Final

Groundwater Assessment Study

A Status Report on the Use of Groundwater
in the Service Area of the
Metropolitan Water District of Southern California

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GROUNDWATER ASSESSMENT STUDY
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
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Appendix B – Summary of Groundwater Basin Management B-1

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This report has been compiled with substantial assistance from Metropolitan's member agencies, the groundwater basin managers, and other state and local agencies. Without this assistance, the report could not have been prepared. Data, reports, GIS input, and review have been provided by those assisting Metropolitan in this endeavor. However, any omissions or errors are fully the responsibility of Metropolitan.

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GLOSSARY

Definitions of key terms as used in this report follows. During the preparation of this report it became clear that the specific usage of some terms varies among basins and that some terms are subject to a wide range of interpretation. In addition to the terms described below, Chapter III, Regional Overview, includes a more detailed discussion with specific examples of important differences among basins regarding concepts such as 'safe yield' and 'available storage'.

"A"

Accumulated overdraft. The cumulative difference between the inflows and outflows in a groundwater basin. In the Orange County Basin, this definition is expanded to include the amount of water necessary to be replaced into the groundwater basin to prevent the landward movement of ocean water into the fresh groundwater body.

Adjudicated basin. A groundwater basin that is managed pursuant to an adjudication.

Adjudication. A court judgment or decree, pursuant to settlement or otherwise, specifying rights to surface water or groundwater and management procedures and/or pumping limits providing for long-term sustainable management of a river system or groundwater basin.

AF. Acre-foot. The amount of water needed to cover an acre (approximate a football field) one foot deep, or 325,900 gallons. One acre-foot can support the annual indoor and outdoor needs of between one and two households per year, and, on average, three acre-feet are needed to irrigate one acre of farmland.

AFY. Acre-foot per year.

Alluvium. A stratified bed of sand, gravel, silt, and clay deposited by flowing water (may also be referred to as alluvial).

Annual overdraft. The quantity by which the production of water from the groundwater supplies during the year exceeds the natural replenishment of such groundwater supplies during the same year.

Aqueduct. A structure for transporting water form one place to another by means of a pipeline, canal, conduit, tunnel or a combination of these things.

Aquifer. A geologic formation of sand, rock and gravel through which water can pass and which can store, transmit and yield significant quantities of water to wells and springs.

Aquitard. A geologic formation of clay, silt or other material that retards but does not completely stop the flow of water to or from an adjacent aquifer. It does not readily yield significant water to wells and springs.

Artesian. An aquifer in which the water is under sufficient pressure to cause it to rise above the bottom of the overlying confining bed, if opportunity to do so should be provided.

Artificial recharge. The addition of water to a groundwater reservoir by human activity, such as putting surface water into recharge basins or injecting water through wells.

Available storage capacity. The volume of a groundwater basin that is unsaturated and capable of storing groundwater. A more detailed discussion of this term is provided in Chapter III, Regional Overview.

"B"

Base flow. Surface flow of a river, not counting storm flow and/or purchased imported water.

Basin equity assessment (BEA). The additional fee charged by Orange County Water District on water pumped that exceeds the BPP, which makes the cost of that water equal to the cost of imported water.

Basin production percentage (BPP). The percentage of an Orange County Water District member agency's total potable water demand that can be produced from the basin without subjecting that member agency to the BEA.

Beneficial use. One of many ways that water can be used either directly by people or for their overall benefit. The State Water Resources Control Board recognizes 23 type of beneficial use criteria for those uses established by the Regional Water Quality Control Boards.

Brackish water. Water containing dissolved minerals in amounts that exceed normally acceptable standards for municipal, domestic, and irrigation uses. Considerably less saline than seawater.

"C"

Calendar year. The period between January 1 and December 31.

CEQA. California Environmental Quality Act.

cfs. Cubic feet per second.

Chloramines. A mixture of ammonia and chlorine used to disinfect water.

Closed basin. A groundwater basin whose topography and geology prevent subsurface outflow of water.

Colored water. Groundwater that is unsuitable for domestic use without treatment due to high color and odor exceeding drinking water standards.

Confined aquifer. A water-bearing subsurface stratum that is bounded above and below by formations of impermeable, or relatively impermeable soil or rock.

Conjunctive use. The planned use of groundwater in conjunction with surface water in overall management to optimize total water resources.

Contaminant. Any substance or property preventing the use or reducing the usability of the water for beneficial uses.

"D"

Deep percolation. The percolation of surface water through the ground beyond the lower limit of the root zone of plants into a groundwater aquifer.

Degraded water. Water within the groundwater basin that, in one characteristic or another, does not meet primary drinking water standards.

Desalting (or desalination). Specific treatment processes, such as reverse osmosis or multi-stage flash distillation, to demineralize seawater or brackish (saline) waters for reuse. Also sometimes used in wastewater treatment to remove salts other pollutants.

Disinfection. Water treatment that destroys potentially harmful bacteria.

Drought condition. Hydrologic conditions during a defined period when rainfall and runoff are much less than average.

"E"

Effective porosity. The volume of voids or open spaces in alluvium and rocks that is interconnected and can transmit fluids.

Effluent. Wastewater or other liquid, partially or completely treated or in its natural state, flowing from a treatment plant.

Evapotransporation (ET). The quantity of water transpired (given off), retained in plant tissues, and evaporated from plant tissues and surrounding soil surface. Quantitatively, it is expressed in terms of depth of water per unit area during a specified period of time.

"F"

Fiscal year. The period from July 1 to June 30 of the following calendar year.

Forebay. A portion of a groundwater basin where large quantities of surface water can recharge the basin through infiltration; also a reservoir or pond situated at the intake of a pumping plant or power plant to stabilize water level.

"G"

Groundwater. Water that occurs beneath the land surface and fills partially or wholly pore spaces of the alluvium, soil or rock formation in which it is situated. Does not include water that is being produced with oil in the production of oil and gas or in a bona fide mining operation.

Groundwater basin. Alluvial reservoir defined by the overlying land surface and all underlying alluvial aquifers that contain water or have the potential to contain water. Boundaries of successively deeper aquifers may differ and make it difficult to define the limits of the basin.

Groundwater budget. A numerical accounting of the recharge, discharge and change in storage of an aquifer, series of aquifers or groundwater basin.

Groundwater in storage. The quantity of water in the zone of saturation.

Groundwater management. The planned and coordinated management of a groundwater basin or portion of a groundwater basin with a goal of long-term sustainability of the resource.

Groundwater management plan. A comprehensive written document developed for the purposes of groundwater management and adopted by an agency having appropriative legal or statutory authority that meets the formal requirements for groundwater management plans as defined under Senate Bill (SB) 1938.

Groundwater mining. The withdrawal of water from an aquifer in excess of recharge over a period of time. If continued, the underground supply would eventually be exhausted or the water table could drop below economically feasible pumping lifts.

Groundwater overdraft. The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average.

Groundwater recharge. The action of increasing groundwater storage by natural conditions or by human activity. See also: Artificial recharge.

Groundwater storage capacity. Volume of void space that can be occupied by water in a given volume of a formation, aquifer or groundwater basin. See also: Total storage. A more detailed discussion of this concept in provided in Chapter III, Regional Overview.

Groundwater subbasin. A subdivision of a groundwater basin created by dividing the basin using geologic or hydrologic conditions or institutional boundaries.

Groundwater table. The upper surface of the zone of saturation (all pores of subsoil filled with water), except where the surface if formed by an impermeable body.

gpm. Gallons per minute.

"H"

Hydrogeology. The branch of geology that deals with the occurrence, distribution, and effect of ground water

Hydrograph. A graph that shows some property of groundwater or surface water (e.g. water level) as a function of time.

Hydrologic balance. An accounting of all water inflow to, water outflow from, and changes in water storage within a hydrologic unit over a specified period.

Hydrologic cycle. The process by which water constantly circulates from the ocean, to the atmosphere, falling to the earth in some form of precipitation, and finally returning to the ocean.

Hydrostratigraphy. The identification of mappable units based upon aquifer properties that have lateral extent and composing a reasonably distinct hydrologic system.

"I"

Imported water. Water that has originated from one hydrologic region and is transferred to another hydrologic region. For example, the Metropolitan Water District (Metropolitan) of Southern California imports water from the Colorado River and Northern California.

Infiltration. The flow of water downward from the land surface into and through the upper soil layers.

Infiltration capacity. The maximum rate at which infiltration can occur under specific conditions of soil moisture.

In-lieu recharge. The practice of using alternate source of supply (e.g. imported water) in place of groundwater thereby leaving groundwater in storage for later use. When supplies are available, Metropolitan financially encourages groundwater producers, through its various in-lieu programs, to turn off their pumping facilities and use imported water from Metropolitan to meet their demands.

"J"

Joint Powers Authority (JPA). An agreement entered into by two or more public agencies that allows them to jointly exercise any power common to the contracting parties. The JPA is defined in Chapter 5 (commencing with §6500) of Division 7 of Title 1 of the California Government Code.

"L"

Land subsidence. The lowering of the natural land surface due to groundwater (or oil or gas) extraction.

Lithology. The description of rock or sediments on the basis of such characteristics as color, mineral composition and grain size.

"M"

Managed basin. A groundwater basin that is managed pursuant to a groundwater management plan developed in accordance with the California Water Code section 10753 (SB 1938, Machado, 2002) or managed pursuant to a State statute establishing a groundwater management agency and setting out the agency's responsibilities, authorities, and powers (e.g. Orange County Water District, Fox Canyon Groundwater Management Agency).

Maximum contaminant level (MCL). The highest drinking water contaminant concentration allowed under Federal and State Drinking Water Regulations.

MGD. Million gallons per day.

Microfiltration. A physical separation process where tiny, hollow straw-like membranes separate particles from water. It is used very effectively as a pre-treatment for reverse osmosis.

mg/L. Milligrams per liter.

"N"

National Pollutant Discharge Elimination System (NPDES). A federal permit authorized by the Clean Water Act, Title IV, which is required for discharge of pollutants to navigable waters of the United States, which includes any discharge to surface waters-lakes, streams, rivers, bays, the ocean, wetlands, storm sewer, or tributary to any surface water body.

Natural recharge. Natural replenishment of an aquifer or groundwater basin from snowmelt, runoff or infiltration of precipitation through seepage from the ground surface.

Natural safe yield. The maximum quantity of water can be drawn over a long period of time without adverse effects exclusive of artificial recharge or other human influences. Also referred to as native yield. A more detailed discussion of this concept is provided in Chapter III, Regi4onal Overview.

Notification level. Notification levels are health-based advisory levels established by CDHS for chemicals in drinking water that lack maximum contaminant levels (MCLs). When chemicals are found at concentrations greater than their notification levels, certain requirements and recommendations apply.

"O"

Operational yield. An optimal amount of groundwater should be withdrawn from an aquifer or groundwater basin each year. It is be a dynamic quantity that is determined based upon basin specific groundwater management goals. Also referred to as operational safe yield. A more detailed discussion of this concept is provided in Chapter III, Regional Overview.

Ordinance. A law set forth by a governmental authority.

Overdraft. See: groundwater overdraft.

"P"

Perched groundwater. Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater.

Percolation. The downward movement of water through the soil or alluvium to the groundwater table. See also: infiltration.

Perforated interval. The depth interval where slotted casing or screen is lace in a well to allow entry of water from the aquifer.

Permeability. The capability of soil or other geologic formations to transmit water.

Potable water. Suitable and safe for drinking.

ppb. **Parts per billion**. Used interchangeably with µg/L (micrograms per liter.)

ppm. Parts per million. Used interchangeably with mg/L (milligrams per liter.)

ppt. Parts per trillion. Used interchangeably with ng/L (nanograms per liter.)

Primary treated water. First major treatment in a wastewater treatment facility, usually sedimentation but not biological oxidation.

Production, producing. The act of extracting groundwater by pumping or otherwise.

psi. Pounds per square inch.

Purveyor. Another name for groundwater producer or pumper.

"R"

Replenishment assessment (RA), commonly known as a pump tax. A charge on each AF of groundwater extracted from the Orange County Basin. Income from the RA finances the replenishment of the Orange County Basin and projects for water recycling and water quality improvements.

Replenishment obligation. Replacement water. Terms used in management of groundwater basins that allow production to be greater than natural safe yield but balance the basin's water budget by utilizing imported or other sources of water to make up the difference.

Recharge. The physical process where water naturally percolates or sinks into a groundwater basin.

Recharge basin. A surface facility, often a large pond, used to increase the infiltration of surface water into a groundwater basin.

Reclamation project. A project where water obtained from a sanitary district or system undergoes additional treatment for a variety of uses, including landscape irrigation, industrial uses, and groundwater recharge.

Recycling. A type of reuse, usually involving running a supply of water through a closed system again and again. Legislation in 1991 legally equates the term "recycled water" to reclaimed water.

Riparian. Of or on the banks of a stream, river, or other body of water.

RO. Reverse osmosis. A method of removing salts or other ions from water by forcing water through a semi-permeable membrane.

Runoff. The volume of surface water flow from and area.

"S"

Safe yield. The maximum quantity of water that can be withdrawn from a groundwater basin over a long period of time without resulting in adverse conditions. Sometimes referred to as sustained yield. A more detailed discussion of this concept is provided in Chapter III, Regional Overview.

Salinity. Generally, the concentration of mineral salts dissolved in water. Salinity may be measured by weight (total dissolved solids - TDS), electrical conductivity, or osmotic pressure. Where seawater is known to be the major source of salt, salinity is often used to refer to the concentration of chlorides in the water.

SARI. Santa Ana Regional Interceptor. A used water discharge line that runs from the Inland Empire to the Orange County Sanitation District.

Saturated zone. The zone in an aquifer in which all interconnected openings, or pore spaces, are filled with water.

