Appendix B

Technical Memorandums

This appendix comprises the 11 technical memorandums that were developed to support the Master Plan.

1. **Validation of Strategy TM.** This TM summarizes the validation work completed through detailed analysis to support the validated concept strategies and additional storage and demand components used in the development of Program alternatives.

2. **Potable Reuse Regulations Summary TM.** This TM summarizes the regulatory requirements for potable reuse. These regulations define the requirements for the level of treatment required for Program alternatives.

3. **Interconnectable Partnership Opportunities TM.** This TM identifies partnerships and potential collaboration opportunities that could be further considered by LADWP to include in Program alternatives.

4. **Identification of Storage and Demands TM.** This TM provides a summary of the potable reuse source, supply, storage, and demand options that were selected for incorporation into Program alternatives development.

5. **Operation NEXT Assessment Tool Summary Description TM**. This TM documents the approach and assumptions that were used in the ONAT model to assess the storage and demand flowrates over a range of anticipated conditions.

6. **Program Alternatives Screening TM.** This TM describes the assessment and screening to a shortlist of Program alternatives, for additional detailed evaluation.

7. **Operation NEXT Assessment Tool Results TM.** This TM focuses on the modeling results, including the main findings for purified recycled water production from a future AWPF. The results from ONAT modeling support the comparison of the Program alternatives and overall sizing of the Program.

8. **Resiliency Analysis TM.** This TM explores the future uncertainties related to climate, seismic, and demand risks through the development of resilience scenarios. The resilience benefits of the Program are evaluated by comparing the changes in water supply reliability and other factors from conditions without the Program.

9. **Cost, Schedule, and Phasing TM.** This TM documents the estimated costs, schedule for Program implementation, and the phasing plan developed for the Program components.

10. **Economic Benefits TM.** This TM estimates potential jobs to be created or supported by the Program alternatives.

11. **Funding TM**. This TM summarizes the initial evaluation of potential Program funding opportunities, with the objective of providing information for use in developing the necessary long-term funding strategy.

Validation of Strategy TM

Validation of Strategy Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
June 26, 2024

Executive Summary

Introduction and Overview

A critical step of the Pure Water Los Angeles Master Plan (MP) was to validate the Pure Water Los Angeles Water Supply Program (Program) strategy developed by the Los Angeles Department of Water and Power (LADWP) in the Concept Study (LADWP 2021a). The Concept Study presented the initial concepts for reusing advanced treated Hyperion Water Reclamation Plant (HWRP) wastewater effluent, and this work served as a foundational document for the MP. The scope of the Concept Study was limited to presenting preliminary concepts. The gaps identified in this technical memorandum (TM) are the next logical steps to advance the Program and are not presented as shortcomings of the preceding work.

The validation effort is intended to meet the direction of the LADWP Board. Per the November 2021 Board Meeting, Pure Water Los Angeles was directed to seek Subject Matter Expert (SME) support to validate the Program strategy.

This effort included steps to validate the Concept Study through enhancement of the original integration components. The validation effort assessed the readiness of the Concept Study strategy and identified gaps that required additional analyses, which were also completed. The original Concept Report strategy was validated as feasible. The validation effort also identified other Program alternatives for assessment that have the potential for enhancing the original concept by addressing the need for more storage and demand opportunities and partnerships for early phases. Thus, the validation effort was the basis for developing Program alternatives for the MP.

The validation effort also included an independent review of cost, schedule, and phasing. The independent review validated that the estimated cost in current dollars and schedule were reasonable, with some considerations noted.

This TM summarizes the validation work that has been completed, including detailed analyses to support the validated concept strategies that will be carried forward as Program alternatives.

Source Water Supply and Integration Components

Following Introduction and Overview (Section 1) and Assessment Elements (Section 2), Sections 3 through 10 of this TM summarize each potential integration component of the Pure Water Los Angeles Program, including the source water supply, storage, and demand components. Each section specifically addresses the following:

- Concept Study: Summarizes the components defined in the Concept Study (LADWP 2021a).
- Validation Summary: Summarizes current operations, potential utilization, and system integration opportunities, and presents detailed assessment basis and findings.
- Modified Program Component Basis: Summarizes validation findings, proposed enhancements to the original component concept, and next steps for refining details for a project-level basis.
- Policy Considerations: Identifies the intricacies of the components that need to be considered at a policy level.

The validation findings initiated the development of the Pure Water Los Angeles Assessment Tool (ONAT) to estimate the available volume of water for Pure Water Los Angeles components based on wastewater projections, hydrological conditions, and water demands. The model has been developed and used to screen Program alternatives. Further modeling will be conducted on the screened alternatives to help select alternatives and evaluate potential Program size.

Table ES-1 summarizes the range of flows for the validated source, supply, storage, and demand locations. The actual flows will be further evaluated through ONAT scenario planning.

Table ES-1. Concept Study Validated Storage and Demand Locations

Integration Location	Source, Supply, Storage, and Demand	Minimum Water Quality	Concept Study, cfs (MGD)	Validation Bookend Volume, cfs (MGD)
HWRP	Source	MBR Effluent	421 (272)	Up to 421 (272)
AWPF (assumes 85% RO recovery)	Supply	IPR or DPR, or both	336 (217)	Up to 356 (230)
LADWP: CB Groundwater Injection	Storage and demand	IPR	42 (27)	10 (6.5) to 59 (38)
SFB	Storage and demand	IPR	280 (181)	Up to 230 (149)
VNC	Storage (short-term) and demand	DPR	252 (163)	Up to 252 (163) (DPR at VNC) Up to 356 (230) (DPR at AWPF)
WRD – (for WCB)	Demand	IPR	14 (9)	Up to 26 (17)
Metropolitan Jensen WTP	Demand	DPR	--	Up to 48 (31)
Metropolitan PWSC	Demand	IPR and DPR	77 (50)	Up to 232 (150)

AWPF = Advanced Water Purification Facility

CB = Central Basin

cfs = cubic foot (feet) per second

DPR = direct potable reuse

IPR = indirect potable reuse

LASAN = Los Angeles Sanitation & Environment

Metropolitan = Metropolitan Water District of Southern California

MGD = million gallons per day

PWSC = Pure Water Southern California Program

RO = reverse osmosis

SFB = San Fernando Basin

VNC = Van Norman Complex

WCB = West Coast Basin

WRD = Water Replenishment Water District of Southern California

WTP = water treatment plant

Additional storage and demand components not considered during the Concept Study have been identified for use in the development of the Program alternatives and are summarized in the *Identification of Storage and Demands TM* (Jacobs and Arcadis 2024a) and the *Interconnectable Partnership Opportunities TM* (Jacobs 2024a).

Conveyance

Large-diameter pipelines are required to convey advanced treated recycled water (ATRW) from the AWPF to the integration components. The Concept Study (LADWP 2021a) established the routing of the three main south to north alignment options, and the WRD-LADWP Joint Master Plan (Jacobs 2022) established the routing of the three main west to east alignment options. Initial review of the proposed conveyance alignments revealed that the proposed alignments could benefit from realignment of certain segments to

avoid going through developed areas outside of public rights-of-way and to follow California Department of Transportation's (Caltrans') requirements when crossing Caltrans' infrastructure in the south to north concept routing.

Additionally, the placement of potential pump station locations was not evaluated for Sepulveda and Cahuenga Alignments in the Concept Study (LADWP 2021a). As such, a desktop evaluation was performed that proposed alternative segment alignments to avoid aboveground conflicts to the proposed south to north alternative alignments, and a hydraulic evaluation was conducted to identify pump station placement requirements for all three proposed alignments (Section 9). The pipe sizes may need to be refined based on ONAT scenario planning. In addition, a routing study is recommended to support a preferred alignment selection.

Reservoirs

Potable and non-potable reservoirs within the LADWP system were evaluated as integration components for additional storage capacity and to determine whether existing infrastructure could be used. The MP validation identified 10 LADWP-owned reservoirs located within the City's boundaries as potential locations for integrating Pure Water Los Angeles ATRW. Aqueduct reservoirs were excluded from this assessment, and Los Angeles Reservoir (LAR) was evaluated under the VNC integration location. Potable reservoirs were categorized as DPR applications, and non-potable reservoirs were categorized as IPR under surface water augmentation (SWA).

These reservoirs were eliminated from further consideration because of neighborhood considerations, conveyance costs, space limitations for additional treatment (for DPR), and low storage possibility (based on the analysis of the reservoir alternatives and LADWP input during a component screening workshop on March 6, 2023, and the Program alternatives confirmation workshop on October 30, 2023). The potable and non-potable reservoirs will not be included in the current Program alternatives but are available for future SWA or treated water augmentation (TWA) adaptability if allowed by LADWP (Jacobs and Arcadis 2024a) (Section 10).

Schedule and Cost

Section 11 of this TM addresses schedule and cost. However, these are preliminary approaches that may not reflect the ultimate Program strategy as the MP is being developed and Program alternatives are refined.

The following significant takeaways resulted from a review of the MP independent schedule:

- Overall general timeline of 31 years as presented in the Concept Study was confirmed, with an adjusted Program period of 2025 to 2055.
- Phasing of construction at HWRP with completion in 2035 was not aligned with the other Program components. LADWP's Hyperion Owner's Agent subsequently adjusted the HWRP phasing schedule (Hazen 2024).
- Cashflow restrictions (that is, annual expenditure caps) will be considered once the Program alternatives are selected to not overly encumber Program funding. The phasing may need to be refined to align with cashflow capabilities and phasing opportunities. The original cashflow did not consider escalation or risk contingency, which can be significant for a Program of this size.

The purpose of the cost validation was to provide an objective perspective about the cost and identify gaps. The construction cost estimate comprises conveyance, injection and extraction wells, and treatment elements. A Program capital cost of $21.2 billion and an annual operations and maintenance (O&M) cost of $398 million were developed at a Class 5 level estimate in 2024 dollars, with a typical expected accuracy range of -20 to -50% on the low side and +30 to +100% on the high side for concept screening (AACE 2020). Two main elements that were not included in the Concept Study (LADWP 2021a) cost

estimate that can have significant impacts include escalation and risk contingency. LADWP has since developed guidance on incorporation of escalation into Pure Water Los Angeles.

Potential Phasing

Based on the enhanced Concept Strategy elements, Table ES-2 identifies a potential phasing implementation pending flow demand confirmation through ONAT scenario planning. The cyclical nature of drought and pluvial conditions drives the need for a balance between available storage and direct use of ATRW.

This approach focuses on the storage and demand options closest to the new AWPF for early delivery to align with Phase 1 of the HWRP conversion to membrane bioreactor (MBR) treatment and an AWPF at or near HWRP, while allowing time for demonstration and approval of DPR options after RO located north of SFB, including a possible siting location at VNC and construction of the long conveyance pipeline to the north that is aligned with Phase 3 production. Given the duration required to construct the pipeline to the north, partnerships would need to be pursued to use the ATRW that would be available for Phases 1 and 2.

Table ES-2. Potential Phasing Implementation with an Enhanced Concept Strategy

HWRP	Timeline[a]	Added Flow, cfs (MGD)[a]	Total Flow, cfs (MGD)[a]	Storage and Demand Locations[b]
Phase 1	2033-2035	IPR: 79 cfs (51 MGD) MBR: 93 cfs (60 MGD)	IPR: 79 cfs (51 MGD) MBR: 93 cfs (60 MGD)	Regional Partnership
Phase 2	2037-2039	IPR: 79 cfs (51 MGD) MBR: 93 cfs (60 MGD)	IPR: 158 cfs (102 MGD) MBR: 186 cfs (120 MGD)	CB[c], Regional Partnership
Phase 3	2048-2050	IPR: 198 cfs (128 MGD) MBR: 235 cfs (152 MGD)	IPR and DPR: 356 cfs (230 MGD) MBR: 421 cfs (272 MGD)	CB, SFB, VNC
Future Phase	2053-2054	No additional flow.	IPR and DPR: 356 cfs (230 MGD) MBR: 421 cfs (272 MGD)	CB, Metropolitan

Note:
Pending confirmation through ONAT scenario planning.
[a] LADWP email 2024. IPR and DPR flowrates assume 85% recovery.
[b] Infrastructure for CB will be delivered in 3 phases.
[c] Year 2040.

Policy Considerations

Sections 3 through 11 of this TM each include a Policy Considerations section relating to integration of Pure Water Los Angeles water into a specific component. The validation process identified important policy considerations that LADWP may further negotiate or decide at a later time, either internally or in discussions with external partners. Although it is acknowledged that the listed policy considerations may affect the Program, they will take significant time and coordination to resolve, which is outside the MP scope. For this TM, the policy considerations listed serve only to memorialize these important decision points for LADWP to further explore as part of overall Program development in the future.

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Acronyms and Abbreviations

°F	degree(s) Fahrenheit
97-005	Process Memo 97-005 document
AF	acre-foot (feet)
AFY	acre-foot (feet) per year
ATRW	advanced treated recycled water
AWPF	Advanced Water Purification Facility
AWTO	Advanced Water Treatment Operator
BAC	biologically activated carbon
BGRP	Brackish Groundwater Reclamation Program
$CaCO_3$	calcium carbonate
Cal Water	California Water Service
Caltrans	California Department of Transportation
CB	Central Basin
CCR	California Code of Regulations
CCT	chlorine contact tank
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic foot (feet) per second
City	City of Los Angeles
County Public Works	Los Angeles County Public Works
CTR	California Toxics Rule
DBP	disinfection by-product
DDW	Division of Drinking Water
DiPPRA	Direct Potable Reuse Responsible Agency
DPR	direct potable reuse
EBCT	empty bed contact time
EPA	U.S. Environmental Protection Agency
fps	foot (feet) per second
ft^2	square foot (feet)
ft^3	cubic foot (feet)

GAC	granular activated carbon
GAMA	Groundwater Ambient Monitoring and Assessment
gpm	gallon(s) per minute
in/hr	inch(es) per hour
HWRP	Hyperion Water Reclamation Plant
IPR	indirect potable reuse
IX	ion exchange
Joint MP	WRD-LADWP Joint Master Plan
LA Metro	Los Angeles County Metropolitan Transportation Authority
LAA	Los Angeles Aqueduct
LAAFP	Los Angeles Aqueduct Filtration Plant
LACFCD	Los Angeles Flood Control District
LACSD	Los Angeles County Sanitation District
LADWP	Los Angeles Department of Water and Power
LAR	Los Angeles Reservoir
LASAN	Los Angeles Sanitation & Environment
lb	pound(s)
LRV	log reduction value
LT2ESWTR	Long-Term 2 Enhanced Surface Water Treatment Rule
MBR	membrane bioreactor
MCL	maximum contaminant level
Metropolitan	Metropolitan Water District of Southern California
MG	million gallons
mg/L	milligram(s) per liter
mg/L-N	milligram(s) per liter of nitrogen
MGD	million gallons per day
MP	Pure Water Los Angeles Master Plan
N	nitrogen
NCP	National Contingency Plan
NDMA	N-nitrosodimethylamine
No.	number

NO_3-N	nitrate-nitrogen
O&M	operations and maintenance
ONAT	Operation NEXT Assessment Tool
PCE	tetrachloroethylene
PPUV	Dr. Pankaj Parekh UV Facility
Program	Pure Water Los Angeles Water Supply Program
psi	pound(s) per square inch
PWSC	Pure Water Southern California Program
RBWRP	Regional Brackish Water Reclamation Program
RFI	Request for Information
RO	reverse osmosis
RWA	raw water augmentation
RWQCB	Regional Water Quality Control Board
SLR	surface loading rate
SME	Subject Matter Expert
S.U.	standard unit
SFB	San Fernando Basin
SWA	surface water augmentation
SWP	State Water Project
SWRCB	State of California Water Resources Control Board
TBD	to be determined
TCE	trichloroethylene
TDS	total dissolved solids
TIN	total inorganic nitrogen
TM	technical memorandum
TN	total nitrogen
TOC	total organic carbon
TSS	total suspended solids
TWA	treated water augmentation
U.S.	United States
UV	ultraviolet

UVAOP	ultraviolet advanced oxidation process
UWMP	Urban Water Management Plan
VNC	Van Norman Complex
V/G/C	enteric virus/*Giardia* cyst/*Cryptosporidium* oocyst
VOC	volatile organic compound
WCB	West Coast Basin
WCBBP	West Coast Basin Barrier Project
WRD	Water Replenishment Water District of Southern California
WRF	water reclamation facility
WRP	water reclamation plant
WTP	water treatment plant

1. Introduction and Overview

A critical step of the Pure Water Los Angeles Master Plan (MP) was to validate the Pure Water Los Angeles Water Supply Program (Program) strategy developed by the Los Angeles Department of Water and Power (LADWP) in the Concept Study (LADWP 2021a). The Concept Study presented the initial concepts for reusing advanced treated Hyperion Water Reclamation Plant (HWRP) wastewater effluent and served as a foundational document for the MP.

The validation effort meets the direction of the Board per the November 2021 Board Meeting, Pure Water Los Angeles was directed to seek Subject Matter Expert (SME) support to validate the Program strategy. The effort to validate the Concept Study through enhancement of the original integration components included the following tasks:

- Identifying water quality requirements
- Assessing and refining component flow demands
- Developing additional treatment approaches
- Identifying partnership opportunities
- Refining conveyance alignments, and assessing critical conditions
- Developing independent cost estimates
- Developing an independent schedule

The validation effort assessed the readiness of the Concept Study strategy, and identified gaps requiring additional analyses, which were also completed. The validation effort also included an independent review of cost, schedule, and phasing. The independent review validated that the estimated cost in current dollars and schedule were reasonable, with a recommendation to include escalation and Program risk contingency. This technical memorandum (TM) provides a high-level summary at this specific point in time (May 2024) of the potable reuse source, supply, storage, and demand options selected for incorporation into the Pure Water Los Angeles Program (Program) alternatives development.

The validation effort considered opportunities, risk, and constraints, including regulations, cost sharing, emerging technologies, and partnership opportunities. The validation step considered the source water, water supply, and integration components consisting of the potential storage and demand associated with the Central Basin (CB), West Coast Basin (WCB), San Fernando Basin (SFB), and Van Norman Complex (VNC); and potential regional partnerships, including with the Metropolitan Water District of Southern California (Metropolitan).

The original Concept Report strategy was validated as feasible, and with enhancements, has been carried forward in the Program alternatives. The validation effort also identified other Program alternatives for assessment by addressing the need for more storage and demand opportunities and partnerships for early phases. Thus, the validation effort provides recommendations to improve the roadmap for LADWP to manage the new source of supply and serves as the basis for developing Program alternatives for this MP.

The validation findings support the development of the Operation NEXT Assessment Tool (ONAT). ONAT is a system model that allows for assessment of potential Pure Water Los Angeles infrastructure and sizing. The model can evaluate different scenarios and is based on the following factors:

- A range of projected hydrological and demand conditions
- Allocations of Pure Water Los Angeles supply
- Regional partnerships
- Water supply and risk conditions

Specifically, ONAT was developed to evaluate the infrastructure needs of Pure Water Los Angeles, comparison of alternatives, and the water supply resiliency and economic benefits of the Program alternatives. ONAT was developed in GoldSim, a modeling platform with Monte Carlo probabilistic capabilities used for visualizing and dynamically simulating complex systems in engineering, science, and

business (GoldSim Technology Group 2024). Results from ONAT modeling will be included in a future TM, with a summary in a future section of the MP.

This TM summarizes the validation work that has been completed, including the detailed analyses to support the validated concept strategies that will be carried forward as Program alternatives.

It is noted that Sections 3 through 10 of this TM each include a Policy Considerations section relating to integration of Pure Water Los Angeles water into a specific component. The validation process identified important policy considerations that LADWP may further negotiate or decide at a later time, either internally or in discussions with external partners. Although it is acknowledged that the listed policy considerations may affect the Program, they will take significant time and coordination to resolve and are outside the MP scope to address. For this TM, the policy considerations listed serve only to memorialize these important decision points for LADWP to further explore as part of overall Program development in the future.

The Validation TM is organized as follows:

- Section 1, Introduction and Overview, provides the Program background information and the purpose of this TM.
- Section 2, Assessment Elements, summarizes the Concept Strategy components that were validated.
- Sections 3 through 10 present the findings of the validation for the Concept Strategy components, including:
  - Source Water Supply and Integration Components
  - CB
  - SFB
  - VNC
  - WCB
  - Metropolitan
  - Conveyance
  - Reservoirs
- Section 11, Schedule and Cost, presents the updated Program schedule and cost.
- Section 12, Potential Phasing Implementation, summarizes the validation outcomes related to phasing and implementation.
- Section 13, References, documents the references used to develop this TM.

The following TMs that were submitted under separate cover provide associated information that complements this Validation TM:

- *Potable Reuse Regulations Summary TM* (Jacobs and Arcadis 2024b): Summarizes the applicable potable reuse regulations that the Program alternative components need to meet.
- *Identification of Storage and Demands TM* (Jacobs and Arcadis 2024a): Summarizes the integration components that were evaluated, validated, and screened for incorporation into the Program alternatives.
- *Interconnectable Partnership Opportunities TM* (Jacobs 2024a): Summarizes the opportunities for provision of Pure Water Los Angeles advanced treated recycled water (ATRW) to local and regional partners outside Los Angeles.

The following attachments provide comprehensive assessments for the information summarized in this Validation TM:

- Attachment A, *Central Basin Injection Wellfield Recharge Water Quality Requirements:* Summarizes the evaluation of geochemical compatibility and pretreatment measures for the ATRW with respect to recharge in CB.

- Attachment B*, Central Basin Groundwater Treatment Evaluation*: Summarizes the evaluation of groundwater quality in the vicinity of the proposed new extraction wells and groundwater treatment upon extraction.
- Attachment C, *Pure Water Los Angeles Conveyance Alignment Review:* Summarizes the initial review of the conveyance alignments to quantify the pipeline sections most likely to be tunneled or potentially trenched.
- Attachment D, *Pure Water Los Angeles Conveyance Alignment Review Supplemental Information:* Summarizes the supplemental review of the conveyance alignments by examining conditions that may conflict with the proposed alignment options.
- Attachment E, *Evaluation of Potable and Non-Potable Reservoirs for Integration into Pure Water Los Angeles Program*: Summarizes the evaluation of reservoirs as integration components for additional storage capacity and whether existing infrastructure can be used.
- Attachment F, *Reservoir and Van Norman Complex Preliminary Screening Evaluation*: Summarizes the screening process used to evaluate the reservoir and VNC integration locations.
- Attachment G, *Cost Estimates*: Summarizes the capital and operations and maintenance (O&M) costs developed for the validation.

2. Assessment Elements

The Concept Study (LADWP 2021a) presented the initial concepts developed by LADWP for using treated wastewater effluent generated from the HWRP and has served as the foundational document for the Pure Water Los Angeles MP. It identified potential water integration components and conveyance alignment options for the Program that could maximize water reuse from the HWRP and allow LADWP to maximize use of its existing water rights and storage credits within Los Angeles' underlying groundwater basins. The scope of the Concept Study was limited to presenting a preliminary concept. The gaps in the Concept Study that are identified in this TM served to identify the next steps that were required to advance the Program.

The following terminology was subsequently developed to characterize the different components:

- Source water partner: A wastewater agency that can provide treated wastewater effluent for further treatment and reuse.
- Supply: Treated wastewater effluent that has undergone advanced water treatment for potable reuse.
- Storage: Where ATRW is placed and held for a specified time before being used for demand.
- Demand: Component that takes ATRW for consumptive end uses or to distribute to partners.

The Concept Report envisioned a focused approach to convey water to VNC using limited partnerships. The water integration components included four major regional partners in addition to storage in SFB and treatment and storage infrastructure in VNC:

1. Los Angeles Sanitation & Environment (LASAN) for providing source water to Pure Water Los Angeles.
2. Water Replenishment Water District of Southern California (WRD) for recharge of CB, as well as recharge of the WCB as part of WRD's Regional Brackish Water Reclamation Program (RBWRP), which has been rebranded as the Brackish Groundwater Reclamation Program (BGRP).
3. Los Angeles County Public Works (County Public Works) for using their spreading basins in SFB.
4. Metropolitan for providing a new source of supply to the Jensen Water Treatment Plant (WTP) and the Pure Water Southern California Program (PWSC) (formerly called the Regional Recycled Water Program).

Table 2-1 summarizes the potential water integration components identified and the potential corresponding flows presented in the Concept Study (LADWP 2021a). The details on the components included in the Concept Study are included in subsequent sections of this TM.

Table 2-1. Water Integration Components Presented in the 2021 Concept Study

Component	Source, Supply, Storage, and Demand	Potential Partner	Description and Supporting Infrastructure Needs	Flow, cfs (MGD)
HWRP	Source	LASAN	▪ Convert HWRP to MBR	421 (272)
APWF	Supply	None	▪ New treatment for ATRW	336 (217)
CB	Storage and demand	WRD	▪ Convey ATRW to CB for augmentation ▪ New injection and extraction wellfields ▪ New treatment system ▪ New pipeline for conveyance	42 (27)
SFB	Storage and demand	County Public Works	▪ Convey ATRW to SFB for injection and spreading ▪ New injection wellfields	280 (181)
VNC	Storage (short-term) and demand	None	▪ Convey ATRW to VNC ▪ New treatment systems	252 (163)
WCB	Storage and demand	WRD	▪ WRD's RBWRP, which has been rebranded as BGRP ▪ Potential for providing IPR water for replenishment for BGRP ▪ Integrate water from BGRP into the potable water system in the Harbor Area	14 (9)
Jensen WTP	Demand	Metropolitan	▪ Convey ATRW to Jensen WTP	TBD
PWSC	Demand	Metropolitan	▪ Convey ATRW to PWSC's Backbone System	77 (50)

BGRP = Brackish Groundwater Reclamation Program
cfs = cubic foot (feet) per second
IPR = indirect potable reuse
MBR = membrane bioreactor
MGD = million gallons per day
RBWRP = Regional Brackish Water Reclamation Program
TBD = to be determined
WCB = West Coast Basin
WRD = Water Replenishment District
WTP = water treatment plant

From the validation step, the work summarized in this TM demonstrates that there are opportunities for enhancing the original concept and incorporating these opportunities into the basis for developing Program alternatives under this MP. The components presented in Table 2-1 were further evaluated and validated through the following activities:

- Reviewing documentation
- Performing technical assessments
- Actively collaborating with LADWP staff
- Engaging potential partners in the region (Jacobs 2024a)

Water quality and treatment requirements for the water integration components were not defined in the Concept Study, so these elements were developed during the validation step.

The validation of the Concept Study components is summarized in Sections 3 through 10, with each section organized as follows:

- Concept Study: Summarizes the component as defined in the Concept Study (LADWP 2021a).

- Validation: Presents the detailed assessment basis and findings, including a summary of current operations and potential utilization and system integration opportunities.
- Modified Program Component Basis: Summarizes recommendations and enhancements to the original component concepts, findings from the validation, and next steps for refining details for a project-level basis.
- Policy Considerations: Identifies the intricacies of the components that need to be considered on a policy level.

3. Source Water Supply

This section provides details about source water supply and potential water integration components.

3.1 Concept Study

The Concept Study (LADWP 2021a) described Component 1 to convert HWRP to an Advanced Water Purification Facility (AWPF) to supply ATRW for Pure Water Los Angeles. Approximately 421 cfs (272 MGD) of secondary effluent would provide source water to the AWPF assumed to be located at the HWRP site, supplying 336 cfs (217 MGD) of ATRW assuming 80% reverse osmosis (RO) recovery.

Effluent from HWRP is the only source of ATRW for Pure Water Los Angeles.

3.2 Validation Summary

This section summarizes the source water supply and integration component validation findings.

3.2.1 Current Operations

LASAN is the source water partner that will provide treated wastewater effluent from HWRP to an AWPF under the Pure Water Los Angeles Program for further treatment to produce IPR or direct potable reuse (DPR) quality water for reuse. HWRP provides secondary treatment with a monthly average dry weather flow of 450 MGD, although current daily average dry weather flows are 250 MGD (LASAN 2023).

3.2.2 Potential Utilization and System Integration Opportunities

The Concept Study (LADWP 2021a) did not include the following:

- Definition of water quality and treatment requirements for the AWPF
- Consideration of an AWPF located offsite from the HWRP property

The work related to the AWPF is being conducted by LADWP's Hyperion Owner's Agent for the HWRP; therefore, this TM does not consider or further evaluate any alternatives or options for treatment and siting for a potential AWPF. The MP relied on information presented in the TMs prepared by LADWP's Hyperion Owner's Agent (Hazen 2024) and LASAN's Consultant Team, as well as input from LADWP and LASAN's coordination workshops.

Thus, the MP validation focused on Program sizing, as detailed in this section.

3.2.2.1 Program Sizing

The MP validation determined the following technical evaluations were needed to further the Program sizing basis, as presented in the Concept Study (LADWP 2021a), which consisted of recycling all HWRP treated wastewater effluent for potable reuse (up to 217 MGD):

- Assessment of the ability for LADWP to use the full flows from HWRP
- Flow estimates for each storage and demand component
- Flow management strategy for flows from the Los Angeles Aqueduct (LAA) to maximize the use of Pure Water Los Angeles ATRW

The MP validation findings initiated the development of ONAT to estimate the available volume of water for Pure Water Los Angeles components, based on wastewater projections, hydrological conditions, and water demands. The model framework, approach, and basis is documented in the *Operation NEXT Assessment Tool Summary Description TM* (Jacobs 2024b). ONAT identifies the anticipated flows for the Program components to understand ATRW volume available for potential partnerships.

3.3 Modified Program Component Basis

Based on this evaluation, the Concept Study (LADWP 2021a) Component 1 to convert HWRP to an AWPF to provide ATRW for Pure Water Los Angeles is feasible. Table 3-1 summarizes the proposed modifications to the flows and Program sizing to enhance Component 1.

Table 3-1. Proposed Component Modifications Based on Master Plan Validation for Source Water Supply

Concept Study Component	Proposed Modification Based on Validation
Component 1: Convert HWRP to an AWPF, with 421 cfs (272 MGD) of secondary effluent producing 336 cfs (217 MGD) of ATRW	Up to 356 cfs (230 MGD) of ATRW produced at an AWPF was recommended for further evaluation, with the location of the AWPF at or near HWRP

The MP validation determined the following assessments are required:

- The estimated flow range for each supply, storage, and demand need to be confirmed.
- Regulatory and water quality requirements need to be assessed and documented.
- Supporting treatment infrastructure needs to be identified.
- Use of existing infrastructure owned by LADWP needs to be evaluated.

Table 3-2 summarizes the water quality requirements and estimated flow demand ranges for the validated storage and demand components. Details on the validation storage and demand components are provided in later sections but summarized in Table 3-2 for convenience. Flows noted as TBD will require additional evaluation because the required input and data to substantiate those values were not available at the time of issuance of this TM. Figure 3-1 provides the source, supply, storage, and demand locations.

For those components that LADWP has full control over, it is anticipated that the values presented here will be further refined using ONAT as part of MP development. For those components requiring partnerships, it will likely not be possible to further refine these values during the master planning phase, so these values serve as placeholders that will need to be further refined as the Program progresses.

Table 3-2. Validated Storage and Demand Locations

Integration Location	Source, Supply, Storage, and Demand	Minimum Water Quality	Concept Study, cfs (MGD)	Validation Bookend Volume, cfs (MGD)
LASAN – HWRP	Source	MBR effluent	421 (272)	Up to 421 (272)
AWPF	Supply	IPR or DPR	336 (217)	Up to 356 (230)
LADWP: CB Groundwater Injection	Storage and demand	IPR	42 (27)	10 (6.5) to 59 (38)
SFB	Storage and demand	IPR	280 (181)	Up to 230 (149)
VNC	Storage (short-term) and demand	DPR	252 (163)	Up to 252 (163) (DPR at VNC) Up to 356 (230) (DPR at AWPF)
WRD – WCB	Demand	IPR	14 (9)	Up to 26 (17)
Metropolitan Jensen WTP	Demand	DPR	TBD	Up to 48 (31)
Metropolitan PWSC	Demand	IPR	77 (50)	Up to 232 (150)

Additional storage and demand components not considered during the Concept Study have been identified for use in the development of the Program alternatives and are summarized in the *Identification of Storage and Demands Technical Memorandum* (Jacobs and Arcadis 2024a) and the *Interconnectable Partnership Opportunities TM* (Jacobs 2024a).

3.4 Policy Considerations

This section summarizes policy considerations related to source water supply.

3.4.1 Direct Potable Reuse

The current water reuse scope of Pure Water Los Angeles includes evaluation of both IPR and DPR options. For DPR, LADWP would likely serve as the Direct Potable Reuse Responsible Agency (DiPRRA) to lead Pure Water Los Angeles and obtain the necessary domestic water supply permit amendment under the adopted DPR regulations.

As described in the adopted DPR regulations, as well as the *Potable Reuse Regulations Summary* TM (Jacobs and Arcadis 2024b), LASAN would be the wastewater partner agency of the DiPRRA under Pure Water Los Angeles. LASAN would be responsible for leading the development and implementation of a wastewater source control program that will meet the DPR regulations (SWRCB 2023), including:

- Developing an early warning system; for example, tracking the results of local health departments' disease surveillance programs and using online monitoring for indicator compounds or surrogates for chemical compounds, which would provide early warning of a potential occurrence that could interfere with the operations of a treatment process or affect water quality.
- Developing an appropriate strategy to optimize HWRP's operations, such as influent flow and load equalization, enhancements to primary treatment, and others.

LADWP should continue working with LASAN to develop a strategy for the formulation of a Joint Plan to comply with the DPR regulatory requirements. The following aspects concerning the source water supply quality management stipulated in Section 64669.20 of the DPR regulations (SWRCB 2023) will need to be addressed through continued collaboration and partnership between the two agencies to advance the DPR alternatives (if selected):

- Develop a plan to investigate and implement wastewater treatment improvement that would provide a WTP to meet the DPR regulations to reduce the level of chemicals to lowest achievable concentrations.
- Develop procedures to verify the wastewater source control program complies with the DPR regulations.
- Develop a plan to communicate water quality status and water quality monitoring results among the DiPRRA and partners agencies in a timely manner.
- Develop procedures the DiPRRA will implement for notifying partner agencies and the SWRCB of operational changes or treatment failure incidents.
- Develop agreements to facilitate the operation of the potential DPR project.

3.4.2 Other Near-Term Actions

There are some near-term actions that could be explored and implemented by LADWP and LASAN jointly for the Program, including:

- Identify and apply for a joint grant for the Program, such as grant funding opportunities provided by the U.S. Bureau of Reclamation.
- Conduct a joint assessment or study to develop a new institutional framework under the DPR regulations.

- Conduct a joint assessment or study to evaluate ocean discharge and potential treatment options, which could include early engagement with the Los Angeles Regional Water Quality Control Board (Los Angeles RWQCB) regarding ocean discharge approaches to identify potential regulatory and legislative needs and roadblocks.
- Develop a joint outreach and communication plan or program.
- Develop a joint benefits assessment for the Program, which may include water quality improvement for ocean discharge.

Jensen WTP (MWD)
LAAFP
VNC
Pacoima Spreading Grounds
Bull Creek
Hansen Spreading Grounds
Tujunga Spreading Grounds
DCT WRP and AWPF (Future)
Central Branch Tujunga Wash
Santa Fe Spreading Grounds
San Gabriel Coastal Spreading Grounds
Rio Hondo Spreading Grounds
Los Angeles Forebay
Montebello Forebay
Hyperion WRP
Edward C. Little WRF (West Basin MWD)
West Coast Basin Barrier Project
PWSC AWPF (MWD)
Map Extent
Pacific Ocean
SAN GABRIEL MOUNTAINS
SANTA MONICA MOUNTAINS
SANTA SUSANA MOUNTAINS
SIMI HILLS
SAN FERNANDO VALLEY
SAN RAFAEL HILLS
PUENTE HILLS
Simi Valley
Sylmar
Burbank
Glendale
Pasadena
Altadena
La Canada Flintridge
Arcadia
Monrovia
Azusa
Alhambra
San Gabriel
Rosemead
El Monte
West Covina
Baldwin Park
Covina
Whittier
Norwalk
Downey
Lynwood
Compton
Hawthorne
Inglewood
Beverly Hills
Santa Monica
Malibu
Torrance
Carson
Lakewood
Bellflower
Long Beach
Fullerton
Buena Park
Anaheim
Garden Grove
Yorba Linda
Montebello
Monterey Park
Los Angeles
East Los Angeles
South Gate
Huntington Park
Redondo Beach
Agoura Hills
Calabasas
Reseda
Winnetka
Canoga Park
Encino
Topanga State Park
Malibu Creek State Park
Griffith Park
Elysian Park
Brand Park
Pierce College
Roscoe Blvd
Devonshire St
Angeles Crest Hwy
Arroyo Seco
Angeles National Forest
San Gabriel Wilderness Area
Santa Fe Dam Open Space
Joint Forces Training Center
UCLA
Pacific Palisades
Corral Canyon
Santa Barbara
Santa Clarita
Palmdale
Victorville
Lancaster
Oxnard
Santa Ana
Oceanside

Legend

- Proposed Water Reclamation Facility/Water Treatment Facility
- Existing Advanced Water Purification Facility
- Existing Drinking Water Treatment Plant
- Existing Water Reclamation Facility
- Bull Creek Stormwater Project
- Forebay
- Spreading Grounds
- North Hollywood Park
- Potential Siting Area for the Advanced Water Purification Facility
- Van Norman Complex
- Pure Water Southern California

Future Wellfield

- Extraction
- Injection

Alignment Options

- Cahuenga
- Florence
- Griffith Parck
- Manchester
- Sepulveda
- Slauson

LACPW Flood Control Facilities

- Flood Control Channels
- West Coast Seawater Barrier Project

Groundwater Basins

- San Fernando
- Central
- Hollywood
- Santa Monica
- West Coast
- City Boundary
- County Boundary

Sources:
LADWP, 2022; LA County, 2023
ESRI World Topo Map; ESRI World Street Map

0 1.5 3 6
Miles
1 inch = 4 miles

Figure 3-1

Source, Supply, Storage, and Demand Components

\\dc1vs01\GISProj\L\LADWP\Operation_NEXT\MapFiles\Fig3-1_OperationNEXT_Source_Supply_Demand_20240606.mxd

4. Central Basin

According to the *2020 Urban Water Management Plan* (UWMP) (LADWP 2021b), CB provides approximately 330,000 acre-feet (AF) of storage capacity for all pumping entities. LADWP currently has a water entitlement volume of 17,236 acre-feet per year (AFY) (24 cfs [15.5 MGD]), with LADWP storage capped at twice that volume at 34,472 AFY (48 cfs [31 MGD]). If LADWP maximizes their storage at 34,472 AFY, they are allowed to pump up to 40% more than their existing entitlements, although they have not exercised this historically.

The CB Judgment also allows for carryover and storage of unused water rights, up to a maximum of 60% of a purveyor's pumping right (LADWP 2021b). Under the CB Judgment 2013 amendment, the ATRW from Pure Water Los Angeles can be applied to replenish CB as either a replenishment project, which would support the extraction by the parties under existing water rights, or as an augmentation project to provide more than existing rights. Water provided in an augmentation project could be extracted up to the volume provided for augmentation (Request for Information [RFI] 027 [LADWP 2023e, 2024c]).

4.1 Concept Study

The Concept Study (LADWP 2021a) described the following components:

- Component 3: A 108-inch-diameter pipeline from HWRP to a tee-junction, followed by a 54-inch- to 66-inch-diameter pipeline that extends to the east to deliver up to 42 cfs (27 MGD) to CB for groundwater replenishment and potentially 77 cfs (50 MGD) to convey to Metropolitan's PWSC backbone
- Component 4: Up to 2 new injection wellfields to replenish 42 cfs (27 MGD) into CB and extract and treat from CB, including 27 new injection wells and 18 new extraction wells, pipelines and 2 new centralized groundwater treatment facilities, and a potential outreach learning center
- Component 5: New pipeline to convey 42 cfs (27 MGD) of water extracted from CB into the potable distribution system, along with one pump station and storage facility

The Concept Study component of groundwater replenishment (through replenishment of existing rights or augmentation exceeding current rights) in the CB presents opportunities for storage and demand of Pure Water Los Angeles ATRW and use within the LADWP service area.

4.2 Validation Summary

This section summarizes the CB validation findings.

4.2.1 Current Operations

LADWP owns and operates two extraction wellfields in CB, the Manhattan Wellfield and the 99th Street Wellfield. Both wellfields are being rehabilitated to maximize production capacity (LADWP 2024b).

Although LADWP has water rights of 17,236 AFY (24 cfs [15 MGD]), current pumping is approximately 6,085 AFY based on 10 months of operation per year at 10 cfs (6.5 MGD); unused rights are forfeited back to the basin. Exercising of water rights is limited by aboveground infrastructure, including older

distribution mains in a closed system that can be subject to overpressurization, with use dependent on demand (LADWP 2024b). Additionally, 1,503 AFY (2 cfs [1 MGD]) of water rights from the WCB can be transferred to CB (LADWP 2021b).

For this evaluation:

- **Injection** refers to injected water and injection wells.
- **Extraction** refers to extraction wells.
- **Production** refers to extraction, treatment of extracted groundwater, and aboveground and buried infrastructure to move water from extraction wells and treatment through the CB potable water distribution system to demand locations.

4.2.2 Potential Utilization and System Integration Opportunities

Taken together, existing LADWP water rights plus transferred WCB water rights are 18,739 AFY (LADWP 2024b). Assuming operations for 10 months during the year, the potential utilization and pumping capacity of these existing rights is 31 cfs (20 MGD).

LADWP is evaluating system improvements to aboveground infrastructure to increase production in CB above the current operations of 10 cfs and potentially beyond the existing rights at 31 cfs (LADWP 2024b), which could provide opportunities for use of Pure Water Los Angeles ATRW.

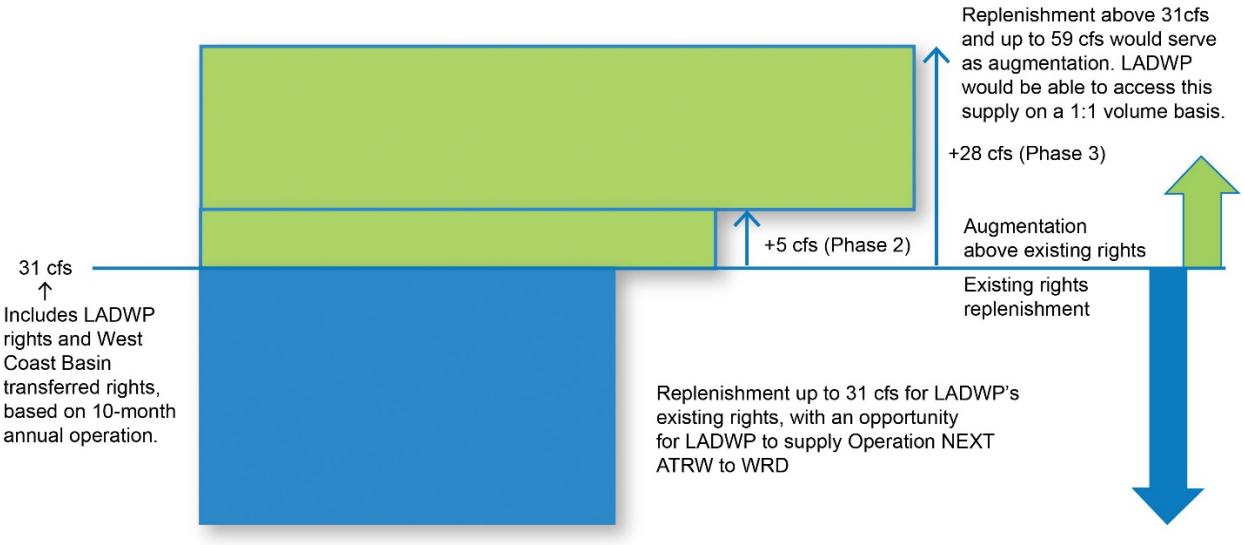
Phased improvements are based on an analysis of demands in CB conducted by LADWP (LADWP 2024b) and are expected to be completed as shown in Table 4-1 and summarized as follows:

- Current: Extraction from Manhattan Wellfield
- Phase 1: Additional capacity from improvements to the 99th Street Wellfield and the Western Trunkline Project
- Phase 2: Manhattan Wellfield improvements, including additional booster pumps and forebay
- Phase 3: Harbor system improvements (upsize Harbor Trunkline)

Within this phasing and as shown on Figure 4-1 and in Table 4-1, Pure Water Los Angeles ATRW supply could serve as both replenishment of existing rights and as augmentation exceeding LADWP's existing groundwater rights to support extraction of more than the full rights (WRD email 2024). By the end of Phase 3, up to 59 cfs (38 MGD) of Pure Water Los Angeles ATRW could be injected into CB with new injection wells. To take advantage of the augmentation, new extraction and treatment facilities would be needed for the new flow exceeding the existing rights.

Figure 4-1 shows the planned phased system improvements in CB, with replenishment and augmentation opportunities identified. LADWP may consider replenishment toward existing entitlements through a purchase agreement with Water Replenishment District which is described further in Section 7.

Figure 4-1. Total Groundwater Production in Central Basin Using Existing Rights and Augmentation



A potential Phase 4 could involve incorporation of variable frequency drives to match diurnal demands in these zones and provide total future capacity of up to 89 cfs (58 MGD); however, estimates for Phase 4 are not included in this analysis.

Table 4-1. Planned Phased System Improvements in Central Basin (Extraction and Production)

Phase[a]	Capacity Added by Phase	Total CB Production Flows [b]		Pure Water Los Angeles New Extraction and Treatment Capacity Totals [c]	
CB	cfs	cfs	MGD	cfs	MGD
Current	10	10	6.5	0	0
Phase 1	6	16	10	0	0
Phase 2	20	36	23	5	3
Phase 3	23	59	38	28	18

[a] Phasing per CB TM (LADWP 2024b)

[b] Equivalent to planned total Pure Water Los Angeles injection flows and assume 10 months of operation annually, for both extraction and injection

[c] These flows represent augmentation exceeding existing rights

As noted in Table 4-1, the Concept Study identified potential injection of Pure Water Los Angeles ATRW in CB; to advance this concept, the MP validation evaluated the following items to supplement the Concept Study:

- Recharge method options
- Injection water quality requirements
- Groundwater treatment requirements for a new extraction wellfield

These assessments are documented in the following TMs, which are provided as attachments and should be referred to for further detail:

- Attachment A, *Central Basin Injection Wellfield Recharge Water Quality Requirements*
- Attachment B, *Central Basin Groundwater Treatment Evaluation*

These assessments related to Component 4 are summarized in the following sections.

The area considered for injection (east of Manhattan Wellfield and north of 99th Street Wellfield) is specifically known as the Los Angeles Forebay because it is an unconfined aquifer that can allow for natural recharge. This is not to be confused with a hydraulic structure commonly used as a forebay for a pump station.

4.2.2.1 Recharge and Extraction Options

In 2013 and in 2014, WRD was appointed as the Watermaster Administrative Body for the Central and West Coast Basins. As Watermaster Administrative Body, WRD is responsible for administering the terms of the legal judgments controlling pumping, water right sales and leases, storage, and carryover conversions (WRD n.d.). WRD's recently broadened interpretation of the storage requirements in the CB Judgment allows for potential alternate recharge and extraction scenarios to be considered for Pure Water Los Angeles. Specifically, the 12-month time requirement assumed in the *WRD-LADWP Joint Master Plan* (Joint MP) (Jacobs 2022) MP for extracting water that has been stored in the groundwater basin will be relaxed and water can be stored for longer than 12 months (RFI 027, LADWP 2023e, 2024c). In addition, the location for augmentation projects and the extraction wells that recover water do not need to be hydrogeologically connected or in the same general area.

Two recharge and extraction options were evaluated for placing Pure Water Los Angeles ATRW in CB:

1. Direct injection using dispersed injection wells along Hyperion Backbone, as suggested by County Public Works (Figure 4-2).
2. The Joint MP (Jacobs 2022) developed the concept of new distributed injection and extraction wellfields. Injection would be in the Los Angeles Forebay Area, and extraction would be just south, as shown on Figure 3-1.

The CB potable water system is a closed system, and production is dependent on demand; otherwise, the system may become overpressurized (LADWP 2024b). Thus, for the purposes of this MP, extraction and injection capacities are estimated based on the phased improvements summarized in Table 4-1.

Table 4-2 summarizes the groundwater that could be extracted with full use of the existing pumping rights based on the water demand values provided by LADWP and augmentation water that could be provided to meet additional demand beyond the pumping rights. The planned phased improvements described here and summarized in Table 4-1 are included in assumptions for total production from the extraction wellfields in CB in Table 4-2.

Table 4-2. Estimated Production and Injection in Central Basin with Pure Water Los Angeles ATRW

Wellfields	Capacity, cfs[a]	Capacity, MGD[a]
Estimated Groundwater Production in CB[b, c]		
Existing Manhattan and 99th Street extraction Wellfields (Phases1, 2; existing rights)	31	20
New extraction Wellfields (Phases 2, 3; augmentation exceeding existing rights)	28	18
Total Production in CB	59	38
Estimated Pure Water Los Angeles ATRW Injection (Replenishment and Augmentation) in CB[a, d]		
Injection of Pure Water Los Angeles ATRW to support extraction of existing rights	31	20
Injection of Pure Water Los Angeles ATRW exceeding existing rights	28	18
Total Injection in CB	59	38

[a] Capacity assumes operations for 10 months per year for both extraction and injection wells.

[b] Phased improvements per LADWP CB TM (LADWP 2024b).

[c] There is existing extraction capacity up to the existing rights of 31 cfs. New extraction wells and treatment are required to access augmentation water exceeding the existing rights. However, LADWP estimated current production capacity (before the CB improvements are implemented) is approximately 16 cfs for Manhattan and 99th Street wellfields (LADWP 2024b; LADWP email 2024b).

[d] Existing rights for both LADWP and those transferred from WCB.

To replenish and augment these volumes, the number of injection wells was estimated at 27 based on a flow rate of 1,000 gallons per minute (gpm) (2.2 cfs) (RFI 64, LADWP 2023f). Seven new extraction wells are estimated at a pumping rate of 2,000 gpm (4.5 cfs) based on the Joint MP (Jacobs 2022). Total capacity with new extraction wells was assumed to match the total capacity of injection of Pure Water Los Angeles ATRW for augmentation, assuming 10 months of operation per year for both injection wells and extraction wells (LADWP 2024b).

Data gaps exist in the water quality and hydrogeology (potential yield and well depths) in the area of the injection and extraction wellfields modeled for the Joint MP. An Injection Test Well Work Plan (Jacobs 2022) was developed for this previous project to support installation of injection test wells and associated monitoring wells to verify the feasibility of installing new recharge and extraction facilities in the Los Angeles Forebay Area. There are multiple approaches to the initial testing of injection wells, and the selected approach will need to balance schedule including land acquisition, feasibility, permitting, and other considerations. LADWP indicated that the test and monitoring well installations, data collection, and analysis would be implemented after completion of the MP.

The injection well testing will be critical to help to:

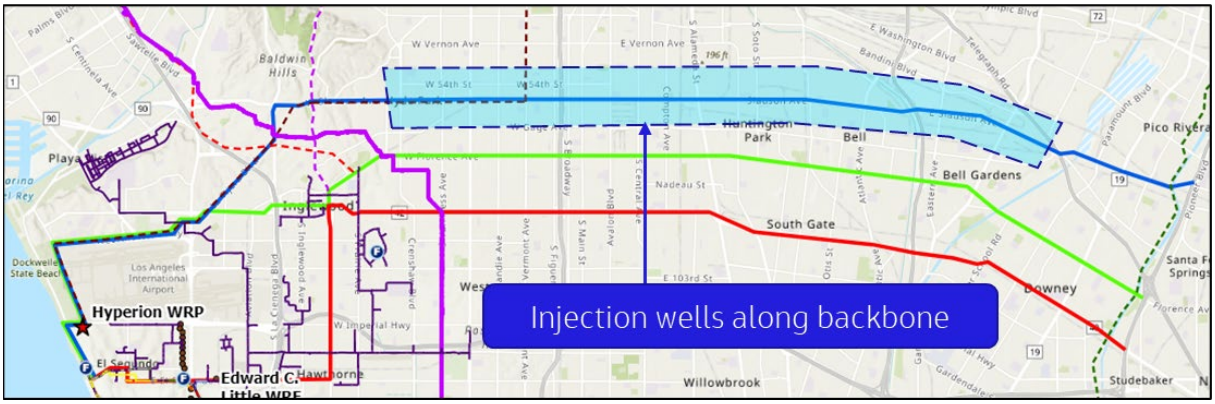
- Refine the understanding of the local geology, hydrogeology, and water quality
- Assess potential injection well operational issues related to the geochemical or physical plugging
- Make recommendations for injection well instrumentation

LADWP may also elect to do initial exploratory drilling in the area and install monitoring wells, which will be a required component of the project to demonstrate compliance with *California Code of Regulations* (CCR) Title 22 requirements, including satisfying the minimum residence time requirements of 2 months, although DDW has typically had a preference for (and expectation of) 6 months for groundwater replenishment projects.

4.2.2.1.1 Injection Along West–East Alignment Option

County Public Works suggested an additional recharge option in CB involving dispersed injection well locations along a west–east alignment option from the CB western boundary and the tie-in connection to the PWSC Backbone near the Montebello Forebay Spreading Grounds, as shown on Figure 4-2.

Figure 4-2. Direct Injection Using Dispersed Injection Wells Along West–East Alignment



Source: LADWP 2022; LA County 2023; ESRI World Topo Map; ESRI World Street Map

The main advantage of this concept is that the need for distribution pipes from the main west–east alignment to the individual injection wellfields could potentially be minimized. The main disadvantage with this approach is the absence of the hydrogeologic connectivity between the injection and extraction wellfields, which means that the water quality of the extracted water would be influenced by ambient water quality instead of the injected ATRW that is of high quality. Also, should contaminants in ambient water be present at elevated levels, treatment would need to be provided, which could result in the need to provide multiple treatment facilities to address water quality issues before distribution. Additionally, this injection arrangement would add cost and O&M requirements because the pipeline would need to be extended beyond the CB injection wellfields if an interconnect with the PWSC Backbone was not to be implemented.

As such, this approach is not recommended for consideration.

4.2.2.1.2 Recommendation for Recharge and Extraction Options

The validation effort evaluated other recharge and extraction options, and Table 4-3 summarizes the potential benefits and considerations of each of these three recharge options related to factors such as:

- Permitting
- Proximity to LADWP's distribution system and local system demands
- Ability to recover the high-quality water recharged

Based on this qualitative evaluation, direct injection through distributed injection and extraction wellfields in the Los Angeles Forebay is the alternative recommended for the MP.

Table 4-3. Central Basin Recharge Options Benefits and Considerations

Recharge Mechanism	Summary of Concept	Benefits	Considerations and Challenges
Direct Injection by Distributed Injection and Extraction Wellfield in Los Angeles Forebay	Concept described in WRD-LADWP Joint Master Plan, consisting of injection wells and extraction wells distributed over ~2 square miles east and north of the Manhattan and 99th Street wellfields, respectively	▪ Single permitting effort for injection wells ▪ Potential adverse effects of injection (groundwater mounding) and extraction (land subsidence) offset one another ▪ Less-variable subsurface conditions; potential to streamline investigation effort and standardize injection and extraction well design ▪ Extracted water quality is expected to be of higher quality compared to ambient water quality once flow from injection wellfield to the extraction wellfield achieves a steady state ▪ Recharge operations (injection) could continue during wet weather seasons	▪ Reliant on phased improvements to CB to increase production capacity in a closed system with older distribution mains. ▪ Initial recovered water at extraction wellfield may require treatment. ▪ Extraction wellfield is required to offset potential adverse effects of injection, reducing flexibility in extraction wellfield location.
Direct Injection through Dispersed Injection Wells along Hyperion Backbone	Injection wells installed along a west–east alignment option between HWRP and connection to Metropolitan's PWSC Backbone	▪ Greater flexibility for injection well placement ▪ Reduced likelihood of excessive groundwater mounding due to injection ▪ Recharge operations (injection) could continue during wet weather seasons	▪ More variability and uncertainty in subsurface conditions and potential injection well capacity. ▪ Each injection well or area of injection would require separate permitting efforts. ▪ More than half of the Hyperion Backbone is outside of LADWP's service area, reducing amount of recoverable recharge. ▪ Potential for improved water quality in the extracted water would not be realized by LADWP.

~ = approximately

4.2.2.2 Injection Water Quality Considerations

This MP includes a preliminary evaluation to assess the geochemical compatibility of Pure Water Los Angeles ATRW and groundwater in the aquifers potentially receiving recharge from new injection wells in CB. Because finished water quality from the AWPF is unknown at this time, evaluations were based on water quality data from advanced water treatment pilot testing conducted for the Donald C. Tillman Water Reclamation Plant (WRP) and groundwater quality data from nearby WRD regional monitoring wells and production wells. Evaluations assessed potential adverse mixing reactions and developed pretreatment measures, equipping considerations to support successful injection wellfield operations. Attachment A, *Central Basin Injection Wellfield Recharge Water Quality Requirements,* documents the entire assessment.

The validation in Attachment A revealed the need for providing post-treatment stabilization at the AWPF and before injection to mitigate potential adverse reactions from the mixing of recharge water and native groundwater (Table 4-4).

Table 4-4. Target Water Chemistry at Point of Recharge

Analyte	Unit	Target Concentration at Point of Recharge[a]	Post-Treatment Stabilization Benefit
pH	S.U.	8.3	Prevent leaching of undesirable metals at AWPF
Alkalinity as $CaCO_3$	mg/L	> 60	Buffering agent for pH control at AWPF
Chlorine Residual[b]	mg/L	3-5	Control biofilm growth at AWPF, and prevent leaching of undesirable metals, possibly with additional chlorine dosing before injection
TSS	mg/L	< 1	Mitigate elevated solids from ATRW post-treatment conditioning that reduce injection well capacity through clogging using filtration before injection or alternative post-treatment chemical selection at AWPF

[a] Assumed water quality for recharge; to be refined with future geochemical evaluations, studies, and permit requirements.

[b] Assumed requirement consistent with WCB Seawater Barrier operational practices.

< = less than

> = greater than

$CaCO_3$ = calcium carbonate

mg/L = milligram(s) per liter

S.U. = standard unit

TSS = total suspended solids

4.2.2.3 Groundwater Treatment

Groundwater extracted from CB for IPR must meet the federal and state drinking water standards set by the U.S. Environmental Protection Agency (EPA) and the State of California Water Resources Control Board's (SWRCB's) Division of Drinking Water (DDW). The following tasks were conducted to identify treatment technologies to guide the overall conceptual treatment process design for the proposed new extraction wellfield in CB:

- Performed a desktop evaluation of groundwater quality in the location of the proposed new extraction wellfields, and identified potential contaminants
- Identified treatment processes and recommended a treatment train
- Identified a treatment site
- Developed a conceptual site layout
- Developed a conceptual cost estimate

This section summarizes the groundwater treatment conceptual design for CB. The detailed assessment is provided in Attachment B, *Central Basin Groundwater Treatment Evaluation Technical Memorandum*.

4.2.2.3.1 Groundwater Quality

To better understand the water quality characteristics and develop potential treatment requirements for the CB component option, an evaluation of ambient groundwater quality was conducted. Because no field water quality data are available at the selected areas for injection and extraction, historical data from the following sources were reviewed and analyzed:

- Data collected from the Groundwater Ambient Monitoring and Assessment (GAMA) centralized public water quality database (SWRCB n.d.)
- *Regional Groundwater Monitoring Report Water Year: Central Basin and West Coast Basin Los Angeles County, California Water Year 2020-2021* (WRD 2022)

Based on the review of the available historical data from five production wells in the surrounding area from the past 10 years (2012 through 2022), 11 water quality parameters of concern were identified that exceed regulatory limits. Most of the production wells with reported elevated concentrations are production wells located east of the proposed injection and extraction wellfields. There are no monitoring well data from the proposed injection or extraction wellfields; therefore, the surrounding production well water quality data provide an indication of the potential for an increased risk for detecting these contaminants at elevated levels. Further field investigation, and groundwater modeling should be conducted in the selected area where field data do not currently exist, as described in the Injection Test Well Work Plan (Jacobs 2022). The additional evaluation will help provide necessary data to confirm whether exceedances exist and define treatment requirements.

The following contaminants that exceeded primary and secondary maximum contaminant levels (MCLs) were carried forward for treatment evaluation:

- Iron
- Manganese
- Volatile organic compounds (VOCs), including:
  - 1,2-dichloroethane
  - Carbon tetrachloride
  - Tetrachloroethylene (PCE)
  - Trichloroethylene (TCE)
- Perchlorate
- Chromium and hexavalent chromium
- Conductivity
- Total dissolved solids (TDS)

4.2.2.3.2 Treatment Objectives

Currently, other utilities, such as Golden State Water Company, are operating wellhead treatment at extraction wells in the Los Angeles Forebay to remove comparable concentrations of contaminants in drinking water wells. Based on our research of DDW's permit website and our email communication with Golden State, DDW has not required these utilities to prepare a Process Memo 97-005 document (97-005) to operate their extraction wells for domestic use of an extremely impaired source (LADWP 2022b). Process Memo 97-005 is a document that describes the process and principles the DDW uses to evaluate proposals, establish permit conditions, and approve the use of an extremely impaired source for drinking water; the process has extensive analysis requirements (SWRCB 2020).

It is important to recognize that the potential for trigging the 97-005 process may exist but remains low in the area of interest because:

- The potential CB Groundwater Augmentation Project is neither designed to remediate any contaminations nor associated with any remediation activities in the area.

- The project will locate extraction wellfields away from major contamination or contaminant sources and will not extract groundwater from screening depths greater than those used by the existing production wells in the surrounding area.

As part of the near-term site investigations led by LADWP, it is recommended that LADWP conduct detailed geochemical and groundwater characterization to inform wellfield site and extraction depth selection so that areas of contamination and the 97-005 process could be effectively avoided.

4.2.2.3.3 Conceptual Treatment Train

The following individual treatment unit processes were selected to meet the overall treatment objectives in a centralized treatment approach from new extraction wells in the Los Angeles Forebay. A preliminary site selection of four parcels identified by LADWP resulted in potential siting of centralized treatment just north of the Manhattan Wellfield for this validation effort. These treatment processes are assumed for this validation effort, but further field data collection and evaluation will be required to confirm the ultimate technology selection.

- **Adsorptive Filtration**: To provide iron and manganese removal through adsorptive filtration technology
- **Granular Activated Carbon (GAC) Contactors**: To provide VOC removal through adsorption
- **Ion Exchange (IX) Resin Sorption**: To provide perchlorate and hexavalent chromium removal (as a future option) through resin sorption
- **Chlorination**: To provide 4-log reduction of virus required for primary disinfection through a chlorine contact tank (CCT)
- **Fluoride and ammonia addition:** To provide the required finished water quality for compatibility

Figure 4-3 presents the schematic process flow diagram of the conceptual treatment processes to treat raw water from the proposed extraction wells. Table 4-5 summarizes the design criteria. Figure 4-4 shows a potential site layout for the treatment facility, not including any potential ancillary facilities on the site.

Figure 4-3. Central Basin Conceptual Groundwater Treatment

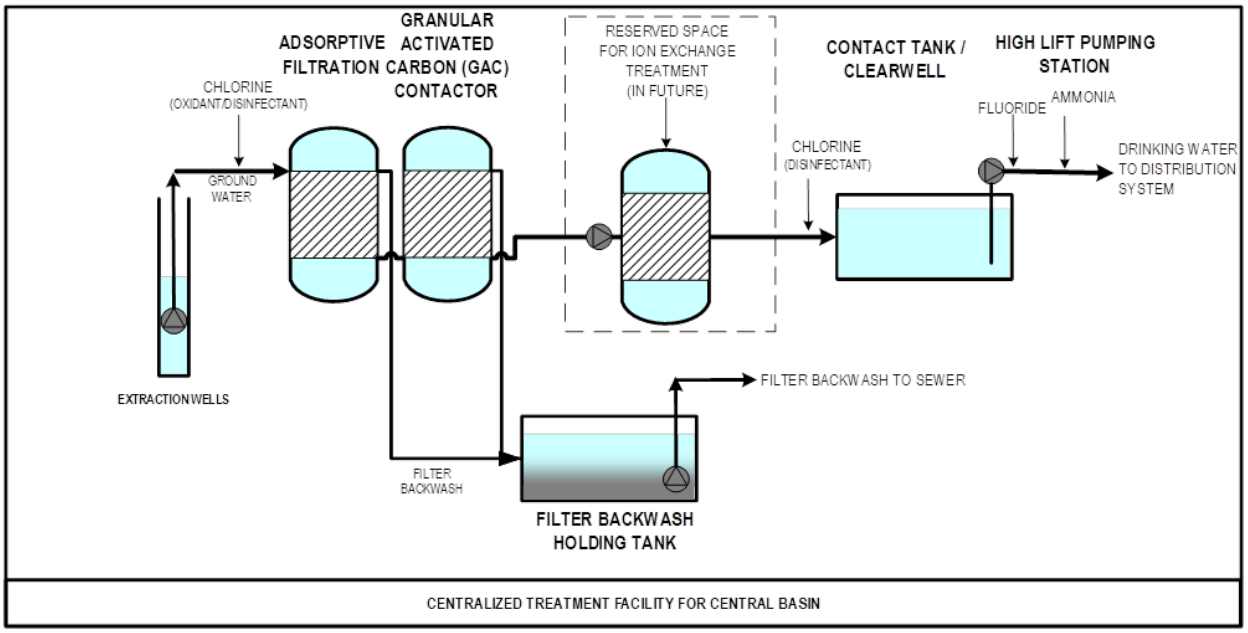


Table 4-5. New Groundwater Treatment Train Design Criteria for Central Basin

Description	Adsorptive Filtration System	GAC Adsorption	IX Resin Sorption (Future)
Media	Pyrolusite	GAC	IX resin
Targeted contaminants	Iron and manganese	VOCs	Perchlorate, total chromium, and hexavalent chromium
Design flow rate (MGD)	18	18	18
Type of filters	Pressure	Pressure	Pressure
Train configuration	Parallel	Lead and Lag	Parallel
No. of vessels (N+2)	14	30 (i.e., 15 lead-lag pairs)	24 (12 per treatment)
Vessel diameter (feet)	12	12	12
Media depth (feet)	3.5	10	4.0
Individual filter area (ft^2)	113	113	113
EBCT per vessel (minutes)	2.5	8.0	3.0
SLR at design flow rate (gpm/ft^2)	10	9.0	10
Media required per vessel	400 ft^3	40,000 lb	440 ft^3
Building or enclosure required	No	No	No

EBCT = empty bed contact time

ft^2 =- square foot (feet)

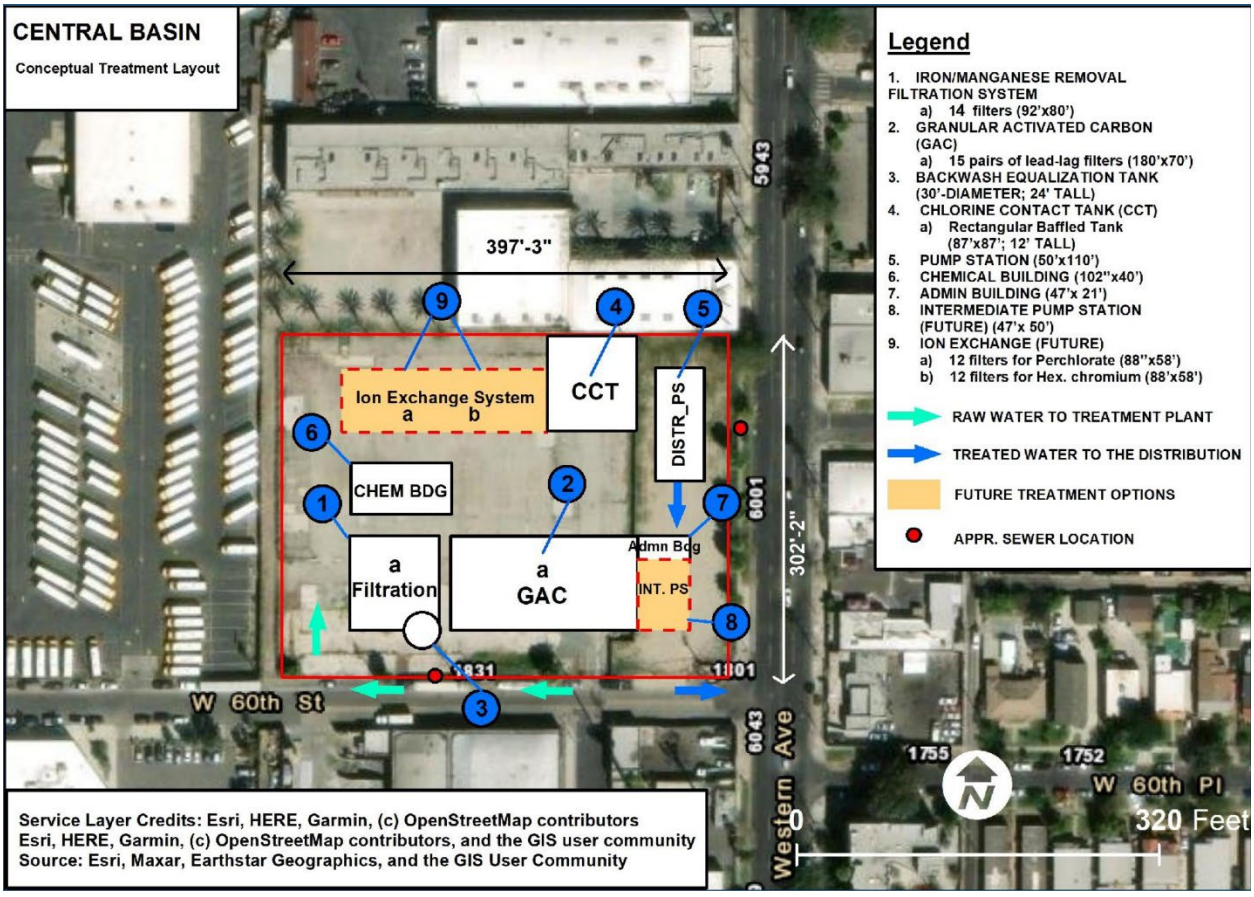
ft^3 = cubic foot (feet)

lb = pound(s)

No. = number

SLR = surface loading rate

Figure 4-4. Conceptual Groundwater Treatment Layout for the Potential Central Basin Groundwater Augmentation Project



4.2.2.3.4 Conceptual Extraction Wells and Treatment Train Cost

Conceptual-level site layouts (Attachment B, *Central Basin Groundwater Treatment Evaluation*) and capital cost estimates were established based on the potential contaminants of concern, design influent, and required effluent concentrations. Refer to Attachment G, *Cost Estimates* for a detailed breakdown. As noted in Section 4.2.2.1, new extraction wells and treatment are needed to access the volume of Pure Water Los Angeles ATRW provided for augmentation exceeding existing entitlements.

Table 4-6. Conceptual Groundwater Treatment Train Cost

Item	Description	Capacity, cfs (MGD)	Capital Cost ($ million)	Annual O&M Cost ($ million)[a]
Distributed Wells	Injection wells (27) Extraction wells (7)	59 (38) 28 (18)	462	2.22
Extraction Treatment	Adsorptive filtration, GAC, IX, and polishing	28 (18)	234	6.64

Notes:

Year 2024 dollars.

AACE Class 5 Level estimates with an accuracy range of -20 to -50% to +30 to +100%.

AACE = AACE International

[a] Based on average annual flow of 14 mgd per ONAT scenario modeling.

4.3 Modified Program Component Basis

Based on this evaluation, the Concept Study (LADWP 2021a) Components 3, 4, and 5 to convey water from HWRP to CB for replenishment are feasible. Proposed modifications to the flows and replenishment methods and locations are presented in this section to enhance Components 3 and 4.

The Concept Study included Component 3 – a pipeline that included capacity for 77 cfs (50 MGD) to PWSC. Section 8 provides details about the size of the pipeline to convey flows to CB and PWSC.

The validation effort resulted in a recommendation for injection and extraction of Pure Water Los Angeles ATRW into CB in the Los Angeles Forebay. Table 4-7 summarizes the proposed component modifications.

Table 4-7. Proposed Component Modifications Based on Master Plan Validation for Central Basin

Concept Study Component	Proposed Modification Based on Validation
Component 3: 108-inch-diameter pipeline from AWPF to CB, including 42 cfs (27 MGD) into CB and 77 cfs (50 MGD) to convey to PWSC	Either new pipeline or through extension of WCB's Inglewood lateral for flow to CB (Jacobs 2024a). Refer to validation in Section 8 for the proposed modifications to pipe sizing and flows for this component.
Component 4: Injection and extraction of 42 cfs (27 MGD) into CB, based on modeling in the WRD-LADWP Joint Master Plan, with 27 injection wells and 18 extraction wells	New injection and extraction wellfields in the Los Angeles Forebay, as follows: ▪ 59 cfs (38 MGD) total injection for replenishment to support extraction of the existing rights (31 cfs [20 MGD]) and augmentation exceeding existing rights (28 cfs [18 MGD]). ▪ Injection capacity of 59 cfs (38 MGD) through 27 new injection wells. ▪ New extraction capacity of 28 cfs (18 MGD) through 7 new extraction wells. ▪ Assumes 10 months of operation per year for both injection and extraction capacity.
Component 4: Injection and extraction locations TBD	Injection and extraction proposed in the Los Angeles Forebay.
Component 4: Extraction treatment TBD Groundwater treatment for 14 cfs (9 MGD) on 2 acres (87,120 ft^2) to 6 acres (261,360 ft^2)	At least 1.2 acres (51,290 ft^2) are needed for centralized treatment of 28 cfs (18 MGD) of extracted groundwater through adsorptive filtration, GAC, IX (future option), chlorination, and fluoride and ammonia addition, based on available water quality data from the surrounding area. Ancillary facilities were not included.
Component 5: Pipeline to convey water extracted from CB to the potable water distribution system 24-inch- to 42-inch-diameter pipeline, and one pump station and storage facility	In development per LADWP CB phased improvements; pipe length may be reduced to connect to CB phased improvements.

The following actions are recommended to refine the project-level definition after ONAT scenario modeling of potential storage and demands and screening of alternatives:

- Install a new test well and conduct aquifer testing (through either pumping or injection) to evaluate potential target aquifer(s) for injection, characterize their hydraulic properties, and collect data for geochemical compatibility evaluation. Note that injection testing will likely have a longer schedule because of permits and infrastructure/equipment needed to deliver the water supply to the test well.
- Install new monitoring wells to confirm water quality data and to support additional groundwater modeling for potential injection well locations and screening depths.
- Pilot test the treatment train for extracted groundwater to inform full-scale plant design.

- Evaluate available LADWP property for injection wells, extraction wells, and groundwater treatment facilities. Evaluate site acquisition needs and availability. If additional sites are needed, conduct a siting study and initiate site acquisition.
- Submit a formal request to WRD and the Storage Panel for guidance on implementation of water augmentation projects in CB, including offering requirements and methods to determine storage duration.

4.4 Policy Considerations

The following policy considerations relate to application of Pure Water Los Angeles ATRW in CB:

- The supply water from the AWPF could be either IPR or DPR quality. The benefits and costs of recharging DPR water qualities should be evaluated. A LADWP policy change would be required to inject DPR quality water.
- Water injected by the CB Water Augmentation Project would not be required to be extracted out within 12 months after injection (RFI 27, LADWP 2023e, 2024c), which provides flexibility in storage and use for LADWP. Using available storage space for longer-term storage is possible according to the latest interpretation of the judgment by WRD shared during the October 2022 meeting.
- LADWP must offer up water for other pumpers to participate in the CB Water Augmentation Project, hence some of the Pure Water Los Angeles ATRW injected might not become a potable water supply to LADWP (RFI 27, LADWP 2023e, 2024c).
- Water quality and hydrogeologic conditions at the proposed injection and extraction wellfields and their immediate surrounding areas are unknown. Should additional water quality analysis determine that the 97-005 process would be required, or unfavorable hydrogeologic conditions result in the need for more injection or extraction wells than currently estimated, the cost-effectiveness of implementing a water augmentation project should be further evaluated. Also, the potential for public concerns surrounding the 97-005 process should also be carefully considered and integrated into the final decision-making process.
- The ability for LADWP to produce more potable water for the City of Los Angeles (City) from CB is dependent on the timing of the capital improvement projects in the potable water system in the CB and Harbor areas. Prioritization of these capital improvement projects and their timely implementation would help increase use of Pure Water Los Angeles water in CB in the early phases rather than in the later phases.
- LADWP should conduct the necessary field investigations and groundwater modeling to confirm potential areas for injection and extraction to inform the future real estate acquisition strategy. LADWP or the City might not own enough properties in identified injection or extraction areas to build enough new wellfield capacity. A strategy should be developed to acquire enough real estate to implement the Program.

5. San Fernando Basin

LADWP currently holds approximately 87,000 AFY (120 cfs [78 MGD]) of water rights in SFB in addition to 591,469 AF of stored water credits as of October 2018 (ULARA 2019). SFB provides approximately 3.2M AF of groundwater storage (ULARA 1999). The SFB has a regulatory requirement to operate within a 360,000 AF range (ULARA 2019). However, current dewatered storage is less than the lower regulatory limit, resulting in a current storage volume of approximately 550,000 AF (LADWP 2021b; ULARA 2019).

5.1 Concept Study

The Concept Study (LADWP 2021b) described Component 6 to convey 202,000 AFY (up to 280 cfs [180 MGD]) of water from the HWRP to SFB, with the potential for a new 28 cfs (18 MGD) proposed injection wellfield located northwest of the Tujunga Spreading Grounds near the Pacoima Spreading Grounds. In the Concept Study, Pure Water Los Angeles flows were prioritized to VNC. SFB was phased to be included after integration at VNC. Infrastructure for this component was estimated as follows:

- Approximately 20 miles of 96-inch-diameter pipeline
- Two to three pump stations
- Storage facilities
- 18 injection and 12 extraction wells
- A centralized groundwater treatment facility

The Concept Study component of groundwater replenishment in SFB presents opportunities for storage and demand of Pure Water Los Angeles ATRW and use within the LADWP service area, while potentially conveying ATRW to the LAAFP.

5.2 Validation Summary

This section summarizes the SFB validation findings.

5.2.1 Current Operations

The City has historically underused its water rights in SFB for decades due to the presence of groundwater contamination primarily caused by commercial and industrial activities. Actual production from the basin averaged 46,623 AFY (64 cfs [42 MGD]) from fiscal year 2015 and 2016 through 2019 and 2020 (LADWP 2021b).

LADWP is implementing SFB remediation projects consistent with the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) and *National Contingency Plan* (NCP) to extract and treat groundwater. These projects were implemented with the goal of reducing and containing contamination, while simultaneously providing LADWP with treated drinking water. The new projects are estimated to bring the total extraction capacity in SFB to approximately 300 cfs (194 MGD) (LADWP 2021b). Once completed, the LADWP pumping plans assume a minimum pumping of 119,123 AFY (164 cfs [106 MGD]) (LADWP 2024d).

For planning purposes, after implementation of Pure Water Los Angeles, a maximum extraction capacity of 220 cfs (142 MGD) was assumed to account for system constraints, such as available demands or blending requirements, that may limit the ability to use extracted groundwater from SFB. More extraction

may be possible with increases in recharge and infrastructure improvements, such as additional east–west conveyance or pumping to VNC.

To increase groundwater recharge in SFB, the City and County Public Works operate a series of spreading grounds and stormwater capture parks to increase the capture and recharge of stormwater into the basin (County Public Works 2023).

5.2.2 Potential Utilization and System Integration Opportunities

LADWP currently holds approximately 87,000 AFY (120 cfs [78 MGD]) of water rights in SFB. Recharge of stormwater in SFB is considered to be part of the native safe yield for the basin and does not directly increase water rights (LADWP 2021b). However, recharge of ATRW from the Donald C. Tillman AWPF or Pure Water Los Angeles can be used to pump water in excess of LADWP's water rights. Pure Water Los Angeles ATRW could use the existing stormwater recharge facilities when available, or new recharge facilities could be constructed to allow for additional extraction, if demands and the distribution system can handle increased groundwater production.

5.2.2.1 Recharge and Extraction Options

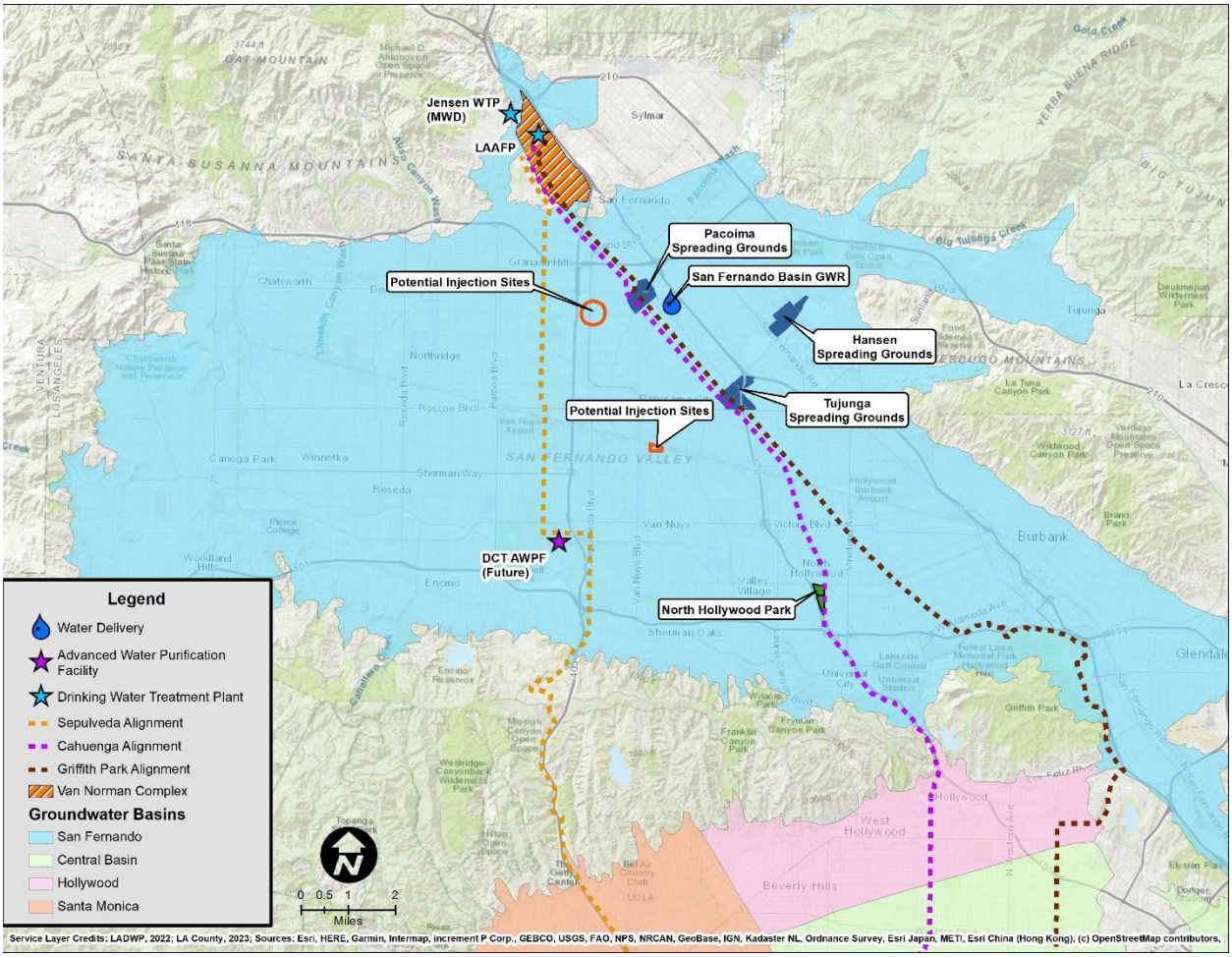
The following three options for recharging Pure Water Los Angeles flows into SFB were evaluated (Figure 5-1):

1. Spreading Grounds: There are three spreading grounds in SFB that could be used for groundwater augmentation: Tujunga, Pacoima, and Hansen Spreading Grounds. During rainfall events, access to the spreading grounds is prioritized for stormwater. Thus, Pure Water Los Angeles access to spreading grounds is assumed to be limited to April through October (LADWP 2023e). Boulevard Pit, located adjacent to the Tujunga Spreading Grounds, could be evaluated for future use if the site is purchased and permitted for recharge, and it could provide a minimum of 2 months of residence time before reaching the Tujunga Wellfield located at the Tujunga Spreading Grounds.
2. Injection Wells: Based on SFB's hydrogeology, it is anticipated that Pure Water Los Angeles ATRW can be recharged through injection using gravity injection wells (Hazen and Arcadis 2024). The number of wells will depend on the location within the basin and the location-specific hydrogeology.
3. Stormwater Capture Parks: There are five new stormwater parks being developed in SFB to capture stormwater runoff during rainfall events and infiltrate it into the groundwater basin (Tetra Tech 2020):
    a. Strathern
    b. Valley Plaza North
    c. Valley Plaza South
    d. Alexandria Park
    e. North Hollywood Infiltration Galleries 1 and 2

Only North Hollywood Infiltration Galleries 1 and 2 are assumed to be used for groundwater augmentation for Pure Water Los Angeles based on the proximity of the other parks to existing production wells. Thus, the third potential method of groundwater recharge is to use the existing washes or new pipeline and recharge through these stormwater capture parks. Use of the existing washes would be contingent on compliance with *California Toxics Rule* (CTR) water quality and monitoring.

The location of the spreading grounds and injections wells could allow recharge water to be captured using the existing production wells that have excess capacity compared to the current groundwater rights. Thus, additional extraction wells as identified in the Concept Study (LADWP 2021a) may not be required, depending on the final recharge locations. Rehabilitation of out of service extraction wellfields located in the southern basin may be required to capture water from the North Hollywood 1 and 2 Stormwater Capture Parks. Modeling will be required to evaluate the impacts of all recharge options on the plume capture for the existing groundwater remediation efforts.

Figure 5-1. San Fernando Basin Groundwater Recharge Locations



5.2.2.1.1 Spreading Grounds

There are three spreading grounds in SFB that were considered for recharging Pure Water Los Angeles ATRW: Tujunga, Pacoima, and Hansen. The Tujunga Spreading Grounds are owned by LADWP, and the Pacoima and Hansen Spreading Grounds are owned by County Public Works (County Public Works 2023). These spreading grounds are used for groundwater augmentation and would require coordination between LADWP and County Public Works to be used in the Program.

County Public Works also owns and operates the Lopez Spreading Grounds. However, this facility was not included in the MP evaluation, as it is located approximately 2.5 miles from the Pure Water Los Angeles alignments and is more than 200 feet higher in elevation. Lopez Spreading Grounds could be considered in the future if additional facilities are required to manage Pure Water Los Angeles flow.

Recharge of stormwater is the primary objective for the spreading grounds. During rainfall events, the spreading grounds would be unavailable to accept ATRW, so it is assumed that the spreading grounds will only be available to accept Pure Water Los Angeles flow from April to October each year, and flows would be diverted to other Program component options from November through March.

Table 5-1 presents the theoretical maximum infiltration rates and assumed stormwater recharge based on the UWMP (LADWP 2021b) and County Public Works' information (County Public Works 2023). The theoretical maximum infiltration rate is the maximum rate at which water can enter the soil in a given condition. The expected stormwater recharge is the estimated annual volume of stormwater to be captured and recharged

each year. Pacoima and Hansen Spreading Grounds are owned by, and usage is controlled by, County Public Works. Tujunga Spreading Grounds is owned by LADWP, which allows LADWP additional operational flexibility. LADWP entered into an agreement with County Public Works to engage County Public Works to operate the spreading grounds in 1990, and County Public Works has been operating the spreading grounds since then. The agreement established the roles and responsibilities of each party (LADWP 1990). Modeling is required to confirm both the short- and long-term infiltration capacity, which may be limited by other factors, such as limits on groundwater levels due to potential contamination and geologic constraints. Modeling or tracer studies are also required to confirm residence time to the extraction wells located at the site.

Table 5-1. San Fernando Basin Spreading Grounds

Location	Spreading Grounds' Owner	Theoretical Maximum Infiltration[a] (AFY)	Expected Stormwater Recharge[a] (AFY)
Tujunga Spreading Grounds	LADWP	86,876	16,000
Pacoima Spreading Grounds	County Public Works	101,356	10,800
Hansen Spreading Grounds	County Public Works	108,595	10,558

[a]Based on reported infiltration and expected stormwater infiltration from 2020 UWMP and County Public Works. Modeling is required to confirm both short- and long-term storage capacity. Theoretical maximum infiltration is the maximum rate at which water can be recharged. Expected stormwater recharge is the expected annual average recharge volume.

Table 5-2 presents the assumed Pure Water Los Angeles flows for the spreading grounds. The assumed flows are less than the theoretical maximum infiltration to account for residence time and potential groundwater mounding.

Table 5-2. Assumed San Fernando Basin Spreading Grounds Capacity

Location	Flow, cfs (MGD)	Justification
Tujunga Spreading Grounds	Up to 30 (19)	Flow limited to basins farthest from production wells to maximize available residence time. Tracer study required to determine residence time and refine recharge capacity.
Pacoima Spreading Grounds	Up to 70 (45)	Conservative estimate limited to 50% of the infiltration capacity 140 cfs (90 MGD) to account for groundwater mounding and basin maintenance.
Hansen Spreading Grounds	Up to 30 (19)	Conservative estimate based on flows > 44 cfs (28 MGD) that may increase mounding and adversely impact operations at the Bradley Landfill (RMC 2012).

LADWP currently operates extraction wells located in the Tujunga Spreading Grounds facility, which may limit recharge capacity to maintain the minimum required 2 months of residence time under the IPR regulations (CCR, Title 22, Social Security, Division 4, Environmental Health [22 CCR 4], Chapter 3, Water Recycling Criteria, Articles 5.1). In cases where the 2-month residence time cannot be maintained or met, recharge at Tujunga Spreading Grounds could be evaluated as a DPR project. DPR has higher water quality standards that eliminates the need for 2-month residence time. This could be accomplished with DPR at the AWPF or through additional chemical and pathogen treatment before spreading or after extraction (SWRCB 2023) if such an approach was determined to be optimal after further evaluation.

5.2.2.1.2 Injection Wells

The location of the new injection wells would be selected based on available land and the ability to maintain the required residence time and capture the water for extraction. Additional evaluation of the impacts of rising water levels on contaminants in the unsaturated zone, landfill gas migration, and operation of existing remediation facilities are recommended. As discussed in this section, treatment will be assumed for all extracted water as a conservative estimate until additional modeling and evaluations can be completed.

A conceptual injection evaluation identified two primary areas in SFB that would have adequate hydraulic capacity for Pure Water Los Angeles injection wells: (1) west of the Pacoima Spreading Grounds, and (2) near the LADWP Valley Center property located southwest of Tujunga Spreading Grounds. These areas were identified as having at least 77 cfs (50 MGD) of injection capacity based on the hydrogeology and available head. Gravity feed was assumed as a conservative estimate, and higher flows may be possible with pressurization. However, additional numerical groundwater modeling, an assessment of water quality and geochemical compatibility, and pilot test wells are recommended to confirm the conceptual analysis and assumed injection rates (Hazen and Arcadis 2024). LADWP is currently planning additional modeling and pilot well testing.

Unlike the spreading grounds, the injection wells would be available year-round, providing a constant location for ATRW flows. This component requires available land for the new injection wells within reasonable proximity to the proposed Program alignments. It is assumed that, based on the contaminant plume locations, injection locations can be sited such that the existing production wells can be used for extraction.

An initial conceptual injection capacity was assumed to be 77 cfs (50 MGD), with the facility located at the LADWP Valley Center facility. If injection is not feasible at this location, additional costs may be incurred for property acquisition. Based on preliminary analysis (Hazen and Arcadis 2024), 17 injection wells are assumed to allow for meeting the target injection capacity, with an assumed operation of 10 months per year per well. Injection well capacity is assumed to be up to 5.4 cfs (3.5 MGD) per well. The preliminary analysis indicated that additional injection capacity is possible through expanding the number of injection wells or using additional injection locations.

5.2.2.1.3 Stormwater Capture Parks

LADWP has worked with the Los Angeles Flood Control District (LACFCD) to support the construction of stormwater capture programs throughout SFB (LADWP 2021b). LADWP's Stormwater Parks Program has also identified several additional City-owned parks that could be used for additional stormwater capture programs that will recharge water from the Tujunga Wash. The proposed parks are also located close to several proposed Pure Water Los Angeles alignments.

Table 5-3 summarizes the capacities of the larger-capacity proposed stormwater parks located close to the alignments. As with the spreading basins, it was assumed that this component option would not be available during storm events and would only be available to accept flows from April to October.

Table 5-3. Stormwater Park Infiltration Rates

Stormwater Park	Approximate Distance to Closest Extraction Wellfield	Infiltration Rates (in/hr)	Infiltration Rates cfs (MGD) [a]
Strathern	< 0.1 mile	4.0	5.7 (3.7)
Valley Plaza North	< 0.1 mile	2.3	4.6 (3.0)
Valley Plaza South	0.2 mile	3.7	3.4 (2.2)
Alexandria Park	0.6 mile	0.7	0.4 (0.3)
North Hollywood Infiltration Galleries 1 and 2	> 1 mile	2.5 to 3.5	23 (15)

[a]Based on Configuration 1 in *Programmatic Analysis Technical Memorandum* (Tetra Tech 2020)

in/hr = inch(es) per hour

For this component option to be advantageous, the stormwater park would need to be close to one of the proposed Program alignments, as percolation rates are relatively small, ranging from approximately 0.4 to

14.0 cfs (0.3 to 9 MGD). Additionally, the stormwater parks need to provide at least 2 months of residence time before reaching any extraction wells and will require modeling with tracer studies for confirmation. The North Hollywood Infiltration Galleries 1 and 2 stormwater parks meet both criteria, while also offering the best potential infiltration rates. The other stormwater parks were not considered further.

The North Hollywood Infiltration Galleries 1 and 2 could potentially accept a combined 23 cfs (15 MGD) of ATRW (during dry weather). However, the North Hollywood Infiltration Galleries have not been funded at this time, and the implementation of these projects is uncertain (LADWP 2023g). Conveyance to the parks could pass through the Tujunga Wash. However, the Tujunga Wash is included in the Los Angeles RWQCB's Basin Plan and would require compliance with the CTR (Los Angeles RWQCB 2014). To reduce the risks associated with the CTR water quality requirements, it was assumed that Pure Water Los Angeles flows could be piped directly to the North Hollywood Infiltration Galleries due to the proximity of the galleries to the Cahuenga and Griffith Park alignments (less than 1.5 miles).

The North Hollywood Infiltration Galleries are in the southern end of the basin, and there would be less time to capture the water before it flows outside of the basin limits, so the water right would be forfeited. In addition, the area has higher groundwater levels, thereby reducing recharge rates. Modeling would be necessary to evaluate the short- and long-term storage capacity. The Verdugo wellfield is located downstream of North Hollywood Park, but this wellfield is currently out of service (LADWP 2021b).

5.2.2.2 Groundwater Recharge Water Quality Considerations

For Pure Water Los Angeles, the baseline assumption is that all water will meet IPR water quality standards before reaching SFB. IPR-quality water can be recharged without the additional chemical or pathogen treatment required for DPR. However, an assessment of water quality and geochemical compatibility is required to confirm any post-treatment stabilization needs at the AWPF. For the MP, it was assumed that the planned post-treatment stabilization at the AWPF, as summarized for CB would be adequate to mitigate adverse reactions from the mixing of recharge water and native groundwater.

5.2.2.2.1 Groundwater Treatment

Groundwater extracted from SFB must meet the federal and state drinking water standards set by EPA and DDW. Groundwater production in SFB has historically been limited by contamination (for example, 1,4-dioxane and VOCs). Several WTPs are currently under construction for treatment of these contaminants. By the end of 2024, SFB will have approximately 145 cfs (94 MGD) of treatment capacity at the North Hollywood West, North Hollywood Central, and Tujunga Treatment facilities for contaminants found in SFB (1,4-dioxane and VOCs) (LADWP 2021b).

Beyond the planned remediation efforts, there is also the potential for contamination in SFB's unsaturated zone. Rising water levels in the basin due to groundwater replenishment could risk mobilizing additional contaminants unless recharge can be located away from contaminated areas. Based on the unknown of mobilizing additional contaminants, it is assumed that treatment will be provided for the full extracted flow of 220 cfs (142 MGD), which will require an additional 75 cfs (48 MGD) of treatment. Treatment is assumed to include 1.4-dioxane and VOC removal.

5.2.2.2.2 Conceptual Treatment Train

The WTPs currently under construction are being permitted under the DDW 97-005 for extremely impaired sources. It is assumed that any new WTPs required for increased production from recharge of Pure Water Los Angeles ATRW would also require permitting under the 97-005 process. It was assumed that the treatment train at any new WTPs would match the existing WTPs and include ultraviolet advanced oxidation (UVAOP) and GAC. It is assumed that chemical disinfection and fluoridation would be achieved using existing facilities at the Tujunga WTP and North Hollywood Pump Station.

5.2.2.3 Conceptual Treatment Train Design Criteria

Based on the proposed treatment train (Figure 5-2), conceptual design criteria were developed to develop the conceptual-level cost estimates included in Table 5-4. UVAOP sizing was based on achieving 2-log 1,4-dioxane, TCE, and PCE reduction based on sizing at the existing SFB WTPs. SFB has approximately 300 cfs (194 MGD) (LADWP 2021b) of existing extraction capacity, and it is assumed that no new extraction wells would be required for Pure Water Los Angeles. For this evaluation, it was assumed that a new centralized groundwater treatment facility would be located at the Tujunga Spreading Grounds due to its proximity to the Tujunga and Rinaldi-Toluca wellfields.

Figure 5-2. San Fernando Basin Conceptual Groundwater Treatment

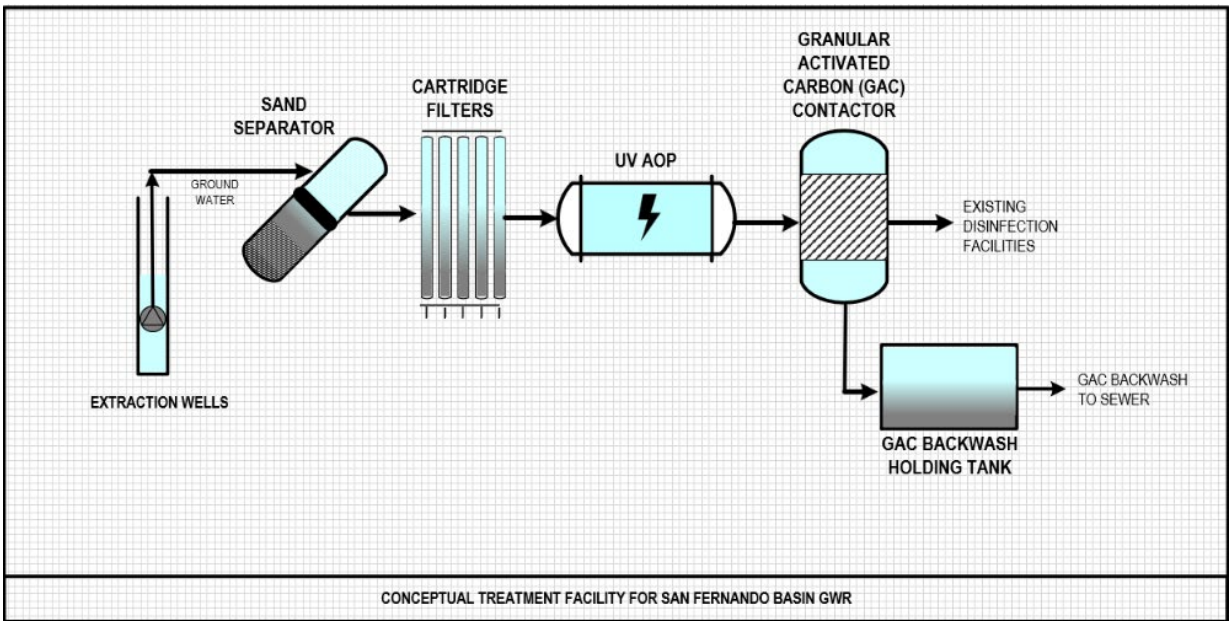


Table 5-4. New Treatment Train Design Criteria for San Fernando Basin

Design Criteria	Units	Value
Design Flow Rate	cfs (MGD)	75 (48)
Conveyance	LF	15,000 at 54-inch diameter
Pre-Filtration		
No. of Sand Separators (Duty, Standby)	-	17,1
No. of Cartridge Filters (Duty, Standby)	-	12, 0
UVAOP		
Design UV Transmittance	%	97
Design Scavenging Term	$second^{-1}$	90,500
AOP Targets	log	2-log 1,4-dioxane, 2-log TCE, 2-log PCE
No. of UV reactors (Duty, Standby)	each	6,1
GAC		
EBCT	minutes	10
No. of Filters (Duty, Standby)	-	33, 2
Backwash Management	-	Backwash tank

- = not applicable

LF = linear foot (feet)

5.2.2.4 Conceptual Layout

For conceptual costing, it was assumed that the new treatment facilities would be co-located with the existing Tujunga WTP and would require filling in an additional approximately 5-acre portion of the spreading grounds (Figure 5-3). Alternative treatment sites within SFB should be evaluated during design based on groundwater modeling and pumping plans for recovering the recharged ATRW.

Figure 5-3. San Fernando Basin Extracted Groundwater Treatment Facility Conceptual Layout

5.2.2.4.1 Conceptual Wells and Treatment Train Cost

Conceptual-level capital cost estimates were established based on the potential contaminants of concern (Table 5-5). Refer to Attachment G, *Cost Estimates*, for the detailed breakdown. No new extraction wells are assumed, and an additional treatment capacity of 75 cfs (48 MGD) is needed to access the volume of Pure Water Los Angeles ATRW provided.

Table 5-5. Conceptual Groundwater Treatment Train Cost

Item	Description	Capacity, cfs (MGD)	Capital Cost ($ million)	Annual O&M Cost ($ million)[a]
Distributed Wells	Injection wells (17)	77 (50)	480	1.66
Extraction Treatment	Pre-filtration, UVAOP, and GAC	75 (48)	899	4.50

Notes:

Year 2024 dollars.

AACE Class 5 Level estimates with an accuracy range of -20 to -50% to +30 to +100%.

[a] Based on average annual flow per ONAT scenario modeling of 111 cfs (72 MGD), which will be treated by existing capacity of 145 cfs (94 MGD).

5.3 Modified Program Component Basis

Based on this evaluation, the Concept Study (LADWP 2021a) Component 6 to convey water from HWRP to SFB for replenishment is feasible. Proposed modifications to the flows and replenishment methods and locations are presented to enhance Component 6.

The estimated planning range for potential usage of Pure Water Los Angeles ATRW in SFB is up to 230 cfs (149 MGD) through the following methods (Table 5-4):

- Spreading through the Pacoima, Hansen, and Tujunga spreading grounds
- Injection using new injection wells
- Recharge at stormwater capture parks

Table 5-6 provides the proposed component modifications based on MP validation.

Table 5-6. Proposed Component Modifications Based on Master Plan Validation for San Fernando Basin

Study Component	Proposed Modification Based on Validation
Component 6: Up to 280 cfs (181 MGD) of ATRW for recharge, including injection of 28 cfs (18 MGD) into SFB using 18 injection wells	Up to 230 cfs (149 MGD) of Pure Water Los Angeles storage in SFB based on: ▪ Up to 77 cfs (50 MGD) of injection capacity, assuming 17 injection wells. ▪ Up to 130 cfs (84 MGD) of spreading ground capacity at Tujunga, Pacoima, and Hansen spreading grounds, seasonally available. ▪ Up to 23 cfs (15 MGD) of stormwater capture park capacity, seasonally available.
Component 6: Extraction of 28 cfs (18 MGD) from SFB using 12 extraction wells	Existing extraction well capacities (300 cfs [194 MGD]) exceed the planned maximum groundwater extraction rate of 220 cfs (142 MGD) based on available infrastructure and demand limitation. Additional extraction wells were not included in the analysis.
Component 6: Injection and extraction locations to be located northwest of the Tujunga Spreading Grounds near the Pacoima Spreading Grounds	Injection locations identified adjacent to the East Valley pipeline and alternatives to the west of the Pacoima Spreading Grounds.
Component 6: Treatment assumed for extracted water	75 cfs (48 MGD) of treatment is assumed to treat all extracted water from the basin due to potential contamination with rising water levels in the basin.

The evaluated range accounts for groundwater recharge using Pure Water Los Angeles flows and does not represent groundwater extraction flows. During dry years when Pure Water Los Angeles flows are prioritized to VNC or if the basin storage capacity is limited, Pure Water Los Angeles flows may be reduced or eliminated until excess flows or basin storage is available.

5.4 Policy Considerations

The following policy considerations are relevant to application of Pure Water Los Angeles ATRW in SFB:

- The supply water from the AWPF could be either IPR or DPR quality. The benefits and costs of recharging both water qualities should be considered.
- Pure Water Los Angeles flow assumptions are based in part on use of spreading grounds owned or operated by County Public Works. Continued coordination with County Public Works on seasonal use of spreading grounds is recommended.
- SFB has extensive groundwater contamination plumes. The short- and long-term storage capacity at spreading grounds, stormwater capture parks, and injection wellfields should be considered in

conjunction with impacts to groundwater levels, contamination plumes, and soil contamination. Therefore, coordination with the City Legal Team is necessary.

- System constraints, such as available demands or blending requirements, may limit the ability to recharge and extract groundwater from SFB. ONAT will be used to evaluate storage and extraction in SFB. Additional infrastructure improvements or conveying SFB groundwater to VNC through the Pure Water Los Angeles backbone or other conveyance options could be considered to maximize use.

6. Van Norman Complex

The VNC is located at the northern boundary of SFB with the Los Angeles Aqueduct Filtration Plant (LAAFP) and Los Angeles Reservoir (LAR). The LAAFP is a 928 cfs (600 MGD), ozone-direct filtration plant with ultraviolet (UV) disinfection that has been in operation since 1986 (LADWP 2014). LAR is a 3,300-million-gallon (MG) (10,127-AF) uncovered finished water storage reservoir supplied by the LAAFP (LADWP and Arcadis 2023), with downstream treatment as required by the Long-Term 2 Enhanced Surface Water Treatment Rule.

For DPR, ATRW may be used to supplement an established drinking water facility by adding the raw water sources before treatment (raw water augmentation [RWA]) or connecting to the treated water after complying with all DPR treatment requirements (treated water augmentation [TWA]). If raw water flows are less than 10% of the combined flow, DPR chemical control treatment with ozone followed by biologically activated carbon is not required; however, pathogen control requirements must still be achieved. The VNC could serve as the primary terminus for the ATRW and directly offset purchased, imported water that currently supplies VNC.

6.1 Concept Study

The Concept Study (LADWP 2021a) described Component 7 to send up to 252 cfs (163 MGD) of ATRW to the LAAFP. The conveyance infrastructure was sized to have the capacity to send all Program flows, 336 cfs (217 MGD), to the LAAFP.

The Concept Study component sending ATRW to VNC presents opportunities for demand of Pure Water Los Angeles ATRW and use in the LADWP service area, especially in dry years.

6.2 Validation Summary

This section summarizes the VNC validation findings.

6.2.1 Current Operations

The LAAFP has a design capacity of 928 cfs (600 MGD) (LADWP 2014). Average raw water flows at LAAFP vary, but generally range between 465 and 743 cfs (300 and 480 MGD) (LADWP 2023b). The LAAFP water supplies are from the Los Angeles Aqueduct and from interconnections with Metropolitan that can either supply raw water from the State Water Project (SWP) or treated water from the Jensen WTP.

6.2.2 Potential Utilization and System Integration Opportunities

Three options were evaluated for integrating ATRW into VNC. All options could directly offset purchased imported water from the SWP. The three integration options at VNC are:

- RWA:
  1. Integrating ATRW by augmenting the raw water supply to LAAFP
  2. Integrating ATRW into LAR
- TWA:
  3. Integrating ATRW directly into the water distribution system downstream of Dr. Pankaj Parekh UV Facility (PPUV) and LAR UV

Note that TWA is not a strategy currently being considered by LADWP, but could provide opportunities for future adaptability. TWA would result in a shorter response time if a treatment upset were to occur.

A target flow of 252 cfs (163 MGD) of ATRW was identified for initial screening of VNC component options. As part of the validation, source water quality goals, conceptual treatment trains, conceptual site layouts, and cost estimates were developed for the screened options. If DPR compliance is achieved at the AWPF and additional treatment is not required at VNC, the full Pure Water Los Angeles flow of 356 cfs (230 MGD) could be sent to VNC with proper conveyance sizing.

Table 6-1 lists advantages and considerations for each component option. All component options could be used to supplement VNC water sources and offset imported water from the SWP.

Table 6-1. Van Norman Complex Potable Reuse Options Advantages and Considerations

VNC Component Options	Advantages	Considerations
Upstream of LAAFP, with a connection to the high-speed raw water channel	▪ Potential source water quality improvement. ▪ Blending of ATRW with other raw water sources. ▪ Limits impact to current flow management. ▪ Adds redundant supply to Van Norman Pump Station 2 or the Rinaldi Trunkline.	▪ LAAFP has annual maintenance shutdowns that would require reallocation of Pure Water Los Angeles flows. ▪ Impacts to operation of existing treatment processes should be minimized. ▪ Requires approval from DDW for post-AWPF DPR compliance. ▪ DPR compliance to be achieved before integration.
Upstream of LAR, with a connection to the existing overflow structure or repurposing of the western outlet for an inlet	▪ LAR storage capacity and ability to blend ATRW. ▪ Additional system reliability during LAAFP routine maintenance and shutdowns.	▪ Impacts to LAR operations should be minimized. ▪ Would not supply Pure Water Los Angeles ATRW to Van Norman Pump Station 2 or the Rinaldi Trunkline, which reduces resiliency and reliability. ▪ May be subject to CTR compliance. ▪ Requires DDW approval of post-AWPF DPR compliance. ▪ DPR compliance to be achieved before integration.
DPR downstream of PPUV or downstream of the LAR UV Disinfection Facility	▪ No impact on existing treatment operations at the LAAFP. ▪ Provides additional water supply if LAAFP or LAR is out of service. ▪ Not impacted by LAAFP routine maintenance shutdowns.	▪ Limited response time to address DPR treatment upsets. ▪ More complex flow balancing is required to match system demands with a connection downstream of LAR. ▪ Requires approval from DDW for post-AWPF DPR compliance, unless DPR is achieved at the AWPF. ▪ Requires LADWP approval of TWA.

Figure 6-1. Van Norman Complex

6.2.3 Upstream of Los Angeles Aqueduct Filtration Plant

One potable reuse component option is to integrate the ATRW into the raw water supply upstream of the LAAFP. This option would:

- Provide blending with other water sources. An initial phase could include a reduced flow that maintains the ATRW contribution to less than 10% of the combined flow to eliminate the need for chemical control per the DPR regulations (LADWP 2023d). Additional pathogen control would still be required to meet the DPR regulations. Compliance can include credits for blending, as well as treatment through LAAFP. However, it was assumed that all DPR compliance requirements would be met before blending to avoid impacts to LAAFP operations and permitting.
- Provide multiple additional treatment barriers when the blending water is greater than 10% ATRW.

- Maintain current VNC hydraulics, including providing redundant supply to the Van Norman Pump Station 2 and Rinaldi Trunkline.

However, there are several considerations that may pose challenges to this component option. During LAAFP's annual shutdowns, Pure Water Los Angeles flows would need to be diverted. LAAFP shutdowns typically occur during the winter months when the SFB spreading grounds are also unavailable. Alternative locations for use during shutdowns will be evaluated during the Program alternative analysis. Additionally, integrating at this location would require a quick response time for operational issues at the DPR treatment facility, which could be located at or near VNC. Noncompliant flows could be sent to the backwash ponds for management.

6.2.4 Los Angeles Reservoir

The second RWA option is to blend the ATRW into LAR. LAR is an uncovered finished water storage reservoir, and water leaving the reservoir receives additional disinfection before entering the water distribution system to meet the requirements of the EPA's Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) (LADWP and Arcadis 2023).

The treated water would flow into LAR using the West Outlet structure, which is currently unused. LAR has a total volume capacity of 3.3 billion gallons. For 2017 to 2023, the intake flows typically range between 232 and 309 cfs (150 and 200 MGD), with maximum values between 387 and 557 cfs (250 and 360 MGD) (LADWP 2023c). Sending ATRW to LAR would maximize blending potential at VNC and provide additional response time in the event of a treatment upset, as well as flow equalization. Based on an ATRW flow of 252 cfs (163 MGD), it would not be possible to maintain a wastewater contribution of less than 10% to avoid additional chemical control requirements. Therefore, this component option would require treatment for chemical control before LAR integration to meet the DPR regulations.

However, there are several considerations that may pose challenges for this component option. When LAR is isolated, and outflow is not possible, LAR may not have sufficient storage volume to accept Pure Water Los Angeles flows, and the ATRW would need to be diverted. Integrating flows into LAR would also not provide redundancy of supplies that can supply Van Norman Pump Station 2 or the Rinaldi Trunkline. The pump station and Rinaldi Trunkline are only supplied from the LAAFP treated water and do not have any interconnection with the treated water from LAR. Based on this limitation, integration only into LAR was eliminated from further consideration (LADWP 2023d). However, integration into LAR could be considered as a backup integration location for future flexibility.

6.2.5 Downstream of Los Angeles Aqueduct Filtration Plant or Los Angeles Reservoir

The third potable reuse component option is to integrate the ATRW directly into the water distribution system downstream of the LAAFP or LAR (that is, TWA). The ATRW would need to be fully treated to meet DPR requirements before integration. Due to the reduced response time for potential treatment issues, TWA is not currently being considered by LADWP. However, this option could be considered for future adaptability with the Pure Water Los Angeles Program.

6.2.5.1 Recommendation for Van Norman Complex Integration

RWA, through integration upstream of the LAAFP, is the preferred approach to integrate Pure Water Los Angeles ATRW at VNC. With this approach, Pure Water Los Angeles ATRW will be blended into the LAAFP raw water supply, which will then be treated through the filtration plant (Figure 6-1). All DPR treatment and regulations are assumed to be achieved before LAAFP integration to limit treatment modifications and changes to the existing LAAFP operations, permitting, and monitoring.

RWA at this location would:

- Provide blending with other water sources. An initial phase could include a reduced flow that maintains the ATRW contribution to less than 10% of the combined flow to eliminate the need for chemical control by ozone followed by biologically activated carbon, or approved alternative. Additional pathogen control would still be required to meet the DPR regulations. Compliance can include credits for blending, as well as treatment through LAAFP.
- Provide additional treatment barriers within LAAFP after DPR regulations have been achieved.
- Maintain current VNC hydraulics, including providing an additional source of supply to the Van Norman Pump Station #2 and Rinaldi Trunkline.

Integrating Pure Water Los Angeles ATRW into LAR was also considered, as it could provide flexibility for managing flows and would not impact LAAFP operations. Integration upstream of LAAFP was the preferred alternative due to the ability to supply the Van Norman Pump Station #2 and Rinaldi Trunkline that cannot be supplied from LAR. However, if DPR compliance is achieved before integration, a connection to LAR could be considered for treatment and hydraulic flexibility. Integration upstream of LAAFP would be the primary location; but during the annual LAAFP shutdown or other events, flow could be transitioned to LAR with additional conveyance and potentially a pump station.

6.2.5.2 Treatment Objectives

Considering the proposed VNC options, Table 6-2 summarizes the water quality goals for the source water entering the DPR treatment trains. If DPR compliance is achieved at the AWPF, additional treatment is not required at VNC.

Table 6-2. Raw Water Augmentation Water Quality Goals

Parameter	Value	Basis
Pathogen Removal Credits (*V/G/C*)	20/14/15	DPR regulations
TOC	< 0.5 mg/L	DPR regulations
TN (nitrate)	< 10 mg/L as N	MCL
TN (nitrite)	< 1 mg/L as N	MCL
pH	7.0-7.8 (upstream of LAAFP) 8.2-8.4 (LAR)	▪ Match existing raw water pH upstream of LAAFP ▪ DWP distribution system targets (LAR)
Disinfection Residual	< 1 mg/L (upstream of LAAFP or LAR)	Residual not required upstream of LAAFP or LAR
DBPs	< 80% MCLs	LADWP water quality preference

DBP = disinfection by-product

N = nitrogen

TOC = total organic carbon

V/G/C = enteric virus/*Giardia*/*Cryptosporidium* oocyst

Integration at VNC with Pure Water Los Angeles flows greater than 10% would require additional chemical control treatment at the AWPF, or possibly at VNC, depending on DDW approval of an alternative approach.

Assuming the upstream IPR ATRW will achieve pathogen removal credits of a minimum of 15/11.5/10.5-log reduction for V/G/C (Hazen 2024), an additional 4-log virus, 2.5-log *Giardia,* and 4.5-log *Cryptosporidium* credit will be required to meet DPR pathogen control regulations (Table 6-3).

Table 6-3. Potential Inactivation Credits Before Blending Upstream of Los Angeles Aqueduct Filtration Plant

Microbial Contaminant	Assumed Inactivation Credits for IPR[a] (log)	DPR Requirements (log)	Required Inactivation Credits (log)
Virus	15	20	5
Giardia	11.5	14	2.5
Cryptosporidium	10.5	15	4.5

[a] Adapted from Hazen 2024

6.2.5.3 Conceptual Direct Potable Reuse Treatment Train

With IPR-quality source water, the VNC options with Pure Water Los Angeles flow representing more than 10% of the raw water to the LAAFP will require chemical control and additional disinfection to meet the log reduction value (LRV) requirements in the DPR regulations. Under the DPR regulation, the prescribed treatment train includes ozone and biological activated carbon (BAC) filtration upstream of RO to meet the chemical control requirements. Additionally, at least 1-log *Cryptosporidium* disinfection using chemical disinfection is required unless an alternative pathogen control approach is approved.

For this MP, requirements for size, space, and cost have been developed based on a conservative treatment train basis. The assumed treatment requirements for the AWPF will be informed by an ongoing LADWP study. For post-AWPF treatment at VNC, UVAOP and GAC will be used as the basis for DPR treatment. This provides a representative estimate for footprint and capital and operating costs. The additional DPR treatment processes at VNC require demonstration and use of the alternative clause in the DPR regulations for chemical control, as well as an alternative for pathogen control. If DPR treatment is located at the AWPF, no additional treatment through the LAAFP will be required.

UVAOP was selected as an additional oxidation step that could provide similar treatment to the prescribed ozone process upstream of RO. UVAOP can also provide high levels of disinfection credit for V/G/C. GAC would provide a separate chemical control treatment mechanism (that is, adsorption) that could provide an additional chemical control barrier (Schimmoller 2023). For the proposed treatment train, it is assumed that MBR at the Hyperion WRF can be used for pathogen and chemical control. Further evaluation of the treatment approach for post-AWPF treatment, including pilot testing and DDW review and approval, is required. Pure Water Los Angeles flows less than 10% would not require chemical control, but additional pathogen log reduction credits would still be required to meet the DPR regulations.

Additionally, LADWP is interested in evaluating the viability of alternative IPR treatment trains at the IPR AWPF consisting of:

- MBR
- RO
- Ozone-peroxide advanced oxidation (peroxone)
- High-dose UV disinfection (and photolysis)

LADWP would be interested in a DPR element that would include chlorination and UV disinfection only at DPR locations. Because peroxone has not yet been implemented or permitted in California, it is expected that demonstration of a treatment train with peroxone would be required for potential approval by DDW.

It is recommended that LADWP begin to develop a research and demonstration plan for both the alternative IPR treatment train with peroxone and the alternative DPR treatment at VNC. The research and demonstration plan should consider pathogen reduction log removal values and chemical control to meet requirements for IPR and DPR.

For integrating upstream of LAAFP, all DPR treatment and regulations are assumed to be achieved before integration to limit treatment modifications and changes to the existing LAAFP operations, permitting, and monitoring.

It is uncertain at this time whether the CTR would apply to integrating ATRW into the LAAFP raw water channel or LAR. LAR is listed in the *Los Angeles Region Basin Plan for Coastal Watersheds of Los Angeles and Ventura County* (Los Angeles RWQCB 2014). However, the LAAFP treated water that currently supplies LAR is not regulated under the CTR. However, based on the Pure Water Los Angeles source water having wastewater origins, it is uncertain whether CTR compliance would be required. Discussions with the Los Angeles RWQCB would be required to determine potential CTR impacts of integrating Pure Water Los Angeles flows at VNC.

The proposed treatment train (that is, UVAOP and GAC) could also provide an additional treatment barrier for N-nitrosodimethylamine (NDMA) and DBPs if Pure Water Los Angeles ATRW is regulated under the CTR (Jacobs and Arcadis 2024b).

The proposed treatment train assumes new facilities for UVAOP and GAC before augmenting the raw water supply to LAAFP to meet the pathogen and chemical control requirement of the DPR regulations.

The proposed UVAOP and GAC treatment facility could provide 6-log virus, 6-log *Giardia*, and 6-log *Cryptosporidium* credit (Table 6-4). This approach assumes approval under the alternative pathogen control clause, as 1-log *Cryptosporidium* is not achieved with chemical inactivation.

Table 6-4. Potential Inactivation Credits Before Blending Upstream of Los Angeles Aqueduct Filtration Plant

Microbial Contaminant	Assumed Inactivation Credits for IPR[a] (log)	New UVAOP (log)	New GAC (log)	Total Available Inactivation (log)	DPR Requirements (log)
Virus	15	6	0	21	20
Giardia	11.5	6	0	17.5	14
Cryptosporidium	10.5	6	0	16.5	15

[a] Adapted from Hazen 2024

6.2.5.4 Conceptual Treatment Train Design Criteria

Based on the proposed treatment train (Figure 6-2), conceptual design criteria were developed to develop the conceptual-level cost estimates included in Table 6-5. UVAOP sizing was based on achieving 0.5-log 1,4-dioxane, 1-log sulfamethoxazole, and 1-log carbamazepine to provide a similar level of treatment to the prescribed ozone treatment process. For implementation, alternative surrogates maybe required based on the AWPF-treated water quality.

Figure 6-2. Los Angeles Aqueduct Filtration Plant New Conceptual Treatment Process Flow

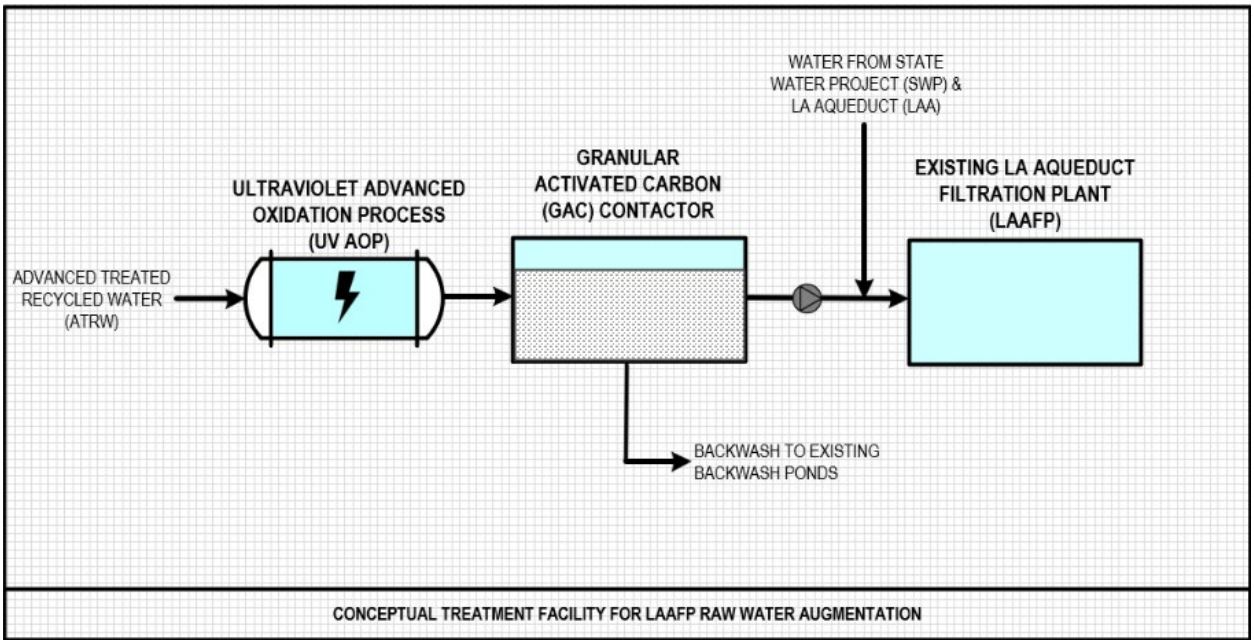


Table 6-5 summarizes the new treatment train design criteria for LAAFP RWA.

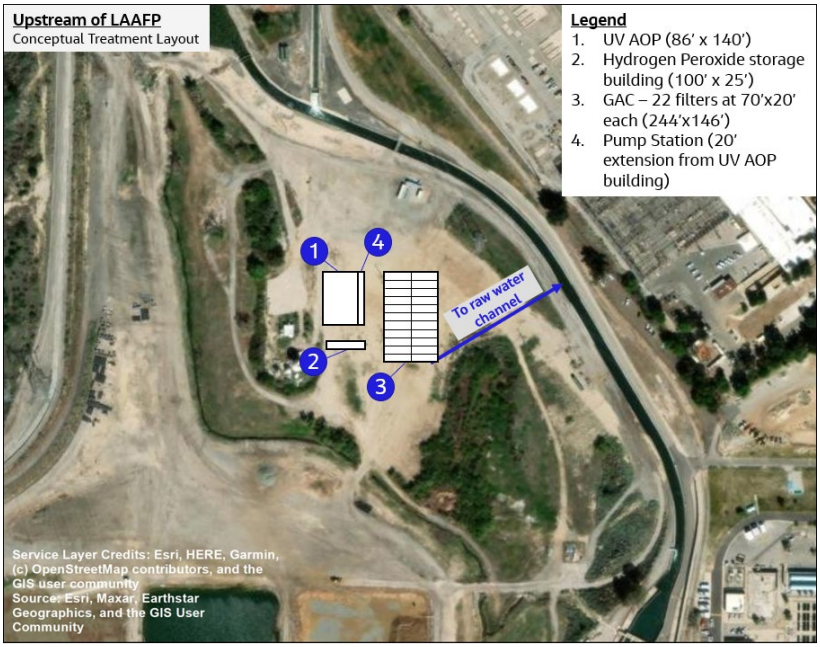
Table 6-5. New Treatment Train Design Criteria for Los Angeles Aqueduct Filtration Plant Raw Water Augmentation

Design Criteria	Units	Value
ATRW Quality Assumptions		
TOC	mg/L	< 0.5
TN (nitrate, nitrite, ammonia)	-	< MCLs
pH	-	7.0-7.8
DBPs	-	< 80% MCLs
UVAOP		
Disinfection credits	V/G/C log	6/6/6
Design UV Transmittance	%	95
AOP Targets	log	0.5-log 1,4-dioxane, 1-log sulfamethoxazole, 1-log carbamazepine
No. of UV Reactors (Duty, Standby)	each	5,1
GAC		
EBCT	minutes	15
No. of Filters	-	22
Backwash management	-	Use existing LAAFP backwash ponds

6.2.5.5 Conceptual Layout

There is an existing disturbed area north of the backwash ponds available for construction of new treatment facilities (approximately 3 acres) with capacity of 252 cfs (163 MGD) (Figure 6-3). This conceptual layout does not include additional power facilities that may be required. Alternative treatment sites in the vicinity of VNC could also be considered.

Figure 6-3. Los Angeles Aqueduct Filtration Plant Raw Water Augmentation Conceptual Layout



6.2.5.6 Conceptual Treatment Train Cost

Table 6-6 summarizes the design influent and required effluent concentrations established to develop conceptual-level cost estimates.

Table 6-6. Raw Water Augmentation Conceptual Treatment Train Cost

Description	Capacity, cfs (MGD)	Capital Cost ($ million)	Annual O&M Cost ($ million)[a]
UVAOP and GAC upgrades	252 (163)	928	27.1

Notes:

Year 2024 dollars.

AACE Class 5 Level estimates with an accuracy range of -20 to -50% to +30 to +100%.

[a] Based on average annual flow of 193 cfs (125 MGD) per ONAT scenario modeling.

6.3 Modified Program Component Basis

Based on this evaluation, the Concept Study (LADWP 2021a) Component 7 to convey water from HWRP to the LAAFP is feasible. Table 6-7 presents the proposed modifications to the flows and treatment trains to enhance Component 7.

The estimated planning range for potential usage of Pure Water Los Angeles ATRW at VNC is up to 252 cfs (163 MGD) through the following RWA methods:

- Integration of ATRW upstream of LAAFP for RWA, with additional treatment for DPR
- Integration of ATRW into LAR for RWA, with additional treatment for DPR

If DPR treatment is provided at the AWPF, the full flow of up to 352 cfs (230 MGD) could be conveyed to VNC for RWA, as additional treatment would not be required.

Table 6-7. Proposed Component Modifications Based on Master Plan Validation for Van Norman Complex

Concept Study Component	Proposed Modification Based on Validation
Component 7: AWPF assumed to include ozone and BAC for DPR compliance	Post-AWPF treatment, assumed to be UVAOP and GAC, could be provided at VNC for fit-for-purpose treatment, with IPR-quality water produced at the AWPF. If AWPF-treated water meets DPR requirements, the full flow could be integrated into VNC.
Component 7: Up to 252 cfs (163 MGD) of ATRW conveyed to the LAAFP	Space is available at or in the vicinity of VNC to provide 252 cfs (163 MGD) of post-AWPF treatment contingent on approval by LADWP.
Component 7: LAAFP would serve as the terminus for ATRW	ATRW after compliance with DPR regulations at the AWPF or VNC could be integrated upstream of LAAFP. CTR compliance may be required, and coordination with Los Angeles RWQCB is recommended to determine applicability of CTR.

6.4 Policy Considerations

The following policy considerations are relevant to application of Pure Water Los Angeles ATRW at VNC:

- DPR projects have several unique considerations due to the uncertainty related to the implementation of the final DPR regulations. The DPR regulations are based on a specified treatment train consisting of ozone and BAC, followed by RO and AOP. The regulations allow for alternative treatment trains to be proposed if they are validated to provide equal or greater treatment for pathogen or chemical control.
- To date, limited information is available for the ability of treatment technologies to meet the specified chemical control requirements post-AWPF. Unless DPR is achieved at the AWPF, demonstration testing would be required to validate the ability to add treatment post-AWPF (such as treatment at VNC) to comply with the DPR regulations. Treatment should consider potential for CTR compliance, if required.
- The DPR regulations require diversion of any flow that does not meet the minimum required pathogen, TOC, or nitrate concentrations. Diversion options at each integration location must be considered.
- Additional staffing and Advanced Water Treatment Operator (AWTO) certification is also required to operate and monitor DPR facilities. AWTO certification may require a new classification to be created in the City's civil service system and will require training for existing staff to obtain the required certifications.
- Integrating Pure Water Los Angeles ATRW into LAR would provide additional flexibility for managing Pure Water Los Angeles if LAAFP is out of service due to the size of the reservoir. However, it would not provide redundancy of supplies to Van Norman Pump Station 2 or the Rinaldi Trunkline. The level of redundancy required for the Pure Water Los Angeles Program should be considered when evaluating the VNC options.
- The ability to integrate Pure Water Los Angeles ATRW at VNC will depend on supply prioritization, LAA flows, and system demands. ONAT will evaluate seasonal and annual variations in Pure Water Los Angeles flows to be treated at VNC. Future treatment train sizing should be evaluated based on the range of flows that can be managed at VNC.

7. West Coast Basin

According to the UWMP, LADWP currently has a water entitlement volume of 1,503 AFY, and there are 120,000 AF of available storage in the WCB. LADWP discontinued operating its WCB Lomita Wellfield and has been unable to pump its entitlement since 1980 due to localized groundwater contamination issues and deterioration of water quality. In 2014, the WCB Judgment was amended, resulting in the City being able to pump up to 5,000 AFY of unused WCB rights out of CB (LADWP 2021b).

7.1 Concept Study

The Concept Study (LADWP 2021a) included Component 2 to convey 14 cfs (9 MGD) of water from the HWRP to the WCB to participate in WRD's RBWRP (now known as the BGRP). Under this approach, water from the HWRP would be used to replenish the WCB and offset groundwater pumping for the BGRP.

In exchange, LADWP had requested to use between 4,000 to 10,000 AFY of product water from the RBWRP as a major partner (LADWP 2021a). This product water, which will be of high quality and exceed drinking water quality standards, would be conveyed to the Harbor Area through a new 2 mile, 24-inch-diameter pipeline and pump station and integrated into the Harbor potable distribution system through the Harbor City Reservoir.

7.2 Validation Summary

The Concept Study component of groundwater replenishment in the WCB presents opportunities for storage and demand of Pure Water Los Angeles ATRW, and through an exchange, use in LADWP's Harbor Area.

This section summarizes the WCB validation findings.

7.2.1 Current Operations

The UWMP noted that LADWP discontinued operating its WCB Lomita Wellfield and has been unable to pump its entitlement since 1980 (LADWP 2021b).

7.2.2 Potential Utilization and System Integration Opportunities

The MP validation evaluated two options to supplement the WCB component basis presented in the Concept Study (LADWP 2021a). Information and assumptions presented herein were shared by WRD during an October 2022 meeting. The two options evaluated are:

1. Send Pure Water Los Angeles ATRW to the WCB Barrier Project (WCBBP).
2. Send Pure Water Los Angeles ATRW to the BGRP, and develop an exchange of water from BGRP to supply LADWP's Harbor Area.

According to WRD (Jacobs 2024a), the location for Pure Water Los Angeles ATRW delivery is still being evaluated. These options are described in the following subsections.

7.2.2.1 West Coast Basin Barrier Project

Groundwater production in the WCB in the early 1900s lowered groundwater levels to below sea level, resulting in seawater intrusion into the drinking water aquifers. The WCBBP currently consists of more than 100 injection wells; it aims to restore groundwater levels along the coast and mitigate seawater intrusion (Jacobs 2022).

The WCBBP extends from El Segundo in the north to Redondo Beach in the south and is one of three seawater barriers operated by County Public Works to mitigate seawater intrusion along the coast. The WCBBP is primarily supplied with ATRW from the Edward C. Little Water Reclamation Facility (WRF) from WCB. However, on average, approximately 25% of the replenishment supplies are supplemented with imported water to offset ATRW supply shortfalls, which provides an opportunity for Pure Water Los Angeles (HDR 2022).

Operation of the barrier is based on maintaining protective groundwater levels, as measured in observation wells surrounding the barrier injection wells. Injection volumes are adjusted monthly to maintain protective levels, with current injection averaging approximately 19 cfs (12 MGD) (HDR 2022). Historically, greater annual demands have been reported, and the WCBBP has the infrastructure to potentially increase injection up to 27 cfs (17.5 MGD), which also matches the existing treatment capacity at Edward C. Little WRF. Thus, potential flow rates of Pure Water Los Angeles ATRW to the WCBBP could range from 19 to 27 cfs (12 to 17.5 MGD).

However, the ability for LADWP to provide a significant volume of ATRW from Pure Water Los Angeles to the WCBBP for recharge is uncertain at this time. For example, Inglewood, Golden State Water Company, and California Water Service (Cal Water) have significant water rights but have not been using them. The Cities of Torrance and Manhattan Beach also have water rights that are not used, but to a lesser volume. An increase in pumping needs would impact injection requirements.

Hence, a conservative minimum assumption of 8 cfs (5 MGD) of additional flow could be provided to the WCBBP for replenishment purposes by WRD using the existing WCB conveyance system, which matches the remaining treatment capacity at Edward C. Little WRP.

As one option to maximize ATRW use, LADWP is continuing to explore opportunities to supply the WCBBP with ATRW from Pure Water Los Angeles to reliably supply the WCBBP with 100% ATRW. Additional pumping in WCB from the BGRP or other pumpers would likely result in increased injection demand. County Public Works shares the goal of using 100% ATRW, but even if there are increased supply demands at the WCBBP, injection volumes would still be based on protective groundwater levels.

7.2.2.2 Exchange of Water from BGRP to Harbor Area and Replenishment to BGRP

WRD initiated the BGRP to develop a regional approach to reclaiming brackish water from an existing saline plume in the WCB and create a new local drinking water supply. In an October 2022 meeting with WRD (Jacobs 2024a), WRD estimated that injection requirements could be as high as 19 cfs (12 MGD) of water to replenish the saline water being removed from the basin as part of the BGRP, with the value dependent on pumping from other water rights holders. WRD is conducting groundwater modeling to identify potential injection locations, including the northern portion of the basin to support the broader saline water remediation effort.

Due to the reduced size, and in particular, the uncertainty in the available potable water from the BGRP, it is currently assumed that obtaining supply to the Harbor Area is no longer an available option as originally conceived in the Concept Study. Thus, participation in the BGRP would be limited to the potential for LADWP to provide WRD with 19 cfs (12 MGD) of Pure Water Los Angeles ATRW for replenishment purposes if the injection sites are located in the northern portion of the WCB.

7.3 Modified Program Component Basis

Based on this evaluation, the Concept Study (LADWP 2021a) Component 2 to convey 14 cfs (9 MGD) of water from the HWRP to the WCB to participate in WRD's BGRP is feasible. Table 7-1 presents the proposed modifications to the flows and specific utilization to enhance Component 2.

The validation effort resulted in a recommendation for supply of Pure Water Los Angeles ATRW to WRD using injection in the Seawater Barrier and BGRP replenishment to support increased pumping for the brackish plume remediation effort. Table 7-1 summarizes the proposed component modifications.

Table 7-1. Proposed Component Modifications Based on Master Plan Validation for West Coast Basin

Concept Study Component	Proposed Modification Based on Validation
Component 2: Convey 14 cfs (9 MGD) to WRD's BGRP, including potential potable water exchange in the Harbor Area	▪ Revise potential flow to 19 cfs (12 MGD), as established during the October 2022 meeting with WRD. ▪ Could be accomplished through a water purchase agreement between WRD and LADWP. ▪ Water exchange opportunity in the Harbor Area may be limited.
Flow to WCBBP (not included in Concept Study)	Assume providing up to 8 cfs (5 MGD) of Pure Water Los Angeles ATRW to WRD based on existing infrastructure capacity.

The following actions are recommended to refine a project-level definition after ONAT scenario modeling of potential storage and demands and screening of alternatives:

- Obtain results from WRD for the modeling of the proposed injection and extraction wells as part of the brackish remediation work that is being conducted by WRD to determine plume movement to further inform potential for injection of Pure Water Los Angeles ATRW.
- Determine viability of WRD purchase of Pure Water Los Angeles ATRW for replenishment in WCB as an offset for imported water.
- Pursue discussions with WRD and pumpers to understand potential for increased water pumping if a higher injection rate is used.

7.4 Policy Considerations

The policy considerations for the use of Pure Water Los Angeles water in WCB are as follows:

- Given the proximity of WCB and the existing recharge infrastructure to the future AWPF, recharging water into the WCB could offer opportunities to use ATRW produced in early phases and provide significant regional benefits. However, because LADWP currently does not have any plans for producing groundwater from WCB as a potable water supply, the use of Pure Water Los Angeles water in WCB would not benefit LADWP's customers and rate payers directly.
- LADWP could continuing work with WRD to identify water exchange opportunities similar to the one envisioned in the Concept Study (LADWP 2021a) where LADWP would receive treated drinking water directly from WRD and LADWP would provide replenishment water to WRD using ATRW produced through Pure Water Los Angeles.

8. Metropolitan Water District of Southern California

Metropolitan is a regional wholesaler that delivers water to 26-member public agencies in a service area of about 19 million people living in the following counties (Metropolitan 2023a):

- Los Angeles
- Orange
- San Bernardino
- San Diego
- Ventura

Metropolitan owns and operates an extensive range of facilities, including (Metropolitan 2023a):

- The Colorado River Aqueduct
- 15 hydroelectric plants
- 9 reservoirs
- 830 miles of large-diameter pipes
- 5 WTPs, including the Jensen WTP, which is located adjacent to VNC

Metropolitan imports water from the Colorado River and Northern California to supplement local supplies, and helps its member agencies develop increased water conservation, recycling, storage, and other local resource programs. LADWP is a Metropolitan member agency (Metropolitan 2023a).

To further increase water supply reliability and diversify Metropolitan's water supply portfolio, Metropolitan has partnered with the Los Angeles County Sanitation District (LACSD) to beneficially reuse cleaned wastewater that currently is being discharged to the Pacific Ocean from LACSD's A.K. Warren WRF in the city of Carson through the implementation of the PWSC. The PWSC would provide nearly 155,000 AFY of sustainable, high-quality water to supplement existing supplies in the Southern California region (Metropolitan n.d.). According to Metropolitan's update to their Board in March 2024 (Metropolitan 2024), the Phase 1 water delivery of 178 cfs (115 MGD) of ATRW from PWSC is estimated to be available by the end of 2032.

8.1 Concept Study

The Concept Study (LADWP 2021a) identified two potential opportunities to collaborate with Metropolitan:

1. Component 8: Convey ATRW to Metropolitan's Jensen WTP through a water exchange, leveraging existing infrastructure between LAAFP and Jensen WTP. This potential partnership would allow both participants operational flexibility, but additional collaboration is required to develop the potential framework for exchanges to account for pending regulations and each agency's water demands. The water quality to be exchanged was not specified.
2. Component 9: Convey up to 77 cfs (50 MGD) of ATRW from the AWPF to Metropolitan's PWSC Backbone system with a new 13-mile-long, 54-inch-diameter pipeline and pump station. It was assumed that LADWP would convey up to 77 cfs (50 MGD) of water from the AWPF to Metropolitan's PWSC Backbone system and also have the ability to receive water from Metropolitan at the connection. The potential water exchange would provide LADWP and Metropolitan flexibility and redundancy for their recycled water programs.

Other potential DPR opportunities and interconnects that involve using Metropolitan's drinking water infrastructure were not considered.

8.2 Validation Summary

This section summarizes the Metropolitan validation findings.

8.2.1 Current Operations

LADWP is a Metropolitan member agency and receives potable water from Metropolitan. LAAFP is currently connected with the Jensen WTP through Metropolitan connections at LA-35, while LA-25 connects to VNC, which connects to the LAAFP outlet line. Currently, there are no operational collaborations for recycled water between LADWP and Metropolitan, aside from potable water backup supplies to LADWP's existing recycled water service in some service areas, such as the Harbor Area (LADWP 2022c).

8.2.2 Potential Utilization and System Integration Opportunities

Throughout the master planning period, LADWP has been actively engaging with Metropolitan to explore collaboration opportunities, including:

- System interconnect
- Workforce development
- Program schedule coordination
- Funding assistance
- DPR research and implementation coordination

Regarding the interconnect opportunities, LADWP and Metropolitan have further discussed the two concepts identified in the Concept Study (LADWP 2021a). The potential for using the existing Sepulveda Feeder to convey Pure Water Los Angeles ATRW was also explored preliminarily as a third opportunity. As this TM was prepared, Metropolitan and LADWP were still in the process of discussing and evaluating the technical viability of the two Concept Study options. However, due to the feasibility concerns related to the Sepulveda Feeder interconnect, it was collaboratively determined that this concept would be removed from further consideration.

8.2.2.1 Jensen Water Treatment Plant

Pure Water Los Angeles water further treated to meet chemical and pathogen control requirements at VNC would require a new interconnect to be conveyed to the Jensen WTP. During a meeting in April 2023, Metropolitan shared that the amount of water that could be received by Metropolitan's existing potable water system and PWSC from Pure Water Los Angeles would be limited by two policy limits:

1. A systemwide nitrogen limit for the drinking WTPs of no more than 2 milligrams per liter of nitrogen (mg/L-N) of total inorganic nitrogen (TIN) at least 95% of the time
2. Limiting water supplies from the recycled water origin to no more than 50% as source water

The Concept Study component of collaboration with Metropolitan presents opportunities for flexibility in supplying Pure Water Los Angeles ATRW through an exchange, especially during wet years, and provides redundancy to both agencies.

According to Metropolitan, the amount of water that could be accepted by the Jensen WTP would vary, depending on the nitrate concentration and the surface water flow treated (Jacobs 2024a). During that meeting, a maximum flow of 48 cfs (31 MGD) was estimated by Metropolitan based on the nitrate and flow limitations. To achieve this interconnection, the Metropolitan institutional requirements described for the PWSC opportunity must be met, and consideration should be given for potential water exchange at the Jensen WTP (Jacobs 2024a). Further collaboration and coordination between Metropolitan and LADWP would be needed to determine feasibility, and the potential integration in locations and routing between

Pure Water Los Angeles and Jensen, and inform future decisions related to either the PWSC or Jensen WTP interconnections.

8.2.2.2 Pure Water Southern California Program Backbone System

An interconnect between Pure Water Los Angeles and PWSC could increase the available water for groundwater recharge and DPR within the Metropolitan system. This interconnect would involve extending Pure Water Los Angeles' west–east alignment option to connect to the PWSC Backbone. This interconnect would offer an additional groundwater recharge opportunity at the Santa Fe Spreading Grounds in San Gabriel Basin.

Metropolitan shared during the April 2023 meeting that they are planning to send part of the flow in the PWSC Backbone for RWA DPR purposes and might provide some of the DPR treatment steps either upstream of or at Weymouth WTP (Jacobs 2024a). This interconnect could also provide Metropolitan additional supplies for DPR for the planned Phase 2 of PWSC.

Metropolitan also shared the amount of water that could be received by PWSC from Pure Water Los Angeles would be limited by the two policy limits described for the Jensen WTP. Metropolitan evaluated a nitrogen level of 5 mg/L nitrate as nitrogen (NO_3-N) in Pure Water Los Angeles ATRW, and the resulting amount of water that could be processed at Weymouth or Diemer would be 42 cfs (27 MGD) using a base-loaded scenario and 78 cfs (50 MGD) using a flexed-loaded scenario (Jacobs 2024a). The flexed-loaded scenario could accommodate more flows from recycled water sources because it accounted for additional flows exceeding the base flow, such as peak flows. LADWP requested Metropolitan as a follow-up to further evaluate the flow limit from Pure Water Los Angeles using a nitrogen level of less than 2 mg/L-N in the Pure Water Los Angeles ATRW (Jacobs 2024a).

LADWP sent a letter to Metropolitan to request Metropolitan to consider such an interconnect with a potential for Pure Water Los Angeles to send up to 232 cfs (150 MGD) of flow to PWSC as an alternative under PWSC's environmental review (LADWP 2023a). Metropolitan has recognized the importance of this potential interconnect opportunity and is currently evaluating upsizing the 14-mile-long pipeline of up to 9 feet in diameter between Whittier Narrows and Canyon Spreading Grounds (Metropolitan 2023b). This pipe size is expected to be able to provide up to 464 cfs (300 MGD) of conveyance capacity, supporting a future interconnect between these two programs.

Temperature management may be needed for the PWSC Backbone if the IPR water is to be discharged into the San Gabriel River, which has a temperature limit of 60 degrees Fahrenheit (°F) that is significantly cooler than typical wastewater effluent of 95°F (Jacobs 2024a).

8.3 Modified Program Component Basis

Based on this evaluation, the Concept Study (LADWP 2021a) components for potential partnership with Metropolitan may provide benefits such that further exploration of these opportunities is warranted. Proposed modifications to the flows and other elements are presented to enhance Component 9.

The estimated planning range for potential usage of Pure Water Los Angeles ATRW through a partnership with Metropolitan is 42 to 232 cfs (27 to 150 MGD) through the following methods:

- Interconnect with the Jensen WTP
- Interconnect with PWSC

Table 8-1 summarizes the proposed component modifications.

Table 8-1. Proposed Component Modifications Based on Master Plan Validation for Metropolitan Water District of Southern California

Concept Study Component	Proposed Modification Based on Validation
Component 8: Convey ATRW to Metropolitan's Jensen WTP, including a water exchange between Jensen WTP and LAAFP; no flow rate was identified	Potential maximum flow of 48 cfs (31 MGD) is assumed based on Metropolitan's nitrate and flow limitations, to be informed by ongoing discussions between Metropolitan and LADWP.
Component 9: Convey ATRW from the AWPF to Metropolitan's PWSC Backbone system, with a new 13-mile-long, 54-inch-diameter pipeline and pump station	▪ The hydraulic capacity that could be available in the PWSC Backbone is up to 108 cfs (70 MGD) using the currently planned 7-foot-diameter pipeline. Upsizing the backbone to 9-foot diameter at and after the point of interconnect could provide carrying capacity for up to 232 cfs (150 MGD) of Pure Water Los Angeles ATRW. ▪ The flow capacity based on water quality requirements communicated by Metropolitan is 42 to 77 cfs (27 to 50 MGD) through the Metropolitan WTPs (Jensen and Weymouth, or Diemer, or some combination of these). ▪ The blend would be limited to 10% dilution to avoid chemical control through ozone and BAC for Phase 1 of DPR implementation. ▪ Temperature management might be needed for ATRW water that is to be discharged into the San Gabriel River, which has a temperature limit of 60°F that is significantly cooler than typical wastewater effluent of 95°F. ▪ Coordination with Metropolitan is needed to confirm the consumptive use demands (quantity and location) for Pure Water Los Angeles ATRW.

The following actions are recommended to refine a project-level definition after scenario modeling of potential storage and demands by ONAT and screening of alternatives:

- Request that Metropolitan confirm the quality and demand for Pure Water Los Angeles ATRW in average, dry, and wet weather years.

8.4 Policy Considerations

This section describes the policy considerations for a partnership with Metropolitan to use Pure Water Los Angeles ATRW.

An interconnect between Pure Water Los Angeles and Jensen WTP would require meeting the water quality and operational requirements under the DPR regulations, as discussed in the *Potable Reuse Regulations Summary TM* (Jacobs and Arcadis 2024b). The type of DPR that might be implemented (such as RWA or TWA) under this interconnect has not been determined, though it would be expected to have significant implications to the permitting arrangement at an agency level. The DPR approach for PWSC is also being determined.

The regulations stipulate that a single DiPRRA be designated for a DPR project, thereby producing potable water and complying with requirements. The DiPRRA will be responsible for:

- Establishing pathogen and chemical control points
- Meeting microorganism log reductions
- Providing the required chemical control

The DiPRRA will be subject to an annual inspection of its facilities and operations to verify proper technical, managerial, and financial capacity.

Metropolitan would likely be the DiPRRA for this interconnect under an RWA DPR scenario if the Pure Water Los Angeles ATRW delivered had not already met the DPR regulations for chemical and pathogen controls; LADWP could serve as a DiPRRA if the water quality meets the DPR regulation requirements. LADWP as the DiPRRA likely involves more extensive operational and system integration for the entire DPR train if it was owned and operated by LADWP and Metropolitan separately, in addition to the source control programs and other required LASAN monitoring for the wastewater treatment system upstream of the DPR train. Significant agency-level coordination and negotiations are required to work out the details should there be a desire to move this interconnect forward.

The adopted regulations do not have the framework or mechanism to handle a regional DPR exchange and direct interconnect involving more than one DiPRRA. There are alternatives clauses related to treatment or treatment sequencing for pathogen and chemical control, but the adopted regulations do not include a broad alternatives clause that supports how to address emerging situations. Pure Water Los Angeles interconnected regional partnerships may be challenging without this flexibility.

Metropolitan is considering DPR and could include Pure Water Los Angeles ATRW, which would include LADWP and LASAN as partner agencies under the DiPRRA (Metropolitan). The operational and system integration would be significant under this interconnect scenario.

The details of these integration options would require comprehensive investigations to develop plans for meeting regulatory requirements. However, a Pure Water Los Angeles and PWSC interconnect would be positively impactful on water supply reliability and climate resiliency for Southern California and beyond.

9. Conveyance

Large-diameter pipelines are required to convey ATRW from the AWPF to the integration components. This section summarizes the validation of the proposed conveyance alignments.

9.1 Concept Study

The Concept Study (LADWP 2021a) presented conveyance alignment alternatives to convey flows to potential Program components, including:

- Component 2: Convey 6 cfs (4 MGD) to 14 cfs (9 MGD) from WRD's BGRP in the WCB to the Harbor Area potable distribution system through a new 24-inch-diameter, 2-mile-long pipeline.
- Component 3: HWRP to CB injection wells through a 108-inch-diameter pipeline to a proposed tee-junction connected to a 54-inch- to 66-inch-diameter pipeline. Conveyance consists of a primary alignment, consistent with the Slauson Alignment, and two alternative alignments to the south of the primary alignment. Capacity of the 108-inch-diameter pipeline is 336 cfs (217 MGD), and capacity for the 54-inch- to 66-inch-diameter pipeline ranges from 91 cfs (59 MGD) to 119 cfs (77 MGD).
- Component 5: Convey 42 cfs (27 MGD) of treated groundwater from CB to the potable distribution system through a 7-mile-long pipeline ranging from 24-inch to 42-inch diameter. Conveyance travels north from CB's groundwater treatment facility to LADWP's potable distribution system.
- Component 6: Convey 280 cfs (181 MGD) of ATRW from a tee-junction to SFB to replenish SFB through 20 miles of 96-inch-diameter pipeline, including two to three pump stations and storage facilities. The estimated flow to be recharged into SFB is up to 280 cfs (181 MGD), including 28 cfs (18 MGD) for injection.
- Component 7: Convey 252 cfs (163 MGD) of ATRW from SFB to LAAFP through a 7-mile-long, 96-inch-diameter pipeline. The three alternatives include the Sepulveda, Cahuenga, and Griffith Park alignments. The Griffith Park Alignment was selected to develop the Program schedule and budget due to preliminary constructability, environmental, and community considerations.
- Component 9: Potential connection to Metropolitan's PWSC Backbone through a 13-mile-long, 54-inch-diameter pipeline to convey up to 77 cfs (50 MGD). Conveyance alignment is extended eastward from CB to connect to the PWSC Backbone near Whittier Narrows and northeast of the Montebello Forebay Spreading Grounds.

The Concept Study conveyance components are critical for delivery of Pure Water Los Angeles ATRW to potential storage and demand locations.

9.2 Validation Summary

This section summarizes the conveyance validation findings.

9.2.1 Current Operations

Conveyance components as shown on Figure 3-1 would deliver ATRW from the AWPF to the storage and demand locations.

9.2.2 Potential Utilization and System Integration Opportunities

The Concept Study (LADWP 2021a) established the routing of the three main south to north alignment options, and the Joint MP (Jacobs 2022) established the routing of the three main west to east alignment options.

- South to north conveyance alignments:
  - Sepulveda
  - Cahuenga
  - Griffith Park
- West to east conveyance alignments:
  - Slauson
  - Florence
  - Manchester

The conveyance validation evaluated general alignment considerations and was conducted in two steps:

1. Conveyance Alignment Review: The initial review focused on quantifying the pipeline sections that would most likely have to be tunneled and those that could potentially be trenched based on a review of the mapping information provided for each of the alignment options. The evaluation identified the crossings required for each alignment and included an estimate of the number of shafts required for construction of tunneled sections and crossings.

2. Supplemental Considerations: The supplemental review complemented the alignment review by examining the following conditions and infrastructure that may conflict with the proposed alignment options:
   - Ground and groundwater conditions
   - Faults
   - Geologic hazards
   - Oil wells and fields
   - Existing utilities
   - Existing subsurface infrastructure

These assessments are summarized in the following subsections and documented in the following TMs, which are provided as attachments and should be referred to for further detail:

- Attachment C, *Pure Water Los Angeles Conveyance Alignment Review*
- Attachment D, *Pure Water Los Angeles Conveyance Alignment Review Supplemental Information*

9.2.2.1 Conveyance Alignment Review and Supplemental Considerations

Initial review of the proposed conveyance alignments revealed aboveground conflicts in the south to north concept routing:

- Crossed existing residential, commercial, and industrial structures
- Tunneling shafts not accounted for with changes in direction or special crossings

As such, the validation performed a desktop evaluation that produced general and specific observations and proposed alternative segment alignments to avoid aboveground conflicts. The following tasks were performed as part of the validation:

- Estimated the percentages of trenched and tunneled construction
- Estimated the number of crossings of notable infrastructure
- Estimated the number of shafts
- Identified aboveground infrastructure conflicts, and provided examples of potentially beneficial realignments

- Identified the number and location of booster pump stations
- Summarized ground conditions, oil wells and fields, utilities, and subsurface infrastructure

The Concept Study alignments were refined based on the validation analyses.

Following these refinements, of the three south to north alignments:

- Griffith Park is the longest at approximately 29.5 miles, Sepulveda is the next longest at approximately 29.0 miles, and Cahuenga is the shortest at approximately 27.3 miles.
- The amount of tunneling was estimated to be less than the Concept Study (LADWP 2021a), with the Sepulveda Alignment having the least amount of tunneling and conversely the most trenching required of the three alignments. Even though the Cahuenga Alignment is the shortest of the three, it still has a longer tunneling length than the Sepulveda Alignment, whereas the Griffith Park Alignment is both the longest alignment and has the most tunneling required.

Following these refinements, of the three west to east alignments:

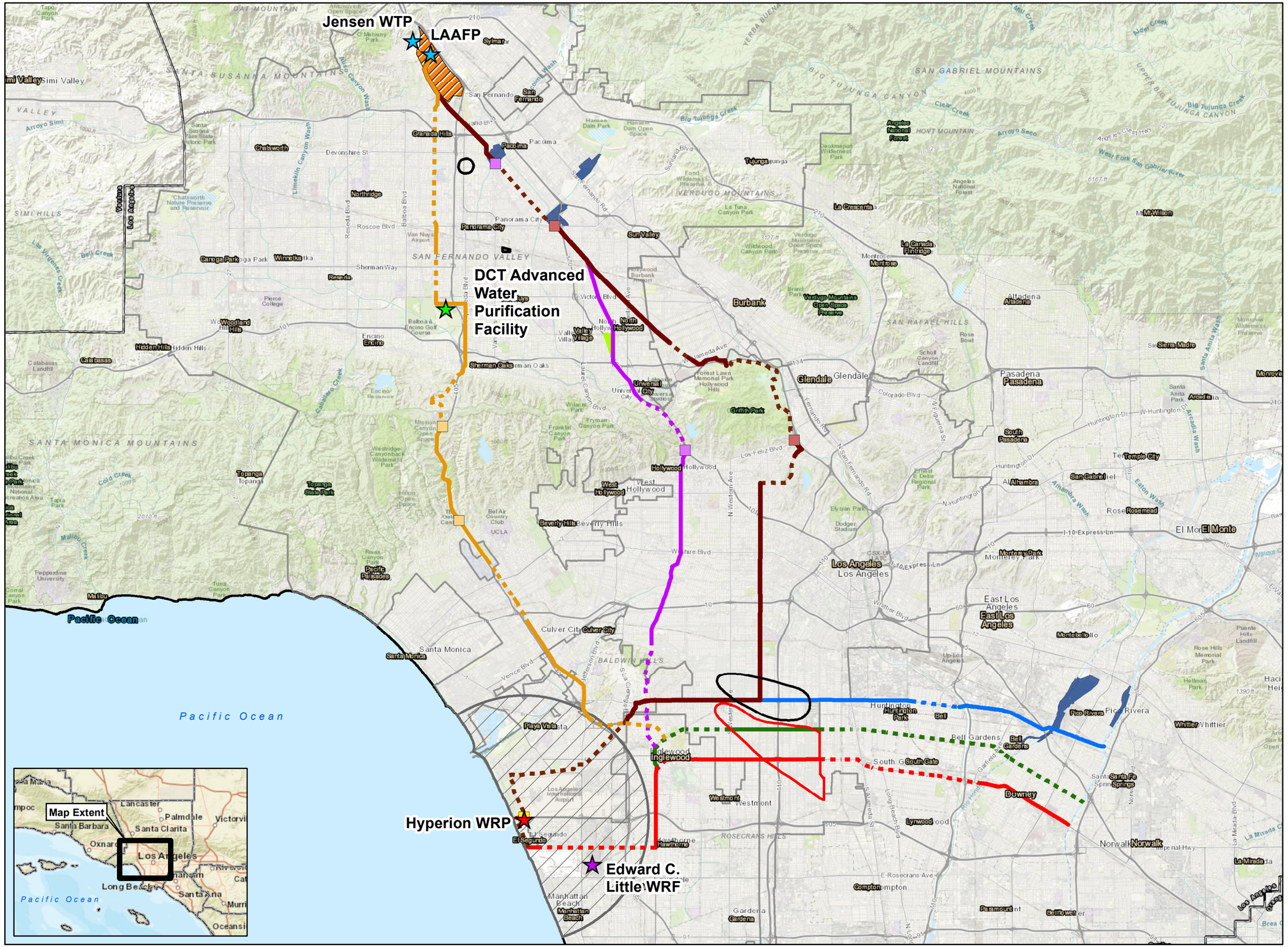
- All are of a similar length, with Slauson at approximately 23.3 miles, Florence at approximately 23.7 miles, and Manchester at approximately 22.8 miles.
- The Florence Alignment was evaluated to have less tunneling than estimated in the Concept Study (LADWP 2021a), while the Slauson and Manchester alignments both had more tunneling than estimated previously. The total number of potential crossings was identified for each alignment; and in each case, most crossings occurred in sections evaluated to be tunneled. Of those crossings within the tunnel sections, most would be regarded as regular crossings and would be constructed as part of the tunnel construction without the need for dedicated shafts or other special provisions.
- However, each alignment also has a number of special crossings (Caltrans and railroad) within the sections evaluated to be tunneled, and these would require shafts at either side and immediately adjacent to the asset. The remainder of the identified crossings occur in sections identified to be trenched; and each one, whether regular or special, will require shafts at each side of each crossing.

Table 9-1 summarizes the main findings for the conveyance alignment validation. Figure 9-1 reflects the potentially beneficial adjustments to the proposed alignments that were identified for consideration for the south to north routing.

Table 9-1. Alignment Option Review Findings Summary

Category	Criteria	Unit	South to North Alignments			West to East Alignments		
			Griffith Park (Eastern) Alignment	Cahuenga (Central) Alignment	Sepulveda (Western) Alignment	Slauson (Northern) Alignment	Florence (Central) Alignment	Manchester (Southern) Alignment
Alignment	Total length	Miles	29.5	27.3	29.0	23.3	23.7	22.8
	Length of trenched construction	Miles (%)	9.7 (33%)	9.3 (34%)	12.7 (44%)	7.5 (32%)	14.9 (63%)	8.5 (37%)
	Length of tunneled construction	Miles (%)	19.8 (67%)	18 (66%)	16.3 (56%)	15.8 (68%)	8.8 (37%)	14.3 (63%)
	Shafts for tunneling	Count	20	18	14	23	8	16
Crossings	Special crossings (Caltrans and railroads)	Count	7	4	3	10	7	8
	Regular crossings (non-Caltrans and railroads)	Count	14	16	22	8	28	17
	Shafts for crossings	Count	42	40	50	36	70	50
Existing underground infrastructure conflicts	LA Metro infrastructure	Count	2	3	1	0	0	0
	Other belowground structures	Count	16	14	13	17	19	19
	Oil fields	Count	5	7	2	7	6	4
	Oil wells	Count	18	9	17	1	2	8
	Gas utilities	Count	14	5	11	17	9	15
	Water utilities	Count	722	654	639	806	602	519
Ground conditions	Soft ground	Miles (%)	26 (88%)	23.2 (85%)	22.9 (79%)	21.7 (93%)	23.7 (100%)	22.8 (100%)
	Rock	Miles (%)	3.5 (12%)	4.1 (15%)	6.1 (21%)	1.6 (7%)	0 (0%)	0 (0%)
	Fault crossings	Count	4	4	3	1	1	1
	Geotechnical risks - Liquefaction	-	Longer alignment in liquefaction zone	Shorter alignment in liquefaction zone	Shorter alignment in liquefaction zone	Similar for all E-W alignments	Similar for all E-W alignments	Similar for all E-W alignments
	Geotechnical risks - Slope stability	-	Shortest alignment in potential landslide zone	Some length of alignment in potential landslide zone	Longest alignment in potential landslide zone	Alignment does not cross landslide zone	Alignment does not cross landslide zone	Alignment does not cross landslide zone

- = not applicable
Caltrans = California Department of Transportation
E-W = east to west
LA Metro = Los Angeles County Metropolitan Transportation Authority



Legend

- Proposed Water Reclamation Facility/Water Treatment Facility
- Existing Advanced Water Purification Facility
- Existing Drinking Water Treatment Plant
- Existing Water Reclamation Facility
- North Hollywood Park
- Potential Siting Area for the Advanced Water Treatment Facility
- Van Norman Complex
- City Boundary
- County Boundary

Alignment Options

- Cahuenga, Open Cut
- Cahuenga, Tunneled
- Florence, Open Cut
- Florence, Tunneled
- Griffith Park, Open Cut
- Griffith Park, Tunneled
- Manchester, Open Cut
- Manchester, Tunneled
- Sepulveda, Open Cut
- Sepulveda, Tunneled
- Slauson, Open Cut
- Slauson, Tunneled

Future Pump Station

- Booster Pump Station, Cahuenga
- Booster Pump Station, Griffith Park
- Booster Pump Station, Sepulveda
- Main Pump Station

Future Wellfield

- Extraction
- Injection

Flood Control Facilities Operated by LACPW

- Spreading Grounds

Sources:
LADWP, 2022;
ESRI World Topo Map; ESRI World Street Map

0 1.5 3 6
Miles
1 inch = 3 miles

Figure 9-1

Conveyance Alignment Options

Pure Water Los Angeles Master Plan

Jacobs

\\dc1vs01\GISProj\L\LADWP\Operation_NEXT\MapFiles\Fig9-1_OperationNEXT_Conveyance_Alignment_Options_20240523.mxd

9.3 Modified Program Component Basis

Based on this evaluation, the Concept Study (LADWP 2021a) Components 2, 3, 5, 6, 7, and 9 for conveyance are feasible based on the maximum pressure of 250 pounds per square inch (psi), an average in-pipe velocity of 5 feet per second (fps), and peak velocity of 7 fps. Proposed modifications to the south to north alignment options are suggested to avoid aboveground conflicts. The pipe sizes may need to be refined based on the ONAT scenario planning. A detailed hydraulic analysis has not been included for this review. Three main assumptions used for this validation exercise include:

- The maximum flow from AWPF to SFB could be up to 356 cfs (230 MGD).
- The maximum flow from SFB to LAAFP could be up to 252 cfs (163 MGD) for IPR at the AWPF.
- The maximum flow from SFB to LAAFP could be up to 356 cfs (230 MGD) for DPR at the AWPF.
- The maximum flow from AWPF to PWSC backbone could be up to 232 cfs (150 MGD).

Proposed component modifications are summarized in Table 9-2.

Table 9-2. Proposed Component Modifications Based on Master Plan Validation

Concept Study Component	Proposed Modification Based on Validation
Component 2: Convey 6 cfs (4 MGD) to 14 cfs (9 MGD) from WRD's BGRP in the WCB to the Harbor Area potable distribution system through a new 24-inch-diameter, 2-mile-long pipeline.	Not evaluated because this option became unavailable, as discussed in Section 4; hence, no modification is proposed.
Component 3: HWRP to CB injection wells through a 108-inch-diameter pipeline to a proposed junction tee connected to a 54-inch- to 66-inch-diameter pipeline. Conveyance consists of a primary alignment, consistent with the Slauson Alignment, and two alternative alignments to the south of the primary alignment. Capacity of the 108-inch-diameter pipeline is 336 cfs (217 MGD), and capacity for the 54-inch- to 66-inch-diameter pipeline ranges from 91 cfs (59 MGD) to 119 cfs (77 MGD).	Evaluated as part of the west–east alignment (Table 9-1 and Attachments C and D). The pipeline size between HWRP to a proposed tee-junction revised to 102-inch diameter to convey up to 356 cfs (230 MGD). The pipeline size proposed between the tee-junction to the CB injection wellfields revised to 90-inch diameter to convey 232 cfs (150 MGD) to PWSC.
Component 5: Convey 280 cfs (181 MGD) of groundwater from CB to the potable distribution system through a 7-mile-long pipeline ranging from 24-inch to 42-inch diameter. Conveyance travels north from a CB groundwater treatment facility to the potable distribution system.	Not evaluated due to the change in the approach for integrating treated groundwater into the CB potable water system (LADWP 2024b); hence, no modification is proposed.
Component 6: Convey 280 cfs (181 MGD) of ATRW from a tee-junction to SFB to replenish SFB through 20 miles of 96-inch-diameter pipeline, including two to three pump stations and storage facilities.	This component was evaluated as part of three south to north alignment options. The main modifications are: ▪ Sepulveda Alignment: A 19-mile-long, 96-inch-diameter pipe to convey up to 337 cfs (218 MGD) from the tee-junction to Donald C. Tillman WRP, including two booster pump stations. East Valley Pipeline is assumed to be available to convey ATRW to SFB. ▪ Cahuenga Alignment: A 21-mile-long, 102-inch-diameter pipe to convey up to 356 cfs (230 MGD) from the tee-junction to SFB, including one booster pump station. ▪ Griffith Park Alignment: A 22-mile-long, 102-inch-diameter pipe to convey up to 356 cfs (230 MGD) from the tee-junction to SFB, including two booster pump stations.

Table 9-2. Proposed Component Modifications Based on Master Plan Validation

Concept Study Component	Proposed Modification Based on Validation
Component 7: Convey 252 cfs (163 MGD) of ATRW from SFB to LAAFP through a 6-mile-long, 96-inch-diameter pipeline. The three alternatives include the Sepulveda, Cahuenga, and Griffith Park alignments. The Griffith Park Alignment was selected to develop the Program schedule and budget due to preliminary constructability, environmental, and community considerations.	This component was evaluated as part of three south to north alignment options. The main modifications are: ▪ Sepulveda Alignment: A 9-mile-long, 96-inch-diameter pipe to convey up to 252 cfs (163 MGD) from Donald C. Tillman WRP to LAAFP. No additional booster pump station is anticipated. ▪ Cahuenga Alignment: A 4-mile-long, 84-inch-diameter pipe to convey up to 252 cfs (163 MGD) from SFB to LAAFP, including one booster pump station. ▪ Griffith Park Alignment: A 4-mile-long, 90-inch-diameter pipe to convey up to 252 cfs (163 MGD) from SFB to LAAPF. No additional pump booster pump station is anticipated.
Component 9: Convey ATRW from CB to Metropolitan's PWSC Backbone system with a new 13-mile-long, 54-inch-diameter pipeline and pump station.	▪ A 12-mile-long, 90-inch-diameter pipe to convey up to 232 cfs (150 MGD) from CB to PWSC. ▪ No additional booster pump station is anticipated.

The following actions are recommended to refine a project-level definition after ONAT scenario modeling of potential storage and demands and screening of alternatives:

- Perform a routing study to support a preferred alignment selection.

9.4 Policy Considerations

This review does not constitute a routing study, nor is it intended to finalize the selection of any of the proposed alignment options or propose a preferred alignment. A routing study will need to be conducted to support a preferred alignment selection.

10. Reservoirs

LADWP owns and operates multiple potable and non-potable reservoirs. Non-potable reservoirs provide raw water supply to drinking WTPs. Potable reservoirs and one uncovered finished water storage reservoir (Los Angeles Reservoir) store and deliver finished water to the potable distribution system.

10.1 Concept Study

The Concept Study (LADWP 2021a) did not include any reservoirs as part of any components.

