Building Water Resilience in Los Angeles County: A Report

September 2017

TECHNICAL DRAFT

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Foreword to the Technical Draft

This document is a technical draft of the Water Resilience Report and the result of an effort to characterize and evaluate water practices throughout Los Angeles County. As a snapshot of the current water landscape, the document is largely informed by interviews of selected water management agencies, existing planning documents and studies, and the familiarity with operations and decision-making strategies of the contributors at the time the information was gathered (winter 2016/ 2017). For this reason, this draft is not intended to be an exhaustive description of water resource management across the County, but rather to highlight some of the principal components of a complex, interconnected water system. Crucial to the exercise was identifying some of the key challenges and threats to the region, while also underscoring the effective strategies and solutions already being implemented.

It is important to note that this draft does not reflect the input of stakeholders other than water management agencies, and the literature review was focused on infrastructure/water management plans. The next draft will include input from other stakeholder groups, and information from additional watershed and water-related plans.

It is hoped that this document will encourage discussion and elicit valuable feedback from a wide range of stakeholders, including NGOs, businesses, governments, and academic institutions. Input from these groups and other water professionals over the next phase of the planning process will ultimately shape this document and inform the subsequent Water Resilience Plan. Considering the report is a still a working draft, it should not yet be widely distributed.

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Abbreviations & Acronyms

ACCCRN	Asian Cities Climate Change Resilience Network
AFY	acre-feet per year
AVEK	Antelope Valley-East Kern Water Agency
Bay-Delta	Sacramento-San Joaquin Bay-Delta
BMP	Best Management Practice
Central Basin MWD	Central Basin Municipal Water District
CEQA	California Environmental Quality Act
CIMP	Coordinated Integrated Monitoring Program
CLWA	Castaic Lake Water Agency
CRA	Colorado River Aqueduct
DAC	Disadvantaged Community
DWR	Department of Water Resources
EWMP	Enhanced Watershed Management Program
IRWM	Integrated Regional Water Management
GLAC	Greater Los Angeles County
gpcd	gallon per capita per day
GRIP	Groundwater Reliability Improvement Program
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
JPA	Joint Powers Authority
LACFCD	Los Angeles County Flood Control District
LACDPW	Los Angeles Department of Public Works
LACSD	Sanitation Districts of Los Angeles County
LADWP	Los Angeles Department of Water and Power
Las Virgenes MWD	Las Virgenes Municipal Water District
LASAN	City of Los Angeles, Bureau of Sanitation
LID	Low Impact Development
Long Beach	City of Long Beach Water Department
Metropolitan	Metropolitan Water District of Southern California
MF	microfiltration
MS4	Municipal Separate Storm Sewer System
MSG Basin	Main San Gabriel Basin
MTBE	methyl tert-butyl ether
NFIP	National Flood Insurance Program
NPDES	National Pollutant Discharge Elimination System
P3	Public-Private Partnerships
Pomona	City of Pomona
PWAG	Public Water Agencies Group

PWP	Pasadena Water and Power
Regional Board	Regional Water Quality Control Board
RO	Reverse Osmosis
Santa Clarita	City of Santa Clarita
Santa Monica	City of Santa Monica
SGMA	Sustainable Groundwater Management Act
SMURRF	Santa Monica Urban Runoff Recycling Facility
SSO	Sanitary Sewer Overflow
SWP	State Water Project
SWRCB	State Water Resources Control Board
TDS	Total dissolved solids
TMDL	Total Maximum Daily Load
UCLA	University of California, Los Angeles
Upper District	Upper San Gabriel Valley Municipal Water District
USACE	United State Army Corps of Engineers
USBR	U.S. Department of the Interior Bureau of Reclamation
US EPA	United States Environmental Protection Agency
UWMPs	Urban Water Management Plans
West Basin MWD	West Basin Municipal Water District
WMP	Watershed Management Program
WRP	Water Reclamation Plant
WSDM	Water Surplus and Drought Management
WVWD	Walnut Valley Water District

Glossary

Adjudicated basin – A surface or groundwater basin that has a court judgement to establish rights of usage.

Appurtenant rights – A right or restriction associated with a parcel of land which goes with the property and continues to do so even when the title is passed.

Aqueduct – An artificial channel for the conveyance of water.

Aquifer – An underground layer of water-bearing permeable rock through which water can easily move and be extracted using a well.

Best management practices (BMP) – Ways of managing land or activities that reduce or prevent water pollution.

Bio-filtration unit – A water pollution control device that contains living material to collect and biologically degrade pollutants.

Bioswale – A landscape element, usually containing vegetation and organic matter, that slows, collects, infiltrates, and filters stormwater.

Brackish – A slightly salty mixture of fresh and salt water.

California WaterFix – The State's plan to upgrade outdated infrastructure in the Sacramento-San Joaquin Bay-Delta to secure California's water supplies and improve the Bay-Delta's ecosystem.

Catch basin – A receptacle located where a street gutter discharges into a sewer, designed to retain matter that might otherwise block the sewer.

Centralized stormwater capture – Stormwater captured away from the point of runoff generation, diverted to large stormwater facilities such as spreading grounds, underground infiltration basins, storage tanks, and large wetland projects.

Cistern – A tank for storing rainwater or stormwater.

Decentralized stormwater capture – Stormwater captured near the point of runoff generation using small stormwater best management practices such as cisterns, rain barrels, green streets, impervious pavement, and bioswales.

Desalter – A water desalination facility that removes salt and treats water for use.

Detention pond – A low lying area or basin that temporarily stores runoff, reduces flooding, and provides some water quality and erosion benefits.

Direct potable reuse – Planned introduction of recycled water either directly into a potable water system, or into a raw water supply immediately upstream of a water treatment plant.

Direct use – Water that is consumed directly by the consumer for uses such as toilet flushing and irrigation.

Disadvantaged community – Census geographies with a median household income that is less than 80 percent of the Statewide annual median household income.

Emergency Operations Center – A facility designed to manage emergency situations at a strategic level.

Emergency Response Plan – A course of action that identifies measures to mitigate the impacts of emergency situations.

Forebay – A pool or basin in front of a larger body of water used for flood control, to trap sediment or debris, to act as a natural habitat, or as a reservoir from which water is taken for the operation of machinery.

Green Street – A stormwater management system that incorporates vegetation, permeable pavements, soils, and other stormwater controls to slow and filter stormwater runoff from impervious surfaces.

Groundwater – Water that collects or flows underground in soil pore spaces and rock fractures.

Groundwater replenishment – A practice where treated wastewater or stormwater is recharged to a groundwater basin to restore water levels.

Indirect potable reuse – Planned use of recycled water for replenishment of a groundwater basin or an aquifer that has been designated as a source of water supply for a public water system.

In-lieu recharge – When an entity does not pump groundwater and uses other supplies or conservation, allowing groundwater levels in the basin to increase.

Integrated Regional Water Management – A collaborative effort to identify and implement water management solutions that improve water quality, quantity, and reliability within participating regions while also achieving social, environmental, and economic objectives.

Interconnection – Connections between water supply distribution systems.

Local surface water – Water that flows within local watersheds and is diverted for direct potable use.

Los Angeles Basin – The region of Los Angeles County south of the Santa Clarita and Antelope Valleys that includes the Los Angeles and San Gabriel Rivers, Santa Monica Bay, Ballona Creek, Malibu Creek, and Dominguez Channel/Los Angeles Harbor watersheds.

Low Impact Development (LID) – A planning or engineering design approach to managing rainwater and stormwater that attempts to mimic a site's pre-development hydrology by using design techniques that infiltrate, filter, store, and retain runoff.

Municipal Separate Storm Sewer System – A stormwater collection and conveyance system owned by a public entity that does not connect to the wastewater collection or conveyance system.

National Pollutant Discharge Elimination System Program– A federal permitting program delegated to the State that regulates wastewater and stormwater discharges from point sources into waters of the United States.

Natural replenishment – A hydrologic process where water enters a groundwater basin.

Natural Safe Yield – The amount of water that naturally replenishes a basin through precipitation and infiltration.

Nonpoint source – A diffuse source whose inputs occur over a wide area and are not easily attributed to a single source such as urban or agricultural runoff.

Operating Safe Yield – The amount of water that can be withdrawn from a basin without producing an undesired effect, in a particular fiscal year free of replenishment assessment.

Plume – A mass of contaminated groundwater.

Point source – A discrete source such as a pipe, ditch, or channel.

Potable water – Water that is safe to drink or use for food preparation, without risk of health problems.

Rain barrel – A tank or receptacle used to collect and store rainwater runoff.

Recycled water – Water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur.

Reservoir – A body of water used as a water supply source.

Resilience – The ability to mitigate and adapt to the impacts of disruptive events.

Retention basin – A basin that captures and holds stormwater permanently to reduce flooding and erosion, and provide water quality benefits, while maintaining a permanent pool of water.

Sanitary Sewer Overflow – A situation that occurs when sanitary sewers discharge raw sewage prior to its treatment.

Seawater intrusion barrier – A facility or method, such as a series of injection wells, used to prevent saltwater from moving into freshwater basins and aquifers.

Stormwater – Water (runoff) that results from a precipitation event or snow/ice melt, and flows in the public right-of-way.

Sustainable Groundwater Management Act – A law enacted in 2014 that established a new structure for managing California's groundwater resources, with a goal of sustainable management of groundwater by the year 2042.

Sustainable – The ability to use a resource in such a way that it is not depleted over time.

Total Maximum Daily Load – The maximum amount of a given pollutant that a body of water can receive and continue to meet minimum water quality standards.

Tree Well – A stormwater management practice constructed around the base of a tree that captures and filters polluted runoff.

Urban runoff – Surface runoff that is created due to impervious surfaces and other characteristics of urbanization. There is dry weather runoff and wet weather runoff (stormwater).

Watermaster – A court appointed agency or individual who administers the water rights, and manages and protects groundwater resources in an adjudicated basin.

Chapter 1 Executive Summary

Water management in Los Angeles County is vast, diverse and complicated. With more than 10 million residents in 88 cities served by some 200 water oversight agencies, planning at a regional scale requires systematic collaboration and coordination. Changing climate and associated cycles of debilitating drought and historic rainfall underscore the need for adaptive management practices that facilitate responsive decision-making across the region. As the region considers how to address aging infrastructure, a growing population, and the challenges of climate change, it is essential that all water stakeholders work together to develop long-term solutions and prepare for new challenges. The Water Resilience Report aims to establish a shared vision for the future of the region's water that provides a foundation for improved management and planning for years to come.

Relying on the conceptual framework of water resilience, the report considers the ability of the region to adapt to the pressures of changing climate, such as withering drought and catastrophic flood, and growing population while ensuring reliable water supply, safety and cleanliness of all local water, and enhanced quality of life for the benefit of all residents. This vision of water resilience encompasses a broad range of healthy watershed indicators like clean rivers, lakes, streams, and coastal waters; thriving and proliferating natural habitats; innovative greening of infrastructure across the region; and a reliable and diversified water supply portfolio increasingly provisioned by local sources. Realizing this vision requires collaborative strategies for water resource management that include development, funding, and implementation of effective multi-benefit solutions at the regional and local scales.

Establishing water resilience within Los Angeles County must combine informed decision-making, adaptive management, and collaborative and coordinated planning across a large and diverse topography inhabited by over 10 million people and hundreds of entities responsible for water resource management. The concept of resilience recognizes that unforeseen forces and changes will inevitably present challenges to water resource management and related operations. A resilient system adapts to these and establishes a "new normal" upon which future management decisions are based, ensuring better preparation in the future. Building resilience in the County's water management requires elaborate planning and coordination across multiple agencies and jurisdictions coupled with nimble flexibility to respond to an ever-changing environmental, social, economic, and political context.

Recognizing the need to assess current practices and establish an innovative, all-inclusive vision for the future of water management, the County of Los Angeles Board of Supervisors set the effort in motion in April 2016 with a motion that called for a plan to this end. The Water Resilience Report serves as the starting point for coordinated resilience building by characterizing water management throughout the region and identifying promising strategies and formidable challenges. The report relies on existing water management planning documents and a series of interviews with water managers sampled from across the County to describe all aspects of current water planning, decision-making, and operations. In characterizing the water management landscape of the region, the report highlights proven strategies and mounting threats that facilitate or hinder the establishment of resilience, respectively. Four key strategies are identified as essential to establishing and maintaining water resilience across the region:

1. Maximizing the capacity of collaborative water groups (e.g. IRWM, EWMP) to articulate regional strategies and implement relevant projects that contribute to supply and quality.
2. Pursuing a diverse portfolio of regional and local water management projects (e.g. stormwater capture, recycled water distribution) that contribute to meeting changing needs (e.g. climate change, increasing demand).
3. Promoting multi-benefit strategies that encourage collaboration and support cost-effectiveness.

4. Engaging a variety of stakeholders to build consensus around the most promising local strategies and mobilizing resources.

Principal challenges to the region's water include climate change, population growth, aging infrastructure, and lack of adequate funding for substantial improvements. Given the characterization of the County and its water management alongside proven strategies and known threat, a few immediate next steps become evident:

1. Engage stakeholders in collective review of the report and revise document to reflect regional needs and vision.
2. Prioritize strategies and projects with the greatest potential for regional impact (e.g. stormwater capture, recycled water infrastructure).
3. Identify viable funding options that support local and regional water strategies.

This Water Resilience Report is intended to serve as the foundation for discussion and will be disseminated widely to encourage broad stakeholder engagement in developing a vision for the region's reliable and resilient water future.

Chapter 2 Introduction

Water management in Los Angeles County is vast, diverse and complicated. With more than 10 million residents in 88 cities served by some 200 water oversight agencies, planning at a regional scale requires systematic collaboration and coordination. Changing climate and associated cycles of debilitating drought and historic rainfall underscore the need for adaptive management practices that facilitate responsive decision-making across the region. As the region considers how to address aging infrastructure, a growing population, and the challenges of climate change, it is essential that all water stakeholders work together to develop long-term solutions and prepare for new challenges. The Water Resilience Report aims to establish a shared vision for the future of the region's water that provides a foundation for improved management and planning for years to come.

Relying on the conceptual framework of water resilience, the report considers the ability of the region to adapt to the pressures of changing climate, such as withering drought and catastrophic flood, and growing population while ensuring reliable water supply, safety and cleanliness of all local water, and enhanced quality of life for the benefit of all residents. This vision of water resilience encompasses a broad range of healthy watershed indicators like clean rivers, lakes, streams, and coastal waters; thriving and proliferating natural habitats; innovative greening of infrastructure across the region; and a reliable and diversified water supply portfolio increasingly provisioned by local sources. Realizing this vision requires collaborative strategies for water resource management that include development, funding, and implementation of effective multi-benefit solutions at the regional and local scales.

The main premise of resilience is that healthy systems must be capable of withstanding stress and evolving into improved states, in other words, surviving shocks and bouncing back to become even stronger and better. When applied to water, this can mean: providing reliable potable water in the face of drought and aging infrastructure; effective flood protection in a context of changing rainfall patterns and frequency; and clean, safe water bodies despite increasing concentration and distribution of pollutants. In short, water resilience indicates that the region is responsive and effective in its management of water to ensure reliable supply and safe, healthy watersheds in the face of multiple challenges.

This report aims to provide an overview of water across the County and highlight valuable resilience-building approaches. Given the breadth and diversity of the County's water landscape, nothing in the report is meant to represent an exhaustive description of water management practices or current challenges. Instead, the focus is on highlighting examples of success alongside current opportunities and ongoing challenges that have been uncovered during the preparation of the document. The next phase of the report includes broad stakeholder engagement to review and provide comments on this current draft.

Aligned with the preparation of the report and the associated planning process is the creation of the H2O4LA brand by the Los Angeles County Department of Public Works. This brand encompasses all water-related outreach and education conducted by the County, including the water resilience planning process of which this report represents the initial phase. The intent is that H2O4LA will symbolize the vision for the region's water future espoused by a subsequent Water Resilience Plan and embody the related activities and programs of the County.

This section provides an introduction to the report and the research process. Chapter 3 briefly explores the concept of resilience and presents a working definition for water resilience that guides the rest of the report. The subsequent chapter, Chapter 4, investigates the full portfolio of water resource management across Los Angeles County, considering everything from stormwater to groundwater and desalination. Evaluating the region's water resilience is the focus of Chapter 5, describing regional challenges and identifying promising or proven strategies that have been employed to reinforce good management and ensure positive outcomes. Chapter 6 provides a summary of the current report and proposes general recommendations for water-

related planning based on the findings of the preceding pages and highlights some specific next steps, including robust stakeholder engagement to review the content and proposals of this draft.

2.1 Research Process

2.1.1 Water Management Agency Research

At the request of the Los Angeles County Board of Supervisors, the Los Angeles County Department of Public Works (LACDPW) conducted research on how agencies and organizations with water management responsibility are building water resilience throughout the region. This initial research was conducted by reviewing an initial sampling of relevant planning documents and conducting interviews with key staff from a handful of agencies and organizations.

Document Review

A variety of water resources documents, such as those shown in Figure 1, was compiled and reviewed to inform the stakeholder interviews. Additional documents provided during interviews were also included.

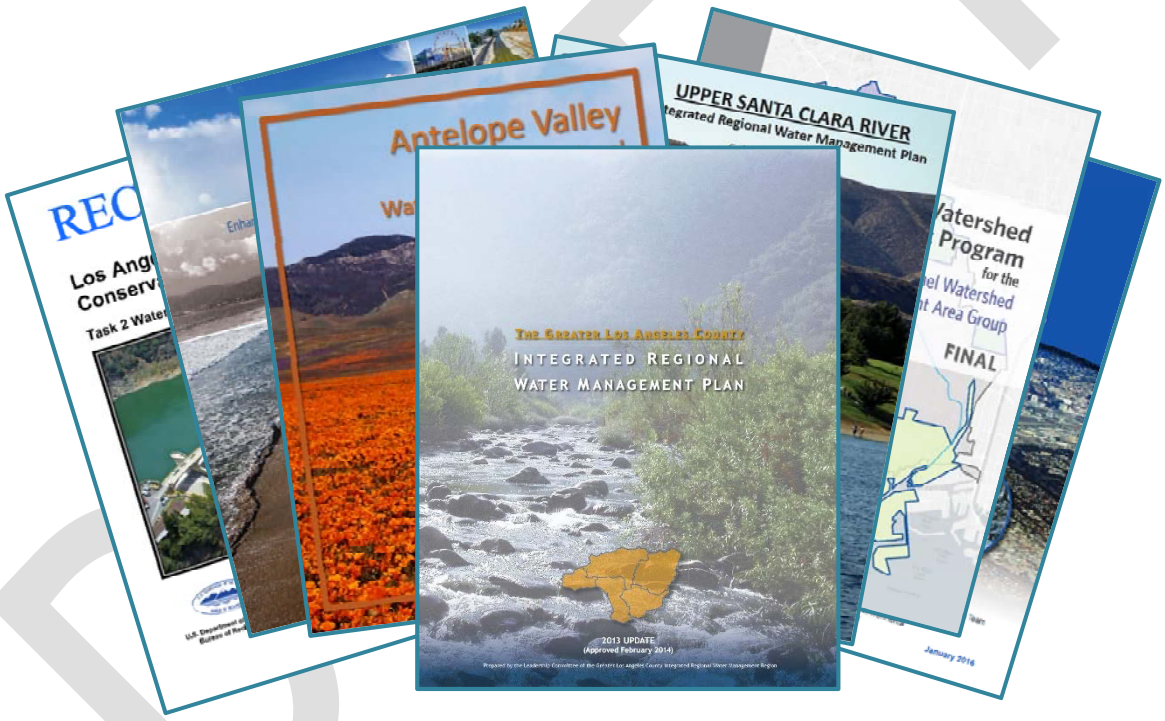


Figure 1: Los Angeles County Water Resources Planning Documents

The types of documents used in the research included:

- Integrated Regional Water Management (IRWM) Plans
- Enhanced Watershed Management Programs (EWMPs) / Watershed Management Programs (WMPs)
- Urban Water Management Plans (UWMPs)
- Integrated Resource Plans
- Groundwater management documents
- Stormwater capture studies

- Climate change studies
- Other water management planning documents and studies that help describe the current water resource management in the County.

The documents used in the initial research are by no means considered to be a comprehensive listing of all documents that exist within the County. It should also be noted that the documents collected were not read in full but used primarily to articulate the description of current water supply sources and infrastructure and to supplement the information collected through the stakeholder interviews.

Worth mentioning here is the growing body of local studies and planning documents based on concepts of resilience. These documents provided a particularly informative foundation for the assessment of current practices and consideration of future challenges and opportunities. The fact that a variety of these types of resilience efforts are ongoing across the County and often developed independent of each other highlights the need for a regional water resource agency to facilitate coordination and collaborative research and planning. Such a regional entity could help to ensure that efforts are not duplicated across agencies and maximize the reach and impact of studies and planning exercises.

Stakeholder Interviews

A series of 18 water management agency interviews were conducted between December 2016 and February 2017 to record various agency perspectives on the resilience of their water systems and of others across the region, as well as explore their ability to respond and adapt to emergencies, medium-term ongoing disturbances, and long-term threats like climate change. The water management agencies interviewed were selected to represent a variety of professional perspectives, priorities and roles throughout Los Angeles County, including the Santa Clarita Valley, Antelope Valley, and Los Angeles Basin areas. These agencies include imported water wholesale agencies, retailers, cities, watermasters, recycled water suppliers, and wastewater agencies. The specific agencies interviewed during this phase of the water resilience initiative are:

Water Districts

- Antelope Valley- East Kern Water Agency (AVEK)
- Castaic Lake Water Agency (CLWA)
- Central Basin Municipal Water District (Central Basin MWD)
- Las Virgenes Municipal Water District (Las Virgenes MWD)
- Main San Gabriel Basin and Raymond Basin Watermaster (Watermaster)
- Metropolitan Water District of Southern California (Metropolitan)
- Upper San Gabriel Valley Municipal Water District (Upper District)
- Walnut Valley Water District (WVWD)
- Water Replenishment District of Southern California (WRD)
- West Basin Municipal Water District (West Basin MWD)

Wastewater Districts

- Sanitation Districts Los Angeles County (LACSD)
- Las Virgenes-Triunfo Joint Powers Authority (Las Virgenes-Triunfo JPA)

Municipal Agencies

- City of Long Beach Water Department (Long Beach)
- City of Los Angeles
    - Bureau of Sanitation (LASAN)

    - Department of Water and Power (LADWP)
- City of Pasadena: Pasadena Water and Power (PWP)
- City of Pomona: Water/Wastewater Utility and Public Works (Pomona)
- City of Santa Monica: Office of Sustainability and Water Department (Santa Monica)
- City of Santa Clarita: Water Department and City Council Member (Santa Clarita)

LACDPW manages and operates the Los Angeles County Flood Control and Waterworks Districts and integrated its information and perspectives on the region's resilience directly into the relevant sections of the document.

Each interview was conducted with staff from the agency able to speak to the resilience of the region from a management, resource, or operations perspective. Interviews typically included one to four staff in management positions, such as general managers, water resource managers, sustainability officers, operations management, and watermasters.

A standard interview agenda was developed and sent to each agency in advance of the interview. Despite the standardized agenda and script of questions, each interview was unique in that much of the information was collected in a more organic conversational method that allowed for agency staff to focus on the resilience topics and issues most relevant to their agency and knowledge. The basic topics discussed during the interviews were:

- How the agency views and uses the term resilience;
- How the agency manages and operates its system;
- What mechanisms are in place to increase the resilience of their infrastructure;
- How stakeholders are involved in decision-making and planning;
- What projects are planned to increase the resilience of their system;
- What are the agency's most notable challenges and noteworthy accomplishments; and
- What funding mechanisms are in place to implement projects and what funding gaps exist.

Responses from the stakeholder interviews were compiled to provide an initial summary and assessment of the County's water resource management systems and governance, current resilience efforts and projects, water management agency engagement with stakeholders, and the challenges to and opportunities for enhancing water resilience in the County. It is important to note these responses reflected the conditions during the time period the interviews were conducted in Winter 2016-17.

Future preparation of a Water Resilience Plan will integrate insight and feedback from a broad range of stakeholders, including additional water agencies, NGOs, community-based organizations, academia, and government representatives. This report will be used as a basis for discussion and provide the platform for compiling commentary and articulating a shared vision for the future of water in Los Angeles County.

Chapter 3 Building Water Resilience

The concept of resilience has evolved over recent years to incorporate an adaptive management approach in the face of a variety of systemic threats such as natural disaster, climate change, and even conflict. Although the term finds its roots in biology and materials engineering, it has expanded to encompass complex social, economic, and political systems like cities, regions, and nations. The main premise is that healthy systems must be capable of withstanding stress and evolving into improved states, in other words, surviving shocks and bouncing back to become even stronger and better. When applied to water, the concept comprises a broad range of opportunities and challenges: reliable provision of potable water in the face of drought and aging infrastructure; effective flood protection in a context of changing rainfall patterns and frequency; and clean, safe water bodies despite increasing concentration and distribution of pollutants. Water resilience addresses all these aspects of water management and necessarily involves complicated coordination and cooperation across sectors and agencies, operation and maintenance of a complex network of interconnected and isolated infrastructure, and education and engagement of diverse stakeholders to sustain a healthy ecosystem. In short, water resilience indicates that the region is responsive and effective in its management of water to ensure reliable supply and safe, healthy watersheds in the face of multiple expected and unforeseen challenges.

Resilience in LA

Definitions of urban resilience often focus on the interrelatedness of three essential elements:

Systems: Infrastructure and physical networks

Agents: Individual and community actors

Institutions: Governance and decision-making

The first phase of the planning process has attempted to establish a working definition for water resilience informed by academic, industry, and policy literature that leads to promising strategies for its application and establishment within Los Angeles County. The review and consideration of this literature is included in Appendix A. This chapter focuses on the general concept and its application to the urban context of Los Angeles County, proposing parameters for a definition of water resilience within the region.

3.1 Defining Water Resilience for Los Angeles County

Los Angeles County is largely urbanized with developed landscape that serves its growing population of over 10 million residents. Extensive hardscape networks present a serious challenge to identifying the open space needed to expand existing or establish new facilities to further enhance water resource resilience. Existing large water channelization systems used to convey stormwater from the mountains to the sea provide crucial flood risk management, but often diminish opportunities to capture and use those flows for local supply as well as to dilute water-borne pollutant concentrations.

In addition to its physical setting, the management of water resources within Los Angeles County is equally complex. A fragmented system of water management is reflected in the 88 cities, approximately 200 water agencies, and multitude of other water-related entities and jurisdictions that share responsibilities for ensuring that water resources goals are met. This complex governance setting points to the need for effective coordination to achieve integrated management, flexibility, responsiveness, and local capacity-building.

Building water resilience within Los Angeles County requires coordinating the management of all jurisdictions and entities to operate and monitor existing systems, while developing innovative means to integrate flexibility and ensure redundancy in the face of changing rainfall patterns and decreasing reliability of imported water. This process must also embrace sharing of information amongst all stakeholders and provide a framework for continued feedback and learning at every stage of decision-

making and operations. Integration of local communities and encouragement of beneficial behavior change is crucial to developing a responsive citizenry that contributes to resilience efforts.

Ultimately, water resilience means the ability of the region to adapt to the pressures of changing climate, such as withering drought and catastrophic flood, and growing population while ensuring reliable water supply, safety and cleanliness of all local water, and enhanced quality of life for the benefit of all residents. This vision of water resilience encompasses a broad range of healthy watershed indicators like clean rivers, lakes, streams, and coastal waters; thriving and proliferating natural habitats; innovative greening of infrastructure across the region; and a reliable and diversified water supply portfolio increasingly provisioned by local sources. Realizing this vision requires collaborative strategies for water resource management that include development, funding, and implementation of effective multi-benefit solutions at the regional and local scales.

Chapter 4 Water in Los Angeles County Today

4.1 Water Supply

Over the last century, federal, state, and local agencies have developed creative plans and implemented large projects to move vast quantities of water great distances to meet water demands in Los Angeles County. Water agencies that operate within the County have a history of working collaboratively to tap a variety of supply sources, implement new production technologies, respond to evolving regulatory requirements, and navigate changing political conditions to meet regional demand with uninterrupted supply. As a result of these efforts, Los Angeles County has one of the broadest and most diverse water supply portfolios in California.

4.1.1 Water Supply History

Originally in the 1800s, local surface water was the primary source of water supporting both urban and agricultural interests within Los Angeles County. Surface flows were highly variable and often associated with periods of flooding or drought. To address the irregularity of surface water supply, groundwater pumping expanded to become a principal source of water. California has since experienced repeated patterns of population booms and droughts that have resulted in periodic depletion of groundwater basins and necessitated reliance on imported water for both direct use and basin replenishment.

In the early 1900's, infrastructure was developed to transport water from the Eastern Sierra Mountains to the growing metropolitan area of the City of Los Angeles. The Los Angeles Aqueduct was the first source of imported water to reach the County, followed by the Colorado River Aqueduct (CRA). These two aqueducts provided the water necessary to support substantial growth in the area during the early 20th century. After World War II, California experienced another period of impressive economic expansion and population growth. The State Water Project, which transported water south from the Sacramento-San Joaquin Delta, helped to address the substantial increase in water demand throughout California, including in Los Angeles County.

As the region continued to grow and water treatment technologies improved, so did the desire to enhance and better leverage local water sources to meet local need. Intense urbanization resulting in the loss of unpaved open space in the County greatly diminished the amount of natural water infiltration and the associated replenishment of groundwater basins. To meet both the flood risk management and water supply needs that resulted, the region developed large surface detention and recharge basins to retain and infiltrate stormwater, supplemented by imported and recycled water. Today, in addition to large-scale stormwater recharge, there is a growing number of smaller, decentralized, stormwater projects undergoing implementation. The use of recycled water as a method to recharge groundwater basins and provide additional supplies began in the 1960s. Most recently, the region has also moved closer to one day tapping into the Pacific Ocean through the development of ocean desalination projects.

Developing local water supply has also been balanced with aggressive water use efficiency programs that seek to limit demand in the face of ongoing population growth and climate change.

4.1.2 Current and Projected Water Supplies and Demands

The U.S. Department of the Interior Bureau of Reclamation (USBR) and LACFCD jointly authored the Los Angeles Basin Study (LA Basin Study), which analyzed supplies and demands in the Los Angeles Basin area using data from the 2013 Greater Los Angeles County (GLAC) IRWM Plan (2014) and 2010 UWMPs. While this analysis only encompassed supply and demand within the Los Angeles Basin and did not include

the Santa Clarita Valley or Antelope Valley, the results provide an important indicator of current and projected supply and demand for the County.

As part of the Los Angeles Basin Study, supplies and demands within region were totaled to estimate the historical 2010 and projected 2035 supplies and demands. Additional assumptions, including potential climate change impacts, were made to project supplies and demands out as far as 2095. Since the supply and demand analysis relied heavily on data from the 2010 UWMPs, the Water Resilience Report provides an update to reflect the most recent data reported in the 2015 UWMPs, while still relying on the same equations and analyses.

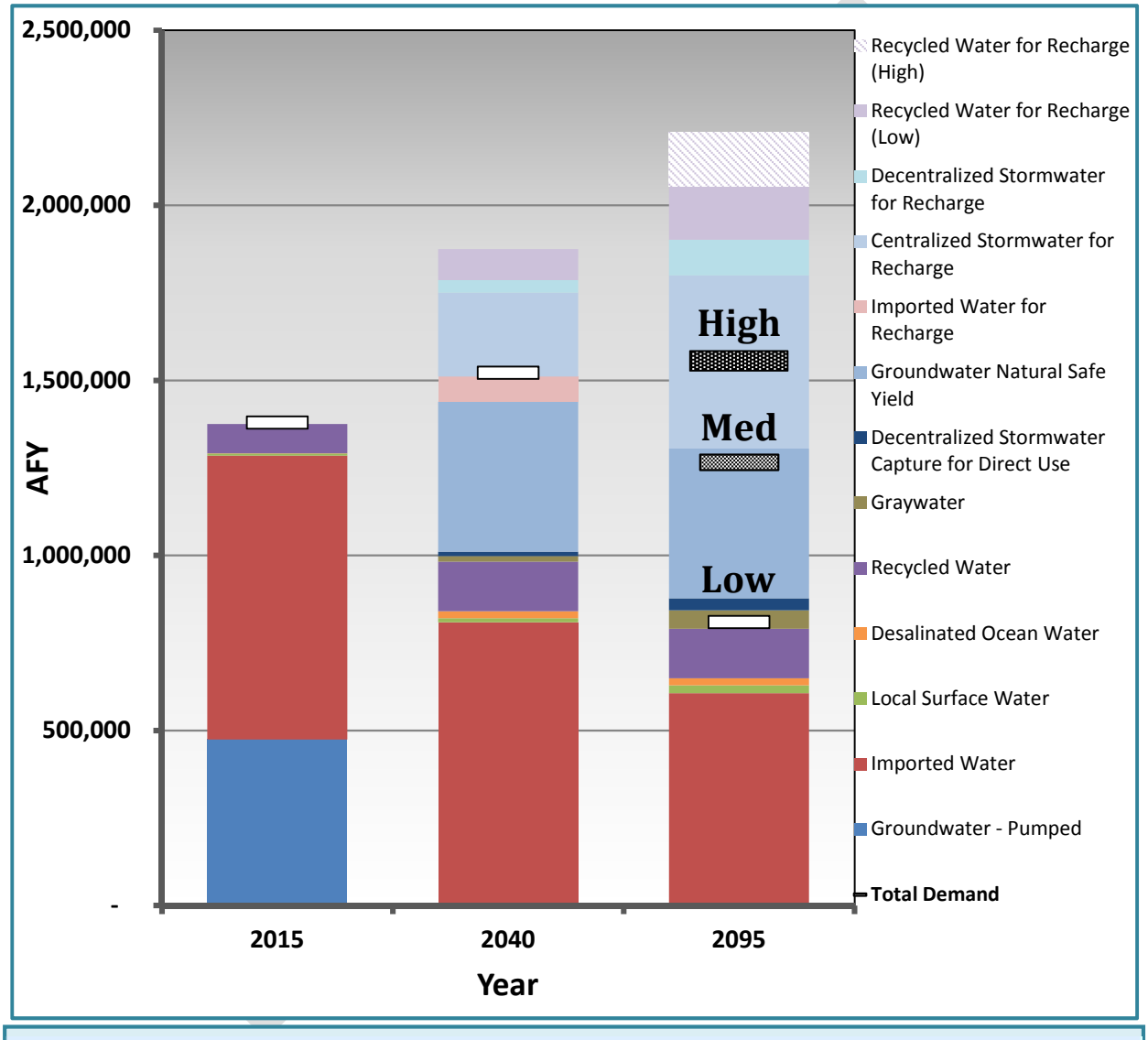


Figure 2: Existing and Projected Supplies and Demands for the Los Angeles Basin Area
(adapted from LA Basin Study, 2015)

Figure 2 shows the updated current (2015) and projected supplies and demands for the Los Angeles Basin area for the years 2040 and 2095. The groundwater pumping shown in 2015 is replaced with groundwater replenishment supply so as to avoid double counting and highlight the initial source of the supply that will result in increased pumping. As illustrated in the figure, total imported water (which is viewed as less reliable due to environmental restrictions and climate change impacts) for direct use decreases slightly in

2040 compared to 2015, despite an increase in total demands. This supply decreases even further in 2095 compared to 2015 direct use. Imported water continues to be utilized in 2040 for replenishment, but is assumed to be replaced with local recycled water and stormwater by 2095 due to the increasing development of these supplies.

