W H I T E   P A P E R

F I N A L   V E R S I O N

Tapping into Available Capacity in Existing Infrastructure to Create Water Supply and Water Quality Solutions

Prepared for

Las Virgenes Municipal Water District

Main San Gabriel Basin Watermaster

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Executive Summary

Scope and Objective of White Paper

Recent implementation of multi-benefit stormwater projects and programs have been gaining momentum throughout Southern California, especially within Los Angeles County. These projects are intended to provide benefits of increasing water supply, improving water quality, and providing tangible community benefits. However, unless these projects capture and infiltrate water in areas that augment groundwater, or the captured stormwater is used directly on-site, then no water supply benefit is achieved. This White Paper examines a possible alternative and solution: to establish a controlled and strategic integration (interconnection) of the existing stormwater system with the wastewater (sewage) collection system (maximize use of existing infrastructure), treating dry-weather urban runoff and "first flush" flows (improve water quality) through the 21 wastewater treatment plants (WWTPs) in Los Angeles County. This strategy would then, in turn, create a potential drought-proof water supply in the form of non-potable and potable reuse (increase water recycling). This White Paper also found that only 28-percent of the Los Angeles Basin directly overlies a groundwater basin that can support the capture and infiltration of stormwater to supplement water supplies (groundwater augmentation). This 28-percent is further limited by existing hardscape and immovable structures such as homes, buildings and other impermeable (hardscape) surfaces. In order for the "Clean, Safe Water" fee proposal to maximize its stated goals of both water supply and quality, this alternative scenario should be considered and evaluated.

The purpose of this White Paper is to explore leveraging available capacity in the WWTPs for treating urban runoff/stormwater (dry-weather flows and initial stormwater runoff containing highest concentration of pollutants) to generate a new source of recycled water. This White Paper provides a high-level analysis to understand the possibilities of connecting the stormwater system to the wastewater collection system through a control element either directly to the influent of a WWTP or to a WWTP via the wastewater collection system.

Figure ES-1. Conceptualization of Connecting Stormwater Infrastructure to Water Recycling System

Either alternative would allow the wastewater agency to control the diversion of polluted urban runoff/stormwater that could then be treated at the WWTP to generate additional water for recycling. Figure ES-1 depicts a conceptualization of this approach.

A permissive or controlled stormwater connection to the wastewater collection system for treatment and reuse presents multiple benefits opportunities including:

- Increase in local water supply through capture and use of stormwater that would otherwise be wasted to the ocean
- Generate continuous low-cost water supply source, which is available during dry-weather
- Improve water quality of the receiving waters thereby helping agencies achieve MS 4 regulatory compliance
- Capture urban runoff/stormwater which can be treated and used for recharge of aquifers and for other beneficial uses, such as irrigation

- Maximize the use of existing wastewater collection systems, treatment, and reclamation plant infrastructure to generate recycled water supplies
- Expand water reuse which provides a reliable, local water supply that reduces vulnerability to droughts and other water supply constraints

Approach

The study approach included the following steps:

- Review of stormwater capture and recycled water studies within LA County
- Gather and synthesize data of flows and capacities of the WWTPs to understand the available capacity of the wastewater treatment system
- Evaluate the effect of conservation in the post-drought period to understand additional capacities in the treatment systems. Specifically, pre- and post-drought flow comparisons were made.
- Map existing infrastructure including WWTPs, wastewater collection and storm drain systems, low flow diversions (LFDs), and recharge prone areas to geographically show the proximity of conveyance and treatment systems
- Understand pathways, benefits, and challenges for connecting the storm drain system to the wastewater collection system

Findings

Within Los Angeles County, there are approximately 21,000 miles of sanitary sewers and 3,300 miles of County-owned storm drains, with thousands of miles of additional city-owned sewer and drainage systems. The total rated capacity of the 21 WWTPs within Los Angeles County is about 1.4 million acre-feet per year (AFY). Out of the total capacity, about 61 percent of the capacity has been utilized and approximately 39 percent is available capacity during the post-drought period of 2017. A comparison of pre- versus post-drought flows show that about 11 percent of the total WWTP capacity (~103,000 AFY) has been conserved as a result of the drought and water conservation programs. Currently, approximately 231,000 AFY of recycled water is used throughout the county for both potable and non-potable uses; future projects are expected to double the existing uses as shown in Figure ES-2.

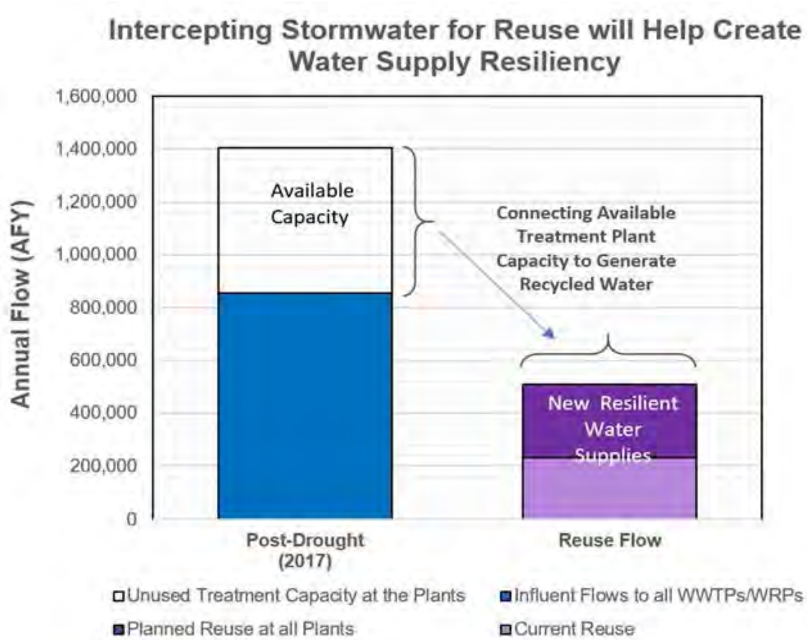

Figure ES-2. Used and Available WWTP Capacities and Reuse Supplies

Summary and Conclusions

This screening level analysis indicates that the careful evaluation of some of the available capacities of the WWTPs could be potentially tapped into to treat urban runoff/stormwater and generate additional recycled water supplies. Also, conservation programs during the drought have reduced flows into the WWTPs, creating additional untapped capacities of the WWTPs. Throughout the county, there are a number of potential diversion locations as shown in Figure ES-3. To help achieve Los Angeles County's stated water quality and supply objectives, and to maximize the benefit of both ratepayer fees and the use of existing infrastructure, collection, storage, and permissive interconnection of the stormwater and sewage collection systems should carefully be evaluated as a viable alternative.

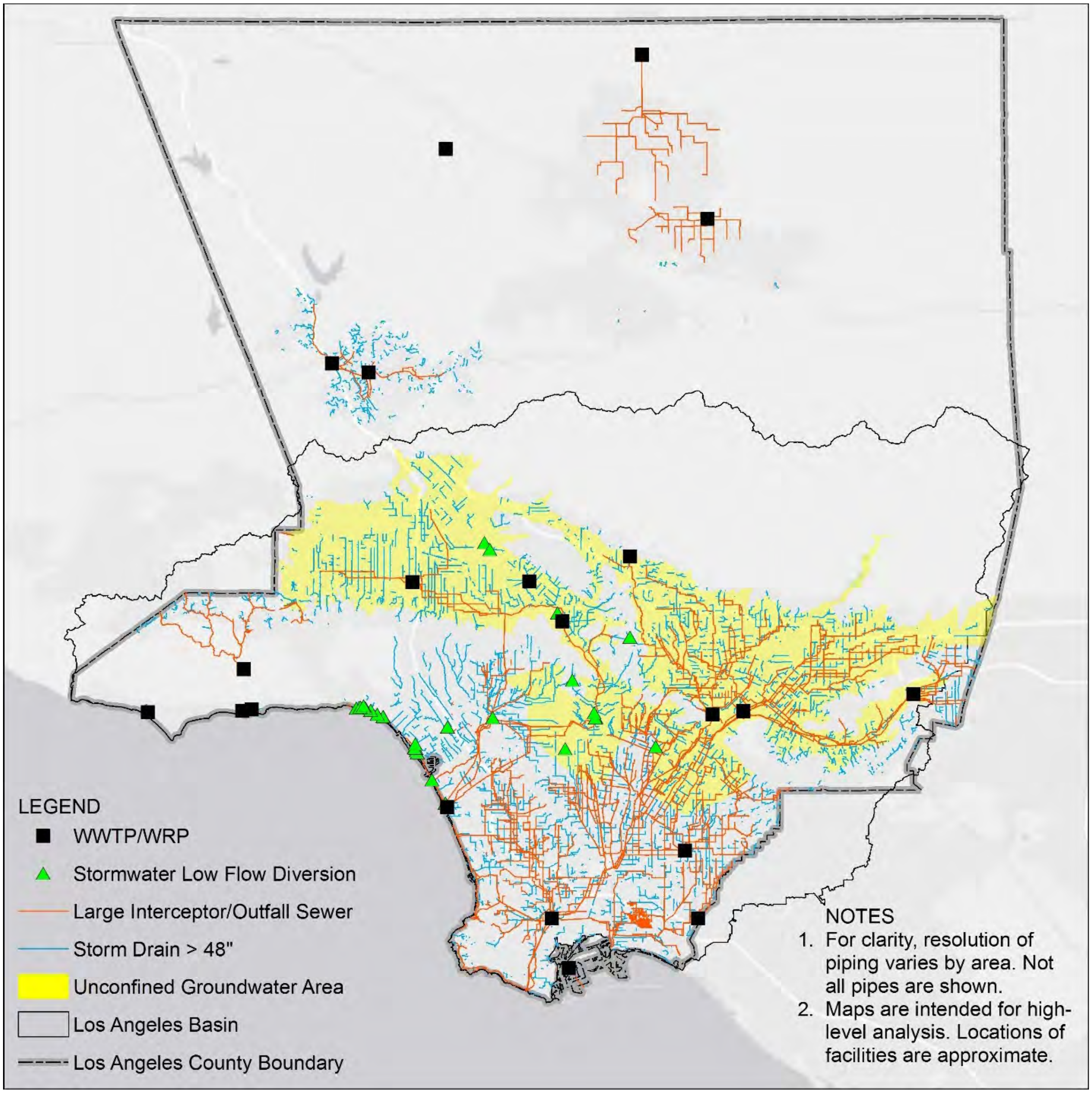

Figure ES-3. Recharge Areas, WWTPs, and Storm Drain Facilities

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Acronyms and Abbreviations

AFY	acre-feet per year
Caltrans	California Department of Transportation
CSMD	Consolidated Sewer Maintenance District of Los Angeles County
GLAC	Greater Los Angeles County
IRP	Integrated Water Resources Plan
JWPCP	Joint Water Pollution Control Plant
LACDPW	Los Angeles County Department of Public Works
LACFCD	Los Angeles County Flood Control District
LACSD	Sanitation Districts of Los Angeles County
LADWP	Los Angeles Department of Water and Power
LASAN	City of Los Angeles Bureau of Sanitation
LFD	low flow diversion
LVMWD	Las Virgenes Municipal Water District
mgd	million gallons per day
MS4	municipal separate storm sewer system
MWD	Metropolitan Water District of Southern California
O&M	operation and maintenance
RWMP	Recycled Water Master Plan
SB	Senate Bill
TMDL	total maximum daily load
USBR	United States Bureau of Reclamation
WBMWD	West Basin Municipal Water District
WRD	Water Replenishment District of Southern California
WRP	Water Reclamation Plant
WWTP	Wastewater Treatment Plant

Background and Objectives

As Los Angeles County becomes less reliant on imported water, further development of local supplies is required to bridge the gap between water supply and demand. Stormwater capture and recycled water projects are repeatedly identified to have the greatest regional impact to generate local water supplies. Recent implementation of multi-benefit stormwater projects are intended to provide benefits of increasing water supply, improving water quality, and, in some instances, providing tangible community benefits.

The Los Angeles Basin Conservation Study found that, on average, centralized stormwater capture contributes to 195,000 acre-feet per year (AFY) of groundwater recharge within Los Angeles County (USBR 2016). In addition to the large, centralized facilities, many small, decentralized facilities capture and infiltrate stormwater throughout the county. However, unless these projects capture and infiltrate water on-site in areas that augment groundwater or the captured stormwater is used directly on-site, then no water supply benefit is achieved. Unfortunately, only 28-percent of the Los Angeles Basin is underlain by an unconfined aquifer. This area is also highly developed and impervious, further reducing the space available for infiltration. Therefore, any stormwater infiltrated above confined aquifers does not generate a water supply benefit unless it is locally reused. Due to the limited area of unconfined aquifer in the region, space for centralized or decentralized stormwater capture for groundwater recharge is limited. Excess stormwater runoff that cannot be contained at capture facilities is discharged to the Pacific Ocean via rivers and tributaries. Within the last 20 years, flows from Los Angeles County to the ocean historically range from 162,000 to 1,700,000 AFY, with over half of the annual flows greater than 700,000 AFY (MWD 2018).

In addition to groundwater replenishment through stormwater capture, Los Angeles County has a history of using recycled water for groundwater augmentation beginning with 1962 with the Montebello Forebay, California's oldest groundwater recharge project. Recycled water is utilized throughout the county as both a source of water and a way to offset potable water demand. Treated wastewater is widely used for applications such as irrigation, cooling towers, and agriculture. However, recent conservation efforts during the drought have resulted in reduced WWTP flows thereby, in some locations, reducing current and projected recycled water availability.

Available capacity in the wastewater (sewage) collection and treatment system provides an opportunity to divert stormwater to augment wastewater flows and generate additional recycled water supply at the Water Reclamation Plants (WRPs), thereby providing a multitude of benefits such as improved water quality, increased water supply, and enhanced flood management to the region and the watersheds.