Reservoirs provide opportunities for storage and use of Pure Water Los Angeles ATRW in areas not served by groundwater.

10.2 Validation Summary

This section summarizes the reservoir validation findings.

10.2.1 Current Operations

The MP validation identified 10 LADWP-owned reservoirs located within the City's boundaries as potential locations for integrating Pure Water Los Angeles ATRW. Aqueduct reservoirs were excluded from this assessment, and LAR – which is an uncovered finished water storage reservoir – was evaluated under the VNC integration location. Potable reservoirs, including LAR, were categorized for DPR applications; and non-potable reservoirs were categorized for IPR under surface water augmentation (SWA). A summary of the regulatory requirements for DPR and SWA can be found in the *Potable Reuse Regulations Summary TM* (Jacobs and Arcadis 2024b).

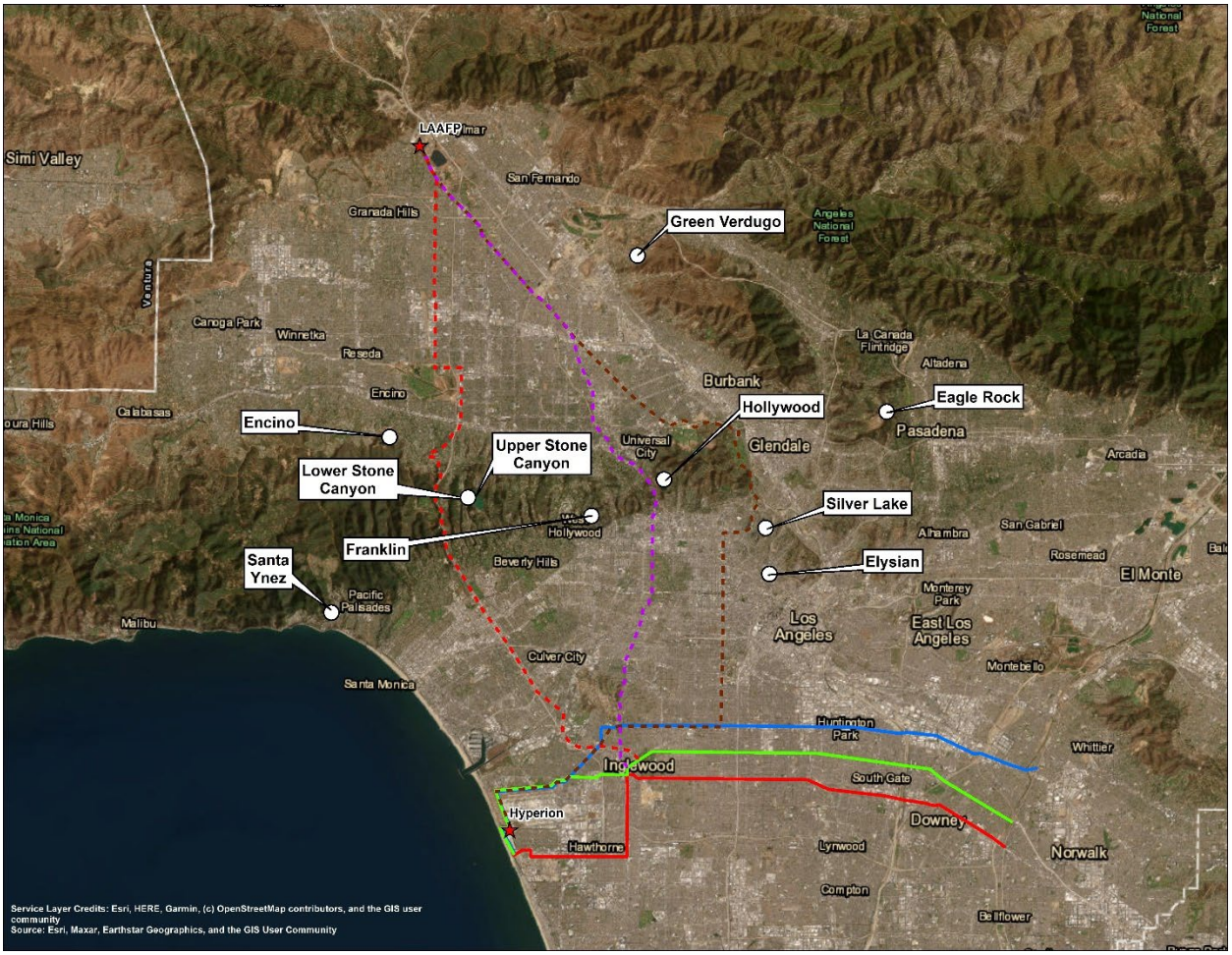
Table 10-1 lists the reservoirs with their storage capacities, and Figure 10-1 shows the locations. Potable reservoirs are connected to the distribution system, while the non-potable reservoirs are currently disconnected from the distribution system. Lower Stone Canyon Reservoir and Encino Reservoir each have a microfiltration plant for surface water treatment. However, neither plant is operational (Black and Veatch 2017a, 2017b).

Table 10-1. Potable and Non-Potable Reservoirs

Reservoir	Capacity (MG)
Potable Reservoirs with Potential for DPR Application	
Eagle Rock	82
Elysian	55
Franklin	67
Green Verdugo	32
Santa Ynez	117
Upper Stone Canyon	137
Non-Potable Reservoirs with Potential for SWA Application	
Encino	3,190
Lower Stone Canyon	2,907
Silver Lake	795
Upper and Lower Hollywood	1,147

Source: (Arcadis 2012)

Figure 10-1. Los Angeles Department of Water and Power Potential Reservoirs for Surface Water Augmentation



10.2.2 Potential Utilization and System Integration Opportunities

Reservoirs within the LADWP system were evaluated as integration components for additional storage capacity and whether or not existing infrastructure could be used. This section summarizes the findings, while the comprehensive assessments are documented in the following attachments:

- Attachment E, *Evaluation of Potable and Non-Potable Reservoirs for Pure Water Los Angeles*
- Attachment F, *Reservoir and Van Norman Complex Preliminary Screening Evaluation*

All reservoirs were assessed considering the following factors:

- Storage capacity
- Land availability
- Potential to repurpose existing infrastructure
- Distance to the nearest alignment
- Site accessibility
- Other considerations

Ultimately, six reservoirs were removed from initial consideration, while the following four remaining reservoirs were evaluated in more detail:

1. Lower Stone Canyon Reservoir (SWA)
2. Upper and Lower Hollywood Reservoir (SWA)
3. Franklin Reservoir (DPR)
4. Upper Stone Canyon Reservoir (DPR)

Subsequently, based on the analysis of the alternatives and LADWP input during a component screening workshop on March 6, 2023, and the Program alternatives confirmation workshop on October 30, 2023, these reservoirs were eliminated from further consideration because of neighborhood considerations, conveyance costs, space limitations for additional treatment (for DPR), and low storage possibility (LADWP 2023h, 2023i).

The potable and non-potable reservoirs will not be included in the current Program alternatives but are available for future SWA or TWA adaptability if allowed by LADWP (Jacobs and Arcadis 2024a).

10.3 Modified Program Component Basis

Reservoirs were not included in the Concept Study components. Table 10-2 summarizes the proposed modifications.

Table 10-2. Proposed Component Modifications Based on Master Plan Validation

Concept Study Component	Proposed Modification Based on Validation
Not included in Concept Study	Potable and non-potable reservoirs will not be included in the current Program alternatives, but are available for future SWA or TWA adaptability if allowed by LADWP

10.4 Policy Considerations

The following policy considerations are relevant to the application of Pure Water Los Angeles ATRW at potable and non-potable reservoirs:

- Integrating ATRW into potable reservoirs through TWA requires compliance with all DPR requirements prior to integration, including DDW approval of an approved treatment approach and consideration for response time for potential treatment upsets.
- Integrating ATRW into non-potable reservoirs through SWA requires consideration for neighborhood impacts, CTR compliance, and the available space for new surface water treatment plants.

11. Schedule and Cost

The purpose of the schedule and cost validation was to provide an objective perspective and identify gaps. While this assessment represented a validation of the Concept Study strategy, revised schedules and costs will be developed for the screened alternatives that are evolving from the original Program strategy. The cost estimates and schedules will establish the cashflow, which will serve as one criterion in finalizing the preferred alternatives and sequencing of projects.

11.1 Schedule Validation

The Concept Strategy (LADWP 2021a) timeline extended from 2022 to 2052 for planning, design, construction, and closeout. An independent schedule was developed for the Program components to provide a conceptual overall timeline demonstrating project sequencing. The overall general timeline was confirmed at 31 years; however, the start of planning will be shifted. At this time, it is projected that LADWP will begin project planning in 2025, subsequent to completion of the MP. With a planning start sometime in 2025 (excluding the HWRP component of the Program), the planning to completion timeline is anticipated from 2025 to 2054.

Review of the MP independent schedule resulted in the following significant takeaways:

- Phasing of construction at HWRP with completion in 2035 was not aligned with the other Program components. It was recommended that HWRP phases be aligned with the conveyance and other treatment projects, so the supply and demand infrastructure are available concurrently to minimize stranded assets. LADWP's Hyperion Owner's Agent provided the HWRP phasing schedule as the following (Hazen 2024; LADWP email 2024a):
  - Phase 1 (2033-2035): 79 cfs (51 MGD) IPR or 93 cfs (60 MGD) MBR effluent
  - Phase 2 (2037-2039): Additional 79 cfs (51 MGD) IPR or 93 cfs (60 MGD) MBR effluent
  - Phase 3 (2048-2050): Additional 198 cfs (128 MGD) IPR (or DPR) or 235 cfs (152 MGD) MBR effluent
- Cashflow restrictions (that is, annual expenditure caps) will be considered once the Program alternatives are selected to not overly encumber Program funding. The phasing may need to be refined to align with cashflow capabilities. The original cashflow did not consider escalation or risk contingency, which can be significant for a Program of this size.

11.2 Cost Validation

The purpose of the cost validation was to provide an objective perspective on the cost and identify gaps. The construction cost estimate completed for validation included conveyance, wells, and treatment elements, as follows:

- HWRP conversion: The conversion of HWRP to an MBR and the addition of an AWPF is being led by LASAN's Owner's Agent and LADWP's Hyperion Owner's Agent, respectively, and validation is outside the scope of this MP. The costs shown in Table 11-1 are from estimates developed by others (Hazen 2024).
- Conveyance: This comprises the infrastructure to convey ATRW water from the AWPF to the supply, storage, and demand facilities. The conveyance costs were estimated independently as a validation for conveyance elements.
- CB Wells and Treatment: This comprises wellfields and centralized treatment to inject, extract, and subsequently treat the conveyed ATRW water from the AWPF. New cost estimates were developed for these newly identified elements from the validation.

- VNC Treatment: This comprises centralized treatment for DPR at VNC for augmenting the raw water supply to LAAFP. New cost estimates were developed for these newly identified elements from the validation.

Construction cost estimates for the conveyance and treatment alternatives conform to the AACE *Recommended Practices for Cost Estimating* (AACE 2020). Table 11-1 provides the capital cost and O&M cost estimates for the Concept Study (LADWP 2021a) and the MP validation in Year 2024 dollars. For this Class 5 level estimate, the typical expected accuracy range is -20 to -50% on the low side and +30 to +100% on the high side for concept screening based on gross unit costs and parametric modeling techniques, for a project definition level up to 2%. The accuracy tightens as the project definition evolves. Details are provided as Attachment G, Cost Estimates.

Table 11-1. Validated Program Cost Estimate

Component	Description	Concept Study[a]		MP Validation[b]	
		Capital Cost $ million	O&M Cost $million /year	Capital Cost $million	O&M Cost $million/ year
1	Convert HWRP to an AWPF	4,427[c]	218	9,095[d]	297
2	Convey ATRW to WCB (WRD's BGRP)	54	0.08	40	0.08
3	Convey ATRW to CB	2,749	13.8	2,039	13.8
4	CB Wellfields	716	6.3	697[e]	8.9[e]
5	Convey Groundwater from CB to Potable Distribution System	321	0.99	TBD	TBD
6	Convey ATRW to SFB	5,244	35	5,819[e]	50.3[e]
7	Convey ATRW to LAAFP	1,580	19	2,143[f]	27.5[f]
8	Convey ATRW to Metropolitan's Jensen WFP	-	-	TBD	TBD
9	Convey ATRW to Metropolitan's PWSC Backbone System	1,447	0.45	1,295	0.45
10	Water System Improvements[g]	131	-	TBD	TBD
Subtotal		16,841	295	21,218	398
Risk Contingency[h]		Not included	-	TBD	-
Escalation[i]		Not included	-	22,976	-
Total				44,193	

Source: Concept Study (LADWP 2021a)

[a] Year 2021 costs.

[b] Year 2024 costs.

[c] Includes escalation to midpoint of construction, based on completion in 2035. All other values exclude escalation.

[d] Hazen 2024.

[e] Includes new wells and treatment.

[f] Includes new treatment.

[g] Definition not available.

[h] This will be determined through monetization of a risk register by the Program Management Team.

[i] Based on escalation per LADWP guidance (LADWP 2024e).

11.3 Policy Considerations

Two main elements that were not included in the Concept Study (LADWP 2021a) cost estimate that can have significant impacts include escalation and risk contingency:

1. Escalation: Cost escalation for a Program of this size and duration can be a significant contributor to the overall cost. Construction costs are often compared using the *Engineering-News Record* 20-city construction cost index (BNP 2024). Similar to the construction cost index, the Consumer Price Index, an indicator of inflation, has changed less than 3% annually over the last 10 years, except for the last few years (2021 to 2023) during the COVID pandemic, the war in Ukraine, and labor force reduction through retirement. During this period, escalation was significantly higher due to market supply and demand imbalances. These imbalances are often corrected over significant time periods such that escalation tracks inflation values. LADWP developed guidance for the escalation values (LADWP 2024e) that were used in the validation cost estimate.

2. Risk contingency: Risk management is essential to supporting a large Program's success by informing schedules, cost estimates, and contingencies for both Program- and project-related risks. Risk is an uncertain event that, if it occurs, will have a positive (opportunity) or negative (threat) effect on one or more of a Program's objectives. Based on the probability of occurrence and the effect if it occurs, a contingency is developed based on a monetized risk register. LADWP has indicated this will be developed by the Program Management Team.

It was recommended that a consensus on markups be established for consistency among the various consultant teams developing cost estimates for the Program. LADWP established these markups and transmitted them to the consultant teams (LADWP 2024e).

12. Potential Phasing Implementation

The MP validated the Concept Strategy (LADWP 2021a) through enhancement of the original integration components by:

- Assessing and revising component flow demands
- Developing additional treatment approaches
- Refining conveyance alignments and assessing critical conditions
- Developing independent cost estimates
- Developing an independent schedule

Based on the enhanced Concept Strategy elements, Table 12-1 identifies a potential phasing implementation option. This approach focuses on the storage and demand options closest to the new AWPF for early delivery to align with Phase 1 of the HWRP conversion to MBR and addition of an AWPF at or near HWRP, while allowing time for demonstration and approval of post-AWPF DPR options and construction of the long conveyance pipeline to the north that is aligned with Phase 3 production. Given the duration required to construct the pipeline to the north, partnerships should be pursued to use the advanced treated water that would be available for Phases 1 and 2. Refer to *Interconnectable Partnership Opportunities Technical Memorandum* (Jacobs 2024a) for more detail on potential partnerships.

Table 12-1. Potential Phasing Implementation with an Enhanced Concept Strategy

HWRP	Timeline[a]	Added Flow, cfs (MGD)[a]	Total Flow, cfs (MGD)[a]	Storage and Demand Locations[b]
Phase 1	2033-2035	79 IPR / 93 MBR (51 IPR / 60 MBR)	79 IPR / 93 MBR (51 IPR /60 MBR)	Regional Partnership
Phase 2	2037-2039	79 IPR / 93 MBR (51 IPR /60 MBR)	158 IPR/186 MBR (102 IPR/120 MBR)	CB[c], Regional Partnership
Phase 3	2048-2050	198 IPR or DPR/235 MBR (128 IPR or DPR /152 MBR)	356 IPR and DPR/421 MBR (230 IPR and DPR/272 MBR)	CB, SFB, VNC
Future Phase	2053-2054	No additional flow.	356 IPR and DPR/421 MBR (230 IPR and DPR/272 MBR)	CB, Metropolitan

Note:
Pending confirmation through ONAT scenario planning.
[a] LADWP email 2024. IPR and DPR flowrates assume 85% RO recovery.
[b] Infrastructure for CB will be delivered in 3 phases.
[c] Year 2040.

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Attachment A
Central Basin Injection Wellfield
Recharge Water Quality Requirements

Central Basin Injection Wellfield Recharge Water Quality Requirements

Date:	June 26, 2024
Project Name:	Pure Water Los Angeles Master Plan
Project No.:	D3611501
Client:	Los Angeles Department of Water and Power (LADWP)
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1. Introduction

LADWP intends to recharge advanced treated recycled water (ATRW) from the Hyperion Water Reclamation Plant (HWRP) into wells populating an injection (recharge) wellfield located in the Los Angeles Forebay (Figure 1). A distributed extraction wellfield located approximately 0.5 to 1 mile southeast of the injection wellfield will recover recharge water (or recharge) for potable use.

LA Sanitation & Environment (LASAN) operates HWRP and is collaborating with LADWP to plan efforts that maximize water reuse from HWRP. LADWP plans to construct the infrastructure over the next several decades to bring recharge water to the new recharge wellfield. ATRW from HWRP will also be conveyed to other locations in LADWP's service area for recharge or other water reuse.

This technical memorandum (TM) examines the geochemical compatibility of using ATRW from HWRP to recharge Central Basin (CB) aquifers. Evaluating geochemical compatibility involves assessing the following:

- Clogging of recharge wells
- Aquifer damage from permeability losses
- Deleterious reactions caused by mixing between recharge and native groundwater (NGW)
- Leaching of undesirable metals imposed by reactions between recharge and reactive minerals

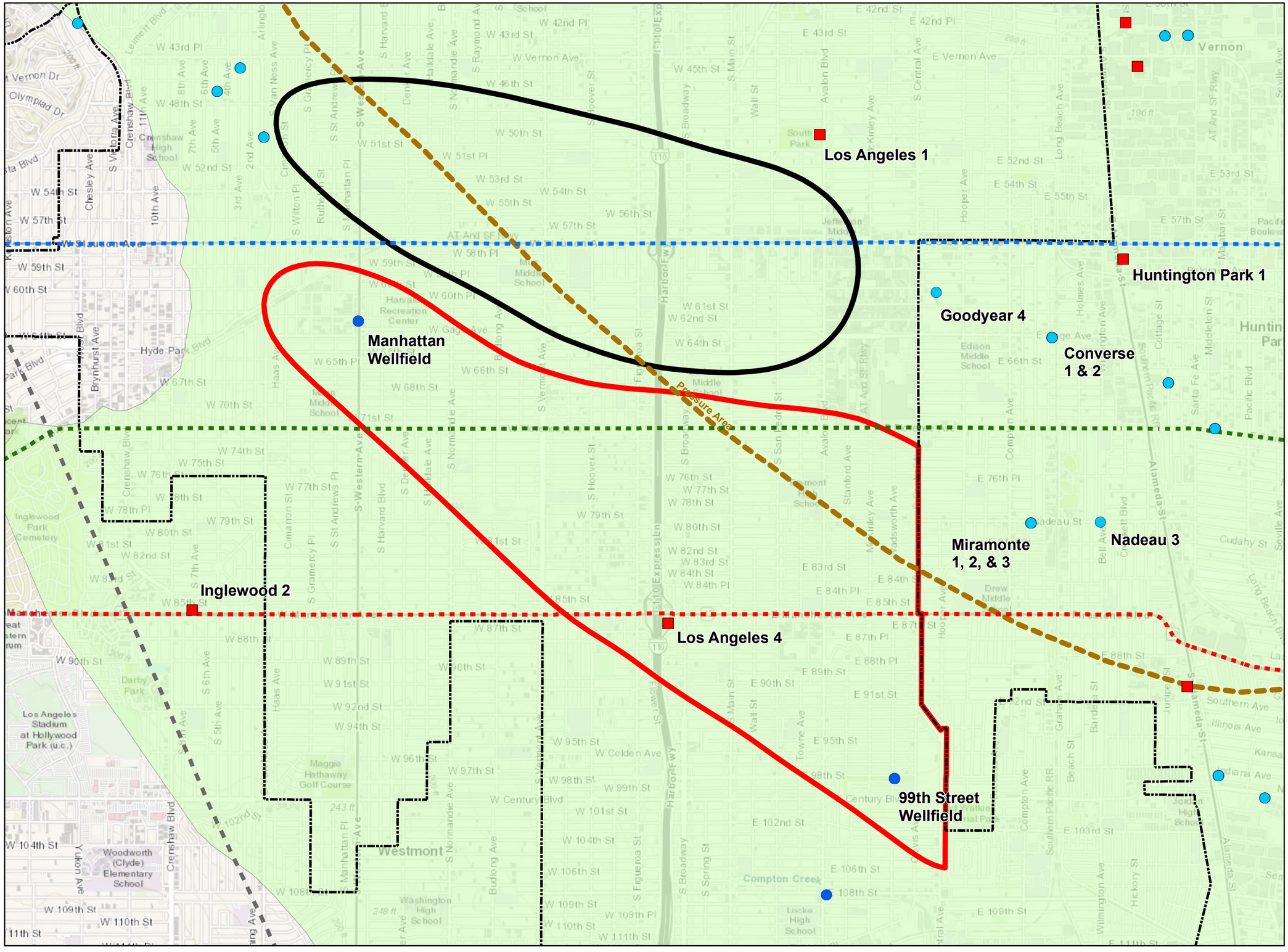
Most importantly, the TM discusses pretreatment measures required for successfully managed aquifer recharge (MAR) operations to mitigate these undesirable physical and chemical reactions.

The TM also addresses topics specific to the LADWP system, such as:

- Chlorination for recharge water
- Reactions between recharge and materials lining water mains
- Location for pretreating recharge water
- Reactions that may preclude or limit the recharge of water containing elevated total suspended solids (TSS)
- Identification of aquifer intervals with the most or least favorable geochemical characteristics for recharge

To evaluate these important topics, this TM includes the following sections:

- Introduction
- Data Supporting the Geochemical Evaluation
- Geochemical Characteristics of Recharge and NGW
- Topics Specific to MAR Operations
- Other Operational Considerations
- References



Hyperion Wells

LADWP Operation NEXT Master Plan

Jacobs

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2. Data Supporting the Geochemical Evaluation

As an AWT system has not been constructed at HWRP, this study relied on chemical constituents from water undergoing full advanced treatment (FAT), described in analyses derived from pilot testing conducted for the Donald C. Tillman Advanced Water Purification Facility (Donald C. Tillman AWPF). LASAN, in partnership with LADWP, conducted the pilot study (Carollo 2021).

The pilot study reports documented the following chemical constituents (Table 1):

- Anions, including:
  - Alkalinity
  - Chloride
  - Sulfate
- Cations, including:
  - Calcium
  - Magnesium
  - Potassium
  - Sodium
- Nutrients
- Organic carbon
- Trace metals
- General water quality parameters, including:
  - Total dissolved solids (TDS)
  - Turbidity
  - Hardness

As the treatment processes at HWRP will closely resemble Donald C. Tillman AWPF, this TM uses the Donald C. Tillman AWPF effluent that is representative of the effluent from HWRP and makes assumptions for other parameters in the finished water quality.

Table 1. Recharge Chemistry for Water Quality Evaluation

Analyte	Unit	Value	Source
pH	S.U.	7.8	Assumed value for final product water
UVT	%	97.6	Table 6-9 Donald C. Tillman AWPF pilot project (Carollo, 2021)
Turbidity	NTU	0.1	Table 6-9 Donald C. Tillman AWPF pilot project (Carollo, 2021)
Aluminum	mg/L	11	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Iron	mg/L	0.008	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Manganese	mg/L	0.38	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Barium	mg/L	0.99	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Boron	mg/L	0.347	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Calcium	mg/L	25	Assumed value for final product water
Fluoride	mg/L	0.12	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Potassium	mg/L	0.576	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Magnesium	mg/L	0.132	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Sodium	mg/L	5.02	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Strontium	mg/L	0.001	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Alkalinity	mg/L	60	Assumed value for final product water

Analyte	Unit	Value	Source
Alkalinity as $CaCO_3$	mg/L	15	Assumed value for final product water
Chloride	mg/L	3.475	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Sulfate	mg/L	0.19	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Silica	mg/L	< 0.43	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
TP	mg/L	0.024	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
Ammonia	mg/L	0.19	Table 6-9 Donald C. Tillman AWPF pilot project (Carollo 2021)
TDS	mg/L	50	Assumed value for final product water
Total Hardness	mg/L	10	Table 6-10 Donald C. Tillman AWPF pilot project (Carollo 2021)
TOC	mg/L	0.1	Assumed value for final product water

Notes:
< = less than
$CaCO_3$ = calcium carbonate
mg/L = milligram(s) per liter
NTU = nephelometric turbidity unit(s)
S.U. = standard unit(s)
TOC = total organic carbon
TP = total phosphorous
UVT = ultraviolet transmissivity

Several sources provided chemical analyses of NGW, including:

- *Regional Groundwater Monitoring Report Water Year 2020-2021* (WRD 2022)
- Water quality monitoring water data (10 years) from the Regional Groundwater Monitoring Program that reported from nearby water supply wells operated by Golden State Water Company (GSWC), including from:
  - Converse 1 and 2
  - Miramonte 1 through 3
  - Nadeau 3
  - Goodyear 4

NGW data contained a comprehensive list of cations, anions, nutrients, trace metals, and general water quality constituents, including the following:

- Field Water Quality Parameters:
  - pH
  - Temperature
  - ORP and Eh
  - Specific conductance
  - Dissolved oxygen
- Laboratory Analyses:
  - Total and Dissolved Aluminum
  - Total and Dissolved Arsenic
  - Total and Dissolved iron
  - Total and Dissolved manganese
  - Calcium
  - Potassium
  - Magnesium
  - Sodium
  - Alkalinity as CO3
  - Chloride
  - Sulfate

- Sulfide
- Silica as SiO_2
- Orthophosphate as P
- TP
- TKN
- Nitrate
- Ammonia
- TDS
- TSS
- TOC
- DOC

The analyses also reported extensively on anthropogenic chemicals influencing the water quality of NGW in CB, including:

- Volatile organic compounds (VOCs)
- Semivolatile organic compounds (SVOCs)
- Perchlorate
- Pesticides
- Polychlorinated biphenyls (PCBs)

However, the anthropogenic compounds do not influence the geochemical compatibility of MAR operations. Hence, this study does not consider these compounds further. Table 2 summarizes the target analytes from NGW used for the water quality evaluation summarized in this TM. As listed, oxidation-reduction potential (ORP) represents a measurement collected in the field, commonly using a silver chloride or Calomel-type electrode (Hem 1986). Eh is the same measurement with an equivalent hydrogen electrode. Most graphing and research literature discusses ORP in terms of Eh. Project staff working on oxidation-reduction (redox) issues can convert ORP to Eh by adding 200 millivolts (mV) to an ORP measurement.

Table 2 summarizes the selected existing surrounding wells already described and their completion details for the wells used to represent the NGW quality for this evaluation. The locally derived aquifer and formation designations appearing in the Regional Groundwater Monitoring Report are also included for monitoring wells (WRD 2022). NGW from CB evaluated for this study includes, from shallowest to deepest, the following aquifers:

- Gaspur
- Gage
- Hollydale
- Lynwood
- Silverado
- Sunnyside

Several wells also screened sand intervals in the Pico Formation, the deepest unit evaluated for this study. Screens from many production wells can extend several hundred feet; thus, they likely span across several aquifers.

Table 2. Wells Used for Water Quality Evaluation

Well	Well Owner	Type	Screen No.	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Aquifer Designation
Huntington Park-1	WRD	MW	5 4 3 2 1	▪ 114 ▪ 275 ▪ 420 ▪ 690 ▪ 890	▪ 134 ▪ 295 ▪ 440 ▪ 710 ▪ 910	▪ Gaspur ▪ Gage ▪ Hollydale ▪ Lynwood ▪ Silverado
Los Angeles-1	WRD	MW	5 4 3 2 1	▪ 350 ▪ 640 ▪ 920 ▪ 1,080 ▪ 1,350	▪ 370 ▪ 660 ▪ 940 ▪ 1,100 ▪ 1,370	▪ Lynwood ▪ Silverado ▪ Sunnyside ▪ Sunnyside ▪ Sunnyside
Los Angeles-3	WRD	MW	6 5 4 3 2 1	▪ 190 ▪ 330 ▪ 550 ▪ 705 ▪ 875 ▪ 1,210	▪ 210 ▪ 350 ▪ 570 ▪ 725 ▪ 895 ▪ 1,230	▪ Gage ▪ Silverado ▪ Sunnyside ▪ Sunnyside ▪ Sunnyside ▪ Pico Formation
Los Angeles-4	WRD	MW	6 5 4 3 2 1	▪ 235 ▪ 355 ▪ 490 ▪ 720 ▪ 1,190 ▪ 1,740	▪ 255 ▪ 375 ▪ 510 ▪ 740 ▪ 1,230 ▪ 1,780	▪ Gage ▪ Lynwood ▪ Silverado ▪ Sunnyside ▪ Sunnyside ▪ Pico Formation
Converse-1	GSWC	PW	-	▪ 296	▪ 918	▪ -
Converse-2	GSWC	PW	-	▪ 600	▪ 1,520	▪ -
Goodyear-4	GSWC	PW	-	▪ 502	▪ 643	▪ -
Miramonte-1	GSWC	PW	-	▪ 999	▪ 1,567	▪ -
Miramonte-2	GSWC	PW	-	▪ 550	▪ 1,034	▪ -
Miramonte-3	GSWC	PW	-	▪ 580	▪ 1,008	▪ -
Nadeau-3	GSWC	PW	-	▪ 575	▪ 600	▪ -
MH-PW-11	LADWP	PW	-	▪ 230 ▪ 425	▪ 400 ▪ 590	▪ -
MH-PW-12	LADWP	PW	-	▪ 690 ▪ 1,390	▪ 1,130 ▪ 1,520	▪ -

Notes:

- = not applicable
bgs = below ground surface
MW = monitoring well
No. = number
PW = production well
WRD = Water Replenishment District of Southern California

3. Geochemical Characteristics of Recharge and Native Groundwater

This section describes the chemical characteristics of ATRW similar to that from the Donald C. Tillman AWPF pilot study and NGW found in CB. Additional data collection efforts and an approach to geochemical modeling to assess potential for mitigating undesirable physical and chemical reactions from injecting ATRW in CB are described in an injection test well work plan for CB (Jacobs 2022).

3.1 Aquifer Recharge

ATRW will exhibit the following characteristics:

- Circumneutral to slightly alkaline pH (7.8; Table 1)
- Low alkalinity (as $CaCO_3$; 15 mg/L)
- Measurable concentrations of DO
- Diluted concentrations of TDS (50 mg/L)
- With correspondingly low ionic strength at 1.25E-3 moles per liter (mol/L)

To prevent dissolving cement linings in conveyance mains, Operators will need to maintain the pH at greater than 7.8 before conveying ATRW from HWRP to the MAR wellfield. Geochemical modeling simulations of the recharge showed that calcite, the primary mineral component in cement-lined piping, dissolved at a pH of less than 7.8. Moreover, further pH adjustment should occur at the wellfield to maintain a pH between 8 and 8.5 before recharging water into CB. A treatment facility located at the wellfield would likely consist of a 10-foot-long by 10-foot-wide area housing a tank or 55-gallon drums, chemical metering pumps mounted on the wall, and a containment area in case of a spill.

Recharging ATRW shows an ionic strength 1 order of magnitude less than the ionic strength of the NGW dispersing interstitial clay minerals. Dispersing clay minerals will migrate with the flowing groundwater and eventually accumulate in aquifer pore throats, a phenomenon known as brush piling. Brush piling of clays can severely damage aquifer permeability. Examples from the petroleum industry (Reed 1972) and aquifer storage and recovery sites (Brown and Silvey 1977; Holloway et al. 2021) have recorded injection well specific capacity losses approaching 90% in the first 60 minutes of initiating recharge operations.

Conditioning the aquifer with aluminum salts (Al-salts), like aluminum chloride, hydroxy-aluminum chloride, or aluminum chloro-hydrate (ACH), a commercial formulation of aluminum chloride, helps stabilize clays in situ in handling unequal ionic strength or differing cations. The +3 charge of the aluminum ion forms a strong ionic bond with the negative surfaces between clay particles, clay particles and other aquifer minerals, and in the interlayered spaces in clays (Reed 1972).

Hydroxy-aluminum chloride and ACH form the $Al(OH)_2$ complex, which forms molecules with a +6 charge that develop an even stronger bond between clay surfaces. Conditioning involves recharging a 0.5 to 1 molar solution of Al-salts to form a radial area extending 10 to 15 feet from the wellbore (Civan 2000).

Utilities should condition the injection wells before initiating recharge operations. Most injection wells require only a single conditioning event over their service lives.

Elevated DO in the recharge, along with a pH greater than 8, will help lessen the reactivity of metal-bearing minerals in the aquifer. DO reacts with metal-bearing sulfides and carbonates to form a hydrous ferric oxide (HFO) coating on the mineral surface (Figure 2). HFO coatings reduce the reactivity of the minerals (passivate) and exhibit a highly adsorptive surface, with an affinity to adsorb metals migrating in the aquifer (Rundell and Randtke 1987; Halberg and Martinell 1976). Yet, the low alkalinity in the recharge signifies that it will exhibit minimal capacity to buffer acid-producing reactions, like most reactions between DO in recharge and reactive metal-bearing minerals. The relationship becomes particularly important in considering reactions with manganese minerals. An alkaline pH prevents manganese minerals from dissolving (Figure 3).

As expected from highly treated ATRW, the recharge contains negligible iron and manganese concentrations and minimal TSS. However, because there might be a long distance between the potential AWPF and the wells, suspended solids that originate from the pipeline, such as TSS from the cement lining, could be present and represent a source of suspended solids that can clog well screen slots and the borehole wall. Some preventive measures, such as providing additional filtration before injection, could be considered.

Table 3 summarizes water quality data for the following PWs:

- Converse
- Miramonte
- Goodyear
- Nadeau
- Manhattan
- Huntington Park

Table 4 summarizes water quality data for WRD's Los Angeles 1-4 MWs.

Table 3. Water Quality Data for Converse, Miramonte, Goodyear, Nadeau, Manhattan, and Huntington Park Production Wells

Field Chemistry	Units	Recharge from Tillman Pilot Study (Carollo 2021)	Converse 1	Converse 2	Miramonte 1	Miramonte 2	Miramonte 3	Goodyear 4	Nadeau 3	Manhattan 11	Manhattan 12	Huntington Park 1	Huntington Park 1	Huntington Park 1	Huntington Park 1
			Zone	Zone	Zone	Zone	Zone	Zone	Zone	Zone	Zone	Zone 1	Zone 2	Zone 3	Zone 4
			Undifferentiated Aquifers	Undifferentiated Aquifers	Undifferentiated Aquifers	Undifferentiated Aquifers	Undifferentiated Aquifers	Undifferentiated Aquifers	Undifferentiated Aquifers	Undifferentiated Aquifers	Undifferentiated Aquifers	Silverado	Lynwood	Hollydale	Gage
pH	S.U.	7.8	7.9	8.0	7.8	7.8	7.9	8.0	7.9	7.6	7.7	7.5	7.7	7.6	7.4
Specific conductance	µS/cm	NA	942.9	651.7	835.0	745.0	923.3	865.0	915.0	853.3	546.3	590.0	630.0	1100.0	1300.0
Turbidity	NTU	0.1	0.3	0.2	0.2	0.1	0.1	1.4	0.2	0.3	0.5	1.1	0.1	0.1	ND
Lab analytes															
Total and dissolved aluminum	µg/L	0.011	ND	ND	ND	ND	ND	ND	ND	43.8	34.7	ND	ND	ND	ND
Total and dissolved arsenic	µg/L	NA	ND	ND	ND	ND	ND	ND	ND	1.1	ND	0.8	0.6	0.5	0.5
Total and dissolved iron	mg/L	0.008	ND	ND	ND	ND	ND	0.5	ND	0.1	0.1	0.3	ND	ND	ND
Total and dissolved manganese	µg/L	0.00038	110	1.3	ND	ND	ND	29.0	ND	4.1	27.9	44.0	ND	5.5	4.1
Calcium	mg/L	25	113.8	60.7	93.7	80.3	86.8	91.0	88.0	93.4	53.8	61.6	65.7	122.0	151.0
Potassium	mg/L	0.576	4.3	3.4	4.1	3.7	3.7	4.1	3.9	4.1	3.8	3.4	3.5	4.4	5.3
Magnesium	mg/L	0.132	26.0	14.3	23.2	19.5	21.0	23.0	21.3	20.8	10.7	14.8	15.8	28.5	38.9
Sodium	mg/L	5.02	53.6	39.8	51.8	46.5	47.3	50.3	48.5	50.5	44.8	39.0	41.0	57.0	62.0
Alkalinity as CO_3	mg/L	60	ND	ND	ND	ND	ND	2.3	ND	ND	ND	ND	ND	ND	ND
HCO_3	mg/L	15	272.5	210	248.3	225.0	228.3	278.3	233.3	248.3	216.3	220.0	230.0	310.0	460.0
Chloride	mg/L	3.475	64.5	24.5	56.0	47.2	56.7	60.7	50.0	82.4	21.2	25.0	31.0	96.0	89.0
Sulfate	mg/L	0.19	147.1	83.2	136.7	113.3	130.0	116.7	130.0	98.4	69.3	93.0	94.0	170.0	170.0
Nitrate	mg/L	NA	6.7	0.5	4.2	2.4	1.7	6.4	2.4	3.0	ND	ND	2.7	1.8	28.0
Ammonia	mg/L	0.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TDS	mg/L	50	623.6	355.0	548.8	503.8	505.0	535.0	508.3	515.0	333.7	370.0	380.0	730.0	840.0
Ionic Strength	mol/L	1.25E-03	1.56E-02	8.88E-03	1.37E-02	1.26E-02	1.26E-02	1.34E-02	1.27E-02	1.29E-02	8.34E-03	9.25E-03	9.50E-03	1.83E-02	2.10E-02
TOC	mg/L	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.6

Notes:

µg/L = microgram(s) per liter
µS/cm = microsiemen(s) per centimeter
HCO_3 = bicarbonate
NA = not analyzed
ND = nondetect

Table 4. Water Quality Data for Water Replenishment District's Los Angeles 1-4 Monitoring Wells

Field Chemistry	Units	Recharge from Tillman Pilot Study (Carollo 2021)	LA 1 Zone 1 Sunnyside	LA 1 Zone 2 Sunnyside	LA 1 Zone 3 Sunnyside	LA 1 Zone 4 Silverado	LA 1 Zone 5 Lynwood	LA 3 Zone 1 Pico Formation	LA 3 Zone 2 Sunnyside	LA 3 Zone 3 Sunnyside	LA 3 Zone 4 Sunnyside	LA 3 Zone 5 Silverado	LA 3 Zone 6 Gage	LA 4 Zone 1 Pico Formation	LA 4 Zone 2 Sunnyside	LA 4 Zone 3 Sunnyside	LA 4 Zone 4 Silverado	LA 4 Zone 5 Lynwood	LA 4 Zone 6 Gage
pH	S.U.	7.8	8.0	7.7	7.8	7.8	7.6	8.2	8.0	7.9	7.9	7.8	7.7	8.1	8.0	8.0	7.7	7.9	7.7
Specific conductance	µS/cm	NA	560.0	570.0	580.0	710.0	1000.0	610.0	570.0	580.0	640.0	870.0	1200.0	3100.0	870.0	560.0	570.0	560.0	660.0
Turbidity	NTU	0.1	0.1	0.6	0.1	0.1	0.2	0.10	0.20	0.15	0.15	0.10	0.10	0.10	0.40	0.10	0.10	0.65	0.15
Lab Analytes																			
Total and dissolved aluminum	µg/L	0.011	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	37.0
Total and dissolved arsenic	µg/L	NA	ND	ND	0.6	1.1	0.6	ND	ND	0.7	ND	0.5	ND	1.9	6.1	ND	1.8	1.1	1.4
Total and dissolved iron	mg/L	0.008	ND	0.2	ND	ND	ND	ND	0.0	ND	0.1	ND	ND	0.6	0.1	ND	ND	0.1	ND
Total and dissolved manganese	µg/L	0.00038	13.0	49.0	6.0	2.0	ND	22.0	82.0	44.0	39.0	ND	ND	15.0	45.0	37.0	43.0	59.0	60.0
Calcium	mg/L	25	56.5	61.1	61.8	76.4	108.0	15.9	57.3	59.1	65.7	89.7	138.0	12.0	18.0	55.0	56.2	56.5	62.3
Potassium	mg/L	0.576	3.9	3.2	3.2	3.8	4.3	4.4	3.7	3.8	4.1	4.3	4.5	18.0	12.0	3.2	3.8	3.7	3.5
Magnesium	mg/L	0.132	12.4	14.4	15.1	19.0	27.5	5.8	13.6	13.7	15.0	21.9	32.6	6.4	7.6	11.2	13.0	12.0	12.0
Sodium	mg/L	5.02	43.0	38.0	39.0	44.0	54.0	110.0	40.0	40.0	43.0	53.0	62.0	670.0	160.0	41.0	10.0	39.0	49.0
Alkalinity as CO_3	mg/L	60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	31.0	3.5	2.2	2.3	2.2	ND
HCO_3	mg/L	15	230.0	230.0	230.0	250.0	280.0	300.0	220.0	230.0	240.0	260.0	310.0	1900.0	540.0	210.0	220.0	210.0	210.0
Chloride	mg/L	3.475	25.0	24.0	25.0	38.0	77.0	40.0	27.0	24.0	41.0	62.0	120.0	36.0	8.7	22.0	23.0	23.0	53.0
Sulfate	mg/L	0.19	77.0	85.0	88.0	110.0	140.0	26.0	77.0	81.0	81.0	120.0	190.0	ND	ND	78.0	78.0	80.0	84.0
Nitrate	mg/L	NA	ND	ND	ND	2.8	14.0	ND	ND	ND	ND	42.0	30.0	ND	ND	ND	ND	ND	8.3
Ammonia	mg/L	0.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TDS	mg/L	50	320.0	350.0	370.0	470.0	620.0	380.0	320.0	330.0	370.0	530.0	750.0	2000.0	470.0	320.0	330.0	320.0	350.0
Ionic strength	mol/L	1.25E-03	8.00E-03	8.75E-03	9.25E-03	1.18E-02	1.55E-02	9.50E-03	8.00E-03	8.25E-03	9.25E-03	1.33E-02	1.88E-02	5.00E-02	1.18E-02	8.00E-03	8.25E-03	8.00E-03	8.75E-03
TOC	mg/L	0.1	0.4	ND	ND	0.5	0.4	1.6	0.4	ND	ND	0.4	0.6	7.5	5.7	0.2	0.2	0.3	0.2

Figure 2. Pyrite Oxidation

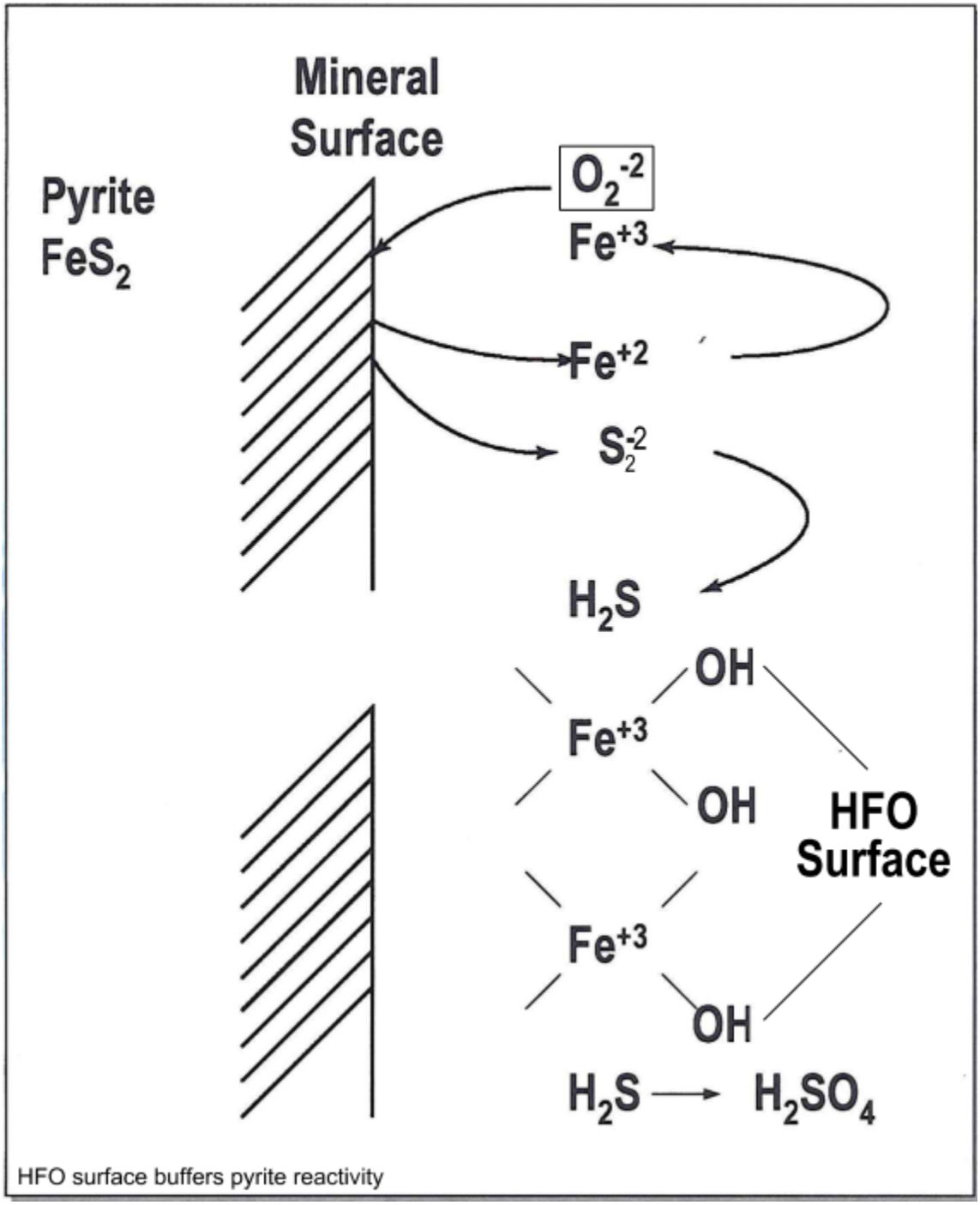
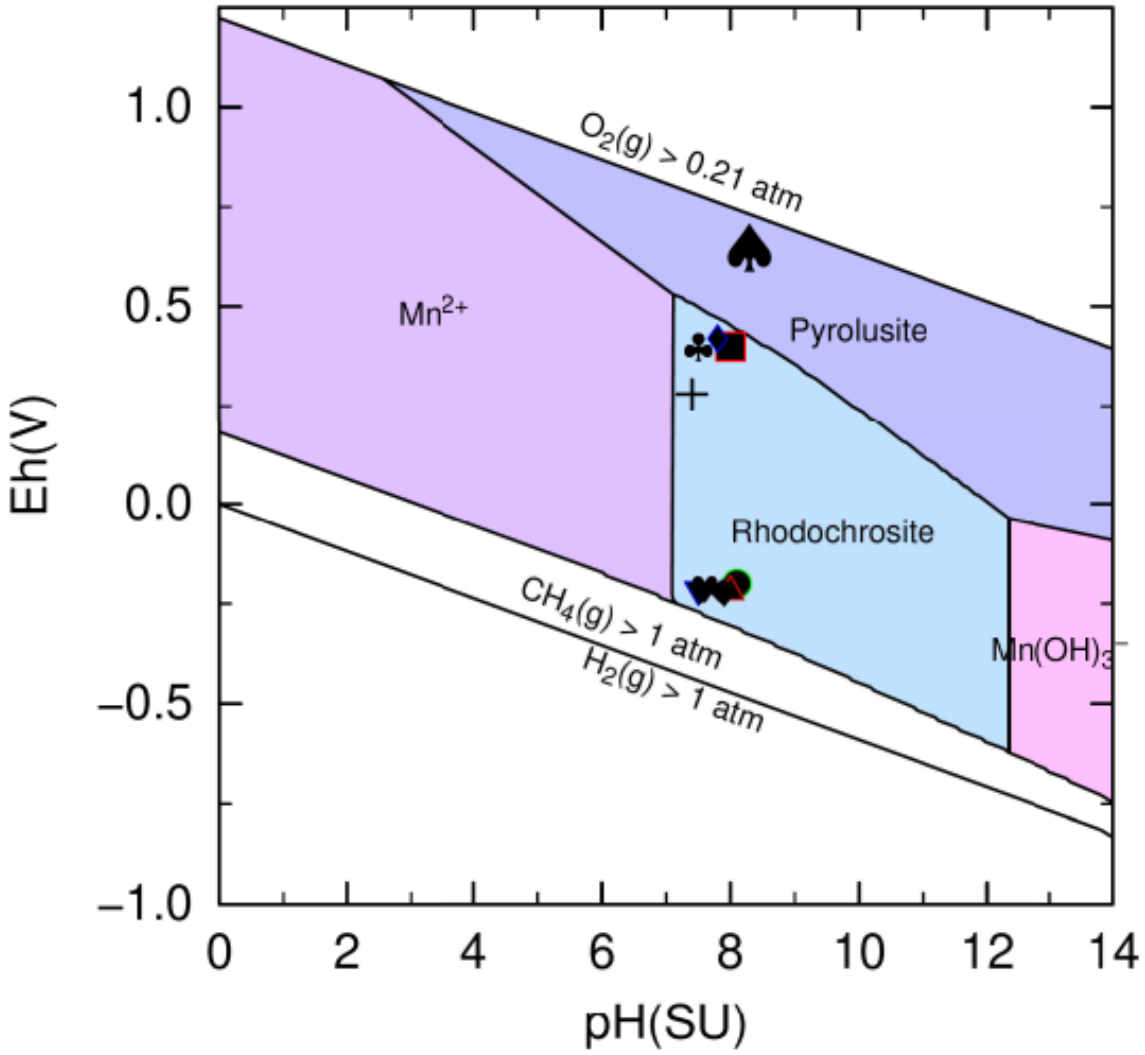


Figure 3. Phase of Manganese and Carbonate and Oxygen System



Legend

- LA 4, Z–1 Pico
- LA 1, Z–1 Sunnyside
- LA 4, Z–2 Sunnyside
- HP 1, Z–1 Silverado
- LA 3, Z–5 Silverado
- HP 1, Z–4 Gage
- LA 4,Z–6 Gage
- HP 1, Z–2 Lynwood
- LA 4, Z–5 Lynwood
- HP 1, Z–3 Hollywood
- Recharge

3.2 Native Groundwater

This study involved examining more than 30 analyses from 6 aquifers and the Pico Formation for PWs and MWs. Typically, groundwater originating from aquifers at progressively increasing depths have markedly differing chemistries, or chemistries that become more brackish and reducing with depth. However, groundwater chemistry from CB varied minimally regarding pH, ionic strength, and major ions. Table 3 and Table 4 summarize water quality data from selected PWs and MWs in CB's Los Angeles Forebay Area.

Groundwater from CB had a circumneutral to slightly alkaline pH ranging from 7.4 to 8.2. Except for a single sample from the Pico Formation, TDS concentrations indicate NGW is classified as freshwater (Hem 1986), with concentrations ranging from 320 to 840 mg/L and corresponding ionic strengths of 0.008 to 0.02 mol/L. The ionic strength of groundwater found in CB approaches or exceeds 1 order of magnitude greater than the example recharge (0.014 mol/L), indicating the need for aquifer conditioning with Al-salts. The single sample from the Pico Formation exhibited a TDS exceeding 2,000 mg/L, characterizing the water as brackish.

Except for a couple of samples, CB groundwater had nearly identical calcium bicarbonate chemistry (Figure 4). Iron and manganese concentrations rarely exceeded their respective secondary maximum contaminant levels of 0.3 and 0.05 mg/L and more often had concentrations less than their respective laboratory method detection limit (MDL).

Elevated concentrations of sulfate in CB NGW ranging from 60 to 190 mg/L suggests oxidation of sulfide minerals like pyrite. At pHs ranging between 7.5 and 8.2, pyrite probably no longer remains reactive. However, pyrite activity will likely increase with the recharge of water containing concentrations of DO greater than 1 mg/L. Pyrite often hosts small amounts of arsenic in the sulfide position of the mineral (Smedley and Kinniburgh 2002; Kolker and Nordstrom 2009).

Arsenic exceeded MDLs in approximately half of the samples, mostly at concentrations less than 1.0 µg/L, with a maximum concentration of 1.9 µg/L. NGW from all of CB had detectable arsenic concentrations. Other trace metals that could become soluble in groundwater may include:

- Iron
- Manganese
- Selenium
- Chromium
- Cadmium
- Molybdenum
- Uranium

The study employed a Microsoft Excel-based program developed by U.S. Geological Survey (USGS) (Jurgens et al. 2009) to characterize redox characteristics of NGW samples using common redox species, including (Table 5 and Table 6):

- DO
- Nitrate
- Manganese
- Iron
- Sulfate

Sample redox ranged from oxic to anoxic, with oxygen to sulfate-reducing conditions representing the main redox processes; and several samples had processes ranging from nitrate to sulfate-reducing, which represent an anoxic to anaerobic redox condition. The program designated a single process: nitrate-reducing for many NGW samples. Generally, redox processes seemed to be progressively more reducing with depth. Redox processes helped define Eh (Figure 5) values for plotting the equilibrium condition of important trace minerals, like manganese, iron, and arsenic phase diagrams (Figure 3, Figure 6, and Figure 7).

The manganese phase diagrams show that samples of recharge and NGW appear in equilibrium with the manganese oxide mineral pyrolusite and the carbonate mineral rhodochrosite. However, if the pH changes to less than 7.5, attributable to acid-producing reactions during water storage, these minerals will dissolve, releasing manganese. Acid-producing reactions can occur during the oxidation of sulfide minerals or the precipitation of metal oxides, an important concern when considering the addition of pH adjustment and buffer addition capability at the wellfield facility.

The iron equilibrium diagram (Figure 6) shows better conditions during storage than the manganese diagram. pH needs to drop to less than 6 S.U. and ORP (Eh) to 0 volts (V) to dissolve iron hydroxide and release dissolved iron. Arsenic appears stable with the As(V) ion and HFO, suggesting that arsenic should adsorb to HFO in its presence. Arsenic remains in equilibrium with HFO even at a lesser pH.

In summary, CB NGW quality looks well suited to MAR operations. A relatively alkaline pH, low iron and manganese, and only modestly reducing conditions should support conditioning reactive minerals in situ with recharge containing DO. A mild cause for concern arises from low concentrations of arsenic exhibited in the NGW from each aquifer and the diluted nature of the recharge derived from reverse osmosis (RO) operations, creating considerations for conditioning the aquifers with Al-salts before starting recharge operations.

Figure 4. Major Ion Chemistry in Central Basin Aquifers

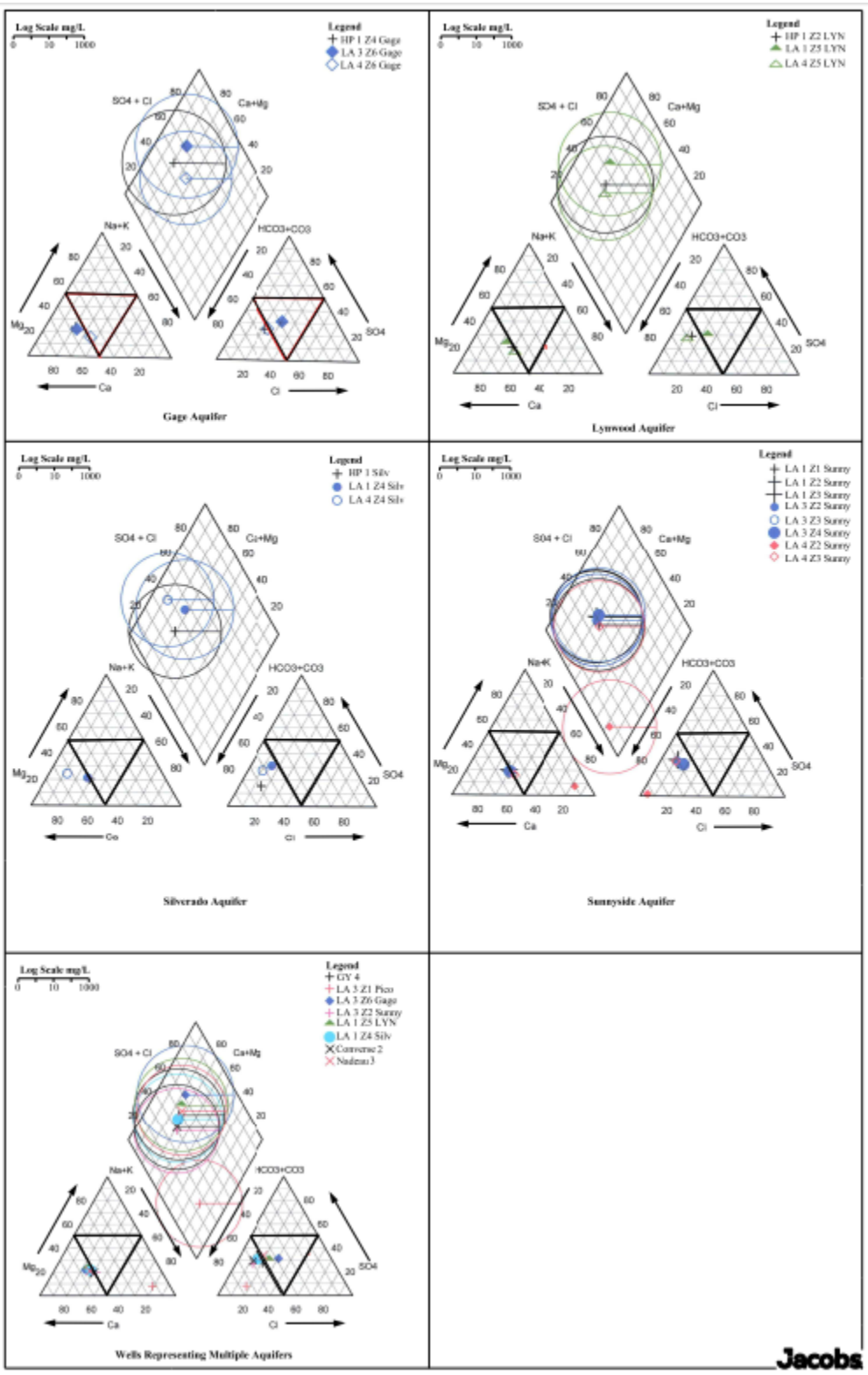


Table 5. Summary of Redox Analyses

Sample ID	Redox Variables	DO	NO_3^- (as Nitrogen)	Mn^{2+}	Fe^{2+}	SO_4^{2-}	Sulfide (sum of H_2S, HS^-, S^{2-})	Redox Assignment			Aquifer
	Units	mg/L	mg/L	µg/L	µg/L	mg/L	mg/L				
	Threshold Values	0.5	0.5	50	100	0.5	none	No. of Params	General Redox Category	Redox Process	
Converse 1		0.1	6.7	110	50	147	0.06	6	Mixed (anoxic)	NO_3-Mn(IV)	Undifferentiated
Converse 2		0.1	0.5	1,300	50	83	0.05	6	Mixed (anoxic)	NO_3-Mn(IV)	Undifferentiated
Miramonte 1		0.02	4.2	10	50	137	0.03	6	Anoxic	NO_3	Undifferentiated
Miramonte 2		0.1	2.4	10	50	113	0.03	6	Anoxic	NO_3	Undifferentiated
Miramonte 3		0.1	1.7	10	50	130	0.01	6	Anoxic	NO_3	Undifferentiated
Nadeau 3		0.1	2.4	10	50	130	0.005	6	Anoxic	NO_3	Undifferentiated
Manhattan 11		0.1	3	4,000	103	98	0.01	6	Mixed (anoxic)	NO_3-Fe(III)	Undifferentiated
Goodyear 4		0.1	6.4	2,900	4,800	117	0.01	6	Mixed (anoxic)	NO_3-Fe(III)	Undifferentiated
LA 3 Z1		0.1	0.3	10	50	26	0.01	6	Suboxic	Suboxic	Pico
LA 4 Z1		0.1	0.5	600	1,900	5	-	5	Mixed (anoxic)	NO_3-Fe(III)/SO_4	Pico
LA 1 Z1		0.1	0.5	10	50	77	-	5	Anoxic	NO_3	Sunnyside
LA1 Z2		0.2	0.5	4,900	200	85	-	5	Mixed (anoxic)	NO_3-Fe(III)/SO_4	Sunnyside
LA 1 Z3		0.1	0.5	6,000	50	88	-	5	Mixed (anoxic)	NO_3-Mn(IV)	Sunnyside
LA 3 Z2		0.1	0.5	10	50	26	-	5	Anoxic	NO_3	Sunnyside
LA 3 Z3		0.1	0.5	4,400	50	81	-	5	Mixed (anoxic)	NO_3-Mn(IV)	Sunnyside
LA 3 Z4		0.1	0.5	3,900	100	81	-	5	Mixed (anoxic)	NO_3-Fe(III)/SO_4	Sunnyside
LA 4 Z2		0.1	0.5	100	6,100	1	-	5	Mixed (anoxic)	NO_3-Fe(III)/SO_4	Sunnyside
LA 4 Z3		0.1	0.5	10	50	78	-	5	Anoxic	NO_3	Sunnyside
HP Z1		0.1	0.5	44,000	300	93	-	5	Mixed (anoxic)	NO_3-Fe(III)/SO_4	Silverado
LA 1 Z4		0.1	3	10	1,100	3	-	5	Mixed (anoxic)	NO_3-Fe(III)/SO_4	Silverado
LA 3 Z5		0.1	42	10	50	120	-	5	Anoxic	NO_3	Silverado
LA 4 Z4		0.1	0.5	10	1,800	78	-	5	Mixed (anoxic)	NO_3-Fe(III)/SO_4	Silverado
HP 1 Z4		0.1	28	4,100	50	170	-	5	Mixed (anoxic)	NO_3-Mn(IV)	Gage
LA 3 Z6		0.1	30	10	50	190	-	5	Anoxic	NO_3	Gage
LA 4 Z6		0.1	8	10	1,400	84	-	5	Mixed (anoxic)	NO_3-Fe(III)/SO_4	Gage
HP 1 Z2		0.1	3	10	50	94	-	5	Anoxic	NO_3	Lynwood
LA 1 Z5		0.1	4	10	50	140	-	5	Anoxic	NO_3	Lynwood
LA 4 Z5		0.1	0.5	10	1800	80	-	5	Mixed (anoxic)	NO_3-Fe(III)/SO_4	Lynwood
HP 1 Z3		0.1	2	10	500	170	-	5	Mixed (anoxic)	NO_3-Fe(III)/SO_4	Hollydale
Recharge		4.3	0.3	1	1	0.6	0.01	6	Oxic	Oxygen reducing	Recharge

Notes:
Fe^{2+} = ferrous iron
H_2S = hydrogen sulfide
HS- = hydrosulfide
ID = identification
Mn^{2+} = manganese cation
NO_3^- = nitrate
Param = parameter
S2- = sulfide
SO_4^{2-} = sulfate

Table 6. Criteria and Threshold Concentrations for Identifying Redox Processes in Groundwater

Redox Category	Redox Process	Electron Acceptor (Reduction) Half-reaction	Criteria for Inferring Process from Water Quality Data					
			DO (mg/L)	Nitrate, as Nitrogen (mg/L)	Manganese (mg/L)	Iron (mg/L)	Sulfate (mg/L)	Iron to Sulfide (mass ratio)
Oxic	O_2	$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$	≥ 0.5	—	< 0.05	< 0.1	—	-
Suboxic	Suboxic	Low O_2; additional data needed to define redox process	< 0.5	< 0.5	< 0.05	< 0.1	—	-
Anoxic	NO_3	$2NO_3^- + 12H^+ + 10e^- \rightarrow N_{2(g)} + 6\ H_2O$; $NO_3^- + 10H^+ + 8e^- \rightarrow NH_4^+ + 3H_2O$	< 0.5	≥ 0.5	< 0.05	< 0.1	—	-
Anoxic	Mn(IV)	$MnO_{2(s)} + 4H^+ + 2e^- \rightarrow Mn^{2+} + 2H_2O$	< 0.5	< 0.5	≥ 0.05	< 0.1	—	-
Anoxic	Fe(III)/SO_4	Fe(III) and (or) SO_4^{2-} reactions as described in individual element half-reactions	< 0.5	< 0.5	—	≥ 0.1	≥ 0.5	No data
Anoxic	Fe(III)	$Fe(OH)_{3(s)} + H^+ + e^- \rightarrow Fe^{2+} + H_2O$; $FeOOH_{(s)} + 3H^+ + e^- \rightarrow Fe^{2+} + 2H_2O$	< 0.5	< 0.5	—	≥ 0.1	≥ 0.5	> 10
Mixed (anoxic)	Fe(III)-SO_4	Fe(III) and SO_4^{2-} reactions as described in individual element half-reactions	< 0.5	< 0.5	—	≥ 0.1	≥ 0.5	≥ 0.3, ≤ 10
Anoxic	SO_4	$SO_4^{2-} + 9H^+ + 8e^- \rightarrow HS^- + 4H_2O$	< 0.5	< 0.5	—	≥ 0.1	≥ 0.5	< 0.3
Anoxic	CH_{4gen}	$CO_{2(g)} + 8H^+ + 8e^- \rightarrow CH_{4(g)} + 2H_2O$	< 0.5	< 0.5	—	≥ 0.1	< 0.5	-

Source: Table was modified from Jurgens et al. 2009.

Redox process:

CH_4gen = methanogenesis
Fe(III) = iron reduction
Mn(IV) = manganese reduction
NO_3 = nitrate reduction
O_2 = oxygen reduction
SO_4 = sulfate reduction

Chemical species:

$CH_{4(g)}$ = methane gas
$CO_{2(g)}$ = carbon dioxide gas
$Fe(OH)_{3(s)}$= iron hydroxide with iron in 3+ oxidation state
FeOOH(s) = iron oxyhydroxide with iron in 3+ oxidation state
$MnO_{2(s)}$ = manganese oxide with manganese in 4+ oxidation state
NO_3 = dissolved nitrate
O_2 = DO
SO_4^{2-} = dissolved sulfate

General notes:

— = criteria do not apply because the species concentration is not affected by the redox process
< = less than
> = greater than
≤ = less than or equal to
≥ = greater than or equal to

Figure 5. Oxidation-reduction Potential Values Compared to Common Redox Species

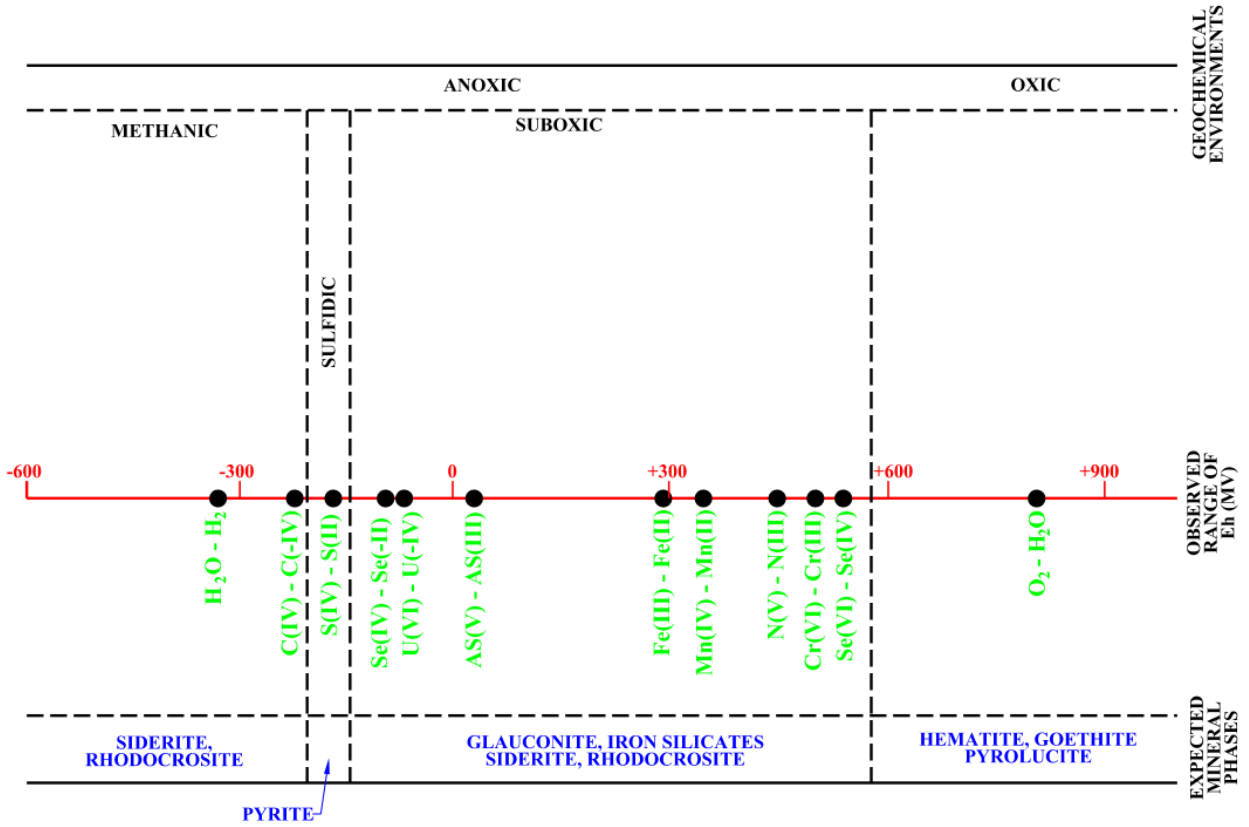
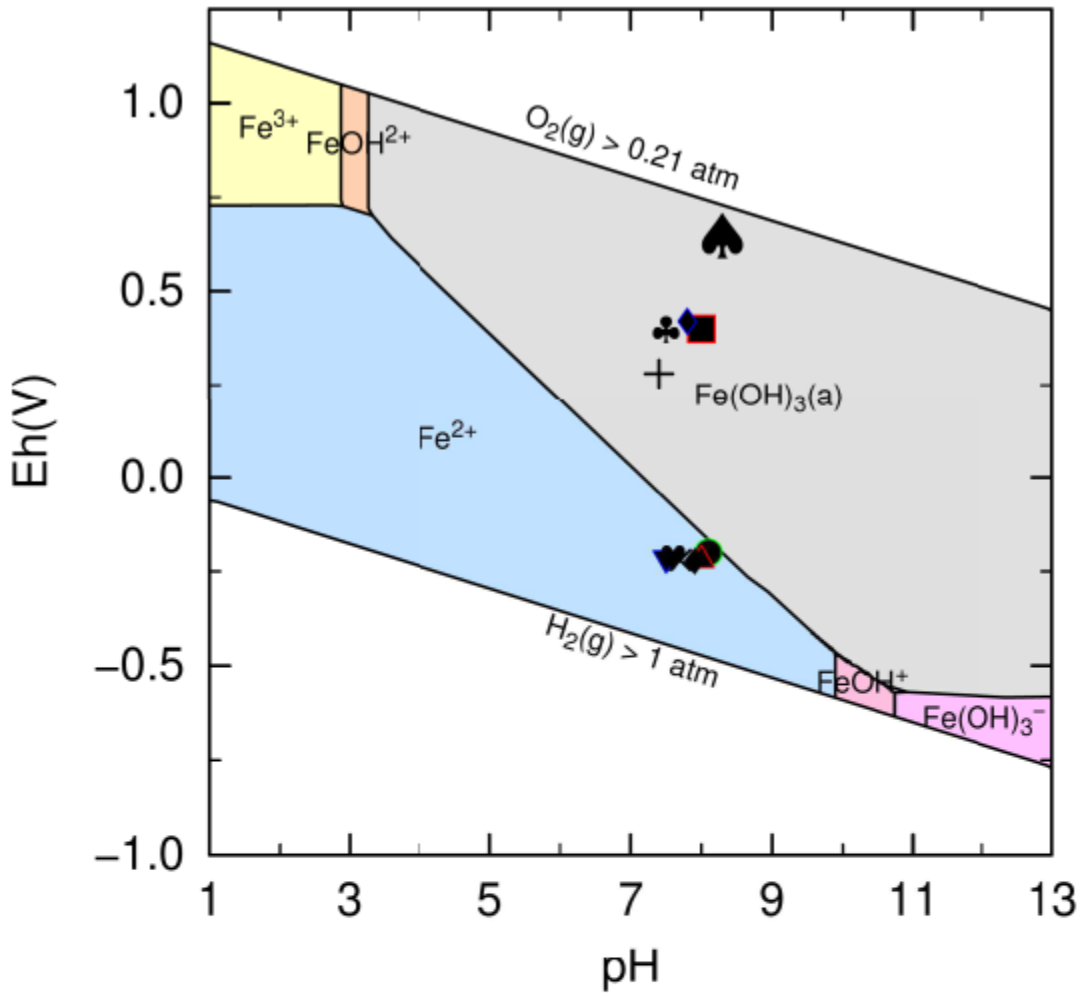


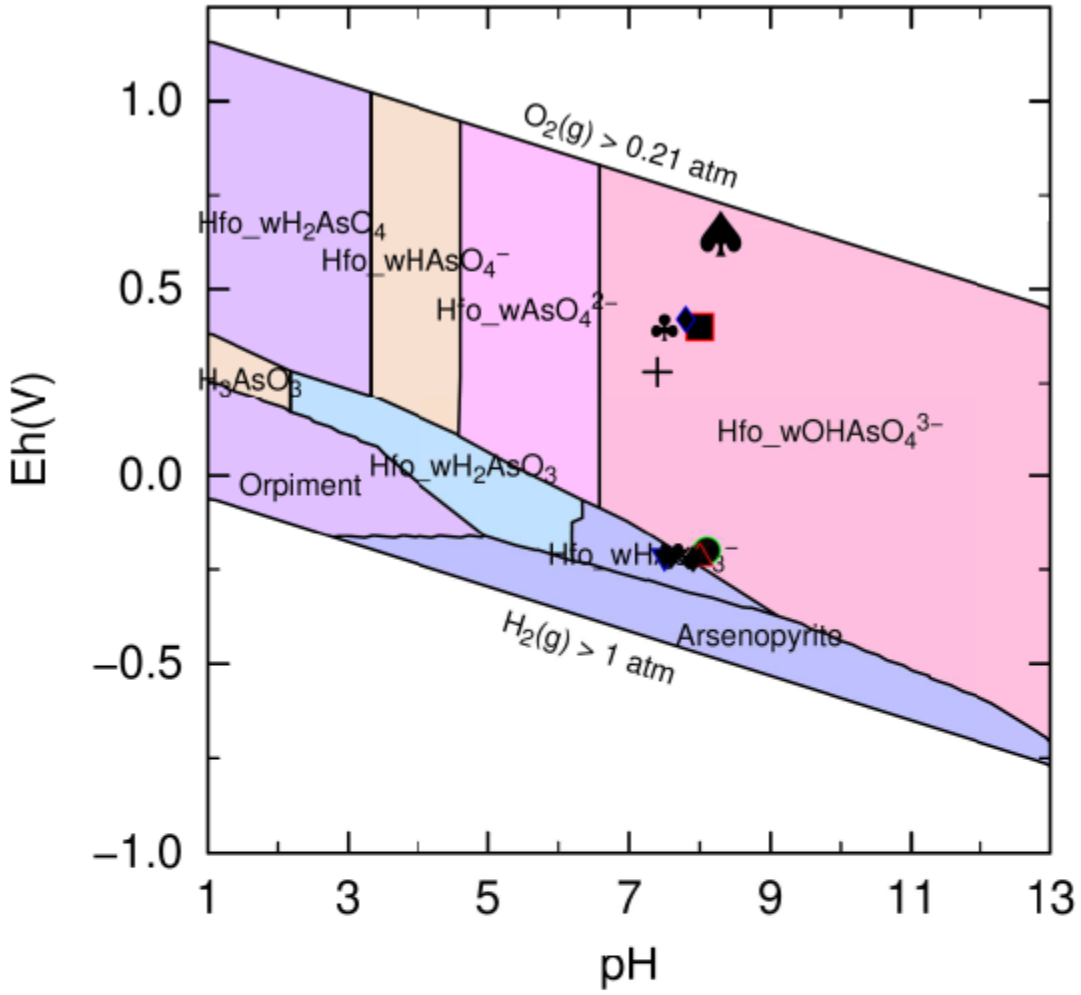
Figure 6. Iron and Oxygen System Phases



Legend

- LA 4, Z–1 Pico
- LA 1, Z–1 Sunnyside
- LA 4, Z–2 Sunnyside
- HP 1, Z–1 Silverado
- LA 3, Z–5 Silverado
- HP 1, Z–4 Gage
- LA 4,Z–6 Gage
- HP 1, Z–2 Lynwood
- LA 4, Z–5 Lynwood
- HP 1, Z–3 Hollywood
- Recharge

Figure 7. Arsenic, Sulfur, Hydrous Ferric Oxide, and Oxygen System Phases



Legend

- LA 4, Z–1 Pico
- LA 1, Z–1 Sunnyside
- LA 4, Z–2 Sunnyside
- HP 1, Z–1 Silverado
- LA 3, Z–5 Silverado
- HP 1, Z–4 Gage
- LA 4,Z–6 Gage
- HP 1, Z–2 Lynwood
- LA 4, Z–5 Lynwood
- HP 1, Z–3 Hollywood
- Recharge

4. Topics Specific to Managed Aquifer Recharge Operations

This section describes important geochemical topics that influence the success of MAR operations for Pure Water Los Angeles.

4.1 Chlorination

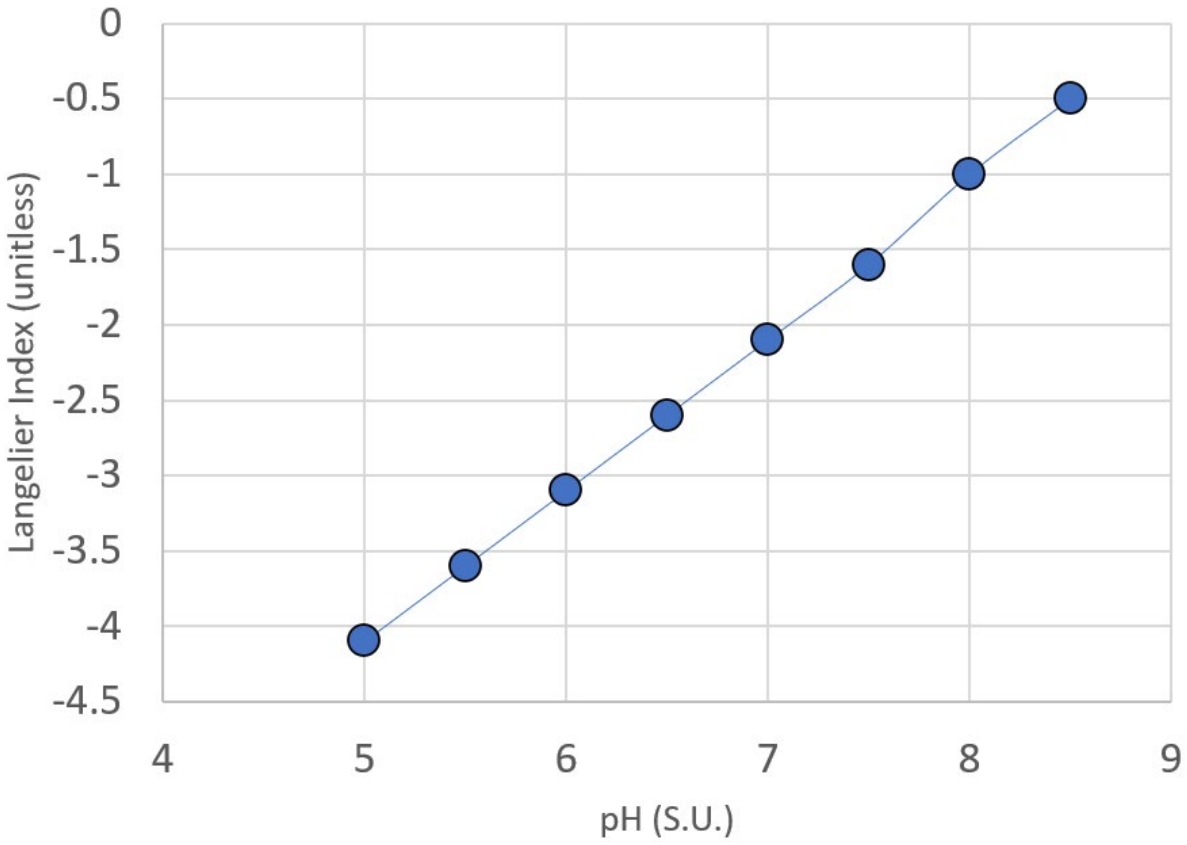
Recharge water should contain a chlorine residual before injection into CB aquifers (Table 3). Typically, a chlorine residual between 3 and 5 mg/L prevents biofilms from forming in the wellbore environment, comprising the screen, filter pack, and borehole wall. Free chlorine derived from sodium hypochlorite or monochloramine offers the necessary disinfecting agents (Pyne 2005).

Biofilms can rapidly clog a well; and, even if removed by conventional well rehabilitation techniques, biofilms can regrow on well surfaces. In addition to preventing biofilm growth, a chlorine residual acts as an oxidant supplemental to DO for passivating reactive minerals in situ (Rundell and Randtke 1987).

4.2 Damage to Pipeline Materials

The potential ATRW obtained from the *Donald C. Tillman Advanced Water Purification Facility Pilot Study* (Carollo 2021) has a Langelier index of -0.94. At such a negative value, ATRW is an aggressive water that can dissolve cement linings coating the insides of the large-diameter pipeline between the ATRW and MAR recharge wellfield. Ideally, the Langelier index should exceed 1.0 (Hem 1986) to protect metal from corrosion. Increasing the recharge pH to greater than 7.8 (Figure 8) raises the Langelier index to around -0.4, a much less-corrosive water than untreated recharge.

Figure 8. Langelier Indices for Recharge Water at Varying pH



4.3 Comparing Recharge Water Chemistry at Other Full Advanced Treatment Facilities

Treated water emanating from FAT facilities comprises two types of processes involving treatment through membrane processes: RO and membrane filtration (MF), either microfiltration or ultrafiltration, and non-membrane techniques, like biologically activated carbon (BAC). In California's potable reuse regulations, RO is a required process for groundwater aquifer recharge projects involving the use of injection wells, hence non-membrane techniques are unlikely to be applicable to this Program.

However, the use of RO has created challenges for groundwater aquifer recharge projects, as it lowers the low ionic strength in the finished water and causes concerns when recharging into an aquifer containing brackish, saline groundwater, or even potable groundwater if the difference in ionic strength between the recharge and native groundwater exceeds 1 order of magnitude in mol/L.

This section provides two case studies selected to represent the issues with the use of RO as compared to a non-membrane-based approach to show how altering the ionic strength in recharge water would impact injection well operations.

4.3.1 Orange County Water District Groundwater Replenishment System: Membrane Treatment

Locally, the Orange County Water District's (OCWD's) Groundwater Replenishment System (GWRS) project currently produces up to 100 million gallons per day (MGD) of high-purity recharge by treating

secondary-treated wastewater from the Orange County Sanitation District (OCSD) using MF or ultrafiltration (UF), RO, and ultraviolet (UV) light, with hydrogen peroxide addition for advanced oxidation (Figure 9). Before recharge, OCWD stabilizes the recharge to protect distribution system piping using partial decarbonation and quicklime addition (WRF 2022).

The GWRS project recharge water consists of diluted TDS concentrations, less than 50 mg/L, an alkaline pH (8.5), and mixed cation-bicarbonate. Containing near-saturated concentrations of DO (8 to 10 mg/L) and measurable nitrate (0.8 to 1.3 mg/L), recharge displays an oxic redox, with oxygen reduction representing the primary redox process. The performance of the OCSD's nitrification treatment and the membranes by the GWRS AWT both influence nitrate concentrations in recharge water (WRF 2022).

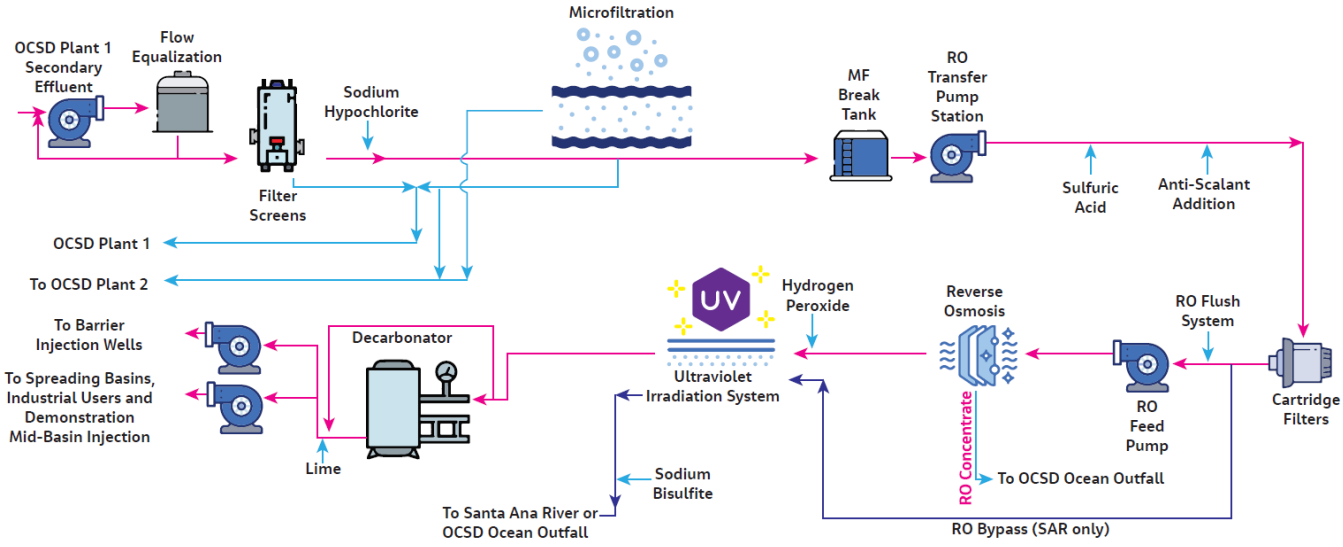
OCWD has not conditioned the receiving aquifers using Al-salts before initiating MAR operations at new wells. Moreover, OCWD has not reported the catastrophic reductions in injection-specific capacity (injectivity) as experienced elsewhere. Yet, documentation of well performance over the many years of operations has been inconsistent. Given the large number of MAR wells operated by OCWD, some fraction always has a very low injectivity and injection capacity originating from clogging by siltation or other mechanisms.

The same recharge chemistry supplies the Talbert Seawater Intrusion Barrier injection wells, Mid-Basin injection wells, and spreading basins within the Orange County Groundwater Basin (OCGB) Forebay Area. The OCGB Forebay Area also receives MAR supplies from local Santa Ana River surface water, local stormwater runoff, and purchased raw imported surface water originating from either the Colorado River or the State Water Project through the Metropolitan Water District of Southern California (Metropolitan) system (WRF 2022).

Infiltration of high-purity recharge into the OCGB Forebay Area has resulted in transient spikes of arsenic at proximal monitoring wells (Fakhreddine et al. 2015). Arsenic concentrations and the frequency of its appearance diminishes with both time and distance from the MAR basins. Before infiltration, the GWRS recharge water did not contain detectable arsenic exceeding the standard drinking water analytical method reporting limit of 1 µg/L.

NGW in the OCGB Forebay Area before introduction of GWRS recharge contained arsenic concentrations ranging from nondetect to 6 µg/L, varying spatially and with depth. Recharge chemistry typifies water treated with MF as well as RO, followed by post-treatment stabilization; thus, this is likely a chemistry that numerous MAR facilities will produce as the number of systems increase worldwide.

Figure 9. Orange County Water District Groundwater Replenishment System Treatment Processes



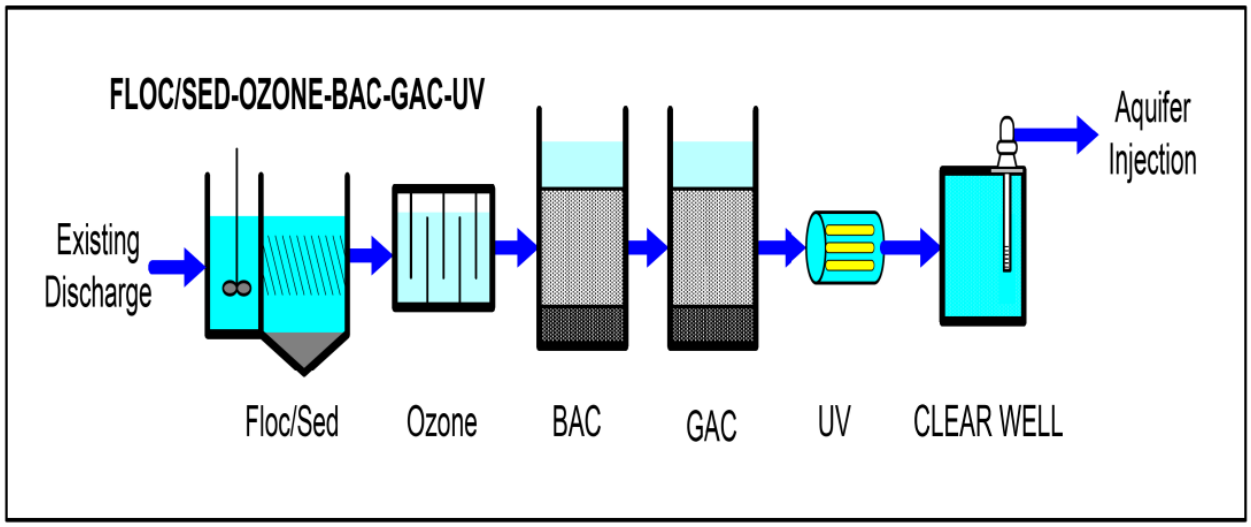
4.3.2 Hampton Roads Sanitation District's Sustainable Water Initiative for Tomorrow Research Center: Non-Membrane Treatment

The Hampton Roads Sanitation District's (HRSD's) Sustainable Water Initiative for Tomorrow (SWIFT) Research Center (SRC) consists of a 1-MGD AWT process recharging water to a test well (TW-1) screened across the upper, middle, and lower zones of the Potomac Aquifer System (PAS) in Nansemond, Virginia. Eventually, HRSD plans on expanding the capacity of their FAT system to 150 MGD (CH2M 2017).

The SRC AWT system treats secondary wastewater using the following processes in order (Figure 10):

1. Flocculation and sedimentation (floc/sed on the figure)
2. Ozone oxidation
3. BAC filtration
4. Granular activated carbon (GAC) adsorption
5. UV disinfection
6. Sodium hypochlorite addition
7. Recharge of the effluent to TW-1

Figure 10. SWIFT Research Center Treatment Processes



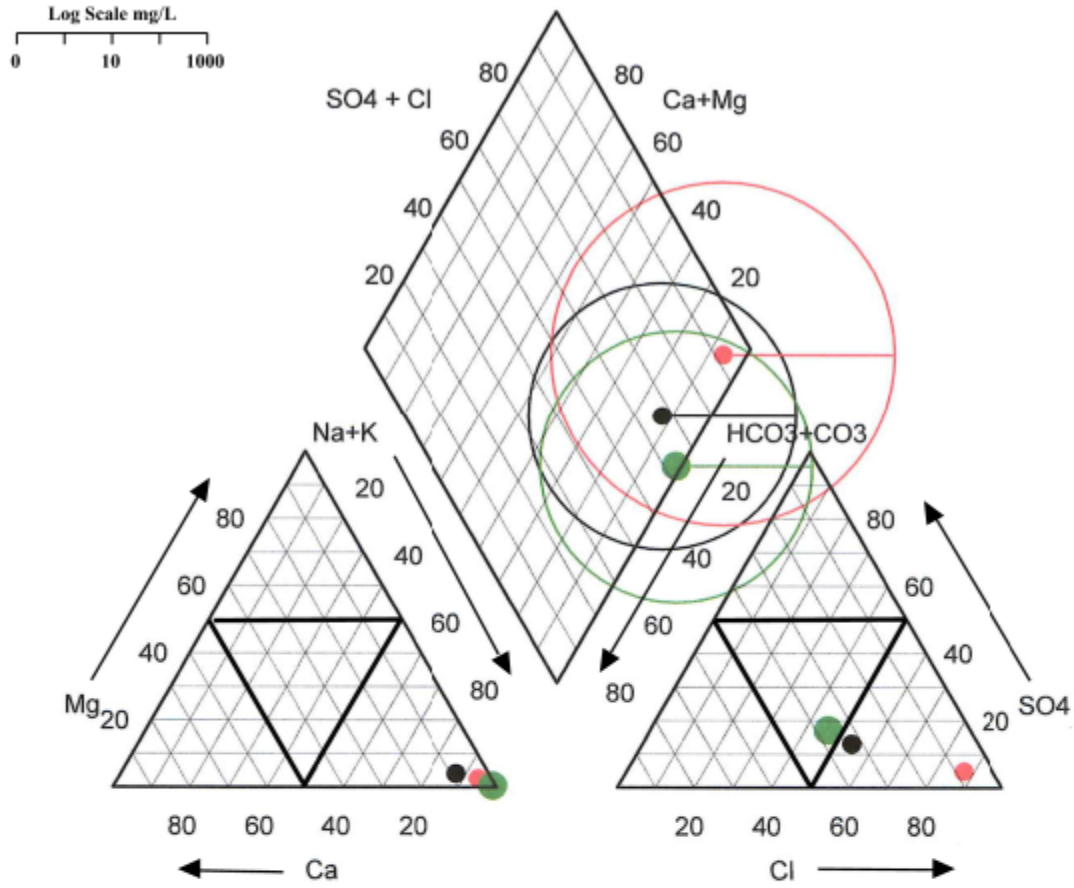
Recharge has the following characteristics (Figure 11) (CH2M 2017):

- TDS concentrations around 660 mg/L
- pH adjusted to 7.6
- DO concentrations exceeding 15 mg/L
- Sodium-chloride chemistry

During 2016, HRSD increased the pH from 6.9 to greater than 7.6 with sodium hydroxide before recharge. In combination with the elevated DO, the pH helped passivate reactive metal-bearing minerals in situ by precipitating an HFO mineral coating on the mineral surface. The coating reduced the reactivity of the mineral surface and served as an adsorption surface for metals migrating in the aquifer environment (CH2M 2017).

The ionic strength of NGW in the receiving aquifer exceeds the recharge by greater than 1 order of magnitude. Several MAR projects that involved recharging fresh water into the PAS containing brackish groundwater have failed or experienced severe formation damage, such as clay dispersion, clay migration, and brush piling, diminishing injectivities and injection capacity. Accordingly, HRSD would condition new MAR wells using Al-salts before starting MAR operations (CH2M 2017).

Figure 11. Ionic Composition of Recharge, Groundwater, and Migrating Recharge at the SWIFT Research Center



Legend

- HRSD SRC Recharge
- HRSD PAS GW
- HRSD Migrating Recharge

HRSD - Hampton Roads Sanitation District
PAS - Potomac Aquifer System
GW - Groundwater

4.4 Wellhead Pretreatment

Evaluation of geochemical compatibility reveals the need for the following pretreatment measures at a facility close to the MAR wellfield:

- Aquifer conditioning with Al-salts
- Increasing pH of recharge to between 8.0 and 8.3
- Addition of a buffering agent
- Chlorination if residual at wellfield is less than 3 mg/L
- Filtration to remove TSS

Table 7 summarizes the target concentrations for parameters in the recharge water that may require pretreatment at the MAR wellfield before recharging.

Table 7. Target Chemistry at Point of Recharge

Analyte	Unit	Concentration in HWRP Effluent	Target Concentration at Point of Recharge	Potential Treatment Approach	Potential Location
pH	S.U.	7.8	8.3	NaOH or KOH	At the wellfield
Alkalinity as $CaCO_3$	mg/L	15	> 60	Liquid CO_2	At AWPF and the wellfield
Chlorine Residual	mg/L	2	3-5	NaOCl	At the wellfield
TSS	mg/L	0	< 1	Bag filters	At the wellfield

Notes:

CO_2 = carbon dioxide
KOH = potassium hydroxide
NaOCl = sodium hypochlorite
NaOH = sodium hydroxide

The difference in ionic strengths between the recharge and NGW approaches or exceeds 1 order of magnitude. Consequently, LADWP should consider conditioning the area around the MAR injection wells with Al-salts before implanting full-scale recharge operations. A single conditioning event should mitigate potentially catastrophic permeability losses. Some FAT facilities treating water using membranes and producing very diluted recharge do not condition wellbores with Al-salts before placing wells in service and have reported no hydraulic losses. However, permeability losses can prove so catastrophic that utilities need to consider using these techniques if there are disparities in ionic strength or prevailing cations.

Increasing the pH to 8.3 in combination with DO and a chlorine residual will passivate reactive metal-bearing minerals and prevent leaching of undesirable or harmful metals. As the recharge contains negligible buffering capacity, LADWP should add an agent, like liquid carbon dioxide, to lift the alkalinity of the recharge from less than 20 mg/L to greater than 60 mg/L. Adding a buffering agent will help control pH in the aquifer and prevent leaching of manganese.

Chlorination offers multiple benefits in controlling biofilms and supplementing the addition of a strong oxidant to the recharge. Pipelines will convey recharge up to 10 miles to the new MAR wellfield. Because of consumption by biota and other factors, chlorine residuals often decline with distance from their point of treatment. So that chlorine residuals can effectively mitigate biofilms in the MAR wells, facilities at the wellfield will include chemical storage tanks and metering pumps to boost residuals from less than 3 to 5 mg/L before recharge enters the MAR wells.

LADWP should consider adding a form of portable filtration at the MAR facility to remove TSS entrained in the recharge during the approximately 10 miles of conveyance required to get ATRW from HWRP to the MAR wellfield. Many facilities employ bag, cartridge, or portable sand filters to remove solids in recharge. Studies have found that the smallest particles represent the greatest threat as clogging agents (Buik and

Willhemsen 2002). Hence, bag or cartridge filters should use the smallest mesh size commercially available.

Although not reported at sites in Southern California, MAR sites elsewhere use wellhead filtration to remove TSS before water enters the MAR well. In New Jersey, Gordon's Corner Water Company (GCWC) uses portable sand filters to remove TSS in treated drinking water before it enters their two aquifer storage and recovery (ASR) wells, a specialized form of MAR. GCWC wells have operated without an interruption in service from 1971 through at least 2004 (Pyne 2005).

Similarly, ASR and MAR wells operated by Suez-Toms River, Brick Township Municipal Utility Authority, New Jersey American Water, and HRSD's SWIFT in Virginia historically used bag filters to effectively remove TSS in recharge. At all locations, use of wellhead filtration has reduced the frequency of backflushing and invasive rehabilitation (CH2M 2009).

5. Other Operational Considerations

This section discusses measures unrelated to geochemical issues important to the success of a MAR facility, including:

- Equip the MAR well with a downhole flow-control valve (DFCV) or foot valve.
- Equip the MAR well with a conventional or airlift pump to allow routine backflushing.
- Run membrane filter index (MFI) tests periodically to characterize the TSS content of the recharge water.

Equipping wells with a DFCV adds significant flexibility to MAR operations. DFCVs can control injection rates while maintaining a positive pressure in the injection piping, preventing the formation of a vacuum and the entrainment of air in the recharge. Companies, including Baski, Inc. and 3R Valve, manufacture DFCVs, although firms often change owners and names, depending on order volume. Moreover, firms may stop production for unanticipated intervals.

DFCVs built by two of the firms rely on sliding sleeves that regulate the amount of water entering the well through the side of the units. The units depend on hydraulic pressure to regulate the sleeves. The third firm uses a modified packer system to regulate flow using pneumatic pressure.

DFCVs have good reliability and are relatively rugged compared to other downhole components, like pumps. However, costs for manufacturing, installation, and training often exceed $75,000 for a single unit. None of the suppliers maintain stock on the shelf, so every DFCV is a custom build.

A significantly simpler and cheaper device, foot valves installed at the base of injection piping, or a vertical line shaft pump, can control pressure in the piping to prevent vacuum formation while setting the injection rate into a relatively narrow flow range. Orifice holes drilled into the bottom of the valves allow water to pass into the well at a set rate based on the diameter of the holes. Foot valves cost about 1/10th of the price of a DFCV. MAR wellfields will often use a combination of DFCVs and foot valves to control flows and pressures. The approach requires hydraulic modeling to achieve the best result but can reduce overall cost by combining the use of both valve types. Equipping one or two MAR wells with DFCVs supports fine-tuning of daily injection operations.

All MAR wells installed in sand aquifers should contain a pump or other equipment to conduct routine backflushing at frequent intervals. Installing a pump in a MAR well allows recharge to be stopped for a brief period so that wells can be pumped to remove TSS that have accumulated in the wellbore since the previous backflushing event. To maximize the energy generated by the backflushing event, the pump should have enough capacity to pump at two times the average recharge rate.

Even the most highly treated recharge contains some amount of TSS. Important to operating a successful MAR facility is understanding the magnitude, range, and temporal nature of TSS loading. These factors help determine the frequency of backflushing and, ultimately, invasive well rehabilitation measures. Running MFI tests requires a rudimentary testing device and measuring the decline in flow rate through

the device at a constant pressure. By characterizing the range of the MFI index and TSS content, an Operator can more accurately predict routine operations, backflushing volumes, and labor needs. The TSS content and MFI indices in recharge should not exceed 1 mg/L and 0.5 second per square liter (s/L^2).

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Attachment B
Central Basin Groundwater Treatment Evaluation

Central Basin Groundwater Treatment Evaluation

Document No.: 240920111234_59fba068
Version No.: Final

Los Angeles Department of Water and Power (LADWP)

Pure Water Los Angeles Master Plan Project
June 26, 2024

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Acronyms and Abbreviations

µg/L	microgram(s) per liter
µS/cm	microsiemen(s) per centimeter
°C	degree(s) Celsius
1,2-DCA	1,2-dichloroethane
AACE	AACE International
AFY	acre-foot (feet) per year
bgs	below ground surface
CB	Central Basin
CCl_4	carbon tetrachloride
CCR	California Code of Regulations
CCT	chlorine contact tank
cfs	cubic foot (feet) per second
CI	confidence interval
Cr[III]	trivalent chromium
Cr[VI]	hexavalent chromium
CT	contact time
DDW	Division of Drinking Water
DPR	direct potable reuse
EBCT	empty bed contact time
EPA	U.S. Environmental Protection Agency
ft^2	square foot (feet)
ft^3	cubic foot (feet)
GAC	granular activated carbon
GAMA	Groundwater Ambient Monitoring and Assessment
Golden State	Golden State Water Company
gpm/ft^2	gallon(s) per minute per square foot
GWR	Ground Water Rule
HOCl	hypochlorous acid
IPR	indirect potable reuse
IX	ion exchange

Joint MP	Joint Los Angeles Basin Replenishment and Extraction Master Plan
kW	kilowatt(s)
L	liter(s)
LADWP	Los Angeles Department of Water and Power
LASAN	LA Sanitation & Environment
lb	pound(s)
MCL	maximum concentration level
mg/L	milligram(s) per liter
MGD	million gallons per day
mm	millimeter(s)
MTZ	mass transfer zone
ND	nondetect or not detected
NH_3-N	ammonia as nitrogen
NL	Notification Level
No.	number
NPV	net present value
O&M	operations and maintenance
OCl^-	hypochlorite ion
PCE	tetrachloroethylene
ppb	part(s) per billion
Program	Pure Water Los Angeles Water Supply Program
psi	pound(s) per square inch
PTA	packed tower aeration
RGWMP	Regional Groundwater Monitoring Program
RL	Response Level
RPD	Replica Parametric Design
SBIX	strong base ion exchange
SLR	surface loading rate
SMCL	secondary maximum contaminant level
SWRCB	State of California Water Resources Control Board
TCE	trichloroethylene

TDS	total dissolved solids
TM	technical memorandum
TOC	total organic carbon
U.S.	United States
VOC	volatile organic compound
WCB	West Coast Basin
WRD	Water Replenishment District of Southern California
WRP	water reclamation plant

1. Introduction

The Los Angeles Department of Water and Power (LADWP) is developing the Pure Water Los Angeles Water Supply Program (Program) in partnership with LA Sanitation & Environment (LASAN) to maximize the supply of advanced purified recycled water from the Hyperion Water Reclamation Plant (WRP) to replenish Los Angeles' groundwater basins. Approximately 3 to 16% of Los Angeles's water supply is from local groundwater resources (LADWP 2023).

LADWP holds permanent water entitlements in the West Coast Basin (WCB) and Central Basin (CB). LADWP is allowed to extract up to 18,739 acre-feet per year (AFY) from CB, including 1,503 AFY from WCB. The Manhattan Wells and the 99th Street Wells are the two existing LADWP wellfields in CB. LADWP plans to produce up to 18,739 AFY at these wellfields once improvements of the potable water systems have been completed.

Both wellfields are being rehabilitated to maximize their production capacity and meet the high water supply demands. As part of the *Joint Los Angeles Basin Replenishment and Extraction Master Plan* (Joint MP) (Jacobs 2022), groundwater modeling was conducted, with the existing Manhattan and 99th Street wellfields pumping at an average total extraction rate of 26 cubic feet per second (cfs [16.5 million gallons per day {MGD})], with new replenishment and extraction wellfield locations adding 46 cfs (29.6 MGD) of extraction and 63 cfs (40.6 MGD) of injection to maximize CB's total rates of extraction and injection.

The analysis conducted in the Joint MP assumed that replenishment water for maintaining LADWP extraction up to its entitlements, including transfer from WCB, would be sourced by Water Replenishment District of Southern California (WRD) and be replenished at other locations farther from the wellfields. After further investigations by LADWP (LADWP 2024a), the total extraction flow rates through augmentation would be reduced to 28 cfs (18 MGD). Additionally, WRD also indicated that they would be planning to inject replenishment water using Pure Water Los Angeles water near Manhattan and 99th Street wellfields to support LADWP's plan to extract up to its entitlements in both CB and WCB.

Wellfield locations and background water quality in the area will be assessed in detail during the project implementation phase through the installation of monitoring wells and collection of borehole samples to provide site-specific data for further evaluation, and for use in groundwater modeling and refinement in treatment strategy.

Table 1-1 summarizes the planned CB improvements.

Table 1-1. Planned Phased System Improvements in the Central Basin

CB	Capacity Added by Phase (cfs)	Total CB Production Flows [a]		Pure Water Los Angeles New Extraction and Treatment Capacity [b]	
		cfs	MGD	cfs	MGD
Current	10	10	6.5	0	0
Phase 1	6	16	10	0	0
Phase 2	20	36	23	5	3
Phase 3	23	59	38	28	18

Source (LADWP 2024a)

[a] Equivalent to planned total Pure Water Los Angeles injection flows; these flows assume 10 months of operation annually, for both extraction and injection.

[b] These flows represent augmentation exceeding existing rights.

This *Central Basin Groundwater Treatment Evaluation* technical memorandum (TM) is part of Task 14 of the Pure Water Los Angeles Master Plan. Task 14 includes conducting alternative evaluations to develop indirect potable reuse (IPR) and direct potable reuse (DPR) options for Pure Water Los Angeles. The purpose of this TM is to summarize a desktop evaluation of groundwater quality surrounding the proposed

new extraction wellfields and establish groundwater treatment for the extracted water. The treatment technologies must provide drinking water quality that meets the federal and state drinking water standards set by the U.S. Environmental Protection Agency (EPA) and the State of California Water Resources Control Board's (SWRCB's) Division of Drinking Water (DDW).

1.1 Regulatory Standards and Guidance

This section describes relevant regulatory standards and guidance for the Program.

1.1.1 Safe Drinking Water Acts

DDW enforces standards established under the federal and state *Safe Drinking Water Acts*. This section summarizes the regulatory standards that are relevant to potential Program options. A primary maximum concentration level (MCL) is an enforceable drinking water standard established based on the following factors:

- Health effect
- Risk assessment
- Detection capability
- Treatability
- Economic feasibility

A secondary maximum contaminant level (SMCL) is established based on impact of a constituent on the aesthetics of water (not necessarily health concerns), such as taste, odor, and color. The MCLs and SMCLs are codified in Title 22 of the *California Code of Regulations* (CCR). Total chromium currently has an MCL of 50 micrograms per liter (µg/L); however, a draft amendment for hexavalent chromium (Cr[VI]) is being proposed at 10 µg/L in Table 66431, Maximum Contaminant Levels—Inorganic Chemicals (SWRCB-DDW 2022).

A Notification Level (NL) is a health-based advisory level established by DDW for unregulated contaminants based on preliminary health reviews. DDW recommends additional notification requirements and recommendations when a contaminant is found at concentrations greater than the NL. A Response Level (RL) is an advisory level established by DDW for a drinking water system that has contaminant concentrations considerably exceeding the NL. At that level, DDW recommends the source be removed from service, depending on the toxicological endpoint.

1.1.2 Process Memo 97-005-R2020: Revised Guidance for Direct Domestic Use of Extremely Impaired Source

Process Memo 97-005 was originally issued in 1997 to provide a regulatory process for DDW to evaluate proposals to use water generated from large remediation projects (for example, Superfund cleanups [that is, sites under the *Comprehensive Environmental Response, Compensation, and Liability Act* {CERCLA}]) (SWRCB-DDW 2020). An extremely impaired source from groundwater meets two or more of the following criteria:

- Contains a contaminant that exceeds 10 times its MCL based on chronic health effects; example contaminants include volatile organic compounds (VOCs), such as tetrachloroethylene (PCE) and trichloroethylene (TCE)
- Contains a contaminant that exceeds 3 times its MCL based on acute health effects; for example, nitrate, perchlorate, or nitrate-nitrogen
- Contains a contaminant that exceeds 10 times its NL, based on chronic health effects
- Contains a contaminant that exceeds 3 times its NL, based on acute health effects

- Contains one or more contaminants that meet any of the criteria of the first four bullet points, and the source has not been adequately characterized by responsible parties
- Is extremely threatened with contamination due to known contaminating activities within the long-term, steady-state capture zone of a drinking water well
- Contains a mixture of contaminants of health concern beyond what is typically seen in terms of number and concentration of contaminants
- Is designed to intercept known contaminants of health concern

Relevant examples of these sources originate from groundwater and include extremely contaminated groundwater, oilfield produced water, and products of toxic site cleanup (SWRCB-DDW 2020). The revised guidance notes that if the impaired source produces or would be expected to produce water that meets only one of these criteria, it may not be considered extremely impaired.

It is important to recognize that the potential for trigging the 97-005 process may exist but remains low in the area of interest for the following reasons:

- The potential CB Groundwater Augmentation Project is neither designed to remediate any contamination nor associated with any remediation activities in the area.
- The project will be designed to avoid major contamination by locating wellfields away from major contamination or contaminant sources or extracting groundwater from greater depths.

As part of the near-term site investigations led by LADWP, it is recommended that LADWP conduct detailed geochemical and groundwater characterization to inform wellfield site and extraction depth selection to avoid areas of extreme contamination and the 97-005 process.

1.2 Objectives

The overall objective of this TM is to evaluate treatment technologies to guide the overall conceptual treatment process design for the proposed new extraction wellfield in CB.

The project has the following general objectives:

- Review the groundwater quality data set, and identify potential contaminants for the extraction wells.
- Select treatment processes, and recommend a process train.
- Develop a conceptual site layout.
- Develop a conceptual cost estimate for the proposed treatments.

1.3 Organization

This TM is organized in the following sections:

- Section 1 – Introduction: Provides the objectives for the treatment evaluation, and describes the contents of this TM.
- Section 2 – Background: Describes the extraction wellfield locations and extracted water quality data from surrounding monitoring and production wells.
- Section 3 – Treatment Design Assumptions: Describes the main treatment design assumptions.
- Section 4 – Treatment Technologies Overview: Summarizes individual treatment technologies selected to meet the overall treatment objectives, as well as the available treatment technologies and their advantages and disadvantages. The results of this evaluation were used to develop a conceptual treatment process.

- Section 5 – Conceptual Treatment Process Overview: Provides the design basis developed for the conceptual treatment process.
- Section 6 – Site Selection and Layout: Provides the proposed site layout.
- Section 7 – Opinion of Probable Costs: Provides cost estimates for capital and operational expenditures.
- Section 8 – Summary and Recommendations: Provides a summary and conclusion for the treatment evaluation, and provides recommendations for further evaluation during the next phase of the project.
- Section 9 – Limitations: Describes the limitations of this evaluation.
- Section 10 – References: Lists the references used in this evaluation.

2. Background

This section focuses on compiling and summarizing the primary groundwater contamination data set extracted from various production and monitoring wells near the extraction wellfield. This section is a summary, and Section 3 further evaluates potential contaminants' treatment objectives.

The following information was retrieved and reviewed as part of the background water quality analysis:

- Data collected from the SWRCB's Groundwater Ambient Monitoring and Assessment (GAMA) centralized public water quality database (2023)
- *Regional Groundwater Monitoring Report Water Year: Central Basin and West Coast Basin Los Angeles County, California Water Year 2020-2021* (WRD 2022)

2.1 Proposed Extraction Wellfield

Figure 2-1 shows the geographical location of the potential new extraction wellfield proposed for CB as part of the Joint MP (Jacobs 2022). The study identified eight distributed parcels spread across the DS 41 and Wellfield 7 areas to site eight extraction wells. Nine injection wells were spread across Figueroa Pump Station area, north of the extraction wells, so a minimum distance of 0.5 mile was maintained between the injection and extraction parcels so the recycled water in the aquifer had adequate residence time before extraction to comply with Title 22 requirements.

WRD has four regional nested groundwater monitoring wells surrounding the extraction wellfield area:

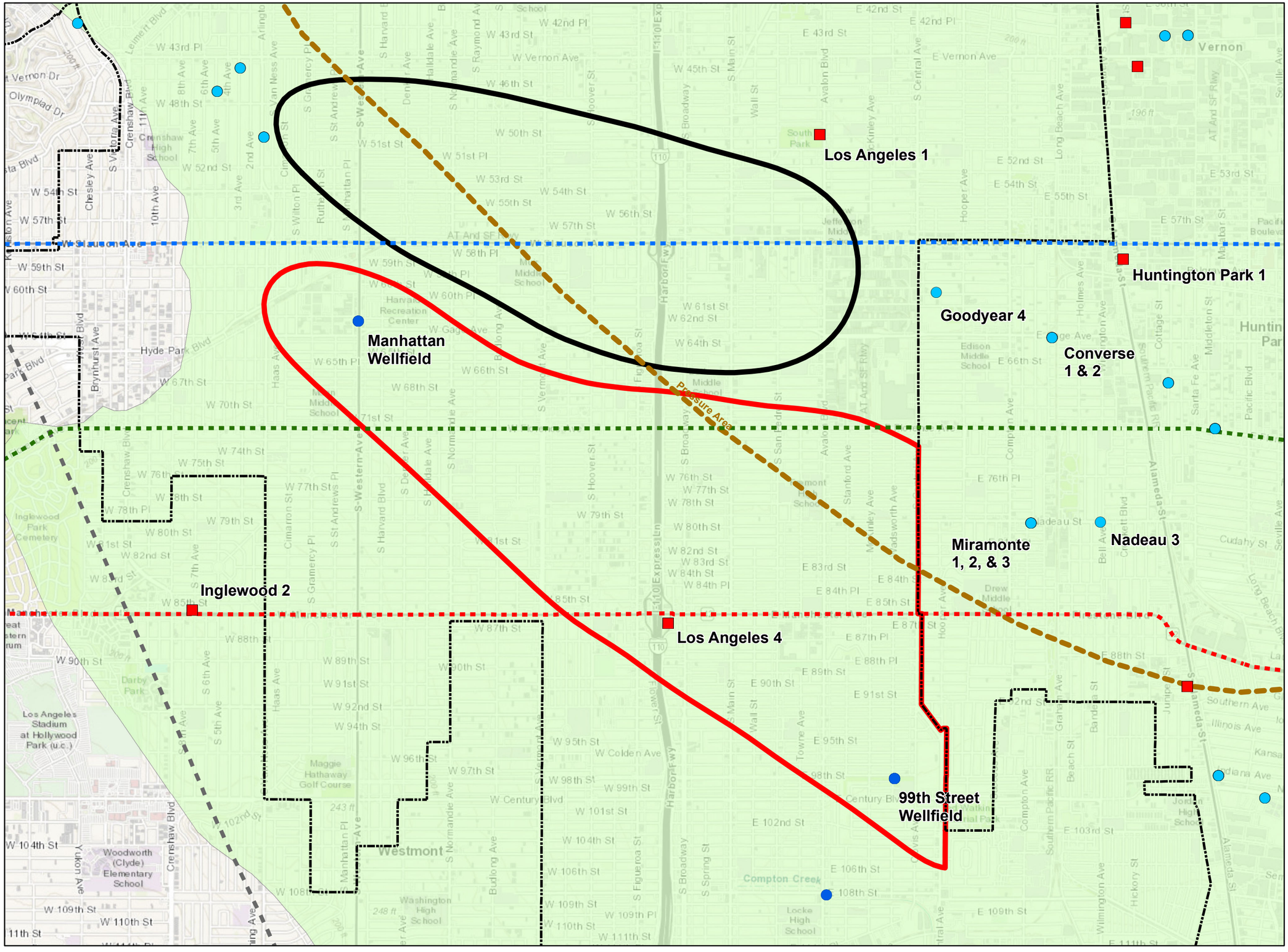
- Inglewood-2: Located southeast of the new extraction wellfield
- Huntington Park-1: Located in the Figueroa Pump Station area, north of the injection wellfield
- Los Angeles-1: Located in the Figueroa Pump Station area, north of the injection wellfield
- Los Angeles-4: Located to the south of Los Angeles-1 monitoring well within the proposed new extraction wellfield area.

The following production wells are located east of the new extraction wellfield:

- Converse 1 and 2
- Miramonte 1, 2, and 3
- Goodyear 4
- Nadeau 3

LADWP's Manhattan Wellfield is approximately 2 miles west of Figueroa Pump Station.

The data set extracted for the four nested WRD monitoring wells had different well depths, ranging from 114 to 1,780 feet below ground surface (bgs), with the deepest of the monitoring wells located at Los-Angeles-1. Information on depths of the production wells was not available; however, the deepest LADWP production well was at MH-PW-12, extending to 1,520 bgs (Jacobs 2022)


Los Angeles 1
Huntington Park 1
Goodyear 4
Converse
1 & 2
Manhattan
Wellfield
Pressure Area
Miramonte
1, 2, & 3
Nadeau 3
Inglewood 2
Los Angeles 4
99th Street
Wellfield
Vernon
Huntington Park
Westmont
Hyde Park Blvd
Crenshaw Blvd
Harbor Fwy
110 Expressway
Compton Creek
Los Angeles
Stadium
at Hollywood
Park (u.c.)
Woodworth
(Clyde)
Elementary
School
Maggie
Hathaway
Golf Course
Inglewood
Park
Cemetery
Darby
Park
Harvard
Recreation
Center
Crenshaw
High
School
Washington
High
School
Locke
High
School
Edison
Middle
School
Drew
Middle
School
Jefferson
Middle
School
Nevin
Middle
School
AT And SF Rlwy
Union Pacific RR
Southern Pacific RR
Century Blvd
Imperial Hwy
Florence Ave
Slauson Ave
Gage Ave
Olympiad Dr
Vernon Dr
Arlington Ave
Van Ness Ave
Western Ave
Harvard Blvd
Normandie Ave
Vermont Ave
Broadway
Main St
Wall St
Avalon Blvd
Central Ave
Alameda St
Long Beach Ave
Hooper Ave
Santa Fe Ave
Pacific Blvd
Middleton St
Cottage St
Holmes Ave
Compton Ave
Graham Ave
Beach St
Towne Ave
Stanford Ave
Munley Ave
Meadowbrook Ave
Bell Ave
Crossett Blvd
Cudahy St
Seville Ave
Jordan
High
School
Chesley Ave
Brynhurst Ave
West Blvd
Haas Ave
Budlong Ave
Figueroa St
Hoover St
Raymond Ave
Lemert Blvd
Crenshaw Blvd
Yukon Ave
Manhattan Pl
Cimarron St
Gramercy Pl
St Andrews Pl
Ruthelen St
Wilton Pl
Hobart Blvd
Denker Ave
Halldale Ave
Normandie Ave
Budlong Ave
Figueroa St
Hoover St
Broadway
Main St
Wall St
Avalon Blvd
Central Ave
Alameda St
Long Beach Ave
Hooper Ave
Santa Fe Ave
Pacific Blvd
Middleton St
Cottage St
Holmes Ave
Compton Ave
Graham Ave
Beach St
Towne Ave
Stanford Ave
Munley Ave
Meadowbrook Ave
Bell Ave
Crossett Blvd
Cudahy St
Seville Ave
Jordan
High
School
Chesley Ave
Brynhurst Ave
West Blvd
Haas Ave
Budlong Ave
Figueroa St
Hoover St
Raymond Ave
Lemert Blvd
Crenshaw Blvd
Yukon Ave
Manhattan Pl
Cimarron St
Gramercy Pl
St Andrews Pl
Ruthelen St
Wilton Pl
Hobart Blvd
Denker Ave
Halldale Ave
Normandie

2.2 Methodology and Assumptions

A historical groundwater quality data set was extracted for the four production wells and LADWP Manhattan Wellfields and qualitatively analyzed. The data set was queried and analyzed to identify potential contaminants that exceeded the regulatory Primary and Secondary MCLs. Contaminants that exceeded NLs and RLs were also flagged.

The following assumptions were applied during the evaluation of water quality data set:

- Because no water quality data were available near the new extraction wellfield locations, a qualitative evaluation of a water quality data set extracted from various production wells, the LADWP Manhattan Wellfield, and WRD monitoring wells was conducted.
- Water quality data for the past 10 years were considered (2012 to 2022).
- The water quality analysis for the locations was conducted without depth intervals of the wells, as several production wells in the GAMA database did not have depth information.
- The weighted average concentration was considered for nested production or monitoring wells. For example, water quality data from Converse 1 and Converse 2 production wells were considered as the weighted average of both wells.
- Contaminants were only queried from the data set if the average concentration of a contaminant was in exceedance of the regulatory MCL, per federal and state drinking water standards discussed in Section 1.3. A 90% confidence interval (CI) was selected for the range.
- Constituents less than the detection limit (or not analyzed) were not considered for further evaluation.

2.3 Groundwater Characterization and Potential Contaminant Identification

The Regional Groundwater Monitoring Program (RGWMP) monitors a network of 300 monitoring wells and reports the overall groundwater quality for CB and WCB. The main water quality parameters reported in the recent RGWMP Report (WRD 2022) and the monitoring data for LADWP's production wells (LADWP 2024b) were analyzed, including:

- Total dissolved solids (TDS)
- Iron
- Manganese
- TCE
- PCE
- Perchlorate
- Cr[VI]

Table 2-1 summarizes the potential contaminants from the qualitative evaluation of groundwater quality data that exceeded the regulatory MCLs for the production wells. The following observations were interpreted from the overall groundwater quality analysis in and around the extraction wellfield:

- TDS concentrations for the monitoring wells in CB are reported in the recent RGWMP Report (WRD 2022) to be relatively low. However, all the four production wells had TDS exceeding the SMCL of 500 mg/L.
- Iron concentrations exceeding the SMCL of 300 µg/L were observed in Los Angeles-4 (at a deeper depth interval of 1,500 feet), and remaining depths had less than 150 µg/L. Similarly, iron concentrations exceeded the SMCL in the production well Goodyear 4.

- Manganese is a common occurrence in groundwater across CB, and nearly 30% of the monitoring wells are reported in the recent RGWMP Report (WRD 2022) to have manganese concentrations exceeding the SMCL of 50 µg/L. The WRD monitoring wells, Huntington Park-1 and Los Angeles-4, show elevated (greater than 25 µg/L) manganese concentrations. Nested production well data for Converse 1 and 2 had manganese concentration exceeding the SMCL.
- TCE detections in the WRD monitoring wells were restricted to within and near the Los Angeles Forebay. Elevated TCE concentrations exceeding the MCL of 5 µg/L were observed at depth (between 100 and 600 feet) in Los Angeles-1 and Huntington Park-1 monitoring wells. TCE was detected at concentrations exceeding the MCL in three out of the four production wells:
  - Converse 1 and 2
  - Goodyear 4
  - Miramonte 1, 2, and 3
- Los Angeles-1 had a PCE detection between 2.5 and 5 µg/L at a shallow depth interval of 300 feet. At depths greater than 600 feet, less than 2.5 µg/L was reported for Los Angeles-1. PCE exceeded the MCL of 5 µg/L only in the nested data for the production wells Converse 1 and 2.
- 1,2-dichloroethane (1,2-DCA) and carbon tetrachloride (CCl_4) were detected exceeding the MCL of 0.5 µg/L in two out of the four production wells groups: (1) Converse 1 and 2 and (2) Miramonte 1, 2, and 3.
- Arsenic is reported in the recent RGWMP Report (WRD 2022) to be relatively low in concentration in most of the monitoring wells, except for a few in the southeastern portion of CB.
- Nitrate (as nitrogen) was reported in the recent RGWMP Report (WRD 2022) as only exceeding the MCL of 10 mg/L at a shallow depth of 300 feet in Los Angeles-1 monitoring well. None of the production wells had detections exceeding the MCL.
- Perchlorate was at concentrations greater than 3 µg/L for shallow depths (less than 300 feet) in Huntington Park-1 and Los Angeles-1; however, at lesser concentrations at deeper well depths. Perchlorate was found exceeding the MCL of 6 µg/L for two of the production wells: (1) Converse 1 and 2 and (2) Goodyear-4.
- The Cr[VI] concentration is reported in the recent RGWMP Report (WRD 2022) to be less than 5 µg/L in most of the monitoring wells, except for Los Angeles-1 detected at 40 µg/L (at depth intervals less than 600 feet). Total chromium exceeded the MCL of 50 µg/L only in Miramonte 1, 2, and 3., Cr[VI] was found exceeding the proposed MCL of 10 µg/L in Goodyear 4 and Miramonte 1, 2, and 3.
- 1,4-dioxane concentrations are reported in the recent RGWMP Report (WRD 2022) as not being detected in most of the monitoring wells; however, it was detected in Los Angeles-1 at less than 0.5 µg/L (less than the NL of 1 µg/L).
- Manhattan Wells experienced infrequent exceedances of MCL for TCE and SMCLs for iron and manganese between 2012 and 2022 (LADWP 2024b).

Based on the data analysis, the following contaminants exceeded MCLs and SMCLs in at least one of the production wells and were carried forward for treatment evaluations:

- VOCs:
  - 1,2-DCA
  - CCl_4
  - PCE
  - TCE

- Inorganic chemicals:
  - Total chromium and Cr[VI]
  - Perchlorate
  - Iron
  - Manganese

Although these contaminants were detected at concentrations exceeding the MCLs and SMCLs in nearby production wells owned by Golden State Water Company (Golden State), they still do not exceed the thresholds described in Section 1.1.2 that would result in trigging the 97-005 process. In an email communication between LADWP and Golden State, Golden State confirmed wellhead treatment is provided to address the exceedance, but the wells are not operated under the 97-005 process (LADWP 2022).

Table 2-1. Historical Water Quality Parameters of Concern for non-LADWP Production Wells and LADWP's Manhattan Wells

Parameters	Unit	MCL	MCL, Type	Average Concentration of Chemicals[a]				
				Converse 1 and 2[b]	Goodyear 4	Miramonte 1, 2, and 3[c]	Nadeau 3	LADWP Manhattan Wells
Distance from the Proposed Injection Wells	miles	-	-	1.1	1.0	0.7	1.0	1.3
1,2-DCA	µg/L	0.50	P	0.7±0.02	ND	0.5±0	ND	ND
CCl_4	µg/L	0.50	P	2.6±0.12	ND	1±0.06	ND	ND
PCE	µg/L	5	P	6±0.18	ND	ND	ND	ND
TCE	µg/L	5	P	45.9±2.1	21.4±0.8	7.3±0.5	3.7±0.1	3±0.8
Perchlorate	µg/L	6	P	7.6±0.1	29.5±0.5	4.1±0.4	ND	ND
Chromium	µg/L	50	P	ND	28.4±3.3	53±23.9	ND	ND
Cr[VI]	µg/L	10	P	7±0.2	19.1±14.7	27.3±21.6	ND	5.8±0.6
Iron	µg/L	300	S	ND	480±0	ND	ND	ND
Manganese	µg/L	50	S	110±0	29±0	ND	ND	32.2±5.1
Conductivity at 25°C	µS/cm	900	S	855.5±43.2	865±53.3	834.4±57.6	915±125	692.6±67.9
TDS	mg/L	500	S	543±14.5	535±48.7	520.5±22.1	508.3±43	429.2±37.5

[a]Average concentrations with ranges at 90% CI.

[b]Converse 1 and 2 wells provide a qualitative evaluation of the weighted average of Converse 1 and Converse 2.

[b]Miramonte 1, 2, and 3 wells provide a qualitative evaluation of the weighted average of Miramonte 1, Miramonte 2, and Miramonte 3.

[c]Manhattan Wells provides a qualitative evaluation of the weighted average of MW05, 06, 06A, 08, 10, 11, and 12.

Concentration > regulatory limit
Concentration < regulatory limit
Constituent ND

Notes:
- = not applicable
< = less than
> = greater than
°C = degree(s) Celsius
µS/cm = microsiemen(s) per centimeter
mg/L = milligram(s) per liter
ND = not detected
P = primary MCL
S = SMCL

3. Treatment Design Assumptions

This section describes the main treatment design assumptions for the conceptual treatment process developed.

3.1 Treatment Objectives

Based on the potential contaminants identified in Section 2.3, Table 3-1 lists the design influent and required effluent concentrations for the conceptual-level cost estimates.

Table 3-1. Treatment Objectives Assumptions

Parameters	Units	Design Influent Concentration[a]		MCL	Required Effluent Treatment Objectives[b]
		Production Wells	LADWP Manhattan Wells		
Iron, total[c]	µg/L	480	-	300 (S)	≤ 150
Manganese, total[c]	µg/L	110	37.3	50 (S)	≤ 25
1,2-DCA[d]	µg/L	0.7	-	0.5 (P)	≤ 0.25
CCl_4[d]	µg/L	2.7	-	0.5 (P)	≤ 0.25
PCE[d]	µg/L	6.2	-	5 (P)	≤ 2.5
TCE[d]	µg/L	48	3.8	5 (P)	≤ 2.5
Chromium, total[d]	µg/L	76.9	-	50 (P)	≤ 25
Cr[VI][e]	µg/L	48.9	6.4	10 (P)	≤ 5
Perchlorate[d]	µg/L	30	-	6 (P)	≤ 3
Viruses[f]	No unit	-	-	-	4 log

[a] Design influent concentration values are based on the maximum of the 90% CI of those contaminants identified in Table 2-1 that exceeded the MCL based on the water quality analysis of production and Manhattan wells.

[b] Operational objectives include that in at least 95% of the measurements less than 50% of the primary or secondary MCL should be achieved; however, it is noted that LADWP typically shuts off wells at an exceedance of 80% of regulatory limits.

[c] Aesthetic objective in accordance with the secondary MCL.

[d] Parameters are the identified contaminants that exceeded the MCL based on the water quality analysis of production and Manhattan wells.

[e] Proposed Cr[VI] MCL.

[f] Per the GWR (EPA 2000), the CT requirements for primary disinfection must achieve 4-log reduction for viruses.

Notes:

≤ = less than or equal to
CT = contact time
P = primary MCL
S = secondary MCL

3.2 Design Flow Rates

The treatment system sizing is based on a centralized treatment facility for the new extraction wells, having a design capacity of 28 cfs (18 MGD), as shown in Table 1-1.

4. Treatment Technologies Overview

This section discusses the individual treatment technologies selected to meet the overall treatment objectives described in Section 3.1. At this stage, the technology selections are based primarily on current best available technologies stated in CCR Title 22. The following technologies, when combined, can produce high-level treated water quality and operational flexibilities:

- **Adsorptive Filtration**: Provides improvements to iron and manganese removal through adsorption filtration technology.
- **Granular Activated Carbon (GAC) Contactors**: Provides improvements to VOC removal through sorption.
- **Ion Exchange (IX) Resin Sorption**: Provides improvements to the perchlorate and Cr[VI] removal (as a future option) through resin sorption.
- **Chlorination**: Provide a 4-log reduction of viruses required for primary disinfection through a chlorine contact tank (CCT).

4.1 Adsorptive Filtration Technology

Adsorption removes iron and manganese by the sorption of iron and manganese onto oxides on a media surface. The sorption mechanism occurs very quickly when the oxides are in an oxidized state. Both sorption kinetics and sorption capacity increase with increasing pH (Civardi and Tompeck 2015).

Several proprietary manganese dioxide-coated sand and ore-type catalytic adsorptive filtration technologies are readily available for iron and manganese removal. Typical media used include (Civardi and Tompeck 2015):

- Manganese greensand, an alumina-silicate mineral coated with a thin layer of manganese dioxide
- Pyrolusite, a naturally occurring manganese dioxide ore

Systems may be designed using either vertical or horizontal pressure filters, as well as gravity filters. The surface loading rate (SLR) can vary from 2 to 12 gallons per minute per square foot (gpm/ft^2), while pyrolusite filters can operate up to 15 gpm/ft^2. Many regulators allow the use of loading rate as high as 6 gpm/ft^2 without pilot testing (Civardi and Tompeck 2015).

An anthracite layer on top of a manganese greensand filter is often used to reduce solid load. An 18-inch depth of manganese greensand with an effective size of 0.3 to 0.35 millimeter (mm) may be provided. Pyrolusite bed depths range from 36 to 48 inches, with an effective size of 0.3 to 0.5 mm (Civardi and Tompeck 2015).

Pyrolusite provides 300 grains of oxidized iron and manganese per cubic foot of bed volume. Manganese greensand has 700 to 1,200 grains of oxidized iron and manganese per square foot of bed area, based on oxidant demand and operation. Both types of adsorptive filtration require media to be backwashed, with or without air scour. Because of the high specific gravity of pyrolusite of 4.0, it requires a higher backwash rate of up to 25 gpm/ft^2 necessary to fluidize the bed (Civardi and Tompeck 2015).

Chlorine or permanganate are the most common oxidants used for the continuous regeneration of the oxide surface, maintaining the media oxidation state, and promoting efficient manganese (Mn[II]) removal over an extended period. Generally, adsorptive removal does not require pH adjustment, contact time for pre-oxidation, or multiple chemical feeds unless permanganate is needed to mitigate the removal of naturally occurring silicate if the manganese is organically bounded. The media life is generally more than 10 years of service (Civardi and Tompeck 2015).

4.2 Granular Activated Carbon Contactors

GAC is a highly porous adsorbent media with a large surface area for adsorbing VOCs (Medina et al. 2022), including 1-2,DCA, CCl_4, TCE, and PCE identified in the water quality analysis. GAC and packed tower aeration (PTA) are the designated best available technologies for the regulated VOCs, per CCR Title 22.

The volume of water flowing through the GAC contactors (pressure vessels) can be quantified as the number of bed volumes treated. As the number of bed volumes increases, the mass transfer zone (MTZ) (that is, the location in the media column where VOCs are being removed from the water) progresses downward through the vessel. When the MTZ reaches the bottom of the vessel, VOCs will be detected in the treated water, resulting in breakthrough. When the media is saturated, the effluent concentration will equal the influent concentration (Medina et al. 2022).

Typically, GAC treatment systems for VOC removal are operated with two vessels in series (lead and lag configuration) so that the media in the lead vessel can reach a greater percent of saturation while maintaining nondetect levels in the lag vessel effluent (BWSP 2021). When breakthrough occurs, the spent media in the lead vessel is removed and replaced with new media, and the lead and lag configuration of the vessels is reversed.

Typically, a train is taken offline during media changeout; though if desired, the system could be designed to allow production from the lag vessel during changeout. Similar to the existing GAC system used by LADWP, the new media can be virgin GAC. The waste (used) media is removed by the vendor and regenerated offsite to destroy VOCs. The regenerated GAC can be returned to service within the drinking water plant, if preferred. The VOC concentrations from the lead and lag vessel effluent are monitored (laboratory analysis) to determine when to change out the media in the lead vessel.

The throughput (bed volumes treated until breakthrough) depends on the concentration of VOCs in the influent, as well as the concentration of competing adsorbents, such as natural organic matter. Breakthrough for three VOCs (1,2-DCA, vinyl chloride, and 1,1,1-trichloroethane) are predicted after a shorter bed volume of less than 3 months (Clark and Adams 1991). Based on the potential contaminants identified in Section 2.3, GAC throughputs for most VOC removal would typically range from 25,000 to 75,000 bed volumes, which is typically months to years of operation at design flow rates. An empty bed contact time (EBCT) of 7.5 to 10 minutes and SLR up to 10 gpm/ft^2 per vessel is proposed for this study.

4.3 Ion Exchange Resin Sorption

IX technology is used for treatment of groundwater and remediation purposes. IX resins are small beads made up of a polymeric material coated with either charged cations or anions. As water flows through an IX contactor, the ions on the resin (typically chloride ions) are replaced with target contaminants of the same charge. Several factors dictate the rate at which a contaminant is adsorbed (DoD 2002), such as:

- The concentration of the targeted contaminant ion in the water
- Resin selectivity
- The presence and concentration of competing ions
- Flow rate
- Resin bead size
- Diffusion characteristics of ions

The treatment of groundwater with perchlorate, chromium, and Cr[VI] can be achieved using various strong or weak anion resins, or selective anion resins (Frank 2002).

The adsorption of perchlorate to IX is a function of perchlorate anions captured on a positively charged resin. Strong base ion exchange (SBIX) resins are available in the market that have effectively demonstrated the ability to reduce perchlorate to less than 4 µg/L in drinking water applications (DoD 2002). Most technologies available are followed by resin regeneration to displace contaminant ions adsorbed on resin; however, waste brine produced is hazardous, and appropriate disposal is required.

Chromium exists primarily in trivalent (Cr[III]) or Cr[VI] oxidation states, with Cr[VI] as a chromate ion in basic solution and as dichromate ion in acidic solutions. SBIX has been used in the past for chromium treatment; however, it results in several hundred parts per billion (ppb) of chromate due to a hydrolysis reaction, which is influenced by pH (Frank 2002).

Weak-base anion resins exhibit low chromate leakage and are relatively unaffected by the presence of other anions, such as sulfates and chloride. However, the drawback of using this type of resin is the disposal of spent regenerant containing Cr[VI]. Recently, speciality resins using nonregenerable media have been developed by well-established resin manufacturers (Frank 2002) to selectively remove Cr[VI] at pH adjusted to less than 6.5.

As perchlorate, total chromium and Cr[VI] requires treatment using proprietary, nonregenerable resin media for each of the contaminants that are proposed as additional process components (if required). Water flows in down through the IX vessels typically operated in lead and lag configuration. The throughput (bed volumes treated until breakthrough) depends on the concentration of perchlorate and Cr[VI] ions as well as the concentration of competing compounds, such as:

- Total organic carbon (TOC)
- Sulfate
- Bicarbonate
- Nitrate

Based on the potential contaminants identified in Section 2.3, IX throughput for perchlorate treatment would typically range from 40,000 to less than 60,000 bed volumes, providing at least 4 months of operation at design flow rates. For chromium treatment, breakthrough with the provided background chemistry is estimated at around 3,700 bed volumes treated at a Cr[VI] inlet concentration of 27 ppb. That means the tanks will break through after operating for 1 week.

4.4 Chlorination

Chlorine is the primary disinfectant used in groundwater treatment to disinfect the water and maintain chlorine residuals as it travels through the distribution system. Aside from being a strong disinfectant, chlorine, when combined with a pretreatment process, such as adsorptive filtration, can facilitate effective oxidation of the following quality issues:

- Iron and manganese
- Color
- Dissolved organics
- Taste and odor
- Algal growth

Depending on temperature and pH of the water, chlorine addition to water forms hypochlorous acid (HOCl) and hypochlorite ions (OCl^-). Chlorination at a lower pH of 6.5 is preferred because HOCl is more effective in disinfection than OCl^-. It reacts with organics, inorganics, and microorganisms to satisfy the chlorine demand. Chlorine residual is the remaining free chlorine concentration available in the water that continues to provide disinfection. Inactivation is a function of chlorine residual and the amount of time the water spends in contact with the disinfectant before the first service condition, which is called "contact time" or CT.

The *Ground Water Rule* (GWR) (EPA 2000) encourages drinking water systems using groundwater to achieve a 4-log (or 99.99%) removal and inactivation of viruses. A CCT with baffles is typically designed to provide the required residence time for chlorine to meet CT requirements.

Commonly used chlorine compounds to form HOCl are chlorine gas, sodium hypochlorite, or calcium hypochlorite. Sodium hypochlorite solution typically contains 12.5% of available chlorine, with 1 gallon being equivalent to 1 pound (lb) of chlorine. The targeted free chlorine residual range for most systems should be 0.2 to 1.0 mg/L within the distribution system. At no time should the level be greater than 4.0 mg/L at the first service connection after the chlorination system (SWRCB 2018).

5. Conceptual Treatment Process Overview

This section provides the overall concept of how the system will be operated. This information serves as the basis for the development of a more detailed design and process narrative.

5.1 System Description

Figure 5-1 presents the schematic diagram of the conceptual treatment processes to treat raw water from the proposed extractions wells. The system consists of the following base components:

- Adsorptive filtration
- GAC
- CCT
- Fluoride and ammonia addition
- Backwash wastewater management

The filters for iron and manganese removal will be filled with adsorptive media that will be continuously regenerated with chlorine. A provision to direct treated water from GAC to an IX treatment unit (additional component, if required) will be provided. For that purpose, an intermediate pump station will be included to pump through the IX unit. The filtered water will the flow through the clearwell for primary disinfection. Fluoride will be added to the chlorinated water and will be pumped to the distribution system through high-lift pumps. Ammonia will be added at the high-lift pump discharge for secondary disinfection (chloramination) purposes. The filters will be backwashed using a treated water supply with help of backwash water supply pumps. The backwash wastewater will be collected in equalization tanks and will then be pumped into the existing sanitary sewer collection system, depending on the allowable discharge limit.

Each of the units would be configured using a pressure vessels configuration. During subsequent design stages, these assumptions can be reviewed; and the feasibility of using the existing raw water pumps to feed the adsorptive filtration, GAC, and CCT can be evaluated.

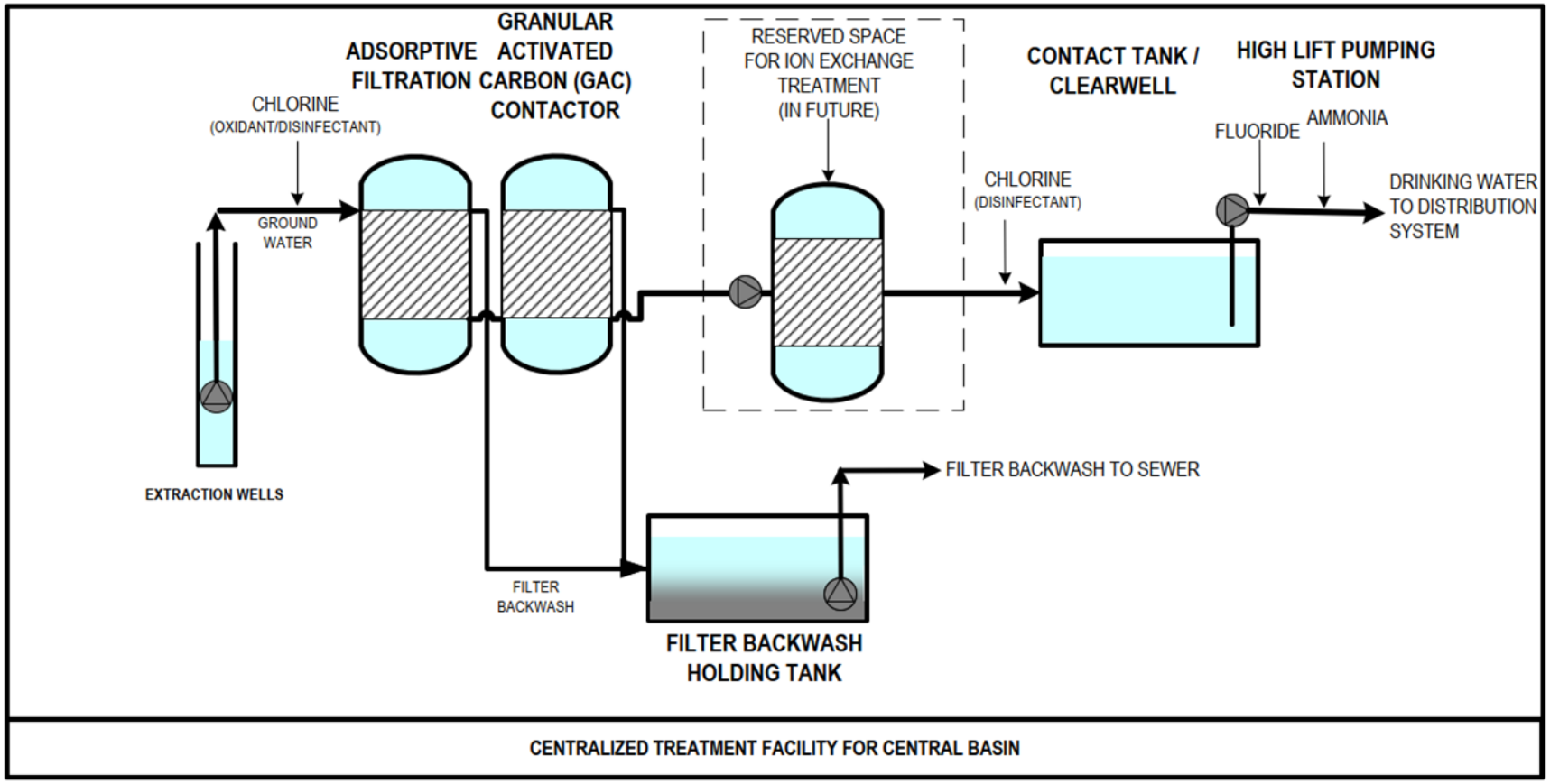


Figure 5-1. Conceptual Treatment Process Flow Diagram

5.2 Assumptions

The conceptual treatment process is based on the following assumptions:

- At this stage, the well pump capacity of the extraction wells is not available. It is assumed the well pumps will feed water through the filters.
- Base components include the following:
  - Filtration
  - GAC
  - Backwash wastewater equalization tank
  - Clearwell for virus inactivation
  - High-lift pump station
  - Chemical Building
- Potential additional components include an IX system (for perchlorate, total chromium, and Cr[VI] removal) and an intermediate pump station to feed the IX system.
- At this stage, the flow variation from demand in the distribution system is not available. The elevation of the distribution system and discharge head pressure are not available. Suitable assumptions were made for design criteria, which must be verified during further evaluation and verified during detailed design.

5.3 Design Basis

At this stage, these criteria are based primarily on current industry best practices. The design basis is to be further evaluated and verified during subsequent design assignments.

This section provides the design criteria for the conceptual treatment process developed.

5.3.1 Treatment Technologies

Pyrolusite media with a high SLR of 10 gpm/ft^2 was selected. A continuous, free chlorine residual of 1.0 mg/L will be provided as the regenerant. GAC includes a minimum EBCT of 8 minutes per vessel and an SLR of 9 gpm/ft^2. Two parallel IX systems are included for perchlorate and chromium treatment, with each system designed for an EBCT of 3 minutes and an SLR of 10 gpm/ft^2 per vessel. The IX system would use nonregenerable media.

Table 5-1 provides the proposed design criteria for adsorptive filtration, GAC, and IX treatment technologies.

Table 5-1. Design Criteria for Adsorptive Filtration, GAC, and IX Treatment

Description	Adsorptive Filtration System	GAC Sorption	IX Resin Sorption (Future)
Media	Pyrolusite	GAC	IX resin
Targeted contaminants	Iron and manganese	VOCs	Perchlorate, total chromium, and Cr[VI]
Design flow rate (MGD)	18	18	18
Type of filters	Pressure	Pressure	Pressure
Train configuration	Parallel	Lead and Lag	Parallel
No. of vessels (N+2)	14	30 (i.e., 15 lead-lag pairs)	24 (12 per treatment)

Description	Adsorptive Filtration System	GAC Sorption	IX Resin Sorption (Future)
Vessel diameter (feet)	12	12	12
Media depth (feet)	3.5	10	4.0
Individual filter area (ft^2)	113	113	113
EBCT per vessel (minutes)	2.5	8.0	3.0
SLR at design flow rate (gpm/ft^2)	10	9.0	10
Media required per vessel	400 ft^3	40,000 lb	440 ft^3
Building or enclosure required	No	No	No

Notes:

ft^2 =- square foot (feet)
ft^3 = cubic foot (feet)
No. = number

5.3.2 Backwash Residual Handling

Iron and manganese particles accumulate in the filter bed over time, and the filters need to be periodically backwashed with water to remove the accumulated particles. This generates a wastewater stream that needs to be managed and disposed of. The backwash wastewater will be directed to an equalization tank and pumped to the sanitary sewer collection system. In addition, the GAC contactors would require backwashing, although this would be required relatively less frequently because of higher water quality being fed through the pyrolusite filters. Backwashing may be required if the facility is shut down for an extended period (for example, more than a week) or if the pressure drop increases beyond an acceptable level.

Based on the raw water quality from Section 2, it is estimated that the daily backwash wastewater concentrations will have approximately 36 mg/L of iron, 7.0 mg/L of manganese, and 80 mg/L of total suspended solids. The backwash wastewater discharged to the Los Angeles sanitary system must comply with *Los Angeles Municipal Code* Section 64.30 for allowable industrial discharges. It is not anticipated that total suspended solids in the backwash wastewater will exceed the discharge limits of 150 mg/L. The characteristics of backwash wastewater must be further evaluated during detailed design.

Table 5-2 summarizes the residual management system design criteria, assuming pyrolusite filters in operation will be backwashed every 24 hours, and the volume of each backwash will be transferred to the sanitary sewer over an 8-hour period.

Table 5-2. Residual Management System Design Criteria and Sizing

Description	Adsorptive Filtration System	GAC Sorption
Media	Pyrolusite	GAC
Backwash frequency (hr)	24	732
Backwash supply loading rate (gpm/ft^2)	28	9
Total backwash volume per vessel (gallons)	43,000	20,000
Recommended equalization tank volume (gallons)	100,000	
Flow to sewage system (pumped) (gpm)	300	
No. of submersible backwash wastewater pumps	2	
Preliminary total power requirement estimate (kW)	10	

Notes:

gpm = gallon(s) per minute
hr = hour(s)

Assumptions

Assumptions for the residual management system include the following:

- There will be continuous pumping of wastewater to the sewer at 300 gpm, depending on the allowable discharge limit; a permit may be required for higher flow discharge.
- Equalization volume and pumping flow to be confirmed with the LADWP based on sanitary sewer system capacity constraints.
- Backwash volume includes high-rate backwash; a provision for filter to waste is included.
- No decanting of sludge produced from backwash water or any ancillaries for sludge collection are considered at this stage of design.

5.3.3 Chlorine Contact Tank

Per the GWR (EPA 2000), the clearwell is designed so at least 4-log reduction of viruses is provided through a disinfection process.

This TM assumes the CCT will provide additional storage volume for operational usage. However, additional onsite storage must be evaluated during further design assignments.

Table 5-3 shows the design criteria to achieve the CT requirements.

Table 5-3. Design Criteria for Chlorine Contact Tank

Description	CCT
Type of CCT	Rectangular[a]
Design flow rate (MGD)	18
Estimated length (feet)	87
Estimated width (feet)	87
Estimated depth (feet)	12
Disinfection contact volume (ft^3)[b]	39,000
Additional operational storage[c]	630,000
Total storage volume	669,000

[a]CCT includes baffles with a baffling factor of 0.5.

[b]Disinfection contact volume to meet 4-log virus inactivation at 18 degrees Celsius (°C).

[c]Operational storage accounts for backwash supply and water balance, assuming 30 minutes.

5.3.4 Pump Stations

A high-lift pump station is required to meet the distribution system demands. An intermediate pump station would be necessary to feed the IX system (proposed additional component). At this stage, the flow variation from demand in the distribution system is not available. The elevation of the distribution system or discharge head pressure are also not available. Suitable assumptions were made for the design criteria, which must be further evaluated and verified during detailed design.

Table 5-4 summarizes the design criteria for the high-lift pump station.

Table 5-4. Design Criteria for High-Lift Pump Station

Description	High-Lift Pump Station[a]	Intermediate Pump Station[b]
Type of pump station	Horizontal centrifugal	Vertical turbine
Design flow rate (MGD)	18	18
No. of high-lift pumps	4 duty, 1 standby	4 duty, 1 standby
Pumping capacity of each pump (gpm)	3,250	3,250
Preliminary total power requirement (kW)	200	200

[a]Assumes a discharge head of 80 psi at the distribution system.

[b]Assumes 60 psi of head at the discharge of the intermediate pump station due to IX system, CCT, and pipe friction.

Note:

psi = pound(s) per square inch

5.3.5 Chemical Supply and Feed Systems

Three liquid chemicals were selected:

- 12.5% sodium hypochlorite for oxidation and primary disinfection
- 18.2% hydrofluorosilicic acid for fluoridation
- 12% ammonium sulfate for chloramination

A Chemical Building is proposed to maintain the chemicals in a single area. Bulk storage tanks and dosing pumps will be required.

The liquid chlorine feed system will be provided for the continuous regeneration of the filter media (oxidant), and primary and secondary disinfection. Chlorine will be injected into the raw water header before the adsorptive filtration vessels and adjusted to achieve the current free chlorine residual target at the outlet of the existing CCT. The ammonium sulfate system will be used with the chlorine system to produce chloramine for secondary disinfection. The fluoridation system will provide fluoride addition in the distribution system.

Table 5-5 summarizes the design criteria used to size the chemical storage and meter pumping system.

Table 5-5. Design Criteria for Chemical Storage and Meter Pumping

Bulk Chemical Storage Tank	Design Capacity for 30-day Storage (gallons)	No. of Tanks	No. of Pumps
Sodium hypochlorite (12.5%)	5,000	1	4 duty and 2 standby
Ammonium sulfate (12%)	5,000	1	1 duty and 1 standby
Hydrofluorosilicic acid (18.2%)	8,000	1 bulk and 1 day tank	1 duty and 1 standby

Assumptions

Chemical storage and meter pumping assumptions include the following:

- The target oxidant dose required to continuously regenerate the adsorptive media was kept at 1 mg/L of chlorine residual.
- A free residual chlorine between 1.0 and 2.5 mg/L was targeted for primary disinfection.
- A ratio of 4.5:1 of free chlorine to ammonia as nitrogen (NH_3-N) was set to determine the ammonium sulfate target dosage, such that a chloramine residual target of 2.0 to 3.0 mg/L at the entry point of the distribution system, and at least 2 mg/L in the distribution system was assumed to prevent nitrification issues (AWWA 2013). Per CCR Title 22, the maximum residual disinfectant level for chlorine was assumed at 4 mg/L (as free chlorine).

- Per Title 22, an optimal fluoride level of 0.7 mg/L was targeted.
- The storage capacity is calculated for each bulk chemical tank based on the average design flow rate and assumed chemical doses.
- The design capacity of each pump was estimated for the assumed maximum chemical dose.

5.3.6 Treated Water Quality

The treated water from the proposed facility must meet federal and state drinking water standards set by EPA and SWRCB-DDW.

6. Site Selection and Layout

This section provides information about the conceptual-level site layout developed based on the design criteria for each of the proposed treatment processes evaluated for a design capacity of 28 cfs (18 MGD).

It is noted that the 2022 assumptions on the extraction flow rates from groundwater augmentation provided by LADWP were higher at 40 cfs (26 MGD) than the February 2024 estimates at 28 cfs (18 MGD). A treatment site selection evaluation was conducted in 2022 based on the system sizing and layout developed at that time using a flow rate of 40 cfs (26 MGD). The layout presented in this section is based on the 40 cfs (26 MGD) layout, but with a reduced footprint for each unit process based on a treatment flow rate of 28 cfs (18 MGD) without further optimization.

It is understood that LADWP would need to further evaluate the potential available real estate for the treatment facility and that the sites identified by LADWP and presented in this TM might become unavailable when this project is in the implementation phase. The treatment processes and layout will be refined further during project implementation.

6.1 Space Requirement

The footprint estimates for the base and additional components were developed using Jacobs' Replica Parametric Design (RPD) tool. Table 6-1 provides a breakdown of the estimated footprint required for the base components and potential additional components.

Table 6-1. Footprint Requirements for the Centralized Water Treatment Facility

Conceptual Treatment Process	Footprint Estimates (ft^2)
Base Components:	
Adsorptive Pyrolusite Filters (16 vessels) (N+2)	7,390
GAC System (15 pairs of lead-lag vessels) (N+1)	12,440
Backwash Wastewater Equalization Tank (depends on allowable discharge limits)	700
Clearwell and CCT (rectangular baffled tank for 4-log virus inactivation + operational volumes)	7,600
Pump Station (including pumps, surge protection, and electrical room)	5,310
Chemical Building (for chlorine, fluoridation, ammonium sulfate)	4,310
Administrative and Office Building	1,000
Potential Additional Components:	
IX System (12 vessels per treatment) (N+2)	10,240
Intermediate Pump Station (including pumps and electrical room)	2,300
Subtotal – Footprint Estimate (including future requirement)	51,290

Assumptions

The facility footprint assumptions include the following:

- The Centralized Treatment Facility will have a capacity of 28 cfs (18 MGD).
- Base components include:
  - Adsorptive filtration
  - GAC contactors
  - CCT for virus inactivation
  - High-lift pump station
  - Chemical and Administrative Buildings

- Potential additional components include an IX System (for perchlorate and Cr[VI] removal) and intermediate pump station.
- Treatment processes are not in the building.

6.2 Treatment Site Selection

Four potential sites recommended by LADWP were evaluated for the feasibility of the proposed layout of the conceptual treatment processes. As presented in Annex A, Treatment Site 1 and 2 were located north of the extraction wells, near each other at 5215 and 5260 Figueroa Street. The estimated footprint for Treatment Sites 1 and 2 were 13,000 and 32,300 ft^2, respectively.

Treatment Site 3 was located south of the extraction wells at 949 West 85th Street and had approximately 11,400 $ft^2$of available space. Treatment Site 4 was located northwest of the extraction well, at the intersection of West 60th Street and South Western Avenue, approximately 2 blocks north of Manhattan Wellfields.

Except for Treatment Site 4, there was not enough space in the remaining three sites to accommodate the required footprint of 51,210 ft^2. The site is in an industrial neighborhood, with an estimated total parcel area of 120,000 ft^2, which will adequately meet the space requirement for the proposed treatment. Although further away from the proposed extraction wellfields, the Treatment Site 4 was considered due to the space available.

6.3 Potential Site Layout

Figure 6-1 shows a new facility for the anticipated treatment process at Treatment Site 4. Figure 6-1 is a conceptual layout at this stage. The exact location and layout must be evaluated during detailed design.

The following assumptions and limitations were identified for the conceptual layout.

- A centralized treatment facility of 28 cfs (18 MGD) capacity was assumed. The treatment facility will house both base and additional components, including:
  - Adsorptive (pyrolusite) filters
  - GAC
  - IX (future)
  - CCT
  - Chemical Building
  - Pump stations
- Pyrolusite filters and GAC were assumed adjacent to each other. The configuration of other treatment processes (for example, IX, CCT) were adjusted to best fit the site layout.
- Treatment processes are not in the building, except for the Chemical and Administrative Buildings. Restrictions on the height of any proposed treatment must be verified.
- A Chemical Building for the entire facility is assumed at the southwestern entrance, located between the filtration and IX system. To make this location accessible for chemical loading and unloading operations, a ring road is recommended for trucks.
- The entrance to the treatment facility is assumed further along West 60th Street (southwestern entrance).
- Conveyance of raw water from the proposed extraction wellfield is not evaluated in this TM. It is assumed that the hydraulic integration between the proposed water treatment facility and the existing water main occurs at the intersection of West 60th Street and South Western Avenue. Raw water is

assumed to enter the facility through the southwestern entrance. Water main diameters and connection points to be confirmed at a later stage based on hydraulic analysis.

- It is assumed that the hydraulic integration between the high-lift pump station and the LADWP distribution system occurs at the intersection of West 60th Street and South Western Avenue. Transmission main diameters and connection points to be confirmed at a later stage based on hydraulic analysis.
- It is assumed that the clean water required for intermittent operational backwash of pyrolusite filters and GAC will be supplied from the CCT.
- There is sanitary sewer system infrastructure available along West 60th Street and South Western Avenue. Connections to the sewer system must be evaluated.
- A 100,000-gallon equalization tank was assumed in the corner of pyrolusite filters, close to a sanitary sewer system. The discharge rate and characteristics of backwash must be further evaluated and verified during detailed design. Discharge to the sewer system is assumed at a flow rate of 300 gpm; however, the existing sewer discharge limitation must be verified. This may require significant sewer system improvements to accommodate the increased waste discharge flow.
- Power requirements were not evaluated in this TM. They must be verified during detailed design.

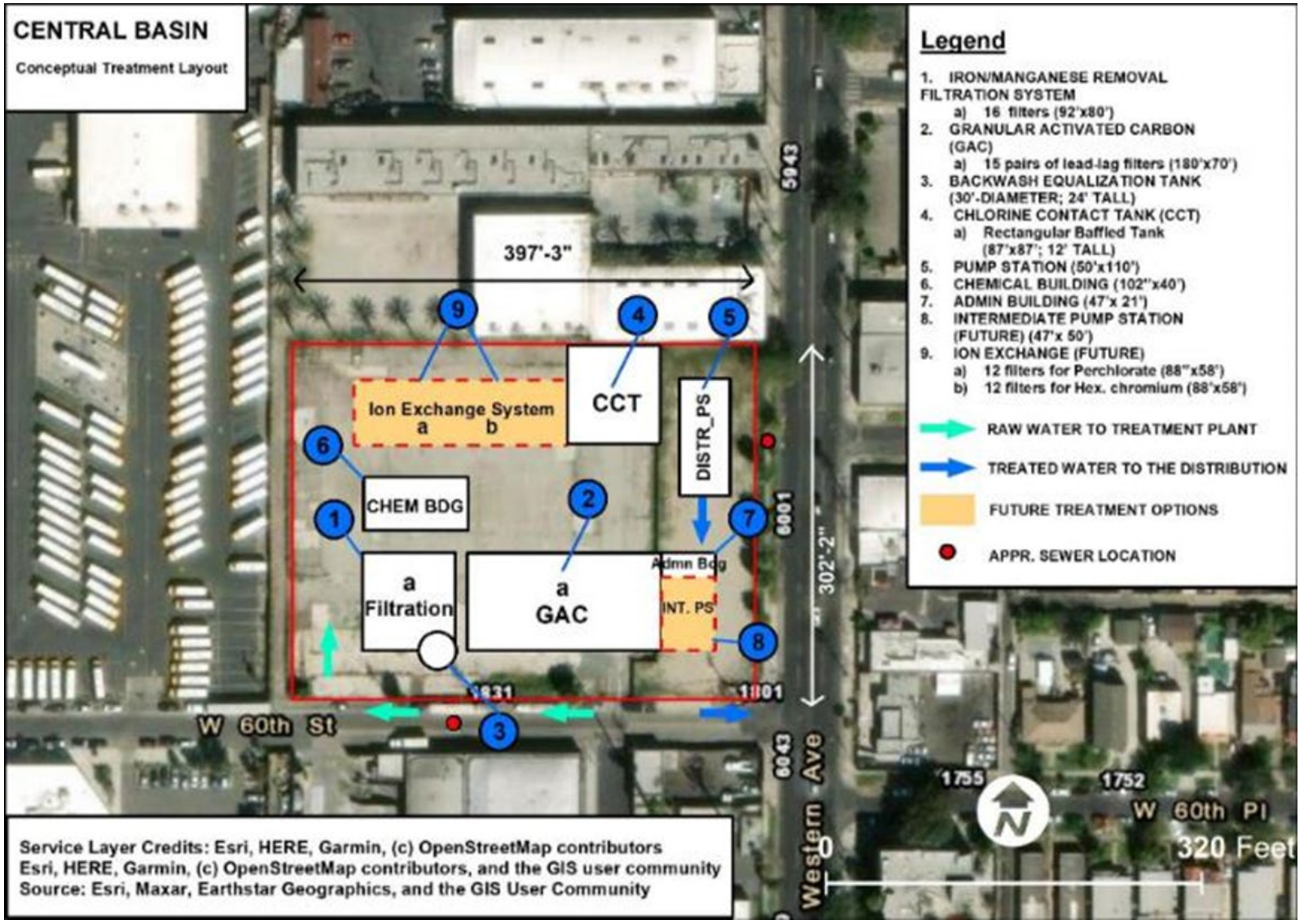


Figure 6-1. Conceptual Treatment Layout

7. Opinion of Probable Costs

Construction costs for the conceptual treatment process were developed using Jacobs' RPD tool, which uses a database of actual project data, typical design values, and quantity takeoffs to develop conceptual cost estimates. Unit process modules within RPD are based on actual equipment and installation costs from Jacobs' projects supplemented by RSMeans and Richardson's cost data.

Table 7-1 provides the capital cost and operations and maintenance (O&M) cost estimates for the treatment systems in 2024 dollars. For this Class 5 level estimate, the typical expected accuracy range is -20 to -50% on the low side and +30 to +100% on the high side for concept screening based on gross unit costs and parametric modeling techniques, for a project definition level up to 2%. The accuracy tightens as the project definition evolves. Annex B provides details about capital and O&M costs. A net present value (NPV) is also provided for comparison and to aid in the decision. The NPV considers O&M costs over a 30-year period at an annual interest rate of 4%.

Table 7-1. Cost Estimates for Conceptual Treatment Processes at Central Basin

Description	Low Range $ Millions	Estimated Cost $ Millions	High Range $ Millions
Capital Cost	164	234	351
Annual O&M Cost	4.6	5.7	7.4
NPV	420	-	768

Assumptions

The cost estimate was based on the following assumptions:

- Capital and operational costs were estimated only for the base components, including:
  - Adsorptive (pyrolusite) filters
  - GAC
  - Clearwell
  - High-lift pump station
  - Chemicals
- Costs are based on recent capital equipment quotes and engineers estimates. Building, infrastructure, utility, installation, and engineering costs are based on unit factors and percent of capital equipment. Extreme price escalations are not considered.
- No power supply or new substation included.
- Media and disposal costs based on recent costs obtained for other projects.
- Unit cost for chemicals based on the RPD tool.
- Permitting fees and regulatory agency coordination support are not included.
- Costs assume use of existing sewer sizing and capacity, which would need to be confirmed.
- Costs do not include site improvements, driveways, roads, or new landscaping.

8. Summary and Recommendations

This section provides the summary and recommendations for next steps.

8.1 Summary

The TM evaluated treatment options to guide an overall conceptual treatment process design for the proposed new extraction wellfield in CB. A desktop evaluation focused on characterization of the groundwater quality of the surrounding LADWP wellfield, production wells, and WRD monitoring wells and identified the main contaminants that exceeded the regulatory MCLs.

A treatment system was identified to address constituents that were identified exceeding MCLs and SMCLs, including:

- Iron
- Manganese
- VOCs
- Possibly perchlorate
- Chromium

A conceptual-level treatment train consisting of pyrolusite filters, GAC, IX (future), and CCT clearwell was developed and an associated footprint for a 28-cfs (18-MGD) treatment train was identified. LADWP provided four options for alternative sites. Of the potential sites, Treatment Site 4 (located northwest of the extraction wells, at the intersection of West 60th Street and South Western Avenue) was the only site large enough to accommodate the treatment.

As a part of this evaluation, conceptual-level (AACE International [AACE] Level 5) capital and O&M costs for the treatment systems were completed. The NPV was also calculated for O&M costs over a 30-year period at an annual interest rate of 4%.

The main findings from this TM are as follows:

- Water quality results analyzed from the historical data set suggested that the following compounds exceeded the primary MCLs:
  - VOCs:
    - 1,2-DCA
    - CCl_4
    - TCE
    - PCE
  - Inorganic contaminants:
    - Total chromium
    - Cr[VI]
    - Perchlorate
- Iron and manganese were identified as contaminants that exceeded the Secondary MCLs. The nine identified contaminants that exceeded primary MCLs and SMCLs were carried forward for treatment evaluations.
- Treatment technologies were selected based on the identified contaminants present in the groundwater analysis. The system consists of base components, including:
  - Adsorptive filtration
  - GAC

  - CCT
  - Fluoride and ammonia addition
  - Backwash wastewater management

  A provision was included to direct treated water from GAC to an IX treatment unit (additional component, if required) to treat perchlorate and chromium contaminants. For that purpose, an intermediate pump station will be included to pump through the IX system. CCT was provided for primary disinfection to achieve 4-log virus inactivation. Fluoride will be added to the chlorinated water and will be pumped to the distribution system through high-lift pumps. Ammonia will be added at the high-lift pump discharge for secondary disinfection (chloramination) purposes. The filters will be backwashed using treated water supply with the help of backwash water supply pumps. The backwash wastewater will be collected in equalization tanks and will be pumped into the existing sanitary sewer collection system, depending on the allowable discharge limit.

- The footprint for the water treatment facility is approximately 51,290 ft^2, which includes space for both base and additional process components. The total estimated capital cost (including contractor markups, engineering, and contingency) for base components is approximately $140.0 million. The estimated annual O&M cost is $4.2 million in 2024 dollars.

8.2 Recommendations

Groundwater quality can be temporally and spatially variable, because different aquifer and aquitard zones within the groundwater basin may contain different levels of contamination. Therefore, groundwater quality impacts on the proposed extraction wellfield must be evaluated in detail during the subsequent detailed design. The installation of new monitoring wells may be required to collect groundwater information to validate the water quality in the proposed injection and extraction locations.

Pilot testing of each treatment unit operation is recommended to determine the best operational parameters before full-scale plant design is completed.

9. Limitations

This report has been prepared in accordance with generally accepted environmental engineering practices and is intended for the sole and exclusive use of LADWP. This report is not for the benefit of a third party and may not be distributed to, disclosed to, used by, or relied upon by a third party without prior written consent of Jacobs, which consent may be withheld in our sole discretion.

Use of this report or the information contained herein, if by a party other than LADWP, will be at the sole risk of such party and will constitute a release and agreement by such party to defend and indemnify Jacobs and our affiliates, officers, employees, and subcontractors from and against liability for direct, indirect, incidental, consequential, or special loss or damage or other liability arising from use of the report or reliance upon its content. To the maximum extent permitted by law, such release from and indemnification against liability will apply in contract, tort (including negligence), strict liability, or other theory of liability.

This is a technical report and is not a legal representation or interpretation of environmental laws, rules, regulations, or policies of governmental agencies.

All findings and conclusions stated in this report are based on facts and circumstances as they existed during the investigation. Any changes in fact or circumstances upon which the report was based may change the findings reported. Jacobs cannot report on, or accurately predict, events that may change the site conditions after the described investigation was completed.

