PROGRESS MEMORANDUM

TO: Carolina Hernandez, P.E., Los Angeles County Public Works

PROJECT: Los Angeles River Master Plan Update

TASK NUMBERS: 3.1 and 3.2


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The following Progress Memorandum summarizes the significant water resources findings for Los Angeles River Master Plan Update Task 3.1 related to water quality and water supply and Task 3.2 related to flood risk management.

Executive Summary

The 51-mile Los Angeles River (herein referred as “LA River” or “river”) is an engineered channel designed in response to historic flood events to convey stormwater to the Pacific Ocean as quickly and efficiently as possible.

Flood Risk Management

As efforts continue to develop the LA River for multi-use benefits (e.g., ecosystem function, open space, parks and recreation, water quality enhancements, water supply) changes to the river must occur within the constraints of managing flood risk. This includes maintaining existing flood conveyance capacity, improving capacity in deficient reaches, accounting for climate change, and resiliency planning for mitigation/evacuation during extreme events. Most reaches of the river currently meet existing design standards for flood conveyance capacity; however, several distinct reaches do not meet those same minimum standards. Understanding the uncertainty in managing flood risk and the recent increased occurrence of extreme weather events in the United States and around the globe, resiliency planning in the case of extreme weather events within the Los Angeles River Watershed (herein referred as “watershed”) is a critical component of flood risk management.
Water Quality

The LA River is an impaired water body with multiple total maximum daily load requirements (TMDLs) established to regulate pollutants. While over 800 water quality improvement projects are planned or have been completed within the LA River Watershed, additional efforts are needed to meet applicable water quality targets established in Enhanced Watershed Management Program/Watershed Management Program (EWMP/WMP), which are the guidance documents for regulatory compliance. While most EWMP/WMP documents that directly impact the river’s mainstem have sufficient projects in place to meet water quality requirements, there is much uncertainty in the funding and implementation of these plans to keep pace with the approved planned milestones.

Water Supply

More than 50% of the region’s water supply is imported from the Colorado River, Sacramento-San Joaquin River Delta, and the Eastern Sierras. With increasing population, regulatory requirements, and demands on the water system accentuated by decreasing reliability in the sources of water supplies due to cyclical droughts and climate change, the LA River presents an opportunity to develop and diversify local water resources that increases the reliability and resiliency of the region’s water supply.
Flood Risk Management

The 51-mile Los Angeles River and its nine major tributaries drain an 834 square-mile watershed (Figure 1) that consists of steep mountains, foothills, and low-laying alluvial plains. The LA River main stem is measured starting from River Mile (RM) 0 at the Pacific Ocean, up to RM 51 at the confluence of Bell Creek and Arroyo Calabasas. Approximately 62% of the LA River Watershed is developed with mixed land uses.¹ Much of this development is intense urbanization almost exclusively contained on the alluvial plains. During a typical storm the most intense precipitation falls in the mountains, where it runs off the steep slopes and collects rapidly in the tributaries, before entering the main channel. Historically large run-off events resulted in the river channel substantially altering its course across the alluvial plains, resulting in large flood plains that encompassed the San Fernando Valley and much of the lower alluvial plain, including the current location of Downtown LA (Figure 2). These large events are characterized often by extreme precipitation, such as in 1862 where 30 consecutive days of rain resulted in 36 inches of rain in LA and the relocation of the LA River Mouth from Venice (in the current Ballona Creek channel) to Wilmington (near the current LA River Mouth in Long Beach). Other extreme historic precipitation events include 62 inches of rain in the mountains in 24 hours in 1889 (Figure 3).

Figure 1: The LA River starts from the confluence of Arroyo Calabasas and Bell Creek in Canoga Park (at RM51) and ends at the Mouth in Long Beach (RM0). The river drains an 834 square-mile watershed.
Figure 2: Historical flooding and river paths prior to 1825.
With increasing urbanization and development within the flood plain in the early 1900s, the risks and costs associated with flooding began to increase. Public outcry following floods in 1914 led to the formation of the LA County Flood Control District (LACFCD) in 1915, which took charge of developing flood management plans. Devastating floods in the 1930’s resulted in Federal funds and assistance to accelerate the pace of the program with the work being performed under the direction of the US Army Corps of Engineers.

The Flood Control Act of 1936 allocated funds to assist LA County in developing and expanding flood management infrastructure, including further channelizing 51 miles of the Los Angeles River. Construction of the channel occurred in several phases between 1936 and 1959. Subsequent
channel improvements were made as part of the LA County Drainage Area (LACDA) project\(^2\) in the late 1990s to early 2000s to increase channel capacity in the lower 12 miles of the river. These improvements were motivated by the February 1980 flood that exceeded capacity of the river with slight overflow of the levees near Wardlow Road. The 1980 flood was estimated to be a 40-year event, which caused concern, since prior to that event the protection level was thought to be adequate for a 100-year event\(^8\).

Changes in flood exceedance frequencies over time may partly be attributed to the effect of urbanization and the associated increase in impervious surfaces in the watershed. However, the effect of urbanization is primarily to increase the run-off volumes for smaller, frequent storm results, with much less relative effect for the potentially devastating larger events (e.g., the 100-year event) (Figure 4) that are the primary focus of current flood risk management.

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Figure 4. Effect of urbanization on flood exceedance frequency. Left frame is for non-urbanized watershed, Right frame is for urbanized watershed. Urbanization over time leads to substantial increases in discharge flow rates for smaller, frequent events, as the ability of the watershed to infiltrate water is decreased. However, the increases become proportionally smaller for larger extreme events.

Channel Physical Characteristics and Hydraulics

Today the channel consists of a mixture of trapezoidal concrete sections, rectangular concrete sections, and trapezoidal sections with soft bottom (Figure 5). The channel is predominantly trapezoidal in shape, with rectangular sections limited to the San Fernando Valley between Sherman Oaks (RM42) and Burbank (RM33) and over a 1-mile stretch near Vernon (RM18) (Figure 6). The most notable soft bottom region is in the Glendale Narrows region from RM31 to RM24, where early efforts to fully concrete the channel were thwarted by hydrostatic forces from upwelling groundwater. Other soft bottom reaches are in the Sepulveda Flood Control Basin (RM46 to RM44), and the Estuary region (RM3 to RM0) (Figure 6). If not maintained, the soft bottom reaches can become heavily vegetated, often with invasive species, and result in decreased flood conveyance capacity.
Figure 5. Typical channel cross sections along the LA River.
The width of the channel generally increases in the downstream direction (Figure 6) to account for the increasing flow rates as run-off accumulates (e.g., see Design Discharge/Capacity in Figure 7) and/or as the channel slope decreases. Analysis of the physical channel characteristics, including width, shape, and material led to the development of 13 Hydraulic Design Reaches, A through M (Figure 6). The hydraulic and flow characteristics are generally similar within each of these reaches, although local effects (e.g., flow constrictions due to bridges) may result in alterations of the flow regime.

The hydraulics in the LA River are complex (Figure 7), with a mixture of subcritical regions (Froude number < 1 indicating slower, deeper flow) and supercritical regions (Froude number > 1 indicating faster, shallower flow). The flow is predominantly subcritical in the soft bottom portions, including the Sepulveda Flood Control Basin and the Glendale Narrows, although there are short supercritical regions in the Glendale Narrows where the channel bottom locally consists of concrete and the flow is accelerated to reduce depth under bridges.

The concreted portions of the river are predominantly supercritical, although local constrictions such as bridges cause flow to locally backup, form hydraulic jumps, and become subcritical. The flow
regimes between RM15 and RM6 are quite variable, with alternating regions of subcritical and supercritical flow. The hydraulics in this region are likely to be particularly sensitive to changes to the channel, with small physical changes potentially resulting in substantial movement of hydraulic jump locations and associated substantial changes in flow depth. Additionally, there are several regions along the river that are hydraulically unstable (0.86 < Froude < 1.13), which may result in large and unstable surface waves. Effects of these waves are often mitigated by increasing channel height to contain the waves and/or constructing channel side-slopes with rough cobble material to reduce wave run-up.

Figure 7. Design Discharge/Capacity, Flow Depth, Flow Velocity, and Froude number in the LA River

Current Flood Risk

The efforts to channelize the LA River and tributaries to manage flood risk have been largely successful with the identified 100-year floodplain area (Figure 8) vastly reduced, and the 500-year floodplain area substantially reduced (Figure 8) compared to historical floodplains (Figure 2). Notwithstanding the overall success, there are problematic reaches along the river, and flood risk remains a real threat that must be managed and mitigated. For example, the Glendale Narrows reach (RM31 to RM24) has known deficiencies that are exacerbated by the heavy vegetation that has established itself in the soft bottom of the channel (Figure 9).
Figure 8. Flood hazards in LA County including 100-year and 500-year floodplains, tsunami inundation areas, and sea-level-rise.
Figure 9. Flood risk remains a real threat along the Glendale Narrows reach. Left: Recent flood plain modeling by USACE\textsuperscript{9}. Right: photograph taken from Glendale Blvd Bridge.

The deficiency of the Glendale Narrows reach is illustrated by comparing channel capacity and discharges for different flood frequencies (Figure 10). Analyses indicate generally less than 50-year protection in this reach, with many regions having less than 10-year protection, and as low as 3-year protection\textsuperscript{10}.

Further downstream, between Downtown LA and South Gate there is mostly a greater than 100-year protection level, although just downstream of the Arroyo Seco the protection level is only at the 77-year frequency\textsuperscript{11}. Following the LACDA improvements in the late 1990s through early 2000s, the lower

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river has 133-year protection level. For flows greater than the 133-year event there are designed overtopping points downstream of Imperial Highway\textsuperscript{12}.