The purpose of this White Paper is to explore the available capacity of the wastewater (sewage) treatment plants for treating additional urban runoff/stormwater (dry-weather flows and initial stormwater runoff containing highest concentration of pollutants) and generating a new source for recycled water. This White Paper provides a high-level analysis to understand the possibilities of controlled connection of the stormwater collection system to the sewage collection system or directly to the WWTP at strategic locations. In either situation, the diversion controlled by the wastewater agency as their system capacity allows would ultimately result in cost effective assistance in achieving MS4 compliance and the generation of additional water for recycled water use. Figure 1-1 depicts a conceptualization of this approach.

Figure 1-1. Conceptualization of Connecting Stormwater Infrastructure to Wastewater Treatment Plant

Permissive integration is system integration through careful consideration of all pertinent agencies that own, operate, and maintain infrastructure to ensure system reliability and compliance. Permissive stormwater connection to the wastewater collection system for treatment and reuse presents multiple benefits including:

- Increase in local water supply through capture and use of stormwater that would otherwise is wasted to the ocean
- Generate continuous low-cost water supply source, which is available during dry-weather as well
- Improve water quality of the receiving waters thereby helping MS4 permittee agencies achieve regulatory compliance
- Capture urban runoff/stormwater which can be treated and used for recharge of aquifers and for other beneficial uses, such as irrigation
- Maximize the use of existing stormwater and sewage collection systems, treatment, and reclamation plant infrastructure to generate recycled water supplies
- Expand water reuse which provides a reliable, local water supply that reduces vulnerability to droughts and other water supply constraints

The study approach included the following steps:

- Review of stormwater capture and recycled water studies within Los Angeles County
- Gather and synthesize data of flows and capacities of the WWTPs to understand the available capacity of the wastewater treatment system
- Evaluate the effect of conservation in the post-drought period to understand additional capacities in the treatment systems. Specifically, pre- and post-drought flow comparisons were made.
- Map existing infrastructure such as, WWTP/WRP facilities, wastewater collection and storm drain systems, low flow diversions (LFDs), and recharge prone areas to geographically show the proximity of conveyance and treatment systems
- Understand pathways, benefits, and challenges for connecting storm drain system to sanitary/ collection system or directly to the WWTP

This white paper is organized as Sections 1 through 7 to cover these steps and draw conclusions and recommendations of this study.

Inventory of Current Studies

Stormwater capture and recycled water projects are commonly identified as local water supplies with the greatest potential impact to offset imported water within Los Angeles County. A number of studies have been conducted to evaluate water supplies and stormwater management throughout the region. The following section provides a summary of relevant studies relating to stormwater capture and recycled water within Los Angeles County within the last 10 years.

2.1 Los Angeles County

2.1.1 Los Angeles County Department of Public Works 2018 Water Resilience Plan

In Spring 2016, the Los Angeles County Board of Supervisors directed the Department of Public Works (LACDPW) to develop a Water Resilience Plan. The plan, which is currently being developed, identifies integrated strategies to capture more water locally, better manage our existing supplies, protect our beaches and oceans from contamination, green neighborhoods and parks, increase public access to rivers, lakes and streams, and improve coordination among relevant government agencies. 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.

The study identified that 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. 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. However, there has been little concerted effort to implement a substantial increase in stormwater capture for the benefit of regional water supplies. (LACDPW 2017)

2.1.2 Bureau of Reclamation 2016 Los Angeles Basin Conservation Study

The Los Angeles Basin Conservation Study was prepared through a partnership between the Los Angeles County Flood Control District (LACFCD) and the U.S. Bureau of Reclamation (USBR). The purpose of the 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.

The study estimated that in the future there will be a total available supply of approximately 630,400 AFY of stormwater. Currently, the LACFCD captures and recharges approximately 200,000 AFY of stormwater in an average year. Therefore, the study includes a strong emphasis on stormwater capture for groundwater recharge and, to explore options that could expand the use of this resource, structural and nonstructural concepts were developed to enhance effective stormwater management under the projected future conditions. Projects in the Local, Regional, Storage, and Management Solutions have the ability to greatly enhance stormwater capture opportunities and enhance the region's overall water supply.

Capital and operations and maintenance (O&M) cost estimates were developed for each project group, and the costs were annualized over a 50-year period. Of the Regional Solutions, Regional Stormwater Capture is the least costly, and second least costly overall. Regional Stormwater Capture provides approximately 26,100 to 59,900 AFY of stormwater conservation, with a cost of $900 to $2,100 per AFY. The remaining project groups have considerably higher cost estimates. By comparison, Local Stormwater Capture ranges between $8,800 to $14,400 per AF. (USBR 2016)

2.1.3 Greater Los Angeles County 2013 Integrated Regional Water Management Plan

The purpose of the 2013 Integrated Regional Water Management Plan is to define a clear vision and direction for the sustainable management of water resources in the Greater Los Angeles County (GLAC) Region for the next 20 years, and to present the basic information regarding possible solutions and the costs and benefits of those solutions.

The plan identifies opportunities for expansion of stormwater capture and management including development of local and regional facilities to capture and treat urban runoff and stormwater as part of a TMDL compliance strategy. Treated stormwater could either be recharged to groundwater, or stored for delivery to local uses, such as landscape irrigation. Increasing local supplies (like stormwater and recycled water) made available for recharging groundwater basins is also a critical element of further implementation of the conjunctive use strategy. (GLAC 2014)

The IRWM Plan has a number of goals relating to stormwater capture and reuse including:

- Increase indirect potable reuse by 80,000 AFY and increase non-potable reuse of recycled water by 83,000 AFY
- Increase capture and use of stormwater runoff by 26,000 AFY that is currently lost to the ocean
- Develop 54,000 AF of new stormwater capture capacity

2.2 Regional

2.2.1 MWD Integrated Water Resource Plan 2015 Update

The Metropolitan Water District of Southern California (MWD) 2015 Integrated Water Resources Plan (IRP) Update builds upon the foundation of diversification and adaptation in previous IRPs to develop a long-term strategy to secure the region's water supply.

In this refinement, the 2015 IRP Update projects a need for more than 723,000 acre-feet of growth in imported and local supplies and reduced water demands from conservation. Local supplies are a key to providing and maintaining water supply reliability into the future since over half of the region's water supplies come from locally developed sources. The plan identifies that approximately 200,000 acre-feet of new local supply and water conservation is needed, in conjunction with stabilizing, protecting and restoring the region's imported supplies.

The approach for local supplies is to develop 20,000 acre-feet of additional water supply through recycling, groundwater recovery and seawater desalination. The goal is also to maintain the base of existing supplies. The additional 20,000 acre-feet of new local supply combined with existing and under-construction local supplies equal a total local supply target of 2.4 million acre-feet by 2040. This level of development represents a total increase of 227,000 acre-feet from 2016 to 2040.

The plan estimates unit costs for the development of future, local supply projects. Costs are shown for stormwater centralized and decentralized capture and recharge, groundwater recovery, recycled water, and seawater desalination as shown in Figure 2-1. While regional stormwater capture projects have the widest range of costs, they are often the most cost-efficient, whereas decentralized stormwater capture is shown to be the most expensive for developing local supplies. (MWD 2016)

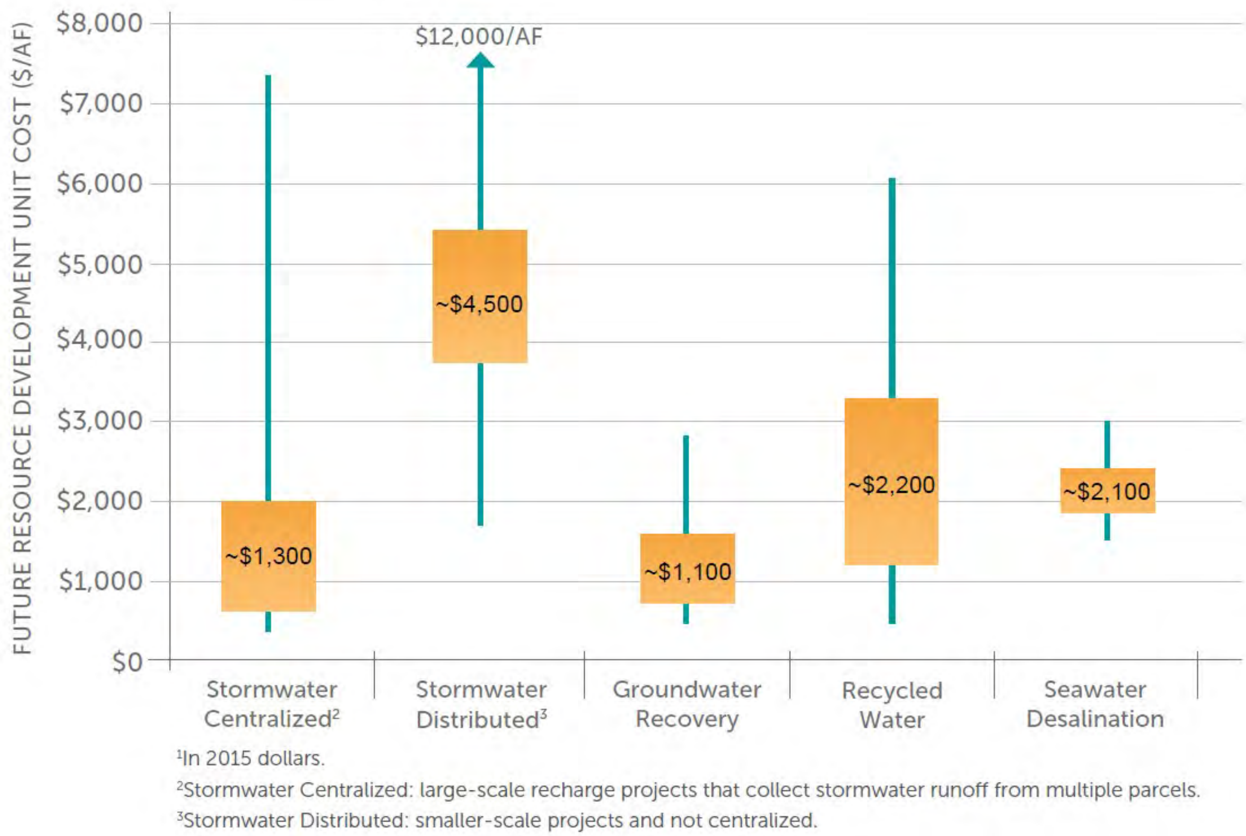

Figure 2-1. Summary of Future Resource Development Unit Costs[1]
Source: MWD 2016, Edited by CH2M

2.2.2 WRD 2012 Stormwater Recharge Feasibility and Pilot Project Development Study

From 2000 to the present, the Water Replenishment District of Southern California (WRD) has participated in the Los Angeles Basin Water Augmentation Study, led by the Council for Watershed Health. The purpose of the augmentation and feasibility study is to explore the potential for reducing surface water pollution and increasing local water supplies by increasing infiltration of urban stormwater runoff.

The study found approximately 10 percent of the 270,000 acres within the WRD service area provided opportunities for local and regional stormwater recharge where nearly 17,000 acre-feet per year of potential water supply benefits can be expected. Of those, nearly 8,000 acres were identified as high-priority areas that could contribute more than 4,000 acre-feet per year to the local potable aquifers. In addition, the study identified that each acre of land in south Los Angeles County that receives well-sited retrofits could annually yield approximately 0.54 acre-feet of groundwater recharge and more than 200 pounds of pollutant reduction. (WRD 2012)

2.3 City of Los Angeles

2.3.1 2018 One Water LA 2040 Plan (Draft)

The purpose of the One Water LA Plan is to increase sustainable water management for the City of Los Angeles. The plan provides a comprehensive strategy for managing water in a more integrated, collaborative, and sustainable way through new project, program, and policy opportunities.

The plan developed 27 concept options including a mix of projects and programs that maximize recycled water use, enhance stormwater capture, contribute to supply sustainability, and provide multiple water quality benefits. A preferred portfolio of concepts was selected and includes dry-weather LFDs, Los Angeles River recharge into the Los Angles Forebay using injection wells, and potable reuse through groundwater, raw water, and treated water augmentation. These projects have an estimated new yield of 147,200 AFY.

The dry-weather LFD concept involves collecting low flows from the stormwater system and transferring them to the wastewater system for treatment. Under normal year conditions, the estimated yield from city-wide implementation is 6,200 AFY, while the yield-weighted unit cost is roughly $1,000 per AF (LASAN 2018). Key benefits of this concept include:

- Minimizes or eliminates the discharge of potentially polluted dry-weather runoff from receiving waters
- Diverts dry-weather runoff in the stormwater collection system to the wastewater collection system to be conveyed to a WRP for treatment and reuse
- Improve health of local watersheds
- Improve local water supply reliability
- Integrate management of water resources and policies
- Balance environmental, economic, and societal goals

2.3.2 City of Los Angeles 2015 Sustainable City pLAn

The Sustainable City pLAn (pLAn) is a roadmap for Los Angeles to become environmentally healthy, economically prosperous, and equitable in opportunity over the next 20 years (City of Los Angeles, 2015). The pLAn focuses on both short-term results and long-term goals including:

- Reduce per capita potable water use by 20 percent by 2017, 22.5 percent by 2025, and 25 percent by 2035
- Reduce purchase of imported water by 50 percent by 2025 and source 50 percent of water locally by 2035, including 150,000 AFY of stormwater capture
- Improve water quality grade-point average
- Reduce sewer spills to 100 times per year by 2025 and 67 times per year by 2035 (175 sewer spills occurred between July 2013 and June 2014)

2.3.3 LADWP 2015 Stormwater Capture Master Plan

The Stormwater Capture Master Plan (SCMP) is the latest major component of Los Angeles Department of Water and Power (LADWP) initiative to increase the local water supply and reduce the dependence on expensive imported water for the City of Los Angeles. The goal of the SCMP is to quantify stormwater capture potential and identify new projects, programs, and policies to significantly increase stormwater capture for water supply within the 20-year planning period.