Seawater intrusion. The movement of salt water into a body of fresh water. It can occur in either surface water or groundwater basins.

Seawater intrusion barrier. A physical facility or method of operation designed to prevent the intrusion of salt water into a body of freshwater, such as the Talbert Barrier or Alamitos Barrier in Orange County and Central basins, respectively.

Secondary MCL. Maximum contaminant level to address taste and odor concerns.

Secondary treatment. Generally, a level of treatment that produces 85 percent removal efficiencies for biological oxygen demand and suspended solids. Usually carried out through the use of trickling filters or by the activated sludge process.

Seepage. The loss of water by infiltration into the soil from a surface water body or source.

Semi-confined aquifer. An aquifer that has aquitards either above or below that allow water to leak into or out of the aquifer.

Spreading basin; spreading grounds. See: recharge basin.

Spring. A location where groundwater flows naturally to the land surface or a surface water body.

Storm flow. Surface flow originating from precipitation and runoff that has not percolated into an aquifer or groundwater basin.

SWP. State Water Project. An aqueduct system that delivers water from northern California to central and southern California.

Subsidence. See: land subsidence.

Sustained yield. See safe yield.

"T"

TDS. Total dissolved solids. A quantitative measure of the residual minerals dissolved in water that remain after evaporation of a solution. Usually expressed in milligrams per liter.

Tertiary treatment. The treatment of wastewater beyond the secondary or biological stage. Normally implies the removal of nutrients, such as phosphorous and nitrogen, and a high percentage of suspended solids.

THM. Trihalomethanes. Any of several synthetic organic compounds formed when chlorine or bromine combine with organic materials in water.

Transpiration. The process in which plant tissues give off water vapor to the atmosphere as an essential physiological process.

Turbidity. Thick or opaque with matter in suspension; muddy water.

"U"

Ultraviolet light disinfection. A disinfection method for water that has received either secondary or tertiary treatment, used as an alternative to chlorination.

Unconfined aquifer. An aquifer that is not bounded on the top by an aquitard. The upper surface of an unconfined aquifer is the water table.

Unsaturated zone. The zone below the land surface in which the pore space is not completely filled with water.

Urban water management plan (UWMP). An UWMP is required for all urban water suppliers having more than 3,000 connections or supplying more than 3,000 AFY of water. The plans include discussions on water supply reliability, water use, water conservation, and water shortage contingency and serve to assist urban water suppliers with their long-term water resources planning.

Usable storage capacity. The quantity of groundwater of acceptable quality that can be economically withdrawn from storage. In some cases the amount of groundwater that can be extracted from a groundwater basin or amount of storage that is used is limited by an adjudication.

"V"

Vadose zone. See: unsaturated zone.

VOC. Volatile organic compound. A chemical compound that evaporates readily at room temperature and contains carbon. These compounds are often highly mobile in groundwater and are generally associated with industrial activities.

"W"

Wastewater. Water that has been previously used by a municipality, industry or agriculture and has suffered a loss of quality as a result of use.

Wastewater reclamation. Treatment and management of municipal, industrial or agricultural wastewater to produce water of suitable quality for additional beneficial uses.

Water rights. A legally protected right to take possession of water occurring in a natural waterway and to divert that water for beneficial use.

Water table. See: groundwater table.

Water year. The period between October 1 and September 30 of the following calendar year.

Watermaster. A court appointed person(s) that has specific responsibilities to carry out court decisions pertaining to a river system or watershed.

Watershed. The total land area that from which water drains or flows to a river, stream, lake or other body of water.

Wellhead treatment. Water quality treatment of water being produced at the well site.

CHAPTER I

INTRODUCTION

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INTRODUCTION

Groundwater is a key component of the water supply picture for Southern California. On a regional level, local groundwater production is used to meet nearly 40 percent of the total annual water demands within Metropolitan's service area. Groundwater production is used to offset peak seasonal water demands on the imported water treatment and distribution systems. Further, surplus water supplies available during wet years are stored in groundwater basins for later use during dry, drought, or emergency periods. As such, the groundwater resource is a key component of water supply reliability planning within Metropolitan's service area. The Groundwater Assessment Study provides a description of the current status of groundwater within The Metropolitan Water District of Southern California (Metropolitan) service area.

PURPOSE

In October 2005, the Metropolitan Board of Directors (Board) directed staff to conduct this Groundwater Assessment Study. The purpose of the study is to document the current status and use of the groundwater basins within the Metropolitan service area.

Groundwater is an important part of Metropolitan's Integrated Water Resource Plan (IRP). The IRP sets out reliability strategies for dry years, and has targeted dry-year yield from service-area groundwater basins of 275,000 AFY by 2010, and 300,000 AFY by 2020/25. Because Metropolitan plans for the potential of three consecutive dry years, the yield targets are multiplied by three for dry-year storage target of 825,000 AF by 2010 and 900,000 AF by 2020/25. These dry-year targets rely on healthy groundwater basins that can maintain baseline annual production during dry years and, in addition, produce the stored dry-year supplies.

As of late 2006 Metropolitan has developed strategies and executed ten contractual agreements for development of dry-year groundwater storage within its service area. Contractual storage capacity totals to nearly 422,000 AF with progress being made each year to fill the storage accounts. Additionally, Metropolitan delivers approximately 200,000 AF of replenishment service in normal years, and for planning purposes anticipates ability to interrupt this service during dry years with groundwater basins able to maintain production levels for three years. To further encourage development of groundwater, Metropolitan also provides incentives for recovery of poor quality groundwater through its Local Resources Program.

Additional progress needs to be made toward the IRP dry-year yield targets for in-service area groundwater storage. This Groundwater Assessment Study provides the basic framework for policy discussions and development of strategies that will allow new thinking about how the groundwater basin resources can be best integrated into the IRP for water supply reliability.

REPORT ORGANIZATION

This report provides a status update on groundwater basins throughout Metropolitan's service area from Ventura County in the north to the southern limits of San Diego County in the south and east into Riverside and San Bernardino Counties.

Chapter I – Introduction

Provides statement of purpose and outline for report.

Chapter II - Methodology

Documents the methodology used to compile the information and mapping.

Chapter III – Regional Overview

Provides a regional overview for orientation and perspectives of the overall service area. It also provides some key discussion of basic differences among the groundwater basins that are important to understanding and interpreting the detailed groundwater basin reports.

Chapter IV – Groundwater Basin Reports

Provides detailed overviews of basins or groups of basins that are organized by sub-regions.

CHAPTER II

METHODOLOGY

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INTRODUCTION

This Groundwater Assessment Study has been prepared with existing data from each of the groundwater basins within the Metropolitan service area. No new studies or technical analyses were conducted. This chapter outlines the process for compiling and displaying the available data that are used herein.

DATA COLLECTION AND REVIEW PROCESS

The following section describes the data collection and review process for the preparation of this document.

Scope of Study and Analysis Period

In its direction to staff in October 2005, the Board defined the scope of the study to include a description of the following items:

- Status and trends in groundwater management and use
- Investments in capital infrastructure
- Current conditions within the basins

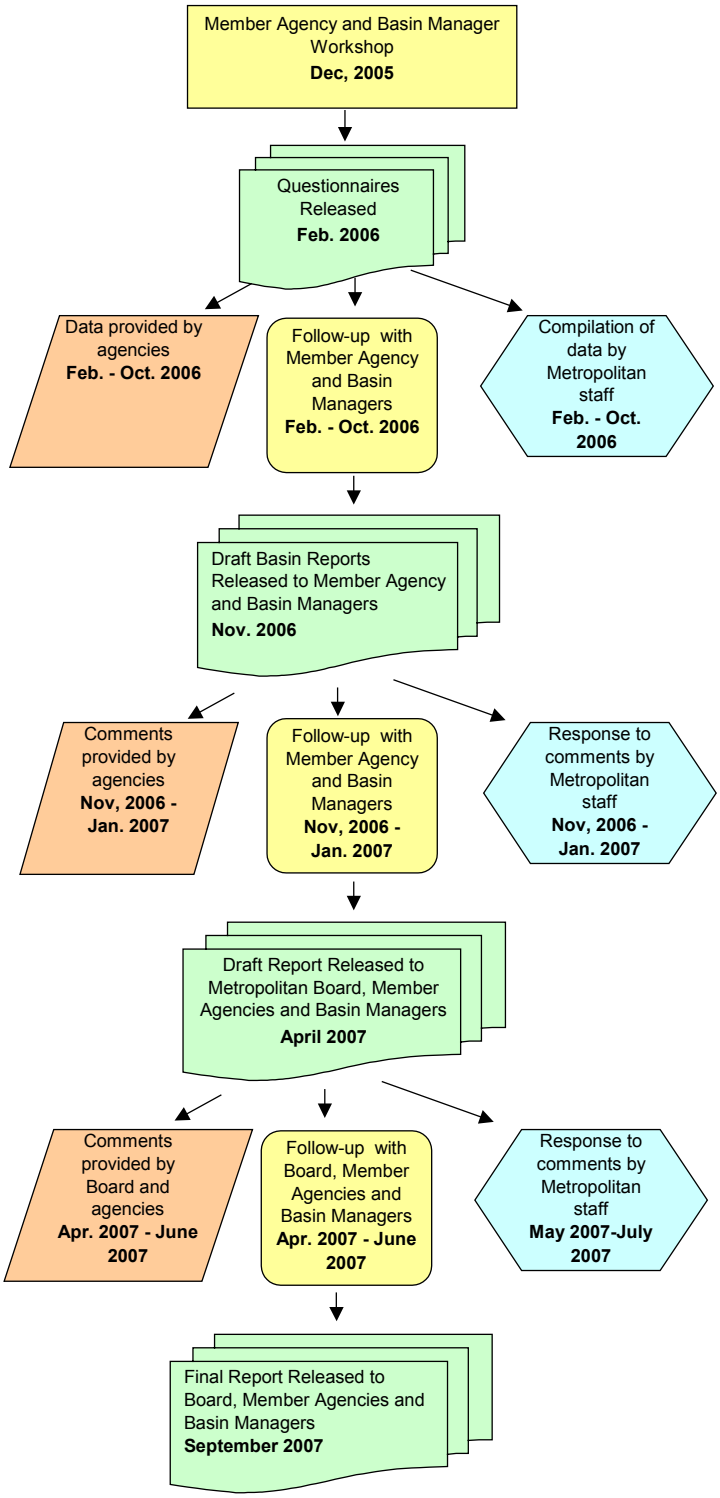
The analysis period for this study is the 20-year period from fiscal years 1985/86 to 2004/05. In some cases (e.g. San Fernando Basin), the basin is managed on a calendar year or water year basis. In these cases, the analysis period is modified to match the data available. This time period was selected to characterize the long-term trends and be as consistent with the most recent urban water management plans, which were adopted in 2005.

Member Agency and Basin Manager Input

The layout and data presented herein was developed based upon extensive input from the overlying Metropolitan member agencies and the groundwater basin managers. The process to prepare this document is shown as a flowchart in **Figure II-1.** Following the Board directive to prepare the Groundwater Assessment Study, Metropolitan invited its member agencies and groundwater basin managers throughout its service area to a workshop to discuss the Groundwater Assessment Study and the desire to establish a collaborative process for gathering and presenting information. At this December 2005 workshop, it was determined that a questionnaire should be developed and distributed to the member agencies and basin managers as the basis for providing input.

In February 2006, the questionnaire was sent out to each member agency and basin manager. The questionnaire requested input regarding the physical description of each basin, groundwater production and recharge, groundwater levels, facilities descriptions, water quality and basin management. Basin data, maps, reports, and questionnaire responses were subsequently.

Figure II-1
Review Process and Report Preparation Timeline



provided by the member agencies or basin managers for many basins within the Metropolitan service area.

In November 2006, the each draft chapter was provided to the overlying member agencies and respective basin managers for review and comment. Draft reports of each basin or group of basins were prepared using a standardized outline. Member agencies and basin managers received copies of their respective groundwater basin reports for review. A regional overview (Chapter III, presented herein) was subsequently prepared using the compiled information from the basin chapters. Metropolitan staff incorporated comments from the member agencies and basin managers.

In April 2007, a draft of the Groundwater Assessment Study report was completed and submitted to the Metropolitan Board of Directors, member agencies and basin managers for review and comment. Comments revised on the draft report were incorporated into this final report. In addition, an executive summary was prepared to accompany the final report.

Literature Review

Metropolitan staff and consultants reviewed the provided information and supplemented it with extensive literature review and discussions with basin parties. Documents reviewed, many of which could be accessed online, included items such as:

- Urban water management plans for water purveyors
- Water management plans
- Engineering reports
- Hydrogeologic reports
- Modeling reports

In addition, water quality data were augmented by data compiled from the Regional Water Quality Control Boards (Regional Boards) through their online Geotracker database. These data can be accessed at: http://www.geotracker.swrcb.ca.gov/.

MAPPING AND DATA PRESENTATION

Data for this study are organized in a Geographic Information System (GIS) format. A GIS is a combination of a database program and a graphical interface that displays data on maps. By compiling the information in a GIS, information can be accessed more easily and can be presented spatially to obtain a better understanding of the groundwater basins. Maps were developed using Environmental System Research Institute (ESRI) ArcGIS 9.1. The groundwater GIS is created in NAD83, California State Plane, Zone VI coordinate system.

Base Map Information

Base map information including freeways, water bodies, aerial photography, and Metropolitan facilities were compiled from Metropolitan files.

Groundwater Basin Boundaries

The groundwater basin boundaries of the California Department of Water Resources Bulletin 118 2004 Update were used initially for this study. This DWR base map was revised for this report based on information and GIS data supplied by the member agencies, the groundwater basin managers, and the Santa Ana Watershed Project Authority (SAWPA). These changes to the DWR mapping provided additional detail or revisions based on current technical studies and/or to reflect basin management and data reporting.

