at the Montebello Forebay Spreading Grounds, and the new Groundwater Reliability Improvement Program (GRIP) Advanced Water Treatment Facility (AWTF). 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 (CIS) that is currently being 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

The District has invested more than $127 million in capital improvement projects that need to be managed and maintained over there useful life; hence the District Board of Directors initiated the development of a Computerized Maintenance Management System (CMMS) and Asset Management Program, specifically an Asset Management Master Plan and Phase 1 Pilot Project. The Asset Management (AM) Plan establishes a priority list of recommended actions and projects using factors as level of effort, business drivers, cost, staff involvement, duration and alignment to the District's strategic direction including any future strategic plans for SCADA and Centralized Information System (CIS), respectively. The completed AM Plan proposes initiatives that are grouped into four elements, including planning, core service delivery, performance management and support services.

This resource is used to track District projects and programs and is thus funded 50% from both the Replenishment Fund and Clean Water Fund.

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TABLES

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Table 1

GROUNDWATER CONDITIONS AND REPLENISHMENT SUMMARY

	WATER YEAR Oct 1 - Sep 30		
	2015/16	***2016/17*** [(a)]	***2017/18*** [(a)]
Total Groundwater Production	214,867 AF	216,700 AF	217,300 AF
Annual Overdraft	(110,600) AF	(61,500) AF	(82,800) AF
Accumulated Overdraft	(832,822) AF	(761,700) AF	

Quantity Required for Artificial Replenishment for the Ensuing Year

Spreading		
Imported for Spreading in Montebello Forebay		8,000 AF
Recycled for Spreading in Montebello Forebay		63,000
	Subtotal Spreading	71,000
Injection		
Alamitos Seawater Barrier Imported Water (WRD side only)		1,620
Alamitos Seawater Barrier Recycled Water (WRD side only)		3,780
Dominguez Gap Seawater Barrier Imported Water		800
Dominguez Barrier Seawater Barrer Recycled Water		7,200
West Coast Seawater Barrier Imported Water		1,720
West Coast Seawater Barrier Recycled Water		15,480
	Subtotal Injection	30,600
In-lieu[(b)]	Subtotal In-lieu	-
	Total	**101,600** 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	8,000	$ 6,402,652
Spreading - Recycled	63,000	$ 7,774,000
Alamitos Barrier - Imported	1,620	$ 1,891,620
Alamitos Barrier - Recycled	3,780	$ 408,240
Dominguez Barrier - Imported	800	$ 1,168,055
Dominguez Barrier - Recycled	7,200	$ 6,724,800
West Coast Barrier - Imported up to 17kaf barrier total	1,520	$ 1,529,120
West Coast Barrier - Imported over 17kaf	200	$ 634,012
West Coast Barrier - Recycled	15,480	$ 13,204,440
In-Lieu MWD Member	0	$ -
In-Lieu WBMWD Customer	0	$ -
TOTAL	**101,600**	**$ 39,736,939**

Imported Water

CBMWD							
MWD Untreated Tier 1 - Spreading ($/af)	8,000	$ 666	$ 695	$ 695	$ 688	$	5,504,000
MWD RTS ($/month)	12	$ 19,250	$ 19,250	$ 30,333	$ 22,021	$	264,252
CBMWD Administrative Surcharge ($/af)	8,000	$ 70	$ 70	$ 70	$ 70	$	560,000
CBMWD Water Service Charge ($/month)	N/A	$ 6,200	$ 6,200	$ 6,200	$ 6,200	$	74,400
Total to CBMWD						**$**	**6,402,652**
LBWD							
MWD Treated Tier 1 - Alamitos Barrier ($/af)	1,620	$ 979	$ 1,015	$ 1,015	$ 1,006	$	1,629,720
MWD Capacity Charge ($/cfs/month)	5.0	$ 908	$ 945	$ 945	$ 936	$	56,160
LBWD RTS ($/af)	1,620	$ 121	$ 121	$ 125	$ 122	$	197,640
LBWD Administrative Surcharge ($/af)	1,620	$ 5	$ 5	$ 5	$ 5	$	8,100
Total to LBWD						**$**	**1,891,620**
WBMWD							
MWD Treated Tier 1-DG/WC Barriers ($/af)	2,520	$ 979	$ 1,015	$ 1,015	$ 1,006	$	2,535,120
MWD RTS ($/af)	1,000	$ 116	$ 120	$ 120	$ 119	$	119,000
MWD Capacity Charge ($/cfs/month)	46.8	$ 550	$ 572	$ 572	$ 567	$	318,427
WBMWD Administrative Surcharge ($/af)	1,000	$ 245	$ 245	$ 270	$ 251	$	251,000
WBMWD Water Service Charge ($/cfs/month)	130	$ 67	$ 67	$ 74	$ 69	$	107,640
Total to West Basin MWD						**$**	**3,331,187**
IN-LIEU							
MWD Member Agency ($/af)	0	-	-	-		No IL Program	
WBMWD Member Agency ($/af)	0	-	-	-		No IL Program	
Total for In-Lieu Payments						**$**	**-**

Recycled Water

LADWP							
Recycled Water for Dominguez Barrier ($/af)	7,200	$ 927	$ 927	$ 955	$ 934	$	6,724,800
Total to LADWP						**$**	**6,724,800**
SDLAC							
Tertiary Water - WN, SJC, Pomona ($/af) ≤50k	50,000	$ 51	$ 51	$ 57	$ 52	$	2,600,000
Tertiary Water - WN, SJC, Pomona ($/af) >50k	13,000	$ 394	$ 394	$ 408	$ 398	$	5,174,000
Total to SDLAC						**$**	**7,774,000**
WBMWD							
WBMWD Recycled Water Rate (S/af)	15,480	$ 837	$ 837	$ 899	$ 853	$	13,204,440
						$	-
Total to WBMWD						**$**	**13,204,440**
LBWD							
Source Water for Vander Lans Plant ($/af)	3,780	$ 107	$ 107	$ 111	$ 108	$	408,240
Total to WRD						**$**	**408,240**
TOTAL	**101,600**					**$**	**39,736,939**

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	Groundwater Resources Improvement Program (GRIP)	100%	0%
039	Supervisory Control And Data Acquisition (SCADA)	50%	50%
040	Computerized Maintenance Management System (CMMS) and Asset Management	50%	50%