Local stormwater has historically contributed a significant amount of water for the City. LADWP and its partners actively recharge the local groundwater aquifers, primarily within the San Fernando Valley Basin, with approximately 29,000 acre-feet per year, and another 35,000 acre-feet per year is recharged into those same aquifers by incidental infiltration through mountain front zones and unpaved surfaces.

The results of the plan show that through the sustained implementation of a suite of centralized projects and the adoption of distributed programmatic approaches, an additional 68,000 to 114,000 acre-feet per year of stormwater for water supply could be realized in the next 20 years. The approximate value of this water to LADWP over the same 20-year time period is $1,100 per acre-foot for recharged water and $1,550 per acre-foot for directly used water, which represents a sound investment in the City's future water supply portfolio. (LADWP 2015)

2.3.4 LADWP 2012 Recycled Water Master Planning Documents

The LADWP Recycled Water Master Planning (RWMP) documents presents the City of Los Angeles' recycled water planning through 2035, as well as long-term recycled water planning for up to 50 years beyond the 2035 horizon. The RWMP documents include an evaluation of recycling alternatives that integrate two strategies to increase recycling: groundwater replenishment and non-potable reuse.

LADWP's 2010 Urban Water Management Plan established a goal of increasing recycled water use citywide to 59,000 AFY by 2035. The RWMP finds the preferred way to achieve this goal is through 30,000 AFY of groundwater replenishment and 9,650 AFY of non-potable reuse (in addition to the 19,350 AFY of existing and planned non-potable reuse).

Existing, planned, and future non-potable water reuse demand is expected to be 29,000 AFY by 2035. The plan identified there is uncertainty as to whether all the potential recycled water demands would be realized in the future. Connection to the recycled water system is voluntary and requires customer participation for successful implementation. It is anticipated that not all customers will connect due to site constraints, cost limitations, or other unknown factors that cannot be predicted. (LADWP 2012)

Inventory of Sanitary Flows and Downstream Recycled Uses

There are over 21,000 miles of sanitary sewer within Los Angeles County and 21 WWTPs. Wastewater collection and treatment agencies in the county include the Sanitation Districts of Los Angeles County (LACSD), the Consolidated Sewer Maintenance District of Los Angeles County (CSMD), the City of Los Angeles Bureau of Sanitation (LASAN), the City of Burbank, and Las Virgenes Municipal Water District (LVMWD).

Of the WWTPs, 17 are currently WRPs used to treat sewer flows for reuse as recycled water. A majority of recycled water is used for non-potable 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 flows directly to the ocean (LACDPW 2017).

The following section provides an overview of existing infrastructure for each of the wastewater treatment agencies within Los Angeles County and the subsequent recycled water uses. Table 3-1 shows the design capacities, influent flows, and recycled flows to identify potential available capacities within the system. A map of the wastewater conveyance system and treatment facilities is shown in Exhibit 1 in Appendix A.

3.1 Existing Wastewater Collection and Treatment Infrastructure

3.1.1 Sanitation Districts of Los Angeles County

The LACSD service area covers approximately 824 square miles and encompasses 78 cities and unincorporated territory within the County. Within the Sanitation Districts' service area, there are approximately 9,500 miles of sewers that are owned and operated by the cities and County that are tributary to the Sanitation Districts' wastewater collection system. The Sanitation Districts own, operate, and maintain approximately 1,400 miles of sewers, ranging from 8 to 144 inches in diameter, that convey approximately 500 million gallons per day (mgd) of wastewater to 11 wastewater treatment plants. Included in the Sanitation Districts' wastewater collection system are 48 active pumping plants located throughout the county (LACSD 2018).

LACSD operates the following wastewater treatment facilities:

- Joint Water Pollution Control Plant (JWPCP)
- La Cañada WRP
- Lancaster WRP
- Long Beach WRP
- Los Coyotes WRP
- Palmdale WRP
- Pomona WRP
- San Jose Creek WRP
- Saugus WRP
- Valencia WRP

- Whittier Narrows WRP

LACSD is in the process of implementing the Clearwater Project in concert with the operation of the JWPCP. The JWPCP is the largest wastewater treatment facility in the LACSD system and uses two large tunnels to convey treated water to an ocean outfall network beginning at Royal Palms Beach at the terminus of Western Avenue. The outfalls diffuse the treated water approximately 1 1/2 miles offshore at a depth of 200 ft. The tunnels are 60 and 80 years old and because of capacity limitations have not been inspected since 1958. This aging infrastructure must be inspected and refurbished as found necessary. To accomplish this and achieve additional wet weather capacity LACSD will construct new tunnel 7 miles in length and 18 ft in diameter with a route essentially parallel to the existing tunnels and joining them at a common manifold structure connected to the outfalls. The capacity of the existing tunnels was almost exceeded twice during major rainstorms, including the rainstorm in January 2017. If the in place tunnel capacity is exceeded, partially treated or untreated wastewater would be discharged to surrounding waterways, resulting in degradation of water quality. In addition to vitally needed protection for water quality and safety of the JWPCP, the added 3rd tunnel could provide capacity for stormwater introduced into the LACSD collection network under controlled conditions, as advocated in this report. The Clearwater Project is an integral part of any strategy aimed at achieving a diversified wet infrastructure to increase water supply and MS4 compliance in a cost effective and environmentally sound manner.

3.1.2 Consolidated Sewer Maintenance District of Los Angeles County

The CSMD is administered by the LACDPW. The CSMD system serves greater than one-half of a million parcels and a population of over 2 million people within the unincorporated areas of the county (excluding Marina del Rey), 37 cities, and 2 contract cities. The District's system includes over 4,600 miles of sanitary sewers, 155 pump stations, and 4 wastewater treatment plants (LACDPW 2018). A majority of the CSMD sewer collection system is tributary to and processed by the LACSD system.

Flows treated at Malibu Mesa WRP are primarily used for irrigation at Pepperdine University. All other CSMD facilities dispose of treated wastewater onsite.

CSMD operates the following wastewater treatment facilities:

- Lake Hughes Community Water Treatment Facility
- Malibu Mesa WRP
- Malibu Water Pollution Control Plant
- Trancas Water Pollution Control Plant

Flows treated at Malibu Mesa WRP are primarily used for irrigation at Pepperdine University. All other CSMD facilities dispose of treated wastewater onsite.

3.1.3 City of Los Angeles Bureau of Sanitation

The LASAN is responsible for over 6,700 miles of sewer lines and 49 pumping plants in addition to four WRPs across the City, which have a combined capacity to treat 580 mgd of wastewater (LASAN 2018).

LASAN operates the following wastewater treatment facilities:

- Donald C. Tillman WRP
- Hyperion WRP
- Los Angeles-Glendale WRP (co-owned by the City of Glendale)
- Terminal Island WRP

The Tillman WRP 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. 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. 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 Municipal Water District (WBMWD) for further treatment at the Edward C. Little Water Recycling Facility (LACDPW 2017).

Table 3-1. Municipal Wastewater Treatment and Reuse Flows within Los Angeles County

Facility	Rated Capacity (AFY)	2010 Pre-Drought Influent Flow (AFY)	2017 Post-Drought Influent Flow (AFY)	% Change in Influent Flow	Current Reused Flows (AFY)	Recycled Water Uses *Data Pending*
Sanitation Districts of Los Angeles County						
JWPCP	448,058	313,349	287,631	-8%	-	Existing: None Future: 168,022 AFY Regional Reuse Program with MWD
La Cañada WRP	224	111	90	-19%	78	Existing: La Canada-Flintridge Country Club
Lancaster WRP	20,163	15,346	14,394	-6%	11,906	Existing: Piute Pond, Apollo Lakes Park, Eastern Agricultural Site, City of Lancaster
Long Beach WRP	28,004	21,305	12,176	-43%	7,005	Existing: City of Long Beach, WRD Alamitos Barrier
Los Coyotes WRP	42,005	24,251	23,512	-3%	6,178	Existing: City of Cerritos, Bellflower, Lakewood Cypress and La Palma, Central Basin MWD
Palmdale WRP	13,442	10,675	9,096	-15%	7,913	Existing: Farming Operations, City of Palmdale
Pomona WRP	16,802	10,025	7,079	-29%	6,331	Existing: Pomona Water Department, Spadra Site: Walnut Valley Water District, Water Replenishment District
San Jose Creek WRP	112,014	86,072	72,496	-16%	53,537	Existing: Water Replenishment District, Miscellaneous Direct Reuse, Puente Hills/Rose Hills, Central Basin MWD, Upper San Gabriel Valley MWD, Rowland Water District
Saugus WRP	7,281	5,623	5,713	2%	-	Existing: None
Valencia WRP	24,195	16,993	15,088	-11%	461	Existing: Castaic Lake Water Agency
Whittier Narrows WRP	16,802	7,942	8,087	2%	7,289	Existing: Water Replenishment District, Upper San Gabriel Valley MWD
Los Angeles County Department of Public Works						
Lake Hughes Community WTF	104	*Data Pending*	29	*Data Pending*	0	Existing: None
Malibu Mesa WRP	224	*Data Pending*	*Data Pending*	*Data Pending*	*Data Pending*	Existing: Irrigation of Pepperdine University
Malibu WPCP	57	*Data Pending*	37	*Data Pending*	0	Existing: None
Trancas WPCP	84	*Data Pending*	46	*Data Pending*	0	Existing: None
City of Los Angeles Bureau of Sanitation						
Donald C. Tillman WRP	89,612	52,344	54,831	5%	34,736	Existing: Beneficial Use Future: 54 AFY Sepulveda Basin (2018), 3,500 AFY Groundwater Replenishment Project – Phase 1 (2019)
Hyperion WRP	504,065	334,699	295,270	-12%	72,216	Existing: purchased by WBMWD for treatment, City of LA's Title 22 customers Future: 1,000 AFY LAX Expansion (Pershing) WRP (2018), 1,680 AFY Advanced Water Purification Facility (Conceptual, timing TBD), 78,000 AFY MBR full scale treatment facility (Conceptual, timing TBD)
LA-Glendale WRP	22,403	22,829	18,303	-20%	12,098	Existing: Beneficial use and irrigation Future: 1,460 AFY Downtown WRP (2022), 316 AFY LA Glendale Recycled Water Storage Project (Conceptual, 2025)
Terminal Island WRP	33,604	18,460	16,208	-12%	2,307	Existing: Dominguez Gap Seawater Intrusion Barrier, Future: 7,400 AFY Harbor Area Customers Expansion & Potable Back-up (2020), 6,600 AFY Pipeline Extension on Gaffey and Phillips 66 On-Site Retrofit (2023), 3,600 AFY Harbor Connection to JWPCP (Conceptual) and/or Connection to Carson Regional Water Recycling Facility (Conceptual, timing TBD)
City of Burbank						
Burbank WRP	12,322	9,147	7,744	-15%	3,005	Existing: Burbank Water and Power Steam Plant, Debell Golf Course, City of Burbank Landfill, Other Future:
Las Virgenes Municipal Water District						
Tapia WRP	13,442	9,391	7,546	-20%	5,938	Existing: Irrigation Future: 5,151 AFY Pure Water Project
Total	***1,404,906***	***958,562***	***855,375***	***-11%***	***230,997***	

WBMWD'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 the District's municipal, commercial and industrial customers, including irrigation, cooling tower water, seawater barrier and groundwater replenishment, and low- and high-pressure boiler feed water (LACDPW 2017).

3.1.4 City of Burbank

Wastewater generated within the City is collected and conveyed by approximately 230 miles of pipelines ranging in diameter from 6 inches to 30 inches, 2 pump stations, and 19 diversion manholes. The City of Los Angeles' 48-inch North Outfall Sewer line runs from west to east through the southern portion of the City. Wastewater is treated by the Burbank WRP which produces a disinfected tertiary effluent. The recycled water from the Burbank WRP is used for power production, landscape irrigation, and evaporative cooling (Burbank Water and Power 2016).

3.1.5 Las Virgenes Municipal Water District

LVMWD, together with its partner agency Triunfo Sanitation District, provides wastewater (sewage) services to residents in the western portion of Los Angeles County and eastern portion of Ventura County through the Las Virgenes-Triunfo Joint Powers Authority. LVMWD's service area consists of 122 square miles including Agoura Hills, Calabasas, Hidden Hills, Westlake Village and neighboring unincorporated Los Angeles County. The LVMWD wastewater collection system includes 56 miles of trunk sewer lines, from 8 inches to 48 inches in diameter, and 2 lift stations that pump wastewater over the mountains to the treatment facility. The Tapia WRP, jointly owned by LVMWD and Triunfo Sanitation District, provides wastewater treatment for the region. 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. (LVMWD 2018)

Inventory of Storm Drain Systems

The Los Angeles County regional flood control system includes catch basins, storm drains, channels, rivers, spreading grounds, and flood control basins. The following sections provides information on the existing storm drain infrastructure and diversions. A map of existing large-diameter gravity mains and existing diversions is shown in Exhibit 2 in Appendix A.

4.1 Regulatory Background

Water quality in the majority of the County of Los Angeles is directly regulated and enforced by the Los Angeles Regional Water Quality Control Board, which regulates discharges from medium and large, municipal separate storm sewer systems (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. (LACDPW 2017)

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 total maximum daily loads (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; or 3) developing and implementing an Enhanced Watershed Management Program. In all three cases, a Coordinated Integrated Monitoring Program is also required to establish a baseline and document any changes over time. (LACDPW 2017)

4.2 Existing Storm Drain Infrastructure

The storm drain system within Los Angeles County is primarily owned and maintained by the LACFCD and local cities. The California Department of Transportation (Caltrans) and Los Angeles County Metropolitan Transportation Authority (Metro) also own and maintain the storm drain infrastructure within their respective jurisdictions.