Specific changes to the DWR mapping are described in **Appendix A** and key changes are summarized below.

Ventura County Basins: These basins are within the management jurisdiction of the Fox Canyon Groundwater Management Agency (GMA), and are limited to those within the Metropolitan service area. Based on recent work performed by the U.S. Geological Survey for the GMA, the basin boundaries have been revised by the GMA and used in its groundwater management plan. Specifically, the U.S. Geological Survey divided DWR's Las Posas Valley basin into the West, East and South Las Posas basins. In addition, the Oxnard Forebay has been distinguished from the Oxnard Plain basin. The revised basin boundaries used by the GMA are used in this report.

San Gabriel Valley: This large DWR basin was divided to reflect groundwater basin adjudications and associated management and use: Main San Gabriel Basin, Puente Basin, Six Basins and Spadra Basin.

Upper Santa Ana Valley: DWR's Upper Santa Ana Valley is broken into the following six subbasins: Temescal, San Timoteo, Riverside-Arlington, Chino Cucamonga, and Rialto-Colton. The Rialto-Colton area is outside the Metropolitan service area and has not been covered in this report. With respect to the remaining basins, the mapping utilized by the Santa Ana Watershed Project Authority (SAWPA) has been used. There are slight variations in the basin boundaries, and divisions of basins to reflect management. The mapping of the common boundary between the Chino and Cucamonga basins has been adjusted to reflect hydrogeology as reflected in mapping rather than the adjudicated boundary presented in DWR Bulletin 118. Riverside Basin has been separated from Arlington Basin. The mapping of Temescal Basin is also somewhat modified from Bulletin 118 as relates to the boundary with Elsinore Basin.

Coastal Plain of Orange County: This basin was modified using the boundaries identified by SAWPA. In addition, the La Habra basin, which was included in the DWR basin, was separated from the Orange County Basin in this report.

Elsinore and Temescal Basins: DWR's mapping of Elsinore and Temescal basins has been broken down into subcomponents for purposes of this report, again using SAWPA's mapping. For purposes of this report, the Bedford, Coldwater and Lee Lake basins have been distinguished from the Elsinore Basin and addressed in one groundwater basin report titled Temescal Valley Basins along with the Temescal Basin. The remainder of Lake Elsinore Basin is addressed in its own groundwater basin report.

San Jacinto Basin: The San Jacinto Basin of Bulletin 118 has been divided into the Hemet-San Jacinto Basins (Hemet North, Hemet South, San Jacinto Upper Pressure, and San Jacinto Canyon) and the West San Jacinto Basins (Perris North, Perris South, Lakeview, Menifee, and San Jacinto Lower Pressure). These more detailed mapping units are reflected in groundwater management plans for this area. Overall boundaries are quite similar to those of Bulletin 118, but have been somewhat refined to better reflect geology.

Temecula Valley: This report addresses only a portion of the area mapped by DWR as the Temecula Valley Basin. Herein the covered portion is called Temecula-Murrieta Basin and is comprised of the Pauba and Temecula aquifers as mapped in the Santa Margarita River Watershed Management Plan and consistent with input received from the Santa Margarita River Watermaster and the Rancho California Water District. We have not used local surface water hydrology designations to further delineate these aquifers as sometimes done in the local documents.

San Diego County Basins: This report's mapping and inclusion of groundwater basins in coastal San Diego County reflects input from Metropolitan's member agency, the San Diego County Water Authority. Basins not used to meet municipal water supply are not included. The Las Flores Basin and San Diego Formation aquifer have been added. Sub-basins have been distinguished for the San Luis Rey Valley Basin.

Basin Management Facilities

The geographic distribution of groundwater management facilities is important to understanding the groundwater basin. Data included in the GIS coverage for each basin are:

- Key wells
- Spreading basins
- Seawater intrusion barriers
- ASR wells
- Desalters
- Other regionally significant facilities

These data were provided by the member agencies or basin managers, or from the literature review as applicable. Each facility is highlighted in a map for each basin that is included in Chapter IV – Groundwater Basin Reports of this document.

Other Data

Production and water level data for each basin are compiled for the period between fiscal years 1985/86 to 2004/05 where available. Primary data sources included electronic data directly from member agencies, basin managers, and water purveyors. When these data were not available, additional sources as part of the literature review were cited to obtain additional production and water level data. Often times, data for all producers in a basin, particularly those who are non-member agencies are not available. For example, production from private wells are often

unquantified and could be significant in some groundwater basins. A complete list of references is provided in each basin report in Chapter IV, Groundwater Basin Reports.

Precipitation data were obtained from representative stations in each basin. Sources included: the California Irrigation Management Information System (CIMIS), University of California Integrated Pest Management (UC IPM) and applicable watermaster reports. CIMIS data can be accessed via the Internet at: http://wwwcimis.water.ca.gov/cimis/data.jsp. UC IPM data can be accessed via the Internet at: http://www.ipm.ucdavis.edu/WEATHER/wxretrieve.html. A complete list of references is provided in each basin report in Chapter IV, Groundwater Basin Reports.

Groundwater recharge data including direct groundwater recharge via spreading basins and injection wells were generally obtained via electronic data directly from the member agencies, basin managers and water purveyors. For some basins in Los Angeles County, runoff recharge data are compiled from Los Angeles County Department of Public Works data. These data are available via the Internet at: http://ladpw.org/wrd/report/

Groundwater data compiled as part of this study have been used to assess the state of the groundwater within the Metropolitan service area. The remaining chapters of this report summarize the data for the entire region (Chapter III, Regional Overview) and for individual groundwater basins (Chapter IV, Groundwater Basin Reports).

DISCLAIMER

This report has been prepared using a wide variety of data and sources. Metropolitan makes no warranties, either expressed or implied, with respect to the data within this report, its accuracy, its quality, or fitness for a particular purpose or use. In no event will Metropolitan be liable for direct, indirect, consequential or incidental damages resulting from any inaccuracies in the data. The readers should review and evaluate the data to determine its suitability of use for their activities.

CHAPTER III

REGIONAL OVERVIEW

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INTRODUCTION

The focus of this chapter is to provide a regional overview on key topics that may assist big-picture thinking and understanding about groundwater use and management in Metropolitan's service area. Information reviewed and considered in this overview is drawn from the groundwater basin reports presented in Chapter IV, Groundwater Basin Reports and is compiled to allow comparison of subregions as well as an assessment of the Metropolitan service area as a whole. Topics addressed in this chapter are: management inclusive of differences related to safe yield, facilities, trends in groundwater production and recharge, groundwater levels and changes in groundwater storage, and availability of basin space for storage. This chapter is not intended to provide a comprehensive summary of the groundwater basin reports presented in Chapter IV.

GROUNDWATER BASIN MANAGEMENT

The following section describes groundwater basin management in the Metropolitan service area. The discussion begins with a description of the various types of management or governing structure within the service area. There are many definitions for safe yield. This section describes how safe yield is interpreted and incorporated in the sustainable operations of the basins. Groundwater storage also plays an important role in groundwater management. A brief description of how groundwater storage opportunities are addressed in the basins is also provided.

Types of Groundwater Management Structure

There are various ways that groundwater is managed in Southern California. To assist in understanding these differences, the groundwater basins in the Metropolitan service area are divided into five specific types. These include:

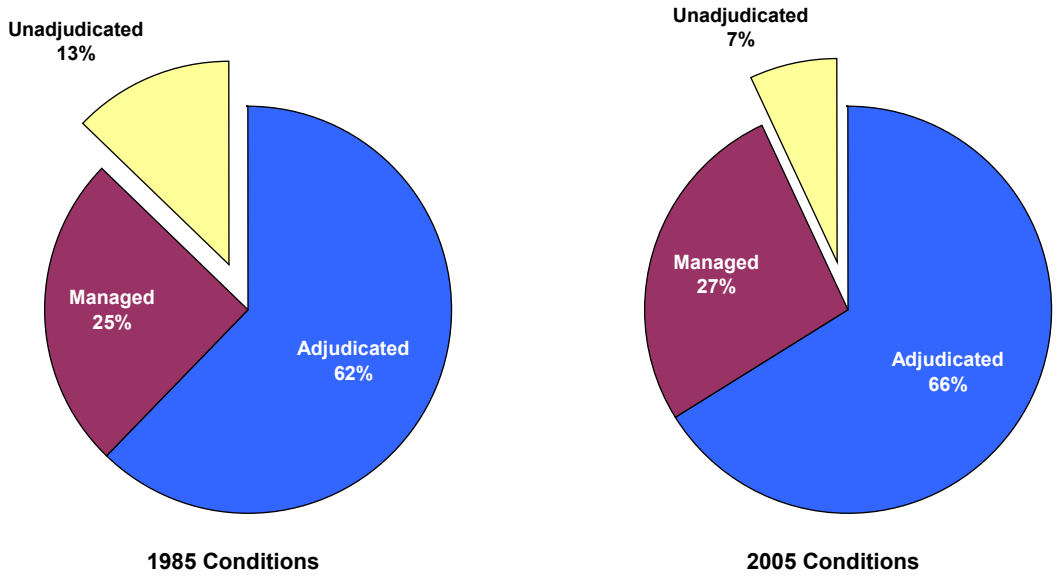
- Formally adjudicated with respect to production, water levels, or downstream flows within the basin,
- managed by an agency created and given authority by State statute,
- managed pursuant to an adopted groundwater management plan developed in accordance with the State water code provisions,
- managed informally by city ordinance or by consensus among some or all of the producers, and
- not governed, managed or adjudicated.

More than 90 percent of the groundwater resources within the Metropolitan service area are adjudicated or formally managed pursuant to statute or adopted groundwater management plan. **Plate III-1** shows the basins as adjudicated, formally managed, or unadjudicated. Basins with a court judgment are included in the 'adjudicated' category. Basins with either a statutory

management agency or adopted groundwater management plan are shown as formally managed. Two substantial basin areas are managed pursuant to state statutes creating groundwater management agencies: the Ventura County basins within the jurisdiction of the Fox Canyon Groundwater Management Agency and the Orange County Basin managed by the Orange County Water District. Basins with groundwater management plans in progress, informal management, or no management framework are designated as 'unadjudicated' on **Plate III-1**.

As shown in **Figure III-1**, nearly two-thirds of the total groundwater production in the Metropolitan service area during 2004/05 was pumped from an adjudicated basin and about 27 percent from a managed basin (combined from both adjudicated and managed is about 93 percent). Only 7 percent of the total groundwater production is pumped from unadjudicated basins. Seven groundwater basins have become managed or adjudicated since 1985, which accounts for the decrease of about 6 percent in production from unadjudicated basins.

Figure III-1
Groundwater Production Classified by Basin Management Type



Of those shown as unadjudicated in 2005, many are in process of moving toward status as formally managed. For example, a groundwater management plan for the Hemet-San Jacinto Basins is likely to be adopted in 2007, superseding the existing judgment covering two of the subbasins in that group. The city of Corona is also preparing a groundwater management plan for the Temescal Basin. The city of Beverly Hills has adopted ordinances that place requirements on groundwater dewatering activities within the Hollywood Basin. The San Luis Rey Watershed Council adopted Watershed Management Guidelines in 2000. The Sweetwater Authority adopted an Interim Groundwater Management Plan in 2001 for the Sweetwater Basins

and the San Diego Formation. Additionally, consideration is being given to formal management of the San Dieguito River Basins and Mission Valley Basin in San Diego County. Management of each groundwater basin has features and characteristics that are unique. These unique features are due to need, specific physical characteristics of basins, history, and preferences of the parties within each of the basins. **Appendix B** summarizes the status of groundwater basin management and summarizes the key provisions of the statutes, judgments, and management plans addressing basins covered by this report.

Safe Yield in Basin Management

Safe yield is generally defined as the maximum quantity of water that can be withdrawn from a groundwater basin over a long period of time without resulting in adverse conditions. Safe yield is typically determined by technical professionals based upon a defined hydrology, water levels or groundwater models and is often used to define the legal rights to extract groundwater in a basin. An operational safe yield may be defined to address short-term basin changes. The natural safe yield (or native safe yield) is often used to define the yield of a basin without active recharge and, in basins where active recharge is common, stresses the importance of groundwater recharge operations in basin management. Safe yield estimates among basins generally differ in how active recharge is handled. Because of these differences, the definition of safe yield is often basin-specific.

For example in the San Fernando Basin, the judgment distinguishes between native safe yield (portion of safe yield derived from native waters) and safe yield (includes return flows from imported water), and divides pumping rights based on native and imported water origins. In contrast, the Raymond Basin judgment sets out fixed pumping rights based upon a safe yield calculation that factors in natural recharge alone and does not include active recharge of runoff. In Raymond Basin, rights to divert surface water for spreading are separately specified for the basin water rights holders so that pumping rights are adjusted upward by recharge activities utilizing native water. In further contrast is the Six Basins judgment which sets out safe yield that is inclusive of active spreading and imported water return flows.

The determination of safe yield may also include quantitative measures to evaluate when adverse conditions occur. Adverse conditions include such things as permanently lowered groundwater levels, subsidence, or degradation of water quality in the aquifer. This is particularly important in basins in which seawater intrusion is a factor. For example, the Ventura County Basins operate under a safe yield that is based upon maintaining water levels to prevent seawater intrusion or migration of contaminants among aquifers. This safe yield is significantly lower than the safe yield determined based on a hydrologic water balance alone.