![FREQUENCY DISCHARGES](image)

*Figure 10. Channel design discharge/capacity and flow rates for different flood frequency intervals.*

Analysis of critical facilities and hazardous material sites (Figure 11) indicates that there are 404 total facilities/sites within the 100-year flood plain, and 4,359 total facilities/sites within the 500-year flood plain (Figure 12). Many of these are within 1-mile of the river as indicated in Figure 6.

\textsuperscript{12} USACE 19967b. U.S. Army Corps of Engineers, Los Angeles District: Los Angeles County Drainage Area Los Angeles River Improvements Project Including Rio Hondo and Compton Creek, Design Memorandum No. 3. October 1997.
Figure 11. Flood hazards and critical facilities within LA County
Figure 12. Flood hazards and critical facilities infrastructure
Water Quality

The LA River Watershed encompasses 834 square miles (Figure 13). Two-hundred seven square miles of the watershed are considered as subwatersheds that drain directly into the mainstem of the river without first entering into major regulated tributary rivers\(^\text{13}\) (herein referred as “direct subwatershed”). Designated beneficial uses of waterbodies in the watershed were established in the Los Angeles Regional Water Quality Control Board Basin Plan (Basin Plan)\(^\text{14}\). Appropriate water quality objectives were subsequently established to ensure the protection of such beneficial uses. 24 beneficial uses were established in the Basin Plan, 18 beneficial uses were identified for waterbodies in the watershed. Beneficial uses that have been attained for a waterbody on or after November 28, 1975 were considered existing beneficial uses. In comparison, beneficial uses were designated as “potential” if there is plan, potential or public desire to put the water to such future use.

As discussed above, approximately 62% of the LA River Watershed is developed with mixed land uses.\(^\text{15}\) Pollutants typically generated from the land use activities, as summarized in Table 1, can be mobilized by dry and wet weather runoff and transported into the river, leading to degraded water quality and creating negative impacts on the aquatic ecosystem as well as human use of the waterway. Many water bodies in the watershed, including the LA River itself, are classified as impaired waters by the Clean Water Act\(^\text{16}\) and require “treatment” to support their designated beneficial uses established in the Basin Plan.

\(^\text{13}\) Such as Tujunga Wash, Arroyo Seco, the Rio Hondo, and others.
Figure 13: Cumulative total and direct tributary areas of the Los Angeles River. Data is derived from the County of Los Angeles LSPC model input.

Table 1: Common pollutants associated with land use types

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Typical Pollutants</th>
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</thead>
<tbody>
<tr>
<td>Residential</td>
<td>Bacteria, Nutrients (Nitrogen, Phosphorus), Trash, Pesticides,</td>
</tr>
<tr>
<td>Commercial</td>
<td>Oil and Grease, Trash</td>
</tr>
<tr>
<td>Transportation</td>
<td>Trace Metals (Copper, Zinc, Lead), Suspended Solid, Volatile Organic Compounds</td>
</tr>
<tr>
<td>Industrial</td>
<td>Trace metals (Copper, Zinc, Lead), Bacteria, Suspended Solid, PCBs, DDTs,</td>
</tr>
</tbody>
</table>

During the development of the County of Los Angeles-led Integrated Regional Water Management Plan (IRWMP) in 2014, water quality modeling was conducted to prioritize areas with significant water quality concerns in the watershed. Subsequently adapted for this effort, the resultant water quality

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priority mapping represents an integrated evaluation of dry and wet-weather drainage quality compared to impaired receiving water bodies, their identified beneficial uses and impairments, and land use-based pollutant loading rates18(Figure 14).

In an effort to restore impaired water bodies, Section 303(d) of the Clean Water Act established Total Daily Maximum Loads (TMDLs), a regulatory item that sets the maximum pollutant allowed to be discharged into an impaired water body. The river is subject to five TMDLs that collectively regulate discharges of 13 pollutants. TMDL targets are established based on pollutant source assessments, as well as human health and ecosystem toxicity analyses. As a result, TMDL targets vary spatially and temporally throughout the river.

Considerable resources from the public and private sectors have been dedicated to improve the water quality within impaired water bodies in the LA River Watershed. Over 800 water quality improvement

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projects are planned, in development, under construction, and/or have been in operation within the watershed to date (Figure 15). The purpose of water quality improvement projects is to capture stormwater and urban runoff for treatment, infiltration, direct use, or discharged to the receiving waters. Water quality improvement projects vary in size and targeted pollutants. They range from regional stormwater retention facilities that can treat up to hundreds of acres of tributary area, to local bioretention planters that are sized to capture and treat stormwater generated on a single parcel. Collectively, water quality improvement projects contribute toward TMDL compliance established in the watershed.

Figure 15: Water quality projects in the Los Angeles River Watershed.

Aiming at a more holistic and effective approach for addressing water quality issues, the 2012 Los Angeles County MS4 Permit allowed permittees to collaboratively develop WMP or EWMP to facilitate watershed-wide implementation strategies for TMDL compliance. Through watershed-specific water quality priority identification and modeling-based reasonable assurance analyses, each EWMP/WMP outlines an implementation plan that includes structural and non-structural best management practices (BMP) necessary to achieve applicable water quality targets. The watershed is subject to one EWMP (Upper Los Angeles River Watershed EWMP) and two WMPs (Los Angeles River Upper Reach 2 WMP and Lower Los Angeles River WMP). The three plans established structural BMP implementation targets in terms of static volume retention for each subwatershed. Utilizing the EWMP/WMP
implementation targets and the project database developed in Task 2 of the LARMP Update, the EWMP/WMP capacity targets and capacity achieved within the 207 square miles of the direct subwatersheds\textsuperscript{19} were aggregated to create the EWMP/WMP target ruler (Figure 16). Although it can be shown that planned and/or completed projects help to nearly meet the requirements set forth in the 2012 MS4 permit, there is much uncertainty in the funding and implementation of these plans to keep pace with the approved planned milestones.

\textbf{Figure 16:} Comparison between total EWMP/WMP capacity targets and targets achieved by already planned or completed projects to-date. Additional water quality improvement projects are needed in some locations to meet the capacity targets.

\textsuperscript{19} As defined previously, direct subwatershed refers to those tributary areas that flow into the mainstem of the river without entering major regulated upstream tributaries such as the Tujunga Wash, Arroyo Seco, the Rio Hondo, and others.
Water Supply

Water is a scarce and valuable resource in Southern California. More than 50% of the region’s water supply is imported from the Colorado River, Sacramento-San Joaquin River Delta, and the Eastern Sierras.\(^\text{20}\) In the Los Angeles Basin, the sources of water supply are comprised of 57% from imported water, 34% from groundwater, and 9% sourced from recycled water, water conservation measures, and local surface water diversions.\(^\text{21}\) There is a regional desire by the major water suppliers in the greater Los Angeles Basin to increase reliability by improving local water supply.\(^\text{22,23,24,25,26}\) Local water supply sources include groundwater, recycled water, and stormwater. With increasing population, regulatory requirements, and demands on the water system accentuated by decreasing reliability in the sources of water supplies due to cyclical droughts and climate change, it is crucial to diversify and develop local water resources strategies that increase the reliability and resiliency of the region’s water supply.

Hydrology

The Los Angeles River drains an 834-square mile watershed. Rainfall exhibits both inter-annual and intra-annual variability with mean annual rainfall depths varying between 13 inches in the lower reaches and 39 inches in the mountains. The wettest months of the year occur between October and April, as is typical of Mediterranean climates (Figure 17).

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\(^{20}\) The Metropolitan Water District of Southern California, 2015, Urban Water Management Plan
\(^{21}\) U.S. Department of the Interior Bureau of Reclamation, County of Los Angeles Department of Public Works Los Angeles County Flood Control District, November 2016, Los Angeles Basin Study
\(^{22}\) ibid
\(^{23}\) Mayoral Executive Directive No. 5, October 2014, Emergency Drought Response – Creating a Water Wise City
\(^{24}\) Los Angeles Department of Water and Power, 2015, Urban Water Management Plan
\(^{25}\) Water Replenishment District of Southern California, 2016, Groundwater Basins Master Plan
\(^{26}\) Los Angeles County Department of Public Works, 2014, The Greater Los Angeles County Region Integrated Regional Water Management Plan Update
Figure 17: Annual and seasonal precipitation variability in the LA River Watershed

As shown in Figure 18, hydrologic drivers in the LA River Watershed are numerous: inputs to the Los Angeles River are comprised of wet weather runoff originating in the mountains and flatlands and dry weather inputs from incidental dry weather urban runoff, groundwater upwelling in the soft bottom reaches, and effluent discharge from the Donald C. Tillman Water Reclamation Plant (DCTWRP), Los Angeles Glendale Water Reclamation Plant (LAGWRP), and Burbank Water Reclamation Plant (BWRP). Beneficial use includes demand from the underlying groundwater basins, namely the groundwater basins managed by the Upper Los Angeles River Area (ULARA) and the Water Replenishment District of Southern California (WRD), habitat in the Glendale Narrows region, significant bird habitat in the lower reaches between RM 9 and 3, and recreation in several locations including the Sepulveda Basin and Glendale Narrows.
Figure 18: Hydrologic drivers in the LA River Watershed

Dry Weather Flows

Inflows to the river consist of dry weather and wet weather flows. Dry weather inflows are comprised of incidental urban runoff entering the river through storm drain outfalls, flows from the three WRPs, and groundwater upwelling. Dry weather outflows consist of evaporation and evapotranspiration (ET) as shown in Figure 19. The assumptions on possible existing dry weather flow were based on the One Water LA 2040 Plan Volume 8 Technical Support Materials and updated for the LARMP Update process. Dry weather inflows from DCTWRP and LAGWRP were assumed to be 42.0 cfs at RM 43 and 12.1 cfs at RM 30, respectively, based on the 10th percentile of daily average total effluent flow between 2013 and 2015. Dry weather inflow from BWRP was assumed to be 7.0 cfs at RM 32 based on the National Pollutant Discharge Elimination System (NPDES) Permit CA0055531. Groundwater upwelling was assumed as 5.6 cfs applied evenly throughout the soft bottom reach based on the 11-year annual average (WY2002-03 – WY2012-13). Incidental urban runoff was assumed to be 84 gallons per day per impervious acre (gpd/imp ac) based on monitoring from 12 low flow diversions.