The 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. (LACDPW 2017)

The gravity mains within the LACFCD storm drain system range from 6-inch diameter pipes to boxes greater than 12 feet and are typically reinforced concrete pipe or box. Other pipe materials also include steel, cast/ductile iron, corrugated metal, unreinforced concrete, asbestos cement, brick, cured-in-place pipe liner, high density polyethylene, and plastic.

4.3 Existing Diversions

Dry-weather urban runoff is non-stormwater flow generated in urban areas due to overirrigation, broken sprinkler systems, fire hydrant testing, car washing, and other sources. Since urban runoff carries pollutants that are typically present on landscape and streetscape such as trash, metals, dissolved nutrients, and bacteria, it is considered a source of pollution.

Through Senate Bill (SB) 485, County Sanitation Districts have the authority to collect and treat urban runoff as wastewater. Further, they have accepted the introduction of urban runoff for treatment on a limited basis within their treatment facilities. A LFD is a structural system that diverts this polluted water away from the storm drains into the sanitary sewer or another treatment system to eliminate the discharge of potentially polluted dry-weather runoff into receiving waters. In addition to dry-weather flow, where possible LFDs are sized to capture the first 0.1 inch of rainfall. Additional stormwater could be captured for water quality or water supply benefits by providing storage upstream of the diversion and metering the stored flows into the sewer after wet-weather peaks in the sewer have subsided. By using an integrated control system, the storage can be located in areas where land is available and/or less expensive and release can be timed with the operation of the diversion.

LACFCD, LASAN, and the cities of Santa Monica, Long Beach, Redondo Beach, and Manhattan Beach have taken proactive steps to improve stormwater quality and watershed health by incorporating these devices. In total, there are 54 LFDs located in Los Angeles County as listed in Table 4-1 and are shown in Exhibits 2 through 8 in Appendix A. The City of Long Beach is currently working to bring three new diversions online. Most LFDs are located along the coastline to capture flows before discharge to the ocean. LFDs are used for water quality benefit and are typically not considered a source of water.

Table 4-1. Existing LFDs within Los Angeles County

Facility Name	Capacity (gpm)	Facility Name	Capacity (gpm)
LACFCD		***LASAN***	
Alamitos Bay	120	8th/Enterprise	700
Arena Pump Plant	60	Bay Club Drive	340
Ashland Avenue	30	Downtown	Gravity
Avenue I	60	Echo Park	450
Boone Olive Pump Plant	96	Garvanza	190
El Segundo Pump Plant	60	Imperial Hwy	644
Electric Avenue Pump Plant	76	Kinney Circle (LFD)	500
Hermosa Strand Infiltration Trench	250	LA Zoo	12,000
Herondo Street	60,120	Mar Vista	4,800
Manhattan Beach Pump Plant	50	Marquez Canyon	300
Manhattan, 28th & The Strand	130	Palisades Park	1,480
Marie Canyon	100	Penmar	2,700
Marina Del Rey (Oxford Basin)	200	Santa Monica (New)	10,000
Parker Mesa/Castlerock	75	Santa Monica Canyon	3,500
Pershing Drive, Line C	240	South LA Wetlands	6,700
Playa del Rey	180	Sun Valley Park	80
Pulga Canyon	260	Temescal	3,500
Rose Avenue	100	Temescal Canyon	3,500
Santa Ynez	826	Thornton	1,500
Washington Blvd	63.9	Tuxford (LFD)	180
Westchester	125	Westminster Dog Park	Gravity

Table 4-1. Existing LFDs within Los Angeles County

Facility Name	Capacity (gpm)	Facility Name	Capacity (gpm)
		Westside Park	60
City of Santa Monica		***City of Long Beach***	
Montana Avenue	n/a	Appian Way	30
Pico-Kenter (diverts to SMURRF)	n/a	Belmont Pump Plant	60
Santa Monica Pier	n/a	Colorado Lagoon	60
Wilshire Boulevard	n/a	Termino Avenue Drain	n/a
City of Redondo Beach		***City of Manhattan Beach***	
Redondo Beach Pier	n/a	Manhattan Beach Pier	50
Sapphire	n/a		

Source: LACDPW 2014, LASAN 2017

Results and Findings

5.1 Infrastructure Mapping

Existing infrastructure was mapped to geographically show the proximity of conveyance and treatment systems within Los Angeles County. Maps of these systems are shown in Exhibits 1 through 8 in Appendix A. The following section provides source information and discussion of the maps.

Wastewater Treatment Facilities. WWTP locations were obtained from LACSD, LACDPW, LASAN, City of Burbank, and LVMWD. A number of facilities are located along the coast and most facilities are located in the southern half of the county.

Wastewater Collection System. The wastewater collection system map data was collected from LACSD, LACDPW, LASAN, and LVMWD. Due to the size of the collection system and high-level scale of the map and study, only the interceptor and outfall sewers are shown for LACSD and LASAN which range from 18 inches to 12.5 feet in diameter. The LACDPW sewer system is much smaller by comparison and was not mapped. For clarity, small diameter pipes are screened from the figures.

Storm Drain System. The existing storm drain system was obtained from LACFCD and includes both county and city drainage facilities. The conveyance system includes gravity mains, force mains, culverts, catch basins, lateral connections, maintenance holes, pump stations, channels, and natural drainage. Due to hydraulics, a potential storm drain diversion is most suitable for a gravity line therefore only gravity lines are displayed. Due to potential minimum flow requirements in some surface waters, diversion of open channel flows and rivers were not considered for this analysis. For clarity, small diameter pipes are screened from the figures.

Low Flow Diversions. LFD locations were obtained from LACFCD and LASAN. Most LFDs are located along the coast as downstream efforts to capture and treat flows prior to ocean discharge. However, LASAN has installed several LFDs inland to help capture flows from some of the priority, poor quality sub-watershed discharges.

Unconfined Aquifer. The unconfined aquifer data was developed as part of the Los Angeles Basin Conservation Study. The data shows that only 28-percent of the Los Angeles Basin is underlain by an unconfined aquifer. Any water that is infiltrated outside of the unconfined aquifer does not contribute to water supply. Unfortunately, most of this area is urban and highly impervious, further limiting the potential of locally infiltrating stormwater.

Los Angeles Basin. The Los Angeles Basin area was obtained from the Los Angeles Basin Conservation Study and includes the Los Angeles River, San Gabriel River, Ballona Creek, South Santa Monica Bay, North Santa Monica Bay, Malibu Creek, and Dominguez Channel/Los Angeles Harbor watersheds. Nearly 95-percent of the Los Angeles County's population resides within this area (USBR 2016).

Los Angeles County and local municipalities own an extensive network of wastewater and stormwater collection systems. Within the county, there are approximately 21,000 miles of sewers and 3,300 miles of storm drains owned by LACFCD with thousands of miles of additional city-owned sewer and drainage systems. The mapping of the sewer and storm drain systems indicate numerous potential points at which flow in the storm drain could be diverted to the sewer in a controlled fashion as capacity is available.

5.2 Effects of Conservation on Sewer Flows

California's current drought began in 2012 and the continuing absence of rain lead to a state of emergency declared in January 2014. Indoor conservation during the drought has led to reduced flows to wastewater systems which has been observed at most of the WWTPs. To understand the influence of the drought on sewer flows, influent flows were collected for the year 2010 to represent the sewer flows before the impacts of the drought and conservation efforts. Post-drought data were collected for the year 2017 to represent the current sewage flows after conservation was in effect. Although seasonal and year-to-year conditions may vary, these are considered representative years suitable for a high-level analysis.

As shown in Table 3-1, the cumulative sewer flow reduction between 2010 and 2017 is approximately 103,000 AFY, a drop of 11 percent throughout the county, as shown in Figure 5-1. Some facilities have seen reductions well above 20 percent indicating available capacity in both the sewage collection system and connected treatment facilities. This analysis does not account for population growth during the same period (2010-2017). Available capacity may be limited to dry weather, since many of the WWTPs/WRPs/sewage collection systems continue to operate at capacity during and immediately following wet-weather. This indicates that while capacity is available, storage may be necessary. The potential available capacity, if used in a controlled fashion, could be used to increase the supply of water available for recycling and assist in meeting MS4 requirements.

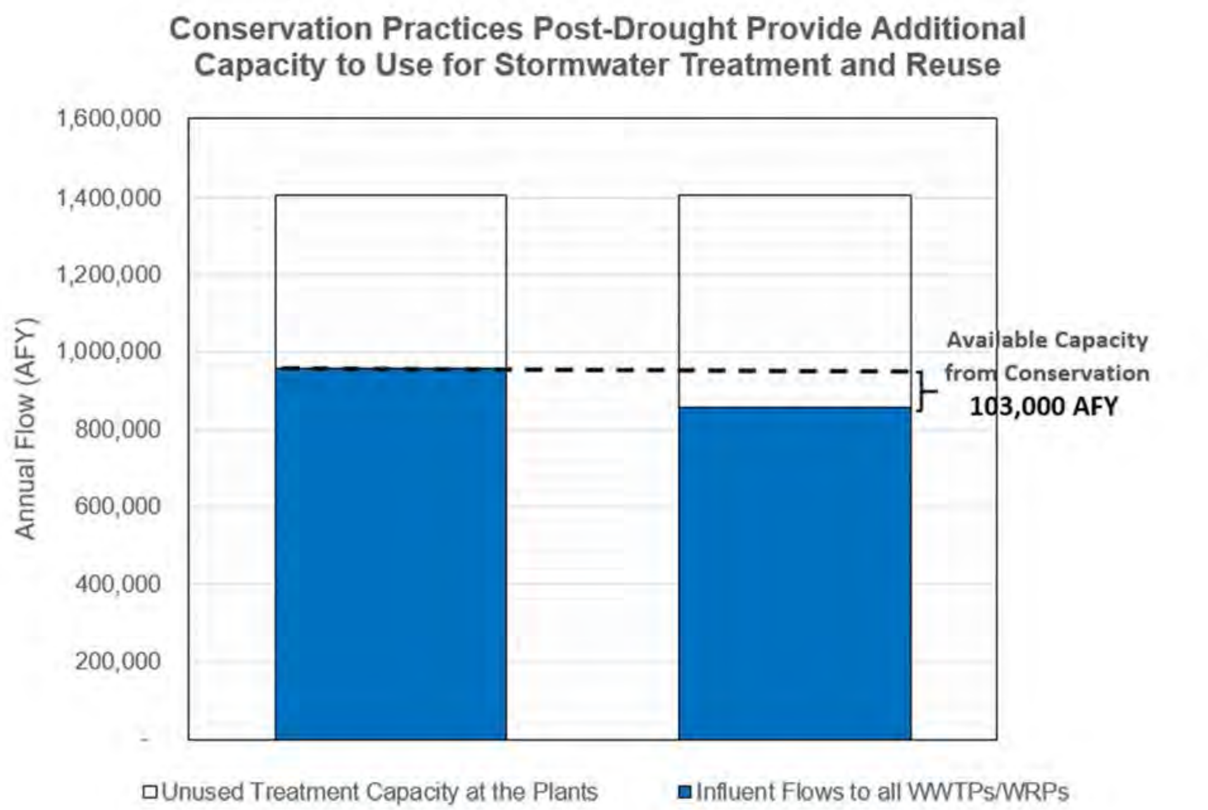

Figure 5-1. Pre- and Post-Drought Influent Sewer Flows

5.3 Recycled Water Capacity Evaluation

Within Los Angeles County, approximately 231,000 AFY of flows are reused for both potable and non-potable applications as shown in Table 3-1. A number of future water reuse projects have been identified by the water reclamation and distributing agencies. Over the next 10 years, future reuse projects will more than double the reuse flows currently being delivered.

In addition to demand from future projects, 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. Regional wastewater collection systems have identified this as a challenge (LACDPW 2017). Diversions from the storm drain system can supplement sewer flows and provide an additional source of water to help meet future recycled water demand as shown in Figure 5-2. While cumulative sewer flows appear to be sufficient to meet total current and future recycled water demands, utilization of recycled water at some WRPs is currently fully subscribed with an increasing demand. Due to infrastructure limitations and supply/demand locations, not all sewer flows are used to produce recycled water.

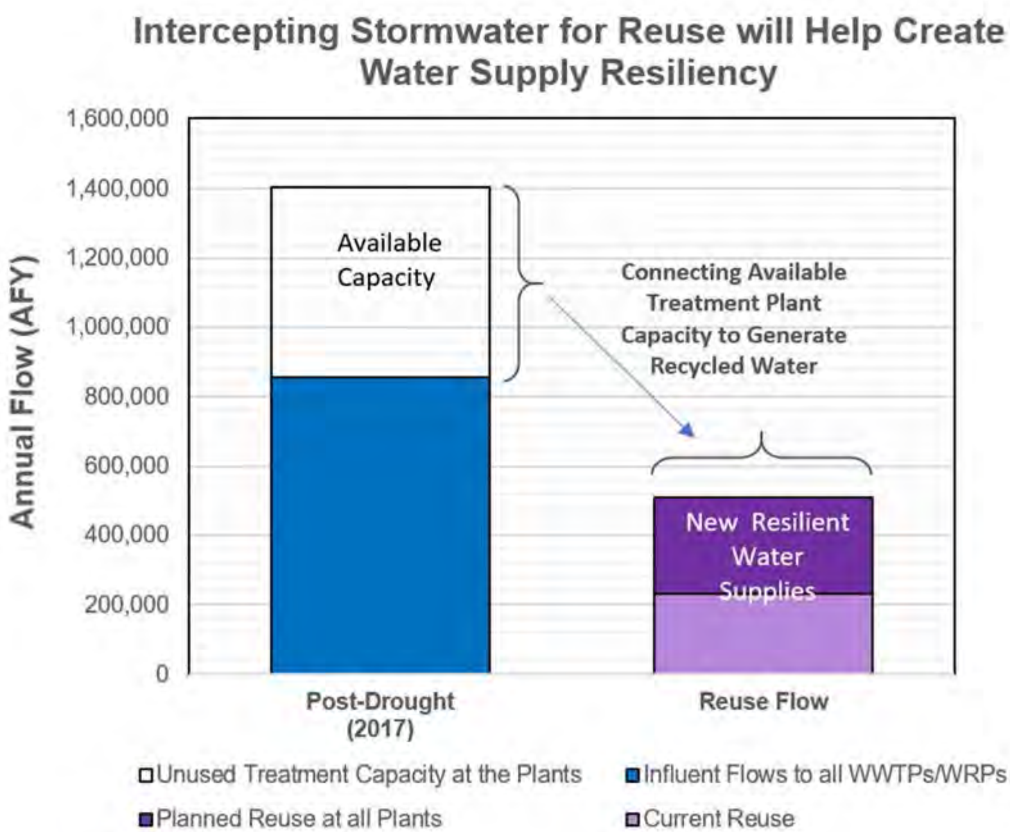

Figure 5-2. Used and Available capacities and Reuse supplies

Pathways, Benefits, and Challenges for Permissive Integration

The following section describes the benefits and challenges of implementing storm drain diversion of stormwater for the purpose of providing water quality and supply benefits.