A basin is in overdraft if the amount of water pumped from the basin exceeds the safe yield of the basin over a period of time. Pumping in individual years may vary above or below the long-term yield of the basin during drought or wet years, or as dictated by basin management strategies and does not necessarily mean that a basin is in overdraft. Basins such as the Orange County Basin may allow short-term “overdraft” of the basin (based upon change in storage) to meet management goals yet have established a maximum accumulated overdraft

allowable that prevents adverse conditions within the basin. The Basin Pumping Percentage (BPP) is used to maintain the storage in the Orange County Basin within this desired range.

It is also important to recognize that if water management or other factors in the basin change, the safe yield of the basin may also change. Cultural or land use factors that were in place at the time that the technical calculations were performed are also important. Where land use has changed considerably, the safe yield may no longer reflect actual conditions. This is particularly important in basins where impervious cover has increased runoff and reduced recharge. Where rights to produce groundwater are fixed and are not adjusted based on key well elevations or other on-going type of measurement, the basin may become over drafted even though adjudicated. On-going monitoring of water levels by watermasters is helpful to identify these types of situations so that appropriate management actions can be implemented.

This variability is important to understanding the role of imported water in the sustained operations of the groundwater basins. It is important to note that imported replenishment water is factored into the safe yield and fixed rights for production of groundwater in some groundwater basins while in other basins, imported replenishment water allows increased pumping. While all the managed and adjudicated basins are focused at sustainability, as described below, the means of getting there can vary.

Methods of Sustainable Basin Operations

One of the key objectives of groundwater basin management is to provide for sustainable operations of the groundwater basin over the long term. This means that long-term recharge and production or discharge of groundwater is balanced and that the basin is operated within its safe yield. Each basin has developed unique management characteristics for accomplishing this objective. Examples of various management operation styles are described below.

Some basins are managed or adjudicated to maintain a fixed maximum amount of groundwater pumping from year to year. For example, the Central Basin has been adjudicated with a fixed pumping allocation above the native safe yield of the basin, which requires supplemental recharge with imported and recycled water to support the fixed pumping rights of the groundwater producers. The amount of supplemental recharge is dependent upon annual hydrologic conditions. The Water Replenishment District of Southern California was created by statute with duties for accomplishing the supplement recharge. The watermaster function is focused on strict accounting pursuant to the established rules.

Other basins are managed or adjudicated to allow for variations in groundwater pumping but still maintain sustainable operations. For example, the judgment for the Main San Gabriel Basin provides for setting an annual operational safe yield with associated adjustments in pumping rights that are not subject to payment for replacement water. Producers may pump in excess of the annual pumping right set through this process, but this excess production is subject to payment for imported supplemental water to recharge the basin. The watermaster is a board comprised of representatives of the basin producers, and makes decisions regarding setting of the annual operational yield.

The Orange County Basin management model is similar to the Main San Gabriel Basin model. In the Orange County Basin pumping limits are not fixed. The Orange County Water District (OCWD) establishes the annual Basin Pumping Percentage (very similar to annual operating safe yield), and production over the BPP incurs costs (basin equity assessment). The key difference is that the Orange County Basin's BEA will parallel Metropolitan's full service water costs (this is a price signal associated with basin management objectives), whereas the cost of replacement water in Main San Gabriel Basin will parallel the cost of replenishment water from Metropolitan's member agency and from the San Gabriel Valley Municipal Water District. Water supply strategies adopted in Main San Gabriel and Orange County basins differ in that water purveyors in Main San Gabriel Basin are mostly dependent on groundwater. In Orange County Basin, water purveyors use both imported water and groundwater and the BPP dictates the percentage of each that is used.

Chino Basin is also similar to the Main San Gabriel Basin with respect to safe yield and pumping. In Chino, the safe yield is specified in the judgment and divided among three groups or pools of producers. This production is sustained by natural recharge and no replenishment costs are assessed to support it. The judgment allows production in excess of the safe yield, but requires the replacement of these pumped amounts that then incur the replenishment obligation costs.

Provisions for Groundwater Storage and Recapture

In many basins, groundwater storage is an important aspect of groundwater management. A review of basin adjudications and management plans has pointed out differences in the allowances made for storage and recapture of surplus water. Most of the judgments, statutes, and plans for groundwater basin management clearly provide for storage and recovery of surplus water. In most cases, the basin manager or watermaster must approve of the storage and extraction, and provide accounting for the stored and extracted water. Of note, however, are the judgments in Central, West Coast, and Puente basins that do not provide for more than carryover of limited unpumped rights. Further, the Central Basin judgment appears to restrict recovery of water not expressly provided for in the specification of fixed pumping rights. Also of note is the provision of the Orange County Water District Act which gives OCWD the power to regulate and control the storage of water and use of groundwater basin storage space but also gives the directive that use of the groundwater basin for replenishing and managing the groundwater supplies shall have priority over use of the groundwater basin for storage of water.

BASIN OPERATIONS

The following section describes current operations in the groundwater basins within the Metropolitan service area. This section includes a description of groundwater facilities, production, active recharge and treatment.

Groundwater Facilities

Groundwater facilities identified within the service area include:

- More than 4,300 active groundwater production wells
- 36 ASR wells
- 5,000 acres of spreading
- 400 acres of water quality wetlands
- 7 seawater intrusion barriers and
- 16 desalters

The locations of these facilities are shown on **Plate III-2**. These facilities are summarized by region in **Table III-1**.

Groundwater Production

One of the factors that affect groundwater production is precipitation. The locations of representative precipitation stations and key wells are shown in **Plate III-3**. Average precipitation is approximately 15.2 inches (based upon average of 17 stations throughout service area). Periods 1985/86 to1994/95 and 1995/96 to 2004/05 have approximately equal precipitation. Each period had two significantly wet years. Cumulative departure from mean curves (which both begin and end at approximately zero) suggest similar hydrologic conditions between the two periods. As shown in **Figures III-2 and III-3**, groundwater production generally increases during periods of low precipitation and decreases during periods of high precipitation. Groundwater production varies as much 30 percent between the wettest and driest years.

Changes in production patterns are important to understanding the water supply needs of the region. Groundwater production currently meets about 40 percent of the total water demand within the Metropolitan service area. Groundwater production increased about 8 percent from the period between 1985/86 and 1994/95 to the period between 1995/96 and 2004/05. These changes are summarized in **Plate III-4**. Likewise, full- service plus agricultural Metropolitan deliveries increased 14 percent over this same period. Groundwater production increased in all areas except in the Northwest Metropolitan service area, which decreased 20 percent due to mandatory pumping restrictions implemented to address declining water levels and seawater intrusion. The largest increases in production occurred in the San Fernando Valley and the Eastside portion of the Metropolitan service area. The smallest increases were noted in Los Angeles Coastal Plain and San Diego County. Small increases in the Los Angeles Coastal Plain are a result of strict pumping limits in these basins under their respective adjudications. Data summarized by region are provided in **Table III-2**.

Active Groundwater Recharge

Active groundwater recharge is an important component of groundwater management within the Metropolitan service area. The term ‘active recharge’ is used herein to mean all artificial

recharge using local (i.e. runoff diverted to spreading basins), imported and recycled waters exclusive of natural recharge.

Table III-1
Groundwater Facilities in Metropolitan Service Area

Sub-Region	Active Wells	ASR/ Injection Wells	Spreading Basins (acres)	Water Quality Wetlands (acres)	Seawater Barriers	Desalters
Northwest Service Area	611	19	220	0	0	1
San Fernando Valley	146	0	314	0	0	0
San Gabriel Valley	414	7	1,930	0	0	0
Los Angeles Coastal Plain	1,382	4	1,006	0	3[1]	3
Orange County	500	0	1,034	400	1[1]	3
Inland Empire	773	2	350	0	0	2
Eastside Service Area	453	4	53	0	0	5
San Diego County.	85 [3]	0	65	0	3[2]	2
Total	**4,364**	**36**	**4,972**	**400**	**7**	**16**

1. Alamitos Barrier Project is attributed to the Los Angeles Coastal Plain region.
2. Wastewater effluent from Camp Pendleton is spread to create seawater intrusion barriers in San Mateo, and San Onofre Basins and injected in the Las Flores Basin.
3. Data for several basins in San Diego are incomplete.

Table III-3 summarizes the active recharge in the Metropolitan service area by region. **Figure III-4** shows the total active recharge within the Metropolitan service area for the period 1985 through 2004. For this 20-year study period, an average of approximately 681,000 AFY or about 90 percent of the total active recharge was recharged to the groundwater basins by direct

recharge methods (i.e. injection or spreading). For this period, about 77,000 AFY was recharged to the groundwater basins via in-lieu methods.

Figure III-2
Precipitation in Metropolitan Service Area

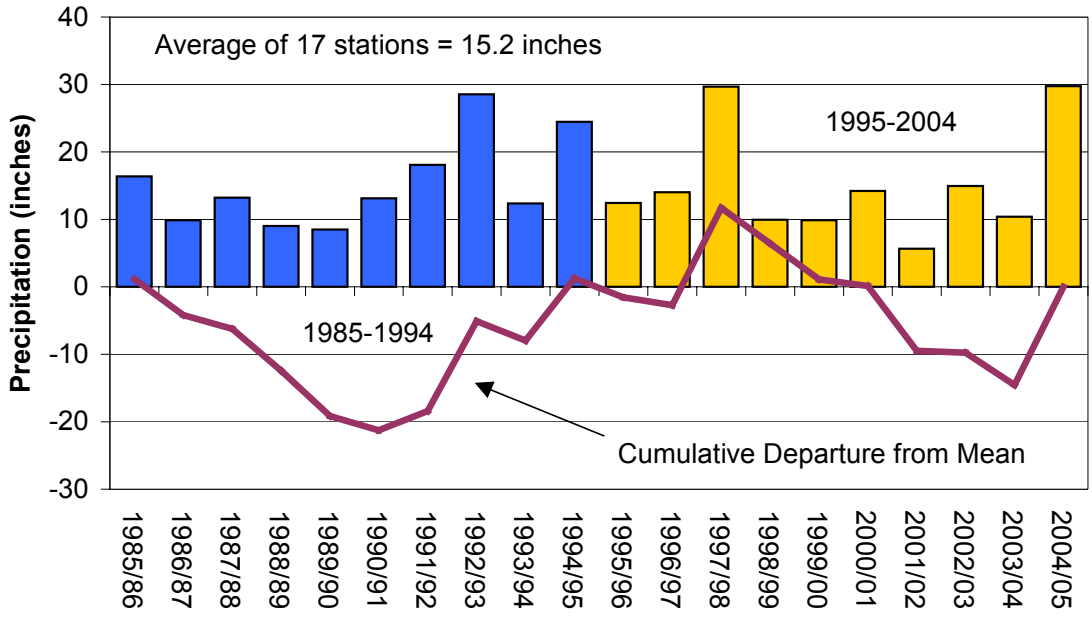


Figure III-3
Groundwater Production in Metropolitan Service Area

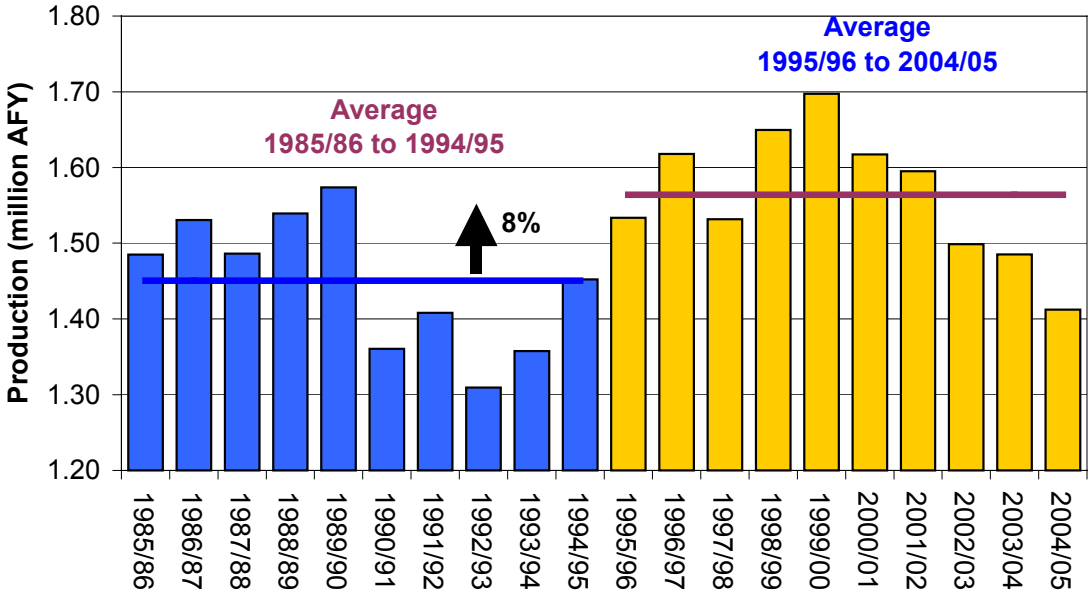


Table III-2
Groundwater Production in the Metropolitan Service Area by Sub-Region

Sub-Region	Average 1985-2004 (AFY)	Average 1985-1994 (AFY)	Average 1995-2004 (AFY)	Percent Change 1985-94 to 1995-04
Northwest Service Area	137,000	152,000	122,000	-20%
San Fernando Valley	99,000	90,000	109,000	21%
San Gabriel Valley	308,000	297,000	320,000	8%
Los Angeles Coastal Plain	244,000	241,000	248,000	3%
Orange County	297,000	275,000	318,000	16%
Inland Empire	172,000	164,000	181,000	10%
Eastside Service Area	197,000	181,000	213,000	18%
San Diego County	52,000	51,000	52,000	3%
Total	**1,506,000**	**1,451,000**	**1,563,000**	**8%**

Note: Data are rounded to nearest 1,000 AF.