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27 City of Los Angeles, October 2017, One Water LA 2040 Plan, Volume 8 – Technical Support Materials, Final.
29 Water Replenishment District of Southern California, ULARA 2014, Water Year 2012-2013 Watermaster Report
that the City of Los Angeles operates. Finally, evaporation was applied along the entire length of the river while ET was applied in the reaches where riparian vegetation exists. Evaporation and ET values were based on the Los Angeles County LSPC model’s potential ET values, which are based on conversion of computed National Climatic Data Center (NCDC) evaporation pan data from Long Beach Airport (Gage 23129) and Burbank-Glendale-Pasadena (Gage 23152) using pan coefficients of 0.74-0.78. This equates to a composite ET of 0.50 inches per day (in/d) for reaches upstream of RM 24 and 0.41 in/d for reaches downstream of RM 24. This analysis estimates existing dry weather flow as 51,000 acre-feet per year (AFY) at the mouth of the river (Figure 19). Note that the RM markers on the horizontal axis represent one-mile intervals with RM 51 and RM1 representing RM51-RM50 and RM1-RM0, respectively.

Figure 19: Estimated existing dry weather flow in the LA River

In recent years, agencies and municipalities have expressed intent to increase reuse of water treated at WRPs that currently discharge effluent into the LA River, as well as to manage groundwater upwelling and urban runoff. Combined, these actions could change the current beneficial uses of the existing dry weather flow regime within the river. In response to this challenge, the State Water Resources Control Board along with the Los Angeles Regional Water Quality Control Board (together, “the Water Boards”), both of which support maximizing the use of recycled water and protecting
beneficial uses, has embarked on a multi-year study (currently in first year) to develop an approach to balancing the impact of dry weather flow diversions with the identified beneficial uses.

Upon review of the dry weather inputs, and their potential for reductions in the future, it is conceivable that the current dry weather flow regime could approach zero. A possible future dry weather flow scenario was estimated by assuming that all three WRPs recycle 100% of their effluent, groundwater upwelling is reduced by 50%, urban dry weather urban runoff is reduced by 50% from a partial implementation of the EWMPs and WMPs by 2038, and ET increases by 25%. This results in a possible future dry weather flow of 1,000 AFY at the mouth of the river (Figure 20).

![Estimated Possible Future Dry Weather Flow](image)

**Figure 20: Estimated possible future dry weather flow in the LA River**

Understanding the current Water Boards' process for developing the future low flow regime, a plausible future dry weather flow scenario was estimated by assuming that two-thirds (28 cfs or 67%) of existing effluent from the DCTWRP is used to recharge groundwater and the same reduction of 67% is applied to the effluent flowrates from LAGWRP and BWRP resulting in 4 cfs released from LAGWRP and 2.3 cfs released from BWRP. It was also assumed that groundwater upwelling is eliminated due to it being managed by the Los Angeles Department of Water and Power (LADWP) and dry weather urban runoff ceases due to implementation of the EWMPs and WMPs by 2038. This results in a possible
future dry weather flow of 10,000 AFY at the mouth of the river – an 80% reduction in the estimated existing dry weather flow (Figure 21).

Figure 21: Estimated plausible future dry weather flow in the LA River

Wet Weather Flow

Wet weather flows were estimated using the Los Angeles County Watershed Model for the Loading Simulation Program in C++ (LSPC), developed by Los Angeles County Department of Public Works (LACDPW)30 and adapted for LADWP’s Stormwater Capture Master Plan (SCMP)31, and One Water LA.32 Comparison of modeled flow volumes with USGS gage 11103000 at Los Angeles River above Long Beach for the period of available overlapping record (WY1989 - WY1992) indicates modeled

31 Los Angeles Department of Water and Power (LADWP), 2015, Stormwater Capture Master Plan.
annual flow volumes are typically within approximately 1% of measured annual flow volumes (LACDPW, 2010, Figure 843). The annual runoff volumes at the mouth of the LA River were extracted from the model by quantifying the total precipitation over the LA River Watershed and the contributing flows from each portion of the watershed for each water year (WY) between 1988 and 2011. The wettest year was WY 2005 (October 1, 2004 through September 30, 2005) resulting in a discharge volume of 950,000 AF at the mouth and the driest year was WY 2007 (October 1, 2006 through September 30, 2007) resulting in a discharge volume of 51,000 AF at the mouth (Figure 22). It is notable to mention that the driest year discharge volume is comparable to average dry weather runoff at the mouth.

Figure 22: Wet weather flows at the mouth of the LA River

**Groundwater Basins**

Local groundwater basins are unique and valuable resources that play a critical role in the management of local water resources. Groundwater development has multiple water supply and level-
of-service benefits including reduction of imported water through increased local water supply, flexibility to adjust the resource mix within an integrated water strategy, and improved water system resiliency through access to underground storage and contingency reserves during droughts or emergencies. Local groundwater basins offer reliable water storage of recycled water and captured stormwater, as well as natural replenishment during wet years.

The ULARA Watermaster manages the four groundwater basins overlying the ULARA, which are the San Fernando Basin (SFB), Sylmar Basin, Verdugo Basin, and Eagle Rock Basin. One of the key challenges in the ULARA is the need to increase recharge into the local groundwater basins due to historical over-pumping, particularly in the SFB. The figure below shows the cumulative change in storage in the SFB since the beginning of safe yield operation implemented by the Superior Court for the County of Los Angeles (Court) in the Fall of 1968 in an effort to stop the overdraft of the SFB that began in 1954. The State Water Resources Control Board’s Division of Water Rights established a regulatory requirement of 360,000 AF for groundwater storage, which considered wet and dry cycles, operational flexibility, and annual pumping based on the calculated safe yield. It established an upper regulatory storage limit of 210,000 AF above the 1954 storage level to prevent excess groundwater from rising and leaving the basin and a lower regulatory storage limit of 150,000 AF below the 1954 storage level to allow for additional storage space in wet years. The graph also tracks the cumulative change in groundwater storage (blue area) since 1968 and shows that there has been an overall declining trend in groundwater storage since 1980 (Figure 23). This decline can be attributed to several factors including pumping in excess of long-term recharge, decrease in natural recharge caused by increased urbanization and runoff leaving the basin, and a decrease in stormwater spreading. In 2016, the available storage space in the SFB is approximately 600,000 AF\(^{34}\).

\(^{34}\) Upper Los Angeles River Area, December 2017, Annual Watermaster Report, 2015-16 Water Year
LACDPW and LADWP jointly operate spreading basins in the northeastern portion of the SFB, downstream of Pacoima, Big Tujunga, and Hansen Dams, with the goal of partially offsetting the increase in runoff due to urbanization. The long-term average amount of spreading operations in the SFB is 30,000 AFY (Figure 24 and Table 2).
Figure 24: Annual spreading operations in the San Fernando Basin
### Table 2: Annual spreading operations in the San Fernando Basin (from Figure 24 above)\(^{35}\)

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<th>Year</th>
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<th>Hansen Lopez</th>
<th>Pacoima</th>
<th>Tujunga</th>
<th>TOTAL (acre-feet)</th>
<th>Headworks</th>
<th>Tujunga</th>
<th>TOTAL (acre-feet)</th>
<th>Grand Total (acre-feet)</th>
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</table>

\(^{35}\) Spreading by Burbank began in 2009-10 Water Year following completion of the Burbank MWD connection. These volumes are reported by LACDPW spreading data, and are therefore included in the “Grand Total” column.

---

1. Spread by Burbank began in 2009-10 Water Year following completion of the Burbank MWD connection. These volumes are reported by LACDPW spreading data, and are therefore included in the "Grand Total" column.
WRD manages the Central Basin (CB) and West Coast Basin (WCB), which overlie the reaches of the LA River downstream of downtown LA. Prior to the 1960s, extractions from both groundwater basins exceeded natural replenishment resulting in declining groundwater levels and seawater intrusion into the WCB. As a result, both basins were adjudicated to limit the amount of annual groundwater extraction: The CB was adjudicated in 1965 and established an Allowable Pumping Allocation (APA) of 217,367 AFY. The WCB was adjudicated in 1961 and allows for extraction of 64,468.25 AFY. These pumping rights are based on historical use and not safe yield of the basins. To allow pumping in excess of natural safe yield (173,400 AF), WRD and its partners replenish water artificially through surface spreading, injection at seawater barrier injection wells, and through the District’s In-Lieu Program, and charge pumpers a Replenishment Assessment (RA) to cover the replenishment costs in both basins. The sources for replenishment water are recycled water provided by the Sanitation Districts of Los Angeles County (SDLAC), West Basin Municipal Water District (WBMWD), and Los Angeles Sanitation Bureau (LASAN); imported water provided by the Metropolitan Water District of Southern California (MWD); and in-lieu water. WRD in partnership with LACDPW recharges groundwater through surface spreading in the Montebello Forebay Spreading Grounds, within the unlined portion of the San Gabriel River, and behind the Whittier Narrows Dam in the Whittier Narrows Reservoir. The long-term replenishment volume averages 130,000 AFY, of which 50,000 AFY is local water consisting of stormwater and river base flow (Figure 25 and Table 3). WRD also injects water at the three seawater intrusion barriers, that are owned and operated by LACDPW, which consist of the West Coast Basin Barrier Project (WCBBP), the Dominguez Gap Barrier Project (DGBP), and the Alamitos Barrier Project (ABP). The long-term average amount of replenishment water used for injection is 30,000 AFY (Figure 25 and Table 3). Additionally, WRD has an In-Lieu Program that provides an alternative means for replenishing groundwater by encouraging basin pumpers to purchase imported water when available instead of pumping. Historically, the majority of the water has been provided by MWD’s seasonal discounted water, but this has been suspended since 2011 due to lack of surplus supplies caused by drought and other factors. There remain, however, a few local projects within the City of Long Beach. The long-term average of In-Lieu water is 19,000 AFY (Figure 26 and Table 4).36

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STORMWATER AND RIVER BASEFLOW CAPTURE VARIES YEAR TO YEAR

The long-term average amount of stormwater and river baseflow captured and recharged in the Montebello Forebay Spreading Grounds is approximately 50,000 acre-feet per year.