6.1 Legislative Pathways

Regulatory pathways for stormwater diversion to the sanitary sewer have already been established through the use of LFDs and are described in the following section.

6.1.1 SB 485, Hernandez - County Sanitation District Act

SB 485, Hernandez - County Sanitation District Act was enacted in 2015 which gives LACSD the authority to assist local jurisdictions with stormwater and urban runoff projects. The County Sanitation District Act authorizes a sanitation district to acquire, construct, and complete certain works, property, or structures necessary or convenient for sewage collection, treatment, and disposal. This bill would authorize specified sanitation districts in the County of Los Angeles to acquire, construct, operate, maintain, and furnish facilities for the diversion, management, and treatment of stormwater and dry-weather runoff, the discharge of the water to the stormwater drainage system, and the beneficial use of the water. The law requires a district to consult with the Los Angeles County Flood Control District and the relevant watermaster or water replenishment district prior to initiating a stormwater or dry-weather runoff program within the boundaries of an adjudicated groundwater basin or within the service area of a water replenishment district, as applicable.

6.1.2 LACSD Dry-Weather Urban Runoff Diversion Policy

LACSD enacted new guidance in 2014 which provides procedures for diversion of dry-weather flows into the Districts' collection system. The policy requires the owner of the stormwater collection system to obtain an Industrial Wastewater Discharge Permit, install pretreatment to remove large solids, provide a means for measuring flow, provide necessary monitoring and control systems, and pay appropriate fees (LACSD 2014).

The policy also requires:

- the discharge rate will be limited to ensure the downstream sewer will not flow more than ¾ depth;
- discharge to the sewer must be pumped with a check value between the pump and connecting sewer to ensure wastewater does not backflow into the storm drain system;
- a rain collector must be installed to automatically shut off diversion upon sensing 0.1-inch of rainwater; and,
- diversions are not allowed where incompatible pollutants have been detected in quantities that may impact the downstream treatment.

Historically, diversions have been limited to dry-weather flows. Since the implementation of SB 485, LACSD has been open to accepting stormwater from controlled systems. Connection fees for diversions operated by government agencies have been waived in several districts to make projects more cost effective and LACSD is working on a project in the City of Carson to accept stormwater when capacity is available. In most areas of the County, systems that involve the acceptance of stormwater will need to incorporate storage to mitigate the risks associated with accepting flows during a storm. Storage can be located anywhere in the subwatershed and release from the storage can be timed with the operation of the downstream diversion. Operating diversions in this way is expected to lead to greater opportunities to reuse the water after treatment. Projects are being evaluated on a case-by-case basis.

6.1.3 Municipal Water District Law of 1911

Municipal water districts have the authority to acquire, control, distribute, store, spread, sink, treat, purify, recycle, recapture, and salvage any water, including sewage and storm waters. In 2017, LVMWD developed Draft *Policy Principles for Dry-Weather Urban Runoff Diversions* to help eliminate dry weather discharges with the potential benefit of additional source water for recycling and future potable reuse (LVMWD, 2018).

6.2 Benefits

6.2.1 Water Quality

In 2004 LASAN evaluated, as part of their water Integrated Resources Plan, dry-weather runoff options for the Ballona Creek, Dominguez Channel, Los Angeles River, and Santa Monica Bay watersheds. The study analyzed both source control measures and methods that address runoff that has entered the storm drain system. For runoff that already entered the storm drain, diversion to a WWTP was analyzed as an option. The study also analyzed bacteria, trash, pesticides, nutrients, selenium, and other key toxics as the main constituents of concern and potentially likely requirements for meeting the TMDLs for dry weather. Of these, bacteria was determined to be the primary constituent of concern for dry-weather urban runoff treatment. The study estimated future dry-weather treatment and discharge needs to address the Bacteria TMDL throughout the City of Los Angeles' watersheds to be about 87 million gallons per day (LACFCD 2014, LASAN 2004)

Water quality benefits from diversion of dry-weather flows vary from location to location based on the tributary areas. For existing coastal watersheds, the benefits of LFDs have been realized in the form of improved ocean water quality and fewer beach closures due to health risks associated with poor water quality (LACFCD 2014). Monitoring results of existing LFDs throughout the county indicate beneficial impacts to meeting water quality regulations.

The Westchester Storm Drain LFD project provides an example of the water quality benefits associated with this type of diversion. The storm drain connecting to the structure receives its urban runoff from West Manchester Boulevard in the community of Westchester and northern portions of Los Angeles International Airport. The hydrologic drainage area tributary to this drain is 2,416 acres. The construction of the LFD was completed in October 2004 and the facility began diverting dry-weather runoff to the LASAN sanitary sewer in May 2005. The Watershed Management Division of the Los Angeles County Department Public Works obtained weekly runoff samples upstream of diversion and tested for bacteria levels. The sampling effort continued until October 31, 2005, the end of the dry-weather season. Analysis of water samples showed elevated bacteria levels in the North Westchester storm drain. The water quality results at the shoreline were comparatively lower than the levels inside the storm drain and below the set water quality standards (LACFCD 2006), due to the effects of the LFD.

6.2.2 Water Supply

Typically, LFDs are installed for water quality benefit and are not considered a significant water source. Modeling will need to be conducted on a systematic, case-by-case basis to determine the water supply benefit of adding new diversions or increasing the capacity of existing diversions. This additional source water diverted to the WRPs can be used to produce recycled water, which has a direct benefit to water supply within the region. Recycled water is a reliable, local supply source that reduces dependence on imported water and is considered a drought-proof supply.

6.2.3 Infrastructure

Recent drought and conservation may have had deleterious impacts on wastewater systems. Declining indoor water usage decreases wastewater flows and may increase pollutant and solids concentrations, which could increase blockages, odors, and corrosion in pipes. This may lead to increases in O&M costs, odor complaints, and an accelerated degradation of infrastructure (CUWA 2017). Therefore, in some situations the addition of stormwater can be advantageous to the conveyance and treatment of wastewater in reducing unwanted conditions.

6.2.4 Pilot Testing for Wet Weather Diversion

As discussed in Section 4, there are a number of existing LFDs throughout Los Angeles County that divert dry-weather flows to the sanitary sewer system. Expansion of these existing diversions beyond dry-weather to include wet-weather flows can provide opportunities for stormwater treatment. This action could lead to new water supplies and possibly be a cost effective, environmentally sound component for MS4 compliance. However, it would be beneficial to pilot test both the incorporation of controlled wet-weather flows into the sewer collection system as well as directly to the influent of the WWTP. This pilot work would be at selected locations to understand the benefits and challenges. Existing LFD locations provide opportunities to pilot this concept through controlled storage and release upstream of an existing diversion. In cooperation with LACFCD, the wastewater agency should be the primary authority for the pilot work. The regulatory community must be an active participant in pilot work.

6.3 Challenges

6.3.1 Collection and Treatment System Capacity

Wet weather flows can stress the sanitary sewer collection system and generate high peak flows at WWTPs leading to the bypass of certain treatment processes resulting in regulatory violations. Therefore, existing sanitary sewer and treatment capacities must be evaluated to identify the amount of stormwater ("first flush") that could be diverted into the system without risk of overflow or exceeding the WWTP's peak flow capacity. Modeling should be conducted to determine the maximum permissive or controlled capacity that can used to size the storm drain diversions. Utilization of storage facilities can help address capacity issues during peak hours. New technologies, such as smart manhole covers, can monitor the flows throughout the system on a real-time basis to minimize overflow risk. For the alternative of controlled diversion of stormwater directly to the WWTP, the collection system challenges are essentially avoided to this case, the treatment plant operator knows the plant capacity available from currently existing plant flow meters and can adjust the amount directed from the stormwater system to safely utilize the available capacity. A pump or gravity diversion system could be utilized depending on the specific circumstances. The necessity of storage would be part of the size specific evaluation. In all cases, a control system with redundant measures must be employed.

6.3.2 Operation and Maintenance

Historically, wastewater agencies do not plan and construct these LFDs to the sanitary sewer system. Generally, they are planned, constructed, and maintained by the cities and other agencies required to meet water quality standards related to the discharge of water from storm drains. Most wastewater agencies categorize LFDs as industrial waste discharge facilities subject to connection permit fees[1] and annual surcharge fees which fund the O&M of the collection and treatment system. Where a diversion includes multiple benefits, such as water supply, additional funding partners and avenues may become available, which would assist in establishing a collaborative effort among stakeholders.

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[1] Connection fees for local governmental diversions have been waived in LACSD districts 2, 3, 8, 15, and 18. Waivers in additional LACSD districts will be proposed when projects are proposed in those districts.

Design and construction costs of LFD facilities in Los Angeles County have varied widely based on treatment capacity, site conditions, and sewer infrastructure availability. In addition, LFD facilities require substantial regular maintenance. Similar to initial costs, O&M expenses vary widely based on many factors, such as the type of LFD facility, treatment volume, weather conditions, watershed characteristics, sampling requirements, calibration, and equipment replacement.

Table 6-1 lists the capital and O&M costs associated with the LACFCD's LFD facilities, which range from 60- to 800-gallon-per-minute diversion capacities.

Table 6-1. LACFCD Approximate Capital and Operation Cost of LFDs

Item	One-Time Cost
Capital Costs	
Design, project management, environmental permitting	$50,000 — $500,000
Construction	$150,000 — $2,000,000
Sewer connection fee[1]	$40,000 — $1,000,000
Range of Initial Costs per LFD	**$240,000 — $3,500,000**
O&M Costs	
Maintenance (inspections, telemetry monitoring, logging, reporting, repairs, cleanouts, etc.)	$35,000 — $100,000
Equipment replacement (pumps, sensors, etc.)	$5,000 — $30,000
Annual industrial waste surcharge fee	$5,000 — $30,000
Sewer connection fee trigger (may apply when discharge exceeds permitted volume and/or rate) [1]	$0 — $100,000
Range of Annual Operation and Maintenance	**$45,000 — $260,000**

Source: LACFCD 2014
Notes:
[1] Connection fees for local governmental diversions have been waived in LACSD districts 2, 3, 8, 15, and 18. Waivers in additional LACSD districts will be proposed when projects are proposed in those districts.

6.3.3 Regulatory

Diversion of urban runoff/stormwater creates a regulatory benefit through the perspective of MS4 compliance and reduced storm drain discharges to surface waters. Consequently, this causes potential compliance issues for wastewater agencies due to the increased potential of sewage spills from the introduction of stormwater. Involvement and participation of the regulatory, drainage, and wastewater agencies is necessary to understanding the benefits and determining regulatory liability for diversions.

Summary and Conclusions

Stormwater management in urban areas remains a challenge that requires evaluating and applying a variety of management options such as capture, store, and treat, while generating sustainable new water supplies such as recycled water. Multiple stormwater management solutions are available when it comes to managing stormwater quality and quantity. Resource needs for capital costs (planning, design and construction), land purchase, and skilled labor for ongoing O&M can stress resource allocations for developing long-term sustainable solutions. These projects are intended to provide benefits of increasing water supply, improving water quality, and in some instances providing tangible community benefits. However, unless the projects capture and infiltrate water on-site in areas that augment groundwater or the captured stormwater is used directly on-site, then no water supply benefit is achieved. This White Paper examines a possible alternative, i.e., permissive controlled integration (interconnect) of the existing stormwater system to the wastewater collection system or directly to the WWTP (maximize use of existing infrastructure) and treat urban runoff/stormwater (improve water quality) through the Los Angeles County's 21 WWTPs which would then in turn create a potential new drought-proof water supply in the form of non-potable and potable reuse (increase water recycling). In addition, any stormwater ("first flush") introduced into the wastewater system that cannot be reused will have undergone treatment such that it will aid in MS4 compliance and protection of water quality in the receiving environment. This multifaced approach to maximum utilization of existing wet infrastructure could be cost effective and environmentally sound.

With the recent years of drought and conservation efforts, the flows in the sanitary sewer systems and WWTPs have declined. The effects of low sewer flows on the collection and treatment systems have been documented. This situation has produced seemingly available wastewater collection and treatment capacity, and offers opportunities to introduce stormwater into the wastewater collection system at strategic locations under controlled conditions, that may involve storage of collected stormwater prior to diversion. The added potential water supply would provide water quality and water supply benefits to the region and watershed.

Mapping of the existing wastewater and storm drain infrastructure indicate that a number of potential connection points exist where a stormwater diversion project may be implemented. Further evaluation to understand the hydraulic impacts on the wastewater system needs to be conducted. Permissive integration is system integration through careful consideration of all pertinent agencies that own, operate, and maintain infrastructure to ensure system reliability and compliance. The key to permissive integration is the identification of key interested stakeholders and their early involvement in consultation and planning of these projects.