Methods of groundwater recharge have generally remained unchanged over the past 20 years as the relative proportion of each method are essentially the same between the 1985/86 to 1994/95 and 1995/96 to 2004/05 time periods as shown in **Figure III-5**. Likewise, the total recharge remained nearly constant with a decrease of about 2 percent between the two timeframes.

Recharge of captured runoff is by far the largest component of active recharge. When comparing the recharge portfolios for the two timeframes, the percentage of the recharge accomplished with use of runoff increased by 7 percent. Moreover, use of imported water for recharge as a component of the total groundwater recharge portfolio decreased 5 percent when comparing the two, ten-year timeframes (as shown in **Figure III-5**). In addition, the amount of active recharge supporting production decreased from 53 to 48 percent as shown in **Table III-4**. In other words, groundwater production grew about 5 percent more than artificial recharge between the two timeframes.

Trends in groundwater recharge have been examined in two different ways. **Table III-3** compares average annual recharge by sub-region for the two, ten-year time frames. These data include direct and in-lieu recharge as well as recharge that was accomplished under the cyclic pre-delivery program.

Table III-3
Groundwater Recharge in Metropolitan Service Area by Sub-Region

Sub-Region	Average 1985-2004 (AFY)	Average 1985-1994 (AFY)	Average 1995-2004 (AFY)	Change 1985-94 to 1995-04 (%)
Northwest Service Area	60,000	57,000	64,000	13%
San Fernando Valley	31,000	28,000	34,000	20%
San Gabriel Valley	169,000	168,000	170,000	2%
Los Angeles Coastal Plain	195,000	221,000	170,000	-23%
Orange County	257,000	243,000	271,000	11%
Inland Empire	23,000	28,000	18,000	-36%
Eastside Service Area	23,000	22,000	23,000	4%
San Diego County	0	0	0	0%
Total	**758,000**	**767,000**	**750,000**	**-2%**

Note: Data are rounded to nearest 1,000 AF.

Table III-4
Comparison of Production to Active Recharge for the Metropolitan Service Area 1985-1994 to 1995-2004

Component	Average 1985-1994 (AFY)	Average 1995-2004 (AFY)	Change %
Production	1,451,000	1,563,000	8%
Active recharge	767,000	750,000	-3%
Percent of Production Supported by Active Recharge	53%	48%	-5%

Note: Data are rounded to nearest 1,000 AF.

Figure III-4
Active Recharge in the Metropolitan Service Area 1985 to 2004

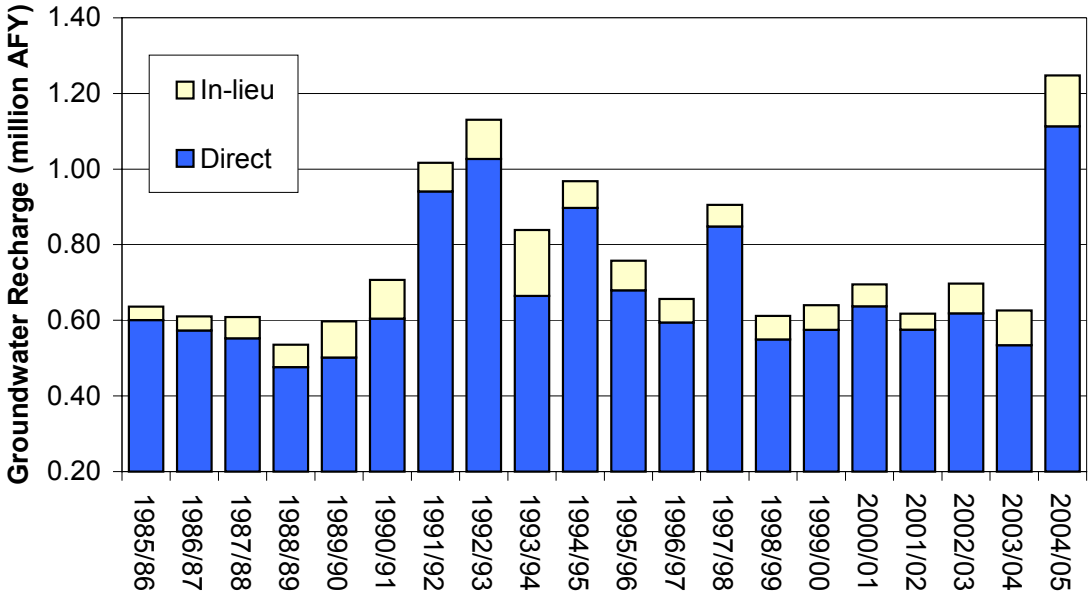


Figure III-5
Comparison of Recharge in the Metropolitan Service Area
1985-1994 to 1995-2004

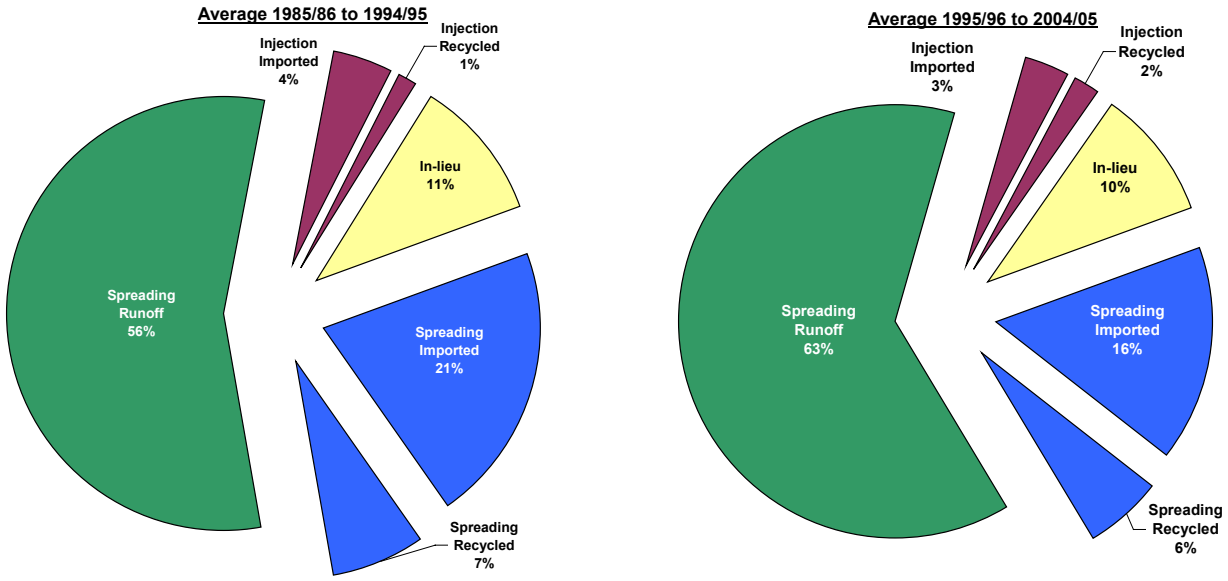


Plate III-5 compares direct recharge within the sub-regions for two wet years, 1992/93 and 2004/05. Each of these wet years was preceded by a series of drier years as shown on **Figure III-2**. This comparison presents a different picture for recharge. In most sub-regions, total direct recharge for these two years was either relatively constant or showed substantial increases in recharge. This may be due in part to rainfall patterns during the course of each of the two years and to investments and increased efforts to capture runoff. Of note, active recharge in the Northwest subregion declined between these two years. This is a result of less water recharged from the Santa Clara River. A comparison of the two years is not made for the San Diego County basins due to limited available data.

In 2004/05, direct recharge used about 60 percent of the reported available capacity for spreading and injection. Total direct recharge (all sources of water) for the year totaled about 1.11 million AF as compared to the reported capacity of 1.85 million AFY for spreading and injection. This usage rate reflects rainfall patterns, and availability of regional and local conveyance and recharge capacity.

Groundwater Treatment

Many new groundwater treatment facilities have been constructed since 1985, which have greatly increased the amount of groundwater that can be used for beneficial uses. Groundwater treatment and blending needs within the Metropolitan service area are summarized in **Table III-5**.

Approximately 21 percent (300,000 AF) of groundwater production in 2004/05 was either treated or is blended for water quality considerations. These estimates are based upon data received from basin managers or groundwater producers. Because the amount of water blended is often not measured, the estimate of amount blended could be significantly underestimated. About 40,000 AF, or nearly 20 percent of the water treated, was produced in 2004/05 as part of Metropolitan's LRP Groundwater Recovery Projects. Nearly all of the treated groundwater is treated for TDS, nitrate, volatile organic compounds (VOCs), or perchlorate.

The largest percentage of treated or blended groundwater occurs in the San Fernando Valley and San Gabriel Valley, where significant VOC plumes have been identified, and in the Eastside and the San Diego County basins where high TDS groundwater is common. For example, many of the San Diego basins are not used for municipal demand because of high TDS. The Arlington, Temescal, Perris and Menifee Desalters in the Eastside area basins have come online since 1985, which has greatly increased the treatment capacity in these basins.

Lower percentages of treated groundwater are found in Northwest, Orange County, and Los Angeles Coastal Plain basins. The Northwest area basins are largely used to serve agricultural demand, for which significant treatment is not needed. On the other hand, about 15 percent of the municipal groundwater in the Fox Canyon GMA is treated or blended. Because large portions of the Los Angeles and Orange County basins are protected from surface contaminants by clay aquitards, these basins tend to have less of a need to treat produced groundwater.

Table III-5
Groundwater Treatment and Blending in Metropolitan Service Area by Sub-Region in 2004

Sub-Region	Treated (AF)	Blended (AF)	Treated or Blended (AF)	Percent Treated	Percent Treated or Blended
Northwest Service Area	3,000	10,000	13,000	2%	11%
San Fernando Valley	18,000	51,000	69,000	22%	88%
San Gabriel Valley	83,000	4,000	87,000	28%	29%
Los Angeles Coastal Plain	15,000	0	15,000	6%	6%
Orange County	20,000	2,000	22,000	8%	8%
Inland Empire	12,000	7,000	19,000	7%	11%
Eastside Service Area	50,000	11,000	61,000	24%	29%
San Diego County	14,000	0	14,000	27%	27%
Total	**215,000**	**85,000**	**300,000**	**15%**	**21%**

Note: Data are rounded to nearest 1,000 AF.

GROUNDWATER LEVELS AND CHANGE IN STORAGE

Groundwater level changes between 1985 and 2004 are highly variable throughout the Metropolitan service area. In some basins, water levels are increasing while in others, they are decreasing. In addition, it is not uncommon for some portions of the basin to be increasing while other areas within the basin are decreasing or stable.

Five general patterns of water level trends have been identified for the groundwater basins in the Metropolitan service area. These are:

- basins in slow decline
- basins in arrested decline and recovery
- basins with stable, flat water levels
- basins with stable average water levels but with wide swings
- basins with rising water levels often due to poor water quality and decreases in use

A few basins also calculate annual changes in storage. In general, these estimates correlate well with changes in water level and help to quantify the relative importance of water level changes. A summary of groundwater level and storage trends is provided in **Table III-6**.

A number of groundwater basins have had slowly declining water levels over the study timeframe. These include the San Fernando, Raymond, Hemet-San Jacinto, Elsinore and Temescal basins. In all cases, the decline is recognized but turnaround is not yet seen in the data. Both the San Fernando and Raymond basins are adjudicated with pumping restrictions tied to fixed estimate of safe yield recognized in the judgment. For example, total groundwater in storage has decreased about 12 percent in the Raymond Basin since 1985. These situations point out the need to monitor and re-assess safe yield as cultural conditions change and a longer period of record becomes available. In addition, several of the groundwater basins in Riverside County have declining water levels.

The Ventura County basins within the jurisdiction of the Fox Canyon Groundwater Management Agency also showed declining water levels between 1985 and 1990. The GMA has instituted mandatory production cutbacks of 20 percent in these managed groundwater basins to allow recovery of groundwater levels and halting of seawater intrusion. Since 1990, most of these basins have shown a healthy recovery in groundwater level.

The Central and Chino basins are examples of basins operated such that water levels are generally very stable from year-to-year. Each of these basins has a drawdown area, but overall water levels are consistent. In Central Basin, the judgment restricts pumping to a safe yield that depends upon active recharge from runoff, recycling and imported water sources. The Water Replenishment District of Southern California has statutory responsibility to recharge the Central Basin. This combination of management has resulted in the stable water levels.

The Orange County and Main San Gabriel basins, managed and adjudicated, respectively, provide examples of basins with stable water levels over the long-term but with operational swings in the short-term. Each of these basins is very responsive to stormwater recharge, and the management structures in each case provide sufficient flexibility to take full advantage of the hydrologic conditions.