Figure 25: Historical amounts of water recharged in the Montebello Forebay Spreading Grounds
Table 3: Historical amounts of water recharged in the Montebello Forebay spreading grounds (in acre-feet)(a) 
(from Figure 25 above)

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<td>River Baseflow</td>
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(a) Includes the Figueroa Spreading Grounds, White Sands Reservoir Conservation Field, San Gabriel spreading grounds and unlined San Gabriel River below Station F283.

(b) CBMWD purchased 1,530 af of imported water for spreading for Downey, Lakewood, and Cerritos.

(c) Includes 1,670 af of EPA extracted groundwater from WNDW considered lower area replenishment water paid for by WRD in 2013.

(d) Includes 500 af of EPA extracted groundwater from WNDW considered lower area replenishment water paid for by WRD in June 2005.

(e) Includes 13,000 af of water banked by Long Beach under a storage agreement with WRD (792 of GLW, 12,210 of P74).

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

37 ibid
Figure 26: Historical amounts of replenishment water for Central and West Coast Basins
### Table 4: Historical amounts of replenishment water for Central and West Coast Basins (in-acre-feet) (from Figure 26 above)\(^{38}\)

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<th>Total</th>
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<td>118,222</td>
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<tr>
<td>2012-13</td>
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<td>2015-16</td>
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<td>118,222</td>
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</tr>
<tr>
<td>2016-17</td>
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<td>13,258</td>
<td>118,222</td>
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</tr>
<tr>
<td>Average</td>
<td>100,964</td>
<td>13,258</td>
<td>118,222</td>
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<td>2,535,869</td>
<td>2,030,995</td>
<td>2,950,480</td>
<td></td>
</tr>
</tbody>
</table>

\(^{38}\) ibid
The WRD Board of Directors also determined, after extensive review and analysis of water level fluctuations in the district, that the optimum quantity of Accumulated Overdraft (AOD) is 612,000 AF and the minimum quantity of AOD is 900,000 AF. They also adopted a policy related to managing the basin when the Optimum AOD falls too low: “An Accumulated Overdraft greater than the Optimum Quantity is a deficit. WRD will make up the deficit within a 20-year period as decided by the Board on an annual basis. If the deficit is within 5 percent of the Optimum Quantity, then no action needs to be taken to allow for natural replenishment to makeup the deficit.”39 Figure 27 illustrates how WRD, in partnership with LACDPW, LACFCD, SDLAC, LASAN, and WBMWD, has been highly successful at managing and keeping the basin in balance, within the Optimal AOD.

Figure 27: Accumulated overdraft in the WRD groundwater basins

Historical replenishment averages 178,000 AFY, consisting of approximately 60% of recycled, local, makeup and in-lieu water, and 40% of imported water. Historical total water use in the WRD service area averages to about 620,000 AFY, with approximately 250,000 AFY in groundwater production, 350,000 AFY in imported water use, and 20,000 AFY in reclaimed water use.40 Figure 28 shows how

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39 ibid.
40 ibid.
through WRD’s aggressive conservation efforts and effective management of the basin, demand for imported water has been reduced. For the past 30 years, direct water use overlying the basin has been steadily declining. During this same time period, imported water use overlying the basin has decreased by over 200,000 AFY while recycled water use has steadily increased to approximately 35,000 AFY.

**Figure 28: Direct water use in the WRD service area**

In 2016-17, total overlying demand in the WRD service area was 487,000 AF, of which 298,000 AF was demand in the Central Basin and 189,000 AF was demand in the West Coast Basin. In the Central Basin, 183,000 AF was supplied through water rights extractions, 101,000 AF was supplied through imported water, and 14,000 AF was supplied through recycled water. In the WCB, 27,000 AF was supplied through water rights extractions, 139,000 AF was supplied through imported water, and 23,000 AF was supplied through recycled water (Figure 29).
Recent Judgement Amendments allow for water rights holders enhanced use of unused storage space in the CB and WCB and for increased pumping above the adjudicated rights by recharging the basin with new water supplies through water augmentation projects. The Amendments include rules for the use of the unused storage space, which is divided into basin operating reserve, individual storage accounts, community storage pool, regional storage projects, and water rights transfers. Pumpers are permitted to convert carryover to storage for later recovery and for use of 330,000 AF of storage space in the Central Basin and 120,000 AF of storage space in the West Coast Basin. The ability to use storage provides pumpers the ability to bank water for future uncertainty. Storage and augmentation can be used to allow pumpers to meet greater demand from the basin and reduce overlying use of imported water. The Los Angeles River is a potential supply source for augmentation and increased groundwater production, providing valuable benefits for the region.

Groundwater recharge pathways vary. The SFB overlies an unconfined aquifer, which makes it suitable for surface spreading while the CB and WCB overlie confined aquifers. The 2015 SCMP41 created an inventory and synthesized existing and planned actions by LADWP, LACFCD, other City, County, regional, and Federal agencies, and local non-governmental entities that impact stormwater.

41 LADWP, August 2015, Stormwater Capture Master Plan.
Extensive hydrologic modeling calculated the amount of stormwater generated and the multiple constraints associated with capturing the stormwater for beneficial use and determining the realistic amount of stormwater that can be relied upon currently and under future scenarios. Some of the identified projects are located at County-owned or jointly managed facilities, which include Big Tujunga and Pacoima Dam to LA Filtration Plant, Big Tujunga Dam Sediment Removal, Canterbury Power Line Easement, LA Forebay Recharge System (LAR Pilot, LAR Full Scale, and Upper Ballona), Old Pacoima Wash, San Fernando Road Swales, Spreading Grounds Optimization, Valley Generating Station Stormwater Capture (Phase I and II), and Van Norman Stormwater Capture, among many others.

Development of local water supply represents a resource value that accrues over time. The value can be monetized by avoiding expenses of purchased water. In addition, due to the uncertain nature in the availability of purchased imported water, there is a regional value to increasing the volume of local groundwater storage and developing local supplies and that are in excess of the value of the purchased water itself.

Conclusions

1. Flood Management Capacity
   - The flood management capacity of the Los Angeles River has been vastly improved through channelization efforts during the 1930s through 1950s, and subsequent improvements in the Lower River in the late 1990s through early 2000s. Despite these efforts flood-risk remains a real threat, particularly in the Glendale Narrows reach. Finding solutions for these deficient conditions remains a priority.

   - The history of the LA River channelization indicates that improvements typically followed large and often catastrophic flood events. Even the recent improvements in the lower river were motivated by a large event in 1980 that resulted in re-analysis of flood frequency incorporating additional decades of hydrology data. Today, it is almost three decades since the hydrology was studied, and the current levels of protection were estimated. Given the large amount of additional data, improved analysis techniques, and the acknowledgement of climate change and non-stationarity, it is imperative that the hydrology be revised to better estimate and proactively manage flood risk.

   - It is acknowledged that while flood risk can be managed to a certain level, there is always the possibility of the “big one” resulting in inundation of cities and neighborhoods. Planning should involve assessment of locations of critical infrastructure and hazardous facilities, to plan evacuation routes and other mitigation strategies. Updated hydrologic analyses and more detailed flood plain mapping including estimates of flow velocities and depths may form an important part of this analyses.

2. Water Quality
   - The Los Angeles River is an impaired water body with five TMDLs established for 13 pollutants. Three EWMP/WMPs have been developed within the Los Angeles River
Watershed and served as the guidance for TMDL compliances. Additional water quality improvements are needed to meet water quality targets established in EWMP/WMPs.

- Uncertain funding and implementation scenarios exist making the timeline to water quality compliance difficult to predict. Creative funding measures and alternative project delivery scenarios, such as public-private-partnerships, may be required to keep pace with regulations.

3. **Water Supply**

- Approximately 50,000 AF of dry weather flow travels down the Los Angeles River to the ocean every year. The average annual volume of wet weather flow that reaches the ocean is approximately 280,000 AF (ranging from less than 50,000 AF to nearly 1,000,000 AF).

- The LA River’s base flow and stormwater flow are valuable resources that can be used to develop the region’s local water supply portfolio to reduce the region’s dependence on imported water and improve system reliability and resilience.