Key findings of the study and recommendations include:

- Only 28-percent of the Los Angeles Basin is available for groundwater augmentation through stormwater infiltration. This area is densely populated, further limiting future centralized and decentralized project development.
- Within the county, there are approximately 21,000 miles of sewers and 3,300 miles of storm drains owned by LACFCD with thousands of miles of additional city-owned sewer and drainage systems.
- The cumulative municipal wastewater treatment capacity in Los Angeles County is 1.4M AFY. A comparison of pre- versus post-drought flows show a 103,000 AFY reduction in influent sewer flows, from 958,000 AFY in 2010 to 855,000 AFY in 2017. This analysis did not account for population growth from 2010 to 2017.
- Additional sewer capacity cause by the drought presents an opportunity to maximize the use of this infrastructure for the co-equal benefits of water quality and water supply, through the introduction

of stormwater under controlled conditions, likely involving storage of collected stormwater prior to diversion to the collection system.

- Of the current wastewater flows treated, approximately 231,000 AFY are reused for both potable and non-potable uses. Within the next 10 years, planned reuse project will more than double the current reuse flow rate.
- There are 47 LFDs within Los Angeles County that handle dry-weather flows only. LFDs are designed to capture dry-weather flow and provide water quality benefits but are typically not considered a source of water supply. Construction of more LFDs and/or expansion of existing LFDs to accept some of the wet-weather flows should be tested by developing pilot studies.
- Controlled diversion of urban runoff/stormwater from the storm drain system can help to address MS4 requirements while generating the potential for more recycled water to help meet future demands.
- Potential diversions should be analyzed on a case-by-case basis to ensure permissive integration of the storm drain and wastewater systems.
- Projects will need to be evaluated on a case-by-case basis to determine their impacts on both the local conveyance system and the treatment process.
- Projects should be prioritized in coordination with planned investments by water and wastewater agencies to avoid duplication, and leverage all available funding sources. To maximize water quality benefit, priority should also be given to handling dry-weather flows.
- Maximizing the use of existing infrastructure may inherently provide a more cost-effective solution.

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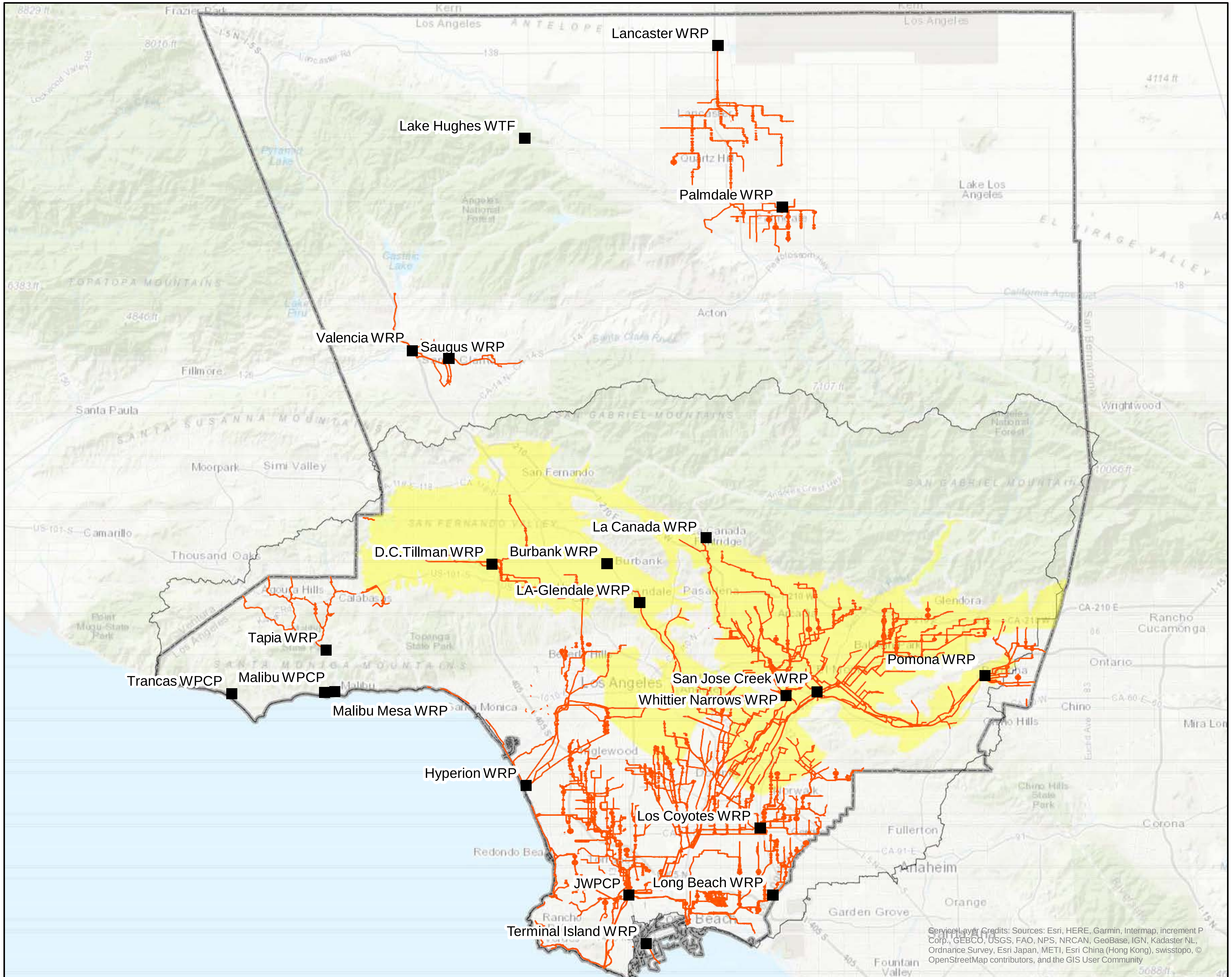
Appendix A
Exhibits



LEGEND

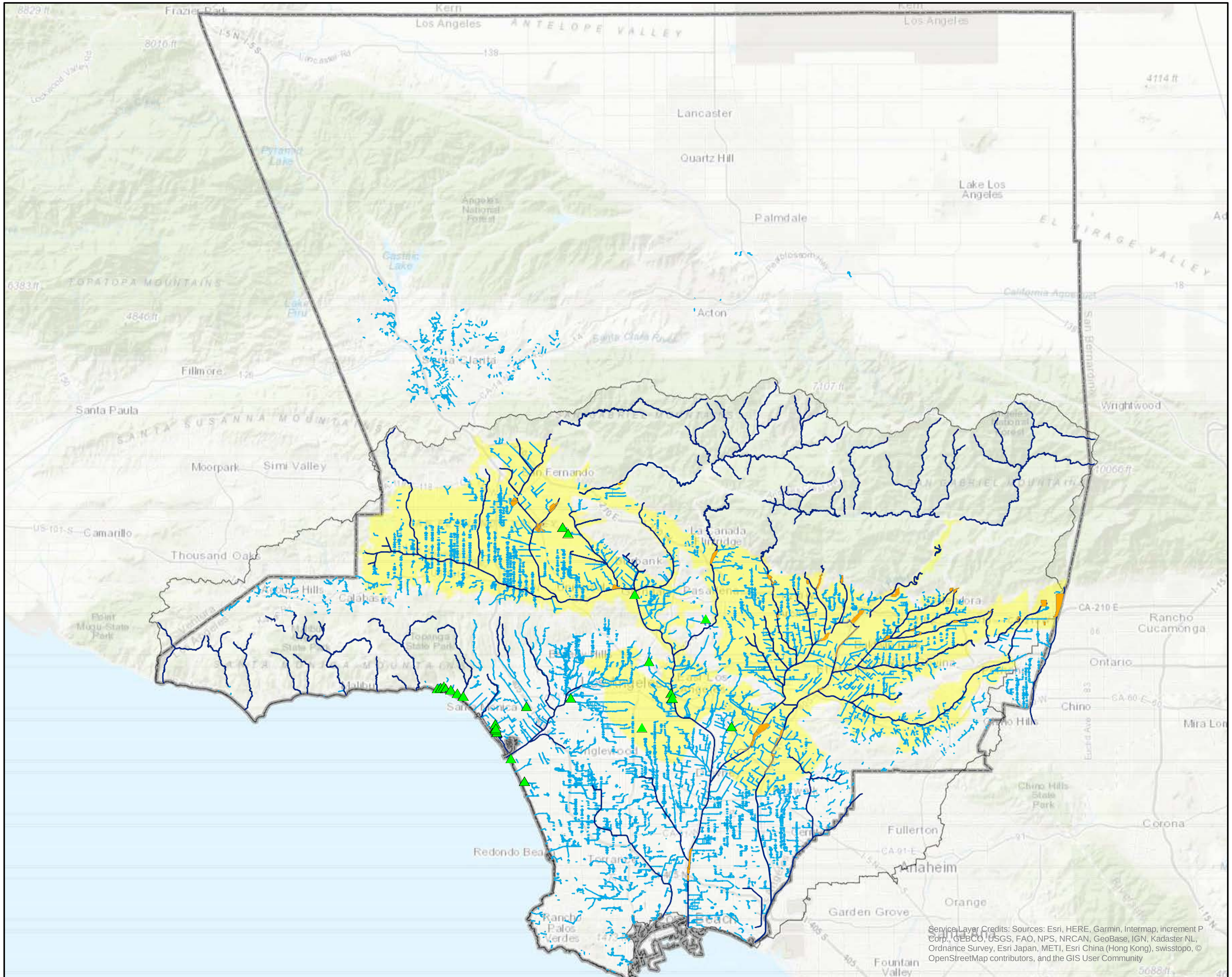
- ■ Wastewater Treatment/Reclamation Facility
- Large Interceptor/Outfall Sewer
- Unconfined Groundwater Area
- Los Angeles Basin
- Los Angeles County Boundary

Notes:
1. For clarity, resolution of piping varies by area. Not all pipes are shown.
2. Maps are intended for high-level analysis. Locations of facilities are approximate.

0 5 10 20
Miles

Exhibit1
Sewer Collection and Treatment Facilities within Los Angeles County

ch2m:



LEGEND

- Stormwater Low Flow Diversion
- Spreading Grounds
- Major Channels
- Storm Drain > 48"
- Unconfined Groundwater Area
- Los Angeles Basin
- Los Angeles County Boundary

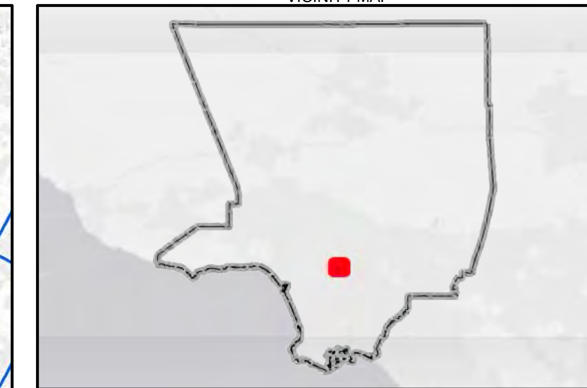
Notes:

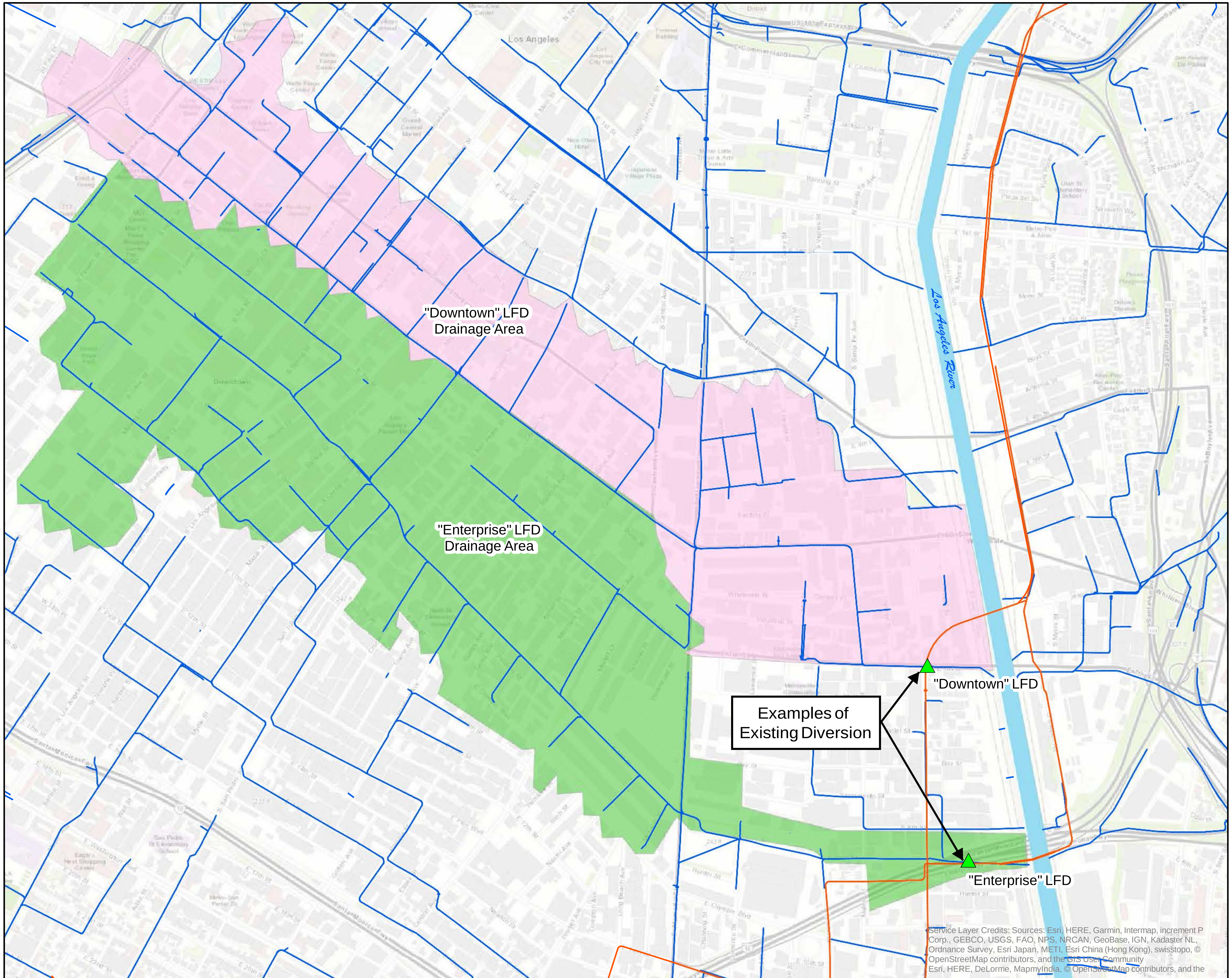
1. For clarity, resolution of pipes varies by area. Not all pipes are shown.
2. Maps are intended for high-level analysis. Locations of facilities are approximate.