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Annex A.
Potential Treatment Site Locations

Treatment Site Selection

Figure A-1 shows the four potential sites evaluated for the feasibility of the proposed layout of the conceptual treatment processes.

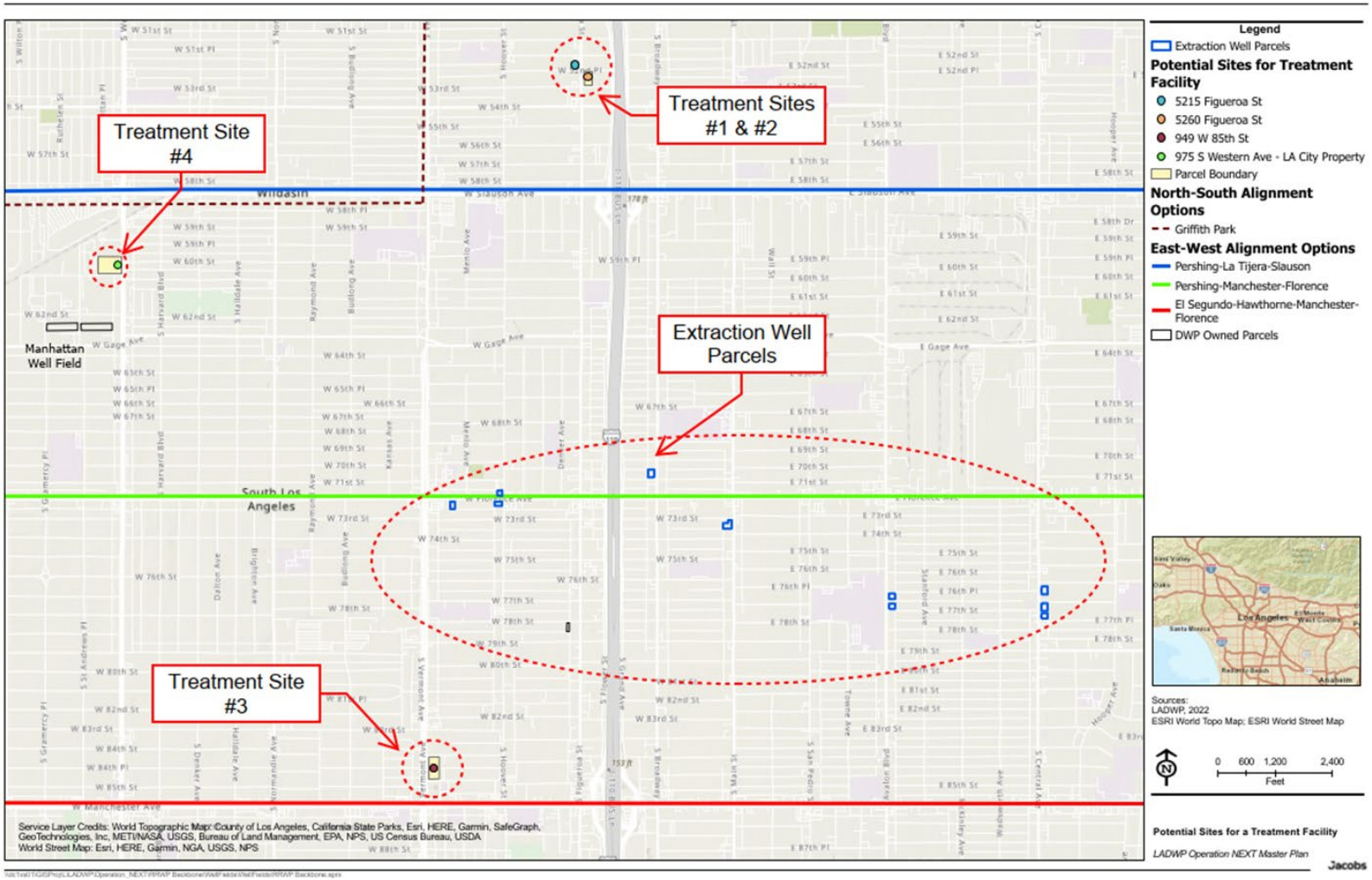

Figure A-1. Four Potential Sites Evaluated for the Proposed Conceptual Treatment Processes Layout.

Treatment Sites 1 and 2

Figure A-2 provides geographical location of Treatment Sites 1 and 2 in proximity to each other at 5215 and 5260 Figueroa Street.

Figure A-2. Geographical Location and Approximate Footprint of Treatment Sites 1 and 2

Treatment Site 3

Figure A-3 provides geographical location of Treatment Site 3 located south of the extraction wells at 949 West 85th Street.

Figure A-3. Geographical Location and Approximate Footprint of Treatment Site 3

Figure A-4 provides geographical location of Treatment Site 4 located northwest of the extraction well, at the intersection of West 60th Street and South Western Avenue.

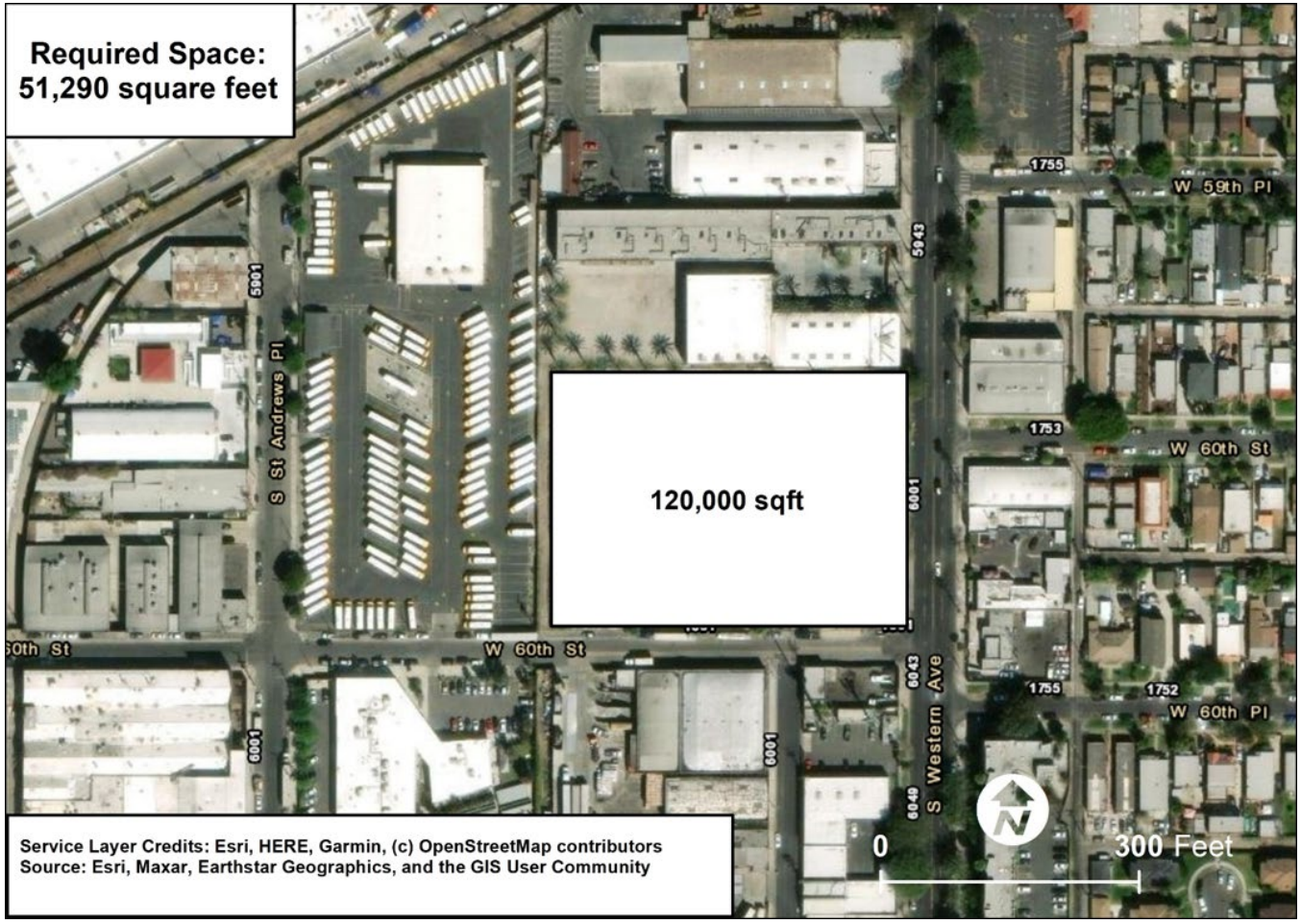

Figure A-4. Geographical Location and Approximate Footprint of Treatment Site 4

Annex B.
Cost Breakdown

Table B-1 provides the Pure Water Los Angeles capital cost estimate at a treatment capacity flow of 18 MGD.

Table B-1. Capital Cost Estimate

Description	Cost Estimate, $ (in 2024 US Dollars)
High-rate Pressure Filters (18 vessels) (N+2)	11,101,000
GAC System (19 pairs of lead and lag vessels) (N+1)	23,568,000
Backwash Wastewater Equalization Tank (depends on allowable discharge limits)	282,000
Clearwell and CCT (rectangular baffled tank for 4-log virus inactivation + operational volumes)	1,514,000
Pump Station (including pumps, surge protection, and electrical room)	4,612,000
Chemical Building (for chlorine, fluoridation, and ammonium sulfate)	1,938,000
Overall Sitework (including yard piping and yard electrical)	9,895,000
PLC, Networking, and Communications Upgrade Allowance	2,581,000
Total Equipment and Installation Costs	**55,491,000**
Tax (applied to 40% of Total Project Cost)	2,108,658
Location Adjustment Factor (112.9)	65,030,014
Mobilization (5%)	3,251,501
General Conditions (10%)	6,503,001
Art and Permit Fees (LADBS) (3%)	1,950,900
Complexity Index (Risk Contingency) (10%)	6,503,001
Bonds and Insurance (3%)	2,497,153
Profit (10%)	8,323,842
Project Definition (Class V) (45%)	42,326,735
Design-Build Factor (15%)	20,457,922
Construction Costs	**156,844,070**
Program and Project Management (10%)	15,684,407
Planning (1%)	1,568,441
Design Engineering (10%)	15,684,407
Services During Construction (5%)	7,842,203
Bid & Award (0.5%)	784,220
Startup and Commissioning (0.5%)	784,220
Post-Construction (1%)	1,568,441
Construction Management (15%)	23,526,610
Land and ROW	10,000,000
Non-Construction Costs	**77,442,950**
Total – Capital Cost Estimate	**234,287,020**
AACE Level Low Range (-30%)	164,000,914
AACE Level Low Range (+50%)	351,430,530

Notes:
AACE = AACE International
CCT = chlorine contact tank
GAC = granular activated carbon
PLC = programmable logic controller

Operations and Maintenance Cost

Table B-2 provides the Pure Water Los Angeles operations and maintenance (O&M) cost estimate at a treatment capacity flow of 18 MGD.

Table B-2. Operations and Maintenance Cost Estimate

Item	Quantity	Unit	Unit Cost	Unit	Annual Cost (in 2024 USD)
Power	1,540	kW	$0.185	kW-hr	2,087,000
GAC Media Replacement	336,000	lb	$3.3	$/lb	1,092,000
Pyrolusite Media Replacement	242,103	lb	$0.5	$/lb	123,522
Sodium Hypochlorite	77,775	lb/yr	$1.2	$/lb	96,045
Hydrofluorosilicic Acid	12,810	lb/yr	$3.0	$/lb	38,865
Ammonium Sulfate	57,950	lb/yr	$1.4	$/lb	83,527
Labor	3,440	hr	$130	$/hr	447,200
Equipment Maintenance	1% of equipment cost per year		1% of equipment cost		263,000
Total Annual Operating Cost					4,231,160
With Contingency			35%		5,712,066
AACE Level	5		-20%	to	30%
Contingency Range	Low				
Total Estimated O&M Cost			4,569,653	to	7,425,686

Notes:

AACE = AACE International
GAC = granular activated carbon
hr = hour(s)
kW = kilowatt(s)
kW-hr = kilowatt-hour(s)
lb/yr = pound(s) per year
USD = U.S. dollars

Assumptions

O&M assumptions include the following:

- Assumed the plant is operational for 10 months with 28 cfs (18 MGD) flow capacity.
- No feed supply pump included; 200 kW for each of 5 high-lift pumps and 100 kW for 2 backwash supply pumps; 5 kW each for each of 2 backwash wastewater pumps.
- GAC media replacement is assumed twice a year, and media replacement assumes GAC is reactivated.
- Pyrolusite media replacement is assumed once in 20 years.
- Unit cost of chemicals were estimated using RPD.
- Labor assumes 40 hours per week average for two full-time operators.
- Excludes process control operational sampling.
- 1% of equipment cost per year (estimated from Replica Parametric Design System).

Attachment C
Pure Water Los Angeles Conveyance Alignment Review

Pure Water Los Angeles Conveyance Alignment Review

Document No.: 231120101322_b513ef7a
Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan Project
June 26, 2024

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Acronyms and Abbreviations

°	degree(s)
ATRW	advanced treated recycled water
AWWA	American Water Works Association
Blvd.	boulevard
Caltrans	California Department of Transportation
EPB	earth pressure balance
HRWP	Hyperion Water Reclamation Plant
I-	Interstate #
LA Metro	Los Angeles County Metropolitan Transportation Authority
LAAFP	Los Angeles Aqueduct Filtration Plant
LADWP	Los Angeles Department of Water and Power
PWSC	Pure Water Southern California
ROW	right-of-way
RRWP	Regional Recycled Water Program
SoCalGas	Southern California Gas Company
TBM	tunnel boring machine
WRP	water reclamation plant
WSP	welded steel pipe
WWTP	wastewater treatment plant

1. Introduction

Los Angeles Department of Water and Power (LADWP) has engaged Jacobs to develop the Pure Water Los Angeles Water Supply Program (Program) Master Plan. As part of the scope under Subtask 4 – Validation of Strategy of the Task Order Request for Proposal, Jacobs is required to: "*…validate the overall Program structure….conduct a cursory evaluation of the Program alignment and cost for the conveyance of water from Hyperion to LAAFP, and recommend potential alternatives.*"

This report provides general and specific observations from a review of the proposed conveyance alignments for the Program supplied to Jacobs in a .kmz file in May 2022. The .kmz file contains three generally west-to-east alignment options and three generally south-to-north alignment options connecting the Hyperion Water Reclamation Plant (HWRP) in the southwest (referred to as Hyperion WWTP in the .kmz file) to the Los Angeles Aqueduct Filtration Plant (LAAFP) in the north.

All six alignments branches reviewed are shown on Figure 1-1. This, along with the other images in this document, are shown with north oriented toward the top of the image. On all images, the original proposed alignments are shown in purple and potential alignment changes are shown in yellow.

In the analysis that follows, the alignments are reviewed geographically from north to south and west to east (left to right), which is a different orientation to the proposed flow rate.

A significant portion of the Program cost and schedule is attributed to the construction required for pipeline installation. The LADWP Concept Report used the assumptions presented in Table 1-1, based on past project experience (LADWP 2021).

Table 1-1. Assumed Open-cut and Tunneling Ratios in the LADWP Concept Report

Pipeline Diameter (inches)	Open-cut (%)	Tunneled (%)
< 24	100	0
24 to < 54	80	20
54 to < 72	70	30
> 72	15	85

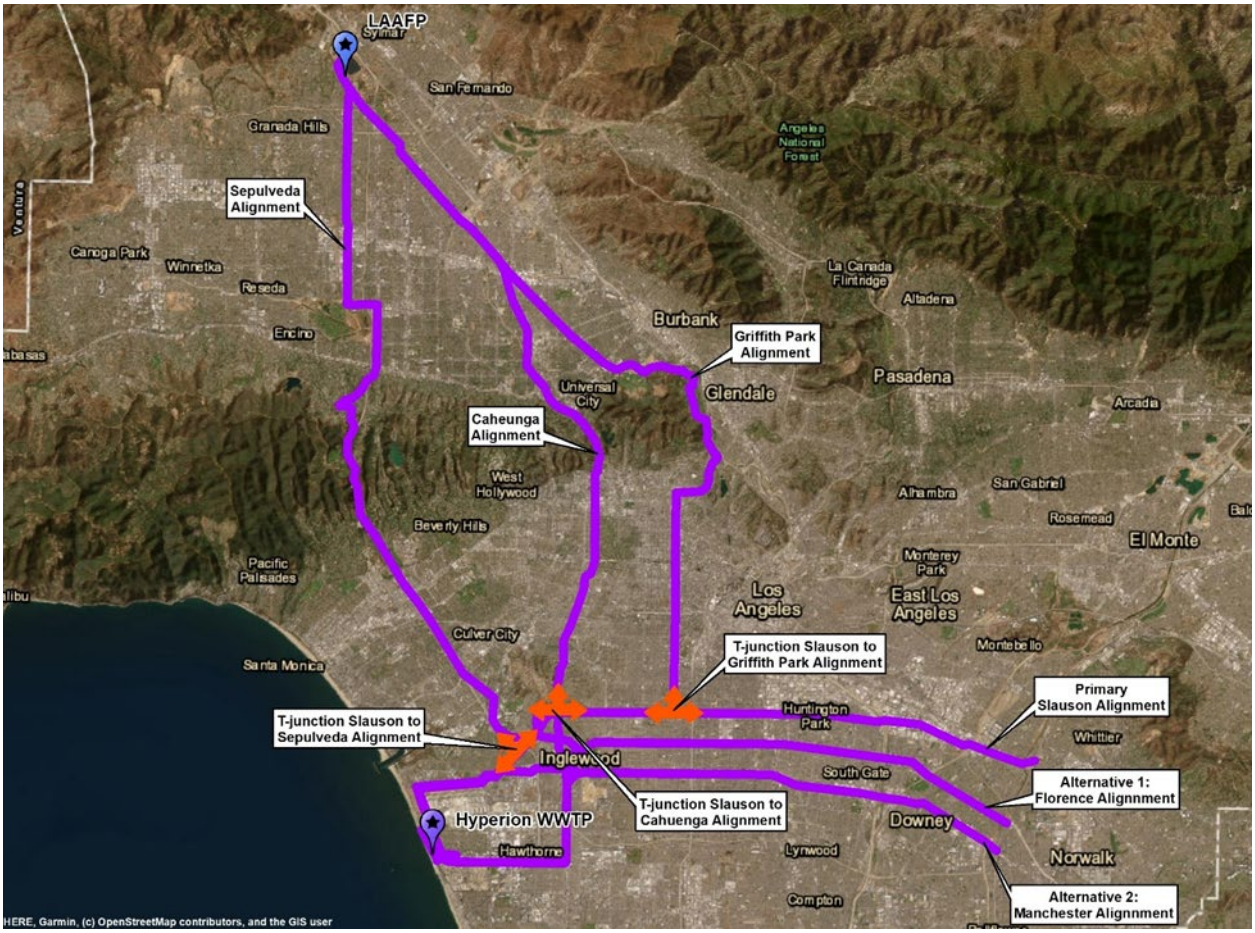

Figure 1-1. Proposed Alignment Options

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

1.1 Purpose and Study Limitations

This study aims to identify and quantify which sections of the alignment would most likely have to be tunneled and which sections could potentially be trenched, based on a review of the mapping information provided to validate or refine the ratios used in the LADWP Concept Report. The evaluation identifies the crossings required for each alignment and estimates the number of shafts required to construct tunneled sections and crossings but does not identify potential locations of those shafts.

This review does not constitute a routing study, nor is it intended to validate any of the proposed alignment options or propose a preferred alignment. No pipe diameter refinements or hydraulic analysis has been included as part of this review. No additional research has been conducted on the following topics:

- Geotechnical and ground conditions
- Specific construction methodologies
- Underground utilities and structures
- Rights-of-way (ROWs)
- Easements
- Land acquisitions
- Permitting

The review also does not account for traffic disruption, local community impacts, or environmental impacts, and does not evaluate or compare cost, schedule, and risk. Section 11 notes these and other observed data gaps for further consideration.

2. General Alignment Considerations

This section describes general alignment considerations but is independent of any agreements LADWP may have or may seek in the future with the owners of any parcels of land or specific infrastructure that the alignments cross.

2.1 Trenched or Tunneled Construction

Some sections of the proposed alignment options will have to be tunneled. These include crossings of infrastructure, such as:

- Freeways
- Railroads
- Certain street intersections
- Drainage channels
- In most cases, sections of the proposed alignments that pass below existing properties

While it may be possible to avoid some of these by adjusting the alignment, some crossings will be inevitable given the length and urban setting of the proposed pipeline. For these reasons, the need for a tunneled installation of a pipeline is often independent of the pipeline diameter.

Most of the other proposed alignment options could theoretically be trenched. These are typically sections that follow public roads. However, various factors need to be evaluated, and compared with the relative merits of tunneling to determine the preferred construction methodology. Some of the factors that should be considered include:

- Utility and existing infrastructure conflicts
- ROWs
- Easements
- Land acquisition
- Permitting
- Traffic disruption
- Local community impacts
- Environmental impacts
- Cost
- Schedule
- Risk

Similarly, in areas that could be predominantly trenched, but where numerous crossings would be required in short succession, it may be more efficient to tunnel the whole of the section. This has been conservatively assumed in the evaluation of each individual alignment.

Some sections of the proposed alignments include a tight angled bend or junction. To achieve these with tunnel construction, a shaft would be required at the bend or junction to facilitate the change in direction. At locations with small-radius bends or large available ROW, it may be possible to avoid the need for shafts by introducing a curve to the alignment, with a radius large enough for the anticipated tunneling equipment to achieve. Ideally, shafts would be avoided where reasonably practicable, because they would add cost to the project and may require additional property acquisition.

2.2 Crossings and Tunneled Sections

This section describes the crossings and tunneled sections.

2.2.1 Construction Methodology

Underground crossings and tunneled sections would be used to install the pipeline below infrastructure that could not efficiently be crossed by open-trench construction, such as roads, railroads, drainage channels, and other existing infrastructure.

It is understood that the desired pipe material is welded steel pipe (WSP). For corrosion control considerations, it is not advisable to directly jack WSP carrier pipe for trenchless installations. If direct jacking of carrier pipe is desired to reduce cost, concrete cylinder pipe conforming to the standards of American Water Works Association (AWWA) *C300-16, Reinforced Concrete Pressure Pipe, Steel-Cylinder Type* could be considered. Otherwise, the WSP carrier pipe must be installed within an initial ground support system installed using tunneling techniques.

For a carrier pipe to be installed within an initial ground support system, the system would typically be at least 6 inches larger in radius than the pipe to allow the manual installation of pipeline support blocks. Depending on the construction methodology, the clearance could be much greater.

Table 2-1 summarizes possible construction methodologies and initial liners for a variety of conditions. As a subsequent stage to this investigation, it is recommended to evaluate the length, ground conditions, and ground water level that can be expected at each crossing location or tunneled section to estimate the extent of each type of construction methodology and initial liner that could be expected.

Table 2-1. Possible Tunnel Construction Methodologies and Initial Linings for Various Conditions

Length	Ground Conditions	Tunnel Relative to Water Table	Construction Methodology	Initial Liner
< ~750 feet	Soil	Above	Open-face TBM	Pipe-jacked steel casing
		Below	Microtunneling or EPB	Pipe-jacked steel casing
	Rock	Above	Drill and blast or rock TBM	Rock bolts and shotcrete
		Below	Drill and blast or microtunneling	Rock bolts, grouting, shotcrete and waterproof lining
> ~750 feet	Soil	Above	Open-face TBM	Ribs and lagging or liner plate
		Below	EPB or slurry TBM	Precast concrete rings
	Rock	Above	Drill and blast	Rock bolts and shotcrete
		Below	Rock TBM	Precast concrete rings
Special Crossing (Caltrans, Railroad)	Soil	Above	Open-face TBM	Pipe-jacked steel casing
		Below	Microtunneling	Pipe-jacked steel casing
	Rock	Above	Rock TBM	Steel casing
		Below	Rock TBM	Steel casing

Notes:
~ = approximately
< = less than
> = greater than
EPB = earth pressure balance
TBM = tunnel boring machine

Open-face tunnel boring machines, also known as open shield machines, comprise a shield with no frontal ground support. The ground is excavated either manually or mechanically, using a digger arm or rotary header with an operator at the tunnel face. This is an effective solution for shorter lengths of tunnel in soft ground above the water table.

Microtunneling machines are remotely operated; hence, they are a common solution to construct tunnels where it is not possible to have an operator within the tunnel, typically due to their smaller size. They can be employed in both soft ground and hard rock and both above and below the water table.

EPB or slurry TBMs are typically larger in diameter and provide a pressurized face for good ground control during excavation. They are an effective solution for longer tunnel drives in soft ground, and they can be used above or below the water table.

Rock TBMs are similar to EPB TBMs, but are specifically designed to excavate rock. They are an effective solution for longer tunnel drives, and they can be used above the water table or can be pressurized for use below the water table.

Drill and blast is an alternative method for sequential excavation in hard rock. It can be a more effective solution in shorter length tunnels and can be applied above the groundwater table and, in some situations, also below the groundwater table with effective groundwater control.

A pipe-jacked steel casing initial liner would be installed from the launch shaft using hydraulic jacks to push the casing into the ground behind the tunneling machine. The steel casing would have to be designed to withstand the expected compressive forces. This is a common solution in soft ground.

Rock bolts and shotcrete can be used as an initial liner for crossings and tunnels excavated in rock. The rock bolts prevent any larger pieces of fractured rock from falling by tying them into the rock mass and the shotcrete provides overall stability and prevents smaller pieces of rock falling over time. In excavations where there is the potential for water ingress, a waterproof lining can be installed before the shotcrete. This type of lining can be used with either mechanized excavation or drill and blast methods.

Ribs and lagging are used as an initial lining by installing rings of wide-flange beams at regular spacing along the tunnel length and placing steel or wood lagging between the rings to provide ground support. They are typically used as an initial liner in soft ground and because there is no easy way to seal the lining, they are typically used above the water table.

Precast concrete rings can be used as both an initial liner and permanent lining, depending on the desired use. They can be reinforced or unreinforced and could be a whole ring; or, for larger-diameter tunnels, a ring can be made up of several segments. They are generally used with TBMs and can be made water-tight for use below the water table.

As a general rule, at shallow depths, soft ground can be expected in the San Fernando Valley and downtown sections of the alignments, whereas rock can be expected in the Santa Monica Mountains and foothills. A full geotechnical investigation would be required to understand and analyze the expected ground conditions, including ground water, gassy ground conditions that can be expected in some sections of the downtown portion of the alignment options and seismic risks.

2.2.2 Caltrans and Railroads

California Department of Transportation (Caltrans) will not permit pipe to be directly installed by tunneling methods below freeways or their connected on- and off-ramps. The same is true for railroad operators and their infrastructure. Instead, these agencies require a larger steel casing to be installed for the pipeline to be installed within.

Furthermore, these agencies generally will not permit longitudinal or angled crossings of their infrastructure, instead requiring a perpendicular crossing or as near to perpendicular as possible.

For these reasons, a launch and reception pit will be required adjacent to each crossing to facilitate the casing installation.

It is possible a waiver could be granted to tunnel obliquely beneath these assets if the crossing is at depth, but this should not be assumed and would need to be assessed on a case-by-case basis.

For sections of the alignment that pass below elevated Caltrans and railroad infrastructure, trenched construction may be possible to directly install a casing. These sections would typically be subject to a long permit process and should be assessed on a case-by-case basis.

The following sections describe Caltrans and railroad infrastructure that require special crossings, for each alignment option.

2.2.3 City Streets

Trenched and tunneled construction along city streets is typically not subject to the same restrictions as crossing below Caltrans infrastructure. However, the City and County of Los Angeles, as well as any other jurisdictions that the alignments pass through, should be consulted to understand any specific requirements.

Any alignment sections following city streets ROWs should be evaluated to determine whether trenched or tunneled construction is the most appropriate methodology.

Sections that are determined to be trenched may still require tunneled crossings at significant intersections. The following sections assess the number of significant intersections that would likely need a tunneled crossing, for each alignment option.

Significant intersections that could require tunneled crossings have the following characteristics:

- Multiple lanes in each direction
- Main thoroughfares
- Truck routes
- Intersections that connect to freeways
- Locations that would otherwise cut off access to a property

2.2.4 Drainage Channels

Drainage channel crossings are typically not subject to the same restrictions as Caltrans and railroad infrastructure, and can be tunneled below without the need for a launch and reception shaft immediately adjacent to the crossing. This should be confirmed with the infrastructure owner. Within the City of Los Angeles and Los Angeles County, most drainage channels are owned and operated by the Los Angeles County Flood Control District. There may also be some that fall under the jurisdiction of the U.S. Army Corps of Engineers.

The following sections assess the number of drainage channel crossings, for each alignment option.

2.2.5 Other Crossings

The following sections discuss other crossings unique to each alignment and their potential impacts, for each alignment option.

2.2.6 Crossing Summary

Where crossings occur in sections evaluated to be tunneled, those regarded as regular crossings would be constructed as part of the tunnel construction without the need for dedicated shafts or other special provisions. Any special crossings (Caltrans and railroad) within sections evaluated to be tunneled would require shafts at either side and immediately adjacent to the asset.

Any crossings identified in sections to be trenched, whether regular or special, will require shafts at each side of each crossing. Figure 2-1 shows the crossing classifications.

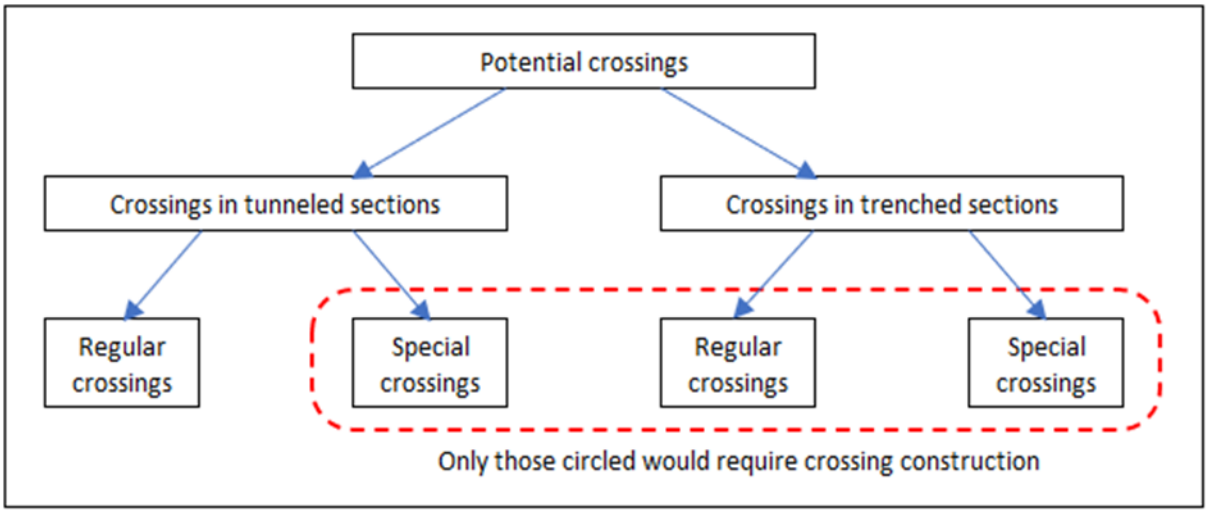

Figure 2-1. Crossing Classifications

2.3 Other Infrastructure Conflicts

This section describes the other infrastructure conflicts.

2.3.1 LA Metro

In several locations, the proposed alignment options conflict with existing at-grade and below-grade Los Angeles County Metropolitan Transportation Authority (LA Metro) infrastructure. Each case is noted in the alignment analysis presented in Annex A. As-built plans of existing infrastructure should be obtained to fully understand the conflicts and mitigate impacts appropriately.

2.3.2 Existing Structures

A number of sections along the proposed alignment options cross existing residential, commercial, and industrial structures. In these cases, it may be preferable to adjust the alignment to avoid or minimize the number of structures crossed. Some examples of these are given in later sections specific to each alignment. Where avoidance is impossible, tunneling may be preferred, although obtaining easements to tunnel below the properties may be a lengthy process.

Some properties may need to be acquired to facilitate construction. The acquisition could be temporary if a property was only needed during construction.

2.3.3 Powerlines

Some sections of the proposed alignment options follow the path of high-voltage overhead power lines. This presents an increased risk of corrosion to welded steel pipes and additional corrosion protection may be required. A corrosion control specialist should be consulted to fully understand the risk and determine appropriate mitigation.

2.3.4 Future Projects

Each alignment and any future adjustments to the alignments need to be coordinated with future construction projects in the Los Angeles metropolitan area, including, for example, the following projects:

- Sepulveda Transit Corridor (LA Metro 2022a)
- Vermont Transit Corridor (LA Metro 2022b)

- West Santa Ana Branch Transit Corridor (LA Metro 2022c)
- Rail to Rail Active Transportation Corridor (LA Metro 2022d)
- Rail to River Active Transportation Corridor (LA Metro 2022e)
- SoCalGas Angeles Link Green Hydrogen Pipeline (SoCalGas 2022)

More information about these specific projects can be found at the links in the References section.

3. Alignment Review

Considering the factors discussed in Section 2, each proposed alignment was reviewed with an analysis of which sections should be considered for trenched or tunneled construction. The detailed results of this analysis can be found in Annex A and are summarized in the following sections.

For each alignment, the number of crossings was estimated, with special crossings being Caltrans and railroads and regular crossings referring to crossing of all other infrastructure. Typically, crossings would start and end approximately 30 feet away from the infrastructure. To estimate the length of the crossings, an average length of 200 feet was assumed, although this will vary and should be evaluated at in further detail during a later stage of the project. For sections that were evaluated to be primarily trenched, an estimate was made for the total length of tunneled crossings within those sections.

An estimate of the number of shafts required for each crossing and tunneled section was made based on the following assumptions:

- Special crossings within sections evaluated to be tunneled would require a shaft immediately adjacent to either side of the asset.
- All crossings within sections evaluated to be trenched would require a shaft at either side of the asset.
- For tunnel sections with 42- to 66-inch-diameter pipes, regularly spaced shafts would be required no more than 4,000 feet apart.
- For tunnel sections with 96- to 108-inch-diameter pipes, regularly spaced shafts would be required no more than 8,000 feet apart.

Smaller-diameter tunnels become more inefficient to construct the longer they get, because there is not enough space within the tunnel to employ a California switch to allow supply and muck carts to pass each other and hence, they will typically have intermediate shafts at more regular intervals.

Total shaft quantities presented in Annex A do not account for overlap between regularly spaced shafts for tunnel sections and shafts required for crossings that could use the same site. The further refinement of this estimate should be undertaken during a later phase of the project to optimize the number of shafts.

For the north–south alignments, 96-inch-diameter pipes were assumed, based on the schematic diagram supplied to Jacobs. For the west–east alignments, the schematic suggested 108-inch-diameter pipes from the HWRP to the T-junction with the north–south alignments, then 66-inch-diamter pipes between the T-junction and Western Avenue and then 54-inch-diameter pipes from Western Avenue to the eastern end of the alignment. Because the location of the T-junction differs for each combination of north–south and west–east alignment, for comparison,108-inch-diameter pipe has been assumed between the HWRP and the junction with the Cahuenga alignment, which is the central of the three north–south alignments. From that point to Western Avenue, 66-inch-diameter pipes have been assumed and from Western Avenue to the eastern end of the alignment, 54-inch-diameter pipe was assumed. This can be refined later if required.

In Annex A, the column titled Main Construction Method denotes the assumed predominant method of construction (trenched or tunneled) for each section of each alignment. The following two columns estimate the length of trenched construction and length of tunnel construction for each section, considering that even those denoted as being predominantly trenched will still require some minimal tunneling at crossings.

In some sections of the alignment options, numerous major crossings occur in close succession; it was conservatively assumed more efficient to tunnel these sections than apply a combination of trenched and tunnel construction. Further analysis may prove a mixture of trench and tunnel construction to be a more appropriate solution.

Similarly, for sections identified to be potentially trenched, several factors may lead to tunneling as a more appropriate solution. This analysis did not consider geotechnical or ground conditions, underground utilities and structures or ROW, easements, land acquisitions, or permitting.

The review also does not account for traffic disruption, local community impacts, or environmental impacts, and does not evaluate or compare cost, schedule and risk.

Finally, several potentially beneficial adjustments to the proposed alignments were observed and are reported in the following sections specific to each alignment for consideration and further evaluation.

4. Griffith Park (Eastern) Alignment

This section describes the Griffith Park (eastern) alignment geographically from north to south, which is a different orientation to the proposed flow rate.

4.1 Overview

This alignment (Figure 4-1) runs north to south from the LAAFP to the intersection of Vermont Avenue and W. Slauson Avenue. At the northern end, in the San Fernando Valley, the alignment largely follows an overhead power line corridor in a northwest–southeast direction through a densely populated area. The alignment then skirts around the eastern edge of the Santa Monica Mountain range on the western side of Interstate (I-)5 and back around to Vermont Avenue. The southern end of the alignment is in a straight north–south orientation along Vermont Avenue to Slauson Avenue through densely populated areas.

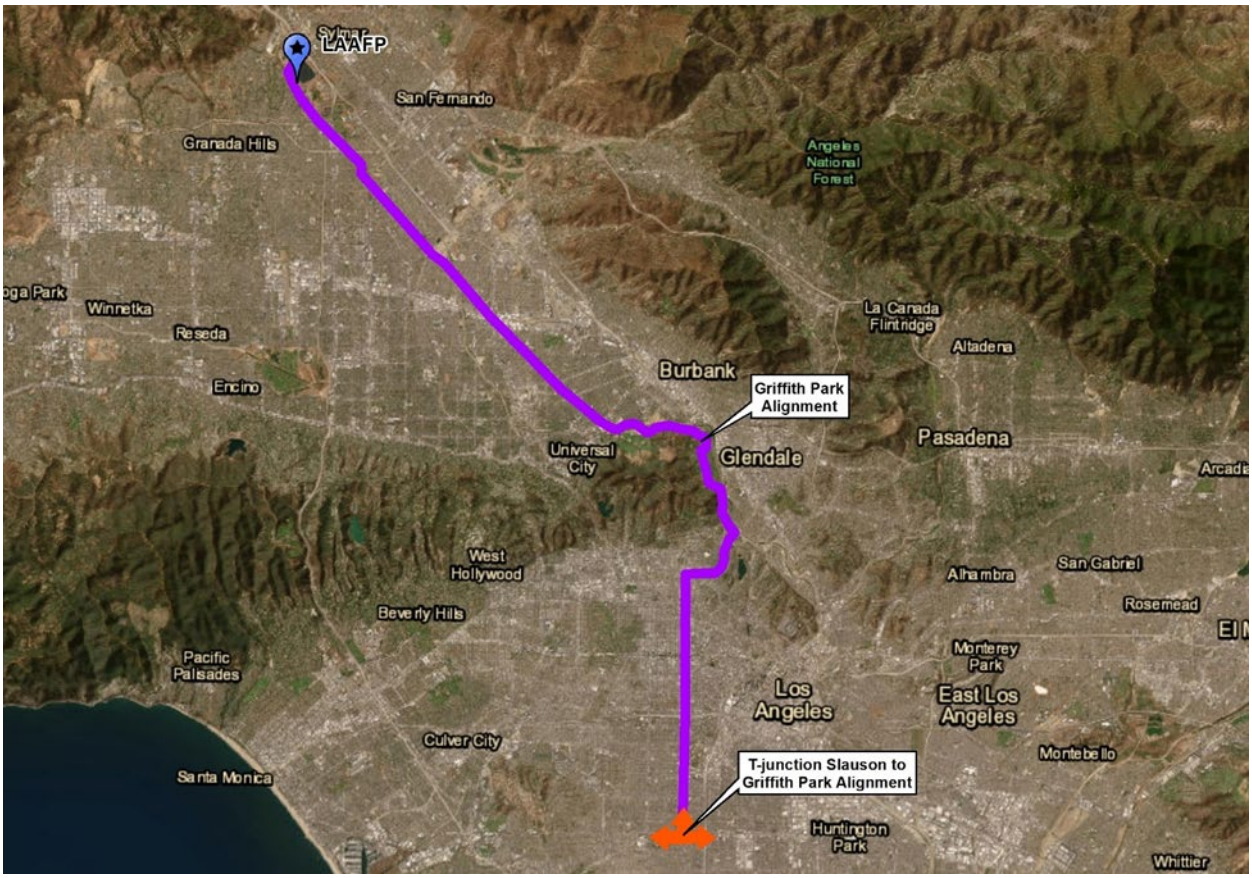

Figure 4-1. Griffith Park Alignment

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

This whole alignment is assumed to be 96-inch-diameter pipe and has a total length of approximately 29.5 miles. The evaluation estimated 9.7 miles (33%) could be trenched and 19.8 miles (67%) would be tunneled, compared to the LADWP Concept Report, which assumed 15% of it would be trenched and 85% would be tunneled (Table 4-1).

Table 4-1. Griffith Park Alignment Construction Methodology by Pipe Diameter

Diameter (inches)	LADWP Concept Report				Alignment Review Estimate			
	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)
54	-	-	-	-	-	-	-	-
66	-	-	-	-	-	-	-	-
96	4.4	25.0	15	85	9.7	19.8	33	67
108	-	-	-	-	-	-	-	-
Total	**4.4**	**25.0**	**15**	**85**	**9.7**	**19.8**	**33**	**67**

- = not applicable

Annex A provides a detailed analysis of the alignment.

4.2 Crossings

Table 4-2 presents the potential crossing locations noted during the alignment review, listed by category from north to south. Of these 77 crossings:

- 56 were identified as regular crossings within sections evaluated to be tunneled.
- 7 were identified as special crossings (Caltrans and railroad) within sections evaluated to be tunneled.
- 14 crossings were identified within the sections evaluated to be trenched, including both special and regular crossings.

Hence, a total of 21 crossings would be required.

Table 4-2. Griffith Park Alignment Potential Crossing Locations

Type	Crossing	
Caltrans	▪ I-405, 118, 170, 134, and 101	
Railroads	▪ Four railroad tracks in one location just south of Sherman Way. ▪ At-grade LA Metro E (Expo) Line at Vermont Avenue and Exposition Blvd.	
Drainage channels	▪ Four crossings of same drainage channel at the northern end of the alignment between LAAFP and Rinaldi Street ▪ Tujunga Wash Storm Drain Channel at Tonopah Street ▪ Los Angeles River at the 134 Freeway	
Major road crossings	▪ Woodman Avenue and San Jose Street ▪ Woodman Avenue and Devonshire Street ▪ Mercer Street ▪ Van Nuys Blvd. ▪ Terra Bella Street ▪ Osbourne Street ▪ Branford Street ▪ Sheldon Street and Roscoe Blvd. ▪ Strathern Street ▪ Whitset Avenue ▪ Saticoy Street ▪ Laurel Canyon Blvd. ▪ Sherman Way ▪ Lankershim Blvd. ▪ Dehougne Street ▪ Vanowen Street ▪ Victory Blvd.	▪ Vermont Place ▪ Santa Monica Blvd. ▪ Melrose Avenue ▪ Beverly Blvd. ▪ W. 1st Street ▪ W. 3rd Street ▪ W. 4th Street ▪ W. 6th Street ▪ W. 7th Street ▪ W. 8th Street ▪ James M. Wood Blvd. ▪ W. Olympic Blvd. ▪ W. Pico Blvd. ▪ Venice Blvd. ▪ W. Washington Blvd. ▪ W. Adams Blvd. ▪ W. Jefferson Blvd.

Type	Crossing	
	▪ Vineland Avenue ▪ Burbank Blvd. ▪ Chandler Blvd. ▪ Magnolia Blvd. ▪ W. Clark Avenue and N. Hollywood Way ▪ W. Verdugo Avenue ▪ W. Alameda Avenue ▪ Riverside Dr. ▪ Zoo entrance ▪ I-5 on- and off-ramps ▪ Griffith Park Blvd. ▪ Sunset Blvd. ▪ N. Virgil Avenue ▪ Lexington Avenue	▪ Exposition Blvd. ▪ W. Martin Luther King Jr. Blvd. ▪ W. 42nd Street ▪ W 43rd Street ▪ W. Vernon Avenue ▪ W. 48th Street ▪ W. 49th Street ▪ W. 53rd Street ▪ W. 54th Street ▪ W. 55th Street ▪ W. 56th Street ▪ W. 57th Street ▪ W. 58th Street
Other infrastructure	▪ Electrical substation north of Rinaldi Street and Haskell Avenue ▪ Pacoima Spreading Grounds ▪ Electrical substation west of Tujunga Avenue between Vanowen Street and Kittridge Street	

Blvd. = boulevard

4.3 Potential Realignments

This section describes potentially beneficial adjustments to the proposed alignment for consideration, listed from north to south. Further evaluation is recommended to determine the feasibility and benefits of each for comparison to the proposed alignment.

4.3.1 Electrical Substation at Rinaldi Street

Immediately to the north of Rinaldi Street, the proposed alignment crosses an electrical substation highlighted on Figure 4-2. Adjusting the alignment to avoid the substation may provide the opportunity to trench this section and would mitigate the risk of impacting sensitive equipment within the substation during tunnel construction.

Figure 4-2. Proposed Alignment Conflict with Electrical Substation

Source:

1. Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

2. LADWP 2022; Jacobs 2022

4.3.2 I-405 and 118 Freeways and Residential and Commercial Properties

Between Rinaldi Street and Devonshire Street, the proposed alignment crosses the I-405 and 118 Freeway, as well as several residential and commercial properties.

At either side of the I-405 crossing are residential properties; because this crossing will need a casing, a launch and reception shaft would be required at either side of the interstate. For this reason, it may be preferable to adjust the alignment to avoid the residential properties.

The proposed 118 Freeway crossing occurs at Chatsworth Drive. The freeway is elevated at this location and the proposed alignment is at approximately 45 degrees (°) to the freeway and at approximately 90° to Chatsworth Drive, which passes below the freeway. To the north of the crossing are residential properties. Because this crossing will need to be realigned closer to 90° to the freeway and will require a casing with a launch and reception shaft at each side of the crossing, an alignment adjustment may be beneficial.

Finally, easements to tunnel beneath residential and commercial properties may be difficult to obtain.

For these reasons, it is recommended to consider realigning this section of the alignment as shown on Figure 4-3. A possible option would be to route the pipeline from Rinaldi Street due south down Haskell Avenue and east along Devonshire Street. This would cross both the interstate and the freeway perpendicularly and at points where the freeways are elevated. It would also avoid the need to tunnel below existing properties. The realignment could potentially be trenched in places.

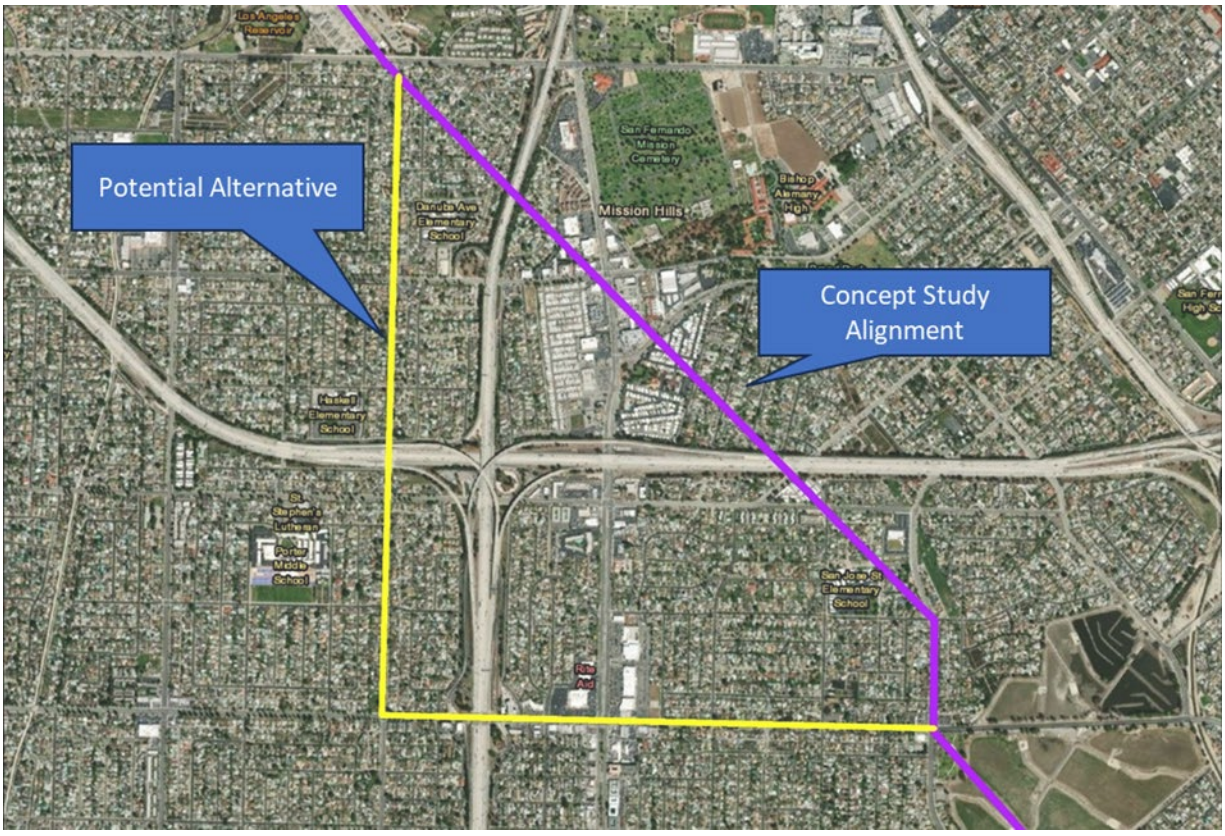

Figure 4-3. Potential Realignment Between Rinaldi Street and Devonshire Street

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

4.3.3 Pacoima Spreading Grounds

Between Devonshire Street and Filmore Street, the proposed alignment passes through the Pacoima Spreading Grounds. The spreading grounds provide groundwater recharge for the San Fernando Groundwater Basin and are currently undergoing a construction project to increase their storage capacity and percolation rate. As such, it is possible trenching this section may not be permitted, and even a tunnel beneath the spreading grounds may not be permissible due to the potential impact on the groundwater regime and functionality of the spreading grounds. It is recommended to investigate this further to confirm the feasibility of tunneling this section.

4.3.4 170 Freeway and Residential Properties

Between Roscoe Blvd. and Strathern Street, the proposed alignment crosses several residential properties and the 170 Freeway at an oblique angle. Easements to tunnel beneath residential properties may be difficult to obtain and the freeway crossing will need to be realigned closer to 90° to the freeway, with a launch and reception shaft at each side of the crossing.

This may be achievable by routing the alignment to cross the freeway along Cantara Street, and then south down Potter Street to join the alignment at Strathern Street, as shown on Figure 4-4.

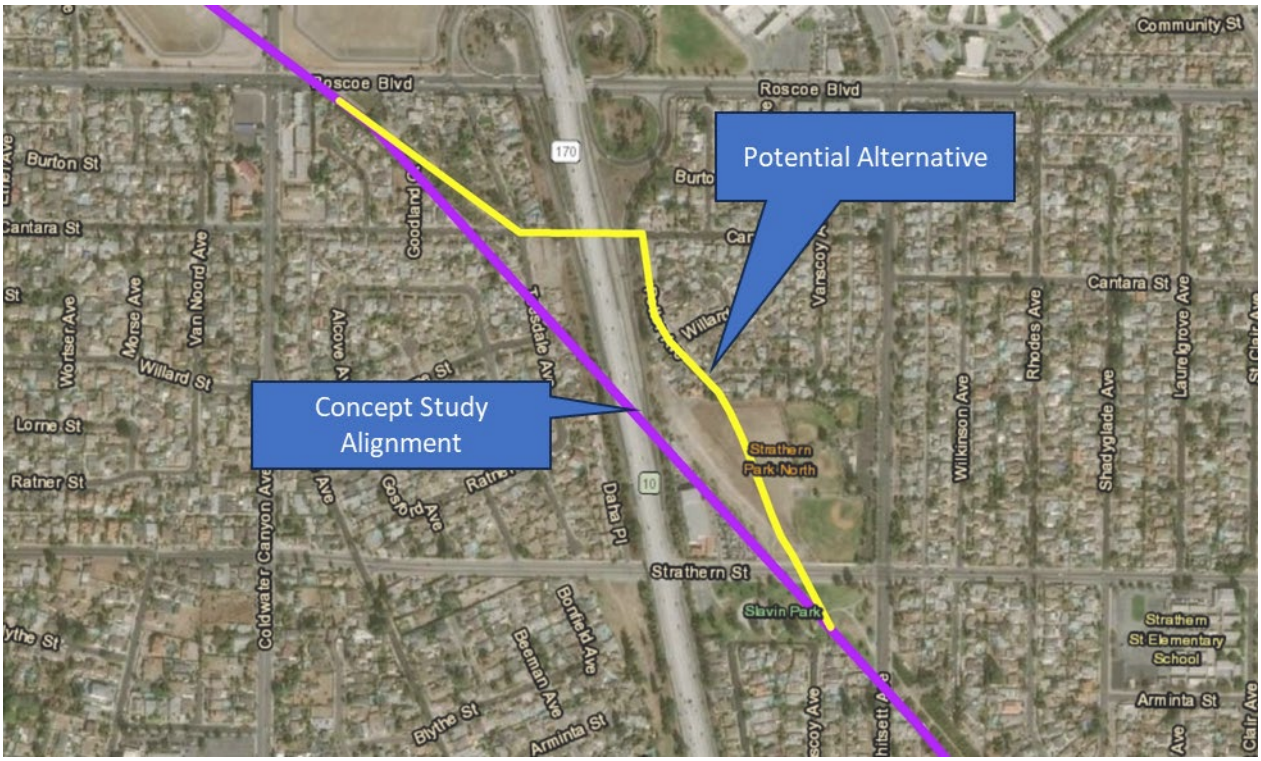

Figure 4-4. Potential Realignment Between Roscoe Blvd. and Strathern Street

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

4.3.5 Railroad South of Sherman Way

Between Sherman Way and Vose Street, the proposed alignment crosses four railroad tracks at an oblique angle. This would need to be realigned closer to 90° with a shaft at either side of the crossing. It appears there may be enough vacant land available on both sides of the crossing to achieve this, as Figure 4-5 shows.

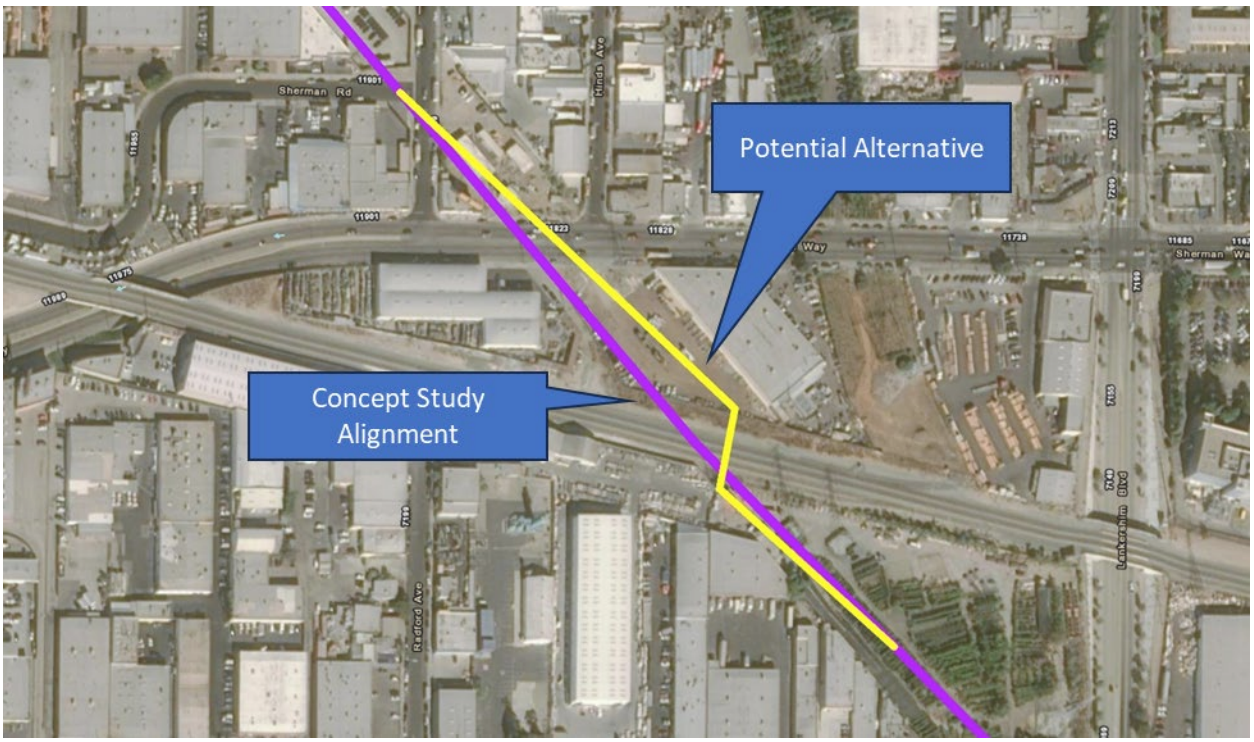

Figure 4-5. Potential Realignment Between Sherman Way and Vose Street

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

4.3.6 Electrical Substation at Tujunga Avenue

Just west of Tujunga Avenue, between Archwood Street and Kittridge Street, the proposed alignment crosses an electrical substation that would have to be tunneled unless the substation could be acquired and demolished. It may be possible to adjust the alignment to avoid the substation to trench this section, which would mitigate the risk of impacting sensitive equipment within the substation during tunnel construction. There are numerous ways this could be addressed by using the surrounding roadways' ROWs (Figure 4-6).

Figure 4-6. Proposed Alignment Conflict with Electrical Substation

Source:
1. Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
2. LADWP 2022; Jacobs 2022

4.3.7 Residential Properties Between W. Chandler Blvd. and W. Clark Avenue

The section of the proposed alignment between W. Chandler Blvd. and W. Clark Avenue appears to cross several residential properties. Easements to tunnel beneath these properties may be difficult to obtain.

It is recommended to investigate rerouting this section of the alignment either along W. Chandler Blvd. and N. Hollywood Way or along Evergreen Street and W. Clark Avenue to avoid the residential properties as shown on Figure 4-7. This realignment could potentially be trenched.

Figure 4-7. Potential Realignment Between W. Chandler Blvd. and W. Clark Avenue

Source:
1. Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
2. LADWP 2022; Jacobs 2022

4.3.8 134 Freeway and Los Angeles River

From W. Alameda Avenue, the proposed alignment crosses park land and parking lots, then follows Riverside Drive before crossing the Los Angeles River and the 134 Freeway at an oblique angle. Not only would the route need to be realigned to achieve a 90° crossing of the 134 Freeway, but a shaft would be required on either side of the freeway to facilitate the crossing. The proposed alignment does not appear to have sufficient space on the northern side of the crossing to locate a shaft.

There are several ways this section could be successfully realigned, as shown on Figure 4-8, including:

- From W. Alameda Avenue down Bob Hope Drive to Forest Lawn Drive
- Along W. Alameda Avenue down S. Buena Vista Street to Forest Lawn Drive
- Along W. Alameda Avenue down S. Buena Vista Street along W. Riverside Drive and down S. Reese Place to Forest Lawn Drive
- Along W. Alameda Avenue down S. Keystone Street to Forest Lawn Drive

The first two of these would cross the 134 Freeway at an elevated section where it may be possible to use trenched construction.

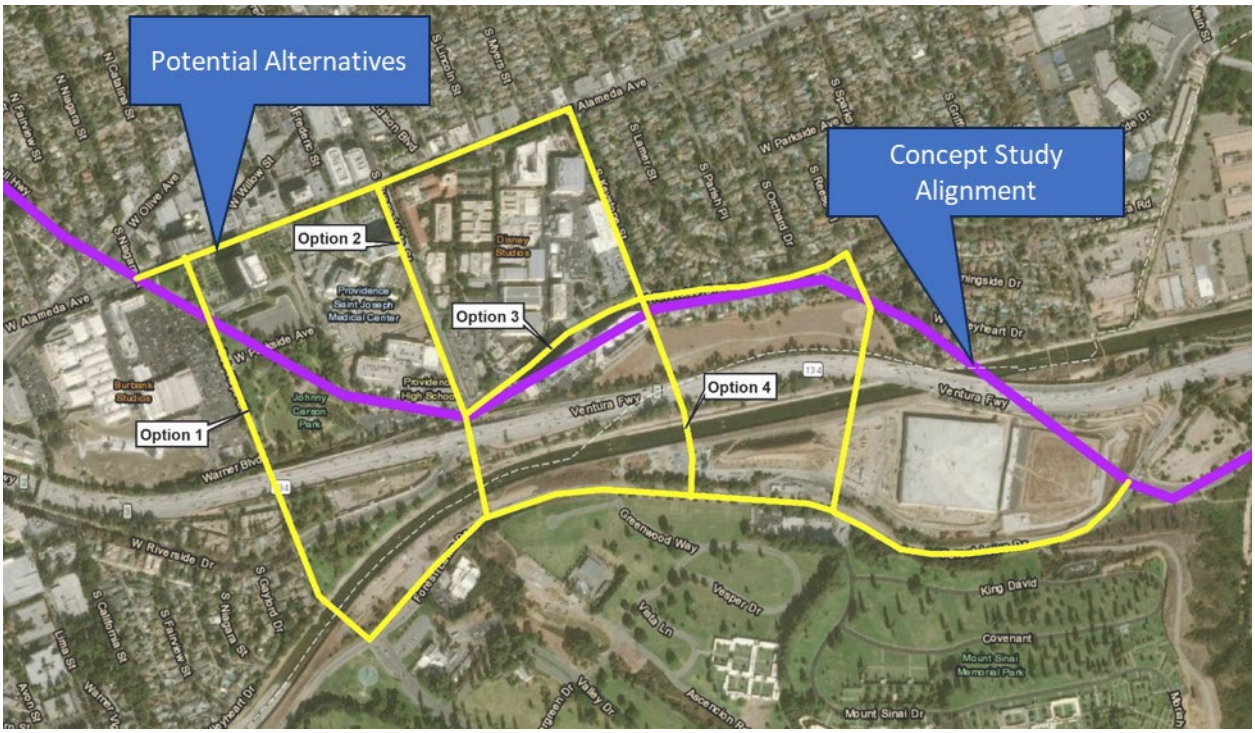

Figure 4-8. Potential Realignment Between W. Alameda Avenue and Forest Lawn Drive

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

4.3.9 Intersection of Riverside Drive and Hyperion Avenue

At the intersection of Riverside Drive and Hyperion Avenue, the proposed alignment makes a sharp turn into a cutting between two different grade levels. Because this would be challenging to trench, tunneling could be considered with a possible shorter alignment and minimal easements between Los Feliz Blvd. and Rowena Avenue, as shown on Figure 4-9.

Figure 4-9. Potential Realignment Between Los Feliz Blvd. and Rowena Avenue

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

4.3.10 101 Freeway and LA Metro Red Line

The proposed alignment crosses the 101 Freeway at the intersection with N. Vermont Avenue at an oblique angle. The freeway is in a cutting, with N. Vermont Avenue passing overhead. Consideration should be given to realigning this crossing closer to 90°.

One option may be to move the alignment one block east to N. Virgil Avenue, which passes below an elevated section of the 101 Freeway and has no connecting on- and off-ramps. This would also avoid conflict with the LA Metro Red Line subway alignment which runs below N. Vermont Avenue.

5. Cahuenga (Central) Alignment

This section describes the Cahuenga (central) alignment geographically from north to south, which is a different orientation to the proposed flow rate.

5.1 Overview

This alignment (Figure 5-1) runs north to south from the LAAFP to the intersection of N. La Brea Avenue and W. Florence Avenue. At the northern end, in the San Fernando Valley, the alignment follows an overhead power line corridor in a northwest–southeast direction, then crosses a mostly residential area to join the Lankershim Blvd., Tujunga Avenue, and 101 Freeway and Cahuenga Blvd. ROWs. The alignment then passes through the Santa Monica Mountain range following the 101 Freeway and Cahuenga Blvd. corridor to N. Highland Avenue. The southern end of the alignment passes south along Highland Avenue and La Brea Avenue through densely populated areas.

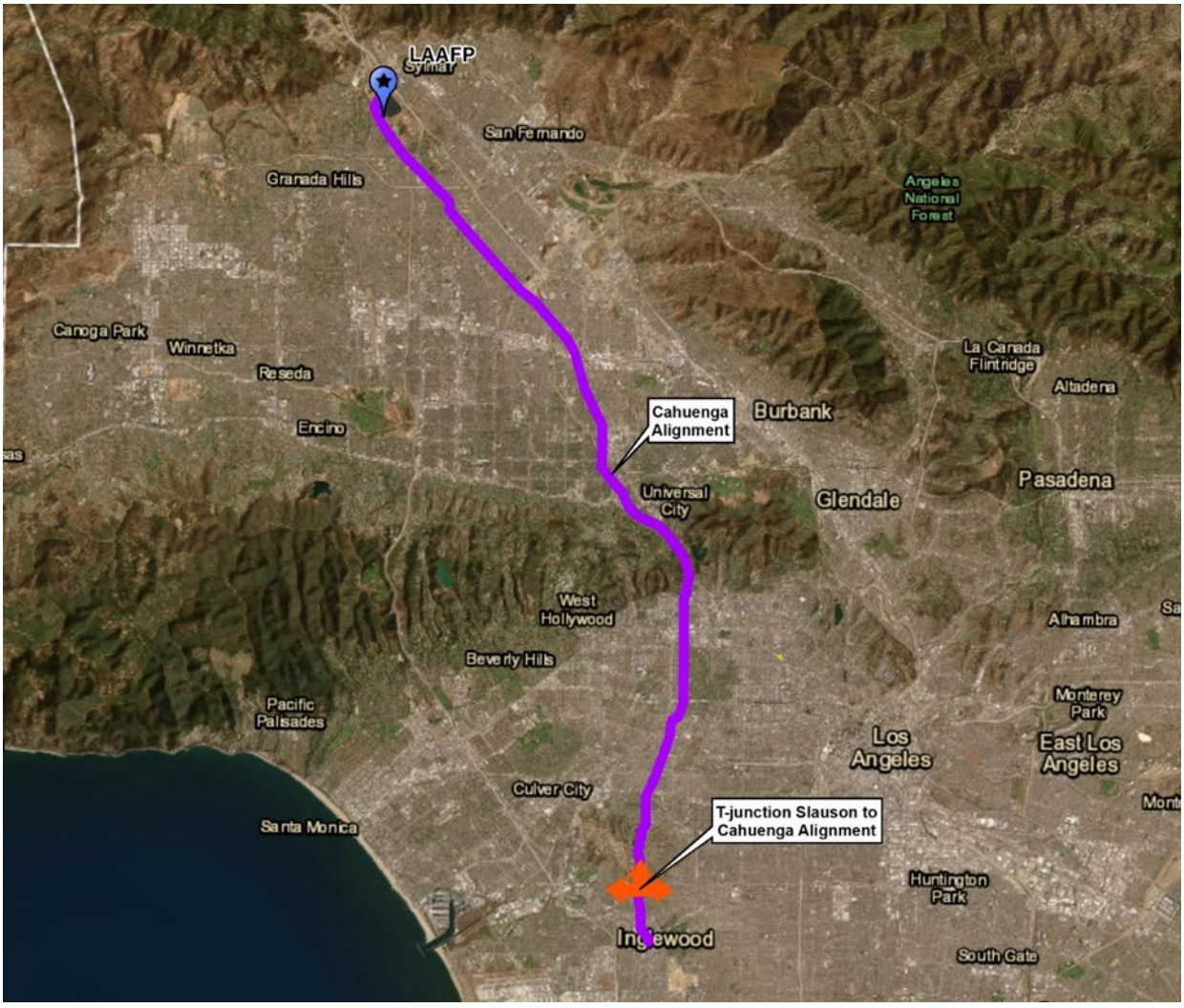

Figure 5-1. Cahuenga Alignment

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

The whole of this alignment is assumed to be 96-inch-diameter pipe with a total length of approximately 27.3 miles. The evaluation estimated 9.3 miles (34%) could be trenched and 18.0 miles (66%) would be tunneled, compared to the LADWP Concept Report, which assumed 15% trenched and 85% tunneled (Table 5-1).

Table 5-1. Cahuenga Alignment Construction Methodology by Pipe Diameter

Diameter (inches)	LADWP Concept Report				Analysis Review Estimate			
	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)
54	-	-	-	-	-	-	-	-
66	-	-	-	-	-	-	-	-
96	4.1	23.2	15	85	9.3	18.0	34	66
108	-	-	-	-	-	-	-	-
Total	**4.1**	**23.2**	**15**	**85**	**9.3**	**18.0**	**34**	**66**

Annex A provides a detailed analysis of the alignment.

5.2 Crossings

Table 5-2 presents the potential crossing locations noted during the alignment review, listed by category from north to south. Of these 67 crossings:

- 47 were identified as regular crossings within sections evaluated to be tunneled.
- 4 were identified as special crossings (Caltrans and railroad) within sections evaluated to be tunneled.
- 16 crossings were identified within the sections evaluated to be trenched, including both special and regular crossings.

Hence, a total of 20 crossings would be required.

Table 5-2. Cahuenga Alignment Potential Crossing Locations

Type	Crossing	
Caltrans	▪ I-405, 118, 170	
Railroads	▪ Four railroad tracks in one location just south of Sherman Way	
Drainage channels	▪ Four crossings of same drainage channel at the northern end of the alignment between LAAFP and Rinaldi Street ▪ Tujunga Wash Storm Drain Channel at Tonopah Street ▪ Los Angeles River at the 101 Freeway	
Major road crossings	▪ Woodman Avenue and San Jose Street ▪ Woodman Avenue and Devonshire Street ▪ Mercer Street ▪ Van Nuys Blvd. ▪ Terra Bella Street ▪ Osbourne Street ▪ Branford Street ▪ Sheldon Street and Roscoe Blvd. ▪ Strathern Street ▪ Whitset Avenue Saticoy Street ▪ Laurel Canyon Blvd. ▪ Sherman Way ▪ Vanowen Street ▪ Oxnard Street	▪ Regal Place ▪ Universal Studios Blvd. ▪ Barham Blvd. ▪ Cadet Ct. and Oakcrest Dr. ▪ Pilgrimage Bridge ▪ Franklin Avenue ▪ Hollywood Blvd. ▪ Sunset Blvd. ▪ Fountain Avenue ▪ Lexington Avenue ▪ Santa Monica Blvd. ▪ Romaine Street ▪ Willoughby Avenue ▪ Waring Avenue

Type	Crossing	
	▪ Hatteras Street ▪ Colling Street ▪ Burbank Blvd. ▪ Chandler Blvd. ▪ Magnolia Blvd. ▪ Moorpark Street ▪ Vineland Avenue ▪ Campo De Cahuenga	▪ Melrose Avenue ▪ Beverly Blvd. ▪ W. 3rd Street ▪ W. 6th Street ▪ Stocker Street ▪ W. Fairview Blvd. ▪ Centinela Avenue ▪ W. Hyde Park Blvd and W. Juniper Street
Other infrastructure	▪ Electrical substation north of Rinaldi Street and Haskell Avenue ▪ Pacoima Spreading Grounds	

5.3 Potential Realignments

This section describes potentially beneficial adjustments to the proposed alignment for consideration, listed from north to south. Further evaluation is recommended to determine feasibility and benefits of each for comparison to the proposed alignment.

5.3.1 Electrical Substation at Rinaldi Street

The northern part of this alignment follows the same route as the Griffith Park alignment and crosses the electrical substation discussed in the previous section, so the same recommendations apply.

5.3.2 I-405 and 118 Freeways and Residential and Commercial Properties

The crossing of I-405, the 118 Freeway, and several residential and commercial properties between Rinaldi Street and Devonshire Street is also the same for this alignment as for the Griffith Park alignment, so the same recommendations apply.

5.3.3 Pacoima Spreading Grounds

Between Devonshire Street and Filmore Street, the proposed alignment passes through the Pacoima Spreading Grounds as for the Griffith Park alignment, so the same recommendations apply.

5.3.4 170 Freeway and Residential Properties

Between Roscoe Blvd. and Strathern Street, the proposed alignment crosses a number of residential properties and the 170 Freeway at an oblique angle as it does for the Griffith Park alignment, so the same recommendations apply.

5.3.5 Railroad South of Sherman Way and Residential and Commercial Properties

From Valario Street to the intersection of Lankershim Blvd. and Victory Blvd., the proposed alignment appears to cross several residential and commercial properties. Easements to tunnel beneath these properties may be difficult to obtain.

Along this same section between Sherman Way and Vose Street, the proposed alignment crosses four railroad tracks at an oblique angle. This would need to be realigned closer to 90° with a shaft at either side of the crossing.

It is recommended to investigate rerouting this section of the alignment, and two possible options are shown on Figure 5-2. The first could be to follow Laurel Canyon Blvd. south and turn east on Victory Blvd.

to Lankershim Blvd. This would cross the railroad at a point where it is elevated above the roadway. The second involves heading east on Valario Street and then following the overhead power line corridor south, crossing the railroad lines at 90° and then heading due south on Lankershim Blvd. Either of these could potentially be trenched.

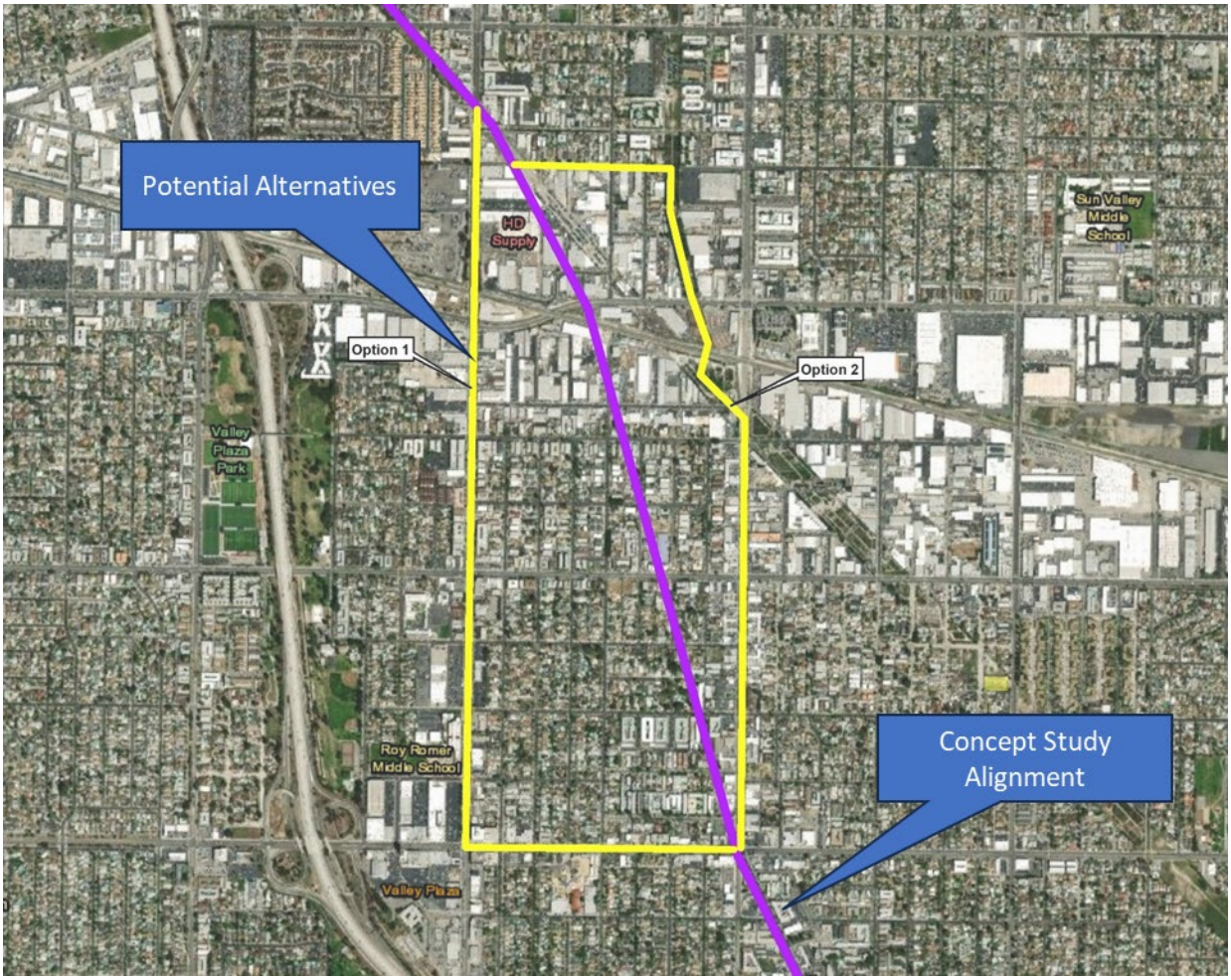

Figure 5-2. Potential Realignment to Avoid Railroad and Property Crossing

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

5.3.6 101 Freeway and Los Angeles River

The proposed alignment appears to follow the 101 Freeway from the intersection with the 134 Freeway, south to the intersection with Lankershim Blvd. This would not be permitted by Caltrans.

It is recommended to investigate possible alternatives for this section, two of which are shown on Figure 5-3. The first begins at the intersection of Victory Blvd. and Colfax Avenue, with the alignment running due south along Colfax Avenue to Ventura Blvd., then turning east along Ventura Blvd. to rejoin the proposed alignment at Lankershim Blvd. This option would cross an elevated section of the 170 Freeway, the at-grade LA Metro Orange Line Busway, an elevated section of the 101 Freeway and the Los Angeles River.

The second option shown follows Lankershim Blvd. from the intersection with Burbank Blvd. all the way down to Ventura Blvd. This option would cross an elevated section of the 134 Freeway, the Los Angeles River, and an elevated section of the 101 Freeway.

Both options end at the intersection of Lankershim Blvd. and Ventura Blvd. and Cahuenga Blvd., from where the alignment can follow Cahuenga Blvd. through the Santa Monica Mountains, rather than the 101 Freeway ROW.

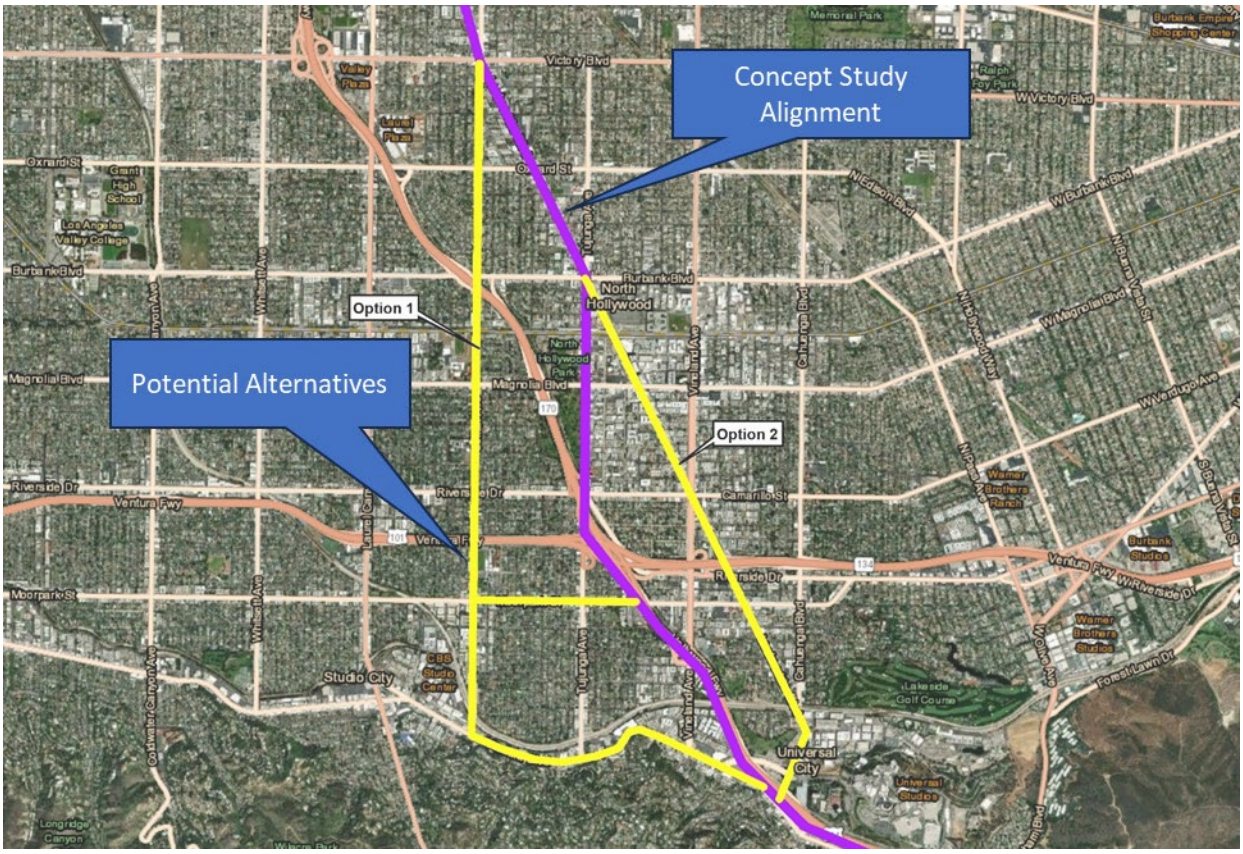

Figure 5-3. Potential Realignment Between Victory Blvd. and Lankershim Blvd.

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

6. Sepulveda (Western) Alignment

This section describes the Sepulveda (western) alignment geographically from north to south, which is a different orientation to the proposed flow rate.

6.1 Overview

This alignment (Figure 6-1) runs north to south from the LAAFP to the intersection of Centinela Avenue and E. Florence Avenue. At the northern end, in the San Fernando Valley, the alignment follows Woodley Avenue, turning due east through the Donald C. Tilman WRP and then turning south down Sepulveda Blvd. It is assumed the alignment is intended to follow the Sepulveda Blvd. ROW through the Santa Monica Mountain range and all the way through to Centinela Avenue through densely populated areas.

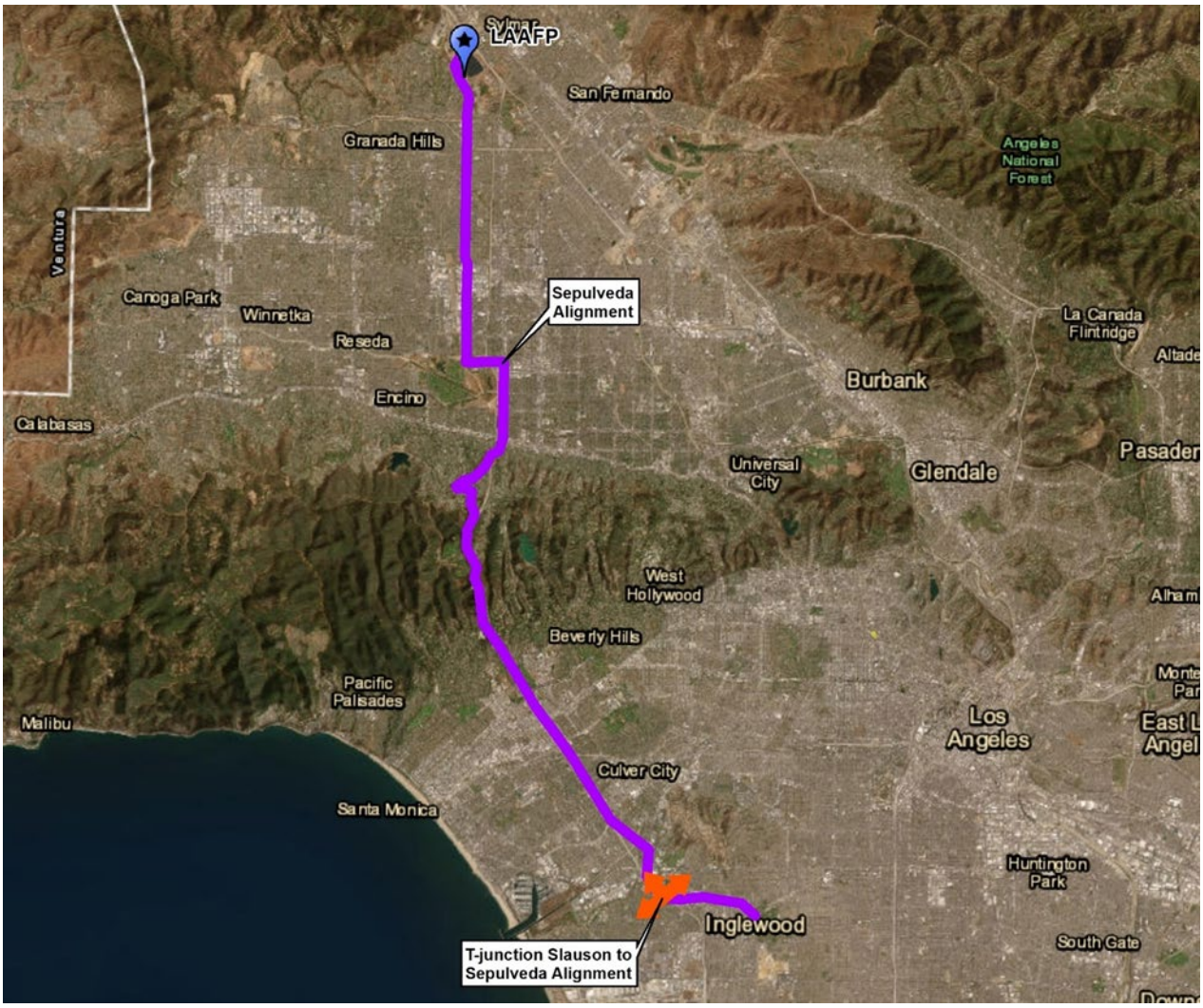

Figure 6-1. Sepulveda Alignment

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

The whole of this alignment is assumed to be 96-inch-diameter pipe, with a total length of approximately 29.0 miles. The evaluation estimated 12.7 miles (44%) could be trenched and 16.3 miles (56%) would be tunneled, compared to the LADWP Concept Report, which assumed 15% trenched and 85% tunneled (Table 6-1).

Table 6-1. Sepulveda Alignment Construction Methodology by Pipe Diameter

Diameter (inches)	LADWP Concept Report				Alignment Review Estimate			
	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)
54	-	-	-	-	-	-	-	-
66	-	-	-	-	-	-	-	-
96	4.4	24.7	15	85	12.7	16.3	44	56
108	-	-	-	-	-	-	-	-
Total	4.4	24.7	15	85	12.7	16.3	44	56

Annex A provides a detailed analysis of the alignment.

6.2 Crossings

Table 6-2 presents the potential crossing locations noted during the alignment review, listed by category from north to south. Of these 72 crossings:

- 47 were identified as regular crossings within sections evaluated to be tunneled
- 2 were identified as special crossings (Caltrans and railroad) within sections evaluated to be tunneled
- 23 crossings were identified within the sections evaluated to be trenched, including both special and regular crossings

Hence, a total of 25 crossings would be required.

Table 6-2. Sepulveda Alignment Potential Crossing Locations

Type	Crossing	
Caltrans	▪ I-405, I-10	
Railroads	▪ Single track between Roscoe Blvd. and Raymer Street ▪ Twin tracks at E. Florence Avenue	
Drainage channels	▪ Four crossings of same drainage channel at the northern end of the alignment between LAAFP and Rinaldi Street ▪ Los Angeles River at Valleyheart Drive ▪ Storm drain just north of Rose Avenue ▪ Storm drain just south of Lucerne Avenue	
Major road crossings	▪ San Fernando Mission Blvd. ▪ Horace Street ▪ Chatsworth Street ▪ Devonshire Street ▪ Lassen Street ▪ Kinze Street ▪ Plummer Street ▪ Nordoff Street ▪ Parthenia Street ▪ Raymer Street ▪ Daily Dr. ▪ Waterman Dr.	▪ Sutton Street ▪ Fiume Walk ▪ I-405 on- and off-ramps x4 ▪ Mission Dump Rd. ▪ Mountaingate Dr. ▪ Bel Air Crest Rd. ▪ Bel Terrace ▪ Moraga Drive. ▪ N. Church Ln. ▪ Sunset Blvd. ▪ Constitution Avenue ▪ Ohio Avenue

Type	Crossing	
	▪ Lindbergh Street ▪ Stagg Street ▪ Byrd Street ▪ Sherman Way ▪ Vanowen Street ▪ Orange Line Busway x3 ▪ Oxnard Street ▪ Hatteras Street ▪ Burbank Blvd. ▪ Albers Street ▪ Magnolia Blvd. ▪ Camarillo Street ▪ Ventura Blvd. ▪ Dickens Street ▪ I-405 on and off ramp	▪ Santa Monica Blvd. ▪ W. Olympic Blvd. ▪ Tennesea Avenue ▪ Exposition Blvd. ▪ Palms Blvd. ▪ Venice Blvd. ▪ I-405 on- and off-ramps ▪ Washington Place ▪ Washington Blvd. ▪ Culver Blvd. ▪ Jefferson Blvd. ▪ Slauson Avenue Hillside Memorial Park entrance ▪ S La Tijera Blvd. ▪ La Cienega Blvd. ▪ N. La Brea Avenue
Other infrastructure	▪ Donald C. Tillman WRP	

6.3 Potential Realignments

This section describes potentially beneficial adjustments to the proposed alignment for consideration, listed from north to south. Further evaluation is recommended to determine feasibility and benefits of each for comparison to the proposed alignment.

6.3.1 Donald C. Tilman Water Reclamation Plant

The proposed alignment (Figure 6-2) crosses west to east from Woodley Avenue to Sepulveda Blvd., directly through the Donald C. Tilman WRP, then crosses I-405 at an oblique angle, the Orange Line Busway twice, and several residential properties.

A possible alternative would be to divert the alignment southeast on the eastern side of the plant, to facilitate a perpendicular crossing of I-405 onto Oxnard Street, to connect back into the proposed alignment.

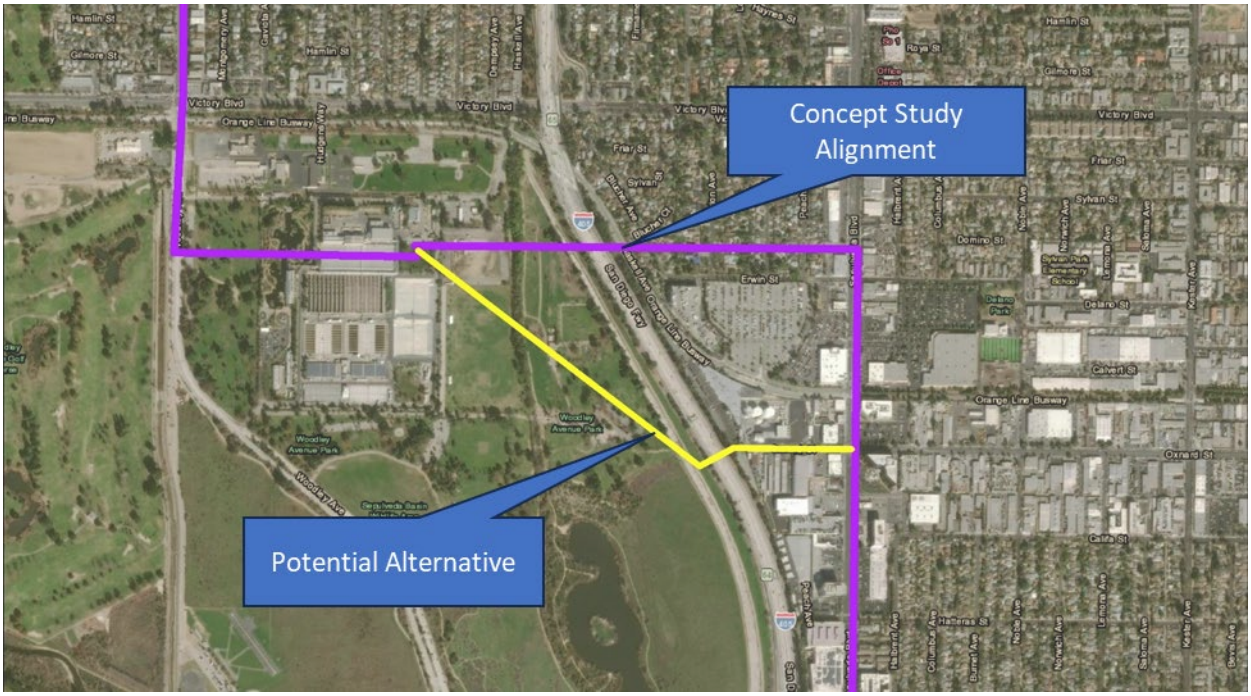

Figure 6-2. Donald C. Tilman Water Reclamation Plant Crossing

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

7. Slauson (Northern) Primary Alignment

This section describes the Slauson (northern) primary alignment geographically from west to east.

7.1 Overview

This alignment (Figure 7-1) runs west to east from the HWRP to the point where Slauson Avenue passes below I-605. The alignment passes along the western and northern boundary of Los Angeles International Airport and then northeast along S. La Tijera Blvd. to Slauson Avenue, which it follows for approximately 16.5 miles to I-605.

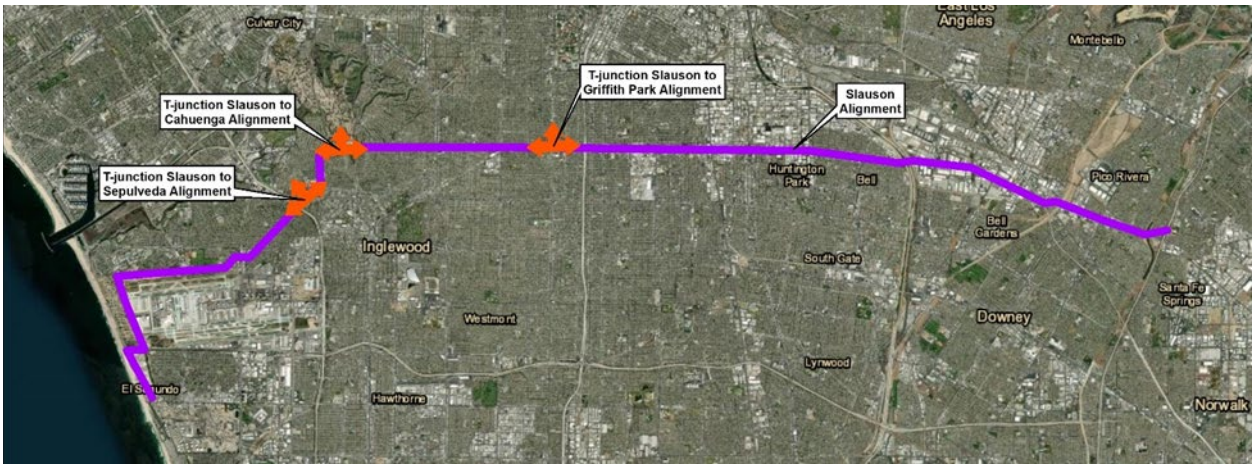

Figure 7-1. Slauson Primary Alignment

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

This alignment is assumed to have the following infrastructure:

- A 108-inch-diameter pipe from the HWRP to the T-junctions, depending on the ultimate north-bound alignment used
- A 66-inch-diameter pipe along Slauson Avenue from the T-junctions to the potential Central Basin injection wellfields near S. Western Blvd.
- A 54-inch-diameter pipe along Slauson Avenue from the potential Central Basin injection wellfields to the eastern end of the alignment

The total length of the alignment is approximately 23.3 miles. The evaluation estimated 7.5 miles (32%) could be trenched and 15.8 miles (68%) would be tunneled, compared to the LADWP Concept Report, which assumed 70% trenched and 30% tunneled for the 54-inch- and 66-inch-diameter pipe sections and 15% trenched and 85% tunneled for the 108-inch-diameter pipe sections, which aggregates to 54% trenched and 46% tunneled over the whole alignment (Table 7-1).

Table 7-1. Slauson Primary Alignment Construction Methodology by Pipe Diameter

Diameter (inches)	LADWP Concept Report				Alignment Review Estimate			
	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)
54	9.3	4.0	70	30	1.7	11.6	12	88
66	2.2	1.0	70	30	0.0	3.2	0	100
96	-	-	-	-	-	-	-	-
108	1.0	5.8	15	85	5.8	1.0	85	15
Total	**12.6**	**10.7**	**54**	**46**	**7.5**	**15.8**	**32**	**68**

Annex A provides a detailed analysis of the alignment.

7.2 Crossings

Table 7-2 presents the potential crossing locations noted during the alignment review, listed by category from west to east. Of these 52 crossings:

- 34 were identified as regular crossings within sections evaluated to be tunneled
- 9 were identified as special crossings (Caltrans and railroad) within sections evaluated to be tunneled
- 9 crossings were identified within the sections evaluated to be trenched, including both special and regular crossings

Hence, a total of 18 crossings would be required.

Table 7-2. Slauson Primary Alignment Potential Crossing Locations

Type	Crossing
Caltrans	▪ I-405, I-710
Railroads	▪ LA Metro K Line at-grade at Slauson Avenue and Crenshaw Blvd. ▪ Single track at-grade at Long Beach Avenue ▪ Multiple tracks in open-cut trench at Alameda Street ▪ Single track at-grade between S. Boyle Avenue and Alcoa Avenue ▪ Single track at-grade at S. Downey Road ▪ Single track at-grade east of I-710 ▪ Single track at-grade between Boxford Avenue and S. Malt Avenue ▪ Four tracks at-grade east of the San Gabriel River Channel
Drainage channels	▪ Los Angeles River just west of I-710 ▪ Rio Hondo Channel on Slauson Avenue just east of S. Bluff Road ▪ San Gabriel River Channel on Slauson Avenue just west of I-605
Major road crossings	▪ World Way W. ▪ Pershing Drive and Westchester Pkwy. ▪ Lincoln Blvd. ▪ Westchester Pkwy. and La Tijera Blvd. ▪ Manchester Avenue ▪ Airport Blvd. ▪ W. Centinela Avenue ▪ S. Fairfax Avenue ▪ S. La Brea Avenue ▪ Overhill Dr. ▪ Crenshaw Blvd. ▪ S. Van Ness Avenue ▪ S. Avalon Blvd. ▪ Hooper Avenue ▪ Compton Avenue ▪ Alameda Street ▪ S. Santa Fe Avenue ▪ Pacific Blvd. ▪ S. Soto Street ▪ S. Boyle Avenue ▪ Alcoa Avenue ▪ S. Downey Road ▪ Atlantic Blvd. ▪ S. Eastern Avenue

Type	Crossing	
	▪ Western Avenue ▪ S. Normandie Avenue ▪ Vermont Avenue ▪ S. Hoover Street ▪ Figueroa Street ▪ I-110 Freeway on- and off-ramps ▪ S. Broadway ▪ S. Main Street	▪ Garfield Avenue ▪ E. Gage Avenue ▪ Telegraph Road ▪ Paramount Blvd. ▪ Rosemead Blvd. ▪ Passons Blvd. ▪ I-605 on- and off-ramps
Other infrastructure	▪ None	

7.3 Potential Realignments

This section describes potentially beneficial adjustments to the proposed alignment for consideration, listed from west to east. Further evaluation is recommended to determine feasibility and benefits of each for comparison to the proposed alignment.

7.3.1 Residential Properties Between La Cienega Blvd. and Slauson Avenue

Between the intersection of La Tijera Blvd. and La Cienega Blvd. and the intersection of S. La Tijera Blvd. and Slauson Avenue, the proposed alignment takes a direct route passing below several residential properties. Because it may be difficult to obtain easements to tunnel beneath these properties, it is suggested to investigate realigning the route to follow La Tijera Blvd. as shown on Figure 7-2. It may also be possible to trench this section.

Figure 7-2. Potential Realignment Between La Cienega Blvd. and Slauson Avenue

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

7.3.2 Railroads by the San Gabriel River

Immediately east of the San Gabriel River channel, the proposed alignment is approximately west–east in orientation. At that location, it crosses four railroad tracks: three in an approximately northwest to southeast orientation and a single track in a north–south orientation. Because it would be impossible to cross all the tracks perpendicularly at this point, it is recommended to investigate realigning this section to avoid the point at which the railroads cross and facilitate a perpendicular crossing. The optimal location will depend on the final termination point of the alignment.

8. Alternative 1: Florence (Central) Alignment

This section describes the Alternative 1: Florence (central) alignment geographically from west to east.

8.1 Overview

This alignment (Figure 8-1) runs west to east from the HWRP to the point where Florence Avenue passes below I-605. The alignment travels east along E. El Segundo Blvd. then north along Hawthorne Blvd. to Florence Avenue, which it follows for approximately 15.4 miles to I-605.

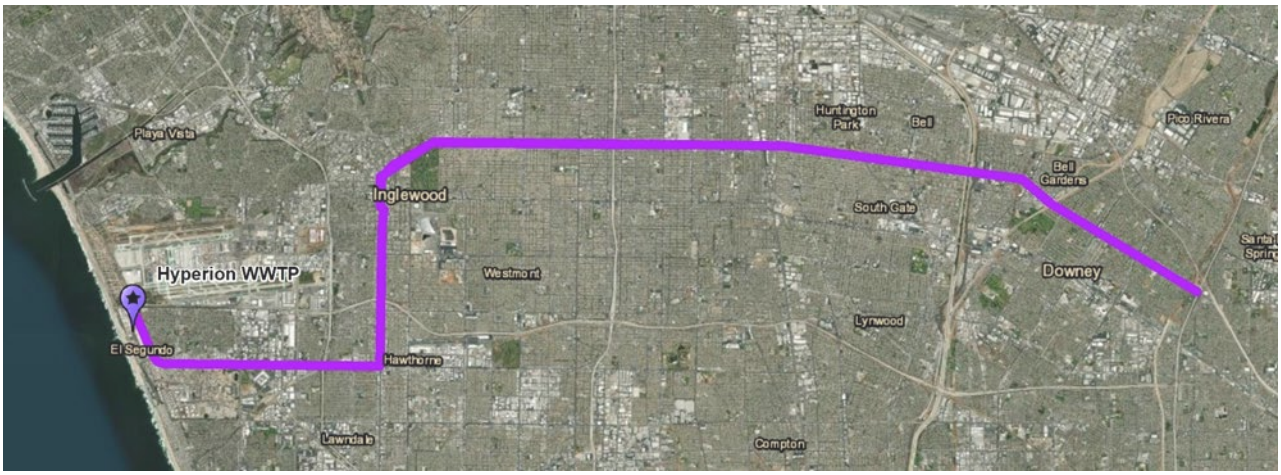

Figure 8-1. Alternative 1: Florence Alignment

Source:

1. Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

2. LADWP 2022; Jacobs 2022

This alignment is assumed to have a 108-inch-diameter pipe from the HWRP to S. La Brea Blvd. and Florence Avenue, a 66-inch-diameter pipe along Florence Avenue from S. La Brea Blvd. to S. Western Blvd. and a 54-inch-diameter pipe along Florence Avenue from S. Western Blvd. to the eastern end of the alignment.

The total length of the alignment is approximately 23.7 miles. The evaluation estimated 14.9 miles (63%) could be trenched and 8.8 miles (37%) would be tunneled, compared to the LADWP Concept Report, which assumed 70% trenched and 30% tunneled for the 54-inch- and 66-inch-diameter pipe sections and 15% trenched and 85% tunneled for the 108-inch-diameter pipe sections, which aggregates to 50% trenched and 50% tunneled over the whole alignment (Table 8-1).

Table 8-1. Alternative 1: Florence Alignment Construction Methodology by Pipe Diameter

Diameter (inches)	LADWP Concept Report				Alignment Review Estimate			
	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)
54	8.8	3.8	70	30	8.8	3.8	70	30
66	1.8	0.8	70	30	2.5	0.1	97	3
96	-	-	-	-	-	-	-	-
108	1.3	7.2	15	85	3.6	4.9	42	58
Total	**11.9**	**11.8**	**50**	**50**	**14.9**	**8.8**	**63**	**37**

Annex A provides a detailed analysis of the alignment.

8.2 Crossings

Table 8-2 presents the potential crossing locations noted during the alignment review, listed by category from west to east. Of these 54 crossings:

- 19 were identified as regular crossings within sections evaluated to be tunneled
- 3 were identified as special crossings (Caltrans and railroad) within sections evaluated to be tunneled
- 32 crossings were identified within the sections evaluated to be trenched, including both special and regular crossings

Hence, a total of 35 crossings would be required.

Table 8-2. Alternative 1: Florence Alignment Potential Crossing Locations

Type	Crossing
Caltrans	▪ I-105 in cutting, I-710
Railroads	▪ Single track at-grade east of I-405 ▪ Single track at-grade between W 126th Street and W. Broadway ▪ LA Metro C (Green) Line in cutting in the center of I-105 ▪ LA Metro A (Blue) Line four tracks at-grade at Graham Avenue ▪ Multiple tracks in open-cut trench at Alameda Street ▪ Single track at-grade at California Avenue
Drainage channels	▪ Los Angeles River just west of I-710 ▪ Rio Hondo Channel just east of Scout Avenue ▪ San Gabriel River Channel just west of I-605
Major road crossings	▪ W. Grand Avenue ▪ Chevron Refinery entrance ▪ N. Pacific Coast Highway ▪ N. Douglas Street ▪ S. Aviation Blvd. ▪ I-405 on- and off-ramps x2 ▪ La Cienega Blvd. ▪ S. Inglewood Avenue ▪ W. 120th Street ▪ Imperial Highway ▪ Lennox Blvd. ▪ Century Blvd. ▪ E. Arbor Vitae Street ▪ S. La Brea Avenue and Market Street ▪ E. Hillcrest Blvd. ▪ W. Manchester Blvd. ▪ N. La Brea Avenue and E. Florence Avenue ▪ Crenshaw Blvd. ▪ Western Avenue ▪ S. Normandie Avenue ▪ Vermont Avenue ▪ S. Hoover Street ▪ Figueroa Street ▪ I-110 on- and off-ramps ▪ S. Broadway ▪ S. Main Street ▪ San Pedro Street ▪ Avalon Blvd. ▪ Hooper Avenue ▪ Compton Avenue ▪ Alameda Street ▪ S. Santa Fe Avenue ▪ Pacific Blvd. ▪ State Street ▪ Atlantic Avenue ▪ Wilcox Avenue ▪ I-710 on- and off-ramps x2 ▪ Eastern Avenue ▪ Garfield Avenue ▪ Paramount Blvd. ▪ Lakewood Blvd. ▪ I-605 on- and off-ramps
Other infrastructure	▪ None

8.3 Potential Realignments

There are no suggested changes for this alignment.

9. Alternative 2: Manchester (Southern) Alignment

This section describes the Alternative 2: Manchester (southern) alignment geographically from west to east.

9.1 Overview

This alignment (Figure 9-1) runs west to east from the HWRP to the point where Firestone Blvd. passes below I-605. The alignment travels east along E. El Segundo Blvd. then north along Hawthorne Blvd. to Manchester Avenue, which it follows, becoming Firestone Avenue, for approximately 14.5 miles to I-605.

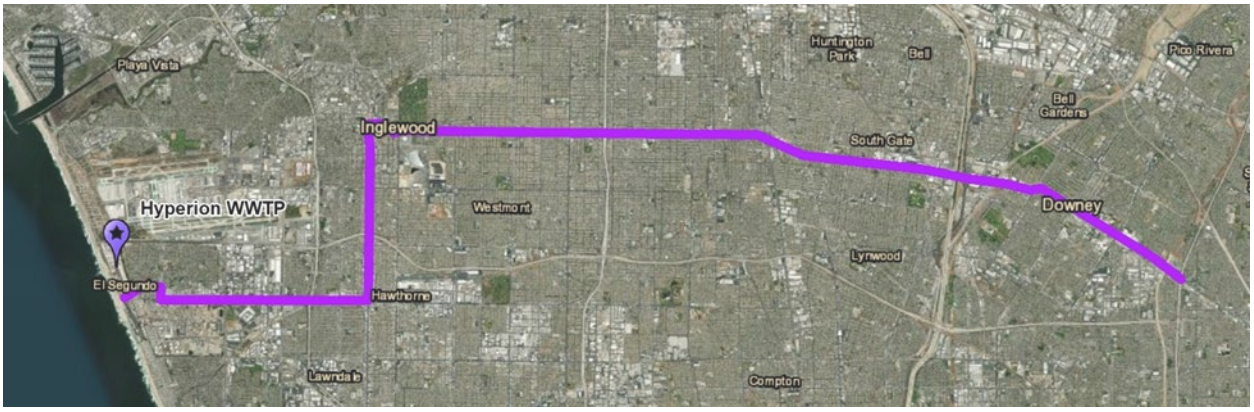

Figure 9-1. Alternative 2: Manchester Alignment

Source:

1. *Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community*
2. *LADWP 2022; Jacobs 2022*

This alignment is assumed to have a 108-inch-diameter pipe from the HWRP to S. La Brea Blvd. and E. Tamarack Avenue, a 66-inch-diameter pipe from E. Tamarack Avenue and Manchester Avenue to S. Western Blvd. and a 54-inch-diameter pipe along Manchester Avenue and Firestone Blvd. from S. Western Blvd. to the eastern end of the alignment.

The total length of the alignment is approximately 22.8 miles. The evaluation estimated 8.5 miles (37%) could be trenched and 14.3 miles (63%) would be tunneled, compared to the LADWP Concept Report, which assumed 70% trenched and 30% tunneled for the 54-inch- and 66-inch-diameter pipe sections and 15% trenched and 85% tunneled for the 108-inch-diameter pipe sections, which aggregates to 51% trenched and 49% tunneled over the whole alignment (Table 9-1).

Table 9-1. Alternative 2: Manchester Alignment Construction Methodology by Pipe Diameter

Diameter (inches)	LADWP Concept Report				Analysis Review Estimate			
	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)
54	8.7	3.7	70	30	4.5	7.9	36	64
66	1.9	0.8	70	30	0.5	2.2	19	81
96	-	-	-	-	-	-	-	-
108	1.2	6.5	15	85	3.6	4.1	46	54
Total	**11.7**	**11.1**	**51**	**49**	**8.5**	**14.3**	**37**	**63**

Annex A provides a detailed analysis of the alignment.

9.2 Crossings

Table 9-2 presents the potential crossing locations noted during the alignment review, listed by category from west to east. Of these 58 crossings:

- 33 were identified as regular crossings within sections evaluated to be tunneled
- 5 were identified as special crossings (Caltrans and railroad) within sections evaluated to be tunneled
- 20 crossings were identified within the sections evaluated to be trenched, including both special and regular crossings

Hence, a total of 25 crossings would be required.

Table 9-2. Alternative 2: Manchester Alignment Potential Crossing Locations

Type	Crossing
Caltrans	▪ I-105 in cutting, I-710
Railroads	▪ Single track at-grade east of I-405 ▪ Single track at-grade between W. 126th Street and W. Broadway ▪ LA Metro C (Green) Line in cutting in the center of I-105 ▪ Multiple tracks in open-cut trench at Alameda Street ▪ Single track at-grade at Firestone Place ▪ Railroad at Old River School Road
Drainage channels	▪ Los Angeles River just west of I-710 ▪ Rio Hondo Channel just east of Garfield Avenue ▪ San Gabriel River Channel just west of I-605
Major road crossings	▪ W. Grand Avenue ▪ Chevron Refinery entrance ▪ N. Pacific Coast Highway ▪ N. Douglas Street ▪ S. Aviation Blvd. ▪ I-405 on- and off-ramps x2 ▪ La Cienega Blvd. ▪ S. Inglewood Avenue ▪ W. 120th Street ▪ Imperial Highway ▪ Lennox Blvd. ▪ Century Blvd. ▪ E. Arbor Vitae Street ▪ S. Prairie Avenue ▪ Inglewood Cemetery entrance ▪ Crenshaw Blvd. ▪ S. Van Ness Avenue ▪ S. Western Avenue ▪ S. Normandie Avenue ▪ S. Vermont Avenue ▪ S. Hoover Street ▪ Figueroa Street ▪ I-110 on- and off-ramps ▪ S. Broadway ▪ S. Main Street ▪ San Pedro Street ▪ Avalon Blvd. ▪ Hooper Avenue ▪ Compton Avenue ▪ Alameda Street ▪ Santa Fe Avenue ▪ Long Beach Blvd. ▪ State Street ▪ California Avenue ▪ Otis Street ▪ Atlantic Avenue ▪ I-710 on- and off-ramps x2 ▪ Garfield Avenue ▪ Old River School Road ▪ Rives Avenue ▪ Paramount Blvd. ▪ Downey Avenue ▪ Brookshire Avenue ▪ Lakewood Blvd. ▪ I-605 on- and off-ramps
Other infrastructure	▪ None

9.3 Potential Realignments

There are no suggested changes for this alignment.

10. Summary

Of the three north–south alignments, Griffith Park is the longest at approximately 29.5 miles, Sepulveda is the next longest at approximately 29.0 miles, and Cahuenga is the shortest at approximately 27.3 miles.

The three west–east alignments are of a very similar length, with Slauson at approximately 23.3 miles, Florence at approximately 23.7 miles, and Manchester at approximately 22.8 miles.

Table 10-11 and Table 10-2 summarize the length and percentage of trenched verses tunnel construction evaluated for each of the alignment options and compare them to the aggregated percentages presented in the LADWP Concept Report.

Table 10-1. Summary of Trenched and Tunneled Sections for the North-South Alignments

Alignment	LADWP Concept Report		Analysis Review Estimate			
	Trenched (%)	Tunneled (%)	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)
Griffith Park	15	85	9.7	19.8	33	67
Cahuenga	15	85	9.3	18.0	34	66
Sepulveda	15	85	12.7	16.3	44	56

Table 10-2. Summary of Trenched and Tunneled Sections for the West-East Alignments

Alignment	LADWP Concept Report		Analysis Review Estimate			
	Trenched (%)	Tunneled (%)	Trenched (miles)	Tunneled (miles)	Trenched (%)	Tunneled (%)
Slauson	54	46	7.5	15.8	32	68
Florence	50	50	14.9	8.8	63	37
Manchester	51	49	8.5	14.3	37	63

For the north–south alignments, in all cases, the amount of tunneling evaluated is less than estimated in the LADWP Concept Report, with the Sepulveda alignment having the lowest percentage of tunneling and conversely the highest percentage of trenching of the three alignments. Even though the Cahuenga alignment is the shortest of the three, it still has a greater length of tunneling than the Sepulveda alignment, whereas the Griffith Park alignment is both the longest alignment and has the greatest length of tunneling.

For the west–east alignments, the Florence alignment was evaluated to have less tunneling than estimated in the LADWP Concept Report, whereas the Slauson and Manchester alignments both had more tunneling than estimated. While the Slauson and Manchester alignments were evaluated to have similar amounts of tunnel construction, at 68% and 63%, respectively, the Florence alignment was evaluated to have the opposite ratio, with 63% trenched and only 37% tunneled. This is largely due to the difference at the eastern end of the alignments. Whereas the Slauson and Manchester alignments pass through largely industrial areas with numerous major crossings at their eastern ends, the Florence alignment passes through a residential neighborhood with relatively few major crossings at its eastern end, which lends itself more toward trenched construction.

The total number of potential crossings was identified for each alignment, and in each case the majority occurred in sections evaluated to be tunneled. Of those crossings within the tunnel sections, most would be regarded as regular crossings and would be constructed as part of the tunnel construction without the need for dedicated shafts or other special provisions.

However, each alignment also has several special crossings (Caltrans and railroad) within the sections evaluated for tunneling, and these would require shafts at either side and immediately adjacent to the asset. The remainder of the identified crossings occur in sections identified to be trenched and each one, whether regular or special, will require shafts at each side of each crossing.

Table 10-3 and Table 10-4 summarize the crossings identified by type (regular or special), for tunnel and trenched sections.

Table 10-3. Summary of Identified Crossings for the North-South Alignments

Alignment	Potential Crossings	Regular Crossings in Tunnel Sections	Special Crossings in Tunnel Sections	Regular Crossings in Trenched Sections	Special Crossings in Trenched Sections	Estimated Crossings Required
Griffith Park	77	56	7	14	0	21
Cahuenga	67	47	4	16	0	20
Sepulveda	72	47	2	22	1	25

Table 10-4. Summary of Identified Crossings for the West-East Alignments

Alignment	Potential Crossings	Regular Crossings in Tunnel Sections	Special Crossings in Tunnel Sections	Regular Crossings in Trenched Sections	Special Crossings in Trenched Sections	Estimated Crossings Required
Slauson	52	34	9	8	1	18
Florence	54	19	3	28	4	35
Manchester	58	33	5	17	3	25

For the north–south alignments, although the Griffith Park alignment has the most potential crossings, it also has the most regular crossings within sections identified for tunneling; hence, it will not need a separate crossing construction. The Sepulveda alignment will require the most crossings with 25 crossings estimated, followed by the Griffith Park alignment with 21 crossings estimated, and the Cahuenga alignment with 20 crossings estimated.

For the west–east alignments, while there are a similar number of potential crossings along all three, the proportion that would occur within sections evaluated to be tunneled differs and hence the resulting number of crossings to be constructed varies from 35 for the Florence alignment to 25 for the Manchester alignment and 18 for the Slauson alignment. The Florence alignment requires more crossings due to being evaluated as having a greater length of trenched sections compared to the other two alignments.

Shafts will be required to facilitate both tunneling and crossings. In tunneled sections, regular spaced shafts are required as discussed earlier. For crossings in sections evaluated to be trenched, one shaft at each side of the crossing is assumed. Table 10-5 and Table 10-6 list the number of shafts estimated for each alignment.

Table 10-5. Estimated Number of Shafts for the North-South Alignments

Alignment	Tunneling Shafts	Crossing Shafts	Total Shafts
Griffith Park	20	42	62
Cahuenga	18	40	58
Sepulveda	14	50	64

Table 10-6. Estimated Number of Shafts for the West-East Alignments

Alignment	Tunneling Shafts	Crossing Shafts	Total Shafts
Slauson	23	36	59
Florence	8	70	78
Manchester	16	50	66

As a general rule, the greater the length of trenched sections in any given alignment, the greater the number of crossings required and hence, the greater the number of shafts required. This is due to the frequency of potential crossings identified in the dense urban setting of the alignments and the spacing between them being less than the distance between regularly spaced shafts for tunnel construction. For the north–south alignments, Sepulveda has the greatest percentage of trenched sections and, accordingly, the greatest number of crossings and hence the greatest number of shafts, with the Cahuenga alignment requiring the fewest number of shafts. Similarly, for the west–east alignments, this is even more apparent for the Florence alignment, which has a significantly higher proportion of trenched sections than the other two alignments and hence more crossings and therefore more shafts.

Each alignment is different, so it is reasonable to expect that the percentages of trenched and tunneled sections, crossings and shafts will vary for each. Although applying a general rule of thumb is sufficient for initial high-level estimating purposes, considering each alignment option individually gives a greater confidence in any estimating exercise and provides a basis to compare alignment options.

The information presented in this report is based on limited data reviewed for this evaluation and many other factors that have not been included as part of this study could influence these results. As stated, the information presented is not intended to be used solely to determine a preferred alignment.

Section 11 provides additional information that could be used to validate these results, increase confidence in an associated cost estimate, and provide a reliable comparison of the different alignment options.

11. Recommendations

It is recommended that the following actions are taken for each of the alignment options to validate and further refine the evaluation presented in this report:

- Refine pipe diameters.
- Conduct detailed hydraulic analysis.
- Review existing underground utilities.
- Review existing underground infrastructure as-built drawings.
- Investigate geotechnical and geological conditions.
- Determine likely preferred construction methodology for all tunnel sections and tunneled crossings.
- Define individual length of each crossing.
- Refine the estimated number of shafts.
- Evaluate corrosion risk due to high-voltage power lines.
- Understand requirements for Caltrans and railroad crossings.
- Understand the City and County of Los Angeles requirements for street crossings.
- Evaluate ROWs, easements, and land acquisitions required.
- Determine permitting requirements.
- Evaluate traffic disruption.
- Evaluate local community impacts.
- Assess environmental impacts.
- Estimate cost and schedule.
- Conduct a risk assessment.
- Review future projects with potential conflicts.

12. References

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Annex A.
Alignment Analysis Details

From	To	Pipe Diameter (in)	Alignment characterisation and comments	Main Construction Method	Trenched Length (mi)	Tunnelled Length (mi)	Total Length (mi)	Crossings			Shafts			Major Crossings					Possible amendments
								Special	General	Total	Tunnelling	Crossings	Total	Caltrans	Railroad	Storm drains	Roads	Other	
LAAFP	Rinaldi Road	96	Van Norman Reservoir and surrounding land including numerous storm drain channel crossings. Variable ground level. Crossings and ground level variability suggest tunnelling.	Tunnelled	0.0	1.6	1.6	0	5	5	2	0	2	---	---	Four crossings of same storm drain channel	---	Electrical Substation	Realign to avoid substation.
Rinaldi Road	Woodman Ave. and San Jose St.	96	Crosses numerous residential and commercial properties and two major freeways. Freeway crossings would have to be perpendicular. Easements for tunnelling below properties may be difficult to obtain. As drawn, alignment would be tunnelled.	Tunnelled	0.0	1.8	1.8	2	0	2	2	4	6	I-405, 118 Fwy	---	---	---	---	Realign to follow Haskell Ave. and Devonshire St. to avoid properties and allow perpendicular crossing of Caltrans infrastructure. Could possibly be trenched.
Woodman Ave. and San Jose St.	Woodman Ave. and Devonshire St.	96	Wholly along Woodman Ave. right of way. Short section could be trenched but since a crossing is assumed to be required at each end tunneling is assumed for such a short section.	Tunnelled	0.0	0.3	0.3	0	2	2	1	0	1	---	---	---	Woodman Ave. and San Jose St., Woodman Ave. and Devonshire St.	---	Realignment of previous section could impact this section.
Woodman Ave. and Devonshire St.	Filmore St.	96	Pacoima Spreading Grounds. Could be trenched if permits can be obtained but may impact functionality of the spreading grounds so assumed tunnelled.	Tunnelled	0.0	0.5	0.5	0	1	1	1	0	1	---	---	---	---	Pacoima Spreading Grounds	Avoid spreading grounds. May not be permitted to trench or tunnel below.
Filmore St.	Roscoe Blvd.	96	Assumed to be within overhead powerline right of way parallel to Canterbury Ave. Assume trenched construction but right of way permission below power lines, utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	2.6	0.3	2.9	0	7	7	0	14	14	---	---	Tujunga Wash Storm Drain Channel	Mercer St., Van Nuys Blvd., Terra Bella St., Osbourne St., Branford St., Sheldon St. and Roscoe Blvd.	---	---
Roscoe Blvd.	Chandler Blvd.	96	Assumed to be within overhead powerline right of way. Assume tunnelled construction due to number of crossings and associated shafts that would be required for trenched construction. Freeway and railroad crossings would have to be perpendicular.	Tunnelled	0.0	5.0	5.0	2	12	14	4	4	8	170 Fwy	Four tracks at grade just south of Sherman Way	---	Strathern St., Whitset Ave. Saticoy St., Laurel Canyon Blvd., Sherman Way, Lankershim Blvd., Dehougne St., Vanowen St., Victory Blvd., Vineland Ave., Burbank Blvd.,	Electrical Substation	Realign to cross 170 Fwy perpendicularly. Realign to cross railroad lines perpendicularly.
Chandler Blvd.	W. Clark Ave. and N. Hollywood Way	96	Assume tunnelled as alignment crosses numerous residential properties. Easements for tunnelling below properties may be difficult to obtain.	Tunnelled	0.0	0.6	0.6	0	3	3	1	0	1	---	---	---	Chandler Blvd., Magnolia Blvd., W. Clark Ave. and N. Hollywood Way	---	Realign either along Chandler Blvd and N. Hollywood Way or Evergreen St. and W. Clark Ave. to avoid residential properties.
W. Clark Ave. and N. Hollywood Way	N. Fairview St.	96	North section assumed to be within overhead powerline right of way, south section follows N. Whitnall Hwy right of way. Assume trenched construction but right of way permission below power lines may dictate tunnelling to be more efficient.	Trenched	0.8	0.04	0.8	0	1	1	0	2	2	---	---	---	W. Verdugo Ave.	---	---
N. Fairview St.	S. Buena Vista St. and 134 Fwy	96	Crosses park land and parking lots. Assume permit for trenching would not be obtainable and tunnelled construction would be required.	Tunnelled	0.0	0.5	0.5	0	1	1	1	0	1	---	---	---	W. Alameda Ave.	---	Several options for realignment from W. Alameda Ave to Forest Lawn Dr. and Zoo Dr. to facilitate perpendicular crossing of 134 Fwy. Could possibly be trenched.
S. Buena Vista St. and 134 Fwy	Forest Lawn Dr. and Zoo Dr.	96	Follows W. Riverside Dr right of way, crosses numerous residential properties, the 134 Fwy and the LA River. Freeway crossing would have to be perpendicular. Assume tunnelled as alignment crosses numerous residential properties. Easements for tunnelling below properties may be difficult to obtain.	Tunnelled	0.0	1.0	1.0	1	1	2	1	2	3	134 Fwy	---	LA River	---	---	Several options for realignment from W. Alameda Ave to Forest Lawn Dr. and Zoo Dr. to facilitate perpendicular crossing of 134 Fwy. Could possibly be trenched.
Forest Lawn Dr. and Zoo Dr.	Los Feliz Blvd. and Riverside Dr.	96	Assumed alignment follows Zoo Dr., Western Heritage Way and Crystal Springs Drive right of ways. Due to minimal crossings, assume trenched construction.	Trenched	4.5	0.1	4.6	0	3	3	0	6	6	---	---	---	Riverside Dr., Zoo entrance, I-5 on/off ramps	---	---
Los Feliz Blvd. and Riverside Dr.	Hyperion Ave. and Rowena Ave.	96	Follows Riverside Dr. and Hyperion Ave. right of way with sharp bend, change in grade at the intersection of the two and Hyperion Ave is in a cutting. Assume tunnelled construction to avoid these obstacles.	Tunnelled	0.0	0.7	0.7	0	0	0	1	0	1	---	---	---	---	---	Realign with direct tunnel between Riverside Dr. and Hyperion Ave.
Hyperion Ave. and Rowena Ave.	N. Vermont Ave. and Fountain Ave.	96	Hyperion Ave. and Fountain Ave. right of way. Due to minimal crossings assume trenched construction.	Trenched	1.8	0.1	1.9	0	3	3	0	6	6	---	---	---	Griffith Park Blvd., Sunset Blvd., N. Virgil Ave.	---	---
N. Vermont Ave. and Fountain Ave.	N. Vermont Ave. and Wilshire Blvd.	96	N. Vermont Ave. right of way. Whole section follows LA Metro B (Red) Line subway alignment. At southern end alignment crosses LA Metro D (Purple) Line subway alignment. Could be trenched but number of crossings, associated shafts and existing LA Metro infrastructure may dictate tunnelling to be more efficient. Freeway crossing would have to be perpendicular.	Tunnelled	0.0	2.3	2.3	1	9	10	2	2	4	101 Fwy	---	---	Lexington Ave., Vermont Pl., Santa Monica Blvd., Melrose Ave., Beverly Blvd., W. 1st St., W. 3rd St., W. 4th St., W. 6th St.	---	Consider alternative route to avoid LA Metro B (Red) Line subway alignment and cross 101 Fwy perpendicularly.
N. Vermont Ave. and Wilshire Blvd.	N. Vermont Ave. and Slauson Ave.	96	N. Vermont Ave. right of way. Crosses elevated I-10 freeway. Assume tunnelled construction due to number of crossings and associated shafts that would be required for trenched construction.	Tunnelled	0.0	5.0	5.0	1	22	23	4	2	6	---	LA Metro E (Expo) Line at grade	---	W. 7th St., W. 8th St., James M. Wood Blvd., W. Olympic Blvd., W. Pico Blvd., Venice Blvd., W. Washington Blvd., W. Adams Blvd., W. Jefferson Blvd., Exposition Blvd., W. Martin Luther King Jr. Blvd., W. 42nd St., W 43rd St., W. Vernon Ave., W. 48th St., W. 49th St., W. 53rd St., W. 54th St., W. 55th St., W. 56th St., W. 57th St., W. 58th St.	---	---
LAAFP	Rinaldi Road	96	Van Norman Reservoir and surrounding land including numerous storm drain channel crossings. Variable ground level. Crossings and ground level variability suggest tunnelling.	Tunnelled	0.0	1.6	1.6	0	5	5	2	0	2	---	---	Four crossings of same storm drain channel	---	Electrical Substation	Realign to avoid substation.
Rinaldi Road	Woodman Ave. and San Jose St.	96	Crosses numerous residential and commercial properties and two major freeways. Freeway crossings would have to be perpendicular. Easements for tunnelling below properties may be difficult to obtain. As drawn, alignment would be tunnelled.	Tunnelled	0.0	1.8	1.8	2	0	2	2	4	6	I-405, 118 Fwy	---	---	---	---	Realign to follow Haskell Ave. and Devonshire St. to avoid properties and allow perpendicular crossing of Caltrans infrastructure. Could possibly be trenched.

From	To	Pipe Diameter (in)	Alignment characterisation and comments	Main Construction Method	Trenched Length (mi)	Tunnelled Length (mi)	Total Length (mi)	Crossings			Shafts			Major Crossings					Possible amendments
								Special	General	Total	Tunnelling	Crossings	Total	Caltrans	Railroad	Storm drains	Roads	Other	
Woodman Ave. and San Jose St.	Woodman Ave. and Devonshire St.	96	Wholly along Woodman Ave. right of way. Short section could be trenched but since a crossing is assumed to be required at each end tunneling is assumed for such a short section.	Tunnelled	0.0	0.3	0.3	0	2	2	1	0	1	---	---	---	Woodman Ave. and San Jose St., Woodman Ave. and Devonshire St.	---	Realignment of previous section could impact this section.
Woodman Ave. and Devonshire St.	Filmore St.	96	Pacoima Spreading Grounds. Could be trenched if permits can be obtained but may impact functionality of the spreading grounds so assumed tunnelled.	Tunnelled	0.0	0.5	0.5	0	1	1	1	0	1	---	---	---	---	Pacoima Spreading Grounds	Avoid spreading grounds. May not be permitted to trench or tunnel below.
Filmore St.	Roscoe Blvd.	96	Assumed to be within overhead powerline right of way parallel to Canterbury Ave. Assume trenched construction but right of way permission below power lines, utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	2.6	0.3	2.9	0	7	7	0	14	14	---	---	Tujunga Wash Storm Drain Channel	Mercer St., Van Nuys Blvd., Terra Bella St., Osbourne St., Branford St., Sheldon St. and Roscoe Blvd.	---	---
Roscoe Blvd.	Valerio St.	96	Assumed to be within overhead powerline right of way. Assume tunnelled construction due to number of crossings and associated shafts that would be required for trenched construction. Freeway crossing would have to be perpendicular.	Tunnelled	0.0	1.6	1.6	1	4	5	2	2	4	170 Fwy	---	---	Strathern St., Whitset Ave., Saticoy St., Laurel Canyon Blvd.,	---	---
Valerio St.	Victory Blvd. and Lankershim Blvd.	96	Assume tunnelled as alignment crosses numerous residential and commercial/industrial properties and a railroad. Easements for tunnelling below properties may be difficult to obtain. Railroad crossing would have to be perpendicular.	Tunnelled	0.0	1.3	1.3	1	2	3	1	2	3	---	Four tracks at grade just south of Sherman Way	---	Sherman Way, Vanowen St.,	---	Realignment along Lankershim Blvd. could facilitate perpendicular crossing of railroad. Could possibly be trenched.
Victory Blvd. and Lankershim Blvd.	Tujunga Ave. and Camarillo St.	96	Follows Lankershim Blvd. and Tujunga Ave. right of way. Could be trenched but number of crossings and associated shafts may dictate tunnelling to be more	Tunnelled	0.0	2.1	2.1	0	6	6	2	0	2	---	---	---	Oxnard St., Hatteras St., Collins St., Burbank Blvd., Chandler Blvd., Magnolia Blvd.	---	---
Tujunga Ave. and Camarillo St.	Lankershim Blvd. and Ventura Blvd.	96	Crosses below elevated 170 Fwy. and follows 101 Fwy right of way which would not be permitted.	Tunnelled	0.0	1.5	1.5	0	4	4	1	0	1	---	---	LA River	Moorpark St., Vineland Ave., Campo De Cahuenga	---	Realign to avoid 101 Fwy. right of way by either continuing along Lankershim Blvd. to Cahuenga Blvd. or Colfax Blvd. and Ventura Blvd. to Cahuenga Blvd.
Lankershim Blvd. and Ventura Blvd.	Hollywood Bowl entrance	96	Assumed this section of the alignment follows Cahuenga Blvd. and not the 101 Fwy. which would not be permitted. It would have to be coordinated with the LA Metro B (Red) Line subway alignment just south of the Universal City station. Assumed trenched construction but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	3.0	0.2	3.2	0	5	5	0	10	10	---	---	---	Regal Pl., Universal Studios Blvd., Barham Blvd., Cadet Ct. and Oakcrest Dr., Pilgrimage Bridge	---	---
Hollywood Bowl entrance	S. Highland Ave. and Wilshire Blvd.	96	Follows N. Highland Ave. right of way through residential and commercial areas. Would have to be coordinated with crossing of LA Metro B (Red) Line subway at N. Highland Ave. and Hollywood Blvd. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	3.4	3.4	0	13	13	3	0	3	---	---	---	Franklin Ave., Hollywood Blvd., Sunset Blvd., Fountain Ave., Lexington Ave., Santa Monica Blvd., Romaine St., Willoughby Ave., Waring Ave., Melrose Ave., Beverly Blvd., W. 3rd St., W. 6th St.	---	---
S. Highland Ave. and Wilshire Blvd.	S. La Brea Ave. and Coliseum St.	96	Follows N. Highland Ave., Edgewood Pl. and S. La Brea Ave. right of way. Crosses elevated section of I-10 freeway and elevated section of LA Metro A (Blue) Line. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	3.3	3.3	0	10	10	3	0	3	---	---	---	W. Olympic Blvd., San Vincente Blvd., W. Pico Blvd., Venice Blvd., W. Washington Blvd., W. Adams Blvd., W. Jefferson Blvd., W. Exposition Blvd., Obama Blvd., Coliseum St.	---	---
S. La Brea Ave. and Coliseum St.	S. La Brea Ave. and Slauson Ave.	96	Wholly along S. La Brea Ave. between residential area to the east and the Kenneth Hahn State Recreation Area / Baldwin Hills to the west. Due to minimal number of crossings this section is assumed to be trenched.	Trenched	2.1	0.04	2.1	0	1	1	0	2	2	---	---	---	Stocker St.	---	---
S. La Brea Ave. and Slauson Ave.	N. La Brea Ave. and W. Florence Ave.	96	Wholly along S. La Brea Ave. and N. La Brea Ave. through residential and commercial area. Passes below elevated railway at Florence Ave. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Trenched	1.6	0.1	1.7	0	3	3	0	6	6	---	---	---	W. Fairview Blvd., Centinela Ave., W. Hyde Park Blvd. and W. Juniper St.	---	---
LAAFP	Woodley Ave. and Rinaldi Road	96	Van Norman Reservoir and surrounding land including numerous storm drain channel crossings, below residential properties and along Woodley Ave. right of way. Variable ground level. Easements for tunnelling below properties may be difficult to obtain. Crossings and ground level variability suggest tunnelling.	Tunnelled	0.0	1.9	1.9	0	4	4	2	0	2	---	---	Four crossings of same storm drain channel	---	---	---
Woodley Ave. and Rinaldi Road	Woodley Ave. and Roscoe Blvd.	96	Wholly along Woodley Ave. right of way through mostly residential neighbourhoods. Passes below elevated 118 freeway. Assumed trenched but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	3.7	0.3	4.0	0	9	9	0	18	18	---	---	---	San Fernando Mission Blvd., Horace St., Chatsworth St., Devonshire St., Lassen St., Kinze St., Plummer St., Nordoff St., Parthenia St.	---	---
Woodley Ave. and Roscoe Blvd.	Woodley Ave. and Saticoy St.	96	Wholly along Woodley Ave. right of way through commercial and industrial areas alongside Van Nuys Airport. Due to number of crossings required to prevent cutting off access to dead end roads adjacent to the airport, tunnelling is assumed for this section.	Tunnelled	0.0	0.9	0.9	1	6	7	1	2	3	---	Single track between Roscoe Blvd. and Raymer St.	---	Raymer St., Daily Dr., Waterman Dr., Lindbergh St., Stagg St., Byrd St.	---	---
Woodley Ave. and Saticoy St.	Woodley Ave. and Victory Blvd.	96	Wholly along Woodley Ave. right of way through residential, commercial and industrial areas. Due to minimal number of crossings this section is assumed to be trenched.	Trenched	1.4	0.1	1.5	0	2	2	0	4	4	---	---	---	Sherman Way, Vanowen St.	---	---

From	To	Pipe Diameter (in)	Alignment characterisation and comments	Main Construction Method	Trenched Length (mi)	Tunnelled Length (mi)	Total Length (mi)	Crossings			Shafts			Major Crossings					Possible amendments
								Special	General	Total	Tunnelling	Crossings	Total	Caltrans	Railroad	Storm drains	Roads	Other	
Woodley Ave. and Victory Blvd.	Sepulveda Blvd. north of Erwin St.	96	Follows Woodley Ave. then crosses Donald C. Tillman Water Reclamation Plant, I-405, Orange Line Busway and residential area. Easements for tunnelling below properties may be difficult to obtain. Due to numerous conflicts, tunnelling is assumed.	Tunnelled	0.0	1.2	1.2	1	3	4	1	2	3	I-405	---	---	Orange Line Busway x2	Donald C. Tillman Water Reclamation Plant	Realignment to avoid Donald C. Tilman Water Reclamation Plant if necessary and/or cross I-405 freeway perpendicularly. Could be trenched.
Sepulveda Blvd. north of Erwin St.	Sepulveda Blvd. and Valley Vista Blvd.	96	Wholly along Sepulveda Blvd. right of way. Passes below elevated section of 101 Fwy. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	2.4	2.4	0	12	12	2	0	2	---	---	LA River	Orange Line Busway, Oxnard St., Hatteras St., Burbank Blvd., Albers St., Magnolia Blvd., Camarillo St., Ventura Blvd., Dickens St., I-405 on/off ramp, Sutton St.	---	---
Sepulveda Blvd. and Valley Vista Blvd.	Sepulveda Blvd. and Skirball Centre Dr.	96	Follows N. Sepulveda Blvd. right of way passing below an elevated section of I-405 Fwy, through a short road tunnel and through a mostly residential area. Due to minimal crossings and residential streets this section is assumed to be trenched.	Trenched	2.7	0.1	2.8	0	2	2	0	4	4	---	---	---	Fiume Walk, I-405 on/off ramps	---	---
Sepulveda Blvd. and Skirball Centre Dr.	Sepulveda Blvd. and Wilshire Blvd.	96	It's assumed this section of the alignment follows N. Sepulveda Blvd. right of way and not the I-405 freeway which would not be permitted instead passing below an elevated section of the I-405 Fwy. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	5.3	5.3	0	11	11	4	0	4	---	---	---	I-405 on/off ramps x3, Mission Dump Rd., Mountaingate Dr., Bel Air Crest Rd., Bel Terrace, Moraga Dr., N. Church Ln., Sunset Blvd., Constitution Ave.	---	---
Sepulveda Blvd. and Wilshire Blvd.	Cotner Ave. and W. Pico Blvd.	96	It's assumed the north end of this section is intended to follow Sepulveda Blvd. on the east side of the I-405 freeway rather than crossing the I-405 freeway as drawn and then follows Cotner Ave. right of way. As such the alignment passes below several elevated I-405 on/off ramps. Due to small number of crossings this section is assumed to be trenched but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	1.4	0.2	1.6	0	4	4	0	8	8	---	---	---	Ohio Ave., Santa Monica Blvd., W. Olympic Blvd., Tennessee Ave.	---	---
Cotner Ave. and W. Pico Blvd.	Sepulveda Blvd. and National Blvd.	96	It's assumed this section of the alignment is intended to follow Sepulveda Blvd. right of way. South of Pico Blvd. this section crosses the LA Metro at grade E (Expo) Line, numerous residential properties and the elevated I-405 and I-10 freeway interchange. Due to small number of crossings this section is assumed to be trenched but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	0.8	0.0	0.8	0	1	1	0	2	2	I-10	---	---	Exposition Blvd.	---	Realign along Sepulveda Blvd.
Sepulveda Blvd. and National Blvd.	Sepulveda Blvd. and Ballona Creek	96	It's assumed this section of the alignment is intended to follow Sepulveda Blvd. right of way. As the whole section is within the roadway right of way. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	3.5	3.5	0	10	10	3	0	3	---	---	Storm drain just north of Rose Ave., storm drain just south of Lucerne Ave.	Palms Blvd., Venice Blvd., I-405 on/off ramps, Washington Pl., Washington Blvd., Culver Blvd., Jefferson Blvd., Slauson Ave.	---	---
Sepulveda Blvd. and Ballona Creek	Ballona Creek and W. Centinela Ave.	96	Alignment follows Ballona Creek. This would have to be tunnelled.	Tunnelled	0.0	0.2	0.2	0	1	1	1	0	1	---	---	Ballona Creek	---	---	---
Ballona Creek and W. Centinela Ave.	Centinela Ave. and E. Florence Ave.	96	Assumed to follow Centinela Ave. right of way for the whole of this section through residential and commercial areas. As the whole section is within the roadway right of way with minimal crossings, trenched construction is assumed.	Trenched	2.7	0.2	2.9	1	4	5	0	10	10	---	Twin tracks at E. Florence Ave.	---	Hillside Memorial Park entrance, S La Tijera Blvd., La Cienega Blvd., N. La Brea Ave.	---	---
HWWTP	La Tijera Blvd. and Sepulveda Blvd.	108	Follows S. Pershing Dr., Westchester Pkwy and La Tijera Blvd. right of way around LAX airport. As this is not in a built up area and has minimal crossings trenched construction is assumed.	Trenched	3.8	0.2	4.0	0	4	4	0	8	8	---	---	---	World Way W., Pershing Dr. and Westchester Pkwy., Lincoln Blvd., Westchester Pkwy. and La Tijera Blvd.	---	---
La Tijera Blvd. and Sepulveda Blvd.	La Tijera Blvd. and La Cienega Blvd.	108	This section follows La Tijera Blvd. right of way through a mostly residential and small commercial areas. Assumed to be trenched but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	1.9	0.2	2.1	1	3	4	0	8	8	I-405	---	---	Manchester Ave., Airport Blvd., W. Centinela Ave.,	---	---
La Tijera Blvd. and La Cienega Blvd.	S. La Tijera Blvd. and Slauson Ave.	108	This section follows a direct line between the two points below a number of residential properties and hence would have to be tunnelled. Easements for tunnelling below properties may be difficult to obtain.	Tunnelled	0.0	0.7	0.7	0	0	0	1	0	1	---	---	---	---	---	Realign along La Tijera Blvd. to avoid residential properties. Could be trenched.
S. La Tijera Blvd. and Slauson Ave.	W. Slauson Ave. and S. Western Ave.	66	This section follows the Slauson Ave. right of way. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	3.2	3.2	1	5	6	5	2	7	---	LA Metro K Line at grade	---	S. Fairfax Ave., S. La Brea Ave., Overhill Dr., Crenshaw Blvd., S. Van Ness Ave.	---	---
W. Slauson Ave. and S. Western Ave.	E. Slauson Ave. and S. Central Ave.	54	This section follows the Slauson Ave. right of way crossing disused railway lines between Western Ave., and Denker Ave and below an elevated section of the I-110 freeway. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	3.0	3.0	0	9	9	4	0	4	---	---	---	Western Ave., S. Normandie Ave., Vermont Ave., S. Hoover St., Figueroa St., I-110 Freeway on/off ramps, S. Broadway, S. Main St., S. Avalon Blvd.	---	---

From	To	Pipe Diameter (in)	Alignment characterisation and comments	Main Construction Method	Trenched Length (mi)	Tunnelled Length (mi)	Total Length (mi)	Crossings			Shafts			Major Crossings					Possible amendments
								Special	General	Total	Tunnelling	Crossings	Total	Caltrans	Railroad	Storm drains	Roads	Other	
W. Slauson Ave. and S. Western Ave.	E. Slauson Ave. and Maywood Ave.	54	This section follows the Slauson Ave. right of way crossing numerous at grade rail lines and an elevated section of the LA Metro A (Blue) Line through a mostly commercial and industrial area. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	3.1	3.1	4	9	13	5	8	13	---	Single track at grade at Long Beach Ave., multiple tracks in open cut trench at Alameda St., single track at grade between S. Boyle Ave. and Alcoa Ave., single track at grade at S	---	Hooper Ave., Compton Ave., Alameda St., S. Santa Fe Ave., Pacific Blvd., S. Soto St., S. Boyle Ave., Alcoa Ave., S. Downey Road	---	---
E. Slauson Ave. and Maywood Ave.	E. Slauson Ave. and Alamo Ave.	54	This section follows the Slauson Ave. right of way through residential neighbourhood. As the whole section is within the roadway right of way with minimal crossings, trenched construction is assumed.	Trenched	1.7	0.04	1.7	0	1	1	0	2	2	---	---	---	Atlantic Blvd.	---	---
E. Slauson Ave. and Alamo Ave.	Slauson Ave. and I-605	54	This section follows the Slauson Ave. right of way with various crossings at grade, elevated and in cuttings including an elevated section of the I-5 freeway, through a mostly commercial and industrial area. Some crossings could be combined due to their proximity. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	5.5	5.5	4	11	15	8	8	16	I-710	Single track at grade east of I-710, single track at grade between Boxford Ave. and S. Malt Ave. four tracks at grade east of the San Gabriel River Channel	LA River, Rio Hondo Channel, San Gabriel River Channel	S. Eastern Ave., Garfield Ave., E. Gage Ave., Telegraph Road, Paramount Blvd., Rosemead Blvd., Passons Blvd., I-605 on/off ramps	---	Consider alternative route at eastern end of this alignment to avoid crossing rail lines that cross each other approximately perpendicular.
HWWTP	Whiting St.	108	Open land between the HWWTP and residential neighbourhood. Variable ground level suggests tunnelled construction.	Tunnelled	0.0	1.1	1.1	0	1	1	1	0	1	---	---	---	W. Grand Ave.	---	---
Whiting St.	El Segundo Blvd. and Hawthorne Blvd.	108	Wholly along El Segundo Blvd. right of way through residential, commercial and industrial areas. Crosses below elevated railroad at S. Aviation Blvd. and elevated section of I-405 freeway. Assume trenched construction but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	3.6	0.3	3.9	1	8	9	0	18	18	---	Single track at grade east of I-405.	---	Chevron Refinery entrance, N. Pacific Coast Hwy., N. Douglas St., S. Aviation Blvd., I-405 freeway on/off ramps x2, La Cienega Blvd., S. Inglewood Ave.	---	---
El Segundo Blvd. and Hawthorne Blvd.	S. La Brea Ave. and E. TamaraCk Ave.	108	Wholly along Hawthorne Blvd. / S. La Brea Ave. right of way through residential and commercial areas. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	2.7	2.7	3	5	8	2	6	8	I-105 in cutting	Single track at grade between W 126th St. and W. Broadway, LA Metro C (Green) Line in cutting.	---	W. 120th St., Imperial Hwy., Lennox Blvd., Century Blvd., E. Arbor Vitae St.	---	---
S. La Brea Ave. and E. TamaraCk Ave.	E. Florence Blvd. N. La Brea Blvd.	108	Wholly along S. La Brea Ave. right of way through mostly commercial and industrial areas. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	0.8	0.8	0	3	3	1	0	1	---	---	---	S. La Brea Ave. and Market St., E. Hillcrest Blvd., W. Manchester Blvd.	---	---
E. Florence Blvd. N. La Brea Blvd.	E. Florence Blvd. and West Blvd.	66	Wholly along E. Florence Ave. right of way through mostly commercial and industrial areas. Assume trenched construction but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	1.2	0.04	1.2	0	1	1	0	2	2	---	---	---	N. La Brea Ave. and E. Florence Ave.	---	---
E. Florence Blvd. N. La Brea Blvd.	E. Florence Blvd. and S. Western Ave.	66	Wholly along E. Florence Ave. right of way through residential and commercial areas. Assume trenched construction but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	1.4	0.04	1.4	0	1	1	0	2	2	---	---	---	Crenshaw Blvd.	---	---
E. Florence Blvd. and West Blvd.	E. Florence Blvd. and S. Central Ave.	54	Wholly along E. Florence Ave. right of way through residential and commercial areas. Crosses below an elevated section of the I-110 freeway. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	3.0	3.0	0	10	10	4	0	4	---	---	---	Western Ave., S. Normandie Ave., Vermont Ave., S. Hoover St., Figueroa St., I-110 freeway on/off ramps, S. Broadway, S. Main St., San Pedro St., Avalon Blvd.	---	---
E. Florence Blvd. and S. Western Ave.	E. Florence Blvd. and LA River	54	Wholly along E. Florence Ave. right of way through residential and commercial areas. Assume trenched construction but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	4.5	0.4	4.9	3	8	11	0	22	22	---	LA Metro A (Blue) Line four tracks at grade, multiple tracks in open cut trench, single track at grade at California Ave.	---	Hooper Ave., Compton Ave., Alameda St., S. Santa Fe Ave., Pacific Blvd., State St., Atlantic Ave., Wilcox Ave.	---	---
E. Florence Blvd. and LA River	Florence Blvd. and I-605	54	Wholly along E. Florence Ave. right of way through residential and commercial areas. Assume trenched construction but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	4.3	0.4	4.7	0	10	10	0	20	20	I-710	---	LA River, Rio Hondo Channel, San Gabriel River Channel	I-710 on/off ramps x2, Eastern Ave., Garfield Ave., Paramount Blvd., Lakewood Blvd., I-605 on/off ramps	---	---
HWWTP	Whiting St.	108	Open land between the HWWTP and residential neighbourhood. Variable ground level suggests tunnelled construction.	Tunnelled	0.0	1.1	1.1	0	1	1	1	0	1	---	---	---	W. Grand Ave.	---	---

From	To	Pipe Diameter (in)	Alignment characterisation and comments	Main Construction Method	Trenched Length (mi)	Tunnelled Length (mi)	Total Length (mi)	Crossings			Shafts			Major Crossings					Possible amendments
								Special	General	Total	Tunnelling	Crossings	Total	Caltrans	Railroad	Storm drains	Roads	Other	
Whiting St.	El Segundo Blvd. and Hawthorne Blvd.	108	Wholly along El Segundo Blvd. right of way through residential, commercial and industrial areas. Crosses below elevated railroad at S. Aviation Blvd. and elevated section of I-405 freeway. Assume trenched construction but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	3.6	0.3	3.9	1	8	9	0	18	18	---	Single track at grade east of I-405.	---	Chevron Refinery entrance, N. Pacific Coast Hwy., N. Douglas St., S. Aviation Blvd. I-405 freeway on/off ramps x2, La Cienega Blvd., S. Inglewood Ave.	---	---
El Segundo Blvd. and Hawthorne Blvd.	S. La Brea Ave. and E. Tamarak Ave.	108	Wholly along Hawthorne Blvd. / S. La Brea Ave. right of way through residential and commercial areas. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	2.7	2.7	3	5	8	2	6	8	I-105 in cutting	Single track at grade between W 126th St. and W. Broadway, LA Metro C (Green) Line in cutting.	---	W. 120th St., Imperial Hwy., Lennox Blvd., Century Blvd., E. Arbor Vitae St.	---	---
S. La Brea Ave. and E. Tamarak Ave.	E. Tamarak Ave. and W. Manchester Blvd.	66	Wholly along E. Tamarak Ave. right of way through residential area. As there are no crossings anticipated trenched construction is assumed.	Trenched	0.5	0.0	0.5	0	0	0	0	0	0	---	---	---	---	---	---
E. Tamarak Ave. and W. Manchester Blvd.	W. Manchester Blvd. and S. Western Ave.	66	Wholly along W. Manchester Blvd., right of way through residential and commercial areas. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	2.2	2.2	0	4	4	3	0	3	---	---	---	S. Prairie Ave., Inglewood Cemetery entrance, Crenshaw Blvd., S. Van Ness Ave.	---	---
W. Manchester Blvd. and S. Western Ave.	W. Manchester Blvd. and S. Central Ave.	54	Wholly along W. Manchester Blvd., right of way through residential and commercial areas. Crosses below an elevated section of the I-110 freeway. Could be trenched but number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	3.0	3.0	0	10	10	4	0	4	---	---	---	S. Western Ave., S. Normandie Ave., S. Vermont Ave., S. Hoover St., Figueroa St., I-110 freeway on/off ramps, S. Broadway, S. Main St., San Pedro St., Avalon Blvd.	---	---
W. Manchester Blvd. and S. Western Ave.	Firestone Blvd. and LA River	54	It's assumed this section of the alignment is intended to follow Firestone Blvd. right of way. Crosses below 4 track elevated section of LA Metro A (Blue) Line. Assume trenched construction but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	4.5	0.4	4.9	2	9	11	0	22	22	---	Multiple tracks in open cut trench, single track at grade at Firestone Pl.	---	Hooper Ave., Compton Ave., Alameda St., Santa Fe Ave., Long Beach Blvd., State St., California Ave., Otis St., Atlantic Ave.	---	---
Firestone Blvd. and LA River	Firestone Blvd. and I-605	54	It's assumed this section of the alignment is intended to follow Firestone Blvd. right of way. Could be trenched but utilities, number of crossings and associated shafts in dense urban area suggests tunnelling may be more efficient.	Tunnelled	0.0	4.5	4.5	2	13	15	6	4	10	I-710	Rail line at Old River School Road	LA River, Rio Hondo Channel, San Gabriel River Channel	I-710 on/off ramps x2, Garfield Ave., Old River School Road, Rives Ave., Paramount Blvd., Downey Ave., Brookshire Ave., Lakewood Blvd., I-605 on/off ramps	---	---
S. Western Ave. and W. 3rd St.	S. Western Ave. and Florence Ave.	66	Wholly along Western Ave. right of way through residential and commercial areas. Crosses underground LA Metro D (Purple) Line alignment at Wilshire Blvd. and abandoned railroad tracks just south of Slauson Ave. Assume trenched construction but utilities, number of crossings and associated shafts may dictate tunnelling to be more efficient.	Trenched	5.9	0.6	6.5	2	14	16	0	32	32	I-105 in cutting including on/off ramps	LA Metro E (Expo) Line at grade at W. Exposition Blvd.	---	W. 6th St., W. 8th St., W. Olympic Blvd., W. Pico Blvd., Venice Blvd., W. Washington Blvd., W. Adams Blvd., W. Jefferson Blvd., W. Exposition Blvd., W. Martin Luther King Jr Blvd., W. Vernon Ave., W. 48th St., Slauson Ave. W. Gage Ave.	---	---
							162.0	41	355	396	99	320	419						

From	To	Pipe Diameter (in)	Alignment characterisation and comments	Main Construction Method	Trenched Length (mi)	Tunnelled Length (mi)	Total Length (mi)	Crossings			Shafts			Major Crossings					Possible amendments
								Special	General	Total	Tunnelling	Crossings	Total	Caltrans	Railroad	Storm drains	Roads	Other	

	Main Construction Method	Trenched Length (mi)	Tunnelled Length (mi)	Total Length (mi)	Crossings			Shafts			Trenched vs. Tunnelled
					Special	General	Total	Tunnelling	Crossings	Total	
Griffith Park	Trenched	9.7	0.5	10.2	0	14	14	0	28	28	33%
	Tunnelled	0.0	19.3	19.3	7	56	63	20	14	34	67%
	Total	9.7	19.8	29.5	7	70	77	20	42	62	100%
	Total (check)	9.7	19.8	29.5	7	70	77	20	42	62	
Cahuenga	Trenched	9.3	0.6	9.9	0	16	16	0	32	32	34%
	Tunnelled	0.0	17.4	17.4	4	47	51	18	8	26	66%
	Total	9.3	18.0	27.3	4	63	67	18	40	58	100%
	Total (check)	9.3	18.0	27.3	4	63	67	18	40	58	
Sepulveda	Trenched	12.7	0.9	13.6	1	22	23	0	46	46	44%
	Tunnelled	0.0	15.4	15.4	2	47	49	14	4	18	56%
	Total	12.7	16.3	29.0	3	69	72	14	50	64	100%
	Total (check)	12.7	16.3	29.0	3	69	72	14	50	64	
Slauson	Trenched	7.5	0.3	7.8	1	8	9	0	18	18	32%
	Tunnelled	0.0	15.5	15.5	9	34	43	23	18	41	68%
	Total	7.5	15.8	23.3	10	42	52	23	36	59	100%
	Total (check)	7.5	15.8	23.3	10	42	52	23	36	59	
Florence	Trenched	14.9	1.2	16.1	4	28	32	0	64	64	63%
	Tunnelled	0.0	7.6	7.6	3	19	22	8	6	14	37%
	Total	14.9	8.8	23.7	7	47	54	8	70	78	100%
	Total (check)	14.9	8.8	23.7	7	47	54	8	70	78	
Manchester	Trenched	8.5	0.8	9.3	3	17	20	0	40	40	37%
	Tunnelled	0.0	13.5	13.5	5	33	38	16	10	26	63%
	Total	8.5	14.3	22.8	8	50	58	16	50	66	100%
	Total (check)	8.5	14.3	22.8	8	50	58	16	50	66	
Central Basin	Trenched	5.9	0.6	6.5	2	14	16	0	32	32	91%
	Tunnelled	0.0	0.0	0.0	0	0	0	0	0	0	9%
	Total	5.9	0.6	6.5	2	14	16	0	32	32	100%

Attachment D
Pure Water Los Angeles Conveyance Alignment Review Supplemental Information

Pure Water Los Angeles Conveyance Alignment Review Supplemental Information

Date:	June 26, 2024
Project Name:	Pure Water Los Angeles Program (Program)
Project No.:	D3611501
Document No.:	240920111234_59fba068
Client:	Los Angeles Department of Water and Power (LADWP)
Prepared By:	S. Firth, D. Jankly, C. Schaffer, Jacobs
Reviewed By:	Z. Yu, Jacobs
Revision No.:	Final

Jacobs Engineering Group Inc.

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1. Introduction

LADWP has engaged Jacobs to develop the Program Water Supply Program Master Plan (MP). As part of the scope under Subtask 4 – Validation of Strategy of the Task Order Request for Proposal, Jacobs is required to: "validate the overall Program structure….conduct a cursory evaluation of the Program alignment and cost for the conveyance of water from Hyperion to *[Los Angeles Aqueduct Filtration Plant (*LAAFP*)]*, and recommend potential alternatives."

1.1 Overview

This technical memorandum (TM) is supplemental to the Pure Water Los Angeles Conveyance Alignment Review (Appendix D). The alignment review focused on quantifying the pipeline sections that would most likely have to be tunneled and those that could potentially be trenched, based on a review of the mapping information provided for each alignment option. This evaluation identified the likely crossings required for each alignment option and estimated the number of shafts required to construct the tunneled sections and crossings.

Exhibit 1-1 shows the alignments. For the alignment descriptions, refer to the MP.

1.2 Purpose

This TM complements the alignment review by examining the ground and groundwater conditions, existing utilities, and existing underground infrastructure that may conflict with the proposed alignment options.

Like the alignment review, this supplemental information does not constitute a routing study, and it is not intended to validate any of the proposed alignment options or propose a preferred alignment. No refinement of pipe diameters or hydraulic analysis has been included as part of this review. No additional research has been conducted for any of the following factors:

- Specific construction methodologies
- Rights-of-way (ROWs)
- Easements
- Land acquisitions
- Permitting

The review also does not account for traffic disruption, local community impacts, or environmental impacts and does not evaluate or compare cost, schedule, and risk. This TM notes these and other observed data gaps for further consideration in the Recommendations section.

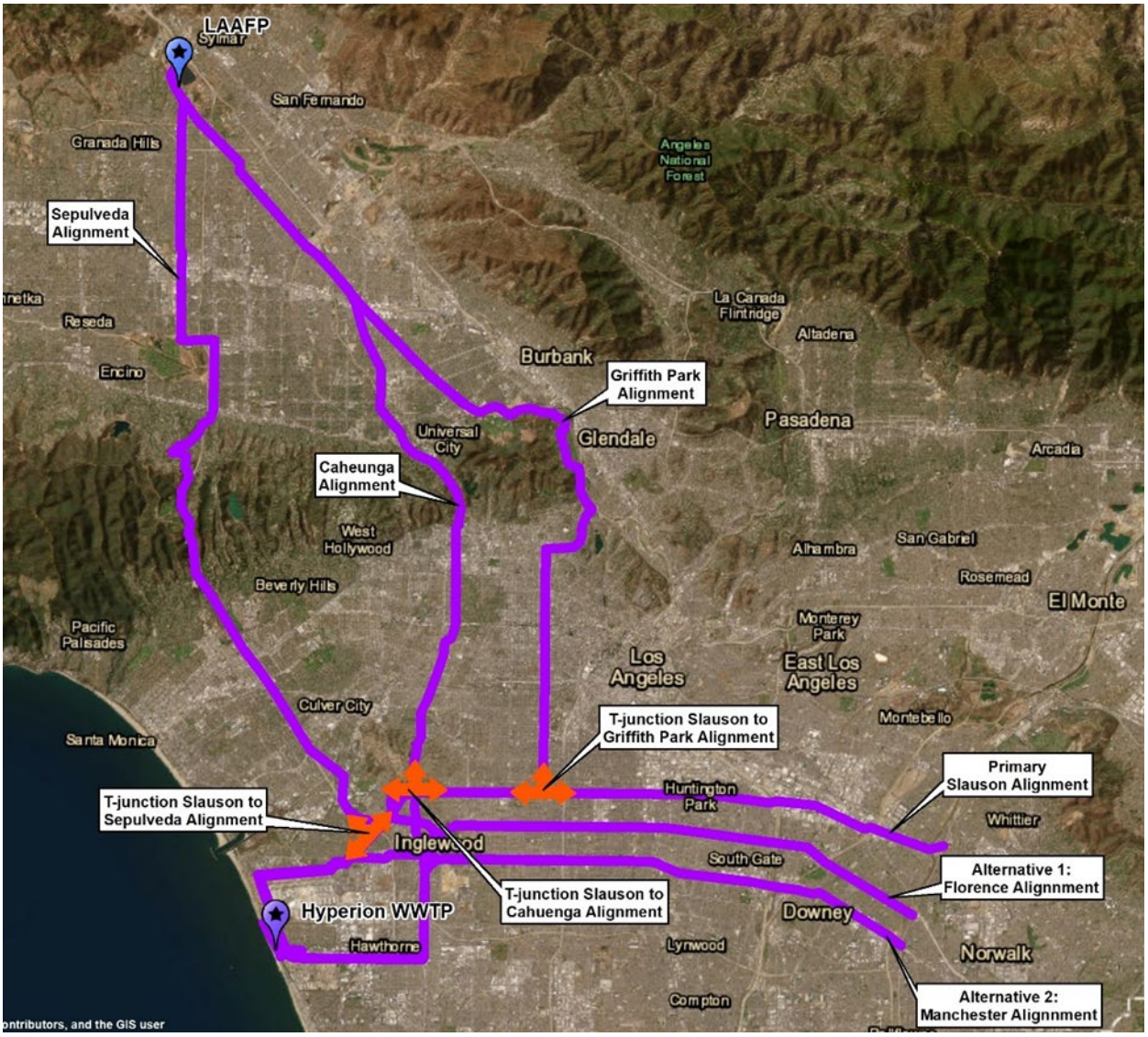

Exhibit 1-1. Proposed Alignment Options

Source:

1. Service Layer Credits: Esri, Maxar, Earthstar Geographics, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

2. LADWP 2022; Jacobs 2022

2. Ground Conditions

This section discusses the geotechnical conditions and oil fields and oil wells in the project areas.

2.1 Geotechnical Conditions

This section discusses geotechnical conditions in the project areas, including the following factors:

- Ground characteristics
- Groundwater levels
- Faulting
- Geologic hazards

The following terminology is used in this TM:

- **North–south alignments** refers to the Sepulveda, Cahuenga, and Griffith Park alignments.
- **West–east alignments** refers to the primary Slauson alignment, Alternative 1 Florence alignment, and Alternative 2 Manchester alignment.
- **Project alignments** refers to both the north–south and west–east alignments.

The project alignments transect three distinct physiographic areas of Southern California:

1. The northern portions of the north–south alignments transect the San Fernando Valley.
2. The central portion of the north–south alignments transect the Santa Monica Mountains.
3. The southern portion of the north–south, as well as the entire west–east alignment, transects the Los Angeles Basin.

The project alignments are underlain by alluvial soils and bedrock and are crossed by a number of mapped active faults (CGS 2010 and 2012, and USGS and CGS, 2023) (Table 2-1).

Table 2-1. Ground Conditions by Alignment

Alignment	Alignment Length (mi)	Estimated Proportion of Rock [a]		Estimated Proportion of Alluvial Soils		Active Fault Crossings [b]
		(%)	(mi)	(%)	(mi)	
Griffith Park (Eastern) Alignment	29.5	12	3.5	88	26.0	4
Cahuenga (Central) Alignment	27.3	15	4.1	85	23.2	4
Sepulveda (Western) Alignment	29.0	21	6.1	79	22.9	3
Slauson (Northern) Alignment	23.3	7	1.6	93	21.7	1
Florence (Central) Alignment	23.7	0	0	100	23.7	1
Manchester (Southern) Alignment	22.8	0	0	100	22.8	1

[a] Mapped (CGS, 2010 and 2012), hard rock (granitic and volcanic rocks and slate) and soft rock (some siltstone, claystone, sandstone, and conglomerate) that outcrops along the alignment.

[b] Holocene and latest Quaternary (last rupture less than 15,000 year ago) faults thought to be capable of direct ground rupture (USGS and CGS, 2023).

Note:

mi = mile(s)

2.1.1 Ground Characterization

Most of the length of the project alignments are in the Los Angeles Basin and San Fernando Valley. These areas are underlain by thousands of feet of sediment (alluvial soil and sedimentary bedrock) overlying (granitic and metamorphic) basement rock (Yerkes et al. 1965). Exceptions include areas underlain by artificial fill, and areas adjacent to faults where sedimentary bedrock has been uplifted to or very near the surface. In the San Fernando Valley, sedimentary bedrock is present in the vicinity from where the north–south alignment options merge (northwest of the State Route 118 and Interstate [I]-405 interchange) to the northern end of these alignments at the LAAFP (CGS 2010 and 2012). In Los Angeles

Basin, the sedimentary bedrock is present in the Baldwin Hills area near the Sepulveda, Cahuenga, and Slauson alignments (CGS 2010 and 2012).

Artificial fill soils are present locally, as most of the project area is urban and developed. Historically, artificial fill soils were placed during the construction of projects to generally raise the grade (ground level) at a site, or to replace soils that were considered detrimental to a proposed development. The depth and lateral extent of these fill soils depends on the original topography, as well as urban development in the project area.

The composition of the alluvial soils in the project area will vary. The alluvial soils present will consist of fine-grained sediment (silts and clays), coarse-grained sediment (sands, gravels, cobbles, and boulders), and mixtures of both. From a geologic perspective, the alluvial soils are considered unconsolidated because the soils lack cementation typically associated with rock formations.

The sedimentary rocks in the project area consist of layers of siltstone, claystone, shale, sandstone, and conglomerate. These rocks are consolidated and indurated. However, many of the sedimentary rock formations in the project are generally considered to be soft rocks, in contrast to a granitic type of rock.

The north–south alignments traverse or cross very near to the Santa Monica Mountains. The Santa Monica Mountains are composed of basement rock (such as metamorphic, igneous, and sedimentary); sedimentary bedrock; and localized surficial deposits (such as alluvial soils and landslide deposits) (CGS 2010 and 2012). The basement rocks in the area of the alignments primarily consist of granitic rocks and slate. In addition, some volcanic rocks are present locally (CGS 2010 and 2012). Figure 1 shows the detailed geology in the project area (figures are included at the end of this TM).

2.1.2 Groundwater

Based on California Geological Survey (CGS) mapping (1997a, 1998a-i), historical high groundwater levels of less than 10 feet below ground surface (bgs) are mapped in the following areas near the project alignments:

San Fernando Valley Area:

- In the area of the LAAFP near the Van Norman Reservoir
- In the area of the Los Angeles River

Los Angeles Basin Area:

- Near the foothills of the Santa Monica Mountains
- The area west of the Central Basin Distribution System's northern end point, in the vicinity of the La Brea Tar Pits
- At the western and northern foothills of the Baldwin Hills, near the Sepulveda, Cahuenga, and Slauson alignments
- In the area of the future desalter for the Distribution System-Harbor area, near the refineries in Torrance
- Near Ballona Creek and the Hyperion Water Reclamation Plant near El Segundo
- In the Huntington Park, Bell Gardens, Pico Rivera, and Downey areas

In the central part of the San Fernando Valley, near the north–south alignments, historical high groundwater levels are generally less than 100 feet bgs. Groundwater data reviewed from very widely spaced wells available from the California Department of Water Resources (CDWR) (2022) concur that shallow groundwater conditions are not present in the central part of the San Fernando Valley. As listed in this section, shallow groundwater conditions are likely near the valley margins, where crossed by the north–south alternatives, such as in the area of the LAAFP near the Van Norman Reservoir, and near the Los Angeles River.

In general, the Santa Monica Mountains do not have a true groundwater table. However, significant groundwater flows may be present in or near bedrock fracture and fault zones. In addition, local areas, such as within permeable beds or below drainages, may have groundwater perched above less-permeable materials.

In the Los Angeles Basin area near the project alignments, historically high groundwater levels less than 100 feet bgs are commonplace. Groundwater data reviewed from very widely spaced wells (CDWR 2022) indicate that groundwater is shallower than 100 feet bgs in the Beverly Hills, Santa Monica, and Culver City area, and in the project alignment areas generally south of Rosecrans Avenue. As listed, shallow groundwater conditions are likely to be present below some areas of the project alignments in the Los Angeles Basin.

2.1.3 Faults

The general project area is underlain by a number of active fault lines, many of which have ruptured (generated an earthquake) during the last 100 years. As seen during many earthquakes around the world, some fault lines can generate ground rupture, resulting in damage to building structures and infrastructure.

Figure 2 show the faults mapped in the project region. In general, faults that have ruptured in the latest Quaternary time (last 15,000 years) are considered more likely to rupture again versus faults that have experienced older ruptures. In California, the Alquist-Priolo Earthquake Fault Zoning Act mandates that habitable structures may not be constructed on an active fault line (defined as having moved in the Holocene, or last 12,000 years). Potentially active faults are faults that have moved between about 15,000 and 130,000 years ago.

Figure 2 shows faults as follows:

- Active faults considered capable of ground rupture are shown in red and yellow.
- Potentially active faults are shown in green.
- The remaining faults shown on Figure 2 either are not considered capable of ground rupture (blind thrust faults) or are not known to have ruptured in the Late Quaternary (last 130,000 years).

Fault-induced ground rupture has historically been a cause of earthquake damage in Southern California. In particular, the area around the LAAFP and Van Norman Reservoir experienced ground rupture during the 1971 Sylmar earthquake (CGS 1998a). As summarized in Table 2-1, each of the project alignments is crossed at least once by a mapped active fault.