- Efforts to capture flows in the Upper and Lower LA River Watershed for groundwater recharge in the SFB and CB should continue to be prioritized.
FLOOD RISK MANAGEMENT

LA RIVER FLOOD CHANNEL, 1978
Source: Clarence Inman Collection, Floodwaters rushing along the Narrows southward under the Los Feliz Bridge in 1978. Accessed from: https://boomcalifornia.com/2013/06/17/showdown-at-the-glendale-narrows/
THE LA RIVER AND ITS 9 MAJOR TRIBUTARIES, DRAIN AN 834 SQ. MI. WATERSHED
SLOPES IN THE UPPER WATERSHED ARE PREDOMINANTLY ORIENTED TO THE SOUTH
THE LA RIVER DROPS 780 FEET IN JUST 51 MILES

HISTORICAL WETLAND ECOLOGY (1870)

HISTORICAL FLOODING AND RIVER PATHS PRIOR TO 1825

Source: Based on Blake Gumprecht, "The Los Angeles River: Its Life, Death, and Possible Rebirth.", 2001
Noachian Deluge of California:
- 30 consecutive days of rain
- 35" in LA City
- LA River mouth shifts from Venice to Wilmington

Los Angeles Basin Flood:
- 10" rain
- 45 deaths regionally
- 5,601 homes lost
- $70 million damage

Tropical Storm:
- 5.42" in LA

Major Storm:
- 7.36" in LA in 24 hours
- 45 deaths regionally

Major Storm:
- 87 deaths in California

Major Storm:
- 13.4" in 10 days

Major Storm:
- 12.75" in 9 days
- 30 deaths regionally

El Nino fuels winter storms:
- downed trees and powerlines
- mud and debris flows prompted evacuation

LA RIVER HISTORY: NORTH FIGUEROA BRIDGE AT ARROYO SECO 1938

Source: Los Angeles Public Library, Image from Boyle Heights
LA RIVER HISTORY: GRIFFITH PARK 1938

Source: Army Corps of Engineers, 1938, Griffith Park
LA RIVER HISTORY: 1948-1951
HYDRAULICS

Source: Olm
Analysis of the River channel geometry: vegetation (roughness), width, depth, and slope.

Channel geometry data were extracted from the US Army Corps one-dimensional HEC-RAS (Hydraulic Engineering Center - River Analysis System) version 4.1 model for the Los Angeles River. These data were used to define hydraulically similar Design Reaches, A through M, as indicated in the figure and on the map on Slide 13.
HYDRAULIC DESIGN REACHES

Classification

- **M**, Mile 47.4 to 51.0
- **L**, Mile 45.6 to 47.2
- **K**, Mile 43.4 to 45.4
- **J**, Mile 37.8 to 42.7
- **I**, Mile 33.9 to 37.5
- **H**, Mile 32.0 to 33.8
- **G**, Mile 31.1 to 31.8
- **F**, Mile 24.5 to 30.3
- **E**, Mile 19.8 to 23.9
- **D**, Mile 18.9 to 19.7
- **C**, Mile 12.8 to 18.8
- **B**, Mile 3.0 to 11.9
- **A**, Mile 0.0 to 2.8
- **Transition**

Source: Geosyntec
WATER RESOURCES

CHANNEL SHAPE VARIES

Classification

- Trapezoidal
- Rectangular

Source: Geosyntec
Concrete
Soft Bottom (Earthen)
Classification:
Concrete
Classification:
Soft Bottom (Earthen)
Source: Geosyntec
Classification:
- Narrow, 55 ft
- Wide, 585 ft

Source: Geosyntec
RIVER CHANNELIZATION: CROSS SECTIONS

Confluence - Mile 51

Valley - Mile 46

Soft Bottom - Mile 34.5

Downtown - Mile 22

Southeastern Cities - Mile 17

Source: OLIN
LA RIVER AVERAGE FLOW: 90-95% OF THE TIME
LA RIVER AT SPRING STREET BRIDGE: 5-10% OF THE TIME

Source: Geosyntec
LA RIVER AT LOS FELIZ BRIDGE, 1969
<1% OF THE TIME
## HYDRAULICS

### MODELING RESULTS FROM USACE 1-D HEC-RAS MODELS\(^1,2,3\) AT DESIGN DISCHARGE/CAPACITY\(^3\)

<table>
<thead>
<tr>
<th>Location</th>
<th>Design Discharge/Capacity (^2) (cubic feet per second)</th>
<th>Flow Depth (ft)</th>
<th>Flow Velocity (fps)</th>
<th>Froude Number (^4)</th>
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</thead>
<tbody>
<tr>
<td>Canoga Park</td>
<td>51</td>
<td></td>
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<td></td>
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<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>Van Nuys</td>
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<td></td>
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<tr>
<td>Sherman Oaks</td>
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<td></td>
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</tr>
<tr>
<td>Studio City</td>
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<td>Burbank</td>
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<tr>
<td>Vernon</td>
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</tr>
<tr>
<td>Bell Gardens</td>
<td>14</td>
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<tr>
<td>South Gate</td>
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<tr>
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<tr>
<td>Long Beach</td>
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</tbody>
</table>

Footnotes:
3. HEC-RAS models were updated by Geosyntec to include new 6th Street Bridge (currently under construction) at River Mile 21.1.
4. The flow rates in the 1-D HEC-RAS models provided by USACE for the LA River are a combination of design discharge and channel capacities and represent at or near capacity conditions.
5. The Froude number is the dimensionless ratio of channel velocity to wave speed for open channel flow. When Froude < 1 the flow is subcritical (slower and deeper) and when Froude > 1 the flow is supercritical (faster and shallower). Between Froude numbers of approximately 0.86 and 1.13 the flow can easily change between subcritical and supercritical states and tends to become unstable with formation of surface waves. Froude numbers greater than approximately 2 are also unstable.
WATER RESOURCES

FREQUENCY DISCHARGES

Design Discharge / Capacity\(^2\)
(USACE 1-D HEC-RAS models\(^2\))

<table>
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<tr>
<th>Location</th>
<th>50 Year Frequency Discharge(^4) (cfs)</th>
<th>100 Year Frequency Discharge(^4) (cfs)</th>
<th>133 Year Frequency Discharge(^4) (cfs)</th>
<th>200 Year Frequency Discharge(^4) (cfs)</th>
<th>500 Year Frequency Discharge(^4) (cfs)</th>
<th>Composite Frequency Discharge (cfs)</th>
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<td>Van Nuys</td>
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</tbody>
</table>

Footnotes:
1. Flow rates are from the 1-D HEC-RAS models provided by USACE for the LA River and are a combination of design discharge and channel capacities and represent at or near capacity conditions.
3. HEC-RAS models were updated by Geosyntec to include new 6th Street Bridge (currently under construction) at River Mile 21.1.
EFFECT OF URBANIZATION

i. Steady-state 1-D modeling of Los Angeles River with specific break out areas analyzed to determine flood plain.

### FEMA FLOODPLAIN MAPPING

- **100 Year Flood Plain** (9.7 sq mi / 1.2% Basin)
- **500 Year Flood Plain** (39.8 sq mi / 4.8% Basin)

Source: Los Angeles County GIS Data Portal, Flood Zones; The Flood Insurance Study (FIS) for Los Angeles County was issued by FEMA in 2008 and revised in 2016.
USACE FLOODPLAIN MAPPING

i. Unsteady 1-D modeling of Los Angeles River with full 2-D flood plain modeling.
ii. Analyses limited to 13 miles between Barham Boulevard and First Street.

Source: USACE, Floodplain Management Services Special Study Los Angeles River Floodplain Analysis, October 2016; Mapping limited to area from Barham Boulevard to First Street.)
Over 3,300 PARCELS across Los Angeles County will be submerged by an average of 5 to 10 feet of water when a 100 year flood event occurs.
VEGETATION AND WATER CONVEYANCE

Vegetation and Flood Control Capacity Have an Inverse Relationship

- **Planted Banks + Concrete Channel**: 40%-50% Capacity
- **Grassed Banks + Grassed Channel**: 55% Capacity
- **Grassed Banks + Concrete Channel**: 75% Capacity
- **Low Flow Channel Planted with Shrubs/Trees + Concrete Channel**: 80% Capacity
- **Low Flow Channel Planted with Grasses + Concrete Channel**: 95% Capacity

Source: Geosyntec & OLIN, Tested Channel Capacity Scenarios At River Mile 11.8 (Rio Hondo Confluence).
ARkSTORM SCENARIO

i. The ARkStorm is a hypothetical storm scenario based upon back-to-back atmospheric river (AR) events, using historic storm events from January 1969 and February 1986, simulated on a state-wide scale.

ii. The scenario may represent an event as rare as 1 in 1000 years for parts of California, although the resulting rainfall in the Los Angeles region was determined to be similar to a 1 in 500 year event.

iii. Detailed hydraulic modeling was not performed, but rather the resulting floodplains were based upon the FEMA 500-year floodplain.

iv. The results are for illustrative purposes only, and should not be used to quantitatively assess flood risk.

v. For more information see: https://pubs.usgs.gov/of/2010/1312/

---

**ARkStorm Scenario (USGS)**

“Anthropogenic forcing is found to yield large twenty-first-century increases in the frequency of wet extremes, including a more than threefold increase in sub-seasonal events comparable to California’s ‘Great Flood of 1862’.”

Swain, Daniel L., Baird Langenbrunner, J. David Neelin, and Alex Hall, “Increasing precipitation volatility in twenty-First-century California”, Nature, 2018

Tsunami Inundation Area (20 sq mi / 0.4% LA County)

The high-end SLR scenario (1.41 meter SLR) used in this study conforms with California’s Climate Change Assessments to date, which are estimated for California under the A1B and A2 emission scenarios (Bromirski et al. 2012).