As shown in Figure 2, stormwater capture has significant potential for use as supply in the future. As imported water supplies decrease, local supplies are expected to increase to bridge the gap and meet demand. Recycled water use shows increases in both dark purple for direct use but more noticeably in light purple (for groundwater recharge) even under a lower-use assumption. The greatest opportunity for future increases in local supply lies with stormwater capture through both distributed and centralized projects.

Figure 2 also shows how projected demands for 2095 compare with total projected available supplies. The high demand bar for 2095 represents the gallon per capita per day (gpcd) demand average for the Los Angeles Basin region, which remains static at the 2040 gpcd average (123 gpcd). The medium demand bar reflects a 100 gpcd water use target for the Los Angeles Basin region, similar to the '20X2020' target set by Long Beach. The low demand bar represents a 64 gpcd target, based on an adjusted water use rate in Perth, Australia complemented by additional outdoor conservation. While demands unsurprisingly tend to increase proportionately with population growth, there is the possibility of reducing per capita demands to decrease overall regional demand. Expanded development of local supply and enhanced demand management represent essential strategies for meeting medium or low water use targets. A combination of these strategies will be critical to ensuring the reliance of the regional water supply and building overall water resilience.

The sections below describe each of the supply sources, their associated infrastructure, and relevant management and governance setting. Highlighted are current and planned efforts to enhance the resilience of these sources in the face of known threats and unforeseen stressors. Since emergency response efforts typically involve entire distribution systems supplying water from multiple sources, these efforts are highlighted in a separate section.

4.1.3 Imported Water

Sources and Infrastructure

Water imported from outside the County is used to meet approximately 2/3 of all demand within Los Angeles County. Imported water is delivered to Los Angeles County from three major sources: the Sacramento-San Joaquin Bay-Delta (Bay-Delta) via the California State Water Project (SWP), the Colorado River via the CRA, and Owen's Valley and Mono Lake via the Los Angeles Aqueduct. These sources of water are shown in Figure 3.

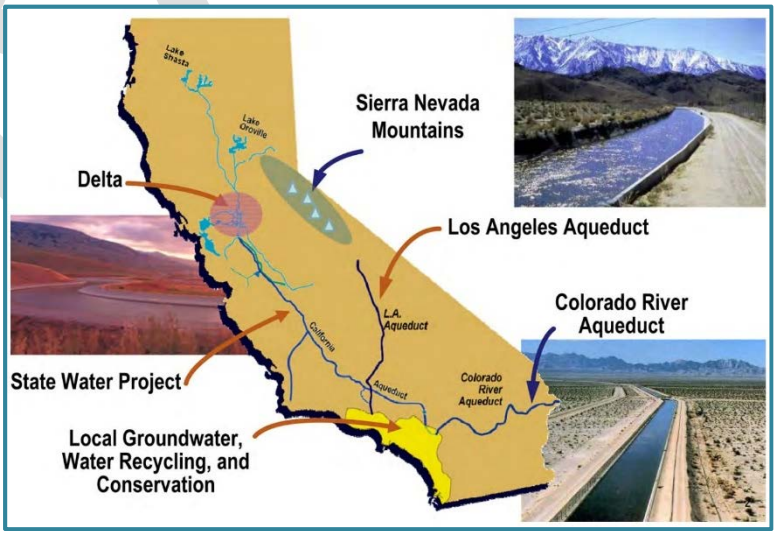


Figure 3: Imported Water Sources

State Water Project

The SWP transports rainfall and snowpack melt from the Sierra Nevada mountain range through the Bay-Delta to southern California. The SWP is a system of reservoirs, pumps and aqueducts that carries water from Lake Oroville and other facilities north of Sacramento to the Sacramento-San Joaquin Delta and then transports that water to central

Figure 4: State Water Project

and southern California. After passing through the Edmonston Pumping Plant and traversing the Tehachapi Mountains, the Aqueduct divides into East and West Branches. The West Branch terminates at Castaic Lake and serves the western Los Angeles Basin and the Santa Clarita Valley portions of the County. The East Branch delivers water to the eastern and southern portions of the Los Angeles Basin and the Antelope Valley portions of the County.

The infrastructure built for the SWP has become an important water management tool for moving SWP supplies and transferring additional water from other entities. However, there are certain obstacles that must be overcome to bring these waters to Los Angeles County, including substantive limitations on the movement of water across the Bay-Delta system, court ordered pumping restrictions, constraints related to the quality of water, and the cost of the water. Some diversion agreements along the SWP keep water from making it to Los Angeles County. Metropolitan, among others, has agreements in place to store water in multiple groundwater basins along the aqueduct, with the majority of these storage basins located in Kern County.

Environmental concerns in the Bay-Delta have limited the volume of water that can be pumped from the SWP. The potential impact of further declines in ecological indicators in the Bay-Delta system on SWP water deliveries is unclear. Uncertainty about the long-term stability of the levee system surrounding the Delta system raises concerns about the ability to transfer water via the Bay-Delta to the SWP, particularly under the impending conditions of climate change.

Colorado River

The CRA diverts water along a 242-mile conveyance system from the Colorado River at Lake Havasu on the border of the state of California and Arizona. The aqueduct conveys the water across the Mojave and Colorado deserts to the east side of the Santa Ana Mountains at its terminus at Lake Mathews in Riverside County. Reservoirs along the Colorado River include Lake Mead and Lake Powell, which have experienced decreased water levels due to the effect of drought since 2000 (Metropolitan, June 2016).

Los Angeles Aqueducts

Water from the Mono Basin and Owens Valley is delivered through the Los Angeles Aqueducts to the City of Los Angeles. The Los Angeles Aqueduct runs 105 miles south from Mono Basin to Owen's Valley, and then 233 miles to the City of Los Angeles. Aqueduct deliveries vary from year to year due to fluctuating precipitation in the Sierra Nevada Mountains and mandatory in-stream flow requirements. Since its construction, the diversion of water from Mono Lake has been restricted to address water supply and air quality impacts within the Mono Lake area. Water quality concerns such as disinfection byproducts may require future treatment of Los Angeles Aqueduct water. Additionally, the energy needed to transport water from such distances is expected to become increasingly costly and the resulting carbon footprint of such energy use is a significant concern.

Storage Facilities

Given the seasonal variance in supply availability, the reliability of the imported water system is dependent upon significant storage facilities and strategies. The SWP and CRA systems own and operate large surface reservoirs that serve the entire system. In addition, imported water contractors also own and operate storage facilities that serve Southern California, including Los Angeles County agencies. In particular, Metropolitan owns and operates above-ground reservoirs outside the County (such as Diamond Valley Lake) that are

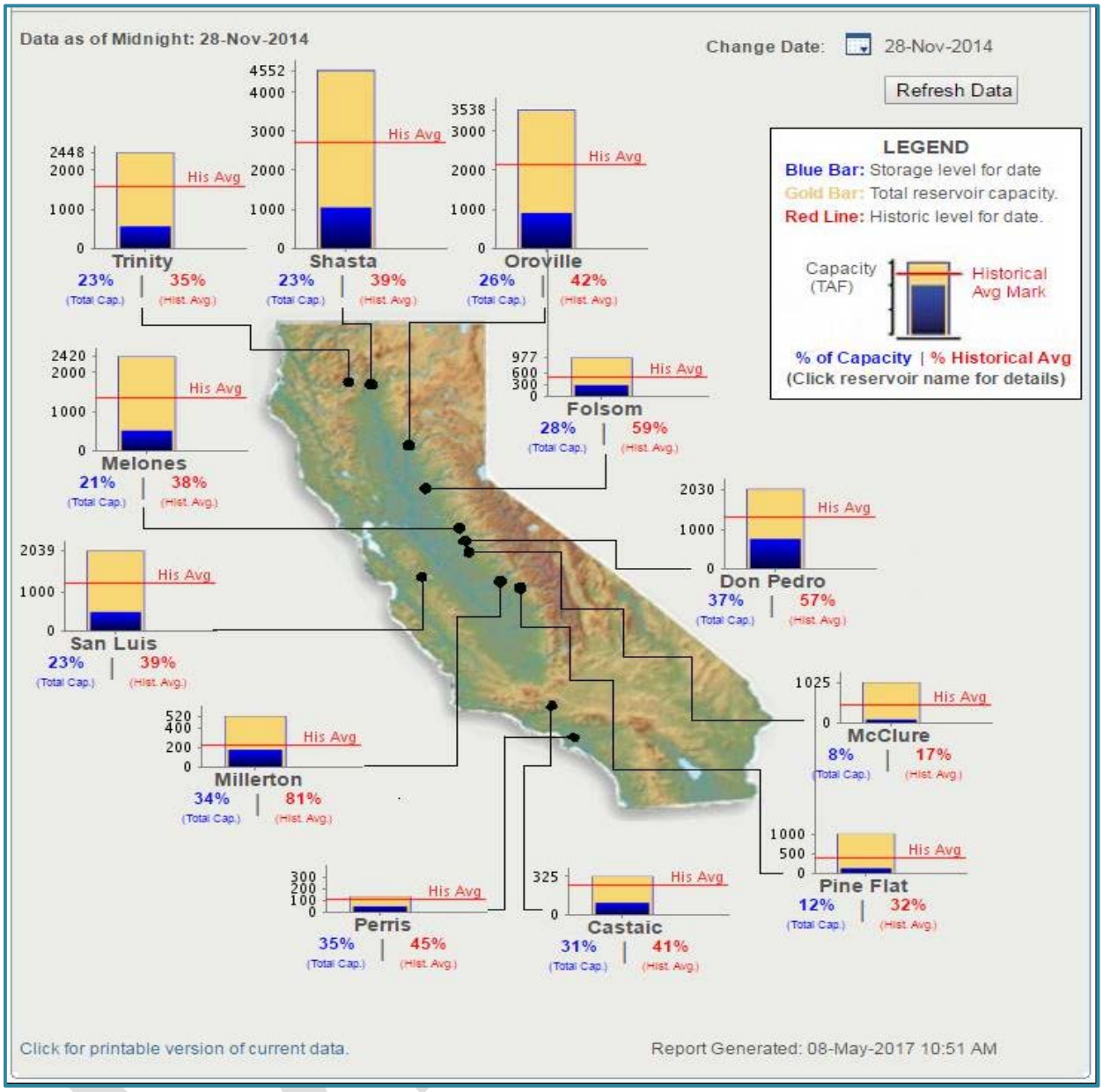


Figure 5: Conditions for Major Reservoirs: 28-Nov-2014
Image Source: http://cdec.water.ca.gov/

used to facilitate water delivery to local water agencies and districts. Locally, agencies store imported water to regulate supply distribution throughout the year. For example, Las Virgenes MWD purchases treated water from Metropolitan and stores it in Las Virgenes Reservoir. The reservoir provides up to a six-month supply of water for its service area in the event of an emergency. Also, the storage allows Las Virgenes MWD to purchase a more consistent volume of water from Metropolitan year-round and to meet peak summertime demands by treating water stored in the reservoir at its Westlake Filtration Plant.

Where groundwater recharge is an option, water management agencies store imported water supplies within groundwater banks as well as local groundwater basins.

The importance of storage is illustrated by California's most recent prolonged drought (2012-2016). Figure 5 shows the difference between the capacity and the actual water levels within the SWP's major storage reservoirs in 2014. Without these reservoirs and extensive statewide conservation, demands would not have been able to be met. The drought also impacted groundwater storage by significantly reducing replenishment from rainfall and snowmelt resulting in groundwater levels well below historical averages.

Governance and Management

Resilience in LA

In the Santa Clarita Valley Basin area, CLWA provides the wholesale services to the region as a SWP contractor, and coordinates closely with its four retail agencies.

West Basin MWD and Central Basin MWD also provide a regional agency role within their service areas, both as a connection to imported water services and as a source of financial assistance and educational (e.g. conservation) programs.

In the Antelope Valley, AVEK fills some of the roles of a regional agency by providing its retailers with conservation funding and being the region's connection to imported water.

Imported water from the SWP and CRA is served to customers through a system of wholesale and retail agencies. The Santa Clarita and Antelope valleys are served directly by two SWP Contractors, CLWA and AVEK, respectively. Within the Los Angeles Basin, Metropolitan combines SWP and CRA to provide wholesale supplies to both direct retail and wholesale agencies. This entire imported water system that serves Los Angeles County is comprised of interconnected facilities that are owned and operated by several agencies that must work cooperatively to meet both local and regional needs.

Imported water wholesale agencies often take on a larger role than just delivering water. Wholesale agencies have more regional service boundaries that cover many smaller agencies, often compelling them to provide regional management and support for the smaller retailers within their service area. Serving as regional leaders, these agencies can help facilitate regional collaboration, provide conservation programming, funding, emergency response and support project implementation.

State Water Project

The Department of Water Resources (DWR) manages the SWP and sets allocations each year for its contractors based on snowpack levels in the Sierra Nevada region. There are six SWP contractors in Los Angeles County: Metropolitan and SGVMWD in the Los Angeles Basin area, CLWA in the Santa Clarita Valley, and AVEK, Palmdale Water District, and Littlerock Creek Irrigation District in the Antelope Valley area. Metropolitan delivers imported water to its 26 member agencies across six counties. Seventeen of these member agencies are within Los Angeles County, of which five are also wholesale suppliers (Central Basin MWD, Foothill Municipal Water District, Three Valleys Municipal Water District (Three Valleys MWD), Upper District, and West Basin MWD). The wholesale agencies in Los Angeles County are shown in Figure 6.

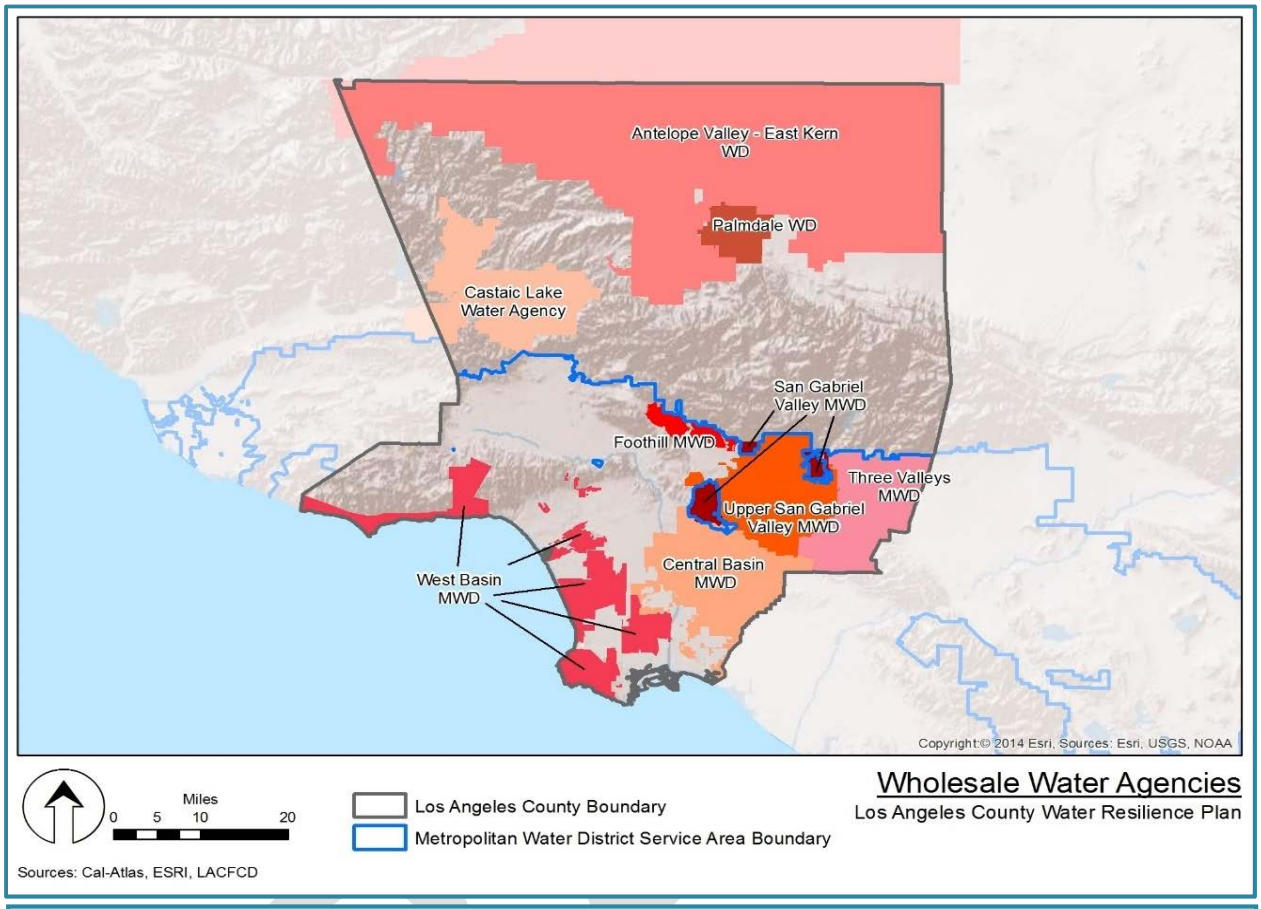


Figure 6: Wholesale Water Agencies

The SWP contractors often work together throughout the region to leverage the use of the SWP system by transferring water between agencies and as a method for implementing in-lieu projects and programs. Given the capacity of the conveyance system is often underutilized, these programs provide opportunities for resilience enhancements as these facilities can be utilized to move additional water across the region for purposes such as water transfers, water banking, and providing emergency water supply during disruptions. On a local scale, Metropolitan, AVEK and CLWA imported water facilities are also used as regional supply backbone systems.

Colorado River

Metropolitan owns and operates the CRA that brings Colorado River water to southern California. Because Metropolitan manages supplies from both the CRA and the SWP, they have been able to modify normal operations to bring Colorado River water further west during recent drought-related SWP cutbacks to maintain supply deliveries to member agencies. Several of Metropolitan's member agencies have also made modifications to their local systems to maximize the use of the more readily available CRA water.

Over the years, Metropolitan increased CRA supply reliability through programs that it helped fund and implement, including: farm and irrigation district conservation programs; improved reservoir system operations; land management programs; and water transfers and exchanges through arrangements with agricultural water districts in southern California, San Diego County Water Authority, and entities in Arizona and Nevada that use Colorado River water, and USBR. Metropolitan's goal for Colorado River

supplies is to maintain current supplies and programs, while also maintaining flexibility through dry-year programs and storage. This goal involves protecting existing supply and storage programs in the face of risks that could impact Colorado River supplies in the future (Metropolitan, June 2016).

Figure 7: Colorado River Aqueduct

Los Angeles Aqueduct

LADWP manages the Los Angeles Aqueduct. Diversions of water from Mono Lake that feed the Los Angeles Aqueduct have been reduced following a decision of the State Water Resources Control Board (SWRCB), in an effort to raise Mono Lake water levels. Additionally, exporting water from the Owens Valley is limited by the Inyo-Los Angeles Long Term Water Agreement (and related Memorandum of Agreement) and the Memorandum of Agreement between the Great Basin Air Pollution Control District and the City of Los Angeles (to reduce dust air pollution from the Owens Lake bed). The recent settlement over the dust issue has required environmental enhancements and reduced the supply available to the City of Los Angeles. These restrictions coupled with the recent drought have reduced supplies to LADWP by approximately 30% (LADWP, June 2016).

Water Transfers

Water transfers involving SWP facilities or supplies require approval by DWR. Metropolitan holds an exclusive contractual right to deliver SWP entitlement water to its service area, therefore limiting options for water agencies within the territory to supplement their supplies through arrangements with other imported water contractors. For example, in order for LADWP to replace the supplies no longer available from the Los Angeles Aqueduct it must either purchase more imported water from Metropolitan or identify other local sources of supply.

Current Resilience Efforts

Climate change imposes larger hydrologic variations and potentially threatens to reduce supplies from all three imported water sources due to potential changes in precipitation patterns and more intensive storm and drought conditions. More concerning is the potential that snowpack will be decreased as the snow line rises, and more precipitation falls as rain rather than snow thereby limiting the amount of seasonal spring flows from melting snow. Compounding the effects of a diminishing amount of available water is the resulting projected increases in demands.

Even without the longer-term effects of climate change, existing droughts have highlighted the vulnerability of reliable water supplies. Figure 8 shows the SWP reservoir, Lake Oroville, in 2011 and 2014, before and after California's most recent period of prolonged drought.

Figure 8: Lake Oroville Before and During the Drought

A number of climate change studies attempted to predict the supply reliability of imported water supplies in the future. In 2011, LADWP conducted a study on potential climate change impacts in the eastern sierra and to investigate opportunities to improve the Los Angeles Aqueduct system to mitigate potential impacts. This study is helping water managers plan and develop measures to enhance the performance of the Los Angeles Aqueducts and ensure future reliability (LADWP, June 2016). Additionally, sea level rise studies are being incorporated into facilities planning, particularly for the SWP.

One effort being conducted to enhance the reliability and resiliency of the SWP is called the California WaterFix. California WaterFix is designed to decrease the vulnerability of the water supply system to two-third of the state's population to earthquakes, flooding, saltwater intrusion, climate change and further environmental degradation. The WaterFix will seek to change the way in which water is taken from the Bay-Delta and to modernize the delivery system with new facilities, equipment, and technologies to reduce harm to fish. New intake facilities will be added farther upstream from the state and federal pumping plants in the southern portion of the Bay-Delta to reduce overall adverse environmental impacts on the Bay-Delta and provide higher quality water to water suppliers. The new facilities will work in conjunction with existing facilities providing greater operation flexibility to protect fish when they are present. A modernized system can more reliably capture water from peak storms and flood flows to refill reservoirs and replenish groundwater basins. A modernized system will ensure that water is available for drought and emergency needs and help protect supplies from earthquakes or other natural disasters that could disrupt the current system.

Imported water management in Los Angeles County is heavily influenced by Metropolitan's water management strategies, particularly Metropolitan's Water Surplus and Drought Management (WSDM) Plan. The guiding principle of the WSDM Plan is that Metropolitan will encourage storage of water during periods of surplus and work jointly with its member agencies to minimize the impacts of water shortages on the region's retail consumers and economy during periods of shortage.

When forecasts of supplies and demands predict pressure on storage reserves, Metropolitan can trigger the Water Supply Allocation Plan. Metropolitan's Water Supply Allocation Plan aims to distribute a limited amount of water supply during drought periods according to local conditions and needs of the region's retail water consumers (Metropolitan, January 2016). Metropolitan's Integrated Water Resources Plan is used to assess and adapt to changing conditions facing southern California and increase the reliability of the region's water supply regardless of the challenges that emerge. Metropolitan has shown an increasingly diversified water supply portfolio for southern California as more local agencies increase their local supplies and decrease dependence on imported water to meet increasing water demands while Metropolitan works to stabilize its imported supplies and management of supplies through surplus and drought cycles.

Resilience in LA

The California WaterFix seeks to make the SWP that brings water to Southern California more resilient under normal and drought conditions, as well as to respond to climate change by modernizing the intake and delivery system. An aligned strategy, known as EcoRestore, is hoped to improve conditions for fish species and habitat in the San Francisco Bay-Delta.

Developing local supplies to decrease dependence on imported water will help increase the availability and reliability of both local and regional supply. Even agencies that cannot readily use local supplies are supporting their development as a method of increasing imported water sustainability. Metropolitan funds the Local Resources Program to provide funding for agencies to develop local supplies for the benefit of the region.

Resilience in LA

Efforts to increase local water supplies often involve a partnership with the LACFCD to utilize existing conveyance and recharge facilities designed to deliver and store local water. For example, LACFCD's San Gabriel Coastal Spreading Grounds accepts WRD's recycled water for recharging the Central Basin.

The majority of agencies in the County have strategic goals to lessen their reliance on imported water or, in some cases, entirely eliminate dependence on imported water sources. WRD is an example of one agency that is moving toward independence from imported water through their "Water Independence Now" campaign which seeks to eliminate the use of imported water for replenishment of the Central and West Coast groundwater basins. WRD's Groundwater Reliability Improvement Program (GRIP) is a major initiative being implemented to offset imported water replenishment with recycled water supplies, thus increasing reliance on local water sources and minimizing the need for imported water in the replenishment of regional groundwater.

Other agencies like LADWP and Santa Monica have aggressive mid-term goals to reduce imported water use. As part of the City of Los Angeles' Sustainable City pLAn, LADWP aims to reduce the purchase of imported water by 50% by 2025 (City of Los Angeles, 2015). Santa Monica has a goal to utilize 100% local supplies by 2020 (City of Santa Monica, January 2014).

Some agencies do not have pumping rights to a potable groundwater basin and are entirely dependent on imported water for potable use. These agencies are focusing on ways to interconnect with other imported water users that do have access to local supplies so that in-lieu programs and projects can be implemented. Interconnections in these areas play a major factor in allowing the agencies to meet demands and diminish their reliance on imported water sources, thus making them more capable of withstanding shocks and unforeseen changes that could impact the imported water supply.

4.1.4 Groundwater

Sources and Infrastructure

The groundwater basins within the County are shown in Figure 9. Over 500,000 acre-feet per year (AFY) of groundwater is used to meet County water demands when combining the Los Angeles Basin, Santa Clarita Valley, and Antelope Valley areas.

Within the Santa Clarita Valley, groundwater is pumped from two aquifer systems within the Santa Clara River Groundwater Basin, East Subbasin, the shallow Alluvium Aquifer which underlies the Santa Clara River and its several tributaries, and the Saugus Formation which underlies practically the entire Upper Santa Clara River area.

Resilience in LA

WRD's Groundwater Reliability Improvement Program (GRIP) is a major initiative being implemented to offset imported water replenishment with recycled water supplies. The GRIP project utilizes advanced treatment for a portion of the recycled water used for replenishment to increase the total amount allowed per groundwater recharge regulations.

In the Antelope Valley, the large Antelope Valley Groundwater Basin is a major source of water supply for the region. The Antelope Valley Groundwater Basin is comprised of two primary aquifers: the upper aquifer and the lower aquifer (DWR, 2004). Both the Santa Clara and Antelope Valley Groundwater Basins are generally considered to have good water quality.

Within the Los Angeles Basin, there are several groundwater basins that operate independently and some that operate in coordinated systems through underflows (e.g. Central Basin into West Coast Basin and Six

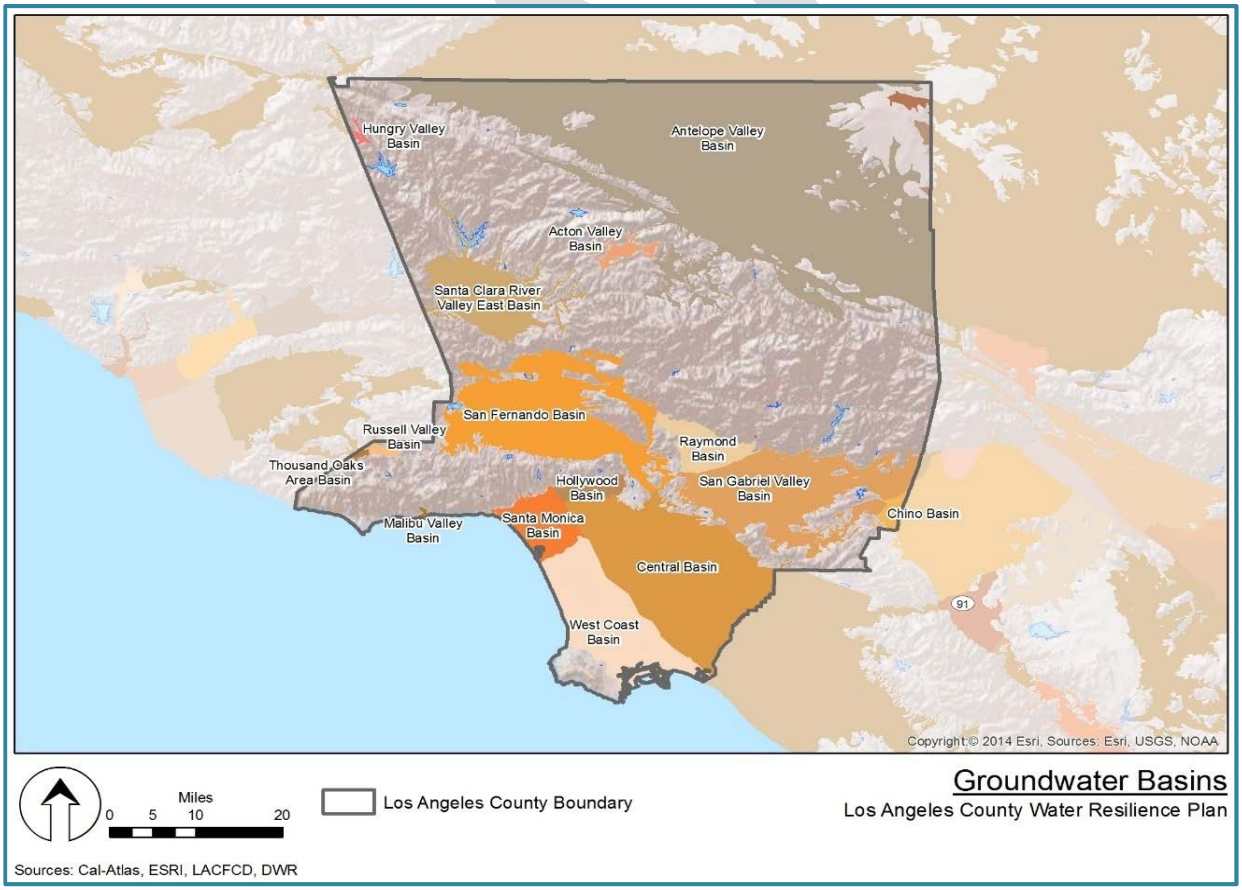


Figure 9: Groundwater Basins

Basins). Groundwater basin water quality is a significant issue in many areas of the County, as natural conditions result in high dissolved salt levels. In some aquifers, salt levels are so high the water is termed "brackish," which either requires desalination or advanced treatment to make the supply usable or blending the treated water with other supplies that have a lower salt content. In addition, given historic land uses involving industrial process and agriculture there are several basin areas that have been considered unusable for potable supply and/or require intensive treatment process for use.

Basin Recharge

Groundwater basin recharge can occur via existing and restored natural channel bottoms or percolation of rainwater (natural recharge), however in the Los Angeles Basin area natural recharge is typically insufficient to maintain basin water levels and current pumping levels due to the extent of impervious urbanized surfaces and the presence of clay soils in several parts of the region. Many agencies rely on artificial recharge to spreading grounds and injection wells to ensure groundwater recharge. Local surface/stormwater, recycled water and imported water are all used at spreading grounds to replenish groundwater levels. The Los Angeles Basin groundwater basins utilize imported water and recycled water to supplement stormwater recharge and ensure pumping does not overdraft the basins. Water purveyors in the Santa Clarita Valley and Antelope Valley are evaluating the feasibility of using imported water injection and recycled water for replenishment in the future.

Groundwater basins within the Santa Clarita Valley and Antelope Valley require less artificial recharge than the Los Angeles Basin area because these areas receive stormwater runoff flows from surrounding hills and mountains and have more open space that allows natural percolation. In the Santa Clarita Valley, groundwater is recharged primarily through rainfall, stream flow from the Santa Clara River and deep percolation. In the Antelope Valley, the groundwater basin is principally recharged by deep percolation of precipitation and runoff from the surrounding mountains and hills, though additional artificial recharge occurs from return flows from agricultural irrigation, urban irrigation, and wastewater management activities.