Table III-6
Groundwater Storage and Water Level Changes in Metropolitan Service Area

Sub-Region	Change in Storage 1985-2004 (AF)	Change in Storage 1985-2004 (%)	Water Level Changes (1985-2004)	Status
Northwest Metropolitan Service Area				
Ventura County Basins	Insufficient data to determine		Water levels in key wells increased 25 to 50 feet in the inland basins since 1990. Water levels in key wells in coastal areas increased as much as 120 feet between 1990 and 1995 and have remained relatively stable since that time.	Arrested decline and recovery
San Fernando Valley				
San Fernando	-108,245	-4%	Water levels in key wells dropped 25 to 50 feet	Long-term decline
Sylmar	Insufficient data to determine		Water levels in key wells increased about 15 feet	Rising
Verdugo	Insufficient data to determine		Water levels in key well decreased 40 feet	Long-term decline
Eagle Rock	Insufficient data to determine			Insufficient Data
San Gabriel Valley				
Raymond	-114,410 (through 2002)	-12%	Water levels in key wells in eastern portion of Pasadena unit and Santa Anita unit decrease about 75 feet. Despite increases of between 50 and 100 feet in key wells in Monk Hill and western portion of Pasadena unit, net decrease in water level and storage is noted.	Long-term decline
Main San Gabriel	Insufficient data to determine		Water levels in key well suggest that water levels in basin are essentially unchanged.	Stable with wide swings
Puente	Insufficient data to determine		Water levels in key well suggest that water levels in basin are essentially unchanged.	Stable with flat water levels
Six Basins	Insufficient data to determine		Water levels in key wells in upper basins decrease as much as 70 feet. Water levels in key well in Pomona basin increases about 150 feet	Rising
Los Angeles Coastal Plain				
Central	27,101	+ Less than 0.5%	Water levels in keys well increase less than 10 feet in the forebay areas and decrease about 15 feet in the forebay areas.	Stable with flat water levels
West Coast			Water levels in key well increased about 10 feet.	Stable with flat water levels
Hollywood	Insufficient data to determine		Water levels in key wells in the eastern portion of the basin are essentially unchanged.	Stable with flat water levels

Table III-6 (continued)
Storage and Water Level Changes in Metropolitan Service Area by Region

Region	Change in Storage 1985-2004 (AF)	Change in Storage 1985-2004 (%)	Water Level Changes (1985-2004)	Status
Los Angeles Coastal Plain (continued)				
Santa Monica	Insufficient data to determine		Water levels in key wells increased from 20 to 50 feet in Arcadia and Charnock subbasins. Other basins remained unchanged.	Rising
Orange County				
Orange County	-110,000 (through 2004/05)	- Less than 0.5%	Water levels in key well in south-central pressure area decreased up to 70 feet that may be due to seasonal variations. Water levels in key wells are essentially unchanged in northern central pressure and forebay locations.	Stable with wide swings
San Juan	Insufficient data to determine		Insufficient data to determine	Insufficient Data
Inland Empire				
Chino	Insufficient data to determine		Water levels in key wells are essentially unchanged throughout most of the basin.	Stable with flat water levels
Cucamonga	Insufficient data to determine		Water levels in key well decreased about 120 feet.	Long-term decline
Eastside Metropolitan Service Area				
Riverside	Insufficient data to determine		Water levels in key well in Riverside North are stable. Water levels in key well in Riverside South dropped about 30 feet.	Stable/Decreasing
Arlington	Insufficient data to determine		Water Levels in key well near desalter wells dropped 50 feet. Other wells in basin seem to be stable.	Stable with flat water levels
Temescal Valley	Insufficient data to determine		Water levels in key well in Temescal Basin dropped about 50 feet. Water levels in key well in Coldwater Basin dropped about 200 feet. Water levels in Lee Lake and Bedford were stable.	Long-term decline
Elsinore	-43,343	-4%	Water levels in key wells dropped as much as 240 feet.	Long-term decline
West San Jacinto	Insufficient data to determine		Except for the San Jacinto Lower Pressure area, water levels are increasing in key wells as much as 90 feet	Rising
Hemet-San Jacinto	-219,235	-8%	Water levels are declining in all basins with drops ranging from 20 to more than 100 feet.	Long-term decline
Temecula-Murrieta	Insufficient data to determine		Water level in key well dropped about 75 feet.	Long-term decline
San Diego Co	Insufficient data to determine			Insufficient Data

AVAILABILITY OF GROUNDWATER BASIN STORAGE

As of June 2006, there is at least 7.5 million AF of unused storage space in the groundwater aquifers within the Metropolitan service area, assuming that all the unsaturated space below the ground surface or the full basin level could be used for groundwater storage programs. Clearly, not all the unsaturated space identified can be used. For example, groundwater levels within 50 to 100 feet of the ground surface increases the risk for liquefaction so the upper 50 to 100 feet is generally not considered usable for storage. In addition, because of some overlying land uses that may require lower groundwater levels (e.g. gravel mining, landfills), the entire unused portion may not be able to be used for storage. Given these considerations, the estimated amount of the unused space that could potentially be used for storage is referred to herein as *available storage space*. As of June 2006, there is approximately 3.2 million AF of available storage space within the Metropolitan service area, a portion of which has already been allocated for groundwater storage programs but has not been stored yet, as described below. The estimated available storage space does not consider the feasibility of actually delivering water or the facilities needed to store and extract the water. **Table III-7** summarizes the amount of groundwater storage space available by sub-region. **Plate III-6** shows the distribution of the available storage space.

Feasibility may be affected by institutional uncertainties, expense of necessary capital investment for storage, extraction, and/or conveyance of water supplies, water quality issues including contaminant remediation operations, lack of overlying demand for imported water supplies, watermaster allocations of storage space for long or short-term use, or other factors.

For example, nearly 1 million AF of available storage space has been identified for the Ventura County basins. Evaluations of feasibility of a storage program in these basins would need to consider factors such as the current distribution of demand for imported water supplies, sources of water available for storage, and concern for migration of contaminants, particularly in the coastal areas. Similarly, more than 500,000 AF of storage space is available in the San Fernando Valley, but use of a portion of this storage capacity would need to consider the on-going contaminant remediation operations in the basin and ensure that neither clean-up nor stored water would be compromised.

Further, management objectives within each basin must be considered. For instance, the Orange County Water District Act directs that basin operations take priority over storage. Basins such as Orange and Main San Gabriel allocate basin space to capturing runoff available during periodic wet years, while also allocating a portion of the available space to address dry-year needs. The Main San Gabriel Basin has cyclic agreements to store up to 180,000 AF of pre-delivered replenishment water. Orange County Basin has, to date, allocated 66,000 AF to long-term dry-year storage and an additional 16,000 AF to mid-term storage. Chino Basin has allocated up to 500,000 AF of storage space to long-term storage and has entered an agreement with Metropolitan for 100,000 AF of that. Chino Basin is also considering a re-operation of the basin to generate additional operational benefits. Lastly, the parties in Central and West Coast basins are discussing the allocation and institutional structure to manage 450,000 AF of available space within those basins.

Table III-7
Available Groundwater Storage Space in Metropolitan Service Area by Sub-Region

Sub-Region	Portion of Unused Storage Space Available for Storage (AF)	Amount Allocated to MWD [1] (AF)	Amount in account as of June 2006 (AF)	Net Portion of Unused Storage Space Available [2] (AF)
Northwest Service Area	1,000,000	210,000	55,000	945,000
San Fernando Valley	504,000	0	0	504,000
San Gabriel Valley	270,000	177,000	83,000	245,000
Los Angeles Coastal Plain	450,000	19,000	15,000	450,000
Orange County	135,000	82,000	51,000	135,000
Inland Empire	500,000	100,000	61,000	439,000
Eastside Service Area	512,000	12,000	0	500,000
San Diego County	19,000	0	0	19,000
Total	**3,390,000**	**600,000**	**265,000**	**3,237,000**

1. Includes Conjunctive Use, Supplemental Storage, Cyclic and Cooperative Storage Accounts
2. The estimate of available storage space does not account for institutional uncertainties, necessary capital investments, water quality considerations, and presence of overlying demand or other considerations.

Existing Groundwater Storage Programs

Metropolitan has historically supported groundwater storage programs within its service area. At this time, about 600,000 AF of groundwater storage is currently allocated for storage programs within the service area, including dry-year conjunctive use, supplemental storage and cyclic storage programs. As of June 2006, about 265,000 AF was in storage in these programs.

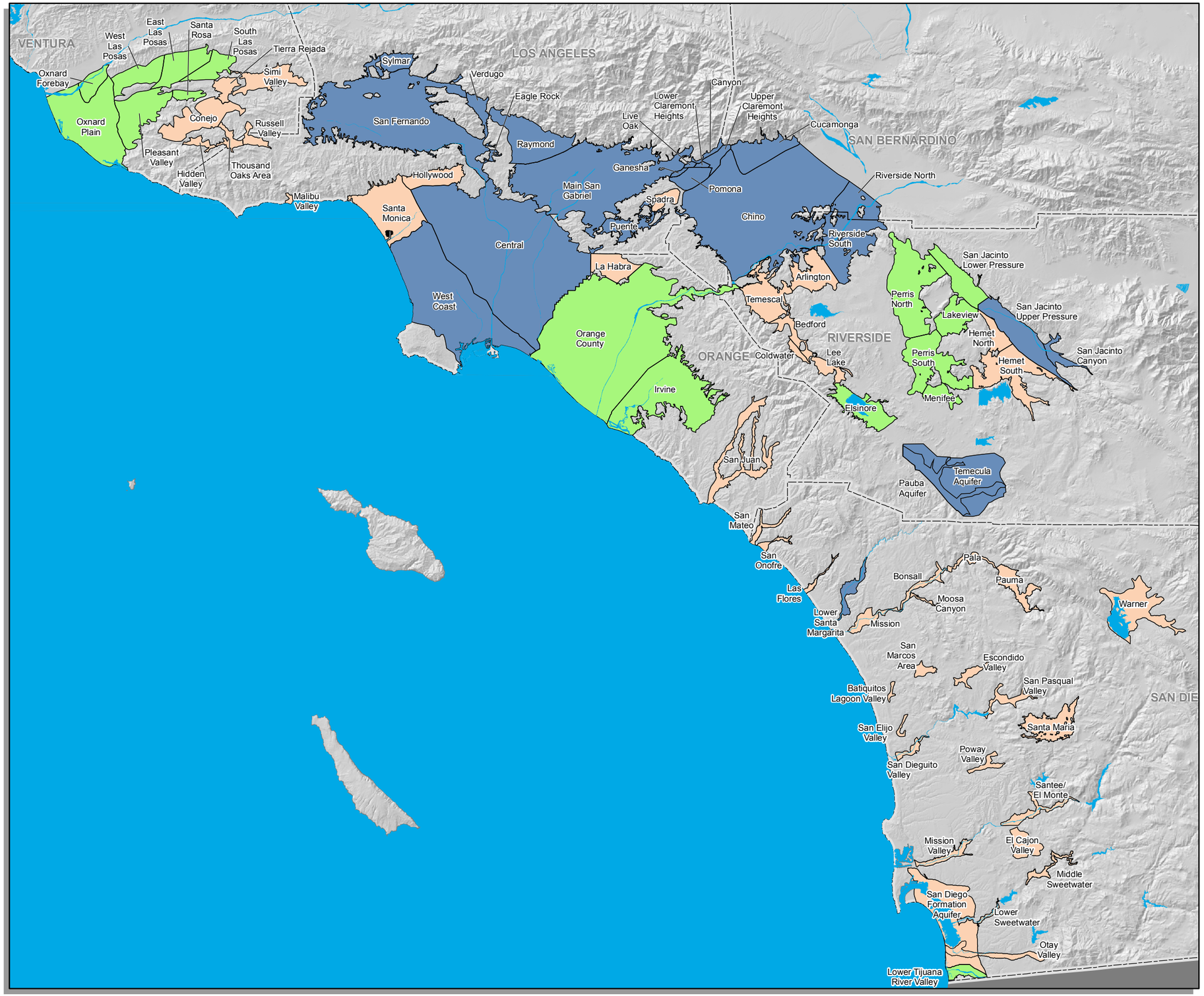
Plate III-7 shows the location of existing dry-year conjunctive use storage programs. The agreement for Metropolitan's initial contractual storage program was executed with the Calleguas Municipal Water District in 1995. Since then, an additional nine programs have been developed utilizing State Proposition 13 funds and Metropolitan capital funds. Facilities to implement these programs are currently under design and construction, and are anticipated to be fully operational prior to 2010. A tenth program, the Raymond Basin conjunctive use program, is currently in preliminary design and environmental review. **Table III-8** summarizes these programs.

Table III-8
Contractual Groundwater Dry-Year Conjunctive Use Programs in the Metropolitan Service Area in 2006

Basin	Partners	Total Storage (AF)	Dry Year Yield (AF)
Proposition 13 Programs			
Central Basin	Long Beach	13,000	4,300
Raymond Basin (Monk Hill)	Foothill MWD	9,000	3,000
Chino Basin	IEUA Three Valleys MWD Chino Basin Watermaster	100,000	33,000
Orange County Basin	MWDOC OCWD	66,000	20,000
Six Basins (Live Oak)	Three Valleys MWD City of La Verne	3,000	1,000
Central Basin	Compton	2,289	763
Central Basin	Long Beach with Lakewood	3,600	1,200
Six Basins (Upper Claremont Heights)	Three Valley MWD	3,000	1,000
Elsinore Basin	Western MWD Elsinore Valley MWD	12,000	4,000
Other Programs			
East Las Posas Basin	Calleguas MWD	210,000	47,000
Total Contracted Capacity	--	**421,889**	**115,263**
Programs in Process			
Raymond Basin (Monk Hill/Pasadena)	Pasadena Foothill MWD	66,000	22,000

SUMMARY

The status of groundwater in the Metropolitan service area is generally good. More than 90 percent of annual groundwater production is from basins that are either adjudicated or formally managed. Extensive groundwater facility improvements have been made over the past 20 years, which have supported an 8 percent increase in groundwater production. Improvements include construction of groundwater treatment facilities, a portion of which are funded under Metropolitan's LRP program. In 2004/05, more than 20 percent of the groundwater produced within the service area was treated or blended to address water quality issues. With respect to the water supply portfolio for recharge of the groundwater basins, the proportion of runoff used increased 7 percent while the use of imported water supplies decreased 5 percent. With respect to storage, nearly 600,000 AF has been allocated for Metropolitan storage in the service area to improve reliability. Up to 3.2 million AF of storage capacity could be developed in the future.