0 5 10 20
Miles

Exhibit 2
Flood Management and Storm Drain Facilities within Los Angeles County

VICINITY MAP





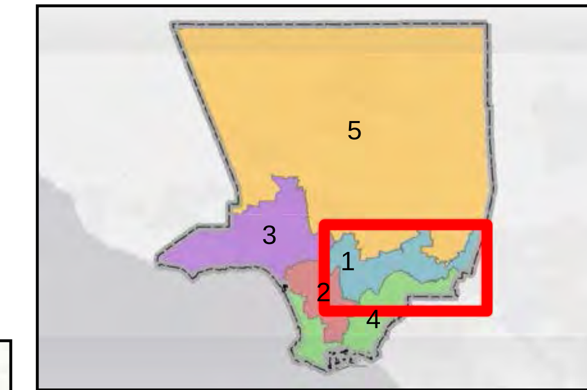
LEGEND

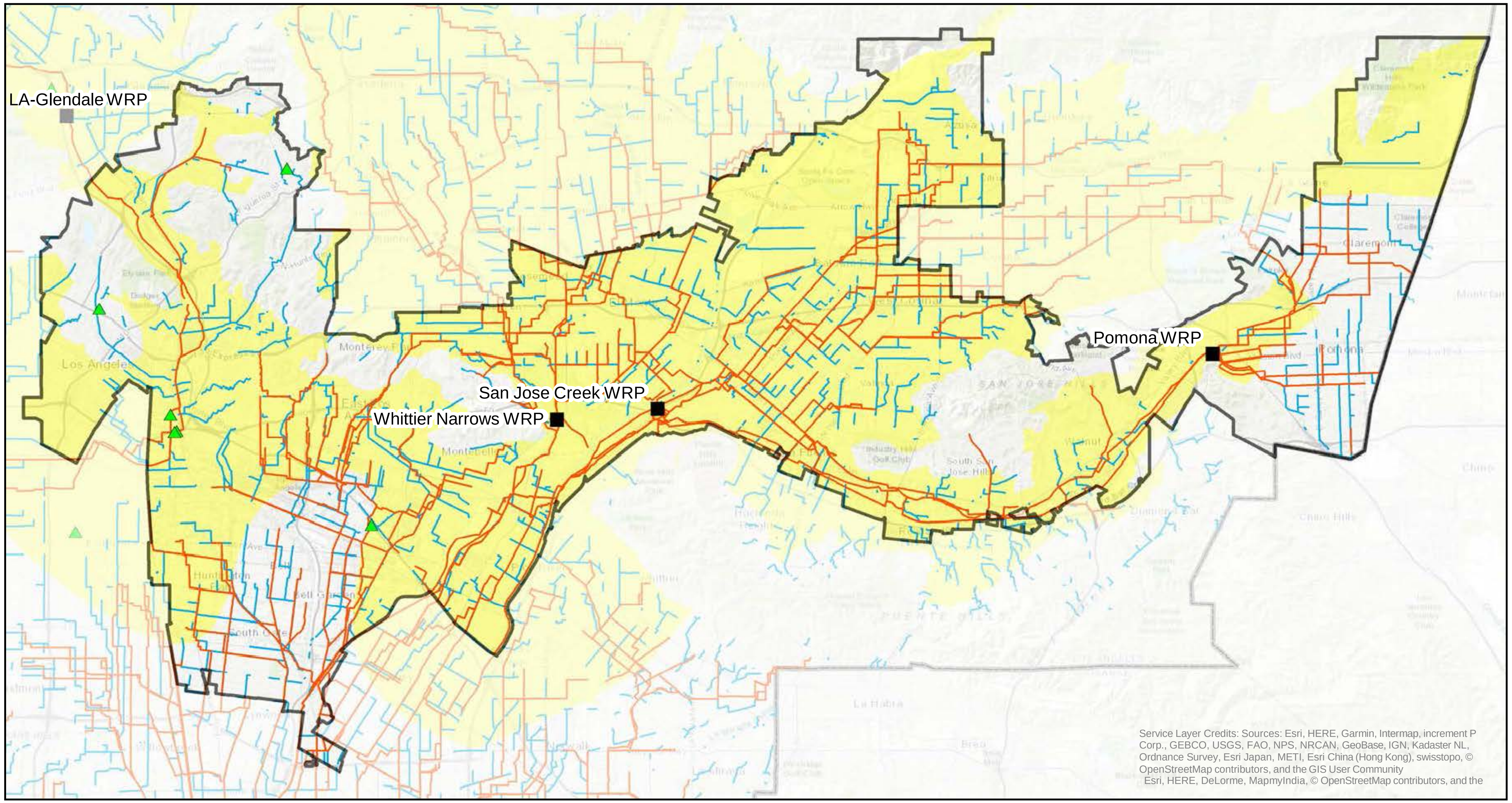
- Stormwater Low Flow Diversion
- Large Interceptor/Outfall Sewer
- Storm Drain
- "Downtown" LFD Drainage Area
- "Enterprise" LFD Drainage Area

N

0 625 1,250 2,500
Feet

Exhibit 3
Examples of Existing Storm Drain Diversions to Sanitary Sewer





LEGEND

- Stormwater Low Flow Diversion
- Wastewater Treatment/Reclamation Facility
- Large Interceptor/Outfall Sewer
- Storm Drain > 48"
- Unconfined Groundwater Area
- Los Angeles County Boundary
- Supervisor District Boundary

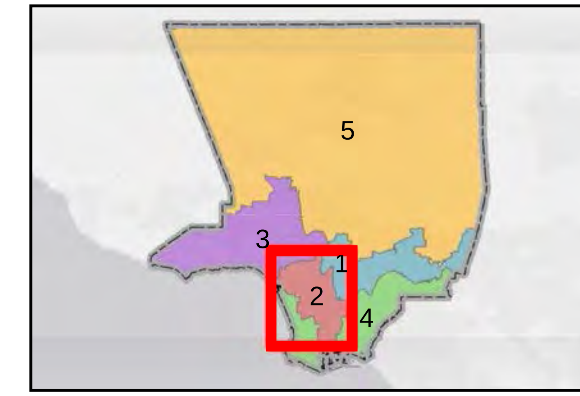
Notes:

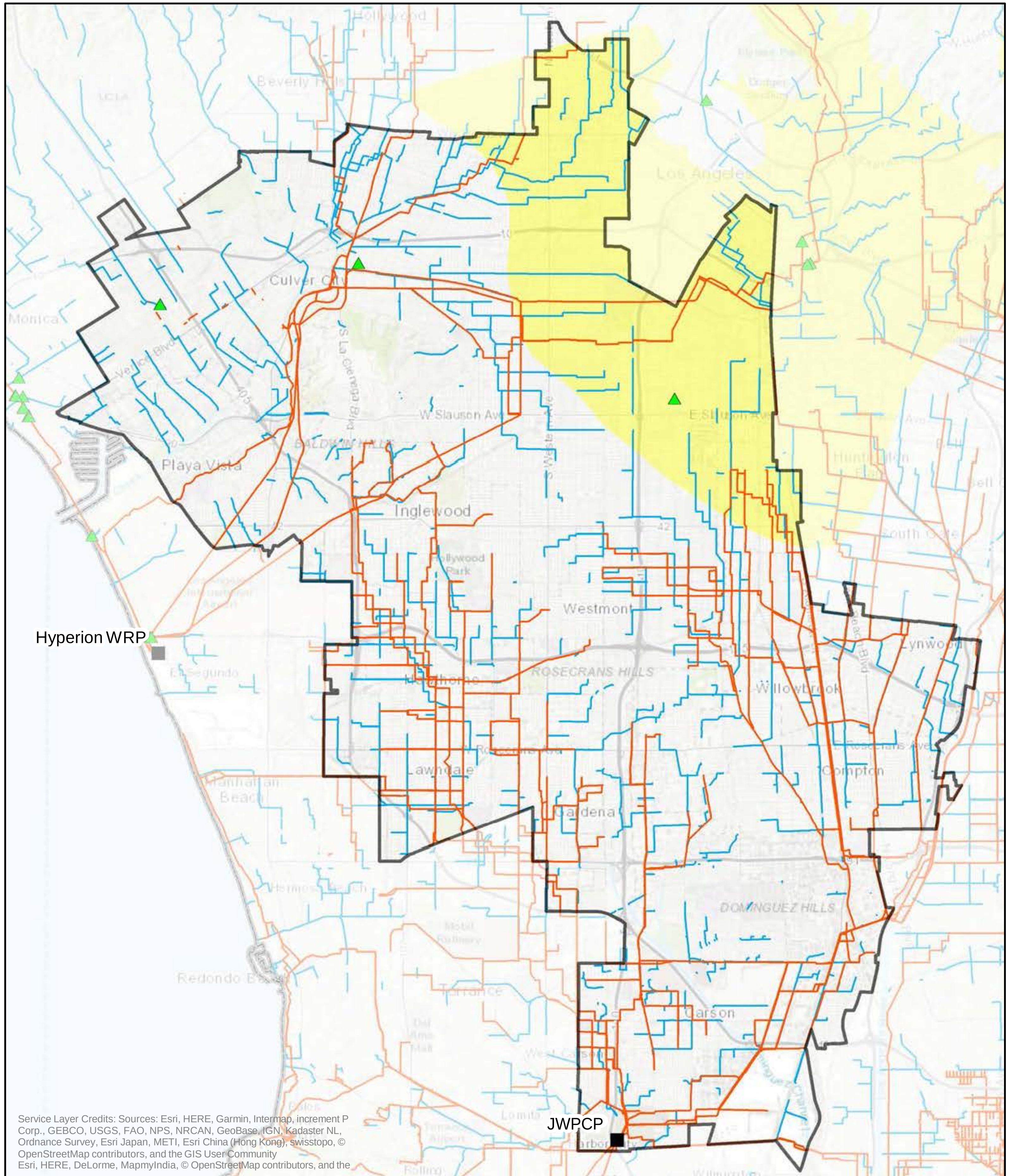
1. For clarity, resolution of piping varies by area. Not all pipes are shown.
2. Maps are intended for high-level analysis. Locations of facilities are approximate.

0 1.5 3 6
Miles

Exhibit 4
Los Angeles County Board of Supervisors
District 1 - Hilda L. Solis
Storm Drain and Sewer Facilities

ch2m





LEGEND

- Stormwater Low Flow Diversion
- Wastewater Treatment/Reclamation Facility
- Large Interceptor/Outfall Sewer
- Storm Drain > 48"
- Unconfined Groundwater Area
- Los Angeles County Boundary
- Supervisor District Boundary

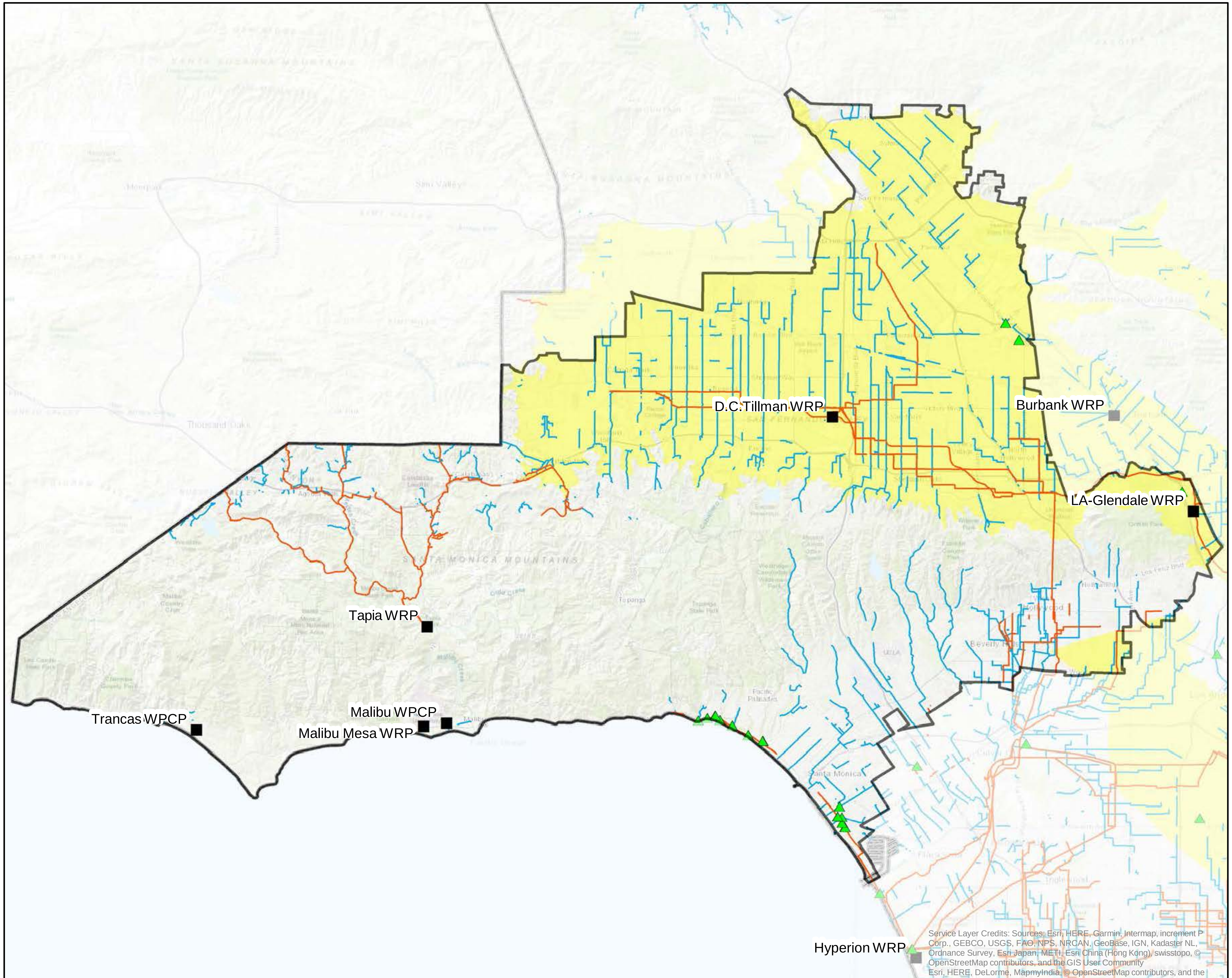
Notes:
1. For clarity, resolution of piping varies by area. Not all pipes are shown.
2. Maps are intended for high-level analysis. Locations of facilities are approximate.