Recharge can also occur "in-lieu," when an agency suspends normal production from its wells and uses other supplies thereby allowing groundwater levels in the basin to increase. The amount of water that can be recharged in a basin may be limited by local runoff, recharge capacity, overlying groundwater demands, and water rights.

Where groundwater basins have confined aquifers, such as in portions of the West Coast and Central Basins, stormwater infiltration and spreading is not a viable option. In these basins, the LACFCD owns, operates, and maintains injection wells used to replenish the basin. Most of the groundwater in the West Coast and Central Basins remains at an elevation below sea level due to historic over-pumping. To prevent further seawater intrusion into the West Coast and Central Basins, three seawater intrusion barriers, the Alamitos, Dominguez Gap, and West Coast Basin Barriers, are maintained by injecting imported water and recycled water.

As a result of developing the barriers, the saline influence was confined to a single plume now trapped inland of the West Coast Basin Barrier. The saline plume continues to impact pumping capacity in the West Coast Basin and results in one-third of the pumping rights in the basin going unused. WRD and West Basin Municipal Water District both have implemented desalters in the basin to pump and treat some of the saline water for use.

Extraction Wells and Interconnections

Groundwater is extracted through a number of wells owned by agencies and individual pumpers with water rights. In some areas of the County, aging wells and distribution lines in need of rehabilitation or replacement have resulted in water rights going unused. Agencies must then purchase imported water to meet demands and, in some cases, only provide enough system pressure to distribute any flows to end users.

In some areas of the County, interconnections between neighboring agencies and imported water purveyors have been strategically implemented. However, there are some areas (e.g. San Gabriel Valley, Gateway and Antelope Valley) where there are several very small retail water supply agencies and mutual water companies that are not well connected given a lack of financial resources. This lack of connectivity creates an isolation between systems that reduces the ability of purveyors to receive back up supplies from another entity.

Governance and Management

Most groundwater basins in Los Angeles County are adjudicated (via a court decision) and producers within these basins follow management guidelines established by their respective adjudications. Currently, there are eight local groundwater basins within the County that are adjudicated, meaning that a court judgment has been established to determine the rights of usage. For each one, a Watermaster (an agency, individual, or group of individuals) is appointed by a court to carry out the terms of the court order by administering the adjudicated water rights in a basin and managing and protecting the groundwater resources. The Watermaster monitors water pumped from the basin, and water quality in the basin to ensure the groundwater is managed sustainably. Non-adjudicated basins still have extensive oversight through various special districts and associations. Non-adjudicated basins include the Santa Monica Basin, Hollywood Basin, Puente Basin, Spadra Basin, and Santa Clara River Groundwater Basin.

In 2014, the State of California adopted the Sustainable Groundwater Management Act (SGMA) in response to overpumping and a lack of groundwater recharge in some areas of the state. SGMA requires the formation of locally-controlled groundwater sustainability agencies (GSAs), which are responsible for developing and implementing a groundwater sustainability plan (GSP). The purpose of the GSP is to ensure the basin is operated within its sustainable yield, without causing undesirable results. Most adjudicated basins in Los Angeles County already have these structures in place through the Watermaster and are already meeting SGMA requirements. Unadjudicated basins (such as Santa Clara River Groundwater Basin, East Subbasin, Santa Monica Basin, and Hollywood Basin) require the formation of a GSA to improve the reliability and quality of the groundwater supply. In many cases this role is being embraced by the regional wholesale agency or a regional agency in coordination with other local partners.

Resilience in LA

In the MSG Basin area, the Watermaster and Upper District both provide a leadership and support role to the San Gabriel Valley area and are considered a resource for information and guidance on emergency response and other basic functions by smaller agencies in the basin.

Groundwater basin management in many areas of the County is changing, as Watermasters are realizing a need to account for changes in natural replenishment differently. Recent amendments to the West Coast and Central Basin Judgments allow for more flexibility in the use of these basins' storage capacity, including conjunctive use of the groundwater basins. These Judgment amendments allow for increased optimization of the West Coast and Central Basin operations and provide for a more reliable and cost-effective water supply for the region. Judgment amendments provide for water to be stored in the basins, allow interbasin transfer of storage rights between the West Coast and Central Basins, and permit pumping beyond adjudicated rights through water augmentation projects (CH2M & RMC, September 2016)).

Due to ongoing issues with declining or low groundwater levels, groundwater management requires coordination with other water management entities who provide water for replenishment. In the San Gabriel Valley, the Main San Gabriel Basin Watermaster works closely with wholesale suppliers like Upper District, San Gabriel Valley Municipal Water District, and Three Valleys MWD to replenish groundwater basins with imported water. WRD, the Watermaster for Central Basin and the West Coast Basin, coordinates regularly with LACFCD, which manages the spreading grounds that recharge groundwater basins and the injection wells that maintain the seawater barrier, West Basin MWD, LADWP, LASAN, and

LACSD that supply the recycled water purchased by WRD for the seawater barriers, and LBWD which operates the Leo J. Vander Lans Advanced Water Treatment Facility for the Alamitos Barrier.

Because Watermasters have service boundaries that span multiple water agencies and cities, these entities often take on larger regional roles. Watermasters can provide support roles for smaller agencies within their jurisdiction by helping to facilitate regional collaboration, provide information on conservation, funding, emergency response and supporting project implementation.

- In the West Coast Basin and Central Basin areas, WRD is the Watermaster and functions as a regional entity, providing technical assistance to pumpers and is the regional expert on how best to utilize storage.
- In the MSG Basin area, the Watermaster and Upper District both provide a leadership and support role to the San Gabriel Valley area and are considered a resource for information and guidance on emergency response and other basic functions by smaller agencies in the basin. The Main San Gabriel Basin Watermaster also provides ongoing technical support for recycled water development in the San Gabriel Valley. The Main San Gabriel Basin Watermaster is conducting groundwater modeling as a preliminary step towards participating in Metropolitan's Regional Recycled Water Project that would utilize recycled water from LACSD's Joint Water Pollution Control Plant in Carson for spreading in the MSG Basin and other basins in the region. Through participating in the Regional Recycled Water Project, both the Main San Gabriel Basin Watermaster and Upper District are helping increase supply reliability throughout the region.

Groundwater regulation states that recharge cannot negatively impact any existing plumes. However, regulation of contaminated groundwater is complicated because several agencies enforce and oversee their respective programs, and the standards imposed by different agencies may be in conflict. For instance, a groundwater remediation project must comply with regulations specified by the Department of Toxic Substances Control, the United States Environmental Protection Agency (US EPA), the Regional Water Quality Control Board (Regional Board), and the California Department of Public Health Division of Drinking Water. Watermasters coordinate with these agencies regularly to protect the quality of the groundwater basins.

The uniform water recycling criteria for groundwater replenishment was adopted in June 2014. This action by the SWRCB has created a clear pathway for agencies, and multi-agency collaborations to pursue large scale recycled water groundwater recharge projects in the near future.

Current Resilience Efforts

Groundwater Recharge

A large component of groundwater basin management and pumping allocations is rooted in historical average rates of natural recharge. Reductions in stormwater runoff and groundwater recharge during multiple-year droughts have resulted in overproduction in many basins. Watermasters are working toward managing the basins differently to account for long-term changes in precipitation and runoff. For example, producers in the MSG Basin have been "storing" water over the past several drought years by not pumping in order to mitigate the minimal natural basin replenishment. However, because groundwater levels were already unusually low, it is difficult to consider lack of pumping as "storage" and groundwater levels have remained low. In the Raymond Basin, all nine pumpers in the Pasadena Subarea of the Raymond Basin agreed to reduce pumping by 30% to maintain groundwater levels during the drought, independent of precipitation conditions.

Resilience in LA

In the Raymond Basin, all 9 pumpers in the Pasadena Subarea of the Raymond Basin agreed to reduce pumping by 30% to maintain groundwater levels during the drought, independent of precipitation conditions.

Watermasters are taking action to store imported water in the groundwater basins when it is available. Climate trends have indicated that, on average, wet years will be wetter than in the past and dry years drier, with intensified rain events. Watermasters are increasing their ability to fund, import, and store large amounts of water whenever it is available to protect against reduced supply availability during dry years. The Main San Gabriel Basin Watermaster maintains an emergency water supply program for times when untreated, imported, supplemental water is not available to refill the MSG Basin. The Main San Gabriel Basin Watermaster's Direct Delivery In-Lieu program provides a financial offset to pumpers who have a connection to treated imported water so that they can use treated imported water in-lieu of pumping groundwater (Main San Gabriel Basin Watermaster, 2016).

As a result of the drought and the varied geometry of the groundwater basins, some basins have experienced wells going dry in some areas before others. In these basins, an important component of ensuring the reliability of supply is maintaining interconnections and in-lieu agreements between pumpers to allow for water transfers. A model example of where interconnections and agreements have greatly increased supply reliability within the region amidst the drought is the case of Pasadena in conjunction with pumpers in the Raymond Basin. Pumpers in the Raymond Basin have a network of interconnections that allow them to move water from one entity's system to another. The interconnected system allows the agencies to share water with neighboring pumpers when certain portions of the basin are experiencing water quality issues or agencies need additional water to meet demand.

Conjunctive use and water banking are major programs utilized to increase reliability of water supply through storing water in the groundwater basins. Throughout the County, water agencies use conjunctive use as a mechanism to protect against water supply deficiencies in dry years. Wholesale agencies such as Upper District, Central Basin MWD, West Basin (through Metropolitan), and AVEK purchase imported water to store in groundwater basins, to both meet replenishment needs for normal pumping and store water for use when other supplies are diminished or unavailable. Similarly, a major mechanism for building resilience against drought in the Antelope Valley is water banking. AVEK utilizes groundwater banks to ensure it can continue to deliver water to its retail agencies during a drought that lasts multiple years, even with minimal SWP deliveries. AVEK currently has two water banks that it can utilize to meet demand if there were a disruption in SWP deliveries. CLWA is also evaluating the option of using recycled water and imported water for replenishment in the Santa Clarita Valley as part of their Water Resources Reconnaissance Study (June 2015) to improve local supply.

Resilience in LA

AVEK utilizes groundwater banks to ensure it can continue to deliver water to its retail agencies during a drought that lasts multiple years, even with minimal SWP deliveries.

Groundwater Quality

Several groundwater basins in the County have contaminated groundwater or plumes that impact the ability for agencies to pump. Some of the water quality issues are naturally occurring while others are caused by anthropogenic polluting activities. The following strategies are being used by agencies to address groundwater quality issues:

- Watermasters and water managers typically know where water quality issues exist and can manage pumping to reduce the spread of the plumes. WRD and the Main San Gabriel Basin Watermaster regularly monitor groundwater quality and pumping to reduce the spread of contaminated water.

Resilience in LA

CLWA is managing perchlorate contamination in the Santa Clara Valley Groundwater Basin by pumping and treating the contaminated groundwater onsite, while also drilling new wells in other areas to restore the lost capacity.

- Pumpers are responsible for treating groundwater to meet water quality regulations. For example, Los Angeles County Waterworks District 40 uses onsite wellhead treatment and blending with imported water to dilute arsenic concentrations in the Antelope Valley.
- In the Santa Clara Valley Groundwater Basin there is perchlorate contamination in one part of the basin. The site is being managed to prevent additional spread of the contamination and to remediate the groundwater onsite. CLWA is pumping and treating the contaminated groundwater already dispersed throughout the basin, and is drilling wells in other areas to restore the lost capacity in the meantime.
- Santa Monica experienced methyl tert-butyl ether (MTBE) contamination in its groundwater supply that took the supply offline for several years. Since then, Santa Monica has constructed a treatment plant (shown in Figure 10) to treat the contamination and allow the City to use groundwater again.

Some groundwater basins have experienced water quality issues because groundwater levels have dropped during the drought causing contamination plumes to move. In the Main San Gabriel Basin, some areas with high nitrates or chromium have developed. In the Central Basin, multiple groundwater plumes in the upper portion of the basin appear to be moving down and could eventually impact where pumping is occurring. Another concern is that sea level rise will cause increased seawater intrusion. As a result, demands related to barrier operations will increase.

Figure 10: Santa Monica Water Treatment Plant
https://www.smgov.net/

Residential use of potable water, the importation of water, and the use of recycled water, among other activities, all have the potential to increase the level of total dissolved solids (TDS) in groundwater. With naturally occurring elevated levels of TDS already present in both local surface water and groundwater, the need to manage salts levels has been recognized for some time. Water managers try to avoid future groundwater quality issues using Salt and Nutrient Management Plans.

4.1.5 Local Surface Water and Stormwater

Sources and Infrastructure

Surface Water Supplies

Direct diversion and use of local surface water is not a major supply source in Los Angeles County. The Los Angeles River and the San Gabriel River are the two major river systems in the County used to divert surface water for supply. The Upper Santa Clara River, while a major river system in the County, is not used to divert surface water for supply and remains the last major undammed river system in southern California. The Santa Clara River interacts significantly with the underlying groundwater basins which is a significant supply source for the Santa Clarita Valley. In the Antelope Valley, Little Rock Creek is the

only developed surface water supply in the region. The surface water systems used for supply as well as their associated infrastructure are summarized below.

The Los Angeles River flows 51 miles from the union of Bell Creek and Arroyo Calabasas in the San Fernando Valley, then southeast through the City of Burbank and eventually southward to Long Beach. Originally, the Los Angeles River was the primary water source for the City of Los Angeles. Following several catastrophic floods, the United State Army Corps of Engineers (USACE) encased most of the river bed and banks in concrete, effectively eliminating interaction between groundwater and surface water in certain areas. Today, the river is primarily fed from stormwater, effluent from wastewater treatment plants, urban runoff, base flow from the Santa Monica and San Gabriel Mountains, and groundwater inflow in the Glendale Narrows.

The San Gabriel River flows 75 miles southwest from the San Gabriel Mountains, then southward from the Whittier Narrows to its ocean discharge at the City of Seal Beach. Unlike the Los Angeles River, due to more favorable soil conditions and planning efforts by the LACFCD to conserve surface flows, the San Gabriel River has a natural bed for most of its length, although the banks are armored with rip rap and concrete for flood risk mitigation purposes. The river is fed by stormwater, base flow from the San Gabriel Mountains, dry weather urban runoff and effluent from wastewater treatment plants.

Water from the Los Angeles and San Gabriel rivers is either treated for direct use or used for groundwater recharge. Significant quantities of surface water naturally recharge groundwater via the permeable bottom in the San Gabriel River, yet because the Los Angeles River is largely encased in concrete, natural recharge through the river bed is limited. Along both rivers, spreading grounds have been developed by the LACFCD and other agencies in several locations to increase groundwater recharge.

Little Rock Creek is the only surface water in the Antelope Valley diverted for supply at this time. Flows from the Creek originate in the San Gabriel Mountains and are captured in Little Rock Creek Reservoir (Antelope Valley Regional Water Management Group, December 2013).

Surface Water Facilities

Several smaller reservoirs have also been developed within the County to assist in the management of water supplies. However, most of these local reservoirs are limited in their ability to capture local runoff. Most of the remaining dams in the County have been developed for flood management purposes and are typically not used for long-term (e.g., multi-year) surface water storage.

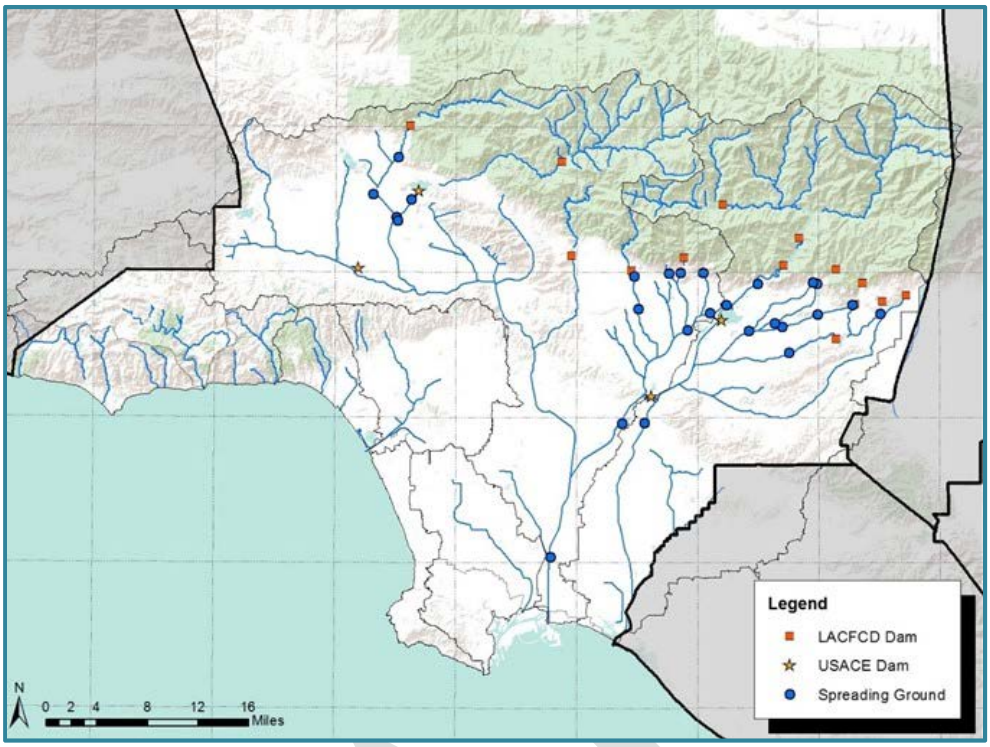


Figure 11: Surface Water Facilities in Los Angeles Basin Area

The USACE oversees Hansen, Lopez and Sepulveda dams in the Los Angeles River watershed and Santa Fe and Whittier Narrows Dams in the San Gabriel River watershed. Additionally, LACFCD oversees several surface water storage facilities including 14 major dams, which were created to improve flood protection and store runoff for subsequent release and diversion to several spreading grounds for groundwater recharge. Additional spreading grounds are owned and operated by non-LACFCD entities in the County, such as LADWP. The LACFCD's 27 spreading grounds are used to recharge local surface water in addition to imported and recycled water. The LACFCD's and USACE's surface water facilities are shown in Figure 11 for the Los Angeles Basin area.

Eleven dams within the County were constructed as part of the San Gabriel River and Montebello Forebay water conservation system to impound runoff from the San Gabriel Mountains prior to release for downstream spreading and groundwater recharge. As a result of these systems, LACFCD is able to conserve about 95 percent of the precipitation falling on the San Gabriel River Watershed (including the Rio Hondo) down to the Coastal Spreading Grounds during most years.

On tributaries to the Los Angeles River, the Big Tujunga and Pacoima dams provide similar functions. LACFCD also oversees 17 inflatable rubber dams throughout the Los Angeles River basin. Most are used to divert flows into the spreading grounds, although several rubber dams in the San Gabriel watershed also promote short-term groundwater recharge through the river bottom. Sediment accumulation in dams and spreading facilities is a major issue that continues to be addressed through mitigation programs that typically involve sediment removal and relocation to selected placement sites.

In the Antelope Valley, water from Little Rock Creek is collected behind Little Rock Creek Dam Reservoir. The Dam was recently renovated to increase storage capacity due to sediment accumulation. Water from the reservoir is transferred to Palmdale Lake and then treated at the Palmdale Water District's water treatment plant for distribution.

Stormwater Runoff and Capture

The capture and use of stormwater runoff (runoff from urban areas that has not yet reached streams and rivers) is a source of supply that is currently underutilized in most areas of the County. The City of Los Angeles maintains several distributed stormwater capture and treatment facilities throughout the city which are summarized in LADWP's Stormwater Capture Master Plan (August 2015). These facilities include the Elmer Avenue Neighborhood Retrofit Project (Figure 12) and Woodman Avenue Green Infrastructure Project which utilize best management practices (BMPs) such as bioswales to capture and infiltrate stormwater into the ground rather than directing it to nearby flood protection facilities. Other decentralized stormwater runoff projects include green streets, such as the Riverdale Avenue Green Street Project in the City of Los Angeles which provides runoff capture near the Los Angeles River (LADWP, August 2015).

Figure 12: Elmer Avenue Stormwater Capture Project, City of Los Angeles

http://ww2.kqed.org/

In addition to decentralized stormwater capture and infiltration, many water agencies have implemented rain barrel and cistern programs to increase localized stormwater capture for direct use by ratepayers. These programs provide some water supply to the user and are key components of rain garden and conservation programs.

Projects and programs that capture stormwater are particularly valuable for building water resilience in the County because they can provide a suite of benefits beyond additional water supply. Local stormwater capture decreases dependence on imported water sources, helps improve water quality in receiving water bodies to meet water quality mandates, provides some flood protection, reduces peak flows that impact the region's waterways, and often involves development of new greenspace for habitat restoration and community recreation. Through these benefits, effective stormwater management contributes to developing a more resilient watershed that can more successfully withstand the threat of climate change and increased needs presented by a growing population.

Governance and Management

Water agencies that have water diversion rights within the Los Angeles River watershed include PWP and LADWP. PWP uses its rights for recharge of the local groundwater basin. LADWP has full rights to flows in the Los Angeles River and uses its diversion rights for groundwater recharge at various locations across the San Fernando Valley.

The Long Beach Judgement provides for an accounting of runoff in the San Gabriel River and Rio Hondo to ensure enough water is available for entities downstream of Whittier Narrows. The San Gabriel River Watermaster determines the annual volumes and usable water for users in the upper area and lower area (CDM Smith, January 2013).

Surface runoff diversions from the San Gabriel River and its tributaries to Whittier Narrows are prescribed in the MSG Basin Judgment. Retail agencies with diversion rights for direct use include Cal American, Covina Irrigation, and Azusa Valley. The San Gabriel River has been fully appropriated by the SWRCB, with surface water rights belonging to two entities: the San Gabriel River Water Committee and the San

Gabriel Valley Protective Association, which then distribute the water for either direct use or for groundwater recharge.

Stormwater management involves multiple jurisdictions. LACFCD is primarily responsible for stormwater capture and infiltration at spreading facilities as part of its role in flood risk mitigation and water conservation. The USACE Dams are operated based on various constraints and operational priorities including flood protection, recreation, habitat preservation, and water conservation. Enhanced storage behind dams and better coordination between the USACE and local flood management entities regarding the timing of release of waters is a topic of discussion.

Local water supply agencies like LADWP often have their own decentralized stormwater infiltration facilities that they manage. These supply agencies also provide the actual distribution of captured stormwater for supply and often partner with LACFCD to manage stormwater as a resource. Additionally, city public works departments are responsible for localized runoff collection to storm drains from streets and are identified as responsible parties for nonpoint source discharges to receiving water bodies because the stormwater flows over their jurisdictions into the storm collection system.

Because of the many agencies involved in stormwater capture and use, and the multiple benefits these supply projects can provide, stormwater capture projects typically involve collaborative efforts between several agencies that manage different aspects of the stormwater systems. Within the City of Los Angeles, these include LADWP, LACFCD, LASAN, the Los Angeles Bureau of Street Services, the Los Angeles Bureau of Engineering, and the USACE. Stormwater capture projects provide multiple benefits for multiple agencies, allow for the opportunity to cost-share, and reduce the individual financial burden (LADWP, August 2015).

Resilience in LA

LACFCD is the principal owner and operator of recharge facilities throughout the County and maintains its spreading basins to receive and store stormwater in the region's groundwater basins. Recycled water and imported water are also used to recharge groundwater basins in partnership with the region's groundwater masters and water agencies.

Los Angeles County and cities within the County have developed Low Impact Development (LID) Ordinances that mandate the inclusion of distributed stormwater capture projects, such as those shown in Figure 13, in new development and significant redevelopment projects. Additionally, the 2012 Los Angeles County Municipal Separate Storm Sewer System (MS4) Permit calls for increased local stormwater capture through LID and regional infiltration projects.

Once adopted by the SWRCB, Senate Bill 918 and the release of the draft uniform water recycling criteria for surface water augmentation will provide a clear pathway for large scale advanced treated recycled water facilities to augment certain surface water reservoirs, which shall increase local drinking water supplies.

Increasing the stormwater component of the water supply portfolio will require storing water that arrives and is captured during wet periods for use during dry conditions. Groundwater basins offer the greatest potential to store large volumes of water. However, their use is limited by existing contamination plumes in several groundwater basins and the capability to readily recover recharged water. A successful stormwater capture and storage program depends on efficient use of these groundwater basins, which will require close coordination among regulatory agencies, and a diversified portfolio of decentralized projects developed and overseen by various entities.

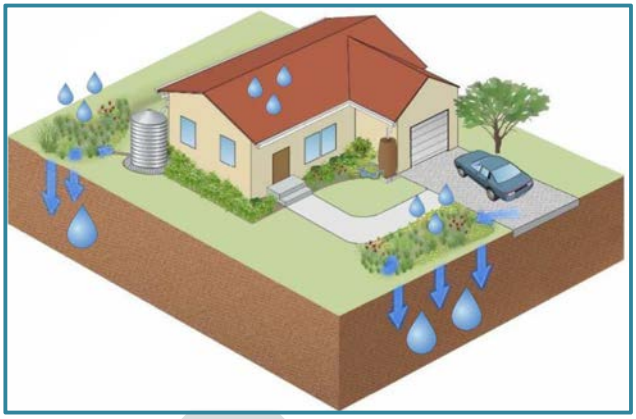


Figure 13: Schematic of LID at the Parcel Scale

Image Source: LA Basin Study

Current Resilience Efforts

Sediment accumulation in reservoirs reduces capacity and supply reliability in surface water facilities. Sediment removal projects are key projects for ensuring optimal operations of dams and reservoirs, and maximizing the amount of stormwater available for storage and reuse. A recent example is the Santa Anita Dam Sediment Removal project within the San Gabriel Watershed. The project removed sediment from behind the dam to improve flood protection and increase stormwater conservation. Concerns over environmental impacts to local habitat have impeded efforts to remove sediment at Devil's Gate Dam and others, although sediment mitigation efforts are ongoing and promise to increase the capacity of the reservoir once implemented. LACFCD has also successfully completed and planned numerous other projects in addition to sediment removal efforts that protect existing reservoir capacity and protect supply reliability. One such suite of projects, which supplements the Santa Anita Dam Sediment Removal project, provides improvements to ensure infrastructure is resilient and increases storage capacity at downstream facilities such as the Santa Anita Debris Dam. These projects involved multiple partners, including the Cities of Arcadia and Sierra Madre, and the Raymond Basin Watermaster.

Resilience in LA

LACFCD is committed to ensuring dam safety and has invested over $160M in dam improvement and upgrade costs since 1994. As a result, LACFCD's dams all meet or exceed current codes and the agency has a perfect track record in downstream safety.

Prolonged drought has resulted in less stormwater recharge throughout the County. As an example, eight of the last ten years have had below average stormwater capture in the San Gabriel Valley Watershed. The Main San Gabriel Basin Watermaster has been working with LACFCD, Upper District, and municipalities to expand stormwater capture in the MSG Basin. The agencies have identified six stormwater capture projects that could introduce new water to the MSG Basin, with four of the six projects implemented thus far (Main San Gabriel Basin Watermaster 2015-2016 Annual Report).

There has been some concern over the impact high volumes of stormwater infiltration will have on groundwater quality. A study completed by the Los Angeles and San Gabriel Rivers Watershed Council in 2007 called the Los Angeles Basin Water Augmentation Study, investigated the impact of stormwater infiltration on surface water quality and groundwater supplies. The study found that groundwater quality was not impacted by waterborne pollutants in urban runoff during the monitoring period between 2000 and 2007. This study has proven useful for many agencies interested in developing stormwater capture and infiltration projects in their jurisdictions.

Additional studies have focused on the future of stormwater capture, investigating new opportunities and promising innovations. In 2015, LADWP completed its Stormwater Capture Master Plan that evaluated the potential for stormwater capture in the City of Los Angeles. The Stormwater Capture Master Plan outlines LADWP's strategies over the next 20 years to implement related projects and programs and to cooperate with other agencies on projects in the City that will contribute to more reliable and sustainable local water supplies. Through this effort, LADWP identified several potential stormwater capture opportunities within the City of Los Angeles.

LACFCD and USBR developed the Los Angeles Basin Stormwater Conservation Study (2016) to assess the Los Angeles Basin's current and projected water supplies and demands, identify any gaps, and develop adaptation strategies to address impacts from climate change and population growth. As part of the study, the group developed project concept alternatives and conducted a tradeoff analysis to evaluate the benefits and costs of stormwater concepts for the region. Project concepts included benefits such as supply, recreation, and habitat. Tradeoffs considered the potential economic, financial, environmental, and social effects of the multi-benefit project concepts. Results of the analysis showed that LACFCD Dam projects, local solutions, regional impact programs, and green infrastructure programs had benefits with the most value and should be considered for feasibility in the future.

Resilience in LA

LACFCD and USBR developed the Los Angeles Basin Study in 2016 to predict potential supply gaps and opportunities under projected climate change conditions. The study included potential alternatives and a tradeoff analysis to evaluate the benefits and costs of stormwater concepts for the region.

While the lion's share of engineered stormwater capture and infiltration within Los Angeles County is implemented by LACFCD, several cities have begun implementing distributed stormwater capture and infiltration facilities to recharge groundwater while also improving surface water quality. In the City of Los Angeles, several stormwater capture projects have been successfully implemented through funding supplied by Proposition O. Additionally, LADWP coordinates with LACFCD regularly to implement projects that improve spreading grounds capacity in the San Fernando Basin area to increase supply reliability.

The City of Los Angeles is also in the process of preparing the One Water LA Plan that will provide an integrated approach for water supply, wastewater treatment, and stormwater management in the City of Los Angeles. One Water LA is a component of the City of Los Angeles Sustainability pLAn and involves multiple agencies and stakeholders working on the City of Los Angeles's water issues. The collaborative effort aims to address long-term supplies for the City of Los Angeles in addition to enhancing resilience to drought conditions and climate change.

Several other cities are beginning to focus on next steps for distributed stormwater capture projects, particularly as a means to address water quality mandates in the MS4 Permit. These cities have participated in the development of programs to address water quality issues while also increasing local supply reliability. For example, many agencies have collaborated to develop EWMPs that include projects that provide water quality benefits while also augmenting water supply through infiltration or offsetting potable water use through onsite use.

In areas of the County not impacted by the Los Angeles County MS4 permit and not experiencing surface water body quality issues, like the Antelope Valley, stormwater capture and infiltration projects are not a priority. In this part of the County, the landscape is interior rural desert plateau where runoff infiltrates into groundwater basins naturally.

4.1.6 Recycled Water

Sources and Infrastructure

Wastewater is collected and treated at water reclamation plants throughout the County to produce secondary, tertiary, and in some cases, advanced treated recycled water. The major wastewater service areas are shown in Figure 14.

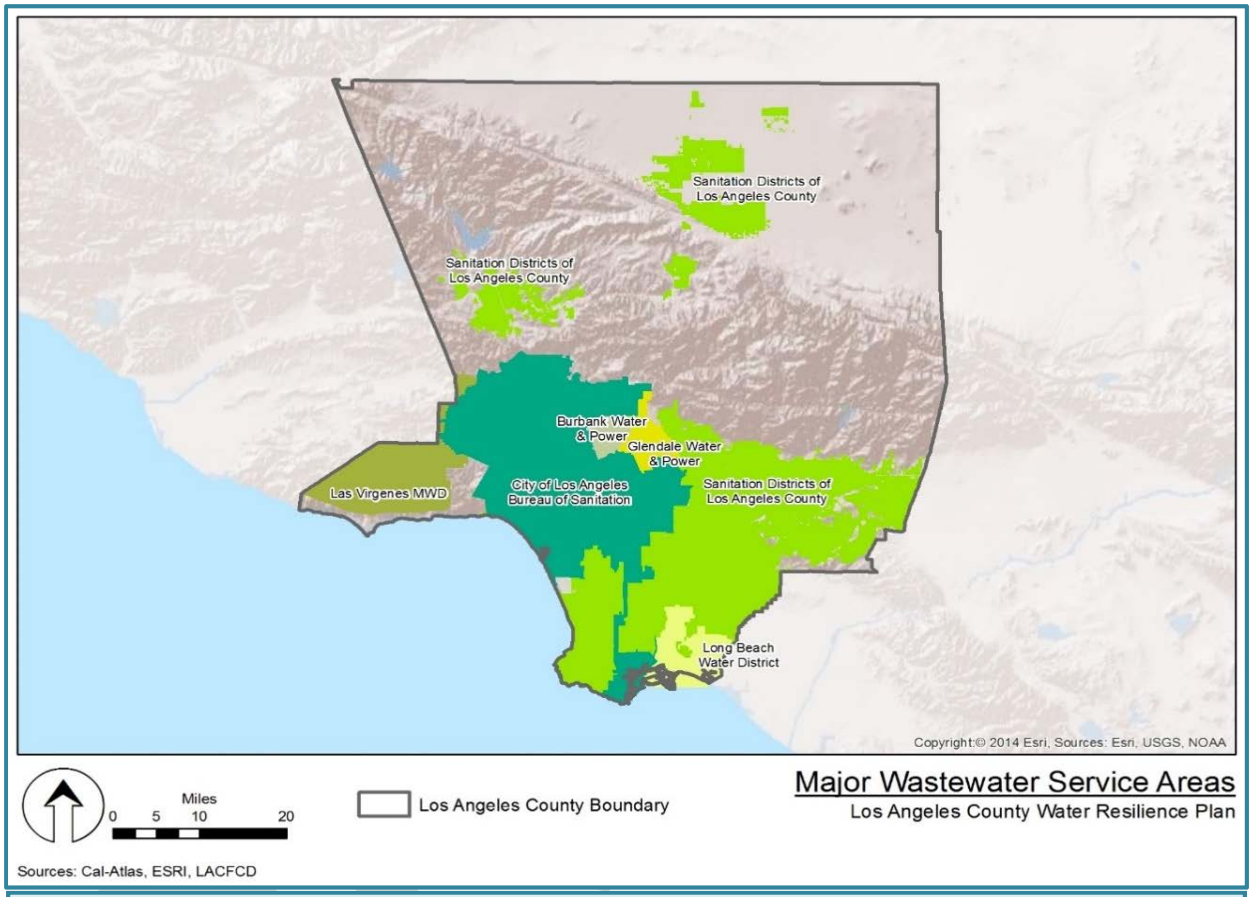


Figure 14: Major Wastewater Service Areas

The majority of recycled water is used for nonpotable reuse, such as urban landscape and agricultural irrigation, industrial processing needs, and environmental applications, as well as indirect potable reuse through groundwater recharge at spreading basins or for maintenance of seawater barriers in groundwater basins along the coast. The remainder is currently discharged to creeks and rivers that can support riparian habitat in some river or channel sections, or directly to the ocean.