Legend

Management Category

- Adjudicated
- Unadjudicated
- State Management Statute or Adopted Groundwater Management Plan

Other Features

- Groundwater Basin Boundary
- County Boundary
- Water

N W E S

7 3.5 0 7 Miles

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Plate III-1

Groundwater Basin Management in 2006

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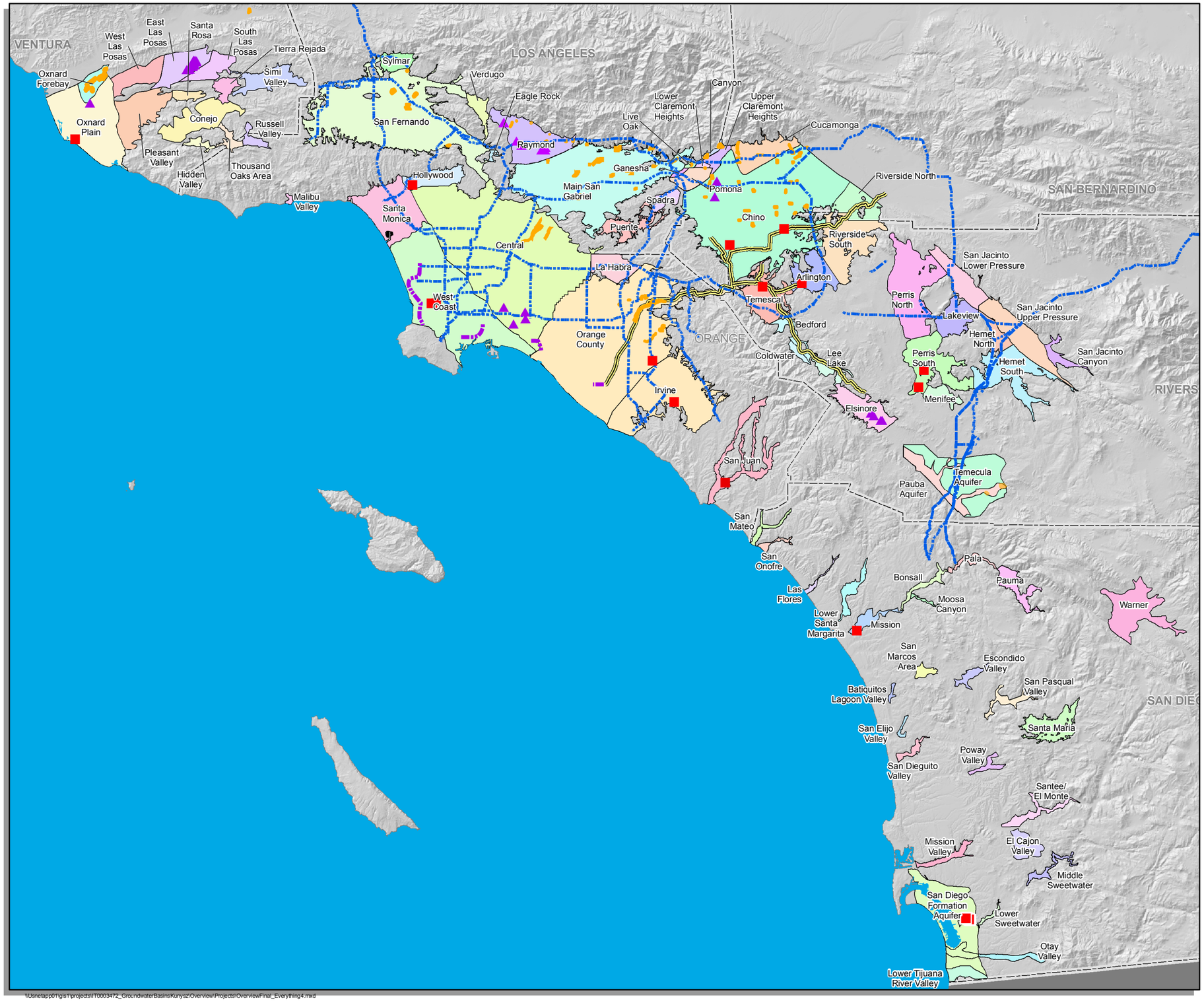

Legend

- ASR Well
- Desalter
- Seawater Barrier
- Santa Ana Regional Interceptor Line
- MWD Pipeline
- Spreading Facility/Recharge Basin

N W E S

7 3.5 0 7 Miles

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Plate III-2

Groundwater Basin Facilities as of 2006

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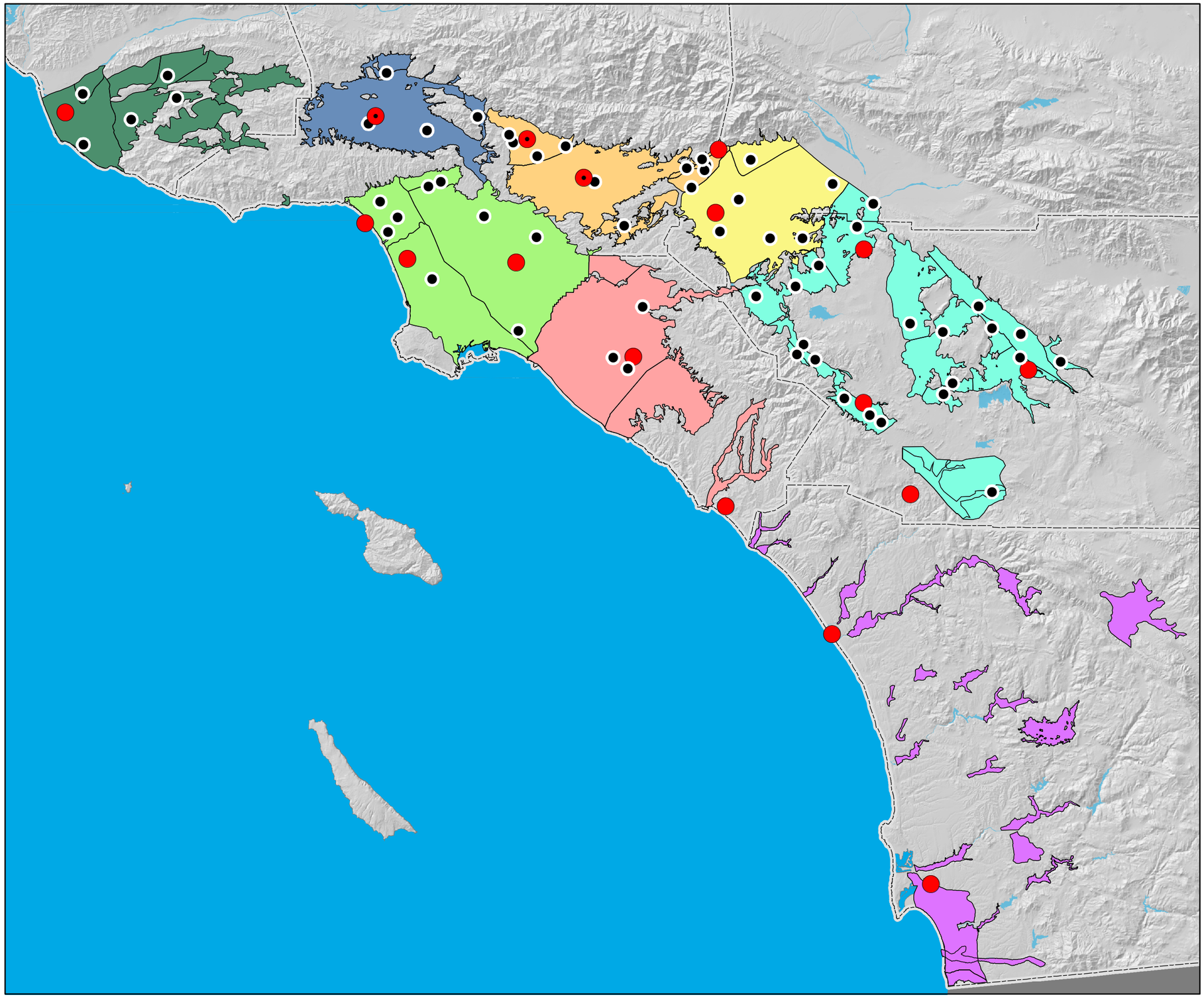

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Legend

Groundwater Basin Sub-Region

- Northwest Metropolitan Service Area Basins
- San Fernando Valley Basins
- Los Angeles County Coastal Plain Basins
- San Gabriel Valley Basins
- Orange County Basins
- Inland Empire Basins
- Eastside Metropolitan Service Area Basins
- San Diego County Basins

Other Features

- Average of Multiple Stations
- Precipitation Stations
- Key wells
- **Water Body**
- **County**

N W E S

7.5 3.75 0 7.5 Miles

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Plate III-3

Locations of Precipitation Stations and Key Wells

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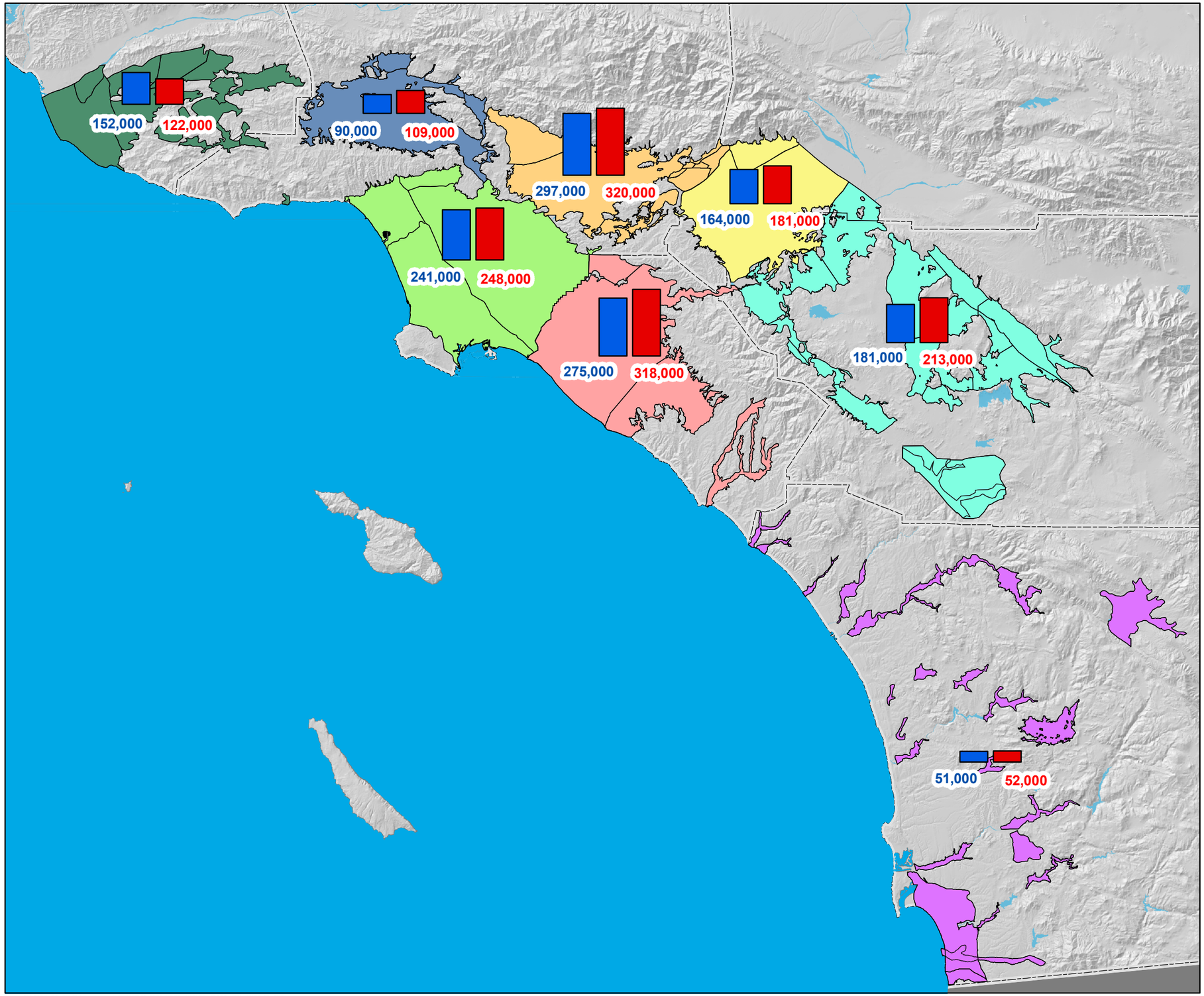

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Legend

Groundwater Basin Sub-Region

- Northwest Metropolitan Service Area Basins
- San Fernando Valley Basins
- Los Angeles County Coastal Plain Basins
- San Gabriel Valley Basins
- Orange County Basins
- Inland Empire Basins
- Eastside Metropolitan Service Area Basins
- San Diego County Basins

Average Annual Production (AFY)