2.1.4 Geologic Hazards

In addition to fault-induced ground rupture discussed in Section 2.1.3, the project alignments could be at risk of damage from other geologic hazards, as discussed in this section.

2.1.4.1 Seismic Shaking

The project alignments are located within the seismically active region of Southern California and may be subject to seismic ground shaking over time. Preliminary seismic data research and review was conducted for the northern and southern ends of the north–south alignments, and the eastern end of the west–east alignments, using the U.S. Geological Survey (USGS) seismic design maps (ASCE 2023). Considering the conceptual level of the project, this information is intended to provide a general frame of reference for the ground accelerations (the severity of ground shaking) that would be used during design of the project.

USGS parameter PGA_M is the peak ground acceleration (PGA) corrected for site effects (that is, subsurface conditions). PGA is an estimation of maximum ground shaking a site can experience over a specified period of time. The period of time considered is a mean recurrence interval of about 2,475 years (2% probability of exceedance within a 50-year period). For conceptual purposes, the project alignments are

classified as Site Class D (stiff soil). Using the 2017 USGS Seismic Design Maps, PGA_M varies along the alignments, ranging from roughly 1.0g (g = acceleration due to gravity) near the northern end of the north–south alignments (near the LAAFP), to 0.8g near the southern end (near the Distribution System - Harbor) and at the eastern end of the west–east alignments.

2.1.4.2 Liquefaction and Lateral Spreading

Soil liquefaction occurs in the upper 50 to 75 feet bgs when saturated, loose soils lose their strength because of excess pore water pressure caused by earthquake ground shaking. Pore pressures develop when the space (pores) between the soil particles is filled with water, which exerts pressure on the soil particles, influencing how tightly the soil particles are pressed together. Before an earthquake, the pore water pressure is static, depending on the depth below the groundwater table; however, the shaking caused by an earthquake can increase the pore water pressure to a point where the soil loses strength, and ground deformation can occur.

The following primary factors affect the possibility of liquefaction in a soil deposit:

- Intensity and duration of the earthquake shaking
- Soil type
- Relative density of the soil
- Pressures of material above the soil
- Depth to groundwater

The types of soils most susceptible to liquefaction are:

- Clean, loose, uniformly graded, fine-grained sands
- Nonplastic silts that are saturated
- Silty sands

When liquefaction occurs, the strength of the soil decreases, and the ability of the soil to support structures is reduced. The potential impacts of liquefaction may include:

- Settlement of the ground surface
- Additional forces pushing down on foundation piles as a result of soil settlement above the liquefied layers (downdrag)
- Lateral spreading (similar to a landslide)
- Reduction of the shear strength of the liquefied soil, resulting in reduced load-carrying capacity

Liquefied soils can also exert additional dynamic pressures on retaining walls, which can cause them to tilt or slide. Liquefaction-induced ground failure has historically been a major cause of earthquake damage in Southern California. In particular, the area around the LAAFP and Van Norman Reservoir experienced liquefaction-induced ground failure during the 1971 Sylmar and 1994 Northridge earthquakes (CGS 1998a).

As shown on Figure 3, portions of each of the project alignments are in a Liquefaction Zone established by CGS (2023). The Liquefaction Zones are delineated in areas that have historically experienced liquefaction, or in areas where conditions favorable to liquefaction may exist, including the presence of a shallow groundwater table and loose soils. These zones are established in areas that would require site-specific liquefaction investigation and evaluation before construction of habitable structures.

2.1.4.3 Tsunami and Seiches

Tsunamis are waves typically generated offshore or within large, open bodies of water, primarily during a subaqueous fault rupture or a subaqueous landslide event. Seiches are waves generated within a large, closed body of water, also caused either by subaqueous fault ruptures or landslide events, or by ground oscillations from distant earthquakes.

Based on a review of the Los Angeles County Tsunami Hazards Area Map (CGS 2021), the project alignments are not in tsunami hazard zones. The Van Norman Reservoir and other nearby closed water bodies could experience a seiche, which could impact the northern end of the north-south alignment options.

2.1.4.4 Slope Stability

Except for where the north-south alignments cross the Santa Monica Mountains, the project alignments traverse relatively gently sloping land. Through the Santa Monica Mountains, the alignments are located along or near established roadways that have been in existence for many decades. It is likely that if significant landslide hazards were present in these areas, they would have already been remediated.

As Figure 3 shows, portions of each of the north-south alignments are located in a Landslide Zone established by CGS (2023). The west–east alignments do not cross Landslide Hazard Zones. The Landslide Zones are delineated in areas that have historically experienced land sliding, or in areas where conditions favorable to landslides may exist, including steeply sloped areas. These zones are established in areas that would require site-specific landslide investigation and evaluation. However, it is likely that if significant landslide hazards were present near the alignments in the Santa Monica Mountains, they would have already been remediated.

2.1.4.5 Expansive Soils

Expansive soils are clay-rich soils that swell and shrink with wetting and drying. The shrink-swell capacities of expansive soils can result in differential movement below or adjacent to a structure. This differential movement can result in significant damage to pavements, as well as foundations and buried structures. Clay-rich soils may exist locally within alluvial soils present in the project area shown on Exhibit 1-1. Bedrock units also can exhibit expansive properties due to the clay content within the bedrock; this includes some of the common siltstone and claystone units mapped in the project area.

2.1.4.6 Ground Settlement and Collapsible Soils

Near the surface, ground settlement can occur when new loads are added to soil, or when a change in water levels results in a decrease in pore water pressures within compressible soils. Collapsible soils consist predominantly of sand- and silt-size particles arranged in a loose "honeycomb" structure. This loose structure is held together by small amounts of water-softening cementing agents, such as clay or calcium carbonate. When the soil becomes wet, these cementing agents soften, and the honeycomb structure collapses and generates ground settlement. The alluvial soils within the project area may be prone to collapse or settlement, which can result in differential movement, potentially causing structural distress.

2.1.4.7 Corrosive Materials

Soils can be corrosive to ferrous metals, depending on the soils' pH level, electrical resistivity, and chloride content. In addition, water-soluble sulfates in soil can react adversely with concrete. Corrosive subsurface conditions are present, at least locally, in the project area.

2.1.4.8 Naturally Occurring Oil and Gas

As discussed in Section 2.2, the project area is underlain by numerous oil fields and oil wells. The naturally occurring oil and gas underlying these areas can pose a health and safety hazard, particularly due to the explosive nature of the hazardous gases.

Methane is a naturally occurring gas associated with the decomposition of organic materials. Methane gas is common in oil and gas fields and often occurs with hydrogen sulfide gas (H_2S). H_2S is produced by anaerobic decomposition of any type of organic or inorganic mater that contains sulfur. Methane and H_2S

are considered hazardous gases because of their explosive properties. H_2S is also highly toxic when inhaled and typically has a strong rotten-egg-like odor at lower, nontoxic levels. Methane and H_2S can be present in soil and groundwater. These gases can seep into tunnels and other excavations through soil and through discontinuities (such as fractures, faults) in bedrock.

The City of Los Angeles (City) Department of Public Works Bureau of Engineering has mapped potential methane zones and methane buffer zones within city limits. These methane zones and methane buffer zones have been established where there is a potential for naturally occurring gases to create a hazard to life and property. Figure 4 shows the methane zones and buffers designated by the City (2004). At some point along each of the project alignments, a methane zone is crossed.

2.2 Oil Wells and Oil Fields

The California Department of Conservation, Geologic Energy Management Division (CalGEM) oversees the drilling, operations, and maintenance of underground well locations throughout the state of California. Oil wells and oil field boundaries are updated and maintained using the Well Statewide Tracking and Reporting System (WellSTAR). These data are monitored and maintained on an as-needed basis, providing the most-current data reflective of status.

Project alignment options were analyzed to determine the number of WellSTAR oil wells and oil fields within 100 feet of each (200-foot buffer). Table 2-2 shows the number of oil wells and oil fields within the specified study area.

Table 2-2. Oil Wells and Oil Fields by Alignment

Alignment	No. of Oil Wells	No. of Oil Fields
Griffith Park (Eastern) Alignment	18	5
Cahuenga (Central) Alignment	9	7
Sepulveda (Western) Alignment	17	2
Slauson (Northern) Alignment	1	7
Florence (Central) Alignment	2	6
Manchester (Southern) Alignment	8	4

Source: California Department of Conservation 2023

No. = number

As Figure 5 shows, there are many wells and oil fields in the Los Angeles Basin, but few wells are in the San Fernando Valley or Santa Monica Mountains. Many of the well clusters are shown in the Inglewood and Salt Lake Oil Fields near the Cahuenga alignment; however, many of these wells are just outside of the study area. In addition, there is an array of wells in the Los Angeles City Oil Field near the Griffith Park alignment, and further south in the Portero Oil Field near the Manchester alignment.

In Table 2-2, the Sepulveda alignment shows many oil wells within the study area; however, the wells are hard to visualize at the current map scale. All 17 wells near Sepulveda are part of the Dowlen-Federal oil and gas property just west of I-405 and north of Wilshire Boulevard.

2.3 Construction Impacts

The construction methodology for both the trenched and tunneled sections will depend on the ground and groundwater conditions along the alignment, as well as the depth, length, and other factors relevant to each individual section. It is reasonable to assume that a variety of construction methodologies will be employed across the whole alignment due to the varying nature of the existing conditions over such a wide project area. For the tunnel sections, the various potential construction methodologies are discussed in more detail in Section 2.2.1 of the Pure Water Los Angeles Conveyance Alignment Review report, included in Appendix D.

For any underground construction, it is important to classify the ground in terms of the gas expected to be encountered. Gassy or potentially gassy ground, as defined by Occupational Safety and Health Administration (OSHA), can present specific hazards to underground construction workers. This classification will influence the tunnel construction methodology and special provisions that will be required during construction to mitigate associated risks.

3. Utilities

Underground utilities can be defined as any belowground structure, facility, line, or installation pertaining to a utility or service provider. These services include sewer lines, water lines, and gas lines. Using publicly available data from Los Angeles County (LADPW 2023) and the California Office of Emergency Services (CalOES 2023), a proximity analysis was performed to determine the number of utilities within 100 feet of each alignment (200-foot buffer).

As part of the geographic information system (GIS) desktop study, a threshold of 24 inches in diameter and greater was established to limit the number of underground water and gas utilities. Each service was then grouped using the following categories:

1. Water Utilities:
    a. Water pipelines
    b. Sewer pipelines and storm drains
2. Gas Utilities:
    a. Gas pipelines
    b. Gas transmission lines

Table 3-1 summarizes the results. Each number represents the total number of utilities within the 100-foot study area.

Table 3-1. Utilities by Alignment

Alignment	No. of Water Utilities	No. of Gas Utilities	Total
Griffith Park (Eastern) Alignment	722	14	736
Cahuenga (Central) Alignment	654	5	659
Sepulveda (Western) Alignment	639	11	650
Slauson (Northern) Alignment	806	17	823
Florence (Central) Alignment	602	9	611
Manchester (Southern) Alignment	519	15	524

Source: Los Angeles County 2023; California Office of Emergency Services 2023

The Slauson and Griffith Park areas appear to have the highest concentrations of underground utilities within the study area. Both alignments transverse through some of the more densely populated and developed areas in Los Angeles, and it can be presumed that these areas require more concentrated utility services to support the urban center.

In contrast, more of the Sepulveda and Cahuenga alignments pass through the Santa Monica Mountains through areas with presumably fewer underground utilities for underdeveloped portions of Southern California.

Because conflicts with utilities are unavoidable within the project area, it will be essential to identify and assess each utility that could be impacted by the alignment, before construction, to understand the implications and determine whether the utility should be protected in place, rerouted, or removed to mitigate the impacts.

4. Existing Underground Infrastructure

This section includes a discussion on existing subway structures and other underground infrastructure that conflicts with the proposed alignment.

4.1 Subway Structures

The Los Angeles County Metropolitan Transit Authority (LA Metro) currently owns and maintains two rapid transit subway lines (the B and D lines) serving 22 stations throughout Los Angeles County. The B Line spans from North Hollywood to Union Station (north to south), while the D Line currently runs from Wilshire and Western to Union Station (west to east) (LA Metro 2023).

An expansion of the D Line is in progress and will extend from the current Willshire and Western terminus to the Westwood and VA Hospital station along Wilshire Boulevard. A forecasted staggered opening between 2024 and 2027 is projected, with three sections opening during that time frame (LA Metro 2023).

Table 4-1 summarizes the subway structure crossings. Although not operational, the D Line extension to the Westwood and VA Hospital station is included in the analysis as the tunnels are constructed.

Table 4-1. Summary of Subway Structure Crossings by Alignment

Alignment	No. of Subway Crossings
Griffith Park (Eastern) Alignment	2
Cahuenga (Central) Alignment	3
Sepulveda (Western) Alignment	1
Slauson (Northern) Alignment	0
Florence (Central) Alignment	0
Manchester (Southern) Alignment	0

Source: LA Metro 2023

Figure 6 shows two intersections along the Griffith Park alignment, one with the B Line and one with the D Line. The B Line crossing is a parallel stretch that runs north–south along N Vermont Avenue for 2.2 miles. The Cahuenga alignment intersects the B Line twice, and the D Line at the intersection of Wilshire Boulevard and S Highland Avenue. The Sepulveda alignment intersects the new tunnels located near the future D Line terminus at the Westwood and VA Hospital station.

The three west–east alignment options do not intersect with any subway structures.

4.2 Other Underground Infrastructure

Additional underground infrastructure was identified and included in the underground assessment. The California State Water Resources Control Board (SWRCB) provides locations and descriptions of utilities that may impact groundwater. These features include underground storage tanks and water monitoring wells and equipment within 100 feet of each alignment (200-foot buffer) not identified in other sections. Table 4-2 provides a summary of potential conflicts between this underground infrastructure for each alignment.

Table 4-2. Underground Structure Crossings by Alignment

Alignment	No. of Crossings
Griffith Park (Eastern) Alignment	16
Cahuenga (Central) Alignment	14
Sepulveda (Western) Alignment	13
Slauson (Northern) Alignment	17
Florence (Central) Alignment	19
Manchester (Southern) Alignment	19

Source: SWRCB 2023

The number of crossings is somewhat similar across all proposed alignments. The west–east alignment portions have slightly more crossings, where gas and service stations are more frequent. As for the water and gas utilities summary, there appears to be fewer utilities in the north–south alignments, particularly in the Cahuenga and Sepulveda alignments that traverse through the Santa Monica Mountains.

Abandoned piles and tiebacks are another hazard to tunnel construction, particularly in an urban environment. Available records for buildings along the alignments should be reviewed to identify potential conflicts.

Preconstruction surveys of all structures within the zone of influence of the tunneled sections should be conducted to establish a baseline for assessing claims of damage from construction activity.

5. Conclusions

From a review of the geotechnical conditions, it is evident that most, and in some cases, all of each alignment option is in alluvial soil. For the north–south alignments, rock appears most evident in the Sepulveda alignment at an estimated 21%, with the Cahuenga and Griffith Park alignments estimated to be in 15% and 12% rock, respectively. For the west–east alignments, only the primary Slauson alignment is estimated to encounter rock and only for 7% of its length. The two alternative west–east alignment options are estimated to be wholly in alluvial soil.

Generally, shallow groundwater conditions are not present in the central part of the San Fernando Valley; however, they are likely in the valley margins, such as the area around the LAAFP near the Van Norman Reservoir and in the vicinity of the Los Angeles River. In the Los Angeles Basin area near the project alignment options, historically high groundwater levels shallower than 100 feet bgs are commonplace.

The project area is located within the seismically active region of Southern California and may be subject to seismic ground shaking over time. The general project area is underlain by a number of active fault lines, and every alignment option is crossed by at least one active fault.

Portions of each alignment option are in a Liquefaction Zone (CGS 2023).

The project alignment options are not located in tsunami hazard zones; however, the Van Norman Reservoir and other nearby closed water bodies could potentially experience a seiche (waves generated within a large, closed, body of water), which could impact the northern end of the north–south alignments.

Portions of each of the north–south alignments are located in a Landslide Zones (CGS 2023). Except for where the north–south alignments cross the Santa Monica Mountains, the project alignments traverse relatively gently sloping land. Through the Santa Monica Mountains, the alignments are located along or near established roadways, where it is likely that any significant landslide hazards would have already been remediated. The west–east alignments do not cross Landslide Hazard Zones.

Expansive clay-rich soils that are subject to swelling and shrinking with wetting and drying, which can result in damage to pavements, foundations, and buried structures, may exist locally within alluvial soils

present in the project area. The alluvial soils within the project area may also be prone to collapse or settlement, which can result in differential movement, potentially causing structural distress.

There are a number of oil fields and oil wells within the project area and, in particular, close to each of the north–south and west–east alignment options.

The naturally occurring oil and gas underlying these areas can pose a health and safety hazard, particularly due to the explosive nature of the hazardous gases. The hazards presented by gassy or potentially gassy ground will need to be mitigated. At some point along each of the project alignments, a methane zone is crossed. Numerous construction methodologies are likely to be employed to suit particular ground and groundwater conditions, as well as the depth, length, and other factors expected to vary along the project alignment. Other corrosive subsurface conditions are present, at least locally.

As can be expected in any urban setting, there are many utilities within the project area. A review of only the water and gas utilities greater than 24 inches in diameter revealed several hundred intersecting with each of the alignment options. Most of those identified were water lines. All utilities need to be identified and assessed before construction to mitigate impacts to service or construction.

There are two existing LA Metro subway lines that intersect at least once with each of the north–south project alignment options, one of which runs parallel to the Griffith Park alignment option for approximately 2.2 miles. The three west–east alignment options do not intersect with any subway structures.

Numerous other underground infrastructure, including water storage tanks and water monitoring wells and equipment, were identified close to each of the north–south and west–east alignment options. These and other potential infrastructure, such as piles and tiebacks, should be identified before construction.

6. Recommendations

It is recommended that the following actions are taken for each of the alignment options to validate and further refine the evaluation presented in this and the alignment review TMs:

- Refine pipe diameters.
- Conduct detailed hydraulic analysis.
- Identify and review all remaining underground utilities and seek as-built drawings.
- Acquire and review existing underground infrastructure as-built drawings.
- Map out soft ground and hard rock sections in relation to the sections identified to be trenched and tunneled.
- Determine the likely preferred construction methodology for all tunnel sections and tunneled crossings.
- Define the individual length of each crossing.
- Refine the estimated number of shafts.
- Evaluate corrosion risk due to high-voltage power lines.
- Evaluate soil corrosion potential.
- Understand requirements for California Department of Transportation (Caltrans) and railroad crossings.
- Understand the City and County of Los Angeles requirements for street crossings.
- Evaluate ROWs, easements, and land acquisitions required.
- Determine permitting requirements.
- Evaluate traffic disruption.
- Evaluate local community impacts.
- Assess environmental impacts.
- Estimate cost and schedule.
- Conduct a risk assessment.
- Review future projects with potential conflicts.

7. References

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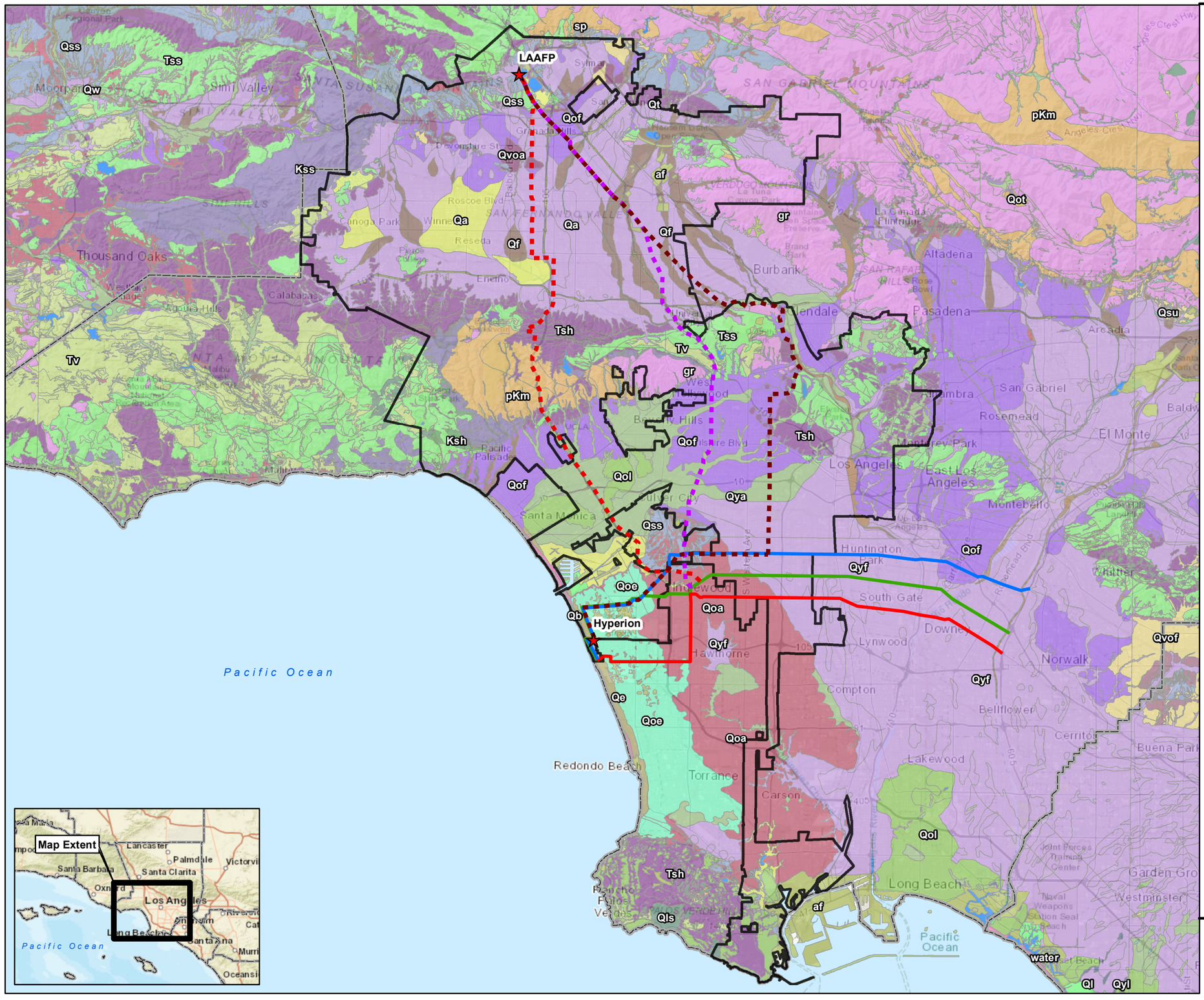
Figures



Legend

North-South Alignment Options

- Griffith Park
- Cahuenga
- Sepulveda

East-West Alignment Options

- Primary Slauson Alignment
- Alternative 1: Florence Alignment
- Alternative 2: Manchester Alignment
- City Boundary
- County Boundary

USGS Geology

- Ksh: Fine-grained Cretaceous age formations of sedimentary origin
- Kss: Coarse-grain... Cretaceous age formations of sedimentary origin
- Qa: Alluvial Valley Deposits
- Qb: Beach Deposits
- Qe: Eolian and Dune Deposits
- Qf: Alluvial Fan Deposits
- Ql: Lacustrine, Playa and Estuarine (Paralic) Deposits
- Qls: Landslide Deposits; may include debris flows and older landslides
- Qoa: Old Alluvial Valley Deposits
- Qoe: Old Eolian and Dune Deposits
- Qof: Old Alluvial Fan Deposits
- Qol: Old Lacustrine, Playa and Estuarine (Paralic) Deposits
- Qot: Old Terrace Deposits
- Qsh: Fine-grained formations of Pleistocene age and younger; includes fine-grained sandstone, siltstone, mudstone, shale, siliceous and calcareous sediments
- Qss: Coarse-grain... formations of Pleistocene age and younger; primarily sandstone and conglomerate
- Qsu: Undifferentiat... Surficial Deposits; includes colluvium, slope wash, talus deposits, and other surface deposits of all ages
- Qt: Terrace Deposits; includes marine and stream terrace deposits
- Qvoa: Very Old Alluvial Valley Deposits
- Qvof: Very Old Alluvial Fan Deposits
- Qw: Alluvial Wash Deposits
- Qya: Young Alluvial Valley Deposits
- Qye: Young Eolian and Dune Deposits
- Qyf: Young Alluvial Fan Deposits
- Qyl: Young Lacustrine, Playa and Estuarine (Paralic) Deposits
- Tsh: Fine-grained Tertiary age formations of sedimentary origin
- Tss: Coarse-grain... Tertiary age formations of sedimentary origin
- Tv: Tertiary age formations of volcanic origin
- af: Artificial Fill
- gr: Granitic and other intrusive crystalline rocks of all ages
- pKm: Cretaceous and Pre-Cretaceo... metamorphic formations of sedimentary and volcanic origin
- sp: Serpentinite of all ages
- water

0 2 4 8
Miles
1 inch = 4 miles

Figure 1

Geologic Map

Sources:
California Geological Survey, 2010 and 2012, see text.
ESRI World Topo Map; ESRI World Street Map

Pure Water Los Angeles Master Plan

Jacobs

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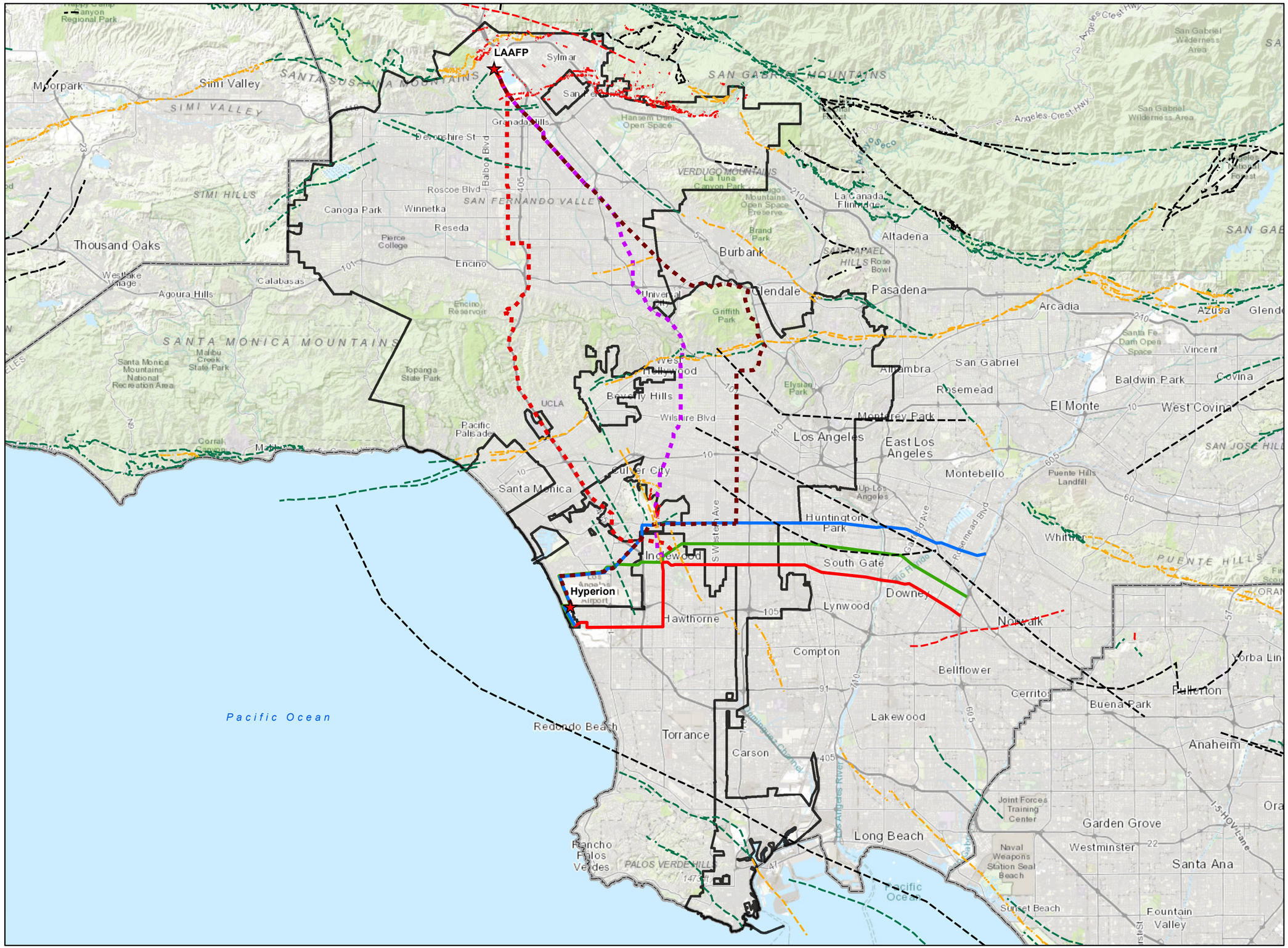

Legend

- Treatment Facilities

North-South Alignment Options

- Griffith Park
- Cahuenga
- Sepulveda

East-West Alignment Options

- Primary Slauson Alignment
- Alternative 1: Florence Alignment
- Alternative 2: Manchester Alignment

Quaternary Faults

- Historical (<150 years)
- Latest Quaternary (<15,000 years)
- Late Quaternary (<130,000 years)
- Undifferentiated Quaternary (<1.6 million years)
- City Boundary
- County Boundary

Sources:
United States Geological Survey (USGS)
and California Geological Survey (CGS), 2023,
see text.
ESRI World Topo Map; ESRI World Street Map

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Miles

1 inch = 4 miles

Figure 2

Fault Map

Pure Water Los Angeles Master Plan

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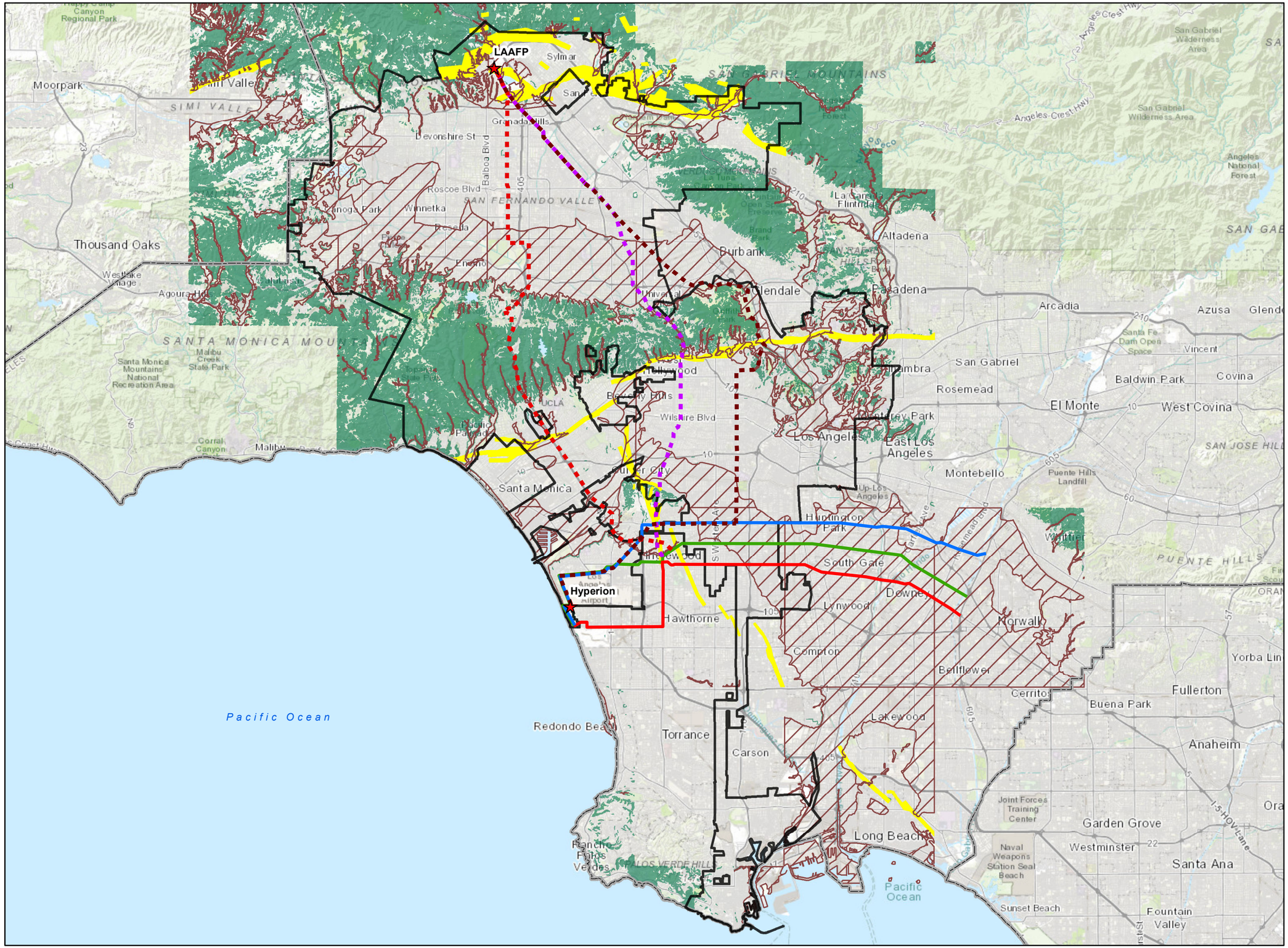

Legend

- Treatment Facilities

North-South Alignment Options

- Griffith Park
- Cahuenga
- Sepulveda

East-West Alignment Options

- Primary Slauson
- Alternative 1: Florence
- Alternative 2: Manchester
- Fault Zone
- Landslide Zone
- Liquefaction Zone
- City Boundary
- County Boundary

Sources:
California Geological Survey, 2023, see text.
ESRI World Topo Map; ESRI World Street Map

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Miles

1 inch = 4 miles

Figure 3

Seismic Hazard Map

Pure Water Los Angeles Master Plan

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Oat Mountain
Aliso Canyon
Cascade
Horse Meadows (Abd.)
Mission (Abd.)
Mission (Abd.)
Pacoima
San Fernando
Santa Monica Mountains
Beverly Hills
Sherman (Abd)
San Vicente
Salt Lake
South Salt Lake
Los Angeles City
Sawtelle
Beverly Hills
Cheviot Hills
Union Station
Boyle Heights (Abd)
Los Angeles Downtown
Las Cienegas
Santa Monica
Venice Beach (Abd)
Playa Del Rey
Inglewood
Potrero
Hyperion
Howard Township
El Segundo
Lawndale
Alondra
Rosecrans
Compton
East Rosecrans
South Rosecrans
Dominguez
Torrance
Long Beach Airport
Long Beach
Gaffey (Abd)
Wilmington
San Pedro
Pacific Ocean

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Methane Zone
Methane Buffer Zone
Council District Boundary

BASIC GRID MAP
CITY OF LOS ANGELES
BUREAU OF ENGINEERING
Ordinance 175,790

Figure 4

Methane and
Methane Zone Buffers

Pure Water Los Angeles

Jacobs

JAMES K. HAHN
MAYOR

METHANE AND METHANE BUFFER ZONES

CITY OF LOS ANGELES

Prepared by GIS Mapping, Bureau of Engineering, Dept. of Public Works - 03/31/04

N

LA DPW ENGINEERING
Serving the Present; Designing the Future

GARY LEE MOORE, P.E.
CITY ENGINEER

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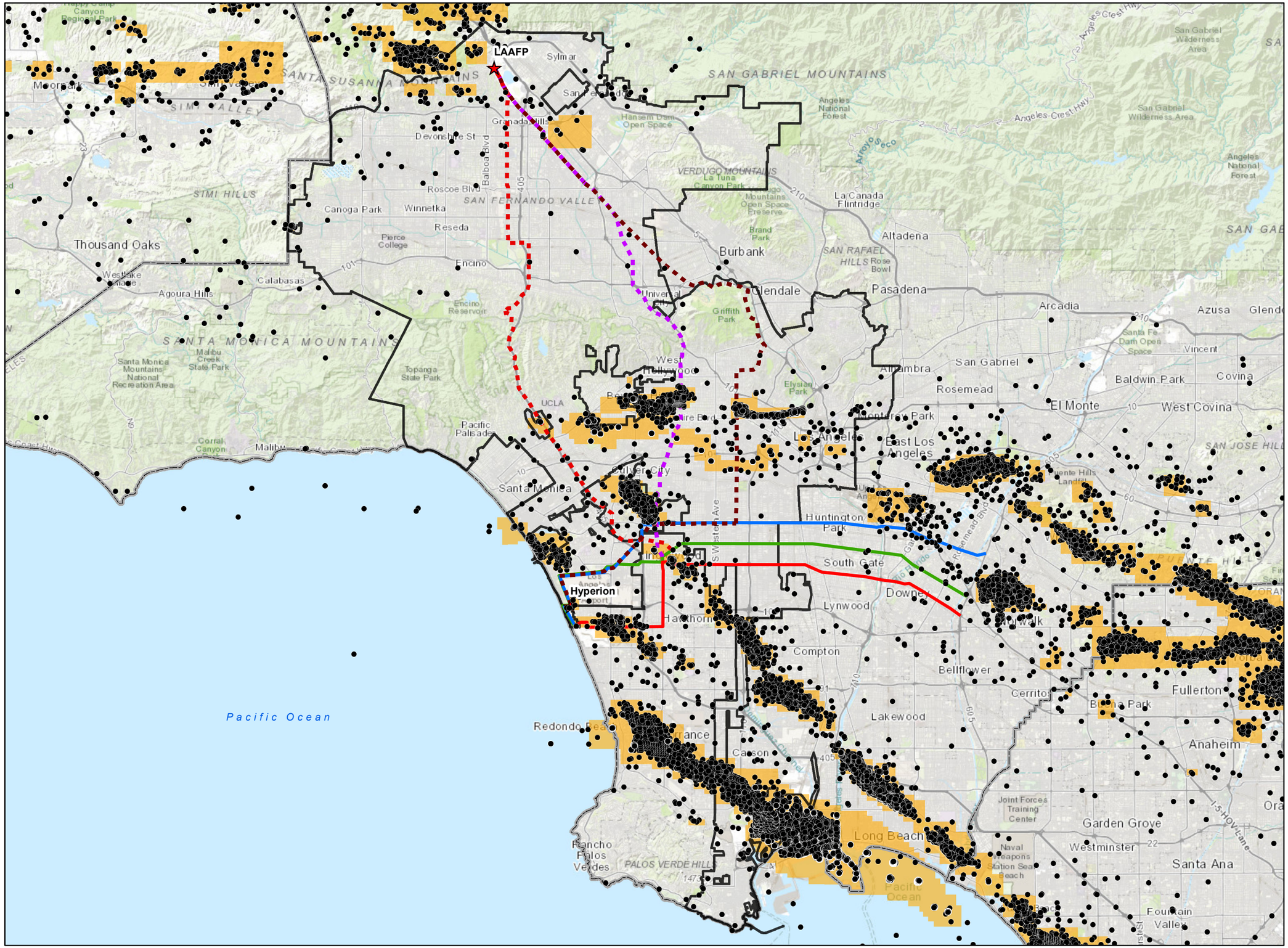

Legend

- Treatment Facilities
- Oil Well
- Oil Field Boundary

North-South Alignment Options

- Griffith Park
- Cahuenga
- Sepulveda

East-West Alignment Options

- Primary Slauson
- Alternative 1: Florence
- Alternative 2: Manchester
- City Boundary
- County Boundary

Sources:
California Geological Survey, 2023
ESRI World Topo Map; ESRI World Street Map

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Miles

1 inch = 4 miles

Figure 5

Oil Wells and Oil Fields Map

LADWP Project NEXT

Jacobs

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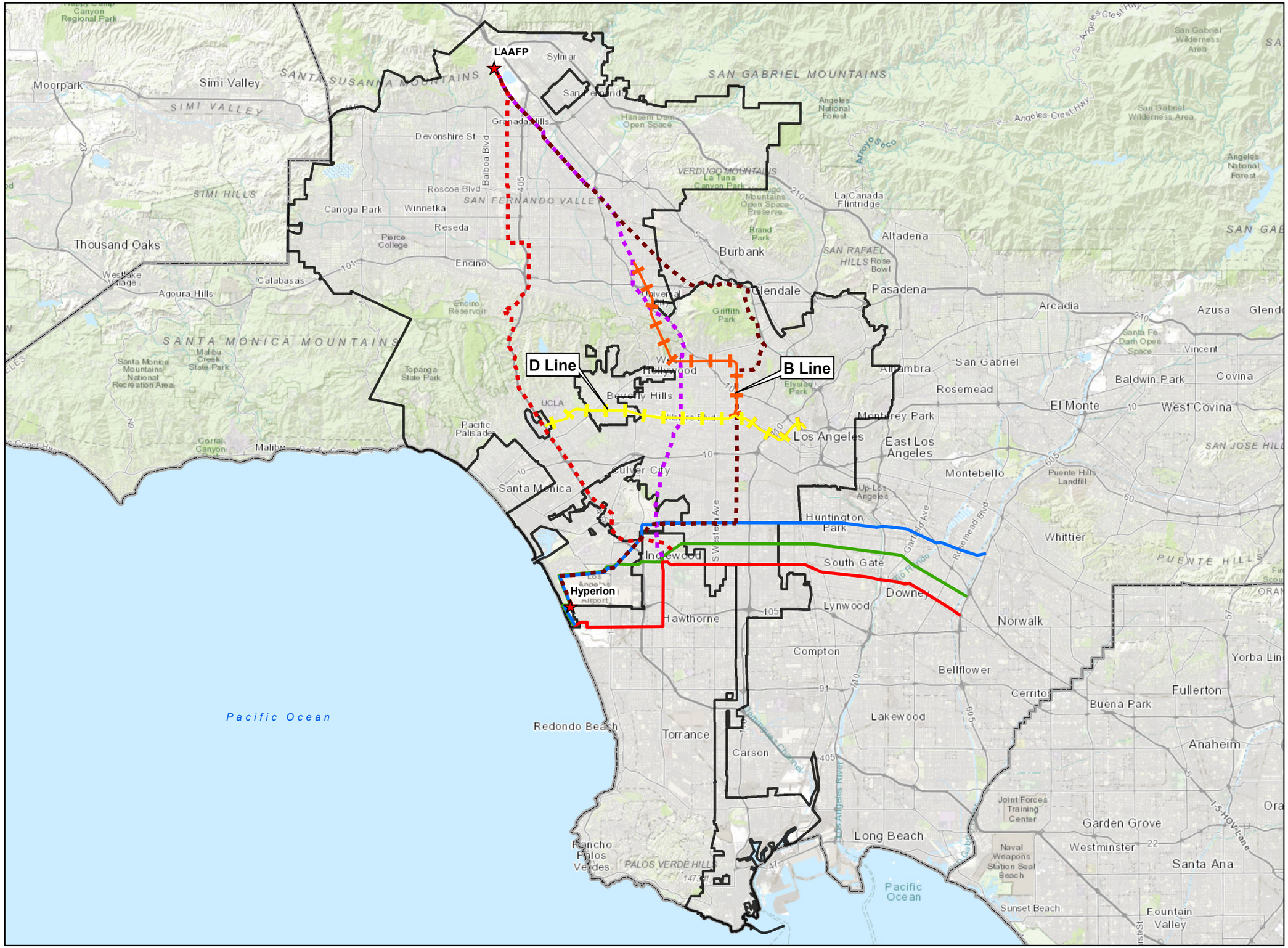

Legend

- Treatment Facilities

North-South Alignment Options

- Griffith Park
- Cahuenga
- Sepulveda

East-West Alignment Options

- Primary Slauson
- Alternative 1: Florence
- Alternative 2: Manchester

Metro Rail Line

- B Line
- D Line
- City Boundary
- County Boundary

Sources:
Metro, 2023
ESRI World Topo Map; ESRI World Street Map

0 1 2 4
Miles

1 inch = 4 miles

Figure 6

Subway Structures Map

Pure Water Los Angeles Master Plan

Jacobs

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Attachment E
Evaluation of Potable and Non-Potable Reservoirs for Pure Water Los Angeles

Evaluation of Potable and Non-Potable Reservoirs for Pure Water Los Angeles

Date:	June 26, 2024
Project Name:	Pure Water Los Angeles Master Plan
Project No.:	D2611501
Document No.:	240920111234_59fba068
Client:	Los Angeles Department of Water and Power (LADWP)
Version No.:	Final

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1. Introduction and Overview

The Pure Water Los Angeles Master Plan evaluates potential alternatives for potable reuse to maximize use of recycled water from the Hyperion Water Reclamation Plant and the anticipated Advanced Water Purification Facility (AWPF). Locations for integrating potable reuse were identified within the LADWP water distribution system as well as through external partnerships. Existing non-potable and potable water reservoirs were identified as potential storage and demand locations. This technical memorandum summarizes the screening and analysis of using reservoirs as Pure Water Los Angeles storage and demand locations.

2. Reservoirs

Ten LADWP-owned reservoirs located within the city's boundaries were identified as potential locations for integrating Pure Water Los Angeles water (Table 2-1, Figure 2-1). Aqueduct reservoirs were excluded from this assessment, and Los Angeles Reservoir (LAR) was evaluated under the Van Norman Complex (VNC) integration location. Potable water reservoirs were categorized as direct potable reuse (DPR) applications, and non-potable reservoirs were categorized as indirect potable reuse (IPR) under surface water augmentation (SWA). A summary of the regulatory requirements for DPR and SWA can be found in the *Potable Reuse Regulations Summary Technical Memorandum* (Jacobs and Arcadis 2024).

The following potable reservoirs were identified as potential applications for DPR:

- Eagle Rock
- Elysian
- Franklin
- Green Verdugo
- Santa Ynez
- Upper Stone Canyon

The following non-potable reservoirs were identified as potential applications for SWA:

- Encino
- Lower Stone Canyon
- Silver Lake
- Upper and Lower Hollywood

Table 2-1. Los Angeles Department of Water and Power Reservoirs Considered for Potable Reuse

Reservoir	Capacity (MG)	Type
Eagle Rock	82	Potable
Elysian	55	Potable
Encino	3,190	Non-potable
Franklin	67	Potable
Green Verdugo	32	Potable
Lower Stone Canyon	2,907	Non-potable
Santa Ynez	117	Potable
Silver Lake	795	Non-potable
Upper and Lower Hollywood	1,147	Non-potable
Upper Stone Canyon	137	Potable

Source: (Arcadis 2012)

Note:

MG = million gallons

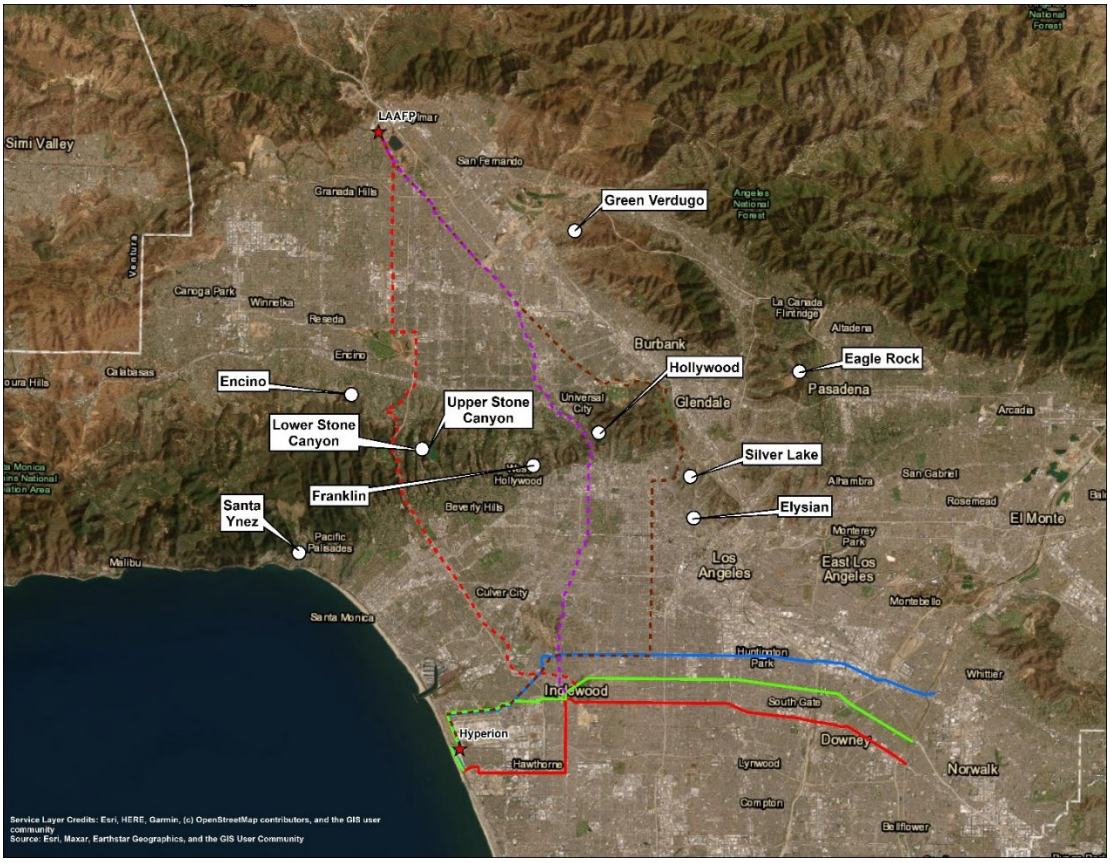

Figure 2-1. Los Angeles Department of Water and Power Potential Reservoirs for Surface Water Augmentation

All reservoirs were assessed considering the following factors:

- Storage capacity
- Land availability

- Potential to repurpose existing infrastructure
- Distance to the nearest alignment
- Site accessibility
- Other considerations

Ultimately, six reservoirs were removed from consideration for the following reasons:

- **Encino Reservoir**: As of the end of 2016, offers potential storage capacity of up to 3.2 billion gallons and could receive a flow rate of recycled water between 28 and 82 cubic feet per second (cfs) (18 and 53 million gallons per day [MGD]), while maintaining the required retention time of 2 to 6 months. Encino Reservoir has an existing microfiltration (MF) plant that is out of service (Black and Veatch 2017a). However, due to the distance to the nearest proposed alignment and water level limitations that decrease the usable portion of the reservoir, this reservoir was removed from consideration.
- **Silver Lake Reservoir**: Silver Lake Reservoir is close to private properties and is valued among residents as a natural feature. Potential Pure Water Los Angeles flows were not included in the *Silver Lake Reservoir Complex Master Plan* (Raman et al. 2020), which includes competing opportunities for the reservoir. The distribution system in this area is primarily supplied by the San Fernando Basin (SFB) wellfields, and adding additional supply to this area would decrease the ability to pump water from the SFB, which is required for remediation activities. This reservoir was removed from consideration due to upstream impacts on SFB wellfield operations.
- **Eagle Rock, Elysian, Green Verdugo, and Santa Ynez reservoirs**: These reservoirs have a relatively small storage capacity, ranging from 32 to117 MG, lack available land for construction of new treatment facilities, and are located between 10,000 and more than 30,000 feet from the nearest proposed alignment. Due to these reasons, these reservoirs were removed from consideration.

The following four remaining reservoirs were evaluated in more detail and screened using the multi-criteria decision analysis (MCDA) (Attachment F, *Reservoir and Van Norman Complex Preliminary Screening Evaluation*):

1. Lower Stone Canyon Reservoir for SWA
2. Upper and Lower Hollywood Reservoirs for SW
3. Franklin Reservoir for DPR
4. Upper Stone Canyon Reservoirs for DPR

2.1 Non-potable Reservoirs for Conveyance Pumping

As an alternative to SWA, Lower Stone Canyon and Lower Hollywood Reservoir were also considered for use as forebays for intermediate pump stations. Conveying recycled water to SFB and VNC will require considering intermediate pump stations along each of the alignments. However, this use of the reservoirs was not considered further due to the following reasons:

- Water would have to be dechlorinated before entering the reservoirs, requiring additional footprint and capital and annual operations and maintenance (O&M) costs for dechlorination and chlorination at the outlet to maintain a residual for conveyance.
- Water must comply with the water quality and monitoring requirements of the *California Toxics Rule* (CTR), which may require additional footprint and capital and annual O&M costs for monitoring and potential treatment.
- Water quality could degrade due to stormwater entering the reservoirs, which could increase downstream treatment complexity and costs.
- Lower Stone Canyon Reservoir is not located at an elevation that would allow maintaining an in-pipe pressure of less than 300 pounds per square inch (psi) to minimize material cost without adding an additional pump station.

Using the reservoirs as forebays for pump stations would require a significant amount of new infrastructure, including:

- Conveyance to and from the reservoirs
- Discharge and intake structures
- Possible wet well installations
- Various other visual upgrades

2.2 Surface Water Augmentation

Lower Stone Canyon and Lower Hollywood Reservoir were both considered for SWA. Both reservoirs are currently disconnected from LADWP's distribution system but have storage volumes exceeding 1,000 MG (3,069 acre-feet [AF]) that would allow for the required residence time and dilution to meet the SWA regulations (Arcadis 2012).

Lower Stone Canyon has an existing 15 cfs (10 MGD) MF plant, while Hollywood Reservoir does not have an existing water treatment plant. The Stone Canyon Reservoir MF plant is offline and would require extensive rehabilitation to bring back online, as well as coordination with the Division of Drinking Water (DDW) (Black and Veatch 2017b). Expansion or the addition of water treatment facilities at the non-potable reservoirs would require close coordination with the neighborhoods surrounding the reservoirs.

2.2.1 Source Water Quality Goals for Surface Water Augmentation

Considering the proposed treatment for SWA, the water quality goals for the source water entering the surface water (raw water reservoirs) are listed in Table 2-2.

CTR compliance must be monitored at the point of discharge to the augmentation water body, not at or leaving the treatment plant. For Pure Water Los Angeles, extended conveyance times will be likely due to distance of the storage and demands locations from the AWPF. The residence time in conveyance could potentially result in water quality concerns, such as reformation of N-nitrosodimethylamine (NDMA) or disinfection by-products (DBPs). CTR compliance could require upstream treatment measures or additional treatment at the reservoirs.

Upstream treatment upgrades could include:

- Tight chloramine control upstream of reverse osmosis (RO) (for example, preformed monochloramine)
- Effective source control and improved chlorination and chloramination practices at wastewater treatment plants (WWTPs)
- Elimination of the use of Mannich polymers at solids handing facilities of WWTPs
- Reduction of concentrations of NDMA and precursors using ultraviolet advanced oxidation process (UVAOP)
- Nutrient limiting analysis and close monitoring of nutrients in Pure Water Los Angeles water, considering that phosphate is typically limiting for biostimulation

Treatment at the reservoirs could include granular activated carbon (GAC) for DBP or ultraviolet (UV) photolysis for NDMA. Pilot testing will be required to determine the potential treatment upgrades at the AWPF or treatment at the reservoirs. Dechlorination before discharge to the reservoirs may be required, depending on the chlorine residuals used for conveyance.

Table 2-2. Surface Water Augmentation Draft Water Quality Goals

Parameter	Value	Basis
Pathogen Removal Credits *(V/G/C)*	8/7/8 (1% dilution and > 180 days' retention) 10/9/10 (10% dilution and 60-180 days' retention)	SWA regulation SWTR requires additional 4/3/2 log removal leaving the reservoir
TOC	< 0.5 mg/L	-
TN (nitrate, nitrite, ammonia)	1-3 mg/L nitrate	Assumed biostimulation goal for Basin Plan compliance (Los Angeles RWQCB 2014)
pH	8.3 ± 0.2	LADWP distribution system target (CDM Smith et al. 2021)
Disinfection Residual	< 0.1 mg/L chlorine	Basin Plan requirement (Los Angeles RWQCB 2014)
NDMA and DBPs (more than listed)	NDMA: 0.69 ng/L Bromoform: 4.3 µg/L DBCM: 0.41 µg/L DCBM: 0.56 µg/L	CTR compliance
TDS, Sulfate, Chloride, Boron	TDS (SMCL): 500 mg/L Sulfate (SMCL): 250 mg/L Chloride (SMCL): 250 mg/L Boron (CA-NL): 1,000 µg/L	California drinking water MCLs and SMCLs

Notes:
> = greater than
< = less than
µg/L = microgram(s) per liter
CA-NL = California Notification Level
DBCM = dibromochloromethane
DCBM = dichlorobromomethane
MCL = maximum contaminant level
mg/L = milligram(s) per liter
ng/L = nanogram(s) per liter
SMCL = secondary maximum contaminant level
SWTR = Surface Water Treatment Rule
TDS = total dissolved solids
TOC = total organic carbon
TN = total nitrogen
V/G/C = virus/*Giardia*/*Cryptosporidium*

2.2.2 Conceptual Treatment Train

Based on receiving IPR water, the non-potable reservoirs could be used without providing additional treatment before augmentation or with additional CTR compliance treatment. The water that leaves the surface water reservoir must be treated to meet Surface Water Treatment Rule requirements. For these applications, the assumed treatment trains (Figure 2-2) to meet the applicable regulatory requirements include:

- Cartridge filters and strainers
- MF
- Chemical disinfection

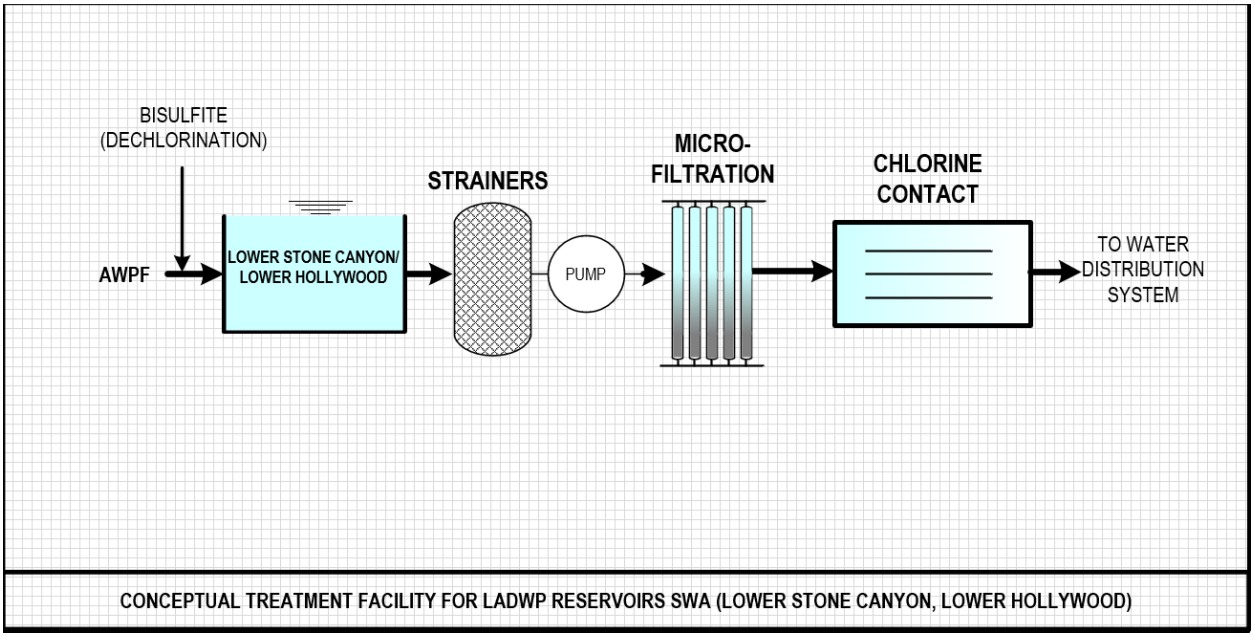

Figure 2-2. Surface Water Augmentation Reservoir Conceptual Treatment Process Flow

2.2.3 Conceptual Treatment Train Design Criteria

Based on the chemical and pathogen control requirements, conceptual design criteria were developed to estimate conceptual-level cost estimates included in Table 2-3.

Table 2-3. Summary of Treatment Train Design Criteria for Los Angeles Department of Water and Power Reservoir Surface Water Augmentation

Design Criteria	Units	Value
Recycled Water Quality Assumptions		
TOC	mg/L	< 0.5
TN (nitrate, nitrite, ammonia)	mg/L	1-3
pH	-	8.2-8.3
Disinfection Residual	mg/L chlorine	< 0.1
NDMA	ng/L	< 0.69
Bromoform	µg/L	< 4.3
CDBM	µg/L	< 0.41
DCBM	µg/L	< 0.27
Cartridge Filters and Strainers		
Type	-	Automatic backwashing
Configuration	-	(N duty + 1 standby)
Screen Opening Size	µm	200-400
Clean Headloss	psig	1 to 2
Maximum Operating Pressure	psig	150
MF		
Membrane Material	-	PVDF
Type	-	Encased MF or UF
Flow Direction	-	Outside-in

Design Criteria	Units	Value
Maximum Instantaneous Flux	gfd	50
Design Recovery	%	95
Minimum Spare Space Capacity	%	10
Chlorine Disinfection		
Chemical	-	Sodium hypochlorite (onsite)
Chlorine Concentration	%	0.8
Design Dose	mg/L	< 4.0
Average Dose	mg/L	2.5
Ammonia		
Chemical	-	Liquid ammonium sulfate
Ammonia to Chlorine Ratio	-	4:1
Fluoride		
Chemical	-	Hydrofluorosilicic acid
Design Dose	mg/L	0.7

Notes:

- = not applicable
µm = micrometer(s)
CDBM = chlorodibromomethane
gfd = gallon(s) per foot per day
ng/L = nanogram(s) per liter
psig = pound(s) per square inch gauge
PVDF = polyvinylidene fluoride
UF = ultrafiltration

2.2.4 Lower Stone Canyon Reservoir

Lower Stone Canyon Reservoir is located near Mulholland Drive and the San Diego Freeway (I-405), approximately 2.4 miles east of the Sepulveda alignment. This reservoir has approximately 3 billion gallons of storage capacity and could receive a flow of up to 77 cfs (50 MGD), while maintaining the minimum 2-month retention time required for SWA at the maximum water level. However, water levels are required to be lower by October to provide capacity to accept stormwater. Based on actual reservoir volumes in 2022, the average flow for 2-month retention time would be 57 cfs (37 MGD) (LADWP 2023a).

2.2.5 Conceptual Layout

There is an existing MF plant located at the southwestern corner of the reservoir. The plant has a capacity of 15 cfs (10 MGD), but has been out of service since 2013. Integrating recycled water at Lower Stone Canyon Reservoir offers an opportunity to reuse underused existing infrastructure through rehabilitation of the MF plant as an initial construction phase.

Space for additional capacity is limited at the reservoir site. Additional treatment facilities were evaluated in the open space near the existing chloramination station west of Upper Stone Canyon (Figure 2-3). New treatment facilities would require a footprint of approximately 1.3 acres and include the following infrastructure, as shown on (Figure 2-3):

- Administration and Control Building
- Process area
- Electrical and mechanical rooms
- Chemical facility
- Pump station

However, the available space is constrained and would not allow for additional CTR treatment, if required. The conceptual treatment layout on Figure 2-3 does not include CTR treatment.

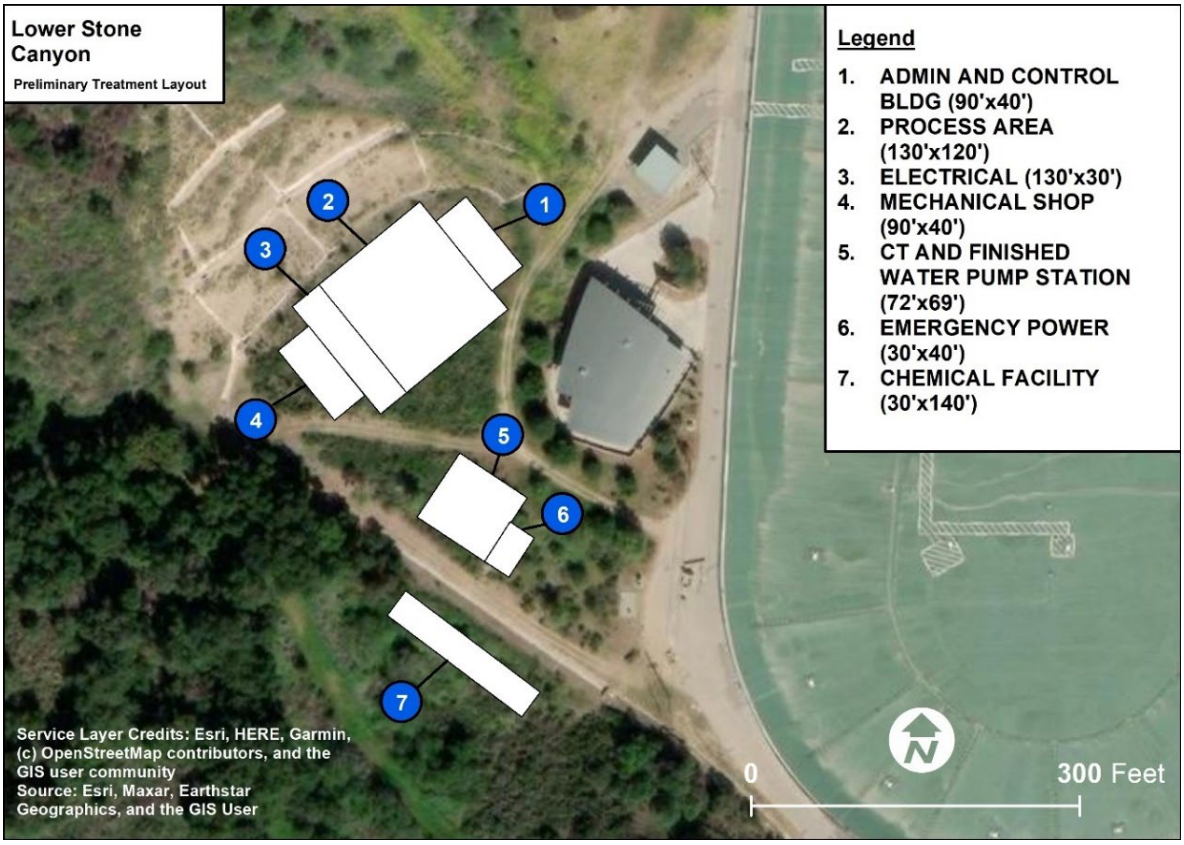

Figure 2-3. Lower Stone Canyon Reservoir Conceptual Treatment Layout

Furthermore, Lower Stone Canyon Reservoir is close to residential areas, and residents consider the reservoir to be a valued natural feature. Based on space limitations, expansion beyond the existing MF plant was not considered feasible.

2.2.6 Conveyance from Sepulveda Alignment

The nearest Pure Water Los Angeles alignment to Lower Stone Canyon is the Sepulveda alignment. Conveyance from the Sepulveda alignment to Lower Stone Canyon Reservoir would need to cross under I-405 and generally follow Mulholland Drive. Mulholland Drive is a high traffic road, increasing construction difficulty. This conveyance route would require approximately 14,000 feet of new pipeline.

Hollywood Reservoir is located near the Hollywood Freeway (State Route [SR]-170) and Lakeridge Road, approximately 0.5 mile east of the Cahuenga alignment. This reservoir has 1.1 billion gallons of storage capacity between the Upper Hollywood and Hollywood reservoirs and can receive a flow of up 28 cfs (18 MGD), while maintaining the minimum 2-month retention time required for SWA at the maximum storage capacity. Based on actual reservoir volumes in 2022, the average flow for 2-month retention time would be 26 cfs (17 MGD) (LADWP 2023b).

2.2.7 Conceptual Layout

There is an existing dam between Upper Hollywood Reservoir and Lower Hollywood Reservoir near the northwestern corner of Hollywood Reservoir. Construction near this area would need to consider dam stability and maintain the structural integrity of the dam. Additionally, the road to access Hollywood Reservoir is narrow and located in local neighborhoods. Construction accessibility would likely require

enhancements to this roadway. These considerations increase the site work cost of integration of recycled water at Lower Hollywood Reservoir.

Furthermore, Lower Hollywood Reservoir is close to residential areas, and residents consider the reservoir to be a valued natural feature.

Additional treatment facilities were evaluated in the area at the southeastern end of the reservoir. New treatment facilities would require a footprint of approximately 1.0 acre and include the following infrastructure, as shown on (Figure 2-4):

- Administration and Control Building
- Process area
- Electrical and mechanical rooms
- Chemical facility
- Pump station

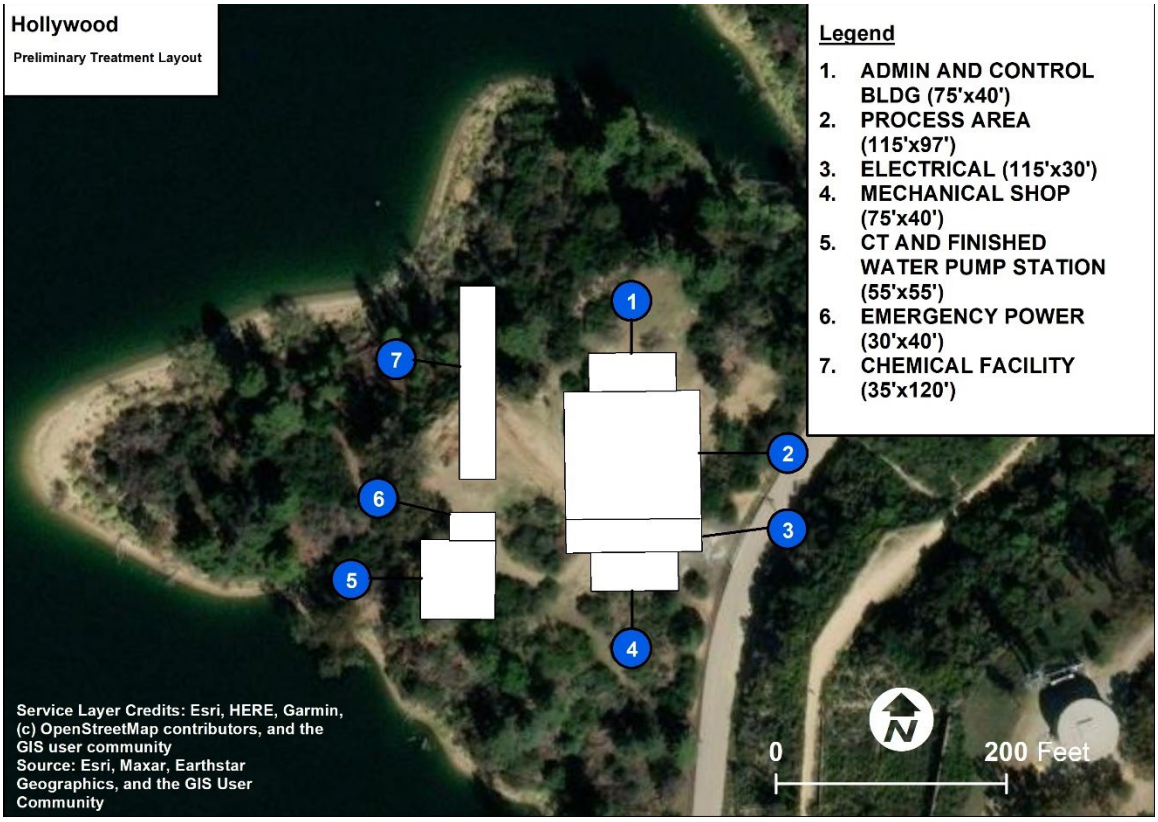

Figure 2-4. Hollywood Reservoir Conceptual Treatment Layout

The available space is constrained and would not allow for additional CTR treatment, if required. The conceptual treatment layout in Figure 2-4 does not include CTR treatment. Based on the required footprint and potential for additional CTR treatment, treatment at the reservoir is not feasible.

2.2.8 Conveyance from Cahuenga Alignment

The nearest Pure Water Los Angeles alignment to Lower Hollywood is the Cahuenga alignment. Conveyance from the Cahuenga alignment to Lower Hollywood Reservoir would start at SR-101 and generally follow the reservoir service road that has an elevation change of approximately 200 feet. This conveyance route would require approximately 2,500 feet of new pipeline.

2.2.9 Surface Water Augmentation Summary

SWA has the potential to reduce treatment required for potable reuse by eliminating the need for chemical control and reducing pathogen requirements from the AWPF. Lower Stone Canyon and Upper and Lower Hollywood Reservoirs were considered as locations for SWA. Due to space limitations at each site, construction of new treatment facilities for surface water treatment or CTR compliance would present significant challenges.

Lower Stone Canyon has an existing 15 cfs (10 MGD) MF plant that could be rehabilitated for treating the reservoir water. However, Lower Stone Canyon Reservoir would require more than 14,000 feet of conveyance on congested streets. Based on construction constraints, conveyance costs, and limited flow capacity, Lower Stone Canyon and Lower Hollywood Reservoir were screened out from additional consideration.

The non-potable reservoirs were evaluated during the Multicriteria Decision Analysis workshop in September 2022, as documented in Attachment F, Reservoir and Van Norman Complex Preliminary Screening Evaluation.

2.3 Treated Water Augmentation

Upper Stone Canyon and Franklin Reservoirs were both considered for potential DPR locations within LADWP's distribution system. These reservoirs could provide additional integration locations for added flexibility in the system. These are both potable reservoirs and would require full DPR treatment before integration, as no additional treatment is currently provided at these sites.

2.3.1 Source Water Quality Goals for Treated Water Augmentation

Table 2-4 lists the water quality goals for the source water entering the DPR treatment trains.

Table 2-4. Direct Potable Reuse with Treated Water Augmentation Draft Water Quality Goals

Parameter	Value	Basis
Pathogen Removal Credits *(V/G/C)*	20/14/15	Draft DPR regulations
TOC	< 0.5 mg/L	Draft DPR regulations
TN (nitrate)	< 10 mg/L	MCL
TN (nitrite)	< 1 mg/L	MCL
pH	8.2-8.4	LADWP distribution system targets (LAR or downstream of LAAFP and LAR)
Disinfection Residual	> 1.5 mg/L	Target distribution system chloramine residual (downstream of LAAFP and LAR)
DBPs	< 80% MCLs	LADWP water quality preference

Note:

LAAFP = Los Angeles Aqueduct Filtration Plant

2.3.2 Conceptual Treatment Train

For the potable reservoirs, the assumed flows would be greater than a 10:1 dilution and would require chemical and pathogen control before entering the reservoirs. To meet DPR requirements, the recycled water entering these reservoirs was assumed to be treated using the conceptual treatment train:

- Ozone and biologically activated carbon (BAC)
- UV disinfection
- Chlorine disinfection

The performance of ozone and BAC after RO would require validation under the Alternative Treatment Clause of the DPR regulations, and the effectiveness of ozone and BAC post-RO is unknown. Subsequent to this evaluation, the conceptual treatment train for DPR compliance at VNC has been updated to include UVAOP and GAC. UVAOP and GAC would have a similar footprint to ozone and BAC, which provides a conservative footprint estimate. As such, the initial screening of the reservoirs was not updated to the revised treatment train.

Figure 2-5 is the process flow diagram for DPR reservoir treatment.

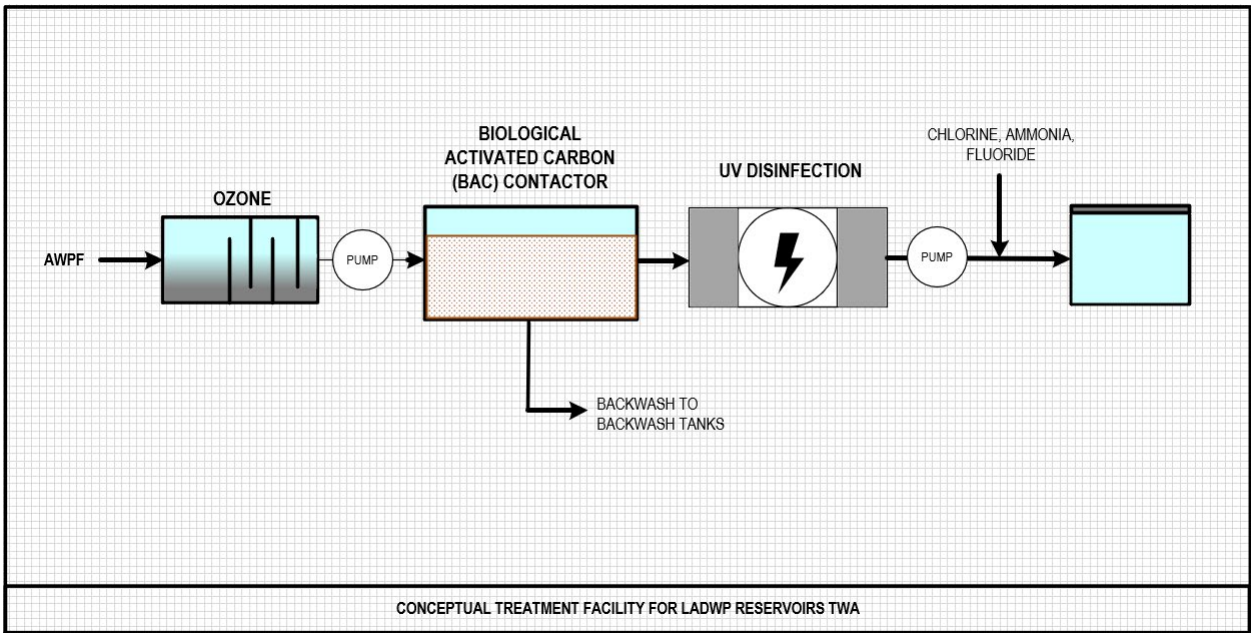

Figure 2-5. Direct Potable Reuse Reservoir Conceptual Treatment

2.3.3 Conceptual Treatment Train Design Criteria

Based on the chemical and pathogen control requirements listed in Table 2-5, conceptual design criteria were developed to estimate conceptual-level footprint and cost estimates.

Table 2-5. Summary of Treatment Train Design Criteria for Los Angeles Department of Water and Power Reservoir Treated Water Augmentation

Design Criteria	Units	Value
Recycled Water Quality Assumptions		
TOC	mg/L	< 0.5
TN (nitrate, nitrite, ammonia)	-	< MCLs
pH	-	8.2-8.3
DBPs	-	< 80% MCLs
Ozone		
Cryptosporidium Inactivation	Log	1-log *Cryptosporidium*
Ozone to TOC Ratio	-	1:1
Minimum Dose	mg/L	4
Bromate Mitigation Required	Yes or no	No
Quenching Required for Taste and Odor Events	Yes or no	No
Estimated Transfer Efficiency	%	90%

Design Criteria	Units	Value
BAC		
BAC EBCT	Minutes	15
No. of Filters	-	20
Backwash Management	-	Storage tanks with recycle and sewer connections
UV Treatment		
Design UVT	%	95
Average UVT	%	97
Target *Cryptosporidium* Inactivation	Log	6-log *Cryptosporidium*
No. of UV Reactors (Duty)	Each	2 (Upper Stone Canyon) 1 (Franklin)
No. of UV Reactors (Standby)	Each	1
Chlorine Disinfection		
Chemical	-	Sodium hypochlorite (onsite)
Chlorine Concentration	%	0.8
Design Dose	mg/L	< 4.0
Average Dose	mg/L	2.5
Ammonia		
Chemical	-	Liquid ammonium sulfate
Ammonia to Chlorine Ratio	-	4:1
Fluoride		
Chemical	-	Hydrofluorosilicic acid
Design Dose	mg/L	0.7

Notes:

EBCT = empty bed contact time
No. = number
UVT = ultraviolet transmissivity

2.3.4 Franklin Reservoir

Franklin Reservoir is located north of the intersection of Sunset Boulevard and Woodland Drive, approximately 4 miles west of the Cahuenga alignment. Conveyance from the Cahuenga alignment to Franklin Reservoir would be approximately 5 miles. This reservoir has 67 MG of storage capacity. The average historical outflow from Franklin Reservoir since 2019 is approximately 46 cfs (30 MGD) (LADWP 2023c). Therefore, this component option assumes a treatment capacity of 46 cfs (30 MGD) of recycled water.

The existing reservoir supply from VNC would be used when demands exceed the proposed treatment capacity, and the Pure Water Los Angeles supply to the reservoir would be reduced when demands are lower. This will result in increased operational complexity for maintaining reservoir levels and managing the Pure Water Los Angeles supply.

2.3.5 Conceptual Layout

Additional treatment facilities could be located in the unused reservoir basin south of the Franklin Reservoir. The conceptual layout of the proposed treatment includes (Figure 2-6):

- Ozone and BAC
- UV disinfection
- Chemical storage and feed
- Electrical Building
- Pump station

Construction in this area would need to consider dam stability and maintain the structural integrity of the dam located at the southern end of the basin. Fill would be required to locate the treatment facilities out of any potential flood zone, as the reservoir is used for stormwater management.

Alternative locations considered for the new treatment facilities included an open area of land adjacent to the southeastern corner of the reservoir and the orange grove south of the stormwater basin. However, conceptual layouts of the required treatment facilities indicated that both alternative locations were not large enough to accommodate the new facilities.

2.3.6 Conveyance from Cahuenga Alignment

The nearest Pure Water Los Angeles alignment to Franklin is the Cahuenga alignment. Conveyance from the Cahuenga alignment to Franklin Reservoir would need to begin at the intersection of N. Highland Avenue and Sunset Boulevard and follow Sunset Boulevard until N. Alpine Drive, where it would then turn northward through residential neighborhoods until reaching the reservoir. Sunset Boulevard is a highly trafficked road, and construction of this conveyance route would require traffic controls. This conveyance route would require approximately 29,000 feet of new pipeline. Figure 2-6 shows the conceptual treatment layout.

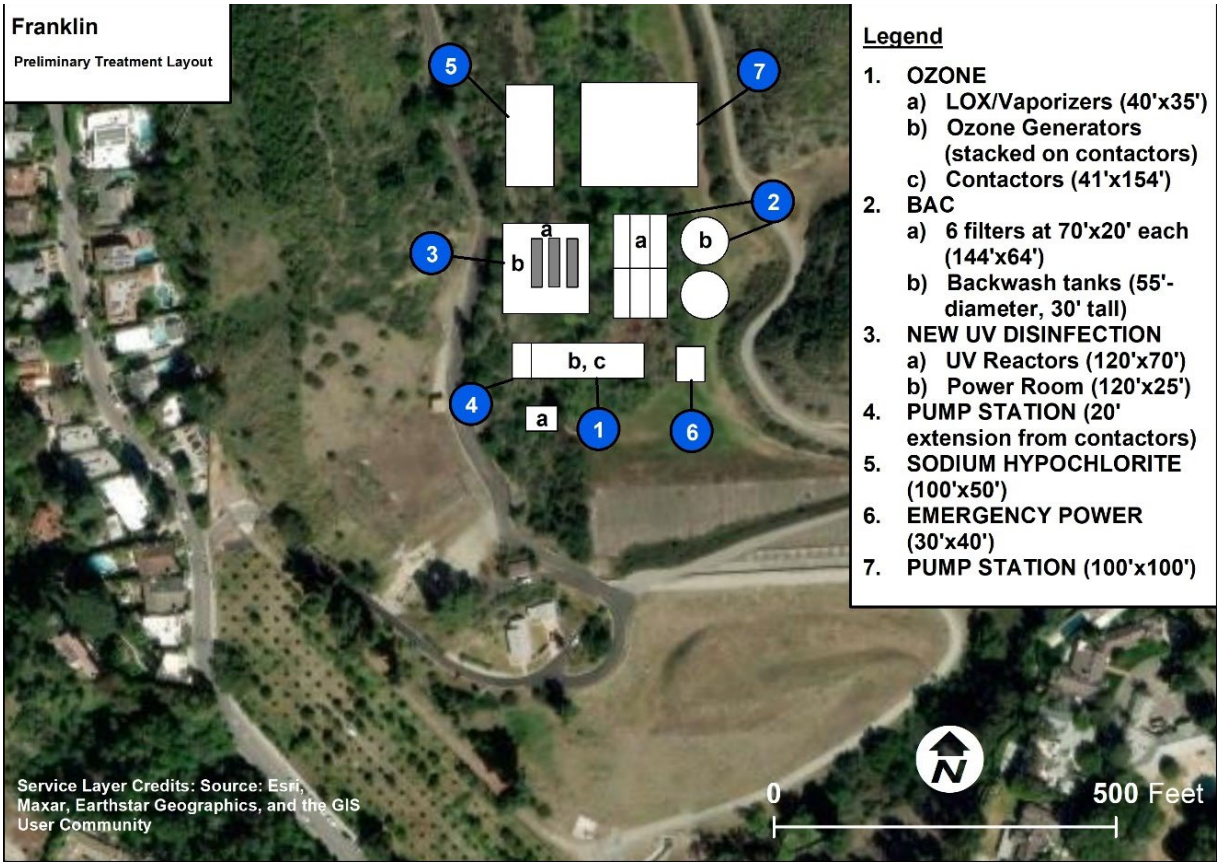

Figure 2-6. Franklin Reservoir Conceptual Treatment Layout

2.3.7 Upper Stone Canyon Reservoir

Upper Stone Canyon Reservoir is adjacent to the Lower Stone Canyon Reservoir located near Mulholland Drive and the San Diego Freeway (Highway I-405), approximately 2 miles east of the Sepulveda alignment. This reservoir has 137 MG of storage capacity. The average historical flow to Upper Stone Canyon Reservoir since 2017 is approximately 74 cfs (48 MGD) (LADWP 2023d). Therefore, this component option assumes a treatment capacity of 74 cfs (48 MGD) of recycled water.

The existing reservoir supply from VNC would be used when demands exceed the proposed treatment capacity, and the Pure Water Los Angeles supply to the reservoir would be reduced when demand are lower. This will result in increased operational complexity for maintaining reservoir levels and managing the Pure Water Los Angeles supply.

2.3.8 Conceptual Layout

Additional treatment facilities could be constructed in the open space near the existing chloramination station west of Upper Stone Canyon Reservoir. New treatment facilities would include (Figure 2-7):

- Ozone and BAC
- UV disinfection
- Chemical storage and feed
- Electrical Building
- Pump station

The available space is constrained and considered to not be feasible, given the available space and neighborhood considerations.

2.3.9 Conveyance from Sepulveda Alignment

The nearest Pure Water Los Angeles alignment to Upper Stone Canyon is the Sepulveda alignment. Conveyance from the Sepulveda alignment to Upper Stone Canyon Reservoir would need to cross under Highway I-405 and generally follow Mulholland Drive. Mulholland Drive is a very narrow, winding service road, making construction potentially difficult. This conveyance route would require approximately 13,000 feet of new pipeline.

Figure 2-7 shows the conceptual treatment layout.

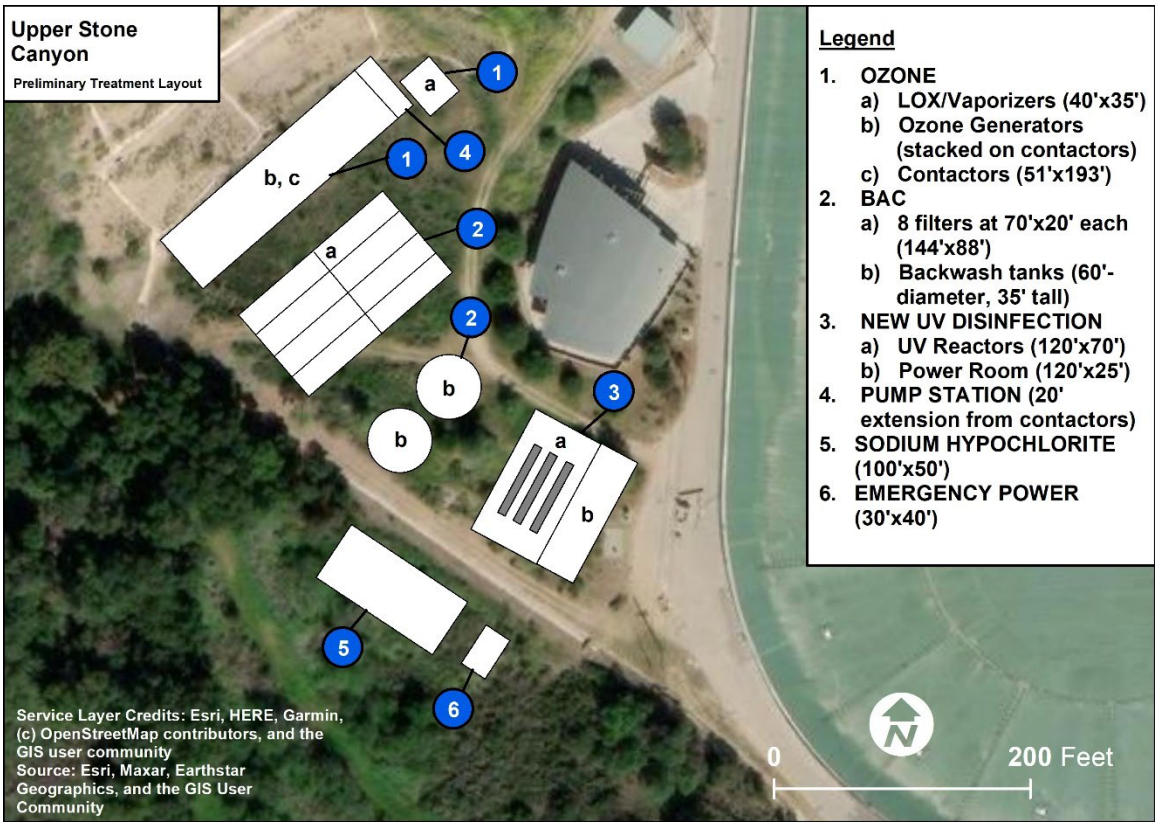

Figure 2-7. Upper Stone Canyon Reservoir Conceptual Treatment Layout

2.4 Non-potable and Potable Reservoir Summary

Ten LADWP-owned reservoirs located within the city's boundaries were identified as potential locations for integrating Pure Water Los Angeles water. Aqueduct reservoirs were excluded from this assessment, and LAR was evaluated under the VNC integration location. Potable reservoirs were categorized as DPR applications, and non-potable reservoirs were categorized as IPR under SWA. Based on initial screening, four reservoirs were evaluated in more detail:

1. Lower Stone Canyon Reservoir for SWA
2. Lower Hollywood Reservoirs for SWA
3. Franklin Reservoir for DPR
4. Upper Stone Canyon Reservoirs for DPR

SWA has the potential to reduce treatment required for potable reuse by eliminating the need for chemical control and reducing pathogen requirements from the AWPF. However, due to space limitations at each site, construction of new treatment facilities for surface water treatment or CTR compliance would present significant challenges. Lower Stone Canyon has an existing out of service15 cfs (10 MGD) MF plant that could be rehabilitated for treating the reservoir water to avoid construction of new treatment

facilities. Lower Stone Canyon Reservoir would also require more than 14,000 feet of conveyance on congested streets. Lower Hollywood Reservoir is located closer to the proposed alignment and is estimated to require approximately 2,500 ft of conveyance.

Potable water reservoirs within LADWP's distribution system could be used at storage and demand locations for integrating Pure Water Los Angeles flows. Based on an initial screening, Franklin and Upper Stone Canyon Reservoirs were considered as locations for DPR treatment. Due to space limitations at each site, construction of new treatment facilities for DPR compliance would also be present significant challenges. Both reservoirs would also require extensive conveyance from the nearest alignment.

Based on the evaluation, the non-potable and potable reservoirs were all eliminated from further consideration in Program alternatives when the AWPF produces IPR-quality water and requires additional onsite treatment. However, the reservoirs could be considered for future adaptability as the Pure Water Los Angeles Program develops.

3. References

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Attachment F
Reservoir and Van Norman Complex Preliminary Screening Evaluation

Reservoir and Van Norman Complex Preliminary Screening Evaluation

Date:	June 26, 2024
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Project No.:	D2611501
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Client:	Los Angeles Department of Water and Power (LADWP)
Version No.:	Final

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1. Introduction and Overview

The Pure Water Los Angeles (Program) Master Plan (MP) evaluates potential alternatives for potable reuse to maximize use of recycled water from the Hyperion Water Reclamation Plant and the anticipated Advanced Water Purification Facility (AWPF). Locations for integrating potable reuse were identified within the LADWP water distribution system, as well as through external partnerships. More information about the evaluation and validation of these alternatives is provided in the *Validation of Strategy Technical Memorandum* (Jacobs and Arcadis 2024) and *Interconnectable Partnership Opportunities Technical* Memorandum (Jacobs 2024).

As part of the storage and demand location evaluation, the open non-potable and covered potable reservoirs and Van Norman Complex (VNC) integration locations were screened to identify the preferred locations for incorporating into the Program alternatives. This technical memorandum summarizes the screening process used to evaluate the reservoir and VNC locations. These preferred locations will be carried forward for confirmation with LADWP, followed by inclusion in the Program alternative comparison, screening, and short-listing of the preferred Program alternatives.

2. Decision Criteria and Component Option Evaluation

Decision science provides transparency and a structured and defensible decision-making process. A multi-criteria decision analysis (MCDA) process was used as the decision science method for selecting preferred potable reuse storage and demand options for the MP. Additional evaluations will be completed for the overall Program alternatives selection.

The MCDA process considers both financial (cost) and nonfinancial criteria and goals. The nonfinancial goals are defined to establish a common understanding of how they would apply to the Program storage and demand options, and measurement scales are assigned to score the performance of each component option relative to each goal. The relative importance of each goal is then established using weighting factors. The final component option score is then determined by the sum of the unitless value score, with weights applied to them. Scores are developed by multiplying the unitless value score by the weight assigned to the criteria, and then adding the values for all of the goals.

Equation 2-1 shows how the score for each project was computed:

$$u_p = \sum_{j=1}^{c} v_{p,j}\, w_j$$ (Eq. 2-1: Calculation of Project Concept Score)

Where:

u_p = Project ("p") score

j = Metric subgoal

c = Number of metric subgoals (five)

v = Project metric value

p = Project concept

w = Weight

The MCDA process was used to rank the Program component options according to the weighted subgoals and the performance of each component option against the criteria (component option score). The following steps were used in the decision-making process:

1. Define the storage and demand evaluation criteria and subcriteria – The evaluation criteria were established through discussions with the LADWP MP Team; the subgoal list determined the different dimensions used to evaluate the projects.

2. Determine the subcriteria weightings – Once the subcriteria were identified, a weight was applied to each subcriteria as a function of the importance given to that item. Criteria weighting was selected through a pair-wise analysis survey completed by representatives of LADWP and Los Angeles Sanitation & Environment (LASAN). Pair-wise methodology takes each criterion and compares it against the other criterion in pairs. For each pair, the participants selected which criterion they felt was more important. Once all criterion pairings had been voted on, the number of times each criterion was selected was divided by the total number of pairings.

3. Define the Program storage and demand options – All the storage and demand locations that would be considered in the selection process were defined during this step.

4. Determine the performance metric for each subcriteria – Once the subcriteria or dimensions to evaluate the projects are known, it's necessary to measure each subcriteria for each component option. Measurements can be quantitative or qualitative, for example:

   - Cost of the component option in dollars
   - Additional groundwater storage in million gallons (MG)
   - Permitting difficulty

5. Transform the performance metrices into a unitless value score – The goal of this step is to have consistency across the multiple possible units identified under the performance metric step. The transformation consists of converting the performance metric to a unitless scale of 1 to 5 based on the range of values observed. For example, if a metric had a range from 10,000 to 110,000 acre-feet per year (AFY), 10,000 AFY would now have a unitless score of 1 (representing the worst score), and 110,000 AFY would have a unitless score of 5 (representing the best score).

6. Rank component options based on scores – LADWP was asked to score the selected storage and demand locations against the five subcriteria during a workshop on March 6 and 8, 2023. The final component option scores were obtained by adding the product of the unitless value score and the weight of each subgoal. Once a score was obtained for each storage and demand option, options were ranked from highest to lowest score.

2.1 Selection Criteria

Based on workshops with LADWP, 10 subcriteria were identified and consolidated into 5 weighted subcriteria. The consolidated subcriteria would still be given a score but were averaged for the final subcriteria score that was multiplied against the identified weighting.

Performance metrics provide measures of the performance of each option with respect to each of the subcriteria listed in Table 2-1. Table 2-1 provides the selection criteria used to evaluate the storage and demand locations. Additional selection criteria are being developed for evaluating Program alternatives and will be updated when available. Metrics can be quantitative (for example, total recharge per year or cost of a project) or qualitative (for example, high, medium, or low benefits). Each metric was transformed into a unitless value score on a scale of 1 to 5 by assigning the lowest range value a 1 and highest range value a 5 and interpolating all the other values between.

Table 2-1. Multi-criteria Decision Analysis Subcriteria Weightings

No.	Subgoal	Weighting (%)	Metric
1	Increase Water System Resiliency	31	--
1.a	Reinforce Water Security	--	Additional water stored in gallons
1.b	Increase System Production Capacity	--	Additional production capacity
1.c	Meet All Water Regulations and Standards	--	Qualitative metric based on relevant regulations
2	Meet Program Milestones and Schedule	12	Qualitative metric based on potential schedule obstacles
3	Provide a Cost-effective Water Supply	15	$/AF of water or $/MG of water
4	Maximize Water System Reliability	29	Qualitative metric based on operational complexity of the component option and response time
5	Benefit Community	13	--
5.a	Elevate Environmental Stewardship	--	Qualitative metric based on the impact to the environment, new park spaces, and green jobs
5.b	Foster Public Support	--	Qualitative metric based on politics and community response

Notes:
-- = not applicable
AF = acre-foot (feet)
No. = number

2.2 Storage and Demand Locations Evaluated

During a two-part workshop with LADWP and the Pure Water Los Angeles MP Team held on March 6 and 8, 2023, VNC and reservoir storage and demand options were evaluated and screened using the MCDA tool. The evaluated locations included:

- VNC: Integrating upstream of the Los Angeles Aqueduct Filtration Plant (LAAFP) or integrating directly into the Los Angeles River (LAR)
- Reservoirs: Integrating into Lower Stone Canyon (LSC) and Hollywood surface water reservoirs and integrating into Upper Stone Canyon and Franklin treated water reservoirs

San Fernando Basin (SFB) and Central Basin (CB) were not screened, as these locations were well defined, with limited component options to screen.

Table 2-2, Table 2-3, and Table 2-4 describe the advantages and considerations for all component options as compared against the subcriteria defined in the MCDA tool. Additional details about the evaluated options can be found in the *Validation of Strategy Technical Memorandum* (Jacobs and Arcadis 2024).

Table 2-2. Van Norman Complex Direct Potable Reuse Options Multi-criteria Decision Analysis Considerations

Criteria	Upstream of LAAFP	LAR
Increase Water System Resiliency	▪ Adds a new source of water supply at VNC ▪ Presents regulatory risks because DPR regulations are in draft form and are subject to change ▪ Presents regulatory risks because Alternatives Clause for alternative treatment train requires validation of treatment and negotiations with DDW	▪ Adds a new source of water supply at VNC ▪ Presents regulatory risks because DPR regulations are in draft form and are subject to change ▪ Presents regulatory risks because Alternatives Clause for alternative treatment train requires validation of treatment and negotiations with DDW ▪ Potentially increases production capacity at VNC by integrating downstream of LAAFP ▪ Can continue production during annual LAAFP maintenance shutdowns
Meet Program Milestones and Schedule	▪ Maintains schedule, as there are minimal schedule or construction obstacle differences between VNC options ▪ Presents regulatory risks because Draft DPR regulations Alternative Clause for proposed treatment train presents permitting and implementation risk ▪ Manages neighborhood and political risks, which are anticipated to be minimal at VNC and similar between options	
Provide a Cost-effective Water Supply	▪ Upgrades to existing infrastructure (PPUV) increases LRV potential and reduces cost ▪ Costs would be similar if DPR compliance is achieved before blending in the raw water channel ▪ Potential to reduce construction footprint and number of new facilities required	▪ Results in higher costs due to new UV facility and pump station
Maximize Water System Reliability	▪ Provides additional treatment barriers with integration point before the water distribution system ▪ Limits reliability because Pure Water Los Angeles water cannot be sent during LAAFP routine maintenance shutdowns ▪ Reduces response time to potential treatment upsets ▪ Potential to improve LAAFP raw water quality	▪ Maintains flows during LAAFP routine maintenance shutdowns ▪ Blends Pure Water Los Angeles water with LAAFP treated water in LAR ▪ Reduces flows through LAAFP, which reduces O&M costs ▪ Reduces impact of Pure Water Los Angeles flow variations
Benefit Community	▪ Reduces risk because minimal impact is expected at VNC with avoidance of sensitive habitat ▪ Reduces risk because construction of new facilities uses previously disturbed areas ▪ Results in minimal public concern expected for VNC	

Notes:
DDW = State Water Resources Control Board Division of Drinking Water
DPR = direct potable reuse
LRV = log reduction value
O&M = operations and maintenance
PPUV = Dr. Pankaj Parekh UV Facility
UV = ultraviolet light

Table 2-3. Surface Water Augmentation at Surface Water Reservoir Options Multi-criteria Decision Analysis Considerations

Subcriteria	LSC (SWA)	Lower Hollywood (SWA)
Increase Water System Resiliency	▪ Adds 3.3 billion gallons of storage potential ▪ Provides new system inputs; increases system production capacity and system storage ▪ Follows existing SWA regulations ▪ Leverages proposed treatment train that is approved and being implemented by other projects in California	▪ Adds 1.1 billion gallons of storage potential ▪ Provides new system inputs; increases system production capacity and system storage ▪ Follows existing SWA regulations ▪ Leverages proposed treatment train that is approved and being implemented by other projects in California
Meet Program Milestones and Schedule	▪ Assumes construction can be implemented in two phases, with Phase 1 using the existing MF plant ▪ Anticipates neighborhood and political risks for new construction due to high visibility ▪ Assumes established regulations and implementation will present reduced permitting obstacles	▪ Introduces construction risks with limited available land for new infrastructure ▪ Introduces risk due to challenging site access ▪ Anticipates neighborhood and political risks for new construction due to high visibility ▪ Assumes established regulations and implementation will present reduced permitting obstacles
Provide a Cost-effective Water Supply	▪ Potentially reduces costs by using existing infrastructure ▪ Requires fewer treatment technologies compared to DPR ▪ Requires long conveyance from nearest Pure Water Los Angeles alignment and inlet structures	▪ Requires minimal conveyance from nearest Pure Water Los Angeles alignment ▪ Provides less potential capacity compared to LSC ▪ Requires new inlet and outlet structure
Maximize Water System Reliability	▪ Provides longer response time ▪ Provides flexibility for flow control ▪ Does not require chemical control ▪ Requires compliance with CTR ▪ Provides ability to store water ▪ Adds ability to control water levels	
Benefit Community	▪ Results in minimal environmental impact expected at reservoirs ▪ Uses previously disturbed areas or unused areas ▪ Results in minimal concern expected for Phase 1 of construction ▪ Reduces public visibility, as Phase 2 of construction is potentially sited at Upper Stone Canyon	▪ Results in minimal environmental impact expected at reservoirs ▪ Uses previously disturbed areas or unused areas ▪ Increases risk because access is through neighborhoods and is highly visible to neighbors

Notes:
CTR = California Toxic Rule
MF = microfiltration
SWA = surface water augmentation

Table 2-4. Direct Potable Reuse at Treated Water Reservoir Options Multi-criteria Decision Analysis Considerations

Subcriteria	Upper Stone Canyon (DPR)	Franklin (DPR)
Increase Water System Resiliency	▪ Assumes no additional storage volume added, as reservoir is already being used as a source of potable water ▪ Provides new system inputs; increases system capacity ▪ Introduces regulatory risk, as DPR regulations are only available in draft form and are subject to change ▪ Introduces regulatory risk, as Alternatives Clause for alternative treatment train requires validation of treatment and negotiations with DDW	
Meet Program Milestones and Schedule	▪ Introduces permitting and implementation risk due to draft DPR regulations Alternative Clause ▪ Anticipates neighborhood and political risks for new construction due to high visibility	▪ Introduces permitting and implementation risk due to draft DPR regulations Alternative Clause ▪ Anticipates neighborhood and political risks for new construction due to high visibility ▪ Includes conveyance through highly trafficked streets ▪ Introduces risk due to construction within impounded area
Provide a Cost-effective Water Supply	▪ Results in higher costs than SWA ▪ Has a shorter conveyance than LSC from the closest Pure Water Los Angeles alignment	▪ Requires the longest and most difficult conveyance from the closest Pure Water Los Angeles alignment ▪ Provides less capacity
Maximize Water System Reliability	▪ Requires adjusting flows to match demands, increasing operational complexity ▪ Shifts flows to other Pure Water Los Angeles storage and demand locations based on matching distribution system demands ▪ Results in minimal response time due to reservoir size	
Benefit Community	▪ Results in minimal environmental impact expected at reservoirs ▪ Uses previously disturbed areas or unused areas ▪ Reduces risk by being located near existing infrastructure ▪ Reduces visibility	▪ Results in minimal environmental impact expected at reservoirs ▪ Uses previously disturbed areas or unused areas ▪ Increases risk with access through neighborhoods ▪ Increases risk because conveyance from nearest Pure Water Los Angeles alignment would be along major roadways

Based on the MCDA evaluation and considerations described in the tables, DPR treatment at the treated water reservoirs was removed from further consideration and not included in any Program alternatives with indirect potable reuse source water. Treated water reservoirs may still be considered if DPR treatment occurs at the AWPF. Both VNC options received similar scores, as did the surface water reservoirs; and all were further evaluated in the development of Program alternatives. Table 2-5 and Figure 2-1 and Figure 2-2 present the weighted MCDA scores for the evaluated options.

Table 2-5. Multi-criteria Decision Analysis Weighted Scores from Screening Workshops on March 6 and 8, 2023

Alternative	Alternative Scoring	Increase Water System Resiliency			Meet Program Milestones and Schedule	Provide a Cost-effective Water Supply	Maximize Water System Reliability	Benefit Community	
		Reinforce Water Security	*Increase System Production Capacity*	*Meet All Water Regulations and Standards*			*Increase Operational Flexibility*	*Elevate Environmental Stewardship*	*Foster Public Support*
Weighting		31%			12%	15%	29%	13%	
VNC Alternatives									
Upstream of LAAFP	**3.3**	1	3.3	3	3	5	3.5	3.4	3.1
LAR	**3.4**	1	4.3	2.9	2.7	5	3.9	2.9	3.1
LADWP Reservoir Alternatives									
LSC	**3.7**	5	4.3	5	2.8	3	3.8	3	2.4
Lower Hollywood	**3.3**	4	4.5	5	2.5	2	3.8	3	1.8
Upper Stone Canyon	**2.5**	1	3.0	3	2.6	3	2.2	3	2.3
Franklin	**2.2**	1	3.8	3	2.5	1	2.2	3	2.1

Notes:

For Program criteria with subcriteria, the subcriteria scores are averaged before applying the criteria weighting.

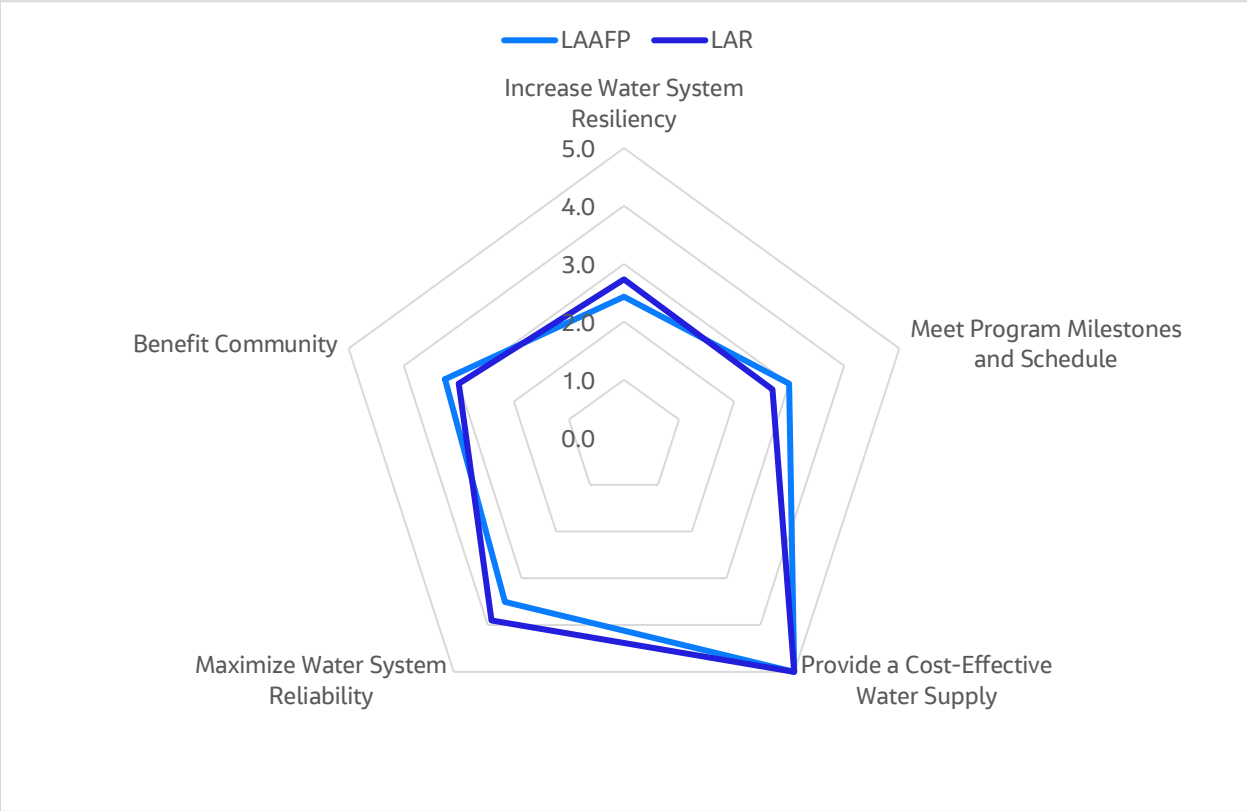

Figure 2-1. Multi-criteria Decision Analysis Van Norman Complex Subgoal Distribution from Screening Workshops on March 6 and 8, 2023

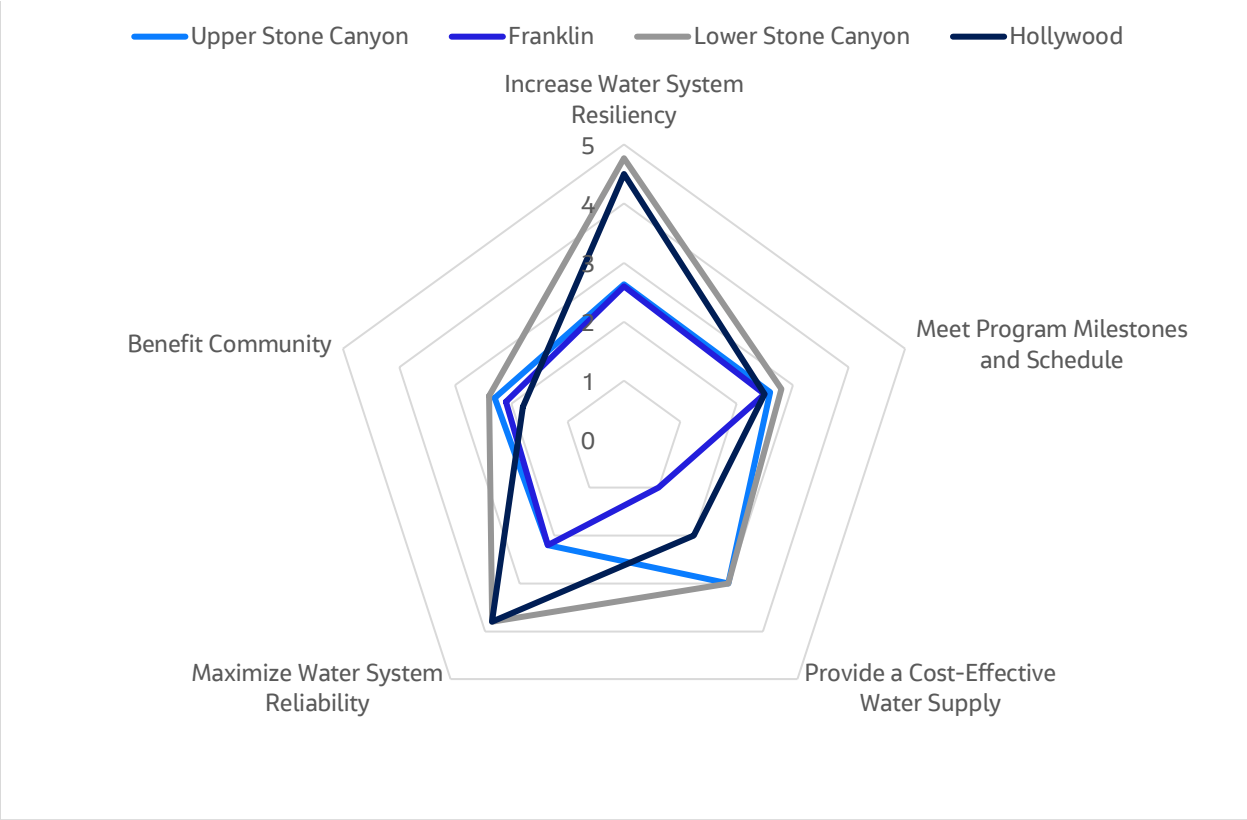

Figure 2-2. Multi-criteria Decision Analysis Reservoir Subgoal Distribution from Screening Workshops on March 6 and 8, 2023

In summary, the storage and demand options at VNC and the LADWP reservoir locations were screened based on the MCDA. The screened storage and demand options that were recommended to be further evaluated as part of the Program alternatives include:

- DPR upstream of LAAFP or at LAR at VNC
- SWA at LSC Reservoir
- SWA at Hollywood Reservoir

Integration location component options that were not screened but will also be further evaluated as part of the Program alternatives include:

- Groundwater replenishment (GWR) in SFB, including:
  - Injection wells
  - Spreading grounds
  - Stormwater parks
- GWR injection wells in CB
- Interagency partnerships

3. References

Jacobs and Arcadis. 2024. Validation of Strategy *Technical Memorandum*. June 13.

Jacobs. 2024. Interconnectable Partnership Opportunities *Technical Memorandum*. May 23.

Attachment G
Cost Estimates

Pure Water Los Angeles Master Plan
Central Basin Distributed Injection and Extraction Wells

Basis of Estimate					
Total Injection Rate	38	MGD	59	cfs	
Total Extraction Rate	18	MGD	28	cfs	
Injection Rate per Well	1,000	gpm			
Extraction Rate per Well	2,000	gpm			
Number of Injection Wells	27				
Number of Extraction Wells	7				
Injection Wells					
Materials	316 SST				
Diameter	18	inch			
Injection Rate	1,000	gpm			
Backwashing Rate	2,000	gpm			
Total depth	1,500	feet			
DTSW	150	feet			
Specific Capacity	21	gpm/ft			
Pumping Level	245	feet			
Discharge Pressure	0	PSI	With air gap to storm or sanitary sewer		
TDH	245	Feet			
Injection Specific Cap	12	55% of pumping SC			
Injection Level	67	feet			
Power Requirements					
WHP	124	HP			
BHP	165	HP	75% plant efficiency		
Overall	183	HP	90% drive efficiency		
	137	KW			
Online Factor	0.89%	Assumes backwashing 1.5 hours per week			
Hours	78	hours/year/well			
Electrical costs	$0.15	per KWH/well	**$1,602**		**per year/well**
Extraction Wells					
Materials	316 SST				
Diameter	18	inch			
Extraction Rate	2,000	gpm			
Total depth	1,500	feet			
DTSW	150	feet			
Specific Capacity	21	gpm/ft	avg SC of MWF wells at end of testing		
Pumping Level	245	feet			
Discharge Pressure	35	PSI	Assumption		
TDH	260	Feet			
Power Requirements					
WHP	132	HP			
BHP	175	HP	75% plant efficiency		
Overall	195	HP	90% drive efficiency		
	145	KW			
Online Factor	100%				
Hours	8,760	hours/year/well			
Electrical costs	$0.15	per KWH/well	**$190,980**		**per year/well**

Pure Water Los Angeles Master Plan
Central Basin Injection Wells Construction Costs

Well Construction	**Number**	**Units**	**Units Costs**	**Extended Costs**
Mobilization	1	LS	$200,000	$200,000
Sound Control	1	LS	$100,000	$100,000
Drill and Install Conductor Casing	50	LF	$750	$37,500
Pilot Borehole Drilling	1450	LF	$100	$145,000
Geophysical Logging	1	LS	$11,000	$11,000
Ream Pilot Borehole	1450	LF	$100	$145,000
Caliper Logging	1	LS	$10,000	$10,000
Well Construction	1500	LF	$825	$1,237,500
Mechanical Well Development	1	LS	$75,000	$75,000
Pumping Well Development	1	LS	$25,000	$25,000
Aquifer Testing/Flowmeter Testing	1	LS	$30,000	$30,000
Video/Gyro	1	LS	$7,500	$7,500
Disinfection	1	LS	$10,000	$10,000
Disposal of Drilling Waste	1	LS	$100,000	$100,000
Subtotal				$2,133,500
Equipping	**Number**	**Units**	**Units Costs**	**Extended Costs**
Mobilization	1	LS	$200,000	$200,000
Electrical Service and Improvements	1	LS	$400,000	$400,000
Down Well Flow Control Valve, Eductor, and Mechanical	1	LS	$200,000	$200,000
Well Pump, 2000 gpm 500 foot setting	1	LS	$200,000	$200,000
Mechanical Installation, Piping and Appurtenances	1	LS	$300,000	$300,000
Well Enclosure and Civil Improvements	1	LS	$850,000	$850,000
Security	1	LS	$100,000	$100,000
I&C	1	LS	$200,000	$200,000
Subtotal				$2,450,000
Cost Per Well			June 2023	**$4,583,500**
Number of Wells				27
Costs All Wells			June 2023	**$123,754,500**
ENR CCI Escalation Factor				1.00712
Subtotal of Project Costs (Costs All Wells)			Escalated to March 2024	**$124,635,227**

Notes:

Well Construction:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021)

Equipping:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021, 2022)

ENR Cost Indexes in Los Angeles: June 2023 (15112.29); March 2024 (15219.84)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
Central Basin Extraction Wells Construction Costs

Well Construction	Number	Units	Units Costs	Extended Costs
Mobilization	1	LS	$200,000	$200,000
Sound Control	1	LS	$100,000	$100,000
Drill and Install Conductor Casing	50	LF	$750	$37,500
Pilot Borehole Drilling	1450	LF	$100	$145,000
Geophysical Logging	1	LS	$11,000	$11,000
Ream Pilot Borehole	1450	LF	$100	$145,000
Caliper Logging	1	LS	$10,000	$10,000
Well Construction	1500	LF	$825	$1,237,500
Mechanical Well Development	1	LS	$75,000	$75,000
Pumping Well Development	1	LS	$25,000	$25,000
Aquifer Testing/Flowmeter Testing	1	LS	$30,000	$30,000
Video/Gyro	1	LS	$7,500	$7,500
Disinfection	1	LS	$10,000	$10,000
Disposal of Drilling Waste	1	LS	$100,000	$100,000
Subtotal				$2,133,500
Equipping	**Number**	**Units**	**Units Costs**	**Extended Costs**
Mobilization	1	LS	$200,000	$200,000
Electrical Service and Improvements	1	LS	$400,000	$400,000
Well Pump, 2000 gpm 500 foot setting	1	LS	$200,000	$200,000
Mechanical Installation, Piping and Appurtenances	1	LS	$300,000	$300,000
Well Enclosure and Civil Improvements	1	LS	$850,000	$850,000
Security	1	LS	$100,000	$100,000
I&C	1	LS	$200,000	$200,000
Subtotal				$2,250,000
Cost Per Well			June 2023	**$4,383,500**
Number of Wells				**7**
Costs All Wells			June 2023	**$30,684,500**
ENR CCI Escalation Factor				1.00712
Subtotal of Project Costs (Costs All Wells)			Escalated to March 2024	**$30,902,873**

Notes:

Well Construction:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021)

Equipping:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021)

ENR Cost Indexes in Los Angeles: June 2023 (15112.29); March 2024 (15219.84)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
Central Basin Injection and Extraction Wells Capital Costs (March 2024$)

Item			Value
Subtotal of Project Costs (All Wells)			
Injection Wells			$124,635,227
Extraction Wells			$30,902,873
Tax (applied to 40% of Total Project Cost)	9.50%		
Subtotal with Tax			$155,538,100
With Location Adjustment Factor	112.9		$175,602,515
Subtotal with Adjustment Factor			**$175,602,515**
Mobilization	5%		
General Conditions	10%		
Art and Permit Fees (LADBS)	3%		$5,268,075
Complexity Index (Risk Contingency)	10%		$17,560,251
Subtotal 1			**$198,430,842**
Bonds/Insurance	3%		
Profit	10%		
Subtotal 2			**$198,430,842**
Project Definition (Class V)	45%	6.384%	$76,625,260
Subtotal 3			**$275,056,102**
Design-Build Factor	15%		$41,258,415
Subtotal 4			**$316,314,517**
CONSTRUCTION COSTS			**$316,314,517**
Non-Construction Costs			
Program and Project Management	10%		$31,631,452
Planning	1%		$3,163,145
Design Engineering	10%		$31,631,452
Services During Construction	5%		$15,815,726
Bid & Award	0.5%		$1,581,573
Startup and Commissioning	0.5%		$1,581,573
Post-Construction	1%		$3,163,145
Construction Management	15%		$47,447,178
Land and ROW	LS		$10,000,000
NON-CONSTRUCTION COSTS			**$146,015,242**
Total Capital Cost Estimate			**$462,329,760**

Notes:

* Incorporates markups from LADWP *Operation NEXT Program's Cost Escalation and Markups Technical Memorandum* (March 21, 2024)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
Central Basin Injection and Extraction Wells O&M Costs

Flow at 100% Capacity

Extraction Wells		
Power	$1,042,753	per year
Equipment Replacement and Repair	$70,000	all wells/year, 2% of equipping costs
Periodic Well Rehabilitation	$100,000	1 well per year (staggered rehab)
Labor	$130,000	0.25% LOE operator, two at $130/hr (1000 hr/yr)
	$1,812,717	Includes 35% contingency
Injection Wells		
Power	$33,729	per year
Equipment Replacement and Repair	$378,000	all wells/year, 2% of equipping costs
Periodic Well Rehabilitation	$300,000	3 wells per year (staggered rehab)
Labor	$390,000	0.75% LOE operator, two at $130/hr (2000 hr/yr)
	$1,487,334	Includes 35% contingency

Concept Study - Basis for Approach II, Alternative 6
February 2024 ONAT Results for Alternatives Screening - 1990 Start Hydrology

Alternative	**CB Total LADWP Extractions**	**CB Total LADWP Extractions**	
Alt 1	26,200	23	
Alt 2	26,200	23	
Alt 3	26,300	23	
Alt 4	16,100	14	
Alt 5 & 6	16,100	14	Approach II, Alternative 6
Alt7	13,400	12	
Alt 8 & 9	13,400	12	

GoldSim 14.0.0383

Simulation Filename: OpNextGS_v1.031; Simulation Start Time: 3/14/2024

Injection Capacity, MGD	38
Extraction Capacity, MGD	18

Alternative	**Injection**		**Extraction**	
	Power	**Total**	**Power**	**Total**
Alt 1	$20,747	$1,088,747	$1,042,753	$1,342,753
Alt 2	$20,747	$1,088,747	$1,042,753	$1,342,753
Alt 3	$20,826	$1,088,826	$1,042,753	$1,342,753
Alt 4	$12,749	$1,080,749	$832,096	$1,132,096
Alt 5 & 6	$12,749	$1,080,749	$832,096	$1,132,096
Alt7	$10,611	$1,078,611	$692,552	$992,552
Alt 8 & 9	$10,611	$1,078,611	$692,552	$992,552

Assumption: Injection = Extraction

$2,212,845 **Total**

Pure Water Los Angeles Master Plan
Central Basin Groundwater Treatment Construction Costs

Scope of Project		Conceptual Treatment Processes
Design Flow		**18 MGD**
Adsorptive Filtration (Includes Tanks, System Piping, Actuated Valves, Instrumentation, and Automatic PLC Control Panel)		$11,101,000
GAC Contactors (Includes Tanks, System Piping, Actuated Valves, Instrumentation, and Automatic PLC Control Panel)		$23,568,000
Backwash Equalization Tank (including a backwash pump)		$282,000
Rectangular Clearwell (includes baffles)		$1,514,000
High Lift Pump Station (includes high lift pumps, surge protection basin, and electrical room)		$4,612,000
Chemical Building (includes containment, corridor and electrical area for chlorine, fluoridation, ammonium sulfate)		$1,938,000
SUBTOTAL - PROJECT COST		$43,015,000
Additional Project Costs		
Demolition	0.0%	$0
Overall Sitework	6.0%	$2,581,000
Plant Control System	6.0%	$2,581,000
Yard Electrical/SCADA	9.0%	$3,872,000
Yard Piping	8.0%	$3,442,000
SUBTOTAL with Additional Project Costs		$55,491,000
Tax (applied to 40% of Total Project Cost)	9.50%	$2,108,658
Subtotal with Tax		$57,599,658
With Location Adjustment Factor	112.9	$65,030,014
Subtotal with Adjustment Factor		$65,030,014
Mobilization	5%	$3,251,501
General Conditions	10%	$6,503,001
Art and Permit Fees (LADBS)	3%	$1,950,900
Complexity Index (Risk Contingency)	10%	$6,503,001
Subtotal 1		$83,238,418
Bonds/Insurance	3%	$2,497,153
Profit	10%	$8,323,842
Subtotal 2		$94,059,412
Project Definition (Class V)	45%	
Subtotal 3		$136,386,148
Design-Build Factor	15%	$20,457,922
Subtotal 4		$156,844,070
CONSTRUCTION COSTS		**$156,844,070**
Non-Construction Costs		
Program and Project Management	10%	$15,684,407
Planning	1%	$1,568,441
Design Engineering	10%	$15,684,407
Services During Construction	5%	$7,842,203
Bid & Award	0.5%	$784,220
Startup and Commissioning	0.5%	$784,220
Post-Construction	1%	$1,568,441
Construction Management	15%	$23,526,610
Land and ROW		$10,000,000
NON-CONSTRUCTION COSTS		**$77,442,950**
Total Capital Cost Estimate		**$234,287,020**

* Incorporates markups from LADWP *Operation NEXT Program's Cost Escalation and Markups Technical Memorandum* (March 21, 2024)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
Central Basin Extraction Treatment O&M Cost

Annual O&M Costs

	CB (18 MGD)	Annual O&M (Alt 4-9)
Power	$ 2,984,000	$ 2,381,171
GAC Media Replacement	$ 1,235,000	$ 1,235,000
Pyrolusite Media Replacement	$ 204,190	$ 204,190
Sodium hypochlorite	$ 144,881	$ 115,612
Hydrofluorosilicic Acid	$ 64,719	$ 51,644
Ammonium sulfate	$ 46,119	$ 36,802
Labor	$ 540,800	$ 540,800
Equipment maintenance	$ 354,000	$ 354,000
Subtotal	$ 5,573,708	$ 4,919,219
Contingency (35%)	$ 1,950,798	$ 1,721,726
TOTAL	$ 7,524,506	$ 6,640,945

Note:
Concept Study - Basis for Approach II, Alternative 6
Based on an average annual flow per ONAT scenario modeling of 22 cfs (14 MGD)

Pure Water Los Angeles Master Plan
San Fernando Injection Wells

Basis of Estimate					
Total Injection Rate	50	MGD	77	cfs	
Injection Rate per Well	1,000	gpm			
Number of Injection Wells	35				
Injection Wells					
Materials	316 SST				
Diamater	18	inch			
Injection Rate	1,000	gpm			
Backwashing Rate	2,000	gpm			
Total depth	1,500	feet			
DTSW	150	feet			
Specific Capacity	21	gpm/ft			
Pumping Level	245	feet			
Discharge Pressure	0	PSI	With air gap to storm or sanitary sewer		
TDH	245	Feet			
Injection Specific Cap	12	80% of pumping SC			
Injection Level	67	feet			
Power Requirements					
WHP	124	HP			
BHP	165	HP			
Overall	183	HP			
	137	KW			
Online Factor	0.89%	Assumes backwashing 1.5 hours per week			
Hours	78	hours/year/well			
Electrical costs	$0.12	per KWH/well	**$1,249**		**per year/well**

Pure Water Los Angeles Master Plan
San Fernando Basin Injection Wells Construction Costs

Well Construction	Number	Units	Units Costs	Extended Costs
Mobilization	1	LS	$200,000	$411,765
Sound Control	1	LS	$100,000	$205,882
Drill and Install Conductor Casing	50	LF	$750	$77,206
Pilot Borehole Drilling	1450	LF	$100	$298,529
Geophysical Logging	1	LS	$11,000	$22,647
Ream Pilot Borehole	1450	LF	$100	$298,529
Caliper Logging	1	LS	$10,000	$20,588
Well Construction	1500	LF	$825	$2,547,794
Mechanical Well Development	1	LS	$75,000	$154,412
Pumping Well Development	1	LS	$25,000	$51,471
Aquifer Testing/Flowmeter Testing	1	LS	$30,000	$61,765
Video/Gyro	1	LS	$7,500	$15,441
Disinfection	1	LS	$10,000	$20,588
Disposal of Drilling Waste	1	LS	$100,000	$205,882
				$4,392,500
Equipping	**Number**	**Units**	**Units Costs**	**Extended Costs**
Mobilization	1	LS	$200,000	$411,765
Electrical Service and Improvements	1	LS	$400,000	$823,529
Down Well Flow Control Valve, Eductor, and Mechanical	1	LS	$200,000	$411,765
Well Pump, 2000 gpm 500 foot setting	1	LS	$200,000	$411,765
Mechanical Installation, Piping and Appurtenances	1	LS	$300,000	$617,647
Well Enclosure and Civil Improvements	1	LS	$850,000	$1,750,000
Security	1	LS	$100,000	$205,882
I&C	1	LS	$200,000	$411,765
				$4,632,353
Cost Per Well			June 2023	**$9,024,853**
Number of Wells				**17**
Costs All Wells			June 2023	**$153,422,500**
ENR CCI Escalation Factor				1.00712
Subtotal of Project Costs (Costs All Wells)			Escalated to March 2024	**$154,514,366**

Notes:
Well Construction:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021)

Equipping:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021, 2022)

ENR Cost Indexes in Los Angeles: June 2023 (15112.29); March 2024 (15219.84)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
San Fernando Basin Injection Wells Capital Costs (March 2024$)

Item			Value
Subtotal of Project Costs (All Wells)			
Injection Wells			$154,514,366
Tax (applied to 40% of Total Project Cost)	9.50%		
Subtotal with Tax			$154,514,366
With Location Adjustment Factor	112.9		$174,446,719
Subtotal with Adjustment Factor			**$174,446,719**
Mobilization	5%		
General Conditions	10%		
Art and Permit Fees (LADBS)	3%		$5,233,402
Complexity Index (Risk Contingency)	10%		$17,444,672
Subtotal 1			**$197,124,792**
Bonds/Insurance	3%		
Profit	10%		
Subtotal 2			**$197,124,792**
Project Definition (Class V)	45%	6.384%	$101,291,392
Subtotal 3			**$298,416,184**
Design-Build Factor	15%		$44,762,428
Subtotal 4			**$343,178,612**
CONSTRUCTION COSTS			**$343,178,612**
Non-Construction Costs			
Program and Project Management	10%		$34,317,861
Planning	1%		$3,431,786
Design Engineering	10%		$34,317,861
Services During Construction	5%		$17,158,931
Bid & Award	0.5%		$1,715,893
Startup and Commissioning	0.5%		$1,715,893
Post-Construction	1%		$3,431,786
Construction Management	15%		$51,476,792
Land and ROW	LS		$10,000,000
NON-CONSTRUCTION COSTS			**$157,566,803**
Total Capital Cost Estimate			**$500,745,415**

* Incorporates markups from LADWP *Operation NEXT Program's Cost Escalation and Markups Technical Memorandum* (March 21, 2024)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
San Fernando Basin Injection Wells O&M Costs

Flow at 100% Capacity

Injection Wells		
Power	$43,723	per year
Equipment Replacement and Repair	$490,000	all wells/year, 2% of equipping costs
Periodic Well Rehabilitation	$300,000	3 wells per year (staggered rehab)
Labor	$390,000	0.75% LOE operator, two at $130/hr (2000 hr/yr)
	$1,652,026	Includes 35% contingency

Concept Study - Basis for Approach II, Alternative 6
February 2024 ONAT Results for Alternatives Screening - 1990 Start Hydrology

Alternative	**SFB Total LADWP Extractions (AFY)**	**SFB Total LADWP Extractions (MGD)**	
Alt 1	103,900	93	
Alt 2	105,400	94	
Alt 3	84,900	76	
Alt 4	64,000	57	
Alt 5 & 6	64,000	57	Approach II, Alternative 6
Alt7	55,700	50	
Alt 8 & 9	55,700	50	

GoldSim 14.0.0383

Simulation Filename: OpNextGS_v1.031; Simulation Start Time: 3/14/2024

Pure Water Los Angeles Master Plan
San Fernando Basin Extraction Treatment Cost (2024$)

Description	SFB (48 MGD)	Notes
Sand Separator	$1,900,000	2000 gpm, 18 (17+1), NHW, 40% install, CCI correction for July 2016 to 2024
Cartridge Filters	$5,960,000	2880 gpm, 12 (12+0), NHW, 40% install, 1.27 CCI correction for July 2016 to Feb 2023
UV AOP and Peroxide Equipment	$23,520,000	Estimate from Trojan email (2/29/2024) scaled from 4 reactors to 7 reactors w/ 40% installation July 2016 to Feb 2023
GAC Equipment	$22,751,000	See Detailed GAC costs
Backwash Storage Tank	$9,280,000	Based on NHW Cast In-Place tank for approx. 400,000 gal, including misc. improvements, CCI correction
Metals	$640,000	1% of the installed equipment cost
Mechanical	$15,860,000	25% of the installed equipment cost
Electrical	$9,520,000	15% of the installed equipment cost
Instrumentation and Control	$6,350,000	10% of the installed equipment cost
Process Subtotal	**$95,781,000**	
UV Reactor Building	$11,310,000	
Peroxide Building	$3,330,000	
Building Subtotal	**$14,640,000**	
Subtotal	**$110,421,000**	
Site Civil and Yard Piping	$27,610,000	25% of the Subtotal for potential spreading basin filing
Site Electrical and Control	$16,570,000	15% of the Subtotal
Site Civil and Electrical Subtotal	**$44,180,000**	
Conveyance	$65,270,000	15000 LF of 54" pipe, Jacobs spreadsheet
Conveyance Subtotal	**$65,270,000**	
Subtotal of Project Costs	**$219,871,000**	
Tax (applied to 40% of Total Project Cost)	$8,355,098	9.50%
Subtotal with Tax	$228,226,098	
With Location Adjustment Factor	$257,667,265	112.9
Subtotal with Adjustment Factor	$257,667,265	
Mobilization	$12,883,363	5%
General Conditions	$25,766,726	10%
Art and Permit Fees (LADBS)	$7,730,018	3%
Complexity Index (Risk Contingency)	$25,766,726	10%
Subtotal 1	$329,814,099	
Bonds/Insurance	$9,894,423	3%
Profit	$32,981,410	10%
Subtotal 2	$372,689,932	
Project Definition (Class V)	$167,710,469	45%
Subtotal 3	$540,400,401	
Design-Build Factor	$81,060,060	15%
Subtotal 4	$621,460,461	
CONSTRUCTION COSTS	**$621,460,461**	
Non-Construction Costs		
Program and Project Management	$62,146,046	10%
Planning	$6,214,605	1%
Design Engineering	$62,146,046	10%
Services During Construction	$31,073,023	5%
Bid & Award	$3,107,302	0.5%
Startup and Commissioning	$3,107,302	0.5%
Post-Construction	$6,214,605	1%
Construction Management	$93,219,069	15%
Land and ROW	$10,000,000	
NON-CONSTRUCTION COSTS	**$277,227,998**	
Total Capital Cost Estimate	**$898,688,459**	

* Incorporates markups from LADWP *Operation NEXT Program's Cost Escalation and Markups Technical Memorandum* (March 21, 2024)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
San Fernando Basin Extraction Treatment O&M Cost (2024$)

Concept Study - Basis for Approach II, Alternative 6

Annual O&M Costs

	SFB (48 MGD)	Annual O&M (Alt 4-9)
Power	$ 5,072,000	$ -
Consumables	$ 4,682,000	$ -
Chemicals	$ 2,124,000	$ -
Labor	$ 3,203,000	$ -
General Maintenance	$ 3,299,000	$ 3,299,000
Water Quality Monitori	$ 1,250,000	$ -
Subtotal	$ 19,630,000	$ 3,299,000
Contingency (35%)	$ 6,871,000	$ 1,155,000
	$ 26,500,000	$ 4,500,000

Note:
Based on an average annual flow per ONAT scenario modeling of 111 cfs (72 MGD), which will be treated by existing capacity of 145 cfs (94 MGD)

Pure Water Los Angeles Master Plan
Raw Water Augmentation - LAAFP DPR Treatment Cost (2024$)

Description	LAAFP (163 MGD)	Notes
UV AOP and Peroxide Equipment	$17,640,000	Estimate from Trojan email (2/29/2024) w/ 40% installation, added 6th UV reactor to be conservative
GAC Equipment	$81,820,000	See Jacobs Detailed GAC spreadsheet (15 min EBCT in a building)
Pumps	$4,540,000	
Metals	$1,040,000	1% of the installed equipment cost
Mechanical	$26,000,000	25% of the installed equipment cost
Electrical	$15,600,000	15% of the installed equipment cost
Instrumentation and Control	$10,400,000	10% of the installed equipment cost
Process Subtotal	**$157,040,000**	
UPS Building	$2,690,000	
UV Reactor Building	$8,790,000	
Peroxide Building	$3,030,000	
Pump Station	$4,540,000	
Building Subtotal	**$19,050,000**	
Subtotal	**$176,090,000**	
Site Civil and Yard Piping	$24,660,000	14% of the Subtotal
Site Electrical and Control	$26,420,000	15% of the Subtotal
Site Civil and Electrical Subtotal	**$51,080,000**	
Subtotal	**$227,170,000**	
Subtotal of Project Costs	**$227,170,000**	
Tax (applied to 40% of Total Project Cost)	$8,632,460	9.50%
Subtotal with Tax	$235,802,460	
With Location Adjustment Factor	$266,220,977	112.9
Subtotal with Adjustment Factor	$266,220,977	
Mobilization	$13,311,049	5%
General Conditions	$26,622,098	10%
Art and Permit Fees (LADBS)	$7,986,629	3%
Complexity Index (Risk Contingency)	$26,622,098	10%
Subtotal 1	$340,762,851	
Bonds/Insurance	$10,222,886	3%
Profit	$34,076,285	10%
Subtotal 2	$385,062,022	
Project Definition (Class V)	$173,277,910	45%
Subtotal 3	$558,339,931	
Design-Build Factor	$83,750,990	15%
Subtotal 4	$642,090,921	
CONSTRUCTION COSTS	**$642,090,921**	
Non-Construction Costs		
Program and Project Management	$64,209,092	10%
Planning	$6,420,909	1%
Design Engineering	$64,209,092	10%
Services During Construction	$32,104,546	5%
Bid & Award	$3,210,455	0.5%
Startup and Commissioning	$3,210,455	0.5%
Post-Construction	$6,420,909	1%
Construction Management	$96,313,638	15%
Land and ROW	$10,000,000	
NON-CONSTRUCTION COSTS	**$286,099,096**	
Total Capital Cost Estimate	**$928,190,017**	

* Incorporates markups from LADWP *Operation NEXT Program's Cost Escalation and Markups Technical Memorandum* (March 21, 2024)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
Raw Water Augmentation - LAAFP DPR Treatment O&M Cost (2024$)

Concept Study - Basis for Approach II, Alternative 6

Annual O&M Costs

	VNC (163 MGD)	Annual O&M (Alt 4-6)
Power	$ 5,217,000	$ 3,999,000
Consumables	$ 12,144,000	$ 9,308,000
Chemicals	$ 1,442,000	$ 1,106,000
Labor	$ 2,330,000	$ 1,786,000
General Maintenance	$ 3,407,550	$ 3,408,000
Water Quality Monitori	$ 500,000	$ 500,000
Subtotal	$ 25,040,550	$ 20,107,000
Contingency (35%)	$ 8,765,000	$ 7,038,000
	$ 33,800,000	$ 27,100,000

Note:
Based on an average annual flow per ONAT scenario modeling of 193 cfs (125 MGD)

Potable Reuse Regulations Summary TM

Potable Reuse Regulations Summary Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
May 14, 2024

Executive Summary

Overview

The Pure Water Los Angeles Master Plan is evaluating potential water integration components and conveyance alternatives to maximize the potable reuse of water from the Hyperion Water Reclamation Plant (Hyperion WRP). Regulatory and end-user requirements set limits on the purified water quality and treatment processes that will be needed for the Pure Water Los Angeles program (Program).

Potable Reuse Approaches

The California State Water Resources Control Board Division of Drinking Water (DDW) regulates public water systems and oversees the implementation of water recycling projects such as Pure Water Los Angeles. The *California Water Code*, Section 13561, defines two types of potable recycled water use: indirect potable reuse (IPR) and direct potable reuse (DPR). Each category's requirements vary based on the specific application of reuse.

There are two IPR approaches:

1) **Groundwater replenishment:** Includes using an aquifer to provide an environmental buffer between the point of recycled water application and groundwater wells that supply water into a drinking water system. There are two types of groundwater replenishment projects with different regulatory requirements:
   a. Surface application using spreading basins
   b. Subsurface application through direct injection
2) **Surface water augmentation:** Includes using a non-potable reservoir to provide an environmental buffer between the point of recycled water application and a water treatment plant that supplies water into a drinking water system.

There are two DPR approaches:

1) **Raw water augmentation:** Includes introducing advanced treated recycled water immediately upstream of a water treatment plant that supplies drinking water into a drinking water system.
2) **Treated water augmentation:** Includes introducing advanced treated recycled water directly into a public drinking water distribution system.

DDW is responsible for the protection of public health, the regulation of drinking water, and the water recycling criteria. The Los Angeles Regional Water Quality Control Board (RWQCB) is responsible for permitting and enforcement of water quality objectives for the beneficial uses of the state's waters within the areas considered for Pure Water Los Angeles (Los Angeles RWQCB 2014, 2019).

This technical memorandum (TM) summarizes the applicable potable reuse regulations that the Program alternative components need to meet. This information provides the foundation for the development of storage and demand components and the Program alternatives in subsequent TMs.

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Acronyms and Abbreviations

°F	degree(s) Fahrenheit
µg/L	microgram(s) per liter
22 CCR 4	*California Code of Regulations* Title 22, Social Security, Division 4, Environmental Health
AL	action level
AOP	advanced oxidation process
AWPF	advanced water purification facility
AWTO	Advanced Water Treatment Operator
BAC	biological activated carbon
CA-NV AWWA	California-Nevada section of the American Water Works Association
CB	Central Basin
CCR	*California Code of Regulations*
CDBM	chlorodibromomethane
CEC	contaminant of emerging concern
CFR	*Code of Federal Regulations*
County Public Works	Los Angeles County Public Works
CTR	*California Toxics Rule*
CWC	*California Water Code*
CWEA	California Water Environment Association
DCBM	dichlorobromomethane
DDW	Division of Drinking Water
DiPRRA	Direct Potable Reuse Responsible Agency
DO	dissolved oxygen
DPR	direct potable reuse
GRRP	Groundwater Replenishment Reuse Project
GWR	groundwater replenishment
Hyperion WRP	Hyperion Water Reclamation Plant
IPR	indirect potable reuse
LADWP	Los Angeles Department of Water and Power
LASAN	LA Sanitation & Environment

LRV	log reduction value
MBAS	methylene blue activated substances
MBR	membrane bioreactor
MCL	maximum contaminant level
MF	membrane filtration
mg/L	milligram(s) per liter
MTL	monitoring trigger level
N	nitrogen
NDMA	N-nitrosodimethylamine
ng/L	nanogram(s) per liter
NL	notification level
NO_2-N	nitrite nitrogen
NO_3	nitrate
NO_3-N	nitrate nitrogen
NTU	nephelometric turbidity unit
PCB	polychlorinated biphenyl
pg/L	picogram(s) per liter
Program	Pure Water Los Angeles program
PWSC	Pure Water Southern California
RO	reverse osmosis
RWA	raw water augmentation
RWC	recycled wastewater contribution
RWQCB	Regional Water Quality Control Board
SCADA	supervisory control and data acquisition
SDWA	*Safe Drinking Water Act*
SFB	San Fernando Basin
SWA	surface water augmentation
SWRCB	California State Water Resources Control Board
SWSAP	Surface Water Source Augmentation Project
SWTR	*Surface Water Treatment Rule*
TDS	total dissolved solids

TM	technical memorandum
TOC	total organic carbon
TTHM	total trihalomethane
TWA	treated water augmentation
UV	ultraviolet
VNC	Van Norman Complex
WARM	warm freshwater habitat beneficial use designation for water bodies
WCB	West Coast Basin
WTP	water treatment plant
WWC	wastewater contribution

1 Introduction

The Pure Water Los Angeles Master Plan is evaluating potential water integration components and conveyance alternatives to maximize the potable reuse of water from the Hyperion Water Reclamation Plant (Hyperion WRP). There are four general categories of water integration components being evaluated, which are described in more detail in the technical memorandums (TMs) *Validation of Strategy* (Jacobs and Arcadis 2024) and *Identification of Storage and Demands* (Arcadis and Jacobs 2024). The four categories are:

1) Indirect potable reuse (IPR) through groundwater replenishment (GWR) in Central Basin (CB) and San Fernando Basin (SFB)
2) IPR with surface water augmentation (SWA) for non-potable reservoirs
3) Direct potable reuse (DPR) through raw water augmentation (RWA) at the Van Norman Complex (VNC) or treated water augmentation (TWA), if approved by Los Angeles Department of Water and Power (LADWP), at potable water reservoirs in the distribution system
4) Provision for providing IPR quality, or possibly DPR quality, water to local and regional partners

Regulatory and end-user requirements set limits on the purified water quality and treatment processes that will be needed for the Pure Water Los Angeles program (Program). Each integration location has unique considerations for the applicable regulations, as well as:

- Water quality
- Capacity
- Infrastructure

The purpose of this TM is to summarize the applicable potable reuse regulations that the Program alternative components need to meet. This information provides the foundation for the development of storage and demand components and the Program alternatives in subsequent TMs.

2 Potable Reuse Approaches

The California State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) regulates public water systems and oversees the implementation of water recycling projects, such as Pure Water Los Angeles. The *California Water Code* (CWC), Section 13561, defines two types of potable recycled water use: IPR and DPR. Each category's requirements may vary based on the specific application of reuse.

There are two IPR approaches, which are regulated separately under the *California Code of Regulations* (CCR) (Title 22, Social Security, Division 4, Environmental Health [22 CCR 4], Chapter 3, Water Recycling Criteria, Articles 5.1, 5.2, and 5.3). These are:

1) **GWR:** Includes using an aquifer to provide an environmental buffer between the point of recycled water application and groundwater wells that supply water into a drinking water system. There are two types of groundwater replenishment projects with different regulatory requirements:
   a. Surface application using spreading basins
   b. Subsurface application through direct injection
2) **SWA:** Includes using a non-potable reservoir to provide an environmental buffer between the point of recycled water application and a water treatment plant (WTP) that supplies water into a drinking water system.

Two approaches for integrating recycled water as DPR are regulated under a single set of criteria, as represented in the adopted DPR regulations under 22 CCR 4, Chapter 17, Surface Water Treatment, Article 10, Direct Potable Reuse. These are:

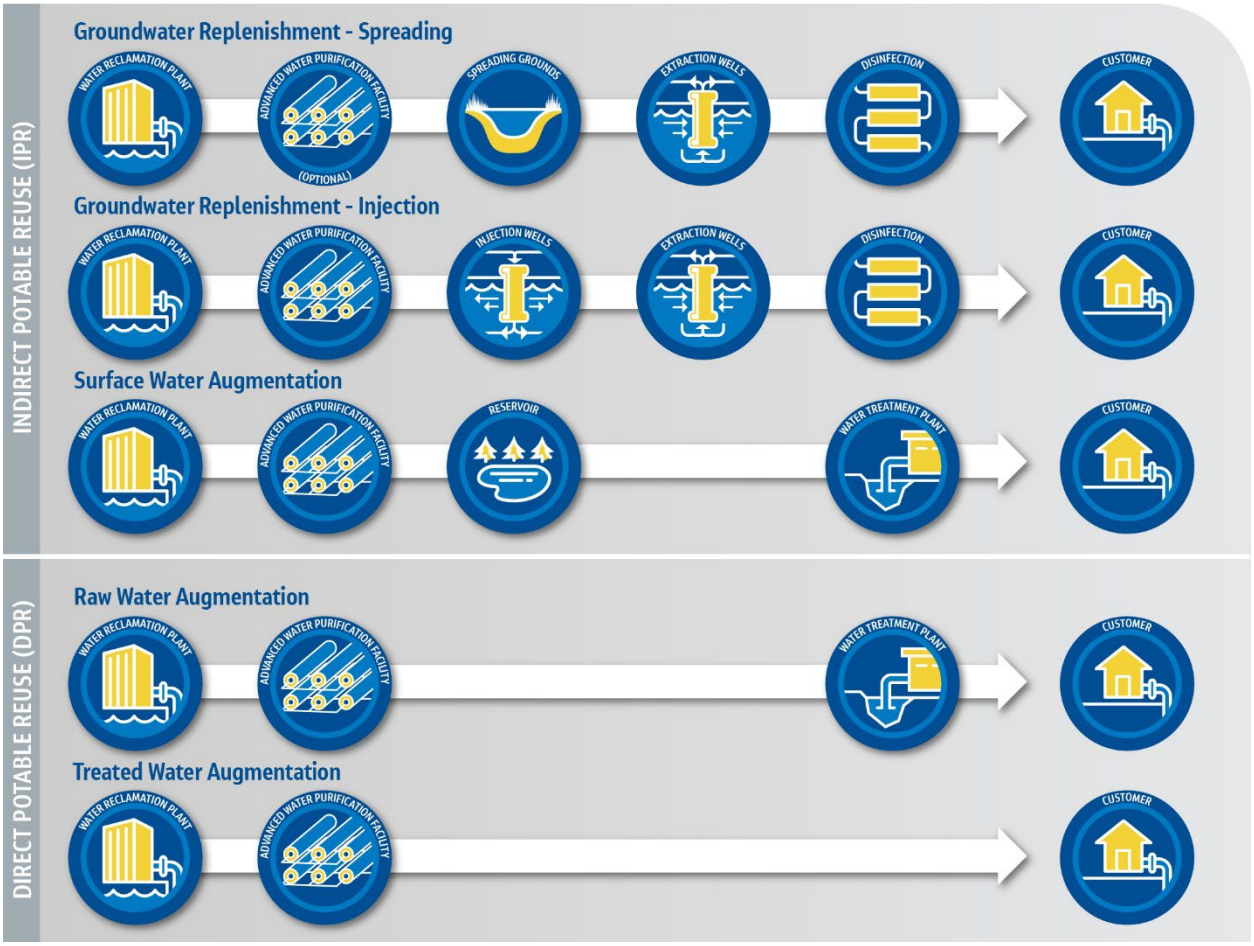
1) **RWA:** Includes introducing advanced treated recycled water immediately upstream of a WTP that supplies drinking water into a drinking water system.
2) **TWA:** Includes introducing advanced treated recycled water directly into a public drinking water distribution system.

The presence of an environmental buffer between the advanced water treatment process and the consumer provides time to respond to and address system or water quality issues before the water reaches customers. The presence and size of an environmental buffer is the main difference between IPR and DPR. Figure 2-1 shows the different approaches to IPR and DPR, with an increasing level of treatment required as the buffer is reduced or eliminated.

Existing potable reuse regulations for recycled water systems include criteria for the protection of public health and receiving waters. Regulatory requirements for the protection of public health specific to water reuse are provided under the 22 CCR 4, Chapter 3, Water Recycling Criteria. Regulations aimed at safeguarding receiving waters do not particularly focus on water reuse. However, in the case of GWR (IPR), SWA (IPR), and RWA (DPR) systems, the purified water is released into these receiving waters. As a result, the quality standards established for the receiving waters are applied to the treated water, following guidelines from the Water Quality Control Plan for the Los Angeles Region (Los Angeles RWQCB 2014, 2019).

DDW is responsible for the protection of public health, the regulation of drinking water, and the water recycling criteria. The Los Angeles Regional Water Quality Control Board (RWQCB) is responsible for permitting and enforcement of water quality objectives for the beneficial uses of the state's waters within the areas considered for Pure Water Los Angeles (Los Angeles RWQCB 2014, 2019).

Figure 2-1. Indirect and Direct Potable Reuse Approaches



3 Indirect Potable Reuse

There are two types of IPR projects under Title 22 regulations:

1) **Groundwater Replenishment Reuse Projects (GRRPs).** The SWRCB adopted revised regulations for GRRPs on June 18, 2014 (Articles 5.1 and 5.2 of 22 CCR 4, Chapter 3), to reflect scientific and technological advances since the original regulations for groundwater replenishment with recycled water were adopted in 1978.
2) **Surface Water Source Augmentation Projects (SWSAPs).** The SWRCB adopted regulations for SWSAPs on October 1, 2018 (Article 5.3 of 22 CCR 4, Chapter 3).

3.1 Source Water Control

Recycled municipal wastewater used for IPR is sourced from a wastewater management agency that implements and administers an industrial pretreatment and pollutant source control program: LA Sanitation & Environment (LASAN), the Operator and Maintainer of the Hyperion WRP (City of Los Angeles 2023). IPR projects require source control program activities beyond traditional industrial pretreatment programs, such as the assessment of the fate of chemicals that would compromise the ability to reliably meet advanced water treatment water quality requirements.

3.2 Groundwater Replenishment Reuse Projects

The planned use of recycled water for replenishment of groundwater basins has been practiced in the state of California for more than five decades. Los Angeles County Public Works (County Public Works) began supplementing the Montebello Forebay Spreading Grounds with recycled water in 1962 to replenish underlying groundwater basins, and Orange County Water District began supplementing injection wells with recycled water in 1976 to replenish an underlying groundwater basin to provide a seawater barrier (SWRCB 2019).

A GRRP involves the planned use of recycled water to replenish a groundwater basin designated for use as a domestic water supply source. There are two ways to implement a GRRP: (1) through surface application where the recycled water is applied to a spreading area; and (2) through subsurface application, where the recycled water is applied by other means, such as injection wells.

3.2.1 Pathogen Control

A GRRP must be designed and operated to reliably meet the pathogen control requirements in Table 3-1.

Table 3-1. Groundwater Replenishment Pathogen Log Reduction Values

Parameter	Surface Application	Subsurface Application
Enteric virus [a] (log)	12	12
Giardia cyst [a] (log)	10	10
Cryptosporidium oocyst [a] (log)	10	10
Multibarrier approach (minimum number of required treatment processes) [b]	3 (filtration, disinfection, and soil aquifer treatment)	3 (full advanced treatment with RO and AOP)

Source: (22 CCR 4, Chapter 3, Articles 5.1 and 5.2)

[a] An individual treatment process must be credited with at least 1-log reduction, but no more than 6-log reduction.

[b] MF is typically used upstream of RO to reduce fouling and provides pathogen reduction for *Giardia* cyst and *Cryptosporidium* oocyst.

AOP = advanced oxidation process

MF = membrane filtration

RO = reverse osmosis

Per the CCR, pathogen removal credits can be obtained based on the groundwater retention time between the point of application and extraction (Table 3-2) to reduce the pathogen reduction requirements at the treatment facility. A minimum subsurface travel time of 2 months is required to maintain water that is suitable for potable consumption and allow for adequate response time to system or water quality issues. To estimate the retention time, a tracer study or groundwater modeling can be used. Modeling will receive less reduction credit per month than a tracer study. For each month retained underground, recycled water will receive 1-log virus reduction credit.

For surface application, a recycled wastewater that meets disinfected tertiary recycled water requirements or provides advanced treatment and is retained underground for 6 months will be credited with 10-log *Giardia* cyst and 10-log *Cryptosporidium* oocyst reduction.

Table 3-2. Groundwater Replenishment Pathogen Log Reduction Credits

Parameter	Enteric Virus Log Reduction Credit per Month of Retention	
	Surface Application (log)	Subsurface Application (log)
Tracer study with physical tracer	1.0	1.0
Tracer study with intrinsic tracer	0.67	0.67
Numerical modeling	0.50	0.50
Analytical modeling	0.25	0.25

Source: (22 CCR 4, Chapter 3, Articles 5.1 and 5.2)

3.2.2 Diluent Water and Total Organic Carbon Requirements

Per the CCR, diluent water may be required, depending on the source water quality. The recycled wastewater contribution (RWC) is the fraction equal to the quantity of recycled water applied divided by the sum of the quantity of recycled water and credited diluent water. The initial maximum RWC cannot exceed 0.20 (that is, 20% recycled water). However, an alternative initial RWC (up to 1.0 or 100% recycled water) can be approved by DDW if:

- The increase is approved and permitted by DDW and the Los Angeles RWQCB.
- The total organic carbon (TOC) 20-week running average has not exceeded 0.5 milligram per liter (mg/L) divided by the proposed maximum RWC for the previous 52 weeks.
- With the use of reverse osmosis (RO) treatment, TOC in the RO permeate is typically less than 0.5 mg/L. Thus, based on the planned IPR water quality for Pure Water Los Angeles, diluent water is not expected to be required for this Program.

3.2.3 Response to Process Issues

Per the CCR, investigation and corrective actions are required within 24 hours if pathogen reduction is less than required. DDW and the Los Angeles RWQCB must be notified immediately if the event lasts more than 4 hours, or 8 hours combined within a 7-day period.

If the overall treatment train pathogen reduction is reduced by more than 2 log for any target pathogen, DDW and the Los Angeles RWQCB must be notified immediately, and application of the recycled water must be discontinued unless directed otherwise.

3.2.4 Impaired Drinking Water Source

DDW has Policy 97-005 for extremely impaired drinking water sources that provides a 10-step process to:

- Assess and characterize the water source
- Determine treatment and monitoring

- Evaluate human health risks
- Discuss community outreach

Policy 97-005 was published in November 1997 and revised in September 2020. The SFB remediation projects were completed under Policy 97-005. While extreme and widespread contamination conditions similar to SFB have not been reported in the CB near the proposed injection and extraction wellfields, the preliminary data indicate that a risk for triggering the Policy 97-005 process exists. This is especially in areas located in the northeastern to southeastern side of the proposed location, with injection and extraction at shallower depths.

3.3 Surface Water Source Augmentation Projects

A SWSAP is a project involving the planned placement of recycled water into a surface water reservoir that is used as a source of domestic drinking water supply and subsequently treated in a drinking WTP.

3.3.1 Reservoir Requirements

Per the CCR, to implement a SWSAP, the selected surface water reservoir is required to have been in operation as an approved surface water source for at least 5 years before receiving recycled water, unless approved by the SWRCB. The SWRCB can approve up to a minimum of 2 years. Section 5.2.2 discusses implications of this requirement for LADWP's non-potable reservoirs. The reservoir operation must provide adequate mixing capacity to address a short-term failure of upstream treatment of up to 24 hours. In addition, the theoretical retention time of the reservoir must be no less than 60 days to be able to respond to and potentially mitigate upstream treatment failures.

3.3.2 Pathogen Control

Per the CCR, pathogen control requirements depend on the retention time and the achieved blend ratio in the reservoir (Table 3-3). SWSAPs require 12/10/10 log reduction for enteric virus, *Giardia* cyst, and *Cryptosporidium* oocyst, respectively. The regulations assume 4/3/2 log reduction, for virus, *Giardia* cyst, and *Cryptosporidium* oocyst, respectively, will be achieved at a typical WTP after the water is extracted from the reservoir, resulting in a minimum requirement of 8/7/8 log reduction, respectively, at the advanced water purification facility (AWPF). Full advanced treatment, which typically consists of MF ahead of RO and ultraviolet (UV)-AOP, is required for treating recycled municipal wastewater before the point of application in a reservoir.

Table 3-3. Surface Water Augmentation Pathogen Log Reduction Values

Parameter	SWA Dilution Factor, Detention Time, and LRVs					
Dilution Factor	≤ 1% Recycled Water by Volume[a] (1:100 dilution)			≤ 10% Recycled Water by Volume[a] (1:10 dilution)		
Retention time (days)	60-119	120-179	≥ 180	60-119	120-179	≥ 180
Enteric virus [b] (log)	9	8	8	10	9	9
Giardia cyst [b] (log)	8	7	7	9	8	8
Cryptosporidium oocyst [b] (log)	9	8	8	10	9	9
Multibarrier approach (no. of required treatment processes)	2	2	2	3	3	3
Additional SWRCB approval required	Yes	Yes	No	Yes	Yes	No

Source: (22 CCR 4, Chapter 3, Article 5.3)

[a] The maximum percent, by volume, of recycled water delivered during any 24-hour period in the withdrawn water.
[b] An individual treatment process may be credited with no more than 6-log reduction, with at least two processes each being credited with no less than 1.0-log reduction. A single treatment process may receive log credits for one or more pathogens.

LRV = log reduction value

3.3.3 Response to Process Issues

Per the CCR, investigation and corrective actions are required within 24 hours if pathogen reduction is less than required. DDW and the Los Angeles RWQCB must be notified immediately if the event lasts more than 4 hours, or 8 hours combined within a 7-day period.

If the overall treatment train pathogen reduction is reduced by more than 2 log for any target pathogen, DDW and the Los Angeles RWQCB must be notified within 24 hours and application of the recycled water discontinued unless directed otherwise.

3.3.4 California Toxics Rule

The *California Toxics Rule* (CTR) establishes numeric water quality criteria for California waters of the State and waters of the United States, which include the surface water reservoirs under evaluation in the Master Plan. The CTR identifies 126 priority toxic pollutants with monitoring requirements or concentration limits. Several of the identified pollutants have concentration limits that are less than drinking water maximum contaminant levels (MCLs) and require strict monitoring.

Of the 126 compound limits, there are 4 that have historically been the most challenging to meet in potable reuse applications:

1) N-Nitrosodimethylamine (NDMA)
2) Bromoform
3) Chlorodibromomethane (CDBM)
4) Dichlorobromomethane (DCBM)

Table 3-4 lists the CTR limits for these compounds, as well as the drinking water MCLs for reference.

Table 3-4. California Toxics Rule Challenging Compound Limits

Parameter	CTR Standard for Surface Water (µg/L)	MCL for Treated Potable Supply (µg/L)
NDMA	0.00069	0.010
Bromoform	4.3	-
CDBM	0.41	-
DCBM	0.56	-
TTHM	-	80 (as locational running annual average)

- = not applicable
µg/L = microgram(s) per liter
TTHM = total trihalomethane

3.3.5 Surface Water Treatment Rule

If the recycled water meets the requirements for a SWSAP, the water in the reservoir is considered surface water. As surface water, the water leaving the reservoir must also be treated to comply with the regulations of the *Surface Water Treatment Rule* (SWTR) (*Code of Federal Regulations* [CFR], Title 40, Protection of the Environment, Part 141, National Primary Drinking Water Regulations, Subpart H, Filtration and Disinfection), which establishes treatment criteria for surface water sources or groundwater sources under the direct influence of surface water.

To meet the SWTR requirements, the outlet water must achieve 4-log enteric virus, 3-log *Giardia* cyst, and 2-log *Cryptosporidium* oocyst reduction through subsequent treatment in a drinking WTP. The SWTR refers to all subsequent surface water treatment rules as well, including the Enhanced SWTR and Long-Term 2 Enhanced SWTR.

3.4 Safe Drinking Water Act

GRRPs and SWSAPs need to meet *Safe Drinking Water Act* (SDWA) drinking water MCLs (except nitrogen) and action levels (ALs) for lead and copper. Table 3-5 shows the pertinent SDWA requirements.

Table 3-5. Safe Drinking Water Act Requirements

Parameter	Value
Inorganic chemicals per Table 64431-A (except nitrogen) Radionuclide chemicals per Tables 64442 and 64443, Chapter 15 Organic chemicals per Table 64444-A, Chapter 15 Disinfection byproducts per Table 64533-A, Chapter 15.5	Primary MCL
Lead	AL
Copper	AL
Asbestos per Table 64432-A	Detection Limit
Secondary drinking water contaminants per Tables 64449-A and 64449-B	Secondary MCL

3.5 Additional Contaminant Monitoring

GRRPs and SWSAPs are required to monitor for additional contaminants, as shown in Table 3-6.

Table 3-6. Additional Contaminant Monitoring

Parameter	Value
Health-based CECs[a]	≤ to NLs
Performance indicator CECs per Table 7[b]	≤ to MTLs
Bioanalytical screening tools for CECs per Table 9[b]	≤ to MTLs

[a] California's Drinking Water Notification Levels (SWRCB 2023)

[b] California's Recycled Water Policy (SWRCB 2018)

CEC = contaminant of emerging concern

MTL = monitoring trigger level

NL = notification level

3.6 Regional Water Quality Control Board Basin Plans

The SWRCB and nine RWQCBs regulate the protection of surface water and groundwater quality in California. The Basin Plans describe the regions' water quality regulations and programs to implement the regulations (Los Angeles RWQCB 2014, 2019; Santa Ana RWQCB 2019). IPR projects that will include groundwater replenishment or SWA must comply with the water quality objectives identified in the Basin Plans.

The Los Angeles RWQCB Basin Plan identifies basin and sub-basin groundwater quality management goals for groundwater basins in the Los Angeles Region, including:

- SFB
- CB
- West Coast Basin (WCB)

Additional groundwater basin water quality objectives (such as for the San Gabriel Basin and potentially the Orange County Basin) would be applicable if a partnership with Pure Water Southern California (PWSC) is included as part of Pure Water Los Angeles. The implications of these additional objectives should be considered if the PWSC partnership progresses.

These basins are included in the Master Plan as potential applications for groundwater replenishment. Tables 3-7 and 3-8 summarize the parameters that impact treatment requirements.

Table 3-7. Groundwater Basin Water Quality Objectives

Basin	Objectives (mg/L)				
	NO_3-N	TDS	Sulfate	Chloride	Boron
SFB					
West of Highway 405	10	800	300	100	1.5
East of Highway 405 (overall)	10	700	300	100	1.5
Sunland-Tujunga Area	10	400	50	50	0.5
Foothill Area	10	400	100	50	1.0
Area Encompassing Rinaldi Toluca, Tujunga, Erwin, North Hollywood, Whithall, Los Angeles and Verdugo, Crystal Springs, Headworks, and Glendale and Burbank Well Fields	10	600	250	100	1.5
Narrows Area (below the confluence of Verdugo Wash and the Los Angeles River)	10	900	300	150	1.5
CB	10	700	250	150	1.0
WCB	10	800	250	250	1.5
Main San Gabriel Basin (if interconnected with PWSC)	10	450	100	100	0.5
Orange County (if interconnected with PWSC)	3.4	500	500	500	0.75

Source: (Los Angeles RWQCB 2014, 2019; Metropolitan 2019; Santa Ana RWQCB 2019)

NO_3-N = nitrate nitrogen

TDS = total dissolved solids

There are no site-specific water quality objectives identified for any of the non-potable reservoirs evaluated in the Master Plan for SWA. However, qualitative and quantitative water quality objectives have been developed by the Los Angeles RWQCB for the parameters provided in Table 3-8. These objectives apply to all inland surface waters in the region.

Table 3-8. Regional Water Quality Objectives for Surface Waters

Constituent	Requirement
Ammonia	▪ Un-ionized ammonia ▪ ≤ 0.035 mg/L (4-day average) ▪ ≤ 0.233 mg/L (1-hour average) ▪ Ammonia-N 1-hour average limit is pH dependent: 1.3 to 49 mg/L ▪ Ammonia-N 30-day average limit is pH and temperature dependent (assuming Early Life Stage Present condition): 0.18 to 6.7 mg/L
Bioaccumulation	▪ To be determined
Biostimulatory Substances	▪ To be determined – Nitrogen and phosphorus limits are typical
Chemical Constituents, Pesticides, and Radionuclides	▪ ≤ drinking water MCLs
Chlorine, Total Residual	▪ Chorine residual ≤ 0.1 mg/L
MBAS	▪ MBAS ≤ 0.5 mg/L
Nitrogen (Nitrate, Nitrite)	▪ ≤ 10 mg/L as NO_3-N + NO_2-N ▪ ≤ 45 mg/L as NO_3 ▪ ≤ 10 mg/L as NO_3-N ▪ ≤ 1 mg/L as NO_2-N
DO	▪ DO content of WARM waters cannot be lowered to ≤ 5 mg/L due to discharge
pH	▪ > 6.5 to < 8.5
PCBs	▪ Pass-through or uncontrollable discharges are limited to 70 pg/L (30-day average) for protection of human health and 14 ng/L (daily average) to protect aquatic life in inland fresh waters
Taste and Odors	▪ Waters will not contain taste or odor-producing substances in detrimental concentrations
Temperature	▪ For WARM waters, temperature will not be altered more than 5°F greater than the natural temperature and at no time be raised greater than 80°F as a result of discharge
Toxicity	▪ Waters will be maintained free of toxic substances in detrimental concentrations
Turbidity	▪ If natural turbidity = 0 to 50 NTU, increases will not exceed 20% ▪ If natural turbidity > 50 NTU, increases will not exceed 10%

Source: (Los Angeles RWQCB 2014, 2019)
< = less than
> = greater than
°F = degree(s) Fahrenheit
DO = dissolved oxygen
MBAS = methylene blue activated substances
ng/L = nanogram(s) per liter
N = nitrogen
NO_2-N = nitrite nitrogen
NO_3 = nitrate
NTU = nephelometric turbidity unit
PCB = polychlorinated biphenyl
pg/L = picogram(s) per liter
WARM = warm freshwater habitat beneficial use designation for water bodies

4 Direct Potable Reuse

The SWRCB was required to adopt uniform water recycling criteria for DPR by December 31, 2023. The requirement was dependent on the expert panel determining that the proposed criteria will adequately protect public health, according to CWC Section 13561.2. The SWRCB has released the following during the rulemaking process for ultimate incorporation into 22 CCR 4, Chapter 17:

- Early anticipated draft regulations for DPR in *A Proposed Framework for Regulating Direct Potable Reuse in California* (SWRCB 2019)
- Draft criteria in the *DPR Framework 2nd edition Addendum – Early Draft of Anticipated Criteria for Direct Potable Reuse* (SWRCB 2021)
- Text of Proposed Regulations for Direct Potable Reuse (SWRCB 2023b)
- Text of Changes to Proposed Regulations for Direct Potable Reuse (SWRCB 2023c)

After a final public comment period that closed on November 6, 2023, the SWRCB adopted new regulations for DPR on December 19, 2023.

4.1 Source Water Control

The source water control identified in Section 3.1 will apply to DPR.

4.2 Direct Potable Reuse Responsible Agency

The text for the adopted regulations stipulates that a single Direct Potable Reuse Responsible Agency (DiPRRA) be designated for a DPR project, thereby producing potable water and complying with requirements. The DiPRRA will be responsible for establishing pathogen and chemical control points, meeting microorganism log reductions, and providing the required chemical control. The DiPRRA will be subject to an annual inspection of its facilities and operations to verify proper technical, managerial, and financial capacity.