Wastewater collection and treatment agencies in Los Angeles County include LACSD, LASAN, and the Las Virgenes-Triunfo JPA. West Basin MWD purchases water from LASAN for further treatment as needed for specific recycled water end uses. Supplies from these agencies are conveyed to the local wholesale, retail water purveyors, or in certain cases directly to customers for delivery to the end users located in their respective service areas.

LACSD consists of 24 independent special districts throughout Los Angeles County and conveys and treats approximately half the wastewater in the County through 1,410 miles of sewers, 48 active pump stations, and 11 wastewater treatment plants. Within the Los Angeles Basin metropolitan area, LACSD maintains a

regional interconnected system of facilities called the Joint Outfall System. The Joint Outfall System employs two types of treatment plants: 1) upstream water reclamation plants (WRPs) that capture low salinity, high quality wastewater and treat it to disinfected tertiary recycled water; and 2) a downstream Joint Water Pollution Control Plant that captures and treats the higher salinity wastewater along with the solids removed from the upstream plants. Because of the wastewater quality at the Joint Water Pollution Control Plant, reclaimed water from the plant requires additional treatment to allow it to be recycled and reused (LACSD, March 2016).

In addition to the Joint Outfall System, LACSD manages smaller regional wastewater systems in the Santa Clarita Valley and Antelope Valley. Each valley has two WRPs that produce tertiary recycled water that is used for a variety of uses, such as municipal irrigation, agricultural irrigation and wildlife habitat. All recycled water in the Antelope Valley is beneficially reused with seasonal storage (LACSD, March 2016).

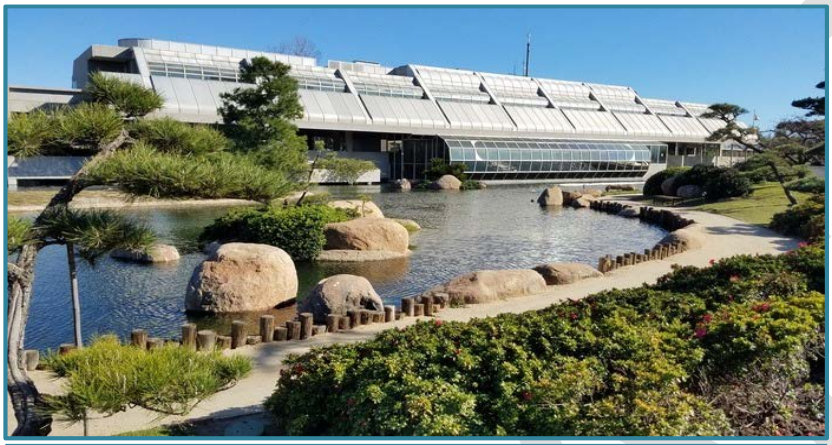


Figure 15: Tilman Water Reclamation Plant, City of Los Angeles

Image Source: http://assets.atlasobscura.com

There are four WRPs owned and operated by LASAN: Donald C. Tilman WRP (Tilman WRP), Los Angeles-Glendale WRP, Terminal Island WRP, Hyperion WRP (Hyperion WRP). The Tilman WRP (shown in Figure 15) and Los Angeles-Glendale WRP treat wastewater to tertiary standards for non-potable reuse in the City of Los Angeles and City of Glendale. A portion of the treated wastewater from these plants is discharged to the Los Angeles River for environmental purposes. The Terminal Island WRP uses tertiary treatment with a portion of the wastewater being treated with microfiltration (MF) and reverse osmosis (RO). Recycled water from the Terminal Island WRP is supplied to WRD for the Dominguez Gap Seawater Intrusion Barrier and to LADWP for landscape irrigation at the Harbor Generating Station. The remaining Terminal Island WRP treated effluent is discharged to the Los Angeles Harbor. Recent expansion of the Advanced Water Purification Facility at the Terminal Island WRP has increased the volume of advanced treated recycled water from the plant to 12 million gallons per day (mgd) or 100% of the plant flow, which supports projects like WRD's Dominguez Gap Seawater Intrusion Barrier. The Hyperion WRP is the oldest and largest wastewater treatment plant in the City of Los Angeles. Wastewater at the plant receives secondary treatment. The majority of secondary treated effluent from the Hyperion WRP is discharged via a 5-mile pipeline to the Santa Monica Bay with approximately 45 mgd being reused at the plant or sold to West Basin MWD for further treatment at the Edward C. Little Water Recycling Facility (LADWP, June 2016).

West Basin MWD's Edward C. Little Water Recycling Facility accepts secondary effluent from the Hyperion WRP and treats it to recycled water standards. The facility produces five different qualities of "designer" or custom-made recycled water that meet the unique needs of West Basin MWD's municipal, commercial and industrial customers, including irrigation, cooling tower water, seawater barrier and groundwater replenishment, and low- and high-pressure boiler feed water.

The Las Virgenes-Triunfo JPA manages the Tapia Water Reclamation Facility. This facility produces tertiary-treated recycled water that is used to irrigate golf courses, parks, school grounds, highway landscapes and the common areas of some housing developments. Currently, flows to the Tapia Water

Reclamation Facility average 6-7 mgd, as compared to the treatment plant's capacity of 12 mgd, primarily due to water conservation.

Agencies are beginning to research the feasibility of implementing direct potable reuse projects to increase local supply. Direct potable reuse projects involve introducing advanced treated recycled water either directly into the public water system, or into a raw water supply, such as a reservoir, immediately upstream of a water treatment plant. The main difference between indirect potable reuse and direct potable reuse is there is less residence time before use. Agencies such as LADWP are investigating the feasibility of utilizing direct potable reuse as a supply, but are not able to do so until water quality regulations are released for this type of supply.

Governance and Management

Local wastewater collection system agencies that do not have their own treatment capabilities can contract with regional treatment agencies to treat their effluent for either discharge or further use. Agencies that own and operate recycled water plants treat effluent for reuse and as such have the rights to the recycled water produced. If water supply agencies wish to serve recycled water to their customers, they must contract with the owners of the recycled water treatment facilities.

As an example, Long Beach Water gets recycled water from LACSD's Long Beach WRP. All the water produced from the plant originated from effluent flows coming from the City of Long Beach. Similarly, all the recycled water produced at LASAN's Tilman WRP is used within the City of Los Angeles. However, LASAN's Los Angeles-Glendale WRP is a joint project between the City of Glendale and the City of Los Angeles, with the City of Pasadena having purchased a portion of the City of Glendale's contracted recycled water (LADWP, June 2016).

Because of the often higher salinity of recycled water, it is regulated to ensure direct and indirect reuse do not impact surface and groundwater quality. The SWRCB adopted a Recycled Water Policy in February 2009 that allows the increased use of recycled water in a manner that complies with state and federal water quality laws. As part of the policy, Salt and Nutrient Management Plans must be developed to facilitate basin-wide management of salts and nutrients. Agencies in Los Angeles County have developed or are in the process of developing Salt and Nutrient Management Plans to allow recycled water project development in their region without creating potential salinity issues in the groundwater as a result.

Regulatory restrictions on recycled water are a key constraining factor on how recycled water supplies are developed. The SWRCB is the agency responsible for regulating recycled water and establishing uniform statewide recycling criteria. Because direct potable reuse is a new, evolving category of supply, water quality criteria regulating its use are still under development. In 2017, Assembly Bill 574 was signed into law, setting in motion a schedule and process for developing statewide recycling criteria. Until the water quality criteria are developed, agencies are not able to fully assess the feasibility of implementing direct potable reuse projects.

Current Resilience Efforts

Partnerships between wastewater and water agencies throughout the County have resulted in several ongoing recycled water programs and are now focused on expanding their recycled water systems to offset potable demands and increase the resilience of supply during periods of drought. Upper District is expanding its recycled water system in the San Gabriel Valley and is planning its Indirect Reuse Replenishment Project which will use highly treated recycled water for enhancing existing replenishment within the MSG Basin through LACFCD's spreading facilities, reducing the San Gabriel Valley's reliance on imported water by approximately 25%. The Main San Gabriel Basin Watermaster is providing technical review and support for the project. For the West Coast and Central basins, WRD is expanding its use of recycled water for replenishment and injection at the barriers through its "Water Independence Now" initiative. The "Water Independence Now" program aims to maximize local stormwater and recycled water sources to replenish, preserve and protect the West Coast and Central basins so that no imported water is

used for groundwater replenishment by 2018. Key projects include GRIP, the Leo J. Vander Lans Advanced Water Treatment Facility Expansion, and increased recycled water purchases for spreading and injection.

As part of the effort to increase recycled water use in the County, West Basin MWD has completed its fourth expansion of the Edward C Little Water Recycling Facility (initial construction of the facility has been referred to as Phase 1 and the four expansions Phases 2 through 5), and now produces roughly 40,000 AFY of recycled water. As part of the Phase V Expansion Project, West Basin MWD's Carson Facility will implement ultraviolet and advanced oxidation processes to provide up to one additional mgd of water to the Dominguez Gap seawater barrier.

In the San Fernando Valley, the City of Los Angeles is planning its Groundwater Replenishment Project. The project will use highly purified recycled water from the Tilman WRP and deliver it to the existing Hansen Spreading Grounds and Pacoima Spreading Grounds, operated by LACFCD, in the San Fernando Valley area. The project will require construction of an Advanced Water Purification Facility which will further treat tertiary effluent from the Tilman WRP (LADWP, June 2016).

Resilience in LA

LADWP's Groundwater Replenishment Project will use highly purified recycled water from the Tilman WRP and deliver it to the existing Hansen Spreading Grounds and Pacoima Spreading Grounds in the San Fernando Valley area.

The Las Virgenes-Triunfo JPA is planning a regional potable reuse project, called the Pure Water Project Las Virgenes-Triunfo, which involves advanced treatment of excess recycled water produced at its Tapia Water Reclamation Facility in the wintertime to augment supplies stored in Las Virgenes Reservoir. The project is expected to produce up to 5,000 AFY of new, drought-resilient local water supplies. Upon completion, the Pure Water Project Las Virgenes-Triunfo will supply 15% of the total water demands for Las Virgenes MWD and its JPA partner, Triunfo Sanitation District, which owns Oak Park Water Service in Ventura County.

In the Santa Clarita Valley, CLWA assessed recycled water options as part of the Water Resources Reconnaissance Study (2015) which recommended groundwater recharge using recycled water and expansion of the non-potable systems for future development.

In the Antelope Valley, LACSD manages recycled water production and use. Currently, all the recycled water produced in the Antelope Valley is beneficially reused with the use of seasonal storage reservoirs (LACSD, March 2016). Much of the current recycled water production currently goes to agricultural use. Efforts are underway to increase urban usage of the recycled water, and the Palmdale Water District is pursuing a groundwater recharge project using recycled water that would supplement water supplies in the Antelope Valley.

Resilience in LA

A partnership between Metropolitan and LACSD could provide advanced treatment to the effluent from the Joint Water Pollution Control Plant for groundwater recharge in several groundwater basins in Los Angeles and Orange counties.

Metropolitan and LACSD have entered into a partnership to explore the development of a large regional recycled water project to beneficially reuse water currently discharged to the ocean from the Joint Water Pollution Control Plant. This potential supply has been previously untapped due to its relatively high salinity content. The project would provide advanced treatment to the relatively high salinity effluent to create a new source of water to recharge several groundwater basins in Los Angeles and Orange Counties. If the project is approved, Metropolitan would build a new purification plant, distribution pipelines, and facilities to infiltrate or inject the water into the groundwater basins (Friess, 2016). A groundbreaking on a 0.5 MGD demonstration-scale recycled water plant for the Regional Recycled Water Advanced Purification Center

was held in September 2017 and construction is anticipated to be complete in late 2018. A full scale facility would produce up to 150 MGD.

4.1.7 Ocean Desalination

Although not yet implemented within the County of Los Angeles, it is worth noting that desalination is under consideration. West Basin MWD developed an Ocean Water Desalination Program Master Plan (2013) to define the overall desalination program scope and the key project components. West Basin MWD conducted an eight-year ocean water desalination pilot testing at the El Segundo Power Generating Station in El Segundo (Figure 16), California to assess the feasibility of turning ocean water into drinking water. As a result of the pilot study, West Basin MWD concluded that ocean water desalination could be a viable alternative water supply. In 2010, West Basin MWD completed the construction of their Ocean Water Desalination Demonstration Facility to evaluate technical feasibility of the project. West Basin MWD will publish the corresponding EIR and then will continue to explore ocean desalination as a future supply. The planned ocean desalination facility will be owned and operated by West Basin MWD. In addition to West Basin MWD's role, several federal, State, and local regulatory agencies are involved in the oversight of this project. Numerous permits, in addition to thorough California Environmental Quality Act (CEQA) analyses are required before the ocean desalination facility can be built. West Basin MWD is implementing on-going consultation and coordination with agencies such as U.S. Fish and Wildlife Service, the National Marine Fisheries Service, USACE, the Regional Board, the California State Lands Commission, the California Department of Fish and Wildlife, the California Coastal Commission, the California Department of Public Health, the California Department of Parks and Recreation, the California Department of Transportation, the South Coast Air Quality Management District, Metropolitan, and multiple cities that surround the area the facility will be built.

Figure 16: West Basin MWD Desalination Pilot Facility
Source: http://westbasindesal.org/

As part of the assessment and design of the ocean desalination facility, West Basin MWD is planning against future challenges that could reduce use of ocean desalination as a local supply source. Potential sea level rise impacts are being incorporated into planning of the desalination facility and environmental impacts are being considered and addressed. West Basin MWD is currently developing an Environmental Impact Report for the ocean desalination facility in which they are quantifying potential impacts in compliance with CEQA requirements. Potential environmental concerns associated with ocean desalination programs include marine impacts from intake structures, marine impacts from brine discharge, and the high-energy usage of such facilities. West Basin MWD has been dedicated to investigating and researching new and emerging technologies which may mitigate negative environmental impacts.

Resilience in LA

West Basin MWD is moving forward with ocean desalination as a future supply that can be tapped even when other supplies may be impacted by drought or other conditions.

4.1.8 Water Use Efficiency/Conservation

Conservation can be considered a type of supply in that it offsets the use of potable water to meet the same need through increasing water use efficiency. Both indoor and outdoor conservation measures are implemented throughout the County. Indoor water conservation utilizes water efficient appliances such as low-flow toilets, efficient showerheads, and high efficiency clothes washers. Outdoor conservation can involve efficient sprinkler systems and appliances, weather based irrigation controllers, soil moisture sensor systems, turf removal, and installation of drought tolerant landscape. In addition to converting landscape and appliances to reduce water use, agencies have also implemented education and outreach programs and modified rate structures to help promote behavioral changes that reduce potable demand.

Governance and Management

Conservation programs require a partnership between a city or local jurisdiction and water district for implementation. These programs are often facilitated by a conservation manager responsible for coordinating between agencies. Regional agencies can also play a key role in implementing conservation programs by providing key elements of these programs to retail agencies at low cost so that they do not have to waste resources pursuing them individually.

In 2010 Urban Water Management Plans, urban water suppliers were required to comply with conservation targets laid out in the Water Conservation Bill of 2009 (SBx7-7) which sets water conservation targets for 2015 and 2020 to support an overall State goal of reducing urban potable per capita water use by 20% by 2020. The 2015 UWMPs included updates to the progress toward reaching the 20% demand reductions and status on demand management measures.

Urban water suppliers are required to have a Water Shortage Contingency Plan as part of their UWMP with Stages of Action to be undertaken by the agencies in response to water supply shortages. The Stages of Action represent different levels of water shortage with voluntary and mandatory prohibitions to reduce water use. Typically, there are penalties for failure to comply with provisions. During the recent drought, several agencies implemented high stages of shortage as a mechanism to enforce water use reduction in their service areas.

In addition to a Water Shortage Contingency Plan, cities and counties have the authority to implement ordinances to reduce water use or promote conservation initiatives. Water waste ordinances have now become a required component of UWMP compliance. Additionally, LID ordinances promote onsite reuse of water.

Current Resilience Efforts

Conservation Programs

In 2015, as a result of the ongoing drought, Governor Brown issued an executive order directing the SWRCB to impose a state-wide 25% water use reduction. The SWRCB's mandatory water use reduction drove water agencies to increase focus on water conservation programs in their district. By 2016, many agencies within Los Angeles County were able to meet their allocated reductions.

Given the severity of the last two droughts, and the associated regulatory drivers, an enormous amount of effort has gone into conservation programs. Huge reductions (in some cases over 30%) of per capita use throughout the County have been attained in recent years – contributing significantly to the region's capacity for resilient water management in the face of drought. For example, customers of Las Virgenes MWD reduced their demands by 37% in July 2015, as compared to the same period in 2013. Over time, residential indoor fixture replacement programs have been very successful in the County and so there is hardening in that sector, i.e. it is unlikely that significant additional gains can be made through these programs. However, there may still be additional opportunities for indoor fixture replacement at schools and public buildings, which could represent additional reductions. Outdoor rebates for turf replacement, efficient nozzles, and landscape retrofits are the types of programs most funded by agencies currently.

Several agencies in the County have placed emphasis on promoting conservation within their service areas, both because of statewide mandatory reductions and a desire to reduce demands as part of their long-term supply plan. Long Beach Water is one agency that has focused on marketing to promote conservation in its service area. Their Lawn-to-Garden Program has been successful because they have invested time into ensuring the gardens are appealing to the public and receive positive coverage in newspapers. The City has an ordinance requiring 50-60% plant cover material in yards, and because of this ordinance, homeowners cannot just convert to rocks to be reimbursed through the Lawn-to-Garden Program. Long Beach Water has invested time into reviewing garden designs and conducting audits to confirm the gardens are in compliance with the ordinance. Due to this careful oversight, the gardens have aesthetic value and have gained a much wider acceptance than in previous years. Because the lawns were converted to attractive drought tolerant gardens as opposed to encouraging browning grass, the demand reduction is expected to have a long-term, sustainable impact.

Resilience in LA

Part of the lasting conservation success of Long Beach Water's Lawn-to-Garden Program is the agency invested the time into reviewing garden designs and conducting audits to confirm the gardens maintained aesthetic value.

Metropolitan and other imported water wholesale agencies like Central Basin MWD, Upper District, AVEK, and CLWA have provided rebate programs for their retail agencies to participate in for demand reduction. Typically, these rebate programs become completely allocated, but some agencies have found that greater participation by smaller retail agencies and disadvantaged communities is possible.

In addition to indoor and outdoor rebate programs, wholesale agencies help support public outreach and school education programs in their services areas. Metropolitan's member agencies and their associated retail agencies have access to public outreach and school education program funding through Metropolitan. Both wholesale and retail agencies throughout the County have led active public information campaigns to promote behavioral changes through education and awareness. Outreach using bill inserts, newsletters, school programs, special events, and maintaining online webpages dedicated to conservation has resulted in large demand reductions during the previous drought. As noted by agencies, these behavioral changes are expected to have some portion of lasting demand reductions remaining as long-term savings.

Net Zero

Recently, the Los Angeles County Board of Supervisors established an initiative called the Net Zero Water Ordinance. The ordinance is an ambitious project to promote sustainability and to reduce water consumption within County unincorporated areas through a combination of possible requirements for new development that include integrated water efficiency measures, alternate onsite water sources, regional recycled water systems, additional groundwater rights, and in-lieu offsite and onsite water conservation projects. The Ordinance will supplement established state and local water conservation requirements and demand management strategies.

Rate Structures and Enforcement

During the most recent drought, agencies have been successful at reducing demands through a variety of mechanisms, including using innovative rate structures, penalties, and enforcement. Some agencies have converted or are in the process of converting to a budget-based rate structure to motivate conservation through their billing.

Resilience in LA

Before converting to a budget-based rate structure in 2016, Las Virgenes MWD used patrolling to enforce their outdoor irrigation policies, which was effective, but very unpopular. Once the new rate structure was implemented, it was possible to lift the enforcement, while still keeping water use down.

- LADWP patrols water waste through its Water Conservation Unit. The agency converted from a two-tiered rate structure to a four-tiered rate structure, with excessive use penalties for Tier 4. Based on an audit of top users, LADWP went to properties that did not pass an assessment of parcel size to water use and issued water-budgets to those users. When those water budgets were exceeded, fines were issued.
- Las Virgenes MWD finished converting to a budget-based rate structure in 2016. Before finishing the conversion, they used patrolling to enforce their outdoor irrigation policy, which was effective, but very unpopular. Once the new rate structure was implemented, they lifted the enforcement and assigned each customer an individualized water budget based on the unique characteristics of their property. Water usage within the budgeted amount is billed at the lowest rate. Inefficient and wasteful water usage is billed at a substantially higher rate.

4.1.9 Water Supply Emergency Resilience

In addition to cyclical and long-term resilience efforts, water management agencies have emergency response plans and mechanisms in place to ensure they have prepared, appropriate responses during emergency or disaster events such as earthquakes, system failures, water quality exceedances or other disturbances.

Infrastructure

Emergency Storage

Maintaining emergency storage is a standard practice in water management around the County – however the amount and accessibility of storage varies. Some agencies point out that the volume of storage is not as important as the distribution of that storage throughout the system given that a break on the only line to access the storage renders it useless. Examples include:

- Metropolitan maintains a 6-month supply of emergency storage south of the fault lines to ensure demands can be met if an earthquake interrupts supplies from the Bay-Delta, Colorado Aqueduct, and Los Angeles Aqueduct. Metropolitan has emergency storage at its reservoirs (Diamond Valley Lake, Lake Mathews, and Lake Skinner), at the SWP terminal reservoirs (including Castaic Lake in Los Angeles County), and in its groundwater conjunctive use storage accounts. While most of this storage is located outside of Los Angeles County, Metropolitan, with few exceptions, can deliver this emergency supply throughout its service area via gravity, thereby eliminating dependence on power sources that may be unavailable or inoperative after an earthquake. This emergency supply is maintained as a baseline and is not used to mitigate drought conditions. Metropolitan member agencies are required to have 1-week of local supply available in case of an emergency disruption to Metropolitan's facilities.
- Las Virgenes MWD has a reservoir that can provide up to a 6-month supply in an emergency situation. Maintaining a storage reservoir helps the agency manage the potential for shortages that would be associated with a major disaster such as an earthquake.

- In the San Gabriel Valley, in addition to emergency storage in surface reservoirs, untreated imported water is held in the MSG Basin in groundwater storage accounts in anticipation of a future demand, possibly resulting from the short-term loss of imported water supplies for groundwater replenishment.
- Medium-sized agencies such as WVWD and Pasadena are working to distribute storage in several areas throughout their system of pressure zones and distribution lines. They maintain enough supply in storage to last between 7 -10 days in an emergency.

Emergency Interconnections

When an emergency situation occurs, a common response is reliance on interconnections and agreements with neighboring agencies unaffected by the disruption. This mechanism is considered an important method of ensuring access to supply and uninterrupted service by water managers. Interconnections can be particularly important in cases where the agency is entirely dependent on one source of potable supply and is less critical for non-emergency services like wastewater collection or groundwater recharge. The substantial network of imported water distribution systems within Los Angeles County provides an interconnection framework that allows for imported water users to work collaboratively to route and transfer water around and through nearly all areas of the County. In addition, local agencies have also worked together to build interconnections between their local systems, for example:

Resilience in LA

Pumpers in the Raymond Basin have a substantial network of interconnections and agreements that allow them to pump and sell water to each other if contaminated groundwater or other temporary issues inhibit the ability to pump and use supply at their well.

- Las Virgenes MWD does not have access to groundwater that is suitable for potable use and is entirely dependent on imported sources for drinking water. The agency is also geographically more isolated than other portions of Metropolitan's service area, making it difficult to convey Colorado River Aqueduct supplies to its service area. As a result, interconnections are particularly important. Las Virgenes MWD has several interconnections with LADWP and is planning the construction of a large interconnection with Calleguas Municipal Water District in Ventura County. The new interconnection will allow emergency water supplies to be moved in either direction, depending on the location of the supply interruption.
- Pumpers in the Raymond Basin have a substantial network of interconnections and agreements that allow them to pump and sell water to each other if contaminated groundwater or other temporary issues inhibit the ability to pump and use supply at their well(s). They have also developed a detailed schematic of this network and an emergency committee to help facilitate the program to meet needs as they arise.

Redundancies and Backup Equipment

Many agencies focus on ensuring there are redundancies in their system to prepare for emergency situations. Pump stations are a key component for moving flows through a system. Having redundant facilities and equipment (e.g. generators) in case one pump malfunctions and portable generators to manage a power outage are crucial elements for ensuring a resilient water delivery system. In addition, smaller components of the system, such as valves, are also extremely useful pieces of infrastructure during an emergency. Valves are used by agencies to isolate the area of their distribution system experiencing failure. By isolating the impacted areas, agencies are also able to save and contain in-system wastewater and water flows during emergencies.

Governance and Management

Most agencies have individual Emergency Response Plans that contain information such as lists of contractors' phone numbers, resources, and other pertinent information to guide activity during emergencies. Some smaller agencies do not have sufficient Emergency Response Plans (if at all), which puts them at risk during emergency situations. These agencies tend to rely on larger regional agencies and neighboring agencies to develop their own plans and strengthen their ability to respond effectively to these situations. Examples of this regional emergency planning coordination can be found around the Raymond Basin and San Gabriel Valley areas. Through coordination, these agencies learn what resources can be shared (from all utility sectors including transportation, power as well as parks, police and other departments) in times of crisis and what areas of their own emergency preparedness is lacking compared to other entities in the region.

Being linked to an Emergency Operations Center is another mechanism for managing emergency situations. Many agencies in the County have an Emergency Operations Center in place or are in the process of linking into one.

4.2 Water Quality

Unlike water supply, which is more heavily dependent on infrastructure systems, environmental water quality management is structured more around the regulatory frameworks that guide treatment requirements and project development than the physical infrastructure. The sections that follow describe the regulatory background that provides much of the foundation for water quality management today as well as the infrastructure, governance and current actions being implemented to improve environmental water quality in the County.

4.2.1 Background

In the early to mid-1900s, discharges to waterways were primarily from natural undeveloped areas and not viewed or perceived as pollution. Continued industrial and urban growth, along with lack of regulations protecting water quality, led to pollution of the country's rivers, streams and lakes to the extent that it threatened public health through contamination of water and food supplies, destruction of fish and wildlife and diminished other benefits provided by natural resources. As a result, in 1948, the U.S. Congress enacted the Federal Water Pollution Control Act which gave states the responsibility for abating water pollution. At that time, the act simply acknowledged pollution as a concern, but did not require action or provide oversight; therefore, achieving little benefit for water quality.

In 1969 the Porter-Cologne Water Quality Control Act (Porter-Cologne Act) was enacted to govern water quality regulations in California. It was established as a program to protect the water quality and the associated beneficial uses. The Porter-Cologne Act created and entrusted the SWRCB and the nine Regional Boards the duties and powers to preserve and enhance all beneficial uses of the state's immensely complex waterscape. The Porter-Cologne Act also required that the Regional Boards adopt Basin Plans, otherwise known as water quality control plans, specific to each region in order to establish beneficial uses, water quality objectives to protect those uses, and implementation programs to attain the objectives.

Growing public awareness and concern for controlling water pollution led to sweeping amendments of the Federal Water Pollution Control Act in 1972. The improved and more robust federal regulation became commonly known as the Clean Water Act. The Clean Water Act built upon California's Porter-Cologne Act and established the basic structure for regulating discharges into the waters of the United States, gave the US EPA the authority to implement pollution control programs, and made it unlawful to discharge any pollutant from a point source to waters of the United States without a National Pollutant Discharge Elimination System (NPDES) permit.

4.2.2 Regulatory Framework

Currently, water quality objectives for pollutants such as metals, toxic pollutants, and bacteria are established by the U.S. EPA, SWRCB and the nine Regional Boards in Statewide and Regional Water Quality Control Plans (e.g. Basin Plans) and state-level Policies in accordance with the Clean Water Act and the state Porter-Cologne Water Quality Act. Water quality is assessed through discharge and ambient monitoring and reporting programs. Waterbodies that are found to be impaired are added to the State's 303(d) list, which prompts the development of Total Maximum Daily Loads (TMDLs) that establish maximum allowed numeric targets for specific pollutants within a particular water body. In many cases, TMDLs include implementation plans and information regarding sources contributing to the impairment, as well as recommendations on how to monitor and treat those sources. TMDLs are normally developed by the Regional Boards, and then approved by the SWRCB and State Office of Administrative Law before being submitted the US EPA for Federal approval.

Figure 17: Santa Monica Low Flow Diversion
LACFCD owns and operates 21 low-flow diversions that divert polluted water away from the ocean for treatment before being discharged.

Water quality in the majority of the County of Los Angeles is directly regulated and enforced by the Los Angeles Regional Board, which regulates discharges from medium and large MS4s through the Los Angeles County MS4 Permit issued under the NPDES Program. The Antelope Valley, while within the County of Los Angeles, is regulated by the Lahontan Regional Board and falls outside the jurisdiction of the Los Angeles County MS4 Permit and its requirements.

The most recent Los Angeles County MS4 permit was issued in 2012 and lists the unincorporated County, LACFCD, and 84 municipalities within the County as responsible permittees. At the central core of the current permit for the Los Angeles Region is the requirement to meet the targets and schedules for 33 TMDLs incorporated into the permit. The permit also established three compliance pathways: 1) meeting numerical targets in permittee receiving waters; 2) developing and implementing a Watershed Management Program (WMP); or 3) developing and implementing an Enhanced Watershed Management Program (EWMP). In all three cases, a Coordinated Integrated Monitoring Program (CIMP) is also required to establish a baseline and document any changes over time.

Jurisdictions that elected to implement WMP's and EWMP's were encouraged to collaborate with other permittees at the watershed level, and required to identify water quality priorities, layout a program to meet water quality targets, and include watershed modeling to demonstrate that the programs will meet water quality standards. Both programs utilize structural and non-structural BMPs to achieve compliance and employ long-term monitoring in the watershed to establish baseline conditions and to track the progress of their implementation. The EWMP plans require development and implementation of larger-scale regional projects that result in additional benefits, such as water conservation, habitat restoration, flood protection, and recreation opportunities. Finally, these programs are subject to an iterative and adaptive management approach that allows for biannual modification of the programs in response to new information and changing conditions (e.g. completion of BMPs and the ongoing collection of new monitoring data).

4.2.3 Infrastructure

Stormwater

Infrastructure to treat stormwater includes small, distributed projects that capture and treat small volumes of stormwater onsite as well larger treatment facilities that treat volumes on a community scale. Projects integrate minimum control measures and best management practices to capture and treat typical volumes of stormwater generated by common rain events and can either release water once treated or infiltrate it directly into the ground. For example, in the Marina del Rey, LACDPW has implemented small, distributed stormwater projects at Marina del Rey Harbor parking lots to capture and treat small volumes of stormwater onsite thru bio-filtration units.

Figure 18: Construction of the Sun Valley Park Infiltration Gallery

In addition to small distributed BMPs, larger stormwater facilities such as underground infiltration galleries, manage stormwater flows on a community-scale. Several park areas are being enhanced to house infiltration galleries underneath park space to treat and harvest stormwater for groundwater infiltration. Stormwater flows are typically diverted from flood control channels to facilities such as those shown being constructed in Figure 18 under Sun Valley Park. The Sun Valley Park Watershed Multi-benefit Project and Rory Shaw Wetlands is an example of a regional BMP project designed to treat stormwater on a community scale. The project will convert a landfill into a multi-purpose wetlands park with detention ponds and wetlands to treat stormwater runoff for water quality enhancement. Treated flows will then be pumped to an infiltration basin already constructed under Sun Valley Park to recharge the groundwater basin and reduce flooding downstream. These types of stormwater capture projects provide water quality, both water supply, and flood management benefits.

While stormwater capture projects can contribute to supply through direct use or infiltration, this is not always the case. It is important to note that many stormwater quality projects are designed to improve environmental water quality by capturing stormwater and urban runoff from hard surfaces, detaining the water for treatment using filtration, biofiltration or other means and then releasing the treated runoff into the channels, rivers or the ocean. These facilities provide environmental water quality benefits without increasing water supply. Despite the need for water quality improvement, these projects are often difficult to identify funding.