- 160,000
- 1985/86 to 1994/95
- 1995/96 to 2004/05

Other Features

- Water Body
- County

N W E S

6 3 0 6 Miles

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Plate III-4

Trends in Average Annual Groundwater Production by Sub-Region

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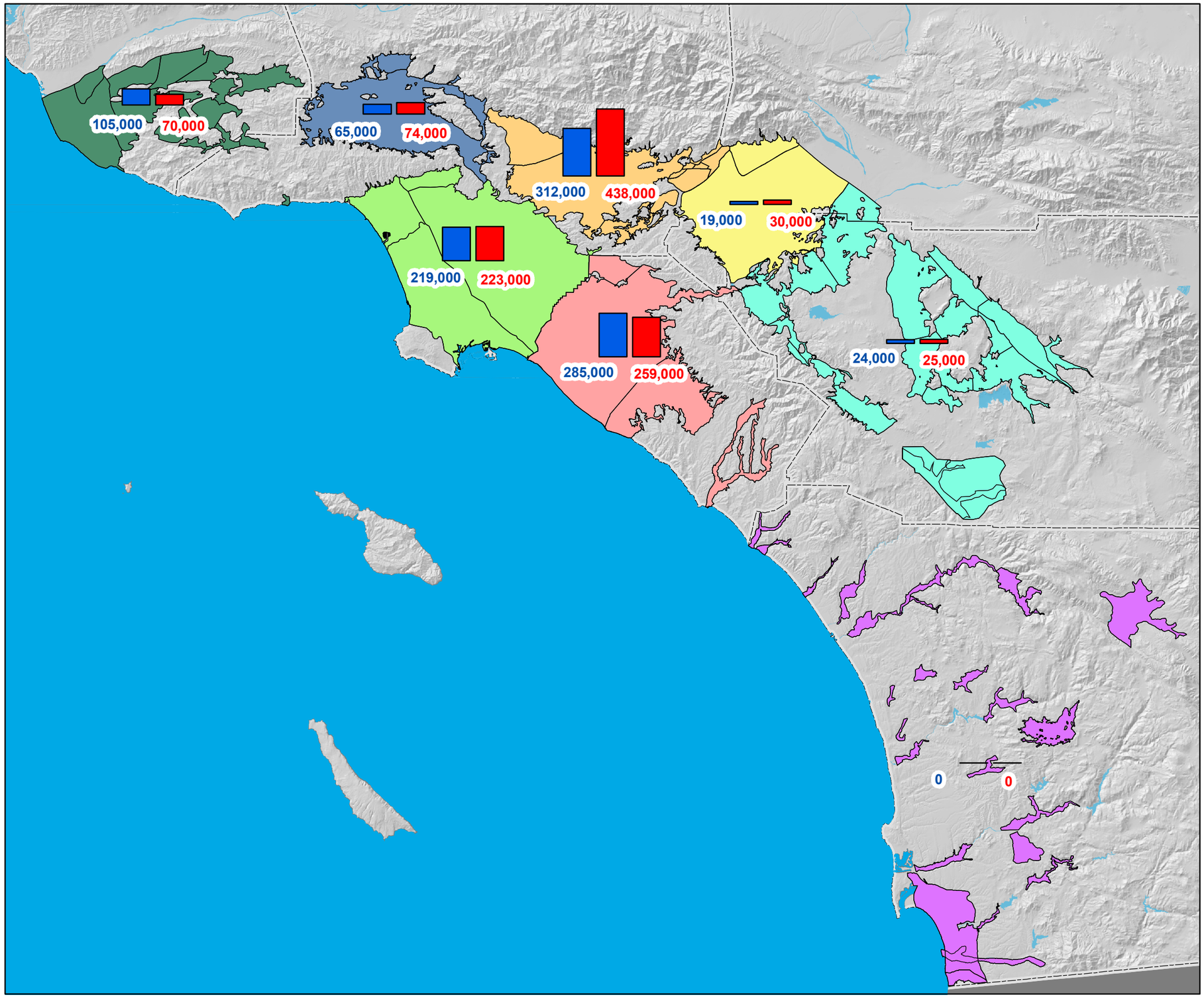

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Legend

Groundwater Basin Sub-Region

- Northwest Metropolitan Service Area Basins
- San Fernando Valley Basins
- Los Angeles County Coastal Plain Basins
- San Gabriel Valley Basins
- Orange County Basins
- Inland Empire Basins
- Eastside Metropolitan Service Area Basins
- San Diego County Basins

Wet Year Direct Recharge (AFY)

- 220,000
- 1992/93
- 2004/05

Other Features

- County
- Water Body

N W E S

6 3 0 6 Miles

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Plate III-5

Trends in Wet Year Direct Groundwater Recharge by Sub-Region

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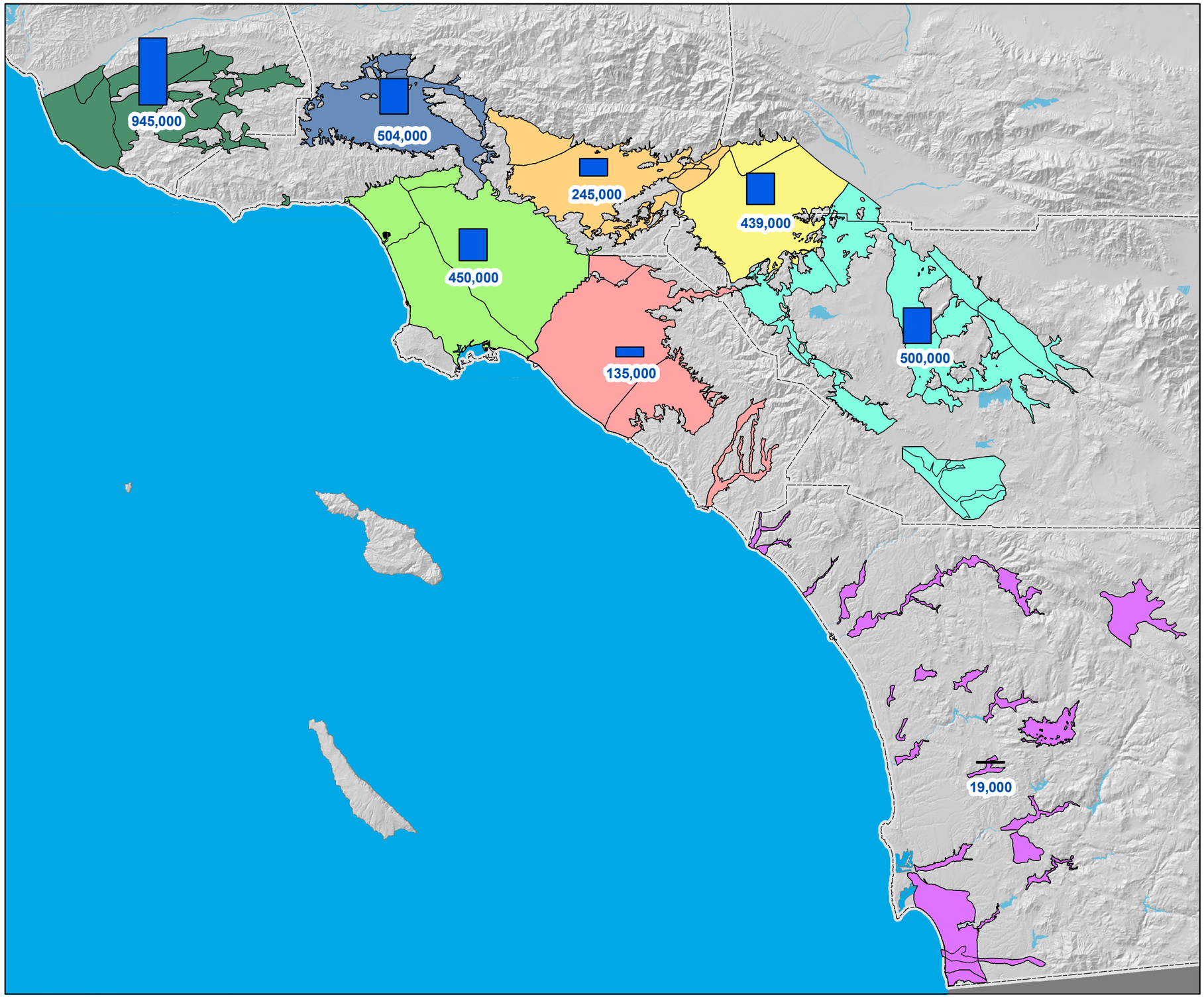

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Legend

Groundwater Basin Sub-Region

- Northwest Metropolitan Service Area Basins
- San Fernando Valley Basins
- Los Angeles County Coastal Plain Basins
- San Gabriel Valley Basins
- Orange County Basins
- Inland Empire Basins
- Eastside Metropolitan Service Area Basins
- San Diego County Basins

Available Storage Space (AF)

- 470,000
- Available Storage Space

Other Features

- **Water Body**
- **County**

N W E S

6 3 0 6 Miles

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Plate III-6

Available Groundwater Storage Space in 2006

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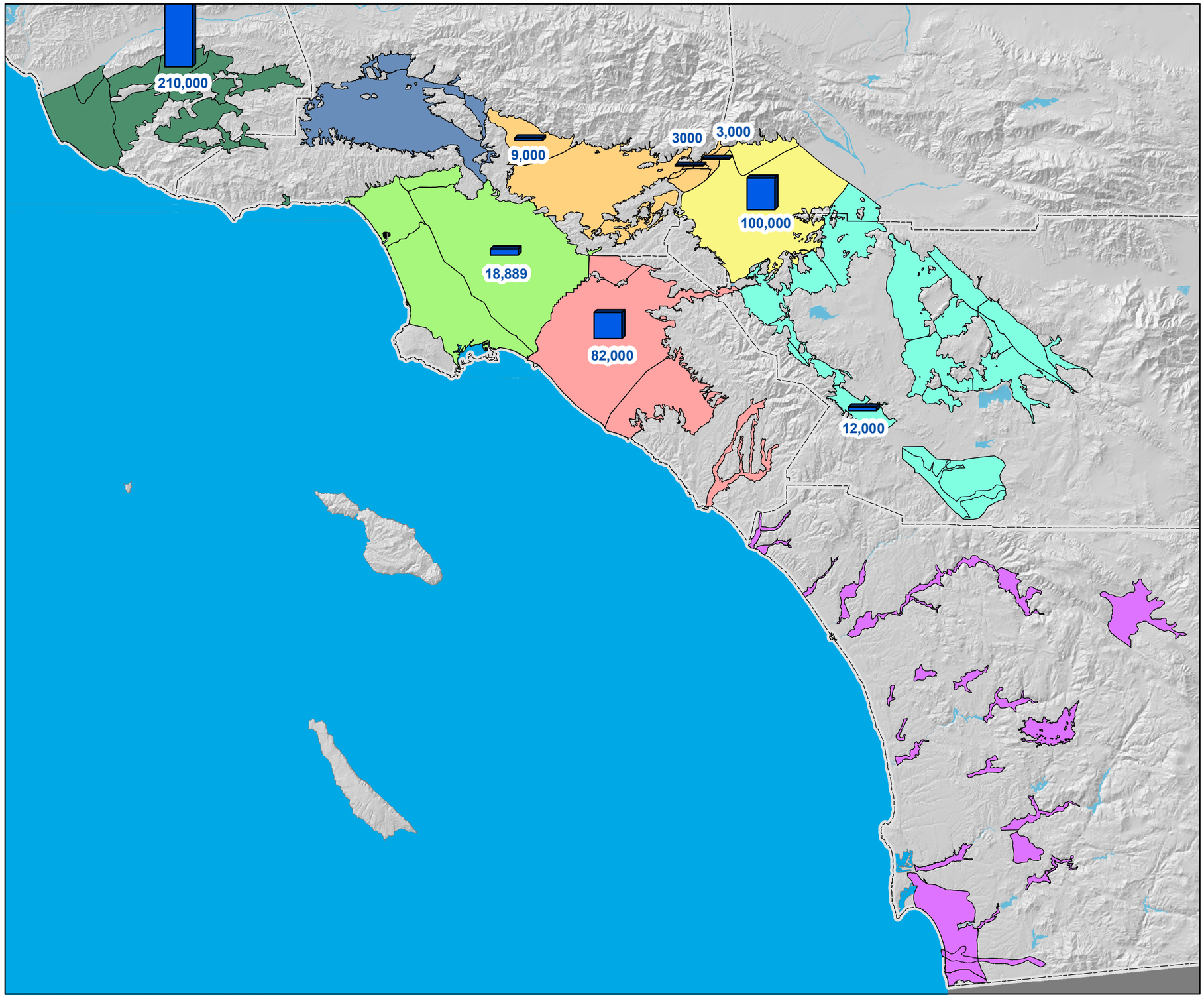

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Legend

Groundwater Basin Sub-Region

- Northwest Metropolitan Service Area Basins
- San Fernando Valley Basins
- Los Angeles County Coastal Plain Basins
- San Gabriel Valley Basins
- Orange County Basins
- Inland Empire Basins
- Eastside Metropolitan Service Area Basins
- San Diego County Basins

Contracted Groundwater Storage (AF)

- 110,000
- Contracted Groundwater Storage

Other Features

- Water Body
- County

N W E S

6 3 0 6 Miles

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Plate III-7

Contractural Conjunctive Use Programs in 2006

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CHAPTER IV

GROUNDWATER BASIN REPORTS

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Legend

Chapter IV Basin Reports

Northwest Metropolitan Service Area Basins
- 1. Ventura County

San Fernando Valley Basins
- 2. Upper Los Angeles River Area

Los Angeles County Coastal Plain Basins
- 3. Central
- 4. West Coast
- 5. Santa Monica
- 6. Hollywood

Los Angeles County Coastal Plain Basins
- 7. Main San Gabriel and Puente
- 8. Raymond
- 9. Six

Orange County Basins
- 10. Orange County
- 11. San Juan

Inland Empire Basins
- 12. Chino and Cucamonga

Eastside Metropolitan Service Area Basins
- 13. Riverside
- 14. Arlington
- 15. Temescal Valley
- 16. Elsinore
- 17. West San Jacinto
- 18. Hemet-San Jacinto
- 19. Temecula-Murrieta

San Diego County Basins
- 20. Overview
- 21. North San Diego County
- 22. Central San Diego County
- 23. South San Diego County

Other Basins Not Covered
- 24. Other

Other Features
- County
- Groundwater Basin Boundary
- Water Body

Plate IV-1

Groundwater Assessment Study Basin Reports Index Map

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