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		
1942-43	17.91	1967-68	11.46	1992-93	26.55		
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	**91 years**			
			Running 91 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	
	2016/17	2017/18
Average Annual Groundwater Deficiency (from Table 4)	(105,385)	(105,385)
Adjustments/Variances to AAGD		
(1) Local Water at Spreading Grounds[(a)]	10,000 [(d)]	0 [(d)]
(2) Precipitation, mountain front recharge, applied water[(a)]	2,000 [(d)]	0 [(d)]
(3) Subsurface inflow[(b)]	(2,000) [(d)]	0 [(d)]
(4) Groundwater Extractions[(c)]	(33,900) [(d)]	(22,600) [(d)]
ANNUAL OVERDRAFT [AAGD+(1)+(2)+(3)-(4)]	(61,500)	(82,800)

** 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)

ITEM	AMOUNT
Accumulated Overdraft at End of Previous Water Year	(832,822)
Estimated Annual Overdraft for Current Year	(61,500)
Subtotal without artificial replenishment	(894,322)
Planned Artificial Replenishment for Current Year	
Imported Water Purchased for Spreading	43,000
Recycled Water Purchased for Spreading	61,000
Imported and Recycled Water Purchased for Barrier Wells	28,650
Replenishment Subtotal	132,650
PROJECTED ACCUMULATED OVERDRAFT FOR CURRENT YEAR	**(761,700)**

Table 8

CHANGES IN GROUNDWATER STORAGE

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

Note: Numbers in parentheses represent negative values.

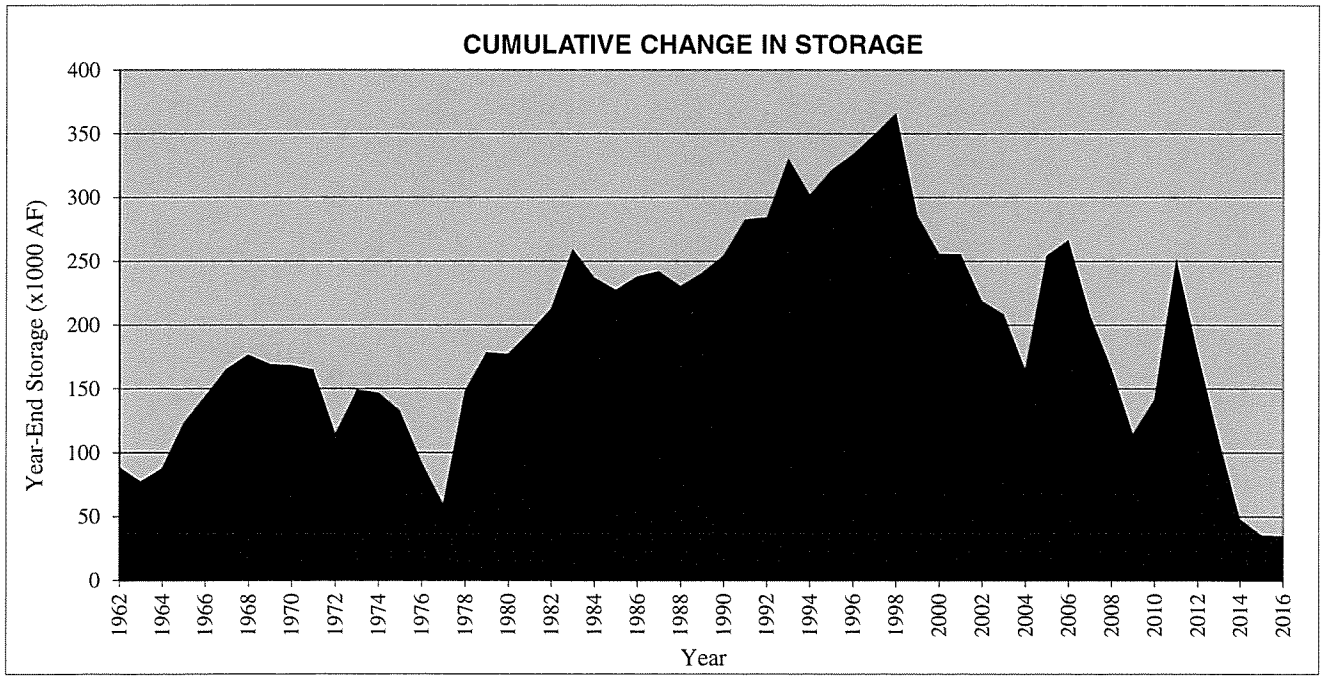

Table 9

QUANTITY OF WATER REQUIRED FOR ARTIFICIAL REPLENISHMENT

WATER TYPE	AMOUNT (AF)
Long Term Average for Imported Spreading (updated, see below)*	16,000
Recycled Water for Spreading (WRD Purchases)	55,000
Total Spreading	**71,000**
West Coast Barrier - Imported	1,720
West Coast Barrier - Recycled	15,480
Dominguez Gap - Imported	800
Dominguez Gap - Recycled	7,200
Alamitos Barrier - Imported - WRD portion only	1,620
Alamitos Barrier - Recycled - WRD portion only	3,780
Total Barriers	**30,600**
In-Lieu Central Basin	0
In-Lieu West Coast Basin	0
Total In-Lieu	**0**
Total Water Purchase Estimate for Ensuing Year	101,600
Less Other Actions	0
Total Water Purchase Estimate for Ensuing Year	**101,600**

* - 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:

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. Equals new Long Term Average of 16,000 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	35,429	3,802	44,041	15,436	-	-	-	77,993
2015-16	-	23,961	23,961	6,480	51,551	2,802	60,833	11,162 [f]	-	-	-	95,956
TOTAL	**579,810**	**1,923,366**	**2,503,176**	**616,194**	**1,178,684**	**180,759**	**1,975,637**	**2,876,978**	**157,800**	**57,321**	**215,121**	**7,570,912**

(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.