The adopted regulations do not have the framework or mechanism to handle a regional DPR exchange and direct interconnect involving more than one DiPRRA. There are alternatives clauses related to treatment or treatment sequencing for pathogen and chemical control, but the regulations do not include a broad alternatives clause that supports how to address emerging situations. Consequently, Pure Water Los Angeles interconnected regional partnerships that involve DPR would be challenging and require addressing this issue with DDW moving forward.

4.3 Treatment Train

The adopted DPR regulations require a high degree of protection for pathogenic organisms, unknown chemicals, and chemical peaks. The identified treatment train in the adopted DPR regulations includes ozone and biological activated carbon (BAC) processes upstream of RO and AOP. Ozone and BAC are included for additional chemical and pathogen control as part of the new chemical control requirements to provide a barrier to low molecular weight organics that may by poorly removed by RO. Membrane filtration is expected to be necessary upstream of RO to reduce fouling and provide pathogen reduction credits.

Three treatment mechanisms are required for pathogen control:

1) Physical separation
2) Chemical inactivation
3) UV inactivation

The final text incorporated into the adopted regulations allows for the use of an alternative mechanism for pathogen control under Section 64669.45, Pathogen Control that meets the requirements of these three treatment mechanisms, which must include physical separation and inactivation. An independent advisory panel must review and approve the alternative for the protection of public health.

Treatment trains that do not contain this specific sequence of processes may still be permitted under Section 64669.50, Chemical Control, which states:

> *(r) "A DiPRRA may use an alternative to a treatment or treatment sequence requirement in this subsection (a) through (l) and (o) if the DiPRRA:*
>
> 1. *Demonstrates to the State Board that the proposed alternative provides an equivalent or better level of performance with respect to the efficacy and reliability of the removal of contaminants that pose a risk to public health, and assures an equivalent or better level of protection to public health;*
> 2. *Identifies the chemical control point(s) and the surrogate and/or operational parameter(s) and establish the critical limit(s) for the surrogate(s) and/or operational parameter(s); and*
> 3. *Receives written approval from the State Board prior to implementation of the alternative, with approval based on compliance with this subsection…."*
> 4. *If required by the State Board, conducts a public meeting on the proposed alternative, disseminates information to the public, and receives public comments…"*

An independent advisory panel must review and approve the alternative for the protection of public health.

4.3.1 Pathogen Control

The adopted DPR regulations require that the recycled water receives continuous treatment before entering the drinking water distribution system and meets the pathogen control criteria in Table 4-1. The pathogen log reduction must be validated for each treatment process.

Table 4-1. Direct Potable Reuse Pathogen Log Reduction Values

Parameter	LRVs
Enteric virus[a] (log)	20
Giardia cyst[a] (log)	14
Cryptosporidium oocyst[a] (log)	15
Multibarrier approach (minimum number of required treatment processes)[b,c]	4 (full advanced treatment with ozone and BAC, RO, and AOP in this sequence, plus extra processes)

[a]An individual treatment process must be credited with at least 1-log reduction, but no more than 6-log reduction. A single treatment process may receive log credits for one or more pathogens.

[b] MF is expected to be necessary upstream of RO to reduce fouling and to provide pathogen reduction credits.

[c] Treatment train must include at least three diverse treatment processes for pathogen reduction: membrane physical separation, chemical inactivation, and UV inactivation. Alternatives to this are allowed as long as three mechanisms are included that provide at least physical separation and inactivation, and must assure equivalent or better level of protection of public health.

For DPR applications that blend DPR water with the source water for an existing WTP, the blended DPR flow would be treated by filtration and disinfection processes that currently receive pathogen LRV credit for drinking water treatment. The adopted regulations discuss a credit for continuous blending of DPR project water with a surface water source up to a maximum LRV of 2 logs (Section 64669.45 Pathogen Control, Subsection (d) (1)), with later subsections allowing for the potential validation of treatment processes for greater LRVs.

DDW's response to the August 2021 Expert Panel Report clarified that free chlorine disinfection or approved alternative filtration LRVs at existing drinking WTPs that have already been validated would apply to Section 64669.45 (NWRI 2022). It is unclear how much log reduction credit may be possible to be achieved through other processes (flocculation, sedimentation, conventional filtration) at an existing WTP for DPR, even though the same treatment processes receive log reduction credits for drinking water treatment.

4.3.2 Chemical Control

The focus on chemicals in DPR projects differs from IPR projects in two important ways:

1) DPR projects have limited or no environmental buffer that would dampen chemical peaks.
2) Without an environmental buffer, the urgency to recognize and respond to treatment deficiencies increases.

The adopted DPR criteria specifies control of chemical constituents through continuous treatment before distribution with at least three diverse treatment processes for chemical reduction, including:

1) Ozone and BAC
2) RO
3) AOP

The order of the advanced treatment is required to be in the order listed, with ozone and BAC upstream of RO, followed by AOP. The ozone and BAC process must be validated.

The adopted DPR regulations require a minimum of 1-log reduction of formaldehyde, acetone, carbamazepine, and sulfamethoxazole through ozone and BAC treatment. There are two possible ways to meet this requirement:

1) The treatment train must include a treatment process that will provide no less than 1-log reduction of the target chemicals.
2) The recycled water is blended with other raw water or treated water sources at a dilution ratio of at least10 to 1 or less than 10% recycled water. This eliminates the need for ozone and BAC.

4.3.3 Pathogen and Chemical Control Point Monitoring and Response Plan

The DiPRRA must develop and operate the DPR project in accordance with an approved Pathogen and Chemical Control Point Monitoring and Response Plan. Important aspects of the plan include the response times for the pathogen control points and chemical control points, which is the time it takes for the control system to identify and respond to an acute exposure threat. Response times, at a minimum, must include:

- The time intervals between online measurements taken at a pathogen or chemical control point
- The time it takes for online measurements to be completed
- The time it takes to determine:
  - At least 16-log enteric virus, 10-log *Giardia* cyst, and 11-log *Cryptosporidium* oocyst reduction is being achieved.
  - The TOC concentration meets the 0.5 mg/L limit before distribution, or 0.5 mg/L divided by the municipal wastewater contribution (WWC) if blended before distribution.
  - Nitrate, nitrite, and nitrate plus nitrite concentrations comply with the MCLs.
  - Time to actuate a diversion or shutoff valve if the limits are not achieved to divert or completely stop the flow to the distribution system.

The adopted regulations allow for flexibility in the approach to meeting TOC requirements when advanced treated water is blended in a reservoir, and compliance with a TOC of 0.5 mg/L before distribution is demonstrated through hydrodynamic modeling, tracer testing, and diluent capacity.

4.4 California Toxics Rule

Monitoring of CTR requirements identified in Section 3.3.4 will apply for DPR application, if the DPR application includes discharge to a water body, such as RWA.

4.5 Safe Drinking Water Act

The SDWA requirements identified in Section 3.4 will apply for DPR application.

4.6 Los Angeles Regional Water Quality Control Board Basin Plan

The Los Angeles RWQCB Basin Plan requirements identified in Section 3.6 will apply to RWA through a reservoir.

4.7 Reporting and Operator Certification Requirements

The adopted DPR regulations define a DiPRRA as the single agency responsible for complying with the requirements for a DPR project. The DiPRRA can have partner agencies that participate in the project. The DiPRRA submits the permit application for the entire DPR project with the following elements:

- Engineering report
- Joint plan
- Technical, managerial, and financial capacity demonstration
- Operations plan
- Operator certification
- Monitoring plan

Elements that have unique conditions are summarized in the following subsections.

4.7.1 Joint Plan

The DiPRRA will submit a Joint Plan that describes the partner agencies involved in the DPR project, the roles and responsibilities of each partner agency, the legal authority of each to fulfill its role, and the overall organizational structure involved in implementing the Joint Plan.

The Joint Plan must address the procedures to confirm that the DiPRRA will have current knowledge of the status of treatment for the entire DPR project, a description of the corrective actions to be taken if water delivered from a treatment facility fails to meet the applicable treatment or water quality requirements, the procedures the DiPRRA will implement to notify partner agencies and the SWRCB of operational changes that may adversely affect the quality of water delivered by the treatment facility, treatment failure incidents and the corresponding corrective actions taken, and the steps that will be taken to provide an alternative source of supply in the event the DPR project is unable to provide water.

Establishing the legal authorities, roles and responsibilities, and structure of the DiPRRA organization is crucial to providing safe drinking water. For the Pure Water Los Angeles program, LADWP would be the DiPRRA, with LASAN as a partner agency. Negotiations with DDW would be required to determine the DiPRRA for programs that engage in regional partnerships, given that the regulations require a single DiPRRA.

4.7.2 Operations Plan

In addition to the required Engineering Report, the DiPRRA must also submit an Operations Plan for approval in writing by the SWRCB. The Operations Plan must address how the supervisory control and data acquisition (SCADA) system identifies the LRV performance status of each process for which LRV has been attributed to meet the pathogen requirements. The plan must also describe treatment operations quality

control; and if partner agencies are responsible for providing treatment for partially treated DPR water, the plan must describe Operator and SCADA system communications between the partner agency treatment plant and DiPRRA treatment facilities.

As part of the Operations Plan, a DPR project proponent can conduct a treatment failure analysis similar to those the SWRCB requires in the permitting of other severely impaired sources. The treatment failure analysis will address the likelihood of equipment failure or malfunction throughout the treatment process, as well as the potential for human error.

4.7.3 Operator Certification

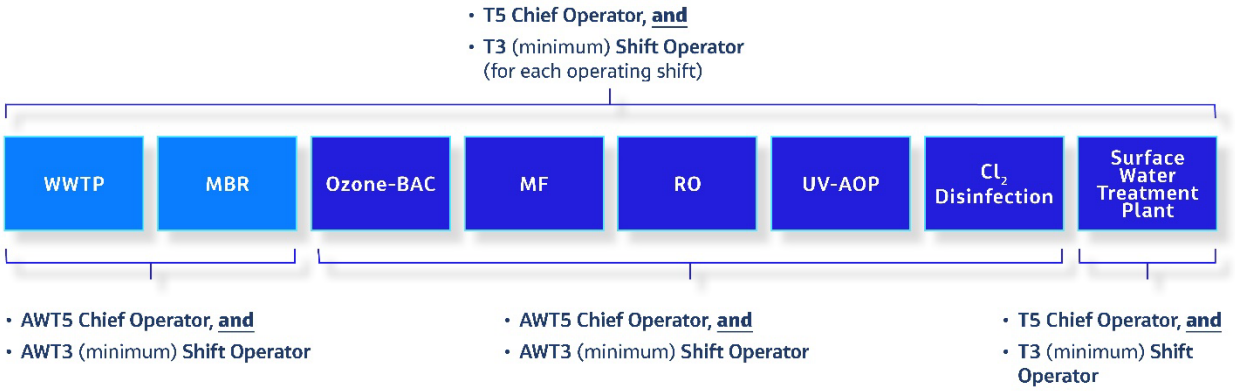
Any facility that provides pathogen control, chemical control, or corrosion control pursuant to Sections 64669.45, 64669.50, or 64669.110, respectively, is deemed a WTP and must provide certified Operators. The DiPRRA is required to designate at least one Chief Operator with a valid grade T5 Water Treatment Operator certification to oversee operations of the entire treatment train. The DiPRRA must also designate at least one Shift Operator with at least a valid grade T3 Water Treatment Operator certification to oversee operations of the entire treatment train for each operating shift (SWRCB 2024).

For any facility providing chemical control per Section 64669.50, the DiPRRA must designate a Chief Operator who holds an Advanced Water Treatment Operator (AWTO) grade AWT5 and a Shift Operator who holds at least a grade AWT3 (CA-NV AWWA and CWEA n.d.).

Additionally, a Chief or Shift Operator must be onsite anytime a treatment plant is providing pathogen control or chemical control. Thus, this certification would be required for the membrane bioreactor (MBR) facilities providing pathogen control and receiving pathogen LRV credit. Operators not designated by the DiPRRA as a Chief or Shift Treatment Operator will be certified as an AWTO, but may hold AWTO certification at any grade (grades AWT3, AWT4, or AWT5).

If the DPR treatment facilities are provided at separate facilities, they will be considered as a single treatment facility for determining the level of Operator certification required (Figure 4-1).

Figure 4-1. Operator Certification Requirements for Direct Potable Reuse



A conservative interpretation would be that both LADWP as the DiPRRA and LASAN as a partner agency operating the MBR process that provides pathogen control would need to meet the extensive AWTO Operator certification requirements noted. It is assumed that the MBR process would be responsible for both pathogen and chemical control. Further discussion with DDW is recommended as the Program progresses.

5 Discussion

This section summarizes the applicable regulations, governing authorities, and policy considerations for GRRPs, SWSAPs, and DPR projects for the Program.

5.1 Applicable Regulations and Authorities

The Master Plan integration locations being evaluated include:

- GRRPs, such as for CB and SFB
- SWSAPs, such as for Lower Stone Canyon and Lower Hollywood Reservoirs for IPR
- DPR at VNC

Table 5-1 summarizes the regulations governing these different applications of IPR and DPR for the Program elements.

Table 5-1. Potable Reuse Regulations Summary

Regulating Agency	Regulation	Application		
		GRRP	SWSAP	DPR
DDW	IPR Pathogen Control	✓	✓	-
DDW	DPR Pathogen Control	-	-	✓
DDW	DPR Chemical Control	-	-	✓
DDW	SWTR	-	✓	✓[a]
DDW	SDWA	✓	✓	✓
RWQCB	CTR	-	✓	✓
Los Angeles RWQCB	Los Angeles RWQCB Basin Plan[b]	✓	✓	✓

[a]SWTR would apply to DPR water used in an RWA application.

[b]San Gabriel Basin Plan and potentially the Orange County Basin Plan would be applicable if a partnership with PWSC is included (Los Angeles RWQCB 2014, 2019; Santa Ana RWQCB 2019; Metropolitan 2019).

- = not applicable

✓= applicable

5.2 Policy Considerations

Based on the integration locations being evaluated, compliance with multiple regulatory frameworks may be required and may vary, depending on the selected type of integration locations for each Program alternative. This section summarizes the regulatory and policy considerations for each project type.

5.2.1 Groundwater Replenishment Reuse Projects

GRRP regulations are well established and have been in place for 10 years, with many similar projects being successfully operated in the state. It is assumed that water from the AWPF would meet all regulatory requirements without the need for additional treatment before recharge. The advantage of GRRP, as well as SWSAP, is that the additional chemical control required for DPR projects would not be required, which could allow for less-expensive implementation of projects.

If DPR quality water is produced at the AWPF, a policy change would be required to allow potable water to be used for groundwater recharge. Consideration should be given to potential costs and benefits of producing DPR quality water before recharge as related to providing additional groundwater quality protection. However, consideration should also be given to potential contaminants already present in the groundwater basins.

CB and SFB both have known areas of contamination. The location of GRRPs need to be considered in relation to known contamination (that is, soil and groundwater contamination), or additional treatment may be required for the extracted water.

LADWP has existing infrastructure in each basin for groundwater recharge and extraction. To maximize existing infrastructure, tracer studies or groundwater modeling will be required to confirm residence time between the recharge and extraction locations for compliance with the minimum residence time of 2 months. Tracer study protocols and the modeling approach can be prepared as Program planning assumptions are developed so that planned flow conditions are considered appropriately. The tracer studies or modeling should be completed before initiating surface recharge to allow for potential modifications to the spreading basin design and construction.

Compliance with pathogen removal requirements will be determined before the water leaves the AWPF, which would allow for diversion of undertreated flow to occur at the AWPF without impacting the conveyance system.

5.2.2 Surface Water Source Augmentation Projects

SWSAPs, similar to GRRPs, have established regulatory frameworks. SWSAPs are also being implemented by several utilities within Southern California (such as Pure Water San Diego) (City of San Diego 2024). SWSAPs offer the benefit of less-stringent pathogen and treatment requirements than DPR projects due to the response time and blending provided by integrating the water into a reservoir with additional treatment upon withdrawal.

Before implementing a SWSAP, the reservoir must be operated for 2 to 5 years before the introduction of recycled water to establish baseline conditions. This requirement has implications for the phasing of any SWSAP. Lower Stone Canyon Reservoir could be brought back into service with the existing Stone Canyon Microfiltration Plant to develop baseline data without requiring any new infrastructure specific to Pure Water Los Angeles. Other uncovered reservoirs (such as Lower Hollywood Reservoir) would require new infrastructure (conveyance and a WTP at the reservoir) to connect the reservoirs to the distribution system.

Despite SWSAPs having less-stringent pathogen and chemical treatment requirements, the reservoirs under consideration must comply with CTR requirements that are more stringent than drinking water MCLs. This requires tighter residual chlorination or chloramination controls at the AWPF and potentially higher levels of treatment for NDMA control.

The reservoirs under consideration are also located approximately 20 miles from an AWPF at or in the vicinity of the Hyperion WRP. The length of conveyance presents a risk of formation and reformation of regulated contaminants after the AWPF, which may require additional treatment at the reservoir that will increase cost and operational complexity.

The regulatory requirements for residence time will also impact reservoir operational complexity and the ability to accept Pure Water Los Angeles water. If reservoir levels are lowered, the Pure Water Los Angeles flow that can be accepted will decrease accordingly, and controls will be required to adjust flows based on reservoir operation.

5.2.3 Direct Potable Reuse Projects

DPR projects have several unique considerations due to the uncertainty related to the implementation of the regulations. The adopted regulations are based on a specified treatment train consisting of ozone and BAC, RO, and UV-AOP. The adopted regulations allow for alternative treatment trains to be proposed if they are validated to provide equal or greater treatment for pathogen or chemical control.

To date, limited information is available for the ability of treatment technologies to meet the regulatory requirements for potential treatment approaches after RO. Unless DPR is achieved at the AWPF, extensive

testing would be required to validate the ability of post-RO treatment (such as treatment at VNC) to comply with the adopted regulations.

Testing results and approval by DDW will influence the location and treatment technologies required for DPR. Testing can also provide an opportunity for LADWP water treatment operations staff to gain experience with the treatment technologies. Consideration should be given to having the pilot be managed under the Pure Water Los Angeles program to manage the main components that influence the schedule and implementation approach.

The adopted DPR regulations also require diversion of any flow that does not meet the minimum required pathogen, TOC, or nitrate concentrations. Diversion options at each integration location must be considered. A greater level of staffing and Operator certification is also required to operate and monitor DPR facilities.

The adopted DPR regulations as written also present challenges to address regarding the ability to engage in a regional DPR exchange with PWSC because the regulations assume a single DiPRRA for a DPR project. In addition, LADWP will need to consider potential policy changes to address the use of DPR water for TWA or for groundwater recharge. Currently, neither application is allowed per LADWP policy. These issues require further consideration during Program alternative screening and analysis, and in future Program phases.

5.2.4 Summary

Based on the current regulations, the evaluated GRRP and SWSAP applications would be able to meet all applicable regulations with IPR quality water produced at the AWPF. This would allow for earlier implementation of these projects based on the regulations and proximity to the AWPF.

It is likely that DPR quality water would not be required under the first phases of upgrades at Hyperion WRP and the AWPF. Implementing DPR at the AWPF during a later phase would provide the most certainty for meeting the adopted regulations, but could limit regional partnerships, increase costs, and require consideration of recharging DPR quality water.

Based on the potential planned phasing, implementing DPR treatment at VNC would allow time for implementation of the DPR regulations, including development of alternative treatment trains, before committing to a specific treatment train and integration approach.

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Interconnectable Partnership Opportunities TM

Interconnectable Partnership Opportunities Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
June 4, 2024

Executive Summary

The Pure Water Los Angeles Master Plan (MP) evaluates potential alternatives for potable reuse to maximize the use of recycled water from the Hyperion Water Reclamation Plant (HWRP) and the anticipated Advanced Water Purification Facility (AWPF). Components for integrating potable reuse were identified within the Los Angeles Department of Water and Power's (LADWP's) water system, including groundwater basins and treatment facilities, as well as through external partnerships.

The Operation NEXT Assessment Tool (ONAT)[1] will be used to estimate the available volume of water for Pure Water Los Angeles Program (Program) components, based on wastewater projections, hydrological conditions, and water demands. ONAT will identify the anticipated flows for the components controlled by LADWP that were incorporated into the Program alternatives and the potential recycled water volumes that may be available for partnerships (Jacobs 2024).

The objectives of partnerships under Pure Water Los Angeles are as follows:

- Maximize recycled water use to:
  - Reduce purchases of imported water in the region
  - Increase drought and climate resiliency within the region and beyond
  - Improve system flexibility
- Maximize the use of existing and planned infrastructure
- Maximize potential opportunities for cost-sharing to lower the cost burden for LADWP's rate payers

This technical memorandum (TM) identifies the types of partnerships and potential collaboration opportunities LADWP could evaluate further as the Program progresses. The MP evaluation considered systems that could be interconnected with Pure Water Los Angeles, including a source water partner, and regional and local partners.

As the source water partner, Los Angeles Sanitation & Environment (LASAN) can provide treated wastewater effluent to the Pure Water Los Angeles Program for further treatment and reuse. According to LASAN, the HWRP would be converted in three phases (Hazen 2024):

- Phase 1 (2033-2035)
- Phase 2 (2037-2039)
- Phase 3 (2048-2050)

This TM evaluates four potential regional partners, and the potential opportunities are summarized here:

1. **West Basin Municipal Water District (West Basin):** The existing connectivity between the HWRP and West Basin's system offers potential for this partnership, which could leverage West Basin's existing infrastructure in several different possible ways. One important advantage of this partnership is that it could allow LADWP to deliver additional secondary effluent (or possibly membrane bioreactor filtrate) to West Basin to produce advanced treated recycled water (ATRW), while new Pure Water Los Angeles conveyance and the AWPF are constructed.

   This opportunity would require expansions to the advanced treatment capacity at West Basin's Edward C. Little Water Recycling Facility (ECLWRF) up to 139 cubic feet per second (cfs) (90 million

[1] In August 2024, Operation NEXT was rebranded as Pure Water Los Angeles; however, due to legacy Program documentation, ONAT will retain its original name.

gallons per day [MGD]) feed, as well as modifications to West Basin's recycled water conveyance, as described in *Technical Memorandum 3 Treatment Alternatives* (Hazen 2024).

Technical details requiring specific agreements will be addressed in the future. This partnership would require addressing additional policy considerations and evaluation by LADWP as the project advances to future phases.

2. **Water Replenishment Water District of Southern California (WRD):** WRD has expressed interest in obtaining water from Pure Water Los Angeles to support WRD's brackish plume remediation effort in West Coast Basin (WCB), as well as replenishing regularly to sustain the safe yield within WCB and Central Basin (CB) (Jacobs 2021). WRD also confirmed its interest in using Pure Water Los Angeles water to replenish CB up to LADWP's entitlements in the future (WRD 2024).

   As a result, based on the historical and projected pumping activities, WRD has identified a potential demand for 42,729 acre-feet per year (AFY) (59 cfs [39 MGD]) of ATRW to replenish both basins, in addition to the additional 5,600 AFY (8 cfs [5 MGD]) of replenishment water through the West Coast Basin Barrier Project (WCBBP), which has been accounted for as part of the West Basin demands.

   The requirements to provide an opportunity for right holders to participate in the groundwater augmentation project in CB could also allow CB's right holders to participate in Pure Water Los Angeles, which could result in additional demands for Pure Water Los Angeles ATRW.

   The details of how such an offering would be implemented are unclear until LADWP submits an application to the CB's Storage Panel. This partnership would require addressing additional policy considerations and evaluation by LADWP as the project advances to future phases.

3. **Metropolitan Water District of Southern California (Metropolitan).** Potential interconnections between Pure Water Los Angeles and Metropolitan's Jensen Water Treatment Plant (WTP) and Pure Water Southern California (PWSC) program could provide opportunities to increase regional water supply reliability and resiliency. PWSC's environmental review includes a Pure Water Los Angeles and PWSC interconnection, which marks a significant milestone for this concept.

   Technical aspects need to be addressed to help advance the evaluation of these potential interconnect opportunities, such as Metropolitan's potential demands for Pure Water Los Angeles water under different climate conditions and water quality constraints. This partnership would require addressing additional policy considerations and evaluation by LADWP as the project advances to future phases.

4. **Los Angeles County Public Works (County Public Works).** County Public Works' spreading grounds in CB and San Fernando Basin and the WCBBP have been identified as potential partnerships for Pure Water Los Angeles. An additional evaluation to identify ways to optimize County Public Works' injection wells and spreading grounds operations would help Pure Water Los Angeles to maximize the use of such infrastructure.

   The Bull Creek Stormwater Capture Project, which captures dry-weather flows from Bull Creek and diverts to Pacoima Spreading Grounds through a pipeline, could provide up to 100 cfs (65 MGD) of conveyance capacity for the Sepulveda Alignment to access Pacoima Spreading Grounds.

   The implications on permitting and the operations of Central Tujunga Wash and Bull Creek would need to be carefully evaluated. This partnership would require addressing additional policy considerations and evaluation by LADWP as the project advances to future phases.

Existing LADWP customers could also serve as local partners under Pure Water Los Angeles, especially those near the alignment alternatives with potential for using recycled water. LADWP could engage these

customers, as well as other customers near the selected Program alternative alignment, to identify demands and evaluate the cost-effectiveness of these connections.

This TM concludes that potential partnership opportunities are viable options and could allow a wider use of ATRW, while benefiting LADWP and the partners. Continued engagement with these partners to gauge interest and gain insight on their potential demands under varying climate conditions will be critical to support proper Program sizing. Further discussions with the potential partners are recommended as the project advances to future phases. Ultimately, LADWP and the potential partners should evaluate the cost, benefit, and risk for each interconnectable partnership opportunity. Table ES-1 summarizes the next steps and additional analyses.

Table ES-1. Partnership Recommended Next Steps and Additional Analyses

Location	Recommended Next Steps and Additional Analyses
LASAN	▪ Continue collaborating to develop a synchronized schedule and approach for Program implementation.
West Basin	▪ If desired, continue engaging with West Basin to work out the technical details about options for modifying the ECLWRF and its recycled water distribution system to support near-term actions and the overall Program implementation. ▪ Evaluate use of West Basin's infrastructure to accelerate water delivery to CB. ▪ Determine the role and potential for West Basin to accelerate water delivery by Pure Water Los Angeles. ▪ Determine the potential institutional arrangement options with West Basin. ▪ Determine the capital improvement needs and the associated costs with West Basin to allow for comparison against other options. ▪ Determine the potential of phasing and implementation of HWRP and Pure Water Los Angeles as near-term actions using West Basin's infrastructure.
WRD	▪ If desired, continue engaging with WRD to develop the technical details to support further evaluation of the potential opportunities and quantify the potential water that could be provided to WRD through Pure Water Los Angeles. ▪ Define the flow rates or demands and the potential variability for the use of Pure Water Los Angeles water for groundwater basin replenishment. ▪ Collaborate with WRD to further define the identified opportunities, such as recharge locations and methods. ▪ Evaluate the potential of mobilizing organic compounds from the soil matrix of the spreading grounds if Montebello Spreading Grounds are to be used. ▪ Evaluate how costs could be shared for replenishing CB using injection wells from Pure Water Los Angeles. ▪ Develop a joint strategy to maximize recharge during wet weather seasons.
Metropolitan	▪ If desired, continue engaging with Metropolitan to discuss technical details, requirements, or agreements needed for potential opportunities for Jensen WTP and PWSC. ▪ Conduct comprehensive investigations jointly with Metropolitan to evaluate the details of these integration options to develop plans for meeting regulatory requirements. ▪ Metropolitan has a policy of limiting its system to use no more than 50% of recycled water as a source; conduct additional discussions with Metropolitan to determine whether modification is possible to increase the flexibility to incorporate ATRW into the potable water system. ▪ Metropolitan to provide additional analysis to determine capacity at their Weymouth or Diemer WTPs, or both, to receive Pure Water Los Angeles ATRW by lowering the nitrate concentration in Pure Water Los Angeles water to 2 mg/L as N for identified scenarios. ▪ Investigate water quality specifications required for interconnect between Jensen WTP and PWSC jointly with Metropolitan. ▪ Identify institutional arrangements necessary for these interconnections to be permitted under the DPR regulations.

Table ES-1. Partnership Recommended Next Steps and Additional Analyses

County Public Works	▪ If desired, continue engaging with County Public Works to discuss technical details, requirements, or agreements needed for these potential opportunities. ▪ Quantify the potential capacities available at the identified recharge facilities. ▪ Determine whether operational optimization exists to increase the facilities' availability, and identify the pathway for optimization. ▪ Consider implementing policies that would increase the use of recycled water for groundwater replenishment in both wet and dry seasons. ▪ Evaluate water quality requirements and permitting implications.
Local Opportunities	▪ If desired, continue engaging potential local partners to explore opportunities for interconnection and identify additional potential beneficial uses of Pure Water Los Angeles water.

DPR = direct potable reuse
mg/L = milligram(s) per liter
N = nitrogen

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A Source Water Partner
B Identification of Regional Partnership Opportunities
C Identification of Local Partnership Opportunities

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Acronyms and Abbreviations

AFY	acre-foot (feet) per year
ATRW	advanced treated recycled water
AWPF	advanced water purification facility
CB	Central Basin
cfs	cubic foot (feet) per second
County Public Works	Los Angeles County Public Works
DiPRRA	direct potable reuse responsible agency
DPR	direct potable reuse
ELCWRF	Edward C. Little Water Recycling Facility
fps	foot (feet) per second
HWRP	Hyperion Water Reclamation Plant
IPR	indirect potable reuse
Jensen WTP	Joseph Jensen Water Treatment Plant
LACSD	Los Angeles County Sanitation Districts
LADWP	Los Angeles Department of Water and Power
LASAN	Los Angeles Sanitation & Environment
MBR	membrane bioreactor
Metropolitan	Metropolitan Water District of Southern California
mg/L	milligram(s) per liter
MP	Master Plan
N	nitrogen
Program	Pure Water Los Angeles Program
PWSC	Pure Water Southern California Program
RO	reverse osmosis
ROC	reverse osmosis concentrate
SFB	San Fernando Basin
TM	technical memorandum
VNC	Van Norman Complex
WCB	West Coast Basin

WCBBP	West Coast Basin Barrier Project
West Basin	West Basin Municipal Water District
WRD	Water Replenishment District
WTP	water treatment plant

1 Introduction

The Pure Water Los Angeles (Program) Master Plan (MP) evaluates potential water integration components and conveyance alternatives to maximize the potable reuse of water from the Hyperion Water Reclamation Plant (HWRP). The MP evaluates three general categories of water integration components:

1. Groundwater recharge in West Coast Basin (WCB), Central Basin (CB), and San Fernando Basin (SFB)
2. Direct potable reuse (DPR) at the Van Norman Complex (VNC) or at the Advanced Water Purification Facility (AWPF), at or in the vicinity of the HWRP
3. The provision of advanced treated recycled water (ATRW) to local and regional partners

The objectives of partnerships under Pure Water Los Angeles are as follows:

- Maximize recycled water use to:
  - Reduce purchases of imported water in the region
  - Increase drought and climate resiliency within the region and beyond
  - Improve system flexibility
- Maximize the use of existing and planned infrastructure
- Maximize potential opportunities for cost-sharing to lower the cost burden for Los Angeles Department of Water and Power's (LADWP's) rate payers

This technical memorandum (TM) considers systems that could be interconnected with Pure Water Los Angeles. An interconnectable system is defined as a water, wastewater, or recycled water system that could be physically connected to Pure Water Los Angeles, including partner entities' conveyance, groundwater basins, recharge facilities, or treatment facilities.

For Pure Water Los Angeles, three types of partnerships have been identified and are discussed in this TM:

1. Source water partner: A wastewater agency, in this case, Los Angeles Sanitation & Environment (LASAN), that can provide treated wastewater effluent to the Program for further treatment and reuse
2. Regional partner: Covers a large geographic region, encompassing cities and areas of special designation, with the ability to process or use large volumes of water from the Program
3. Local partner: Could be a single city, an area of special designation, or an existing LADWP customer that is located within proximity to a potential Pure Water Los Angeles conveyance alignment

The following attachments provide more detailed assessments for the information summarized in this TM and should be referred to for further detail:

- Attachment A, Source Water Partner
- Attachment B, Identification of Regional Partnership Opportunities
- Attachment C, Identification of Local Partnership Opportunities

Each attachment provides the following information for each partnership type:

- Organizational overview
- Existing infrastructure
- Opportunities and findings
- Other considerations and next steps

The formation of a partnership is a complex process that requires collaboration and time. As a result, it is likely not possible to refine flow values and secure agreements during the MP phase. The goal of this TM is to identify the potential partnership opportunities that LADWP may consider further as the Program progresses. This information is not intended to be exhaustive; as LADWP continues engaging potential partners, other opportunities could arise.

Collaboration, such as the potential partnerships under consideration by LADWP, can benefit the agencies implementing reuse projects. For example, one of the longest partnerships producing recycled water in Southern California is between Orange County Water District and Orange County Sanitation District. Orange County Water District's Groundwater Replenishment System has its origins in 1976 with Water Factory 21 and historically provides up to 130 MGD of purified water to replenish local groundwater to increase local water supply reliability. The former general manager of Orange County Water District credited the strong partnership between the two entities for the success of the Groundwater Replenishment System (Holmer and Vanyo 2020).

It is also acknowledged that this partnership resulted in effective management of water quality. In particular, Orange County Sanitation District had early recognition of water quality concerns that prompted them to implement a robust pretreatment program to reduce pollutant burden to the wastewater treatment plants and to the downstream AWPF (EPA 2022).

2 Source Water Partner

A source water partner is a wastewater agency (in this case, LASAN) that can provide the Program with treated wastewater effluent for further treatment and reuse. LADWP is currently evaluating the technical details about how this partnership would work, with support from LADWP's HWRP Owner's Agent (Hazen 2024), and the LASAN Team, supported by Carollo Engineers. Based on a recent flow projection update for HWRP, the high projected inflow at the HWRP could reach 467 cubic feet per second (cfs) (302 million gallons per day [MGD]), while the low projected inflow could be at 390 cfs (252 MGD), with the median inflow rates being 421 cfs (272 MGD) by Year 2035 (LASAN 2023).

LADWP and LASAN are currently evaluating the AWPF location options. LASAN has led a detailed evaluation on co-locating an AWPF within the HWRP's footprint (Carollo 2020). Concurrently, LADWP has engaged its HWRP Owner's Agent to evaluate offsite and hybrid AWPF options for comprehensive consideration and, ultimately, the selection of an optimal AWPF arrangement for Pure Water Los Angeles will be based on factors such as cost, footprint, and phasing (Hazen 2024).

The construction phasing for the HWRP will have a significant impact on the phasing and implementation strategy for Pure Water Los Angeles. Based on the schedule provided by the Hyperion Owner's Agent (Hazen 2024; LADWP 2024), membrane bioreactor (MBR) effluent from the HWRP is anticipated to be delivered in three phases (Table 2-1).

Table 2-1. Anticipated Pure Water Los Angeles Phasing

Treatment Step	Phase 1 cfs (MGD)	Phase 2 cfs (MGD)	Phase 3 cfs (MGD)	Total Capacity cfs (MGD)
MBR Effluent[a]	93 (60)	93 (60)	235 (152)	421 (272)
AWPF Product Water[a]	79 (51)	79 (51)	198 (128)	356 (230)
ROC Return	14 (9)	14 (9)	37 (24)	65 (42)

Source (Hazen 2024)

[a] The numbers presented herein are based on assumptions for converting HWRP to MBR, and not on AWPF location; they may change for each potential alternative.

ROC = reverse osmosis concentrate

3 Potential Regional Partners

This TM defines a regional water partner as an entity that covers a large geographic region, encompassing cities and areas of special designation, and that has the ability to process or use large volumes of water from the Program. This TM evaluates four regional partners:

1. West Basin Municipal Water District (West Basin) (Figure 3-1)
2. Water Replenishment District (WRD) (Figure 3-2)
3. Metropolitan Water District of Southern California (Metropolitan) (Figure 3-3)
4. Los Angeles County Public Works (County Public Works) (Figure 3-4)

LADWP provides potable water to portions of West Hollywood, Culver City, and small parts of the County of Los Angeles (LADWP 2021).

The MP Team reviewed publicly available documents, and LADWP met with these entities on potential collaboration opportunities, with the MP Consultant Team participating or reviewing meeting minutes for the meetings, as listed in Table 3-1. Potential opportunities with each of these regional partners are identified in the following subsections.

Table 3-1. Meeting Engagements with Potential Regional Partners

Agency or Entity	Meeting Engagement
West Basin	▪ September 21, 2022
WRD	▪ October 31, 2022
Metropolitan	▪ October 20, 2022 (a joint meeting with LACSD) ▪ March 16, 2023 ▪ April 24, 2023 ▪ May 24, 2023 ▪ April 17, 2024
County Public Works	▪ January 5, 2023

LACSD = Los Angeles County Sanitation Districts

While this section of the TM focuses on identifying opportunities to partner and leverage existing infrastructure owned by other agencies, leveraging another agency's infrastructure could introduce risk to the asset owner related to operations. Such risks would need to be mitigated, and the asset owners may request compensation related to continuing to meet their primary objective of reliably serving their customers.

This TM identifies regional partnerships that are feasible from a technical perspective and that may be beneficial to explore further. It is recommended that LADWP continue engaging with these potential partners and further the discussions. The discussions that LADWP will convene with the potential regional partners will ultimately determine the costs, benefits, and risks of each opportunity. Final decisions should be made based on the additional outcomes from collaboration with the regional partners, allowing LADWP and the potential regional partners to reach an informed determination.

Hyperion WRP

Hyperion Secondary Pump Station (West Basin)

Edward C. Little WRF (West Basin)

Carson Facility (West Basin)

Pacific Ocean

Map Extent

Note: LADWP currently provides potable water to portions of West Hollywood, Culver City, and small parts of the County of Los Angeles (Source: LADWP 2021)

Legend

- Existing Advanced Water Purification Facility
- Existing Water Reclamation Facility
- Potential Siting Area for the Advanced Water Purification Facility
- West Basin Service Area
- City Boundary
- County Boundary

West Basin Infrastructure

- ECLWRF Brine Line
- Carson Facility Brine Line
- West Basin Recycled Water Distribution System

Alignment Options

- Cahuenga
- Florence
- Griffith Park
- Manchester
- Sepulveda
- Slauson

Flood Control Facilities Operated by LACPW

- Flood Control Channels
- West Coast Seawater Barrier Project
- Spreading Grounds

Future Wellfield

- Extraction
- Injection

Groundwater Basins

- San Fernando
- Central
- Hollywood
- Santa Monica
- West Coast

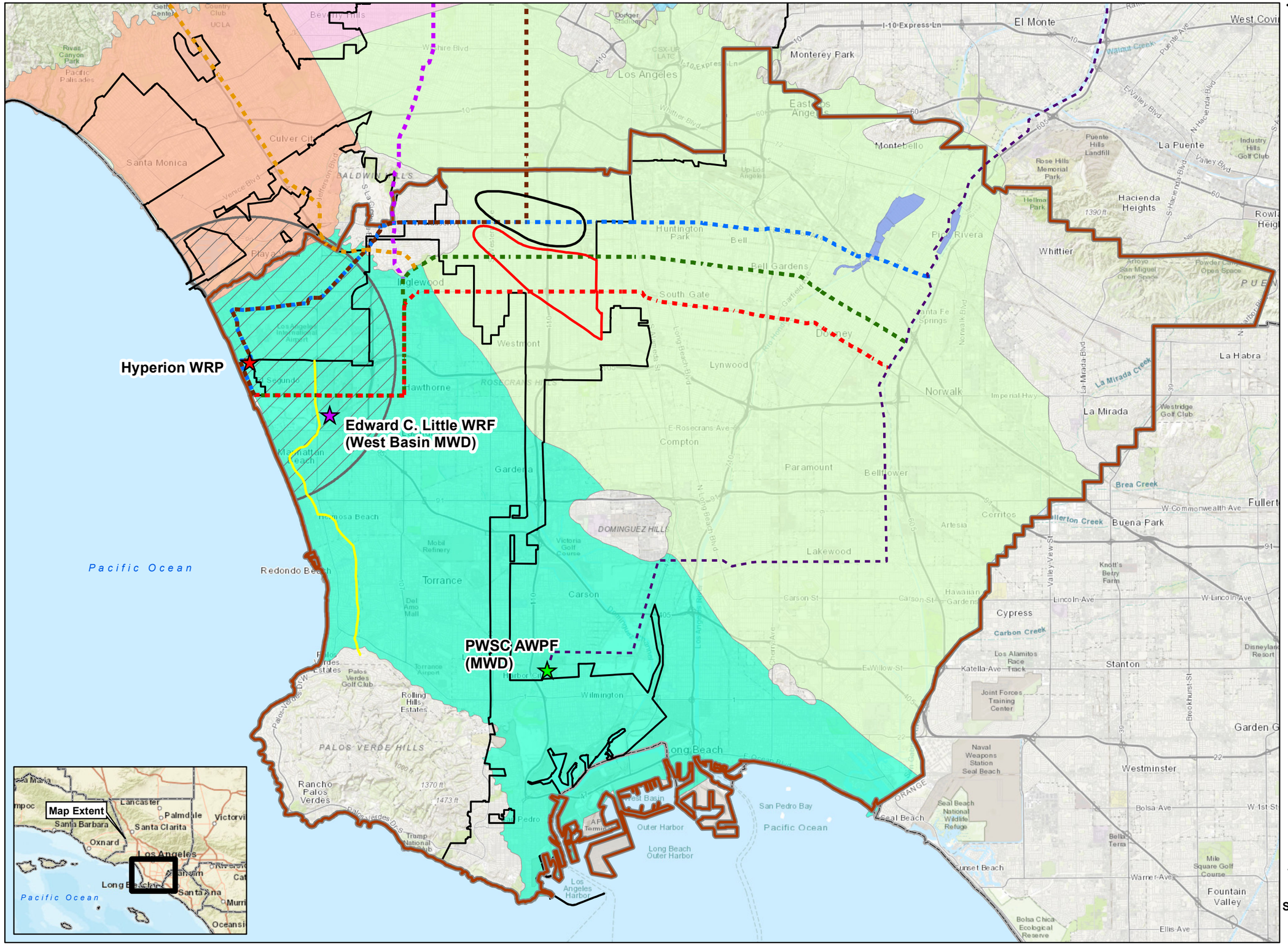
Sources:
LADWP, 2022; LA County, 2023
ESRI World Topo Map; ESRI World Street Map

0 1.5 3 6
Miles

1 inch = 3 miles

Figure 3-1

West Basin Service Area and Key Infrastructure



Legend

- Proposed Water Reclamation Facility/Water Treatment Facility
- Existing Advanced Water Purification Facility
- Existing Water Reclamation Facility
- WRD Service Area
- Potential Siting Area for the Advanced Water Purification Facility
- Pure Water Southern California
- City Boundary
- County Boundary

Alignment Options

- Cahuenga
- Florence
- Griffith Park
- Manchester
- Sepulveda
- Slauson

Future Wellfield

- Extraction
- Injection

Flood Control Facilities Operated by LACPW

- Flood Control Channels
- West Coast Seawater Barrier Project
- Spreading Grounds

Groundwater Basins

- San Fernando
- Central
- Hollywood
- Santa Monica
- West Coast

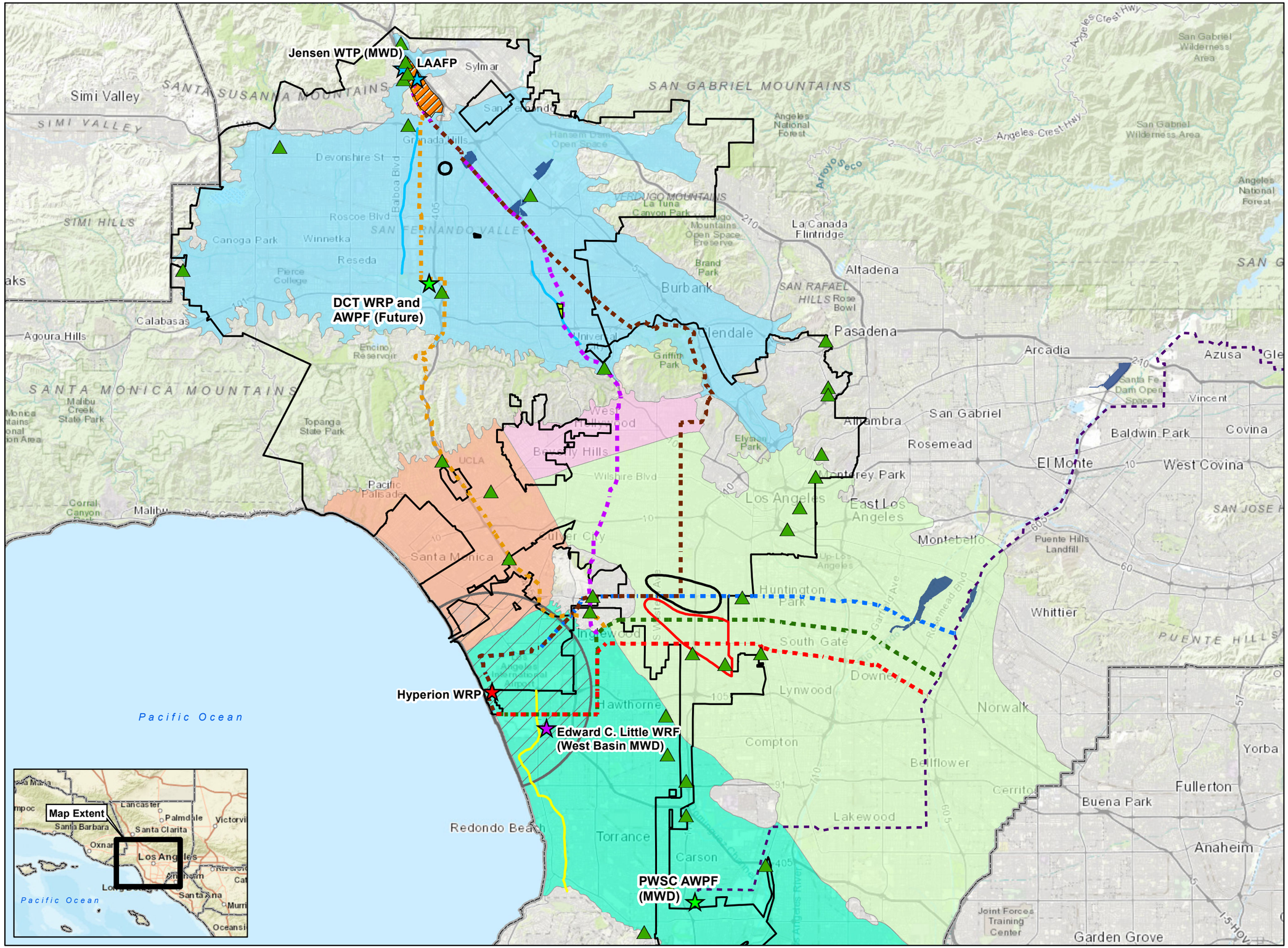
Sources:
LADWP, 2022; LA County, 2023
ESRI World Topo Map; ESRI World Street Map

0 0.75 1.5 3
Miles

1 inch = 3 miles

Figure 3-2

Service Area of Water Replenishment District of Southern California



Legend

- Proposed Water Reclamation Facility/Water Treatment Facility
- Existing Advanced Water Purification Facility
- Existing Drinking Water Treatment Plant
- Existing Water Reclamation Facility
- MWD Connections
- North Hollywood Park
- Potential Siting Area for the Advanced Water Purification Facility
- Van Norman Complex
- Pure Water Southern California
- City Boundary
- County Boundary

Alignment Options

- Cahuenga
- Florence
- Griffith Park
- Manchester
- Sepulveda
- Slauson

Future Wellfield

- Extraction
- Injection

Flood Control Facilities Operated by LACPW

- Flood Control Channels
- West Coast Seawater Barrier Project
- Spreading Grounds

Groundwater Basins

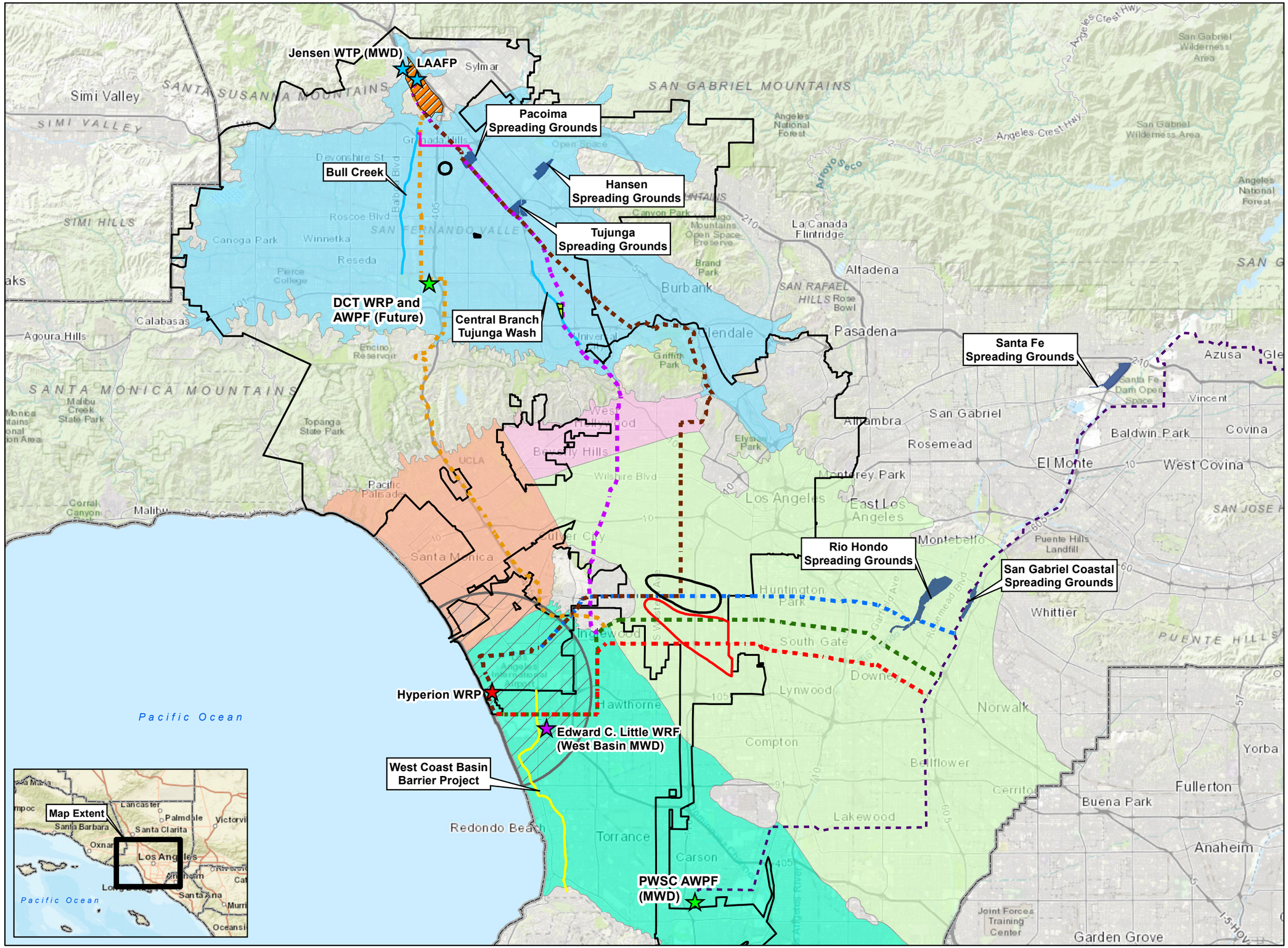
- San Fernando
- Central
- Hollywood
- Santa Monica
- West Coast

Sources:
LADWP, 2022; LA County, 2023
ESRI World Topo Map; ESRI World Street Map

0 1.5 3 6
Miles

1 inch = 4 miles

Figure 3-3
Metropolitan Water District of Southern California's Connections and Other Key Interconnectable Infrastructure



Legend

- Proposed Water Reclamation Facility/Water Treatment Facility
- Existing Advanced Water Purification Facility
- Existing Drinking Water Treatment Plant
- Existing Water Reclamation Facility
- Bull Creek Stormwater Project
- North Hollywood Park
- Potential Siting Area for the Advanced Water Purification Facility
- Van Norman Complex
- Pure Water Southern California
- City Boundary
- County Boundary

Alignment Options

- Cahuenga
- Florence
- Griffith Park
- Manchester
- Sepulveda
- Slauson

Future Wellfield

- Extraction
- Injection

Flood Control Facilities Operated by LACPW

- Flood Control Channels
- West Coast Seawater Barrier Project
- Spreading Grounds

Groundwater Basins

- San Fernando
- Central
- Hollywood
- Santa Monica
- West Coast

Sources:
LADWP, 2022; LA County, 2023
ESRI World Topo Map; ESRI World Street Map

0 1.5 3 6
Miles
1 inch = 4 miles

Figure 3-4
Interconnectable Flood Control Facilities Operated By Los Angeles County of Public Works

\\dc1vs01\GISProj\L\LADWP\Operation_NEXT\MapFiles\Fig5-1_OperationNEXT_LACPW_Facilities_20240521.mxd

3.1 West Basin Municipal Water District

West Basin, a member agency of Metropolitan, is a potable water wholesaler for imported water purchased from Metropolitan. It serves 17 cities and unincorporated areas in Los Angeles County, with nearly 1 million residents. West Basin is also a recycled water producer and provider of five types of recycled water of different quality, including recycled water to the West Coast Basin Barrier Project (WCBBP) (WBMWD 2023).

LADWP's partnership with West Basin dates back to the 1990s, and it has been actively engaging with West Basin throughout the MP's development. Furthermore, due to the existing hydraulic connectivity and proximity to the HWRP, and West Basin's extensive recycled water infrastructure (Figure 3-1), West Basin has been identified as a potential partner for Pure Water Los Angeles. The September 2022 meeting with West Basin (Table 3-1) identified the following potential opportunities for collaboration:

- Use the HWRP secondary effluent pump station and force main to convey additional flows to the Edward C. Little Water Recycling Facility (ECLWRF) for treatment or distribution for LADWP.
- Use the existing ECLWRF site by expanding its advanced water treatment capacity to produce additional ATRW to meet identified demands.
- Use available unused capacity in the Inglewood Lateral to deliver indirect potable reuse (IPR) flows to CB's new injection wells for groundwater augmentation. An extension of the Inglewood Lateral would be necessary.
- Convey additional ATRW to the Westside System for non-potable water uses if there is a demand.
- Convey additional ATRW to the WCBBP, though WRD and County Public Works have yet to determine the exact volume.
- Supply ATRW to the Harbor Area using West Basin infrastructure; however, this potential option was eliminated due to the high cost of retrofit for LADWP's industrial customers if they switch from the current potable water supply to ATRW.

During the September 2022 meeting, West Basin expressed interest in participating in research opportunities and strategy discussions related to DPR treatment after reverse osmosis (RO). West Basin has also expressed willingness to collaborate with LADWP to support the implementation of Pure Water Los Angeles. During the meeting, LADWP and West Basin acknowledged that interconnectivity could have significant operational challenges and would require additional joint evaluation as the concepts develop.

In addition to these areas, LADWP and West Basin would explore the following unique opportunities:

- Implement a tertiary MBR at the ECLWRF (HDR 2022).
- Increase water delivery to the WCBBP using the unused barrier train capacity.
- Provide additional flows to West Basin to support its recycled water service expansion.

The following capacity limitations for using West Basin's existing infrastructure need to be recognized because the necessary upgrades or retrofits could reduce the cost-effectiveness of the potential opportunities:

- The existing capacity of the conveyance system between the HWRP and the ECLWRF is 111 cfs (72 MGD), but that could be increased to 169 cfs (109 MGD) with electrical upgrades at the secondary pump station, which would allow the pipeline to be operated at a greater in-pipe velocity of approximately 8.6 feet per second (fps) (HDR 2022). It would only be possible to convey flows up to 169 cfs (109 MGD) if the brine line capacity was increased when MBR filtrate is conveyed to the ECLWRF; whereas, if ATRW is sent to ECLWRF, the brine discharge from ECLWRF would no longer be necessary.

- The ECLWRF brine line has a firm capacity of 12.8 cfs (8.3 MGD). Based on the historical average discharge, approximately 8.5 cfs (5.5 MGD) of the brine line capacity is unused (HDR 2022). This translates to an RO permeate production of up to 48 cfs (31 MGD), based on 85% RO recovery. This limitation would be important when considering the potential expansion of RO treatment at ELCWRF.

The Concept Study (LADWP 2021) did not include an interconnection between Pure Water Los Angeles and West Basin as an opportunity. To further evaluate this opportunity, the following aspects will need to be addressed:

- The volumes to be provided to West Basin under Pure Water Los Angeles
- The role and potential for using West Basin to accelerate water delivery by Pure Water Los Angeles
- The potential institutional arrangement options for the expanded use of West Basin's infrastructure
- The capital improvement needs and the associated cost for this interconnection

Modification to the existing partnership would require engagement and time. As such, the technical details will be developed once a mutual desire to advance this partnership has been established. It is recommended that LADWP continue engaging, collaborating, and coordinating with West Basin to evaluate these opportunities and determine their feasibility.

3.2 Water Replenishment District

WRD is the Basin Manager and Watermaster for CB and WCB, and serves a population of 4 million residents. Based on the October 2022 meeting (Table 3-1), there are potential demands for Pure Water Los Angeles water from WRD, mainly derived from WRD's brackish remediation activity in WCB and its desire to eliminate imported water supply to replenish its basins (LADWP 2022b). WRD also expressed interest in the potential for Pure Water Los Angeles to provide replenishment water up to LADWP's entitlements in CB and WCB (WRD 2024), which would require operating agreements between the entities. Table 3-2 summarizes WRD's water replenishment demands.

Table 3-2. Potential Future Replenishment Water Demand in West Coast and Central Basins

Basin	Description	AFY	cfs[a]	MGD[a]
WCB	Additional replenishment due to remediation of the brackish plume	13,000	18	12
WCB[b]	Additional replenishment through WCBBP	5,600	8	5
CB	Replenishment water to replace imported supply	11,000	15	10
CB	Replenishment water up to LADWP's entitlements in CB and WCB	18,739	26	17
Total[b]		42,739	59	39

[a] Values represent a 12-month annual operating period. Numbers have been rounded.

[b] WCBBP demand is represented in the West Basin demands, and therefore not represented in the WRD total.

AFY = acre-foot (feet) per year

Additionally, WRD would have an important role in implementing the groundwater augmentation project in CB. Further engagement is required with WRD, and potentially the Storage Panel, to better understand the requirements. Additionally, the extent of the participation offering must be provided to other right holders to receive approval for a groundwater augmentation project in CB.

Additional analyses could be conducted jointly to further define the potential partnership opportunities between these two agencies, including:

- Define the flow rates or demands and the potential variability for the use of Pure Water Los Angeles water for groundwater basin replenishment.
- Collaborate with WRD to further define the identified opportunities, such as recharge locations and methods.

- Evaluate the potential of mobilizing organic compounds from the soil matrix of the spreading grounds if Montebello Spreading Grounds are to be used.
- Evaluate how costs could be shared for replenishing CB using injection wells from Pure Water Los Angeles.
- Develop a joint strategy to maximize recharge during wet weather seasons.

LADWP should continue its active engagement with WRD to discuss the technical details, requirements, or agreements needed for these potential opportunities. Continued engagement with, and input from, WRD would further support the evaluation of the opportunities described in this section and quantify the water that could be provided to them through Pure Water Los Angeles.

3.3 Metropolitan Water District of Southern California

Metropolitan is a public water wholesaler in Southern California that imports water through the Colorado River Aqueduct and State Water Project (Metropolitan 2023). It serves 26 public water agencies, including cities, municipal water districts, and 1 county water authority, which then deliver supplies directly or indirectly to 19 million people in the following counties:

- Los Angeles
- Orange
- Riverside
- San Bernardino
- San Diego
- Ventura

Two Metropolitan interconnection options have been identified with Pure Water Los Angeles (Figure 3-3):

1. Joseph Jensen Water Treatment Plant (Jensen WTP)
2. Pure Water Los Angeles and Pure Water Southern California Program (PWSC)

To further advance these interconnection opportunities, the following aspects would need to be addressed:

- Metropolitan's policy of limiting its system to use no more than 50% of recycled water as a source, which it confirmed during the April 2023 meeting (Table 3-1). Further discussions with Metropolitan would help clarify the basis of the policy and potential to adjust this limitation to use more ATRW supply in its system.
- The methodology for reaching the 50% recycled water source limit and the approach for implementation under the base- and flexed-loaded scenarios. In a base-loaded scenario, the flow rate is calculated based on the minimum potable water demands for water produced at a Metropolitan water treatment plant (WTP). In a flexed-loaded scenario, the flow rate is calculated based on the diurnal change of the potable water demands for water produced at a WTP.
- The methodology for reaching a systemwide nitrogen limit for the drinking WTPs of no more than 2 mg/L of nitrogen from total inorganic nitrogen 95% of the time.
- The potential flow that could be provided by Pure Water Los Angeles if the nitrate-nitrogen in Pure Water Los Angeles water was at 2 mg/L as nitrate for the base- and flexed-loaded scenarios.
- The water quality requirements for an interconnection between Pure Water Los Angeles and Jensen WTP or PWSC.
- For Pure Water Los Angeles and PWSC, the level of additional treatment at each AWPF for DPR and the timing of implementation of this additional treatment (if any) must be considered.

- A roadmap to identify institutional arrangements necessary for these interconnections to be permitted under the IPR or DPR regulations, or both. This needs to be developed, including which agency would serve as the direct potable reuse responsible agency (DiPRRA) under each interconnect scenario.
- The resolution of a potential tie-in location for the Pure Water Los Angeles and PWSC interconnect.

From a conveyance perspective, these additional factors need to be considered and further evaluated:

- The Pure Water Los Angeles and Jensen WTP interconnection would only be reasonable if ATRW was conveyed to VNC. All the south to north alignments (that is, Sepulveda, Cahuenga, and Griffith Park) could offer this interconnect opportunity if they were extended to VNC.
- The Pure Water Los Angeles to PWSC interconnect would require a relatively long, dedicated pipeline along one of the three west–east alignment options. The costs need to be further evaluated for interconnecting the two programs under a lower-flow scenario due to the water quality constraints and a high-flow scenario of 232 cfs (150 MGD) by overcoming the constraints.

The following near-term analyses could be conducted jointly by Metropolitan and LADWP to inform feasibility and follow-up actions:

- Conduct comprehensive investigations to evaluate the details of these integration options to develop plans for meeting regulatory requirements.
- Metropolitan has a policy of limiting its system to use no more than 50% of recycled water as a source; conduct additional discussions with Metropolitan to determine whether modification is possible to increase the flexibility to incorporate ATRW into the potable water system.
- Metropolitan to provide additional analysis to determine capacity at Metropolitan's Weymouth or Diemer WTPs, or both, to receive Pure Water Los Angeles ATRW by lowering the nitrate concentration to 2 mg/L as nitrogen for identified scenarios.
- Investigate water quality specifications required for interconnect between Jensen WTP and PWSC.
- Identify institutional arrangements necessary for these interconnections to be permitted under the DPR regulations.

To move forward with this potential partnership, LADWP should consider continuing engagement with Metropolitan to discuss the technical details, requirements, or agreements needed for these potential opportunities. Continued engagement with, and input from, Metropolitan will support the further evaluation of the opportunities described in this section and quantify the water that could be provided to them through Pure Water Los Angeles.

3.4 Los Angeles County Public Works

County Public Works operates and maintains flood control-related infrastructure, including seawater intrusion barriers, spreading grounds, and flood control channels (County Public Works 2023). Their existing infrastructure could support recharge and flow conveyance for Pure Water Los Angeles ATRW when there is unused capacity, such as during dry-weather seasons for spreading grounds and flood control channels.

Table 3-3 lists the most promising interconnectable infrastructure owned or operated by County Public Works. To advance this interconnection opportunity further, the following aspects would need to be addressed as near-term next steps:

- Quantify the potential capacities available at each of these facilities.
- Determine whether operational optimization exists to increase the facilities' availability for recharge or conveyance, and identify the pathway for such optimization.

- Consider implementing policies that could enhance acceptance of recycled water.
- Evaluate water quality requirements and permitting implications.

Based on these factors, it is recommended that a study be conducted to increase the use of the identified County Public Works infrastructure. The purpose of the study would be to provide additional data to further evaluate the feasibility of these potential interconnection opportunities, based on the alignment options presented in Table 3-3, and based on the County Public Works' infrastructure shown on Figure 3-4.

Table 3-3. Potential Interconnect Opportunities for Further Evaluation

County Public Works Facility	S-N Alignment Options			W-E Alignment Options			Others
	Sepulveda	Cahuenga	Griffith Park	Slauson	Florence	Manchester	West Basin
WCBBP	--	--	--	--	--	--	✓
Rio Hondo Spreading Grounds	--	--	--	✓	✓	--	--
San Gabriel Coastal Spreading Grounds	--	--	--	✓	--	--	--
Hansen Spreading Grounds	✓	✓	✓	--	--	--	--
Tujunga Spreading Grounds[a]	✓	✓	✓	--	--	--	--
Pacoima Spreading Grounds	✓	✓	✓	--	--	--	--
Boulevard Pit[b]	✓	✓	✓	--	--	--	--
Central Tujunga Wash	✓	✓	✓	--	--	--	--
Bull Creek Stormwater Capture Project	✓	--	--	--	--	--	--

[a] Tujunga Spreading Grounds is operated by County Public Works but owned by LADWP.

[b] The pit is currently owned by Vulcan Materials Company. A plan for partnership between LADWP and County Public Works to repurpose the pit has been considered.

✓ = potential opportunity

-- = no opportunity

S-N = south to north

W-E = west to east

If LADWP elects to evaluate the County Public Works opportunities further, LADWP should also continue its active engagement with the County Public Works to discuss the technical details, requirements, or agreements needed for these potential opportunities. Continued engagement with, and input from, County Public Works will support the further evaluation of the opportunities described in this section and quantify the water that could be provided to them through Pure Water Los Angeles.

4 Local Partners

This TM defines a local partner as a city, an area of special designation, or an existing customer of LADWP that is located within proximity to a Pure Water Los Angeles conveyance alignment for easy access to the water. Local partners could be unique and important components of the overall Program, even though their demands are expected to be significantly less than those of regional partners. Given the historical ties between these communities and the City of Los Angeles, providing local partners with access to Pure Water Los Angeles ATRW could broaden the local support provided by these partners.

4.1 Local Cities or Areas of Special Designation

The opportunities for partnering with local cities and areas of special designation are alignment-specific, as shown on Figure 4-1 and provided in Table 4-1.

Table 4-1. Alignment-Based Interconnection Opportunities with Local Cities and Areas of Special Designation

Local Partner	Potential Demand (MGD)	S-N Alignments			West Basin System Expansion	W-E Alignment
		Griffith Park	Cahuenga	Sepulveda		
City of Santa Monica	Up to 5 (IPR)[a]	--	--	✓	✓	--
Culver City (West Basin)	Up to 0.1 (NPR)[b]	--	✓	✓	--	--
Kenneth Hanh State Park and Surrounding Area (LADWP and West Basin)	Up to 0.4 (NPR)[b]	--	✓	--	--	--
City of Beverly Hills	Up to 5 (IPR)[c]	--	✓ through West Hollywood	✓	--	--
West Hollywood (West Basin)	TBD (NPR)	--	✓	✓ through Beverly Hills	--	--
West Los Angeles Veterinary Affairs Center, Los Angeles National Cemetery (West Basin)	TBD (NPR)	--	--	✓	--	--
City of Burbank	Up to 4.5 (DPR and IPR)[d]	✓ direct delivery	✓ direct delivery	✓ water exchange	--	--
City of Glendale[e]	TBD (IPR)	✓	--	--	--	--
City of San Fernando	TBD (IPR)	✓	✓	--	--	--
CB Municipal Water District	TBD (NPR)	--	--	--	--	✓

[a]Value reported by LADWP (2022a).

[b] Value reported by HDR (2022).

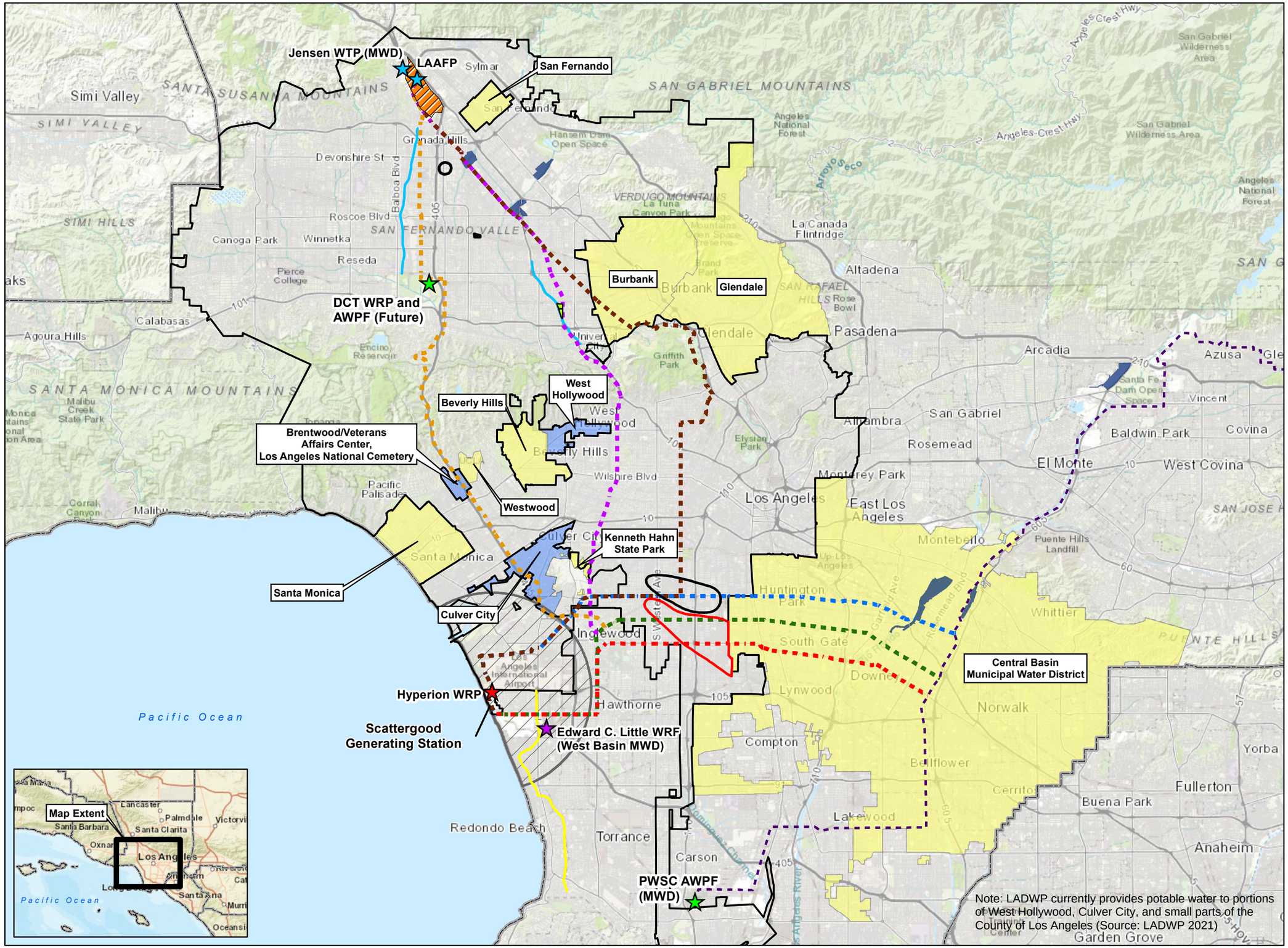
[c]Based on future expanded capacity of Foothill WTP (CBH 2021). Ultimate demand needs to be determined by further engagement with the City of Beverly Hills and further evaluation.

[d]Value reported by BWP(2021).

BWP = Burbank Water and Power

NPR = non-potable reuse

TBD = to be determined



Legend

- Proposed Water Reclamation Facility/Water Treatment Facility
- Existing Advanced Water Purification Facility
- Existing Drinking Water Treatment Plant
- Existing Water Reclamation Facility
- North Hollywood Park
- Potential Siting Area for the Advanced Water Purification Facility
- Van Norman Complex
- Pure Water Southern California
- Cities/Universities/Parks/CBMWD
- West Basin MWD Service Area
- City Boundary
- County Boundary

Alignment Options

- Cahuenga
- Florence
- Griffith Park
- Manchester
- Sepulveda
- Slauson

Future Wellfield

- Extraction
- Injection

Flood Control Facilities Operated by LACPW

- Flood Control Channels
- West Coast Seawater Barrier Project
- Spreading Grounds

Sources:
LADWP, 2022; LA County, 2023
ESRI World Topo Map; ESRI World Street Map

0 1.5 3 6
Miles

1 inch = 4 miles

Figure 4-1

Potential Local Partners

Many cities and areas of special designation are within HWRP's sewershed and are contributing wastewater flows to HWRP. Further engagement with these entities would be beneficial to maximize the Program's benefits to local communities. These entities are either member agencies of Metropolitan or are represented by member agencies of Metropolitan.

4.2 Los Angeles Department of Water and Power Existing Customers

Existing LADWP customers could also serve as potential local partners under Pure Water Los Angeles. The MP identified several potential LADWP customers near the alignment alternatives and with the potential to use recycled water, based on a review of the *Recycled Water Master Plan* (LADWP 2012):

- Bel-Air Country Club: Mainly irrigation
- Los Angeles Country Club: Mainly irrigation
- Rancho Park: Mainly irrigation
- Westwood, University of California, Los Angeles campus: Irrigation and other non-potable reuse
- LADWP Power System: Green hydrogen generation

LADWP could engage these customers, as well as other customers near the selected Program alternative alignment to identify demand and evaluate the cost-effectiveness and potential benefits of these connections.

5 Conclusions

This TM presents three types of potential partnership opportunities that could be formed under Pure Water Los Angeles:

1. Source water
2. Regional partners
3. Local partners

Table 5-1 summarizes the potential opportunities and potential demands from regional and local partners.

Partnership opportunities could expand the beneficial uses of Pure Water Los Angeles beyond LADWP's service area. These potential expanded beneficial uses may include:

- Increasing replenishment of local water groundwater basins using a locally sourced sustainable supply
- Increasing regional recycled water use to further decrease the use of purchased imported water supply

Continued engagement with these partners to gauge interest and gain insight on their potential water demands under varying climate conditions will be critical for proper Program sizing and continued Program development.

Table 5-1. Potential Partnership Opportunities

Component[a]	Flow, cfs (MGD) Low	Flow, cfs (MGD) High
Source Water Partner		
LASAN and HWRP (MBR)[b]	-	Up to 421 (272)
Regional Partnership Opportunities		
West Basin[c]	31 (20)	62 (40)
WRD[d]	26 (17)	59 (39)
Metropolitan	48 (31) Jensen WTP	232 (150) PWSC
County Public Works [e]	0 (0)	130 (84)
Local Partnership Opportunities		
Refer to Attachment C for a full list of the agencies	TBD	TBD

[a] Pending confirmation through ONAT scenario planning.
[b] Based on LASAN 2023 and LADWP 2024. Only the high bookend flow is shown, as this is the basis for component sizing.
[c] Including approximately 8 cfs (5 MGD) of additional flow to WCB.
[d] Excluding approximately 8 cfs (5 MGD) of additional flow to WCB processed by West Basin.
[e] County Public Works offers infrastructure to convey Pure Water Los Angeles flows for recharge into groundwater basins.
ONAT = Operation NEXT[2] Assessment Tool

Table 5-2 summarizes the recommended next steps and additional analyses for each potential partnership outside of the MP.

[2] In August 2024, Operation NEXT was rebranded as Pure Water Los Angeles; however, due to legacy Program documentation, ONAT will retain its original name.

Table 5-2. Partnership Recommended Next Steps and Additional Analyses

Location	Recommended Next Steps and Additional Analyses
LASAN	▪ Continue collaborating to develop a synchronized schedule and approach for Program implementation.
West Basin	▪ If desired, continue engaging with West Basin to work out the technical details about options for modifying the ECLWRF and its recycled water distribution system to support near-term actions and the overall Program implementation. ▪ Evaluate use of West Basin's infrastructure to accelerate water delivery to CB. ▪ Determine the role and potential for West Basin to accelerate water delivery by Pure Water Los Angeles. ▪ Determine the potential institutional arrangement options with West Basin. ▪ Determine the capital improvement needs and the associated cost with West Basin to allow for comparison against other options. ▪ Determine the potential of phasing and implementation of HWRP and Pure Water Los Angeles as near-term actions using West Basin's infrastructure.
WRD	▪ If desired, continue engaging with WRD to develop the technical details to support further evaluation of the potential opportunities, and quantify the potential water that could be provided to WRD through Pure Water Los Angeles. ▪ Define the flow rates or demands and the potential variability for the use of Pure Water Los Angeles water for groundwater basin replenishment. ▪ Collaborate with WRD to further define the identified opportunities, such as recharge locations and methods. ▪ Evaluate the potential of mobilizing organic compounds from the soil matrix of the spreading grounds if Montebello Spreading Grounds are to be used. ▪ Evaluate how costs could be shared for replenishing CB using injection wells from Pure Water Los Angeles. ▪ Develop a joint strategy to maximize recharge during wet weather seasons.
Metropolitan	▪ If desired, continue engaging with Metropolitan to discuss technical details, requirements, or agreements needed for potential opportunities for Jensen WTP and PWSC. ▪ Conduct comprehensive investigations jointly with Metropolitan to evaluate the details of these integration options to develop plans for meeting regulatory requirements. ▪ Metropolitan has a policy of limiting its system to use no more than 50% of recycled water as a source; conduct additional discussions with Metropolitan to determine whether modification is possible to increase the flexibility to incorporate ATRW into the potable water system. ▪ Metropolitan to provide additional analysis to determine capacity at Metropolitan's Weymouth or Diemer WTPs, or both to receive Pure Water Los Angeles ATRW by lowering the nitrate concentration in Pure Water Los Angeles water to 2 mg/L as N for identified scenarios. ▪ Investigate water quality specifications required for interconnect between Jensen WTP and PWSC jointly with Metropolitan. ▪ Identify institutional arrangements necessary for these interconnections to be permitted under the DPR regulations.
County Public Works	▪ If desired, continue engaging with County Public Works to discuss technical details, requirements, or agreements needed for these potential opportunities. ▪ Quantify the potential capacities available at the identified recharge facilities. ▪ Determine whether operational optimization exists to increase the facilities' availability, and identify the pathway for optimization. ▪ Consider implementing policies that would increase the use of recycled water for groundwater replenishment in both wet and dry seasons. ▪ Evaluate water quality requirements and permitting implications.
Local Opportunities	▪ If desired, continue engaging potential local partners to explore opportunities for interconnection, and identify additional potential beneficial use of Pure Water Los Angeles water.

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Attachment A
Source Water Partner

Source Water Partner

Date:	June 4, 2024
Project Name:	Pure Water Los Angeles Master Plan
Project No.:	D3611501
Client:	Los Angeles Department of Water and Power (LADWP)
Revision No.:	003

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Introduction

A source water partner is a wastewater agency, in this case, Los Angeles Sanitation & Environment (LASAN), that can provide treated wastewater effluent to the Pure Water Los Angeles Program (Program) for further treatment and reuse. The technical details explaining how this partnership would work are currently being evaluated by LADWP's Hyperion Water Reclamation Plant (HWRP) Owner's Agent. The evaluation conducted for this technical memorandum (TM) relied on information presented in the TMs prepared by LADWP's HWRP Owner's Agent and LASAN's Consultant Team, as well as input from LADWP and LASAN's Early Wins Workshop Series. The TMs reviewed include:

- *Technical Memorandum 3 Treatment Alternatives Evaluation,* prepared for LADWP (Hazen 2024)
- *HWRP 100 Percent Water Reuse Spatial Feasibility Study Technical Memorandum*, prepared for LASAN (Carollo 2020)

The Early Wins Workshop Series is still ongoing; the 2023 meetings that Jacobs and Arcadis attended representing the Master Plan (MP) Team were on the following dates:

- January 27
- April 6
- April 27
- May 15
- June 8
- September 26

Organizational Overview

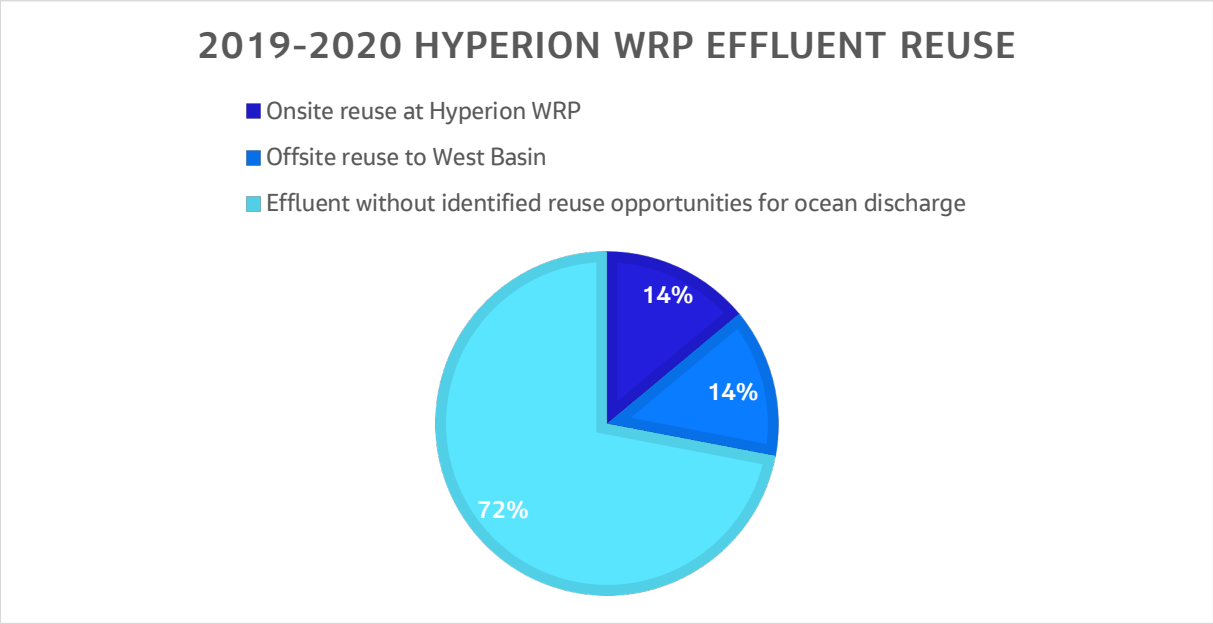
LASAN is one of the five bureaus under the Department of Public Works; and LASAN owns, operates, and maintains wastewater collection and treatment systems serving two service areas: the HWRP Service Area and the Terminal Island Service Area. The HWRP Service Area collects and treats flow mainly from the City of Los Angeles, as well as 20 contracting agencies (LADWP 2022).

The treatment services within the HWRP Service Area are provided by two upstream satellite plants, Donald C. Tillman and Los Angeles-Glendale Water Reclamation Plants (WRPs), and a main terminal plant, HWRP. The two satellite plants are located in the San Fernando Valley and produce recycled water for non-potable beneficial uses.

The HWRP treats most of the flows within the service area, including solids from the two satellite facilities, and the remainder of the sewage flow collected from the sewershed. Based on the latest flow projection

estimates, the inflow rates into HWRP are estimated to be between 252 million gallons per day (MGD) for a low-flow scenario and 302 MGD for a high-flow scenario by 2035 (LASAN 2023). A portion of the effluent (approximately 70 MGD or 28% of the total inflow) is reused, including flows sent offsite to West Basin Municipal Water District (West Basin) as well as non-potable uses within HWRP (LADWP 2022). The remainder of the effluent not sent to West Basin and the return flows from the in-plant reuse are co-mingled with reverse osmosis (RO) concentrate from West Basin and discharged into the Santa Monica Bay. Figure 2-1 shows the amount of HWRP effluent reuse in Fiscal Year 2019-2020.

Figure 2-1. Hyperion WRP Effluent Reuse Reported for Fiscal Year 2019-2020



Source: (LADWP 2022)

Existing Infrastructure Upgrade Options

HWRP will produce the source water for Pure Water Los Angeles. The facility was last upgraded in the 1990s to provide full secondary treatment using high-purity oxygen activated sludge as the main biological treatment approach to meet ocean discharge requirements. The biosolids in the activated sludge process are removed using secondary clarifiers before the treated effluent leaves the plant for either ocean discharge through a 5-mile-long outfall or for further treatment to meet reuse regulations by West Basin at their Edward C. Little Water Recycling Facility. The biosolids generated through the treatment processes are treated in the bio-energy facility to generate digester biogas for renewable energy generation (Carollo 2020).

LASAN is currently evaluating treatment options for upgrading HWRP to produce a new water supply suitable for reuse applications, including potable reuse. The biological treatment technologies contemplated jointly by LASAN and LADWP included a membrane bioreactor (MBR) for solids and liquid separation or a conventional activated sludge using a gravity clarifier for solids and liquid separation. MBR was selected as the preferred biological treatment technology for HWRP by LASAN and LADWP (Hazen 2024).

LADWP and LASAN are currently evaluating the Advanced Water Purification Facility (AWPF) location options. LASAN has led a detailed evaluation on co-locating an AWPF within HWRP's footprint (Carollo 2020). On a parallel track, LADWP has also engaged its HWRP Owner's Agent to evaluate offsite AWPF options to allow for comprehensive consideration and, ultimately, the selection of an AWPF location for Pure Water Los Angeles (Hazen 2024). For the purpose of the MP, it has been assumed that the AWPF will be at or in the vicinity of the HWRP.

HWRP construction phasing will have a significant impact on the Pure Water Los Angeles phasing and implementation strategy. Close coordination will take place to confirm the phasing and schedules for each activity align. Based on the schedule provided by the HWRP Owner's Agent (Hazen 2024; LADWP 2024), MBR effluent from HWRP is anticipated to be delivered over three phases (Table 3-1).

Table 3-1. Anticipated Pure Water Los Angeles Phasing

Treatment Step	Phase 1 cfs (MGD)	Phase 2 cfs (MGD)	Phase 3 cfs (MGD)	Total Capacity cfs (MGD)
MBR Effluent	93 (60)	93 (60)	235 (152)	421 (272)

Source: (Hazen 2024)

Notes:

The numbers presented here are based on assumptions for converting HWRP to MBR, and not on AWPF location; they may change for each potential alternative.

cfs = cubic foot (feet) per second

The first two phases provide a potential opportunity to leverage existing infrastructure because they align within the existing capacity of West Basin's secondary effluent pump station and force main capacity, based on operation at an increased in-pipe velocity of 8.3 feet per second (HDR 2022).

Opportunities and Findings

The collaboration between LADWP and LASAN to implement Pure Water Los Angeles provides multiple benefits, including:

- Reduces treated wastewater effluent discharge into Santa Monica Bay
- Provides a drought-resilient, alternate water supply to Los Angeles and the region
- Potential offset to purchased imported water supplies

LADWP has been actively engaging LASAN through an Early Win Workshop Series to develop strategies to help accelerate water delivery. The workshops have also allowed this partnership to make decisions together. The decisions made or being evaluated by this partnership include:

- Selecting the biological treatment technology, focusing on the consideration of MBR or conventional activated sludge; MBR has been selected
- Implementing an MBR pilot study at HWRP; this effort is currently underway
- Evaluating AWPF location options for selection of an ultimate location

Direct Potable Reuse Considerations

The current water reuse scope of Pure Water Los Angeles includes evaluation of both indirect potable reuse (IPR) and direct potable reuse (DPR) options. For DPR, LADWP would serve as the Direct Potable

Reuse Responsible Agency (DiPRRA) to lead Pure Water Los Angeles and obtain the necessary domestic water supply permit amendment under the current adopted DPR regulations.

As described in the adopted DPR regulations, as well as the *Potable Reuse Regulations Summary* (Jacobs and Arcadis 2024), LASAN will be the wastewater partner agency of the DiPRRA under Pure Water Los Angeles. LASAN will be responsible for leading the development and implementation of a wastewater source control program that will meet the DPR regulations (SWRCB 2023), including:

- Developing an early warning system; for example, tracking the results of local health departments' disease surveillance programs and using online monitoring for indicator compounds or surrogates for chemical compounds, which would provide early warning of a potential occurrence that could interfere with the operations of a treatment process or affect water quality
- Developing an appropriate strategy to optimize HWRP's operations, such as influent flow and load equalization, enhancements to primary treatment, and others

The technical details of this DPR partnership will continue to be developed by both agencies as the Program progresses beyond the planning horizon of this MP.

Other Near-Term Action Opportunities

There are some more near-term actions that could be explored and implemented by LADWP and LASAN jointly for the Program, including:

- Identifying and applying for a joint grant for the Program, such as grant funding opportunities provided by the U.S. Bureau of Reclamation
- Conducting a joint assessment or study to develop a new institutional framework under the DPR regulations
- Conducting a joint assessment or study to evaluate ocean discharge and potential treatment options, which could include early engagement with the Los Angeles Regional Water Quality Control Board regarding ocean discharge approaches to identify potential regulatory and legislative needs and roadblocks
- Developing a joint outreach and communication plan or program
- Developing a joint benefits assessment for the Program, which may include water quality improvement for ocean discharge

Other Considerations and Next Steps

Some technical gaps that were not addressed in the Concept Study (LADWP 2021) that are critical for the development of the MP include the following:

- The location of the AWPF
- The treatment processes within the AWPF for IPR or DPR, or both
- Expected water quality from the AWPF, such as:
  - Nitrogen levels
  - California Toxics Rule compliance approach (if required)
  - Log reduction value credits to be achieved
  - Treatment for chemical control for DPR, if used

- The phasing between HWRP conversion and the AWPF
- Concentrate management from the AWPF
- Capital and operations and maintenance (O&M) costs of HWRP conversion and operations associated with the Pure Water Los Angeles Program
- Capital costs and O&M costs of the AWPF
- Conveyance and pumping infrastructure for an offsite AWPF option, including conveyance pipelines and pumps for MBR filtrate from and for RO concentrate to HWRP
- The disinfectant to be used for maintaining disinfection residual in the conveyance pipelines and the concentrations to be maintained

Based on the scope specified by LADWP, the identified gaps will be addressed by LADWP, supported by its HWRP Owner's Agent, in collaboration with LASAN and its consulting team. The technical information and recommendations generated by the HWRP Owner's Agent will be incorporated into the MP analysis when available.

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Attachment B
Identification of Regional Partnership Opportunities

Identification of Regional Partnership Opportunities

Date: June 4, 2024
Project Name: Pure Water Los Angeles Master Plan
Project No.: D2611501
Client: Los Angeles Department of Water and Power (LAWDP)
Revision No.: 003

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1. Introduction

A regional partner, as defined in this technical memorandum (TM), is an entity that covers a large geographic region, encompassing cities and areas of special designation, and has the ability to process or use large volumes of water from the Pure Water Los Angeles Program (Program). Four regional partners were identified and evaluated:

1. West Basin Municipal Water District (West Basin)
2. Water Replenishment District of Southern California (WRD)
3. Los Angeles County Public Works (County Public Works)
4. Metropolitan Water District of Southern California (Metropolitan)

The team reviewed publicly available documents and conducted meeting discussions with these entities on potential collaboration opportunities. Table 1-1 lists the meetings that were held with potential partnership agencies, with the Master Plan (MP) Consultant Team participating or reviewing meeting minutes for the meetings to support the preparation of this attachment and associated TM.

Table 1-1. Meeting Engagements with Potential Regional Partners

Agency or Entity	Meeting Engagement
West Basin	▪ September 21, 2022 ▪ April 2024
WRD	▪ October 31, 2022 ▪ April 2024
Metropolitan	▪ October 20, 2022 ▪ March 16, 2023 ▪ April 24, 2023 ▪ May 24, 2023 ▪ April 2024
County Public Works	▪ January 5, 2023

While this attachment focuses on identifying opportunities to partner and leverage existing infrastructure owned by other agencies, leveraging another agency's infrastructure could introduce risk to the Asset Owner related to operations. Such risks would need to be mitigated, and the Asset Owners may request compensation related to continuing to meet their primary objective of reliably serving their customers.

This attachment identifies regional partnerships that are feasible from a technical perspective and that may be beneficial to explore further. It is recommended that LADWP continue engaging with these potential partners and further the discussions. The discussions that LADWP will convene with the potential regional partners will ultimately determine the costs, benefits, and risks of each opportunity. Final decisions should be made based on the additional outcomes from collaboration with the regional partners, allowing LADWP and the potential regional partners to reach an informed determination.

2. West Basin Municipal Water District

This section provides an overview of West Basin and identifies potential opportunities for partnership.

2.1 Organizational Overview

West Basin, a member agency of Metropolitan, is a potable water wholesaler for imported water purchased from Metropolitan. It serves 17 cities and unincorporated areas in Los Angeles County, with nearly 1 million residents (WBMWD 2023).

West Basin is also a recycled water producer and provider of five types of recycled water quality, including recycled water to the West Coast Basin Barrier Project (WCBBP). It also supplies potable water to the WCBBP and the Dominguez Gap Seawater Barrier Project (WBMWD 2023).

West Basin produced an average of 54 cubic feet per second (cfs) (35 million gallons per day [MGD]) of recycled water between 2014 and 2019 (HDR 2021). On average, the recycled water produced is used approximately as follows:

- 50% for industrial use
- 33% for WCBBP injection
- 17% for irrigation
- Less than 1% for mixed use

The overall secondary effluent demands at Edward C. Little Water Recycling Facility (ECLWRF) vary seasonally, with the peak around late summer to early fall and a dip around winter to early spring (HDR 2021). The peak secondary effluent demand at ECLWRF was reported at 66 cfs (43 MGD) in September of 2017, and the low secondary effluent demand was reported at 43 cfs (28 MGD) in March of 2018. This decrease indicates that the demand variability is due mainly to customers who increase water use during hotter periods, such as irrigation and cooling tower customers, but not by WCBBP injection or boiler feed demands.

West Basin has a long history of working with LADWP and Los Angeles Sanitation & Environment (LASAN). The three agencies have been in partnership recycling wastewater effluent from the Hyperion Water Reclamation Plant (HWRP) since the 1990s. The original agreement stated that West Basin would receive up to 79 cfs (51 MGD) of secondary effluent from HWRP, but the agreement was amended to increase the total allowable flow to 108 cfs (70 MGD) in 2011 (HDR 2021).

West Basin also serves the Playa Del Rey area within Los Angeles. In Fiscal Year 2020-2021, approximately 1.2 cfs (0.8 MGD) of the recycled water was supplied to the Westside System in Los Angeles for primarily non-potable reuse (HDR 2021).

West Basin worked with LADWP and LASAN on the initial planning of the HWRP membrane bioreactor (MBR) pilot study to gather field data to develop a design basis for conversion of HWRP's secondary treatment from high-purity oxygen-activated sludge to MBR. The conversion would significantly improve

the water quality and operability of downstream processes, thereby providing operations and maintenance (O&M) cost savings by possibly allowing West Basin to take treatment unit processes offline.

2.2 Existing Infrastructure

West Basin owns four treatment facilities (one main treatment plant and three satellite facilities) and an extensive recycled water distribution system with about 100 miles of pipelines (WBMWD 2023).

West Basin owns the following infrastructure that LADWP could potentially partner to use as part of Pure Water Los Angeles:

- HWRP Secondary Effluent Pump Station and force main
- ECLWRF
- ECLWRF Brine Line
- Seawater Barrier Pipeline
- Juanita Millender-McDonald Carson Regional Water Recycling Plant (Carson Facility)
- Carson Facility Brine Line
- Title 22 recycled water distribution system, including:
  - Conveyance to Inglewood Area through the Inglewood Lateral
  - Conveyance to the Carson Facility

The technical details presented in the remainder of this section concern this infrastructure owned by West Basin, as described in West Basin's *2021 Recycled Water Master Plan* (HDR 2021). The information serves as the basis to identify the advantages and limitations of using West Basin's infrastructure to support Pure Water Los Angeles.

2.2.1 HWRP Secondary Effluent Pump Station and Force Main

The HWRP Secondary Effluent Pump Station is located within the southwestern corner of HWRP. The pump station has a firm pumping capacity of 169 cfs (109 MGD), but is currently limited to 111 cfs (72 MGD) based on the available electrical transformer capacity, given that, contractually, only up to 108 cfs (70 MGD) of flow could be sent to West Basin (HDR 2021).

The secondary effluent force main is a 60-inch-diameter, polyvinyl chloride (PVC)-lined, reinforced-concrete pressure pipe that conveys secondary effluent from the HWRP pump station to the ECLWRF. For the force main to convey 169 cfs (109 MGD) of flow based on the pump station's firm capacity, an in-pipe velocity of 8.6 feet per second (fps) would need to be maintained (HDR 2021).

Hence, the maximum flow that could be conveyed from HWRP to ECLWRF is 169 cfs (109 MGD), with electrical upgrades, and without upsizing the pipeline and pumps. Upsizing the pipeline and pumps could be considered, depending on the cost-effectiveness.

LADWP is currently evaluating the potential for the partial and full use of the ECLWRF site to produce advanced treated recycled water (ATRW) under Pure Water Los Angeles. *Technical Memorandum 3 Treatment Alternatives Evaluation* (Hazen 2024) provides the technical details and the implications on how existing infrastructure might be used.

2.2.2 Edward C. Little Water Recycling Facility

ECLWRF is West Basin's main treatment plant that receives secondary effluent from HWRP. Table 2-1 shows the water quality produced, treatment train, and the respective design capacity at ECLWRF.

Table 2-1. Treatment Train Design Capacity at Edward C. Little Water Recycling Facility

Product Water Quality	Treatment Train	Design Capacity cfs (MGD)	Average Flow 2016-2019 cfs (MGD)
Title 22 Disinfected Tertiary	High-rate Clarifier, Dual Media Filters, Chlorination	62 (40)	28 (18)
Barrier (IPR Water for Injection)	Ozone, MF or UF, RO, UVAOP, Stabilization, Chlorination	27 (17.5)	19 (12)
Low-pressure Boiler Feed	Ozone, MF or UF, single-pass RO	3.4 (2.2)	2.6 (1.7)
High-pressure Boiler Feed	Ozone, MF or UF, 2-pass RO	4.0 (2.6)	3.5 (2.3)
Total		96.4 (62.3)	53 (34)

Source: HDR 2021

IPR = indirect potable use

MF = microfiltration

RO = reverse osmosis

UF = ultrafiltration

UVAOP = ultraviolet advanced oxidation process

Based on our evaluation with the anticipated conversion of the HWRP to MBR, the following treatment unit processes could potentially go offline permanently at the ECLWRF:

- High-rate clarifier
- Dual media filters
- Ozone
- MF and UF
- Solids handling facilities

Removal of these treatment processes would provide space for expansion of RO and UVAOP to produce IPR water. Ozone is also used at ECLWRF.

The typical operational range for the Barrier train that provides injection water to WCBBP ranges from 15 to 22 cfs (10 to 14 MGD), which is less than its design capacity of 27 cfs (17.5 MGD).

2.2.3 Edward C. Little Water Recycling Facility Brine Line

ECLWRF has a dedicated brine line that conveys RO concentrate to the HWRP outfall for disposal. The brine line is a 2.9-mile-long, 18-inch-diameter pipeline that discharges into a manifold located above the outfall at the HWRP. The pipeline consists of multiple segments using standard dimension ratios (SDRs) of 17, 15.5, and 13.5 high-density polyethylene (HDPE) pipeline, with a design maximum pipeline velocity of 10 fps (HDR 2021).

Based on a 10 fps limit and the smallest inner diameter of the SDR 13.5 HDPE pipe segment (diameter of 15.33 inches), the pipeline has a maximum carrying capacity of 12.8 cfs (8.3 MGD) if it is operated under pressurized conditions. Based on the historical weekly average discharge data, the brine line currently has an available unused carrying capacity of 8.3 cfs (5.5 MGD) (HDR 2021).

2.2.4 West Coast Basin Barrier Project

The WCBBP consists of a 30-inch-diameter, cement-mortar-lined and -coated transmission main and a pump station with a firm pumping capacity of 31.3 cfs (20.2 MGD). This is 7.3 cfs (4.7 MGD) greater than the design capacity of the Barrier train at the ECLWRF of 27.1 cfs (17.5 MGD) (HDR 2021).

2.2.5 Juanita Millender-McDonald Carson Regional Water Recycling Facility

The Carson Facility is West Basin's largest satellite facility and is located in Carson near the Harbor area. This facility receives Title 22 disinfected tertiary recycled water produced at the ECLWRF and then provides further treatment (HDR 2021):

- Tertiary disinfected recycled water to MF and an RO train to produce boiler feed water
- Tertiary disinfected recycled water to Biofor (by Suez) nitrified recycled water for cooling towers

LADWP and West Basin worked together in the past to evaluate the feasibility of extending West Basin's recycled water distribution system to LADWP's Harbor Recycled Water System to produce RO-quality water for LADWP's industrial customers using the Carson Facility. However, based on the feedback from LADWP's industrial customers in the Harbor area, the retrofit to use ATRW would be very costly. Based on that feedback, LADWP would continue to use potable water supply for these customers by increasing groundwater production in Central Basin (CB), which would be replenished using ATRW from Pure Water Los Angeles to meet the demand (LADWP 2024a).

2.2.6 Carson Facility Brine Line

The Carson Facility also has a dedicated brine line that conveys RO concentrate to and discharges it at the A.K. Warren Water Resource Facility (Warren Facility, formerly known as the Joint Water Pollution Control Plant), with the brine line discharging to the plant's outfall surge tower through a standpipe for backflow prevention (HDR 2021).

The brine line is a 5.4-mile-long, 14-inch-diameter pipeline made with SDR 11 HDPE (216 lineal feet) and PVC C905 (28,190 lineal feet) pipe. The flow is pressurized using the discharge pressure applied at the RO trains. An emergency bypass diversion is installed midway along the brine line to allow brine to be discharged into the Dominguez Channel in case of emergency (HDR 2021).

Due to the pressure limit of 8 pounds per square inch (psi) at the Warren Facility outfall surge tower, the maximum carrying capacity of the brine flow is limited to approximately 1.7 cfs (1.1 MGD). Based on the 2019 average RO concentrate flow, the brine line had an annual average available capacity of approximately 0.6 cfs (0.4 MGD) remaining (HDR 2021). If the Carson Facility were to be considered for providing treatment to produce backup recycled water for industrial use in the Harbor area, the brine line constraints identified would need to be carefully evaluated and addressed.

2.2.7 Title 22 Recycled Water Distribution System

West Basin owns and operates an extensive Title 22 recycled water distribution system that carries Title 22 disinfected tertiary recycled water. As shown on Figure 2-1, the system is currently largely underused.

Inglewood Lateral

Hyperion Secondary Effluent Pump Station

Edward C. Little WRF (West Basin)

Carson Facility (West Basin)

Pacific Ocean

Legend

Annual Average Unused Capacity in Primary Transmission Mains (MGD)

- >50
- 40-50
- 30-40
- 20-30
- 10-20
- 5-10
- 1-5
- 0-1

- Existing Advanced Water Purification Facility
- West Basin Recycled Water Distribution System
- West Basin Service Area
- City Boundary
- County Boundary

Sources:
LADWP, 2022; LA County, 2023
ESRI World Topo Map; ESRI World Street Map

0 0.5 1 2
Miles

1 inch = 1 miles

Figure 2-1

Annual Average Unused Capacity in Primary Transmission Mains in West Basin's Recycled Water Distribution System

Pure Water Los Angeles Master Plan

Jacobs

\\dc1vs01\GISProj\L\LADWP\Operation_NEXT\MapFiles\Fig2-1_OperationNEXT_WestBasin_Distribution_20240522.mxd

The 36-inch-diameter Inglewood Lateral that terminates in Inglewood is in proximity to the proposed new injection wellfields being contemplated under Pure Water Los Angeles in CB. The pipeline consists of short segments of 48-inch- and 42-inch-diameter pipeline near the ECLWRF. The remainder of the pipeline to Inglewood is 36 inches in diameter, including the Inglewood Lateral. It has been estimated that the available unused capacity based on the existing average annual demand is greater than 77 cfs (50 MGD) for the 48-inch- and 42-inch-diameter pipe segments and approximately 46 to 62 cfs (30 to 40 MGD) for the 36-inch-diameter pipe segments (HDR 2021).

The conveyance pipeline that connects the ECLWRF and the Carson Facility consists of mostly 42-inch-diameter pipe from ECLWRF, with a shorter segment of 30-inch-diameter pipe connected to the Carson Facility. It has been estimated to have approximately 46 to 62 cfs (30 to 40 MGD) of unused capacity available based on the existing average annual demand (HDR 2021).

2.3 Opportunities and Findings

There are several opportunities for a potential LADWP and West Basin partnership that could help accelerate water delivery by Pure Water Los Angeles. This section summarizes the opportunities identified jointly by LADWP and West Basin in a September 2022 meeting, as well as other opportunities identified based on the team's evaluation.

2.3.1 Opportunities Identified during September 2022 Meeting

LADWP has been actively engaging with West Basin throughout the MP's development. Potential collaboration areas were discussed in a meeting between the two agencies in September 2022, as follows:

- Use the HWRP secondary effluent pump station and force main to convey additional flows to the ECLWRF for treatment or distribution for LADWP.
- Use the ECLWRF to produce ATRW to meet identified demands. West Basin would also need to isolate the northern part of its distribution system to only convey ATRW. The southern part of their system would remain as is, conveying tertiary treated Title 22 water.
- Use the available unused capacity in the Inglewood Lateral to deliver IPR flows to CB's new injection wells for groundwater augmentation. An extension of Inglewood Lateral would be necessary.
- Convey additional recycled water to the Westside System, if there is a demand.
- Convey additional ATRW to WCBBP; volume to be determined by WRD and County Public Works.

West Basin expressed interest in participating in research opportunities and strategy discussions related to post-RO direct potable reuse (DPR) treatment, collaborating with LADWP to support the implementation of Pure Water Los Angeles, and investing in their own infrastructure to achieve greater benefits. LADWP and West Basin acknowledged at the meeting that interconnectivity could have significant operational challenges and would require additional evaluation jointly as the concepts further develop.

2.3.2 Other Opportunities and Considerations

In addition to the identified areas, there are also some other unique opportunities that could be further explored jointly by West Basin and LADWP.

2.3.2.1 Tertiary Membrane Bioreactor at Edward C. Little Water Recycling Facility

West Basin indicated in their *Recycled Water Master Plan* (HDR 2021) that it has considered investing in a tertiary MBR at the ECLWRF to address the water quality and treatability challenges associated with receiving high-purity oxygen-activated sludge secondary effluent from HWRP. Implementation of such an option would be made possible in terms of economics by taking several treatment units offline. This strategy could provide a very different outlook about the infrastructure requirements at the ECLWRF, as well as their satellite facilities.

The ongoing collaboration and potential implementation of this project could potentially accelerate water delivery by Pure Water Los Angeles by decoupling the MBR conversion at HWRP. This option would require significant institutional collaboration, but it could be a significant schedule accelerator for Pure Water Los Angeles.

2.3.2.2 Near-term Delivery of Direct Potable Reuse Water

West Basin's recycled water system is unique in that it uses ozone as pretreatment for the MF and UF units to break down large, organic foulant compounds. After implementation of an MBR option, the ozone system would no longer be needed for IPR treatment. The ozone system is currently sized for a capacity of 45 MGD (70 cfs), with a maximum applied ozone dose of 12 milligrams per liter (mg/L) (HDR 2021). This offers an opportunity to potentially use the existing ozone system as part of the treatment steps to deliver DPR-quality water using the prescribed treatment train.

2.3.2.3 Increase Water Delivery to the West Coast Basin Barrier Project

West Basin typically produces between 15 and 22 cfs (10 and 14 MGD), with an average of 19 cfs (12 MGD) of IPR water from the Barrier train. There could be potential for producing additional IPR flows, approximately 8 cfs (5 MGD), up to the design capacity of 27 cfs (17.5 MGD) without modification to the existing Barrier train and the supporting infrastructure. This could provide a potential opportunity that could be implemented as part of the near-term actions for water delivery, provided there is a demand and operational capacity in the WCBBP. The feasibility would need to be further evaluated jointly between the following entities:

- West Basin
- WRD
- County Public Works
- LADWP

2.3.2.4 Infrastructure Limitations for Edward C. Little Water Recycling Facility

Treatment at ECLWRF would require significant modifications to provide the additional treatment capacity for production of IPR- or DPR-quality water.

There is a capacity limitation for both the secondary pump station and the force main, as well as the brine line. West Basin estimated that the conveyance system between HWRP and ECLWRF is about 169 cfs (109 MGD), assuming the completion of electrical upgrades at the secondary pump station and the in-pipe velocity operated at 8.3 fps. Based on the historical average flow of approximately 54 cfs (35 MGD) (HDR 2021), the estimated unused carrying capacity could be up to 114 cfs (74 MGD).

The other limitation identified is the brine line capacity. Assuming an RO recovery of 85% and the reported total carrying capacity of the brine line of 12.8 cfs (8.3 MGD) (HDR 2021), the total allowable RO

feed would be limited to about 85 cfs (55 MGD). Based on historical brine discharge flow and the reported unused capacity of 8.5 cfs (5.5 MGD) available (HDR 2021), additional RO feed flow would be limited to 57 cfs (37 MGD), producing approximately 48 cfs (31 MGD) of RO permeate without the need to upgrade the brine line. This capacity, coupled with the unused capacity in the distribution system identified in Section 2.2.7, would be sufficient to meet the current projected demand for a potential groundwater augmentation project in CB.

2.3.2.5 Additional Flows for West Basin's Recycled Water Service

West Basin has identified significant additional recycled water demand within their service area. If any available water from Pure Water Los Angeles was identified, additional water could potentially be made available to West Basin to support their expansion, considering the seasonal variability in its recycled water demands.

2.4 Other Considerations and Next Steps

An interconnection between Pure Water Los Angeles and West Basin was not included as an opportunity in the Concept Study (LADWP 2021). To further evaluate this opportunity, the following aspects will need to be addressed:

- The volumes to be provided to West Basin under Pure Water Los Angeles
- The use of West Basin's infrastructure to deliver water to CB for injection to support increased groundwater production in the CB area, and the potential flow volumes and timing
- The role and potential for using West Basin to accelerate water delivery by Pure Water Los Angeles
- The potential institutional arrangement options for expanded use of West Basin's infrastructure would need to be discussed and negotiated
- The capital improvement needs and the associated cost for this interconnect option would need to be further negotiated and refined to allow for a comparison against other options
- The potential of phasing and implementation of HWRP and Pure Water Los Angeles as near-term actions using West Basin's infrastructure

If LADWP elects to move forward, continued engagement with West Basin would be required to finalize the technical details about options for modifying ECLWRF and its recycled water distribution system to support near-term actions and the overall Program implementation.

3. Water Replenishment District of Southern California

This section provides an overview of WRD and identifies potential opportunities for partnership.

3.1 Organizational Overview

WRD was formed in 1959. WRD is the Basin Manager and Watermaster for CB and West Coast Basin (WCB), serving a population of 4 million residents, with a service area of 420 square miles, including a portion of Los Angeles (Figure 3-2 in the main TM). WRD determines water replenishment requirements to sustain safe yield of the basins and monitors and protects the water quality of the basins. The two basins provide about 220,000 acre-feet per year (AFY) (or approximately 303 cfs [196 MGD]) of groundwater, nearly half of its service area's supply needs (WRD 2023).

WRD is also responsible for assessing the replenishment water needs each year for the groundwater basins based on the expected pumping by right holders. WRD provides supplemental replenishment water and recharge through two County Public Works infrastructure systems (WRD 2023):

1. The Montebello Forebay Spreading Grounds for CB
2. The seawater barrier injection wells located along the coast of WCB

The sources of water currently being used for replenishment include stormwater, recycled water, and potable water. WRD operates two advanced water purification facilities that produce some of the recycled water used for replenishment, with the remainder of the recycled water flows being supplied by West Basin and LADWP (WRD 2023).

In 2013 and 2014, the Superior Court of California (SCC) issued two Judgment Amendments (SCC 2013, 2014) that allowed implementation of groundwater augmentation projects by rights holders, including the City of Los Angeles (City), as long as they do not pose "material physical harm" to the basin. WRD interpreted at the time that augmented water must be extracted out within 12 months after injection, but this requirement may be relaxed (LADWP Request for Information [RFI] 27).

Subsequently, in 2022, LADWP and WRD conducted a *Joint Los Angeles Basin Replenishment and Extraction Master Plan* (Joint Master Plan) to develop a planning concept for a potential groundwater augmentation project using ATRW produced through Pure Water Los Angeles based on the initial interpretation (Jacobs 2022). A potential groundwater augmentation project in CB was assumed based on the full use of LADWP's existing rights:

- Transfer of WCB's pumping rights of 1,503 AFY (2 cfs [1.3 MGD]) to CB
- Use CB's pumping rights of 17,236 AFY (24 cfs [16 MGD])

3.2 Existing Infrastructure

An important asset that could be used by Pure Water Los Angeles under this partnership is the groundwater basins. These basins not only provide storage for WRD and LADWP, but also provide a way for rights holders in the region to access water provided by Pure Water Los Angeles without the need to construct extensive distribution and conveyance systems to deliver the water once the recharge infrastructure is in place.

WRD owns three water treatment facilities: two advanced water treatment facilities and a groundwater desalter (WRD 2023). Table 3-1 summarizes the current capacities of these facilities. The opportunities to interconnect directly with these facilities have not been identified. However, Pure Water Los Angeles could be invaluable in providing WRD additional recycled water for replenishment of the groundwater basins.

Table 3-1. Water Replenishment Water District of Southern California Treatment Facilities

Facility	Existing Capacity, cfs (MGD)	End Use	Planned Expansion
ARC Facility	23 (14.8)	Provide replenishment water to CB in the Montebello Forebay area by spreading	No
Leo J. Vander Lans Advanced Water Treatment Facility	12 (8)	Provide replenishment water to Alamitos Seawater Barrier for CB and WCB by injection to prevent seawater intrusion	No
Robert W. Goldsworthy Desalter	8 (5)	Produce drinking water by remediating trapped seawater in WCB	Yes

Source: (WRD 2023)

ARC Facility = Albert Robles Center for Water Recycling & Environmental Learning

3.3 Opportunities and Findings

Through LADWP's engagement with WRD in October 2022, WRD provided the updates summarized in this section that superseded the assumptions used in the Concept Study (LADWP 2021), as well as those elements that were not considered.

3.3.1 Brackish Groundwater Reclamation Program

According to WRD, they have made significant changes to the concepts documented in the Regional Brackish Water Reclamation Program, currently known as Brackish Groundwater Reclamation Program, after completion of the Feasibility Study (Jacobs 2021). These changes were communicated to LADWP in the October 31, 2022, meeting with WRD. The discussion herein is based on information presented during that meeting.

According to WRD, they are currently focusing on a hot spot remedy to target treatment of the high saline plume in the WCB Silverado Aquifer. WRD would likely install new wells for the saline water extraction, as well as use existing wells at the City Yard, Brewer, and Delthorne Park near the Goldsworthy Desalter in Torrance, California. WRD has evaluated the use of typical production wells and remediation wells. The Division of Drinking Water (DDW) approved the use of remediation wells at a 2,000- to 3,000-gallon-per-minute (gpm) capacity to be installed in vaults in the street.

WRD would likely add two new extraction wells near the high total dissolved solids concentration area in the Torrance area. The extracted water would be pumped to the Goldsworthy Desalter for treatment. The total future program size, including the use of existing wells, is estimated up to 15 cfs (10 MGD). Hence, a new regional desalter would not be constructed, and the program size would be smaller than the capacity presented in the Feasibility Study (Jacobs 2021).

The program would consist of additional expansion of the Goldsworthy Desalter and, potentially, a new desalter in Manhattan Beach to treat an isolated northern brackish plume. Modeling of the proposed extraction and injection wells will be conducted to determine plume movement. This work was noted as scheduled to be completed by WRD around November 2023. It is expected that LADWP will follow up with WRD to obtain updated information.

Injection would likely be a combination of existing WCBBP wells and new inland injection wells in WCB. The contribution from the seawater barriers would be limited based on the recent modeling findings from Dominguez Gap in WCB, as indicated during the meeting. If West Basin changes its water quality to IPR in their system, the injection would likely be moved up north, closer to HWRP.

WRD estimated in the October 2022 meeting (LADWP 2022b) that injection requirements could be as high as 13,000 AFY of water to replenish the water being removed, but the volume would also be dependent on how much water the rights holders pump out. Inglewood, Golden State Water Company, and California Water Service (Cal Water) have significant water rights but have not been using them. The Cities of Torrance and Manhattan Beach also have water rights that are not used, but to a lesser extent. Thus, if the pumping needs increase, this would impact injection requirements.

WRD's modeling would clarify the injection volumes needed. The injection would most likely be shifted up to the northern portion of the basin, away from the Inglewood Fault. The exact location is being evaluated by WRD.

With the change in the direction of the Brackish Groundwater Reclamation Program, receiving potable water produced through desalting is no longer viable. The conveyance and other supporting infrastructure

used to convey desalted brackish groundwater to tie into the drinking water storage tank in the Harbor area would not be needed. Given WRD's desire to continue their remediation effort, opportunities to provide replenishment water to the brackish desalting effort led by WRD exist, as indicated by WRD. If the replenishment locations are in WCB's northern area, it would be logistically favorable and cost-effective for Pure Water Los Angeles to provide the replenishment water.

For this planning effort, it is assumed that an additional demand of up to 13,000 AFY (or approximately 19 cfs [12 MGD]) for WCB could potentially be provided by Pure Water Los Angeles through a water purchase agreement between WRD and LADWP. LADWP does not currently have any extraction plans in WCB; hence, no replenishment related to extraction in WCB by LADWP is expected (LADWP RFI 45).

3.3.2 Potential Groundwater Augmentation Projects

The groundwater augmentation rules described by WRD in the October 2022 meeting (LADWP 2022b) differ from the assumptions used in the Joint Master Plan (Jacobs 2022), as described in this section.

3.3.2.1 Judgment Interpretation

WRD shared with LADWP at the October 2022 meeting (LADWP 2022b) that they broadened their interpretation of the injection and extraction time limits because the judgment does not specify any time limits for these projects. Specifically, WRD indicated that the 12-month time requirement for extracting water that has been put into a groundwater basin would likely not apply. The intent is to not allow project owners to store water in the groundwater basin indefinitely, especially if there are other needs from other rights holders to store their water. However, if the demand for the storage space does not exceed the allocated amount, water can be stored in the basin as long as needed (LADWP RFI 27).

WRD will plan to conduct periodic check-ins with the project owners and rights holders participating in an augmentation project every 3 to 5 years or on a longer time limit when water will be removed. The check-in period will be established in an agreement between the parties; the 3-year and 5-year periods for check-ins mentioned are not firm requirements but would be negotiated case by case.

3.3.2.2 Water Augmentation Project Requirements

WRD shared with LADWP at the October 2022 meeting (LADWP 2022b) that as part of the requirements, existing rights holders must be offered an opportunity to participate in groundwater augmentation projects. The financial percentage they contribute to a project directly correlates to the percentage of added flow they can increase their pumping by.

WRD does not anticipate many rights holders will participate because demands are down based on trends in 2022, but they will identify an estimated number of parties that would be interested in participating in the augmentation project. The frequency of the offering, such as at the beginning of the project or yearly or other time limits, would need to be determined by the Storage Panel for CB and WCB.

WRD also confirmed in the October 2022 meeting that the locations for an augmentation project and the extraction wells do not need to be hydrogeologically connected or directly adjacent to each other.

3.3.2.3 Recharge Option Considerations

This section describes recharge option considerations, including spreading at Montebello Forebay and injection, based on input provided by WRD during the October 2022 meeting (LADWP 2022b).

Spreading at Montebello Forebay

The use of the Montebello or Los Angeles Forebay to recharge Pure Water Los Angeles water was discussed in the October 2022 meeting. WRD has never allowed other entities or rights holders to spread water at the Los Angeles Forebay, but WRD communicated that it does not anticipate other rights holders would object to allowing Pure Water Los Angeles to spread water there.

The possibility of recharging the Montebello Forebay at the southern end was discussed, as well as the possibility of operating the recharge basins on a more continuous basis to allow for more recharge. WRD noted that interconnecting piping between the Rio Hondo and San Gabriel Coastal Spreading Grounds exists to facilitate movement of water from these two spreading grounds. Operational constraints of the Montebello Forebay need to be reviewed with County Public Works.

WRD mentioned a possible water quality concern regarding the release of organics adsorbed to the soil when transitioning replenishment water from tertiary quality to advanced treated IPR water from Pure Water Los Angeles (or Pure Water Southern California Program [PWSC]). WRD mentioned at the meeting that Colorado State University studied the leaching of adsorbed organics from soil resulting from the use for ATRW for WRD, and there seems to be a concern about the potential for releasing adsorbed organics from spreading ground soil when switching from tertiary disinfected to ATRW (LADWP 2022a). Los Angeles County Sanitation District's (LACSD's) tertiary effluent contains per- and polyfluoroalkyl substances (PFAS), as expected in tertiary effluent; blending of IPR water, such as water from Pure Water Los Angeles, could help reduce the concentration and meet permit requirements.

WRD indicated in the October 2022 meeting that they currently prioritize replenishment of CB at Montebello Forebay using stormwater through the Rio Hondo and San Gabriel Coastal Spreading Grounds because stormwater is available at no cost to WRD. A significant increase in a steady supply of recharge water going into these spreading grounds would also need to be carefully evaluated due to the mounding of groundwater observed in the area related to the spreading activities. When mounding occurs, the distance between the bottom of the spreading grounds and the groundwater table or hydraulic grade line is reduced. This phenomenon could reduce the recharge capacity of these spreading grounds.

Injection

Injection projects need to be mindful of mobilizing existing contaminants in the basin to another (deeper) level of the basin. There is a benefit to injecting water at a deeper level of the aquifer, as it helps pressurize the lower areas to prevent the contaminants from migrating downward.

3.3.2.4 Opportunities for Pure Water Los Angeles

As communicated in the October 2022 meeting with LADWP (LADWP 2022b), WRD's current interpretation of the judgment will have significant positive implications to how LADWP could use CB, given that storage within the basin for longer than 12 months is expected to be allowed (LADWP RFI 27). Water delivery to the potential groundwater augmentation project could potentially be accelerated if West Basin and LADWP elect to move forward and reach an agreement on the interconnect opportunity under Pure Water Los Angeles after further investigations and evaluations of potential benefits and liabilities.

Additionally, offering rights holders the ability to participate in the potential groundwater augmentation project would also help provide access to Pure Water Los Angeles water to the region and help other entities in the region to increase climate resiliency.

Based on the conversation with WRD, underused pumping rights are often associated with the presence of contaminants in the wells, which require treatment. There might be opportunities for WRD to support these rights holders by providing financial assistance to address the situation and increase use.

The greatest uncertainty about this specific opportunity is that there is no clear guidance or precedent on how such arrangements might work. WRD has indicated that such details would only be considered case by case by the Storage Panel once LADWP submits a project application. The uncertainty limits LADWP's ability to weigh and consider such an option objectively against other options. For example, it is unclear whether there would be a cap on the maximum percentage of water that must be offered by Pure Water Los Angeles if the responses to the offering for participation were overwhelming.

3.3.3 Potential Replenishment Water Demand

This section describes the potential replenishment water demand for CB and WCB.

WRD expressed during the October 2022 meeting (LADWP 2022b) that CB would experience a shortfall of about 11,000 AFY (approximately 15 cfs [10 MGD]) in groundwater replenishment if the use of imported water (21,000 AFY [29 cfs {19 MGD}]) for replenishment purposes was eliminated based on existing pumping. This amount was estimated after factoring in the recycled water contribution from the ARC Facility of 10,000 AFY (14 cfs [9 MGD]). Hence, WRD is interested in purchasing on a long-term basis approximately 11,000 AFY (approximately 15 cfs [10 MGD]) of recycled water for replenishment to achieve this goal.

WRD also indicated in the October 2022 meeting that they are interested in purchasing water from PWSC but have not determined the demand and timing. They are interested in getting water from PWSC if the project can deliver water in Rio Hondo. During the meeting, WRD indicated that if that happens, it would be a 30-year purchase agreement.

In 2024, WRD wrote to LADWP that WRD is responsible for ensuring LADWP's adjudicated water rights are available. Given the potential extraction locations, WRD has requested that LADWP plan on providing replenishment water to WRD that is proportional to LADWP's adjudicated rights in CB, plus water rights that are leased from other entities or transferred from WCB. Additional details are expected to be further discussed and evaluated in the future. Based on LADWP's CB TM (LADWP 2024c) and WRD's email communication (WRD 2024), 18,739 AFY (26 cfs [17 MGD]) of replenishment water will be required to support LADWP to extract its full entitlements in CB and the entitlements transferred from WCB.

Table 3-2 summarizes the potential future replenishment water demand in the two basins based on the input from WRD. The ultimate replenishment water needs by WRD could change depending on additional pumping activities within these basins. Table 3-2 does not include the potential demand from other rights holders through participation of a potential groundwater augmentation project operated under Pure Water Los Angeles, given that information would not become available until LADWP submits an application to the Storage Panel.

Table 3-2. Potential Future Replenishment Water Demand in West Coast and Central Basins

Basin	Potential Future Replenishment Water Demand			
	Description	AFY	cfs[a]	MGD[a]
WCB	Additional replenishment due to remediation of the brackish plume	13,000	18	12
WCB[b]	Additional replenishment through WCBBP	5,600	8	5
CB	Replenishment water to replace imported supply	11,000	15	10
CB	Replenishment water up to LADWP's entitlements in CB and WCB	18,739	26	17
Total[b]		42,739	59	39

[a] Values represent a 12-month annual operating period. Numbers have been rounded.

[b] WCBBP demand is represented in the West Basin demands; therefore, it is not represented in the WRD total.

3.4 Other Considerations and Next Steps

The current data gaps identified for this interconnect opportunity with WRD include:

- The WCB replenishment location for WRD's desalting effort has not been identified, so the feasibility for Pure Water Los Angeles to provide water is uncertain.
- Guidelines for implementing groundwater augmentation projects in CB are unavailable, and the process cannot be defined unless LADWP moves forward with an application and submits it to the Storage Panel for consideration. For example, the amount of water that needs to be offered to other rights holders and the frequency of the offering could have significant implications to the economic viability of a potential groundwater augmentation option for CB.
- The technical details on how to replenish CB to support LADWP's plan to extract its entitlements (including those transferred from WCB using injection wells, such as the locations and the potential flow variability resulting from how the injection wells would be operated) need to be determined.
- Interest from rights holders to participate in a potential groundwater augmentation project in CB is unknown.

Additional analyses could be conducted jointly to further define the potential partnership opportunities between these two agencies, as follows:

- Define the flow rates or demands and the potential variability for the use of Pure Water Los Angeles water for groundwater basin replenishment.
- Collaborate with WRD to further define the identified opportunities, such as recharge locations and methods.
- Evaluate the potential of mobilizing organic compounds from the soil matrix of the spreading grounds if Montebello Spreading Grounds are to be used.
- Evaluate how costs could be shared for replenishing CB using injection wells from Pure Water Los Angeles.
- Develop a joint strategy to maximize recharge during wet weather seasons.

To move forward with this potential partnership, if desired, LADWP would need to continue its active engagement with WRD to develop the details to address the items described in this section to support further evaluation of the potential opportunities and quantify the potential water that could be provided to WRD through Pure Water Los Angeles.

4. Metropolitan Water District of Southern California

This section provides an overview of Metropolitan and identifies potential opportunities for partnership.

4.1 Organizational Overview

Metropolitan is a public water wholesaler that imports water to Southern California through the Colorado River Aqueduct (CRA) and State Water Project (SWP). Metropolitan has 26 member agencies within a service area of about 19 million people living in the following counties (Metropolitan 2023a):

- Los Angeles
- Orange
- Riverside
- San Bernardino
- San Diego
- Ventura

As the availability and reliability of imported water supplies become less certain, Metropolitan is in partnership with LACSD to implement a regional recycled water program, PWSC, to recycle wastewater effluent from the Warren Facility through IPR and DPR. The planned program capacity of PWSC is up to 232 cfs (150 MGD) (Metropolitan 2023a).

4.2 Existing and Planned Infrastructure

This section provides details about existing and planned infrastructure for Pure Water Los Angeles. Figure 3-3 in the main TM shows the Metropolitan potable water connections and potential interconnectable infrastructure.

4.2.1 Drinking Water System

Metropolitan owns extensive drinking water infrastructure for their conveyance and distribution system, reservoir storage, and treatment of surface water in Southern California, as well as service connections for deliveries into local member agency distribution systems.

Metropolitan owns five drinking water treatment plants (WTPs), with treatment capacities ranging between 340 to 1,160 cfs (220 to 750 MGD). Three of these WTPs have been identified as relevant to the Pure Water Los Angeles Program (Table 4-1).

Table 4-1. Metropolitan's Regional Water Treatment Plants

Existing Treatment Plant (Location)	Process and Water Type	Rated Capacity cfs (MGD)	Identified Potential DPR Opportunity
Joseph Jensen WTP (Granada Hills)	Conventional treatment with ozone; SWP supplies	1,160 (750)	Interconnect with Pure Water Los Angeles through VNC
F. E. Weymouth WTP (La Verne)	Conventional treatment with ozone; blend of SWP and CRA water	805 (520)	Interconnect with PWSC
Robert B. Diemer WTP (Yorba Linda)	Conventional treatment with ozone; blend of SWP and CRA water	805 (520)	Interconnect with PWSC

Source: (Metropolitan 2021)

VNC = Van Norman Complex

Metropolitan's Jensen WTP is adjacent to the VNC, with existing connections to allow treated and untreated imported water to flow from the Jensen WTP site to VNC (LADWP 2022a), including:

- LA-35 Van Norman Raw Water Connection
- LA-25 Jensen WTP Treated Water Connection

Additionally, LADWP's potable water system interconnects with Metropolitan's system throughout to provide regular, emergency, and backup supplies. Currently, Metropolitan regularly delivers untreated water to LADWP through LA-35 for treatment at the Los Angeles Aqueduct Filtration Plant. It also regularly delivers treated water supply to LADWP in the Eagle Rock and Harbor areas. LADWP expects that LA-17 at Eagle Rock would continue to receive flows from Metropolitan regularly, due to the existing hydraulic conditions within LADWP's system. The Harbor area, historically fed by LA-16 and others, will receive groundwater produced in CB once capital improvements to the potable water system in the Harbor area have been completed.

4.2.2 Pure Water Southern California

PWSC is a regional recycled water program under development by Metropolitan in partnership with LACSD. It involves the production of up to 232 cfs (150 MGD) of ATRW for IPR and DPR purposes. The PWSC Backbone would carry flows from the Advanced Water Purification Facility (AWPF) at the Warren Facility to recharge WCB, CB, and Main San Gabriel Basin, as well as deliver IPR water to the Weymouth WTP for further treatment for DPR at a blending ratio less than 10% for Phase 1. In Phase 2, DPR reuse through raw water augmentation would be expanded to up to 93 cfs (60 MGD) (Metropolitan 2023). The exact treatment approach to meet the DPR regulation and the facility location is yet to be determined.

Additionally, Metropolitan is planning to send part of the flow in the PWSC Backbone for raw water augmentation DPR purposes and might provide DPR treatment either upstream of or at Weymouth Filtration Plant. The conveyance would interconnect at the Weymouth WTP, with existing conveyance connecting to the Diemer WTP through an existing bypass for DPR (Metropolitan 2023b). Metropolitan is currently conducting an environmental review for the entire program that would include these reuse components.

The opportunity for Metropolitan to supply ATRW to LADWP's industrial customers in the Harbor area through PWSC was discussed. However, after feedback from LADWP's industrial customers, such a change would require a costly retrofit at those industrial sites. As a result, the concept for PWSC to supply LADWP's industrial customers in the Harbor was eliminated (LADWP 2024).

4.3 Opportunities and Findings

In the Concept Study (LADWP 2021), LADWP identified two interconnect opportunities with Metropolitan:

1. Jensen WTP was identified as a potential demand under Pure Water Los Angeles to receive flows as a point of connection downstream of VNC. The flow volume that could be provided to Jensen WTP through DPR was not defined. Additionally, the water quality requirements for such an interconnect were not established.
2. PWSC was identified as a potential demand under Pure Water Los Angeles to receive flows of up to 77 cfs (50 MGD) by extending the west–east alignment to interconnect with the PWSC Backbone. The water quality requirements for the interconnect were not defined.

Other potential DPR opportunities and interconnects that involve using Metropolitan's drinking water infrastructure were not considered in the Concept Study.

The next section summarizes potential collaboration opportunities identified through active engagement with Metropolitan, based on a review of the adopted DPR regulations.

4.3.1 Pure Water Los Angeles and Joseph Jensen Water Treatment Plant Interconnect

The interconnect between Pure Water Los Angeles and Jensen WTP could potentially increase the water reliability of the SWP-dependent area in Metropolitan's Western Branch system, which includes part of LADWP's service area, Las Virgenes Municipal Water District (MWD), and Calleguas MWD (Metropolitan 2023a).

To achieve this potential interconnect, the following Metropolitan institutional requirements need to be met:

- A systemwide nitrogen limit for the drinking WTPs of no more than 2 mg/L of nitrogen from total inorganic nitrogen 95% of the time
- An institutional policy of limiting water supplies from recycled water to no more than 50% as source water
- Metropolitan's *Policy for Acceptance of New Water into Conveyance Facilities*, also known as the Pump-In Policy, that states that a new source of water is allowed to be introduced into a conveyance facility owned by Metropolitan if the quality of the new water is equal to or better than the ambient quality of water in the conveyance facility; ambient quality for any constituent would be the representative concentration at the beginning of the conveyance facility (Metropolitan 2001)

According to Metropolitan's internal evaluation shared with LADWP at the April 2023 meeting (LADWP 2023b), the amount of Pure Water Los Angeles water that could be accepted by Jensen WTP would vary, depending on the nitrate concentration in the surface water (to ensure a nitrate-nitrogen concentration of no more than 2 mg/L) and the amount of surface water treated (to ensure that no more than 50% of source water is recycled water) at Jensen WTP. For example, if nitrate as nitrogen (NO_3-N) were 2 mg/L in Pure Water Los Angeles water, and using the base load conditions, 48 cfs (31 MGD) could be accepted due to the relatively low flow being treated at Jensen WTP in recent years.

In addition to these requirements, an interconnect between Pure Water Los Angeles and Jensen WTP would require meeting the water quality and operational requirements under the adopted DPR regulations, as discussed in the *Potable Reuse Regulations Summary TM* (Jacobs and Arcadis 2024). The type of DPR that might be implemented under this interconnect has not been determined; it would be expected to have significant implications to the permitting arrangement at an agency level. For example, Metropolitan would likely be the Direct Potable Reuse Responsible Agency (DiPRRA) for this interconnect if the water to be delivered by LADWP did not meet the DPR regulatory requirements for a raw water augmentation DPR project. However, if LADWP supplies water that meets all DPR requirements before delivery to Jensen WTP, it is possible that LADWP could serve as the DiPRRA but would require confirmation with DDW as to the delineation of responsibility based on the adopted DPR regulations.

The former involves more extensive operational and system integration. LADWP would own and operate the AWPF upstream, while Metropolitan owns and operates the drinking WTP for raw water augmentation. Additionally, source control programs and other required monitoring for the wastewater treatment systems controlled by LASAN upstream of the DPR train would also need to be coordinated directly with Metropolitan. Significant agency-level coordination and negotiations would be required to develop the details should there be a desire to move this interconnect forward.

Based on the input provided by Metropolitan at the April 2023 meeting, this interconnect could result in a water demand up to 48 cfs (31 MGD).

4.3.2 Pure Water Los Angeles and Pure Water Southern California Program Interconnection

The interconnect between Pure Water Los Angeles and PWSC could increase the available water for groundwater recharge and DPR within the Metropolitan system. This interconnect would involve extending Pure Water Los Angeles's west–east alignment option to connect to the PWSC Backbone. This interconnect would offer an additional groundwater recharge opportunity in San Gabriel Basin. Additionally, Metropolitan is planning to send part of the flow in the PWSC Backbone for raw water augmentation DPR purposes and might provide DPR treatment either upstream of or at Weymouth WTP. This interconnect could also provide Metropolitan additional supplies for DPR.

According to the information shared by Metropolitan in the April 2023 meeting (LADWP 2023b), the amount of water that could be received by PWSC from Pure Water Los Angeles would be limited by the two policy limits described in Section 4.6. Metropolitan evaluated a nitrogen level of 5 mg/L NO_3-N in Pure Water Los Angeles water, and the resulting amount of water that could be processed at Weymouth or Diemer WTP, or both, would be 42 cfs (27 MGD) using a base-loaded scenario and 77 cfs (50 MGD) using a flexed-loaded scenario.

The flexed-loaded scenario could accommodate higher flow because it accounts for additional flows exceeding base flow, such as peak flows. LADWP requested that Metropolitan follow up to further evaluate the flow limit from Pure Water Los Angeles using a nitrogen level of less than 2 mg/L NO_3-N in the future to see whether additional flow could be integrated into PWSC under those loading scenarios in case the policy limits remain unchanged in the future.

Separately, LADWP sent a letter to Metropolitan to request that Metropolitan consider an interconnect with potential for Pure Water Los Angeles to send up to 232 cfs (150 MGD) of flow to PWSC as an alternative under PWSC's environmental review (LADWP 2023a). Metropolitan has recognized the importance of this potential interconnect opportunity and is currently evaluating upsizing a 14-mile-long pipeline of up to 9-feet diameter between Whittier Narrows and Canyon Spreading Grounds (Metropolitan 2023b). This pipe size would be expected to provide up to 464 cfs (300 MGD) of conveyance capacity, providing future interconnection between these two programs. The tie-in location for the two programs should be coordinated between LADWP and Metropolitan in the future and resolved collaboratively.

Including Pure Water Los Angeles water in PWSC would mean that LADWP and LASAN would need to be partner agencies under the DiPRRA led by Metropolitan because Metropolitan is planning to implement DPR (Metropolitan 2023b). The operational and system integration would be significant under this interconnect scenario.

The details of a potential Pure Water Los Angeles and PWSC interconnect would require comprehensive investigations to develop plans for meeting regulatory requirements. The investigations and permitting of this interconnection, while lengthy, may provide potentially significant benefits to water supply reliability and resiliency for the City and Southern California region.

Based on the information described (LADWP 2023), this interconnect could result in a water demand range of 0 cfs (0 MGD, no interconnection) and up to 232 cfs (150 MGD).

4.3.3 Other Interconnect Opportunities Using Metropolitan's Existing Drinking Water Infrastructure

This subsection describes interconnect opportunities using Metropolitan's existing drinking water infrastructure identified during the early planning phase of the MP. The following opportunities were identified to be infeasible due to potential operational complexity and policy conflicts:

- **Metropolitan's Connections:** These options would use Metropolitan's connections to feed DPR water into LADWP's potable water system in areas that are near a future DPR AWPF facility, such as the connections south of the Santa Monica Mountains (including LA-29, LA7, LA-30, LA-23, and LA-31). In this scenario, LADWP would be the DiPRRA for treated water augmentation. The main advantage of this approach is tie-in at these connection points could potentially have less infrastructure impacts on LADWP's potable water system because these connections have traditionally been used to provide backup supplies to LADWP. The feasibility of such a concept would require evaluation of LADWP's potable water system hydraulics to determine operational implications. The technical feasibility for the expanded use of these connections and the modification requirements for the tie-ins would need to be worked out between the two agencies should such a treated water augmentation approach be considered in the future.
- **Sepulveda Feeder**: Metropolitan is currently implementing the Sepulveda Feeder Pump Stations Project, which involves reversing flow in Sepulveda Feeder from flowing north to south to south to north, allowing Metropolitan to convey water from the Common Pool into the western SWP-dependent area when needed. The project involves installing new pump stations with capacity of up to 30 cfs (19 MGD) (Metropolitan 2023c, d).

Based on the early engagement meeting with Metropolitan, the flexibility of Sepulveda Feeder will be used to move water in either direction, depending on the specific needs. The limit of no more than 50% of the supply from recycled water sources in Metropolitan's system would also make any integration of Pure Water Los Angeles water at this location challenging because the flows in Sepulveda Feeder vary significantly. The potential for using the existing Sepulveda Feeder to convey Pure Water Los Angeles water was also explored preliminarily as a third opportunity. This option was eliminated by LADWP.

4.4 Other Considerations and Next Steps

Based on the opportunities identified, interconnections with Jensen WTP and PWSC have been identified as two promising opportunities for Pure Water Los Angeles. To advance these interconnect opportunities, the following technical gaps would need to be addressed through additional interagency engagement and coordination:

- Metropolitan has a policy of limiting its system to use no more than 50% of recycled water as a source; Additional discussions would help to identify the basis of the policy and any room to modify it to increase the flexibility to incorporate ATRW more directly into their system
- Metropolitan's methodology to determine the 50% recycled water source limit and the approach for implementation under the base- load and flexed- loaded scenarios
- The potential flow could be provided by Pure Water Los Angeles if the NO_3-N in Pure Water Los Angeles water was at 2 mg/L for all scenarios
- The water quality specifications required for an interconnect between Pure Water Los Angeles and Jensen WTP or PWSC

- A roadmap to identify institutional arrangements necessary for these interconnections to be permitted under the DPR regulations
- LADWP could work with Metropolitan to help identify exchange opportunities
- The tie-in location between Pure Water Los Angeles and PWSC will need to be further evaluated and coordinated collaboratively between LADWP and Metropolitan
- The potential demands for Pure Water Los Angeles water under different climate conditions, such as dry and wet years, for Jensen WTP and PWSC interconnect scenarios

From a conveyance perspective, these additional factors need to be considered and further evaluated:

- Pure Water Los Angeles and Jensen WTP interconnect would only be reasonable to consider if ATRW would be conveyed up to VNC using a south–north alignment.
- All the three south–north alignments (that is, Sepulveda, Cahuenga, and Griffith Park) could offer this interconnect opportunity if they were extended to VNC.

To move forward with this potential partnership, LADWP should continue its active engagement with Metropolitan to discuss technical details, requirements, or agreements needed for these potential opportunities to move forward. Continued engagement with and input from Metropolitan will support further the evaluation of the opportunities described in this section and quantify the water that could be provided to Metropolitan through Pure Water Los Angeles.

As LADWP continues to develop the Program, with inputs from systemwide modeling, potential flows to Metropolitan and other partner agencies will require ongoing engagement and evaluation with respect to Pure Water Los Angeles' goals for partnerships.

5. Los Angeles County Public Works

This section provides an overview of County Public Works and identifies potential opportunities for partnership.

5.1 Organizational Overview

The Los Angeles County Flood Control District (LACFCD) was established in 1915 to provide flood protection, water conservation, recreation, and aesthetic enhancement within its service area of 2,700 square miles in Los Angeles County. LACFCD entered into an operational agreement with County Public Works to transfer its planning and operational activities to County Public Works. County Public Works now operates and maintains flood control-related infrastructure, including seawater intrusion barriers, spreading grounds, and flood control channels (County Public Works 2023).

5.2 Existing Infrastructure

County Public Works operates and maintains infrastructure that could be interconnected with Pure Water Los Angeles to provide additional infrastructure for recharge of groundwater basins. The notable infrastructure in the area operated by County Public Works includes (County Public Works 2023):

- Seawater intrusion barrier: WCBBP
- Spreading grounds in CB:
  - Rio Hondo Spreading Grounds
  - San Gabriel Coastal Spreading Grounds

- Spreading grounds in San Fernando Valley:
  - Hansen Spreading Grounds
  - Pacoima Spreading Grounds
  - Tujunga Spreading Grounds (owned by LADWP)
- Spreading grounds in San Gabriel Basin: Santa Fe Spreading Grounds through PWSC

Figure 3-4 in the main TM shows the directly interconnectable facilities by Pure Water Los Angeles that are owned or operated by County Public Works.

5.2.1 West Coast Basin Barrier Project

The WCBBP is a 9-mile seawater intrusion barrier that consists of a line of 153 injections wells, from Los Angeles International Airport to the Palos Verdes Hills north. The barrier currently receives both ATRW and treated imported potable water. The ATRW is provided by West Basin through the barrier pipeline transmission system. The imported water is provided by Metropolitan's West Coast Feeder at West Basin 28 (County Public Works 2023).

5.2.2 San Gabriel Coastal Spreading Grounds

These spreading grounds are in the Montebello Forebay on the western side of San Gabriel River, immediately east of Rio Hondo Spreading Grounds in CB (County Public Works 2023). They were built in the 1930s and have the following capacities:

- Intake: 350 cfs
- Storage: 550 acre-feet (AF)
- Percolation: 75 cfs

The spreading grounds currently receive controlled releases from San Gabriel Canyon Dams, along with the Santa Fe and Whittier Narrows dams, and imported and recycled water. They are connected to Rio Hondo Spreading Grounds through a pipeline constructed in 2012 by WRD in partnership with County Public Works. This connection captures an additional 1,300 AF of stormwater annually and recharges an additional 5,700 AF of recycled water (County Public Works 2023).

5.2.3 Rio Hondo Spreading Grounds

These spreading grounds are located in the Montebello Forebay, immediately west of San Gabriel Coastal Spreading Grounds in CB. They were built in the 1930s and have the following capacities: (County Public Works 2023).

- Intake: 1,950 cfs
- Storage: 3,640 AF
- Percolation: 400 cfs

The spreading grounds currently receive the following types of water (County Public Works 2023):

- Controlled releases from San Gabriel Canyon Dams, along with the Santa Fe and Whittier Narrows dams
- Uncontrolled runoff from the San Gabriel River, Rio Hondo Channel, and their tributaries
- Imported and recycled water

5.2.4 Tujunga Spreading Grounds

Tujunga Spreading Grounds, located in the San Fernando Basin (SFB) downstream of the Hansen Spreading Grounds, is owned by LADWP. LADWP entered into an agreement with County Public Works to engage County Public Works to operate the spreading grounds in 1990, and County Public Works has been operating the spreading grounds since then. The agreement established the roles and responsibilities of each party (LADWP 1990). The facilities have the following capacities (County Public Works 2023):

- Intake: 450 cfs
- Storage: 790 AF
- Percolation: 130 cfs

5.2.5 Hansen Spreading Grounds

The Hansen Spreading Grounds were built in the 1940s in SFB. The facilities have the following capacities (County Public Works 2023):

- Intake: 1,600 cfs
- Storage: 1,276 AF
- Percolation: 150 cfs

The spreading grounds currently receive controlled flows from Hansen Dam and Big Tujunga Dam.

LADWP is currently designing an AWPF in partnership with LASAN at Tillman Water Reclamation Plant (WRP) to provide ATRW for recharge at the Hansen Spreading Grounds. The project is expected to be completed in 2026 and could provide up to 36 cfs (23 MGD) to the spreading grounds.

5.2.6 Pacoima Spreading Grounds

The Pacoima Spreading Grounds were built in the 1930s and is a recharge facility in SFB, with a storage capacity of 530 AF (County Public Works 2023). The spreading grounds have experienced reduced percolation rates of approximately 65 cfs over the years due to the presence of a low, permeable clay layer underlying the spreading basins. The Pacoima Spreading Grounds Enhancement Project is expected to be completed in late 2024, and is designed to increase the percolation rate to 140 cfs by removing the clay layer, expanding the storage capacity to 1,200 AF, and implementing other modifications to improve operability.

The spreading grounds receive flows from four sources:

1. Controlled flow from Pacoima Dam
2. Partially controlled flow from Lopez Flood Control Basin
3. Uncontrolled flow from East Canyon and Pacoima Wash
4. Imported water

5.2.7 Flood Control Channels

LADWP has also identified the potential use of two flood control channels for Pure Water Los Angeles:

1. Central Branch Tujunga Wash that is connected to the City of Los Angeles' Stormwater Capture Parks Program in San Fernando Valley. The lower portion of the wash is in the *Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties. Los Angeles Regional Water Quality Control Board*

(Basin Plan) because it is a tributary of the Los Angeles River (LARWQCB 2014). To discharge recycled water into the wash, the water quality must meet the *California Toxic Rule* (CTR) standards.

2. Bull Creek passes the Lower Van Norman Dam. LADWP identified the potential for diverting Los Angeles Aqueduct water through the Maclay Highline into Bull Creek to access the spreading grounds in San Fernando Valley for recharge while freeing up capacity at VNC to receive, treat, and store more Pure Water Los Angeles water. Bull Creek is in the Basin Plan because it is a tributary of the Los Angeles River (LARWQCB 2014). County Public Works is implementing the Bull Creek Storm Water Project, which diverts flows from Bull Creek using a 6-foot-high rubber dam and conveys the diverted flows from west to east through a 60-inch-diamter, 3-mile-long pipeline to Pacoima Spreading Grounds. This pipeline crosses the potential Sepulveda Alignment.

5.3 Opportunities and Findings

In the Concept Study (LADWP 2021), the opportunities identified for interconnecting with County Public Works' facilities were the three spreading grounds in the San Fernando Valley. The opportunities for interconnecting with the WCBBP and Montebello Forebay Spreading Grounds, and the use of Central Tujunga Wash to access the Stormwater Capture Parks Program's facilities were not identified.

The opportunities and findings presented in this section were feedback gathered during the January 5, 2023, meeting with County Public Works regarding these potential interconnect opportunities identified during the early master planning phase.

5.3.1 West Coast Basin Barrier Project

The WCBBP is currently connected to the West Basin's system to use ATRW for replenishment of WCB and prevent seawater intrusion. County Public Works operates and maintains the barrier, and the injection volumes are adjusted monthly based on protective groundwater levels measured in nearby observation wells (County Public Works 2023).

Historically, the barrier uses approximately 20% potable water supplies for injection, with the remaining demand being met by recycled water. The inability to use recycled water as the only source of supply to the barrier has been due primarily to operational challenges associated with the upstream treatment plant upset at ECLWRF, as well as the barrier injection wells. If some of the operational challenges could be addressed and minimized, opportunities to use 100% recycled water for the barrier could potentially be realized.

The current capacity of the barrier is approximately 19 cfs (12 MGD). County Public Works indicated that the potential for increased recharge into the barrier is limited by geology and the amount of pumping in WCB. More pumping in WCB could translate to higher replenishment demand for the WCBBP.

5.3.2 Montebello Forebay Spreading Grounds

County Public Works shared with the LADWP at the January 2023 meeting that the San Gabriel Coastal and Rio Hondo Spreading Grounds are the most productive spreading grounds of all County Public Works' spreading ground facilities (LADWP 2023c). They capture 95% of the drainage through Whittier Narrows. The combined capacity is approximately 200 cfs. The amount of water captured and used from the spreading grounds is seasonally dependent. County Public Works reported that based on their experience, during dry years, excess capacity in the spreading grounds has been observed. During years with above-average precipitation, there have been times when excess water needs to be discharged to prevent overflow.

County Public Works indicated during the January 2023 meeting that the use of these spreading grounds, as well as others in SFB, has been prioritized for capturing and infiltrating stormwater. Spreading recycled water for groundwater recharge is a secondary benefit provided by these basins. Therefore, the possibility to reserve spreading basins for recycled water use does not exist unless other facilities are provided to offset the capacity loss. County Public Works noted that they were unable to accept flows from WRD's ARC Facility because of the spreading grounds' limitation.

Basin capacity is also constrained by how the spreading basins are operated. Currently, the basins are operated in rotation with an approximately 2-week cycle of recharge, infiltration, and drying. As such, only one-third of the basins could receive water at any given time. County Public Works indicated the importance of the drying process for maintaining performance and mitigating vector issues, and this practice has been implemented in all spreading grounds operated by County Public Works.

The concept of building a structure, such as a park, over the basins to mitigate vector issues to eliminate drying time and allow for a steadier inflow into the basins was discussed. County Public Works commented that because of the technical challenges a retrofit of this nature entails at these two spreading grounds, as well as potential O&M challenges regarding access to the spreading grounds, this idea would be best suited for a new facility so that these issues could be addressed more easily.

County Public Works also remarked that because San Gabriel is easier to operate relative to Rio Hondo, San Gabriel traditionally has higher utilization rates even though a pipeline is already in place to connect the two spreading grounds to offer operational flexibility. Hence, Rio Hondo tends to have more excess capacity normally and affords more opportunities for using Rio Hondo to recharge recycled water during dry weather seasons.

Given the feedback provided by County Public Works, the opportunity of using Montebello Forebay Spreading Grounds as a steady recharge infrastructure component that would be available year-round is limited, given the priority that has been placed on stormwater capture. The use of the spreading grounds would be cost-effective if Pure Water Los Angeles interconnects with PWSC. Operational implications at the AWPF and overall flow management during dry weather seasons need to be evaluated.

5.3.3 Spreading Grounds in San Fernando Basin

County Public Works currently operates these three main spreading grounds facilities that have been identified to provide additional avenues for recharge using product water from Pure Water Los Angeles:

1. Tujunga Spreading Grounds
2. Hansen Spreading Grounds
3. Pacoima Spreading Grounds

The cycles of recharge, infiltration, and drying for vector mitigation are also practiced in the spreading grounds in San Fernando, consistent with the practice described in Section 5.3.2. This practice will constrain the amount of Pure Water Los Angeles water that could be accepted by these spreading grounds in SFB.

This section provides a summary of the opportunities and findings for their use.

5.3.3.1 Tujunga Spreading Grounds

As noted in Section 4.2, the Tujunga Spreading Grounds are owned by LADWP. In the agreement established, LADWP has the right to prioritize the use of the spreading grounds for spreading of its own

water over other uses, provided that LADWP gives County Public Works advance notice. This arrangement offers an opportunity for LADWP to spread Pure Water Los Angeles water using this spreading ground.

LADWP currently operates water supply wells within the spreading grounds, which may limit recharge capacity to maintain the minimum required 2 months of residence time under the IPR regulations. In cases when the 2-month residence time could not be met, recharge at Tujunga Spreading Grounds could be permitted as a DPR project with additional treatment before or after extraction to meet DPR regulations (SWRCB 2023) if this approach was determined to be optimal after further evaluation.

An opportunity to develop an operational strategy jointly with County Public Works would be beneficial to maximize the use of Tujunga Spreading Grounds by supporting the goals of maximizing recycled water recharge using Pure Water Los Angeles water and capturing stormwater and recharge water. This strategy could serve as the framework for Boulevard Pit described in the following subsections should LADWP decide to acquire it when it becomes available.

5.3.3.2 Hansen Spreading Grounds

LADWP owns the East Valley Recycled Water Pipe that connects the Tillman WRP to the Hansen Spreading Grounds. LADWP is currently designing an AWPF in partnership with LASAN at Tillman WRP to provide ATRW for recharge at the Hansen Spreading Grounds. The project is expected to be completed in 2026 and could provide up to 39 cfs (25 MGD) to the spreading grounds (LADWP 2023a).

County Public Works noted that, given that the basins in Hansen Spreading Grounds will need to be operated in the same fashion as the Montebello Spreading Grounds (that is, a full fill-drain-dry cycle), the capacity at Hansen Spreading Grounds could also be constrained as a result. Hence, additional water from Pure Water Los Angeles exceeding what would be supplied by Tillman AWPF would need to be evaluated to determine capacity.

5.3.3.3 Pacoima Spreading Grounds

According to County Public Works, with the expansion and upgrades, there will be significant storage potential at the Pacoima Spreading Grounds. The spreading grounds do not receive any recycled water and could offer capacity for recharge once the upgrades have been completed. This could offer another opportunity for Pure Water Los Angeles. Given County Public Works' policy on the use of spreading grounds, Pacoima Spreading Grounds would be unavailable during wet weather seasons. If Pure Water Los Angeles could overcome the operational constraints, Pacoima could provide important infrastructure for recharging SFB.

5.3.3.4 Boulevard Pit

Boulevard Pit is an active aggregate mining facility owned by Vulcan Materials Company. It is adjacent to Hansen Spreading Grounds and near Tujunga Spreading Grounds. It is currently unavailable to be used for recharge. However, it could potentially be integrated to accept recycled water in the future once the mining activity ceases, and there might be an opportunity to acquire the property. A concept for the City, County Public Works, and Upper Los Angeles River Area (ULARA) Watermaster to acquire the pit jointly for conversion into a new stormwater retention and recharge facility has been contemplated for many years (ULARA 2001). Modeling would be required before recharge to confirm the minimum required 2 months of residence time under the IPR regulations was achieved, given the proximity of the Tujunga Wellfield.

LADWP could potentially offer to purchase the property and set up a partnership arrangement with County Public Works similar to Tujunga Spreading Grounds. The type of reuse permit (that is, IPR or DPR) required

for recharge at Boulevard Pit would have to be evaluated to determine whether the minimum travel time of 2 months of residence time under the IPR regulations are attainable or if the adopted DPR provision would need to be met (SWRCB 2023).

5.3.4 Flood Control Channels

LADWP has also identified the potential use of Central Branch Tujunga Wash to access the Stormwater Capture Parks in Los Angeles and Bull Creek for Los Angeles Aqueduct water diversion for recharge in SFB. The concepts were explored with County Public Works during the January 2023 meeting. County Public Works indicated that while they would be willing to further explore the use of both the Bull Creek Wash and the Central Tujunga Wash with LADWP, they think that the potential policy and permitting implications would make their use challenging.

These two channels are listed in the Basin Plan; hence, compliance to the Basin Plan requirements would be necessary, including the CTR, if the use of these channels involved discharge of Pure Water Los Angeles water. Depending on the Pure Water Los Angeles water quality at the points of discharge, additional treatment might be needed to meet the Basin Plan requirements.

The Bull Creek Storm Water Project's pipeline would cross the Sepulveda Alignment, which offers the potential for discharging ATRW flows from the Sepulveda Alignment into this new pipeline to convey flows to Pacoima Spreading Grounds or to the new potential injection site during dry seasons. According to LADWP, approximately 100 cfs of capacity could be available for Pure Water Los Angeles during dry weather seasons (LADWP 2024b). Assessing the technical feasibility for this potential interconnection would require further coordination between LADWP and County of Public Works. Based on the priority for using flood-control-related infrastructure, the opportunity to use this pipeline would likely be limited to dry weather seasons.

5.4 Other Considerations and Next Steps

Based on the discussions with County Public Works, the critical data gaps concerning the ability to partner and the extent of use of the available County Public Works facilities by Pure Water Los Angeles include:

- Quantify the potential capacities available at each of these facilities.
- Determine whether operational optimization exists to increase the facilities' availability, and identify the pathway for optimization.
- Consider implementing policies that could enhance the facilities used by recycled water.
- Evaluate water quality requirements and permitting implications.

Based on these gaps, it is recommended that an adaptive management study for increasing use of County Public Works infrastructure be conducted to provide additional data to further evaluate the feasibility of these interconnect opportunities based on the alignment options presented in Table 5-1.

Table 5-1. Potential Interconnect Opportunities for Further Evaluation

County Public Works Facility	N-S Alignment Options			W-E Alignment Options			Others
	Sepulveda	Cahuenga	Griffith Park	Slauson	Florence	Manchester	West Basin
WCBBP	--	--	--	--	--	--	✓
Rio Hondo Spreading Grounds	--	--	--	✓	✓	--	--
San Gabriel Coastal Spreading Grounds	--	--	--	✓	--	--	--
Hansen Spreading Grounds	✓	✓	✓	--	--	--	--
Tujunga Spreading Grounds[a]	✓	✓	✓	--	--	--	--
Pacoima Spreading Grounds	✓	✓	✓	--	--	--	--
Boulevard Pit[b]	✓	✓	✓	--	--	--	--
Central Tujunga Wash	✓	✓	✓	--	--	--	--
Bull Creek Stormwater Capture Project	✓	--	--	--	--	--	--

[a] Tujunga Spreading Grounds is operated by the County Public Works but owned by LADWP.

[b] The pit is currently owned by Vulcan Materials Company. A plan for partnership between LADWP and County Public Works to repurpose the pit has been considered.

✓ = potential opportunity

-- = no opportunity

N-S = north–south

W-E = west–east

If LADWP elects to move forward with these potential partnerships, LADWP should continue its active engagement with the County Public Works to discuss technical details, requirements, or agreements needed for these potential opportunities. Continued engagement with and input from the County Public Works will support further the evaluation of the opportunities described in this section and quantify the water that could be conveyed and recharged through the County Public Works' infrastructure.

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Attachment C
Identification of Local Partnership Opportunities

Jacobs

Identification of Local Partnership Opportunities

Date:	June 4, 2024
Project Name:	Pure Water Los Angeles Master Plan
Project No.:	D2611501
Client:	Los Angeles Department of Water and Power (LADWP)
Revision No.:	003

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1. Introduction

Local partners, as defined in this technical memorandum (TM), could be a city, an area of special designation, or an existing customer of LADWP that is located within proximity to a Pure Water Los Angeles Program (Program) conveyance alignment for easy access to the water. This group of partners share these common characteristics:

- Proximity to Program alignments
- Share a geographic border with Los Angeles
- Have existing or future demands or have an expressed interest in using recycled water
- Have smaller demands compared to the regional partners
- Types of reuse might range from non-potable reuse (NPR) to indirect potable reuse (IPR) or direct potable reuse (DPR)
- Those that are closer to the future Advanced Water Purification Facility (AWPF) and have immediate needs for water could be part of the early water delivery in the early phasing of the Program

Local partners could be a unique and important addition to the overall Program, even though their demands are expected to be significantly less compared to regional partners. Given the historical ties between these communities and Los Angeles, providing local partners access to Pure Water Los Angeles water could potentially broaden the local support provided by these partners. This TM presents the findings from the review of potential partnership opportunities with local partners.

2. Local Cities or Areas of Special Designation

The potential opportunities for partnering with local cities and areas of special designation are alignment specific, with potential local partners identified based on their proximity to the identified conveyance alignments. Urban Water Management Plans (UWMPs) prepared by the identified cities were reviewed to provide an initial assessment of their potential interest in getting water from Pure Water Los Angeles.

Table 2-1 presents potential local partners and summarizes the potential interconnect opportunities based on Program alignments. Figure 4-1 in the main body of the Partnership TM shows the locations of potential local partners.

Table 2-1. Alignment-based Potential Interconnect Opportunities with Local Cities and Areas of Special Designation

Local Partner	Potential Demand, MGD	North-South Alignments			West Basin System Expansion	West-East Alignment
		Griffith Park	Cahuenga	Sepulveda		
City of Santa Monica	Up to 5 (IPR)[a]	--	--	✓	✓	--
Culver City (West Basin)	Up to 0.1 (NPR)[b]	--	✓	✓	--	--
Kenneth Hahn State Park and Surrounding Area (LADWP and West Basin)	Up to 0.4 (NPR)[b]	--	✓	--	--	--
City of Beverly Hills	Up to 5 (IPR)[c]	--	✓ through West Hollywood	✓	--	--
West Hollywood (West Basin)	TBD (NPR)	--	✓	✓ through Beverly Hills	--	--
West Los Angeles Veterinary Affairs Center, Los Angeles National Cemetery (West Basin)	TBD (NPR)	--	--	✓	--	--
City of Burbank	Up to 4.5 (DPR and IPR)[d]	✓ direct delivery	✓ direct delivery	✓ water exchange	--	--
City of Glendale	TBD (IPR)	✓	--	--	--	--
City of San Fernando	TBD (IPR)	✓	✓	--	--	--
Central Basin MWD	TBD (NPR)	--	--	--	--	✓

[a] Value reported by LADWP (2022a).

[b] Value reported by HDR (2022).

[c] Based on future expanded capacity of Foothill Water Treatment Plant (CBH 2021). Ultimate demand needs to be determined by further engagement with the City of Beverly Hills and further evaluation.

[d] Value reported by BWP (2021).

✓ = potential opportunity

-- = not an opportunity

BWP = Burbank Water & Power

MGD = million gallons per day

MWD = municipal water district

TBD = to be determined

West Basin = West Basin Municipal Water District

Many of these identified cities and areas of special designation are located within Hyperion Water Reclamation Plant's (HWRP's) sewershed and are contributing wastewater flow to HWRP, as described in Attachment A. Hence, they might be interested in participating in the Program and getting access to the Pure Water Los Angeles water supply, pending the Program alternative alignment selection. Further engagement with these entities would be beneficial for maximizing the Program benefits to local communities.

Finally, these entities are either member agencies of Metropolitan Water District of Southern California (Metropolitan) or represented by member agencies of Metropolitan. Hence, water exchange might be a potential alternative pathway for access instead of a physical connection should that become a possibility and a physical interconnect between Pure Water Los Angeles and Metropolitan's infrastructure exists.

2.1 City of Santa Monica

Santa Monica is an urban coastal community, bordered to the west by the Pacific Ocean and surrounded by Los Angeles to the north, east, and south. The City of Santa Monica's water service area consists entirely of the Santa Monica city limits, with limited service in Los Angeles (CSM 2023). An interconnect with Pure Water Los Angeles could be considered for implementation if the Sepulveda Alignment is selected, or if expanding and upgrading West Basin's system were to be implemented.

Based on the engagement with the City of Santa Monica in a September 2022 meeting, there are several potential opportunities for a Pure Water Los Angeles partnership between LADWP and the City of Santa Monica where the water could flow from the Sepulveda Alignment or from LADWP's 16-inch-diameter recycled water pipeline in Playa Vista.

As noted in Attachment A, the ability to produce additional advanced treated recycled water at the Edward C. Little Water Recycling Facility is limited by brine line capacity, followed by the secondary effluent pumping and conveyance capacities, such that continued engagement with West Basin would be important. This engagement could include conducting additional evaluations to determine a best strategy forward that would be mutually beneficial, and determining the feasibility of a potential West Basin to LADWP to Santa Monica interconnect option.

The City of Santa Monica identified two potential integration options that could generate up to approximately 8 cubic feet per second (cfs) (5 MGD) of Pure Water Los Angeles demand to be considered as the Program advances based on the September 2022 meeting:

1. **Charnock Injection Wells**: Addition of new injection wells near the Charnock Wellfield for groundwater augmentation in the vicinity of existing production wells.
2. **Santa Monica Airport Injection**: Installation of new injection wells at the Santa Monica Airport for groundwater augmentation. The Santa Monica Airport is potentially closing by the end of 2028 (CSM 2023), making the land potentially available for new injection wells. However, potential environmental remediation may be required after the airport is out of service and before drilling new injection wells.

The City of Santa Monica is developing a One Water Master Plan that will assist with further refining partnership opportunities and potential demands.

2.2 Local Partners in West Basin Municipal Water District's Service Area

West Basin is the water wholesaler for several cities and areas of special designation that are along the potential alignment options for Pure Water Los Angeles bordered with Los Angeles. Potential partners include:

- Culver City: Feasible for the Sepulveda or Cahuenga alignments
- Kenneth Hanh State Park and its Surrounding Areas: Feasible for the Cahuenga alignment
- West Hollywood: Feasible for the Cahuenga Alignment or Sepulveda Alignment through Beverly Hills
- West Los Angeles Veterinary Affairs Center and Los Angeles National Cemetery: Feasible for the Sepulveda Alignment

LADWP currently provides water supplies to the following areas (HDR 2022):

- Part of Culver City
- Kenneth Hanh State Park and its surrounding area
- West Hollywood
- The entire area of West Los Angeles Veterinary Affairs Center and Los Angeles National Cemetery

These areas currently do not have access to recycled water. West Basin currently has plans to expand its recycled water distribution system to serve the eastern part of Culver City and Kenneth Hanh State Park and its surrounding area. In collaboration with LADWP, West Basin estimated that this area has a potential recycled water demand of 0.93 cfs (0.6 MGD) (HDR 2022).

No recycled water demand estimates have been reported by West Basin for the other two potential areas listed. Given that these areas are within West Basin's service area, coordination with West Basin would be necessary to gauge interest and identify potential demand once a Program alternative has been selected.

2.3 City of Beverly Hills

Beverly Hills is bordered by Los Angeles and West Hollywood. The City of Beverly Hills has expressed an interest in accessing recycled water and reported its effort to work with LADWP and Los Angeles Sanitation & Environment (LASAN) to attain supplies through previous reuse planning efforts, such as Los Angeles One Water Plan and Sustainability Plan (CBH 2021).

The City of Beverly Hills uses imported water supply purchased from Metropolitan, as well as local groundwater from Hollywood Groundwater Basin and La Brea Subarea of the Central Basin, to meet its demand. The City of Beverly Hills has plans to increase groundwater production to meet up to 30% of its demand by 2025 (CBH 2021).

Because these two basins do not receive any artificial recharge, the pumping is limited to the natural yield. An interconnect with Pure Water Los Angeles would provide a source of recharge water that could potentially increase groundwater production. The ultimate demand for groundwater recharge would need to be further evaluated by the City of Beverly Hills. Based on the future expanded capacity of up to 7.3 cfs (4.7 MGD) for the Foothill Water Treatment Plant, the potential IPR water demand is assumed to be up to 8 cfs (5 MGD).

Given the City of Beverly Hills' interest, as well as their water supply portfolio, LADWP could engage them to explore this potential partnership opportunity. Interconnection would be most cost-effective through either the Sepulveda Alignment or Cahuenga Alignment.

2.4 City of Burbank

Burbank is bordered by Los Angeles. BWP is already an existing partner of LADWP. It currently delivers disinfected tertiary recycled water to LADWP's service in North Hollywood from the Burbank Water Reclamation Plant, with 45 acre-feet (AF) delivered in 2020; the amount of water to be delivered to LADWP is expected to increase to 260 acre-feet per year (AFY) (BWP 2021).

BWP identified the potential constructive collaboration between BWP's recycled water program and Pure Water Los Angeles. BWP has identified up to 5,000 AFY of recycled water surplus (BWP 2021). It has recognized the potential for BWP to supplement LADWP's recycled water supply for IPR or eventually, DPR. The partnership between BWP and LADWP under Pure Water Los Angeles could build upon the existing agreement for recycled water exchanges to LADWP customers in the North Hollywood service area.

This potential interconnect opportunity would use the Griffith Park or Cahuenga Alignment, particularly under a DPR scenario. If water delivery were through a water exchange, the Sepulveda Alignment could be used for IPR through groundwater recharge in the San Fernando Basin.

2.5 City of Glendale

Glendale is bordered by Los Angeles. The City of Glendale has been in partnership with the City of Los Angeles since the 1970s, which led to co-owning the Los Angeles-Glendale Water Reclamation Plant (WRP), with LASAN operating and maintaining the plant (CoG 2021). Both cities have an equal share of recycled water.

Glendale currently only uses about 2,000 AFY of recycled water each year out of its 6,000 to 8,000 AFY of recycled water entitlement. Glendale has planned to expand its recycled water use in the future by DPR, with the amount up to 2,900 AFY by 2030 (CoG 2021).

For DPR water delivery, a Program alternative that uses the Griffith Park Alignment would be the most favorable option. It is recommended that LADWP continue engaging the City of Glendale to gauge their interest in further increasing DPR water use to support future Program planning for Pure Water Los Angeles.

2.6 City of San Fernando

San Fernando is surrounded by Los Angeles. The City of San Fernando (CSF) stated in their 2020 UWMP that CSF does not use recycled water and does not have the ability to use recycled water due to a lack of infrastructure. However, if recycled water becomes available, CSF could benefit from replacing potable water with recycled water for irrigation of city parks and medians and other large landscapes, as well as dual plumbed buildings. The CSF also is evaluating an option for installing a scalping plant to provide recycled water, with Southern California Edison being a funding partner (CSF 2021).

Given the strong interest for CSF to implement recycled water use, LADWP could engage with CSF to gauge interest and identify potential demand for water from Pure Water Los Angeles. The interconnect would be most cost-effective when a Program alternative uses Cahuenga or Griffith Park alignments.