There is uncertainty regarding the upper-bound or high-end for SLR by the end of the century and other studies have predicted higher estimates (NRC, 2012) of as much as 1.67 meters (CO-CAT 2013, p.2)

1.41 METER SEA LEVEL RISE WITH 100 YEAR COASTAL STORM EVENT

Source: Cal-Adapt, Seal Level Rise Tool, 1.41 meters Sea Level Rise Scenario, 2018, Downloaded from http://keystone.gisc.berkeley.edu/cec_gas_study_layers/South_coast/
FLOOD HAZARDS

Source: Los Angeles County GIS Data Portal, Flood Zones; The Flood Insurance Study (FIS) for Los Angeles County was issued by FEMA in 2008 and revised in 2016 & USACE, Floodplain Management Services Special Study Los Angeles River Floodplain Analysis, October 2016; Mapping limited to area from Barham Boulevard to First Street), & state of California, 2009, Tsunami Inundation Map for Emergency Planning, produced by California Emergency Management Agency, California Geological Survey, and University of Southern California - Tsunami Research Center Cal-Adapt. 1.41 meters Sea Level Rise Scenario, 2018. http://keystone.gisc.berkeley.edu/cec_gas_study_layers/South_coast/
### National Benefit-Cost Ratio Per Peril

<table>
<thead>
<tr>
<th>Overall Hazard Benefit-Cost Ratio</th>
<th>Federally Funded</th>
<th>Beyond Code Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine Flood¹</td>
<td>7:1</td>
<td>5:1</td>
</tr>
</tbody>
</table>

*BCR numbers in this study have been rounded

| Footnotes: 1. Benefit-cost ratio for riverine flooding based on modeling of the 1% annual chance flood |
CRITICAL FACILITIES

A structure or other improvement that, because of its function, size, service area, or uniqueness, has the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if it is destroyed or damaged or if its functionality is impaired.

Critical facility types based on:
Los Angeles County Comprehensive Floodplain Management Plan, September 2016

- Disaster and Emergency Operations Center
- Police and Fire Stations
- Medical Facilities
- Schools
- Hazardous Facilities

Source: Los Angeles County GIS Data Portal, Points of Interest, 2016 & EPA, FRIS Geospatial Data, 2018
A structure or other improvement that, because of its function, size, service area, or uniqueness, has the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if it is destroyed or damaged or if its functionality is impaired.

Critical infrastructure types based on:
Los Angeles County Comprehensive Floodplain Management Plan, September 2016
FLOOD HAZARDS & CRITICAL FACILITIES & INFRASTRUCTURE

- Disaster and Emergency Operations Centers
- Police and Fire Stations
- Medical Facilities
- Schools
- Hazardous Facilities

100 Year Floodplain (FEMA & USACE)
500 Year Floodplain (FEMA & USACE)
Tsunami Inundation Area (CalOES)
1.41 meter Sea Level Rise with 100 Year Storm Event (Cal-adapt)
Evacuation Routes
Transmission Lines
Passenger Rail

- Wastewater Treatment Plants
- Oil and Gas Facilities
- Electric Power Facilities
- Transit Facilities
- Bridges
- Freeway Exits

## Flood Hazards & Critical Facilities & Infrastructure

<table>
<thead>
<tr>
<th>Facility Description</th>
<th>FEMA 100-YR Floodplain</th>
<th>FEMA 500-YR Floodplain</th>
<th>Tsunami Inundation</th>
<th>1.41m Sea Level Rise W/ 100-YR Storm Event</th>
<th>Any of the 4 Flood Hazard Areas</th>
<th>Total Facilities</th>
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<td>Hazardous Material Sites</td>
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<td><strong>Totals</strong></td>
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<td><strong>4,359</strong></td>
<td><strong>285</strong></td>
<td><strong>238</strong></td>
<td><strong>4,446</strong></td>
<td><strong>28,841</strong></td>
</tr>
</tbody>
</table>

Note: Not all infrastructure and facilities in the flood hazard area are directly caused by flooding from the LA River.

**Water Resources**

## CONDITIONS ALONG THE LA RIVER CORRIDOR

<table>
<thead>
<tr>
<th>Location</th>
<th>FEMA 100 and 500 Year LA River Flood Hazard Area Composite</th>
<th>Tsunami &amp; Sea Level Rise</th>
<th>Composite: Critical Facilities</th>
<th>Composite: Critical Infrastructure</th>
</tr>
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<tbody>
<tr>
<td>Canoga Park</td>
<td>51</td>
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</table>
# Hazardous Facilities: Within 1 Mile of LA River

<table>
<thead>
<tr>
<th>Location</th>
<th>Large Quantity Hazardous Waste Generators</th>
<th>Brownfield Sites</th>
<th>Wastewater Treatment Plants</th>
<th>Toxic Release Sites</th>
<th>Superfund Sites</th>
<th>Polluting Power Plants</th>
<th>Composite: Hazardous Facilities</th>
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<tbody>
<tr>
<td>Canoga Park</td>
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CRITICAL FACILITIES: WITHIN 1 MILE OF LA RIVER

<table>
<thead>
<tr>
<th>Location</th>
<th>Hazardous Facilities</th>
<th>Schools</th>
<th>Medical Facilities</th>
<th>Fire Stations</th>
<th>Disaster and Emergency Operations</th>
<th>Critical Facilities</th>
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### CRITICAL INFRASTRUCTURE: WITHIN 1 MILE OF LA RIVER

<table>
<thead>
<tr>
<th>Location</th>
<th>Wastewater Facilities</th>
<th>Oil and Gas Facilities</th>
<th>Electric Power Facilities</th>
<th>Transmission Lines</th>
<th>Metro/Railways</th>
<th>Freeways</th>
<th>Freeway Exits</th>
<th>Bridges</th>
<th>Transit Facilities</th>
<th>Composite: Critical Infrastructure</th>
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WATER QUALITY
WATER AS RECREATIONAL RESOURCE
WATER QUALITY IMPROVEMENTS, DOMINGUEZ GAP WETLANDS, 2018
WATER QUALITY PRIORITIES

Priority Areas
1 (Lower)
5 (Higher)

Source: LACDPW LSPC Model Input, 2012; http://dpw.lacounty.gov/wmd/irwmp/; Geosyntec, 2018
TRIBUTARY AREAS

Direct Tributary Area
< 1mi$^2$ at the head
207 mi$^2$ at the mouth

Total Tributary Area
40 mi$^2$ at the head
834 mi$^2$ at the mouth

Cumulative Direct Drainage Area to the LA River
- River Mile 51
- River Mile 0

Cumulative Total Drainage Area to the LA River
- River Mile 51
- River Mile 0

Source: LACDPW LSPC Model Input, 2012
TRIBUTARY AREAS

<table>
<thead>
<tr>
<th>Location</th>
<th>Total/Direct LAR Watershed Drainage Area</th>
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<tbody>
<tr>
<td>Canoga Park</td>
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<td>Reseda</td>
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</table>
WATER RESOURCES

PROJECTS WITH WATER QUALITY BENEFITS

Water Quality Projects
- ● Constructed
- ○ In-Development
- □ Planned

Cumulative Direct Drainage Area to the LA River
- River Mile 51
- River Mile 0

Source: OLIN/Geosyntec, LARMP Task 2 Project Database
EWMP/WMP TARGET RULER

Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

MUN Classification

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
INDUSTRIAL PROCESS SUPPLY

Uses of water for industrial activities that depend primarily on water quality.

PROC Classification

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
INDUSTRIAL SERVICE SUPPLY

Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

IND Classification

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
GROWTH WATER RECHARGE

Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

GWR Classification

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
ARA V Classification

Existing Stream/Waterbody

Potential Stream/Waterbody

Intermittent Stream/Waterbody

Not Designated Stream/Waterbody

**NAVIGATION**

Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

**NAV Classification**

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
COMMERCIAL AND SPORT FISHING

Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

COMM Classification

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
WARM FRESHWATER HABITAT

Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

WARM Classification

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

**COLD Classification**
- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

**EST Classification**

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Uses of water that support wetland ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

WET Classification

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

MARINE HABITAT

MAR Classification
- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
WILD Classification

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

RARE Classification

- **Existing Stream/Waterbody**
- **Potential Stream/Waterbody**
- **Intermittent Stream/Waterbody**
- **Not Designated Stream/Waterbody**

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.

**MIGRATION OF AQUATIC ORGANISMS**

**MIGR Classification**

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

**SPAWN, REPRODUCTION, AND/OR EARLY DEVELOPMENT**

SPWN Classification

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

**SHELL Classification**
- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

**REC-1 Classification**

- [ ] Existing Stream/Waterbody
- [ ] Potential Stream/Waterbody
- [ ] Intermittent Stream/Waterbody
- [ ] Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beach-combing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

**REC-2 Classification**

- Existing Stream/Waterbody
- Potential Stream/Waterbody
- Intermittent Stream/Waterbody
- Not Designated Stream/Waterbody

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
Ammonia (mg/L)

- 1.6
- 2.4

Nitrate (mg/L)  

8

Nitrite (mg/L)

1

NITRIENT TMDL

Nitrate+Nitrite (mg/L)

8

Trash (lb)

Dry Weather Selenium (μg/L)

- No Target
- 5

Dry Weather Copper (μg/L)

- No Target
- 22
- 23
- 26
- 30

Dry Weather Lead (μg/L)

- **No Target**
- **10**
- **11**
- **12**
- **19**

**BACTERIA TMDL — DRY WEATHER**

Dry Weather Bacteria (Exceedance Days Allowed per year)

<table>
<thead>
<tr>
<th>Location</th>
<th>Bacteria</th>
<th>Single Sample Exceedance Objectives (MPN/100mL)</th>
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<tbody>
<tr>
<td>Los Angeles River Reaches 1-6</td>
<td>E.coli</td>
<td>253</td>
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<tr>
<td>Los Angeles River Estuary</td>
<td>E.coli</td>
<td>253</td>
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<tr>
<td></td>
<td>Total coliform</td>
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<td>Fecal coliform</td>
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<tr>
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</table>