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
TOTAL	1,048,987	163,513	1,212,500	259,898	26,147	286,045	187,524	11,562	199,086	66,214	4,875	71,089	270,175	1,768,719

(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	-	-	-
TOTAL	601,281	272,040	873,321

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	44,041	15,436	-	77,993	10,013	17,345	27,358	12,723	118,074
2015-16	23,961	60,833	11,162	-	95,956	8,105	17,152	25,257	-	121,213
TOTAL	**2,503,176**	**1,975,637**	**2,876,978**	**215,121**	**7,570,912**	**1,496,409**	**201,222**	**1,697,630**	**873,321**	**10,141,862**

** 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
1959-60	245,400	66,600	312,000
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	184,018	30,849	214,867
TOTAL	**11,554,893**	**2,972,042**	**14,526,935**

* Numbers sometimes updated when pumping adjustments are required

HISTORICAL AMOUNTS OF WATER USE
IN THE WRD SERVICE AREA *

(in acre-feet)

WATER YEAR	GROUNDWATER PRODUCTION	IMPORTED WATER FOR DIRECT USE*	RECLAIMED WATER FOR DIRECT USE*	TOTAL WATER	PERCENT GROUNDWATER
1960-61	312,000	196,800		508,800	61%
1961-62	334,900	178,784		513,684	65%
1962-63	284,500	222,131		506,631	56%
1963-64	280,400	257,725		538,125	52%
1964-65	271,400	313,766		585,166	46%
1965-66	283,600	308,043		591,643	48%
1966-67	269,000	352,787		621,787	43%
1967-68	281,700	374,526		656,226	43%
1968-69	275,400	365,528		640,928	43%
1969-70	284,800	398,149		682,949	42%
1970-71	272,500	397,122		669,622	41%
1971-72	280,900	428,713		709,613	40%
1972-73	265,900	400,785		666,685	40%
1973-74	266,300	410,546		676,846	39%
1974-75	269,800	380,228		650,028	42%
1975-76	274,700	404,958		679,658	40%
1976-77	271,300	355,896		627,196	43%
1977-78	254,900	373,116		628,016	41%
1978-79	265,000	380,101	100	645,201	41%
1979-80	266,600	397,213	200	664,013	40%
1980-81	269,626	294,730	300	564,656	48%
1981-82	264,461	391,734	300	656,495	40%
1982-83	252,090	408,543	400	661,033	38%
1983-84	248,590	441,151	1,800	691,541	36%
1984-85	245,831	451,549	2,000	699,380	35%
1985-86	249,334	427,860	2,400	679,594	37%
1986-87	244,686	478,744	2,300	725,730	34%
1987-88	238,541	479,318	3,500	721,359	33%
1988-89	244,530	466,166	5,300	715,996	34%
1989-90	245,668	448,285	5,900	699,853	35%
1990-91	240,700	485,109	5,000	730,809	33%
1991-92	252,718	395,191	4,900	652,809	39%
1992-93	190,736	388,949	824	580,509	33%
1993-94	198,392	483,287	3,413	685,092	29%
1994-95	221,998	437,191	6,143	665,332	33%
1995-96	234,636	426,699	19,804	681,139	34%
1996-97	240,137	436,569	25,046	701,752	34%
1997-98	240,164	375,738	27,075	642,976	37%
1998-99	256,367	396,655	30,510	683,532	38%
1999-00	252,082	395,681	33,589	681,352	37%
2000-01	249,231	395,024	32,589	676,845	37%
2001-02	250,231	395,799	38,694	684,723	37%
2002-03	242,214	381,148	38,839	662,202	37%
2003-04	248,378	389,233	36,626	674,237	37%
2004-05	230,079	402,660	33,988	666,727	35%
2005-06	227,931	366,815	35,301	630,047	36%
2006-07	235,908	376,492	41,899	654,299	36%
2007-08	244,768	346,035	45,120	635,923	38%
2008-09	243,201	320,711	43,153	607,065	40%
2009-10	241,403	278,857	43,547	563,808	43%
2010-11	215,109	286,448	39,418	540,975	40%
2011-12	241,417	282,746	42,138	566,301	43%
2012-13	238,667	304,325	45,377	588,370	41%
2013-14	242,051	304,501	55,311	601,863	40%
2014-15	210,193	292,889	52,704	555,786	38%
2015-16	214,867	238,664	53,179	506,710	42%
TOTAL	**14,172,535**	**20,768,414**	**858,688**	**35,799,636**	40%