N

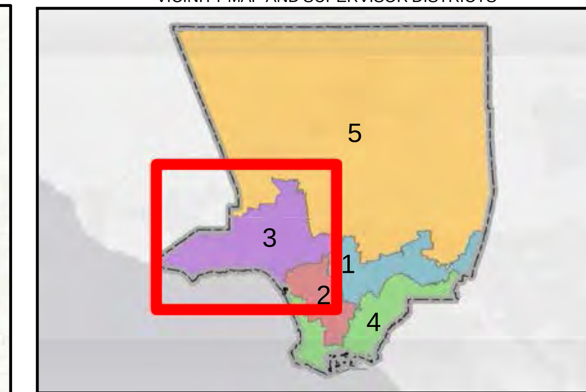
0 1 2 4
Miles

Exhibit 5
Los Angeles County Board of Supervisors
District 2 - Mark Ridley-Thomas
Storm Drain and Sewer Facilities

ch2m



VICINITY MAP AND SUPERVISOR DISTRICTS



LEGEND

- Stormwater Low Flow Diversion
- Wastewater Treatment/Reclamation Facility
- Large Interceptor/Outfall Sewer
- Storm Drain > 48"
- Unconfined Groundwater Area
- Los Angeles County Boundary
- Supervisor District Boundary

Notes:
1. For clarity, resolution of piping varies by area. Not all pipes are shown.
2. Maps are intended for high-level analysis. Locations of facilities are approximate.

N

0 1.75 3.5 7
Miles

Exhibit 6
Los Angeles County Board of Supervisors
District 3 - Sheila Kuehl
Storm Drain and Sewer Facilities

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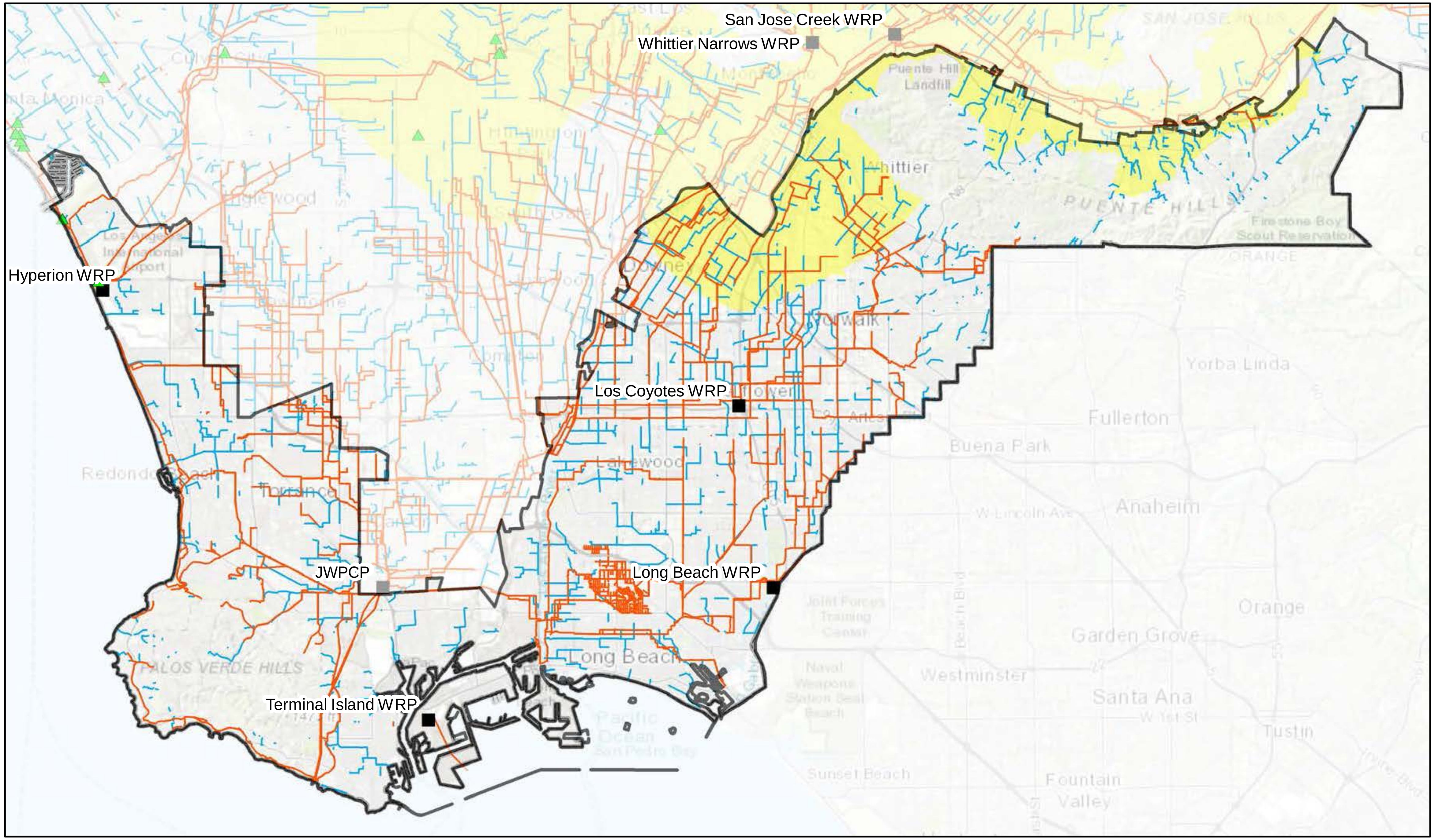
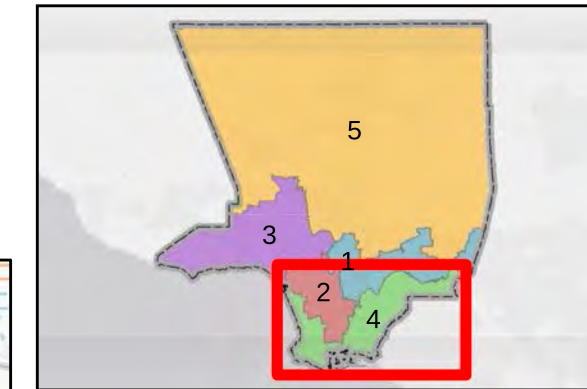


VICINITY MAP AND SUPERVISOR DISTRICTS



LEGEND

- Stormwater Low Flow Diversion
- Wastewater Treatment/Reclamation Facility
- Large Interceptor/Outfall Sewer
- Storm Drain > 48"
- Unconfined Groundwater Area
- Los Angeles County Boundary
- Supervisor District Boundary

Notes:
1. For clarity, resolution of piping varies by area. Not all pipes are shown.
2. Maps are intended for high-level analysis. Locations of facilities are approximate.

N

0 1.75 3.5 7
Miles

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Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the

Exhibit 7
Los Angeles County Board of Supervisors
District 4 - Janice Hahn
Storm Drain and Sewer Facilities

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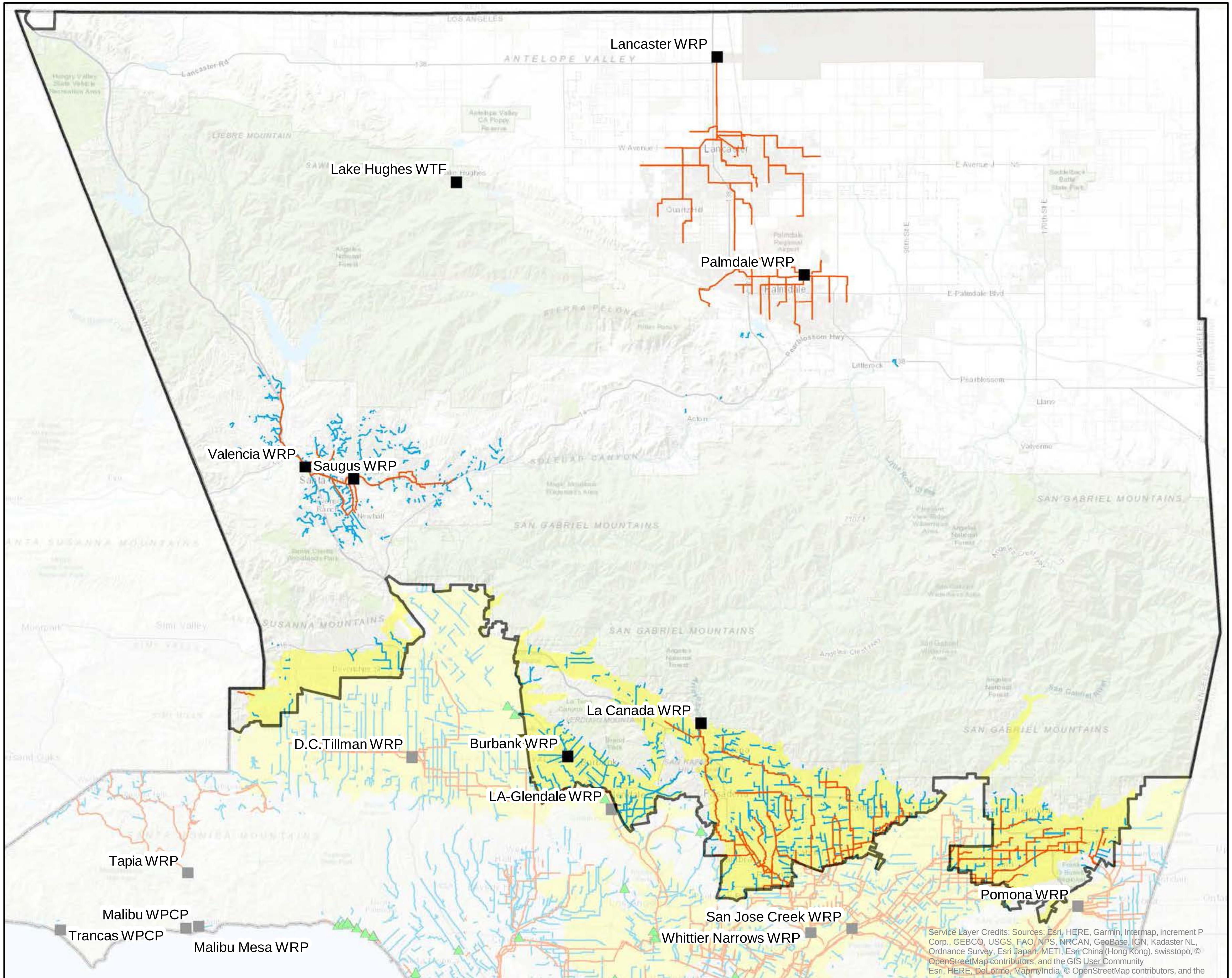
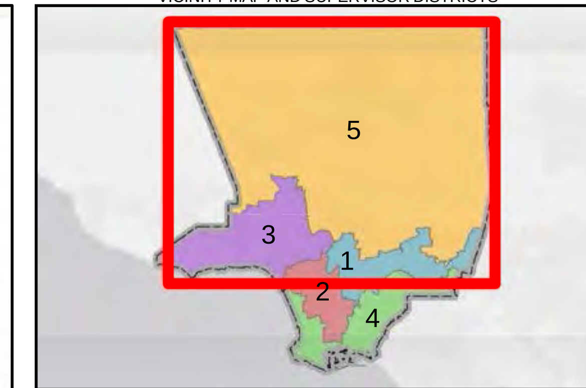
ch2m



VICINITY MAP AND SUPERVISOR DISTRICTS



LEGEND

- Stormwater Low Flow Diversion
- Wastewater Treatment/Reclamation Facility
- Large Interceptor/Outfall Sewer
- Storm Drain > 48"
- Unconfined Groundwater Area
- Los Angeles County Boundary
- Supervisor District Boundary

Notes:

1. For clarity, resolution of piping varies by area. Not all pipes are shown.
2. Maps are intended for high-level analysis. Locations of facilities are approximate.

N

0 3 6 12

Miles

Exhibit 8
Los Angeles County Board of Supervisors
District 5 - Kathryn Barger
Storm Drain and Sewer Facilities

ch2m