The City of Los Angeles implemented several stormwater treatment projects throughout the city over the last decade through funding from the voter approved Proposition O. Los Angeles voters overwhelmingly passed Proposition O in 2004 to fund projects (up to $500 million) that prevent and remove pollutants from the regional waterways and ocean, consequently protecting public safety and meeting federal Clean Water Act regulations. Projects implemented through the Proposition included lake rehabilitation, wetlands restoration, and park revitalization using BMPs such as swales, constructed wetlands, tree wells (such as those shown in Figure 19), and vegetated buffer strips. An example of such a project includes the Grand Boulevard Tree Wells project that provided filtration systems around native trees to capture polluted urban runoff from the surrounding high-density residential and commercial corridor and remove pollutants before the water flows to the Santa Monica Bay.

Figure 19: Grand Boulevard Tree Wells
http://www.lastormwater.org

Wastewater

As described in *Section 4.1 – Water Supply* wastewater infrastructure in the County includes collection and conveyance systems, and WRPs. Treated wastewater is either reused as recycled water for direct use or recharge, discharged to rivers and streams, or discharged to the ocean via ocean outfalls.

4.2.4 Governance and Management

Stormwater Management

Environmental water quality issues due to nonpoint sources such as stormwater and urban runoff are the responsibility of the cities and county from which the water drains. Point sources are also identified in TMDLs and those entities must also adhere to the regulations set forth in the TMDLs. This management framework applies to all areas of Los Angeles County. Additionally, the LACDPW, LACFCD and cities within the Los Angeles Basin and Santa Clarita Valley areas, are responsible for complying with the regulations outlined in the Los Angeles County MS4 permit. Cities in the Antelope Valley lie outside the jurisdiction of the Los Angeles County MS4 permit, though must comply with separate NPDES regulations, as applicable.

To comply with the Los Angeles County MS4 permit, municipalities, non-governmental organizations and community stakeholders throughout the County came together to develop EWMPs and WMPs that identify current and future multi-benefit projects that will improve water quality, promote water conservation, enhance recreational opportunities, manage flood risk, improve local aesthetics, and support public education opportunities. Through these collaborative efforts, city and county agencies are able to address the water quality mandates outlined in the permit and work toward meeting TMDLs.

Resilience in LA

The City of Pomona has regular meetings between the water utility and public works departments to facilitate coordination on overlapping water management issues such as water quality and flooding.

Cities often have separate divisions or departments for managing stormwater vs managing water supply. Some cities, like the City of Pomona, have regular meetings between departments to facilitate coordination on overlapping issues. For the City of Los Angeles, in which water supply, stormwater, and wastewater are managed by several different agencies the City of Los Angeles is

implementing its One Water program to help focus an integration of their water-related systems and facilitate communication and coordination between all City Departments.

Wastewater Management

Wastewater agencies are responsible for managing the point source discharge water quality of the effluent they produce. As described in *Section 4.1 – Water Supply*, these agencies include LACSD who treats approximately half the wastewater in the County including wastewater collected in the Santa Clarita Valley and Antelope Valley, as well as LASAN and the Las Virgenes-Triunfo JPA. These agencies manage their system to ensure proper treatment and disposal of wastewater collected from the sanitary sewer. Any agency with a collection system over one mile is required to develop a sewer system management plan (SSMP). The SSMP is a document that details how a specific sewer collection system is operated, maintained, repaired, and funded.

In addition to LACSD's wastewater responsibilities, Senate Bill 485 was enacted in 2015 which gives LACSD the authority to assist local jurisdictions with stormwater and urban runoff projects. Under this new authority, LACSD is now authorized to acquire, construct, operate, and maintain facilities to divert, manage, discharge, and beneficially use stormwater and dry weather runoff from the stormwater drainage system (Friess, 2016).

4.2.5 Current Resilience Efforts

Emergency Disturbance

Stormwater Management

Stormwater quality issues do not typically result in emergency situations. Bacteria contamination at stormwater outfalls after rain events is one example that could be considered an emergency situation. Public agencies respond to these disturbances with beach closures to prevent human contact.

Wastewater Management

As part of a wastewater agency's SSMP, the agency must develop and implement a Sanitary Sewer Overflow (SSO) emergency response plan that identifies measures to protect public health and the environment. These SSO response plans outline proper notification procedures, a program to respond to overflows, procedures to address emergency operations, and additional necessary procedures to ensure all reasonable steps are taken to contain and prevent discharge of untreated and partially treated wastewater. Part of LACSD's SSO Response Plan is to notify LACSD's Long Beach Main Central Alarm Center (CAC) upon becoming aware of a potential spillage. This CAC has 24 hr/day trained staff to respond to the emergency. An additional key component of the response plan is conducting water quality sampling (Hyde, February 2014). Through experiencing past SSO emergencies, LACSD has learned more about the vulnerabilities of its system and added additional layers of redundancies to their system to protect against such situations.

Adding back-up generators, backup telemetry systems, and real-time remote monitoring systems on critical manholes to alert operators when there is the potential for an overflow to occur are all important improvements for local agencies to respond effectively to emergencies. LACSD has been investing in improving its collection system infrastructure over the past 15 years and plans to incorporate improved flow and level monitoring and telemetry technologies into their planning for future infrastructure needs as these technologies are developed (Friess, 2016).

Cyclic and Long-Term Resilience Efforts

Stormwater Management

Through EWMP and WMP implementation, cities are implementing additional programs to improve water quality in their watersheds. In the County of Los Angeles, the unincorporated County, LACFCD and the 84 permittees formed 19 watershed groups. Of those, the County is member of 12 EWMP groups and the

LACFCD member of 18 WMP and EWMP groups. As a result of the EWMPs, green street programs, regional BMPs, LID projects and ordinances, and other watershed control measures are being designed and implemented. These projects and programs are designed to improve surface water quality, reduce runoff, and increase stormwater infiltration to enhance supply reliability.

Through the development of WMPs and EWMPs, it was estimated that the cost of implementation efforts to comply with the MS4 permit is approximately $20 billion over the next 20 years. Permittees have begun to implement the WMPs, EWMPs, and CIMPs in spite of budget shortfalls but are actively working to secure funding for the implementation of BMP's in order to reach compliance with the water quality objectives. It is anticipated that many of the permittees will have difficulties fully implementing these programs due to the lack of dedicated funding.

A number of regional water quality programs have been implemented to improve water quality discharges to rivers and the Santa Monica Bay. The Santa Monica Urban Runoff Recycling Facility (SMURRF), shown in Figure 20, is a joint project between Santa Monica and City of Los Angeles to collect and treat dry weather urban runoff from storm drains to use for nonpotable uses. Santa Monica is considering modifying the facility to be able to produce a more consistent non-potable water supply by utilizing advanced treatment technologies to produce potable water (Kennedy/Jenks Consultants, December 2014).

Figure 20: Santa Monica Urban Runoff Recycling Facility
https://www.smgov.net

Another project designed to reduce stormwater and dry weather runoff pollution to the Santa Monica Bay and its tributaries is the LACDPW's Oxford Basin Multiuse Enhancement Project in the Marina del Rey. This project, completed in June 2016, enhanced the Oxford Retention Basin's water quality and flood control functions by removing accumulated sediment and adding additional features such as native vegetation and recreational amenities. The revitalized retention basin reduces contaminant loading to the Marina del Rey Harbor which ultimately discharges to the ocean.

Wastewater Management

Indoor conservation during the drought has led to reduced flows to wastewater systems. Lower flows can lead to less dilution of raw sewage, increased biological activity in the sewer causing increased odors levels and corrosion rates, increased travel time to facilities, unused capacity at treatment facilities, and the possible need to modify treatment process operations for the more concentrated wastewater (Friess, 2016). LACSD has responded to flow reductions by using more chemicals for treatment and aeration to compensate for these issues.

Wastewater facilities are generally located at low points in the watershed which can make them vulnerable to climate change impacts such as sea level rise. The majority of facilities in the County are at adequate distances from the coast to not be at risk from sea level rise. Facilities that have not been built, such as the West Basin MWD desalination plant, are incorporating climate change projections into their planning.

Many agencies have researched localized climate change studies and are incorporating expected impacts into their facilities planning. LACSD and LASAN both have facilities near the coast and have investigated localized sea level rise impacts identified by the Climate Change in the Los Angeles Region Project (conducted by University of California, Los Angeles (UCLA) researcher Dr. Alexander Hall). This project downscaled global climate change models to the Los Angeles region. LASAN has found that facilities at Hyperion and Terminal Island WRPs are within the areas that will be impacted by sea level rise. LACSD's Joint Water Pollution Control Plant is not at risk from flooding due to sea level rise; however there may be hydraulic impacts to the wastewater system due to sea level rise. LACSD is planning a new tunnel to replace the existing aging tunnels that convey effluent from the treatment plant to the ocean outfalls. The new tunnel will ensure there is sufficient hydraulic capacity to accommodate the high flows associated with severe weather conditions and the high pressure of projected increased sea levels. LACSD has also recently re-ballasted the offshore ocean outfall system to protect it against storm surges and severe weather (Friess, 2016).

Resilience in LA

LACSD is planning a new tunnel to supplement the existing ocean outfall tunnels to provide hydraulic capacity to accommodate the high flows associated with severe weather conditions and the high pressure of the projected increased sea levels, as well as provide redundancy and operational flexibility.

4.3 Flood Risk Management

4.3.1 Background

Flood risk has been a regional concern for well over a century. Today, all 88 cities within Los Angeles County have their own flood risk mitigation infrastructure, typically consisting of catch basins and storm drains that ultimately feed into the LACFCD system. Some larger cities have stretches of open channel and various other flood protection infrastructure, but the vast majority of the existing system is owned and operated by the LACFCD or the USACE. This intricate network has successfully minimized flood risk to residents throughout the region since its establishment in the early 1900s.

It was in 1915 that the California State Legislature adopted the Los Angeles County Flood Control Act after a disastrous regional flood cost numerous lives and resulted in extensive damage. The Flood Control Act established the LACFCD to provide for regional flood protection and water conservation. The joint mission of the LACFCD to mitigate flood risk and capture stormwater for groundwater replenishment highlights an early understanding of the simultaneous threat and opportunity this resource presented. The 1915 Flood Control Act directed the LACFCD to capture and store stormwater, causing it to become the focal point for efforts to save stormwater and augment the region's dwindling groundwater supply. Over the several decades that followed, LACFCD and USACE designed and constructed most of the region's major dams, concrete-lined channels, storm drains and spreading grounds that comprise the regional flood protection and water conservation system today.

Since its creation, the LACFCD has been governed by the Los Angeles County Board of Supervisors. Today, the LACFCD is managed and operated by the LACDPW.

The 1915 Flood Control Act established the authority and means by which to fund, develop, and operate extensive infrastructure dedicated to flood risk mitigation. History had shown that heavy rainfall can turn dry riverbeds into torrents of fast-moving water and quickly flood large portions of the region. The establishment of the LACFCD provided for the development of drainage infrastructure to carry water away from inland flood-prone areas and out into coastal waters. So effective is the system that an estimated 500,000 acre-feet (160 billion gallons) of stormwater, approximately one-third of the region's total water demand, flow out to sea every year.

Resilience in LA

LACFCD's role in water management has evolved to meet other needs of the region. Today, LACFCD still minimizes flood risk while contributed to water conservation and water quality through innovative investments.

The history and testimony of resilience demonstrated through the success of the flood control infrastructure is further established by LACFCD's success in evolving to meet the region's other water management needs. When the infrastructure was first constructed, it centered on minimizing flood risk and preventing damage to property. However, as the region underwent rapid urbanization and population growth it became prudent to consider the region's water supply portfolio. There was a significant dependence on imported water, but the reliability of that supply was threatened by growing demands in other service regions and the costs associated with delivery. Increasing the amount of stormwater captured and stored during wet years can prove significant in sustaining groundwater supplies during the dry years. Not only is this supply local, it also sustainable and studies are underway to demonstrate its low carbon footprint (low energy use and low GHG emissions). As such, innovative and proactive investments into LACFCD's stormwater infrastructure will ensure that less stormwater is wasted into the ocean and instead factored into the region's diversified supply portfolio.

4.3.2 Infrastructure

LACFCD encompasses more than 2,700 square miles and approximately 2.1 million land parcels within 6 major watersheds. It includes drainage infrastructure within 86 incorporated cities as well as the unincorporated County areas. This includes 14 major dams and reservoirs, 483 miles of open channel, 27 spreading grounds, 3,330 miles of underground storm drains, 47 pump plants, 172 debris basins, 27 sediment placement sites, 3 seawater intrusion barriers and an estimated 82,000 catch basins.

Figure 21: Morris Dam, LACFCD Facility in the San Gabriel Mountains

LACFCD's infrastructure serves the community through its practical flood risk mitigation and water conservation efforts while providing a variety of environmental, social, and cultural benefits that include habitat restoration, recreational opportunities, and iconic backdrops for life in the region. The facilities are designed, operated, and maintained with a focus on safety and functionality. There are several aspects of the infrastructure, its management, and the interactions with the communities it serves that contribute to regional water resilience, for example:

- The design of the conveyance infrastructure typically integrates capacity for increased flow rates after a burn event, including sediment flow, from undeveloped land;
- Large facilities, including dams, are continually assessed and retrofitted as needed to meet the latest regulatory standards, including hydraulic capacity and seismic loading;
- Cities and residents are asked to report local drainage needs so they may be evaluated, prioritized and efficiently resolved by staff;

- Robust inspection and rating systems are utilized to perform condition assessments on a regular basis;
- Small- and large-scale repair and rehabilitation programs ensure system capacity remains intact and operationally sound;
- Throughout the year, critical infrastructure is inspected and cleared, with emphasis on those facilities impacted by recent fires or other conditions affecting stormwater runoff;
- The development of Asset Management Plans and Capital Improvement Plans proactively direct attention to aging infrastructure and facilitate replacement, repurposing, and/or improvements to the system; and
- Protocols for post-fire soil erosion mitigation are established in partnership with both local and federal agencies.

As much as possible, ongoing infrastructure improvements represent collaborative efforts with regional stakeholders that incorporate multiple benefits and multiple funding partners.

4.3.3 Governance and Management

Regional flood protection in the County is primarily managed by the LACFCD, but relies on important partnerships with countless other local and regional entities. Cities and other water agencies are key collaborators in the development of broad solutions to increase system capacities, reduce demands, and address basic needs. One such role of cities is the installation and maintenance of catch basin inserts to improve surface water quality without impacting flood risk mitigation. Additionally, many projects and planning efforts are implemented only after a series of community meetings to ensure integration of public opinion in management decisions regarding the region's resources.

LACFCD, in association with the USACE, constructs, manages and maintains the County's flood infrastructure, including debris basins, storm drains, culverts, dams, reservoirs, spreading basins, and flood protection channels. At present, local drainage issues are managed by the municipalities whose jurisdiction they occur in, but are reviewed and permitted by the LACFCD whenever they tie into the LACFCD system. The northern part of the County lies outside the jurisdiction of LACFCD and is primarily managed by local districts.

Resilience in LA

The LACFCD conserves water for beneficial and useful purposes by spreading, storing, retaining, or allowing them to percolate into the soil within the LACFCD service area.

Within its jurisdiction, LACFCD provides for the control and conservation of flood, storm, and other wastewaters. The LACFCD conserves such waters for beneficial and useful purposes by spreading, storing, retaining, or allowing them to percolate into the soil within the LACFCD service area. The LACFCD also protects the harbors, waterways, public highways and property in the LACFCD boundaries from potential damage caused by such waters and may provide for recreational use of LACFCD facilities. In addition, each city also has flood risk management responsibilities at the local level.

The LACFCD diligently operates and maintains its infrastructure through a number of routine maintenance activities and as-needed small and large capital improvement projects. Additionally, large-scale facilities that pose a risk of flooding should they fail, such as dams, have extensive engineering and regulatory oversight as well as established Emergency Action Plans. These plans were developed in conjunction with both the regional regulatory agencies and the first responders involved in enacting the plans. An emergency exercise is also conducted annually to ensure all involved parties are best prepared to respond, if needed.

In addition to maintaining the physical infrastructure, the LACFCD also works with the USACE and the Federal Emergency Management Agency (FEMA) to implement non-structural programs that assess flood risk and mandate flood insurance for vulnerable areas. It is important to note that even with the vast network

of dams, major channels, and drains, the region is still susceptible to routine localized and, in severe cases, regional flooding. Most of the system is designed to handle the 50-year or 100-year flood event, so unusually heavy or continued rainfall can surpass the capacity of the flood protection system, overtopping levees and channel walls and overwhelming drains. Limited open space and high costs of large infrastructure projects make expansion of the system into new areas difficult and require extensive planning and reliable financing mechanisms to provide for even localized extensions and improvements. Available funding sources for the LACFCD support the operations and maintenance of the existing system, but cannot underwrite significant expansion or renewal of the system.

In the areas of the County outside of the LACFCD boundaries, such as the Antelope Valley, flood risk management is conducted at the municipal level by the cities. Regional flood protection facilities in these areas are limited and generally located in urban zones. In the Antelope Valley, the valley floor is essentially an alluvial fan, making much of it subject to inundation and shallow flooding with unpredictable flow paths. Additionally, flash storms tend to occur in the area, leading to high stream flow volumes over short periods of time. Urban drainage facilities in the Antelope Valley have limited hydraulic capacity which at times causes localized flooding problems. Urban drainage facilities generally consist of local detention basins, street drainage inlets, underground storm drain pipes, and culverts. There are no regional flood management facilities maintained in the Antelope Valley.

4.3.4 Current Resilience Efforts

Emergency Disturbance

The Santa Clarita Valley has experienced flood events occasionally due to flashy hydrology and a natural river channel. Santa Clarita participates in the National Flood Insurance Program (NFIP), to help lessen financial devastation impacts from flood events. NFIP allows city residents to obtain direct federal relief following declared flood disasters. The major elements of this program include flood hazard mapping, flood insurance, and floodplain management. As part of the NFIP, Santa Clarita has adopted a local floodplain ordinance and is responsible for regulating development in floodplains. In exchange for these efforts, FEMA provides the community with flood maps that show risk of flooding, offers federally backed flood insurance and provides assistance in flooding events (Kennedy/Jenks Consultants, February 2014).

Resilience in LA

The City of Santa Clarita has adopted a local floodplain ordinance as part of their NFIP and is responsible for regulating development in floodplains. In exchange for these efforts, FEMA provides the community with flood maps that show risk of flooding, offers federally backed flood insurance and provides assistance in flooding events.

Cyclic and Long-Term Resilience Efforts

As detailed in the Los Angeles Basin Study discussed in *Section 4.1 – Water Supply*, climate change is expected to cause changes in weather patterns, particularly peakier storms that can contribute to flooding issues. Still, most agencies and cities interviewed for this study were not as concerned about flooding or stormwater capture/use because such issues are addressed primarily by LACFCD. Nonetheless, coastal facilities managed by local agencies and districts are incorporating potential sea level rise and 100-year flood projections into planning efforts. Additionally, a few cities have begun to prioritize resilience efforts by considering and planning for stormwater capture infrastructure and even establishing funding mechanisms to implement these sustainability efforts. This has been true in the cities of Santa Clarita and Santa Monica for some time and has recently taken effect in the City of Culver City's where local Measure CW, the Clean Water, Clean Beach Parcel Tax, was passed in November 2016 to provide funds for improvements in water quality in Ballona Creek, Marina del Rey, Santa Monica Bay, and the Pacific Ocean.

The LACFCD's original mission to provide flood protection has evolved as the focus of planning has turned to sustainable, multi-benefit solutions that look at optimizing water management approaches and practices throughout the County, leveraging related land use planning, expanding regional collaboration on projects and oversight, and enhancing public services. The Los Angeles River, for example, which was channelized by the USACE to reduce flood risk, is now being seen as a river corridor for environmental enhancements and recreational opportunities. In 1996, the Los Angeles County Board of Supervisors adopted the Los Angeles River Master Plan that served as a multi-objective guide for the Los Angeles River, recognizing its primary flood protection purpose, while advocating for environmental enhancement, creation of recreational opportunities, and encouragement of economic development throughout the Los Angeles River corridor. The Los Angeles River continues to attract multiple interests and there are several new planning efforts in process that envision the river as an asset to the diverse communities that surround it. In October 2016, LACDPW began an effort to update the Los Angeles River Master Plan through a collaborative process that engages regional and local stakeholders, including partner agencies, local elected officials, community representatives, and members of the public. The updated Los Angeles River Master Plan aims to link the multiple efforts already underway along the 51 miles of the river system into a single, comprehensive plan that articulates a vision for multi-benefit uses and provides actionable strategies.

Resilience In LA

The updated Los Angeles River Master Plan aims to link the multiple efforts already underway along the 51 miles of the river system into a single, comprehensive plan that articulates a vision for multi-benefit uses and provides actionable strategies.

4.4 Healthy Habitats and Open Space [TO BE DEVELOPED IN COLLABORATION WITH STAKEHOLDERS]

4.5 Stakeholder Engagement

4.5.1 Integrated Regional Water Management

Collaboration on water resources management and project development has occurred in Los Angeles County for many decades. But it was not until the State Legislature passed the Regional Water Management Planning Act (SB 1672) in 2002 that the statewide IRWM Program officially began. Water resources had long been an important topic state-wide, but the numerous agencies involved in the water landscape typically operated independently of one another. IRWM was developed to encourage and empower local agencies to work collaboratively to manage local and imported water supplies. The end goal is to improve water quality, quantity, and reliability within participating regions. This includes the management of all aspects of water resources in a region and considers a broad range of resource management issues, competing water demands, new approaches to ensuring water supply reliability, and new ways of financing.

California voters passed Proposition 50 in November 2002, Proposition 84 in November 2006, and Proposition 1 in November 2014 which set aside grant funds for IRWM planning and project implementation to be administered by DWR. Though these bond acts have provided over $1.5 billion to support and advance IRWM, it is important to distinguish that IRWM is greater than just a grant program

– it is a philosophy that continues to shape State and regional efforts in water management. Other sources of funding are also utilized, and continue to be pursued to ensure ongoing projects within the IRWM philosophy can continue to be constructed. Concurrently, many of the collaborative ideas to improve and sustain the IRWM program were captured in the April 2017 report by DWR titled "Stakeholder Perspectives: Recommendations for Sustaining and Strengthening IRWM." Key concepts were categorized into four strategies that are consistent with regional efforts to create sustainable water supplies through sustainable IRWM practices. These strategies, along with some of the core concepts within each, are as follows:

Figure 22: IRWM Regions in Los Angeles County

Strategy 1 – Improve Alignment

- Task Force for Regulatory Alignment at federal, State, and local permitting and flood management agencies level.
- Create a pilot program for "one-stop shop" environmental permitting for projects.

Strategy 2 – Strengthen Practices

- Provide noncompetitive base-level funding.
- Provide funding for noncompetitive grants for IRWM regions to address inter-regional and designated statewide water management priorities.
- Establish a DAC and Tribal task force to facilitate and monitor implementation of actions to increase DAC involvement in IRWM.

Strategy 3 – Improve Services

- Provide comprehensive training to Regional Service Representatives.
- Work with Legislature and appropriate State offices to develop and implement guidelines and procedures for partial, full, or incremental advance disbursement of grant funds.

Strategy 4 – Communicate Values

- Establish a full-time position to serve as the statewide IRWM information officer.
- Work with IRWM Roundtable of Regions and other stakeholders to develop performance metrics and reporting processes to measure/track the value and accomplishments of IRWM

Supports both State and Regional Efforts towards Resilience

The Governor's vision to improve and sustain the state's water future for generations to come is being realized through 10 actions that are detailed in the California Water Action Plan. IRWM is central to implementing that vision and its application in southern California is consistent with several the actions detailed in the California Water Action Plan:

- Action 1, as it promotes regional collaboration on making conservation a way of life.
- Action 2, as it enables self-identified regions to integrate and implement water management solutions for their region.
- Action 5, as it provides resources and framework for joint approaches to manage and prepare for dry periods.

- Action 6, as supports projects that expand water storage capacity and improve groundwater management.
- Action 7, as it facilitates safe water for all communities.
- Action 8, as it increases flood protection.
- Action 9, as it improves operational and regulatory efficiency.
- Action 10, as it identifies sustainable and integrated financing opportunities.

The IRWM model maintains that regional water managers, who are organized into regional water management groups, are best suited and best positioned to manage water resources to meet regional needs. The importance of large inter-regional water management systems such as the SWP is undeniable, but it is essential to acknowledge that most of California's water resource management investments are made at the local and regional levels. It is through the many local IRWM investments that water management challenges presented during California's recent drought could be most efficiently be addressed.

Resilience in LA

IRWM efforts within the County have led to a number of additional partnerships and projects contributing to water resilience within the region.

IRWM efforts in the County have produced and supported multiple partnerships and projects that have helped build water resilience regionally. This has been demonstrated not just through the collaborative processes now established to recommend projects for grant funding, but also by the growing number of partnerships where agencies have come together to co-fund projects and/or combine and modify projects to achieve multiple benefits. The paradigm shift away from single-purpose projects has allowed many projects to concurrently address multiple aspects such as stormwater capture and infiltration, water quality improvement, habitat enhancement, and new recreational opportunities for communities. Other IRWM benefits to the County include improved inter-agency trust, minimized conflict, collective strength, tailored solutions, and better collaborative management of resources.

IRWM Regions now cover approximately 90% of the state's geographic area and 99% of the state's population. Each region has its own unique challenges and opportunities based on their make-up, geographical location, and local interests. The regions interacting within the County are all unique in and of themselves as well.

Regional Structure

Within Los Angeles County, there are three IRWM regions, shown in Figure 22. The general coverage of each region is as follows:

- GLAC Region, which covers 84 cities in Los Angeles County and portions of three other counties *(Note the GLAC Region wholly encompasses the Los Angeles Gateway IRWM Region which developed a separate IRWM Plan in 2013, but has since been collaborating with and incorporated into the GLAC IRWM Region).*
- Upper Santa Clara River Region, which contains the upper reaches of the Santa Clara River in Los Angeles County, including the City of Santa Clarita and various unincorporated areas of Los Angeles County.

- Antelope Valley Region, which includes portions of northern Los Angeles County (including the Cities of Palmdale and Lancaster), southern Kern County, and western San Bernardino County.

Overall, the GLAC IRWM covers the coastal and southern half while the Upper Santa Clara River and Antelope Valley Regions cover the northern half. Due to its size (over 2,200 square miles representing around nine million people) and complexity, the GLAC IRWM is also subdivided into five watershed-based subregions. The GLAC subregions are shown in Figure 23.

Figure 23: GLAC IRWM Subregions

4.5.2 Water Agency Collaboration and Partnerships

Because some agencies are much smaller or more dispersed than others in the County, some groups of agencies have formed focused stakeholder groups that address shared needs or goals. For example, the Public Water Agencies Group (PWAG), a group of 16 water agencies within Los Angeles County was created to help facilitate communication with the County to obtain necessary County permits. The PWAG has expanded its mission to provide collective commentary on a variety of regulatory issues and coordinate emergency planning and resource sharing.

Partnerships are formed between agencies to help fund and implement water projects that will benefit both groups. In some cases, this involves agencies that serve different purposes within overlapping jurisdictions where one agency's supply is another agency's waste. For example, stormwater capture and infiltration projects between LADWP and LACFCD have worked well for both agencies, providing LADWP with a water supply benefit and LACFCD with additional opportunities for flood risk management. In areas like the San Fernando Groundwater Basin, where one agency owns all water rights, the distribution of benefits is clearer than in other regions that facilitate and may even require collaboration and formal partnership.

In other cases, neighboring water agencies might work together or form a JPA to work toward improving the reliability of their regional supply. WVWD and Rowland Water District coordinate regularly on supply development projects through a JPA they formed called Puente Basin Water Agency. The two agencies jointly develop projects that bring additional supply to their connected systems, thus benefitting the combined area they serve.

Resilience in LA

The Public Water Agencies Group (PWAG), a group of 16 water agencies within Los Angeles County was created to help facilitate communication with the County to obtain necessary County permits. The PWAG has expanded its mission to provide collective commentary on a variety of regulatory issues and coordinate emergency planning and resource sharing.

In addition, the Groundwater Replenishment Coordinating Group (which includes Upper District, San Gabriel Valley Municipal Water District, Three Valleys Municipal Water District, Central Basin MWD, WRD, Metropolitan, LACSD and LACFCD) meets regularly to coordinate replenishment of stormwater, untreated imported water and recycled water into groundwater basins within the County.

While partnerships often provide tangible benefits, they may not always be the most appropriate management decision even when they present opportunity for additional funding and shared benefits. In some cases, partnerships can impede progress on

planned projects while less collaborative alternatives may promote timely completion. Successful partnerships require alignment of multiple parameters.

Regulatory Coordination

Ensuring water resources are resilient to a variety of stresses and disturbances requires regular and consistent communication and coordination with regulatory agencies. During the recent drought, the SWRCB set specific conservation targets for large urban water supplies, requiring reporting of water production information, prohibiting wasteful water use and giving water agencies additional enforcement authority to prevent those practices. As part of the regulation, water agencies are required to report monthly water use. As part of the MS4 requirements and TMDLs, the County and cities are required to adhere to waste load allocations and discharge requirements. Through implementation of the TMDLs, these entities coordinate regularly with the Regional Board to ensure key milestones are being met and to evaluate potential strategies for long-term compliance.

Stakeholder Coordination

Transparency and Public Education

Some agencies have developed regular workshops to educate and involve boards, councils, stakeholders and the public on strategies and decision-making. Others have implemented as-needed stakeholder engagement mechanisms related to the implementation of specific projects. Examples of these types of outreach include:

- LASAN's success in increasing rates several years ago after coordinated outreach to all 96 neighborhood councils within its service area explaining why a rate increase was needed.
- WRD holding several workshops every year to communicate with its stakeholders regarding its Replenishment Assessment so that the agency is transparent about the cost estimation process and purpose. Funds from the Replenishment Assessment pay for contributing towards water resilience and supply reliability through projects like GRIP. WRD has also hosted workshops to educate the public on different water-related topic to raise general awareness about water resource management.
- West Basin MWD forming a Recycled Water Workgroup to enhance stakeholder understanding of the challenges and complexity of their recycled water supply, treatment, and distribution system. The agency found these discussions to be a useful tool to educate stakeholders, including major customers, retailers, environmental groups, and City of Los Angeles staff, on the agency challenges and complexities that necessarily result in higher costs.
- Central Basin MWD holding monthly purveyor workshops that cover issues important to its retail agencies.
- Las Virgenes MWD holding quarterly resident tours of its facilities and funding the water science program for the region's 4th and 5th grade students.

Stakeholder Advisory Committees

Agencies have found that involving stakeholders in decisions on large and somewhat controversial projects can contribute to project success. Incorporating input from environmental groups and the community can help gain the support of potential project opponents.

The Las Virgenes-Triunfo JPA developed its plans for the Pure Water Project Las Virgenes-Triunfo through a unique, stakeholder-driven process. Representatives from NGOs, local municipalities, state and federal agencies, and resource conservation organizations were invited to assist the JPA to formulate a plan to beneficially reuse all of its recycled water and effectively eliminate seasonal discharges to Malibu Creek. With the help of the stakeholders, the JPA set aside previous plans to build a new dam and reservoir in the Santa Monica Mountains and adopted a superior alternative involving advanced treatment of the recycled water for potable use.

Resilience in LA

Las Virgenes-Triunfo JPA formed a stakeholder group to discuss its goal to beneficially reuse all of the recycled water produced at its Tapia Water Reclamation Facility. With the help of the stakeholders, the JPA set aside previous plans to build a new dam and reservoir in the Santa Monica Mountains and adopted an alternative involving advanced treatment of the recycled water for potable use.

For the GRIP project, WRD conducted outreach with the community neighboring the future location of the project, acknowledging impacts of the new treatment plant. WRD incorporated viable ideas from the community into the design of the facility and constructed an education center at the site for the public.

Santa Monica maintains an Ad-Hoc Water Advisory Committee composed of environmental groups and City Councilmembers that coordinates on issues related to resilience.

Inclusive Planning

Resilient water resource management, including flood risk mitigation, requires collaboration and coordination across multiple agencies to develop, fund and implement effective projects and policies. Local communities also expect greater involvement in project planning and more targeted responses to their needs and concerns than in the past. As a result, planning efforts today aim to engage communities and develop projects that address known functional needs while providing additional benefits to the neighborhoods they occupy. Such benefits include aesthetic enhancement, habitat restoration, creation of recreational opportunities, and improving water quality. Several ongoing programs and studies in the Los Angeles region currently explore the future of water resource planning and emphasize these approaches. These programs and studies are referenced throughout this report and include EWMPs, the IRWM program, One Water LA, the City of Los Angeles Stormwater Capture Master Plan, and the Greater LA Water Collaborative, Greenways to Rivers Arterial Stormwater System, Los Angeles River Ecosystem Restoration Feasibility Study, and the Water LA Program Collaborative.

In Phase II of this planning effort we will explore the role of other stakeholders including environmental and environmental justice NGO, businesses, academics, cities, COGs and others.