** - Includes imported & recycled at seawater barriers, but not spreading grounds.*

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FIGURES

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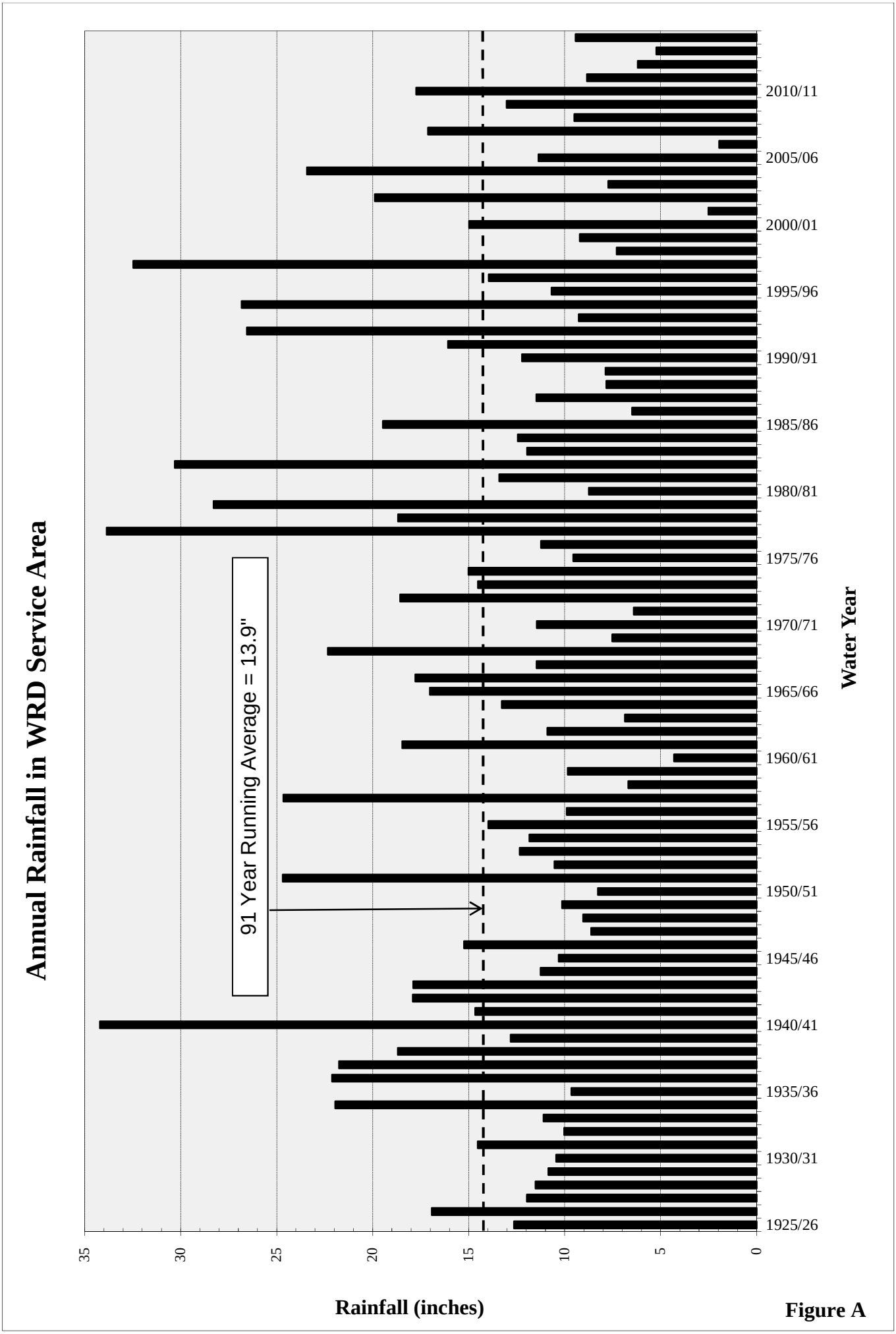
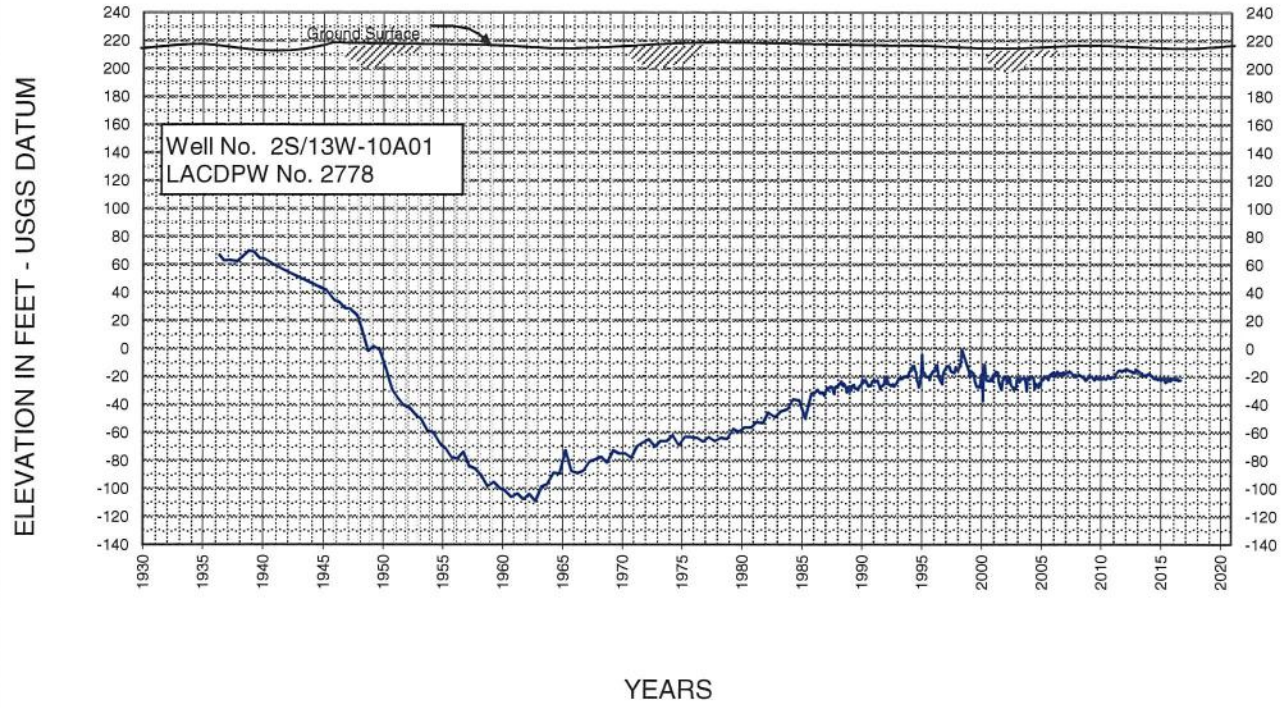
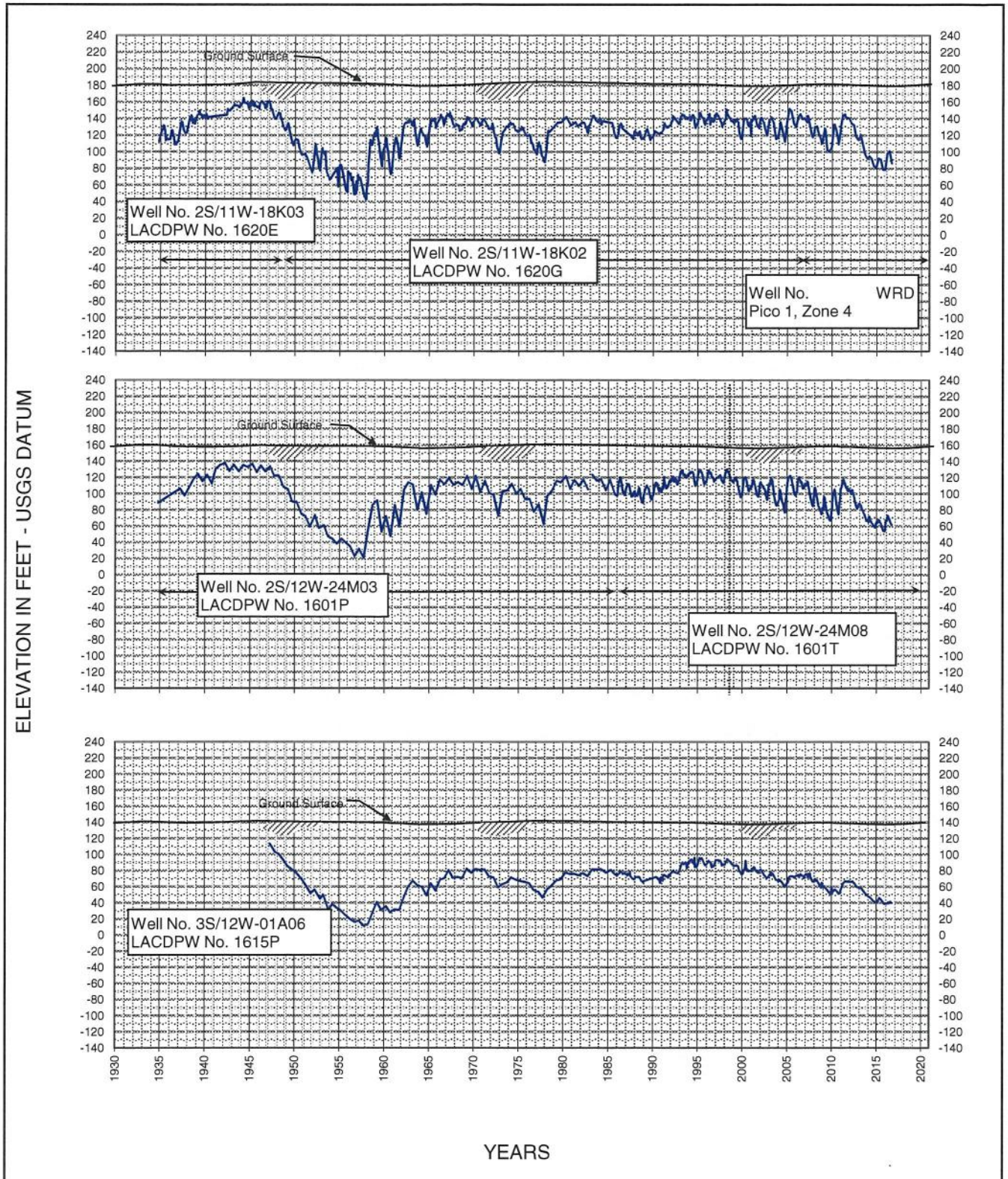