2.7 Central Basin Municipal Water District

The Central Basin MWD service area is on the eastern side of Los Angeles, with part of its service area bordered by Los Angeles. Central Basin MWD has a recycled water program that provides an alternative water supply from the San Jose Creek WRP in Whittier and the Los Coyotes WRP in Cerritos to the following users:

- Industrial users, such as:
  - Textiles
  - Paper production
  - Dye houses
  - Cogeneration plants
- Irrigation users, such as:
  - Parks
  - Street medians
  - Golf courses

The potential additional recycled water demand within Central Basin MWD's service area would require input from Central Basin MWD. Given the location of Central Basin MWD, the interconnect would only be cost-effective if Pure Water Los Angeles interconnected with the Pure Water Southern California Program using the west–east alignment.

3. Los Angeles Department of Water and Power's Existing Customers

Existing customers of LADWP could also serve as potential local partners under Pure Water Los Angeles. The MP Team identified several potential LADWP customers that are near the alignment alternatives and have the potential to use recycled water. The potential customers that may benefit from the supply from Pure Water Los Angeles include (LADWP 2012):

- Bel-Air Country Club: Mainly irrigation
- Los Angeles Country Club: Mainly irrigation
- Rancho Park: Mainly irrigation
- Westwood, University of California, Los Angeles campus: Irrigation and other NPR
- LADWP Power System: Green hydrogen generation

LADWP could engage these and other customers located near the selected Program alternative alignment to identify demand and evaluate the cost-effectiveness of these connections. Among these examples, the potential exists for constructive collaboration between Pure Water Los Angeles and the Power System's Los Angeles 100% Renewable Energy Study (LA100 study), which is described here.

The LADWP Power System completed an LA100 study, which provided a road map to power Los Angeles using 100% carbon-free fuel (NREL 2021). LA100 presents options to comply with the requirements established in Senate Bill 100 that requires zero-carbon sources supply 100% of electric retail sales to end-user customers by 2045.

Green hydrogen was identified as a carbon-free, reliable, and resilient fuel source that could supplement energy needs during extreme situations, such as wildfires or a heat storm (LADWP 2022b).

Green hydrogen is produced by electrolysis of water that is powered by excess renewable energy. It serves as a form of seasonal energy storage to reduce the amount of renewable electricity that would otherwise be reduced during a specific time of the day if a storage option is unavailable to prevent oversupply of electricity into the electricity grid. It is estimated that the City of Los Angeles would need approximately 2,600 megawatts (MW) of clean, dispatchable, local capacity by 2045 to provide power supply reliability during extreme events. This electrolyzer capacity would translate to a water demand of approximately 4.3 cfs (2.8 MGD)[1]. LADWP indicated recycled water could be a source of water supply for green hydrogen generation if it is available for this use (LADWP 2022b).

The first step toward the use of hydrogen would be to replace Scattergood Generating Station (SGS) Units 1 and 2 with fuel-flexible combined-cycle equipment with a capacity of 346 MW that is capable of burning green hydrogen (LADWP 2022b). SGS is located immediately south of the HWRP.

Given the plan for the use of green hydrogen, further engagement between the Water and Power Systems within LADWP would be necessary to identify synergies between LA100 and Pure Water Los Angeles. For example, if onsite green hydrogen generation at SGS would be considered once LADWP's electricity supply becomes 100% renewable and a surplus of recycled water exists, the hydrogen generation could be factored into the demand and early phasing of Pure Water Los Angeles, given the proximity of SGS to HWRP. The oxygen generated from the electrolysis process could even potentially be used at HWRP for its wastewater treatment process.

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[1] Approximately 9 kilograms (kg) of water is required to produce 1 kg of hydrogen (LADWP 2022b). Based on the product specification of the H-Tec PEM Electrolyzer ME450: 1 MW nominal load of electrolyzer capacity generates approximately 450 kg per day of hydrogen (H-Tec 2023). This calculation does not include water demand required for cooling if needed.

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Identification of Storage and Demands TM

Identification of Storage and Demands Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
May 29, 2024

Executive Summary

Overview

The Pure Water Los Angeles (Program) Master Plan (MP) evaluates potential alternatives for potable reuse to maximize the use of recycled water from the Hyperion Water Reclamation Plant (HWRP) and the anticipated Advanced Water Purification Facility (AWPF). Locations for integrating potable reuse were identified in the Los Angeles Department of Water and Power (LADWP) water system as well as through external partnerships.

This technical memorandum (TM) provides a high-level summary of the potable reuse source, supply, storage, and demand options selected for incorporation into the Program alternatives development. These alternatives will be carried forward for the Program alternative comparison, screening, and shortlisting of the preferred Program alternatives. Details about the storage and demand locations, including basis of flows, operational and infrastructure needs, and considerations, are provided in the *Validation of Strategy Technical Memorandum* (Jacobs and Arcadis 2024) and *Interconnectable Partnership Opportunities Technical Memorandum* (Jacobs 2024).

Components

Program components can be classified based on their ability to either source, supply, store, or directly distribute Program water based on the following definitions:

- Source water partner: A wastewater agency, in this case, Los Angeles Sanitation & Environment (LASAN), that can provide treated wastewater effluent to the Program for further treatment and reuse
- Supply: Treated wastewater effluent that has undergone advanced water treatment for potable reuse
- Storage: Where AWPF treated water is placed and held for a specified time before being used for demand
- Demand: Component that takes AWPF treated water for consumptive end uses or distribution to partners

The AWPF, which is to be served by and located at or in the vicinity of the HWRP, will be the supply of all water for the Program. The location of the AWPF is currently being evaluated by LASAN and LADWP's Owner's Agent under a separate contract.

The following storage and demand locations were identified to be used in the development of Program alternatives (Table ES-1):

- Central Basin (CB)
- San Fernando Basin (SFB)
- Van Norman Complex (VNC)
- Potential partnership with West Basin Municipal Water District (West Basin)
- Potential partnership with Metropolitan Water District of Southern California (Metropolitan)
- Potential partnership with Water Replenishment District (WRD)

Additional partnerships (such as with the City of Santa Monica) are discussed in the *Interconnectable Partnership Opportunities Technical Memorandum* (Jacobs 2024). Only the larger regional partnerships are addressed in this TM.

Table ES-1. Pure Water Los Angeles Potable Reuse Alternatives for Storage and Demand Locations

Component Description	Potable Reuse	Potential Pure Water Los Angeles Water Supply	
		cfs[a]	MGD[a]
CB (Storage) GWR and extraction in the Los Angeles Forebay through phased upgrades to distribution and the existing Manhattan and 99th Street wellfields, as well as new injection and extraction wellfields. Requires plume management and extraction treatment.	GWR	10 to 59	6.5 to 38
SFB (Storage)			
Spreading Grounds GWR at Tujunga, Pacoima, and Hansen Spreading Grounds and extraction with existing production wells. Requires plume management and extraction treatment.	GWR	Up to 130	Up to 84
Injection Wells GWR through new injection wells and extraction with existing production wells. Requires plume management and extraction treatment.	GWR	Up to 77	Up to 50
Stormwater Capture Parks Recharge in planned infiltration galleries during dry conditions and extraction with existing production wells. Requires plume management and extraction treatment.	GWR	Up to 23	Up to 15
VNC (Demand) Integration of DPR treated water into the raw water supply upstream of LAAFP or into LAR (uncovered finished water reservoir).	RWA	Up to 252 (DPR at VNC) Up to 356 (DPR at AWPF)	Up to 163 (DPR at VNC) Up to 230 (DPR at AWPF)
West Basin (Demand) Delivery of water to ECLWRF for meeting West Basin demands. Includes 27 cfs (17.5 MGD) to WCB and 35 cfs (22.5 MGD) to West Basin customers, with seasonal variations.	GWR	31 to 62	20 to 40
WRD (Demand) Support of the brackish plume remediation in WCB up to 18 cfs (12 MGD), replenishment to sustain a safe yield for existing customers in CB up to 15 cfs (10 MGD), and replenishment for LADWP's entitlements in CB and WCB up to 26 cfs (17 MGD).	GWR	Up to 59	Up to 39
Metropolitan (Demand)			
PWSC Connection to the PWSC Backbone to convey recycled water from the Warren Facility AWPF to recharge WCB, CB, and Main San Gabriel Basin, and to Weymouth WTP for RWA.	GWR or RWA	Up to 232	Up to 150
Jensen WTP Interconnect with Jensen WTP.	RWA	Up to 48	Up to 31

[a] Groundwater injection wells for CB and SFB assume a 10-month annual operating period. All other locations assume a 12-month annual operating period.

Notes:

DPR = direct potable reuse
ECLWRF = Edward C. Little Water Recycling Facility
GWR = groundwater replenishment
LAAFP = Los Angeles Aqueduct Filtration Plant
LAR = Los Angeles Reservoir
PWSC = Pure Water Southern California
RWA = raw water augmentation
WCB = West Coast Basin
WTP = water treatment plant

Recommended Additional Analyses

Additional steps to verify and further develop the assumptions for each storage and demand location will be required in future efforts to refine Program flows and integration requirements. Table ES-2 summarizes the recommended additional analyses required for each location, within and outside of the MP.

Table ES-2. Pure Water Los Angeles Storage and Demands Recommended Additional Analyses

Location	Recommended Additional Analyses
CB	▪ Evaluate flows that can be managed in CB as part of Pure Water Los Angeles. ▪ Initiate pilot test wells to determine design criteria. ▪ Conduct additional groundwater quality sampling and evaluation of compatibility of Pure Water Los Angeles water quality for injection. ▪ Conduct additional groundwater modeling once field data concerning ambient water quality and hydrogeological characteristics of the selected areas become available to better refine the limits of CB and the feasibility of proposed alternatives. ▪ Initiate a CB study to determine the following: - Groundwater production capacity - New production wells and wellfield locations - Water quality monitoring requirements - Required treatment - Opportunities to acquire additional groundwater rights.
SFB	▪ Evaluate allocation of flows when spreading grounds and stormwater capture parks are not available during wet weather as part of Pure Water Los Angeles. ▪ Complete groundwater modeling or a tracer study to confirm residence time of recycled water spread at Tujunga Spreading Grounds. ▪ Conduct groundwater modeling to evaluate potential impacts on contaminant plumes. ▪ Confirm range of demands that can be met through SFB extraction. ▪ Initiate pilot test wells to determine design criteria. ▪ Conduct additional groundwater quality sampling and evaluation of compatibility of Pure Water Los Angeles water quality for injection. ▪ Conduct groundwater modeling to evaluate long-term capacity, residence time, and capture for stormwater capture parks.
VNC	▪ Evaluate flows that can be managed at VNC as part of Pure Water Los Angeles. ▪ Conduct validation testing of post-AWPF treatment for compliance with DPR regulations and DDW coordination.
West Basin	▪ Evaluate use of West Basin's infrastructure to accelerate water delivery to CB and the Harbor area. ▪ Determine the role and potential for West Basin to accelerate water delivery by Pure Water Los Angeles. ▪ Determine the potential institutional arrangement options with West Basin. ▪ Determine the capital improvement needs and the associated cost with West Basin to allow for comparison against other options. ▪ Determine the potential of phasing and implementation of HWRP and Pure Water Los Angeles as near-term actions using West Basin's infrastructure.
Metropolitan	▪ Conduct comprehensive investigations jointly with Metropolitan to evaluate the details of these integration options to develop plans for meeting regulatory requirements. ▪ Metropolitan has a policy of limiting its system to use no more than 50% of recycled water as a source; conduct additional discussions with Metropolitan to determine whether modification is possible to increase the flexibility to incorporate ATRW into the potable water system. ▪ Metropolitan to provide additional analysis to determine capacity at their at their Weymouth or Diemer WTPs, or both, to receive Pure Water Los Angeles ATRW by lowering the nitrate concentration in Pure Water Los Angeles water to 2 mg/L as N for base-loaded or flexed scenarios.

Location	Recommended Additional Analyses
	▪ Investigate water quality specifications required for interconnect between Jensen WTP and PWSC jointly with Metropolitan. ▪ Identify institutional arrangements necessary for these interconnections to be permitted under the DPR regulations, including DiPRRA requirements.
WRD	▪ Define the flow rates or demands and the potential variability for the use of Pure Water Los Angeles water for GWR. ▪ Collaborate with WRD to further define the identified opportunities, such as recharge locations and methods. ▪ Evaluate the potential of mobilizing organic compounds, such as PFAS, from the soil matrix of the spreading grounds if Montebello Forebay Spreading Grounds are to be used. ▪ Evaluate how costs could be shared for replenishing CB using injection wells from Pure Water Los Angeles. ▪ Develop a joint strategy to maximize recharge during wet weather seasons.

Notes:

ATRW = advanced treated recycled water
DDW = Division of Drinking Water
DiPRRA = Direct Potable Reuse Responsible Agency
mg/L = milligram(s) per liter
N = nitrogen
Jensen WTP = Joseph Jensen Water Treatment Plant
ONAT = Operation NEXT Assessment Tool
PFAS = per- and polyfluoroalkyl substances

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Acronyms and Abbreviations

AF	acre-foot (feet)
AFY	acre-foot (feet) per year
ATRW	advanced treated recycled water
AWPF	Advanced Water Purification Facility
CB	Central Basin
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
cfs	cubic foot (feet) per second
City	City of Los Angeles
County Public Works	Los Angeles County Public Works
CTR	California Toxics Rule
DBP	disinfection by-product
DDW	Division of Drinking Water
DiPRRA	Direct Potable Reuse Responsible Agency
DPR	direct potable reuse
ECLWRF	Edward C. Little Water Recycling Facility
GAC	granular activated carbon
gpm	gallon(s) per minute
GWR	groundwater replenishment
HWRP	Hyperion Water Reclamation Plant
in/hr	inch(es) per hour
IPR	indirect potable reuse
Jensen WTP	Joseph Jensen Water Treatment Plant
LAA	Los Angeles Aqueduct
LAAFP	Los Angeles Aqueduct Filtration Plant
LADWP	Los Angeles Department of Water and Power
LAR	Los Angeles Reservoir
LASAN	Los Angeles Sanitation & Environment
Metropolitan	Metropolitan Water District of Southern California
MGD	million gallons per day

mg/L	milligram(s) per liter
MP	Pure Water Los Angeles Master Plan
N	nitrogen
NDMA	N-nitrosodimethylamine
No.	number
mg/L-N	milligram(s) per liter as nitrogen
ONAT	Operation NEXT Assessment Tool
Parks Program	Stormwater Parks Program
PFAS	per- and polyfluoroalkyl substances
Program	Pure Water Los Angeles Program
PWSC	Pure Water Southern California
RFI	Request for Information
RWQCB	Regional Water Quality Control Board
RWA	raw water augmentation
SFB	San Fernando Basin
SWP	State Water Project
SZ	Service Zone
Tillman AWPF	Donald C. Tillman Advanced Water Purification Facility
TIN	total inorganic nitrogen
TM	technical memorandum
TWA	treated water augmentation
UV	ultraviolet
UVAOP	ultraviolet advanced oxidation process
VNC	Van Norman Complex
VOC	volatile organic compound
WCB	West Coast Basin
WCBBP	West Coast Basin Barrier Project
West Basin	West Basin Municipal Water District
WRD	Water Replenishment Water District of Southern California
WTP	water treatment plant

1 Introduction

The Pure Water Los Angeles (Program) Master Plan (MP) evaluates potential alternatives for potable reuse to maximize the use of recycled water from the Hyperion Water Reclamation Plant (HWRP) and the anticipated Advanced Water Purification Facility (AWPF). Locations for integrating potable reuse were identified in the Los Angeles Department of Water and Power (LADWP) water distribution system as well as through external partnerships.

This technical memorandum (TM) provides a high-level summary at this specific point in time (May 2024) of the potable reuse source, supply, storage, and demand options selected for incorporation into the Program alternatives development. These alternatives will be carried forward for confirmation with LADWP, followed by Program alternative comparison, screening, and shortlisting of the preferred Program alternatives. Details about the storage and demand locations, including basis of flows, operational and infrastructure needs, and additional considerations, are provided in the *Validation of Strategy Technical Memorandum* (Jacobs and Arcadis 2024) and *Interconnectable Partnership Opportunities Technical Memorandum* (Jacobs 2024).

2 Components

Program components can be classified based on their ability to either source, supply, store, or directly distribute Program water based on the following definitions:

- Source water partner: A wastewater agency, in this case, Los Angeles Sanitation & Environment (LASAN), that can provide treated wastewater effluent to the Pure Water Los Angeles Program for further treatment and reuse
- Supply: Treated wastewater effluent that has undergone advanced water treatment for potable reuse
- Storage: Where AWPF treated water is placed and held for a specified time before being used for demand
- Demand: Component that takes AWPF treated water for consumptive end uses or distribution to partners

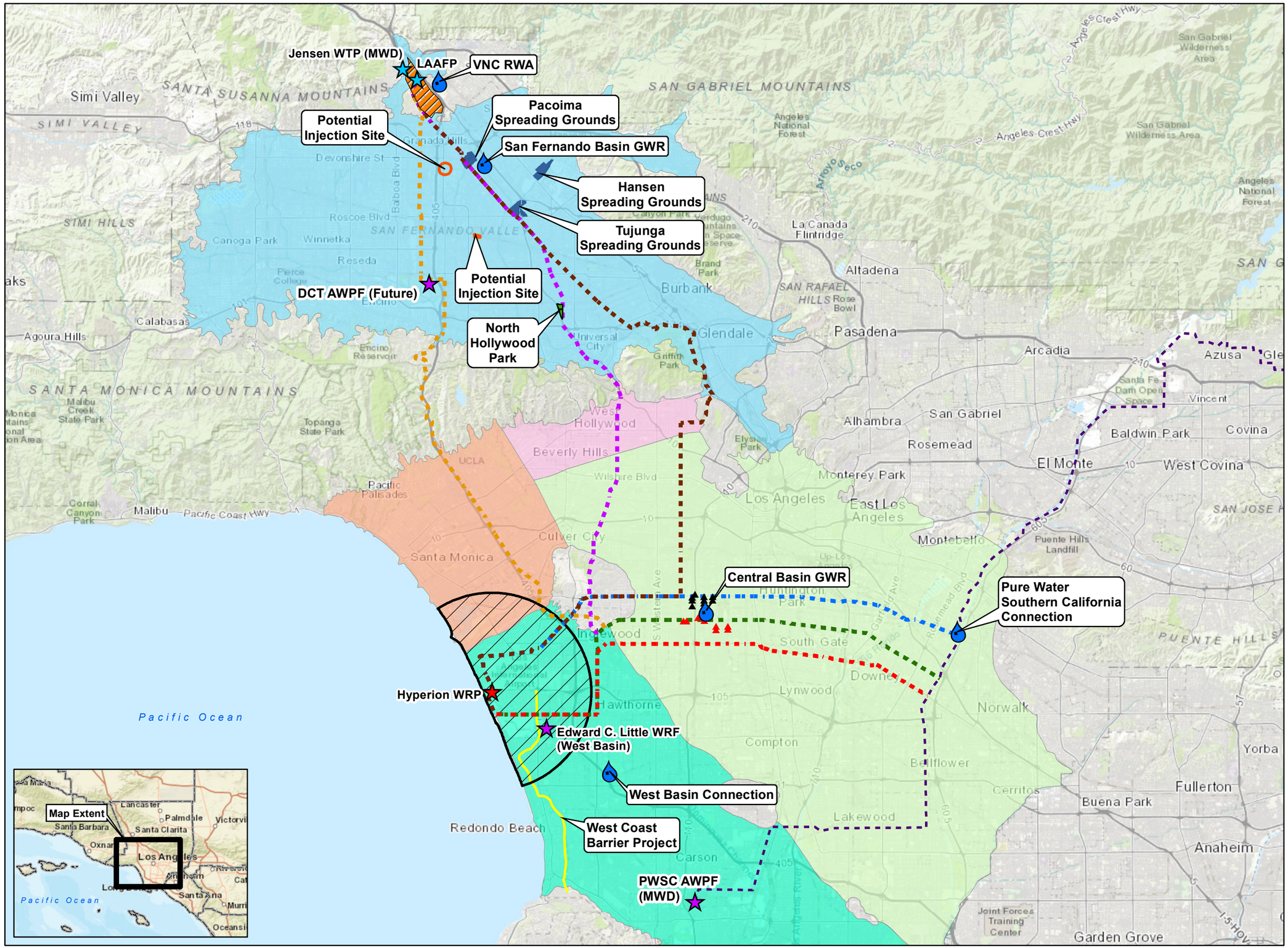
The AWPF, which is to be served by and located at or near the HWRP, will be the supply of all water for the Program. The location of the AWPF is currently being evaluated by LASAN and LADWP's Owner's Agent under a separate contract.

The following storage and demand locations were identified to be used in development of Program alternatives (Figure 2-1):

- Central Basin (CB)
- San Fernando Basin (SFB)
- Van Norman Complex (VNC)
- Potential partnership with West Basin Municipal Water District (West Basin)
- Potential partnership with Metropolitan Water District of Southern California (Metropolitan)
- Potential partnership with Water Replenishment District (WRD)

Additional partnerships (such as with the City of Santa Monica) are discussed in the *Interconnectable Partnership Opportunities Technical Memorandum* (Jacobs 2024). Only the larger regional partnerships are included in this TM.

Table 2-1a, 2-1b, and Table 2-2 provide details about the individual storage and demand potable reuse locations, additional infrastructure, and technical analyses required for validation. Currently, all alternatives and flows assume the supply meets at least indirect potable reuse (IPR) water quality and regulatory requirements leaving the AWPF.



Legend

- Water Delivery
- Advanced Water Purification Facility
- Drinking Water Treatment Plant
- Water Reclamation Plant
- New Extraction Wells
- New Injection Wells
- Potential Siting Area for the Advanced Water Purification Facility
- Van Norman Complex
- Pure Water Southern California

Alignment Options

- Cahuenga
- Florence
- Griffith Park
- Manchester
- Sepulveda
- Slauson

Groundwater Basins

- San Fernando
- Central
- Hollywood
- Santa Monica
- West Coast

Sources:
LADWP, 2022; LA County, 2023
ESRI World Topo Map; ESRI World Street Map

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Miles
1 inch = 4 miles

Figure 2-1. Source, Supply, Storage, and Demand Components

Pure Water Los Angeles Master Plan

Jacobs

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Table 2-1a. Pure Water Los Angeles Potable Reuse Alternatives Matrix for LADWP Storage and Demand Locations [a]

Integration Location	CB	VNC
Potable Reuse	GWR	RWA
Foundational Assumptions	▪ CB will be used for up to 16,071 AFY (28 cfs [18 MGD]) (LADWP 2024a) of Pure Water Los Angeles ATRW for groundwater augmentation (WRD 2024) based on an injection to extraction ratio of 1:1, with the potential for storing the flow for more than 1 year. The flows in cfs and MGD represent a 10-month annual operating period. ▪ Up to 18,739 AFY (WRD 2024; LADWP 2021a, 2024a) for existing LADWP; WCB transferred entitlements of Pure Water Los Angeles ATRW will be injected for GWR, which will require an agreement between WRD and LADWP. ▪ IPR and DPR quality water will be considered for GWR. ▪ Storage can be more than 1 year without losing the rights. ▪ West Basin's existing recycled water distribution system could be used to deliver flow to new CB injection wellfields by extending the Inglewood Lateral.	▪ UVAOP and GAC or alternative treatment technologies after the AWPF must be able to comply with DPR regulations as an alternative concept and requires validation testing. ▪ ONAT analysis to evaluate the range of flows to VNC. ▪ CTR compliance (Arcadis and Jacobs 2024) is not considered in treatment train selection, but the proposed treatment train would provide benefits for CTR compliance; Los Angeles RWQCB could regulate aqueducts and LAR for CTR compliance. ▪ Location will require balancing various flow sources to VNC (LAA, SWP). ▪ Flow to other storage and demand locations or discharge to the ocean may be required during VNC shutdowns. ▪ The chemical control requirements of the DPR regulations may be met if a blend of 10% or less of Pure Water Los Angeles AWPF treated water is achieved. However, additional pathogen control is required with a blend of 10% or less, likely necessitating post-AWPF treatment. ▪ DPR requirements will be met before integrating water into VNC.
Location Options	Injection and extraction in Los Angeles Forebay, and extraction at 99th Street and Manhattan Wellfields.	Upstream of LAAFP.
Storage	34,472 AF of LADWP's storage, plus other unused available storage (e.g., community storage, operational reserve) if approved (Los Angeles Superior Court 2013).	--
Demand	10 to 59 cfs (6.5 to 38 MGD)[b].	Up to 252 cfs (Up to 163 MGD) for DPR at VNC; up to 352 cfs (230 MGD) for DPR at AWPF.
General Description	GWR and extraction in the Los Angeles Forebay through phased upgrades to distribution and the existing Manhattan and 99th Street wellfields, as well as new injection and extraction wellfields. Requires plume management and extraction treatment.	Integration of DPR treated water into the raw water supply upstream of LAAFP or into LAR (potable water reservoir).
Operational Challenges and Other Considerations	▪ There would be impacts on nitrification in the upstream potable water zones due to potential increased water age. ▪ Existing contaminants and native constituents in the basin might impact treatment train selection and operation, with the potential to trigger the 97-005-R2020 process (SWRCB 2020). ▪ Potential to sell unused water to WRD. ▪ Real estate needed for new infrastructure. ▪ Capital improvements will be completed to provide supply of potable water from Harbor Trunkline (LADWP 2024b). ▪ Capital improvements are needed to support greater production from CB; LADWP is evaluating how to address operational challenges in CB through phased improvements (LADWP 2024b). ▪ Further evaluation is recommended with respect to the following factors: - Increased number of extraction wells - Integration into the existing distribution system - Balancing of distribution system pressures - Management of excess water scenarios	▪ During LAAFP annual shutdowns, the Pure Water Los Angeles AWPF treated water would need to be diverted to other locations or flows reduced. ▪ With DPR compliance before integration, a connection to LAR could be considered for additional flexibility to manage flows. ▪ Meet response time and diversion requirements if AWPF experiences treatment operational issues. ▪ An initial phase could include a reduced flow that would allow blending of less than 10% Pure Water Los Angeles AWPF treated water to eliminate the need for chemical control, though additional pathogen control may be required. ▪ Current hydraulics in VNC are maintained. ▪ Assumes DDW approval of the post-AWPF treatment approach.
Additional Infrastructure	▪ Conveyance from selected Program alignment. ▪ New distributed injection and extraction wellfields that would be in the Los Angeles Forebay Area east of the Manhattan Wellfield and north of the 99th Street Wellfield. ▪ Preliminary assumption is based on 27 new injection wells with an injection rate of 1,000 gpm and 7 extraction wells with an extraction rate of 2,000 gpm (LADWP RFI 64). ▪ Centralized treatment facility for the new extraction wells, including infrastructure for the following processes: - Adsorptive filtration - GAC - Ion exchange resin sorption (future) - Chlorination ▪ Leveraging CB for extraction of both existing entitlements and Pure Water Los Angeles supply requires improvements, including (LADWP 2024a): - Upgrades to pump stations - Reconfiguration or upsizing of trunklines - Other improvements in the 477 pressure zone, Harbor, and LA-16 areas	▪ Conveyance from selected Program alignment. ▪ New treatment facilities assumed to include UVAOP and GAC (if approved by DDW). ▪ Conveyance to LAR if flexibility to flow into LAR is desired.

Integration Location	CB	VNC
Additional Technical Analysis	▪ Evaluate flows that can be managed in CB as part of Pure Water Los Angeles. ▪ Initiate pilot test wells to determine design criteria. ▪ Conduct additional groundwater quality sampling (requiring new monitoring wells) and evaluate compatibility of Pure Water Los Angeles water quality. ▪ Conduct additional groundwater modeling once field data concerning ambient water quality and hydrogeological characteristics of the selected areas become available to better refine the limits of CB and the feasibility of proposed alternatives. ▪ Initiate a CB study to determine: - Groundwater production capacity - New production well and wellfield locations - Water quality monitoring - Required treatment - Opportunities to acquire additional groundwater rights	▪ Evaluate flows that can be managed at VNC (as part of Pure Water Los Angeles). ▪ Conduct validation testing of post-AWPF treatment for DPR regulatory compliance and DDW coordination.

[a] Groundwater injection wells for CB and SFB assume a 10-month annual operating period. All other locations assume a 12-month annual operating period.

[b] Assumes GWR and augmentation in CB based on direction from WRD (WRD 2024a) and assuming a 10-month operating period per year of 31 cfs (20 MGD) for replenishment and 28 cfs (18 MGD) for augmentation (LADWP 2024b).

Notes:

-- = not applicable
AF = acre-foot (feet)
AFY = acre-foot (feet) per year
ATRW = advanced treated recycled water
cfs = cubic foot (feet) per second
CTR = California Toxics Rule
DDW = Division of Drinking Water
DPR = direct potable reuse
GAC = granular activated carbon
gpm = gallon(s) per minute
GWR = groundwater replenishment
LAA = Los Angeles Aqueduct
LAAFP = Los Angeles Aqueduct Filtration Plant
LAR = Los Angeles Reservoir
MGD = million gallons per day
ONAT = Operation NEXT Assessment Tool
RFI = Request for Information
RWA = raw water augmentation
RWQCB = Regional Water Quality Control Board
SWP = State Water Project
UVAOP = ultraviolet advanced oxidation process
WCB = West Coast Basin

Table 2-1b. Pure Water Los Angeles Potable Reuse Alternatives Matrix for LADWP Storage and Demand Locations

Integration Location	SFB		
Potable Reuse	GWR		
Foundational Assumptions	▪ Groundwater recharge in SFB will be included in all Program alternatives and may include water from Pure Water Los Angeles or Tillman AWPF, or a combination of both. ▪ 77 cfs (50 MGD) or 56,000 AFY of SFB groundwater injection capacity will be included for all alternatives. ▪ IPR and DPR quality water will be considered for groundwater recharge. ▪ Spreading grounds and stormwater capture parks will be seasonally available for recharge. ▪ Extensive monitoring and modeling will be needed to verify that groundwater recharge doesn't create adverse groundwater conditions. ▪ Planning is required to balance recharge, extraction, and storage to prevent stranded assets or recharging water that can't be captured.		
Location Options	Spreading Grounds (Tujunga, Pacoima, Hansen)	Injection Wells	Stormwater Capture Parks
Storage	3,200,000 AF total capacity, 360,000 AF of regulatory storage, and 550,000 AF of current dewatered storage[a]		
Demand[b]	Up to 130 cfs (up to 84 MGD)	Up to 77 cfs (up to 50 MGD)	Up to 23 cfs (up to 15 MGD)
General Description	GWR at Tujunga, Pacoima, and Hansen Spreading Grounds, and extraction with existing production wells. Requires plume management and extraction treatment.	GWR through new injection wells and extraction with existing production wells. Requires plume management and extraction treatment.	GWR in planned infiltration galleries during dry conditions and extraction with existing production wells. Requires plume management and extraction treatment.
Operational Challenges and Other Considerations	▪ During rainfall events, the spreading grounds would be unavailable to accept recycled water. Planning assumes the spreading grounds would be unavailable during the wet season (November through March). ▪ Tujunga Spreading Grounds are owned by LADWP and operated in conjunction with County Public Works and can be use as needed for the Program. ▪ Pacoima and Hansen spreading grounds are owned by County Public Works, used for groundwater augmentation, and would require coordination between LADWP and County Public Works. ▪ The groundwater replenishment and extraction capacity in SFB must also be considered based on impacts to the distribution system. Excess water can be stored with consideration for storage limits and increases in groundwater levels.	▪ Injection wells would be available for groundwater recharge 10-months per year, providing a constant location for recycled water flows (unlike spreading grounds). ▪ Requires available land for the new injection wells. ▪ Preliminary assumption is 17 new injection wells (Hazen and Arcadis 2024). ▪ Consideration should be given to contaminant plume locations when siting injection wells. ▪ The groundwater replenishment and extraction capacity in SFB must also be considered based on impacts to the distribution system. Excess water can be stored with consideration for storage limits and increases in groundwater levels.	▪ During rainfall events, the stormwater capture parks would be unavailable to accept recycled water. Planning assumes the spreading grounds would be unavailable during the wet season, from November through March. ▪ Stormwater capture parks need to provide at least 2 months of residence time before reaching production wells. ▪ Only North Hollywood infiltration galleries 1 and 2 are assumed to be used based on proximity of the other parks to existing production wells. ▪ North Hollywood infiltration galleries have not been constructed, and the schedule is uncertain. ▪ The GWR and extraction capacity in SFB must also be considered based on impacts to the distribution system. Excess water can be stored with consideration for storage limits and increases in groundwater levels.
Additional Infrastructure	▪ Conveyance from selected Program alignment. ▪ Treatment assumed for all groundwater extracted exceeding North Hollywood West, North Hollywood Central, and Tujunga WTP capacities. Treatment assumed to include UVAOP and GAC to match existing WTPs.	▪ Conveyance from the selected Program alignment. ▪ New injection wells. ▪ Treatment assumed for all groundwater extracted exceeding North Hollywood West, North Hollywood Central, and Tujunga WTP capacities. Treatment assumed to include UVAOP and GAC to match existing WTPs.	▪ Conveyance from the selected Program alignment. ▪ Rehabilitation of out of service wellfields for extraction may be required based on the final stormwater park location. ▪ Treatment assumed for all groundwater extracted exceeding North Hollywood West, North Hollywood Central, and Tujunga WTP capacities. Treatment assumed to include UVAOP and GAC to match existing WTPs.
Additional Technical Analysis	▪ As part of Pure Water Los Angeles, evaluate allocation of flows when spreading grounds and stormwater capture parks are not available during wet weather. ▪ Conduct groundwater modeling or a tracer study to confirm residence time of recycled water spread at Tujunga Spreading Grounds. ▪ Conduct groundwater modeling to evaluate potential impacts on contaminant plumes. ▪ Confirm the range of demands that can be met through SFB extraction.	▪ As part of Pure Water Los Angeles, evaluate allocation of flows when spreading grounds and stormwater capture parks are not available during wet weather. ▪ Initiate pilot test wells to determine design criteria. ▪ Conduct additional groundwater quality sampling and evaluation of compatibility of Pure Water Los Angeles water quality. ▪ Conduct groundwater modeling to evaluate potential impacts on contaminant plumes. ▪ Confirm range of demands that can be met through SFB extraction.	▪ As part of Pure Water Los Angeles, evaluate allocation of flows when spreading grounds and stormwater capture parks are not available during wet weather. ▪ Conduct groundwater modeling to evaluate long-term capacity, residence time, and capture. ▪ Conduct groundwater modeling to evaluate potential impacts on contaminant plumes. ▪ Confirm range of demands that can be met through SFB extraction.

[a] (LADWP 2021a; ULARA 1999, 2019)

[b] Demand flows represent GWR flows for Pure Water Los Angeles water.

Notes:

County Public Works = Los Angeles County Public Works
Tillman AWPF = Donald C. Tillman Advanced Water Purification Facility
WTP = water treatment plant

Table 2-2. Pure Water Los Angeles Potable Reuse Alternatives Matrix for Partnerships

Integration Location	West Basin	Metropolitan		WRD
Potable Reuse	GWR	GWR or RWA		GWR
Foundational Assumptions	Significant agency-level coordination and negotiations are expected to work out the details should there be a desire to move this regional partnership opportunity forward.	Significant agency-level coordination and negotiations are expected to work out the details should there be a desire to move this regional partnership opportunity forward.		Significant agency-level coordination and negotiations are expected to work out the details should there be a desire to move this regional partnership opportunity forward.
Location Options	ECLWRF	PWSC	Jensen WTP	WCB and CB
Storage	--	--	--	--
Demand	▪ 31 to 62 cfs (20-40 MGD); includes up to 27 cfs (17.5 MGD) to WCB and up to 35 cfs (22.5 MGD) to West Basin customers, with seasonal variations.	▪ Up to 232 cfs (up 150 MGD) of hydraulic capacity; actual flow to depend on water quality and Metropolitan DPR goals.	▪ Up to 48 cfs (31 MGD) (Jacobs 2024), depending on Metropolitan's water quality requirements and allowable recycled water used in their potable water system.	▪ Up to an additional potential demand of 18,600 AFY to WCB, as follows: – 13,000 AFY (18 cfs [12 MGD]) of additional replenishment due to remediation of the brackish plume – 5,600 AFY (8 cfs [5 MGD]) of additional replenishment through WCBBP, represented in West Basin demands ▪ Up to an additional potential demand of 29,739 AFY to CB, as follows: – 11,000 AFY (15 cfs [10 MGD]) of replenishment water to replace imported supply – 18,739 AFY (26 cfs [17 MGD]) of replenishment water up to LADWP's entitlements in CB and WCB
General Description	▪ Delivery of water to ECLWRF for meeting West Basin demands.	▪ Connection to PWSC Backbone to convey recycled water from the Warren Facility AWPF to recharge WCB, CB, and Main San Gabriel Basin, and to Weymouth WTP for RWA.	▪ Interconnect with Jensen WTP.	▪ For WCB: – Additional replenishment due to remediation of the brackish plume; recharge location and potential tie-in location are unknown. – Additional replenishment through WCBBP. ▪ For CB: – Replenishment water to replace imported supply from Metropolitan for recharge at Montebello Forebay using existing spreading grounds. – Replenishment water in CB related to LADWP's extraction of its entitlements, including transfer from WCB, could be replenished through new injection wells near the Manhattan wells.
Operational Challenges and other Considerations	▪ Delivery of flow based on City demands and policies. ▪ Need interagency agreement. ▪ Potential for locating Pure Water Los Angeles AWPF at the ECLWRF AWPF site. ▪ Flow assumes expansion of flows to WCB.	▪ A Metropolitan systemwide N limit for the drinking WTPs of no more than 2 mg/L-N of TIN at least 95% of the time. ▪ Water supplies from recycled water origin will be no more than 50% as source water to Metropolitan's surface WTPs. ▪ The type of DPR that might be implemented under this partnership has not been determined; it would be expected to have significant implications to the permitting arrangement at an agency level led by the DiPRRA.	▪ A systemwide N limit for the drinking WTPs of no more than 2 mg/L-N of TIN at 95% of the time. ▪ Water supplies from recycled water origin to no more than 50% as source water to Metropolitan's surface water plants. ▪ The type of DPR that might be implemented under this partnership has not been determined; it would be expected to have significant implications to the permitting arrangement at an agency level led by the DiPRRA.	▪ Need interagency agreement. ▪ Tie-in locations for the recharge using new infrastructure needs to be defined in the future between the two agencies. ▪ If spreading grounds in Montebello Forebay is to be used, the potential lack of access to the spreading grounds during wet weather seasons should be understood to provide better flow management for Pure Water Los Angeles.
Additional Infrastructure	▪ Uses existing infrastructure.	▪ LADWP to construct conveyance to the PWSC Backbone.	▪ Additional infrastructure needs are under development while the feasibility of the partnership is evaluated.	▪ New conveyance and injection wells to recharge the replenishment water up to LADWP's entitlements. ▪ Potential pipeline to connect to recharge locations specified by WRD to deliver replenishment water.
Additional Technical Analysis	▪ Evaluate the use of West Basin's infrastructure to accelerate delivered water to CB and the Harbor area. ▪ Evaluate the role and potential for using West Basin to accelerate water delivery by Pure Water Los Angeles. ▪ Define the potential institutional arrangement options. ▪ Define the capital improvement needs and the associated cost to allow for comparison against other options.	▪ Develop details of integration options to develop plans for meeting regulatory requirements. ▪ Metropolitan has a policy of limiting its system to use no more than 50% of recycled water as a source; additional discussions are needed to determine whether modification is possible to increase the flexibility to incorporate ATRW. ▪ Conduct additional analysis to determine capacity at Metropolitan's treatment plants to receive Pure Water Los Angeles ATRW by lowering the nitrate concentration in Pure Water Los Angeles ATRW to 2 mg/L as N. ▪ Investigate water quality specifications required for interconnect between Jensen WTP and PWSC.		▪ Define the flow rates or demands and the potential variability of replenishment opportunities. ▪ Collaborate with WRD to further define the identified opportunities, such as recharge locations and methods. ▪ Evaluate the potential of mobilizing organic compounds, such as PFAS, from the soil matrix of the spreading grounds if Montebello Spreading Grounds are to be used.

Integration Location	West Basin	Metropolitan	WRD
	▪ Further develop the potential of phasing and implementation of HWRP and Pure Water Los Angeles AWPF as near-term actions, allowing cost-effective and rapid implementation as part of the Program.	▪ Identify institutional arrangements necessary for these interconnections to be permitted under the DPR regulations, including DiPRRA.	▪ Evaluate how costs could be shared for replenishing CB using injection wells from Pure Water Los Angeles. ▪ Develop a joint strategy to maximize recharge during wet weather seasons.

Notes:

-- = not applicable
City = City of Los Angeles
DiPPRA = Potable Reuse Responsible Agency
ECLWRF = Edward C. Little Water Recycling Facility
mg/L = milligrams(s) per liter
mg/L-N = milligrams(s) per liter as nitrogen
N = nitrogen
PFAS = per- and polyfluoroalkyl substances
PWSC = Pure Water Southern California
TIN = total inorganic nitrogen
WCBBP = West Coast Basin Barrier Project

2.1 Central Basin

CB provides approximately 330,000 AF of available dewatered space in the basin for all pumping entities. LADWP currently has a water entitlement volume of 17,236 AFY (24 cfs [15.5 MGD]), with LADWP storage capped at twice that volume at 34,472 AFY (48 cfs [31 MGD]); whereas, the remaining 185,528 AF of storage is owned by other rights holders, and 110,000 AF is owned by WRD as basin operational reserve (LADWP 2023a).

If LADWP maximizes their storage, they are allowed to pump up to 40% more than their existing entitlements, although they have not exercised this historically. The CB Judgment also allows for carryover and storage of unused water rights up to a maximum of 60% of a purveyor's pumping right (LADWP 2021b).

2.1.1 Current Operations

LADWP owns and operates two extraction wellfields in CB: the Manhattan Wells and the 99th Street Wells. Both wellfields are being rehabilitated to maximize production capacity (LADWP 2024a).

Although LADWP has water rights of 17,236 AFY (24 cfs [15.5 MGD]), current pumping is approximately 7,240 AFY (10 cfs [6.5 MGD]), and unused rights are forfeited back to the basin. Exercising of water rights is limited by aboveground infrastructure, including older distribution mains in a closed system that can be subject to over-pressurization, with utilization dependent on demand (LADWP 2024a).

Additionally, 1,503 AFY (2 cfs [1.3 MGD]) of water rights from WCB can be transferred to LADWP. LADWP confirmed that there will be extraction capacity up to 31 cfs (20 MGD) to pump their existing water entitlements, plus those transferred from WCB (LADWP 2024b).

2.1.2 Potential Utilization and System Integration Opportunities

Under the CB Judgment 2013 amendment (Los Angeles Superior Court 2013), the ATRW from Pure Water Los Angeles can be applied to replenish CB as either a replenishment project, which would support the extraction by the parties under existing water rights, or as an augmentation project exceeding existing rights. Water provided for replenishment would involve an agreement between LADWP and WRD, as WRD is responsible for replenishment. Pure Water Los Angeles ATRW provided for an augmentation project could be extracted by LADWP up to the volume provided for augmentation.

LADWP is evaluating four phases of system improvements to aboveground infrastructure that would incrementally increase production in CB, as shown in Table 2-3, assuming access to additional water rights through groundwater augmentation (LADWP 2024b). For this MP, only the first three phases shown in Table 2-3 will be included in the evaluation. A potential Phase 4 could involve incorporation of variable frequency drives to better match diurnal demands in these zones and provide total future capacity of up to 89 cfs (58 MGD).

For this evaluation:

- **Injection** refers to injected water and injection wells.
- **Extraction** refers to extraction wells.
- **Production** refers to extraction, treatment of extracted groundwater, and aboveground and buried infrastructure to move water from extraction wells and treatment through the CB potable water distribution system to demand locations.

Table 2-3. Central Basin Production Capacity After Proposed System Improvements

Schedule	CB Production Capacity Added by Phase[a,b]		Total CB Production[a,b]		Pure Water Los Angeles Extraction and Treatment Capacity[a,b,c]		System Improvement Needs	Status
	cfs	MGD	cfs	MGD	cfs	MGD		
Current	10	6.5	10	6.5	0	0	--	--
Phase 1	6	4	16	10	0	0	▪ Western Trunkline Project with improvements for flow reconfiguration ▪ 99th Street Production Wells and Filtration Plant	Ongoing
Phase 2	20	13	36	23	5	3	▪ Manhattan Wells Operational Improvements Project: – 477 SZ pumps – Forebay – Outlet line connection to Western Trunkline – Iron and manganese treatment ▪ Additional 5 cfs (3 MGD) of injection and extraction wells and treatment	Conceptual Planning
Phase 3	23	15	59	38	28	18	▪ Upsize and replace the 12-mile-long Harbor Trunkline ▪ Additional 23 cfs (15 MGD) of injection and extraction wells and treatment	Future

[a] Modified from LADWP (2024a). Some values have been rounded for simplicity and consistency with LADWP documents.

[b] Assumes 10-month operation per year (LADWP 2024b).

[c] These flows represent extraction of augmentation water exceeding existing rights.

Notes:

-- = not applicable
SZ = Service Zone

With the phasing shown in Table 2-3, Pure Water Los Angeles water could serve as both replenishment of existing rights and as augmentation exceeding LADWP's existing groundwater rights for extraction of more than the full rights (WRD 2024a). By the end of Phase 3, up to 59 cfs (38 MGD) of Pure Water Los Angeles ATRW could be injected into CB. To take advantage of the augmentation, new extraction and treatment facilities would be needed for the new flow exceeding the existing rights.

It is assumed that all groundwater augmentation in CB would be accomplished through groundwater injection wells. To inject up to 59 cfs (38 MGD), it was preliminarily estimated that, based on an injection rate of 1,000 gpm, 27 new injection wells would be needed; and based on an extraction rate of 2,000 gpm, 7 new extraction wells would be needed (LADWP RFI 64). Well sizing was based on an assumed operation of 10 months per year.

Based on groundwater contamination present at other production wells in the area, treatment facilities are assumed for the added production capacity beyond the current entitlements for iron, manganese, and volatile organic compounds (VOCs). Future treatment for perchlorate and hexavalent chromium removal was also considered (Jacobs and Arcadis 2024).

2.2 San Fernando Basin

LADWP currently holds approximately 87,000 AFY (120 cfs [78 MGD]) of water rights in SFB (LADWP 2021a). SFB provides approximately 3.2 million AF of groundwater storage (ULARA 1999). SFB has a regulatory requirement to operate within a 360,000 AF range (ULARA 2019). However, current dewatered storage is less than the lower regulatory limit, resulting in a current storage volume of approximately 550,000 AF that the City of Los Angeles may use with the consideration of ongoing hydrogeologic and remedial activities (LADWP 2021a; ULARA 2019).

2.2.1 Current Operations

The City of Los Angeles has historically underused its water rights in SFB for decades due to the presence of groundwater contamination primarily caused by commercial and industrial activities. Extraction from the basin has historically averaged approximately 58,000 AFY (80 cfs [52 MGD]) (LADWP 2021a).

LADWP is implementing SFB remediation projects consistent with the *Comprehensive Environmental Response Compensation and Liability Act* (CERCLA) and National Contingency Plan to extract and treat groundwater. These projects were implemented with the goal of reducing and containing contamination, while simultaneously providing LADWP with treated drinking water. The new projects are estimated to bring the total production capacity in SFB to approximately 300 cfs (194 MGD) (LADWP 2021a). For planning purposes, a maximum production capacity of 220 cfs (142 MGD) was assumed to account for system constraints, such as available demands or blending requirements, that may limit the ability to use extracted groundwater from SFB.

To increase GWR in SFB, the City of Los Angeles and County Public Works operate a series of spreading grounds and stormwater capture parks to increase the capture and recharge of stormwater into the basin.

2.2.2 Potential Utilization and System Integration Opportunities

In addition to the existing rights, recharge of stormwater and recycled water from Tillman AWPF or Pure Water Los Angeles would increase LADWP's water rights. Three options, summarized in Table 2-4 and on Figure 2-2, were evaluated for recharging Pure Water Los Angeles ATRW into SFB for groundwater augmentation:

- Spreading grounds
- Injection wells
- Stormwater capture parks

Table 2-4. Pure Water Los Angeles Program Flows to San Fernando Basin

Location	Pure Water Los Angeles Flow		Justification
	cfs	MGD	
Tujunga Spreading Grounds[a]	30	19	Flow limited to basins farthest from production wells to maximize available residence time. Tracer study required to determine residence time and refine recharge capacity.
Pacoima Spreading Grounds[a]	70	45	Conservative estimate limited to 50% of the infiltration capacity (140 cfs [90 MGD]) to limit groundwater mounding.
Hansen Spreading Grounds[b]	30	19	Conservative estimate based on flows > 44 cfs (28 MGD) may increase mounding and adversely impact operations at the Bradley Landfill. Capacity includes any water delivered from the Tillman AWPF.
Injection Wells	77	50	Assumed baseline injection capacity (Hazen and Arcadis 2024). Capacity to be refined based on ONAT model results.
North Hollywood Infiltration Gallery 1[c]	14	9	Infiltration rate of 2.5 in/hr and the gallery area for Configuration 1.

Location	Pure Water Los Angeles Flow		Justification
	cfs	MGD	
North Hollywood Infiltration Gallery 2[c]	9	6	Infiltration rate of 3.5 in/hr and the gallery area for Configuration 1.

[a] LADWP 2023b

[b] RMC 2012

[c] Tetra Tech 2020

Notes:

> = greater than
in/hr = inch(es) per hour

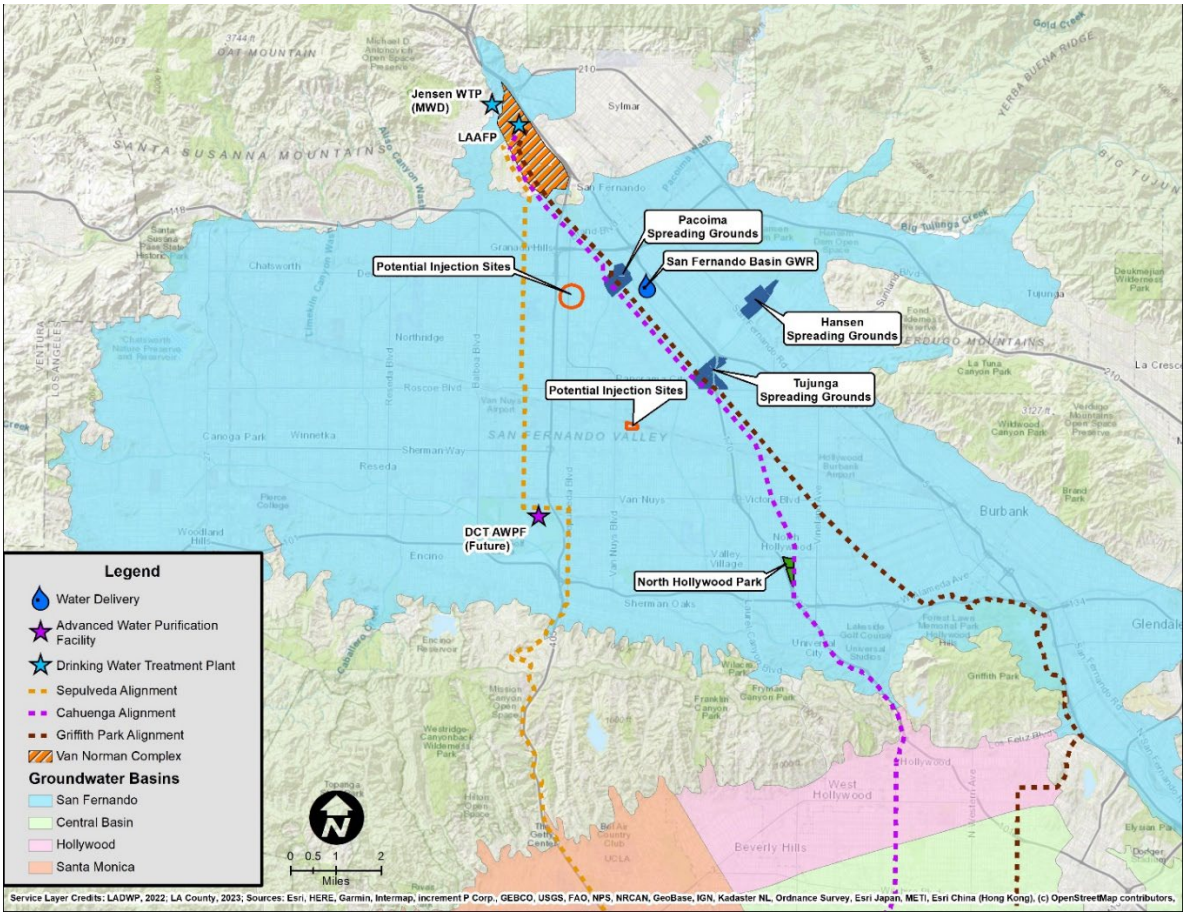

Figure 2-2. San Fernando Basin Groundwater Recharge Locations

2.2.2.1 Spreading Grounds

Three spreading grounds in SFB were considered: Tujunga, Pacoima, and Hansen. The Tujunga Spreading Grounds are owned by LADWP, operated in conjunction with County Public Works, and can be used as needed for the Program. The Pacoima and Hansen spreading grounds are owned by County Public Works, are used for groundwater augmentation, and would require coordination between LADWP and County Public Works (LADWP 2021a).

Currently, recharge with stormwater is the primary objective for the spreading grounds. Therefore, during rainfall events, the spreading grounds would be unavailable to accept Pure Water Los Angeles ATRW. For this reason, it is assumed that the spreading grounds will only be available to accept Pure Water Los Angeles flow from April to October each year, and flows would be diverted to other storage and demand locations from November through March.

Table 2-4 provides the conceptual allocated flows to each spreading ground from April to October. Actual spreading capacity throughout the year will depend on stormwater flows, increases in groundwater levels, and residence times. Spreading ground capacities for Pure Water Los Angeles flows were reduced from maximum infiltration capacity to account for mounding with long-term recharge. Capacity at Hansen Spreading Grounds includes flow from Tillman AWPF. Tillman AWPF will either be recharged in Hansen Spreading Grounds or through injection discussed in the following section.

LADWP currently operates groundwater wells in the Tujunga Spreading Grounds and near the Hansen Spreading Grounds, which may limit recharge capacity to maintain the minimum required 2 months of residence time under the IPR regulations (*California Code of Regulations*, Title 22, Social Security, Division 4, Environmental Health, Chapter 3, Water Recycling Criteria, Articles 5.1). If the residence time is less than 2 months, recharge at Tujunga Spreading Grounds would be permitted as a DPR project under the DPR regulations (SWRCB 2023).

2.2.2.2 Injection Wells

SFB can also be recharged with recycled water through gravity injection wells in portions of the basin to have the available capacity and desirable hydrogeology (Hazen and Arcadis 2024). The location of the new injection wells would be selected based on:

- Available land
- Hydrogeology
- Ability to maintain the required residence time
- Ability to capture the water before mixing with known contaminant plumes in the basin

Multiple areas in SFB were found to be favorable for injection facilities, including areas near the East Valley Pipeline and Pacoima Spreading Grounds (Hazen and Arcadis 2024). Unlike the spreading grounds, the injection wells would be available year-round, providing a consistent location for recycled water flows. Additional modeling is required to confirm potential impacts to groundwater levels and interactions with known contaminant plumes.

An initial conceptual injection capacity was assumed to be 77 cfs (50 MGD). The assumed injection capacity accounts for flows from either Pure Water Los Angeles or Tillman AWPF. If Tillman AWPF discharges to the Hansen Spreading Grounds, the injection capacity will be available to Pure Water Los Angeles. Based on preliminary analysis (Hazen and Arcadis 2024), 17 injection wells are assumed to allow for meeting the target injection capacity with an assumed operation of 10 months per year per well. The preliminary analysis indicated that additional injection capacity is possible through expanding the number of injection wells or using additional injection locations.

2.2.2.3 Stormwater Capture Parks

LADWP has supported the construction of stormwater capture programs throughout SFB. LADWP's Stormwater Parks Program (Parks Program) has also identified several additional City-owned parks that could be used for additional stormwater capture programs that will recharge water from the Tujunga Wash (Tetra Tech 2020). The proposed parks are also located close to several proposed Pure Water Los Angeles alignments or could be accessed from the East Valley pipeline. As with the spreading basins, it was assumed that this alternative would not be available during storm events and would only be available to accept flows from April to October.

Stormwater parks included in the Pure Water Los Angeles evaluation would need to be close to one of the proposed Program alignments or accessible from the East Valley pipeline. They would also need to

provide at least 2 months of residence time before reaching the extraction wells. The North Hollywood infiltration galleries 1 and 2 appear to meet both of these criteria, while also offering the highest potential infiltration rates. The North Hollywood infiltration galleries have not been funded at this time, and the implementation of these projects is uncertain. Table 2-4 provides the conceptual maximum allocated flows to these stormwater capture parks.

2.2.3 Treatment

By the end of 2024, SFB will have approximately 145 cfs (94 MGD) of treatment capacity at the North Hollywood West, North Hollywood Central, and Tujunga treatment facilities for contaminants found in SFB (1,4-dioxane and VOCs). Beyond the planned remediation efforts, there is also the potential for contamination in SFB's unsaturated zone. Rising water levels in the basin due to GWR could risk mobilizing additional contaminants unless recharge can be located away from contaminated areas. Based on the unknown of mobilizing additional contaminants, it is assumed that treatment will be provided for the full extracted flow of 220 cfs (142 MGD), which will require an additional 75 cfs (48 MGD) of treatment. Treatment is assumed to include 1.4-dioxane and VOC removal.

2.3 Van Norman Complex

VNC is located at SFB's northern boundary; both LAAFP and LAR are located at VNC. LAAFP is a 928 cfs (600 MGD), ozone-direct filtration plant with ultraviolet (UV) disinfection that has been in operation since 1986. LAR is a 3,300-MG (10,127 AF) uncovered finished water reservoir that is supplied by LAAFP (LADWP and Arcadis 2023).

2.3.1 Current Operations

Average raw water flows at LAAFP vary, but generally range between 465 and 743 cfs (300 and 480 MGD) (LADWP 2023c). LAAFP water supplies come from the Los Angeles Aqueduct and from interconnections with Metropolitan that can either supply raw water from the SWP or treated water from Jensen WTP.

2.3.2 Potential Utilization and System Integration Opportunities

Pure Water Los Angeles ATRW can be used as an additional raw water supply to VNC and could be used to help offset purchased SWP water. The target Pure Water Los Angeles flow to VNC identified in the Concept Study (LADWP 2021b) was 252 cfs (163 MGD), or 75% of the anticipated flow from the AWPF. Program flows to VNC will vary based on infrastructure design capacity and pre-existing water supplies to VNC, including from LAA and SWP. Treatment of 252 cfs (163 MGD) was determined to be feasible at VNC based on the available space for the assumed treatment train pending final treatment train selection and approval. Actual flows may vary depending on the specific Program alternative and will be evaluated through ONAT. If DPR treatment is achieved at the AWPF, the full flow of 356 cfs (230 MGD) could be integrated at VNC.

Integration at VNC with Pure Water Los Angeles ATRW flows greater than 10% of the total flow through LAAFP would require additional chemical control treatment at the AWPF, or possibly at VNC, depending on approval of an alternative approach by DDW. Post-AWPF treatment for pathogen log reduction credits and chemical control is assumed to include UVAOP and GAC. Further evaluation of the treatment approach for post-AWPF treatment, including pilot testing and DDW negotiation, is required. Pure Water Los Angeles ATRW flows less than 10% would not require chemical control, but additional pathogen log reduction credits would still be required to meet the DPR regulations.

RWA is the preferred approach to integrate Pure Water Los Angeles ATRW at VNC. With this approach, the Pure Water Los Angeles ATRW, treated to DPR standards, will be blended into the LAAFP raw water supply, which will then be treated through the filtration plant (Figure 2-3). All DPR treatment and regulations are assumed to be achieved before LAAFP integration to limit treatment modifications and changes to the existing LAAFP operations, permitting, and monitoring.

Figure 2-3. Van Norman Complex

Service Layer Credits: Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

RWA at this location would:

- Provide blending with other water supplies. An initial phase could include a reduced flow that would allow blending at a ratio less than 10% to delay the need for chemical control. Additional pathogen credits would still be required before blending.
- Provide additional treatment barriers within LAAFP after DPR requirements for pathogen and chemical control have been achieved.
- Maintain current hydraulics in VNC, including providing an additional source of supply to the Van Norman Pump Station #2 and Rinaldi Trunkline.

The proposed post-AWPF treatment train (that is, UVAOP and GAC) would also provide an additional treatment barrier for N-nitrosodimethylamine (NDMA) and disinfection by-products (DBPs) if the Pure Water Los Angeles ATRW is regulated under the CTR (Arcadis and Jacobs 2024). UVAOP and GAC or alternative post-AWPF treatment strategies will require additional validation testing and approval by DDW as an alternative to the requirements of the DPR regulations.

Integrating Pure Water Los Angeles ATRW into LAR was also considered, as it could provide flexibility for managing flows and would not impact LAAFP operations. Integration upstream of LAAFP was the

preferred alternative due to the ability to supply the Van Norman Pump Station #2 and Rinaldi Trunkline that cannot be supplied from LAR. However, if DPR compliance is achieved before integration, a connection to LAR could be considered for treatment and hydraulic flexibility. Integration upstream of LAAFP would be the primary location; but during the annual LAAFP shutdown or other events, flow could be transitioned to LAR with additional conveyance and potentially a pump station.

2.4 West Basin Municipal Water District

West Basin has a long, collaborative history with LADWP and LASAN. The three agencies have been in partnership for recycling wastewater effluent from HWRP since 1991 (HDR 2022). There are many opportunities for an LADWP and West Basin partnership that could be beneficial to the implementation of Pure Water Los Angeles, including potentially accelerating water delivery. Additional details about the partnering opportunities with West Basin are provided in the *Interconnectable Partnership Opportunities Technical Memorandum* (Jacobs 2024), which evaluated the use of existing infrastructure with upgrades and modifications. As a separate effort, LADWP is currently evaluating the potential use of the ECLWRF as a potential site option for the Pure Water Los Angeles AWPF (Hazen 2024).

At the time of this TM development, the projected demand for Pure Water Los Angeles water to West Basin was estimated to vary seasonally from 31 cfs (20 MGD) to 62 cfs (40 MGD), as presented in Table 2-5. Further collaboration and coordination between West Basin, LADWP, and other involved parties would be needed to determine feasibility and inform future decisions.

Table 2-5. Pure Water Los Angeles Program Flows to West Basin

Demands	Existing Flow[a]		Potential Additional Flow[b]		Potential Total Flow	
	cfs	MGD	cfs	MGD	cfs	MGD
WCBBP	19	12.5	8	5	27	17.5
Other West Basin Customers	35	22.5	0	0	35	22.5
Total Demands	54	35	8	5	62	40

[a] Average annual (HDR 2022)

[b] Source (Jacobs 2024)

2.5 Metropolitan Water District of Southern California

Metropolitan owns extensive drinking water infrastructure for conveyance, reservoir storage, and treatment of surface water in Southern California, as well as tie-in connections into local distribution systems. LADWP's potable water system interconnects with Metropolitan's system to provide regular, emergency, and backup supplies. Several partnership opportunities with Metropolitan, including PWSC and an interconnection with Jensen WTP, have been identified, with additional details provided in the *Interconnectable Partnership Opportunities Technical Memorandum* (Jacobs 2024).

2.5.1 Pure Water Southern California

PWSC is a regional recycled water program developed by Metropolitan in partnership with Los Angeles County Sanitation Districts. It involves the production of up to 232 cfs (150 MGD) of ATRW for IPR and DPR purposes. The PWSC Backbone would carry a maximum of 232 cfs (150 MGD) of recycled water from the AWPF at the Warren Facility to recharge WCB, CB, and the Main San Gabriel Basin (Metropolitan 2023a).

PWSC was identified as a potential demand under Pure Water Los Angeles to receive flows by extending Pure Water Los Angeles's east–west alignment option to connect to the PWSC Backbone pipeline. This interconnect would also offer additional GWR opportunity at the Santa Fe Spreading Grounds in the San Gabriel Basin.

Additionally, Metropolitan is planning for DPR with RWA that would include DPR treatment either at the AWPF at the Warren Facility, or potentially upstream of or at the Weymouth WTP. The conveyance would interconnect at the Weymouth WTP, with existing conveyance connecting to the Diemer WTP through an existing bypass for DPR (Metropolitan 2023b).

During a meeting in April 2023, Metropolitan shared that the amount of water that could be received by PWSC from Pure Water Los Angeles would be limited by the two policies (Metropolitan 2023c):

1. A systemwide nitrogen limit for the drinking WTPs of no more than 2 mg/L-N of TIN 95% of the time
2. An institutional policy of limiting water supplies from recycled water to no more than 50% as source water

LADWP subsequently sent a letter to Metropolitan requesting consideration for a Pure Water Los Angeles interconnection of up to 232 cfs (150 MGD) with PWSC as an alternative under PWSC's environmental review (LADWP 2023d). In the April 2023 meeting, Metropolitan presented that the lower end of the flow range was to be 42 cfs (27 MGD) (Jacobs 2024). Hence, the expected range of flows to PWSC are from 42 to 232 cfs (27 to 150 MGD).

Metropolitan has recognized the importance of this potential interconnection and is currently evaluating upsizing the 14-mile-long pipeline segment between Whittier Narrows and Canyon Spreading Grounds to 9 feet in diameter (Metropolitan 2023a). This pipe size would be expected to be able to provide up to 464 cfs (300 MGD) of conveyance capacity, supporting future interconnection between these two programs.

2.5.2 Jensen Water Treatment Plant Interconnect

Metropolitan's Jensen WTP is adjacent to VNC, and an interconnect between Pure Water Los Angeles and Jensen WTP could potentially increase water reliability for Metropolitan. The type of DPR (that is, RWA or treated water augmentation [TWA]), that might be implemented under this interconnect has not been determined yet.

According to Metropolitan, the amount of water that could be accepted by Jensen WTP would vary depending on the nitrate concentration and the surface water flow treated (Metropolitan 2023c). A maximum flow of 48 cfs (31 MGD) was assumed based on the nitrate and flow limitations. To achieve this interconnection, the Metropolitan institutional requirements described for the PWSC opportunity must be met, and consideration should be given for potential water exchange at Jensen WTP (LADWP 2024b). Further collaboration and coordination between Metropolitan and LADWP would be needed to determine feasibility and inform future decisions related to either the PWSC or Jensen WTP interconnections.

2.6 Water Replenishment District

WRD is the Basin Manager and Watermaster for CB and WCB, serving a population of 4 million residents (WRD 2024b). There are four potential identified demands for Pure Water Los Angeles water from WRD, namely:

1. Additional ATRW could replenish the WCBBP.

2. Demands derived from brackish remediation activity in WCB. The potential replenishment locations have yet to be confirmed by WRD.

3. WRD's desire to eliminate imported water supply for replenishing their basins, as indicated in the October 2022 meeting (LADWP 2022). There is a potential for using Montebello Forebay Spreading Grounds.

4. Increased replenishment needs in CB up to LADWP's entitlements due to the anticipated increased use of groundwater supply in the CB area (WRD 2024a). The replenishment locations have been identified to be in the general area of the future injection wellfields in CB, just north of the Manhattan Wellfields.

Table 2-6 summarizes these potential demands from WRD. As LADWP continues engaging with WRD about partnership opportunities under Pure Water Los Angeles, these values are expected to be refined.

Table 2-6. Potential Future Replenishment Water Demand in West Coast and Central Basins

Potential Future Replenishment Water Demand				
Basin	Description	AFY	cfs[a]	MGD[a]
WCB	Additional replenishment due to remediation of the brackish plume	13,000	18	12
WCB[b]	Additional replenishment through WCBBP	5,600	8	5
CB	Replenishment water to replace imported supply	11,000	15	10
CB	Replenishment water up to LADWP's entitlements in CB and WCB	18,739	26	17
	Total[b]	**42,739**	**59**	**39**

[a] Values represent a 12-month annual operating period. Numbers have been rounded.

[b] WCBBP demand is represented in the West Basin demands; therefore, they are not represented in the WRD total.

3 Recommended Additional Analyses

Additional steps to verify and further develop the assumptions for each storage and demand location will be required in future efforts to refine Program flows and integration requirements. Table 3-1 summarizes the recommended additional analyses required for each location.

Table 3-1. Pure Water Los Angeles Storage and Demand Location Recommended Additional Analyses

Location	Recommended Additional Analyses
CB	▪ Evaluate flows that can be managed in CB as part of Pure Water Los Angeles. ▪ Initiate pilot test wells to determine design criteria. ▪ Conduct additional groundwater quality sampling and evaluation of compatibility of Pure Water Los Angeles water quality for injection. ▪ Conduct additional groundwater modeling once field data concerning ambient water quality and hydrogeological characteristics of the selected areas become available to better refine the limits of CB and the feasibility of proposed alternatives. ▪ Initiate a CB study to determine the following: - Groundwater production capacity - New production wells and wellfield locations - Water quality monitoring - Required treatment - Opportunities to acquire additional groundwater rights.
SFB	▪ Evaluate the allocation of flows when spreading grounds and stormwater capture parks are not available during wet weather as part of Pure Water Los Angeles. ▪ Complete groundwater modeling or a tracer study to confirm residence time of recycled water spread at Tujunga Spreading Grounds. ▪ Conduct groundwater modeling to evaluate potential impacts on contaminant plumes. ▪ Confirm the range of demands that can be met through SFB extraction. ▪ Initiate pilot test wells to determine design criteria. ▪ Conduct additional groundwater quality sampling and evaluation of compatibility of Pure Water Los Angeles water quality for injection. ▪ Conduct groundwater modeling to evaluate long-term capacity, residence time, and capture for stormwater capture parks.
VNC	▪ Evaluate flows that can be managed at VNC as part of Pure Water Los Angeles. ▪ Conduct validation testing of post-AWPF treatment for DPR regulations compliance and DDW coordination.
West Basin	▪ Evaluate use of West Basin's infrastructure to accelerate water delivery to CB and the Harbor area. ▪ Determine the role and potential for West Basin to accelerate water delivery by Pure Water Los Angeles. ▪ Determine the potential institutional arrangement options with West Basin. ▪ Determine the capital improvement needs and the associated cost with West Basin to allow for comparison against other options. ▪ Determine the potential of phasing and implementation of HWRP and Pure Water Los Angeles as near-term actions using West Basin's infrastructure.

Location	Recommended Additional Analyses
Metropolitan	▪ Conduct comprehensive investigations jointly with Metropolitan to evaluate the details of these integration options to develop plans for meeting regulatory requirements. ▪ Metropolitan has a policy of limiting its system to use no more than 50% of recycled water as a source; conduct additional discussions with Metropolitan to determine whether modification is possible to increase the flexibility to incorporate ATRW into the potable water system. ▪ Metropolitan to provide additional analysis to determine capacity at their Weymouth or Diemer WTPs, or both, to receive Water Los Angeles ATRW by lowering the nitrate concentration in Pure Water Los Angeles water to 2 mg/L as N for base- or flex-loaded scenarios. ▪ Investigate water quality specifications required for interconnect between Jensen WTP and PWSC jointly with Metropolitan. ▪ Identify institutional arrangements necessary for these interconnections to be permitted under the DPR regulations, including DiPRRA requirements.
WRD	▪ Define the flow rates or demands and the potential variability for the use of Pure Water Los Angeles water for GWR. ▪ Collaborate with WRD to further define the identified opportunities, such as recharge locations and methods. ▪ Evaluate the potential of mobilizing organic compounds, such as PFAS, from the soil matrix of the spreading grounds if Montebello Forebay Spreading Grounds are to be used. ▪ Evaluate how costs could be shared for replenishing CB using injection wells from Pure Water Los Angeles. ▪ Develop a joint strategy to maximize recharge during wet weather seasons.

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Operation NEXT Assessment Tool Summary Description TM

Operation NEXT Assessment Tool Summary Description Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
June 26, 2024

Executive Summary

The Operation NEXT Assessment Tool (ONAT)[1] is a dynamic, probabilistic simulation system model. It is designed to allow the evaluation of multiple Pure Water Los Angeles Water Supply Program (Program) options and provide initial flow estimates for the use of proposed Program infrastructure. These flow estimates are based on projected conditions related to hydrology, storage, and demand.

The final assumptions that are documented in this technical memorandum (TM) set the foundation for the ONAT model and are the result of a collaborative and iterative process with the Los Angeles Department of Water and Power (LADWP). This process supported a thorough review and refinement of assumptions to develop a representative characterization of LADWP's current and future water system, as currently understood.

An initial validation of the ONAT model was carried out to confirm that the model's usage of supplies aligns with historical general operations during various hydrological periods. From this model validation step, the model also successfully replicated the historical shifts in supplies based on wet and dry hydrological periods. These outcomes demonstrate the utility of the model for its intended purpose as a tool in assessing the use of advanced treated recycled water as part of the Pure Water Los Angeles Program.

A fundamental assumption of the model is to prioritize the allocation of water supplies. ONAT includes logic for supply prioritization to meet the City of Los Angeles' demands and logic for prioritization of the new Advanced Water Purification Facility's (AWPF's) production. The model balances the allocation of supplies to meet system demands, the use of system storage, and the allocation of AWPF production among potential demands.

A subsequent TM will summarize the results from the comprehensive modeling of the Program alternatives. The ONAT results from all scenarios will support evaluating and comparing Program alternatives and informing decisions on the future sizing of the Program components.

[1] In August 2024, Operation NEXT was rebranded as Pure Water Los Angeles; however, due to legacy Program documentation, ONAT will retain its original name.

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Acronyms and Abbreviations

AF	acre-foot (feet)
AFY	acre-foot (feet) per year
APA	Allowed Pumping Allocation
ATRW	advanced treated recycled water
AWPF	Advanced Water Purification Facility
CB	Central Basin
City	City of Los Angeles
cfs	cubic foot (feet) per second
DPR	direct potable reuse
GSBM	Groundwater Storage Bank Model
HOA	Hyperion Owner's Agent
HWRP	Hyperion Water Reclamation Plant
I&I	inflow and infiltration
IPR	indirect potable reuse
LAA	Los Angeles Aqueduct
LAAFP	Los Angeles Aqueduct Filtration Plant
LADWP	Los Angeles Department of Water and Power
LAR	Los Angeles Reservoir
LAX	Los Angeles International Airport
MBR	membrane bioreactor
Metropolitan	Metropolitan Water District of Southern California
MF	microfiltration
MGD	million gallons per day
MP	Pure Water Los Angeles Master Plan
MS	Microsoft
No.	number
NPR	non-potable recycled
ONAT	Operation NEXT Assessment Tool
Program	Pure Water Los Angeles Program

PWSC	Pure Water Southern California Program
RO	reverse osmosis
RWA	raw water augmentation
SFB	San Fernando Basin
TM	technical memorandum
UCLA	University of California, Los Angeles
ULARA	Upper Los Angeles River Area Watermaster
UWMP	2020 Urban Water Management Plan
VNC	Van Norman Complex
WCB	West Coast Basin
WCSB	West Coast Sea Barrier
WRD	Water Replenishment Water District of Southern California
WRP	water reclamation plant
WTP	water treatment plant

1. Introduction

Jacobs has been developing a modeling tool to support evaluations of Pure Water Los Angeles Water Supply Program (Program) alternatives being considered in the Master Plan (MP). The Operation NEXT Assessment Tool (ONAT)[2] is a dynamic, probabilistic simulation systems model that allows for efficient assessment of multiple Program options and initial estimates of sizing for Pure Water Los Angeles infrastructure based on projected hydrological and storage and demand conditions. ONAT incorporates and evaluates options for storage and demand of Pure Water Los Angeles water, including groundwater recharge, regional partnerships, and direct potable reuse (DPR) through raw water augmentation (RWA); and ONAT also considers water supply and risk conditions.

Specifically, ONAT is being developed to support answers to the following questions:

- **What are the Pure Water Los Angeles Infrastructure Needs?** (Tasks 4, 5, 6, 9, and 14): Support the identification of infrastructure needs, facility sizing, and related broad operational parameters, and evaluate and recommend facility improvements.
- **How do Alternatives Compare?** (Task 11): This task has several activities, including:
  - Simulate Program facilities and operations of various alternatives.
  - Support alternative development and refinements through an iterative process.
  - Facilitate integration of Pure Water Los Angeles with the existing Los Angeles Department of Water and Power (LADWP) water system.
  - Help demonstrate Program benefits.
  - Identify flows, conveyance limits, and groundwater storage operations and limits as part of the alternatives analysis.

  This version of ONAT does not include any cost information for different Program alternative configurations.
- **What are the Water Supply Resiliency and Economic Benefits?** (Tasks 7 and 9): Explore hazard scenarios, impacts, and benefits of the Pure Water Los Angeles Program; integrate resiliency and economic analysis with the University of California, Los Angeles (UCLA) Resiliency Benefits Study (Chow 2024); and identify vulnerabilities and resilience strategies for Pure Water Los Angeles Program and facilities.

The goal of this technical memorandum (TM) is to provide an overview of the ONAT model framework and approach, as well as the underlying model assumptions. This TM documents the final assumptions used to develop the model, and these assumptions have been incorporated into the model runs. The results of the model runs will be summarized in the ONAT Model Results TM, to be provided under separate cover.

1.1 Model Requirements for Pure Water Los Angeles

As indicated in the discussion document (Jacobs 2023), Jacobs reviewed the availability and applicability of existing models to meet the specific needs of the Pure Water Los Angeles MP. The specific modeling needs of the MP that were identified included support for the following tasks:

- Representation and simulation of all major Pure Water Los Angeles components, including:
  - Advanced Water Purification Facility (AWPF)
  - Pump stations

[2] In August 2024, Operation NEXT was rebranded as Pure Water Los Angeles; however, due to legacy Program documentation, ONAT will retain its original name.

  - Pipelines
  - Storage
  - Well field infrastructure
  - Groundwater basins
  - Water treatment plants (WTPs)
  - Existing water supplies
  - Water demands
  - Wastewater flows
- Sizing of Pure Water Los Angeles facilities: Estimating daily, monthly, and annual flows of facilities to support engineering, cost estimating, and alternatives evaluation (for example, what are the mean, maximum, and minimum flows in AWPF, Pure Water Los Angeles pipelines, and recharge and extraction facilities).
- Sizing of Pure Water Los Angeles Program: Determining how to maximize utilization of Pure Water Los Angeles supply, what operational or facility changes would optimize Program efficiency, and what the right size of facilities would be for specific alternatives and objectives. Although ONAT itself will not size facilities, it will provide flows and facility frequency of usage that can guide the selection of proper facility sizes as the Program moves forward.
- Analysis of alternatives: Integrated modeling to support alternatives development and refinements through an iterative process and evaluation.
- Assessment of resiliency: Exploring resiliency benefits of Pure Water Los Angeles through scenarios and Monte Carlo analysis to assess uncertainties, integrate resiliency and economic analysis (model cost-functions) with the UCLA Resiliency Benefits Study, and identify vulnerabilities and resiliency strategies for the Pure Water Los Angeles Program and facilities.

LADWP's Water Resource Development Group maintains a Groundwater Storage Bank Model (GSBM) (LADWP 2024a) that can support several aspects of the water operations for Pure Water Los Angeles (such as, water system operational logic and priorities). Alternatives analysis and infrastructure constraints analysis are built into the GSBM at a high level. More detailed infrastructure analysis requires a hydraulic model, such as the one that LADWP's Water Master Planning uses (Jacobs 2024). Resiliency and economic benefits are not currently included in the GSBM, because their definitions may depend on their application. Therefore, LADWP has determined the GSBM serves a different purpose and is not primarily intended to evaluate specific infrastructure needs for Pure Water Los Angeles, conduct alternatives analysis, or assess resiliency and economic benefits.

UCLA has developed a simplified annual time-step spreadsheet model to help evaluate resiliency benefits under various earthquake and drought scenarios. This model uses an annual accounting approach to allocate supplies, including Pure Water Los Angeles supplies, to meet annual demands. Under severe shortage scenarios, the model seeks to supply demands with additional emergency supplies, such as trucked water, bottled water, or desalination, to estimate the resiliency benefits that may be provided by Pure Water Los Angeles. The UCLA model does not include any detailed features of the Pure Water Los Angeles Program.

Based on this review and through discussions with the LADWP Pure Water Los Angeles Team, in March 2023, LADWP provided direction that the best approach to meet the needs of the Pure Water Los Angeles MP was to use information from the existing GSBM and the UCLA spreadsheet model as main inputs and assumptions to support a more detailed assessment of Pure Water Los Angeles facilities with this specific ONAT model. Attachment A provides the timeline of ONAT development and decisions.

2. Model Overview

ONAT builds on assumptions from other currently available models and information sources, and focuses the assessment on the infrastructure and operations associated with the Pure Water Los Angeles Program. The ONAT model represents the physical elements of the Pure Water Los Angeles alternatives through links (connections) and storage elements. Figure 2-1 shows a simplified Pure Water Los Angeles system schematic, with components that relate to potential Pure Water Los Angeles Program alternatives. Each link can be limited by capacity or other physical or operational constraints; for example, storage elements are limited by maximum physical storage, and limits to injection and extraction facilities are ruled by physical and operational rules that include permits and local demand limitations. Some of the links and elements of the ONAT model are flexible in their operation, meaning they can be turned on and off, depending on the model scenario being evaluated.

ONAT simulates all flows, storage, and operations on a daily time step. Currently, input is mostly on the monthly and annual time scale, but some inputs can be converted to a daily time scale in the future. The daily time scale will capture events driven by system storage because all other model inputs are monthly. The level of effort to build the model in a monthly or daily time step is virtually the same; therefore, the preference is to build the model for a daily temporal resolution to allow for future improvements and enhanced capabilities.

ONAT can theoretically simulate Pure Water Los Angeles operations from year 2022 through 2050, the period for which water supply and demand projections data are available (same supply and demand data used in the GSBM). ONAT can assume the Program is implemented from day 1 of the simulation (for consistent performance comparison of alternatives) or implement different Program components based on a schedule (for more realistic phasing).

Simulations can be conducted as single trace (deterministic) or multiple traces (stochastic) to reflect uncertainties. For example, data for Los Angeles Aqueduct (LAA) supply are provided as 102 years of adjusted historical data (that is, flows are adjusted for Owens Valley environmental commitments). ONAT can simulate this condition as one particular trace (for example, a sequence of 1978 through 2008) or multiple traces by sampling all historical starting years (for example, start in 1978, 1979, or some other year). This latter method uses an index-sequential-method that keeps the sequence of wet-dry conditions that are exhibited in the historical record, while reflecting uncertainty in the timing of future droughts and wet periods. ONAT keeps track (as a metric) of the amount and frequency of unused supplies, and the accuracy of this metric is linked to the accuracy of system demands and supply availability inputs.

The initial sources for assumptions used in ONAT development are as follows:

- LADWP Microsoft (MS) PowerPoint presentation listing the priority of supplies to meet demands (LADWP 2022b)
- LADWP MS Excel spreadsheet listing assumptions to be used in ONAT (LADWP 2024b)
- 2020 *Urban Water Management Plan* (UWMP) (LADWP 2020)
- Latest Upper Los Angeles River Area Watermaster report from 2019 (ULARA 2019)

The initial assumptions were refined during subsequent meetings and exchanges with LADWP that led to the development of the final assumptions. Attachment B provides the final matrix of assumptions included in the current ONAT model, a result of a series of meetings and discussions with LADWP on how the system should be represented in ONAT for different scenarios and Program alternative configurations. Model assumptions consider inputs from the following sources:

- LADWP's GSBM
- San Fernando groundwater model
- Central Basin judgment limitations (Los Angeles County Superior Court 2013)
- The most recent UWMP (LADWP 2020)

- Recent estimates of future wastewater flows
- Upcoming future changes in the operation of the system (Los Angeles County Superior Court 2013)

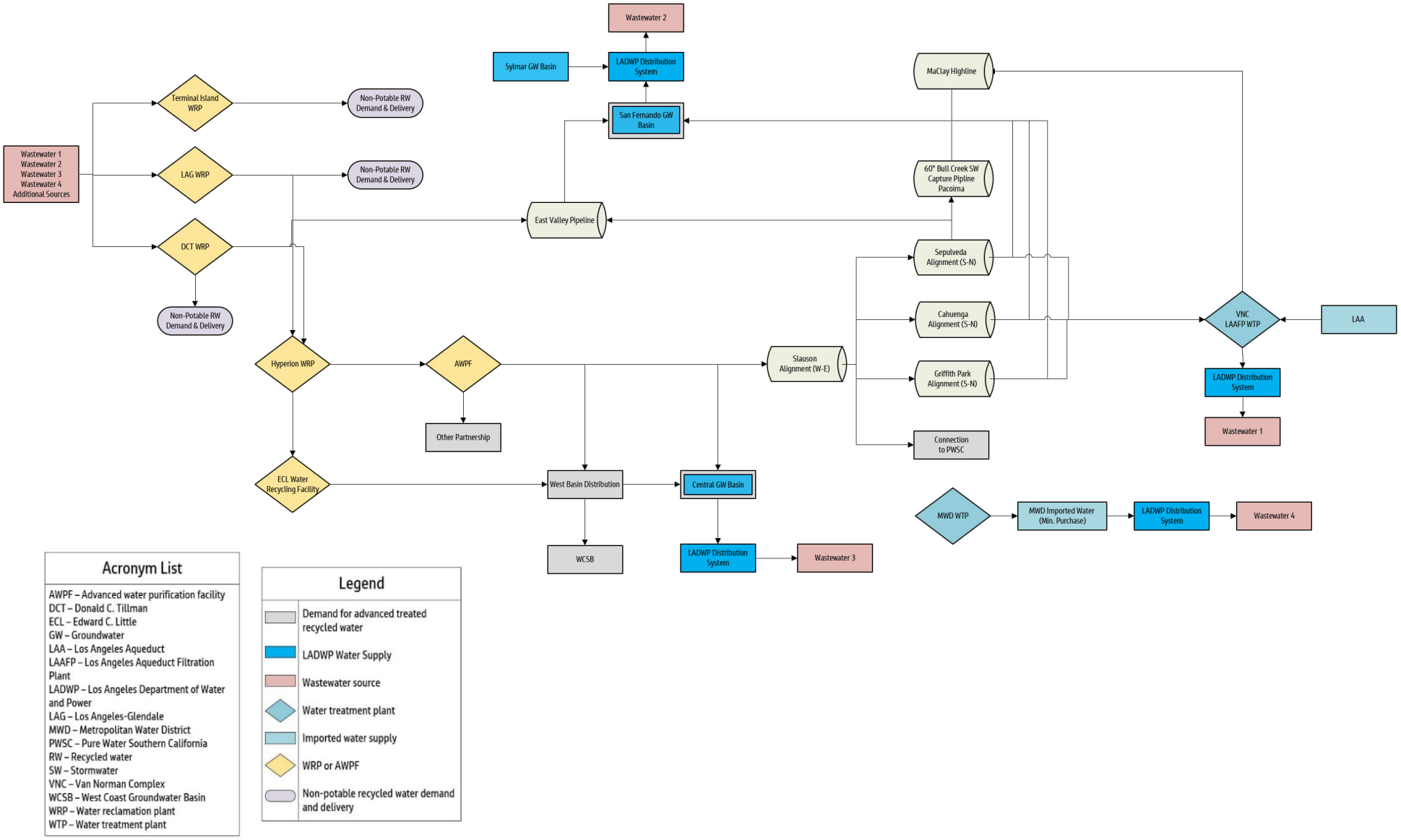
The level of confidence and model accuracy are a function of the confidence and accuracy of model inputs, which include LAA flows and system demands. Given the recognized uncertainties of these two model inputs, some of the model scenarios are run as Monte Carlo simulations to capture the range of potential model results due to uncertainties.

The model development has been structured to build the level of detail necessary for an early assessment of Pure Water Los Angeles Program components, and then to allow the continued addition of more detailed representations of certain parts of the system as the Program develops.

ONAT represents the system, including Pure Water Los Angeles components, as a full cycle system, where the wastewater supply for Pure Water Los Angeles production is mainly a function of the amount of potable water delivered to the service area. Carollo and Stantec (2023) report that between 64 and 67% of the total Hyperion Water Reclamation Plant (HWRP) flow corresponds to indoor water uses within the City's service area. Other sources are from industrial users, contract agencies, stormwater infiltration, and waste streams from other treatment plants. The full cycle approach is recommended for the evaluation of resiliency scenarios that might impact system demands (defined under Section 3) and consequently impact Pure Water Los Angeles production. Section 5 of this TM describes the wastewater generation logic, challenges, and limitations related to available data and assumptions. The resiliency of the sewer system network is not currently incorporated in ONAT given the focus on the use of ATRW.

Figure 2-1 shows the overall model schematic. The first assumption is that all City of Los Angeles (City) demands are supplied by the "Water Supply" items in the schematic. A fraction of the supplied water will be turned into "wastewater sources" to be sent to the four WRP facilities managed by the City, in addition to wastewater sources from contracted agencies (wastewater not originated by the City's deliveries). The wastewater sources delivered to HWRP become the inflow to treatment that eventually become a Pure Water Los Angeles advanced treated recycled water (ATRW) supply to the system, closing the supply and demand loop.

Figure 2-1. Overarching Representation of Pure Water Los Angeles Facilities in the Operation NEXT Assessment Tool



2.1 Validation

Model validation was limited to the represented items that have available historical data and could impact Pure Water Los Angeles production to be delivered or stored in the system without being discharged to the ocean. ONAT is a model to be used for comparative results across different alternatives. The introduction of a new water supply through Pure Water Los Angeles, new extraction capabilities at San Fernando Basin (SFB), and potential improvements at the Central Basin (CB) groundwater basin will change LADWP's overall water supply portfolio in comparison with past operations. These new projects will result in a different water delivery profile from what has occurred in the past.

The ONAT calibration focused on two data comparisons:

1. Model versus historical wastewater production and wastewater flows estimated from water deliveries by ONAT

2. Model versus historical water supply portfolio used to meet system demands in a baseline model scenario (without Pure Water Los Angeles infrastructure) and historical water supply portfolio usage

A limited calibration model run was completed with the available historical data. For this validation scenario run, the model uses the available LAA flows, then uses programmed rules of priority (provided by LADWP in Attachment C) to decide how much is pumped from groundwater supplies and how much purchased imported water from Metropolitan Water District of Southern California (Metropolitan) is necessary to meet all system demands. The model results show good correlation between historical LAA and Metropolitan-imported water supplies, and also re-creates the historical shifts in supplies based on hydrological wet and dry periods.

The groundwater supply usage currently provides a good correlation with historical groundwater usage but could be improved. This is mainly because not enough model rules were introduced in ONAT to try to better represent historical groundwater usage. However, the introduction of historical operations to try to improve the performance of preliminary model results versus historical groundwater usage would be of a minor relevance to the Pure Water Los Angeles Program due to changed operations planned in the future. In addition to the future groundwater operations, the new future planned capacities, usage, and priority of the groundwater basins are included in the ONAT assumptions.

Figure 2-2 shows the validation correlation between historical and modeled annual average wastewater flows. The figure shows ONAT's estimated wastewater inflows (wastewater estimation described under Section 5) to be within 10% of historical values most of the years and less than 6% for the last 10 years when data were available.

Figure 2-3 shows the results of the validation related to the water supply portfolio. Twenty-eight years of water delivery data were available for validation comparison. The validation comparison is broken down to the three main supply sources for the City, LAA, Metropolitan-imported water, and groundwater extractions. The validation was focused on the order of magnitude and overall correlation of supply usage during wet and dry climate sequences. ONAT does not fix the usage of the supplies; ONAT set limits based on operational or physical limitations and implements rules for the selection of supplies to be used.

Figure 2-2. Historical Wastewater Flow Model Validation

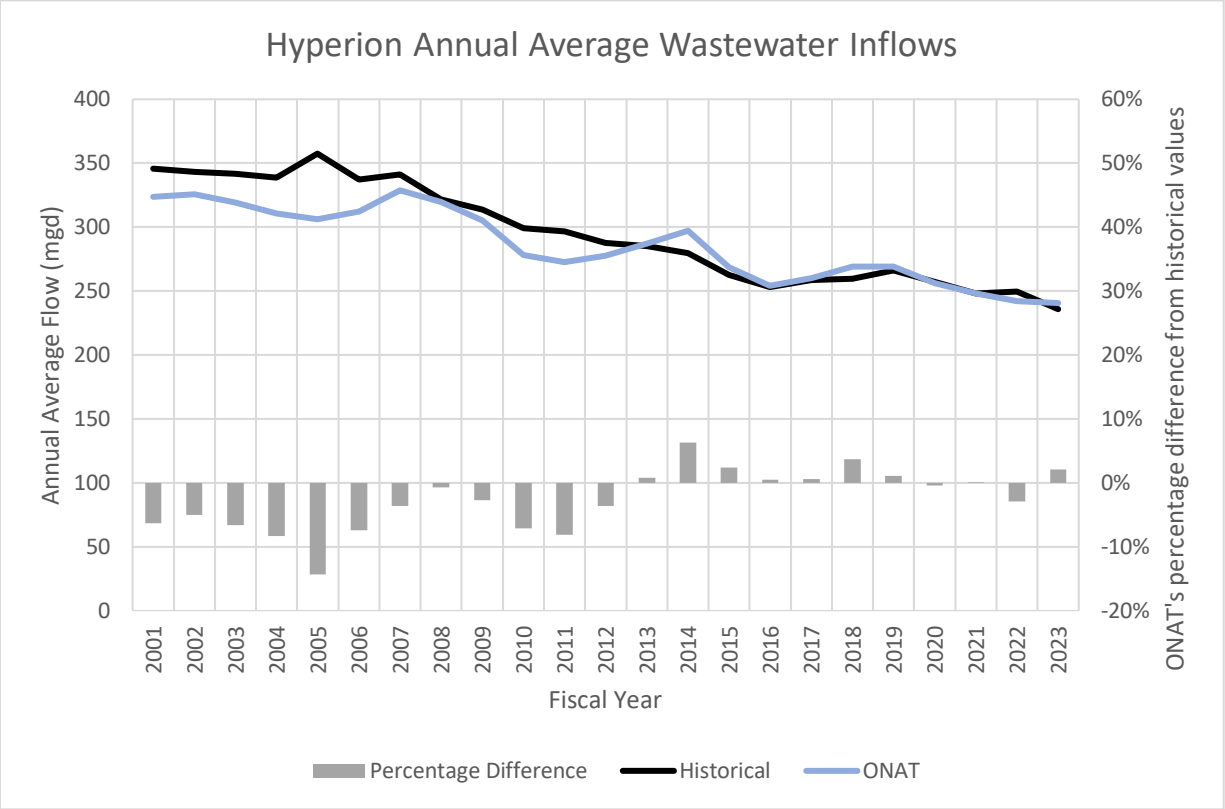
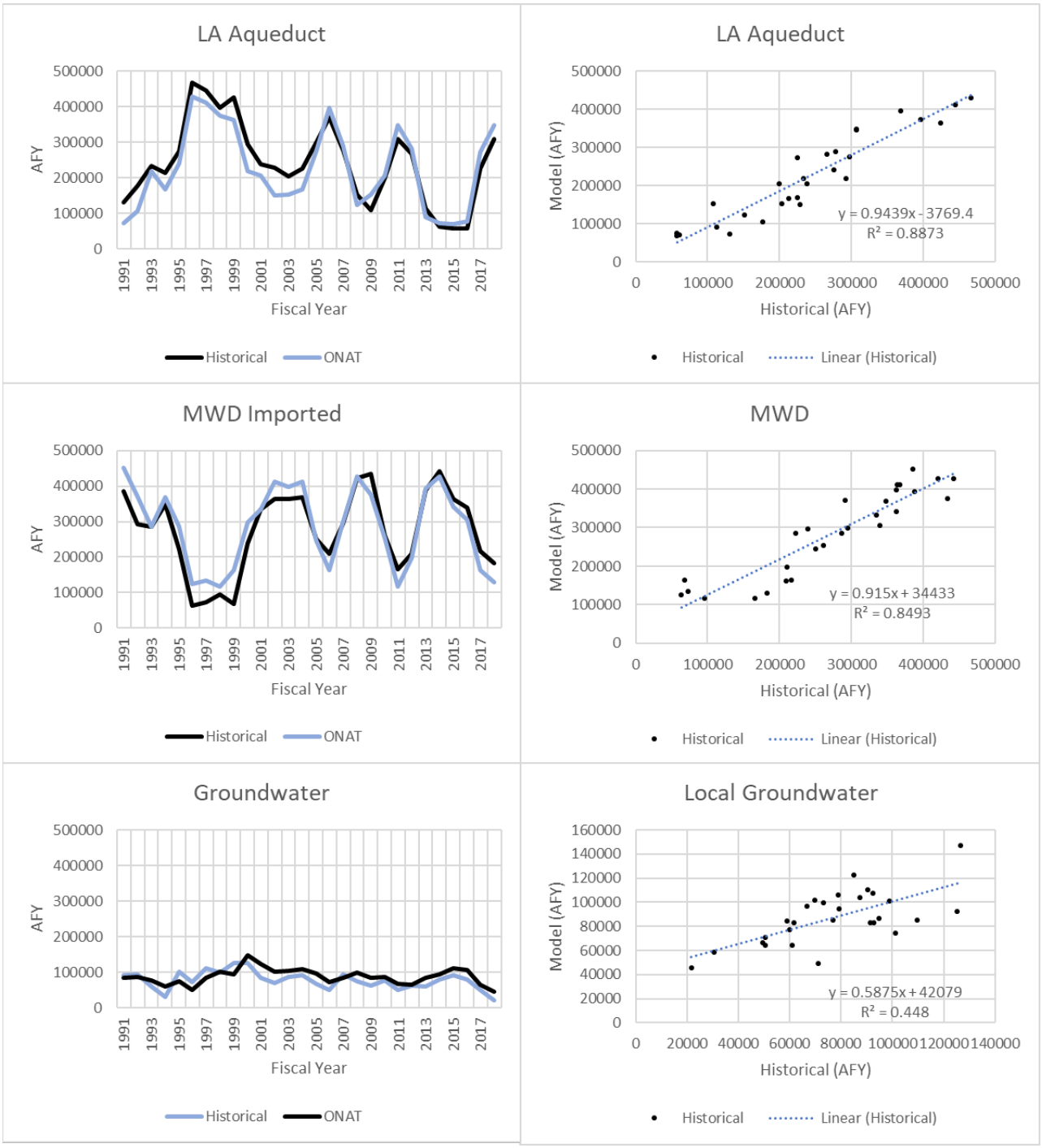


Figure 2-3. ONAT Model Validation Results for the Three Main City Water Supplies



3. Model Scenarios

The introduction of a new water supply in the City's system will change the water delivery dynamics. During dry years, the need for imported supplies could be decreased; and during wet years, storage might be needed. Model scenarios represent different plausible future conditions for evaluating the Pure Water Los Angeles Program and alternatives, estimating imported water needs, and estimating system storage.

The MP considers multiple scenarios that were developed to express plausible future conditions. These future scenarios allow the Pure Water Los Angeles Program to be evaluated for a range of uncertainties. All the scenarios use projected system demands up to 2050, combined with the available 102 years of monthly LAA flow data received from LADWP (from April1922 to March 2024) corrected for Owens Valley environmental requirements. Based on these two inputs, the model runs from fiscal year 2021 (July 2020) to end of fiscal year 2050 (June 2050), for a total of 30 complete full fiscal years.

The model scenarios can be simulated in two modes: deterministic or stochastic. In the deterministic mode, the 30 simulated years will include one single 30-year LAA flow sequence. The 30-year LAA flow sequence can be selected from the 100 years of data available. In this mode, the individual wet-dry patterns of the 30-year historical sequence are preserved. The model will not create synthetic sequences combining years that are not sequential.

The periods for the simulations are based on the demand projections, from fiscal year 2020 to 2050. Model simulations over this time period can incorporate many historical hydrological sequences or hydrological sequences projected by climate models.

Six model scenarios have been identified and selected for use in the MP:

1. **Current Trends Scenario:** Adjusted historical water supply conditions to reflect current operations, infrastructure, and projected future demands. This scenario runs in stochastic mode, presenting results in a probabilistic way.

2. **Extreme Drought Scenario:** Most extreme droughts from the historical record or derived from climate projections. This scenario runs in deterministic mode.

3. **Pluvial Scenario:** Most extreme pluvial (wet) period from the historical record or derived from climate projections. This scenario runs in deterministic mode.

4. **Future Climate Change Scenario:** Future climate projections (for LAA and Metropolitan) affecting water supply availability, consistent with UCLA downscaling. This scenario runs in a stochastic mode, presenting results in a probabilistic way.

5. **Emergency and Seismic Scenario:** Loss of supply from either LAA or Metropolitan, or both, due to a major seismic event representing a time of failure for a specific location in the system, followed by a recovery period until a full recover. This scenario runs in deterministic mode.

6. **Demand Uncertainty Scenario:** Exploration of future alternative water demand projections. This scenario runs in a stochastic mode, incorporating demands uncertainty and presenting results in a probabilistic way.

ONAT scenarios reflect different hydrologic, demand, or water supply availability inputs. For the MP, the Program alternatives (Arcadis 2024) were screened based on ONAT model simulations of the "Current Trends" scenario, which at the time, were slightly different from the final ONAT assumptions. The current set of assumptions is described in the following sections and presented in Attachment B.

4. Water System Demands

LADWP provided future water demand projections from year 2020 to 2050 for baseline modeling (GSBM model inputs). These total water demands were provided as an annual time series and are consistent with LADWP's GSBM model demands. Annual demands are converted to monthly demands with the use of monthly demand patterns also provided by LADWP. Figures 4-1 and 4-2 show the annual total water demands and monthly demand patterns.

Water demands can be modified in ONAT to reflect alternative future assumptions and account for possible reductions as a result of population changes or changes to ordinances. The system demands used will be described in the ONAT Model Results TM to be provided under separate cover.

ONAT is evaluating three system demand scenarios based on the latest population projections and potential ranges of future demands. The results of these demand scenarios will also be presented in the ONAT Model Results TM.

Figure 4-1. Annual Potable and Non-Potable Water Demand Projections for the City

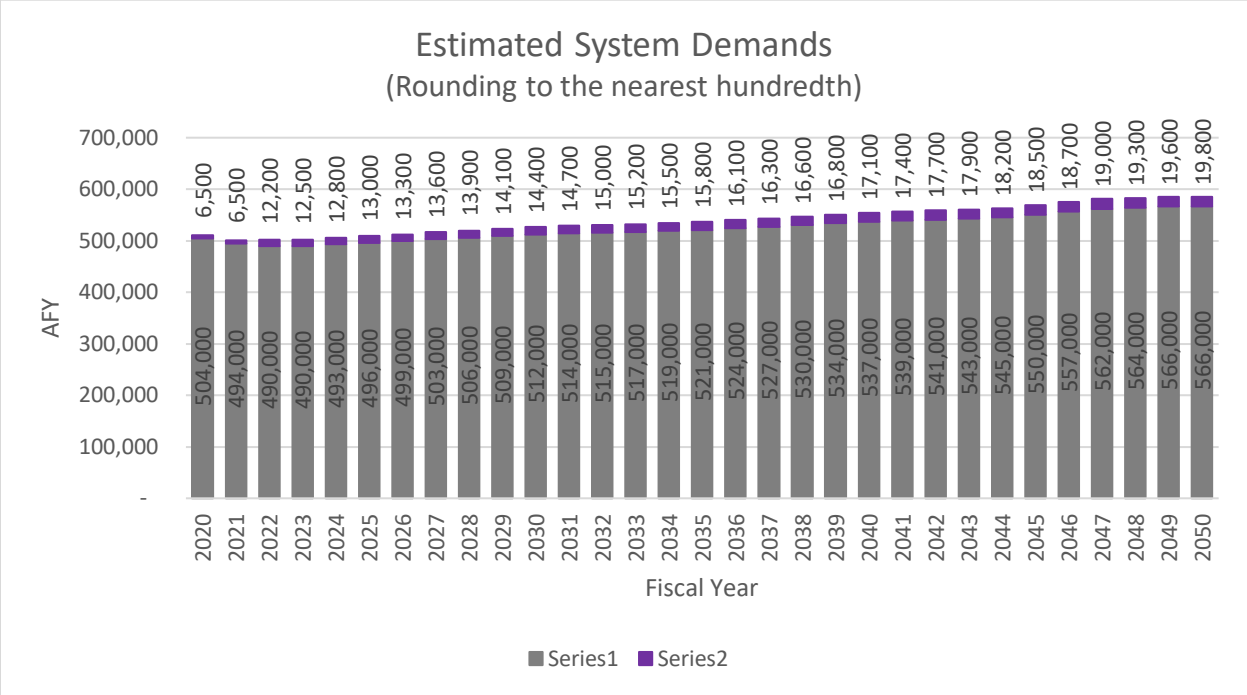
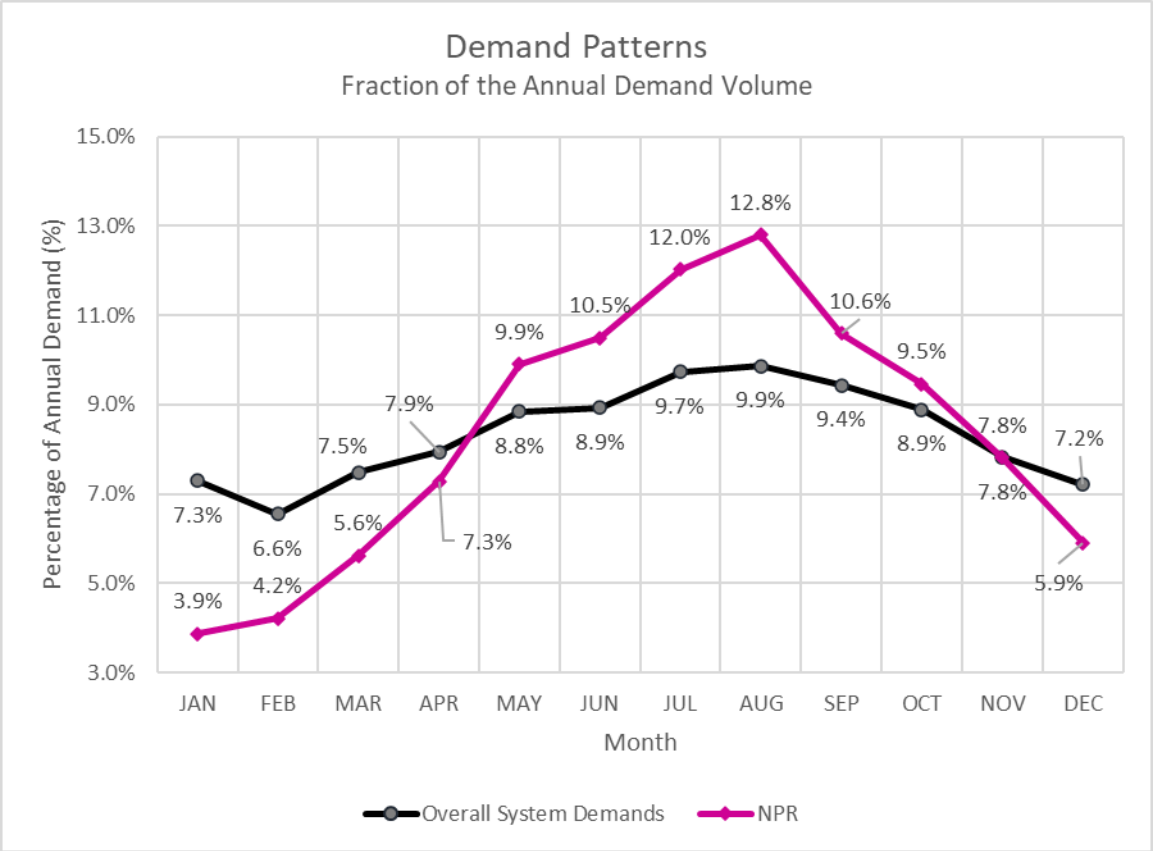


Figure 4-2. Monthly Demand Pattern Applied to Total Water Demand Projections

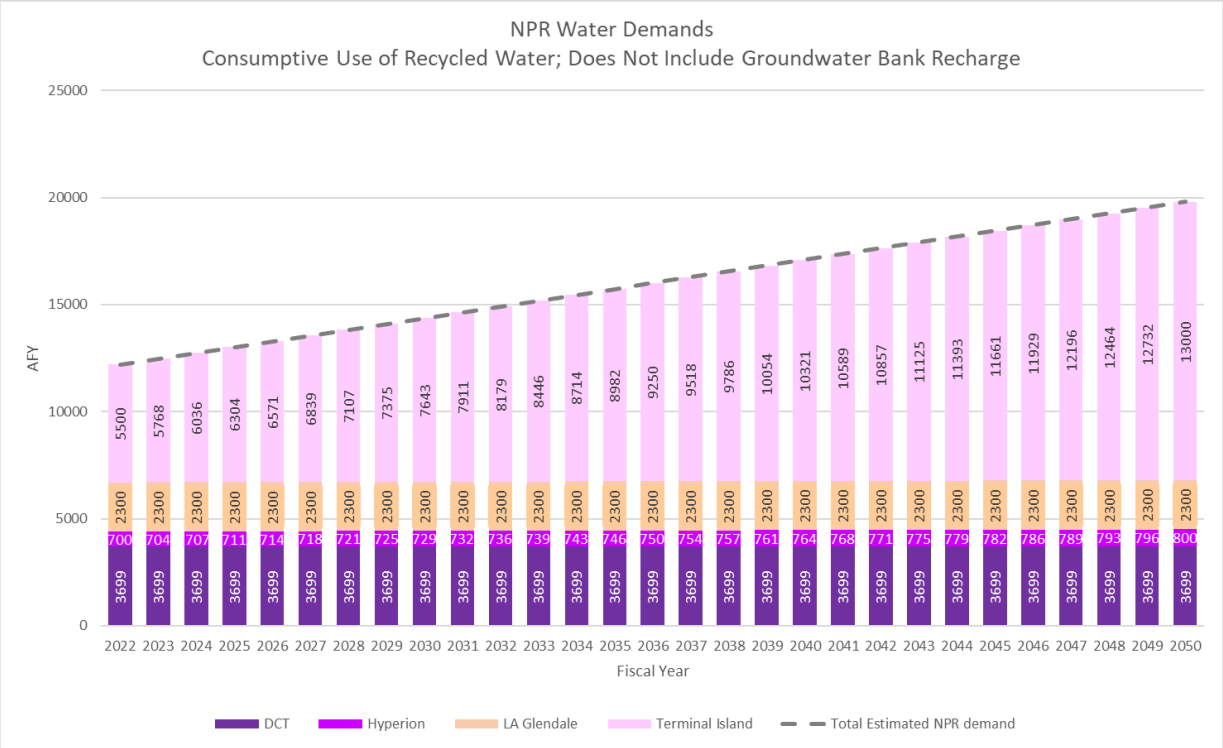


4.1 Recycled Water Demands

LADWP provided non-potable recycled (NPR) demands estimated for years 2024 and 2050 for each one of the four WRPs and recent recycled water monthly deliveries from January 2019 to December 2023 (LADWP 2024c). ONAT used the provided information to determine how much recycled water will be produced by each treatment plant (limited to wastewater availability). It is assumed that the recycled water demand is included in the total system demands.

To better reflect the seasonality of recycled water demands, the four WRP estimates of NPR demands were converted to a monthly time series using the monthly pattern provided for recent recycled water deliveries from January 2019 to December 2023 (LADWP 2024c). The monthly pattern can be changed for different simulations, as needed. Figure 4-3 shows the annual recycled water demand estimate by plant.

Figure 4-3. Annual Non-potable Recycled Demands by Wastewater Treatment Plant



Information on recycled water demands are summarized in the 30% MP Report. The current model assumes all WRPs, except Terminal Island, have constant demands from 2022 to 2050. NPR demands for Terminal Island are expected to gradually increase from current 5,500 to 13,000 acre-feet per year (AFY) by year 2050, or 8 to 18 cubic feet per second (cfs [5 to 12 million gallons per day {MGD}]).

In addition to the NPR demands presented on Figure 4-3, according to LADWP (LADWP 2024d), there are approximately 35.2 cfs (22.8 MGD [25,553 AFY]) of discretionary NPR production historically delivered for environmental uses to lakes in the Sepulveda Basin and overflowing to the Los Angeles River. These flows support the maintenance of Balboa Lake, Japanese Garden Lake, and the Wildlife Lake and are assumed to be kept constant at 31 cfs (20 MGD [22,418 AFY]) throughout the simulation window.

The Donald C. Tillman AWPF and Glendale WRP operate slightly differently from the other two plants. Tillman and Glendale WRPs have the ability to control the wastewater inflows by only diverting for tertiary treatment the amount that can be delivered to demands. Excess flows (that are not delivered to NPR demands) are sent to HWRP. The Tillman AWPF has a limited AWPF capacity (as designed) of 30 MGD (inflow to the treatment). ONAT assumes that Tillman AWPF will supply these average demands in the following order of priority (LADWP 2024e):

1. 2 cfs (1.2 MGD [1,345 AFY]) of tertiary water quality to NPR customers (subject to monthly demand pattern) and 2.1 MGD of purified water (from Tillman AWPF production) to NPR customers
2. 34 cfs (22 MGD [24,514 AFY]) to SFB recharge (the maximum AWPF production at Tillman AWPF), assuming 94% microfiltration (MF) recovery and 85% reverse osmosis (RO) recovery of 46 cfs (30 MGD) inflow
3. 31 cfs (20 MGD [22,418 AFY]) for environmental uses

Wastewater flows that will result in production exceeding these demands at Tillman WRP will be bypassed to HWRP.

5. Wastewater Availability

The ONAT logic includes a simplified approach to estimate wastewater flows from deliveries, resulting in a full cycle model approach. The full cycle approach uses the deliveries from the model at every time step to estimate wastewater flows for treatment in the next time step. The main challenge of this approach is to establish the correlation between water deliveries, the wastewater treatment inflows, wastewater received by Los Angeles WRPs that are external to the City's boundaries (not originating from LADWP deliveries), and additional wastewater flows resulting from inflow and infiltration (I&I). The current full cycle assumption is needed to estimate eventual reductions in wastewater flows in extreme droughts, high conservation assumptions, or in some resiliency scenarios that explore different demand variations or disruptions in the distribution system.

The major components of wastewater flows are:

- Indoor water usage
- Industrial discharges
- Stormwater infiltration
- Agreements with agencies out of the sewershed

Of all these components, indoor usage is the most significant one; therefore, it was used in ONAT to determine available wastewater inflows to the existing plants. The ONAT approach was compared against the four wastewater inflow scenarios produced by Carollo and Stantec (2023) as a validation of the approach for simulation runs that extend between 2020 and 2050.

The wastewater inflows for all the four City's WRPs are estimated by a combination of estimated indoor deliveries and wastewater treatment information available from the UWMP (LADWP 2020). Wastewater flows are based on indoor water usage, I&I, plus other connections from deliveries outside Los Angeles' boundaries but that connect to any of the four City WRPs. Indoor and outdoor demands are determined by using the indoor demand fraction from UWMP Exhibit 2D (LADWP 2020).

The MP Team considered multiple approaches to estimate the correlation between water use and wastewater flows. The current preferred method to estimate wastewater flows was based on a relationship to indoor deliveries. HWRP historical inflows were available from July 2001 and were used for the development of a statistical model correlating indoor deliveries and HWRP wastewater inflows. Carollo and Stantec (2023) cite the *One Water LA* report, which estimates 76% of the total influent to the City's plants is treated at HWRP.

Once the total wastewater flow is estimated, the wastewater flow is allocated among the City's four WRPs. The allocation is based on the historical fraction of the total wastewater that was treated at each individual plant corrected for flow bypasses that currently occur at Tillman WRP and Glendale WRP. Therefore, the percentage split represents the potential fraction of the total wastewater generated by the City that could be treated at a given WRP without any bypass of flows. The percentage split is based on the City's WRPs flows presented in Table 5 of the *Hyperion Flow Projections Update* report (Carollo and Stantec 2023) and latest UWMP (LADWP 2020). This split consists of the following:

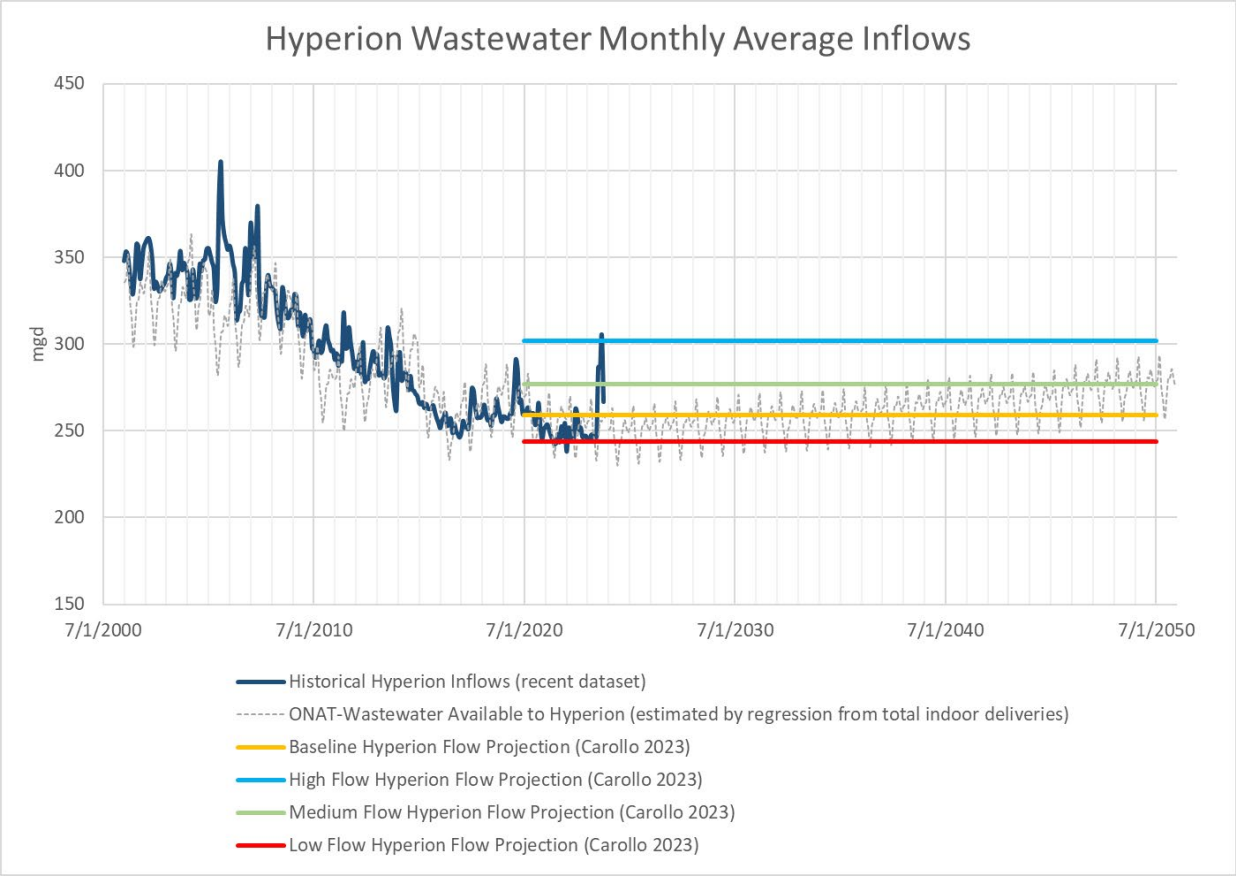
- Tillman WRP: 16% of total reported wastewater flows
- Glendale WRP: 6% of total reported wastewater flows
- Terminal Island WRP: 5% of total reported wastewater flows
- HWRP: 73% of total reported wastewater flows (does not include bypass flows from Glendale WRP and Tillman WRP)

ONAT assumes the wastewater percentages of the total per plant will remain constant during the simulation periods.

Wastewater inflows are reduced by an assumed AWPF efficiency in treatment to reflect loss during the treatment process. The treatment efficiency assumed for the AWPF is 85%. The current estimated future HWRP wastewater inflows average 421 cfs (272 MGD).

Figure 5-1 compares wastewater inflows to HWRP from fiscal year 2000 to fiscal year 2050. The figure shows that the simple statistical model that uses total system potable indoor deliveries presents a good correlation with historical flows (mainly capturing the decreasing flow trend from year 2000 until 2020) and stays withing the estimated range of future flow scenarios described by Carollo and Stantec (2023) from 2020 until 2050. The higher variability of flows is considered conservative to evaluate the system that will produce ATRW. The monthly variability also adds some uncertainty about flows that would not be captured if using constant annual average flow values.

Figure 5-1. Historical Measured and Future Estimated Hyperion Water Reclamation Plant Inflows



6. LADWP Water Supply and Pure Water Los Angeles Demand Assumptions

The City has a diverse water supply portfolio and a mature water conservation program, and both have been critical to maintaining a reliable supply. The four main historical water supplies available to meet the City's demands according to the 2020 UWMP are:

1. LAA water supply
2. Groundwater from SFB, CB, and West Coast Basin (WCB)
3. Purchase of imported water from Metropolitan
4. NPR water

This section includes general descriptions of these supplies. Appendices B and C provide the detailed assumptions and priority of usages. All water supplies come with unique challenges that have been exacerbated by climate change and increasing hydrologic variability (CGO et al. 2018; Konapala et al. 2020). Extremes represented by both more severe droughts and wet events are straining the capabilities in many locations of existing water supplies and infrastructure. The development of new local supplies, such as those from the Pure Water Los Angeles Program, will serve as an important aspect of the City's continued efforts to diversify the water supply portfolio.

The Pure Water Los Angeles ATRW supply would become a major fifth source of supply for the City. However, not all ATRW supply might meet City demands through DPR and IPR applications. Some Pure Water Los Angeles ATRW may be used to recharge groundwater, be stored in surface water reservoirs, or be delivered to water agencies outside of the City (Metropolitan or WCB for example). The different potential uses of Pure Water Los Angeles ATRW production are accounted for in model outputs. The Pure Water Los Angeles ATRW production delivery will also follow a prioritization defined by LADWP that is a function of the hydrological conditions.

Three different priority levels were identified based on LAA runoff year (defined as the year from April to March) hydrological conditions:

1. Conventional Supply and Demand Logic
2. Multiple Dry Years
3. Wet Hydrologic Year

The conventional prioritization will be applied to runoff years that have LAA flows within a range of 164,000 to 276,750 AFY around a median value of 205,000 AFY. This range is based on 80 to 135% of deliveries to the City with 30-year median snowfall and is considered a normal runoff year.

Multiple dry years are runoff years when LADWP experiences an LAA delivery less than 80% of normal conditions or LAA runoff year flows less than164,000 AFY.

The wet hydrologic year category corresponds to years when LADWP experiences LAA flows greater than 135% of normal flow (205,000 AFY), which corresponds to LAA flows greater than 276,750 AFY. Extremely wet years may come with a Potential Emergency Declaration as in 2017 and 2022 (SWRCB 2024), which implies a potential shutdown of all or part of AWPF at or near HWRP.

Attachment C presents a summary table with the prioritization used on LADWP's and Pure Water Los Angeles' supplies as a function of the LAA runoff year. The prioritization was developed by LADWP and provided to Jacobs for use in ONAT modeling.

6.1 LADWP Water Supply Priorities

Each of the primary water supplies available to the City have an assumed priority of use consistent with LADWP assumptions and historical operations. These priorities are based on water rights, contractual requirements, cost of water, and other factors. The priority of supply usage is specified as a model input and can be changed for specific evaluations.

Table 6-1 summarizes LADWP's water supplies, with a brief explanation of the supply assumptions. The priority levels of the supplies will vary based on the LAA runoff year, and are presented in Attachment C. Table 6-1 includes Pure Water Los Angeles as a new supply (ATRW) in the City's water supply portfolio.

The data presented in Table 6-1 are the culmination of numerous collaborative iterations with LADWP. This information was documented in an MS Excel table file, which was shared by LADWP (LADWP 2024b).

6.1.1 Los Angeles Aqueduct

The available water supply from LAA was provided by LADWP based on a 102-year historical period (from April 1922 to March 2024). These estimates of supply are based on historical climate and hydrology and adjusted to reflect current LAA restrictions, agreements, and operations. Historical records might not be representative of future conditions, so for that reason, model scenarios are exposed to hydrological sequences of LAA adjusted for climate change projections (approach described under Section 3).

The ONAT user can decide what hydrological sequence to evaluate for deterministic simulations or select Monte Carlo simulations to use all 102 traces of flows. ONAT uses an index-sequential method of sampling for Monte Carlo simulations that preserves the hydrological sequence of wet-dry conditions when sampling 102 traces of inflow.

The current version of ONAT assumes the LAA time series of flows provided is the maximum available supply. If the total available supply from LAA is not needed (due to low demand or priority of other supplies), then the unused supply will be reported in a model output as "unused supply."

6.1.2 Imported Metropolitan Supply

Imported water from Metropolitan is limited by a total maximum contractual annual supply 3,356,630 AF over a 10-year period (Metropolitan 2015) and a maximum flow based on water treatment capacity.

ONAT can assume a minimum imported Metropolitan delivery based on specific areas with limited access to different supplies. The imported minimum value is a user input and can be easily changed in the model dashboard. Initially, the minimum imported Metropolitan supply was set to 60,000 AFY to include connections in Eagle Rock, Harbor, and the LA-25 connection near the Van Norman Complex to be used during LAAFP maintenance shutdowns. The latest version of the model assumes that improvements in the CB system, as well as agreements to feed refineries in the Harbor with recycled water will reduce Metropolitan-imported demands by up to 20,000 AFY, leaving 40,000 AFY as a minimum imported Metropolitan system demand. To account for future uncertainties around these demands, the model assumes the projected minimum imported Metropolitan supply to be 45,000 AFY to represent a more conservative estimate.

This minimum system demand currently has one of the highest priorities to receive water. The current agreement between Metropolitan and LADWP expires in 2024 and requires an average imported amount of 203,313 AFY or a total of 2,033,130 AF over the 10-year term of the agreement.

Table 6-1. LADWP's Water Supplies and Supply Assumptions

Type	Supply	General Description of the Supply
Groundwater	CB and WCB (basic rights)	18,739 AFY (17,236 AFY from CB plus 1503 from WCB); assumes that WCB rights can be transferred to CB.
Groundwater	SFB (credit usage)	Maximum 360,000 AF of regulatory storage; maximum extraction defined as 220 cfs. Initial available SFB storage 577,008 AF from estimated maximum adjudicated storage (full storage conditions).
Groundwater	SFB basic rights	132,000 AFY includes 45,000 AFY of UWMP "conservative" estimate of stormwater capture by 2035, plus 87,000 AFY, which is based on 43,660 AFY firm yield, plus return water extraction rights (an average of 43,340 AFY). Basic groundwater rights for all basins have the same priority to mimic system operations, which operates with groundwater as a whole rather than specific basins in series.
Groundwater	SFB groundwater remediation pumping	Minimum pumping due to remediation assumed to be always on with highest priority.
Groundwater	Sylmar Basin	3,570 AFY of rights.
Imported	LAA	Average value 259,516 AFY on runoff year (April to March) from 1923 to 2021.
Imported	Metropolitan minimum purchase	45,000 AFY of rights. Representative of expected purchases based on system hydraulics and operational needs of Metropolitan-reliant areas. Based on projected demands from Harbor (LA-5,9,16&21), Eagle Rock (LA-17), and LA-25 near the Van Norman Complex accounting for approximately 15,000 AFY of demands. Not based on 10-year Metropolitan agreement with 2024 expiration. A value of 60,000 AFY should be used if Harbor improvements are not considered.
Imported	Metropolitan additional purchase (beyond minimum)	Limited only to a maximum 10-year contract value (Metropolitan 2015).
NPR	NPR water from the four WRPs (Terminal Island, Hyperion, Glendale, and Tillman)	Some of the total system demands can be offset by NPR water. The current estimate is that NPR demands will grow from 11,000 AFY in 2024 to 18,600 AFY in 2050.
ATRW	Pure Water Los Angeles supply stored in CB and WCB	Up to 55,000 AF of storage in CB will be used for augmentation as 50% of Basin Operating Reserve.
ATRW	Pure Water Los Angeles supply stored in LADWP reservoirs (Lower Stone Canyon or Lower Hollywood reservoirs)	Initially included in the model, but currently inactive because reservoirs are not included in the Program.
ATRW	Pure Water Los Angeles Supply through the LAAFP	DPR option will deliver Pure Water Los Angeles supply to LAAFP; the new supply could vary as a function of many system variables but will not exceed 356 cfs (230 MGD [257,809 AFY]).
ATRW	Pure Water Los Angeles water stored in SFB	Augmentation storage is part of the maximum 360,000 AF of adjudicated storage.

Source: (LADWP 2024b)

AF = acre-foot (feet)

6.1.3 San Fernando Basin

The SFB will soon become a larger contributor to the water supply for the City due to recent improvements in the basin that will allow full use of basin water rights (LADWP 2021). SFB also represents the largest potential storage for Pure Water Los Angeles water. Table 6-2 summarizes SFB model assumptions for supply (recharge), storage, and demands (extraction). The data presented in Table 6-2 are the culmination of numerous collaborative iterations with LADWP. This information was documented in an MS Excel table file (LADWP 2024b).

Table 6-2. San Fernando Basin Model Assumptions

Model Variables	Description
Supply Sources	Imported deliveries to the valley that contribute to basin recharge, Tillman WRP recharge, and Pure Water Los Angeles recharge.
Capacity Available for Supplies	Spreading grounds (dry weather capacity only). Available to Tillman WRP and Pure Water Los Angeles are dry weather spreading grounds' capacity and injection. ONAT includes capacity at Tujunga, Pacoima, and Hansen basins, plus Stormwater Capture Parks and injection, for a total maximum of 230 cfs (149 MGD).
Banked Water Storage	360,000 AF of regulatory storage range, with initial available storage at 577,008 AF(ULARA 2019).
Demand Physical Capacity	Maximum total extraction capacity set to 220 cfs (142 MGD).
Remediation Minimum Extraction	The minimum remediation is set to119,123 AFY. This exceeds current rights (approximately 87,000 AFY).
Demand Rights	Future rights are expected to increase to 132,000 AFY due to stormwater capture projects. Current rights are approximately 87,000 AFY, based on the Native Safe Yield Credit (43,660 AFY) plus return water extraction rights (as a function of the water delivered to the basin floor, approximately 45,000 AFY).
Potential Demands	Initially assumed to be able to serve all of LADWP's demands; the most current direction assumes a limit of 220 cfs (142 MGD) (same as extraction and approximately 159,000 AFY).

Source: (LADWP 2024b)

6.1.3.1 Inflows and Recharge

A constant inflow approach was assumed for the evaluation of the system so that inflow does not vary as a function of wet and dry cycles. ONAT has the capability to run estimates of natural recharge from inflows to SFB. The estimate is based on historical flows from the latest available Upper Los Angeles River Area Watermaster (ULARA) report from December 2019 (ULARA 2019). Where historical natural recharge flows were not available in the historical period from 1921 to 2022, average flows were adjusted and correlated with hydrological indices to fill data gaps.

The ONAT model offers the option to simulate recharge of the SFB groundwater basin with flows from LAA and Pure Water Los Angeles ATRW, in addition to the normal recharge operations described in the ULARA report (ULARA 2019). The recharge capacity is determined by water availability from Pure Water Los Angeles or LAA, basin storage volume, and recharge capacity of the basin.

Recharge capacity is defined by user input and is currently based on the recharge capacity estimate provided by LADWP. The surface recharge capacity is based on estimated dry weather idle recharge capacity for the Tujunga, Pacoima, and Hansen basins and Storm Water Capture Parks from April to October, not exceeding 153 cfs (99 MGD) of surface recharge. ONAT also includes groundwater injection capability. The capacity of the new groundwater injection wells is initially estimated to be 77 cfs (50 MGD), with June and July specified as maintenance months (no injection).

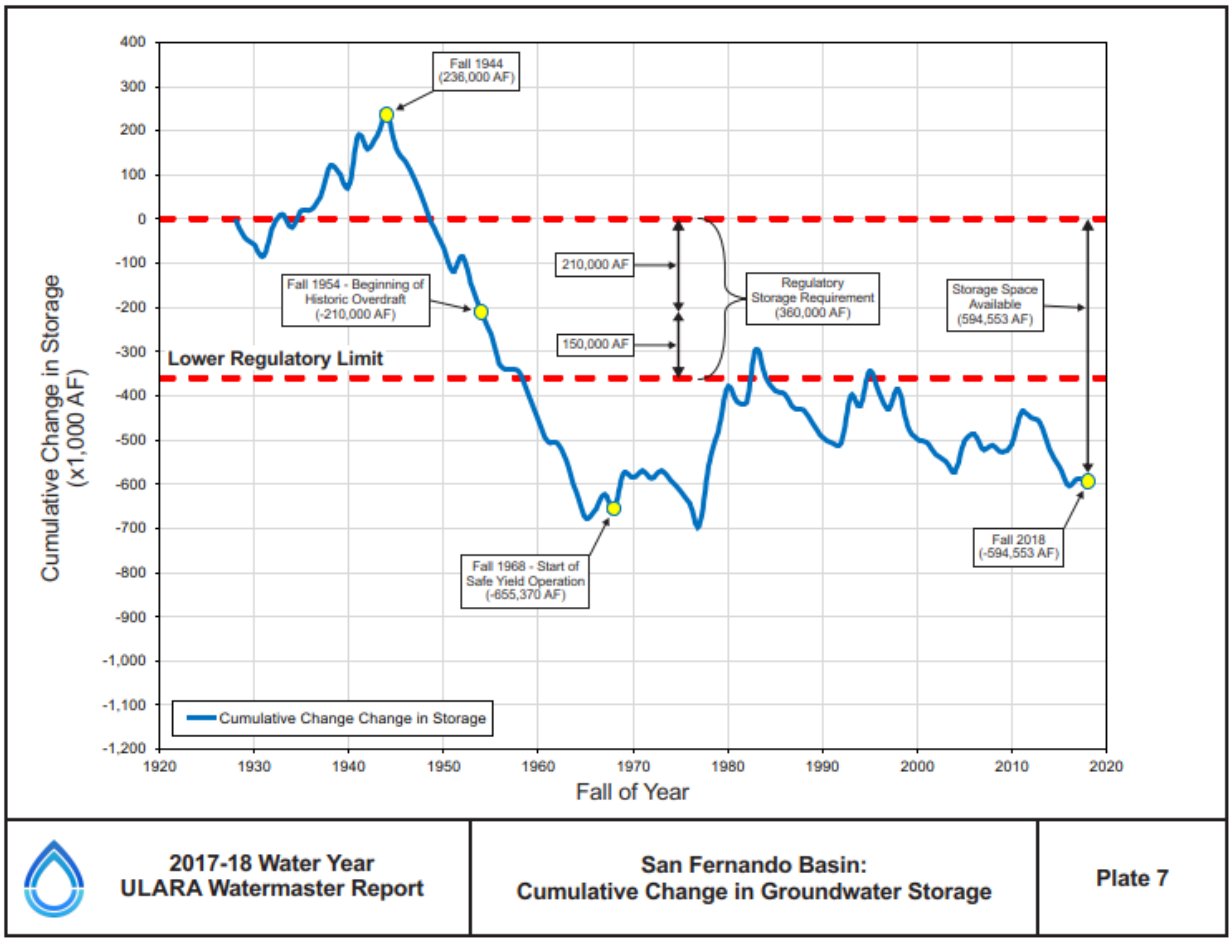
ONAT also considers recharge from Burbank and Glendale's return flows (constant 12 cfs [7.6 MGD] assumed for the system evaluation). These inflows are extracted by the two cities, so the net storage change is zero for these agencies; however, ONAT is set up to have variable recharge.

Tillman WRP water can also be used to recharge SFB if excess production is available after meeting recycled water demands. ONAT assumes Tillman WRP will produce 37 cfs (24 MGD) at Balboa Pump Station, approximately 3 cfs (2.1 MGD) (subject to seasonal variation) of NPR demands will be subtracted from the production, and the remaining will be recharged at SFB up to 37 cfs (24 MGD [26,868 AFY]). An additional 31 cfs (20 MGD) of discretionary environmental use flows is diverted to LAR. Excess treated Tillman WRP flows will flow to HWRP.

6.1.3.2 Storage

The initial available storage in SFB is currently set as 577,008 AF (LADWP 2024b; ULARA 2019). The adjudicated storage capacity is set to 360,000 AF, based on the basin adjudication described in the 2017-2018 ULARA Watermaster Report (ULARA 2019) (Figure 6-1). The current ONAT model includes simplified rules for groundwater bank operational storage that permit up to 360,000 AF of storage in the basin for Pure Water Los Angeles supply.

Figure 6-1. Plate 7 of the 2017-2018 ULARA Report (ULARA 2019) Showing San Fernando Basin Storage Variation



The ONAT model keeps track of changed SFB storage and Pure Water Los Angeles water recharged in SFB. Rules on how to use that water and the priority of using it versus other banked water and rights can be

found in Attachment C. The ONAT model can use a dynamic change of priority to use SFB groundwater storage. If the dynamic use of SFB storage option is selected, the model will adjust the priority of the SFB storage groundwater supply as a function of how much groundwater is currently stored. The SFB groundwater has four different priorities for groundwater use, consisting of:

1. SFB remediation extraction
2. SFB minimum rights
3. SFB banked water, which includes:
   - Natural recharge
   - Unused minimum rights
   - Tillman WRP recharge
   - An option for LAA flows to be recharged that is currently inactive
4. SFB banked Pure Water Los Angeles water

The SFB remediation extraction has the highest priority for use and is estimated to be 166 cfs (107 MGD [119,123 AFY]). The remediation extraction is based on the assumptions from the future native spreading based on the following factors:

- Historical rates
- Replenishment from groundwater recharge and Tillman WRP
- Burbank recharge at Pacoima
- Stormwater spreading
- Stormwater Capture Parks Program

Any future anticipated replenishment from Pure Water Los Angeles is not factored into these projections in the latest LADWP SFB groundwater modeling effort.

6.1.3.3 Extraction

Recent SFB remediation efforts will allow the increased use of the basin's groundwater. Based on preliminary ONAT model results from February 2024, increased overall groundwater supplies will now account for approximately 19% of the entire City's supply in the future. SFB extraction rights for LADWP are a function of natural and artificial basin recharge. Past operation averaged rights approximately to 87,000 AFY. Future operation will rely on improved stormwater capture programs that will translate to additional potential extraction, including:

- Native Safe Yield Credit (43,660 AFY)
- Return water extraction rights (as a function of the water delivered to the basin floor, approximately 43,340 AFY)
- Additional recharge rights resulting from future stormwater capture programs (estimated at 45,000 AFY)

Physical extraction is currently limited to 220 cfs (142 MGD), although it might be possible to increase up to 300 cfs (194 MGD) with additional conveyance infrastructure in the 1134 service zone. The other two agencies that extract flow from SFB, City of Burbank, and City of Glendale, have water rights based only on return flows (ULARA 2019). Valley floor total deliveries for Burbank and Glendale are not available, so the ONAT model then simplifies the estimate of return flow, making it proportional to the return flow credits calculated for the City of Los Angeles based on the latest ULARA report available. In the latest ULARA report (2019), the amount of return flow extraction credit for Burbank and Glendale was 22.36% of the return flow extraction right calculated for Los Angeles.

It is important to mention that the 2014 ULARA report states that "the San Fernando Basin cannot supply the total amounts of groundwater to which these Parties are entitled under the judgment, and that there is a significant shortfall between water rights and actual hydrologic conditions" (ULARA 2014) This shortfall is planned to be addressed with a significant increase of stormwater capture and also additional Tillman WRP and Pure Water Los Angeles flows into the basin.

Recycled water that is replenished into the groundwater basin must meet a minimum of 2 months of retention time before extraction for drinking water in the *California Code of Regulations* Title 22, Social Security Division 4, Chapter 3, Water Recycling Criteria, Article 5.2, Section 60320.224; however, 6 months has typically been used as a minimum in California indirect potable reuse (IPR) projects, in particular for virus reduction (State of California n.d.). Although this retention time is based on hydrogeologic modeling, which has not yet been conducted for future injection and extraction well locations, a hold of 6 months has been incorporated into ONAT to recognize this as the typical retention time that meets this regulatory requirement.

6.1.4 Central and West Coast Basins

LADWP has groundwater extraction and storage rights at CB (17,236 AFY) (Los Angeles Superior Court 2013) and WCB (1,503 AFY) (Los Angeles Superior Court 2014). The model assumes LADWP's Allowed Pumping Allocation (APA) will always be available and is independent of potential exceptional fluctuations in groundwater levels. ONAT represents CB and WCB as one storage component, with the following simplified logic to represent LADWP's share of the basins. Available recharge to t CB groundwater storage could be through the existing Montebello Forebay Spreading Grounds' available capacity or through potential future injection wells. Storage with simplified rules for extraction in CB is considered as part of the current model version.

Table 6-3 summarizes the assumptions related to the usage of LADWP's CB and WCB storage amounts. The data presented in Table 2 are the culmination of numerous collaborative iterations with LADWP. This information was documented in an MS Excel table file (LADWP 2024b).

Table 6-3. Central Basin and West Coast Basin Summary of Assumptions Related to Pure Water Los Angeles

Model Variables	Description
Inflow Sources	Pure Water Los Angeles only; model assumes WRD is responsible to assure enough storage is available to provide the annual APA to the judgment parties.
Augmentation Inflow Capacity	28 cfs (18 MGD), assuming injection and extraction for 10 (of 12) months of the year to account for maintenance. Accounts for Phase 3 of the groundwater utilization plan of which 5 cfs from Phase 2 exceeds LADWP's APA (LADWP 2024f). Extraction capacity accounts for a 10-month operating window for injection and extraction wells.
Storage	Maximum storage of water rights is set as 200% of LADWP's basin rights in CB, for a total of 34,472 AF[a]. In addition to storage of water rights, maximum storage of augmentation water for Pure Water Los Angeles is preliminarily assumed to be 50% of the basin's operational reserve (55,000 AF).
Extraction Physical Capacity	Total extraction capacity assumed to be 59 cfs (38 MGD) (including 28 cfs [18 MGD] for Pure Water Los Angeles); assumes infrastructure upgrades are in place up to Phase 3 of the CB groundwater utilization plan. Assuming injection and extraction for 10 (of 12) months of the year to account for maintenance. Accounts for Phase 3 of the groundwater utilization plan, of which 5 cfs from Phase 2 exceeds LADWP's APA. Extraction capacity accounts for a 10-month operating window for injection and extraction wells (LADWP 2024f).
Extraction Rights	Extraction limited to 140% of LADWP's APA.
Potential Demands	Improvements in the CB areas will allow pumped groundwater to feed the 386 Service Zone (SZ), a portion of the Western Service Area (205 & 325 SZ), and the Harbor Service Area (240 SZ). Because these service areas are defined as "closed systems," the diurnal demands determine the water that can be pumped from groundwater wells. Without variable-frequency drives, the demands that can be fed through "Block Flow" are estimated at 42,594 AFY. There is also the possibility to supply WRD demands to support their management of groundwater storage in CB.

WRD = Water Replenishment Water District of Southern California

[a] This assumption is disconnected from inputs into modeling results due to direction from WRD that was given after modeling inputs were finalized. It is a minor change that is not expected to significantly alter results. Model inputs assume 200% of CB and WCB rights up to 37,478 AF.

6.1.4.1 Inflows and Recharge

Inflows to CB and WCB are focused on LADWP's share of the groundwater storage. Therefore, only inflows that would change the amount of storage in the LADWP share of the basin are considered in ONAT. ONAT assumes that the basic LADWP APA in the basin will always be available, and if not fully used in one year, could be converted into storage. The Pure Water Los Angeles ATRW inflows considered in ONAT are those that could:

- Replace current injections of imported water at the West Coast Sea Barrier (WCSB)
- Be injected and stored using LADWP's share of storage in the basin
- Be injected and extracted as part of a water augmentation program

All Pure Water Los Angeles injection to CB will be through new injection wells that currently are set to 59 cfs (38 MGD) capacity over a 10-month period (LADWP 2024f). In these basins, only injection to the WCSB is limited by capacity. Additional injection quantities can be estimated by ONAT if no physical limitations to injection rates are set. CB recharge through the Montebello Forebay Spreading Grounds could be accounted for as water provided to WRD and not stored in LADWP's CB storage.

6.1.4.2 Storage

The maximum storage considered for CB and WCB is set to be 200% of LADWP's APA or 200% of 17,236 AF (CB rights) for a total of 34,472 AF[3]. In the case that storage fills up, and at some point in the future, water rights could be lost if storage is not transferred, extraction capacity is not increased, or water rights are not changed. ONAT estimates when and how much water would be lost under different operational cases.

Any use of storage in CB beyond the existing APA would need approval from the Watermaster Storage Panel. It has been estimated that there could be the potential for more than 100,000 AF of storage in CB. The 2013 CB judgment (WRD 2013) describes 330,000 AF of available dewatered space, with 110,000 AF of the available dewatered space set aside for WRD. ONAT assumes that 55,000 AF (50% of the 110,000 AF) of dewatered space managed by WRD would be available for augmentation. Extraction capacity would likely limit how much LADWP would store for multiple drought year scenarios, which would likely be only a fraction of the total volume described; however, it is a combination of two variables (extraction capacity and system demands) that will dictate the final potential storage need.

6.1.4.3 Extraction

Extraction limitations can be physical (maximum pumping extraction capacity), regulatory (maximum allowed by adjudication), or demand driven (maximum that the system could take).

Although the maximum current physical extraction capacity is now approximately 10,000 AFY, LADWP could increase extraction capacity with a new well field up to the regulatory 140% of its APA, or even more with the approval of the CB Water Rights Panel. The maximum ONAT extraction is now defined by the user and should be set at a minimum value that would allow LADWP to extract all of its rights in CB and WCB, plus any additional stored Pure Water Los Angeles water. Because this would be a new extraction capacity, ONAT could estimate how much capacity would be needed to meet system demands and use all potential storage with the limitation of 140% of APA.

Under current conditions, demand is the limitation on our extraction, not physical pumping capacity. ONAT models the system for future conditions. Current model assumptions are that CB and WCB extractions are not limited by system demands for those areas but are capped at demand from Phase 3 of

[3] This assumption is disconnected from inputs into modeling results due to direction from WRD that was given after modeling inputs were finalized. It is a minor change that is not expected to significantly alter results. Model inputs assume 200% of CB and WCB combined rights up to 37,478 AF.

GW utilization plan (LADWP 2024f). ONAT assumes the improvements in CB will allow for pumped groundwater to feed the 386 Service Zone (SZ), a portion of the Western Service Area (205 & 325 SZ), and the Harbor Service Area (240 SZ). The maximum extractions are limited by the low point of the diurnal demands as to be able to keep the groundwater pumps constantly operating at "Block Flow" conditions.

Currently, exercising of water rights is limited by aboveground infrastructure, including older distribution mains in a closed system that can be subject to over-pressurization, with use dependent on demand. Planned improvements in CB to relieve these limitations would allow LADWP to access existing groundwater rights and stored augmentation water; thus, ONAT assumes that demands in CB of 59 cfs (38 MGD [42,594 AFY]) could be met by completing the improvements (Phase 3) in the CB system and the extraction of existing water rights and stored Pure Water Los Angeles augmentation water (LADWP 2024f).

6.1.5 LADWP Reservoirs

The potential for storage of Pure Water Los Angeles supply in LADWP reservoirs is incorporated into the ONAT model. The inputs for LADWP reservoirs are inflow pipeline capacity, reservoir capacity, and treatment capacity available to use the stored water. These reservoirs are not part of any of the Program alternatives, but the functionality is built into the ONAT model.

The reservoirs considered are the Lower Stone Canyon and Lower Hollywood reservoirs. The capacity of the reservoir chosen can be set in the dashboard.

6.1.6 Los Angeles Aqueduct Filtration Plant and Van Norman Complex

Pure Water Los Angeles supply can be delivered directly to the Van Norman Complex (VNC) (LAAFP or reservoir), depending on the alternatives. The LAAFP's current capacity is 928 cfs (600 MGD) (LADWP 2012). The capacity potentially available for Pure Water Los Angeles supply to be delivered to the LAAFP or reservoir can be a function of infrastructure limitations or blending of AWPF production and LAA water.

ONAT assumes a limit of 252 cfs (163 MGD) of AWPF production going into LAAFP for Program alternatives that include DPR at VNC. Other alternatives that do not include DPR treatment at VNC can potentially take all AWPF production. ONAT does not account for the storage at the LAAFP (Los Angeles Reservoir [LAR]), it assumes that all the AWPF production delivered at LAAFP will be delivered to system demands.

6.1.7 Metropolitan Pure Water Southern California

The potential connection of Pure Water Los Angeles with Metropolitan's Pure Water Southern California Program (PWSC) is included in the ONAT model to allow evaluation for alternatives when there is a Metropolitan partnership component. Within ONAT, the user can set the maximum flow that could be sent from Pure Water Los Angeles to Metropolitan's PWSC. Additional considerations, outside of ONAT, will be important in establishing the flow entered, as noted in the *Interconnectable Partnership Opportunities* TM (Jacobs 2024). The operation of this potential partnership is tracked in model outputs.

Although this tracking is available in the model, it is outside the scope of the MP; however, this functionality could be used in the future to account for the quantity of Pure Water Los Angeles water that returns to the City as imported deliveries and how much was removed from the City system (going to other Metropolitan deliveries).

6.2 Pure Water Los Angeles Advanced Treated Water Supply and Prioritization

Hyperion Owner's Agent *Technical Memorandum 3 Treatment Alternatives Evaluation* (Hazen 2024) describes available feed flow to HWRP as up to 421 cfs (272 MGD), as well as membrane bioreactor (MBR) effluent of up to 421 cfs (272 MGD). These flowrates are consistent with *LA Sanitation & Environment Hyperion 2035 Program Implementation Plan Technical Memorandum 19 Product Water Distribution* (Carollo 2022) Section 19.3.1, Product Water Flows, which stated projected flows were 421 cfs (272 MGD) of dry weather influent to HWRP and 356 cfs (230 MGD) of product water. TM3 states a recovery of 85% through RO.

No recovery is specified through MBR in TM3 or in *Hyperion Program Implementation Plan*, so for the purposes of ONAT modeling, recovery through MBR is set at 100%. MBR recovery can be adjusted in the future by LADWP beyond the MP, but all MP alternative model runs will be conducted using this assumption. Thus, ONAT assumes a maximum of 356 cfs (230 MGD) of ATRW production, which translates into a maximum 421 cfs (272 MGD) of inflows when assuming an 85% RO recovery and 100% MBR recovery. While a 100% recovery rate is the current assumption, this is an estimate that is subject to change because of updates in the *Hyperion Program Implementation Plan* (LADWP 2024g).

ONAT assumes that there are both MBR treated water demands and ATRW treated water demands. Those MBR and ATRW demands are not system demands necessarily; they are a combination of deliveries to end customers, storage, or demands from outside the system. Pure Water Los Angeles water delivered to storage can eventually become supply to system demands (and, consequently, become wastewater). Pure Water Los Angeles water deliveries to partners and outside the City's system do not return to advanced water treatment through the sewer system.

Pure Water Los Angeles ATRW will provide a new treated water supply for the City. The capacity of Pure Water Los Angeles ATRW production is defined by the ONAT model user but is subject to maximum available wastewater inflows, as described in Section 5. The priority for Pure Water Los Angeles delivery and storage is also subject to ONAT input but is generally prioritized. Table 6-4 summarizes the potential AWPF delivery locations.

Depending on the location of delivery and use of Pure Water Los Angeles ATRW, some deliveries may not return to the City's WRPs. For example, ATRW deliveries to WCB will not return to the City's wastewater system, while Pure Water Los Angeles ATRW deliveries to LAAFP will largely return to the City's wastewater system.

Table 6-4. Potential Advanced Water Purification Facility Delivery Locations

ATRW Potential Delivery Location	Description
West Basin Municipal Water District (West Basin) and WCSB (injection of Pure Water Los Angeles that can be extracted for demands)	53 cfs (34 MGD) of MBR water delivered to West Basin, including: ▪ WCSB injections ▪ Non-potable irrigation ▪ Low-pressure boiler feed water for Chevron ▪ High-pressure boiler feed water for Chevron
LAX	1 cfs (0.75 MGD) of advanced treated water from AWPF is delivered to LAX. The total AWPF production is 2.3 cfs (1.5 MGD).
CB Groundwater Injection	20 MGD of Injection water in the CB Forebay Area, as sales to the WRD.
	28 cfs (18 MGD) of injection water in the CB Los Angeles Forebay Area, in LADWP water augmentation storage bank. Does not represent any treated water augmentation application. Could include deliveries to WRD beyond an augmentation program.

ATRW Potential Delivery Location	Description
Dependent Partnering Opportunities (City of Santa Monica, WRD)	Ability to dedicate flows, at specific priority, to partners. The partnership flows have to be analyzed case by case, if included, so that the overall mass balance is corrected, if needed.
SFB Injection	Ability to move Pure Water Los Angeles water into SFB storage. Capacity of this connection varies among Program alternatives (depending on the pipes being used to convey AWPF production to SFB) and is limited by recharge capacity.
SFB Spreading	Use available spreading capacity in the Tujunga, Pacoima, and Hansen basins; maximum 130 cfs (~90.5 MGD), plus 23 cfs (14.9 MGD) from stormwater parks, all during dry months of the year.
LAAFP	Represents a connection either upstream of the LAAFP or to LAR. Capacity of this connection can vary, depending on the Program alternative being evaluated.
CB Spreading in the Montebello Forebay	Although the model has this capability, it is not currently being used in any alternative.
Groundwater Bank	Additional water sent to and from an LAA groundwater bank, if analysis warrants use of a bank at some point in the future.
Metropolitan PWSC Connection	Connection to Metropolitan PWSC Backbone; up to 232 cfs (150 MGD) of capacity.

~ = approximately

LAX = Los Angeles International Airport

Pure Water Los Angeles supply that exceeds the capability to deliver or store is assumed to be discharged to the ocean. ONAT model inputs also include the maximum capacity and demands for some connections and some uses of ATRW. These assumptions are used to help support potential future examination of right-sizing facilities for various alternatives.

The total production of Pure Water Los Angeles is accounted as the sum of deliveries to the list of locations in Table 6-4. Potential deliveries of tertiary MBR flows from HWRP to West Basin could be accounted for as Pure Water Los Angeles production. The definition of metrics will be further described in the ONAT Model Results TM, to be supplied under separate cover.

At the current ONAT model version, potential deliveries of tertiary MBR flows from HWRP to West Basin are accounted as wastewater usage following MBR. Therefore, these tertiary MBR flows to West Basin are not accounted for as Pure Water Los Angeles production.

The model also keeps track of the amount of Pure Water Los Angeles water delivered to storage. The model metrics that account for the Pure Water Los Angeles water production and usage are reported under Section 8, Model Outputs and Metrics.

Other locations that Pure Water Los Angeles supply could be delivered to that could be evaluated in the ONAT model are:

- West Basin distribution system
- City of Santa Monica and other potential partners
- Montebello Forebay Spreading Grounds
- Santa Fe Spreading Grounds
- City reservoirs; for example, Lower Stone Canyon or Lower Hollywood

The Pure Water Los Angeles demand assumptions for these delivery locations vary depending on alternatives.

7. Model Outputs and Metrics

The ONAT model produces results for all flows (production, conveyance, storage, demand), and deliveries incorporated in the model. Results can be output at daily, monthly, or annual time scales. The development of specific model metrics is being actively advanced and integrated with the MP needs for alternative evaluations, facility sizing, resiliency analysis, and other needs that will be reported in the future TM on ONAT results or the other MP TMs.

The current set of metrics being developed from ONAT includes the following:

- LADWP water supply portfolio summary
- Pure Water Los Angeles ATRW production and unused supply
- Pure Water Los Angeles deliveries by location
- SFB storage accounting
- Conveyance usage
- Deliveries to partners (as incorporated)

Table 7-1 summarizes the main model metrics with the expected use in the MP. The metrics for the different scenarios and Program alternatives will be presented in the future ONAT Model Results TM.

Table 7-1. Summary of Model Metrics and Expected Use in Pure Water Los Angeles Master Plan

Model Metric	Expected Use in the Pure Water Los Angeles MP
LADWP water supply portfolio summary	Shows changes in the water supply portfolio associated with various Pure Water Los Angeles alternatives; supports cost estimates and benefits.
Pure Water Los Angeles production and unused supply	Demonstrates the average, minimum, and maximum usage of Pure Water Los Angeles production; supports sizing and cost estimates.
Pure Water Los Angeles deliveries by location	Demonstrates the delivery of Pure Water Los Angeles supply to locations associated with alternatives.
SFB storage accounting	Shows the storage use and limitations of Pure Water Los Angeles supply; supports refinements to operational regimes or additional benefits.
Conveyance usage	Demonstrates likely daily and monthly flows on various segments of conveyance alignments to support engineering and cost assessments.
Partner delivery	Demonstrates the delivery of Pure Water Los Angeles supply to specific partners associated with alternatives; supports partnership discussions.

8. Next Steps

The initial outcomes from the ONAT model were used in the preliminary screening of Program alternatives, as described in the Program Alternatives Screening TM (Arcadis 2024). Since that time, the ONAT assumptions have been finalized in collaboration with LADWP. The subsequent steps in the MP process that will use the ONAT results include the comprehensive modeling of all of the scenarios described in Section 4. The ONAT results from all scenarios will be instrumental in the infrastructure sizing understanding and analysis.

The ONAT model results will also be used as follows:

- As the foundation for resiliency analyses
- To inform further screening of alternatives
- To provide initial estimates of the use of Pure Water Los Angeles water for the different Program components to inform infrastructure sizing

Based on the modeling results for the scenarios, the preferred projects can be selected and defined by LADWP.

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Attachment A
Timeline of Operation NEXT Assessment Tool Development and Decisions Through September 2023

Attachment A: Timeline of Operation NEXT Assessment Tool Development and Decisions Through September 2023

The need for a water balance and Pure Water Los Angeles systems model was identified early in the Master Plan (MP) development. Initial discussions between the Pure Water Los Angeles Team and other Los Angeles Department of Water and Power (LADWP) teams began in June 2022 as the alternatives development and resiliency tasks were coming more into focus. Jacobs Team members were provided briefings and information related to LADWP's water supply planning and the existing LADWP Groundwater Storage Bank Model (GSBM). In addition, the MP Team met multiple times with the University of California, Los Angeles (UCLA) Team that is conducting a related Pure Water Los Angeles resiliency benefit assessment.

The MP Team explored options for developing the required information with the required level of detail. The need was identified for an Operation NEXT Assessment Tool (ONAT)[4] that would leverage the use of existing input and outputs from the current LADWP model and that would integrate broad assumptions of scenarios that were consistent with ongoing UCLA efforts.

Discussions delayed the onset of ONAT model development until agreement was reached and Notice to Proceed was received on March 21, 2023. With several meetings and workshops, as well as versions of this technical memorandum for review and modification, the MP Team has been developing the ONAT model since that date. The ONAT model has been advanced substantially in recent months as the alternatives are becoming more refined and the information needs are becoming clearer. Table A-1 provides a general timeline of the ONAT discussions and development to date.

Table A-1. General Timeline of ONAT Discussions and Development to Date

Date	Discussion and Development
6/10/2022	Initial water balance modeling discussions with LADWP Pure Water Los Angeles Team.
6/23/2022	Presentation by LADWP team on LADWP GSBM assumptions and use. Discussion on priority of supplies, time steps, and needs of Pure Water Los Angeles MP.
8/24/2022	Resiliency task (Task 9) overview meeting, to discuss the following topics: ▪ Resiliency task goals ▪ Resiliency approach ▪ Existing and past resiliency efforts ▪ Breadth of resiliency benefits ▪ Path forward
2/2/2023	LADWP, Jacobs, and UCLA Resiliency coordination meeting.
3/1/2023	LADWP, Jacobs, and UCLA Resiliency coordination meeting.
3/16/2023	LADWP provided Microsoft Excel spreadsheet listing baseline assumptions for the GSBM.
3/21/2023	Notice to Proceed with ONAT model development.
3/30/2023	LADWP shares results from a monthly time-step model with a matrix of assumptions.
5/26/2023	Meeting with LADWP Pure Water Los Angeles project management to present model approach, scenarios, and sample outputs.
9/1/2023	Refinements and updates to ONAT model. ONAT Workshop 1 (9/13/23).

[4] In August 2024, Operation NEXT was rebranded as Pure Water Los Angeles; however, due to legacy Program documentation, ONAT will retain its original name.

Attachment B
Matrix of Assumptions

Attachment B: Matrix of Assumptions

Table B-1 provides the table of assumptions for the Operation NEXT Assessment Tool (ONAT) model developed for Scenario 1.