4.5.3 Environmental and Environmental Justice NGOs [To Be Developed in Phase II]

4.5.4 Business [To Be Developed in Phase II]

4.5.5 Academics [To Be Developed in Phase II]

4.5.6 General Public [To Be Developed in Phase II]

4.6 Economic and Funding Status

4.6.1 Sources of Funding

To meet funding needs for development of projects that promote water resilience and maintenance of the systems that provide supply, water quality and flood protection benefits, water management agencies must access resources in multiple ways. Typical funding sources include local revenue resulting from rates, fees, taxes, and bonds and external sources such as State and Federal government loans and grants. Some examples of these funding sources are summarized below.

Local Funding Sources

Sources of local funding include utility fees, local taxes, and bonds. Agencies maintain a General Fund that finances many existing programs and can cover management, outreach, inspections, operations and maintenance, and capital investment. Additional funding can be generated by raising rates, taxes or fees or passing bond measures. Proposition 218, passed in 1996, among other things, imposes voter approved requirements that vary depending upon whether the funding source is a tax, fee or special assessment. While exemptions were established for sewer, water, and refuse collection services, stormwater was not included. As such, the County and cities have typically been unable to raise funds for stormwater projects through taxes, fees, or assessments without voter approval. However, as of the passing of Senate Bill 231 in October 2017, stormwater capture falls within the definition of "sewer" and therefore can qualify for the exemptions established in Proposition 218. The new law has not yet been applied and there are still a number of sensitivities to keep in mind for those planning to do so. Various trade associations suggest that counties and cities apply the exemption conservatively, emphasizing the necessity of the fee to achieve sustainability. It is generally agreed that comprehensive stormwater projects that directly lead to trackable water reuse (such as through capturing, treating, and recharging groundwater aquifers) would minimize the risk of challenge.

Resilience in LA

Measure A (County Parks and Open Space Funding) and **Measure M** (County Transportation Funding Extension) are two new funding sources recently passed by Los Angeles County voters in November 2016 that could benefit water resources projects.

Local Propositions, such as the City of Los Angeles Proposition O that provided up to $500 million for water quality projects in 2004, help allocate funds to specific types of water projects. The County recently passed two funding measures that will provide funding for open space, parks, and transportation corridors projects that could potentially incorporate water-related aspects as part of the project design:

- **Measure A –** County Parks and Open Space Funding: The County Parks and Open Space Initiative (referred to as Measure A on the ballot) was passed by voters in November 2016. The measure replaces an expiring funding source and provides supplemental funds for safe and clean neighborhood parks, creation and enhancement of open spaces, protection of beaches and rivers, and additional water conservation throughout the County. To develop the program, Los Angeles County Parks and Recreation commissioned a detailed study on the accessibility of parks and open spaces to communities across the County. The study not only involved spatial research on park locations and their accessibility to surrounding neighborhoods, but also engaged the public in discussions about their perceived needs relevant to park access, safety, and related services.

Measure A can be utilized to help fund water resources projects that utilize parks to capture and infiltrate stormwater through LID, infiltration galleries, and other stormwater BMPs.

- **Measure M –** County Transportation Funding Extension: The Los Angeles County Traffic Improvement Plan (Measure M) was adopted by voters in the November 2016 election. The Measure secures funding to improve freeway traffic and safety, repair damaged roadways and sidewalks, retrofit freeway and road bridges for seismic activity, improve traffic signals, reduce transportation fares, expand public transportation systems, and create local jobs. There is potential to couple transportation projects with green streets programs and other stormwater BMPs projects to improve runoff water quality while repairing roadways.

Loan Programs

State Revolving Fund loans provide a source of funding for any city, county, or district to fund projects including stormwater treatment, water reclamation, and wastewater treatment systems. For example, the State's Clean Water State Revolving Fund provides financial assistance through loans, refinancing, or grants for projects like the construction of publicly-owned treatment facilities (water/wastewater/stormwater treatment, sewers, etc.), implementation of nonpoint source projects to address pollution, and development/implementation of estuary conservation and management plans.

The Water Infrastructure Finance and Innovation Act Program is another loan program, which offers $1 billion in credit assistance for water infrastructure projects. This program provides long-term, low-cost credit assistance in the form of direct loans and loan guarantees.

State and Federal Grant Programs

Several grant programs have received funding through the most recent Water Bond, Proposition 1, the Water Quality, Supply, and Infrastructure Improvement Act of 2014. Proposition 1 provides approximately $7.5 billion in general obligation bonds to fund water infrastructure and management programs (small community wastewater, water recycling, drinking water, stormwater, and groundwater sustainability projects) as well as ecosystem and watershed protection and restoration. Some of the Proposition 1 funded grant programs that could be utilized by water managers to benefit water management systems and planning in the County include the following:

- **IRWM Grant Program.** This program, administered through DWR and discussed earlier, is a collaborative effort to identify and implement water management solutions on a regional scale that increase regional self-reliance, reduce conflict, and manage water to concurrently achieve social, environmental, and economic objectives. The program provides funding for multi-benefit water resources projects.
- **Stormwater Grant Program.** This program, administered through the SWRCB, provides grants for multi-benefit stormwater management projects. Eligible projects include green infrastructure, rainwater and stormwater capture projects, and stormwater treatment facilities.
- **Ecosystem, Watershed Protection and Restoration Funding.** Several agencies, including the Baldwin Hills Conservancy, the San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy, the California Natural Resources Agency, and the Santa Monica Mountains Conservancy are administering programs to provide funding for multi-benefit water quality, water supply, and watershed protection and restoration projects.
- **CalConserve Revolving Fund Water Use and Efficiency Grants.** This fund, administered through DWR, provides loans to public agencies for water conservation and water use efficiency projects and programs to achieve urban water use targets.
- **Water Storage Investment Program.** This program, administered through the California Water Commission and DWR, considers water storage projects that produce real and measurable public benefits, and help address the long-term water needs for California families, farms, communities,

and the environment. Projects must provide measurable benefits to the Bay-Delta ecosystem or its tributaries.

- **Water Desalination Grant Program.** DWR provides grants to local agencies for the planning, design, and construction of water desalination facilities for both brackish and ocean water. It also provides grants for pilot, demonstration, and research projects.
- **Water Recycling Funding Program Construction Grants.** This program, administered through the SWRCB, promotes beneficial use of treated municipal wastewater (water recycling) in order to augment fresh water supplies in California by providing technical and financial assistance to agencies in support of water recycling projects and research.
- **Groundwater Sustainability Program.** This program, administered through the SWRCB, provides funding grants, and loans, for projects that prevent or mitigate the contamination of groundwater that serves or has served as a source of drinking water.
- **Sustainable Groundwater Planning Program.** This program, administered through DWR, provides funds for projects that develop and implement sustainable groundwater planning and projects consistent with groundwater planning requirements outlined in the California Water Code.
- **Flood Management Program.** This program, administered through DWR, provides funding for multi-benefit flood management projects that achieve public safety and include fish and wildlife habitat enhancement.

Other State grant programs include the SWRCB's Clean Water Act 319(h) Non-Point Source Grant Program. This program allocates funding from the US EPA to support projects that implement full scale, on-the-ground management measures or practices in alignment with the watershed-based plans to address water quality problems in surface water and groundwater resulting from nonpoint source pollution.

In addition to state funding, federal grants are also regularly relied on by water managers. USBR, as part of its WaterSMART Programs, administers grants, scientific studies, technical assistance, and scientific expertise through cost-shared financial assistance to non-Federal entities using a competitive process. Program areas include: Water and Energy Efficiency, Water Marketing (water markets or transactions), Cooperative Watershed Management Program and Grants (for watershed management groups and projects), and Drought Program and Grants (contingency planning, resiliency projects, emergency response actions).

Other Potential Sources of Funding

Metropolitan's Local Resources Program

Metropolitan also provides funding to water managers in the County through its Local Resources Program. Metropolitan's Local Resources Program provides funding to member agencies to develop local supplies and reduce their reliance on imported water. As part of the application and project review process, Metropolitan requires agencies to quantify the water supply benefit and associated imported water offset provided by project implementation.

Public-Private Partnerships

Public-Private Partnerships (P3) involve contractual agreements between public and private sectors allowing greater private sector participation in financing, construction, and operation of watershed. Interest in P3 financing is growing as state and local governments face tough budget decisions along with declining federal investment in infrastructure.

4.6.2 Resource Allocation

Water supply and wastewater agencies charge customers rates for service. These rates cover the costs to purchase, access and/or treat water as well as the operations and maintenance of their distribution and

collection systems. While these rates are often sufficient to meet existing infrastructure needs, they are sometimes insufficient to completely fund future capital improvement projects or preventative asset management programs. As a result, agencies generally seek additional grants, loans and financing vehicles to meet these more variable project needs.

Several agencies within Los Angeles County have recently completed a rate adjustment or are in the process of adjusting their rates to increase revenue or better allocate where the revenue is generated. As part of the rate process, some agencies have been able to fund asset management programs that increase the resilience of their systems by proactively conducting rehabilitation and replacement projects on a regular annual basis. Local funds are intended to be enough to maintain and operate the facilities as well as provide for upfront costs and match for capital projects , however, some agencies are still in need of other funding sources to fully meet their needs.

Resilience in LA

The Cities of Santa Monica, Santa Clarita, and Culver City have successfully implemented parcel-based taxes to help fund stormwater projects. The voters in City of Culver City recently passed a similar measure.

Flood protection and stormwater management do not have service rates as a funding source. Funding for flood protection is generally provided by parcel taxes with additional funds provided through emergency response grant programs. The bulk of the County's flood risk management program is funded by the benefit assessment and ad valorem tax allocated to the LACFCD, though cities also play a role in flood protection. Stormwater management currently does not have a dedicated funding source in most parts the County, though some cities, as mentioned previously, have passed parcel fees or taxes to fund it. Water managers typically look to grant programs and bonds, when available, to help fund stormwater management projects. Cost share for these stormwater projects, as well as funding for ongoing operations and maintenance of completed projects requires use of General Funds due to lack of any specific fee or tax to provide ongoing funding.

Two cities interviewed, Santa Monica and Santa Clarita, have successfully passed and implemented a parcel-based fees to fund stormwater projects and Culver City recently passed a similar tax (Measure CW). Both Santa Clarita and Santa Monica continue to monitor implementation of their stormwater parcel fees and Santa Monica has a Citizens Oversight Committee to ensure the City's Clean Beaches and Oceans Measure is properly implemented and objectives are met. As a result of these fees, the cities are able to operate and maintain their water quality and stormwater projects – however generating capital for new projects is still challenging.

In recent years, many agencies have been exploring alternative funding models for capital improvement projects, as well as operations and maintenance. Cost-sharing strategies couples with multi-benefit projects require integrated planning and coordinated collaboration, but can result in underwriting important infrastructure solutions while ensuring that project outcomes have a variety of positive impacts on communities. These approaches provide opportunities to leverage pooled funding to develop projects that address multiple needs.

Chapter 5 Evaluation of Water Resilience in Los Angeles County

A continually evolving socio-political, regulatory, funding, and environmental context presents unforeseeable challenges that require adaptive management, robust and redundant infrastructure, and collaborative planning to prevent interruptions in service. Water management agencies and government entities have developed and implemented a variety of strategies to this end, many of which also represent opportunities to establish enhanced management practices and build resilience across the region.

This chapter explores external threats and stressors that both challenge and necessitate the establishment of resilient water management. Successful or promising strategies implemented by water agencies and local jurisdictions are also highlighted and presented as examples of best practice that contribute to system-wide resilience.

5.1 External Forces Impacting Resilience

As the region continues to strive towards greater resilience in its water planning and management, changing social, political, and environmental contexts provide both new challenges and opportunities. Changing climate and unpredictable rainfall patterns call for enhanced, interconnected infrastructure that can capture and reuse stormwater and provide more options for leveraging stored water in times of drought. Increasing population and greater demand on imported water highlight the need for continued demand management and development of alternative, local supply options. Evolving social, political, and regulatory contexts underscore the importance of adaptive management, responsive decision-making, and expanded stakeholder engagement.

In addition to the impacts of climate change, other natural factors represent ongoing challenges for operations and management of water systems. These factors include the topography and geology of the region and the characteristics of underlying groundwater basins. Animal activity can also pose threats that require mitigation strategies to protect facilities and infrastructure.

5.1.1 Climate Change and Environmental Challenges

There is consensus among meteorological and climate scientists that climate change is occurring around the globe. The rate and degree of that change remains the topic of research, but substantial study has been conducted to determine the impacts of climate change on the Los Angeles region and its extended water supply network.

Multiple recent studies conducted by UCLA have investigated how temperature, snowpack, precipitation, and other weather patterns in the region are changing. One study in particular explored snowpack levels in the Sierra Nevada Mountain ranges, which are principal sources for a large portion of the region's water. The study concluded that more precipitation will likely fall as rain rather than snow and accumulated snow will melt sooner than in modern history due to elevated temperatures. As a result, runoff will occur earlier in the season and in greater volumes, making capture for use much more difficult in the future (Walton 2017). Lesser capture will result in an overall decrease in the total supply that can be imported. Adding to this, external factors such as increased demand on imported supplies outside of the Los Angeles region will likely amplify the problem and lessen the dependability of imported water sources to the region. This likely change in precipitation patterns and resulting runoff highlights the need to enhance the local water supply.

Long-Term Reductions in Sierra Snowpack

Northern California reservoirs are generally thought to be resilient in the long term since their supplies are replenished rather quickly after a period of drought with one or two subsequent wet years. The current 2016-17 wet winter has provided evidence of the region's ability to recover rapidly from a multiple year drought after a single season of heavy rain and snow. However, this assumes that snowpack levels are also consistent with historical wet year levels. The impacts of climate change in California most typically modeled reveal reduced precipitation in the form of snow and earlier than usual melting of the snowpack. These changes would reduce the ability of northern California SWP reservoirs to rebound quickly from drought conditions and limit their ability to meet southern California allocations throughout the year.

Climate Limitations to Local Natural Recharge

Recent droughts have resulted in insufficient local rainfall and natural infiltration to maintain current groundwater basin production within the region. For example, rainfall in the San Gabriel Valley in 2015-16 was below average for the fifth year in a row: the volume of stormwater captured represented approximately 50% of the long-term annual average (Main San Gabriel Basin Watermaster, November 2016). Recent studies predict that climate change will further exacerbate inconsistent annual rainfall by changing precipitation patterns to provide fewer, yet more intense rain events that deliver increased flows over shorter periods.

With natural recharge supplies available only during shorter periods of time, the ability to capture, retain and recharge will be diminished. Therefore, agencies are considering ways to mitigate a potential decrease in local natural (and imported) recharge supply, including supplementing with recycled water. Additionally, agencies are modifying existing recharge facility operations to account for increased flows, when available.

Sea Level Rise

Another potential outcome of climate change is sea level rise. Increasing ocean levels are expected to impact coastal aquifers in the County by putting additional pressure on the seawater barrier system that currently protects the Central and West Coast Basins from intrusion of brackish water. Already aging and in need of repair, the system may be unable to withstand additional stress, resulting in saline contamination along the coasts if not adequately addressed. In addition to infrastructure needs, rising sea level would result in additional fresh water infiltration and required injection to maintain seawater intrusion barriers, thus decreasing the freshwater supply for other purposes.

Sea level rise is also a concern for the Bay-Delta which provides imported water supplies through the SWP. As the ocean levels rise, an increase in water levels in the Bay-Delta can cause a breach of the levees or inundation of the pumps, resulting in water quality issues and flow disruptions that would have serious impacts on deliveries to southern California agencies through the SWP. Strategies identified in the California Water Action Plan (2016) will help mitigate these risks, but sea level rise could still threaten SWP reliability. Higher sea level further compounds the threat of catastrophic seismic activity that could inundate a larger area of the Bay-Delta, threatening water deliveries to southern California.

Physical Limitations to Groundwater Recharge

Where groundwater basins are confined or have poorer water quality, such as in Las Virgenes MWD's service area, infiltration projects have limited supply benefits. It is important to evaluate the potential infiltration benefits of projects to understand whether a project will be cost effective under the specific conditions of the area. For example, CLWA did a reconnaissance study to see if capture and spreading of stormwater would be beneficial. The agency found that due to the unreliable, infrequent supply and the unconfined groundwater basin that allows water to spill into the next basin, stormwater capture and infiltration is not a cost-effective investment for their service area (Carollo, June 2015).

Invasive Species

Quagga Mussels have been an issue in the CRA for a long time and require ongoing maintenance. Quagga mussels were discovered in January of 2007 in Lake Mead and rapidly spread downstream to the Lower Colorado River. The presence and spawning of quagga mussels in the Lower Colorado River and in reservoirs located in southern California poses an immediate threat to water and power systems. If unmanaged, invasive mussel infestations have been known to severely impact the aquatic ecology of lakes and rivers; clog intakes and raw water conveyance systems; reduce the recreational and aesthetic value of lakes and beaches; alter or destroy fish habitats; and render lakes more susceptible to deleterious algae blooms. Metropolitan developed the Quagga Mussel Control Program to control this species. Control mechanisms include chlorination and physical removal of mussels, as well as CRA scheduled shut downs for maintenance and repairs which also presents the opportunity for inspections and the additional benefit of desiccating quagga mussels (Metropolitan, June 2016).

A few isolated adult mussels were discovered in the SWP between Pyramid Lake and Castaic Lake, and within the Castaic hydroelectric facility in Elderberry Forebay. Consequently, mussel monitoring was intensified, but no additional adults have been detected since the initial discovery in late 2016. Clumps of mussels have not been observed and SWP facilities are not currently affected by mussel fouling. DWR and Metropolitan are proactively developing potential control and mitigation solutions in case of confirmed widespread infestation in the future. At this time, there are no operational impacts on water deliveries from Castaic Lake.

5.1.2 Increasing Population & Decreasing Reliability of Imported Water

Figure 24: Developed Los Angeles County Coastline

According to the California Department of Finance, the State's population as a whole is projected to increase by more than 34-percent, while Los Angeles County's population is projected to increase by 16-percent between 2010 and 2050 (Department of Finance, 2013). Projected larger population growth rates outside of Los Angeles County indicate there will be enormous pressure and competition for imported sources of water and the need for increased development of local water supply sources. These competing interests outside the region combined with climate change impacts could pose a significant threat to the reliability of imported water and underscore the need for the development of local water supplies.

At present, Los Angeles County accounts for the largest amount of water demand of any urbanized county in California, with over half of the region's demand supplied by imported water sources (GLAC, 2014). Total water usage within the County portion of Metropolitan's service area exceeded 1.54 million acre-feet in fiscal year 2011-12 (Metropolitan, 2012). Some projections show that imported water supplies could drop by as much as 25-percent by 2035 (Reclamation 2012, DWR 2012).

5.2 Systemic Challenges to Resilience

All the agencies interviewed as part of the assessment recognize the importance of resilient water management and systems and have identified strategies to build resilience through enhanced infrastructure, adaptive management practices, and increased collaboration and inclusive planning approaches. Some of

the strategies currently being implemented by agencies to this end have been discussed in *Chapter 4 – Water in Los Angeles County Today*. This section presents input from agencies on some of the challenges to implementing these strategies and to building resilience within Los Angeles County. In addition to highlighting these impediments, this section aims to underscore current practices and strategies that might be strengthened or enhanced to contribute more effectively to building regional water resilience.

It is important to note that the water resources setting varies greatly throughout the County and as such, the challenges described below may be unique to certain geographic regions or socio-political contexts. The severity of challenges common to multiple agencies is also dependent on the location, as is the mission of the agencies interviewed.

5.2.1 Infrastructure and Systems

Water management infrastructure may represent the most obvious opportunities for enhancement and optimization. Current condition, capacity, and efficiency of existing infrastructure and facilities can be assessed in light of projected future needs and threats. Identified needs or weaknesses can then be addressed through strategies that serve to enhance physical infrastructure, optimize operations, and inform decision-making.

Aging and Unmaintained Infrastructure

Many existing wells, water distribution systems and wastewater collection systems have begun to experience more frequent failure events and require substantial rehabilitation and replacement programs. As an example, LADWP has infrastructure that is over 100 years old and in need of replacement. Other agencies have similar aging infrastructure issues, including wells and pipelines, that will need to be addressed to reduce vulnerability and/or increase adaptive capacity. Some agencies, like LADWP, have been successful in developing and funding asset management programs. However, more often agencies necessarily spend most of their resources on repairing infrastructure after failure has occurred. It has been challenging for these agencies to anticipate and address potential issues within their systems through typical asset management practices (which involve an assessment of and investment in assets before issues arise and risk-based capital improvement programs. These agencies often lack the resources to devote staff time and funding to reducing risk of failure. When interruptions do occur for these agencies, redundancy and coordinated response measures have proven limited in their ability to resolve the issue handily because key facilities are either aging or lacking all together.

Repairing and replacing infrastructure was often cited as the biggest concern in areas with many small agencies or mutual water companies serving DACs. These smaller agencies often have limited resources to dedicate to condition and management assessments and further struggle with allocating the resources to make routine and emergency repairs. In the Antelope Valley and San Gabriel Valley there are several pockets of DACs where pumpers do not possess the means to address aging infrastructure before issues arise. Additionally, within Central Basin MWD's service area, some small and disadvantaged cities cannot afford to invest in their facilities once problems are identified, resulting in city water departments and mutual water companies purchasing unnecessary imported water to supplement groundwater production and increase pressure in their water system.

Resilience in LA

Within Central Basin MWD's service area, some small and disadvantaged cities have to purchase imported water to supplement groundwater production and increase pressure in their water system because they cannot afford to fix aging and broken facilities.

Isolated Water Systems

Interconnections between systems are valuable tools for responding to supply and infrastructure disruptions. In some areas of the County, interconnections are limited or not well understood by smaller agencies. This

issue has been noted in the Antelope Valley, San Gabriel Valley and southeast areas of the County. In Upper District's service area in the San Gabriel Valley, for example, there are several small agencies that would benefit from additional interconnections between systems to increase their resilience when supplies are limited by wells drying and other stressors. In the Antelope Valley, there are several small pumpers and mutual water companies that are not connected to a regional system or rely on a single connection to the imported water supplier, AVEK, resulting in limited backup supply options when wells malfunction or water quality issues arise. Additionally, there tends to be a lack of understanding about system interconnectivity among smaller water agencies in areas like the San Gabriel Valley and southeast County, where several small communities relying on independent water agencies are clustered.

Insufficient Emergency Storage at Local Level

Metropolitan requires its member agencies to have local water storage equivalent to a one-week demand available in the event that an earthquake or some other emergency interrupts Metropolitan deliveries into local systems. Although Metropolitan is not sure which agencies can meet this threshold today, it is assumed that many cannot. Those areas most susceptible to risk are those with a heavy dependence on direct treated imported supply, those that do not have an interconnection or agreements with agencies that have access to other supplies (in particular groundwater), and/or those that have nonfunctioning groundwater facilities. Rural mutual companies within the Antelope Valley and some cities within the San Gabriel Valley and southeast portions of the County are particularly vulnerable for these reasons.

Incomplete Estimations and Effects of Increased Groundwater Recharge

With the push to amass groundwater basin storage and recharge supplies, some agencies pointed out that there has been little consideration of how the supplies will get into the basins and the impacts of those added volumes entering the basin. Some agencies contend that most of the groundwater recharge feasibility plans being developed make assumptions on injection well or spreading basin siting, but do not incorporate the risk of the wells or recharge facilities not functioning as assumed in these plans. Potential issues that could lead to miscalculation of groundwater recharge include lower infiltration rates than expected and potential mounding of groundwater where the recharge occurs.

In addition to limitations in supply estimates, recharge effects on groundwater quality could result in amplified water quality issues. It is acknowledged that there may be more pollutant plumes within many of the County's groundwater basins that are not yet known or fully characterized. Substantial increases of groundwater recharge projects in the County being implemented at a rapid pace could disrupt and move these contaminant plumes into existing well production areas.

Overestimated and Oversubscribed Recycled Water Projections

Recycled water flows, like other water resources, are becoming oversubscribed and may not be sufficient to meet all the recycled water projects currently being considered or planned. Recent conservation efforts during the drought have resulted in reduced wastewater plant flows thereby, in some locations, reducing current and projected recycled water availability estimates that were used to justify new recycled water use projects. The rush to develop recycled water projects over the last five years is also pointing to an emerging conflict as to where and how these future recycled supplies should be used. It is becoming more difficult to implement local decentralized recycled water projects where the wastewater that would be used to supply them is already being or planned to be recycled and beneficially reused. Regional wastewater collection systems such as LACSD have identified this as a challenge.

Articulating Stormwater Supply Volumes

For water supply agencies to be able to participate and fund stormwater capture projects, they need to be able to articulate the amount of water supply that will be generated as a result of project implementation. Appropriate methods to evaluate the safe yield of these projects – to account for the inherent variability of stormwater flows – have not been standardized or adopted by many agencies. Thus, evaluations commonly have such a margin of error that it is difficult for water agencies to assign a unit cost that could incorporate

stormwater as a baseline form of supply to offset imported or other supplies. Without reliable stormwater supply unit costs, this evolving supply cannot be compared against other projects for implementation prioritization and funding. Unpredictable rainfall patterns also contribute to the difficulty in projecting stormwater capture amounts on an annual basis.

Cyber Security

As more and more systems become computerized and integrated, cyber-attacks can create water system interruptions and impede ability to respond to those interruptions. This is an emerging concern for all water agencies and cities, primarily due to the threat of hacking to seize control of the system and shut off supplies. While agencies are beginning to evaluate and test their vulnerabilities to develop safeties, this threat should be of concern for agencies across the County.

5.2.2 Regulatory Environment

The regulatory environment can sometimes pose indirect challenges for water resource managers to implement projects and strategies meant to build resilience. While some regulation may help build resilience in some areas, it can undermine the effort in other areas. Although it may be impossible or imprudent to remove these regulations and protocols, this section highlights some of the key regulatory hurdles identified through this research in the hopes of developing strategies to reconcile them with building resilience.

Expanding regulation intended to protect public health and the environment often poses indirect challenges to the implementation of projects and strategies intended to build resilience. While some regulation may contribute to the establishment of resilient management and practices, it can also represent an impediment. Restrictions on local surface water flows, for example, can restrict necessary maintenance of stormwater detention and recharge basins.

In many cases, agencies are required to obtain prerequisite County, State, and Federal permits in order to comply with existing regulations. The process for obtaining permits can be slow, complicated and result in project delays and increased costs. Some agencies have come together to form focused stakeholder groups to address and coordinate navigation of these complicated processes. Others have resorted to funding salaried positions at regulatory agencies to facilitate permit processing and shorten wait times.

Environmental Restrictions on Local Surface Water Flows

To maintain habitat for aquatic species, some surface water bodies can have restrictions on diversions and/or flow requirements. These environmental demands – in many cases not accounted for in the original planning of infrastructure and facilities decades ago – impact imported water supplies, recycled water supplies, and local surface water. Statewide, regulations to manage ecological conditions for fish species in the Bay-Delta have resulted in restrictions that limit SWP allocations for SWP contractors and Metropolitan member agencies. Locally, the ability to retain wastewater effluent (for reuse) that is currently discharged into rivers is being challenged as these are often the only flows that physically occur within the rivers during the dry season and/or droughts. For example, Las Virgenes MWD has experienced requirements for maintaining discharges from the Tapia WRP to the Malibu Creek in order to provide water pools for endangered steelhead trout when creek levels drop (Kennedy/Jenks Consultants, August 2016). LADWP is also required to discharge a portion of the tertiary treated recycled water from LASAN's treatment plants to maintain environmental flows in the Los Angeles River (LADWP, June 2016).

Diversions of urban runoff for capture for direct use or infiltration can be challenged by similar issues. A question as to the beneficial use of these resources is not easily answered and can delay project implementation.

Maintenance of Stormwater Detention and Recharge Basins

Some agencies have noted that it is complex and challenging for LACFCD and other agencies to maintain and enhance recharge and detention basins given current state and Federal permitting processes and requirements. Of primary concern is the limited ability to remove sediment from those above ground facilities to maintain their capacity and ability to percolate water into the groundwater basins. Environmental permitting can deter such projects that are needed to enhance water supply reliability and flood management effectiveness. This is particularly challenging given a common pattern of years with droughts and fires that compromise soil integrity followed by wet years that erode and deposit substantial amounts of loosened material within recharge basins.

County and State Permit Requirements and Processes

To implement projects that maintain or enhance resilience, agencies are required to attain the necessary County, State, and Federal permits to comply with all regulations. These processes present a challenge to the implementing agency since obtaining permits can be a slow and complicated process resulting in project delays and cost increases. While some agencies have come together to form focused stakeholder groups to address and coordinate navigation of these complicated processes, this approach does not resolve the issue.

MS4 Permits and TMDLs

As part of the requirements of the Los Angeles County Municipal Separate Storm Sewer System (MS4) permit and TMDLs for receiving water bodies throughout the County, agencies are required to restrict contaminant loading to meet water quality objectives. These water quality objectives are, in some cases, viewed as being developed without reliable data and as highly restrictive and difficult to achieve. For example, the Upper Santa Clara River Watershed has the same bacteria environmental regulations and TMDL requirements as other parts of the County, despite having different environmental conditions. The bacteria TMDL for the watershed requires wet weather sampling that contradicts existing restrictions on public access to the natural bottom river during storms. Other areas of the County, except for the Antelope Valley that does not have any TMDLs and is not included in the Los Angeles County MS4 permit, also feel the TMDLs have unrealistic water quality targets that are difficult to attain.

5.2.3 Management, Governance and Coordination

Management of agencies and coordination between agencies is a key element in enhancing resilience. While most agencies acknowledge a great deal of improvement in how agencies are managed relative to resilience, there are still several challenges facing water management entities.

Water Rights

New projects to capture stormwater run into legal obstacles due to the extensive existing water rights and adjudications within the region. If project sponsors could establish rights to captured stormwater, those water rights could provide financial support for the projects through the "sale" of such water. However, in areas where water rights are established and would prevent this financial model for new projects, funding must come from a different source. A Watermaster service may be in a position to provide some funding for the cost of a large-scale project (such as a spreading facility and increased retention) that would provide basin-wide benefit.

There are three important terms to consider when looking at stormwater infiltration benefits and the implications of water rights. In the cases of adjudicated basins, typically the parties to the judgment collectively hold rights to these quantities within a basin:

- Natural Safe Yield, which is comprised of water that comes into the basin such as precipitation and infiltration. Any decline in Natural Safe Yield eventually would reduce the basin's Operating Safe Yield.

- Operating Safe Yield, which is the quantity of water that may be pumped from the basin in a particular fiscal year free of replenishment assessment. The Watermaster typically sets the annual Operating Safe Yield based upon experienced and anticipated long-term consequences to groundwater quality and quantity. If water levels or water quality were to decline because of stormwater capture projects, a Watermaster would likely need to reduce the Operating Safe Yield available for production by parties to the Judgment.
- Appurtenant rights to groundwater storage capacity of the basin, which are based on the parcel ownership above the basin.

It is possible to infiltrate stormwater into a basin to support the basin's Natural Safe Yield and Operating Safe Yield. However, such water would belong to the parties owning rights to the water in the basin, based on their "Pumper's Share," or percentage of the entire Natural Safe Yield and Operating Safe Yield of the Basin. In adjudicated basins, stormwater infiltration projects typically would not create any new water available for appropriation, but only sustain current water supplies.

Moreover, the SWRCB has declared that it will not recognize new diversion rights in an adjudicated and fully appropriated stream (SWRCB Order No. 89-25, § 6.0). Thus, new surface water rights cannot be established in such streams.

Additionally, the ability to salvage or develop "new" water supplies and thereby establish rights to that water is limited by the No Injury Rule. The No Injury Rule provides that the person who by his own efforts makes such waters available is entitled to use them, provided that in doing so he is not infringing the prior rights of others (Hutchins, California Law of Water Rights, 3836). In many basins, however, new water cannot be generated by capturing surface runoff because doing so infringes on existing water rights, therefore violating the No Injury Rule. Similarly, there is typically no surplus available to current non-parties (those not holding rights under a Judgment) because even the waters that flow out of a basin are often under existing obligations from another judgment.

Similar to stormwater, new projects to improve water quality have their own complications related to water rights. As mentioned earlier, water quality responsibility may not lie with the water ownership. For example, the LACFCD, as a conveyor of flood water to the ocean, is still held responsible by the State for the quality of water conveyed via surface waters to the ocean. It is difficult to substantiate the source of some pollutants and therefore hold an appropriate party accountable for the costs of treating water, especially when it is already far outside their jurisdiction and/or blended with other water sources at multiple points along the way.

Limits to Regional Coordination

Although Los Angeles County has a patchwork of densely connected urban areas with many adjacent service areas, not all the water systems serving these communities are well interconnected. In particular, there are several mutual water companies within the Antelope Valley and in some areas of southeast Los Angeles County that operate almost completely independently. In these situations, their financing model does not allow for investments beyond the immediate costs of supplying water. These small agencies are limited in their ability to participate in regional efforts such as regional grant applications for funds to support their systems and participation in regional water security and emergency measures being developed around them. This limitation impacts the ability of these agencies to contribute to regional integrated water resource management decision-making and practices.

Lack of Emergency Plans and Protocols

Emergency response plans and practices contribute to an agency’s ability to react in a controlled and effective manner to unforeseen events, ensuring adaptive and responsive decision-making. While most agencies in the County have developed, or are in the process of developing, an emergency response plan, many smaller agencies have no plan in place, leaving them at risk in the face of unforeseen events. Other emergency protocols, such as maintaining an emergency water supply, are not in place everywhere

throughout the County. Even some larger organizations that have emergency protocols in place acknowledge that they may lack an inventory of resources (both labor and facility) that could be used to rapidly address emergencies.