Annual Rainfall in WRD Service Area
91 Year Running Average = 13.9"
Water Year
2010/11
2005/06
2000/01
1995/96
1990/91
1985/86
1980/81
1975/76
1970/71
1965/66
1960/61
1955/56
1950/51
1945/46
1940/41
1935/36
1930/31
1925/26
35
30
25
20
15
10
5
0
Rainfall (inches)

Figure A



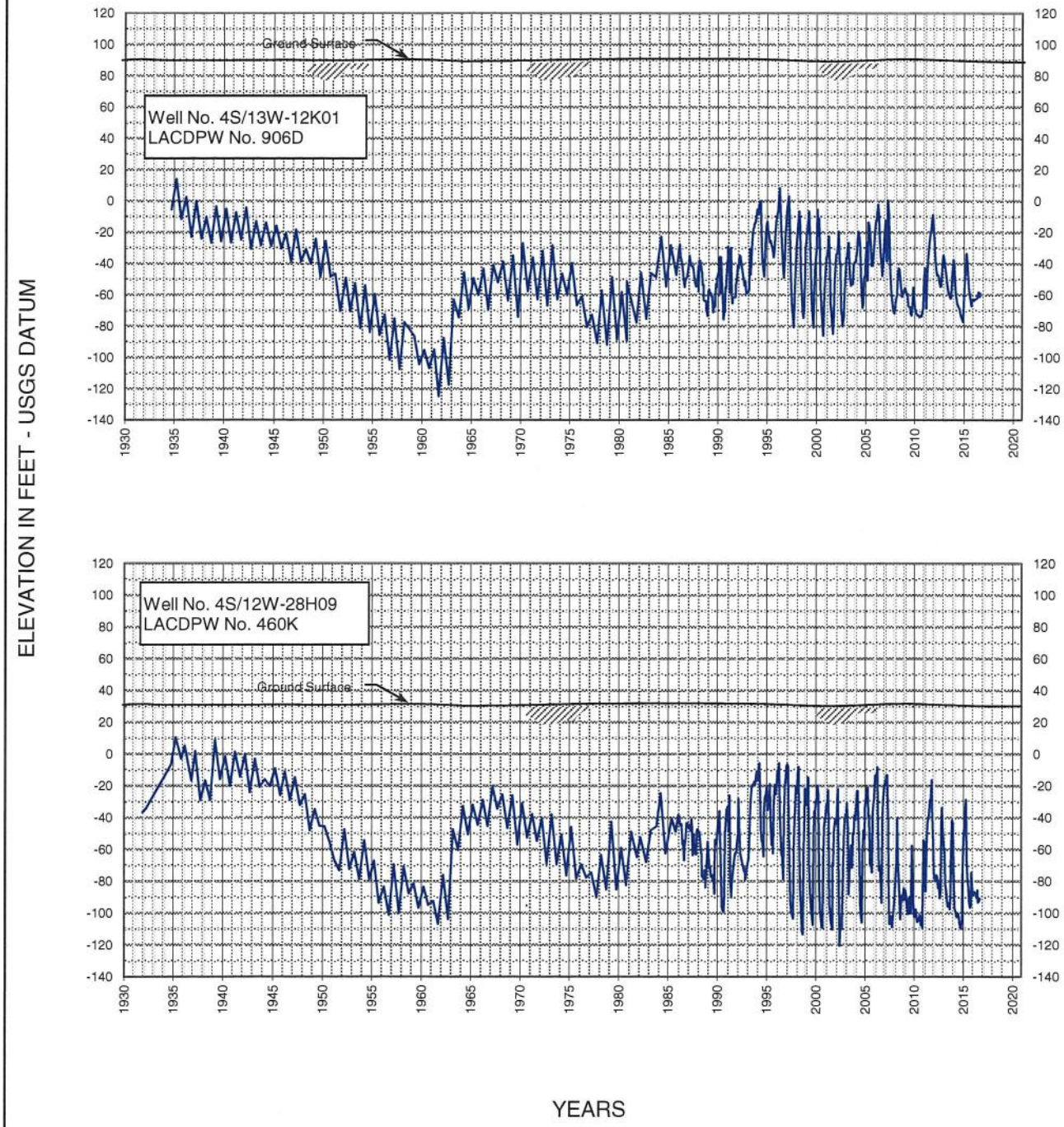
FLUCTUATION OF WATER LEVELS IN THE LOS ANGELES FOREBAY

Figure B



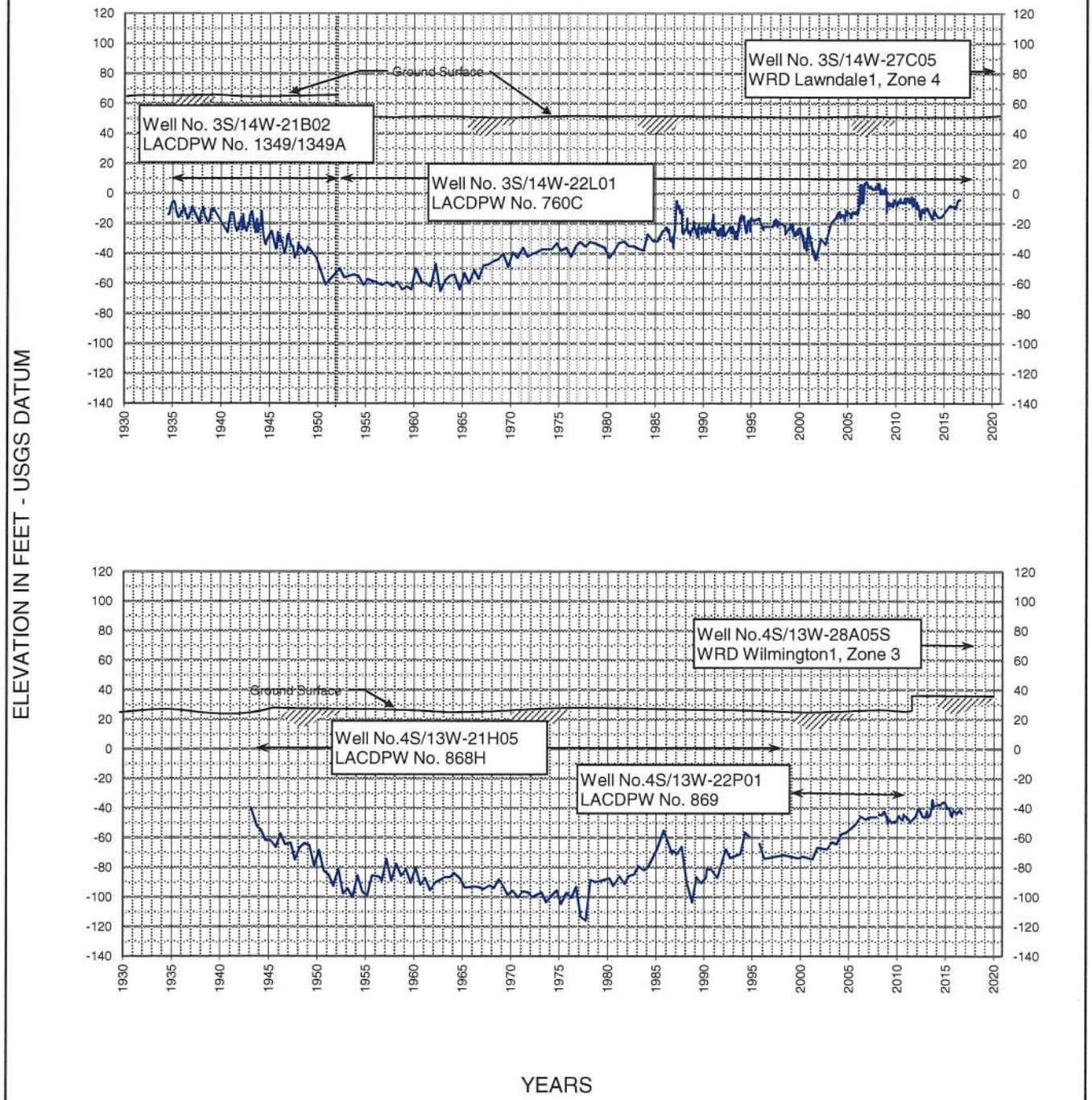
FLUCTUATION OF WATER LEVELS IN THE MONTEBELLO FOREBAY

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

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PLATES

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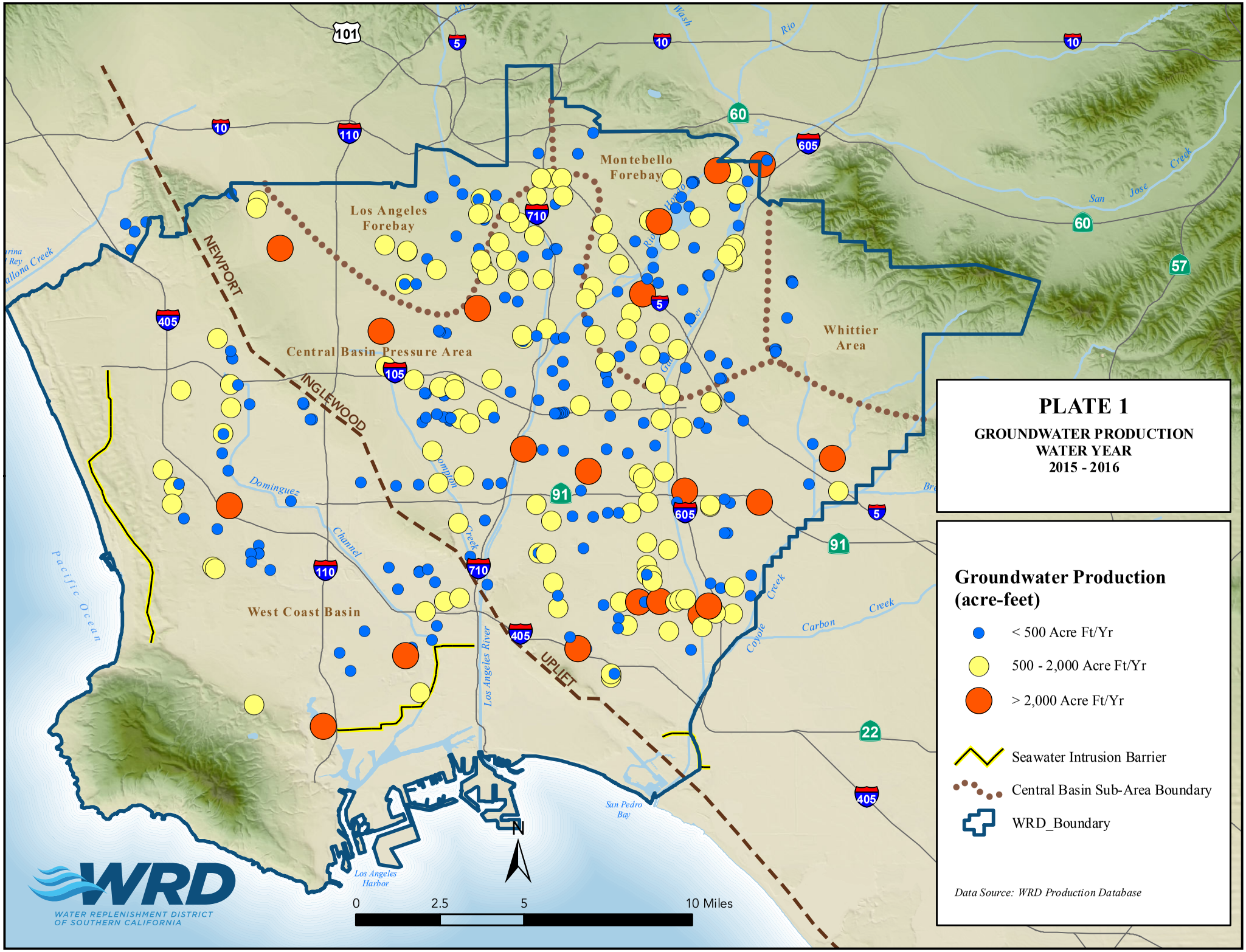