*When the ratio of fecal-to-total coliform exceeds 0.1

METALS TMDL — WET WEATHER

Wet Weather Selenium (μg/L)
- No Target
- 5

Wet Weather Copper (μg/L)

- No Target
- 67.32

WET WEATHER LEAD (μg/L)

- No Target
- 62

Wet Weather Zinc (μg/L)

- No Target
- 159

Wet Weather Cadmium (μg/L)

- No Target
- 3.1

**BACTERIA TMDL — WET WEATHER**

Wet Weather Bacteria (Exceedance Days Allowed per year)

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<tr>
<th>Location</th>
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<td>Fecal coliform</td>
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*When the ratio of fecal-to-total coliform exceeds 0.1

BENEFICIAL USES ALONG THE LA RIVER

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
BENEFICIAL USES ALONG THE LA RIVER

Source: Basin Plan for the Coast Watersheds of Los Angeles and Ventura Counties, Los Angeles Regional Water Quality Control Board, 2018
**WATER QUALITY TOTAL MAXIMUM DAILY LOAD (TMDL)**

- **Total Discharge Average Annual Dry-Weather Volume (acre-feet)**
  - Canoga Park: 51
  - Reseda: 47
  - Van Nuys: 44
  - Sherman Oaks: 41
  - Studio City: 37
  - Burbank: 33
  - Glendale: 31
  - Downtown LA: 22
  - Vernon: 18
  - Bell Gardens: 14
  - South Gate: 12
  - Compton: 9
  - Long Beach: 0

- **Dry Weather Copper (μg/L)**
  - Canoga Park: 30
  - Reseda: 26
  - Van Nuys: 23
  - Sherman Oaks: 26
  - Studio City: 23
  - Burbank: 22
  - Glendale: 26
  - Downtown LA: 22
  - Vernon: 22
  - Bell Gardens: 23
  - South Gate: 23
  - Compton: 23
  - Long Beach: No Target

- **Dry Weather Lead (μg/L)**
  - Canoga Park: 19
  - Reseda: 10
  - Van Nuys: 12
  - Sherman Oaks: 12
  - Studio City: 10
  - Burbank: 11
  - Glendale: 11
  - Downtown LA: 11
  - Vernon: No Target
  - Bell Gardens: 11
  - South Gate: 12
  - Compton: 12
  - Long Beach: No Target

- **Dry Weather Selenium (μg/L)**
  - Canoga Park: 5
  - Reseda: 5
  - Van Nuys: 5
  - Sherman Oaks: 5
  - Studio City: 5
  - Burbank: 5
  - Glendale: 5
  - Downtown LA: 5
  - Vernon: No Target
  - Bell Gardens: 5
  - South Gate: 5
  - Compton: 5
  - Long Beach: No Target

- **Dry Weather Bacteria (Exceedance Days Allowed per Year)**
  - Canoga Park: 9
  - Reseda: 9
  - Van Nuys: 9
  - Sherman Oaks: 9
  - Studio City: 9
  - Burbank: 9
  - Glendale: 9
  - Downtown LA: 9
  - Vernon: 9
  - Bell Gardens: 9
  - South Gate: 9
  - Compton: 9
  - Long Beach: 9

Canoga Park 51
Reseda 47
Van Nuys 44
Sherman Oaks 41
Studio City 37
Burbank 33
Glendale 31
Downtown LA 22
Vernon 18
Bell Gardens 14
South Gate 12
Compton 9
Long Beach 0

WATER SUPPLY

Source: Olin
THE LA RIVER DRAINS AN 834-SQUARE-MILE WATERSHED
LA RIVER WATERSHED MEAN ANNUAL PRECIPITATION 1981-2010

38.7 in / 983 mm

- LA River Max (19.6 in / 500 mm)
- LA River Min (13.1 in / 332 mm)

12.9 in / 327 mm

Source: PRISM Climate Group, Oregon State University, 30-yr Normal Precipitation: Annual, 2015
THE LA RIVER WATERSHED EXPERIENCES DISTINCT SEASONAL AND ANNUAL PRECIPITATION PATTERNS

Annual Precipitation Variability

Seasonal Precipitation Variability (1971-2000):

- **Upper River** (Woodland Hills Pierce College)
- **Middle River** (Los Angeles Downtown USC Campus)
- **Lower River** (Los Angeles Daugherty Airport)

Source: Western Regional Climate Center, Cooperative Climatological Data Summaries, 2018
FLOW IN THE LA RIVER IS IMPACTED BY WATER RECLAMATION PLANTS

Tillman WRP: RM 43 (+42 cfs)
Burbank WRP: RM 31 (+7 cfs)
Los Angeles-Glendale WRP: RM 29 (+12 cfs)

Average Dry-Weather Flow: Cubic Feet per Second (cfs)

5 cfs (3,600 AFY)
71 cfs (50,000 AFY)

Source: Geosyntec
HYDROLOGIC DRIVERS ARE DIVERSE

Upper Los Angeles River Area Watermaster:
- San Fernando Basin
- Sylmar Basin
- Verdugo Basin
- Eagle Rock Basin

Water Replenishment District of Southern California:
- Central Basin
- West Coast Basin

Main San Gabriel Basin Watermaster:
- Main San Gabriel Basin

Raymond Basin Management Board:
- Raymond Basin

Under SGMA Process:
- North Central Basin
- Hollywood Basin (Low Priority)
- Santa Monica Basin

Water Reclamation Plant
Arbor Restoration (Approximate)
Significant Bird Habitat
Tidal Influence Area and Sea Level Rise

Source: LACDPW GIS Data Portal; Geosyntec, 2018
TRIBUTARY AREAS

Direct Tributary Area
< 1 mi² at the head
207 mi² at the mouth

Total Tributary Area
40 mi² at the head
834 mi² at the mouth

Cumulative Direct Drainage Area to the LA River
River Mile 51
River Mile 0

Cumulative Total Drainage Area to the LA River
River Mile 51
River Mile 0

Source: LACDPW LSPC Model Input, 2012
ESTIMATED EXISTING DRY WEATHER FLOW AT MOUTH: 51,000 ACRE-FEET PER YEAR

Assumptions:
- D.C. Tillman WRP Discharge = 42 cfs
- LA/Glendale WRP Discharge = 12.1 cfs
- Burbank Tillman WRP Discharge = 7 cfs
- Upwelling Flow (total) = 5.6 cfs
- Dry Weather Urban Flow = 84 gpd/imp ac
- Evaporation Rate (Upstream of RM 24) = 0.50 in/d (0.021 in/hr)
- Evaporation Rate (Downstream of RM 24) = 0.41 in/d (0.017 in/hr)
- Additional ET in ARBOR Reach = 0

Source: Adapted from OneWater LA 2040 Plan
ESTIMATED POSSIBLE FUTURE DRY WEATHER FLOW AT MOUTH: 1,000 ACRE-FEET PER YEAR

Assumptions:

- D.C. Tillman WRP Discharge = 0 (all recycled)
- LA/Glendale WRP Discharge = 0 (all recycled)
- Burbank Tillman WRP Discharge = 0 (all recycled)
- Upwelling Flow (total) = 2.8 cfs (groundwater management enhanced by 50%)
- Dry Weather Urban Flow = 42 gpd/imp. ac. (50% of EWMP/WMP dry weather targets by 2038)
- Evaporation Rate (Upstream of RM 24) = 0.63 in/d (0.026 in/hr)
- Evaporation Rate (Downstream of RM 24) = 0.51 in/d (0.021 in/hr)
- Additional ET in ARBOR Reach = 0

Source: Geosyntec
ESTIMATED PLAUSIBLE FUTURE DRY WEATHER FLOW AT MOUTH: 10,000 ACRE-FEET PER YEAR

Assumptions:

- DC Tillman WRP Discharge = 14 cfs (20,000 AF (28 cfs) for groundwater recharge)
- LA/Glendale WRP Discharge = 4 cfs (reduced proportionally to Tillman)
- Burbank Tillman WRP Discharge = 2.3 cfs (reduced proportionally to Tillman)
- Upwelling Flow (total) = 0 cfs (management of groundwater by LADWP)
- Dry Weather Urban Flow = 0 gpd/imp ac (EWMP/WMP dry weather targets by 2038)
- Evaporation Rate (Upstream of RM 24) = 0.50 in/d (0.021 in/hr)
- Evaporation Rate (Downstream of RM 24) = 0.41 in/d (0.017 in/hr)
- Additional ET in ARBOR Reach = 0

Source: Geosyntec
ESTIMATED EXISTING AND POSSIBLE FUTURE DRY WEATHER FLOW AT MOUTH:

Estimated Existing: 51,000 acre-feet per year

Plausible Future: 10,000 acre-feet per year

Possible Future: 1,000 acre-feet per year

Source: Adapted from OneWater LA 2040 Plan, Geosyntec
WATER RESOURCES

WET WEATHER FLOWS AT MOUTH

Average Volume of Wet Weather Events:

- 280,000 acre-feet
- 950,000 acre-feet
- 50,000 acre-feet

Wettest Year – 2005:

950,000 acre-feet

Driest Year – 2007

50,000 acre-feet

Note: Flow volumes are calculated from Los Angeles County Watershed Model. Comparison of modeled flow volumes with USGS gage 1103000 at Los Angeles River above Long Beach for the period of available overlapping record (WY1989 - WY1992) indicates modeled annual flow volumes are typically within approximately 1% of measured annual flow volumes (LACDPW, 2010, Figure 84).