Scenario1 As of Feb 27, 2024

Scenario 1 assumptions: 1.Current Trends Scenario: Adjusted APPROACH 1

White cell with bold outline = different from other alternatives

Input ID	ONAT scenario	Baseline Alternative	Approach 1(IPR) F1_IPR_A1	F1_IPR_A2	F1_IPR_A3
	Demands and Wastewater				
0	Hydrology	July-1990 to end of June 2020	July-1990 to end of June 2020	July-1990 to end of June 2020	July-1990 to end of June 2020
1	LA Demands (AFY)	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent
2	Demand Monthly Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
3	Indoor/outdoor Demand Pattern	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020
4	Recycled Water Demand (AFY)	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP
5	Recycled Water monthly pattern	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP
6	Annual Demand Multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier
7	Monthly Demand Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
8	Wastewater estimate independent variable to use	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery
9	Fraction of the deliveries (potable/indoors) that comes back to wastewater plants	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage
10	Residential GPCD	72.92	72.92	72.92	72.92
11	Wastewater Treatment Efficiency (Effluent/Influent)	0.95	0.95	0.95	0.95
12	AWT Efficiency (Effluent/Influent)	0.8456	0.8456	0.8456	0.8456
13	WW Adjustment (Monthly multiplier of the selected deliveries (indoor or total potable) selected on input #8	No multiplier	No multiplier	No multiplier	No multiplier
14	Recycled Water Demand Multiplier	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)
15	*WW Distribution (From UWMP 2020, fraction of total wastewater for each treatment plant)*				
16	DCTWRP	0.1012	0.1012	0.1012	0.1012
17	HWRP	0.8121	0.8121	0.8121	0.8121
18	LAGWRP	0.0405	0.0405	0.0405	0.0405
19	TIWRP	0.0462	0.0462	0.0462	0.0462
20	*Wastewater Plant tertiary production capacity (WW_tert_cap [mgd])*				
21	DCTWRP	80	80	80	80
22	HWRP	450	450	450	450
23	LAGWRP	20	20	20	20
24	TIWRP	30	30	30	30
25	**OpNEXT Controls**				
26	OpNEXT Start Date	7/1/2020	7/1/2020	7/1/2020	7/1/2020
27	Hyperion AWT Feed Capacity (MGD)	No OpNext	230 MGD of produced water (Feed=230/efficiency)=270 MGD	230 MGD of produced water (Feed=230/efficiency)=270 MGD	230 MGD of produced water (Feed=230/efficiency)=270 MGD
28	Schedule (Hyperion ATW production will follow a table schedule)	No Schedule	No Schedule	No Schedule	No Schedule
29	Conveyance Capacity from Hyperion to Storage and VNC (MGD)	0	0	0	0
30	Conveyance Capacity to PWSC connection (MGD)	0	up to 150 mgd	up to 150 mgd	up to 150 mgd
31	Hyperion deliveries to West Basin **MBR not ATW** (MGD)	0	0	0	0
34	LAAFP Blending Ratio Limit (RAW:AWT)	No Blending Ratio Limit	No Blending Ratio, do as Sensitivity using 10:1	No Blending Ratio, do as Sensitivity using 10:1	No Blending Ratio, do as Sensitivity using 10:1
	Conveyance from Hyperion to different destinations and related inputs				
32	Hyperion deliveries to West Basin **AWT** (going OUT of the system loop)	0	40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)	40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)	40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)
36	Hyperion to West Coast Sea Barier (a fraction will go to WCB storage)				
37					
38	Hyperion to Central Basin **ATW** Injection capacity (MGD)	0	Potential phased approach-Consider 37 MGD for the moment	Potential phased approach-Consider 37 MGD for the moment	Potential phased approach-Consider 37 MGD for the moment
39					
40	Partners	No Partners	WRD, Santa Monica or Beverly Hills, demands not defined yet	WRD, Santa Monica or Beverly Hills, demands not defined yet	WRD, Santa Monica or Beverly Hills, demands not defined yet
41	Conveyance capacity from Hyperion to/out San Fernando Basin (subjected to injection/spreading capacity	No OpNext Connection, just current East Valley pipeline for DCT	Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and OpNext, assume 25mgd is DCT, 55 mgd is OpNext.	Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and New conveyance (Max 84 MGD) for OpNex. Total 164 MGD ptential to SFB, assume 25 mgd is for DCT/139 mgd to OpNext	No OpNext recharge at SFB, Use of East Valley Pipeline max 80 MGD/124 cfs for DCT only
42	Capacity to send to LA Reservoirs (lim to available capacity)	0	0	0	0
43	MWD Pure Water capacity (MGD)	0	up to 150 MGD	up to 150 MGD	up to 150 MGD
44	Injection in CB for WRD	0	0	0	0
45	OpNext to Montebello Forebay	0	0	0	0
46	LAA groundwater Bank	0	0	0	0
47	**Supplies and Supply Usage**				
48	*LAA Flows*				
49	Hydrology for LAA	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run
50	Start Year	1990	1990	1990	1990
51	Flows	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021
52	If LAA flows are above this value LADWP will override all priorities - Prioritize LAA if LAA flows are > than value (mgd)	9999	9999	9999	9999
53	*Minimum Supply amount to be used for Deliveries [af/yr]*				
54	San Fernando Basin Minimum Rights (GW_SFB1MinRights)	87000	87000	87000	87000
55	Central Basin Minimum Rights (GW_CB)	17236	17236	17236	17236
56	West Coast Basin Minimum Rights (GW_WCB)	1503	1503	1503	1503
57	Sylmar Minimum Rights (GW_Sylmar)	3570	3570	3570	3570
58	LAA groundwater Bank (GW_Antelope)	0	0	0	0
59	Los Angeles Aqueduct (SW_LAA)	0	0	0	0
60	Imported MWD (IMP_MWD)	60000	60000	60000	60000
61	*Priority of Supplies used to meet Potable Demands*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
61.5	San Fernando Remediation				
62	San Fernando Basic Rights (GW_SFB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
63	Central Basin/West Coast Basin Basic Rights (GW_CBWCB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
64	Sylmar Basic Rights (GW_SylmarBasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
65	San Fernando Stored credits (GW_SFB_StoCredits)	6|6|6	6|6|6	6|6|6	6|6|6
66	LAA groundwater Bank (GW_LAAGWB)	8|8|8	8|8|8	8|8|8	8|8|8
67	ATW from Hyperion stored in the San Fernando Basin (GW_SFB_Augm)	7|7|7	7|7|7	7|7|7	7|7|7
68	Use of SFB if no stored credits or OpNext storage is available (GW_SFB_Bank)	999|999|999	999|999|999	999|999|999	999|999|999
69	Los Angeles Aqueduct (SW_LAA)	2|2|2	2|2|2	2|2|2	2|2|2
70	ATW_WCSBarrier	6|6|6	6|6|6	6|6|6	6|6|6
71	ATW injection in Central Basin (ATW_InjectionCB)	6|6|6	6|6|6	6|6|6	6|6|6
72	ATW from Hyperion to LA Reservoirs (ATW_DWPReservoirs)	5|5|5	5|5|5	5|5|5	5|5|5
73	ATW from Hyperion to LAAFP (AWT_OpNEXTLAAFP)	4|4|3	4|4|3	4|4|3	4|4|3
74	Minimum to be imported from MWD (IMP_MWDmin)	1|1|1	1|1|1	1|1|1	1|1|1
75	IMP_MWD	9|9|9	9|9|9	9|9|9	9|9|9
76	IMP_BlendImp	6|6|6	6|6|6	6|6|6	6|6|6
77	*Priority of Hyperion ATW uses*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
78	WBMWD sales (ATW_WB)	2|2|1	2|2|1	2|2|1	2|2|1
79	WC Sea barrier (WCSB) (ATW_STO_WCSB)	3|3|2	3|3|2	3|3|2	3|3|2
80	CB GW injection (LADWP) (ATW_GW_InjCBDWP)	4|4|3	4|4|3	4|4|3	4|4|3
81	Dependent Partening Opportunities (Ex. Santa Monica) (ATW_Partners)	5|5|5	5|5|5	5|5|5	5|5|5
82	SFB Injection (ATW_STO_SFB)	7|7|6	7|7|6	7|7|6	7|7|6
83	LADWP Reservoirs (ATW_STO_LAReservoirs)	6|6|8	6|6|8	6|6|8	6|6|8
84	LAAFP (ATW_LAAFP)	1|1|0	1|1|0	1|1|0	1|1|0
85	MWD Pure Water connection (ATW_MWDPure)	10|10|10	10|10|10	10|10|10	10|10|10
86	CB GW injection (WRD) (ATW_GW_InjCBWRD)	5|5|4	5|5|4	5|5|4	5|5|4
87	CB spreading in the Montebello Forebay (if available) (ATW_MontebFB)	11|11|11	11|11|11	11|11|11	11|11|11
88	GW Bank (if active) (ATW_LAAGWB)	12|12|12	12|12|12	12|12|12	12|12|12
89					
90	*MWD Imported Supplies*				
91	Maximum MWD Annual Supply (AFY)	400000	400000	400000	400000
92	Maximum flow of imported MWD supply (mgd)	1790	1790	1790	1790
93	*LAA GW Bank*				
94	Bank Utilization	deactivated	deactivated	deactivated	deactivated
95	Recharge Capacity	deactivated	deactivated	deactivated	deactivated
96	Max Storage (AF)	deactivated	deactivated	deactivated	deactivated
97	Extraction Capacity (mgd)	deactivated	deactivated	deactivated	deactivated
98	*Santa Monica Reservoirs*				
99	Location	No Use of reservoir	No Use of reservoir	No Use of reservoir	No Use of reservoir
100	Maximum Releases from Surface Water Reservoirs (MGD)	0	0	0	0
101	Initial Storage (AF)	0	0	0	0
102	*San Fernando Basin*	-	-	-	-
103	Max Basin Physical Storage (AF)	1,100,000	1,100,000	1,100,000	1,100,000
104	Initial Storage at simulation t=0 (AF)	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105
105	Initial Cumulative storage from 1920's zero overdraft reference, and -210,000 AF in 1954	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af

Scenario1 As of Feb 27, 2024

Scenario 1 assumptions: 1.Current Trends Scenario: Adjusted APPROACH 1

White cell with bold outline = different from other alternatives

Input ID	ONAT scenario	Baseline Alternative	Approach 1(IPR) F1_IPR_A1	F1_IPR_A2	F1_IPR_A3
106	Max/Min judgement levels on cumulative storage since 1954 when the basin was recognize as being in a 210,000 AF overdraft	0/-360,000AF	0/-360,000AF	0/-360,000AF	0/-360,000AF
107	Variable San Fernando Basin Inflows OR Constant value	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant
108	Percentage Credit for previous Water Year Imported Water (this is active only if SFB inflows are set to variable)	20.8	20.8	20.8	20.8
109	Dynamic Priority, gives priority to use Bank's supply if close to be full	not active	not active	not active	not active
110	DCT credits	No DCT recharge	Max 25 MGD (28,000 AFY)	Max 25 MGD (28,000 AFY)	Max 25 MGD (28,000 AFY)
111	Max DCT credits, a function of wastewater flows available at DCT, recycled water demands from DCT and bypass of flows from DCT to Hyperion (AFY)	0	28,000 AFY	28,000 AFY	28,000 AFY
112	DCT bypass to Hyperion (MGD)	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4
113	LAG bypass to Hyperion (MGD)	3.8	3.8	3.8	3.8
114	SFB Recharge Capacity	No extra recharge than current operations	Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October	Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October	Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October
115	SFB Extraction Capacity (cfs)	130	220	220	220
116	Surplus LAA to SFB recharge	Not operational	Not operational	Not operational	Not operational
117	San Fernando Basin Extraction Logic	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries
118	If SFB extraction option (#117) is 1(function of LAA flows), Threshold annual volume to use SFB	Not active	Not active	Not active	Not active
119	If SFB extraction option (#117) is 1(function of LAA flows), Threshold LAA flow to use SFB	Not Active	Not Active	Not Active	Not Active
120	Fixed Maximum extraction, Annual limit in AFY if Extraction Logic # 117 is set to a fixed value	NA	NA	NA	NA
121	*Central Basin/WCB*	-	-	-	-
122	Max Storage (% of Basin Rights) maximum 1 year carryover	200%	200%	200%	200%
123	Max Extraction per Judgement (% of annual rights)	140% based on judgment value	223% to match 37 mgd of extraction capacity	223% to match 37 mgd of extraction capacity	223% to match 37 mgd of extraction capacity
124	Central Basin Well Extraction Capacity (MGD)	8.922	TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed	TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed	TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed
125	Max Central basin Demands (% of all demands). If this is more than 10,000 AFY it will reduce the minimum MWD imported water of 60,000 AFY	Historical CB pumping is close to 10,000 AFY or approximally 1.7% of total demands	100%	100%	100%
126	Hyperion ATW to Central Basin recharge switch	No Central Basin Recharge of OpNext Water	ON	ON	ON
127	*Pure Water*				
128	Hyperion opNext capacity to Pure Water MWD	0	up to 150 MGD	up to 150 MGD	up to 150 MGD
129	Pure Water Storage of OpNEXT	None	None	None	None
130	Max OpNEXT Storage Recharge	None	None	None	None
131	Return OpNEXT water to LA via PureWater	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water

Scenario1 As of Feb 27, 2024

Scenario 1 assumptions: 1.Current Trends Scenario: Adjusted APPROACH 2

White cell with bold outline = different from other alternatives

Input ID	ONAT scenario	Baseline Alternative	Approach 2 (IPR and DPR) F2_IPR_A4	F2_IPR_A5	F2_IPR_A6
	Demands and Wastewater				
0	Hydrology	July-1990 to end of June 2020	July-1990 to end of June 2020	July-1990 to end of June 2020	July-1990 to end of June 2020
1	LA Demands (AFY)	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent
2	Demand Monthly Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
3	Indoor/outdoor Demand Pattern	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020
4	Recycled Water Demand (AFY)	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP
5	Recycled Water monthly pattern	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP
6	Annual Demand Multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier
7	Monthly Demand Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
8	Wastewater estimate independent variable to use	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery
9	Fraction of the deliveries (potable/indoors) that comes back to wastewater plants	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage
10	Residential GPCD	72.92	72.92	72.92	72.92
11	Wastewater Treatment Efficiency (Effluent/Influent)	0.95	0.95	0.95	0.95
12	AWT Efficiency (Effluent/Influent)	0.8456	0.8456	0.8456	0.8456
13	WW Adjustment (Monthly multiplier of the selected deliveries (indoor or total potable) selected on input #8	No multiplier	No multiplier	No multiplier	No multiplier
14	Recycled Water Demand Multiplier	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)
15	*WW Distribution (From UWMP 2020, fraction of total wastewater for each treatment plant)*				
16	DCTWRP	0.1012	0.1012	0.1012	0.1012
17	HWRP	0.8121	0.8121	0.8121	0.8121
18	LAGWRP	0.0405	0.0405	0.0405	0.0405
19	TIWRP	0.0462	0.0462	0.0462	0.0462
20	*Wastewater Plant tertiary production capacity (WW_tert_cap [mgd])*				
21	DCTWRP	80	80	80	80
22	HWRP	450	450	450	450
23	LAGWRP	20	20	20	20
24	TIWRP	30	30	30	30
25	**OpNEXT Controls**				
26	OpNEXT Start Date	7/1/2020	7/1/2020	7/1/2020	7/1/2020
27	Hyperion AWT Feed Capacity (MGD)	No OpNext	230 MGD of produced water (Feed=230/efficiency)=270 MGD	230 MGD of produced water (Feed=230/efficiency)=270 MGD	230 MGD of produced water (Feed=230/efficiency)=270 MGD
28	Schedule (Hyperion ATW production will follow a table schedule)	No Schedule	No Schedule	No Schedule	No Schedule
29	Conveyance Capacity from Hyperion to Storage and VNC (MGD)	0	163	163	163
30	Conveyance Capacity to PWSC connection (MGD)	0	up to 150 mgd	up to 150 mgd	up to 150 mgd
31	Hyperion deliveries to West Basin **MBR not ATW** (MGD)	0	0	0	0
34	LAAFP Blending Ratio Limit (RAW:AWT)	No Blending Ratio Limit	No Blending Ratio, do as Sensitivity using 10:1	No Blending Ratio, do as Sensitivity using 10:1	No Blending Ratio, do as Sensitivity using 10:1
	Conveyance from Hyperion to different destinations and related inputs				
32	Hyperion deliveries to West Basin **AWT** (going OUT of the system loop)	0	40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)	40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)	40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)
36	Hyperion to West Coast Sea Barier (a fraction will go to WCB storage)				
37					
38	Hyperion to Central Basin **ATW** Injection capacity (MGD)	0	Potential phased approach-Consider 37 MGD for the moment	Potential phased approach-Consider 37 MGD for the moment	Potential phased approach-Consider 37 MGD for the moment
39					
40	Partners	No Partners	WRD, Santa Monica or Beverly Hills, demands not defined yet	WRD, Burbank, San Fernando, demands not defined yet	WRD, Burbank, Glendale,demands not defined yet
41	Conveyance capacity from Hyperion to/out San Fernando Basin (subjected to injection/spreading capacity	No OpNext Connection, just current East Valley pipeline for DCT	Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and OpNext, assume 25mgd is DCT, 55 mgd is OpNext. Use of Bull Creek Stormwater Capture 60" pipeline for up to 70 cfs to Pacoima in dry months only (based on spreading ground limitation, not conveyance which is 100 cfs)	Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and New conveyance (Max 84 MGD) for OpNex. Total 164 MGD potential to SFB, assume 25 mgd is for DCT/139 mgd to OpNext	Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and New conveyance (Max 84 MGD) for OpNex. Total 164 MGD potential to SFB, assume 25 mgd is for DCT/139 mgd to OpNext
42	Capacity to send to LA Reservoirs (lim to available capacity)	0	0	0	0
43	MWD Pure Water capacity (MGD)	0	up to 150 MGD	up to 150 MGD	up to 150 MGD
44	Injection in CB for WRD	0	0	0	0
45	OpNext to Montebello Forebay	0	0	0	0
46	LAA groundwater Bank	0	0	0	0
47	**Supplies and Supply Usage**				
48	*LAA Flows*				
49	Hydrology for LAA	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run
50	Start Year	1990	1990	1990	1990
51	Flows	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021
52	If LAA flows are above this value LADWP will override all priorities - Prioritize LAA if LAA flows are > than value (mgd)	9999	9999	9999	9999
53	*Minimum Supply amount to be used for Deliveries [af/yr]*				
54	San Fernando Basin Minimum Rights (GW_SFB1MinRights)	87000	87000	87000	87000
55	Central Basin Minimum Rights (GW_CB)	17236	17236	17236	17236
56	West Coast Basin Minimum Rights (GW_WCB)	1503	1503	1503	1503
57	Sylmar Minimum Rights (GW_Sylmar)	3570	3570	3570	3570
58	LAA groundwater Bank (GW_Antelope)	0	0	0	0
59	Los Angeles Aqueduct (SW_LAA)	0	0	0	0
60	Imported MWD (IMP_MWD)	60000	60000	60000	60000
61	*Priority of Supplies used to meet Potable Demands*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
61.5	San Fernando Remediation				
62	San Fernando Basic Rights (GW_SFB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
63	Central Basin/West Coast Basin Basic Rights (GW_CBWCB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
64	Sylmar Basic Rights (GW_SylmarBasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
65	San Fernando Stored credits (GW_SFB_StoCredits)	6|6|6	6|6|6	6|6|6	6|6|6
66	LAA groundwater Bank (GW_LAAGWB)	8|8|8	8|8|8	8|8|8	8|8|8
67	ATW from Hyperion stored in the San Fernando Basin (GW_SFB_Augm)	7|7|7	7|7|7	7|7|7	7|7|7
68	Use of SFB if no stored credits or OpNext storage is available (GW_SFB_Bank)	999|999|999	999|999|999	999|999|999	999|999|999
69	Los Angeles Aqueduct (SW_LAA)	2|2|2	2|2|2	2|2|2	2|2|2
70	ATW_WCSBarrier	6|6|6	6|6|6	6|6|6	6|6|6
71	ATW injection in Central Basin (ATW_InjectionCB)	6|6|6	6|6|6	6|6|6	6|6|6
72	ATW from Hyperion to LA Reservoirs (ATW_DWPReservoirs)	5|5|5	5|5|5	5|5|5	5|5|5
73	ATW from Hyperion to LAAFP (AWT_OpNEXTLAAFP)	4|4|3	4|4|3	4|4|3	4|4|3
74	Minimum to be imported from MWD (IMP_MWDmin)	1|1|1	1|1|1	1|1|1	1|1|1
75	IMP_MWD	9|9|9	9|9|9	9|9|9	9|9|9
76	IMP_BlendImp	6|6|6	6|6|6	6|6|6	6|6|6
77	*Priority of Hyperion ATW uses*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
78	WBMWD sales (ATW_WB)	2|2|1	2|2|1	2|2|1	2|2|1
79	WC Sea barrier (WCSB) (ATW_STO_WCSB)	3|3|2	3|3|2	3|3|2	3|3|2
80	CB GW injection (LADWP) (ATW_GW_InjCBDWP)	4|4|3	4|4|3	4|4|3	4|4|3
81	Dependent Partening Opportunities (Ex. Santa Monica) (ATW_Partners)	5|5|5	5|5|5	5|5|5	5|5|5
82	SFB Injection (ATW_STO_SFB)	7|7|6	7|7|6	7|7|6	7|7|6
83	LADWP Reservoirs (ATW_STO_LAReservoirs)	6|6|8	6|6|8	6|6|8	6|6|8
84	LAAFP (ATW_LAAFP)	1|1|0	1|1|0	1|1|0	1|1|0
85	MWD Pure Water connection (ATW_MWDPure)	10|10|10	10|10|10	10|10|10	10|10|10
86	CB GW injection (WRD) (ATW_GW_InjCBWRD)	5|5|4	5|5|4	5|5|4	5|5|4
87	CB spreading in the Montebello Forebay (if available) (ATW_MontebFB)	11|11|11	11|11|11	11|11|11	11|11|11
88	GW Bank (if active) (ATW_LAAGWB)	12|12|12	12|12|12	12|12|12	12|12|12
89					
90	*MWD Imported Supplies*				
91	Maximum MWD Annual Supply (AFY)	400000	400000	400000	400000
92	Maximum flow of imported MWD supply (mgd)	1790	1790	1790	1790
93	*LAA GW Bank*				
94	Bank Utilization	deactivated	deactivated	deactivated	deactivated
95	Recharge Capacity	deactivated	deactivated	deactivated	deactivated
96	Max Storage (AF)	deactivated	deactivated	deactivated	deactivated
97	Extraction Capacity (mgd)	deactivated	deactivated	deactivated	deactivated
98	*Santa Monica Reservoirs*				
99	Location	No Use of reservoir	No Use of reservoir	No Use of reservoir	No Use of reservoir
100	Maximum Releases from Surface Water Reservoirs (MGD)	0	0	0	0
101	Initial Storage (AF)	0	0	0	0
102	*San Fernando Basin*	-	-	-	-
103	Max Basin Physical Storage (AF)	1,100,000	1,100,000	1,100,000	1,100,000
104	Initial Storage at simulation t=0 (AF)	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105

Scenario1 As of Feb 27, 2024

Scenario 1 assumptions: 1.Current Trends Scenario: Adjusted APPROACH 2

White cell with bold outline = different from other alternatives

Input ID	ONAT scenario	Baseline Alternative	Approach 2 (IPR and DPR) F2_IPR_A4	F2_IPR_A5	F2_IPR_A6
105	Initial Cumulative storage from 1920's zero overdraft reference, and -210,000 AF in 1954	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af
106	Max/Min judgement levels on cumulative storage since 1954 when the basin was recognize as being in a 210,000 AF overdraft	0/-360,000AF	0/-360,000AF	0/-360,000AF	0/-360,000AF
107	Variable San Fernando Basin Inflows OR Constant value	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant
108	Percentage Credit for previous Water Year Imported Water (this is active only if SFB inflows are set to variable)	20.8	20.8	20.8	20.8
109	Dynamic Priority, gives priority to use Bank's supply if close to be full	not active	not active	not active	not active
110	DCT credits	No DCT recharge	Max 25 MGD (28,000 AFY)	Max 25 MGD (28,000 AFY)	Max 25 MGD (28,000 AFY)
111	Max DCT credits, a function of wastewater flows available at DCT, recycled water demands from DCT and bypass of flows from DCT to Hyperion (AFY)	0	28,000 AFY	28,000 AFY	28,000 AFY
112	DCT bypass to Hyperion (MGD)	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4
113	LAG bypass to Hyperion (MGD)	3.8	3.8	3.8	3.8
114	SFB Recharge Capacity	No extra recharge than current operations	Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October	Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October	Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October
115	SFB Extraction Capacity (cfs)	130	220	220	220
116	Surplus LAA to SFB recharge	Not operational	Not operational	Not operational	Not operational
117	San Fernando Basin Extraction Logic	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries
118	If SFB extraction option (#117) is 1(function of LAA flows), Threshold annual volume to use SFB	Not active	Not active	Not active	Not active
119	If SFB extraction option (#117) is 1(function of LAA flows), Threshold LAA flow to use SFB	Not Active	Not Active	Not Active	Not Active
120	Fixed Maximum extraction, Annual limit in AFY if Extraction Logic # 117 is set to a fixed value	NA	NA	NA	NA
121	*Central Basin/WCB*	-	-	-	-
122	Max Storage (% of Basin Rights) maximum 1 year carryover	200%	200%	200%	200%
123	Max Extraction per Judgement (% of annual rights)	140% based on judgment value	223% to match 37 mgd of extraction capacity	223% to match 37 mgd of extraction capacity	223% to match 37 mgd of extraction capacity
124	Central Basin Well Extraction Capacity (MGD)	8.922	TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed	TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed	TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed
125	Max Central basin Demands (% of all demands). If this is more than 10,000 AFY it will reduce the minimum MWD imported water of 60,000 AFY	Historical CB pumping is close to 10,000 AFY or approximally 1.7% of total demands	100%	100%	100%
126	Hyperion ATW to Central Basin recharge switch	No Central Basin Recharge of OpNext Water	ON	ON	ON
127	*Pure Water*				
128	Hyperion opNext capacity to Pure Water MWD	0	up to 150 MGD	up to 150 MGD	up to 150 MGD
129	Pure Water Storage of OpNEXT	None	None	None	None
130	Max OpNEXT Storage Recharge	None	None	None	None
131	Return OpNEXT water to LA via PureWater	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water

Scenario1 As of Feb 27, 2024

Scenario 1 assumptions: 1.Current Trends Scenario: Adjusted APPROACH 3

White cell with bold outline = different from other alternatives

Input ID	ONAT scenario	Baseline Alternative	Approach 3 (DPR) F3_DPR_A7	F3_DPR_A8	F3_DPR_A9
	Demands and Wastewater		-		
0	Hydrology	July-1990 to end of June 2020	July-1990 to end of June 2020	July-1990 to end of June 2020	July-1990 to end of June 2020
1	LA Demands (AFY)	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent
2	Demand Monthly Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
3	Indoor/outdoor Demand Pattern	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020
4	Recycled Water Demand (AFY)	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP
5	Recycled Water monthly pattern	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP
6	Annual Demand Multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier
7	Monthly Demand Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
8	Wastewater estimate independent variable to use	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery
9	Fraction of the deliveries (potable/indoors) that comes back to wastewater plants	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage
10	Residential GPCD	72.92	72.92	72.92	72.92
11	Wastewater Treatment Efficiency (Effluent/Influent)	0.95	0.95	0.95	0.95
12	AWT Efficiency (Effluent/Influent)	0.8456	0.8456	0.8456	0.8456
13	WW Adjustment (Monthly multiplier of the selected deliveries (indoor or total potable) selected on input #8	No multiplier	No multiplier	No multiplier	No multiplier
14	Recycled Water Demand Multiplier	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)
15	*WW Distribution (From UWMP 2020, fraction of total wastewater for each treatment plant)*				
16	DCTWRP	0.1012	0.1012	0.1012	0.1012
17	HWRP	0.8121	0.8121	0.8121	0.8121
18	LAGWRP	0.0405	0.0405	0.0405	0.0405
19	TIWRP	0.0462	0.0462	0.0462	0.0462
20	*Wastewater Plant tertiary production capacity (WW_tert_cap [mgd])*				
21	DCTWRP	80	80	80	80
22	HWRP	450	450	450	450
23	LAGWRP	20	20	20	20
24	TIWRP	30	30	30	30
25	**OpNEXT Controls**				
26	OpNEXT Start Date	7/1/2020	7/1/2020	7/1/2020	7/1/2020
27	Hyperion AWT Feed Capacity (MGD)	No OpNext	230 MGD of produced water (Feed=230/efficiency)=270 MGD	230 MGD of produced water (Feed=230/efficiency)=270 MGD	230 MGD of produced water (Feed=230/efficiency)=270 MGD
28	Schedule (Hyperion ATW production will follow a table schedule)	No Schedule	No Schedule	No Schedule	No Schedule
29	Conveyance Capacity from Hyperion to Storage and VNC (MGD)	0	230	230	230
30	Conveyance Capacity to PWSC connection (MGD)	0	up to 150 mgd	up to 150 mgd	up to 150 mgd
31	Hyperion deliveries to West Basin **MBR not ATW** (MGD)	0	0	0	0
34	LAAFP Blending Ratio Limit (RAW:AWT)	No Blending Ratio Limit	No Blending Ratio, do as Sensitivity using 10:1	No Blending Ratio, do as Sensitivity using 10:1	No Blending Ratio, do as Sensitivity using 10:1
	Conveyance from Hyperion to different destinations and related inputs				
32	Hyperion deliveries to West Basin **AWT** (going OUT of the system loop)	0	40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)	40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)	40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)
36	Hyperion to West Coast Sea Barier (a fraction will go to WCB storage)				
37					
38	Hyperion to Central Basin **ATW** Injection capacity (MGD)	0	Potential phased approach-Consider 37 MGD for the moment	Potential phased approach-Consider 37 MGD for the moment	Potential phased approach-Consider 37 MGD for the moment
39					
40	Partners	No Partners	WRD, Santa Monica or MWD, demands not defined yet	WRD, Santa Monica or MWD, demands not defined yet	WRD, Santa Monica or MWD, demands not defined yet
41	Conveyance capacity from Hyperion to/out San Fernando Basin (subjected to injection/spreading capacity	No OpNext Connection, just current East Valley pipeline for DCT	Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and OpNext, assume 25mgd is DCT, 55 mgd is OpNext. Use of Bull Creek Stormwater Capture 60" pipeline for up to 70 cfs to Pacoima in dry months only (based on spreading ground limitation, not conveyance which is 100 cfs)	Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and New conveyance (Max 84 MGD) for OpNex. Total 164 MGD potential to SFB, assume 25 mgd is for DCT/139 mgd to OpNext	Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and New conveyance (Max 84 MGD) for OpNex. Total 164 MGD potential to SFB, assume 25 mgd is for DCT/139 mgd to OpNext
42	Capacity to send to LA Reservoirs (lim to available capacity)	0	0	0	0
43	MWD Pure Water capacity (MGD)	0	up to 150 MGD	up to 150 MGD	up to 150 MGD
44	Injection in CB for WRD	0	0	0	0
45	OpNext to Montebello Forebay	0	0	0	0
46	LAA groundwater Bank	0	0	0	0
47	**Supplies and Supply Usage**				
48	*LAA Flows*				
49	Hydrology for LAA	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run
50	Start Year	1990	1990	1990	1990
51	Flows	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021
52	If LAA flows are above this value LADWP will override all priorities - Prioritize LAA if LAA flows are > than value (mgd)	9999	9999	9999	9999
53	*Minimum Supply amount to be used for Deliveries [af/yr]*				
54	San Fernando Basin Minimum Rights (GW_SFB1MinRights)	87000	87000	87000	87000
55	Central Basin Minimum Rights (GW_CB)	17236	17236	17236	17236
56	West Coast Basin Minimum Rights (GW_WCB)	1503	1503	1503	1503
57	Sylmar Minimum Rights (GW_Sylmar)	3570	3570	3570	3570
58	LAA groundwater Bank (GW_Antelope)	0	0	0	0
59	Los Angeles Aqueduct (SW_LAA)	0	0	0	0
60	Imported MWD (IMP_MWD)	60000	60000	60000	60000
61	*Priority of Supplies used to meet Potable Demands*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
61.5	San Fernando Remediation				
62	San Fernando Basic Rights (GW_SFB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
63	Central Basin/West Coast Basin Basic Rights (GW_CBWCB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
64	Sylmar Basic Rights (GW_SylmarBasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
65	San Fernando Stored credits (GW_SFB_StoCredits)	6|6|6	6|6|6	6|6|6	6|6|6
66	LAA groundwater Bank (GW_LAAGWB)	8|8|8	8|8|8	8|8|8	8|8|8
67	ATW from Hyperion stored in the San Fernando Basin (GW_SFB_Augm)	7|7|7	7|7|7	7|7|7	7|7|7
68	Use of SFB if no stored credits or OpNext storage is available (GW_SFB_Bank)	999|999|999	999|999|999	999|999|999	999|999|999
69	Los Angeles Aqueduct (SW_LAA)	2|2|2	2|2|2	2|2|2	2|2|2
70	ATW_WCSBarrier	6|6|6	6|6|6	6|6|6	6|6|6
71	ATW injection in Central Basin (ATW_InjectionCB)	6|6|6	6|6|6	6|6|6	6|6|6
72	ATW from Hyperion to LA Reservoirs (ATW_DWPReservoirs)	5|5|5	5|5|5	5|5|5	5|5|5
73	ATW from Hyperion to LAAFP (AWT_OpNEXTLAAFP)	4|4|3	4|4|3	4|4|3	4|4|3
74	Minimum to be imported from MWD (IMP_MWDmin)	1|1|1	1|1|1	1|1|1	1|1|1
75	IMP_MWD	9|9|9	9|9|9	9|9|9	9|9|9
76	IMP_BlendImp	6|6|6	6|6|6	6|6|6	6|6|6
77	*Priority of Hyperion ATW uses*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
78	WBMWD sales (ATW_WB)	2|2|1	2|2|1	2|2|1	2|2|1
79	WC Sea barrier (WCSB) (ATW_STO_WCSB)	3|3|2	3|3|2	3|3|2	3|3|2
80	CB GW injection (LADWP) (ATW_GW_InjCBDWP)	4|4|3	4|4|3	4|4|3	4|4|3
81	Dependent Partening Opportunities (Ex. Santa Monica) (ATW_Partners)	5|5|5	5|5|5	5|5|5	5|5|5
82	SFB Injection (ATW_STO_SFB)	7|7|6	7|7|6	7|7|6	7|7|6
83	LADWP Reservoirs (ATW_STO_LAReservoirs)	6|6|8	6|6|8	6|6|8	6|6|8
84	LAAFP (ATW_LAAFP)	1|1|0	1|1|0	1|1|0	1|1|0
85	MWD Pure Water connection (ATW_MWDPure)	10|10|10	10|10|10	10|10|10	10|10|10
86	CB GW injection (WRD) (ATW_GW_InjCBWRD)	5|5|4	5|5|4	5|5|4	5|5|4
87	CB spreading in the Montebello Forebay (if available) (ATW_MontebFB)	11|11|11	11|11|11	11|11|11	11|11|11
88	GW Bank (if active) (ATW_LAAGWB)	12|12|12	12|12|12	12|12|12	12|12|12
89					
90	*MWD Imported Supplies*				
91	Maximum MWD Annual Supply (AFY)	400000	400000	400000	400000
92	Maximum flow of imported MWD supply (mgd)	1790	1790	1790	1790
93	*LAA GW Bank*				
94	Bank Utilization	deactivated	deactivated	deactivated	deactivated
95	Recharge Capacity	deactivated	deactivated	deactivated	deactivated
96	Max Storage (AF)	deactivated	deactivated	deactivated	deactivated
97	Extraction Capacity (mgd)	deactivated	deactivated	deactivated	deactivated
98	*Santa Monica Reservoirs*				
99	Location	No Use of reservoir	No Use of reservoir	No Use of reservoir	No Use of reservoir
100	Maximum Releases from Surface Water Reservoirs (MGD)	0	0	0	0
101	Initial Storage (AF)	0	0	0	0
102	*San Fernando Basin*	-	-	-	-
103	Max Basin Physical Storage (AF)	1,100,000	1,100,000	1,100,000	1,100,000
104	Initial Storage at simulation t=0 (AF)	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #103+ input #105

Scenario1 As of Feb 27, 2024

Scenario 1 assumptions: 1.Current Trends Scenario: Adjusted APPROACH 3

White cell with bold outline = different from other alternatives

Input ID	ONAT scenario	Baseline Alternative	Approach 3 (DPR) F3_DPR_A7	F3_DPR_A8	F3_DPR_A9
105	Initial Cumulative storage from 1920's zero overdraft reference, and -210,000 AF in 1954	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af
106	Max/Min judgement levels on cumulative storage since 1954 when the basin was recognize as being in a 210,000 AF overdraft	0/-360,000AF	0/-360,000AF	0/-360,000AF	0/-360,000AF
107	Variable San Fernando Basin Inflows OR Constant value	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant
108	Percentage Credit for previous Water Year Imported Water (this is active only if SFB inflows are set to variable)	20.8	20.8	20.8	20.8
109	Dynamic Priority, gives priority to use Bank's supply if close to be full	not active	not active	not active	not active
110	DCT credits	No DCT recharge	Max 25 MGD (28,000 AFY)	Max 25 MGD (28,000 AFY)	Max 25 MGD (28,000 AFY)
111	Max DCT credits, a function of wastewater flows available at DCT, recycled water demands from DCT and bypass of flows from DCT to Hyperion (AFY)	0	28,000 AFY	28,000 AFY	28,000 AFY
112	DCT bypass to Hyperion (MGD)	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4
113	LAG bypass to Hyperion (MGD)	3.8	3.8	3.8	3.8
114	SFB Recharge Capacity	No extra recharge than current operations	Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October	Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October	Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October
115	SFB Extraction Capacity (cfs)	130	220	220	220
116	Surplus LAA to SFB recharge	Not operational	Not operational	Not operational	Not operational
117	San Fernando Basin Extraction Logic	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries
118	If SFB extraction option (#117) is 1(function of LAA flows), Threshold annual volume to use SFB	Not active	Not active	Not active	Not active
119	If SFB extraction option (#117) is 1(function of LAA flows), Threshold LAA flow to use SFB	Not Active	Not Active	Not Active	Not Active
120	Fixed Maximum extraction, Annual limit in AFY if Extraction Logic # 117 is set to a fixed value	NA	NA	NA	NA
121	*Central Basin/WCB*	-	-	-	-
122	Max Storage (% of Basin Rights) maximum 1 year carryover	200%	200%	200%	200%
123	Max Extraction per Judgement (% of annual rights)	140% based on judgment value	223% to match 37 mgd of extraction capacity	223% to match 37 mgd of extraction capacity	223% to match 37 mgd of extraction capacity
124	Central Basin Well Extraction Capacity (MGD)	8.922	mplemented consider 37 mgd for now, equivalent	mplemented consider 37 mgd for now, equivalent	mplemented consider 37 mgd for now, equivalent t
125	Max Central basin Demands (% of all demands). If this is more than 10,000 AFY it will reduce the minimum MWD imported water of 60,000 AFY	Historical CB pumping is close to 10,000 AFY or approximally 1.7% of total demands	100%	100%	100%
126	Hyperion ATW to Central Basin recharge switch	No Central Basin Recharge of OpNext Water	ON	ON	ON
127	*Pure Water*				
128	Hyperion opNext capacity to Pure Water MWD	0	up to 150 MGD	up to 150 MGD	up to 150 MGD
129	Pure Water Storage of OpNEXT	None	None	None	None
130	Max OpNEXT Storage Recharge	None	None	None	None
131	Return OpNEXT water to LA via PureWater	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water

Attachment C
Priority Table

Attachment C: Priority Table

Figure C-1 is the ONAT Supply & Demand Prioritization List provided by Los Angeles Department of Water and Power in 2024.

Figure C-1. Operation NEXT Assessment Tool (ONAT) Supply & Demand Prioritization List provided by Los Angeles Department of Water and Power in 2024

Operation NEXT Assessment Tool (ONAT) Supply & Demand Prioritization List

Revised 1/18/2024

Priority Logic												
Conventional Supply/Demand Logic [1]				Multiple Dry Years [14]				Wet Hydrologic Year [19]			
LADWP Supplies		Demands (For OpNEXT Supplies)		LADWP Supplies		Demands (For OpNEXT Supplies)		LADWP Supplies		Demands (For OpNEXT Supplies)	
1	MWD Minimum Purchase [5]	1	LAAFP [9]	1	MWD Minimum Purchase [5]	1	LAAFP [9]	1	MWD Minimum Purchase [5]	1	WBMWD Sales [15]
2	LAA	2	WBMWD sales [15]	2	LAA	2	WBMWD Sales [15]	2	LAA	2	WC Sea Barrier (WCSB)
3	SFB Basic GW Rights [17]	3	WC Sea Barrier (WCSB)	3	SFB Basic GW Rights [17]	3	WC Sea Barrier (WCSB)	3	OpNEXT Supply via LAAFP [2]	3	CB GW Injection (LADWP) [8]
	Central Basin/WCB (Basic Rights) [6]	4	CB GW Injection (LADWP) [8]		Central Basin/WCB (Basic Rights) [6]	4	CB GW Injection (LADWP) [8]	4	SFB Basic GW Rights [3] [17]	4	CB GW Injection (WRD) [12]
	Sylmar Basin Rights	5	CB GW Injection (WRD) [12]		Sylmar Basin Rights	5	CB GW Injection (WRD) [12]		Central Basin/WCB (Basic Rights) [2,6]	5	Dependent Partnering Opportunities (Ex. Santa Monica)
4	OpNEXT Supply via LAAFP	6	~~LADWP Reservoirs~~ (inactive) [4]	4	OpNEXT Supply via LAAFP	6	~~LADWP Reservoirs~~ (inactive) [4]		Sylmar Basin Rights [2]	6	SFB Injection
5	~~OpNEXT Supply stored in LADWP Reservoirs~~ (inactive) [4]	7	SFB Injection	5	~~OpNEXT Supply stored in LADWP Reservoirs~~ (inactive) [4]	7	SFB Injection	5	~~OpNEXT Supply stored in LADWP Reservoirs~~ (inactive) [4]	7	SFB Spreading
6	GW Stored in CB [7] [18]	8	SFB Spreading	6	GW Stored in CB [7] [18]	8	SFB Spreading	6	GW Stored in CB [7] [18]	8	~~LADWP Reservoirs~~ (inactive) [4]
	GW Stored in WCB (from WCSB) [16]	9	Dependent Partnering Opportunities (Ex. Santa Monica)		GW Stored in WCB (from WCSB) [16]	9	Dependent Partnering Opportunities (Ex. Santa Monica)		GW Stored in WCB (from WCSB) [16]	9	LAAFP [9]
	GW Augmentation storage in CB [11]	10	MWD Pure Water Connection		GW Augmentation storage in CB [11]	10	MWD Pure Water Connection		GW Augmentation storage in CB [11]	10	MWD Pure Water Connection
	SFB Stored Water Credits	11	Spreading in the CB Montebello Forebay via MWD PWSC (if available)		SFB Stored Water Credits	11	Spreading in the CB Montebello Forebay via MWD PWSC (if available)		SFB Stored Water Credits	11	Spreading in the CB Montebello Forebay via MWD PWSC (if available)
7	OpNEXT recharge stored in SFB	12	GW Bank via LAA (not active) [10]	7	OpNEXT recharge stored in SFB	12	GW Bank via LAA (not active) [10]	7	OpNEXT recharge stored in SFB	12	GW Bank via LAA (not active) [10]
8	GW Bank via LAA (not active) [10]			8	GW Bank via LAA (not active) [10]			8	GW Bank via LAA (not active) [10]		
9	MWD Additional Purchase [13]			9	MWD Additional Purchase [13]			9	MWD Additional Purchase [13]		

Notes:

Priority change with respect to "Conventional"

Increase

No Change

Decrease

[1] LAA Delivery refers to LAA flow to City for Runoff Year (April-March). Per Aqueduct Forecasting & Operations on 1/17/2024, the range of 80%-135% of deliveries to the City with 30-year median snowfall is considered a 'Normal Year' This range is 164,000-276,750 AFY around a median value of 205,000 AFY which was also provided by Aqueduct Forecasting & Operations.

For the purposes of the model, Conventional Logic will apply to all years with the two exceptions (Multiple Dry, Wet) depicted above.

[2] LADWP to confirm prioritization in this instance between OpNEXT at LAAFP or SFB rights in further internal discussions.

[3] Pumping may be significantly reduced to accommodate excess LAA Flows.

[4] Inactive - Placeholder for type of reservior TBD (open/covered) in southern part of City, generally. Does not include LAR. Ex. *Upper Stone in consideration for DPR. [keep for what-if reservoir modeling, to help understand their benefit]*

[5] Representative of expected purchases based on system hydraulics and operational needs of MWD reliant areas. Based on estimation of LA-17 and Harbor demands, only. Not based on 10-year MWD agreement with 2024 expiration.

[6] 17,236 AF CB water right. Important to note that LADWP can store 20-60% of this right, dependent upon storage rules and availability.

[7] LADWP's CB storage bank built up by storing water rights (17,236 AFY). LADWP first stored water in CB in 2014.

[8] Injection water in the Central Basin LA Forebay area, in LADWP "water augmentation storage" bank. Doesn't represent any treated water augmentation application.

[9] Represents a connection either upstream of the LAAFP or to LAR.

[10] Additional water sent to/from an LAA GW bank, if analysis warrants use of a bank at some point in the future.

[11] Pumping CB water from CB injection wells.

[12] Injection water in the Central Basin Forebay area, as sales to the Water Replenshiment District (WRD).

[13] Does not consider LADWP's 10-year MWD minimum puchase agreement, expiring in 2024.

[14] 'Dry' means LADWP experiences an LAA Delivery <80% Normal (<164,000 AFY), per meeting with Aqueduct Forecasting & Operations on 1/17/2024.

[15] Could be MBR effluent from Hyperion, advanced treated water, or some variation thereof.

[16] Placeholder for LADWP's storage pool of West Coast Sea Barrier (WCSB) water to be pumped into LADWP's system through a desalter. Concept with LADWP's involvment currently on hold by WRD.

[17] Basic GW rights (#3) all have the same priority to mimic system operations, which operates with groundwater as a whole rather than specific basins in series.

[18] GW stored (#6) will all have the same priority to mimic system operations, which operates with groundwater as a whole rather than specific basins in series

[19] 'Wet Year' means > 135% of 'Normal' (205,000 AFY), which gives a range of >276,750 AFY. Extremely wet years may come with Potential Emergency Declaration as in 2017 and 2022, which implies a potential shutdown of all or part of Hyperion Advanced Treatment.

Program Alternatives Screening TM

Program Alternatives Screening Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
August 8, 2024

Executive Summary

The Pure Water Los Angeles (Program) Master Plan developed nine Program alternatives based on three potable reuse approaches and a range of conveyance alignments:

- Approach I – Indirect potable reuse (IPR) treatment at the Advanced Water Purification Facility (AWPF)
- Approach II – IPR treatment at the AWPF with direct potable reuse (DPR) treatment at or near the Van Norman Complex (VNC), where the Los Angeles Aqueduct Filtration Plant is located in the San Fernando Valley
- Approach III – DPR treatment at the AWPF

The Program alternatives were assessed, screened, and shortlisted to the preferred Program alternatives using a Multi-Criteria Decision Analysis (MCDA) approach. The purpose of the screening process was to determine the list of Program alternatives that will be further evaluated in more detail; from this process, a preferred list will be developed to be carried forward into the *California Environmental Quality Act* (CEQA) review process.

The Los Angeles Department of Water and Power (LADWP) developed seven screening criteria and associated weightings for evaluating the Program alternatives (LADWP 2024a, 2024b), as summarized in Table ES-1.

Table ES-1. LADWP Program Alternatives Screening Criteria and Weightings

No.	Consolidated Criteria	Weight (%)
1	Minimize Operational Complexity and Maintain Water Quality in Distribution System	20
2	Adaptability to Future Supply and Demand Changes	20
3	Cost-effective Water Supply	20
4	Regulatory Acceptance	10
5	Phasing and Early Deliveries	10
6	Regional Partnerships	10
7	Environmental Stewardship	10

Source: (LADWP 2024a, 2024b)

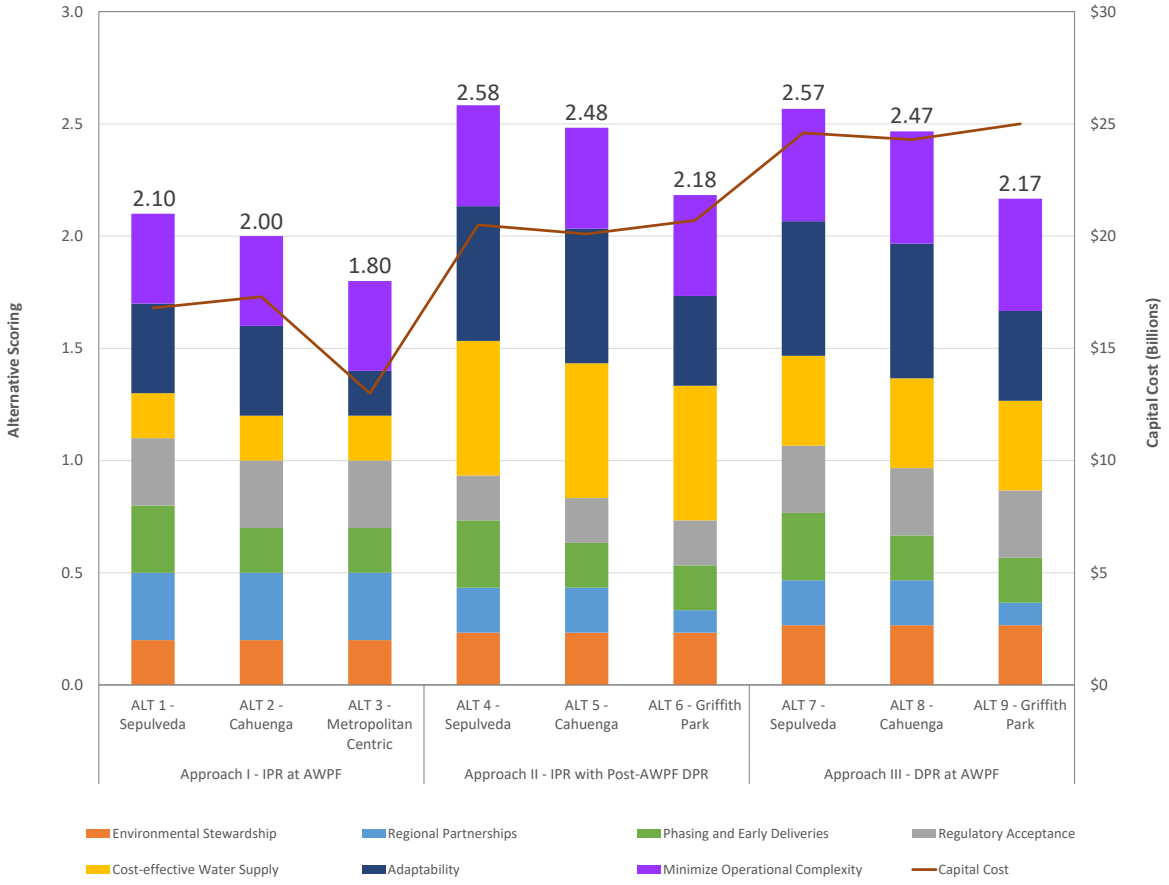
LADWP held Alternatives Workshop 2 on March 26, 2024, to review the Program alternative scoring and develop a list of screened alternatives (LADWP 2024c). Approaches II and III were selected as the preferred Program alternatives because of the following reasons:

- Approach II - Post-AWPF DPR and Approach III – DPR at AWPF scored higher due to adaptability to future supply and demand changes.
- Approach II - Post-AWPF DPR and Approach III – DPR at AWPF scored higher based on cost-effectiveness with respect to the selected criteria, which placed a high value on the use of the Pure Water Los Angeles flow to meet LADWP demands.
- Within a given south–north conveyance alignment (that is, Sepulveda, Cahuenga, or Griffith Park), the Program alternative scores for Approaches II and III were similar.

- Within Approach II - Post-AWPF DPR and Approach III – DPR at AWPF, the Sepulveda alignment (Alternatives 4 and 7) scored the highest due to early phasing benefits and partnership advantages.
- Overall, the lowest rated Approach II – Post-AWPF DPR and Approach III – DPR at AWPF alternative score exceeded the highest Approach I score.

Figure ES-1 summarizes the Program alternative scoring results, as agreed upon by LADWP Water System Executive Management during the workshop held on March 26 (LADWP 2024c).

Figure ES-1. Program Alternative Scoring Summary



Preferred Program alternatives were identified by LADWP as Approach II – Post-AWPF DPR and Approach III – DPR at AWPF. Approaches II and III will both be moved forward for additional analysis and potentially for inclusion in the CEQA review. Approach I will not be carried forward into the additional analysis or CEQA review.

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Acronyms and Abbreviations

AACE	AACE International
AWPF	Advanced Water Purification Facility
ATRW	advanced treated recycled water
BAC	biologically activated carbon
CB	Central Basin
CEQA	California Environmental Quality Act
City	City of Los Angeles
DDW	Division of Drinking Water
DPR	direct potable reuse
GWR	groundwater replenishment
HWRP	Hyperion Water Reclamation Plant
IPR	indirect potable reuse
LADWP	Los Angeles Department of Water and Power
LASAN	Los Angeles Sanitation & Environment
MBR	membrane bioreactor
MCDA	Multi-Criteria Decision Analysis
Metropolitan	Metropolitan Water District of Southern California
MGD	million gallons per day
No.	number
O&M	operations and maintenance
ONAT	Operation NEXT Assessment Tool
Program	Pure Water Los Angeles Program
PWSC	Pure Water Southern California Program
RO	reverse osmosis
RW	recycled water
RWA	raw water augmentation
SFB	San Fernando Basin

SWA	surface water augmentation
TM	technical memorandum
TWA	treated water augmentation
WB	West Basin
WRF	water reclamation facility
WRP	water reclamation plant
VNC	Van Norman Complex

1. Program Alternatives

Three potable reuse approaches were identified for developing Pure Water Los Angeles Program (Program) alternatives based on the level and location of treatment, as follows:

- Approach I – Indirect potable reuse (IPR) treatment at the Advanced Water Purification Facility (AWPF)
- Approach II – IPR treatment at the AWPF with direct potable reuse (DPR) treatment at or near the Van Norman Complex (VNC), where the Los Angeles Aqueduct Filtration Plant is located in the San Fernando Valley
- Approach III – DPR treatment at the AWPF

The three approaches were used to develop nine Program alternatives, with the individual alternatives based on conveyance alignments (Table 1-1 and Figures 1-1 to 1-3). Additional details on the developed approaches are provided in Section 4, Program Alternatives Development, of the *Pure Water Los Angeles Master Plan* (Jacobs 2024).

Note that regardless of approach, all of the currently assumed storage and demand locations south of VNC would ideally utilize IPR-quality water. Because of this, a logical phasing strategy could be to implement IPR treatment and associated conveyance first. At the same time, space could be reserved for DPR treatment at the AWPF while post-AWPF treatment is further evaluated, meaning Approaches II and III can both remain viable. Thus, a notable feature of this strategy is that IPR could always be phased first before deciding between Approach II and II.

Table 1-1. LADWP Pure Water Los Angeles Program Alternatives

Potable Reuse Approach	Program Alternatives	South to North Conveyance Alignment
I – IPR at AWPF	1	Sepulveda
	2	Cahuenga
	3	N/A, Metropolitan centric
II – IPR with Post-AWPF DPR	4	Sepulveda
	5	Cahuenga
	6	Griffith Park
III – DPR at AWPF	7	Sepulveda
	8	Cahuenga
	9	Griffith Park

N/A = not applicable

Figure 1-1. Approach I – IPR at AWPF, Program Alternatives 1 and 2

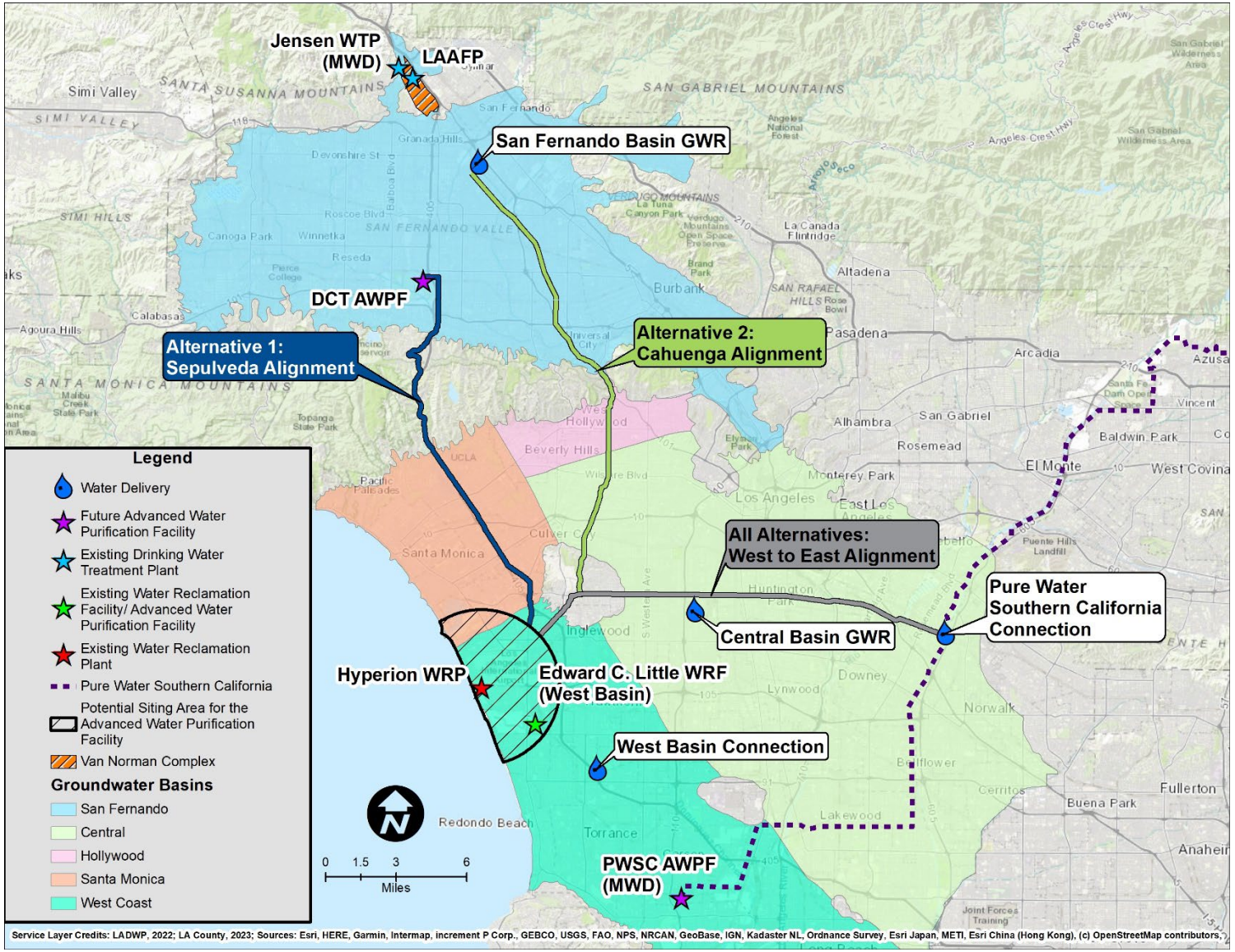


Figure 1-2. Approach I – IPR at AWPF, Program Alternative 3

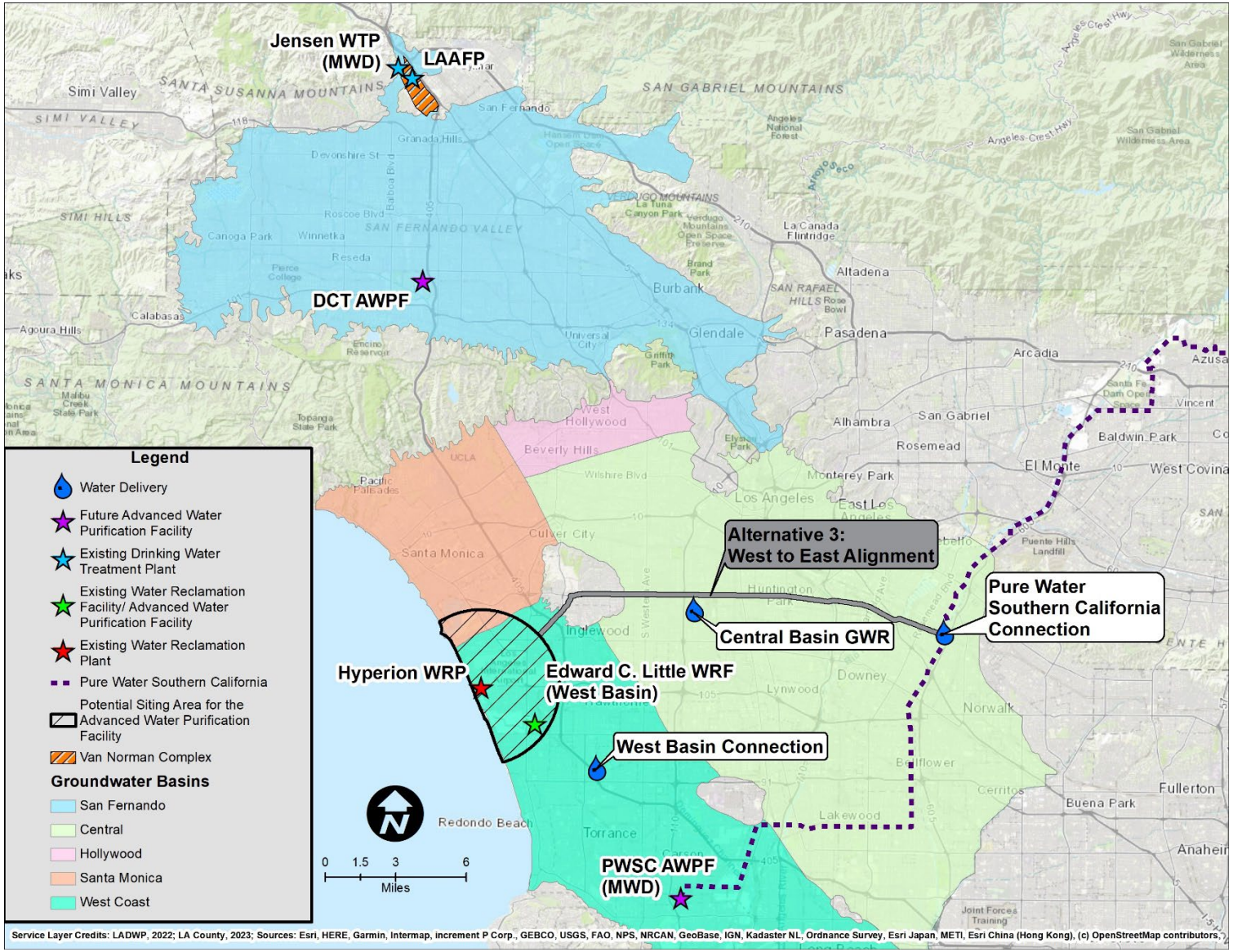


Figure 1-3. Approach II – IPR with Post-AWPF DPR, Alternatives 4-6 and Approach III – DPR at AWPF, Alternatives 7-9

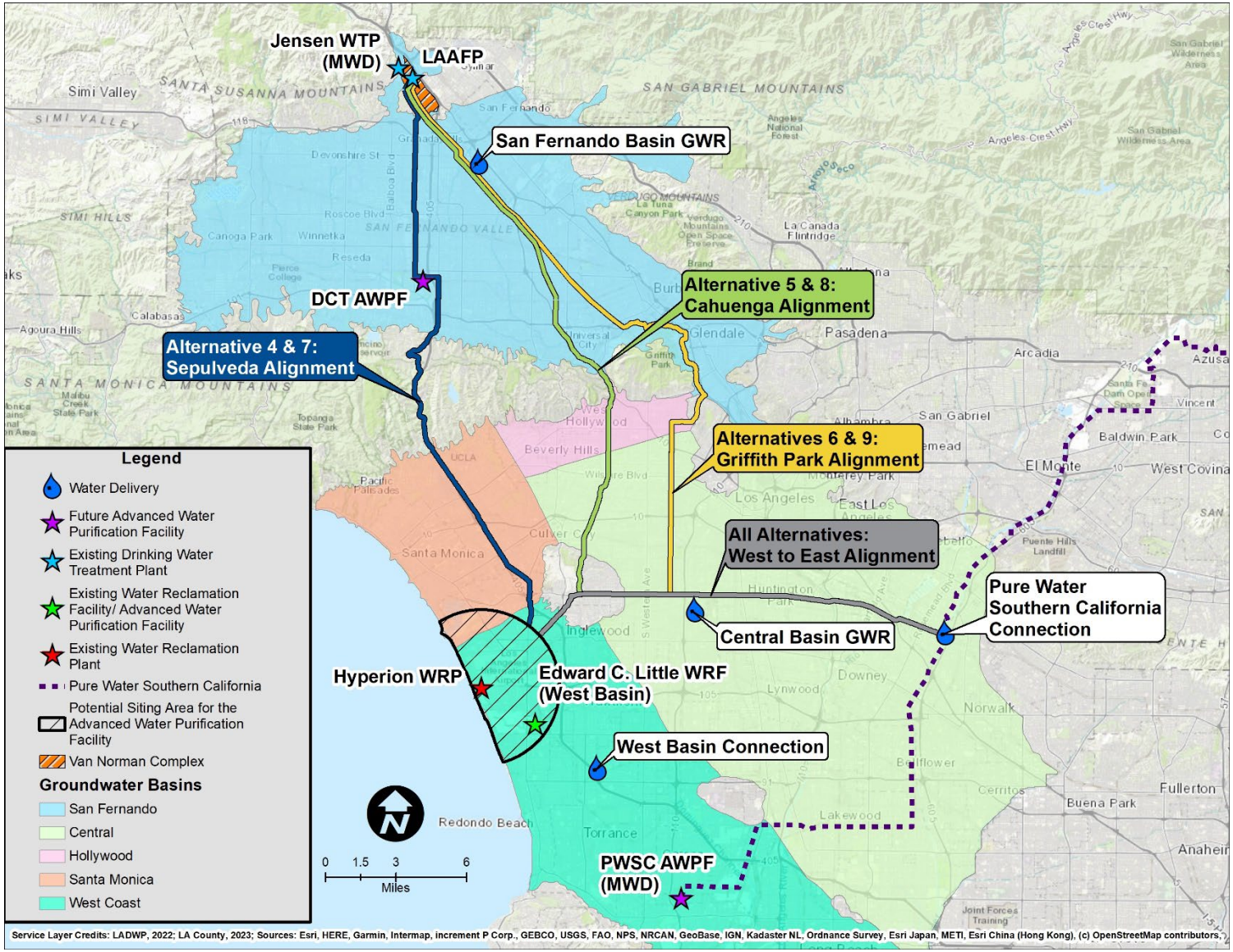


Table 1-2 summarizes the storage and demand locations that could be integrated into each alternative.

Table 1-2. LADWP Pure Water Los Angeles Program Alternative Storage and Demand Locations

Potable Reuse Approach	Program Alternatives	WB Connection	CB GWR	Metropolitan PWSC	SFB GWR	VNC RWA	Metropolitan Jensen
I – IPR at AWPF	1, 2	●	●	●	●		
I – IPR at AWPF	3	●	●	●			
II - IPR with Post-AWPF DPR	4, 5, 6	●	●	●	●	●	●
III – DPR at AWPF	7, 8, 9	●	●	●	●	●	●

CB = Central Basin
GWR = groundwater replenishment
Metropolitan = Metropolitan Water District of Southern California
PWSC = Pure Water Southern California Program
SFB = San Fernando Basin
RWA = raw water augmentation
WB = West Basin

All three approaches have similar considerations, including:

- Using a well-established reuse approach with GWR
- Requiring additional treatment after extraction for GWR
- Requiring coordination with potential Partners for design, flow, and water quality requirements
- Partnering with Los Angeles Sanitation & Environment (LASAN) as a lead Partner for source water supply from the Hyperion Water Reclamation Plant (HWRP)

However, each alternative also has several unique differentiating considerations that were noted in the screening process, some of which are listed in Table 1-3. Section 4 describes how each alternative's considerations were evaluated and scored as part of the screening process.

Table 1-3. LADWP Pure Water Los Angeles Program Alternative Differentiating Considerations

Differentiating Considerations	Approach		
	I	II	III
Treatment level consistent with water use per location	Yes	Yes	No
Future adaptability for TWA	No	Yes	Yes
Delivery to VNC	No	Yes	Yes
Uses DDW-approved treatment train for all potable reuse	Yes	No	Yes
Maximizes in-City AWPF usage through DPR	No	Yes	Yes

City= City of Los Angeles
TWA = treated water augmentation

2. Screening Analysis Purpose

The Program alternatives were assessed, screened, and shortlisted to the preferred Program alternatives using a Multi-Criteria Decision Analysis (MCDA) approach. The purpose of the screening process was to determine the preferred list of Program alternatives that will be further evaluated in more detail, and from the preferred list, which alternatives will be carried forward into the *California Environmental Quality Act* (CEQA) review process.

The MCDA process is a decision science evaluation method used to aid the decision-making process; the MCDA considers both financial (cost) and nonfinancial criteria. The nonfinancial criteria are defined to establish a common understanding of how they would apply to the Program alternatives, and measurement scales are assigned to score the performance of each Program alternative relative to each criterion. The relative importance of each criterion is then established using weighting factors. The final Program alternative score is then determined by the sum of the unitless value score, with weights applied to them. For this analysis, a higher score indicated a more favorable alternative.

3. Screening Criteria and Weightings

The Los Angeles Department of Water and Power (LADWP) developed seven screening criteria and associated weightings for evaluating the Program alternatives (LADWP 2024a, 2024b). Table 3-1 summarizes the selected screening criteria and weightings.

Table 3-1. LADWP Program Alternative Screening Criteria and Weightings

No.	Consolidated Criteria	Evaluation Criteria (%)	Weight (%)
1	Minimize Operational Complexity and Maintain Water Quality in Distribution System	Distribution system flexibility (5)	20
		Pure Water Los Angeles backbone complexity (5)	
		Pure Water Los Angeles treatment complexity (5)	
		Prevents water quality impacts (5)	
2	Adaptability to Future Supply and Demand Changes	Ability to use or provide reasonable access to a range of potable reuse strategies, including (20): ▪ GWR ▪ SWA ▪ RWA ▪ TWA	20
3	Cost-effective Water Supply	Program cost compared to flow used by the City (20)	20
4	Regulatory Acceptance	Level of regulatory uncertainty for treatment selection and Program approval (10)	10
5	Phasing and Early Deliveries	Provides supply in an earlier timeframe (10)	10
6	Regional Partnerships	Ability to manage water in wet years through partnerships (10)	10
7	Environmental Stewardship	Recycled water utilized in a dry year in comparison to the total water demand (3)	10
		Provides brine discharge improvements (4)	
		Provides treatment consistent with water use (3)	

Source: (LADWP 2024a, 2024b)

GWR = groundwater replenishment

No. = number

RW = recycled water

RWA = raw water augmentation

TWA = treated water augmentation

SWA = surface water augmentation

4. Program Alternative Screening Evaluation

This section summarizes the evaluation of each Program alternative based on the identified evaluation criteria. A score of 3 is the most favorable, and a score of 1 is the least favorable, regardless of criterion. Scores are calculated based on each of the identified Program alternatives, and scores may vary within the Program approaches. Scores can be qualitative or quantitative and are intended to be comparisons relative to the other evaluated alternatives. Some or all alternatives could receive the same score within an evaluation criterion.

The Operation NEXT Assessment Tool (ONAT) is a system model that produced initial results to aid the Program alternatives screening process. ONAT allows for assessment and optimization of potential Pure Water Los Angeles infrastructure and sizing. The model can evaluate different scenarios and is based on the following factors:

- A range of projected hydrological and demand conditions
- Allocations of Pure Water Los Angeles supply
- Regional partnerships
- Water supply and risk conditions

Specifically, ONAT is being developed to support evaluating the infrastructure needs of Pure Water Los Angeles, comparison of alternatives, and the water supply resiliency and economic benefits of the Program alternatives. ONAT is being developed in GoldSim, a GoldSim Technology Group modeling platform with Monte Carlo probabilistic capabilities used for visualizing and dynamically simulating complex systems in engineering, science, and business (GoldSim Technology Group 2024).

The assumptions used for ONAT modeling during the alternatives screening phase, along with the associated ONAT model results, are included in Attachments A and B. The ONAT model version from February 2024 generated results that supported the initial screening of alternatives. The main metrics used for this initial screening were:

- Percentage of total City of Los Angeles demands met by advanced treated recycled water (ATRW) deliveries during dry years (Criteria 7: Environmental Stewardship)
- Percentage of total ATRW production managed by LADWP's Partners in wet years (Criteria 6: Regional Partnerships)
- Percentage of average ATRW production that stays within the City of Los Angeles (Criteria 3: Cost-effective Water Supply)

Further modeling will be conducted on the screened alternatives to aid in the comparison and selection of alternatives and, potentially, as an input to determining the potential Program size. This section summarizes the analysis of each Program alternative based on the Program screening criteria.

4.1 Minimize Operational Complexity and Maintain Water Quality in Distribution System

Four subcriteria were developed to evaluate the operational complexity and water quality considerations of the Program alternatives, as described in this subsection.

4.1.1 Distribution System Flexibility

The distribution system flexibility criterion evaluates the Program alternative's ability to provide flexibility for integrating Pure Water Los Angeles water into LADWP's distribution system (Table 4-1).

Table 4-1. Distribution System Flexibility Scoring Scale

Metric	Scale		
	1	2	3
Distribution System Flexibility	Provides low operational flexibility for the distribution system.	Provides moderate operational flexibility for the distribution system.	Provides high operational flexibility for the distribution system.

The main assumptions used to calculate the Program alternatives distribution system flexibility score presented in Table 4-2 include:

- Approach I – IPR at AWPF: The only integration locations in the distribution system are through GWR recharge and recovery. The groundwater extraction locations (that is, CB and SFB) would supply a more limited system demand than VNC. Under this approach, Pure Water Los Angeles water would not be integrated into the VNC. The lack of a connection at the VNC provides a low amount of distribution system flexibility, resulting in a score of 1.
- Approach II – Post-AWPF DPR: This approach would have the same integration locations as Approach I, but would also integrate water at the VNC. However, the flow that can be integrated at the VNC is limited to the treatment capacity for DPR compliance at the VNC, which is currently assumed to be 252 cfs (163 MGD). Under the current treatment capacity assumption, the ability to send some but not all of the flow to VNC provides moderate distribution system flexibility, resulting in a score of 2.
- Approach III – DPR at AWPF: This approach would have the same integration locations as Approach I, but would also integrate water at the VNC. With DPR compliance at the AWPF, the full amount of Pure Water Los Angeles water can be integrated at the VNC and, potentially, other distribution system locations if TWA is pursued in the future. The ability to send the full flow to the VNC provided a high amount of distribution system flexibility, resulting in a score of 3.

Table 4-2. Distribution System Flexibility Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	1
	Alternative 2: Cahuenga	1
	Alternative 3: Metropolitan Centric	1
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	2
	Alternative 5: Cahuenga	2
	Alternative 6: Griffith Park	2
Approach III – DPR at AWPF	Alternative 7: Sepulveda	3
	Alternative 8: Cahuenga	3
	Alternative 9: Griffith Park	3

4.1.2 Pure Water Los Angeles Backbone Complexity

The Pure Water Los Angeles backbone complexity criterion evaluates the complexity of managing Pure Water Los Angeles water within the Program alternative alignment (Table 4-3). The two main factors considered in this subcriterion were the relative flow volume to be managed within the backbone, and the added complexity (and coordination required) resulting from the number of storage and demand locations.

Table 4-3. Pure Water Los Angeles Backbone Scoring Scale

Metric	Scale		
	1	2	3
Pure Water Los Angeles Backbone Complexity	Provides high complexity in the Pure Water Los Angeles backbone.	Provides moderate complexity in the Pure Water Los Angeles backbone	Provides low complexity in the Pure Water Los Angeles backbone

The main assumptions used to calculate the Program alternative backbone complexity score presented in Table 4-4 include:

- Approach I – IPR at AWPF: This approach is estimated to have the most excess Pure Water Los Angeles flows to manage due to the limited number of storage and demand locations in the LADWP system, as the alternatives under this approach do not integrate into the VNC. This results in more coordination and complexity to allocate flows, resulting in a score of 1.
- Approach II – Post-AWPF DPR: This approach is estimated to have a moderate level of flexibility to manage Pure Water Los Angeles flows due to the additional integration at the VNC. However, the flow that can be managed at the VNC is limited by the DPR treatment train's capacity. The VNC provides additional flexibility and reduces complexity relative to Approach I, resulting in a score of 2.
- Approach III – DPR at AWPF: This approach is estimated to have the most flexibility to manage Pure Water Los Angeles flows due to the additional integration at the VNC of up to the full Pure Water Los Angeles flow and, potentially, other distribution system locations if TWA is pursued in the future. The ability to send the full flow to the VNC provides maximum flexibility and the least complexity relative to Approaches I and II, resulting in a score of 3.

Table 4-4. Pure Water Los Angeles Backbone Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	1
	Alternative 2: Cahuenga	1
	Alternative 3: Metropolitan Centric	1
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	2
	Alternative 5: Cahuenga	2
	Alternative 6: Griffith Park	2
Approach III – DPR at AWPF	Alternative 7: Sepulveda	3
	Alternative 8: Cahuenga	3
	Alternative 9: Griffith Park	3

4.1.3 Pure Water Los Angeles Treatment Complexity

The Pure Water Los Angeles treatment complexity criterion evaluates the complexity of the assumed treatment trains and processes in each approach (Table 4-5).

Table 4-5. Pure Water Los Angeles Treatment Complexity Scoring Scale

Metric	Scale		
	1	2	3
Pure Water Los Angeles Treatment Complexity	Provides high treatment process and monitoring complexity (e.g., new and novel treatment processes).	Provides moderate treatment process and monitoring complexity.	Provides low treatment process and monitoring complexity.

The main assumptions used to calculate the Program alternative treatment complexity score presented in Table 4-6 include:

- Approach I – IPR at AWPF: This approach uses an IPR treatment train, which has fewer treatment processes than DPR. Treatment after GWR is assumed to match treatment processes at existing LADWP groundwater treatment facilities, resulting in the least treatment complexity and a score of 3.
- Approach II – Post-AWPF DPR: This approach starts with an IPR treatment train, which has fewer treatment processes than DPR. Treatment after GWR is assumed to match treatment processes at existing LADWP groundwater treatment facilities. For DPR compliance, this approach requires additional treatment at the VNC, but the treatment train, which is assumed to be ultraviolet advanced oxidation process with granular activated carbon, matches treatment processes at existing LADWP groundwater treatment facilities. This approach would require regulatory approval for the DPR treatment approach at the VNC. The addition of post-AWPF treatment at the VNC increases treatment complexity relative to Approach I, resulting in a score of 2.
- Approach III – DPR at AWPF: At full buildout, this approach uses with the DDW-prescribed DPR treatment train at the AWPF, which includes the addition of ozone, biologically activated carbon (BAC), and membrane filtration. These processes are less familiar to LADWP treatment operations staff. Low-dose ozone is currently used at the Los Angeles Aqueduct Filtration Plant. However, the AWPF would be treating tertiary effluent water rather than drinking water (that is, higher doses of ozone would be required, increasing complexity). Similar to Approaches I and II, treatment after GWR is assumed to match treatment processes at existing LADWP groundwater treatment facilities. The increased level of treatment at the AWPF, including unfamiliar treatment processes, increases treatment complexity relative to Approaches I and II, resulting in a score of 1.

Table 4-6. Pure Water Los Angeles Treatment Complexity Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	3
	Alternative 2: Cahuenga	3
	Alternative 3: Metropolitan Centric	3
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	2
	Alternative 5: Cahuenga	2
	Alternative 6: Griffith Park	2
Approach III – DPR at AWPF	Alternative 7: Sepulveda	1
	Alternative 8: Cahuenga	1
	Alternative 9: Griffith Park	1

4.1.4 Water Quality Impacts

The water quality impacts criterion evaluates the potential for reducing water quality in LADWP's distribution system as a result of integrating Pure Water Los Angeles water using the Program alternatives (Table 4-7).

Table 4-7. Water Quality Impacts Scoring Scale

Metric	Scale		
	1	2	3
Water Quality Impacts	Significant negative impacts on water quality (e.g., increase water age or nitrification that cannot be managed)	Moderate negative impacts on water quality, with some challenges related to the introduction and integration of a new water supply	Minimal negative impacts on water quality, with effective measures to address potential issues

The main assumptions used to calculate the water quality impacts score presented in Table 4-8 include:

- Approach I – IPR at AWPF: This approach would increase local groundwater utilization in CB and SFB through GWR and additional extraction. LADWP does not predict water quality impacts from this approach, resulting in a score of 3.
- Approach II – Post-AWPF DPR: This approach would allow for Pure Water Los Angeles water to be integrated at the VNC, which would result in minimal impacts to existing operations and water quality. It is assumed that water quality impacts can be managed, resulting in a score of 3.
- Approach III – DPR at AWPF: This approach would also allow for Pure Water Los Angeles water to be integrated at the VNC, which would result in minimal impacts to existing distribution system operations and water quality similar to Approach II. If treated water augmentation is implemented, this score could be re-evaluated, but water age and quality impacts would need to be understood. It is assumed that water quality impacts can be managed, resulting in a score of 3.

Table 4-8. Water Quality Impacts Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	3
	Alternative 2: Cahuenga	3
	Alternative 3: Metropolitan Centric	3
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	3
	Alternative 5: Cahuenga	3
	Alternative 6: Griffith Park	3
Approach III – DPR at AWPF	Alternative 7: Sepulveda	3
	Alternative 8: Cahuenga	3
	Alternative 9: Griffith Park	3

4.2 Adaptability to Future Supply and Demand Changes

The adaptability to future supply and demand criterion evaluates the flexibility of each Program alternative to adapt to potential future changes in demands (Table 4-9). This criterion assumes that using

or providing access to more potable reuse strategies (for example, GWR, SWA, RWA, or TWA) provides greater flexibility to adapt to potential demand and regulatory changes.

Table 4-9. Adaptability to Future Supply and Demand Changes Scoring Scale

Metric	Scale		
	1	2	3
Adaptability to Future Changes	Provides a strategy to use or provide reasonable access to less than two of the following potable reuse strategies: ▪ GWR ▪ SWA ▪ RWA ▪ TWA	Provides a strategy to use or provide reasonable access to two or three of the following potable reuse strategies: ▪ GWR ▪ SWA ▪ RWA ▪ TWA	Provides a strategy to use or provide reasonable access to more than three of the following potable reuse strategies: ▪ GWR ▪ SWA ▪ RWA ▪ TWA

The main assumptions used to calculate the adaptability score presented in Table 4-10 include:

- Approach I – IPR at AWPF: This approach provides access to GWR. Alternatives 1 and 2 also provide access to SWA at the Lower Stone Canyon and Lower Hollywood Reservoirs if LADWP decides to evaluate those options. Alternatives 1 and 2 provide use or access to two reuse strategies (that is, GWR and SWA), resulting in a score of 2. Alternative 3 only provides use or access to one reuse strategy (that is, GWR), resulting in a score of 1.
- Approach II – Post-AWPF DPR: This approach provides access to GWR and RWA at the VNC. Access to TWA is also provided at the VNC if LADWP decides to consider that option in the future. Alternatives 4 and 5 also provide access to SWA at the Lower Stone Canyon and Lower Hollywood Reservoirs if LADWP decides to evaluate those options. Alternative 6 does not provide access to a non-potable reservoir for SWA. Alternatives 4 and 5 provide use or access to four reuse strategies (that is, GWR, SWA, RWA, and TWA), resulting in a score of 3. Alternative 6 only provides use or access to three reuse strategies (that is, GWR, RWA, and TWA), resulting in a score of 2.
- Approach III – DPR at AWPF: This approach provides access to GWR and RWA. Access to TWA is also provided at the VNC or in the distribution system if LADWP decides to consider that option in the future. Alternatives 7 and 8 also provide access to SWA at the Lower Stone Canyon and Lower Hollywood Reservoirs if LADWP decides to evaluate those options. Alternative 9 does not provide access to a non-potable reservoir for SWA. The scores shown assume a change to LADWP guidelines would occur to allow GWR with potable water. Alternatives 7 and 8 provide use or access to four reuse strategies (that is, GWR, SWA, RWA, and TWA), resulting in a score of 3. Alternative 9 only provides use or access to three reuse strategies (that is, GWR, RWA, and TWA), resulting in a score of 2.

Table 4-10. Adaptability to Future Supply and Demand Changes Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	2
	Alternative 2: Cahuenga	2
	Alternative 3: Metropolitan Centric	1
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	3
	Alternative 5: Cahuenga	3
	Alternative 6: Griffith Park	2
Approach III – DPR at AWPF	Alternative 7: Sepulveda	3
	Alternative 8: Cahuenga	3
	Alternative 9: Griffith Park	2

4.3 Cost-Effective Water Supply

The cost-effective water supply criterion evaluates the capital cost of each Program alternative relative to the amount of water integrated into the LADWP distribution system (Table 4-11).

Table 4-11. Cost-effective Water Supply Scoring Scale

Metric	Scale		
	1	2	3
Cost-effective Water Supply	Cost to City flow ratio is one of the largest values.	Cost to City flow ratio is an intermediate value.	Cost to City flow ratio is one of the smallest values.

Table 4-12 presents the conceptual capital costs for each Program alternative. The estimates were developed for the March 26, 2024, Alternatives Workshop #2, to compare alternatives.

The capital costs include:

- Membrane bioreactor (MBR) upgrades at HWRP (Hazen 2024)
- AWPF (Hazen 2024)
- Pure Water Los Angeles conveyance
- Groundwater injection and extraction
- Groundwater treatment
- Post-AWPF DPR

Cost estimates are consistent with AACE International (AACE) Class 5 costs (AACE 2020) for screening and alternatives comparison, with an expected accuracy range of -50% to +100%. Costs will be further updated as part of the detailed analysis. Cost assumptions for screening and alternative comparison purposes include:

- No escalation or phasing.
- Hybrid AWPF siting at HWRP and WB Edward C. Little Water Reclamation Facility (WRF) for conservative costs.
- Conservative sizing, including up to 232 cubic feet per second (cfs) [150 million gallons per day (MGD)] connection to PWSC provided for all alternatives.

- Potential cost sharing with Partners is not included. For example, costs do not account for potential cost sharing between LADWP and Metropolitan if upsizing of the PWSC pipeline is required.

To normalize the costs based on the flow used by the City, a ratio was calculated by dividing the capital cost by the City's flow utilization. City flow utilization is the percent of the AWPF treated water flows used to meet LADWP demands, but excludes flow used by Partners or discharged to the ocean. City flow utilization percentages were based on ONAT modeling completed at the end of February 2024 (Appendices A and B). Additional modeling refinement will be completed in later stages that will be documented in a subsequent technical memorandum (TM).

A lower ratio would represent a lower cost for water delivered to the City. Table 4-13 presents the following Program alternative score based on the cost and flow assumptions in Table 4-12:

- Approach I had the highest ratios, resulting in a score of 1.
- Approach II had the lowest ratios, resulting in a score of 3.
- Approach III had intermediate ratios, resulting in a score of 2.

Table 4-12. Program Alternative Cost Summary

Approach	Alternative	Total Estimated Capital Cost ($ billions)	City Flow Utilization (%)	Cost to City Flow Ratio
Approach I – IPR at AWPF	Alternative 1: Sepulveda	16.8	16	1.04
	Alternative 2: Cahuenga	17.3	18	0.94
	Alternative 3: Metropolitan Centric	13.0	3	3.92
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	20.5	43	0.47
	Alternative 5: Cahuenga	20.1	44	0.46
	Alternative 6: Griffith Park	20.7	44	0.47
Approach III – DPR at AWPF	Alternative 7: Sepulveda	24.6	46	0.53
	Alternative 8: Cahuenga	24.3	47	0.52
	Alternative 9: Griffith Park	25.0	47	0.54

Table 4-13. Cost-effective Water Supply Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	1
	Alternative 2: Cahuenga	1
	Alternative 3: Metropolitan Centric	1
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	3
	Alternative 5: Cahuenga	3
	Alternative 6: Griffith Park	3
Approach III – DPR at AWPF	Alternative 7: Sepulveda	2
	Alternative 8: Cahuenga	2
	Alternative 9: Griffith Park	2

4.4 Regulatory Acceptance

The regulatory acceptance criterion evaluates the potential for uncertainty related to regulatory approval and any additional testing that would be required to receive approval (Table 4-14).

Table 4-14. Regulatory Acceptance Scoring Scale

Metric	Scale		
	1	2	3
Regulatory Acceptance	Program requires validation and negotiations with the permitting agency without an established protocol in the regulations.	Program requires validation and negotiations with the permitting agency under protocols established in the regulations.	Program meets established regulations without the need for additional testing.

The main assumptions used to calculate the regulatory acceptance score presented in Table 4-15 include:

- Approach I – IPR at AWPF: This approach produces IPR-quality water and would use the prescribed IPR treatment train. No additional validation or negotiation would be required, resulting in a score of 3.
- Approach II – Post-AWPF DPR: This approach produces IPR-quality water from the AWPF and would use the prescribed IPR treatment train. However, post-AWPF DPR is assumed for the flow integrated into the VNC. DPR regulations (Jacobs and Arcadis 2024b) provide flexibility for alternative treatment trains (for example, post-AWPF DPR), but those treatment trains would require validation under permitted protocols to demonstrate the treatment is equal to or better than the DDW-prescribed DPR treatment train, resulting in a score of 2.
- Approach III – DPR at AWPF: This approach produces DPR-quality water and would use the DDW-prescribed DPR treatment train. No additional validation or negotiation beyond what is required in the DPR regulations would be needed, resulting in a score of 3.

Table 4-15. Regulatory Acceptance Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	3
	Alternative 2: Cahuenga	3
	Alternative 3: Metropolitan Centric	3
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	2
	Alternative 5: Cahuenga	2
	Alternative 6: Griffith Park	2
Approach III – DPR at AWPF	Alternative 7: Sepulveda	3
	Alternative 8: Cahuenga	3
	Alternative 9: Griffith Park	3

4.5 Phasing and Early Deliveries

The phasing and early delivery criterion evaluates the potential for each Program alternative to include phasing that would provide near-term access to Pure Water Los Angeles water (Table 4-16).

Table 4-16. Phasing and Early Deliveries Scoring Scale

Metric	Scale		
	1	2	3
Phasing and Early Deliveries	Provides supply in an earlier time frame for specific storage and demand locations beyond two decades of CEQA completion	Provides supply in an earlier time frame for specific storage and demand locations within one to two decades of CEQA completion	Provides supply in an earlier time frame for specific storage and demand locations within one decade of CEQA completion

The main assumptions used to evaluate the phasing and early delivery score presented in Table 4-17 include:

- Approach I – IPR at AWPF: This approach provides early access to Pure Water Los Angeles water through regional partnerships with WB and GWR in CB. Alternative 1 uses the Sepulveda alignment, which could provide additional access to local groundwater basins, demands through local partnerships, and access to the Balboa Pump Station, as well as use the existing East Valley pipeline to access recharge facilities in SFB. Alternative 1 was scored 3 due to better potential for near-term access with a shorter conveyance to SFB, additional local Partners, and use of existing infrastructure. Alternatives 2 (Cahuenga Alignment) and 3 (Metropolitan Centric) were scored 2 due to near-term access primarily through regional partnerships.
- Approach II – Post-AWPF DPR: This approach provides early access to Pure Water Los Angeles water through regional partnerships with WB and GWR in CB. Alternative 4 uses the Sepulveda alignment, which could provide additional access to local groundwater basins, demands through local partnerships, and access to the Balboa Pump Station, as well as use the existing East Valley pipeline to access recharge facilities in SFB. Alternative 4 was scored 3 due to better potential for near-term access with a shorter conveyance to SFB, additional local Partners, and use of existing infrastructure. Alternatives 5 (Cahuenga Alignment) and 6 (Griffith Park Alignment) were scored 2 due to near-term access primarily through regional partnerships.
- Approach III – DPR at AWPF: This approach provides early access to Pure Water Los Angeles water through regional partnerships with WB and GWR in CB. Alternative 7 uses the Sepulveda alignment, which could provide additional access to local groundwater basins, demands through local partnerships, and access to the Balboa Pump Station, as well as use the existing East Valley pipeline to access recharge facilities in SFB. Alternative 7 was scored 3 due to better potential for near-term access with a shorter conveyance to SFB, additional local Partners, and use of existing infrastructure. Alternatives 8 (Cahuenga Alignment) and 9 (Griffith Park Alignment) were scored 2 due to near-term access primarily through regional partnerships.

Table 4-17. Phasing and Early Deliveries Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	3
	Alternative 2: Cahuenga	2
	Alternative 3: Metropolitan Centric	2
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	3
	Alternative 5: Cahuenga	2
	Alternative 6: Griffith Park	2
Approach III – DPR at AWPF	Alternative 7: Sepulveda	3
	Alternative 8: Cahuenga	2
	Alternative 9: Griffith Park	2

4.6 Regional Partnerships

The regional partnership criterion evaluates the potential for each Program alternative to collaborate with regional Partners, as well as provide a demand location for Pure Water Los Angeles flows when flows to the City may be limited (Table 4-18).

Table 4-18. Regional Partnership Scoring Scale

Metric	Scale		
	1	2	3
Regional Partnerships	A lesser amount of water is managed through a regional partnership in a wet year.	A moderate amount of water is managed through a regional partnership in a wet year.	A larger amount of water is managed through a regional partnership in a wet year.

The amounts of water managed through a regional partnership were based on ONAT modeling completed at the end of February 2024 (Attachment A and B). The main assumptions used to evaluate the regional partnerships score presented in Table 4-19 include:

- Approach I – IPR at AWPF: Alternatives provide more available flow for Partners in wet years due to fewer locations in LADWP's system to integrate or store water, resulting in a score of 3 for all alternatives.
- Approach II – Post-AWPF DPR: Alternatives provide less available flow for Partners in wet years due to more locations in LADWP's system to integrate or store water. Alternatives 4 and 5 also provide more access to local Partners, resulting in a score of 2. Alternative 6 has fewer local Partners, resulting in a score of 1.
- Approach III – DPR at AWPF: Similar to Approach II, alternatives provide less available flow for Partners in wet years due to more locations in LADWP's system to integrate or store water. Alternatives 7 and 8 also provide more access to local Partners, resulting in a score of 2. Alternative 9 has fewer local Partners, resulting in a score of 1.

Table 4-19. Regional Partnership Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	3
	Alternative 2: Cahuenga	3
	Alternative 3: Metropolitan Centric	3
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	2
	Alternative 5: Cahuenga	2
	Alternative 6: Griffith Park	1
Approach III – DPR at AWPF	Alternative 7: Sepulveda	2
	Alternative 8: Cahuenga	2
	Alternative 9: Griffith Park	1

4.7 Environmental Stewardship

Three subcriteria were developed to evaluate the potential environmental benefits of the Program alternatives, as described in this section.

4.7.1 Utilization in Dry Year

The utilization in a dry year criterion evaluates the potential to integrate and use Pure Water Los Angeles water in the LADWP distribution system during a dry year. Pure Water Los Angeles would provide a new local water supply that would provide further diversification of LADWP's supply portfolio, as well as provide additional water supplies and put less pressure on existing supplies in a dry year (Table 4-20).

Table 4-20. Utilization in Dry Year Scoring Scale

Metric	Scale		
	1	2	3
Utilization in a Dry Year	Percentage of RW used in a dry year in comparison to the total water demand is < 20%.	Percentage of RW used in a dry year in comparison to the total water demand is between 20 and 35%.	Percentage of RW used in a dry year in comparison to the total water demand is > 35%.

< = less than

> = greater than

Utilization percentages as a proportion of total water demand in the City were based on ONAT modeling completed at the end of February 2024 (Attachments A and B). Utilization was calculated as the average Pure Water Los Angeles flow in a dry year divided by total City demand. Additional modeling refinement will be completed in later stages that will be documented in a subsequent TM.

Modeling results for the Pure Water Los Angeles utilization during dry years score presented in Table 4-21 include:

- Approach I – IPR at AWPF: Pure Water Los Angeles flow utilization by LADWP during a dry year is estimated to be 15 to 17% of the City's total demand for Alternatives 1 and 2 and 6% for Alternative 3, resulting in a score of 1 for all alternatives.
- Approach II – Post-AWPF DPR: Pure Water Los Angeles flow utilization by LADWP during a dry year is estimated to be approximately 34% of the City's total demand, resulting in a score of 2 for all alternatives.
- Approach III – DPR at AWPF: Pure Water Los Angeles flow utilization by LADWP during a dry year is estimated to be approximately 39% of the City's total demand, resulting in a score of 3 for all alternatives.

Table 4-21. Utilization in Dry Year Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	1
	Alternative 2: Cahuenga	1
	Alternative 3: Metropolitan Centric	1
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	2
	Alternative 5: Cahuenga	2
	Alternative 6: Griffith Park	2
Approach III – DPR at AWPF	Alternative 7: Sepulveda	3
	Alternative 8: Cahuenga	3
	Alternative 9: Griffith Park	3

4.7.2 Brine Discharge Improvements

The brine discharge improvements criterion evaluates the potential to improve the water quality of the reverse osmosis (RO) brine before discharge to the ocean (Table 4-22).

Table 4-22. Brine Discharge Improvements Scoring Scale

Metric	Scale		
	1	2	3
Brine Discharge Improvements	Provides little to no potential for brine discharge improvements.	Provides moderate potential for brine discharge improvements.	Provides high potential for brine discharge improvements.

For all alternatives, nitrogen concentrations are expected to be reduced compared to existing concentrations through the addition of MBR. RO treatment does not increase the mass loading of contaminants in the ocean discharge; however, it does decrease the dilution factor by concentrating contaminants in the wastewater. Treatment upstream of RO (for example, ozone and BAC) has the potential to reduce certain contaminants (for example, contaminants of emerging concern) in the ocean discharge. LADWP is currently planning to conduct pilot-scale testing to evaluate the potential of upstream treatment to improve the RO brine water quality. The main assumptions used to evaluate the brine discharge improvements score presented in Table 4-23 include:

- Approach I – IPR at AWPF: AWPF will include IPR-quality water with moderate potential for improved brine quality, resulting in a score of 2.
- Approach II – Post-AWPF DPR: Similar to Approach I, AWPF will include IPR-quality water with moderate potential for improved brine quality, resulting in a score of 2.
- Approach III – DPR at AWPF: AWPF will include DPR-quality water with the most potential for improved brine quality due to the addition of ozone and BAC upstream of RO, resulting in a score of 3.

Table 4-23. Brine Discharge Improvements Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	2
	Alternative 2: Cahuenga	2
	Alternative 3: Metropolitan Centric	2
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	2
	Alternative 5: Cahuenga	2
	Alternative 6: Griffith Park	2
Approach III – DPR at AWPF	Alternative 7: Sepulveda	3
	Alternative 8: Cahuenga	3
	Alternative 9: Griffith Park	3

4.7.3 Treatment Level Consistent with Water Use

The treatment level consistent with water use criterion evaluates the treated water quality compared to the water quality needed for end uses (Table 4-24).

Table 4-24. Treatment Level Consistent with Water Use Scoring Scale

Metric	Scale		
	1	2	3
Treatment meets regulatory requirement for water use	Treatment exceeds regulatory requirements in all applications.	Treatment meets regulatory requirements for some applications and exceeds regulatory requirements for others.	Treatment meets regulatory requirements for all applications.

Overtreatment at the AWPF could result in high capital and operations and maintenance (O&M) costs, as well as larger footprints and energy usage that could have negative environmental impacts when post-AWPF treatment is not needed for the end use. The main assumptions used to evaluate treatment consistent with water use score presented in Table 4-25 include:

- Approach I – IPR at AWPF: This approach includes treatment that meets the regulatory requirements for the water uses (that is, IPR only) for all storage and demand locations, resulting in a score of 3.
- Approach II – Post-AWPF DPR: This approach includes treatment that meets the regulatory requirements for the water uses (that is, IPR up to the VNC, and DPR at the VNC) for all storage and demand locations, resulting in a score of 3.
- Approach III – DPR at AWPF: This approach includes treatment that meets regulatory requirements for the water integration at the VNC. However, DPR-quality water exceeds the regulatory requirements for GWR and the likely water quality needs of local and regional Partners, resulting in a score of 2.

Table 4-25. Treatment Level Consistent with Water Use Score for Each Alternative

Approach	Alternative	Score
Approach I – IPR at AWPF	Alternative 1: Sepulveda	3
	Alternative 2: Cahuenga	3
	Alternative 3: Metropolitan Centric	3
Approach II – IPR with Post-AWPF DPR	Alternative 4: Sepulveda	3
	Alternative 5: Cahuenga	3
	Alternative 6: Griffith Park	3
Approach III – DPR at AWPF	Alternative 7: Sepulveda	2
	Alternative 8: Cahuenga	2
	Alternative 9: Griffith Park	2

5. Findings

LADWP held a workshop on March 26, 2024, to review the Program alternative scoring and develop a list of selected alternatives for additional detailed analysis (LADWP 2024c). Table 5-1 and Figure 5-1 provide the results of the screening evaluation. Approaches II and III had the highest scores, ranging from 2.17 to 2.58, based on the following:

- Approaches II and III scored higher due to adaptability to future supply and demand changes.
- Approaches II and III scored higher based on cost-effectiveness with respect to the selected criteria, which had a high value on the use of the Pure Water Los Angeles flow to meet LADWP demands.
- Within a given conveyance alignment (that is, Sepulveda, Cahuenga, or Griffith Park), the Program alternative scores for Approaches II and III were similar.
- Within Approaches II and III, preliminarily, the Sepulveda alignment (Alternatives 4 and 7) scored the highest due to early phasing benefits and partnership advantages.
- The lowest Approaches II and III alternative score exceeded the highest Approach I score.

5.1 Preferred Program Alternatives

Based on the workshop, the preferred Program alternatives were identified by LADWP as Approach II - Post-AWPF DPR and Approach III – DPR at AWPF. Approaches II and III will both be moved forward for additional analysis and potentially for inclusion in the CEQA review. The differences in the alternatives within an approach are based on conveyance alignments, and a detailed routing study will be undertaken by LADWP to further refine the conveyance alignment selection. The selected approaches provide operational flexibility and adaptability and are more cost-effective based on LADWP's evaluation criteria. The primary difference between Approach II and Approach III is the location of the DPR treatment, either at the AWPF or VNC. Based on the schedule to construct conveyance to VNC, Approach II could be adapted to Approach III if post-AWPF is determined to not be preferred in the future.

5.2 Policy Considerations

The screening analysis considered costs and non-monetary factors for evaluating Pure Water Los Angeles Program alternatives. After evaluation, Approach II - Post-AWPF DPR and Approach III – DPR at AWPF had similar MCDA scores, with the primary variation being among alignments. The screening criteria did not include constructability considerations for the various conveyance alignments. A routing study is planned to better define constructability considerations for each alignment that can be used to better select the preferred alignment and alternative. Input from LADWP's planned outreach efforts will also be critical in further evaluating the conveyance alternatives moving forward.

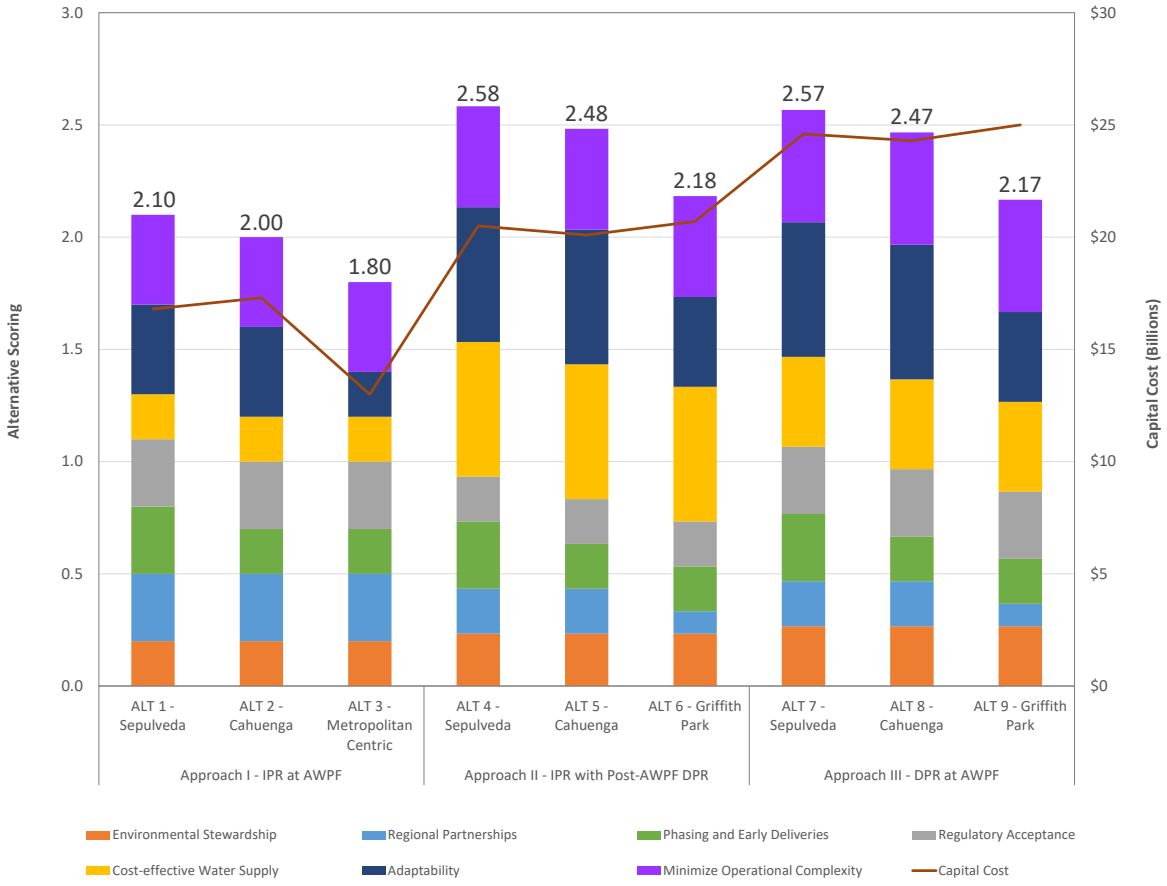
Approach II – Post-AWPF DPR is assumed to produce IPR-quality water from the AWPF, with treatment consistent with the water use, where required. This provides potential cost savings by avoiding overtreatment of the ATRW for both chemical and pathogen controls required by the DPR regulations (Jacobs and Arcadis 2024b). Post-AWPF DPR treatment could be considered under the alternatives clause for chemical control in the DPR regulations.

An alternative treatment train will require testing to demonstrate effectiveness. It is recommended that this testing be discussed, planned, and completed in coordination with DDW to verify the proposed train as a feasible alternative before selecting the final preferred AWPF approach. Space for additional treatment processes should be considered in any siting evaluations to account for potential treatment changes based on testing, future emerging contaminants, or regulatory changes.

Table 5-1. Program Alternative Scoring Summary

Criteria		Approach I – IPR at AWPF			Approach II – IPR With Post-AWPF DPR			Approach III – DPR at AWPF		
	Alternative	1: Sepulveda	2: Cahuenga	3: Metropolitan Centric	4: Sepulveda	5: Cahuenga	6: Griffith Park	7: Sepulveda	8: Cahuenga	9: Griffith Park
	Capital Cost, $ billions	16.8	17.3	13.0	20.5	20.1	20.7	24.6	24.3	25.0
	Annual O&M Cost, $ millions	376	361	305	379	374	381	425	422	439
	Weighting (%)	Subscores								
1. Minimize Operational Complexity and Maintain Water Quality in Distribution System	20	0.40	0.40	0.40	0.45	0.45	0.45	0.50	0.50	0.50
Distribution System Flexibility		1	1	1	2	2	2	3	3	3
–Pure Water Los Angeles Backbone Complexity		1	1	1	2	2	2	3	3	3
–Pure Water Los Angeles Treatment Complexity		3	3	3	2	2	2	1	1	1
Water Quality Impacts		3	3	3	3	3	3	3	3	3
2. Adaptability to Future Supply and Demand Changes	20	0.40	0.40	0.20	0.60	0.60	0.40	0.60	0.60	0.40
Range of Reuse Strategies		2	2	1	3	3	2	3	3	2
3. Cost-effective Water Supply	20	0.20	0.20	0.20	0.60	0.60	0.60	0.40	0.40	0.40
Capital Cost to Flow to City Ratio		1	1	1	3	3	3	2	2	2
4. Regulatory Acceptance	10	0.30	0.30	0.30	0.20	0.20	0.20	0.30	0.30	0.30
Level of Regulatory Uncertainty		3	3	3	2	2	2	3	3	3
5. Phasing and Early Deliveries	10	0.30	0.20	0.20	0.30	0.20	0.20	0.30	0.20	0.20
Provides Supply in an Earlier Time Frame		3	2	2	3	2	2	3	2	2
6. Regional Partnerships	10	0.30	0.30	0.30	0.20	0.20	0.10	0.20	0.20	0.10
Water Managed through Partnerships in Wet Years		3	3	3	2	2	1	2	2	1
7. Environmental Stewardship	10	0.20	0.20	0.20	0.23	0.23	0.23	0.27	0.27	0.27
Utilization in Dry Years		1	1	1	2	2	2	3	3	3
Brine Discharge Improvements		2	2	2	2	2	2	3	3	3
Treatment Level Consistent with Water Use		3	3	3	3	3	3	2	2	2
Total Score		2.10	2.00	1.80	2.58	2.48	2.18	2.57	2.47	2.17

Figure 5-1. Program Alternative Scoring Summary



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Attachment A
Operation NEXT Analysis Tool Assumptions

Scenario1

Scenario 1 assumptions: 1.Current Trends Scenario: Adjusted
APPROACH 1

Input ID	ONAT scenario	Baseline Alternative	Approach 1(IPR) F1_IPR_A1	F1_IPR_A2	F1_IPR_A3
	Demands and Wastewater				
0	Hydrology	July-1990 to end of June 2020	July-1990 to end of June 2020	July-1990 to end of June 2021	July-1990 to end of June 2022
1	LA Demands (AFY)	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent
2	Demand Monthly Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
3	Indoor/outdoor Demand Pattern	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020
4	Recycled Water Demand (AFY)	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP
5	Recycled Water monthly pattern	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP
6	Annual Demand Multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier
7	Monthly Demand Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
8	Wastewater estimate independent variable to use	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery
9	Fraction of the deliveries (potable/indoors) that comes back to wastewater plants	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage
10	Residential GPCD	72.92	72.92	72.92	72.92
11	Wastewater Treatment Efficiency (Effluent/Influent)	0.95	0.95	0.95	0.95
12	AWT Efficiency (Effluent/Influent)	0.8456	0.8456	0.8456	0.8456
13	WW Adjustment (Monthly multiplier of the selected deliveries (indoor or total potable) selected on input #8	No multiplier	No multiplier	No multiplier	No multiplier
14	Recycled Water Demand Multiplier	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)
15	*WW Distribution (From UWMP 2020, fraction of total wastewater for each treatment plant)*				
16	DCTWRP	0.1012	0.1012	0.1012	0.1012
17	HWRP	0.8121	0.8121	0.8121	0.8121
18	LAGWRP	0.0405	0.0405	0.0405	0.0405
19	TIWRP	0.0462	0.0462	0.0462	0.0462
20	*Wastewater Plant tertiary production capacity (WW_tert_cap [mgd])*				
21	DCTWRP	80	80	80	80
22	HWRP	450	450	450	450
23	LAGWRP	20	20	20	20
24	TIWRP	30	30	30	30
25	**OpNEXT Controls**				
26	OpNEXT Start Date	7/1/2020	7/1/2020	7/1/2020	7/1/2020
27	Hyperion AWT Feed Capacity (MGD)	No OpNext	**230 MGD of produced water (Feed=230/efficiency)=270 MGD**	**230 MGD of produced water (Feed=230/efficiency)=270 MGD**	**230 MGD of produced water (Feed=230/efficiency)=270 MGD**
28	Schedule (Hyperion ATW production will follow a table schedule)	No Schedule	No Schedule	No Schedule	No Schedule
29	Conveyance Capacity from Hyperion to Storage and VNC (MGD)	0	0	0	0
30	Conveyance Capacity to PWSC connection (MGD)	0	**up to 150 mgd**	**up to 150 mgd**	**up to 150 mgd**
31	Hyperion deliveries to West Basin **MBR not ATW** (MGD)	0	0	0	0
34	LAAFP Blending Ratio Limit (RAW:AWT)	No Blending Ratio Limit	**No Blending Ratio, do as Sensitivity using 10:1**	**No Blending Ratio, do as Sensitivity using 10:1**	**No Blending Ratio, do as Sensitivity using 10:1**
	Conveyance from Hyperion to different destinations and related inputs				
32	Hyperion deliveries to West Basin **AWT** (going OUT of the system loop)	0	**40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)**	**40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)**	**40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)**
36	Hyperion to West Coast Sea Barier (a fraction will go to WCB storage)				
37					
38	Hyperion to Central Basin **ATW** Injection capacity (MGD)	0	**Potential phased approach-Consider 37 MGD for the moment**	**Potential phased approach-Consider 37 MGD for the moment**	**Potential phased approach-Consider 37 MGD for the moment**
39					
40	Partners	No Partners	**WRD, Santa Monica or Beverly Hills, demands not defined yet**	**WRD, Santa Monica or Beverly Hills, demands not defined yet**	**WRD, Santa Monica or Beverly Hills, demands not defined yet**
41	Conveyance capacity from Hyperion to/out San Fernando Basin (subjected to injection/spreading capacity	No OpNext Connection, just current East Valley pipeline for DCT	**Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and OpNext, assume 25mgd is DCT, 55 mgd is OpNext.**	**Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and New conveyance (Max 84 MGD) for OpNex. Total 164 MGD ptential to SFB, assume 25 mgd is for DCT/139 mgd to OpNext**	**No OpNext recharge at SFB, Use of East Valley Pipeline max 80 MGD/124 cfs for DCT only**
42	Capacity to send to LA Reservoirs (lim to available capacity)	0	0	0	0
43	MWD Pure Water capacity (MGD)	0	**up to 150 MGD**	**up to 150 MGD**	**up to 150 MGD**
44	Injection in CB for WRD	0	0	0	0
45	OpNext to Montebello Forebay	0	0	0	0
46	LAA groundwater Bank	0	0	0	0
47	**Supplies and Supply Usage**				
48	*LAA Flows*				
49	Hydrology for LAA	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run
50	Start Year	1990	1990	1990	1990
51	Flows	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021
52	If LAA flows are above this value LADWP will override all priorities - Prioritize LAA if LAA flows are > than value (mgd)	9999	9999	9999	9999
53	*Minimum Supply amount to be used for Deliveries [af/yr]*				
54	San Fernando Basin Minimum Rights (GW_SFB1MinRights)	87000	87000	87000	87000
55	Central Basin Minimum Rights (GW_CB)	17236	17236	17236	17236
56	West Coast Basin Minimum Rights (GW_WCB)	1503	1503	1503	1503
57	Sylmar Minimum Rights (GW_Sylmar)	3570	3570	3570	3570
58	LAA groundwater Bank (GW_Antelope)	0	0	0	0
59	Los Angeles Aqueduct (SW_LAA)	0	0	0	0
60	Imported MWD (IMP_MWD)	60000	60000	60000	60000
61	*Priority of Supplies used to meet Potable Demands*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
61.5	San Fernando Remediation				
62	San Fernando Basic Rights (GW_SFB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
63	Central Basin/West Coast Basin Basic Rights (GW_CBWCB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
64	Sylmar Basic Rights (GW_SylmarBasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
65	San Fernando Stored credits (GW_SFB_StoCredits)	6|6|6	6|6|6	6|6|6	6|6|6
66	LAA groundwater Bank (GW_LAAGWB)	8|8|8	8|8|8	8|8|8	8|8|8
67	ATW from Hyperion stored in the San Fernando Basin (GW_SFB_Augm)	7|7|7	7|7|7	7|7|7	7|7|7
68	Use of SFB if no stored credits or OpNext storage is available (GW_SFB_Bank)	999|999|999	999|999|999	999|999|999	999|999|999
69	Los Angeles Aqueduct (SW_LAA)	2|2|2	2|2|2	2|2|2	2|2|2
70	ATW_WCSBarrier	6|6|6	6|6|6	6|6|6	6|6|6
71	ATW injection in Central Basin (ATW_InjectionCB)	6|6|6	6|6|6	6|6|6	6|6|6
72	ATW from Hyperion to LA Reservoirs (ATW_DWPReservoirs)	5|5|5	5|5|5	5|5|5	5|5|5
73	ATW from Hyperion to LAAFP (AWT_OpNEXTLAAFP)	4|4|3	4|4|3	4|4|3	4|4|3
74	Minimum to be imported from MWD (IMP_MWDmin)	1|1|1	1|1|1	1|1|1	1|1|1
75	IMP_MWD	9|9|9	9|9|9	9|9|9	9|9|9
76	IMP_BlendImp	6|6|6	6|6|6	6|6|6	6|6|6
77	*Priority of Hyperion ATW uses*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
78	WBMWD sales (ATW_WB)	2|2|1	2|2|1	2|2|1	2|2|1
79	WC Sea barrier (WCSB) (ATW_STO_WCSB)	3|3|2	3|3|2	3|3|2	3|3|2
80	CB GW injection (LADWP) (ATW_GW_InjCBDWP)	4|4|3	4|4|3	4|4|3	4|4|3
81	Dependent Partening Opportunities (Ex. Santa Monica) (ATW_Partners)	5|5|5	5|5|5	5|5|5	5|5|5
82	SFB Injection (ATW_STO_SFB)	7|7|6	7|7|6	7|7|6	7|7|6
83	LADWP Reservoirs (ATW_STO_LAReservoirs)	6|6|8	6|6|8	6|6|8	6|6|8
84	LAAFP (ATW_LAAFP)	1|1|0	1|1|0	1|1|0	1|1|0
85	MWD Pure Water connection (ATW_MWDPure)	10|10|10	10|10|10	10|10|10	10|10|10
86	CB GW injection (WRD) (ATW_GW_InjCBWRD)	5|5|4	5|5|4	5|5|4	5|5|4
87	CB spreading in the Montebello Forebay (if available) (ATW_MontebFB)	11|11|11	11|11|11	11|11|11	11|11|11
88	GW Bank (if active) (ATW_LAAGWB)	12|12|12	12|12|12	12|12|12	12|12|12
89					
90	*MWD Imported Supplies*				
91	Maximum MWD Annual Supply (AFY)	400000	400000	400000	400000
92	Maximum flow of imported MWD supply (mgd)	1790	1790	1790	1790
93	*LAA GW Bank*				
94	Bank Utilization	deactivated	deactivated	deactivated	deactivated
95	Recharge Capacity	deactivated	deactivated	deactivated	deactivated
96	Max Storage (AF)	deactivated	deactivated	deactivated	deactivated
97	Extraction Capacity (mgd)	deactivated	deactivated	deactivated	deactivated
98	*Santa Monica Reservoirs*				
99	Location	No Use of reservoir	No Use of reservoir	No Use of reservoir	No Use of reservoir
100	Maximum Releases from Surface Water Reservoirs (MGD)	0	0	0	0
101	Initial Storage (AF)	0	0	0	0
102	*San Fernando Basin*	-	-	-	-
103	Max Basin Physical Storage (AF)	1,100,000	1,100,000	1,100,000	1,100,000
104	Initial Storage at simulation t=0 (AF)	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79
105	Initial Cumulative storage from 1920's zero overdraft reference, and -210,000 AF in 1954	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af

106	Max/Min judgement levels on cumulative storage since 1954 when the basin was recognize as being in a 210,000 AF overdraft	0/-360,000AF	0/-360,000AF	0/-360,000AF	0/-360,000AF
107	Variable San Fernando Basin Inflows OR Constant value	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant
108	Percentage Credit for previous Water Year Imported Water (this is active only if SFB inflows are set to variable)	20.8	20.8	20.8	20.8
109	Dynamic Priority, gives priority to use Bank's supply if close to be full	not active	not active	not active	not active
110	DCT credits	No DCT recharge	**Max 25 MGD (28,000 AFY)**	**Max 25 MGD (28,000 AFY)**	**Max 25 MGD (28,000 AFY)**
111	Max DCT credits, a function of wastewater flows available at DCT, recycled water demands from DCT and bypass of flows from DCT to Hyperion (AFY)	0	**28,000 AFY**	**28,000 AFY**	**28,000 AFY**
112	DCT bypass to Hyperion (MGD)	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	**9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 5**	**9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 6**	**9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 7**
113	LAG bypass to Hyperion (MGD)	3.8	3.8	3.8	3.8
114	SFB Recharge Capacity	No extra recharge than current operations	**Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October**	**Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October**	**Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October**
115	SFB Extraction Capacity (cfs)	130	**220**	**220**	**220**
116	Surplus LAA to SFB recharge	Not operational	Not operational	Not operational	Not operational
117	San Fernando Basin Extraction Logic	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries
118	If SFB extraction option (#117) is 1(function of LAA flows), Threshold annual volume to use SFB	Not active	Not active	Not active	Not active
119	If SFB extraction option (#117) is 1(function of LAA flows), Threshold LAA flow to use SFB	Not Active	Not Active	Not Active	Not Active
120	Fixed Maximum extraction, Annual limit in AFY if Extraction Logic # 117 is set to a fixed value	NA	NA	NA	NA
121	*Central Basin/WCB*	-	-	-	-
122	Max Storage (% of Basin Rights) maximum 1 year carryover	200%	200%	200%	200%
123	Max Extraction per Judgement (% of annual rights)	140% based on judgment value	**223% to match 37 mgd of extraction capacity**	**223% to match 37 mgd of extraction capacity**	**223% to match 37 mgd of extraction capacity**
124	Central Basin Well Extraction Capacity (MGD)	8.922	**TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed**	**TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed**	**TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed**
125	Max Central basin Demands (% of all demands). If this is more than 10,000 AFY it will reduce the minimum MWD imported water of 60,000 AFY	Historical CB pumping is close to 10,000 AFY or approximally 1.7% of total demands	**100%**	**100%**	**100%**
126	Hyperion ATW to Central Basin recharge switch	No Central Basin Recharge of OpNext Water	**ON**	**ON**	**ON**
127	*Pure Water*				
128	Hyperion opNext capacity to Pure Water MWD	0	**up to 150 MGD**	**up to 150 MGD**	**up to 150 MGD**
129	Pure Water Storage of OpNEXT	None	None	None	None
130	Max OpNEXT Storage Recharge	None	None	None	None
131	Return OpNEXT water to LA via PureWater	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water

Scenario1

Scenario 1 assumptions: 1.Current Trends Scenario: Adjusted
APPROACH 2

Input ID	ONAT scenario	Baseline Alternative	Approach 2 (IPR and DPR) F2_IPR_A4	F2_IPR_A5	F2_IPR_A6
	Demands and Wastewater		-	-	-
0	Hydrology	July-1990 to end of June 2020	July-1990 to end of June 2023	July-1990 to end of June 2024	July-1990 to end of June 2025
1	LA Demands (AFY)	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent
2	Demand Monthly Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
3	Indoor/outdoor Demand Pattern	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020
4	Recycled Water Demand (AFY)	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP
5	Recycled Water monthly pattern	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP
6	Annual Demand Multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier
7	Monthly Demand Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
8	Wastewater estimate independent variable to use	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery
9	Fraction of the deliveries (potable/indoors) that comes back to wastewater plants	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage
10	Residential GPCD	72.92	72.92	72.92	72.92
11	Wastewater Treatment Efficiency (Effluent/Influent)	0.95	0.95	0.95	0.95
12	AWT Efficiency (Effluent/Influent)	0.8456	0.8456	0.8456	0.8456
13	WW Adjustment (Monthly multiplier of the selected deliveries (indoor or total potable) selected on input #8	No multiplier	No multiplier	No multiplier	No multiplier
14	Recycled Water Demand Multiplier	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)
15	*WW Distribution (From UWMP 2020, fraction of total wastewater for each treatment plant)*				
16	DCTWRP	0.1012	0.1012	0.1012	0.1012
17	HWRP	0.8121	0.8121	0.8121	0.8121
18	LAGWRP	0.0405	0.0405	0.0405	0.0405
19	TIWRP	0.0462	0.0462	0.0462	0.0462
20	*Wastewater Plant tertiary production capacity (WW_tert_cap [mgd])*				
21	DCTWRP	80	80	80	80
22	HWRP	450	450	450	450
23	LAGWRP	20	20	20	20
24	TIWRP	30	30	30	30
25	**OpNEXT Controls**				
26	OpNEXT Start Date	7/1/2020	7/1/2020	7/1/2020	7/1/2020
27	Hyperion AWT Feed Capacity (MGD)	No OpNext	**230 MGD of produced water (Feed=230/efficiency)=270 MGD**	**230 MGD of produced water (Feed=230/efficiency)=270 MGD**	**230 MGD of produced water (Feed=230/efficiency)=270 MGD**
28	Schedule (Hyperion ATW production will follow a table schedule)	No Schedule	No Schedule	No Schedule	No Schedule
29	Conveyance Capacity from Hyperion to Storage and VNC (MGD)	0	**163**	**163**	**163**
30	Conveyance Capacity to PWSC connection (MGD)	0	**up to 150 mgd**	**up to 150 mgd**	**up to 150 mgd**
31	Hyperion deliveries to West Basin **MBR not ATW** (MGD)	0	0	0	0
34	LAAFP Blending Ratio Limit (RAW:AWT)	No Blending Ratio Limit	**No Blending Ratio, do as Sensitivity using 10:1**	**No Blending Ratio, do as Sensitivity using 10:1**	**No Blending Ratio, do as Sensitivity using 10:1**
	Conveyance from Hyperion to different destinations and related inputs				
32	Hyperion deliveries to West Basin **AWT** (going OUT of the system loop)	0	**40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)**	**40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)**	**40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)**
36	Hyperion to West Coast Sea Barier (a fraction will go to WCB storage)				
37					
38	Hyperion to Central Basin **ATW** Injection capacity (MGD)	0	**Potential phased approach-Consider 37 MGD for the moment**	**Potential phased approach-Consider 37 MGD for the moment**	**Potential phased approach-Consider 37 MGD for the moment**
39					
40	Partners	No Partners	**WRD, Santa Monica or Beverly Hills, demands not defined yet**	**WRD, Burbank, San Fernando, demands not defined yet**	**WRD, Burbank, Glendale,demands not defined yet**
41	Conveyance capacity from Hyperion to/out San Fernando Basin (subjected to injection/spreading capacity	No OpNext Connection, just current East Valley pipeline for DCT	**Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and OpNext, assume 25mgd is DCT, 55 mgd is OpNext. Use of Bull Creek Stormwater Capture 60" pipeline for up to 70 cfs to Pacoima in dry months only (based on spreading ground limitation, not conveyance which is 100 cfs)**	**Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and New conveyance (Max 84 MGD) for OpNex. Total 164 MGD potential to SFB, assume 25 mgd is for DCT/139 mgd to OpNext**	**Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and New conveyance (Max 84 MGD) for OpNex. Total 164 MGD potential to SFB, assume 25 mgd is for DCT/139 mgd to OpNext**
42	Capacity to send to LA Reservoirs (lim to available capacity)	0	0	0	0
43	MWD Pure Water capacity (MGD)	0	**up to 150 MGD**	**up to 150 MGD**	**up to 150 MGD**
44	Injection in CB for WRD	0	0	0	0
45	OpNext to Montebello Forebay	0	0	0	0
46	LAA groundwater Bank	0	0	0	0
47	**Supplies and Supply Usage**				
48	*LAA Flows*				
49	Hydrology for LAA	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run
50	Start Year	1990	1990	1990	1990
51	Flows	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021
52	If LAA flows are above this value LADWP will override all priorities - Prioritize LAA if LAA flows are > than value (mgd)	9999	9999	9999	9999
53	*Minimum Supply amount to be used for Deliveries [af/yr]*				
54	San Fernando Basin Minimum Rights (GW_SFB1MinRights)	87000	87000	87000	87000
55	Central Basin Minimum Rights (GW_CB)	17236	17236	17236	17236
56	West Coast Basin Minimum Rights (GW_WCB)	1503	1503	1503	1503
57	Sylmar Minimum Rights (GW_Sylmar)	3570	3570	3570	3570
58	LAA groundwater Bank (GW_Antelope)	0	0	0	0
59	Los Angeles Aqueduct (SW_LAA)	0	0	0	0
60	Imported MWD (IMP_MWD)	60000	60000	60000	60000
61	*Priority of Supplies used to meet Potable Demands*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
61.5	San Fernando Remediation				
62	San Fernando Basic Rights (GW_SFB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
63	Central Basin/West Coast Basin Basic Rights (GW_CBWCB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
64	Sylmar Basic Rights (GW_SylmarBasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
65	San Fernando Stored credits (GW_SFB_StoCredits)	6|6|6	6|6|6	6|6|6	6|6|6
66	LAA groundwater Bank (GW_LAAGWB)	8|8|8	8|8|8	8|8|8	8|8|8
67	ATW from Hyperion stored in the San Fernando Basin (GW_SFB_Augm)	7|7|7	7|7|7	7|7|7	7|7|7
68	Use of SFB if no stored credits or OpNext storage is available (GW_SFB_Bank)	999|999|999	999|999|999	999|999|999	999|999|999
69	Los Angeles Aqueduct (SW_LAA)	2|2|2	2|2|2	2|2|2	2|2|2
70	ATW_WCSBarrier	6|6|6	6|6|6	6|6|6	6|6|6
71	ATW injection in Central Basin (ATW_InjectionCB)	6|6|6	6|6|6	6|6|6	6|6|6
72	ATW from Hyperion to LA Reservoirs (ATW_DWPReservoirs)	5|5|5	5|5|5	5|5|5	5|5|5
73	ATW from Hyperion to LAAFP (AWT_OpNEXTLAAFP)	4|4|3	4|4|3	4|4|3	4|4|3
74	Minimum to be imported from MWD (IMP_MWDmin)	1|1|1	1|1|1	1|1|1	1|1|1
75	IMP_MWD	9|9|9	9|9|9	9|9|9	9|9|9
76	IMP_BlendImp	6|6|6	6|6|6	6|6|6	6|6|6
77	*Priority of Hyperion ATW uses*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
78	WBMWD sales (ATW_WB)	2|2|1	2|2|1	2|2|1	2|2|1
79	WC Sea barrier (WCSB) (ATW_STO_WCSB)	3|3|2	3|3|2	3|3|2	3|3|2
80	CB GW injection (LADWP) (ATW_GW_InjCBDWP)	4|4|3	4|4|3	4|4|3	4|4|3
81	Dependent Partening Opportunities (Ex. Santa Monica) (ATW_Partners)	5|5|5	5|5|5	5|5|5	5|5|5
82	SFB Injection (ATW_STO_SFB)	7|7|6	7|7|6	7|7|6	7|7|6
83	LADWP Reservoirs (ATW_STO_LAReservoirs)	6|6|8	6|6|8	6|6|8	6|6|8
84	LAAFP (ATW_LAAFP)	1|1|0	1|1|0	1|1|0	1|1|0
85	MWD Pure Water connection (ATW_MWDPure)	10|10|10	10|10|10	10|10|10	10|10|10
86	CB GW injection (WRD) (ATW_GW_InjCBWRD)	5|5|4	5|5|4	5|5|4	5|5|4
87	CB spreading in the Montebello Forebay (if available) (ATW_MontebFB)	11|11|11	11|11|11	11|11|11	11|11|11
88	GW Bank (if active) (ATW_LAAGWB)	12|12|12	12|12|12	12|12|12	12|12|12
89					
90	*MWD Imported Supplies*				
91	Maximum MWD Annual Supply (AFY)	400000	400000	400000	400000
92	Maximum flow of imported MWD supply (mgd)	1790	1790	1790	1790
93	*LAA GW Bank*				
94	Bank Utilization	deactivated	deactivated	deactivated	deactivated
95	Recharge Capacity	deactivated	deactivated	deactivated	deactivated
96	Max Storage (AF)	deactivated	deactivated	deactivated	deactivated
97	Extraction Capacity (mgd)	deactivated	deactivated	deactivated	deactivated
98	*Santa Monica Reservoirs*				
99	Location	No Use of reservoir	No Use of reservoir	No Use of reservoir	No Use of reservoir
100	Maximum Releases from Surface Water Reservoirs (MGD)	0	0	0	0
101	Initial Storage (AF)	0	0	0	0
102	*San Fernando Basin*	-	-	-	-
103	Max Basin Physical Storage (AF)	1,100,000	1,100,000	1,100,000	1,100,000
104	Initial Storage at simulation t=0 (AF)	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79

105	Initial Cumulative storage from 1920's zero overdraft reference, and -210,000 AF in 1954	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af
106	Max/Min judgement levels on cumulative storage since 1954 when the basin was recognize as being in a 210,000 AF overdraft	0/-360,000AF	0/-360,000AF	0/-360,000AF	0/-360,000AF
107	Variable San Fernando Basin Inflows OR Constant value	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant
108	Percentage Credit for previous Water Year Imported Water (this is active only if SFB inflows are set to variable)	20.8	20.8	20.8	20.8
109	Dynamic Priority, gives priority to use Bank's supply if close to be full	not active	not active	not active	not active
110	DCT credits	No DCT recharge	**Max 25 MGD (28,000 AFY)**	**Max 25 MGD (28,000 AFY)**	**Max 25 MGD (28,000 AFY)**
111	Max DCT credits, a function of wastewater flows available at DCT, recycled water demands from DCT and bypass of flows from DCT to Hyperion (AFY)	0	**28,000 AFY**	**28,000 AFY**	**28,000 AFY**
112	DCT bypass to Hyperion (MGD)	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	**9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 8**	**9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 9**	**9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 10**
113	LAG bypass to Hyperion (MGD)	3.8	3.8	3.8	3.8
114	SFB Recharge Capacity	No extra recharge than current operations	**Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October**	**Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October**	**Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October**
115	SFB Extraction Capacity (cfs)	130	**220**	**220**	**220**
116	Surplus LAA to SFB recharge	Not operational	Not operational	Not operational	Not operational
117	San Fernando Basin Extraction Logic	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries
118	If SFB extraction option (#117) is 1(function of LAA flows), Threshold annual volume to use SFB	Not active	Not active	Not active	Not active
119	If SFB extraction option (#117) is 1(function of LAA flows), Threshold LAA flow to use SFB	Not Active	Not Active	Not Active	Not Active
120	Fixed Maximum extraction, Annual limit in AFY if Extraction Logic # 117 is set to a fixed value	NA	NA	NA	NA
121	*Central Basin/WCB*	-	-	-	-
122	Max Storage (% of Basin Rights) maximum 1 year carryover	200%	200%	200%	200%
123	Max Extraction per Judgement (% of annual rights)	140% based on judgment value	**223% to match 37 mgd of extraction capacity**	**223% to match 37 mgd of extraction capacity**	**223% to match 37 mgd of extraction capacity**
124	Central Basin Well Extraction Capacity (MGD)	8.922	**TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed**	**TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed**	**TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed**
125	Max Central basin Demands (% of all demands). If this is more than 10,000 AFY it will reduce the minimum MWD imported water of 60,000 AFY	Historical CB pumping is close to 10,000 AFY or approximally 1.7% of total demands	**100%**	**100%**	**100%**
126	Hyperion ATW to Central Basin recharge switch	No Central Basin Recharge of OpNext Water	**ON**	**ON**	**ON**
127	*Pure Water*				
128	Hyperion opNext capacity to Pure Water MWD	0	**up to 150 MGD**	**up to 150 MGD**	**up to 150 MGD**
129	Pure Water Storage of OpNEXT	None	None	None	None
130	Max OpNEXT Storage Recharge	None	None	None	None
131	Return OpNEXT water to LA via PureWater	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water

Scenario1

Scenario 1 assumptions: 1.Current Trends Scenario: Adjusted
APPROACH 3

Input ID	ONAT scenario	Baseline Alternative	Approach 3 (DPR) F3_DPR_A7	F3_DPR_A8	F3_DPR_A9
	Demands and Wastewater		-		
0	Hydrology	July-1990 to end of June 2020	July-1990 to end of June 2026	July-1990 to end of June 2027	July-1990 to end of June 2028
1	LA Demands (AFY)	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent	Annual demands (2020 to 2050, constant afterwards)UWMP Equivalent
2	Demand Monthly Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
3	Indoor/outdoor Demand Pattern	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020	Pattern from UWMP 2020
4	Recycled Water Demand (AFY)	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP	Annual demands provided by LADWP
5	Recycled Water monthly pattern	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP	Opt#2- Based on historical data provided by LADWP
6	Annual Demand Multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier	No change, 1 multiplier
7	Monthly Demand Pattern	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns	Provided by LADWP based on historical patterns
8	Wastewater estimate independent variable to use	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery	Function of Potable Delivery
9	Fraction of the deliveries (potable/indoors) that comes back to wastewater plants	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage	Historical Correlation with Indoor usage
10	Residential GPCD	72.92	72.92	72.92	72.92
11	Wastewater Treatment Efficiency (Effluent/Influent)	0.95	0.95	0.95	0.95
12	AWT Efficiency (Effluent/Influent)	0.8456	0.8456	0.8456	0.8456
13	WW Adjustment (Monthly multiplier of the selected deliveries (indoor or total potable) selected on input #8	No multiplier	No multiplier	No multiplier	No multiplier
14	Recycled Water Demand Multiplier	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)	No Multiplier (1)
15	*WW Distribution (From UWMP 2020, fraction of total wastewater for each treatment plant)*				
16	DCTWRP	0.1012	0.1012	0.1012	0.1012
17	HWRP	0.8121	0.8121	0.8121	0.8121
18	LAGWRP	0.0405	0.0405	0.0405	0.0405
19	TIWRP	0.0462	0.0462	0.0462	0.0462
20	*Wastewater Plant tertiary production capacity (WW_tert_cap [mgd])*				
21	DCTWRP	80	80	80	80
22	HWRP	450	450	450	450
23	LAGWRP	20	20	20	20
24	TIWRP	30	30	30	30
25	**OpNEXT Controls**				
26	OpNEXT Start Date	7/1/2020	7/1/2020	7/1/2020	7/1/2020
27	Hyperion AWT Feed Capacity (MGD)	No OpNext	**230 MGD of produced water (Feed=230/efficiency)=270 MGD**	**230 MGD of produced water (Feed=230/efficiency)=270 MGD**	**230 MGD of produced water (Feed=230/efficiency)=270 MGD**
28	Schedule (Hyperion ATW production will follow a table schedule)	No Schedule	No Schedule	No Schedule	No Schedule
29	Conveyance Capacity from Hyperion to Storage and VNC (MGD)	0	**230**	**230**	**230**
30	Conveyance Capacity to PWSC connection (MGD)	0	**up to 150 mgd**	**up to 150 mgd**	**up to 150 mgd**
31	Hyperion deliveries to West Basin **MBR not ATW** (MGD)	0	0	0	0
34	LAAFP Blending Ratio Limit (RAW:AWT)	No Blending Ratio Limit	**No Blending Ratio, do as Sensitivity using 10:1**	**No Blending Ratio, do as Sensitivity using 10:1**	**No Blending Ratio, do as Sensitivity using 10:1**
	Conveyance from Hyperion to different destinations and related inputs				
32	Hyperion deliveries to West Basin **AWT** (going OUT of the system loop)	0	**40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)**	**40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)**	**40 mgd max (20 to 40 range) with monthly pattern (results in average 28.3mgd)**
36	Hyperion to West Coast Sea Barier (a fraction will go to WCB storage)				
37					
38	Hyperion to Central Basin **ATW** Injection capacity (MGD)	0	**Potential phased approach-Consider 37 MGD for the moment**	**Potential phased approach-Consider 37 MGD for the moment**	**Potential phased approach-Consider 37 MGD for the moment**
39					
40	Partners	No Partners	**WRD, Santa Monica or MWD, demands not defined yet**	**WRD, Santa Monica or MWD, demands not defined yet**	**WRD, Santa Monica or MWD, demands not defined yet**
41	Conveyance capacity from Hyperion to/out San Fernando Basin (subjected to injection/spreading capacity	No OpNext Connection, just current East Valley pipeline for DCT	**Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and OpNext, assume 25mgd is DCT, 55 mgd is OpNext. Use of Bull Creek Stormwater Capture 60" pipeline for up to 70 cfs to Pacoima in dry months only (based on spreading ground limitation, not conveyance which is 100 cfs)**	**Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and New conveyance (Max 84 MGD) for OpNex. Total 164 MGD potential to SFB, assume 25 mgd is for DCT/139 mgd to OpNext**	**Use of East Valley Pipeline max 80 MGD/124 cfs for DCT and New conveyance (Max 84 MGD) for OpNex. Total 164 MGD potential to SFB, assume 25 mgd is for DCT/139 mgd to OpNext**
42	Capacity to send to LA Reservoirs (lim to available capacity)	0	0	0	0
43	MWD Pure Water capacity (MGD)	0	**up to 150 MGD**	**up to 150 MGD**	**up to 150 MGD**
44	Injection in CB for WRD	0	0	0	0
45	OpNext to Montebello Forebay	0	0	0	0
46	LAA groundwater Bank	0	0	0	0
47	**Supplies and Supply Usage**				
48	*LAA Flows*				
49	Hydrology for LAA	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run	User defined Start for test runs, stochastic run with 100 realizations for final run
50	Start Year	1990	1990	1990	1990
51	Flows	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021	Historical LAA flows corrected for latest environmental requirements-Monthly Flows from January 1922 to December 2021
52	If LAA flows are above this value LADWP will override all priorities - Prioritize LAA if LAA flows are > than value (mgd)	9999	9999	9999	9999
53	*Minimum Supply amount to be used for Deliveries [af/yr]*				
54	San Fernando Basin Minimum Rights (GW_SFB1MinRights)	87000	87000	87000	87000
55	Central Basin Minimum Rights (GW_CB)	17236	17236	17236	17236
56	West Coast Basin Minimum Rights (GW_WCB)	1503	1503	1503	1503
57	Sylmar Minimum Rights (GW_Sylmar)	3570	3570	3570	3570
58	LAA groundwater Bank (GW_Antelope)	0	0	0	0
59	Los Angeles Aqueduct (SW_LAA)	0	0	0	0
60	Imported MWD (IMP_MWD)	60000	60000	60000	60000
61	*Priority of Supplies used to meet Potable Demands*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
61.5	San Fernando Remediation				
62	San Fernando Basic Rights (GW_SFB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
63	Central Basin/West Coast Basin Basic Rights (GW_CBWCB_BasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
64	Sylmar Basic Rights (GW_SylmarBasicRights)	3|3|4	3|3|4	3|3|4	3|3|4
65	San Fernando Stored credits (GW_SFB_StoCredits)	6|6|6	6|6|6	6|6|6	6|6|6
66	LAA groundwater Bank (GW_LAAGWB)	8|8|8	8|8|8	8|8|8	8|8|8
67	ATW from Hyperion stored in the San Fernando Basin (GW_SFB_Augm)	7|7|7	7|7|7	7|7|7	7|7|7
68	Use of SFB if no stored credits or OpNext storage is available (GW_SFB_Bank)	999|999|999	999|999|999	999|999|999	999|999|999
69	Los Angeles Aqueduct (SW_LAA)	2|2|2	2|2|2	2|2|2	2|2|2
70	ATW_WCSBarrier	6|6|6	6|6|6	6|6|6	6|6|6
71	ATW injection in Central Basin (ATW_InjectionCB)	6|6|6	6|6|6	6|6|6	6|6|6
72	ATW from Hyperion to LA Reservoirs (ATW_DWPReservoirs)	5|5|5	5|5|5	5|5|5	5|5|5
73	ATW from Hyperion to LAAFP (AWT_OpNEXTLAAFP)	4|4|3	4|4|3	4|4|3	4|4|3
74	Minimum to be imported from MWD (IMP_MWDmin)	1|1|1	1|1|1	1|1|1	1|1|1
75	IMP_MWD	9|9|9	9|9|9	9|9|9	9|9|9
76	IMP_BlendImp	6|6|6	6|6|6	6|6|6	6|6|6
77	*Priority of Hyperion ATW uses*	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet	Conventional|Multiple Dry|Wet
78	WBMWD sales (ATW_WB)	2|2|1	2|2|1	2|2|1	2|2|1
79	WC Sea barrier (WCSB) (ATW_STO_WCSB)	3|3|2	3|3|2	3|3|2	3|3|2
80	CB GW injection (LADWP) (ATW_GW_InjCBDWP)	4|4|3	4|4|3	4|4|3	4|4|3
81	Dependent Partening Opportunities (Ex. Santa Monica) (ATW_Partners)	5|5|5	5|5|5	5|5|5	5|5|5
82	SFB Injection (ATW_STO_SFB)	7|7|6	7|7|6	7|7|6	7|7|6
83	LADWP Reservoirs (ATW_STO_LAReservoirs)	6|6|8	6|6|8	6|6|8	6|6|8
84	LAAFP (ATW_LAAFP)	1|1|0	1|1|0	1|1|0	1|1|0
85	MWD Pure Water connection (ATW_MWDPure)	10|10|10	10|10|10	10|10|10	10|10|10
86	CB GW injection (WRD) (ATW_GW_InjCBWRD)	5|5|4	5|5|4	5|5|4	5|5|4
87	CB spreading in the Montebello Forebay (if available) (ATW_MontebFB)	11|11|11	11|11|11	11|11|11	11|11|11
88	GW Bank (if active) (ATW_LAAGWB)	12|12|12	12|12|12	12|12|12	12|12|12
89					
90	*MWD Imported Supplies*				
91	Maximum MWD Annual Supply (AFY)	400000	400000	400000	400000
92	Maximum flow of imported MWD supply (mgd)	1790	1790	1790	1790
93	*LAA GW Bank*				
94	Bank Utilization	deactivated	deactivated	deactivated	deactivated
95	Recharge Capacity	deactivated	deactivated	deactivated	deactivated
96	Max Storage (AF)	deactivated	deactivated	deactivated	deactivated
97	Extraction Capacity (mgd)	deactivated	deactivated	deactivated	deactivated
98	*Santa Monica Reservoirs*				
99	Location	No Use of reservoir	No Use of reservoir	No Use of reservoir	No Use of reservoir
100	Maximum Releases from Surface Water Reservoirs (MGD)	0	0	0	0
101	Initial Storage (AF)	0	0	0	0
102	*San Fernando Basin*	-	-	-	-
103	Max Basin Physical Storage (AF)	1,100,000	1,100,000	1,100,000	1,100,000
104	Initial Storage at simulation t=0 (AF)	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79	Assumes that 1920's zero cumulative overdraft = 1,100,000 AF, therefore initial storage = input #77+ input #79

105	Initial Cumulative storage from 1920's zero overdraft reference, and -210,000 AF in 1954	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af	Should be from ULARA report, current cumulative overdraft since -210,000 AF from 1954 - 7/1/1990= -486,196 af
106	Max/Min judgement levels on cumulative storage since 1954 when the basin was recognize as being in a 210,000 AF overdraft	0/-360,000AF	0/-360,000AF	0/-360,000AF	0/-360,000AF
107	Variable San Fernando Basin Inflows OR Constant value	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant	89,000 AFY constant
108	Percentage Credit for previous Water Year Imported Water (this is active only if SFB inflows are set to variable)	20.8	20.8	20.8	20.8
109	Dynamic Priority, gives priority to use Bank's supply if close to be full	not active	not active	not active	not active
110	DCT credits	No DCT recharge	**Max 25 MGD (28,000 AFY)**	**Max 25 MGD (28,000 AFY)**	**Max 25 MGD (28,000 AFY)**
111	Max DCT credits, a function of wastewater flows available at DCT, recycled water demands from DCT and bypass of flows from DCT to Hyperion (AFY)	0	**28,000 AFY**	**28,000 AFY**	**28,000 AFY**
112	DCT bypass to Hyperion (MGD)	9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 4	**9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 11**	**9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 12**	**9.43 mgd Based on Section 1.3.5 and Baseline assumptions from the Hyperion Flow Projections Update Dec 2023 report provided Jan 13**
113	LAG bypass to Hyperion (MGD)	3.8	3.8	3.8	3.8
114	SFB Recharge Capacity	No extra recharge than current operations	**Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October**	**Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October**	**Layer2-Spreading-130 cfs from April until end of October plus Injection - 50 mgd (77.36 cfs) all year plus 23 cfs for Stormwater Parks from April throughout October**
115	SFB Extraction Capacity (cfs)	130	**220**	**220**	**220**
116	Surplus LAA to SFB recharge	Not operational	Not operational	Not operational	Not operational
117	San Fernando Basin Extraction Logic	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries	Option2-Max extractions are also driven by regulatory Max/Min boundaries
118	If SFB extraction option (#117) is 1(function of LAA flows), Threshold annual volume to use SFB	Not active	Not active	Not active	Not active
119	If SFB extraction option (#117) is 1(function of LAA flows), Threshold LAA flow to use SFB	Not Active	Not Active	Not Active	Not Active
120	Fixed Maximum extraction, Annual limit in AFY if Extraction Logic # 117 is set to a fixed value	NA	NA	NA	NA
121	*Central Basin/WCB*	-	-	-	-
122	Max Storage (% of Basin Rights) maximum 1 year carryover	200%	200%	200%	200%
123	Max Extraction per Judgement (% of annual rights)	140% based on judgment value	**223% to match 37 mgd of extraction capacity**	**223% to match 37 mgd of extraction capacity**	**223% to match 37 mgd of extraction capacity**
124	Central Basin Well Extraction Capacity (MGD)	8.922	**TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed**	**TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed**	**TBD-Phasing might be implemented consider 37 mgd for now, equivalent to all phases completed**
125	Max Central basin Demands (% of all demands). If this is more than 10,000 AFY it will reduce the minimum MWD imported water of 60,000 AFY	Historical CB pumping is close to 10,000 AFY or approximally 1.7% of total demands	**100%**	**100%**	**100%**
126	Hyperion ATW to Central Basin recharge switch	No Central Basin Recharge of OpNext Water	**ON**	**ON**	**ON**
127	*Pure Water*				
128	Hyperion opNext capacity to Pure Water MWD	0	**up to 150 MGD**	**up to 150 MGD**	**up to 150 MGD**
129	Pure Water Storage of OpNEXT	None	None	None	None
130	Max OpNEXT Storage Recharge	None	None	None	None
131	Return OpNEXT water to LA via PureWater	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water	Yes to keep accounting of how much LADWP could have used of Pure water

Attachment B
February 2024 Operation NEXT Analysis Tool Results

Figure B-1 summarizes the February 2024 Operation NEXT Assessment Tool (ONAT) results for average purified water flows estimated to be produced from the Advanced Water Purification Facility (AWPF) over 30 years of model simulation. The losses component on Figure B-1 are the waste streams, assuming 85% recovery through the AWPF. The unused advanced treated recycled water (ATRW) component on Figure B-1 reflects purified water produced and not used either for demands or storage.

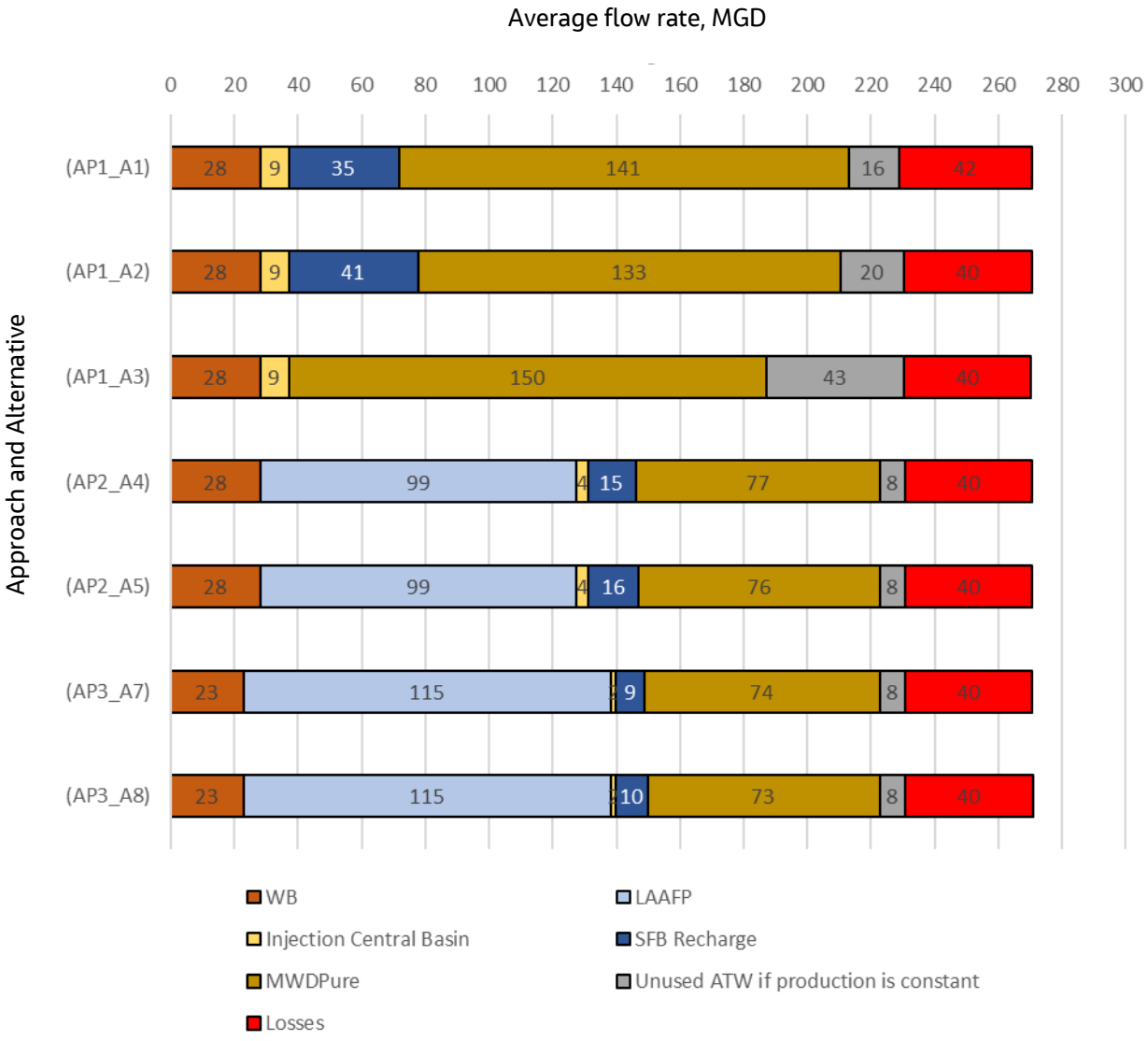


Figure B-1. AWPF Average Flow Over 30 Years of Model Simulation

Figure B-2 summarizes the February 2024 ONAT results for the percentage of average purified water flows estimated to be produced from the AWPF and used by each delivery location over 30 years of model simulation.

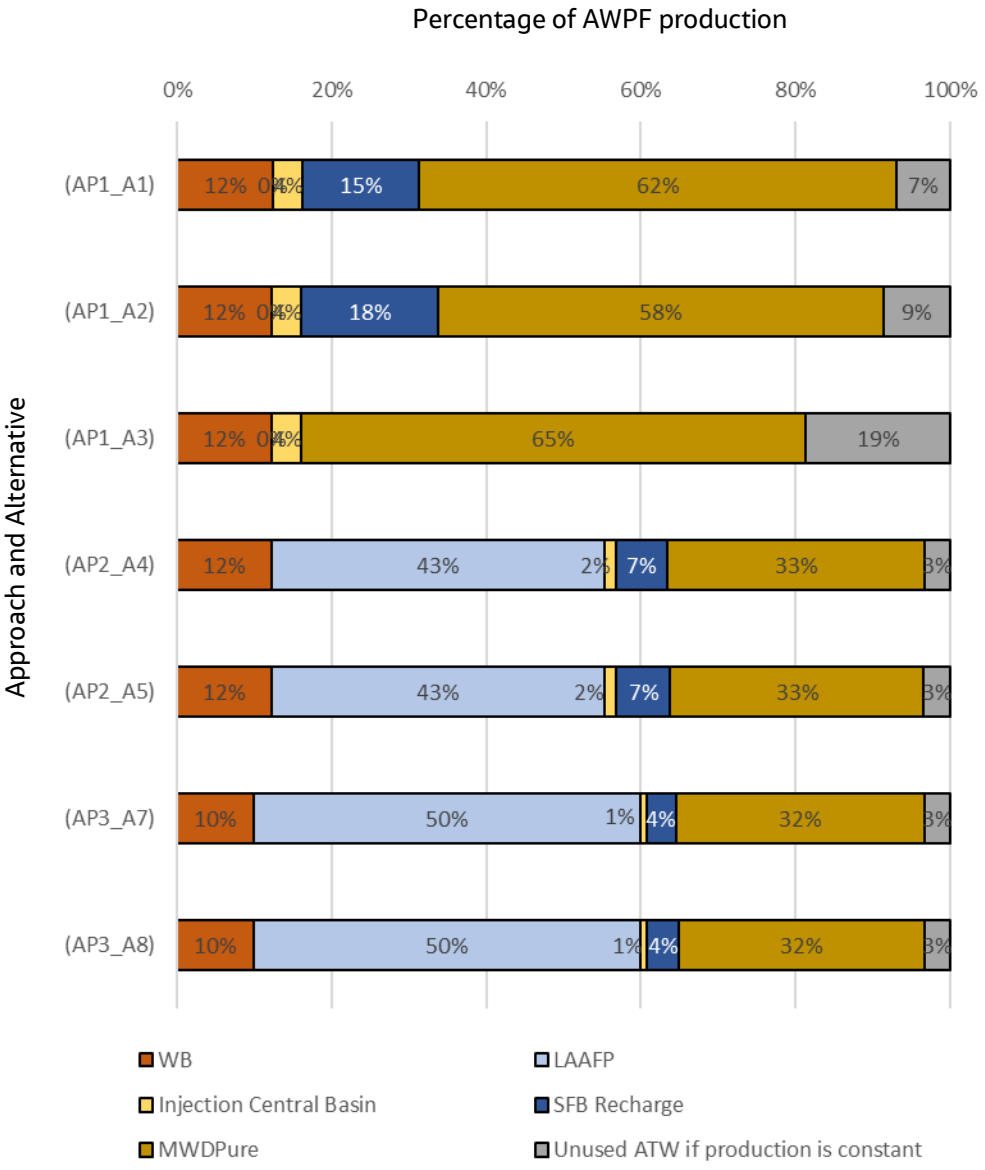


Figure B-2. AWPF Usage Percentage of AWPF Production

Figure B-3 summarizes the February 2024 ONAT results for the percentage of average purified water flows estimated to be produced from the AWPF and used by the City of Los Angeles and regional Partners over 30 years of model simulation. Due to rounding, totals may not add up exactly to 100%.

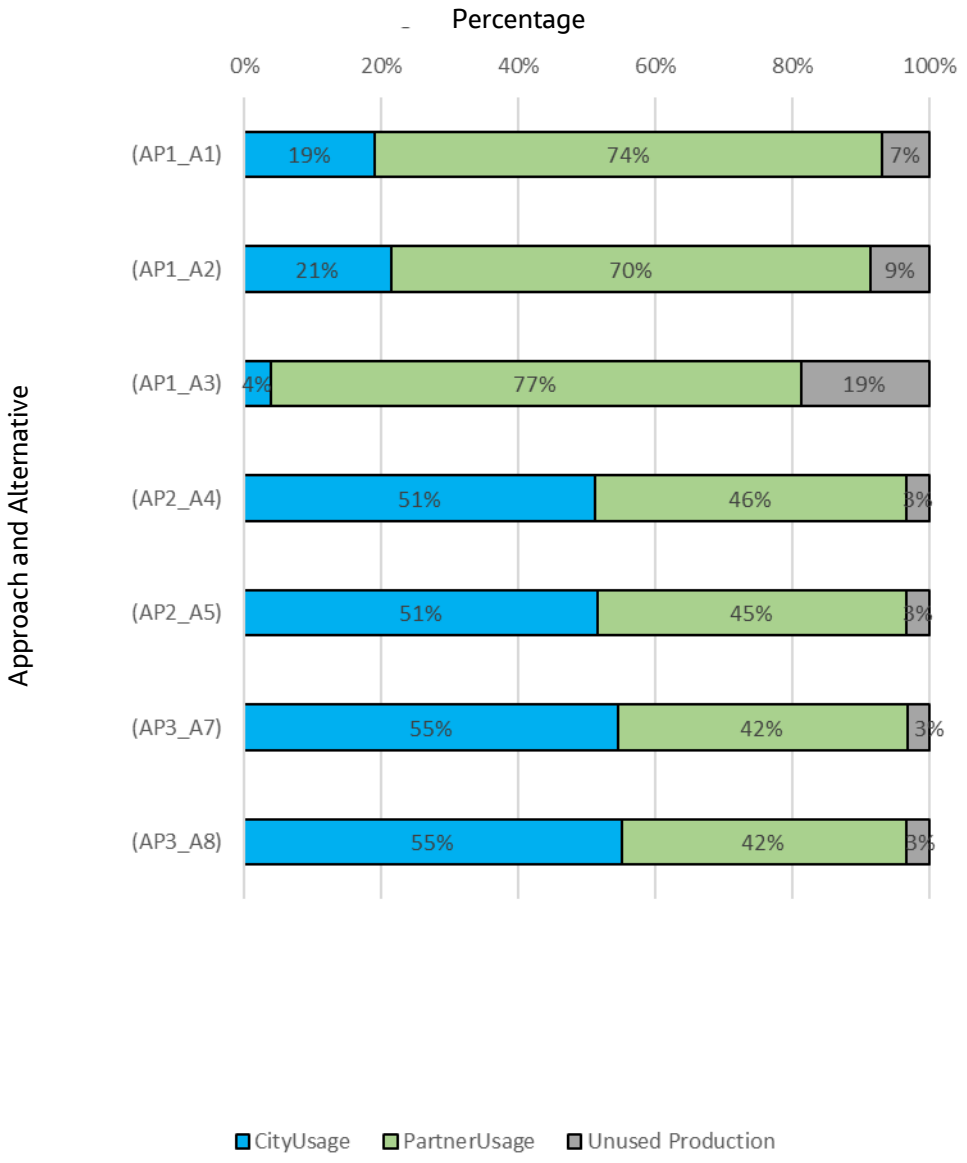


Figure B-3. City and Partners' Usage Percentage of AWPF Production

Operation NEXT Assessment Tool Results TM

Operation NEXT Assessment Tool Results Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
December 20, 2024

Executive Summary

This technical memorandum (TM) complements the *Operation NEXT Assessment Tool Summary Description* TM (Jacobs 2024a), which provided the assumptions used for the Operation NEXT Assessment Tool (ONAT) model. This TM briefly summarizes the modeling assumptions and focuses on the main findings.

ONAT modeling was completed for alternatives that were shortlisted during the March 26, 2024. workshop (Arcadis and Jacobs 2024). These included alternatives in Approach II (Alternatives 4, 5, and 6) and Approach III (Alternatives 7, 8, and 9), shown on Figure ES-1. Approaches II and III have different locations of direct potable reuse (DPR) production and different water production limitations. Alternative 6 has the same ONAT model flow inputs and outputs as Alternative 5, with different physical pipeline routing. Similarly, Alternatives 8 and 9 only vary in pipeline alignment and have the same ONAT model flow inputs and outputs. Based on those similarities, this TM provides results for Alternatives 4, 5, 7, and 8.

Treatment Framework	Alternative Definition
Approach II (IPR and DPR) DPR treatment at VNC - IPR treatment at AWPF, with post-AWPF DPR treatment at VNC	Alternative 4. Sepulveda Alignment to VNC with limited flow to SFB through 54-inch diameter East Valley pipeline*
	Alternative 5. Cahuenga Alignment to VNC with full flow to SFB through alignment*
	Alternative 6. Griffith Park Alignment to VNC with full flow to SFB through alignment (modeling is same as Cahuenga)
Approach III (DPR) Full DPR treatment at AWPF	Alternative 7. Sepulveda Alignment to VNC with limited flow to SFB through 54-inch diameter East Valley pipeline**
	Alternative 8. Cahuenga Alignment to VNC with full flow to SFB through alignment**
	Alternative 9. Griffith Park Alignment to VNC with full flow to SFB through alignment (modeling is same as Cahuenga)

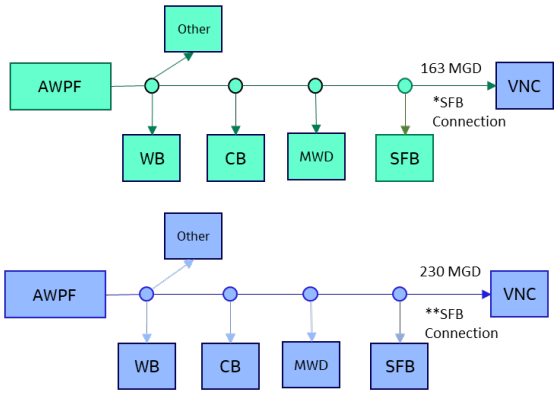


Figure ES-1. Approaches and Alternatives.

Model Inputs and Planning Scenarios

The model results are based on the best estimates of future Los Angeles Aqueduct (LAA) flows from historical data, various combinations of City of Los Angeles (City) system demand projections, and different Pure Water Los Angeles Program (Program) alternative options. The primary model drivers and sources of uncertainty are LAA flows and City demands.

The modeling scenarios use the best estimates of future LAA flows, provided by the Los Angeles Department of Water and Power (LADWP). These estimates are derived from historical data from April 1922 to March 2024. LADWP adjusted the LAA flow estimates to reflect current flow restrictions, which have been changed over time since 1922, and the resulting values are referred to as LAA-adjusted historical flow estimates.

Five demand scenarios were modeled to evaluate a range of possible future demands:

1. Initial – Based on LADWP's 2020 Urban Water Management Plan (UWMP 2020) estimates.
2. High – Based on UWMP 2020 (Southern California Association of Governments SCAG 2016) projections and static water use efficiency estimates.
3. Mid – Assumes no growth from the City's 2020 population and no change in per capita water usage.
4. Low1 – Uses small decreases in the City's population and the achievement of legislative residential indoor water use efficiency targets.
5. Low2 – Uses larger decreases in population and more efficient water use assumptions beyond current residential indoor use targets.

Model Results

Model results are presented at full Program buildout. As a new water supply source for the City's water supply portfolio, the Program would make the City's water supply system more resilient. The model results discussed in this TM are estimates based on the latest assumptions and are subject to change in the future.

Potential changes in the water supply portfolio are estimated from a future system without Pure Water Los Angeles as compared to a future system with Pure Water Los Angeles. For this example, Alternative 4 was modeled at both the Initial demand scenario and the Low2 demand scenario in a future system with Pure Water Los Angeles, as summarized on Figure ES-2, resulting in the following observations from the modeling:

- LAA supply may stay approximately the same, from 40% without the Program to between 40 and 42% of the City demands with the Program, depending on the demand scenario.
- Metropolitan Water District of Southern California (Metropolitan)-imported water may be reduced from 32% without the Program to between 12 and 14% of the City demands with Pure Water Los Angeles.
- Groundwater supply utilization may stay approximately the same, from 25 to 33% of the water supply portfolio without the Program to between 22 and 29% of the City demands with the Program.
- Non-potable recycled water use may stay approximately the same, from 3 to 5% of the City demands with or without the Program.
- The Program, which may use DPR and indirect potable reuse (IPR), will supply between 12 and 21% of the City demands, depending on the demand scenario.

These potential water supply portfolio changes are based on model runs using Alternative 4 and Initial and Low2 demand scenarios; thus, findings may vary when using other alternatives and demand scenarios.

There are two sets of plots included on Figure ES-2. The upper pie charts are based on an Initial demand scenario. The chart on the left is a future system without Pure Water Los Angeles as compared to the upper right pie chart in a future system modeled with Pure Water Los Angeles, using Alternative 4 as the modeled example. The lower pie charts are based on the Low2 demand scenario. Similar to the upper pie charts, the chart on the left is a future system without Pure Water Los Angeles as compared to the upper right pie chart in a future system with Pure Water Los Angeles. These two sets of plots, one at an Initial demand scenario and the other at the lowest-demand scenario, show the modeled supply portfolio differences in a future system with and without Pure Water Los Angeles.

While current groundwater supply utilization represents approximately 10% of LADWP's supply portfolio, in the future, additional groundwater utilization is expected to increase based on projected increased remediation pumping in San Fernando Basin (SFB) and system improvements in the Harbor Area.

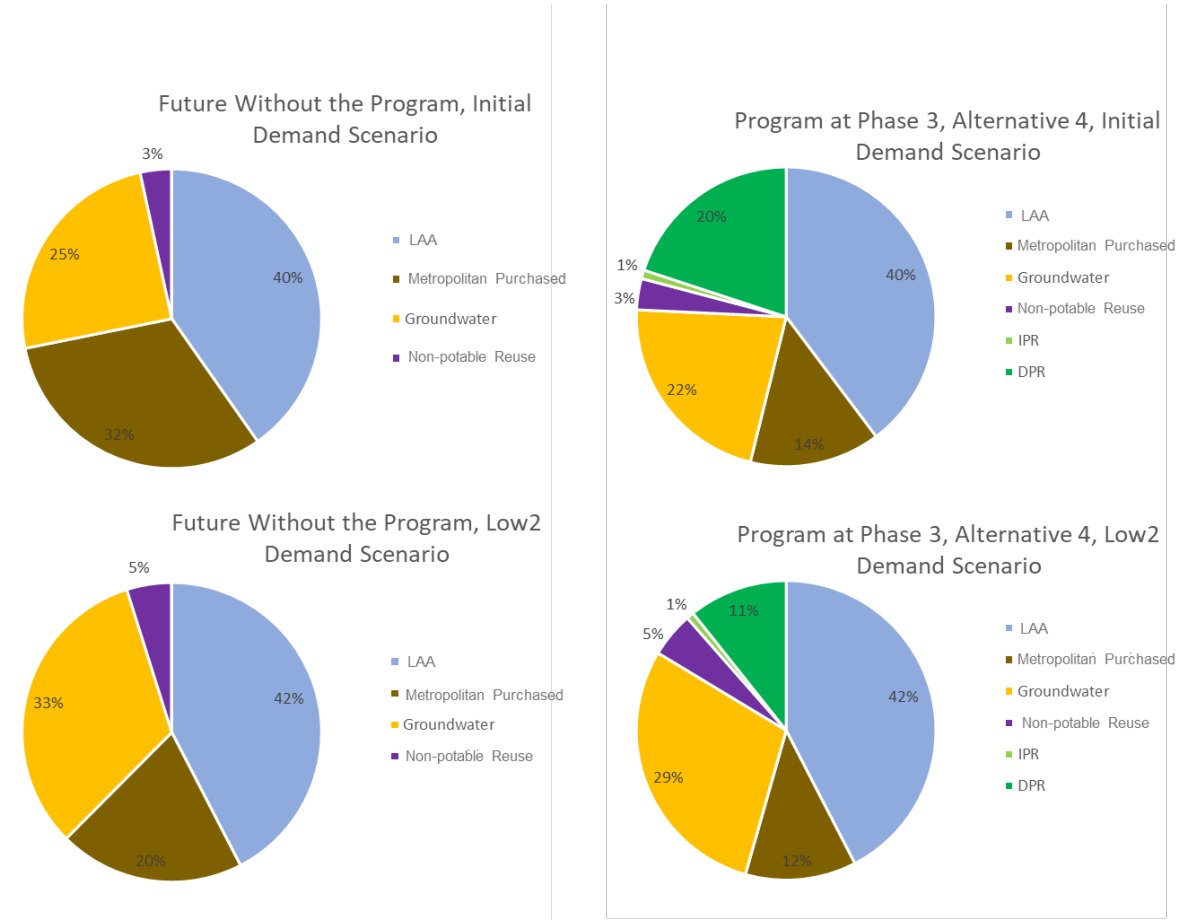
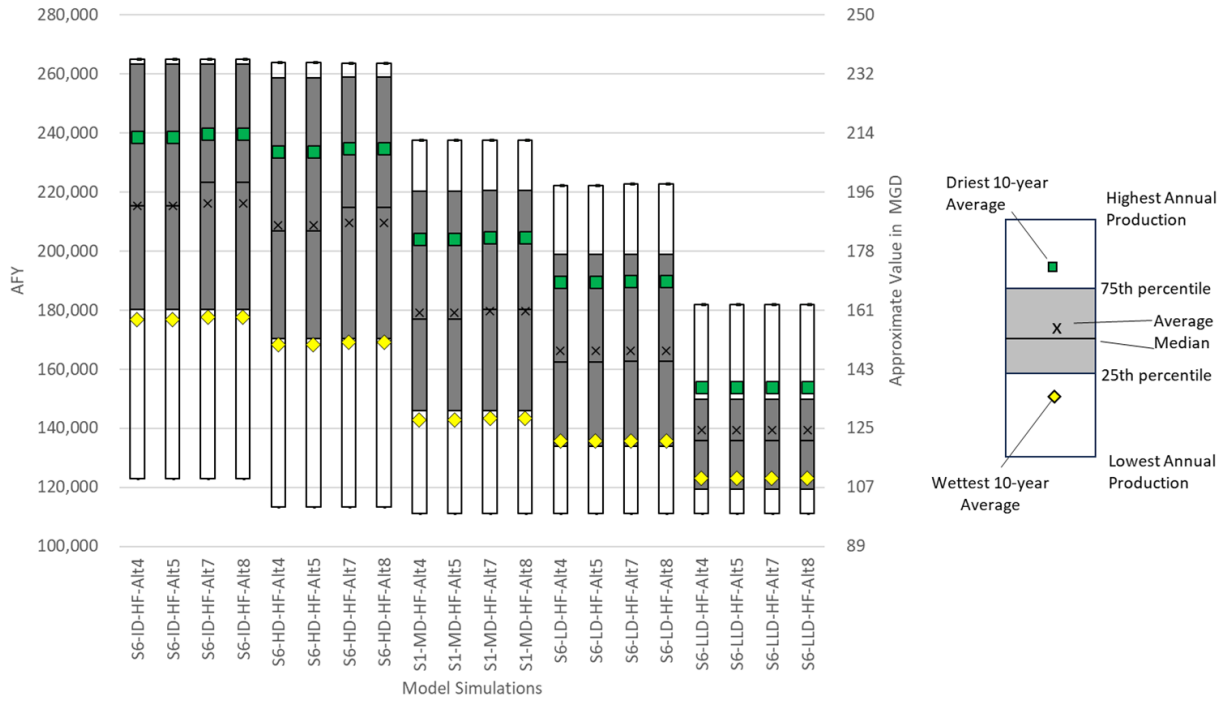


Figure ES-2. Modeled Future LADWP Water Supply Portfolio With and Without Pure Water Los Angeles, Phase 3.

Figure ES-3 summarizes Program production for all the model simulations that use LAA-adjusted historical flows. The x-axis shows the model simulations. The box plot charts show the substantial production variances that could be expected based on the current variability of LAA flows, system demands, and preference for current water supply priorities to meet system demands. The figure shows a minimum demand of approximately 112,000 AFY (approximately 155 cubic feet per second [cfs] or 100 million gallons per day [MGD]) based on constant demands assumed for West Basin (WB), Water Replenishment District of Southern California (WRD), and Metropolitan's Pure Water Southern California (PWSC). Average production can vary from 139,000 AFY (192 cfs [124 MGD]) to 216,000 AFY (298 cfs [193 MGD]), depending on future City demand projections.

Program production can vary significantly based on annual LAA runoff conditions and seasonal variability. The variation of the average Program production can be approximately 78,000 AFY (108 cfs [70 MGD]). Seasonal variations in production are also notable; on average, the difference between the highest and lowest production seasons is approximately 56 cfs (36 MGD). Peak summer demands do not necessarily align with peak Program production because there are high LAA flows during the summer months, creating a seasonal offset where the highest production occurs in spring and lowest production in fall.



Some simulations exceed 260,051 AFY (232 MGD of AWPF capacity) due to MBR demands that are not subjected to the AWPF treatment capacity limitation of 232 MGD (production water)

Figure ES-3. Fiscal Year Annual Program Production at Phase 3 for Various Model Scenarios.

Important findings related to advanced treated recycled water (ATRW) production from the Advanced Water Purification Facility (AWPF) include:

- Each approach and alternative under same system demand conditions produce similar results for AWPF production.
- In the near term (until approximately year 2048 before DPR is implemented), a significant volume of ATRW is used to recharge SFB. After that, for the long-term, production is used at Los Angeles Aqueduct Filtration Plant (LAAFP), with the LAAFP use continuing through the modeling time series that was considered.
- The variability of wet, normal, and dry LAA flow conditions, paired with demand uncertainties is a major driver for variations in AWPF production rates.
- The system uses the Metropolitan PWSC connection less frequently during dry periods and high-demand conditions but could use its entire 73 cfs (47 MGD) potential capacity during wet periods and low-demand conditions, assuming Metropolitan also has the capacity for the water.

Important findings related to the Program as a new water supply to the City include:

- There is near-term use of ATRW delivery for IPR in SFB and Central Basin (CB) (until approximately 2048 before DPR implementation), and then the additional delivery to the LAAFP for DPR for the long-term.
- The long-term use of Metropolitan-purchased imported water reduces from approximately 32% to between 12 and 14% of the entire system demands.
- It is important to balance Program ATRW usage with use of existing groundwater rights.

Important findings related to the system storage include:

- Under the current set of assumptions, CB and SFB may fill up based on water supply prioritization, as well as increases in recharge with the Program and current stormwater improvement projects (Figure ES-4)
- Water storage opportunities within the region could be valuable to optimize the Program ATRW supply and should be further considered.

Figure ES-4 shows a time series of the average annual Program production, and estimates demands for the produced ATRW flows when incorporating Program phasing at the time of writing this TM. It provides the LAA runoff year type (wet, normal, or dry) for the Alternative 4 Mid-demand scenario. The following traits are common across each model run:

- A high correlation between potential idle production flows and wet LAA years
- A minimum production around 155 cfs (100 MGD) after 2054 (once all projects are in place), depending on partners, such as WB, Water Replenishment District of Southern California (WRD), and Metropolitan, with dependence on Metropolitan as a demand to take ATRW flows during wet years
- High LAAFP demands for Program production during dry years
- High use of SFB recharge during the initial project phases until the SFB groundwater basin reaches full capacity
- Idle capacity and idle production up to 77 cfs (50 MGD) is observed across all simulations between 40 and 85% of the time, depending on the demand scenario and LAA flow conditions

Assuming a 272 MGD intake capacity, Table ES-1 shows the resulting percentage of time that the treatment system is simulated to be idle at a given amount, between 25 MGD and 100 MGD. This represents a full range of model scenarios and alternative runs for both minimum and maximum conditions. The total idle amount consists of two parts: idle capacity, where available wastewater to treat is lower than the Program's plant capacity, and idle production, where available Program output is higher than available demands to utilize the treated water. For example, the table shows that the treatment system could experience 50 MGD of idle capacity plus idle production between 40 and 85% of the time. The 40% idle time corresponds to high system demand conditions, while the 85% idle time corresponds to low system demand conditions. All values shown are based on the model assumptions and prioritization described in this TM.

Table ES-1. Idle Capacity plus Production Percentage Across All Demand Scenarios and Alternatives

	Idle Capacity + Production, % of the Time			
Demands Scenarios at Different Influent Flows	25 MGD	50 MGD	75 MGD	100 MGD
Minimum (Scenarios with High Demand)	49	40	33	26
Maximum (Scenarios with Low Demand)	88	85	68	60

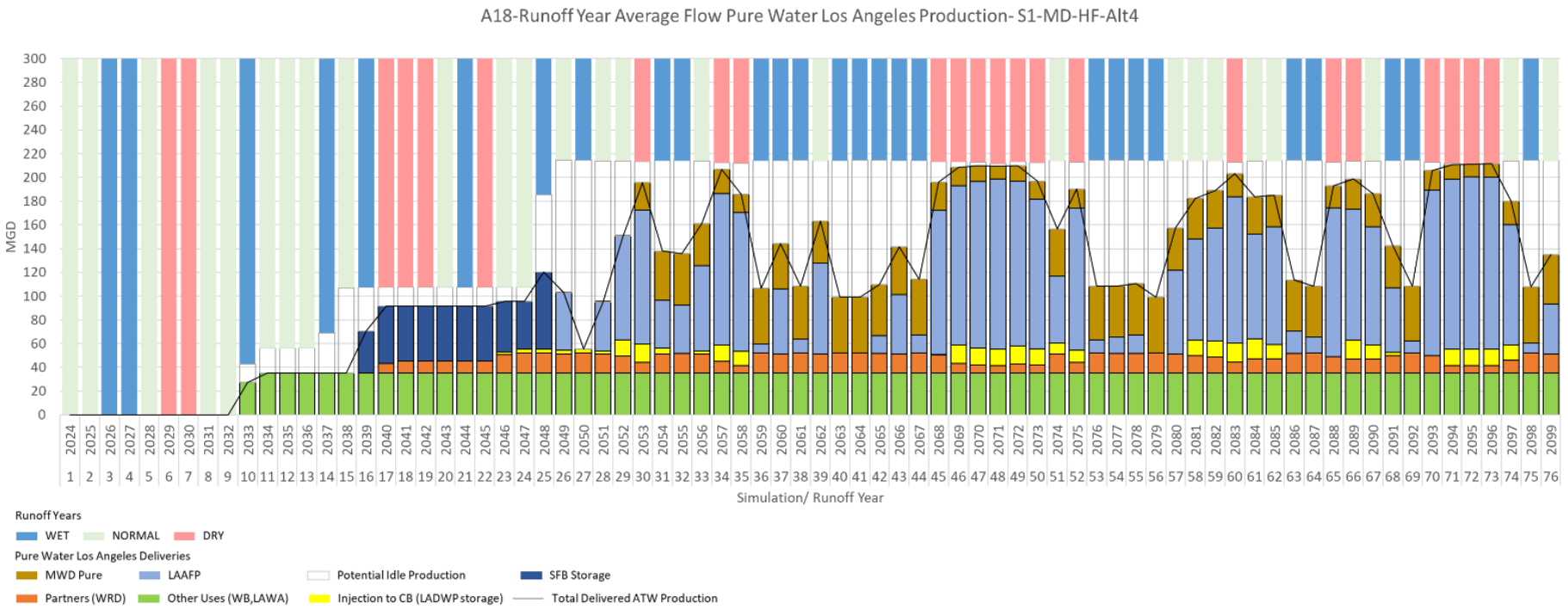


Figure ES-4. Annual Average Pure Water Los Angeles Production.