PLATE 1
GROUNDWATER PRODUCTION
WATER YEAR
2015 - 2016
Groundwater Production
(acre-feet)
< 500 Acre Ft/Yr
500 - 2,000 Acre Ft/Yr
> 2,000 Acre Ft/Yr
Seawater Intrusion Barrier
Central Basin Sub-Area Boundary
WRD_Boundary
Data Source: WRD Production Database
Montebello Forebay
Los Angeles Forebay
Central Basin Pressure Area
West Coast Basin
Whittier Area
NEWPORT
INGLEWOOD
UPLIFT
Pacific Ocean
San Pedro Bay
Los Angeles Harbor
Los Angeles River
Dominguez Channel
Coyote Creek
Carbon Creek
San Jose Creek
Rio Hondo
0
2.5
5
10 Miles
N
WRD
WATER REPLENISHMENT DISTRICT
OF SOUTHERN CALIFORNIA

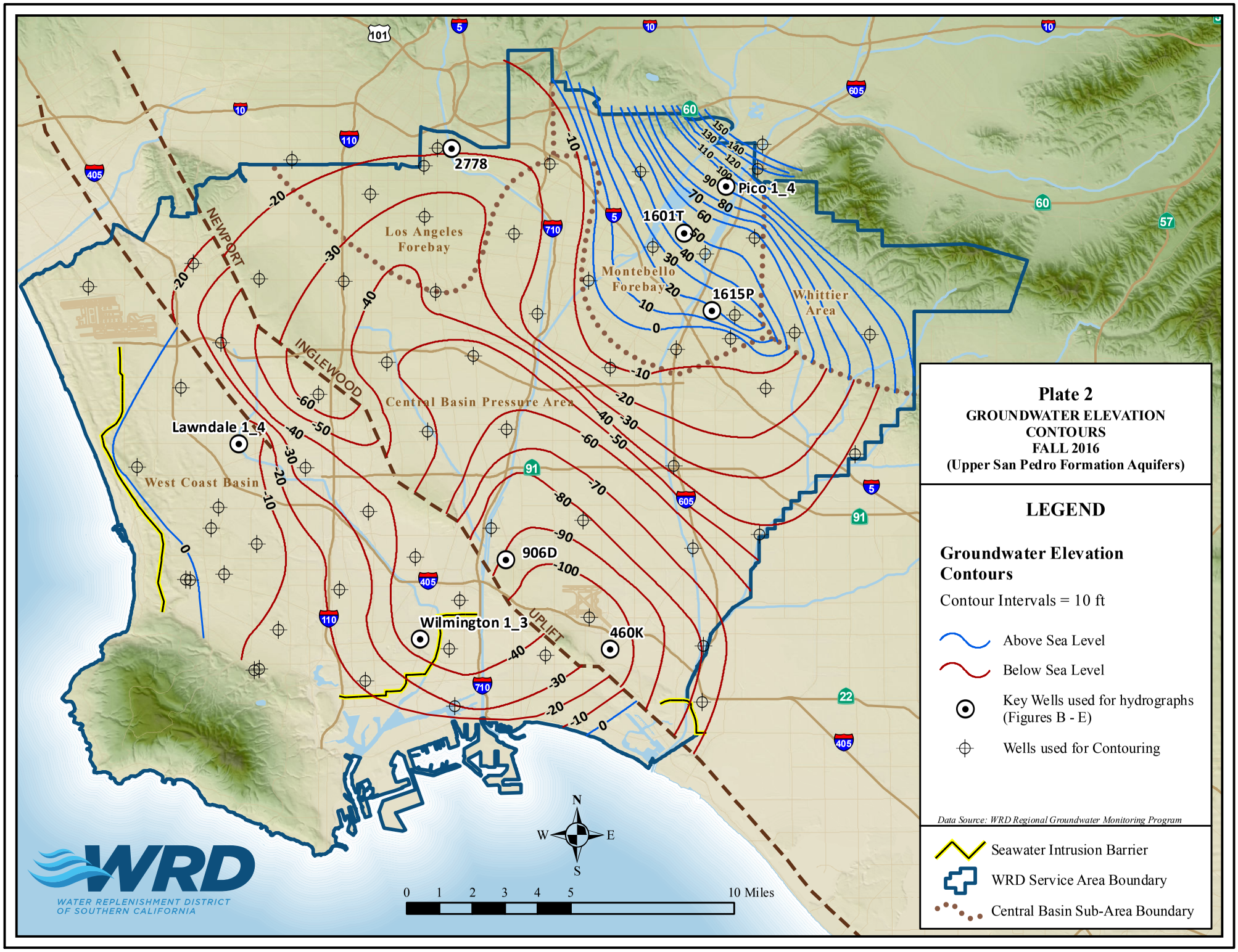
Plate 2
GROUNDWATER ELEVATION CONTOURS
FALL 2016
(Upper San Pedro Formation Aquifers)
LEGEND
Groundwater Elevation Contours
Contour Intervals = 10 ft
Above Sea Level
Below Sea Level
Key Wells used for hydrographs (Figures B - E)
Wells used for Contouring
Data Source: WRD Regional Groundwater Monitoring Program
Seawater Intrusion Barrier
WRD Service Area Boundary
Central Basin Sub-Area Boundary
Los Angeles Forebay
Montebello Forebay
Whittier Area
Central Basin Pressure Area
West Coast Basin
NEWPORT
INGLEWOOD
UPLIFT
2778
Pico 1_4
1601T
1615P
Lawndale 1_4
906D
Wilmington 1_3
460K
N
W
E
S
0 1 2 3 4 5 10 Miles
WRD
WATER REPLENISHMENT DISTRICT OF SOUTHERN CALIFORNIA