Succession Planning and Knowledge Transfer Within Agency

The ability to be resilient at an agency level is improved greatly if there is sufficient staff with a deep and detailed understanding of the agency's or city's systems and facilities. Workforce changes in recent years have meant that the likelihood of hiring and retaining staff for the length of an entire career are slim. Thus, there is a greater need to comprehensively document knowledge of an agency's systems as opposed to relying upon longer apprenticeship relationships to transfer knowledge to junior or newer staff. In addition, some agencies are expanding their traditional missions and engaging in projects involving facilities and systems where there is no baseline institutional knowledge, such as West Basin MWD's desalination program, so the agencies must rely on existing staff learning rapidly and/or hiring experts from a narrow field of candidates. Many agencies would benefit from concerted efforts in succession planning and improved documentation of internal practices and protocols.

Demand Hardening

Given the extended implementation of extensive conservation programs over the past few years, it is assumed that a high percentage of conservation program elements and practices will be continued in normal years as well, reducing the adaptive capacity to drought. Water use reductions from replacing toilets, faucets, washers, and sprinkler systems with more efficient models will remain after the drought. Additionally, most turf that was replaced with drought tolerant landscape (as opposed to just letting the lawn turn brown) will likely not be converted back to lawns after water restrictions are lifted. Because of conservation hardening, it may be more difficult to reach similar levels of reduction in response to droughts from the new, lower baseline use without impacting health and safety.

5.2.4 Funding and Resources

The most obvious need within the County to strengthen an agency's or organization's ability to improve its water management systems and practices is funding. Much of funds supplied by rates and other funding sources are used by water management agencies to meet normal operational needs, leaving little available for enhancements or improvements.

Multiple sources of funding for infrastructure projects and operations exist: general funds, dedicated fees, taxes, grants, bonds, and loans. Fees and taxes generate relatively constant annual amounts that may be primarily used for operations and management, making it difficult to fund new projects or significant infrastructure upgrade. Grants, bonds, and loans can provide additional funding for special projects but can be difficult to acquire (grants) or require some later repayment (bonds and loans). As the value of long-standing funding depreciates year after year, agencies find themselves able to do less and less with the same amounts and necessarily seeking out additional sources. Moreover, as systems and infrastructure age, they require repair and more expensive maintenance, further depleting surpluses used to fund enhancements and innovation that contribute to the resilience of their systems.

One key strategy agencies have identified to meet their funding shortfall is collaboration and cost-sharing. A growing number of infrastructure projects include a variety of agencies handling multiple types of water to deliver multiple benefits. These efforts result in cost-sharing across partners to leverage available funding to ensure a variety of outcomes required by all parties involved. There are numerous drawbacks to this approach, however, since these projects require much more coordination to develop, and there are few reliable tools to determine the value of various benefits to determine required monetary contributions by each partner. As negotiated compromises, resulting projects do not typically meet the original objectives of each partner agency and projects usually take far longer to develop and complete, given the breadth of interests and resulting challenges.

Stormwater Funding Challenges

Unlike utilities like water supply and sanitary sewer systems, most jurisdictions do not have funding mechanisms (e.g. fees, taxes, assessments) in place to underwrite stormwater quality infrastructure planning and improvements. In contrast to water supply and flood protection projects, water quality projects have no dedicated funding source, making it difficult for city public works and County departments to implement projects. Typically, jurisdictions are required to request and obtain their annual budgets for stormwater projects and programs from their General Obligation Funds, in which they compete with other services such as police, fire, and school education needs which are more commonly understood and prioritized by elected officials and communities. With the current lack of a stormwater fee, the primary sources of funding for stormwater continue to be General Funds, revolving fund loan programs, and grants such as the State's Proposition 84 and Proposition 1 programs.

Metropolitan funds the Local Resources Program to provide funding for agencies to develop local supplies and reduce their reliance on imported water. Yet, Metropolitan has noted that stormwater projects are difficult to fund under this program because of a required supply offset/benefit to be calculated, and technical justification for the quantification for stormwater supply benefits is limited.

Proposition 218 is an additional factor limiting the mechanisms by which stormwater projects can be funded. As mentioned in Chapter 4, water and sewer service fees are exempt from the voter approval requirements of Proposition 218, and stormwater service fees may not require voter approval of a measure before a new or increased fee can be levied. However, conservative implementation is needed in order to minimize the risk of challenge.

Funding Needs Identified in Planning

As evidenced by plans for additional stormwater capture, development and implementation of projects with significant impact on water supply require substantial investment. The requisite open space for the most effective regional, large-scale projects also provides new opportunities to enhance adjacent communities through habitat restoration, recreational venues, and aesthetic improvement. While flood protection is handled effectively, stormwater capture and mitigation of waterborne pollutants require substantial project development and related funding. In recent years, several key planning documents have been developed in the County that help quantify the needs and costs associated with project development that addresses water quality and water supply issues. These representative plans include: the Los Angeles Basin Study, the Los Angeles Stormwater Capture Master Plan, WMPs/EWMPs, and the One Water LA Plan. The funding needs identified in these plans are summarized below.

Los Angeles Basin Study

In order to investigate opportunities for enhancing stormwater capture within the Los Angeles Basin, the USBR and the LACFCD collaborated in recent years to develop the Los Angeles Basin Study. The purpose of the Los Angeles Basin Study was to examine the region's water supply and demand, investigate potential impacts from projected population growth and climate change, and develop concepts for stormwater capture to enhance local supplies and help the region adapt to its growing water needs.

Cost estimates for the various project concepts include life-cycle projections for capital costs, operations and maintenance costs, and land acquisition costs. The concept costs varied greatly depending on the type of infrastructure proposed and the geographic area covered. Generally, parcel-sized project concepts implemented throughout the region were much more costly in terms of acre-foot of water generated when compared to larger, regional facilities. To reach the full range of additional stormwater capture, the combined cost for regional stormwater concepts was estimated at $11 billion, while the combination of decentralized or distributed concepts totaled $38 billion.

Los Angeles Stormwater Capture Master Plan

Similar to the County's Los Angeles Basin Study, in 2015 the City of Los Angeles released the Stormwater Capture Master Plan. The plan sets specific targets for stormwater conservation within the city boundaries,

and creates a blueprint for increasing potential stormwater capture by an additional 68,000 to 114,000 acre-feet per year on average (22 billion to 37 billion gallons) by the year 2035. With the City's goal to decrease imported water purchases by 50% by 2024, the strategies outlined in the SCMP will play a critical role in increasing the resilience of the City's local water supply.

The Stormwater Capture Master Plan showcases a range of project types that can enhance the region's local stormwater supplies, categorized as centralized, distributed, and direct use projects. Cost estimates for the various projects accounted for a range of full life cycle costs and were also represented as costs per acre-foot of stormwater captured or conserved. Total cost estimates by category are as follows:

- **Centralized Projects – $2.0 billion.** These projects include spreading ground enhancements, debris basin retrofits, large park retrofits, stormwater capture at gravel pits, largescale wetland projects, and reservoir enhancements and sediment removal.
- **Distributed Projects – $4.1 billion.** These projects include onsite infiltration such as rain gardens/grading and bioswales, green streets, impervious replacement, and subregional infiltration.
- **Direct Use Projects – $1.7 billion.** These projects include on-site direct use and subregional direct use.

Watershed Management Plans and Enhanced Watershed Management Plans

As permittees attempt to fulfill their MS4 responsibilities, numerous impediments and challenges present themselves, including meeting aggressive TMDL timelines, facing enforcement actions by the Regional Board, and the potential for third party lawsuits if receiving water bodies continue to be impaired. However, the most immediate hurdle for jurisdictions will be securing the necessary funding to implement the programs and construct the costly projects spelled out in the WMP, EWMP, and CIMP plans. The WMP and EWMP project lists typically presented planning level cost estimates for BMP types such as regional BMPs and green streets/LID programs. The implementation period for each EWMP and WMP is determined by the compliance schedules for the TMDLs within the EWMP/WMP planning boundaries. Operations and maintenance costs were also estimated in most WMPs and EWMPs. Through the development of WMPs and EWMPs, it was estimated that the cost of implementation efforts to comply with the MS4 permit is approximately $20 billion over the next 20 years.

Permittees have begun to implement the WMPs, EWMPs, and CIMPs in spite of budget shortfalls but are actively working to secure funding for the implementation of BMP's in order to reach compliance with water quality objectives. It is anticipated that many of the permittees will have difficulties fully implementing these programs due to the lack of dedicated funding.

One Water LA

The One Water LA Stormwater and Urban Runoff Facilities Plan (Draft March 2017) investigates a stormwater Capital Improvement Program for the City of Los Angeles to help meet its stormwater and urban runoff needs through the year 2040. Projects proposed within the City's jurisdiction were compiled and evaluated using the three-legged stool evaluation criteria for water quality, water supply, and flood risk management. In total, 1,222 projects were identified and compiled into the project database, with 707 projects already identified as being planned in previous and ongoing stormwater and watershed planning efforts and an additional 515 projects proposed within the One Water LA 2040 Plan. Those projects already planned were developed in the City of Los Angeles Stormwater and Green Infrastructure 5-Year CIP, the EWMPs/WMP in which the City of Los Angeles is involved, the LADWP Stormwater Capture Master Plan, the LABOE Storm Drain Capital Improvement Plan, the LACFCD/USBR Los Angeles Basin Study, and the USACE Los Angeles River Ecosystem Restoration Feasibility Study. Overall the One Water LA evaluation found

that an estimated $9.6 billion in capital is required for implementation of all projects through 2040 with an additional $340 million per year for operations and maintenance.

Regional Water Management Funding Challenges

Because water management in Los Angeles County is becoming more regional and projects involve multiple types of water and agencies, more funding programs are needed to fund these very large and expensive regional projects that benefit several agencies and districts. The difficulty of these projects is that all collaborators must agree in order to implement.

The IRWM Program has been a beneficial source of funding for many agencies, yet, like many grant programs, did not provide funding to mutual water companies until Proposition 1. In some areas, there is a regional entity that implements regional projects to the benefit of the smaller agencies, but other areas of the County have no such regional entity to help facilitate this process.

Projects within the County's IRWM plans show a significant funding need. An approximate analysis of the amount of funding needed to implement projects listed on the GLAC, Gateway, Upper Santa Clara River and Antelope Valley IRWM project lists shows a significant gap in funding. Overall, the IRWM project lists showed total estimated project costs of approximately $4.2 billion for all four IRWM Regions combined, as shown in Table 1. While a portion of these project costs can be funded through the IRWM grant program, other grant programs and local cost share, the majority of these costs have no funding source identified.

IRWM Region	Sum of Project Capital Costs
Greater Los Angeles County	$3.4 billion
Upper Santa Clara River	$0.3 billion
Antelope Valley	$0.2 billion
Gateway	$0.3 billion
TOTAL	**$4.2 billion**

Table 1: IRWM Plan Project Costs

Asset Management Funding Challenges

Some agencies are struggling to find enough funds to implement immediately needed repair and rehabilitation projects while also investing in future capital investment programs. Additional funds (unused to meet immediate annual needs) need to be put in reserve to implement asset management programs that address identified vulnerabilities in facilities before they become critical issues. It can be difficult to fund replacement of aging facilities and infrastructure that do not permit phased implementation to distribute costs over time. This issue can lead to infrastructure such as pipelines and pump stations being replaced in preference over storage reservoirs that would require larger and more costly one-time interventions.

While some agencies in the County have implemented asset management programs that allocate funds annually for repairs and replacements to maintain infrastructure pro-actively, other agencies repair aging infrastructure on an as-needed basis. Some larger cities and districts, such as LADWP, have developed ongoing asset management programs that have a relatively consistent level of annual funding assigned, however, this is not true throughout the County. Additionally, limited water sales during droughts have resulted in even some agencies with asset management programs needing to delay implementation.

Basic Operations and Maintenance Needs Funding Challenges

Many smaller agencies and mutuals that serve DACs are without sufficient funds to adequately maintain and operate their facilities. Funding is usually geared for capital projects and even with low DAC funding match requirements, the ability for those agencies to fund the necessary planning and maintenance is limited. The inability for these agencies to effectively maintain their systems means that disturbances are particularly difficult to address efficiently.

Revenue Decreases from Drought Conservation Programming

The ability to operate and maintain existing infrastructure is dependent upon a baseline amount of revenue generated from annual water sales. Financial and budgetary planning is dependent upon the assumptions of water sales for both water and wastewater (where part of the fee structure can be correlated to water consumed). Reductions in water sales due to conservation (i.e. decreased demand) exacerbates insufficient funding challenges. Even agencies that have traditionally been able to generate sufficient funding locally have needed to delay larger capital projects that could improve the reliability and responsiveness of their infrastructure. Projects to upgrade systems for seismic protection, develop emergency connections, increase local supply, or increase storage depend on revenue generated through water sales and fees. Therefore, revenue decreases can even delay ongoing operation and maintenance programs and projects. The overall effect of the reduced water revenue is there are less local funds to implement the necessary projects and programs that contribute to resilience.

5.3 Opportunities for Resilience

As is true with the challenges described in *Section 5.2 – Challenges to Resilience*, not all strategies and projects to meet those challenges make sense for every area within the County. Additionally, certain strategies that are already implemented in one area, may have yet to be adopted in other areas. This section describes opportunities and strategies that have been implemented in some areas and could be expanded locally or into other areas as "ongoing" whereas strategies that are relatively new to the area are classified as "emerging."

Examples of some of the projects planned (or being considered) by the agencies interviewed are included within this section. These examples are not meant to be a comprehensive listing of projects within Los Angeles County that contribute to resilience, but rather a sampling of the innovative and promising strategies being implemented.

5.3.1 Water Resources and Infrastructure

Developing Local Supplies

One of the most frequently cited impediments to resilience is over-dependence on imported water supply to meet demands. The major solution chosen by water agencies is the development of local supplies that can offset the need for imported water, particularly through expanded use of recycled water and stormwater capture.

Ongoing: Improving groundwater quality

Some basins within the County have significant water quality issues that prevent maximizing production rights. Within these basins, water managers are identifying the issues, monitoring, and remediating the basins to allow full use of water rights.

Within the San Fernando Valley Groundwater Basin, 80 of LADWP's 115 water supply wells have been removed from service or have restricted use due to volatile organic compounds contamination issues (LADWP, June 2016). LADWP's San Fernando Groundwater Basin Remediation Program will not only allow existing facilities and supplies to be accessed, but will also improve the ability to recharge the basin with additional supplies. LADWP completed a Groundwater System Improvement Study in 2015 to provide a framework to collect data and assess overall groundwater quality in San Fernando Basin. LADWP maintains several groundwater remediation facilitates and is investigating additional facilities and strategies to remediate the basin (LADWP, June 2016).

Within the West Coast Basin, WRD continues to remediate the saline plume that was created by seawater intrusion that was trapped inland of the West Coast Basin Barrier after the barrier was put into operation. As described in WRD's adopted Groundwater Basins Master Plan (2016) and 2016 Program Environmental

Impact Report for the Groundwater Basins Master Plan, up to seven desalters could be constructed to contain/remove saline to brackish groundwater in the affected aquifer in order to restore groundwater quality of this principal aquifer used for municipal and industrial supplies. WRD's West Coast Basin Regional Brackish Water Reclamation Project, once implemented, will get rid of the saline mass over the next 20-30 years and bring the local supply up another 10-20%.

Resilience in LA

WRD is planning to implement the West Coast Basin Regional Brackish Water Reclamation Project which will remove the saline plume trapped in the West Coast Basin over the next 20-30 years, increasing local supply by 10-20%.

Additional local remediation is planned within the County to restore pumping capabilities. For example, there is limited pumping in the Monk Hill subarea of the Raymond Basin due to groundwater contamination from past waste management activities. The Monk Hill Treatment System was brought online in 2011 to treat the perchlorate contaminated groundwater from four wells in the subarea. A new Monk Hill Treatment System production well is planned to improve the effectiveness of NASA's cleanup efforts at the site (RMC, June 2016).

Ongoing: Local direct non-potable recycled water supply development

Direct non-potable reuse has been developed throughout the County. This type of supply offsets potable demands, but requires a separate distribution system to be constructed. Water agencies such as Central Basin MWD, Upper District, CLWA, and Pomona, among others, are implementing major non-potable reuse distribution systems to increase recycled water use in their service areas. Some agencies that collect, but do not treat their own wastewater, have an interest in partnering with local water purveyors to develop localized recycled water treatment and distribution projects. Implementation of these decentralized scalping or satellite recycled water projects would, however, reduce flows to larger regional plants.

Some agencies are also working to increase the volume of recycled water supply distributed at existing projects. As an example, West Basin MWD is adding additional facilities as part of its expansion at its Edward C. Little Water Recycling Facility to maximize advanced treated recycled water production for injection at the West Coast Basin Barrier, as well as planning other facility improvements to improve water quality and increase use of recycled water at industrial sites (West Basin MWD, June 2016).

Ongoing: Development of other non-potable supplies to supplement recycled water systems

In some cases, non-potable system expansions are utilizing additional non-potable supplies to supplement recycled water sources. Rowland Water District and WVWD utilize non-potable groundwater from Puente Basin and Spadra Basin to supplement flows in their non-potable systems. Other agencies are planning to develop similar initiatives to maximize non-potable supplies. Pasadena is planning a new non-potable water distribution system to deliver recycled water to customers from the Los Angeles - Glendale Water Reclamation Plant (WRP), tunnel water from Devil's Gate and Richardson Springs, and surface water from Arroyo Seco stream. The project will be phased corresponding to the different extensions of the infrastructure to serve additional users (RMC Water and Environment, June 2016).

Emerging: Increased indirect potable reuse development

Beyond the long-standing historical use of recycled water to recharge the Central Groundwater Basin, water agencies are assessing the feasibility of implementing larger-scale regional indirect potable reuse projects to recharge groundwater basins. These projects sometimes require an additional level of treatment, but provide supply that can be stored indefinitely and later be pumped as potable water. Examples include:

- In the Santa Clarita Valley, CLWA is considering groundwater recharge via surface spreading at an offstream location near the Santa Clara River that could provide for recharge of excess available recycled water in the winter and off-peak irrigation months (Kennedy/Jenks and Luhdorff & Scalmanini, June 2016).

- In the City of Los Angeles, LADWP is planning to implement its Los Angeles Groundwater Replenishment Project which would use highly purified advanced treated recycled water from the Donald C. Tilman WRP for spreading in existing spreading basins in the San Fernando Valley area. LADWP is currently conducting pilot projects to determine the most cost-effective treatment strategy that will help maximize groundwater replenishment using the recycled water (LADWP, June 2016).

Resilience in LA

Upper District's Indirect Reuse Replenishment Project would utilize recycled water from the LACSD's San Jose Creek WRP for spreading at the Santa Fe Spreading Grounds. The water would undergo further treatment through soil aquifer treatment before replenishing groundwater supplies in the Main Basin.

- In the San Gabriel Valley, Upper District evaluated alternatives for groundwater replenishment in the Main San Gabriel Basin using either tertiary treated recycled water with stormwater for blending or full advanced treatment for the recycled water as part of their 2013 Integrated Resources Plan. Upper District worked closely with WaterReuse and LACSD to identify the most appropriate treatment technology and decided to move forward with their Indirect Reuse Replenishment Project. The project would utilize recycled water from the LACSD's San Jose Creek WRP for spreading at the Santa Fe Spreading Grounds. The water would undergo further treatment through soil aquifer treatment before replenishing groundwater supplies in the Main Basin (Stetson Engineers, June 2016f).

Emerging: Centralized large scale recycled water

Beyond individual groundwater basin indirect potable reuse projects, the push to develop even larger-scale recycled water projects that could impact multiple basins and sewersheds are being considered. Centralized initiatives include Metropolitan's and LACSD's Regional Recycled Water Project that would provide advanced treatment to the effluent from LACSD's Joint Water Pollution Control Plant for groundwater recharge within both Los Angeles and Orange County groundwater basins. To greatly expand the existing indirect potable reuse program in the West Coast and Central basins, WRD's GRIP project utilizes advance treatment for a portion of the recycled water used for replenishment to increase the total amount allowed per groundwater recharge regulations. Additionally, WRD is exploring using recycled water for replenishment in the West Coast Basin, as well as additional recycled water replenishment at the Los Angeles Forebay and Montebello Forebay (CH2m and RMC, September 2016). Beyond the "Water Independence Now" initiative, there is potential for even more groundwater replenishment given the storage capacity of the basins within the basin management framework. Additional recycled water and imported water could be recharged and stored to benefit agencies throughout the region.

Emerging: Recycled water storage and efficient use projects

There are opportunities in the County to adjust recycled water flows and localized storage to provide recycled water more effectively during peak times, thereby increasing its overall use. For example, LACSD is adding flow equalization at its San Jose WRP to better manage recycled water flows and Las Virgenes MWD has also investigated ways to improve management of recycled water flows and minimize discharges of recycled water supplies to the Malibu Creek during the wet season. In addition, projects are beginning to marry water use efficiency methods to help better leverage recycled water supplies.

Emerging: Direct potable reuse research and regulatory coordination

Several water supply agencies view direct potable reuse as potentially the most cost-effective form of recycled water. Because of this, more agencies are looking to advance the acceptance of direct potable reuse within the regulatory and public arenas. Although no projects are ready for implementation, significant efforts on planning for such projects are becoming more prevalent – especially with soon to be released

regulatory guidance . Agencies, such as LADWP, are closely monitoring the development of direct potable reuse regulations in preparation for developing this potential distribution method (LADWP, August 2016).

Emerging: Capturing stormwater for supply

Several stormwater projects are being designed as part of EWMP/WMP implementation in the County. These projects include low impact development control measures, green streets that can retain typical runoff from roads and alleys, and regional BMPs on both private and public land that capture and infiltrate stormwater. These projects are intended to provide multiple benefits, including water quality improvement in receiving waters to meet MS4 permit requirements and local supply enhancement. For example, as part of the Upper Santa Clara River Watershed Management Group's EWMP, Santa Clarita is designing a regional infiltration BMP project that will capture and infiltrate stormwater runoff to reduce water quality impacts to the Upper Santa Clara River while also augmenting local water supply. While some of the EWMP/WMP projects are already being designed and implemented, most of the projects are still conceptual.

Figure 25: Green Streets
Image Source: Ballona Creek EWMP

While some agencies have been unable to justify that stormwater capture and infiltration or direct use can provide a cost-effective supply solution, others have identified numerous opportunities for stormwater supply development. LADWP evaluated stormwater capture and infiltration opportunities in its service area as part of its Stormwater Capture Master Plan (2015) and found that active recharge could double to quadruple over the next 20 years through implementation of centralized projects and the adoption of distributed programmatic approaches (LADWP, August 2015).

Resilience in LA

LACFCD stormwater capture infrastructure recharges an average of 200,000 AFY of runoff. This type of infrastructure is very adaptable and resilient, and captured over 650,000 AFY during the exceptionally wet 2004-05 water year.

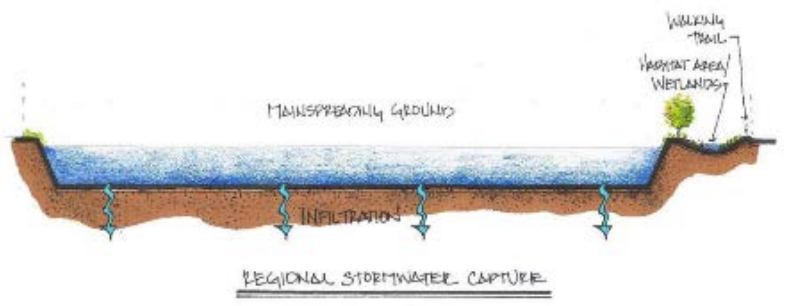
Potential future stormwater projects were also explored in LACFCD's and USBR's Los Angeles Basin Study (2015). The study determined that the region could increase the Los Angeles Basin's total stormwater capture by as much as an additional 240,000 to 400,000 acre-feet per year, roughly 15-25% of current annual demand. The strategies considered would also provide additional benefits such as increased flood protection, improved water quality, additional habitat and recreational opportunities. Project groups from the study were analyzed to determine the most effective combination of stormwater projects to develop moving forward to enhance the region's local supply portfolio and offer varying strategies to help the region adapt to climate change. The project groups included local solutions such as local stormwater capture, LID, and complete streets, regional solutions such as regional stormwater capture, stormwater conveyance systems, and alternative capture, storage solutions such as LACFCD dams, USACE dams, and debris basins, and management solutions such as stormwater policies, green infrastructure policies, and

Resilience in LA

As part of their EWMP, Santa Clarita is designing a regional infiltration BMP project that will capture and infiltrate stormwater runoff to reduce water quality impacts to the Upper Santa Clara River while also augmenting local water supply.

regional impact programs. The types of projects investigated in the Los Angeles Basin Study are described in Figure 26.

Because stormwater projects tend to have multiple benefits that are not easily monetized such as water quality and habitat benefits, these projects typically do not rank as highly compared to projects that can provide a larger supply benefit at a lower cost. Yet, when value is assigned to the full range of stormwater project, the cost-benefit of these projects is more readily observed.



Centralized Concepts

- New Spreading Grounds & Existing Spreading Ground Enhancements
- Large-Scale Park Infiltration Galleries
- Spillway and Capacity Enhancements to County and Army Corps Dams
- Conservation Enhancements to Debris Basins
- Stormwater Injection Wells and other Advanced Technologies

Schematic of a Complete Street

Distributed Concepts

- Full Scale Complete/Green Street Programs
- County-Wide Parcel Sized LID & BMPs
- Increased Scale or Full Build-Out of the EWMP Program County-Wide

Figure 26: Project Types from the Los Angeles Basin Study

Image Source: (LACFCD and USBR, 2016)

Emerging: Capturing urban runoff for use

Using urban runoff as a water supply is not an obvious solution, but has potential to help provide additional supply benefit to water quality improvement projects. Santa Monica currently treats urban runoff for reuse with their SMURRF and is now in the process of planning their Sustainable Water Infrastructure Project which will modify the SMURRF facility to be able to produce a more consistent level of non-potable water supply. The project includes installation of two below grade stormwater storage tanks that will be piped to send runoff to the SMURRF for treatment and non-potable reuse, as well as a shallow brackish/saline groundwater well to replenish the tanks during dry weather and an upgrade to the SMURRF to add a

saltwater RO unit. These efforts will provide additional non-potable supply for Santa Monica while also improving runoff water quality to meet water quality regulations. Ultimately the project will provide advanced treated water that could be used for groundwater injection (SA Associates, September 2016).

Resilience in LA

Las Virgenes MWD is investigating the possibility of accepting dry weather urban runoff diversions into its wastewater system to increase utilization of the Tapia Water Reclamation Facility and produce more recycled water. If implemented, the project would help address surface water quality issues in the City of Agoura Hills and provide additional drinking water supplies in the future through the Pure Water Project Las Virgenes-Triunfo.

Utilization of urban runoff for treatment and use is also being explored by other areas impacted by water quality issues from runoff. Las Virgenes MWD is looking into the possibility of accepting dry weather urban runoff diversions into its wastewater system to increase utilization of the Tapia Water Reclamation Facility and produce more recycled water. If implemented, the project would help address surface water quality issues in the City of Agoura Hills and provide additional drinking water supplies in the future through the Pure Water Project Las Virgenes-Triunfo.

Emerging: Constructing ocean desalination plants

Some agencies believe that desalination is the most reliable form of supply and would greatly enhance the region's ability to bounce back after drought and climate change disruptions, as well as shield the area from the impacts of seismic disturbances and other disruption events on the imported water systems (i.e., SWP, CRA and Los Angeles Aqueducts). Potential environmental impacts associated with ocean water desalination such as marine impacts from intake structures, marine impacts from brine discharge, and high-energy usage are worth mentioning and are being considered by agencies evaluating the potential for ocean desalination as a future supply.

After eight years of pilot testing at their El Segundo Power Generating Station, West Basin MWD built their Ocean Water Desalination Demonstration Facility in 2010 to conduct large scale testing. The agency is moving forward with building a full-scale ocean water desalination facility and is currently working on developing the environmental documentation and attaining the necessary permits for the facility. At this time, West Basin MWD is the only agency within the County that is actively pursuing ocean desalination. However, there is support from other agencies given the overall increase in regional reliability as a result of bringing a new source of supply on-line.

Ocean desalination will necessarily involve some coastal infrastructure critical to the desalination operation or brine disposal. The planning and engineering of these coastal facilities are requiring an accounting of sea level rise to eliminate or mitigate vulnerability to climate change.

Securing Imported Supplies

Although local supply development enhances diversification, and resilience, securing the ability for imported water supplies to continue to reach the County is also critical. It is widely acknowledged that there is no way that the County and its agencies could become completely independent from imported supplies. At a minimum, agencies with current imported water use would maintain those connections and the ability to access imported water as a back-up in case of disturbances to other sources. Additionally, imported water provides a valuable method of recharging groundwater basins to ensure greater groundwater levels during drought disturbances.

Ongoing: Use imported water to blend for local supply water quality improvement

To avoid additional or expanded treatment plants that improve lower quality groundwater for potable use, local agencies are implementing projects that use current imported water flows as blend water with those groundwater supplies to meet drinking water standards. Although the overall consumption of imported

water is reduced given the increased use of groundwater, the concept is reliant upon the continued availability of imported water.

Resilience in LA

In the Antelope Valley, Waterworks District 40 utilizes wellhead treatment and blending with imported water to bring naturally occurring arsenic and chromium levels contaminant levels down to meet drinking water standards.

Puente Basin Water Agency is currently implementing a project to add local Six Basins groundwater into the treated imported water flowing through the Pomona Walnut Rowland Joint Water Line. The blending of those waters serves to reduce constituent concentrations of the groundwater to allow for its use by WVWD and Rowland Water District.

In the Antelope Valley, Waterworks District 40 purchases imported water from AVEK for blending with pumped groundwater from wells impacted by naturally occurring arsenic and chromium. Wellhead treatment and blending with imported water brings contaminant levels down to meet drinking water standards. Without the added imported water, these water quality regulations would not be met (LACDPW, February 2017).

Imported water is also used as diluent for indirect potable reuse projects in several basins. The SWRCB requires a proportion of water spread to be of higher water quality than tertiary-treated recycled water. Indirect potable reuse projects require imported water or stormwater to dilute recycled water being spread. Because stormwater flows are sometimes seen as unreliable, some agencies view imported water as a key supply to meet diluent needs.

Ongoing: Conjunctive Use

Agencies are continuing conjunctive use programs to increase utilization and storage of imported water when it is available. Water banking provides an important supply in the Antelope Valley where surface water supply is limited. AVEK has plans to expand its water banking program to increase utilization of its imported water rights and store additional water in the Antelope Valley Groundwater Basin to increase regional supply reliability.

Emerging: Using more imported water when its available

Some agencies are trying to advocate for more imported water use when it is available to preserve groundwater supplies for times of drought or imported water restrictions. Usually the preference is to always use groundwater as it is lower in cost to produce, however, given the condition of many of the County's groundwater basins after sustained droughts over the past 10 years, increasing imported water use when available is a strategy to enhancing local resilience.

Resilience in LA

Several agencies in the County are beginning to advocate using more imported water when it is available to preserve groundwater supplies and when possible, purchase imported water to help recharge the basins.

Emerging: California WaterFix

The California WaterFix is intended to protect against the impact of sea-level rise by changing the way the water is pumped and conveyed. By implementing this program, the region will be able to realize the allocations promised and maximize the investments made on the SWP. These average allocations have decreased in recent years due to concerns over the ecological impacts to the Bay-Delta from SWP intakes. The California WaterFix planning efforts are based on the co-equal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Bay-Delta ecosystem. Thus, the water restrictions that have resulted from species protection goals will be mitigated or eliminated.

The California WaterFix may also improve the resilience of maintaining water quality for the SWP system for both an emergency, such as an earthquake, and longer term disturbance, such as sea level rise, to the system of levees that currently limit terrestrial and ocean water from mixing around the intakes.

Integrating Water Quality and Supply Solutions

The development of multi-benefit projects is not new, but the increase in their prevalence is due largely to requirements within funding mechanisms such as the IRWM Program and the effectiveness of the projects themselves being more explicitly recognized by agencies and communities. Multi-benefit projects may include both water quality and supply enhancements, often with additional benefits for the local community, such as new recreational opportunities or aesthetic improvements. Additionally, these projects often integrate cost-sharing funding models that leverage relationships and projected benefits to secure necessary financing. Many agencies continue to explore partnerships to develop and implement regional and integrated projects.

Ongoing: IRWM Program project development

The IRWM program can be credited as helping to facilitate development of multi-benefit projects and creating the pathways that are now used more naturally to facilitate dialogue and project development between agencies with disparate missions. Whether the resulting projects and programs are specifically called out as IRWM projects is irrelevant since they are integrated and exhibit the types of coordination heralded by the IRWM Program.

Ongoing: One Water LA initiative

Agencies, community stakeholders and elected officials in the City of Los Angeles have served a critical role in California and nationally by implementing truly integrated planning, with the stakeholder-driven process known as the Integrated Plan for the Wastewater Program, that has continued and evolved into the current One Water LA effort. One Water LA provides a collaborative approach to develop an integrated framework for managing the City of Los Angeles' watersheds, water resources, and water facilities. This program can serve as a blueprint for other cities that wish to implement similar integrated water resources management planning efforts.