GROUNDWATER BASINS

Upper Los Angeles River Area Watermaster:
- San Fernando Basin
- Sylmar Basin
- Verdugo Basin
- Eagle Rock Basin

Water Replenishment District of Southern California:
- Central Basin
- Forebay
- West Coast Basin

Main San Gabriel Basin Watermaster:
- Main San Gabriel Basin

Raymond Basin Management Board:
- Raymond Basin

Under SGMA Process:
- North Central Basin
- Hollywood Basin (Low Priority)
- Santa Monica Basin

Source: Los Angeles County GIS Data Portal, Ground Water Basins, 2014; SGMA, 2016
DEPT TO GROUND WATER

High (25 ft)

Low (425 ft)

Source: Adapted from B3 Insight database compilation, https://www.b3insight.com/
GROUNDWATER BASINS

Groundwater Production Wells (Existing & Historical)

Upper Los Angeles River Area Watermaster:

- San Fernando Basin
- Sylmar Basin
- Verdugo Basin
- Eagle Rock Basin

Water Replenishment District of Southern California:

- Central Basin
- Forebay
- West Coast Basin

Main San Gabriel Basin Watermaster:

- Main San Gabriel Basin

Raymond Basin Management Board:

- Raymond Basin

Under SGMA Process:

- North Central Basin
- Hollywood Basin (Low Priority)
- Santa Monica Basin

San Fernando Basin: 600,000 acre-feet

Amended Judgment for Central Basin allows for use of 330,000 acre-feet of unused storage space along with increased pumping

Amended Judgment for West Coast Basin allows for use of 120,000 acre-feet of unused storage space along with increased pumping

**WATER RESOURCES**

**UPPER LOS ANGELES RIVER AREA: SAN FERNANDO BASIN**

**Maximum Safe Yield:**

- Total: ~86,000 acre ft per year
  - Native Water: 43,660 acre-feet per year
  - Imported Credits: 43,000 acre-feet per year

**Available Storage Space (in 2016):**

- 600,000 acre-feet

---

Fall 1954 – Beginning of historic overdraft - Storage = -210,000 AF

Source: ULARA Annual Watermaster Report, 2015-16 Water Year, December 2017
### ANNUAL SPREADING VARIES FROM YEAR TO YEAR

The long-term average amount of spreading in the San Fernando Basin is approximately 30,000 acre-feet per year.

---

#### Annual Spreading Operations in the San Fernando Basin

<table>
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<tr>
<th>Year</th>
<th>Burbank MWD</th>
<th>City of Los Angeles</th>
<th>LACDPW</th>
<th>LACCDP Watermaster</th>
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</tbody>
</table>

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## Source:
ULARA Annual Watermaster Report: 2015-16 Water Year, Table 2-5: Annual Spreading Operations in the San Fernando Basin, 2017
WATER RESOURCES

WATER REPLENISHMENT DISTRICT: CENTRAL BASIN AND WEST COAST BASIN

Natural Safe Yield
173,400 acre-feet per year

Historical Average Replenishment
180,000 acre-feet per year

Accumulated Overdraft (AOD)
Optimal AOD: 612,000 acre-feet
Minimum AOD: 900,000 acre-feet

Source: WRD Engineering and Survey Report, 2018
Historic amounts of replenishment in the Central and West Coast Basins averages 180,000 acre-feet per year.

Source: WRD Engineering and Survey Report Table D, 2018
The long-term average amount of stormwater and river baseflow captured and recharged in the Montebello Forebay Spreading Grounds is approximately 50,000 acre-feet per year.
WATER RESOURCES

WATER REPLENISHMENT VARIES YEAR TO YEAR

The long-term average amount of replenishment water in the Central and West Coast Basins is approximately 178,000 acre-feet per year.

Source: Water Replenishment District of Southern California (WRD), Engineering Survey and Report, Table D, Historical Amounts of Replenishment Water for Central and West Coast Basins
Historic direct water use in the WRD service area averages 620,000 acre-feet per year.
In the past 30 years, annual direct water use has steadily decreased

- Annual imported water has decreased by approximately 200,000 acre-feet
- Annual recycled water has increased to approximately 35,000 acre-feet

Source: WRD Engineering and Survey Report Table F, 2018
2016-17 TOTAL OVERLYING DEMAND IN WRD SERVICE AREA WAS 487,000 AF

Groundwater Production
- Central Basin: 183,000 acre-feet
- West Cost Basin: 27,000 acre-feet

Adjudicated Pumping
- Central Basin: Allowable Pumping Allocation (APA) of 217,367 acre-feet per year
- West Coast Basin: Annual Pumping Rights of 64,468 acre-feet per year

Amended Judgments
- Amended Judgements provide mechanisms for use and management of storage and increased pumping
  - Central Basin: 330,000 acre-feet
  - West Coast Basin: 120,000 acre-feet
- Development of projects, management of storage and increased pumping can offset overlying demands for imported water and increase regional local water supply

Source: Central Basin Watermaster Report, 2017; West Coast Basin Watermaster Report, 2017
WATER RESOURCES

RECHARGE PATHWAYS VARY

Source: LADWP SCMP
HYDRAULIC CONDUCTIVITY: SOILS ACCEPT WATER AT VARYING RATES

Hydrologic Soil Group

- **Class A** (Ksat > 1.42 in/hr)
- **Class B** (0.57 in/hr < Ksat ≤ 1.42 in/hr)
- **Class C** (0.06 in/hr < Ksat ≤ 0.57 in/hr)
- **Class D** (Ksat ≤ 0.06 in/hr)
- **Not Available**

Source: USDA Natural Resources Conservation Service Web Soil Survey, 2018
RECHARGE: SURFACE SPREADING VS INJECTION

Geophysical Categories
- Category A - Most Conducive to Recharge
- Category B - Somewhat Conducive to Recharge
- Category C - Least Conducive to Recharge

Source: Geosyntec
Dams and Reservoirs

1: Sawpit Dam
2: Highland Dam
3: Chevy Chase Reservoir
4: Glorietta Reservoir
5: Whittier Narrows Dam
6: Santa Anita Dam
7: Devil's Gate Dam
8: Laguna
9: Eagle Rock Dam
10: Hansen Dam
11: Lopez Dam
12: Sepulveda Dam
13: Burbank Reservoir No. 1
14: Glenoaks Reservoir
15: Western Reservoir
16: Burbank Reservoir No. 5
17: Garvey Reservoir
18: Encino Dam
19: Sawpit Debris Basin
20: Eaton Wash Dam
21: Big Tujunga Dam
22: Sierra Madre Dam
23: Ascot Dam
24: Brand Park Reservoir
25: Green Verdugo Dam
26: Elysian Dam
27: Pacoima Dam
28: Morris S. Jones Res.
29: Lincoln Park Lake
30: Peck Road Park Lake
31: Legg Lake
32: Burbank Reservoir No. 4
33: Glorietta Reservoir
34: San Fernando Reservoir
35: Los Angeles Reservoir
36: Van Norman Bypass Reservoir
37: Chatsworth Reservoir
38: Magic Johnson Lake

Source: LA County GIS Portal
EXISTING AND PROPOSED SPREADING GROUNDS AND INJECTION WELLS

- Proposed Spreading Ground
- Existing Spreading Ground Facility
- Planned/In-development
- Existing

- Existing Seawater Barrier Injection Wells
- Proposed Seawater Barrier Injection Wells

E1: Arroyo Seco S.G.
E2: Branford S.B.
E3: Buena Vista S.B.
E4: Dominguez Gap S.G.
E5: Eaton S.B.
E6: Eaton S.G.
E7: Hansen S.G.
E9: Lopez S.G.
E10: Pacoima S.G.
E11: Peck Road S.B.

E12: Rio Hondo Coastal Basin S.G.
E13: Santa Anita S.G.
E14: Santa Fe Reservoir S.G.
E15: Sawpit S.G.
E16: Sierra Madre S.G.
E17: Tujunga Gallery S.G.
E18: Tujunga S.G.
E19: Whittier Narrows W.C. Diversion Canal

N1: Spulveda Dam Spreading Ground
N2: Bull Creek Area Spreading Ground
N3: Browns Creek Area Spreading Ground
N4: Tujunga Spreading Ground Enhancement

Specific Capacity (gpm/ft drawdown)

1-25
25-50
50-75
75-100
100-200
> 200

Water Replenishment District Boundary
Existing and Historic Wells

TRIBUTARY AREA

**Total/Direct LAR Watershed Drainage Area**

- Canoga Park: 51
- Reseda: 47
- Van Nuys: 44
- Sherman Oaks: 41
- Studio City: 37
- Burbank: 33
- Glendale: 31
- Downtown LA: 22
- Vernon: 18
- Bell Gardens: 14
- South Gate: 12
- Compton: 9
- Long Beach: 0

**Total/Direct LAR Watershed Drainage Area (River Right/Left)**

- 40/<1 mi²
- 15/<1 mi²
- 25/<1 mi²

**Groundwater Basins**

- ULARA
- Forebay
- Central Basin
- West Coast Basin

**TRIBUTARY AREA**

- **WATER RESOURCES PROGRESS**


LA RIVER FLOWS

<table>
<thead>
<tr>
<th>Location</th>
<th>Total Discharge</th>
<th>Average Annual</th>
<th>Dry-Weather Volume (acre feet)</th>
<th>Wet-Weather Volume (acre feet)</th>
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<td>650 AFY</td>
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<td>280,000 AFY</td>
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Groundwater Basins

- ULARA
- Forebay
- Central Basin
- West Coast Basin

Total Discharge

- Average Annual
- Dry-Weather Volume (acre feet)
- Wet-Weather Volume (acre feet)

Wettest Year

- Wet-Weather Volume (acre feet) (2007)

Driest Year

- Wet-Weather Volume (acre feet)

LA RIVER FLOWS

WATER RESOURCES

PROGRESS
WATER RESOURCES

VALUE OF RECHARGED WATER

Source: LADWP Stormwater Capture Master Plan, 2015
PROGRESS