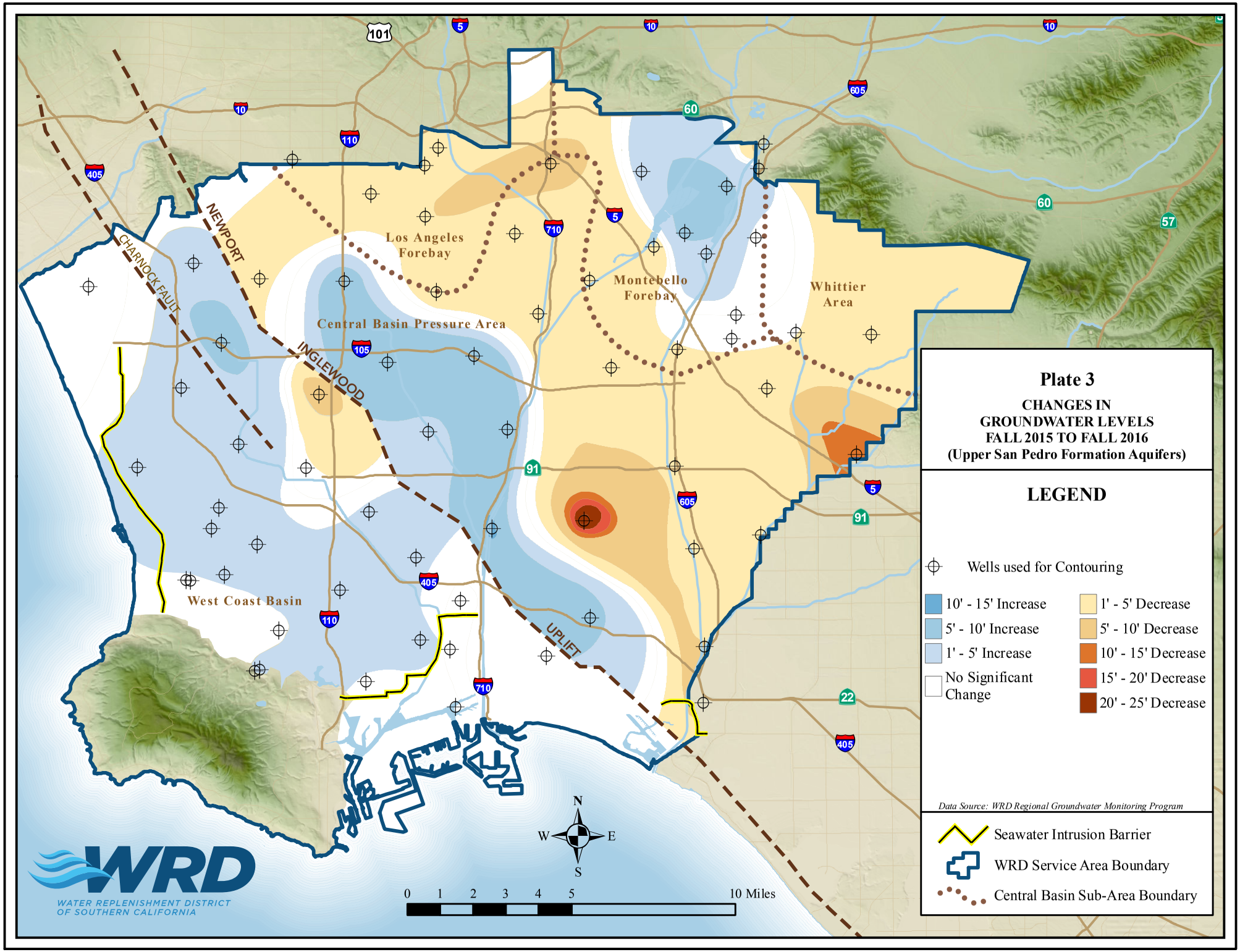
Plate 3
CHANGES IN
GROUNDWATER LEVELS
FALL 2015 TO FALL 2016
(Upper San Pedro Formation Aquifers)
LEGEND
Wells used for Contouring
10' - 15' Increase
5' - 10' Increase
1' - 5' Increase
No Significant Change
1' - 5' Decrease
5' - 10' Decrease
10' - 15' Decrease
15' - 20' Decrease
20' - 25' Decrease
Data Source: WRD Regional Groundwater Monitoring Program
Seawater Intrusion Barrier
WRD Service Area Boundary
Central Basin Sub-Area Boundary
Los Angeles Forebay
Montebello Forebay
Whittier Area
Central Basin Pressure Area
West Coast Basin
NEWPORT
CHARNOCK FAULT
INGLEWOOD
UPLIFT
N
W
E
S
0 1 2 3 4 5 10 Miles
WRD
WATER REPLENISHMENT DISTRICT
OF SOUTHERN CALIFORNIA