Emerging: EWMP project feasibility and facility planning

The projects within EWMPs are meant to meet MS4 water quality requirements, but can also provide other water management benefits to some degree like flood protection and water supply. Many of the projects developed within these efforts throughout the Los Angeles Basin and Santa Clarita Valley are conceptual, so a good deal of work will need to be done to prepare feasibility and facility plans to further define projects. These planning-level analyses must be completed before design and implementation can begin. In cases where some water supply benefits can be quantified, project proponents might seek funding through partnerships with other water management agencies.

Increasing Storage

Los Angeles County has long recognized the importance of storing water for future use. Increasing storage contributes to resilience in emergencies, temporary multi-year conditions, and the long-term impacts of climate change.

Ongoing: Localized storage to meet emergency needs

One of the most important factors in restoring service after an interruption to a water supply system is proximity of storage. If the majority of water stored is at the other end of the system failure, the amount of water stored is irrelevant. With that in mind, agencies are looking for ways to increase smaller localized storage sites through their own, as well as neighboring, systems to meet the Metropolitan recommended one-week supply in local storage.

Ongoing: Increased recharge facility capacity

Recharging groundwater basins can require a good deal of space (if using spreading basins) or energy (if using injection wells). Given the urbanized footprint of most of Los Angeles County, space comes at a premium. At the same time, climate change forecasts predict that local flows will be more variable and intense, underscoring the need for larger detention areas with more efficient groundwater recharge potential.

In areas of the County that are not fully developed, such as the Antelope Valley and Santa Clarita Valley areas, land for recharge is not as much of an issue and large-scale water banks are more prevalent. In the Antelope Valley, water banking provides a significant increase in supply reliability to an area heavily dependent on imported water. AVEK is the agency responsible for developing the large-scale water banks in the Antelope Valley. A project to create a new groundwater bank west of AVEK's existing Westside facility is being considered that would allow Los Angeles Basin agencies to participate and provide additional storage within Los Angeles County.

Because LACFCD and the USACE manage most of the centralized surface water facilities in the County, projects that coordinate with these agencies and how they manage their facilities provide an opportunity to develop additional water supply benefits. WRD, Upper District, and LADWP coordinate with LACFCD regularly on projects that enhance flood protection and increase groundwater recharge.

Resilience in LA

A new groundwater bank west of AVEK's current facilities could form partnerships between AVEK and Los Angeles Basin agencies to provide additional groundwater storage within Los Angeles County.

Cities are also working to expand recharge capacity at local spreading basins. For example, Pasadena is planning a multi-benefit project to increase utilization of their surface water rights from Arroyo Seco. The Arroyo Seco Canyon Project will restore and improve the intake structure, install a new sediment removal mechanism, and expand recharge operations by creating additional spreading basins (RMC, June 2016). Pasadena is also coordinating with LACFCD to pump water from behind Devil's Gate Dam to the Arroyo Seco Spreading Grounds to allow greater utilization of the recharge facility.

Emerging: Regional groundwater basin storage and management

Groundwater recharge and replenishment has helped to withstand seawater intrusion in coastal basins as well as provide additional drought tolerant supplies in the County. Looking ahead, agencies are focusing on better management of basins and improving water quality to allow for a more comprehensive use of existing groundwater basin supplies and expanding the ability to store extra water within the basin. Almost every basin in the County is implementing programs to either understand basin storage potential or to increase recharge to levels in excess of normal year allocations to provide for dry years.

Constructing Interconnections and Enhancing Existing Infrastructure

Agencies are looking to further invest in their systems to enhance their resilience to emergencies, droughts, water quality issues and climate change.

Ongoing: Asset management

As agencies conduct vulnerability assessments and evaluate the current state of their infrastructure, many are including pre-emptive repair and rehabilitation as major components of their Capital Improvement Programs. Las Virgenes MWD recently identified a comprehensive list of facility improvements in its Integrated Master Plan (2014), which evaluates its potable water, recycled water and sanitation systems together. Pasadena identified several projects to address potential seismic vulnerabilities that have been included in annual CIPs over several years. Identifying and addressing these vulnerabilities before they become critical issues help reduce risk.

Ongoing: Increasing the number of interconnections

Many agencies have engaged in programs that identify easy to implement interconnections and are in the process of implementing and constructing them. Some other areas are in dire need of interconnections and agencies such as the Main San Gabriel Basin Watermaster are offering to facilitate progress by identifying priority locations and securing funding to implement projects. Other areas such as the Antelope Valley, recognize the need to develop interconnections yet have difficulty identifying how best to design the system due to a lack of funding and regional entity to lead the effort.

Resilience in LA

The Main San Gabriel Basin Watermaster has offered to help facilitate development of interconnections in the San Gabriel Valley where they are lacking and needed by identifying priority locations and securing funding to implement projects.

Ongoing: Creating redundancies within systems

Interconnections can be considered a form of redundancy, but agencies often use "redundancy" to describe back up power, pumping facilities and treatment processes as well as groundwater extraction facilities that can increase production if water quality limits production at other facilities. Many agencies recognize that there are always more redundancies that can be created so the focus is on how to prioritize projects based on cost-benefit analysis and lessons learned from significant disturbances like the Northridge Earthquake. For example, WVWD keeps back up portable generators to use in emergencies when power is cut off and they need to pump water through their system.

Ongoing: Improving ability to isolate sections of systems

Many agencies that have assessed the resilience of their infrastructure have constructed valves and other structures that permit isolation of smaller sections within a system, as needed. As a low-cost strategy to localize and prevent the spread of possible disturbances, isolation projects are gaining traction among water agencies. Installing and maintaining valves is key strategy employed by Pasadena to help with resiliency during emergencies. If a water main breaks or there is contamination in the system, the valves allow the agency to isolate one section of the system to prevent additional water loss or the spread of contamination.

Emerging: Building new groundwater extraction and conveyance facilities to balance recharge development

Because increasing recharge can cause mounding of groundwater, agencies such as WRD are looking into ways to increase groundwater extraction to control the rise of groundwater levels from increased recharge in certain groundwater basins. As discussed in their Groundwater Basins Master Plan (2016), WRD's Groundwater Basin Optimization Pipeline project would allow additional stormwater capture and recharge in the Montebello Forebay Spreading Grounds by providing additional pumping in the forebay area to reduce groundwater levels so that recharge would not be reduced due to rising groundwater levels during high-rate recharge events. The project is proposed to deliver additional extracted water to participating pumpers as far south as Long Beach, while allowing for an increase in stormwater capture and infiltration in the Central Basin (CH2M and RMC, September 2016).

Emerging: Leveraging imported water infrastructure

The regional imported water system operated by AVEK, CLWA, LADWP, and Metropolitan (and its member agencies) provides a backbone of infrastructure that until recently, was used solely to transport imported water from the SWP, CRA, and Los Angeles Aqueduct systems. In some areas, the system has been used as a method of conducting in-lieu transfers by allowing flows allocated to one agency using local supply to go instead to another agency. These in-lieu transfers are expected to develop even further as major regional supply development projects are implemented. For example, as WRD moves toward imported water independence by replacing imported water for groundwater recharge with recycled water, this volume of imported water is now available for deliveries to other agencies. Development of ocean desalination by West Basin MWD will also have regional benefits by replacing a portion of West Basin MWD's imported water use with desalinated ocean water and allowing their imported water flows to go to other agencies who participate in the desalination plant implementation. In-lieu recharge and storage projects may also be supported by projects such as WRD's Inland Injection Wells that stores water when it is accessible and can allow for future pumping for those that participate.

Resilience in LA

Puente Basin Water Agency is implementing a multi-phase project to blend lower quality Six Basins groundwater from local rights holders with imported supplies flowing through the Pomona Walnut Rowland Joint Water Line to reduce total imported water use.

To expand on this idea, some local agencies are looking to use the imported water infrastructure to also physically route local water supplies of varying qualities through these systems. For example, Puente Basin Water Agency is in the process of implementing its Pomona Basin Regional Groundwater Project that involves injecting Six Basins groundwater into the Pomona Walnut Rowland Joint Water Line imported water distribution pipeline for blending with imported water to meet potable water quality standards (RMC, 2011). As more local supplies are utilized by these agencies, the imported water infrastructure may be able to be leveraged in new ways.

Implementing Water Efficiency Programs

One of the most commonly cited strategies to enhance water resilience is decreasing the need for water altogether.

Ongoing: Emergency / drought mandated conservation

Given the recent drought and required cutbacks mandated by the SWRCB, many agencies saw drastic cutbacks in the amount of water used within their service areas. Some of these programs will result in permanent conservation through efforts such as turf replacement and replacement of interior fixtures, creating the potential for conservation hardening. However, most agencies feel that as water use restrictions are lifted, some demands will rebound and with that the ability to once again employ similar severe cutbacks, such as mandatory water use reductions and limits on outdoor irrigation, without impeding on health and safety.

Ongoing: Long-range conservation programs

Agencies have noted that because there have been two multiple year droughts in California over the last 10 years (water years of 2007-2009 and 2014-2016) (DWR, February 2015) with little time in between them and local precipitation conditions have been below average for 8 of the last 10 years for areas like the San Gabriel Valley (Main San Gabriel Basin Watermaster, November 2016), it is possible that the public may have become accustomed to practicing conservation. Additionally, as part of the 2015 UWMP Demand Management Measures requirement, urban water suppliers aim to have certain water waste prohibitions reflected in ordinances and/or Water Shortage Contingency Plans continuously in place regardless of drought conditions. With these motivating factors, some jurisdictions aim to make permanent recent conservation ordinances implemented in response to drought and SWRCB mandates. The practices that have become standard are those proven not to impact users (e.g. watering two days a week).

Resilience in LA

The County's Net Zero effort aims to integrate water use efficiency strategies into new development within unincorporated communities. The planned ordinance is expected to benefit areas of the County that are experiencing growth.

In addition to water use restrictions, there are ordinances in place that require new development be demand neutral, despite economic or population growth. Several cities also have LID ordinances in place that promote stormwater capture onsite, while others are implementing them as part of their compliance with the Los Angeles County MS4 permit. Areas such as the Antelope Valley and the Santa Clarita Valley that will likely have increases in population through the next 30 to 50 years particularly benefit from ordinances regulating new development while areas closer to build-out may not reap the same benefits. The County's new Net Zero effort to develop an ordinance requiring integration of water use efficiency strategies in new development within unincorporated communities promises to benefit areas of the County that are experiencing growth.

5.3.2 Governance and Institutions

Interdepartmental and Interagency Coordination

Coordination within and between agencies enhances resilience by providing a forum for information and resource sharing. Similar to how interconnections and redundancies function for the physical infrastructure of water management, agency coordination helps strengthen the governance of the systems.

Ongoing: Interdepartmental coordination

Communication between internal departments of a given agency can prove difficult due to different management responsibilities and priorities. This can result in minimal coordination of work and decreased benefit from shared information and collaborative approaches. The EWMP and WMP process is an example where coordination between the city department of public works in charge of stormwater and other city departments managing supply was important for developing multi-benefit opportunities. Integrated programs such as the EWMPs and WMPs are an opportunity to develop better coordination not only between EWMP and WMP group agencies but also within the agencies to facilitate development of cost effective projects with multiple benefits.

Ongoing: Partnerships to increase project development

Agencies are increasingly seeking opportunities to partner with other agencies for regional solutions to local and regional challenges, including groundwater replenishment projects, groundwater quality improvement projects, recycled water development, and ocean desalinization. These efforts span multiple jurisdictions and produce multiple benefits that encourage further collaboration. Partnerships between wastewater and water agencies to develop recycled water supplies is a common example such as is being implemented with Metropolitan's Regional Recycled Water Project at the Joint Water Pollution Control Plant that involves a partnership between Metropolitan, LACSD, LACFCD, the Main San Gabriel Basin Watermaster, and Upper District. LACFCD also often partners with water agencies to help manage flood waters while also providing a supply benefit. More recently, partnerships between city agencies and water agencies to help address water quality compliance while providing water supply are being developed. Agencies continue to develop innovative ways and identify new opportunities to establish regional partnerships.

Ongoing: Emergency plans and programs

Many agencies have updated or are in the process of revising their Emergency Response Plans. These plans provide management and staff with important information to use during emergency situations, including key contacts, locations of resources, and procedure and protocol. Preparing a comprehensive Emergency Response Plan increases an agency's ability to respond effectively to emergency situations and return more quickly to normal levels of service. This type of planning can improve regional coordination between

agencies within an area, thereby increasing available resources for use in an emergency and establishing processes for collaboration and communication during emergencies.

Resilience in LA

In recent years, LACFCD, City of Los Angeles, and other local agencies have leveraged partnerships with UCLA, USC, and other research institutions to collaborate on cutting edge science to achieve new insights into water resources management.

Regional Collaboration and Management

Individual agency operations are enhanced in areas with regional networks that improve the ability to effectively communicate needs, and increase access to necessary resources. This process can create new regional entities and/or empower existing agencies to provide regional leadership, while facilitating collaboration and integrated planning that encourages responsive decision-making and adaptive management.

Ongoing: Watermasters in adjudicated basins

In areas with a strong Watermaster, (e.g. West Coast and Central, Main San Gabriel Basin and Raymond Basin), existing regional entities can support pumpers and smaller agencies. In some areas greater support is required, but there is already an entity capable of providing regional leadership and guidance once better financing and operational support are in place. For example, the Antelope Valley Groundwater Basin was only recently adjudicated and a Watermaster Board appointed. As the Watermaster is developed, there is an opportunity for the Board, which includes AVEK, to act as a regional entity to address the needs of the Antelope Valley.

Emerging: Groundwater Sustainability Agency formation

With the advent of the Sustainable Groundwater Management Act (SGMA), areas that do not have a strong Watermaster are able to solidify management responsibilities and a coordinated plan for managing groundwater basins. To address the requirements of SGMA, basins are forming groundwater sustainability agencies. Within the County, water agencies that utilize supplies from unadjudicated basins are coordinating to develop a groundwater sustainability agency. For example, stakeholders in the Santa Clarita Valley are forming a JPA to serve as the groundwater sustainability agency for the Santa Clarita Valley, East Subbasin. Although most basins within Los Angeles County are adjudicated, the rise of the SGMA has precipitated an increase in basin management and establishment of more formal responsibilities and protocols for areas that are not.

Emerging: Regional imported water wholesalers filling a need for regional leadership

Seeing the benefits and importance of a diversified water supply portfolio, a balance of imported and local water supplies, and a balance of water supply augmentation and conservation, imported water wholesalers are becoming more involved in comprehensive water resources management within the region they serve. These wholesalers are focused on providing consolidated/cost-effective overall water resources support to retailer agency members. The reduction in sales of imported water requires that other sources are tapped to be able to maintain imported water facilities and provide water when needed. In some cases, local retail water supply agencies are supportive of these moves. In other cases, retailers prefer to use funds for their own projects and not consolidate financing.

Metropolitan took on this regional role long ago in the preparation of an integrated resources plan for their entire service area. Metropolitan provides regional conservation programming, funds Local Resource Program development offsets, explores partnerships with local retailers on supply projects, and is now embarking on potential Metropolitan local resources projects. For example, Metropolitan is working on a major recycled water project with LACSD to use the effluent from LACSD's Joint Water Pollution Control Plant for groundwater recharge. There is ongoing debate between member agencies as to how involved Metropolitan should be since it is unclear what the agency's ability is to balance the costs and benefits between such a large service area.

Resilience in LA

Metropolitan currently provides regional conservation programming and local supply offset funds. Future efforts will include direct local resource project implementation to augment regional supplies

Previously focused only on imported water treatment and sales as the wholesaler for the northeastern Los Angeles County, Three Valleys MWD has been active in the formation of the Six Basins Watermaster and recent related planning efforts. Three Valleys MWD has also constructed extraction facilities to access local water rights. Local retailers to Three Valleys MWD are mixed on supporting this direction as some would prefer to maintain control over their own supply development locally.

AVEK is seen by some as the potential regional entity best suited to help address the issues of small mutual water companies struggling within the Antelope Valley. However, taking up this role would require the AVEK Board to expand its current mission and Los Angeles County to support this role. It is not known how supportive the small mutual water companies would be at this point without an understanding of the cost-benefit ratio to those involved. As AVEK continues to develop its role on the Antelope Valley Groundwater Basin Watermaster Board, there is an opportunity for the agency to become more of a leader for the region.

CLWA manages imported water supplies in the Santa Clarita Valley and is now merging with one of its local retail agencies that pumps groundwater to form a new agency, the Santa Clarita Valley Water District, that will manage multiple water resources. With the need for a groundwater sustainability agency according to SGMA, this agency could fill that role and also lead the region in coordination of water resources planning and project implementation. This process is in place and could be approved within a few months.

5.3.3 Stakeholder Engagement

Regional Collaboration and Partnerships

Forming and participating in groups that bring multiple agencies together to solve needs can improve collaboration, create new redundancies in operations and services, and enhance decision-making.

Ongoing: Using the IRWM program to facilitate regional program development, projects and communication

Increased development of multi-benefit projects and programs that involve coordination between stakeholders will help enhance the County's water management and related planning. Support of ongoing programs such as IRWM foster collaboration and development of local regional projects that increase regional self-reliance and result in integrated, multiple benefit solutions for ensuring sustainable water resources.

Resilience in LA

The IRWM Program has helped promote regionalism in the County. IRWM has fostered collaboration and development of regional, multi-benefit projects that provide sustainable solutions.

There is consensus among the agencies interviewed that the IRWM Program has greatly helped improve the regionalism of the Los Angeles Basin, Antelope Valley and Santa Clarita Valley areas. Although there is recognition that the program is sometimes cumbersome

and requires a great deal of resources just to get more resources, there are many agencies that recognize the importance of maintaining the pathways established and further improve upon the IRWM Programs to develop better integrated projects. There is additional hope that the DAC involvement grant will help facilitate their involvement to help meet the support and funding needs.

Information Sharing

Ongoing: Formation of and participation in regional stakeholder groups to solve specific issues

Resilience in LA

West Basin MWD formed a Recycled Water Workgroup with major customers, retailers, environmental groups, and City of Los Angeles staff to enhance stakeholder understanding of the challenges and complexity of their recycled water system.

Many agencies have developed stakeholder groups and provided workshops to facilitate communication with regulatory agencies, retailers, nongovernmental organizations, and the public. Communication with these groups helps meet project or program needs and goals. Whether they are specialized technical workshops or workshops that increase coordination and transparency, the facilitated communication within the group helps foster progress in many cases. For example, the Las Virgenes-Triunfo JPA formed a stakeholder group to discuss its goal to beneficially reuse all of the recycled water produced at its Tapia Water Reclamation Facility. With the help of the stakeholders, the JPA set aside previous plans to build a new dam and reservoir in the Santa Monica Mountains and adopted a superior alternative involving advanced treatment of the recycled water for potable use. West Basin MWD formed a Recycled Water Workgroup with major customers, retailers, environmental groups, and City of Los Angeles staff to enhance stakeholder understanding of the challenges and complexity of their recycled water system. The agency found the workgroup improved stakeholder understanding and support for West Basins MWD's higher water costs. While several of these types of groups do exist, there is recognition that there is always room for more participation and more collaboration.

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Appendix A – Resilience Literature Review

Resilience: Concept and Application

The concept of 'resilience' has begun to enrich and even replace that of 'sustainability' that dominated academic and government literature over the last decades of the 20th century and into the early 2000s. From the Latin, *resilire*, meaning 'to leap or spring back', the term resilience appears to have first been used in the physical sciences to describe "the stability of materials and their resistance to external shocks" (Davoudi et al., 2012). In the 1960s and 1970s, the term began to be applied to ecological systems and was largely encouraged by an article published in 1973 by Crawford Stanley Hollings, who highlighted the ability of ecosystems to return to a state of equilibrium after a disturbance (Carl Folke et al., 2010) The resilience concept was further divided in subsequent decades into two categories: engineering resilience, which referred to a 'bounce-back' of a system or material to its previous state after a perturbation, and ecological resilience, which recognizes that a system may absorb the effects of a disturbance and return to an altered, potentially stronger, state of equilibrium (Davoudi et al., 2010). This latter approach has been applied to social systems in relation to their environment, often called 'social-ecological' systems, and is shaping the management of cities and regions (Norris et al., 2008), as well as the private sector (Ovans, 2015).

Over the years, the definition of resilience as applied to complex social systems has evolved to encompass specific contexts, such as urban settings, and particular stressors or challenges, such as climate change. Definitions of urban resilience often focus on the interrelatedness of three essential elements: systems, agents, and institutions (Tyler and Moench, 2012). Systems represent the infrastructure and physical networks that deliver services and materials within cities and link them to surrounding or adjacent jurisdictions. Systems that are resilient "ensure that functionality is retained and can be rapidly reinstated through system linkages despite some failures or operational disruptions (Tyler and Moench, 2012)." Agents represent the individual and community actors within the urban context. A resilient urban setting depends on these agents being responsive, resourceful, and having a capacity to learn, characteristics that tend to be unequally distributed across the urban landscape and that highlight the vulnerabilities of disenfranchised or disadvantaged communities (DACs). Institutions represent the rules and conventions that structure human behavior and condition the way that agents and systems respond to external stressors through governance and decision-making, provision of reliable information, and application of new knowledge (Tyler and Moench, 2012).

Resilience in LA

Definitions of urban resilience often focus on the interrelatedness of three essential elements:

Systems: Infrastructure and physical networks

Agents: Individual and community actors

Institutions: Governance and decision-making

Resilience in LA

Six key characteristics are identified as crucial to establishing resilience:

1) Flexibility
2) Redundancy
3) Safe failure
4) Responsiveness
5) Resourcefulness
6) Learning

Recognition of these principal components of urban resilience has contributed to a sizable literature focused on tools and methods for adopting a resilience approach, particularly in the face of climate change (ACCCRN, 2014). The Asian Cities Climate Change Resilience Network (ACCCRN) articulates the interconnectedness of the systems, agents and institutions by defining urban resilience to climate change as a trifecta of interrelated outcomes: 1) survival of systems when subjected to shocks; 2) adaptation to these same shocks by the people and organizations serving as decision-makers; and 3) provision of support by institutions for people and organizations (ACCCRN, 2014). In addition, six key

characteristics are identified as crucial to establishing resilience: flexibility, redundancy, safe failure, responsiveness, resourcefulness, and learning (ACCCRN, 2014). More recently, these characteristics have been repackaged as recommendations for governments and organizations:

1) **Maintain diversity and redundancy** – encourage overlap in systems and users with different perspectives and responses;
2) **Manage connectivity** – ensure linkages between systems, agents, and institutions;
3) **Manage slow variables and feedbacks** – establish and maintain principal configurations of systems through appropriate responses;
4) **Foster complex adaptive systems thinking** – promote an awareness of complexity and unpredictability that recognizes interaction of multiple actors;
5) **Encourage learning** – facilitate sharing of knowledge, experimentation, and new discovery as part of adaptive management;
6) **Broaden participation** – encourage engagement of all relevant stakeholders; and
7) **Promote polycentric governance** – ensure collaboration across institutions and scales to ensure timely and effective responses (Biggs et al., 2015).

To achieve urban climate resilience, localities must aim to strengthen systems "to absorb sudden shocks (including those that exceed design thresholds)" (Tyler and Moench, 2012) while ensuring adaptive and cooperative management that engages multiple stakeholders and recognizes the interconnectedness of systems, agents, and institutions. Figure 27 shows a graphic representation of the interactions of these elements and the roles they play.

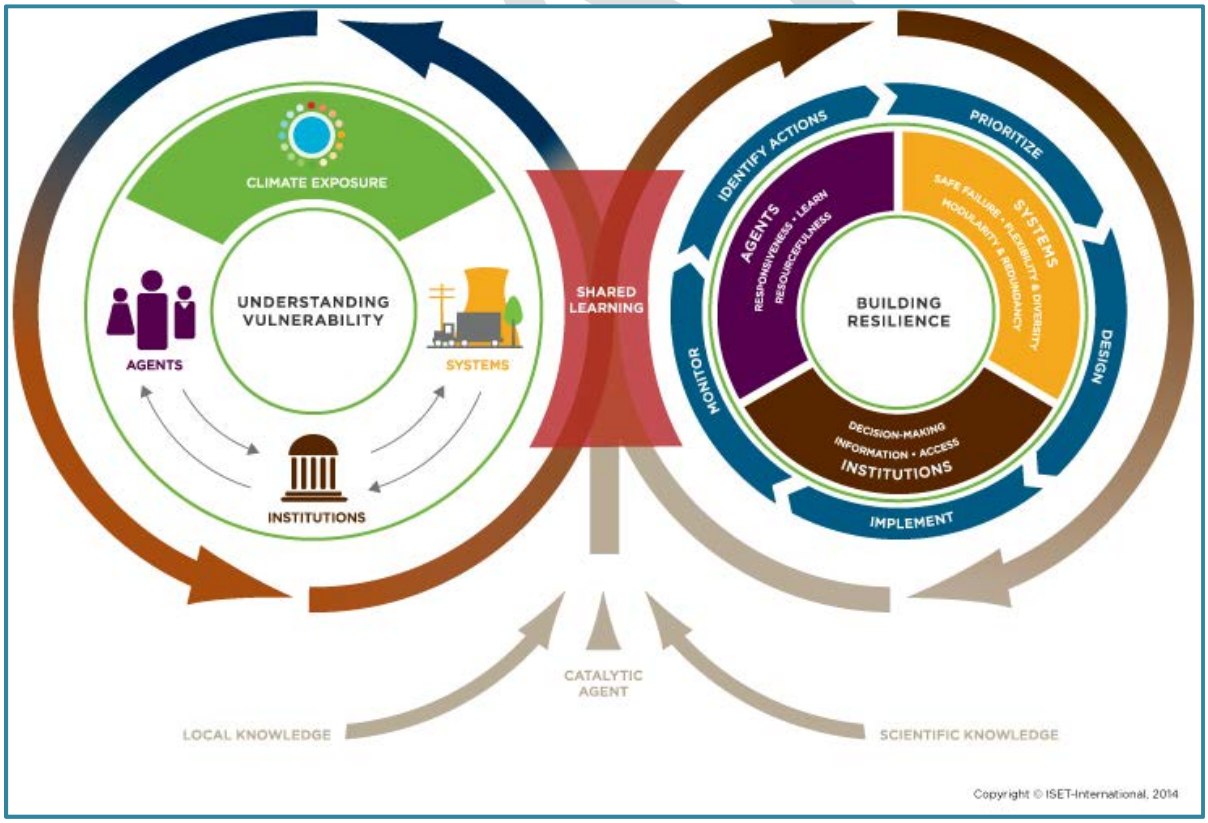

Figure 27: The Climate Resilience Framework

The Climate Resilience Framework developed by the Institute of Social and Environmental Transition-International that highlights the relationships between systems, agents, institutions and climate change and articulates a systems-based approach to building resilience (ISET).

The Meaning of Water Resilience

Application of the resilience paradigm to water management has underscored adaptive management approaches that integrate iterative learning in the face of uncertainty. Principal concepts that apply to resilient water strategies include "*flexibility* in social systems institutions to deal with change; *subsidiarity* and *connectivity* (openness of institutions providing for extensive participation, effective multi-level government); *iterativity* (social structures that promote learning and adaptability without limiting option for future development)…" (Clarvis et al., 2014). These concepts underscore the essential role of adaptability and directly address some of the commonly identified challenges to sustainable urban water management such as uncoordinated institutional frameworks; limited community engagement and participation; stifling regulatory constraints; and insufficient information and communication (Brown and Farrelly, 2009).

Water resilience has been defined as "the water dimensions of how we persist and develop despite changing circumstances, how we adapt to them and how we substantially transform when the situation becomes untenable (Eriksson et al., 2014)." This definition infers the stress factors related to water, e.g. too much or too little water and impaired water quality, but particularly underscores the coordinated reactions to these water-related stresses. A crucial component of the concept of water resilience is the unpredictability of these "changing circumstances" and the flexibility required to adapt to them. Ultimately, practices and decisions need "address the broad spectrum of uncertainties that water infrastructure systems face, including socio-political uncertainties and other uncertainties […] that interact with water infrastructure systems (Buurman and Babovic, 2015)." Figure 28 illustrates a schematic of the multiple systems, each with their own intrinsic uncertainties, that impact the water system.

As a result, the recommended approach for building water resilience relies on adaptive management that integrates flexibility in the design, implementation, and operations of systems, as well as in decision-making processes. Adaptive approaches typically involve "a process that responds to feedback received by a managing agency from monitoring the response of the ecosystem…" and are based "on diversity, redundancy, and multiple levels of management that include local knowledge and local action (Cosens and Williams, 2012)." Building an adaptive capacity in management requires "building flexibility *in* the engineered system, e.g. by making allowance for future expansion, or by creating flexibility *on* the system, which means that projects could be delayed, abandoned, or alternative projects could be pursued as part of an adaptive plan (Buurman and Babovic, 2012)." Water resilience, therefore, relies on a sustainable feedback loop premised on the capacity of the agents to monitor the systems and external factors to develop responsive decisions, the institutions in turn to support and implement these decisions, and the systems to adapt to the new conditions and/or requirements imposed by the agents. This circular approach is referenced in Figure 28.

The integrated and overlapping nature of resilience-based management models and decision-making frameworks call for introduction of the approach into every level of systems, agents, and institutions. For instance, indicators for system performance that have typically been based on sustainability approaches need integrate resilience concepts in order to measure the capacity of systems to be maintained or enhanced over time and in the face of change (Milman and Short, 2008). Typical performance measures have been based on fixed parameters that do not encompass the potential to respond to the unforeseen, nor do they take into account the impact of socio-political elements (Buurman and Babovic, 2012). For agents, it is important to "enhance the capacity of people to more actively become part of the solutions, rather than part of the problems (Eriksson et al., 2014)." Thus, public education and efforts to encourage behavior change are intrinsic components of resilience models. Institutions, in turn, must support and encourage these approaches for both systems and agents through promoting adaptive management and local capacity-

building, while sharing the information necessary for effective decision-making and providing a robust framework for implementation (Cosens and Williams, 2012).

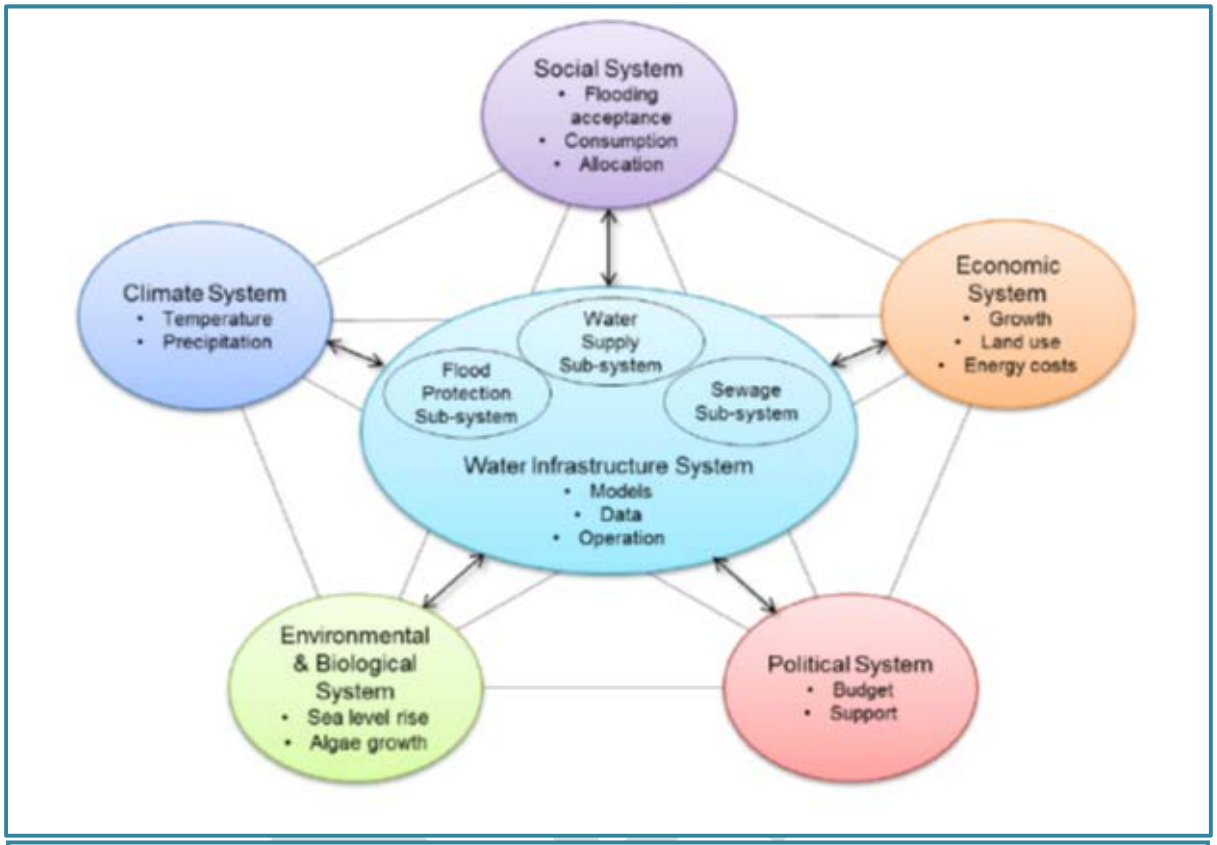

Figure 28: Systems that interact with and impact water infrastructure systems
Image Source: Buurman and Babovic