The ONAT model shows that the Program significantly reduces wastewater discharges to the ocean and enhances system resiliency by providing a useful new water supply for LADWP. Based on the model results, the Program can be refined related to the volumes and priorities of the existing water supply portfolio. The ONAT results can be used to support this discussion and offer insights into various Program strategies that can be tested to help the entire system balance resiliency, the use of current supplies, and sizing of the overall Program. As potential next steps, future ONAT modeling could include:

- Testing strategies that comprehensively characterize uncertainties beyond LAA flows. The main uncertainties include:
  - SFB recharge projections
  - SFB stormwater capture
  - Demand projections
  - Phasing and size of the Program
- Adding model rules so Program production could be turned on and off based on LAA forecasts, estimating when the plant would be operational, and testing the benefits of a forecasted approach; it is also important to determine the size of demand and storage needed to accommodate seasonal variability of LAA flows, emphasizing the importance of finding a steady demand for Program flows
- Running model simulations with baseline Program flows as a higher supply priority, and conducting more robust stochastic model analyses

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A Microsoft Excel File with Model Outputs (electronic file)
B Idle Capacity and Idle Production Metrics

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Acronyms and Abbreviations

AF	acre-foot (feet)
AFY	acre-foot (feet) per year
ATRW	advanced treated recycled water
AWPF	Advanced Water Purification Facility
CB	Central Basin
City	City of Los Angeles
cfs	cubic foot (feet) per second
DPR	direct potable reuse
gpcd	gallon(s) per capita per day
HWRP	Hyperion Water Reclamation Plant
IPR	indirect potable reuse
LAA	Los Angeles Aqueduct
LAAFP	Los Angeles Aqueduct Filtration Plant
LADWP	Los Angeles Department of Water and Power
LAR	Los Angeles Reservoir
Metropolitan	Metropolitan Water District of Southern California
MGD	million gallons per day
MP	Operation NEXT Master Plan
No.	number
NPR	non-potable recycled
ONAT	Operation NEXT Assessment Tool
Program	Pure Water Los Angeles Program
PWSC	Pure Water Southern California Program
RO	reverse osmosis
RWA	raw water augmentation
SFB	San Fernando Basin
TM	technical memorandum
UCLA	University of California, Los Angeles
ULARA	Upper Los Angeles River Area Watermaster
UWMP	2020 Urban Water Management Plan

VNC	Van Norman Complex
WCB	West Coast Basin
WRD	Water Replenishment Water District of Southern California
WRP	water reclamation plant
WTP	Water Treatment Plant

1. Introduction

Jacobs has developed a modeling tool to help evaluate alternatives for the Pure Water Los Angeles Program (Program) Master Plan (MP). Pure Water Los Angeles was formerly known as the Operation NEXT Water Supply Program. The Operation NEXT Assessment Tool (ONAT) was developed with the GoldSim platform, a dynamic, probabilistic simulation systems model platform that allows users to (GoldSim Technology Group 2024):

- Efficiently assess multiple Program options.
- Develop initial sizing estimates for Program infrastructure based on projected hydrological and storage and demand conditions.

ONAT incorporates and evaluates options to store and supply advanced treated recycled water (ATRW), including:

- Groundwater recharge
- Regional partnerships
- Direct potable reuse (DPR) through raw water augmentation (RWA)

ONAT also considers City of Los Angeles' (City's) other water supplies and system demands.

ONAT was developed to support the following tasks:

- Identify infrastructure needs, facility sizing, and related broad operational parameters; and evaluate and recommend facility improvements.
- Analyze alternatives, including:
  - Simulate Program facilities and the operations of various alternatives.
  - Support alternative development and refinements through an iterative process.
  - Inform integration aspects of Program with the existing Los Angeles Department of Water and Power (LADWP) water system.
  - Help demonstrate Program benefits.
  - Identify flows, conveyance limits, and groundwater storage operations and limits.
- Explore Program-related hazard scenarios, impacts, and benefits.
- Integrate resiliency and economic analysis with the University of California, Los Angeles (UCLA) Resiliency Benefits Study (Chow 2024).
- Identify vulnerabilities and resilience strategies for the Program and its related facilities.

This version of ONAT does not include any cost information or energy usage information for different Program alternative configurations.

This technical memorandum (TM) summarizes the ONAT model results related to the screened shortlist of Program alternatives described in the *Program Alternatives Screening* TM (Arcadis 2024) and Sections 4 and 5 of the *Pure Water Los Angeles Master Plan Report* (Jacobs 2024b).

2. Model Overview

This section provides an overview of the model, including its structure, outputs, and metrics, and the planning scenarios that informed its calibration.

2.1 Model Structure

The main model structure consists of five components (Figure 2-1):

- Los Angeles Aqueduct (LAA) Flows: The flows have a strong impact on model results because it is the main supply source for the City but could vary significantly, both monthly and annually
- Other LADWP Water Supplies and Priorities: These include groundwater, Metropolitan Water District of Southern California (Metropolitan)-imported, and non-potable supplies
- System Demands: All City water LADWP is responsible to supply, including potable and non-potable, and indoor and outdoor
- System Operation: Limitations on how the water can be delivered to the system based on overall system capacities and operational rules
- Program Treatment Capacity and Prioritization of Production: Estimated Program production capacity and logic in the model to allocate that to meet various Program demands

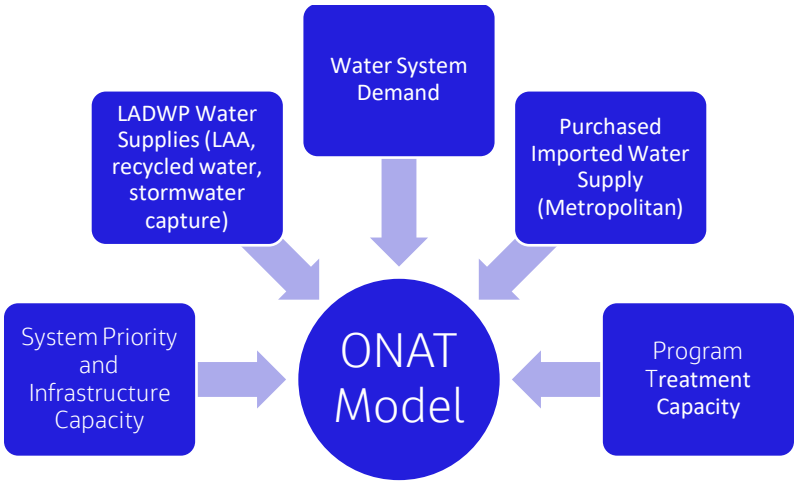


Figure 2-1. Overall Operation NEXT Assessment Tool Model Components.

The ONAT model is a closed-loop system, so the amount of wastewater available for Program production, which also supplies system demands, is based on the amount of wastewater largely generated by water delivered to meet system demands. An extreme shortage of water system demands can impact wastewater flows, which will, in turn, affect Program production. The prioritization of LADWP's supplies and its production is an important input to the model simulations.

2.2 Prioritization of LADWP Supplies and Program Supplies

As described in the *Operation NEXT Assessment Tool Summary Description* TM (Jacobs 2024a), the City has four main historical water supplies available to meet water use demands:

- LAA water supply
- Groundwater from San Fernando Basin (SFB), Central Basin (CB), and West Coast Basin (WCB)
- Water purchased and imported from Metropolitan Water District of Southern California (Metropolitan)
- Non-potable recycled (NPR) water (to offset potable demands)

LADWP developed a priority list for the intent of modeling how these supplies will be used to meet its potable water demands in normal, dry, and wet years (Figure 2-2).

- The highest-priority supply is the projected minimum purchases from Metropolitan to serve LADWP service areas that are not connected to other supplies, and minimum groundwater extraction from SFB using projections from current basin remediation programs.
- The next-highest-priority supply is from LAA.

The priorities are the same for normal and dry years. They change in wet years, when Program supplies through the Los Angeles Aqueduct Filtration Plant (LAAFP) as DPR resources take priority over existing groundwater rights. This is accounting for the fact that during wet years, in general, well operation is scaled down or turned off.

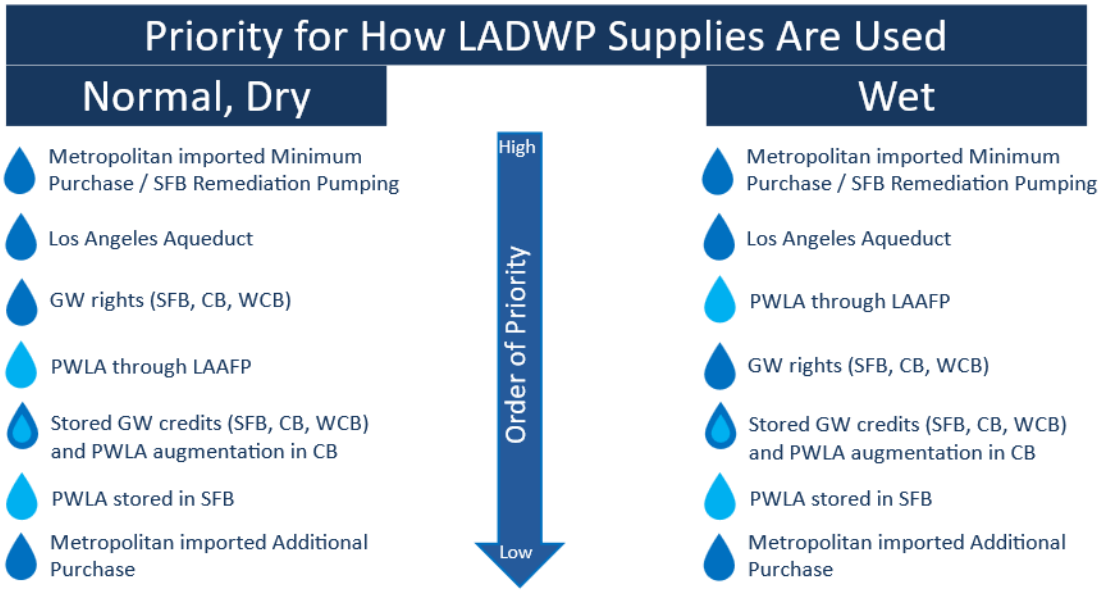


Figure 2-2. LADWP Water Supplies and Prioritization.

The ONAT results indicate that in extreme wet years, the following sources can meet all of LADWP's potable water demands:

- Metropolitan minimum purchases
- Minimum groundwater extractions
- Non-potable deliveries
- LAA supply

Based on historical records, the average future monthly LAA flow is estimated to be 19,800 acre-feet (AF) per month. Historical records range from 0 (April 2013 and April 2014) to 42,800 AF per month (January 1983).

The ONAT model results are intended solely for illustrative purposes. These results have been generated based on assumptions available at the time of development. Projections in this document do not reflect any commitment by LADWP to a future supply portfolio, supply proportions, operations, or strategy. Nothing in this document should be construed as an intent or agreement to future purchases or limits. Results are hypothetical only and subject to change by LADWP.

Using the model results, Figure 2-3 shows how the City could meet modeled future demands using its different existing supplies if the extreme wet historical LAA flow sequence observed between 1981 and

1985 would repeat itself. Those existing supplies include LAA, groundwater, non-potable, and Metropolitan-imported water. The total demands line on Figure 2-3 corresponds to one of the highest demand projections estimated in the model scenarios. The figure shows that LAA flows can be a major contributor to fulfill system demands and, during winter months, could theoretically supply the entire system demands (January and February 2064 of simulation months).

Figure 2-4 shows the opposite condition; that is, system demands exposed to extreme prolonged dry conditions, when LAA flows dropped to less than 20,000 AF some months and close to 0 during other months. Under these conditions, LADWP would have to rely heavily on imported supplies to meet all its demands.

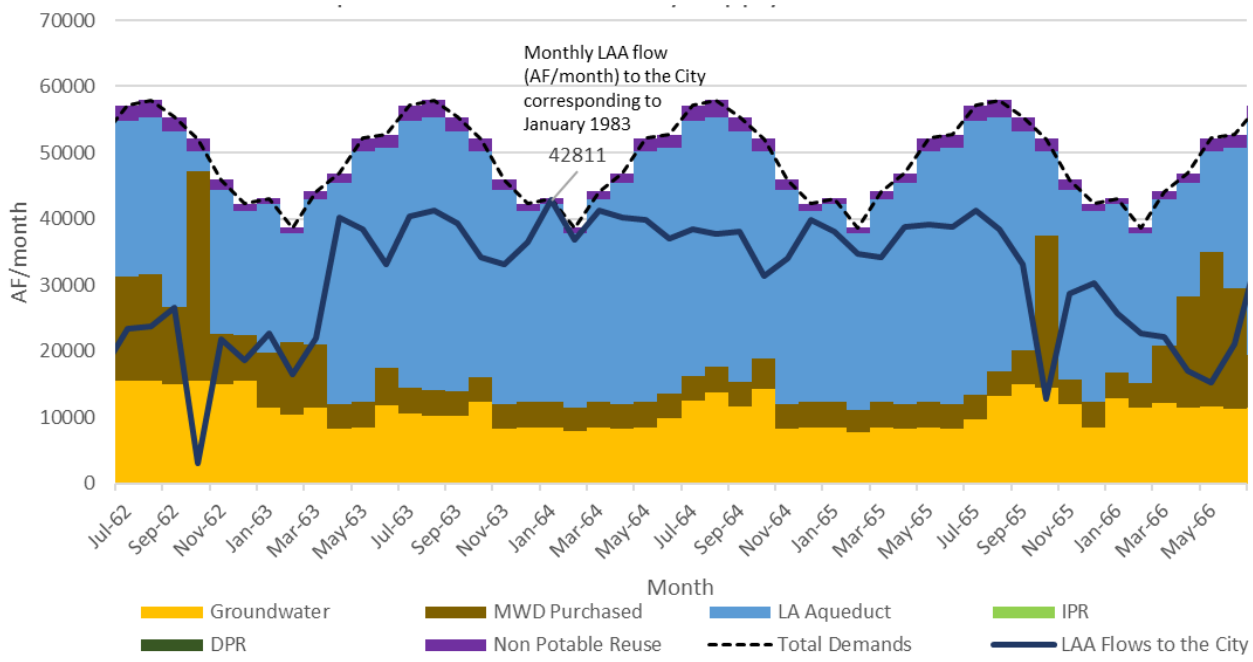


Figure 2-3. How Monthly Supplies Could Be Delivered to Future Demands Under Wet Conditions Without the Program.

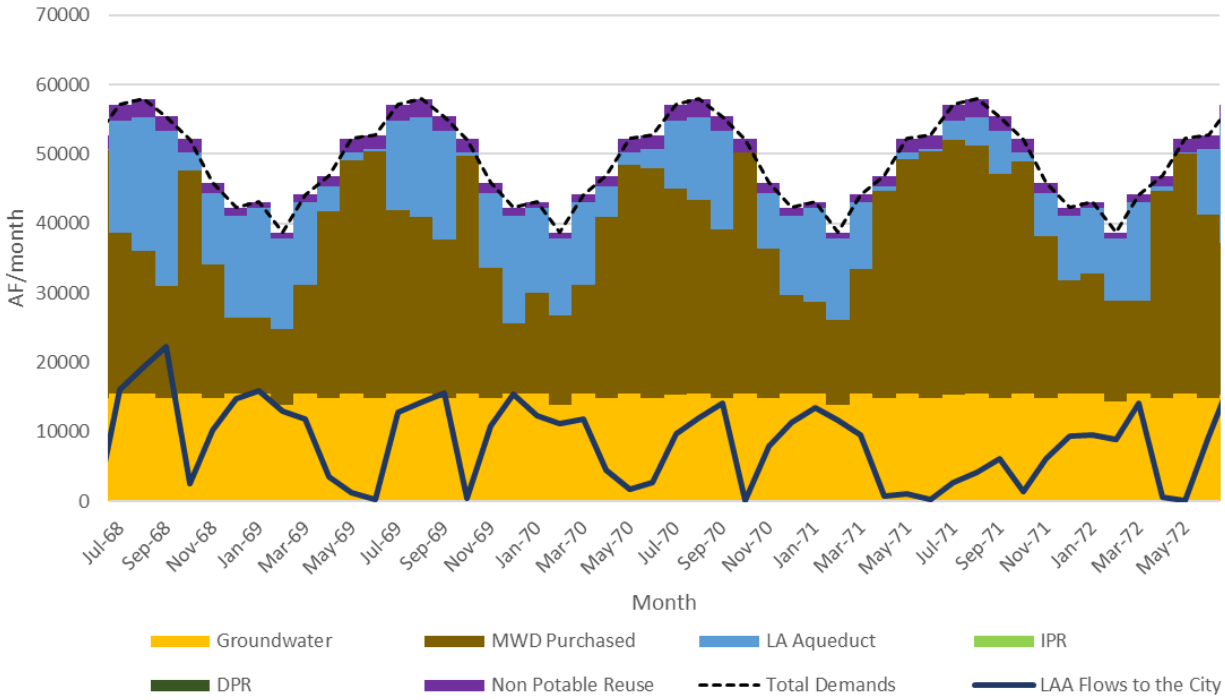


Figure 2-4. How Monthly Supplies Could be Delivered to Future Demands Under Dry Conditions, Without the Program.

The Program also prioritizes how the produced water is allocated in the model runs. Production is driven by available system demands, which are described in order of priority:

- LAAFP – Flows are delivered to the Van Norman Complex (VNC) for delivery into the City's water distribution system. The volume of flow depends on demands and the LAAFP's capacity after available LAA flows are treated at the plant.
- West Basin Municipal Water District (West Basin) – Flows delivered to West Basin are assumed to be secondary effluent- or membrane bioreactor effluent-quality and to have a constant demand in the system with a monthly variation (approximately 54 cubic feet per second [cfs] or 35 million gallons per day [MGD]).
- CB – Recharge is sent to storage when it exceeds the amount pumped by LADWP or when it exceeds current allowable pumping rights.
- Partners – Flows are delivered to partners (in this case, Water Replenishment District of Southern California [WRD]). This is a fixed system demand of 26 cfs (16.7 MGD).
- SFB – Flows are delivered to recharge SFB, and are based on the following factors:
  - Available conveyance capacity
  - Available recharge capacity (which varies seasonally)
  - Overall groundwater basin storage capacity, which is currently limited by the upper volume, based on the *2021 ULARA Water Year Annual Report* (ULARA 2023)
  - Stormwater capture that totals 132,000 AFY from a conservative UWMP assumption, which is a major driver for filling the SFB fast, but needs further verification by LADWP
- Metropolitan Pure Water Southern California Program (PWSC) – Flows are delivered to the Metropolitan PWSC project; currently, these are limited to 73 cfs (47 MGD), based on direction from LADWP.

Advanced Water Purification Facility (AWPF) production rates are driven by the following factors:

- Seasonality of LAA flows
- Seasonality of system demands

- Availability of CB storage and recharge capacity
- Availability of SFB storage and recharge capacity

As partnerships develop, potential for additional production could add up to 153 cfs (99 MGD) to Program demand (WB, Partners, and Metropolitan's PWSC).

The delivery of Program flows (prioritization and capacities) is being addressed using multiple approaches and alternatives, which are simulated in the ONAT.

2.3 Representation of Pure Water Los Angeles Alternatives

ONAT assumptions for inputs and boundary conditions are documented in the *Operation NEXT Assessment Tool Summary Description* TM (Jacobs 2024a). Since that document was developed, information was received that updated values in the model and several modeling assumptions were refined:

- A flow to Metropolitan of up to 73 cfs (47 MGD), as directed by LADWP based on discussions with Metropolitan.
  - Up to 73 cfs (47 MGD) of Pure Water Los Angeles ATRW can be delivered to Metropolitan, assuming that all other Program demands were fulfilled first.
  - This assumes 62 cfs (40 MGD) of flow is directed to Weymouth Water Treatment Plant (WTP), and 11 cfs (7 MGD) is directed to the Raymond Basin in Pasadena.
  - This value was originally assumed to be 232 cfs (150 MGD) of flow to Metropolitan (Jacobs 2024a).
  - Jensen WTP is a component of the ONAT model, but this node was not turned on for the model runs pending ongoing discussions between LADWP and Metropolitan.
- Sylmar groundwater flows were previously accounted for as separate from the SFB maximum extraction of 220 cfs (142 MGD).
  - In practice, Sylmar groundwater flows are accounted for as part of the 220 cfs (142 MGD). Thus, the model was updated to have a separate Sylmar flow that could be turned on or off, and total flow from SFB and Sylmar is capped at 220 cfs (142 MGD).

ONAT model runs took place for the shortlisted Approach II and Approach III alternatives. Approach II consists of indirect potable reuse (IPR) with post-AWPF DPR. Approach III consists of DPR at AWPF. Figure 2-5 summarizes the shortlisted alternatives.

Treatment Framework	Alternative Definition
Approach II (IPR and DPR) DPR treatment at VNC - IPR treatment at AWPF, with post-AWPF DPR treatment at VNC	Alternative 4. Sepulveda Alignment to VNC with limited flow to SFB through 54-inch diameter East Valley pipeline*
	Alternative 5. Cahuenga Alignment to VNC with full flow to SFB through alignment*
	Alternative 6. Griffith Park Alignment to VNC with full flow to SFB through alignment (modeling is same as Cahuenga)
Approach III (DPR) Full DPR treatment at AWPF	Alternative 7. Sepulveda Alignment to VNC with limited flow to SFB through 54-inch diameter East Valley pipeline**
	Alternative 8. Cahuenga Alignment to VNC with full flow to SFB through alignment**
	Alternative 9. Griffith Park Alignment to VNC with full flow to SFB through alignment (modeling is same as Cahuenga)

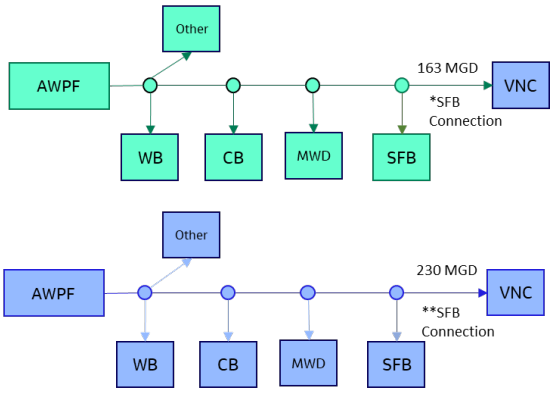


Figure 2-5. Approaches and Alternatives.

Figure 2-6 shows the overall ONAT system schematic, including the main system components. Outputs from these model elements can be retrieved, as needed.

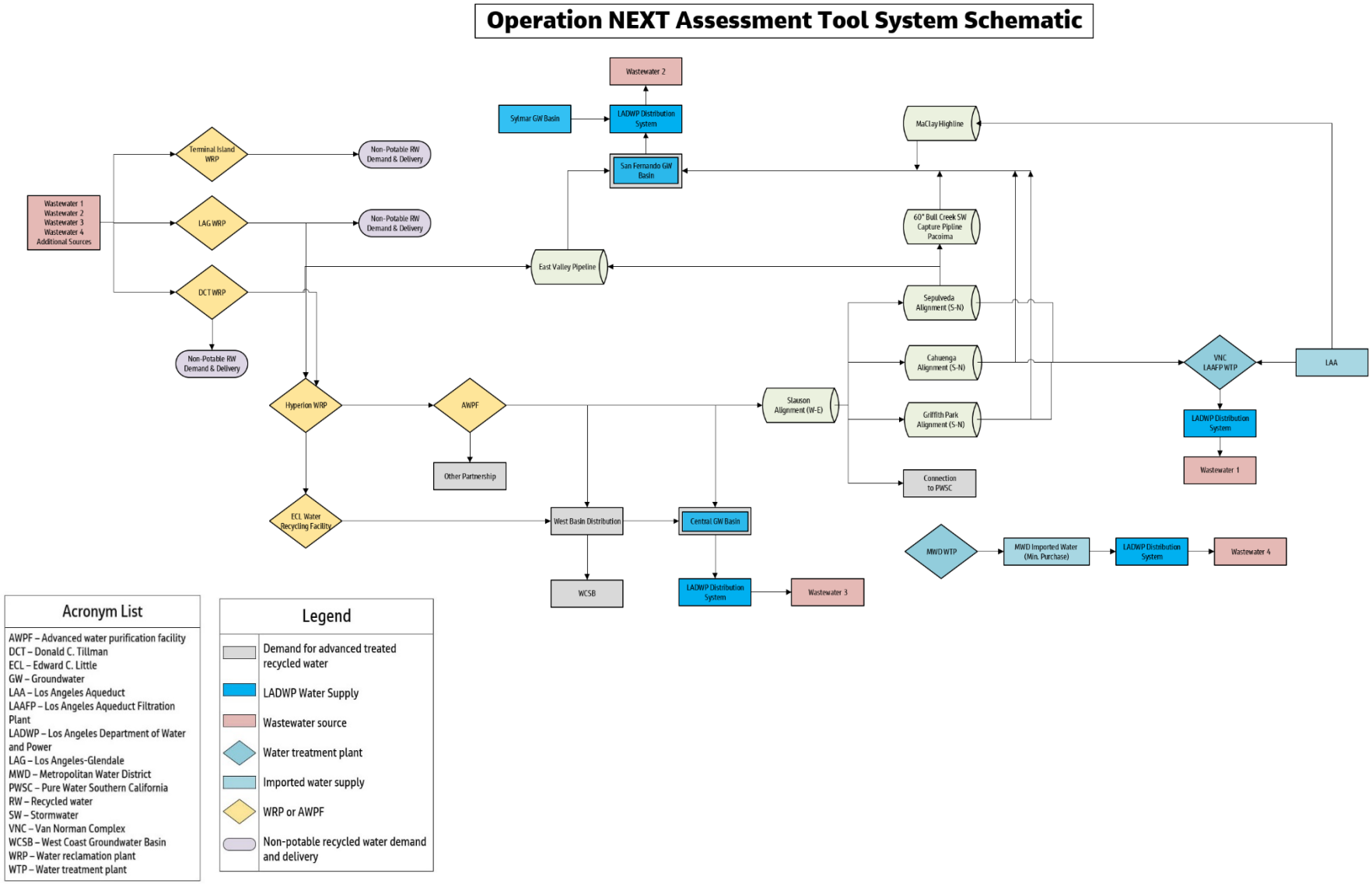


Figure 2-6. Pure Water Los Angeles Facilities and Other Facilities in the Operation NEXT Assessment Tool.

ONAT modeling focuses on flow and volume and does not include specific pipe sizes or velocities. For Approach II, Alternative 5 and Alternative 6 only vary by alignment and have the same model run results. As a result, the model used Alternative 5 to represent both itself and Alternative 6. Similarly, Alternatives 8 and 9 have the same flow and volume results, so the model used Alternative 8 to represent both itself and Alternative 9.

2.4 Planning Scenarios

Planning scenarios were designed to expose the different Program alternatives to factors outside LADWP control:

- Future LAA flows, driven by climate conditions
- Future City demands
- Risk of system failure due to seismic events

The scenarios are a combination of demands and LAA flow assumptions that are applied to Alternatives 4, 5, 7, and 8.

As described in *Operation NEXT Assessment Tool Summary Description* TM (Jacobs 2024a), six model scenarios had initially been identified and selected for use in the MP. The first round of model results indicated the initial scenario definitions should be revised. The primary reason for this change is the relevance of Scenarios 2 and 3. Initially, extended periods of wet and dry conditions were anticipated to significantly affect the model results. However, this assumption proved incorrect. The system's lack of significant surface or subsurface storage capacity, on the order of thousands of acre-feet, and the magnitude of LAA flows relative to system demands result in a system that is highly responsive to LAA flows. The conditions anticipated for Scenarios 2 and 3 were already present in the historical conditions of Scenario 1.

The historical LAA flow records did not show significant long-term dry or wet sequences (exceeding 10 years) that would justify separate scenarios for Scenarios 2 and 3. Therefore, Scenarios 2 and 3 have been replaced by modeling and reporting LADWP production and supplies during the wettest and driest 10-year periods within the historical LAA records. Additional scenarios that adjust LAA flows based on climate models are presented in the *Resiliency Analysis* TM (Jacobs 2024d).

The modified scenarios modeled include:

- **Current Trends Scenario 1:** Adjusted historical water supply conditions to reflect current operations, infrastructure, and projected future demands, including:
  - **Extreme Drought Scenario, Scenario 2 (Jacobs 2024a):** Most extreme droughts from the historical record (1922 to 2023) or derived from historical records
  - **Pluvial Scenario, Scenario 3 (Jacobs 2024a):** Most extreme pluvial (wet) period from the historical record (1922 to 2023) or derived from historical records
- **Future Climate Change Scenario 4:** Future climate projections for LAA and Metropolitan affecting water supply availability, consistent with UCLA downscaling; this scenario runs in a stochastic mode, presenting results in a probabilistic way.
- **Emergency and Seismic Scenario 5:** Loss of supply from either LAA or Metropolitan, or both, due to a major seismic event representing a time of failure for a specific location in the system followed by a recovery period; this scenario runs in deterministic mode.
- **Demand Uncertainty Scenario 6:** Exploration of future alternative water demand projections; this scenario runs in a stochastic mode, incorporating demand uncertainty and presenting results in a probabilistic way.

Scenario 1 addresses the wettest and driest 10-year sequences observed based on recorded historical hydrology, between runoff year 1922 (April 1922 to March 1923) and runoff year 2023 (April 2023 to

March 2024). Scenario 1 addresses extreme expected LAA flow sequences by exposing the system with Pure Water Los Angeles to the 1943 hydrological sequence (LAA flows from 1943 to 2019). This means simulation Year 1 (fiscal year 2025) will be aligned with the LAA sequence of historical flows of 1943. In other words, the July 2024 to June 2100 model simulations, including demand projections and Program alternatives, were run with the LAA flow sequence from July 1943 to end of June 2019.

The LAA flows on Figure 2-7 are based on historical flow records but are limited to current LAA constraints. Therefore, although it is based on historical LAA flow records, the time series on Figure 2-7 (also used in the model) does not correspond to the actual historical LAA flows, which would generally be much higher without the latest LAA constraints. The time series on Figure 2-7 is referred to as LAA-adjusted historical flow.

Figure 2-7 presents the volume of all available runoff years (April through March) from 1922 to 2023. The figure shows the extreme runoff years 1983 (457,374 AF) and 2021 (60,156 AF). It also shows how LADWP classifies the runoff years as wet, normal, or dry:

- LADWP uses the 276,750-AF threshold for a wet year (all years with runoff volumes exceeding this threshold are classified as wet).
- It uses the 164,000-AF threshold for a dry year (all years with runoff volumes less than this threshold are classified as dry).
- It classifies any years with runoff values between the two thresholds as normal runoff years.

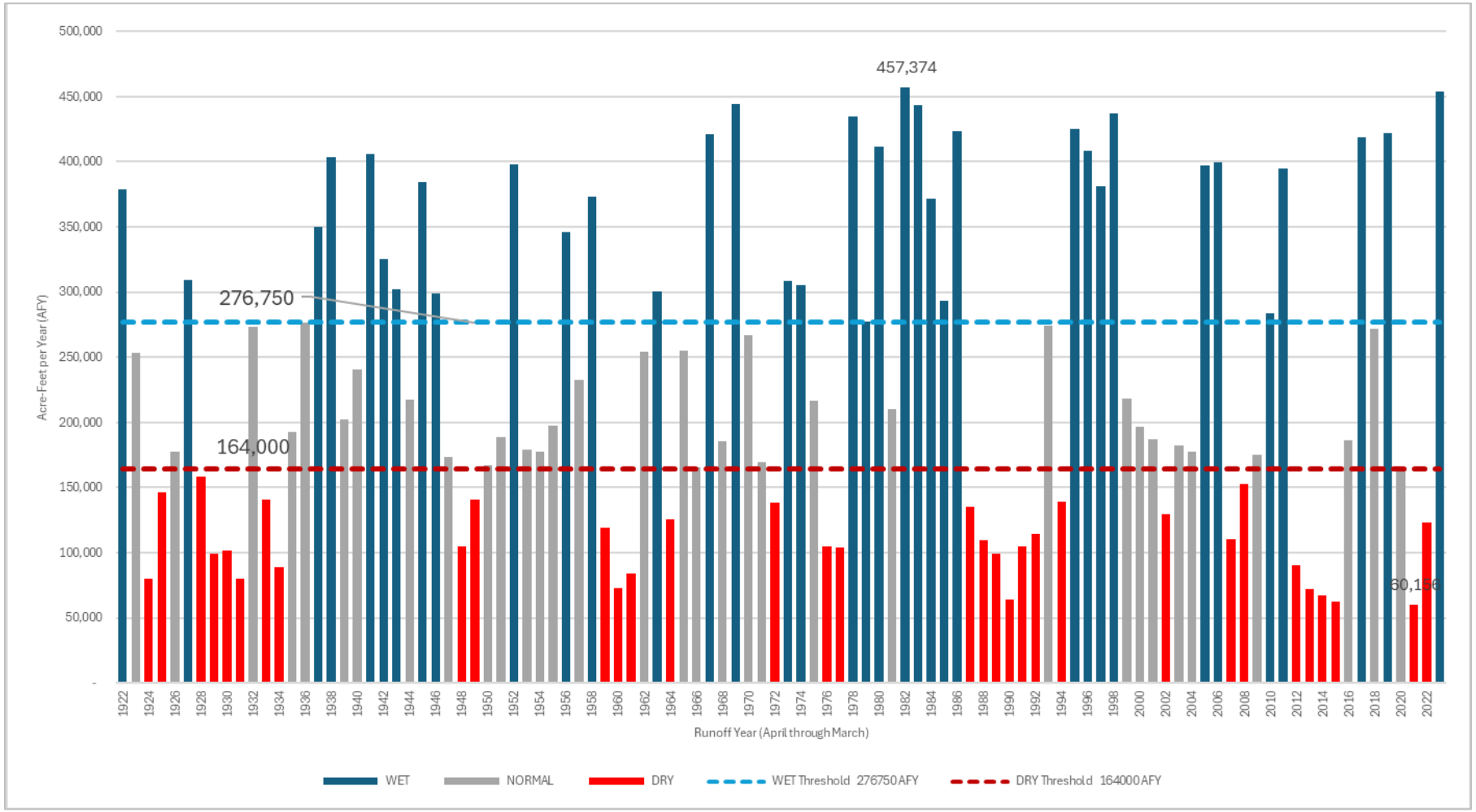


Figure 2-7. Los Angeles Aqueduct Runoff Year Flows based on Historical Records used in Model Simulations.

Out of the entire available sequence of adjusted historical LAA flows, the wettest 10-year sequence is from runoff years 1978 to 1987, extracted from Figure 2-7 and highlighted on Figure 2-8. The period between 1982 and 1986 is also the longest uninterrupted wet period.

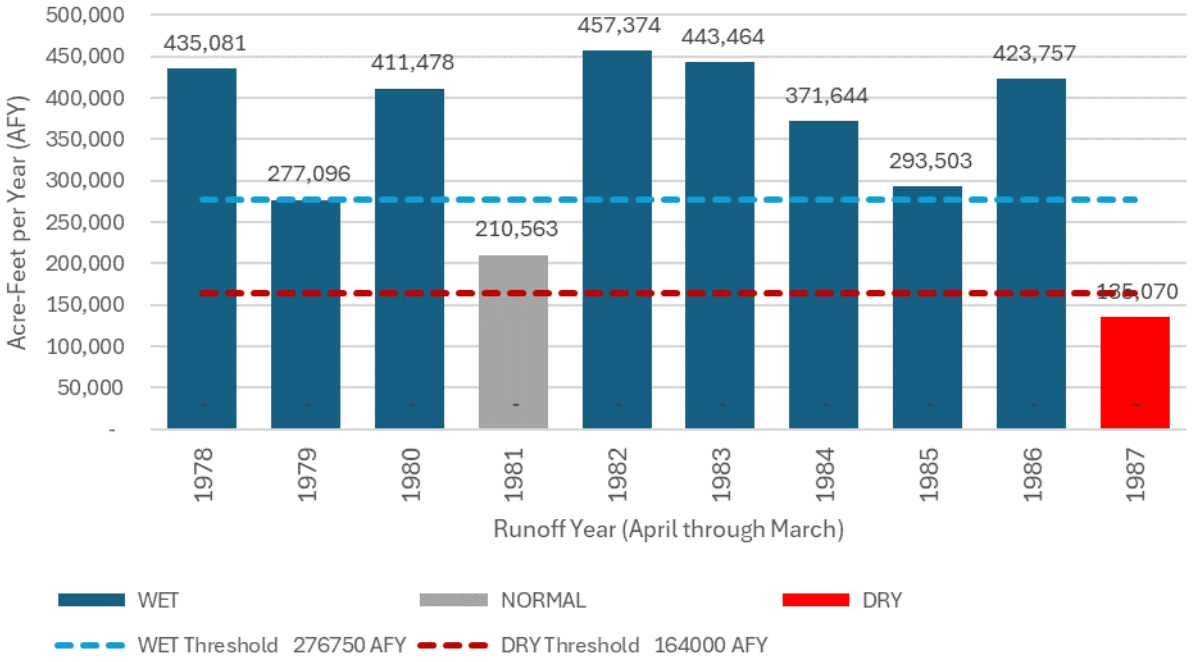


Figure 2-8. Wettest 10-year Sequence of Historically Adjusted Los Angeles Aqueduct Flows from Runoff Years 1922 to 2023.

Out of the entire available historical sequence of LAA flows, the driest 10-year sequence is from runoff years 1985 to 1994, extracted from Figure 2-7 and highlighted on Figure 2-9. Section 3 provides the model results and shows the average Program production during these extreme sequences. The 1987 to 1992 sequence is also the longest and most severe uninterrupted dry period.

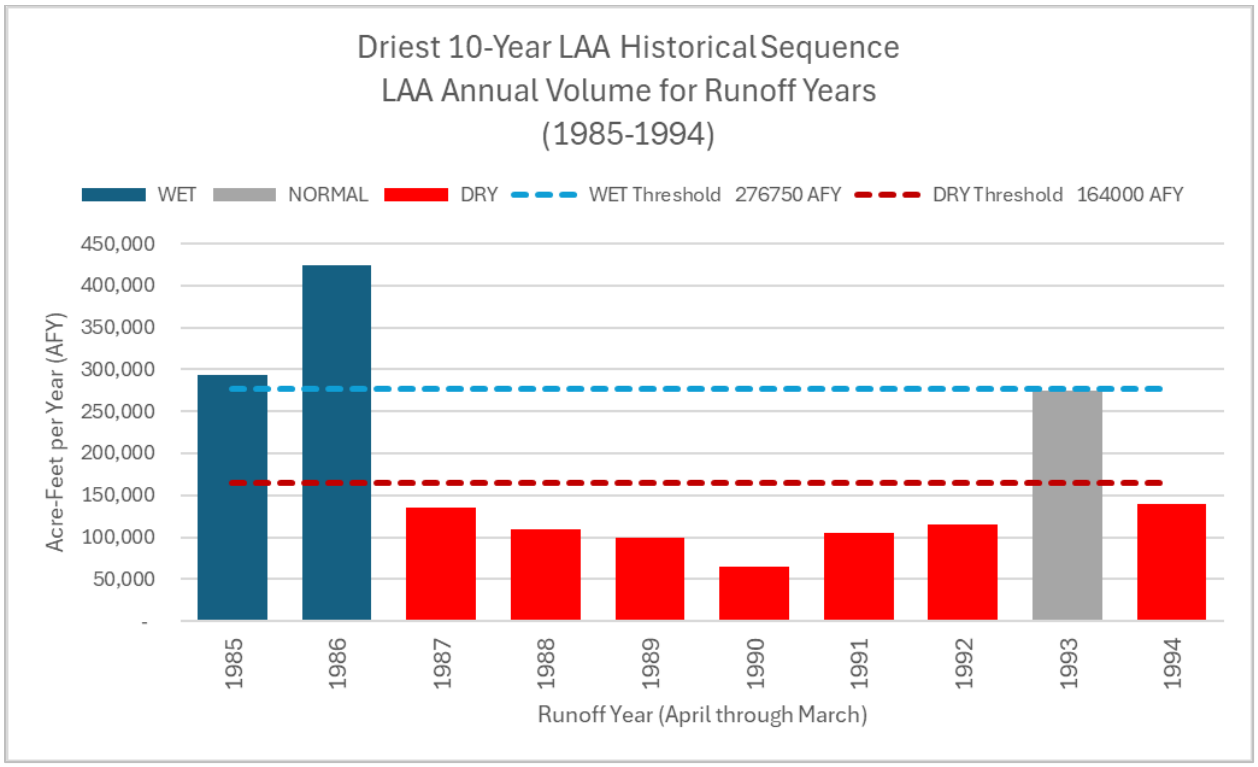


Figure 2-9. Driest 10-year Sequence of Historically Adjusted Los Angeles Aqueduct Flows from Runoff Years 1922 to 2023.

Scenario 6 of the initial planned scenarios would address uncertainties related to demands. These uncertainties include potential shifts in population growth, migration, and water conservation policies. The demands included in the ONAT model rely on the following projections:

- Future demand projection estimates provided by LADWP and included in their groundwater bank model
- Projections presented in the *Hyperion Flow Projections Update Report* (Carollo and Stantec 2024)

One extra scenario was developed as part of the ONAT task: an extreme low-demand projection. Figure 2-10 shows the recent historical demands, which vary from more than 650,000 AF to about 500,000 AF per year. The figure also shows the demand projections considered in the model simulations:

- Initial demands provided by LADWP, consistent with demands being evaluated in its groundwater bank model
- High, Mid, and Low1 demands, based on wastewater projections reported by Carollo and Stantec (2024)
- Low2 demands that project an extreme reduction in demands

Table 2-1 describes these five demand scenarios and assumptions for population and water use efficiency. Demands for each of the projections were kept constant after model year 2060. The higher-demand scenarios have an approximate 0.5% per year increase in demands, while the Low2 demand scenario has a 0.6% per year decrease in demands for the subsequent 20 years.

Table 2-1. Scenario 6 Demand Assumptions

Demand Scenario	Description	Population Assumptions	Water Use Efficiency Assumptions
Initial	ONAT Baseline with LADWP demands	UWMP 2020 projections	Consistent with UWMP 2020 estimates
High	High-demand scenario using high growth and static water use efficiency estimates	UWMP 2020 (SCAG 2016) projections	No changes from current per capita use rates
Mid	Mid-demand scenario with low growth and static water use efficiency estimates	No growth from 2020 population	No changes from current per capita use rates
Low1	Lower-demand scenario combining small decreases in population and achievement of legislative residential indoor use targets	Up to 5% decrease in population	Achievement of residential indoor per capita targets of 42 gpcd by 2030 (SB 1157); no further reductions
Low2	Lowest-demand scenario using lowest growth (population decrease) and higher water use efficiency assumptions	Up to 11% decrease in population by 2050 consistent with the Department of Finance projections from 2023	Achievement of residential indoor per capita targets of 42 gpcd by 2030 (SB 1157); assumed further reductions of 40 gpcd by 2040 and 35 gpcd by 2050

gpcd = gallon(s) per capita per day

The shortlisted Alternatives 4, 5, 7, and 8 were modeled in ONAT for Scenarios 1 and 6, using LAA expected flows based on historical records and the demand ranges presented on Figure 2-10. Scenario 6 is the only one that explores all ranges of demands; Scenario 1 uses the Mid-demand projection.

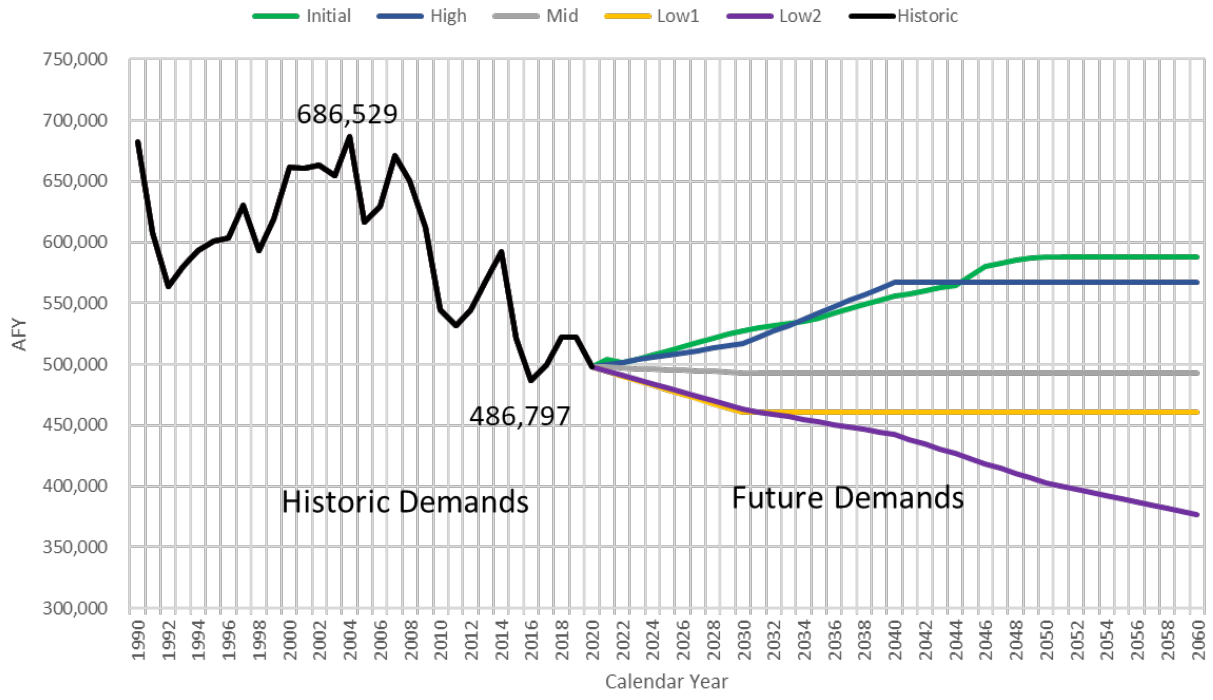


Figure 2-10. Annual LADWP System Demand Scenarios used in ONAT Model Runs.

2.5 Model Outputs and Metrics

This section discusses model outputs that could guide the selection of alternatives, the overall Program performance, and potential infrastructure sizes. This initial set of model outputs provides insights into potential Program-related challenges. However, many other model outputs could be used to advance the Program when the following identified unknowns are advanced or resolved.

- Potential agreements on partnerships
- Management of water supplies during wet years
- Ability to store water supplies

ONAT runs on a daily time step, but most of the main model inputs are in monthly or annual time steps. Results are presented on an annual or a monthly average basis. Summaries are averages, and statistics are generally presented for the period after Phase 3 is implemented, when all projects are implemented (from fiscal year 2054 until the end of the simulation). After ONAT model simulations were completed in late August 2024, Program phasing was revised for the MP, but to maintain the current Program schedule, the revised phasing has not yet been incorporated into ONAT model runs for this TM but can be input in the future by LADWP.

ONAT produces many outputs that can be used to inform future Program planning. Table 2-2 summarizes the primary metrics used to develop the MP.

Table 2-2. Main Operation NEXT Assessment Tool Metrics

Model Metric	Description and Expected Use in the Pure Water Los Angeles MP
Summary of Program production	Demonstrates the average, median, 25th, and 75th percentiles, minimum, and maximum usage of Program production; supports sizing, and cost estimates.
Summary of Program production deliveries to Program demands summary	Demonstrates the average usage of Program production delivered to different Program demands. Supports Program and component sizing and cost estimates.
Summary of LADWP water supply portfolio	Annual average deliveries of LADWP supplies to meet system demands. Shows how different LADWP water supply sources are used to meet City demands for various alternatives and scenarios. Supports Program and component sizing and cost estimates.
Summary of Water Supply Overflows and wastewater discharges to the ocean	Unused LAA or groundwater rights due to lack of demands, full groundwater storage, or lack of infrastructure capacity. Supports Program sizing.
SFB storage accounting time series	Shows the time series for the simulation period of SFB storage use and limitations of Program supply; supports refinements to operational regimes or additional benefits.
CB storage accounting time series	Shows the time series for the simulation period of CB storage use and limitations of Program supply; supports refinements to operational regimes or additional benefits.

The information in Table 2-2 can also be presented for each alternative in time series of annual or monthly averages for all the 20 combinations of model scenarios and alternatives, plus a simulation without Program implementation. Attachment A includes more than 400 figures showing these results. Table 2-3 shows the locations of all the model outputs that can be found in Attachment A.

Table 2-3. Organization of Model Outputs in Attachment A

Excel Tab Name	Contents
Water Supply Summary	Comparative summaries of City's water supply usage, including new Program supply, for all model runs
Water Supply TS	City's water supply portfolio usage, including new Program supply for specific model runs. Time series of data on monthly and annual averages
PWLA Production Summary	Comparative summaries for all model runs related to the Program production
PWLA Production TS	Program production and delivery for specific model runs. Time series of data on monthly and annual averages
Overflow	Unused water supplies, wastewater discharges to the ocean
Storage	Groundwater basin storage volumes

3. Model Results

This section divides the model results into three groups, organized by subsection. Section 3.1 presents a high-level comparison of the 20 combinations of scenarios and alternatives run. Section 3.2 addresses the annual and monthly potential variability of Program production. Section 3.3 discusses the preliminary phasing that are available as of July 2024.

All Phase 3 Program components are assumed to be completed, in place, and operational by July 2053. These results and statistics are based on Phase 3 when all projects have been implemented.

Some modeling results led to the reorganization of initial model scenarios and the merging of initial Scenarios 2 and 3 into Scenario 1 results. Some of the preliminary model results were related to the following factors:

- Extreme LAA flows – There were no extreme long periods of more than 10 years of low or high LAA flows that would justify individual Scenarios 2 and 3. The results of Scenarios 2 and 3 would look the same as Scenario 1, which is designed to include the two most extreme 10-year periods for LAA flows described in Section 2.4.
- LAA flows – LAA flows are the City's highest-priority water source, although these vary seasonally. The system's relatively limited storage and lack of ability to store LAA flows resulted in a system that does not experience impacts from long-term wet and dry cycles. The impacts of a wet or dry sequence of LAA flows do not extend to years after these cycles end.
- Wastewater Availability to the Program – System demands have a significant impact in the Program use for two reasons: (1) the prioritization of Program supplies, compared with other supplies available to the City; (2) having the system as a closed loop, where wastewater used to produce Program water based on the water delivered to the City.
- Water Portfolio Prioritization – Prioritizing supplies to meet system demands impacts the modeling results, because the Program would be displacing mainly imported, purchased water but could be also displacing groundwater rights.
- Similar Results for Alternatives – The alternatives, which differ primarily in terms of conveyance alignments, do not have a big impact on the Program use or how the City's water portfolio is used to meet system demands.
- Low CB Recharge Use – ONAT assumes that the CB hydraulic improvements are in place to allow for CB existing rights to be maximized and for augmentation and extraction exceeding existing rights. These CB improvements would support demand for Program ATRW to be replenished up to these existing rights, which both require an agreement with WRD, along with augmentation of ATRW that exceeds existing water rights for LADWP use (Jacobs 2024c). Without a WRD partnership, the system will offer limited opportunities to recharge CB.

Based on the preliminary findings, results are presented based on deterministic model simulations that extend for 76 years (current year 2024 to the end of the century 2100). The 76-year simulation period from July 2024 to July 2100 corresponds to the historically adjusted LAA flows from July 1943 to July 2019. It includes the wettest and driest 10-year sequences observed between runoff years 1922 and 2023. These simulations include enough information to accommodate the initial Program phasing, and expose the modeled alternative to the identified driest and wettest LAA sequences observed in the available adjusted historical flows.

The shortlisted alternatives were first tested using historical and current trends, as follows.

- A Reference Trend scenario (Scenario 1 with middle demands and adjusted historical LAA flows) was run in deterministic mode to evaluate Program production and water supply portfolio response to critical adjusted historical LAA flow sequences.

- Then, a single model run was designed to cover the situations that Scenarios 1, 2, and 3 originally proposed to evaluate. The scenario "Reference Trend" exposes the Program model to hydrological conditions described in initial scenario definitions (Section 2-4).
- The adjusted historical data provide a limited perspective to potential future outcomes. As a result, the alternatives were then tested considering climate change, emergency loss of supply conditions, and potable water demand uncertainty to provide a more comprehensive picture of the range of future possibilities. Scenario planning model runs for future trends were conducted stochastically to evaluate existing demands and supplies with Program, and to estimate future demands and supplies with Program. These included Scenarios 4, 5, and part of 6 that will be presented in *the Resiliency Analysis* TM (Jacobs 2024d).

It is possible to run the model in a Monte Carlo mode, where all model variables that are impacted by LAA flow variability will show a range of probability instead of one time series of values. It might be relatively early in the Program to describe probabilistic uncertainty for many project components because many variables and challenges need to be settled first. For example, the results in Section 3.1 show a significant interannual and monthly variation of Program production. The intermittent or irregular operation of reverse osmosis membranes at the AWPF is not optimal, because this requires additional membrane preservation steps and could reduce the life of the membranes, so should be evaluated for the Program in the future.

Table 3-1 shows the model simulation runs this TM discusses. Each simulation uses the adjusted LAA flows estimated from historical records, different demand assumptions, and different alternative assumptions.

Table 3-1. Model Runs Presented in Section 3

Scenario ID	ONAT Simulation	Scenario No. [a]	Demand Scenario	LAA Flows [b]	Alternative
0	No Program-MidDem	Reference	Mid	Adjusted historical LAA flows	No Project
1	S1-MD-HF-Alt4	1, 2, and 3	Mid	Adjusted historical LAA flows	4
2	S1-MD-HF-Alt5	1, 2, and 3	Mid	Adjusted historical LAA flows	5
3	S1-MD-HF-Alt7	1, 2, and 3	Mid	Adjusted historical LAA flows	7
4	S1-MD-HF-Alt8	1, 2, and 3	Mid	Adjusted historical LAA flows	8
5	S6-ID-HF-Alt4	6	Initial	Adjusted historical LAA flows	4
6	S6-ID-HF-Alt5	6	Initial	Adjusted historical LAA flows	5
7	S6-ID-HF-Alt7	6	Initial	Adjusted historical LAA flows	7
8	S6-ID-HF-Alt8	6	Initial	Adjusted historical LAA flows	8
9	S6-HD-HF-Alt4	6	High	Adjusted historical LAA flows	4
10	S6-HD-HF-Alt5	6	High	Adjusted historical LAA flows	5
11	S6-HD-HF-Alt7	6	High	Adjusted historical LAA flows	7
12	S6-HD-HF-Alt8	6	High	Adjusted historical LAA flows	8
13	S6-LD-HF-Alt4	6	Low	Adjusted historical LAA flows	4
14	S6-LD-HF-Alt5	6	Low	Adjusted historical LAA flows	5
15	S6-LD-HF-Alt7	6	Low	Adjusted historical LAA flows	7
16	S6-LD-HF-Alt8	6	Low	Adjusted historical LAA flows	8
17	S6-LLD-HF-Alt4	6	Low2	Adjusted historical LAA flows	4
18	S6-LLD-HF-Alt5	6	Low2	Adjusted historical LAA flows	5
19	S6-LLD-HF-Alt7	6	Low2	Adjusted historical LAA flows	7
20	S6-LLD-HF-Alt8	6	Low2	Adjusted historical LAA flows	8

[a] Scenarios 2 and 3 were replaced and will be presented as subsets of Historical LAA flows scenarios for the wettest and driest 10-year sequences within the historical records.

[b] The 76 years of simulation period, from July 2024 to July 2100, corresponds to the LAA historical flows from July 1943 to July 2019 and includes the wettest and driest 10-year sequences observed since 1922.

3.1 Comparative Summaries

This section discusses the overall differences and similarities across the scenarios in Table 3-1. The goal is to provide information on Program production, LADWP's water supply portfolio, and potential supply overflows. This will help identify a few model runs with significant differences, which are further analyzed in Sections 3-2 and 3-3, and that will examine Program phasing and variations in production.

As noted in Section 2, the ONAT model results are intended solely for illustrative purposes. Projections in this document do not reflect any commitment by LADWP to a future supply portfolio, supply proportions, operations, or strategy. Nothing in this document should be construed as an intent or agreement to future purchases or limits. Results are hypothetical only and subject to change by LADWP.

Following the MP, it is expected that further modeling will be conducted on the screened alternatives to aid in their comparison, and potentially, as an input to determining the potential Program size.

The Program production metric accounts for all Program ATRW that is produced and either delivered directly or stored. The metric does not account for idle production capacity or ATRW production without an associated demand; such flows would have to be discharged to the ocean if production was to be kept at the maximum rate.

The Program is anticipated to change the overall LADWP water supply portfolio, estimated from a system without Pure Water Los Angeles as compared to a system with Pure Water Los Angeles. For this example, Alternative 4 was modeled at both the Initial demand scenario and the Low2 demand scenario in the system with Pure Water Los Angeles, as shown on Figure 3-1.

There are two sets of plots included on Figure 3-1. The upper pie charts are based on an Initial demand scenario. The chart on the left is a future system without Pure Water Los Angeles as compared to the upper right pie chart in a future system modeled with Pure Water Los Angeles, using Alternative 4 as the modeled example. Similar to the upper pie charts, the lower pie charts are based on the Low2 demand scenario. The chart on the left is a future system without Pure Water Los Angeles as compared to the lower right pie chart in a future system with Pure Water Los Angeles. These two sets of plots, one at an Initial demand scenario and the other at the lowest-demand scenario, show the modeled supply portfolio differences in a future system with and without Pure Water Los Angeles.

Figure 3-1 shows the expected decrease in imported Metropolitan supply, replaced by Program supplies. The new Program ATRW supply may constitute between 12 and 21% (DPR plus IPR) of the water delivered to the City as compared to a future system without the Program. These potential water supply portfolio changes are based on model runs using Alternative 4 and Initial and Low2 demand scenarios; thus, findings may vary when using other alternatives and demand scenarios.

In wet years, when LAA flows exceed demands or when groundwater storage volumes are completely full, there is more of a chance that Program ATRW supply would have to be discharged to the ocean if production were kept at the maximum rate.

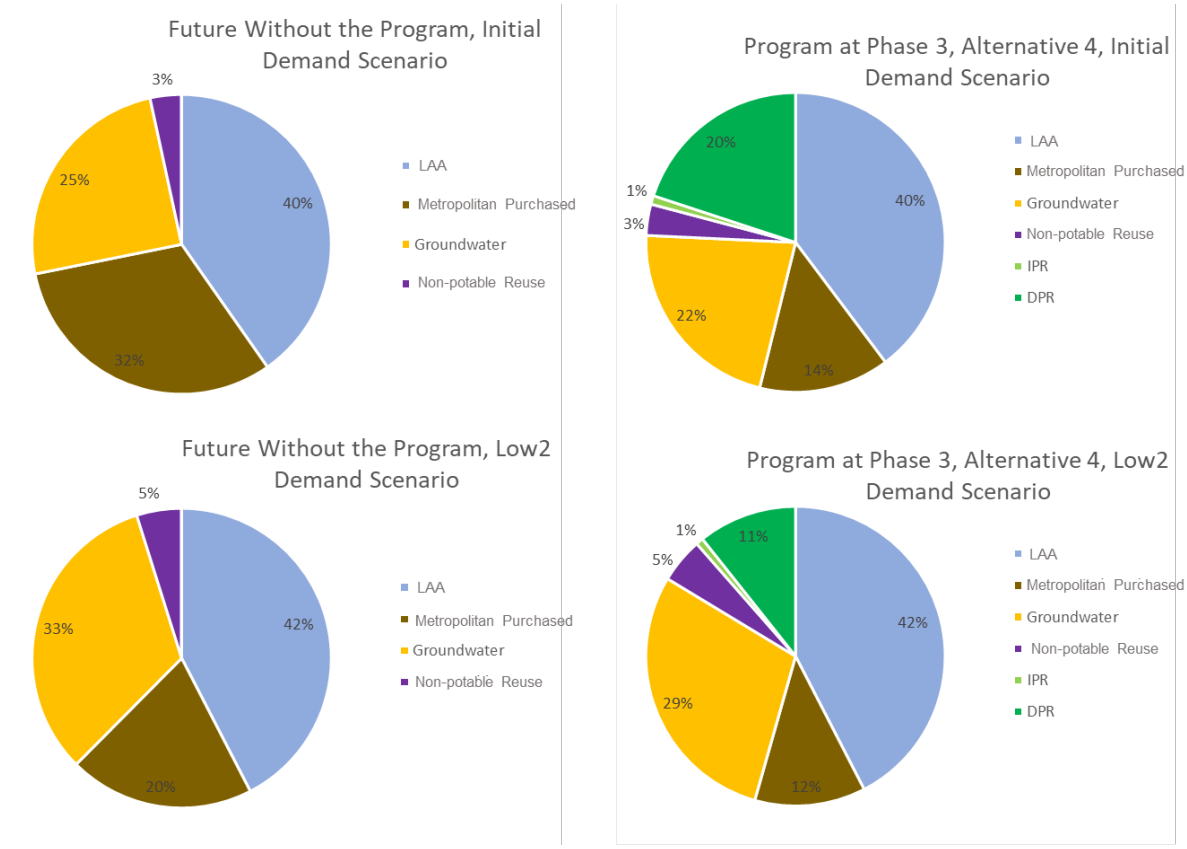


Figure 3-1. Modeled Future Water Supply Portfolio With and Without Pure Water Los Angeles, Phase 3.

Figure 3-2 uses box plots to show the Program's production profile after Phase 3 is implemented. The x-axis labels for the simulation runs are consistent with the labels in Table 3-1, which abbreviates these as follows:

- Alternatives: Alt
- Initial demands: ID
- High demands: HD
- Mid demands: MD
- Low1 demands: LD
- Low2 demands: LLD

The same naming conventions are applied to the rest of the figures in this TM.

For the 20 different model runs, Figure 3-2 shows the maximum and minimum annual productions and the average, median, and interquartile expected values for the Program production. Five distinct groups of results correspond to the five demand scenarios that were run (Table 3-1). The five groups of demand scenarios show higher to lower demands scenarios from left to right. The figure clearly shows a lack of significant variation in Program production among alternatives that share the same demand projection assumptions. However, there is a significant difference in production among the different demand projections. Minimum demands remain relatively the same across the model runs because of the assumption that flow will be distributed as follows (totaling 106,500 AFY or 95 MGD):

- Approximately 39,200 AFY (54 cfs [35 MGD]) could be delivered to West Basin
- Approximately 14,600 AFY (20 cfs [13 MGD]) could be delivered to Partners (WRD), varying as a function of available LADWP's storage in CB
- Up to 52,700 AFY (73 cfs [47 MGD]) could be delivered to Metropolitan's PWSC project

The lowest-demand projections report lower Program production, as well as annual variability in the production. Figure 3-2 also shows the average production for the 10 most critical wet and dry years as described in Section 2.4

Figure 3-3 provides details about the average production presented on Figure 3-2. Figure 3-3 shows, on average (X mark on Figure 3-2), the different uses for Program produced water when Phase 3 is complete. For example, for model run S6-ID-HF-Alt4, Figure 3-2 shows an average annual production of 215,240 AFY (297 cfs [192 MGD]) during the 2054-2100 period. Figure 3-3 shows that the 215,240 AFY (297 cfs [192 MGD]) includes the following volumes of flow:

- 117,260 AFY (162 cfs [104.6 MGD]) of LAAFP deliveries
- 18,720 AFY (26 cfs [16.7 MGD]) for partners (currently WRD, but could include others in the future)
- 30,600 AFY (42 cfs [27.3 MGD]) for Metropolitan PWSC
- 8,300 AFY (11 cfs [7.4 MGD]) for CB injection into LADWP's storage
- 560 AFY (0.8 cfs [0.5 MGD]) for SFB injection
- 39,800 AFY (55 cfs [35.5 MGD]) for West Basin deliveries

For Mid and High demands, there are more LAAFP deliveries for Approach II (Alternatives 7 and 8) that are not limited to 163 MGD of Program water at the LAAFP. For the scenarios with reduced demands, there is more idle production potential without established partnerships. No model runs show significant deliveries to SFB recharge because the groundwater basin may fill up again before Phase 3 is implemented; Section 3.3 discusses phasing in more detail.

Each run has similar potential idle production; however, the total production capacity drops significantly from close to maximum (364 cfs [235 MGD]) to less than 279 cfs [180 MGD], depending on the scenario. Note, the maximum production of 364 cfs (235 MGD) instead of approximately 356 cfs (230 MGD) is because membrane bioreactor deliveries may not incur losses estimated for the AWPF process. Also, if the assumed demand is less, there is less total production capacity because of the closed-loop model results, and less available wastewater flow for the AWPF to treat.

Assuming a 272 MGD intake capacity, Table 3-2 shows the percentage of simulation time that the treatment system will be idle in terms of production and capacity for different flow rates and across the full range of model scenarios and alternative runs, both minimum and maximum. For example, the table shows that the treatment system could experience 50 MGD of idle capacity plus production between 40 and 85% of the time. The 40% idle time corresponds to high system demand conditions, while the 85% idle time corresponds to low-demand conditions. All values shown are based on the model assumptions and prioritization described in this TM. Attachment B provides a detailed description of idle capacity and idle production.

Table 3-2. Idle Capacity Plus Production Percentage Across All Demand Scenarios and Alternatives

	Idle Capacity + Production, % of the Time			
Demands Scenarios at Different Influent Flows	25 MGD	50 MGD	75 MGD	100 MGD
Minimum (Scenarios with High Demand)	49	40	33	26
Maximum (Scenarios with Low Demand)	88	85	68	60

Figure 3-4 shows how LADWP's water supply portfolio may be used to meet system demands when the Program is implemented. The figure shows the average water supply portfolio for the 2054 to 2100 simulated period when all phases of the Program will be completed. Program supplies displace some of the Metropolitan-imported supply in all model simulations where the Program has been implemented.

Figure 3-4 also shows low Program ATRW for IPR usage, because groundwater storage in CB and SFB will fill up during the earlier Program phases, before 2054 (refer to Section 3.2).

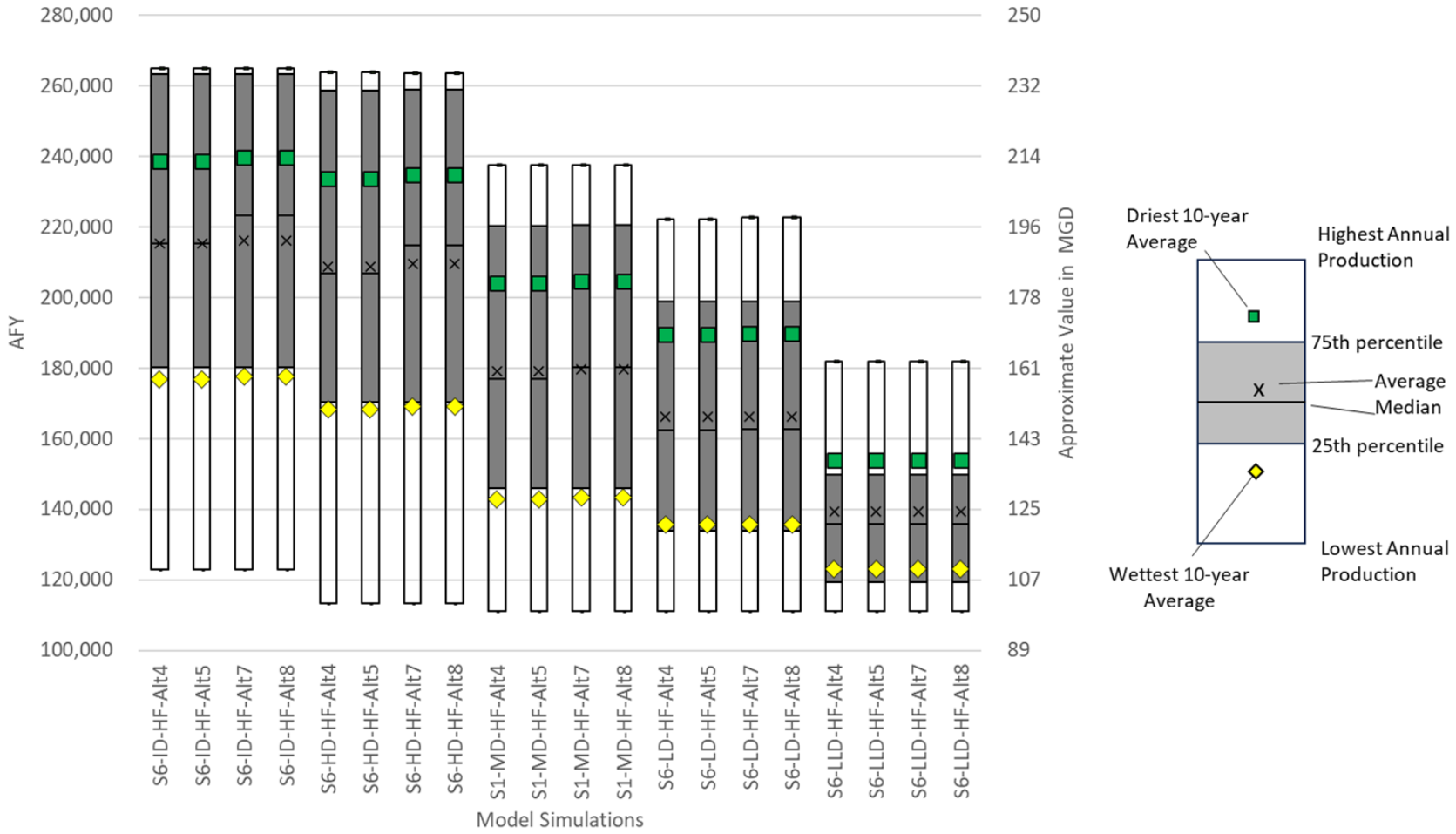
As with current operations, for wet runoff years and extreme low demands (Figure 3-5), LAA flows are sufficient to meet demands. The model also assumes a fixed minimum of Metropolitan supplies based on deliveries supplying Eagle Rock and the Harbor area under current and expected future operations.

Although the demand for Program ATRW is reduced in lower-demand scenarios, it does not go down to zero production on a full-year basis. Even during extreme wet years with low system demands (Figure 3-5), the seasonality and variability of LAA flows versus the City's demand pattern will allow for some Program water to be delivered (for example, October 2062 and October 2065 on Figure 3-5). For high-demand scenarios in wet years (Figure 3-6), as expected, more Program ATRW is anticipated to be used than for low-demand scenarios (Figure 3-5).

The model results also show significant decreases in the Hyperion Water Reclamation Plant (HWRP) discharges to the ocean. Figure 3-7 shows the decrease in the HWRP discharges to the ocean and the magnitude of missed opportunities to supply the system because there is more supply than demand. The information presented on Figure 3-7 can be used to explore various production scenarios to right-size the final build out. Figure 3-7 items include:

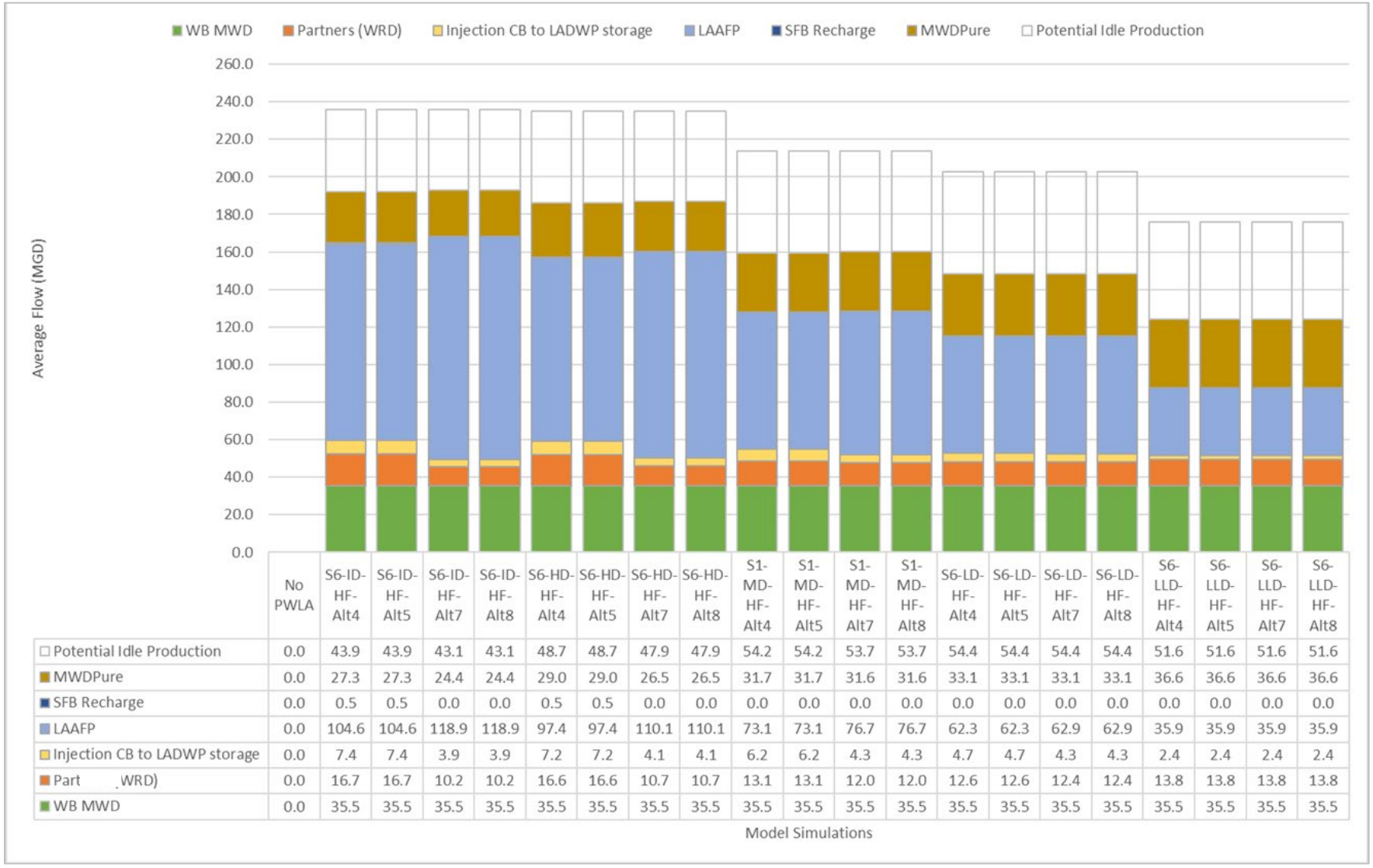
- **HWRP discharges to ocean** – The amount of treated wastewater discharged to the ocean, which does not include potential idle capacity for ATRW. Figure 3-7 shows without the Program, HWRP will continue to discharge treated wastewater to the ocean at a future average rate of approximately 300,000 AFY under the Mid-demand scenario.
- **LAA overflow** – The LAA flows that exceeded treatment capacity or demands after all minimum flow deliveries were allocated (SFB remediation and Metropolitan minimum deliveries).
- **SFB overflow** – The volume of SFB groundwater rights the City could not use or store because SFB would be full. SFB fills up during the first project phases, which results in an increased overflow compared to a situation without the Program.
- **CB and WCB overflow –** The volume of groundwater rights the City could not use or store because CB would be full.

Figure 3-7 shows that while there is a significant decrease in wastewater discharges to the ocean, this reduction is a tradeoff with other water supplies; and the lower the scenario demand, the more overflow is expected.



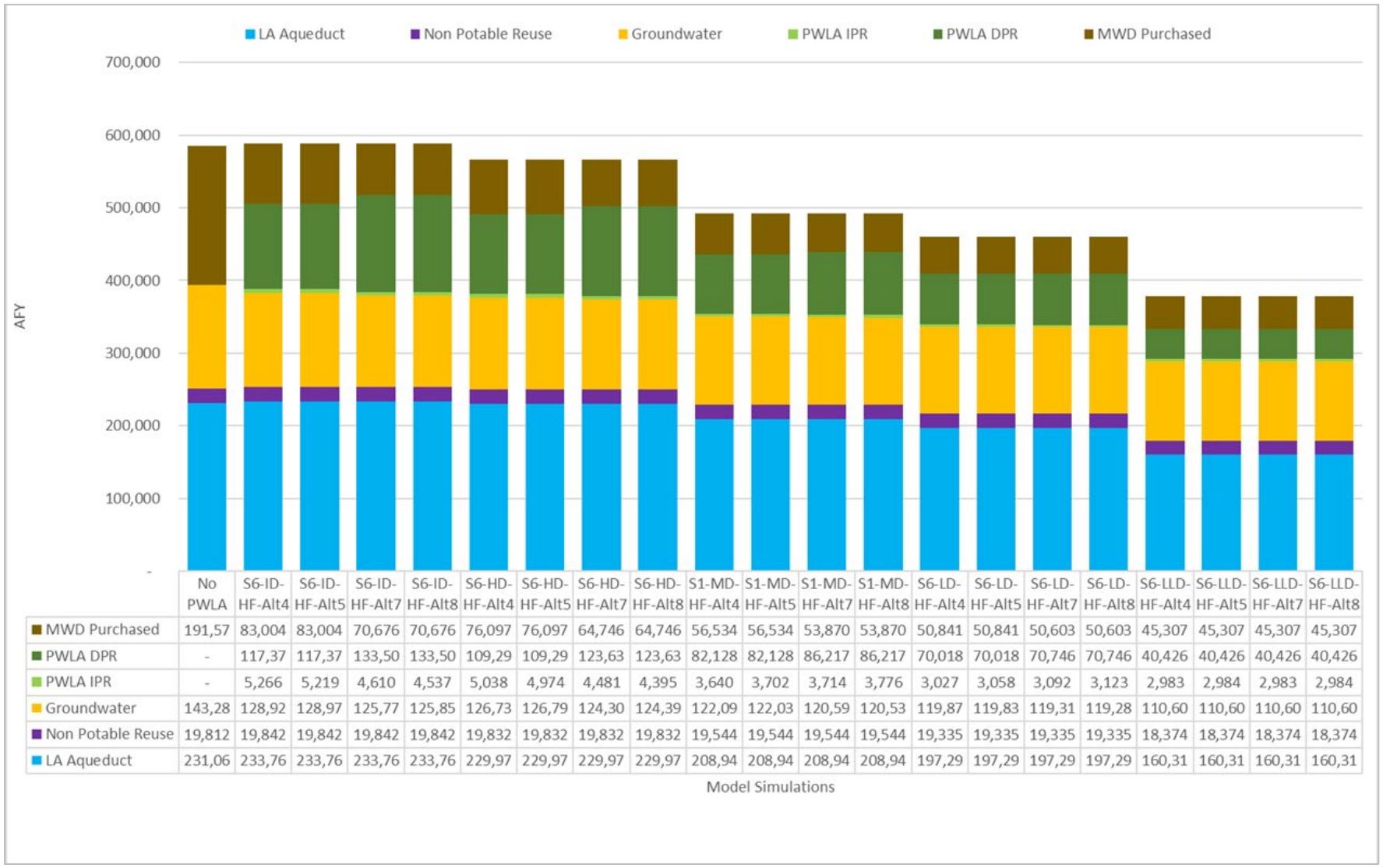
Some simulations exceed 260,051 AFY (232 MGD of AWPF capacity) due to MBR demands that are not subjected to the AWPF treatment capacity limitation of 232 MGD (production water)

Figure 3-2. Program Annual Production for Scenarios 1 and 6.



	No PWLA	S6-ID-HF-Alt4	S6-ID-HF-Alt5	S6-ID-HF-Alt7	S6-ID-HF-Alt8	S6-HD-HF-Alt4	S6-HD-HF-Alt5	S6-HD-HF-Alt7	S6-HD-HF-Alt8	S1-MD-HF-Alt4	S1-MD-HF-Alt5	S1-MD-HF-Alt7	S1-MD-HF-Alt8	S6-LD-HF-Alt4	S6-LD-HF-Alt5	S6-LD-HF-Alt7	S6-LD-HF-Alt8	S6-LLD-HF-Alt4	S6-LLD-HF-Alt5	S6-LLD-HF-Alt7	S6-LLD-HF-Alt8
Potential Idle Production	0.0	43.9	43.9	43.1	43.1	48.7	48.7	47.9	47.9	54.2	54.2	53.7	53.7	54.4	54.4	54.4	54.4	51.6	51.6	51.6	51.6
MWDPure	0.0	27.3	27.3	24.4	24.4	29.0	29.0	26.5	26.5	31.7	31.7	31.6	31.6	33.1	33.1	33.1	33.1	36.6	36.6	36.6	36.6
SFB Recharge	0.0	0.5	0.5	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAAFP	0.0	104.6	104.6	118.9	118.9	97.4	97.4	110.1	110.1	73.1	73.1	76.7	76.7	62.3	62.3	62.9	62.9	35.9	35.9	35.9	35.9
Injection CB to LADWP storage	0.0	7.4	7.4	3.9	3.9	7.2	7.2	4.1	4.1	6.2	6.2	4.3	4.3	4.7	4.7	4.3	4.3	2.4	2.4	2.4	2.4
Part .WRD)	0.0	16.7	16.7	10.2	10.2	16.6	16.6	10.7	10.7	13.1	13.1	12.0	12.0	12.6	12.6	12.4	12.4	13.8	13.8	13.8	13.8
WB MWD	0.0	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5	35.5

Figure 3-3. Average Program Production with Program Deliveries.



	No PWLA	S6-ID-HF-Alt4	S6-ID-HF-Alt5	S6-ID-HF-Alt7	S6-ID-HF-Alt8	S6-HD-HF-Alt4	S6-HD-HF-Alt5	S6-HD-HF-Alt7	S6-HD-HF-Alt8	S1-MD-HF-Alt4	S1-MD-HF-Alt5	S1-MD-HF-Alt7	S1-MD-HF-Alt8	S6-LD-HF-Alt4	S6-LD-HF-Alt5	S6-LD-HF-Alt7	S6-LD-HF-Alt8	S6-LLD-HF-Alt4	S6-LLD-HF-Alt5	S6-LLD-HF-Alt7	S6-LLD-HF-Alt8
MWD Purchased	191,57	83,004	83,004	70,676	70,676	76,097	76,097	64,746	64,746	56,534	56,534	53,870	53,870	50,841	50,841	50,603	50,603	45,307	45,307	45,307	45,307
PWLA DPR	-	117,37	117,37	133,50	133,50	109,29	109,29	123,63	123,63	82,128	82,128	86,217	86,217	70,018	70,018	70,746	70,746	40,426	40,426	40,426	40,426
PWLA IPR	-	5,266	5,219	4,610	4,537	5,038	4,974	4,481	4,395	3,640	3,702	3,714	3,776	3,027	3,058	3,092	3,123	2,983	2,984	2,983	2,984
Groundwater	143,28	128,92	128,97	125,77	125,85	126,73	126,79	124,30	124,39	122,09	122,03	120,59	120,53	119,87	119,83	119,31	119,28	110,60	110,60	110,60	110,60
Non Potable Reuse	19,812	19,842	19,842	19,842	19,842	19,832	19,832	19,832	19,832	19,544	19,544	19,544	19,544	19,335	19,335	19,335	19,335	18,374	18,374	18,374	18,374
LA Aqueduct	231,06	233,76	233,76	233,76	233,76	229,97	229,97	229,97	229,97	208,94	208,94	208,94	208,94	197,29	197,29	197,29	197,29	160,31	160,31	160,31	160,31

Figure 3-4. Average Water Supply Deliveries with the Program.

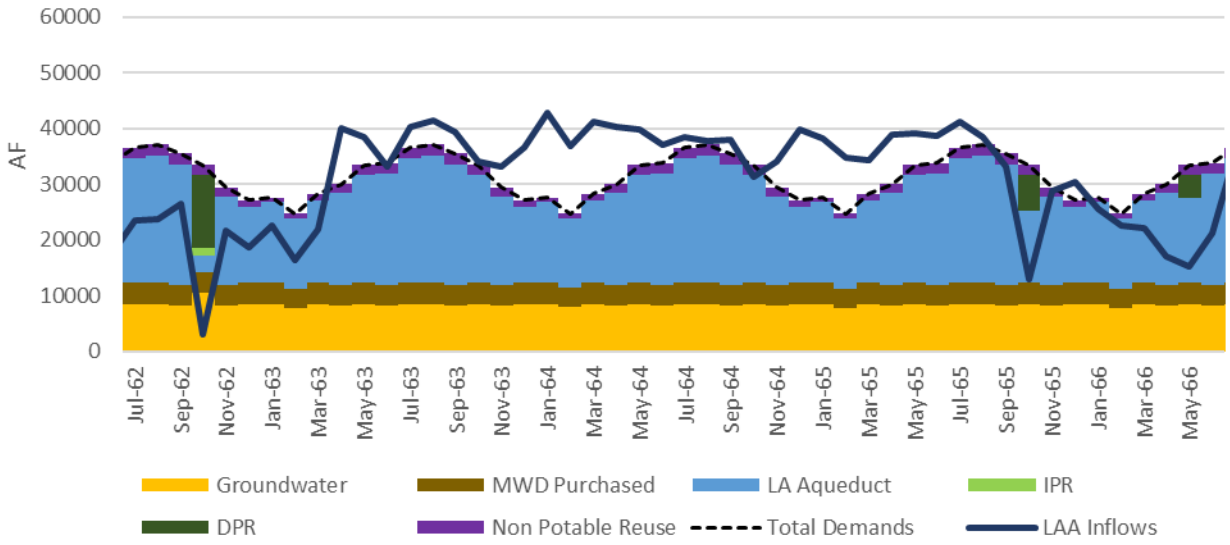


Figure 3-5. Wet Los Angeles Aqueduct Flows Sequence Under Low-demand Scenario with the Program (S6-LLD-HF-Alt4).

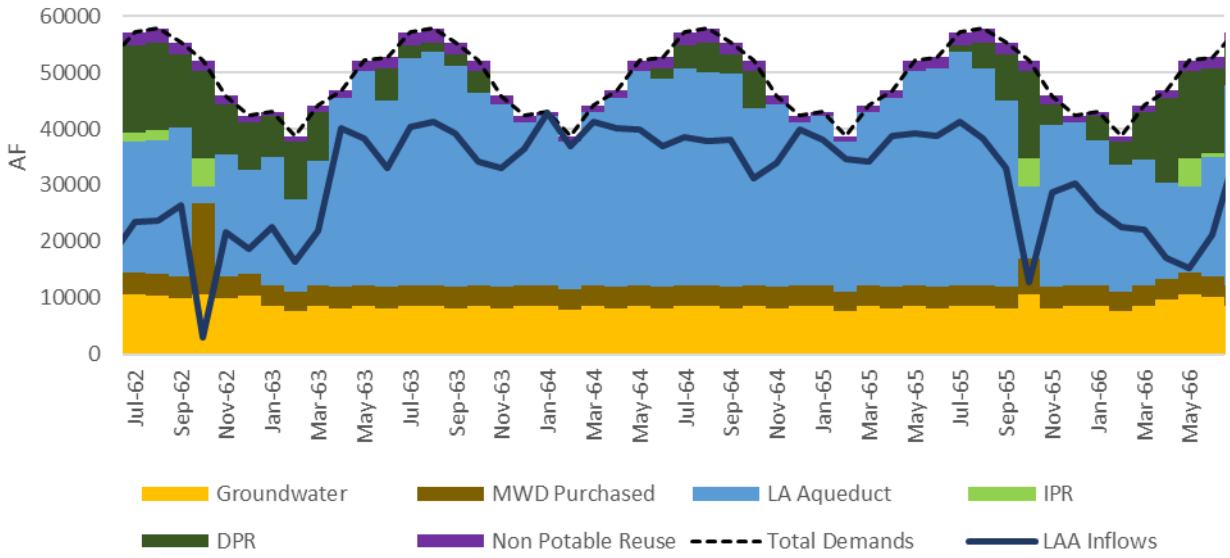
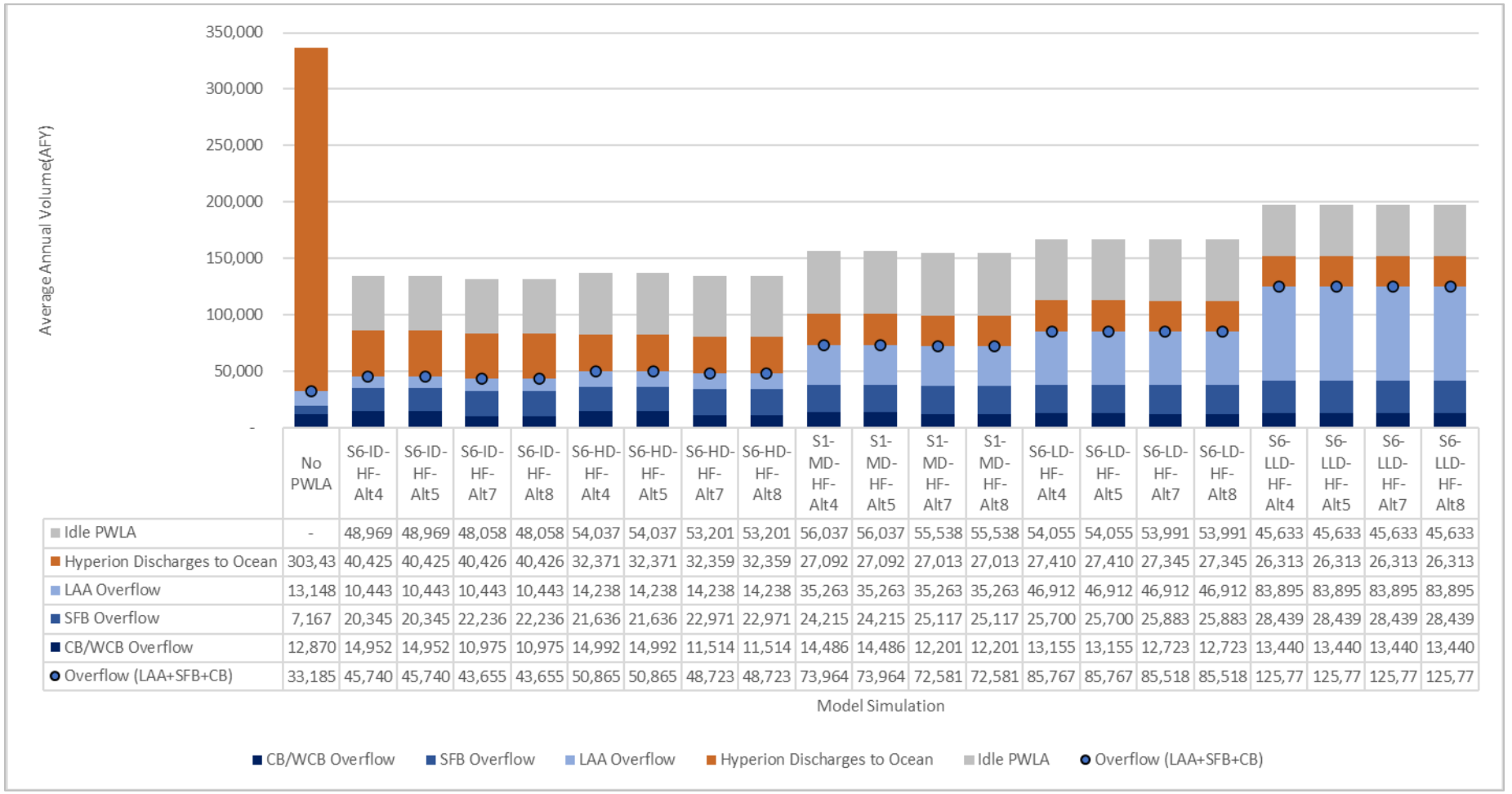


Figure 3-6. Wet Los Angeles Aqueduct Flows Sequence Under High-demand Scenario with the Program (S6-ID-HF-Alt4).



	No PWLA	S6-ID-HF-Alt4	S6-ID-HF-Alt5	S6-ID-HF-Alt7	S6-ID-HF-Alt8	S6-HD-HF-Alt4	S6-HD-HF-Alt5	S6-HD-HF-Alt7	S6-HD-HF-Alt8	S1-MD-HF-Alt4	S1-MD-HF-Alt5	S1-MD-HF-Alt7	S1-MD-HF-Alt8	S6-LD-HF-Alt4	S6-LD-HF-Alt5	S6-LD-HF-Alt7	S6-LD-HF-Alt8	S6-LLD-HF-Alt4	S6-LLD-HF-Alt5	S6-LLD-HF-Alt7	S6-LLD-HF-Alt8
Idle PWLA	-	48,969	48,969	48,058	48,058	54,037	54,037	53,201	53,201	56,037	56,037	55,538	55,538	54,055	54,055	53,991	53,991	45,633	45,633	45,633	45,633
Hyperion Discharges to Ocean	303,43	40,425	40,425	40,426	40,426	32,371	32,371	32,359	32,359	27,092	27,092	27,013	27,013	27,410	27,410	27,345	27,345	26,313	26,313	26,313	26,313
LAA Overflow	13,148	10,443	10,443	10,443	10,443	14,238	14,238	14,238	14,238	35,263	35,263	35,263	35,263	46,912	46,912	46,912	46,912	83,895	83,895	83,895	83,895
SFB Overflow	7,167	20,345	20,345	22,236	22,236	21,636	21,636	22,971	22,971	24,215	24,215	25,117	25,117	25,700	25,700	25,883	25,883	28,439	28,439	28,439	28,439
CB/WCB Overflow	12,870	14,952	14,952	10,975	10,975	14,992	14,992	11,514	11,514	14,486	14,486	12,201	12,201	13,155	13,155	12,723	12,723	13,440	13,440	13,440	13,440
Overflow (LAA+SFB+CB)	33,185	45,740	45,740	43,655	43,655	50,865	50,865	48,723	48,723	73,964	73,964	72,581	72,581	85,767	85,767	85,518	85,518	125,77	125,77	125,77	125,77

Figure 3-7. Average Hyperion Water Reclamation Plant Wastewater Discharges to the Ocean and Potential Water Supply Overflows during Phase 3.

3.2 Program Production Variability

It is important to understand the variability in flows because of the AWPFs' operational constraints. Ideally, an AWPF would operate at peak efficiency under stable flow conditions with minimal fluctuations. The wastewater feed flow to the AWPF remains relatively constant across most demand scenarios. However, during low-demand scenarios, the AWPF is less likely to achieve its maximum production capacity of approximately 356 cfs (230 MGD). With an assumed treatment recovery of approximately 85%, it takes 272 MGD of wastewater feed to produce approximately 230 MGD of water. According to the *Hyperion Flow Projections Update Report* (Carollo and Stantec 2024), the total flow to the HWRP ranges from 302 MGD (high-flow scenario) to 244 MGD (low-flow scenario). For the low-flow scenario, this translates to approximately 207 MGD of AWPF output. Therefore, while wastewater inflows impose a cap on maximum production, the primary limitation on AWPF production is driven by the demands to take AWPF produced water.

ONAT uses the following assumptions:

- Constant Program demands for WB
- Constant demands for WRD
- Up to 73 cfs (47 MGD) of flow that can be sent to Metropolitan

The other demands for AWPF are based on system demands, available LAA flows, LADWP's assigned priority for the water supply portfolio supplies, and groundwater storage conditions (storage and recharge limitations).

The most challenging situation for Program ATRW production variability will be a low system demand scenario, paired with high LAA flows. This situation will limit the AWPF's ability to send water to LAAFP and to groundwater storage. Under the Low2 demand scenarios (Table 3-1), the alternatives do not present significant differences in Program production or water portfolio use (Figure 3-3 and Figure 3-4). The variability analysis on Figure 3-8 (scenario S6-LLD-HF-Alt4) shows one of the most extreme variations in Program production. The figure shows the interannual and monthly variation of Program production under a Low2 system demand scenario, with longer periods of reduced production and some significant monthly variations in production.

Figure 3-8 also shows some common traits across the model runs:

- A high correlation between potential idle production flows and wet LAA years
- Minimum production around 155 cfs (100 MGD) after 2054 (once all Program phases are implemented), depending on partners, such as WB, WRD, and Metropolitan, with the average 28% of production benefiting the City in a very low-demand scenario
- High LAAFP demands for Program production during dry years and low idle production
- High SFB recharge use during the initial Program phases, until SFB reaches full capacity

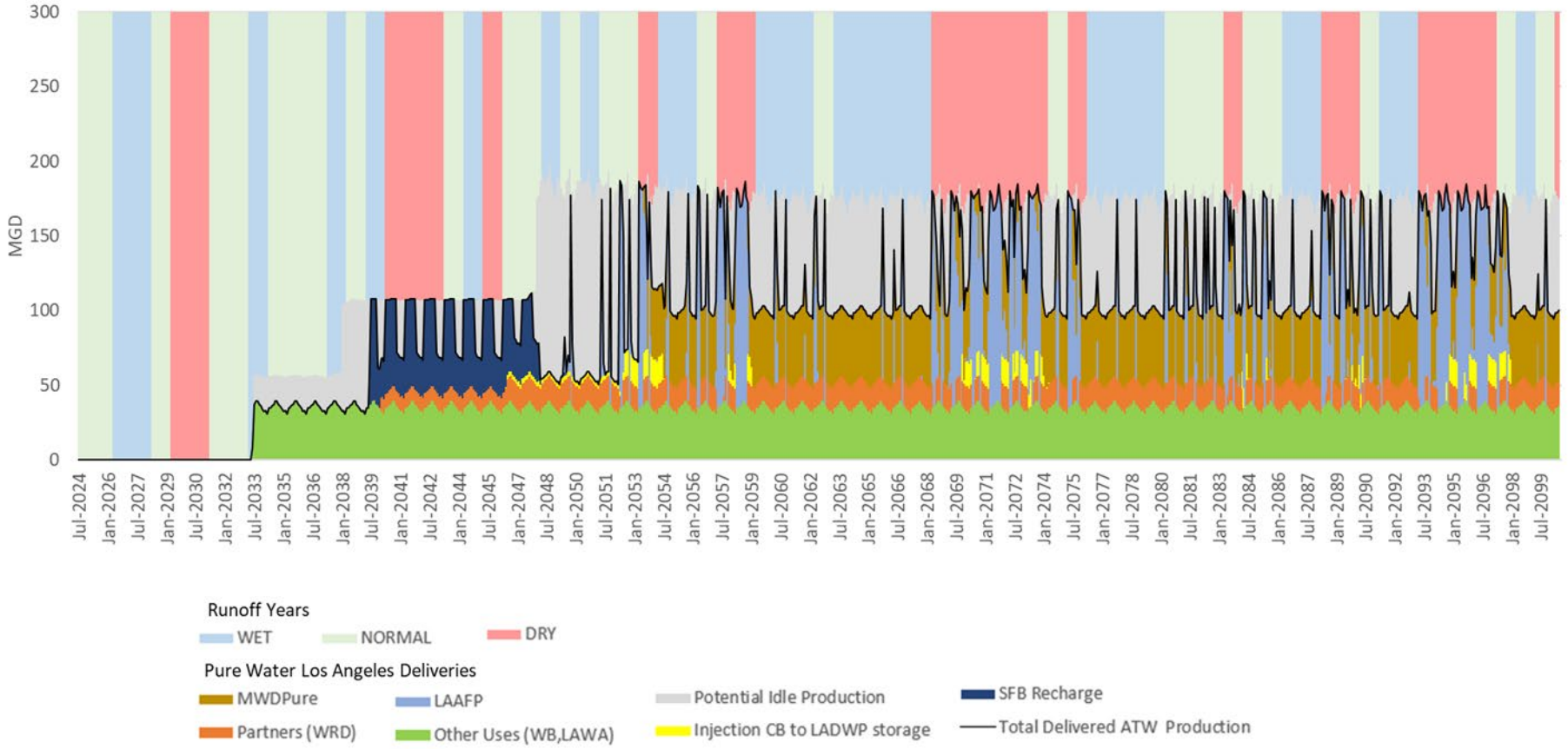


Figure 3-8. Monthly Average Program Production Variability for a Low-demand Scenario (S6-LLD-HF-Alt4).

ONAT model results present two types of variability: (1) annual and (2) monthly. Annual variability would occur because of changes of LAA flows among wet, normal, and dry LAA flow conditions. During prolonged wet LAA flow conditions, the Program production would have to be reduced based on the available Program demands. This would be a long-term (1 or more years) shutdown, or significant reduction, of AWPF production. Monthly variations in water production can be more challenging, and could require short-term strategies that might include:

- Temporary reduction of groundwater extraction
- Additional storage, as available
- Additional recharge capacity for groundwater basins
- Additional partnerships

The demand for ATRW is driven mainly by the availability of LAA flows and future system demands. Figure 3-9 shows the monthly LAA volume range available to supply the City demands in the model. The figure shows the peak of LAA in July, with consistent flow reductions flows until October, and low flows with high variability in April and May. This pattern correlates with the Program production rates at low demands conditions.

Figure 3-10 shows the Program production for the Low2 demand scenario for Alternative 7[1], but Attachment A includes the results for all the other alternatives and scenarios. Figure 3-10 shows more production during April, May, and October, consistent with the low LAA flows. As shown, the delivered Program flows have a lot of monthly variability, from approximately 155 to 277 cfs (100 to 180 MGD), assuming approximately 147 cfs (95 MGD) is partnership driven demands or deliveries. A higher-demand scenario would result in the production of more Program water; however, the monthly production would still vary greatly.

Figure 3-11 shows that for higher demands, the Program production will still vary greatly, within the interquartile demand between 155 to 356 cfs (100 and 230 MGD) for most months of the year; however, more produced ATRW will be delivered.

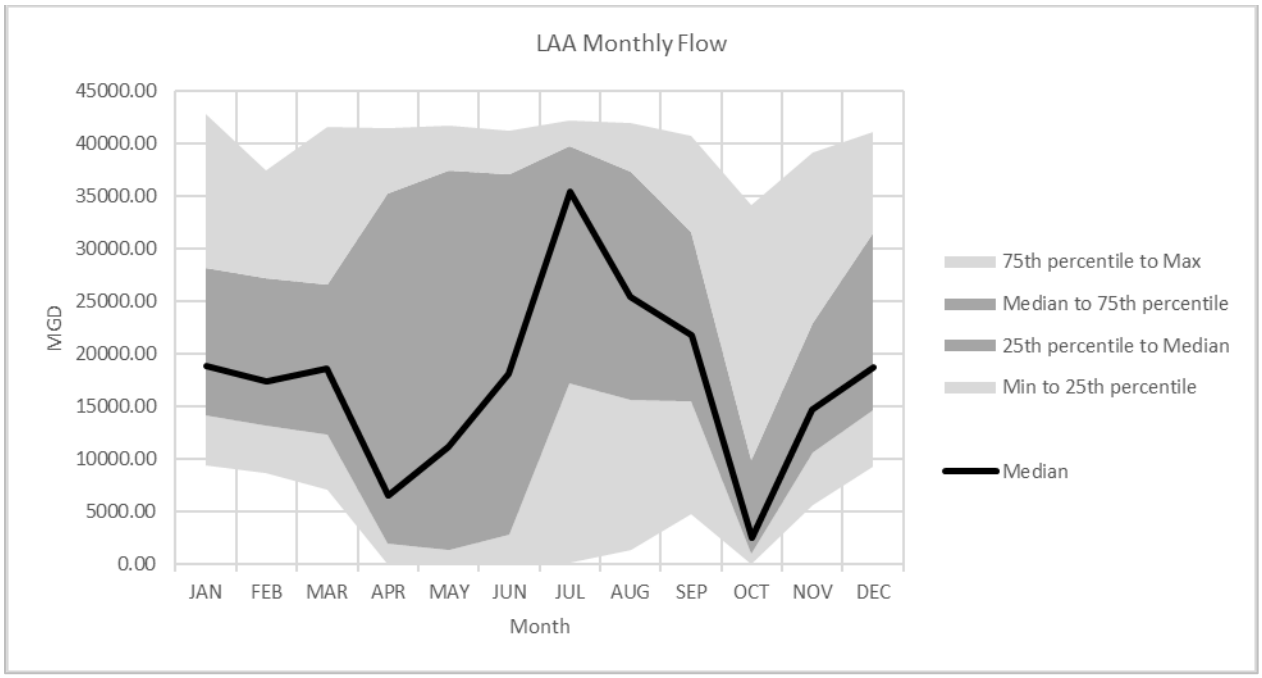


Figure 3-9. Monthly Average Variability of Los Angeles Aqueduct Flows Available to the City.

[1] All alternatives have very similar results; Alternative 7 was selected to show the correlation between LAA flows and Program production.

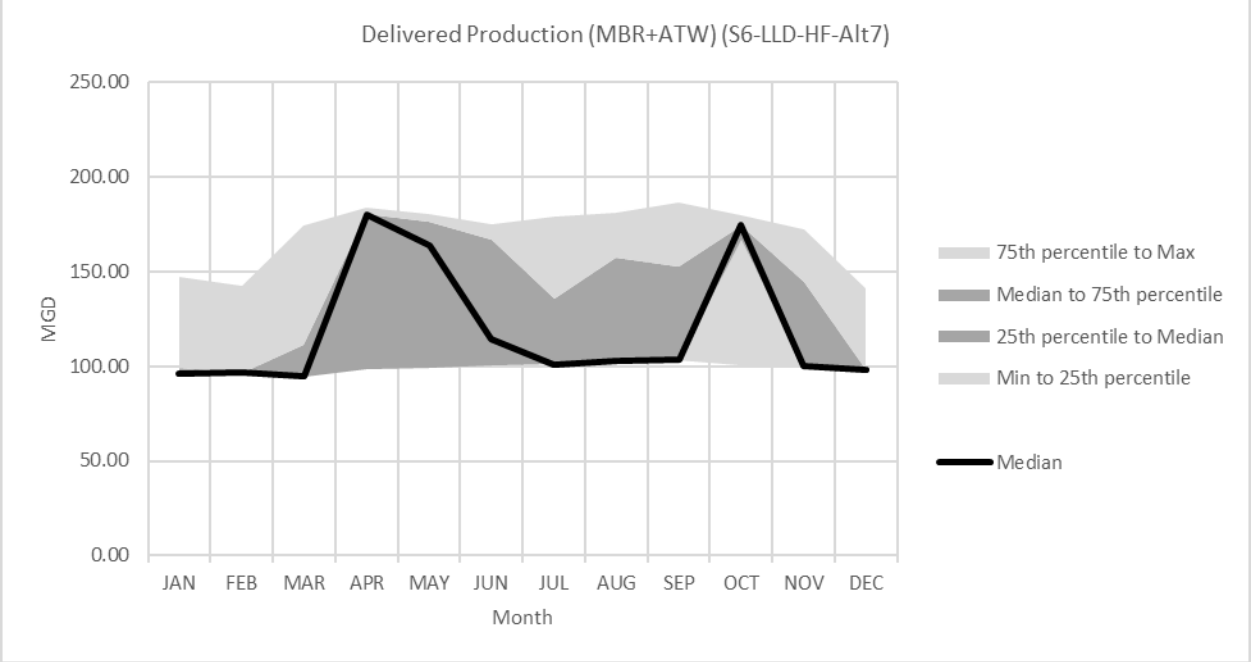


Figure 3-10. Monthly Average Variability of Program-delivered Production Under Low Demands.

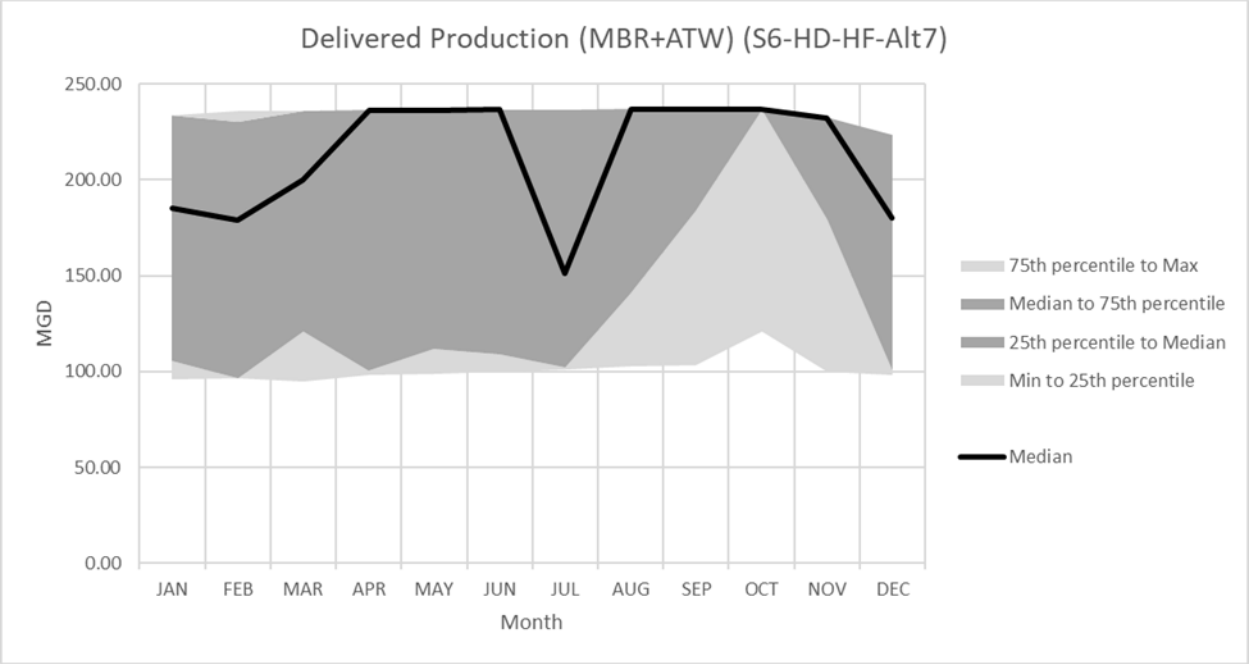


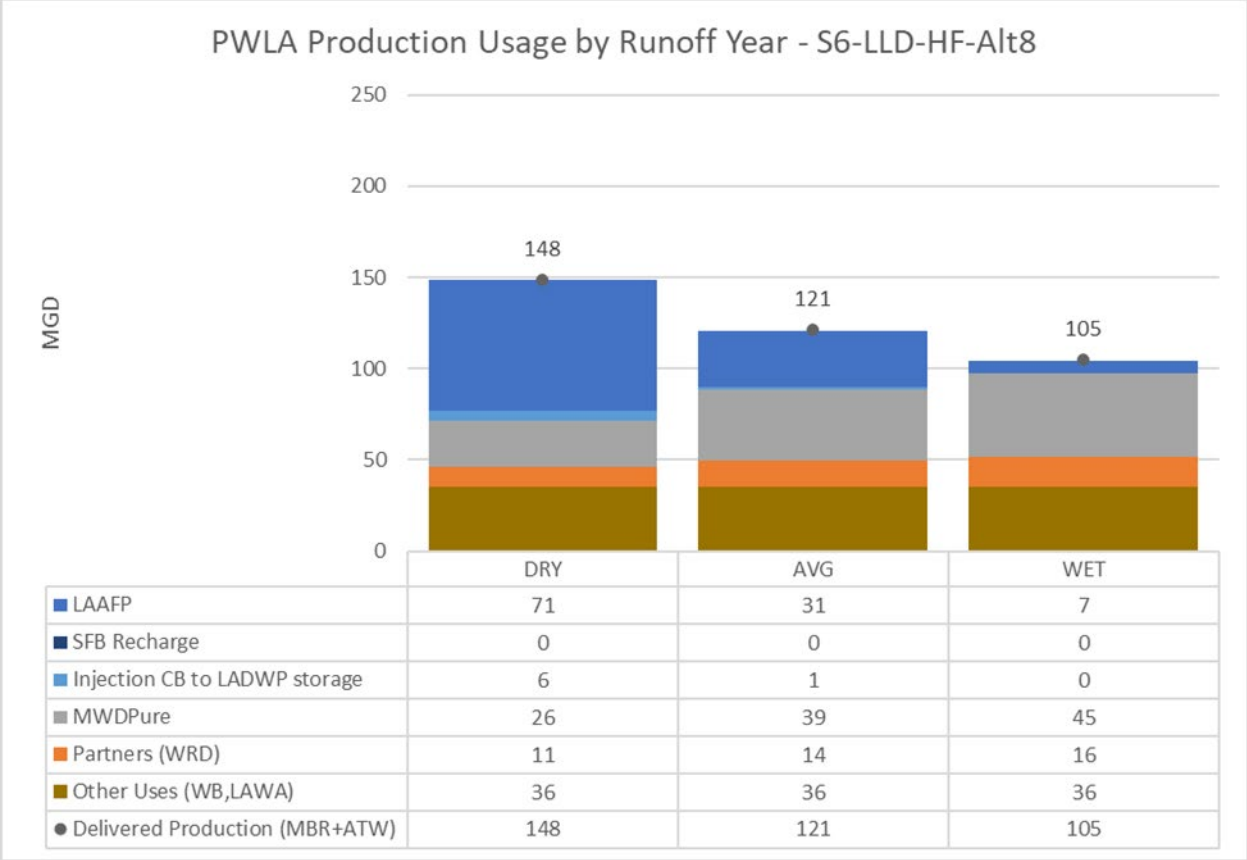
Figure 3-11. Monthly Average Variability of Program-delivered Production Under High Demands.

The annual and monthly production variability can also be categorized by LAA runoff year types and seasonal windows.

Model scenarios with the greatest variability for runoff years and monthly production variation, on average, were selected for presentation here. On average, Scenario S6-HD-HF-Alt8 (Figure 3-12) had the greatest variation among runoff years, and Scenario S6-LLD-HF-Alt8 (Figure 3-13) had the greatest variation in monthly production. Although Figure 3-12 and Figure 3-13 present averages of production variability, the year-to-year or month-to-month variation could be much greater (Figure 3-8).

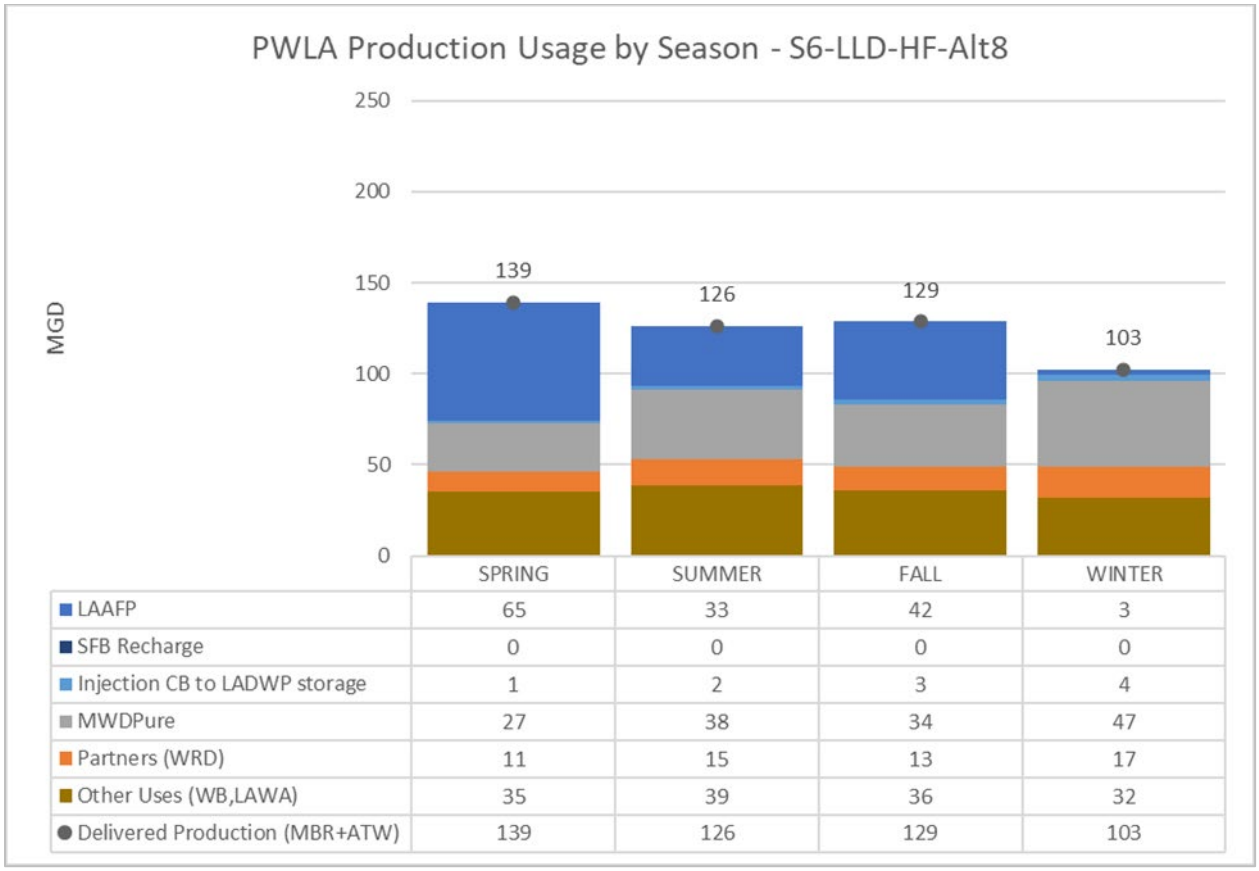
Figure 3-12 shows the average Program production by demand source when Phase 3 is complete. It shows how production varies with Program deliveries across different LAA runoff year types (wet, normal, and dry). The figure shows the most significant difference between dry and wet years, approximately 67 cfs (43 MGD), with 162 cfs (105 MGD) production in wet years and 229 cfs (148 MGD) in dry years. It indicates a high demand for Program water for the LAAFP during dry years of 110 cfs (71 MGD) and a significant reduction during wet years (11 cfs [7 MGD]). It also shows increased reliance on the Metropolitan's PWSC project during wet years of 67 cfs (45 MGD) instead of 40 cfs (26 MGD) in dry years.

Figure 3-13 shows that the combination of system demands and available supplies yield the highest production rates to be during spring and fall, and the lowest are expected during winter. This profile is consistent with the combination of LAA available flows and system demands.



	DRY	AVG	WET
LAAFP	71	31	7
SFB Recharge	0	0	0
Injection CB to LADWP storage	6	1	0
MWDPure	26	39	45
Partners (WRD)	11	14	16
Other Uses (WB,LAWA)	36	36	36
Delivered Production (MBR+ATW)	148	121	105

Figure 3-12. Average Program Production Delivered by Runoff Year Type.



	SPRING	SUMMER	FALL	WINTER
LAAFP	65	33	42	3
SFB Recharge	0	0	0	0
Injection CB to LADWP storage	1	2	3	4
MWDPure	27	38	34	47
Partners (WRD)	11	15	13	17
Other Uses (WB,LAWA)	35	39	36	32
Delivered Production (MBR+ATW)	139	126	129	103

Figure 3-13. Average Program Production Delivered by Season.

3.3 Phasing

The ONAT model simulations include the previously assumed phasing of various projects that will come online between 2024 and 2054. These include phasing for the following components:

- Program water production
- Improvements and infrastructure to extract and recharge CB
- Conveyance and recharge facilities to support recharge at SFB
- Conveyance to LAAFP
- Conveyance to Metropolitan's PWSC backbone

ONAT includes the phasing schedule for projects to quantify how much the facilities are used, and to better size those projects based on more appropriate estimations around their uses. For example, an initial model finding was the relatively low-flow deliveries to LADWP's CB storage, which triggered the discussion of potentially also delivering to partners (in this case, WRD).

This section summarizes the assumed schedule for the model results in this TM. Note, Program phasing was revised after the ONAT modeling was completed for this TM.

Program Feed Capacity:

- Phase 1, July 1, 2023 to June 30, 2038: 60 MGD
- Phase 2. July 1, 2038 to June 30, 2048: 120 MGD
- Phase 3, July 1, 2048 to end of simulation: 272 MGD

CB Total Extraction Capacity:

- Current to June 30, 2040: 10 cfs (6.5 MGD)
- July 1, 2040 to June 30, 2046: 15 cfs (10.0 MGD)
- July 1, 2046 to June 30, 2052: 37 cfs (24.0 MGD)
- July 1, 2052 to end of simulation: 59 cfs (38.0 MGD)

CB Augmentation (Extraction and Injection):

- Current to June 30, 2046: 0 cfs (0 MGD)
- July 1, 2046 to June 30, 2052: 5 cfs (3 MGD)
- July 1, 2052 to end of simulation: 28 cfs (18 MGD)

CB for WRD (Injection):

- Current to June 30, 2040: 0 cfs (0 MGD)
- July 1, 2040 to June 30, 2046: 15 cfs (10 MGD)
- July 1, 2046 to June 6, 2052: 32 cfs (21 MGD)
- July 1, 2052 to end of simulation: 31 cfs (20 MGD)

SFB Recharge:

- Current to June 30, 2039: 0 cfs (0 MGD)
- July 1, 2039 to end of simulation – Recharge Basins and injection wells plus conveyance are ready to receive Program water, seasonal variation of capacity, with a maximum of 230 cfs (148.6 MGD) between April and October. This capacity is shared between Program and recharge flows from Donald C. Tillman Water Reclamation (approximately 37 cfs [24 MGD]). The conveyance from the Program to SFB recharge limits the recharge to 185 cfs (119.6 MGD) in Alternatives 4 and 7, and 215 cfs (139 MGD) in Alternatives 5 and 8.

VNC:

- Current to June 30, 2049: 0 cfs (0 MGD)
- July 1, 2049 to end of simulation – The VNC can receive 356 cfs (230 MGD) of Program water from the AWPF at or near the HWRP, or produce 163 MGD of IPR-quality Program water to be treated and delivered as DPR to the City's distribution system

PWSC:

- Current to June 30, 2053: 0 cfs (0 MGD)
- July 1, 2053 to end of simulation – Metropolitan's PWSC project is active, and Program infrastructure can send up to 73 cfs (47 MGD) of Program water to Metropolitan PWSC

Given how similar the model simulation results are for each alternative, this phasing discussion is based on a comparison between two book-end model simulations for Program production. The lower production simulation was a simulation with lowest demands (S6-LLD-HF-Alt4) and the higher Program production simulation was the same alternative with higher demands (S6-ID-HF-Alt4).

Early phases will include Program deliveries to WB, SFB recharge, as well as WRD and LADWP storage in CB (references to CB storage in the ONAT include also the storage rights of WCB). As mentioned, deliveries to WB and WRD are kept constant, with seasonal variation.

Figure 3-14 and Figure 3-15 show the monthly Program production rates and delivery for different demands. The figures also show the LAA, wet, normal, or dry flow conditions. Figure 3-14 and Figure 3-15 correspond to the lowest and highest demands, and show similar uses of Program water during Phases 1 and 2, with most of the Program flows being delivered to SFB.

Under the phasing plan used for ONAT modeling, AWPF production would not begin until Phase 2 when infrastructure was ready to deliver ATRW to SFB and partners (WRD). Phase 1 could only rely on

membrane bioreactor treatment demands. This phasing plan has since been revised, subsequent to this modeling and thus, new phasing is not reflected in these results.

The Program will have consistent idle capacity during the winter of the previously defined Phase 2 because of a lack of SFB recharge capacity. However, SFB would reach maximum recharge capacity during other seasons.

The difference between the two book-end simulations starts during Phase 3, when the Program is at full production capacity. By that time, in 2048, the lower-demand simulation will have a full SFB and will not be able to deliver Program flows to that basin (Figure 3-16). The higher-demand scenario will delay SFB reaching maximum capacity until 2050 (Figure 3-17). Figure 3-16 and Figure 3-17 also show total groundwater extraction from SFB, with extraction units in cfs (preferred units for SFB). Approximately 140 cfs of extraction are related to SFB's remediation. Additional extraction can be associated with rights or Program storage. Under low demands, there will be few opportunities to extract an amount beyond remediation from SFB because of how the water supply is prioritized. Under the High-demand scenario, there will be more opportunities to extract beyond remediation. In both cases (low and high demand), extraction opportunities decrease after SFB reaches maximum capacity, not because of the basin being full, but because of less demand for this supply once DPR delivery from VNC comes online.

CB (Figure 3-18 and Figure 3-19) will still have available storage; however, it will be limited by the recharge and conveyance capacity. The CB storage current storage assumptions are a round value chosen somewhat arbitrarily and might change in the future.

CB storage for Program reaches full status after 2054 in both book-end scenarios. The lack of extraction capacity from CB (maximum 59 cfs [38 MGD] or 42,600 AFY) in conjunction with the prioritization of the CB supply, results in Program water being stored in CB. Figure 3-18 and Figure 3-19 also show total groundwater extraction from LADWP's account in CB, with extraction units in MGD (preferred units for CB). CB does not have a minimum extraction, so, based on water supply prioritization, some years have few or no extractions from the basin. Extractions under low and high demand will decrease as LADWP reaches maximum storage capacity on its basin account.

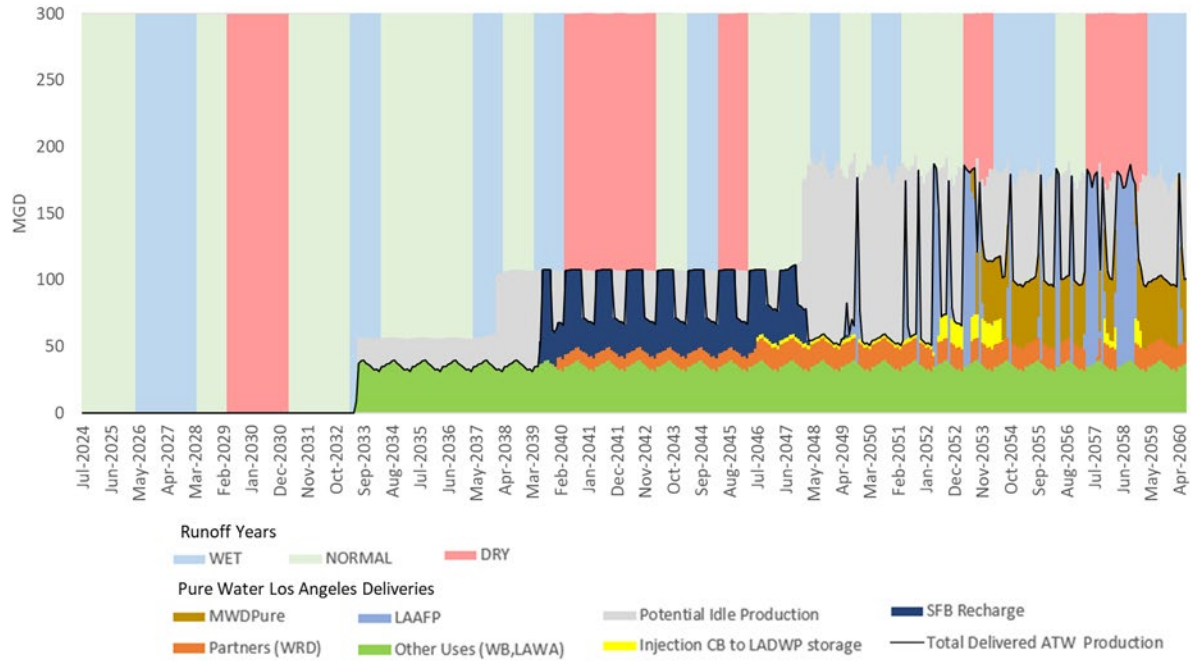


Figure 3-14. Monthly Average Program Flow Production Under a Low-demand Scenario.
Note: Model run S6-LLD-HF-Alt4.

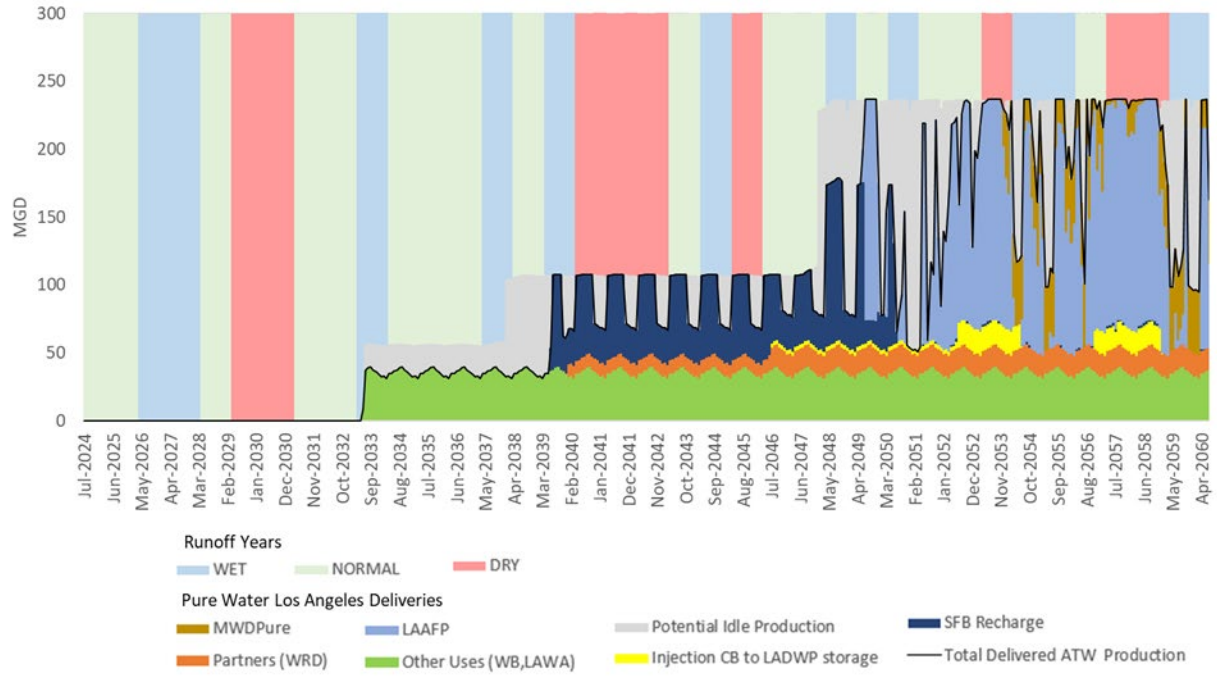


Figure 3-15. Monthly Average Program Flow Production under a High-demand Scenario.
Note: Model run S6-ID-HF-Alt4.

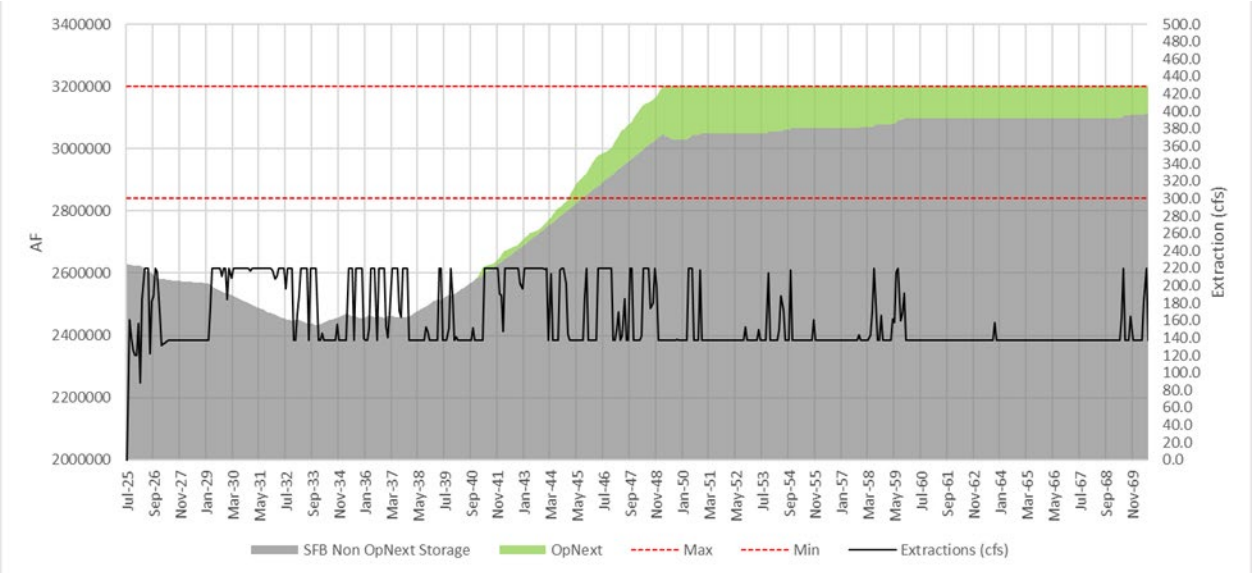


Figure 3-16. San Fernando Basin Storage for a Low-demand Scenario.
Notes: Extraction units in cfs, model run S6-LLD-HF-Alt4.

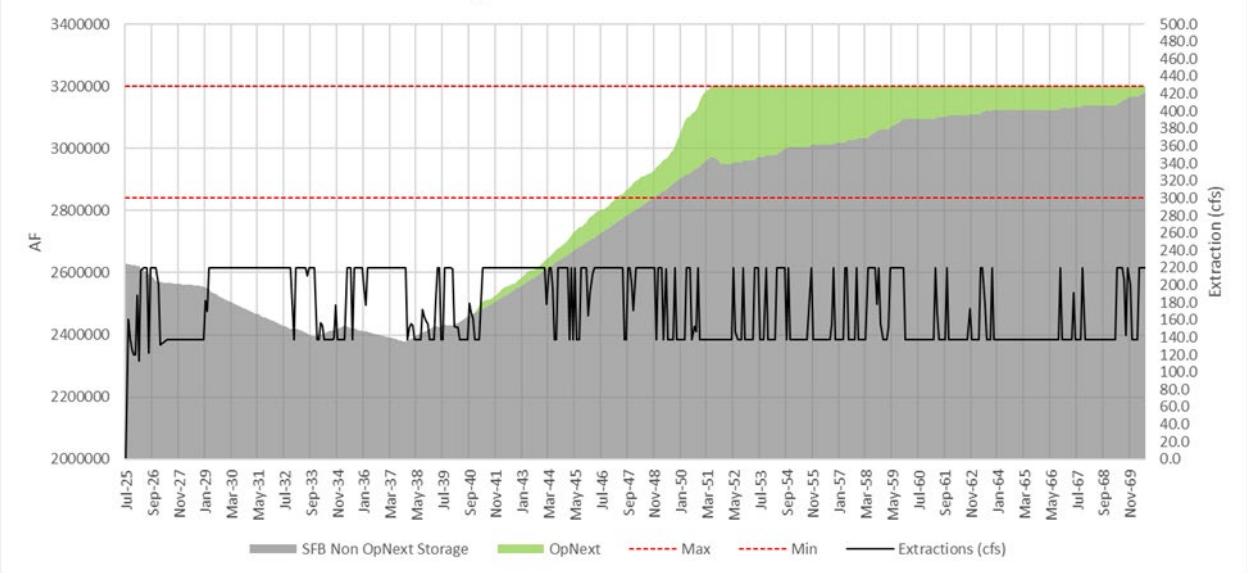


Figure 3-17. San Fernando Basin Storage for a High-demand Scenario.
Notes: Extraction units in cfs, model run S6-HD-HF-Alt4.

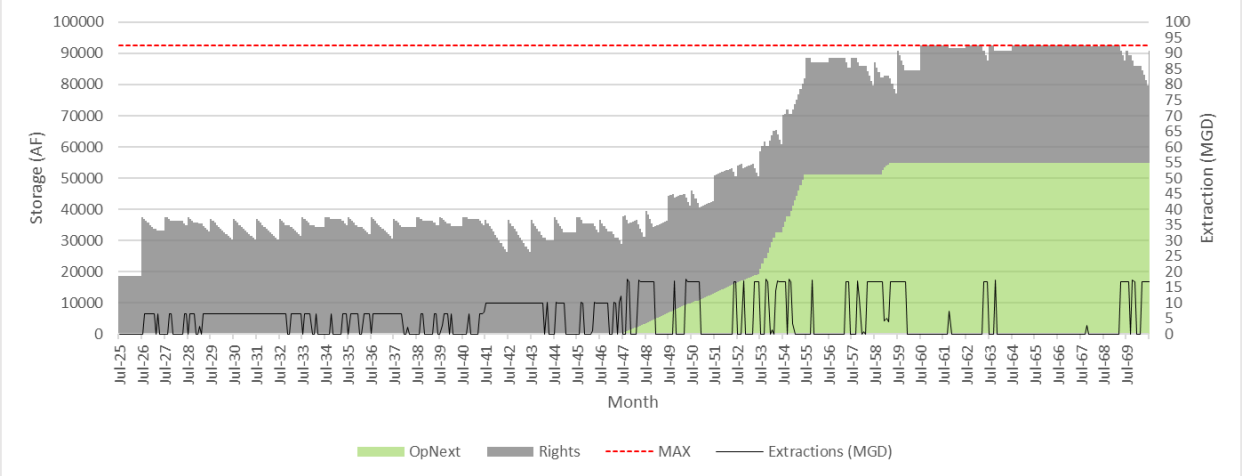


Figure 3-18. Central Basin Storage and LADWP Extractions for a Low-demand Scenario.
Notes: Extraction units in MGD, model run S6-LLD-HF-Alt4.

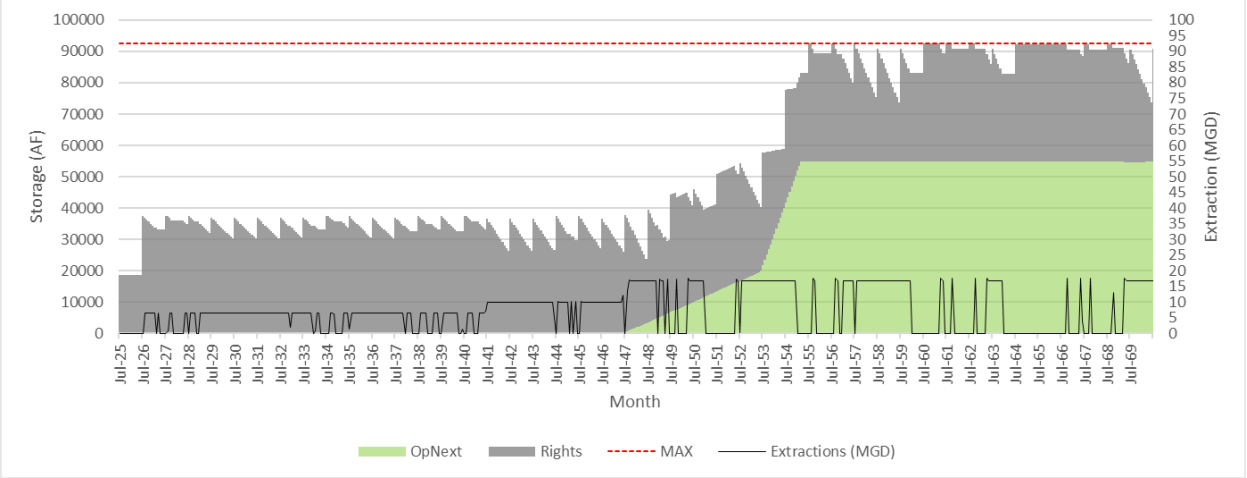


Figure 3-19. Central Basin Storage for a High-demand Scenario.
Notes: Extraction units in MGD, model run S6-HD-HF-Alt4.

4. Conclusions and Next Steps

ONAT offered a starting point to discuss potential strategies that could accommodate Program ATRW production and maximize use of LADWP's current supply portfolio. Program ATRW will increase the system's resiliency during droughts and provide an additional water supply to the existing portfolio.

This TM provides the following information:

- ONAT model outputs that could guide the comparison and selection of alternatives
- Flowrates to the potential Program components
- Overall Program performance under different LAA flow conditions and water supply demand uncertainties

The following traits are common across each model run based on annual average Program production with phasing incorporated:

- A high correlation between potential idle AWPF production flows and wet LAA years
- A minimum production around 155 cfs (100) MGD after 2054 (once all projects are in place) depending on partners, such as WB, WRD, and Metropolitan
- High LAAFP demands for Program ATRW production during dry years
- High use of SFB for recharge of ATRW during the initial project phases until SFB groundwater basin reaches full capacity

Findings related to ONAT model results can be grouped into ATRW production, changes in the water supply portfolio, and changes in groundwater storage.

It will be important to address flow variations in Program water production that result from high LAA flows paired with required groundwater extractions for remediation and system demand uncertainties. The ONAT model development yielded the following findings that are important to ATRW production:

- All approaches and alternatives under same system demand conditions produce similar results related to AWPF production
- In the near term, a significant volume of ATRW is used to recharge SFB and used at LAAFP, with the LAAFP use continuing through the modeling time series that was considered
- The variability of wet, normal, and dry LAA flow conditions, paired with demand uncertainties, is a major driver for AWPF production variability
- The system depends less on the Metropolitan PWSC connection during dry and high-demand conditions but could use the entire 47-MGD capacity during wet and low-demand conditions

The addition of Program IPR and DPR to the LADWP water supply portfolio shows a significant reduction in wastewater discharges to the ocean and enhances system resiliency, providing a useful new water supply for LADWP. ONAT model results yielded the following findings related to the Program as a new water supply for the City:

- Based on Program phasing (availability of infrastructure conveyance and storage and demand locations), ATRW is used for IPR SFB and CB in the early years of the Program. In Phase 3, larger volumes of ATRW are produced for the LAAFP for DPR
- The use of Metropolitan-purchased, imported water decreases from approximately 33% to 19% of the entire system demands in the model simulations produced
- It is important to balance ATRW use with use of existing groundwater rights

The *2015 Stormwater Capture Master Plan* (LADWP 2015) describes that there is a potential to increase recharge in SFB by 68,000 to 114,000 AFY, in addition to the current basin recharge of approximately

60,000 AFY. ONAT assumes that the current SFB recharge plus future stormwater recharge programs will total 132,000 AFY of recharge. Remediating SFB will increase extractions but does not create enough additional space in the long-term for Program ATRW recharge relative to assumed stormwater capture based on LADWP's priorities as defined for ONAT modeling.

Extraction capacity in SFB can only be increased to a certain degree without impacting the use of LAA flows. In the future, a strategy could be explored to adjust the priorities of recharge and extraction to optimize operations and stormwater capture, and to maximize LAA use and storage space in SFB.

The first round of ONAT model results highlighted the following items to be considered for future potential system groundwater storage:

- CB and SFB may fill up based on how water supply is prioritized, and because of increases in recharge.
- Recent and planned stormwater capture programs will significantly increase additional stormwater recharge in SFB.
- Planned Donald C. Tillman Water Reclamation will increase recharge (26,868 AFY) in SFB.
- SFB remediation will increase basin extractions.
- SFB extractions must be balanced with use of LAA flows.
- It may be valuable to discuss large water storage opportunities within the region.

As part of the next steps, the ONAT results can be further used to support discussion and offer insights into various Program strategies that can be tested to help the entire system balance resiliency, the use of current supplies, and sizing of the overall Program. Further ONAT modeling opportunities can include:

- Update phasing of projects.
- Consider dynamic SFB operation, accounting for recharge and credits with Valley floor deliveries, can better represent basin storage. Reduced demand could increase SFB storage. The current model assumes constant yearly recharge.
- Consider advanced strategies for LAA flows and potential additional storage, such as water banking.
- Add model rules to turn Program production on or off based on LAA flow forecasts, and estimate operational periods.
- Add model rules for a stormwater capture value as a function of wet and dry years.
- Determine demand and storage needs for seasonal LAA flow variability.
- Explore system uncertainty using the Monte Carlo analysis model capability.
- Explore various production scenarios to right-size final build out.
- Modify existing assumptions or boundary conditions, such as minimum outfall flows for LASAN.

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Attachment A.
Microsoft Excel File with Model Outputs (electronic file)

Attachment B. Idle Capacity and Idle Production Metrics

Attachment B. Idle Capacity and Idle Production Metrics

B.1 Metric Description

Idle time consists of idle capacity and idle production, as considered in this technical memorandum (TM):

- **Idle capacity** refers to constructed treatment capacity that is unused because there is not enough influent flow to the facility. For example, a system built to accept 272 million gallons per day (MGD) of wastewater may have idle capacity if there is only 200 MGD of influent wastewater, such as through increased water conservation.
- In contrast, when there is available influent flow to treat at the constructed treatment capacity, but there are not enough demands to accept the produced purified recycled water, this can be considered **idle production**. An example of this is where there is at least 272 MGD of influent flow available to produce 230 MGD of purified recycled water from the facility, but only 150 MGD of purified recycled water can be delivered to Los Angeles Department of Water and Power (LADWP) storage and demand locations.

Operation NEXT Assessment Tool (ONAT) simulations assumed that the Advanced Water Purification Facility (AWPF) will always accept the maximum wastewater flows it can process, up to the influent treatment capacity of 272 MGD. If, at a given time step, the production is more than demands, the model accounts for the difference as idle production.

The average idle time can vary significantly within a given model simulation and across model scenarios and alternatives. The main drivers for variations within a given simulation are Los Angeles Aqueduct (LAA) flow availability (variability between wet and dry years) and prioritization of existing supplies. The main driver for variations across scenarios is the system demand variation.

Figure B-1 shows the two potential idle components of the Pure Water Los Angeles Program (Program) treatment system: idle production and idle capacity. It includes three **hypothetical production examples** that could occur over a period ranging from 1 month to several years. These examples assume a fully developed Program treatment system capable of handling up to 272 MGD of wastewater inflows, including assumptions for partnership flows to West Basin Municipal Water District (West Basin), Metropolitan Water District of Southern California (Metropolitan), and Water Replenishment District (WRD), included under the delivered production bar. Figure B-1 also accounts for losses from reverse osmosis (RO) concentrate from the treatment processes.

Example 1: Ample wastewater availability in a high-demand scenario; the full 272 MGD inflow capacity is used, resulting in 230 MGD of production, all of which is delivered to the system and partnerships, resulting in:

- Idle Capacity: None; the plant operates at its maximum inflow capacity of 272 MGD.
- Idle Production: None; all 230 MGD produced is delivered to storage and demand locations.

Example 2: Ample wastewater availability in a lower-demand scenario; the full 272 MGD inflow is treated, resulting in 230 MGD of production, but only 150 MGD is delivered to the system, as follows:

- Idle Capacity: None; the plant operates at its maximum inflow capacity of 272 MGD.
- Idle Production: 80 MGD; only 150 MGD of the 230 MGD produced is delivered.

Example 3: Limited wastewater availability in a lower-demand scenario; wastewater inflows are limited to 200 MGD, supporting production of only 169 MGD. Additionally, there is insufficient customer demand for the full 169 MGD, resulting in:

- Idle Capacity: 72 MGD; the plant cannot use its full 272 MGD inflow capacity due to limited wastewater availability.
- Idle Production: 19 MGD; only 150 MGD of the 169 MGD produced is delivered.

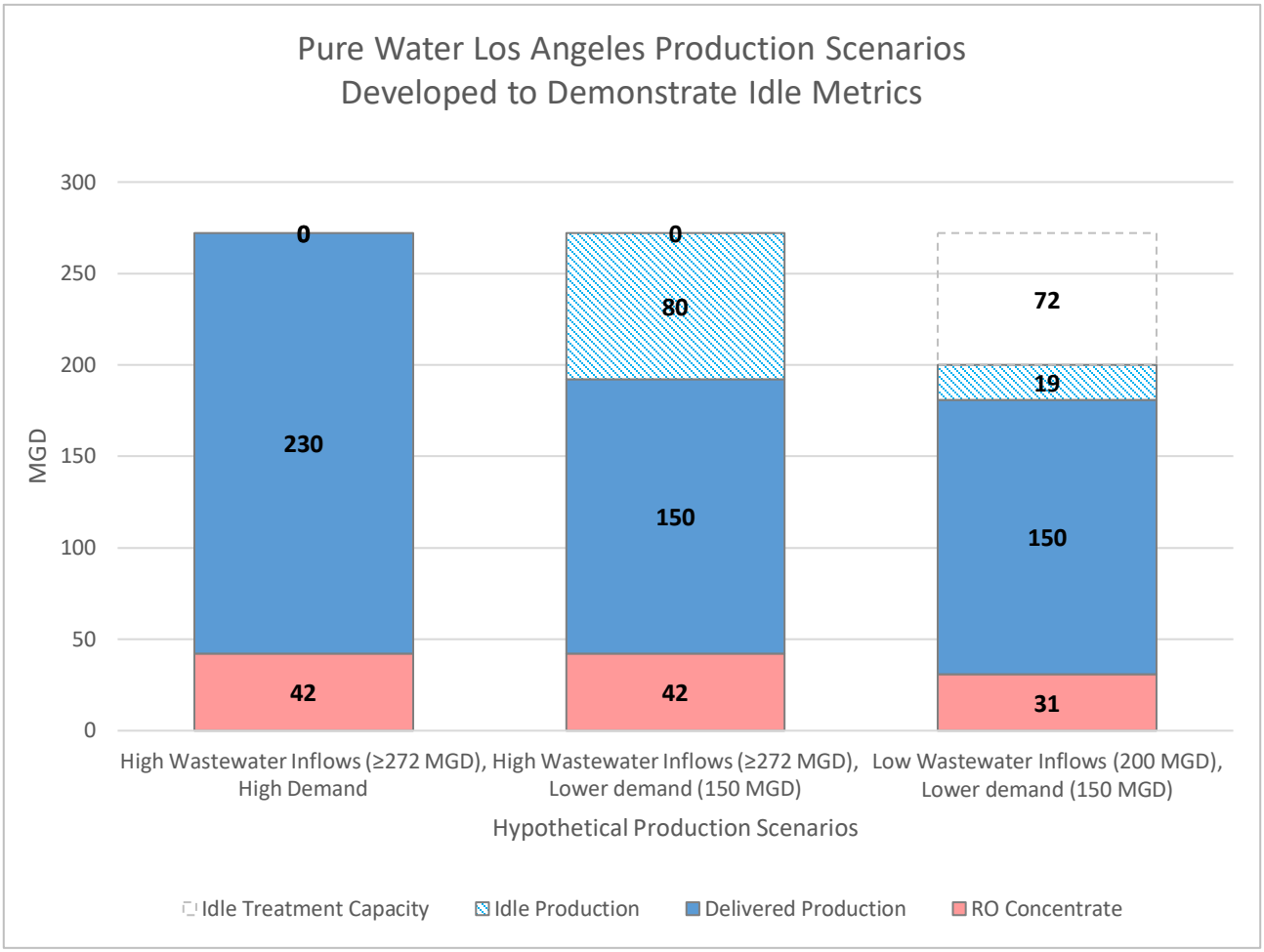

Figure B-1. Examples of Idle Capacity and Idle Production at Different Wastewater Availability and System Demand Conditions.

B.2 Model Results

The combination of idle production and idle capacity is presented here as idle capacity plus production. Assuming a 272 MGD intake capacity, Table B-1 shows the percentage of simulation time that the treatment system will be idle in terms of production and capacity for different flow rates and across the full range of model scenarios and alternative runs, including both minimum and maximum.

Table B-1. Idle Capacity plus Production Percentage Across All Demand Scenarios and Alternatives

	Idle Capacity + Production, % of the Time			
Demands Scenarios at Different Influent Flows	25 MGD	50 MGD	75 MGD	100 MGD
Minimum (Scenarios with High Demand)	49	40	33	26
Maximum (Scenarios with Low Demand)	88	85	68	60

For example, the table shows that the treatment system could experience 50 MGD of idle capacity plus production between 40 and 85% of the time. The 40% idle time corresponds to high system demand conditions, while the 85% idle time corresponds to low-demand conditions. All values shown are based on the model assumptions and prioritization described previously in this TM.

Figure B-2 shows the full exceedance probability for the idle capacity plus production for all model simulations used to develop Table B-1, based on a feed capacity of 272 MGD to the AWPF. There is minimum variability of idle capacity plus production within all alternatives under one demand assumption, showing that the idle capacity plus production is mainly driven by system demands. For example, under high-demand scenarios, all alternatives present a 50% probability of exceeding approximately 24 MGD of idle capacity plus production. The probability of exceeding 24 MGD for lower demands is much higher: 88% of the time. There is a noticeable drop in mid and low demands between 20 and 50 MGD.

Idle capacity plus production exceeding 150 MGD has a low probability, less than 5% for most scenarios and about 18% for the lowest-demand scenario. This suggests that, for example, a 122 MGD feed capacity (272 MGD minus 150 MGD) that results in 104 MGD of purified recycled water could be operating most of the time.

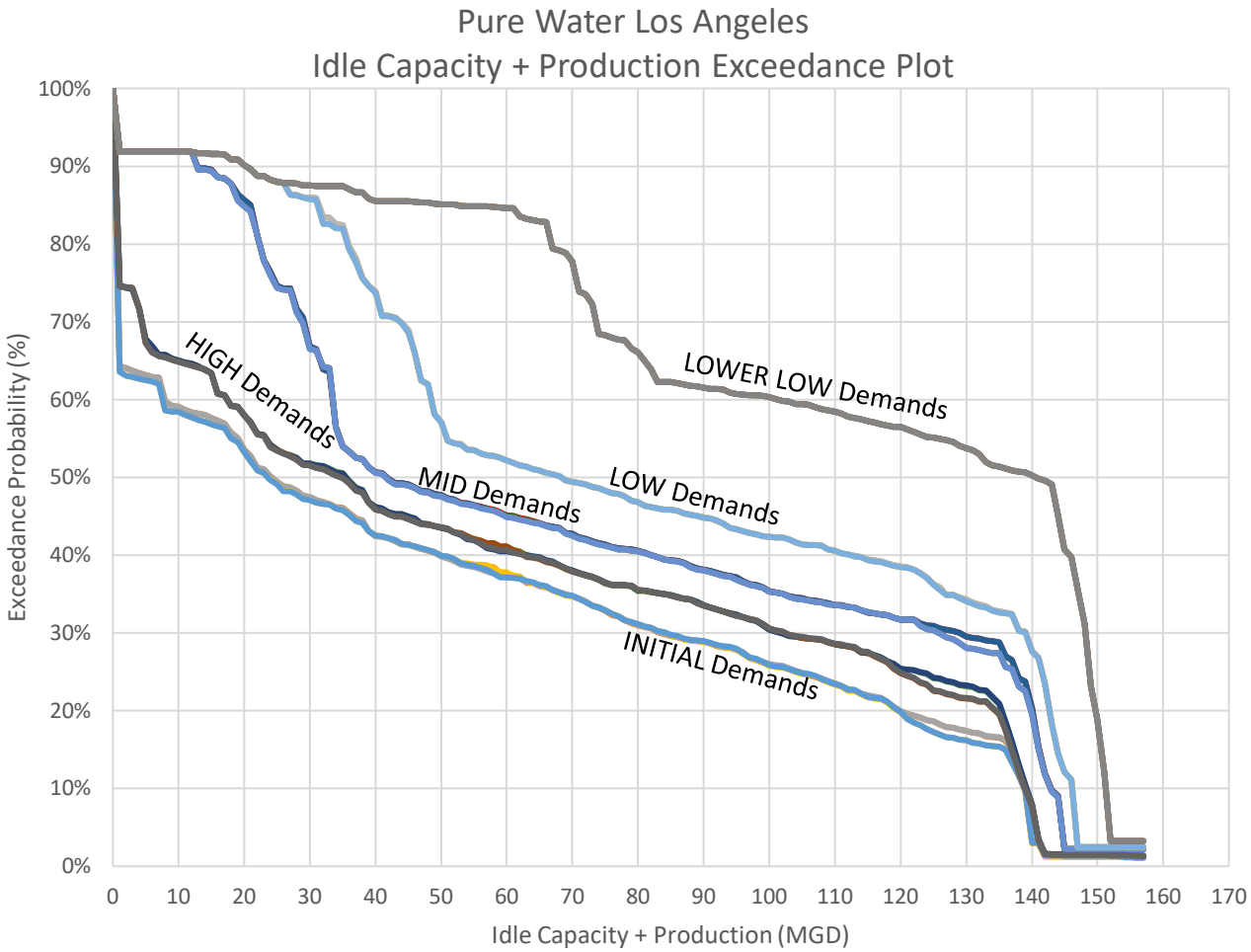

Figure B-2. Idle Capacity Plus Production Exceedance Probabilities Based on Influent Treatment Capacity of 272 MGD to the AWPF.

Resiliency Analysis TM

Resiliency Analysis Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
December 20, 2024

Executive Summary

One of the main drivers of the Pure Water Los Angeles Program (Program) is to maximize the reuse of effluent from Hyperion Water Reclamation Plant (HWRP) to create a new and sustainable local water supply. This new local advanced treated recycled water (ATRW) supply from the Program would increase the resilience of the City of Los Angeles's (City's) water supply portfolio under future uncertainties or hazards.

This technical memorandum (TM) documents the analysis approach, assumptions, and findings of the Pure Water Los Angeles resilience analysis and offers recommendations for consideration in the Master Plan and subsequent steps in Program implementation. It also explores the future uncertainties related to vulnerability to climate, seismic, and demand risks through the development of resilience scenarios. The TM emphasizes two main aspects of resilience:

1. Resilience Benefits of Pure Water Los Angeles
2. Vulnerability of Pure Water Los Angeles Program infrastructure

Sections 1 and 2 introduce resilience and describe the resilience analysis approach. Section 3 summarizes the evaluation of the Program's resilience benefits. It compares potential changes in water supply reliability, water cost, and other factors with conditions if the Program were not implemented. To realize resilience benefits from the Program, Program facilities must be resilient to climate and seismic hazards.

Section 4 of this TM explores the potential future changes in Los Angeles region climate along with seismic risks, and assesses each hazard and its impact to Pure Water Los Angeles facilities. Section 5 provides a summary of the analysis and findings of the components of this assessment.

Resilience Benefits

The resilience benefits analysis evaluates the Program's benefits related to major natural system stressors on the City's water system:

- Climate and hydrology extremes and uncertainty
- Earthquake risks to water infrastructure

Scenarios were developed for these system stressors, to describe the uncertainties and possible outcomes and to develop quantitative estimates of the changes. Each scenario underwent water system modeling for the existing City water system and for the future system with the Program in place. The changes in various resilience metrics with the Program were evaluated, and the benefits are described here.

Six scenarios are being considered for the Master Plan (MP) resilience analysis. These scenarios investigate exogenous factors (outside Los Angeles Department of Water and Power's (LADWP's) control) that may impact the future water supply system and Program, and are important planning considerations:

- **Current Trends Scenario 1:** Adjusted historical water supply conditions to reflect current operations, infrastructure, and projected future demands, including:
  - **Extreme Drought Scenario 2 (Jacobs 2024a):** Most extreme droughts from the historical record (1922 to 2023) or derived from historical records.
  - **Pluvial Scenario 3 (Jacobs 2024a):** Most extreme pluvial (wet) period from the historical record (1922 to 2023) or derived from historical records.
- **Future Climate Change Scenario 4:** Future climate projections affecting water supply availability for Los Angeles Aqueduct and Metropolitan Water District of Southern California (Metropolitan).

- **Emergency and Seismic Scenario 5:** Loss of supply from either Los Angeles Aqueduct or Metropolitan, or both, due to a major seismic event representing a time of failure for a specific location in the system, followed by a recovery period.
- **Demand Uncertainty Scenario 6:** Exploration of future alternative water demand projections, considering population projections and water use efficiency factors.

Scenarios 1a, 1b, and 4 are presented in the companion Operation NEXT Assessment Tool Results TM (Jacobs 2024). This TM focuses on Scenario 4 – Future Climate Change and Scenario 5 – Emergency and Seismic Scenario. Collectively, the scenarios attempt to explore trends and uncertainties related to natural system processes (climate and seismic) and City water use (demands).

Table ES-1 summarizes the water supply, water cost, and wastewater reuse benefits. The Program can provide a reliable water supply that can mitigate both drought-related risks and potential earthquake risks. Through the analysis, it was found that the benefits of Pure Water Los Angeles depend greatly on the presence or absence of pluvial periods, greater available storage for ATRW supply in groundwater basins, and available delivery to other storage or demand locations.

Table ES-1. Resilience Scenario Results

Program Benefits and Impacts	Metric	Reference (no Program)	Historical Hydrology (Scenario 1)	Climate Change Scenario (Scenario 4)	Seismic Scenario (Scenario 5)
Maximize reuse of locally generated wastewater	Total percent of LASAN wastewater used (%), following Phase 3 implementation	10%	46%	49%	46%
Resiliency of water supply during critical scenarios	Reduction in potential water shortages during critical resilience scenarios (AF)	N/A	330,000 AF (over 2 years)	200,000 AF (over 5 years)	225,000 AF (over 2 years)
Economic benefits of water cost savings during critical scenarios	Cost savings during critical resilience scenarios ($B)	N/A	$1.6-2.3 B	$1.0-1.3 B	$1.1-1.6 B

$B = billion(s) of 2024 U.S. dollars
AF = acre-foot (feet)
KAF = 1,000 acre-feet
N/A = not applicable

The Program was found to offer considerable resilience benefits in general, and more pronounced benefits under extreme drought and earthquake scenarios. Maximum utilization for purified recycled water is expected for seismic or other emergency scenarios; and though infrequent, a significant seismic event could disrupt traditional water supply sources, highlighting the critical importance of the Program. Some areas within LADWP's northern service area are served exclusively by the Los Angeles Aqueduct Filtration Plant (LAAFP), meaning that a disruption to current water supply sources poses risks to those areas in particular.

Potable reuse is a vital strategy for building seismic resilience by reducing reliance on more vulnerable, imported water sources. Pure Water Los Angeles will provide a reliable alternative water supply to the Van Norman Complex and the vicinity of the LAAFP to mitigate the risk of water shortages and to support critical infrastructure and public health and safety, even potentially in the face of catastrophic seismic events. By investing in this Program that maximizes water reuse, LADWP can not only mitigate some of the risks associated with natural disasters but also contribute to improving long-term water security and environmental sustainability.

The Program is expected to generate water cost savings over alternative supply options during critical supply shortages. The Program's projected potential cost savings during emergency scenarios, estimated at $1.0 to 2.3 billion for the scenarios examined, underscore its potential to safeguard community well-being, even in the face of adversity.

Vulnerability Assessment

The approach to assess the vulnerability of the Program facilities and operations consists of the following major steps:

- Develop climate change and seismic vulnerability metrics.
- Identify Program systems and facilities.
- Evaluate the vulnerability of Program systems to climate and seismic hazards.
- Assign vulnerability rating to Program facilities.

Climate vulnerability was evaluated for the following hazards:

- **Extreme Heat Days:** Projected number of days exceeding daily maximum temperature of 95 degrees Fahrenheit (°F) or 98th percentile historical temperature
- **Wildfire:** Projected future probability of wildfire near each facility of the Program system
- **Extreme Precipitation:** Projected daily maximum precipitation exceeding the 1% annual exceedance probability (100-year precipitation event)
- **Pluvial Flooding:** Pluvial flooding refers to the flooding caused by high-intensity and short-duration precipitation events; the flooding threat is estimated by combining the projected extreme precipitation with the slope of the facility available for runoff
- **Floodplain Flooding:** Projected future floodplain flooding (rivers, creeks, channels) based on existing Federal Emergency Management Agency flood maps, combined with the 1% and 0.2% annual exceedance probability flow estimates
- **Coastal Flooding and Cliff Retreat:** Projected future sea level and coastal flooding due to inundation and storm surge and estimates of cliff retreat

The vulnerability of Program facilities to seismic hazards is estimated using the following criteria:

- Quaternary faults crossing a facility
- Nearby liquefaction zones
- Nearby landslide zones
- Peak ground acceleration (PGA) (g, which means acceleration due to gravity) information for the Los Angeles region, based on the ShakeMap classification (Wald et al. 1999)

Each facility was then assigned an overall seismic vulnerability rating. Table ES-2 summarizes the vulnerability assessments. This table establishes the overall vulnerability rating to each facility for each individual climate and seismic risk factor. As shown, of the south to north alignments, the Sepulveda alignment crosses fewer faults than the other south to north alignments, so it was rated as less vulnerable for the seismic category.

Table ES-2. Vulnerability Ratings for Each Climate and Seismic Risk Hazard by Facility

Pure Water Los Angeles	Extreme heat[a]	Wildfire	Extreme precipitation	Pluvial and floodplain	Flooding, coastal; cliff retreat	Earthquake, seismic
Proposed AWPF (HWRP)	L	--	L	L	L[b]	L/M
Sepulveda Alignment	M/H	M	L/M	L/M	--	M
Cahuenga Alignment	H	L/M	M	M	--	M/H
Griffith Park Alignment	H	L/M	L/M	M	--	M/H
Slauson Alignment	L/M	L/M	M	M	--	M/H
Florence Alignment	M/H	L/M	M	L/M	--	L/M
Manchester Alignment	M/H	L/M	M	M	--	L
VNC	H	M	L	L	--	M/H
Stormwater Parks	M/H	L	L	L	--	M
Future Wellfields	L	L	M/H	M/H	--	L/M
Spreading Grounds	M/H	M/H	L/M	M	--	L/M
Secondary Potential Injection Location	M/H	L	L	L	--	L

[a] *Days exceeding 95 degrees Fahrenheit*
[b] *Integrated coastal hazard-seismic assessment not conducted, but recommended to verify rating*
L = low risk L/M = low-medium risk M = medium risk M/H = medium high risk H = high risk

Recommendations

Based on the findings of this assessment, a number of recommendations for next steps have been developed. It is important to communicate, socialize, and review these findings with both Program Management and Operations staff to facilitate a supported set of adaptation strategies.

Recommendations to address climate vulnerabilities include:

- **Integrate Multiple Climate Vulnerabilities**: Vulnerabilities have been assessed individually. Specific climate vulnerabilities should be integrated into a compounded/weighted score developed by LADWP to support prioritization and facilitate multihazard resilience actions.
- **Develop Facility-Specific Actions (pluvial flooding, wildfire, and extreme heat vulnerabilities)**: Using the results from this assessment, the most vulnerable across these three categories should be identified, and facility-specific adaptation strategies should be developed. Actions for these hazards will likely be best addressed at the facility level.
- **Develop Regional Strategies**: This assessment has identified some regions where multiple climate hazards are concentrated. These include the coastal zone at HWRP, flooding at the Central Basin area and future recharge wells, and wildfire in the foothills. LADWP and Los Angeles Sanitation & Environment (LASAN) should consider whether regional strategies, such as a regional coastal protection plan or wildfire resilience actions, are more effective than facility-specific actions in these regions.
- **Update and Integrate LADWP and LASAN Design Standards:** Standards are a primary engineering driver for facility design and operations. LADWP and LASAN should consider revisiting, reviewing, and updating design standards and policies, as appropriate, to account for highly likely changes in climate

where the current and future facilities will operate (more extreme precipitation, increase in extreme heat days, higher sea levels).

- **Coordinate with other City and Regional Climate Adaptation Strategies**: LADWP should align its efforts with those of all City departments and regional efforts, so LADWP actions are consistent and integrated.
- **Protect City Occupational Health**: LADWP should develop updated policies and protocols to provide greater protection of worker health during extreme climate events, such as extreme heat and flooding.

Recommendations to address seismic vulnerabilities include:

- **Incorporate Resilient Pipeline Design and Construction:** Jacobs uses the guidelines published by the American Lifelines Alliance as design criteria and guidance for pipelines in seismic zones and near fault lines. Technical best practices include designing steel pipe with thicker cylinders (using a diameter-to-thickness ratio of 90 or 100), requiring stronger joints, and using seismic- and earthquake-resistant ductile iron pipe when crossing fault lines. Flexible joint connections (similar to those discussed here for tunnels) can also be installed at fault crossings.
- **Incorporate Resilient Tunnel Design and Construction:** Tunneling in a seismic region and through fault zones is not uncommon and has been successfully accomplished around the world, including in Los Angeles. A thorough geotechnical investigation and detailed analysis is required to determine the expected ground movement, and to fully understand the prevailing conditions to inform the design. The tunnel structure should then be designed to account for appropriate seismic loading and ground deformation.
- **Pump Stations and Treatment Facilities:** Because the water produced under the Program would ultimately be used for potable purposes, pump stations (including storage tanks and flow control stations) and treatment facilities for the Program could be designated as Criticality Category IV. This category has essential seismic importance as defined in the *Performance Based Seismic Design for LADWP Water System* (LADWP 2019). Facilities identified as Category IV are expected to provide water to essential facilities for post-earthquake response, public, health, and safety, including post-earthquake firefighting. As a result, they will need to be designed to remain functional during and following an earthquake.
- **Performance Standards:** LADWP should communicate the seismic performance standards it will apply to the Program and apply these to all Program elements, including facilities producing source water.

Adoption of these recommendations would address potential vulnerabilities and enhance Program resilience.

Seismic vulnerability could be reduced through integration of design features that will help minimize damage and avoid catastrophic failure in a seismic event. A risk-based investment could be adopted when designing and sizing pipelines to withstand potential earthquake damage.

As a further consideration regarding vulnerability, while designing infrastructure to address frequent scenarios offers efficiency, the threat of “black swan" events, defined as rare, high-impact occurrences with the potential to severely impact or limit entire systems, could also be considered. For critical infrastructure, such as water systems, addressing vulnerability and building resilience through approaches such as scenario planning or considering black swan events could add significant value, despite the additional cost.

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Acronyms and Abbreviations

°F	degree(s) Fahrenheit
AF	acre-foot (feet)
AFY	acre-foot (feet) per year
ATRW	advanced treated recycled water
B	billion(s)
CCTAG	Climate Change Technical Advisory Group
City	City of Los Angeles
CMIP5	Coupled Model Intercomparison Project Phase 5
CoSMoS	Coastal Storm Modeling System
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
g	acceleration due to gravity
GCM	General Circulation Model
HRWP	Hyperion Water Reclamation Plant
km	kilometer(s)
LAA	Los Angeles Aqueduct
LAAFP	Los Angeles Aqueduct Filtration Plant
LADWP	Los Angeles Department of Water and Power
LASAN	Los Angeles Sanitation & Environment
LOCA	locally organized constructed analog
m	meter(s)
Metropolitan	Metropolitan Water District of Southern California
MGD	million gallons per day
mm	millimeter(s)
MP	Master Plan
NOAA	National Oceanic and Atmospheric Administration
ONAT	Operation NEXT Assessment Tool

PGA	peak ground acceleration
Program	Pure Water Los Angeles Program
RCP	representative concentration pathway
TM	technical memorandum
UCLA	University of California Los Angeles
USGS	United States Geological Survey
VIC	variable infiltration capacity

1. Introduction

One of the main drivers of the Pure Water Los Angeles Program (Program) is to maximize reuse of effluent from Hyperion Water Reclamation Plant (HWRP) to create a new and sustainable local water supply. This new and local advanced treated recycled water (ATRW) supply would increase the resilience of the City of Los Angeles's (City's) water supply portfolio under future uncertainties or hazards. This technical memorandum (TM) explores the future uncertainties related to climate, seismic, and demand risks through the development of resilience scenarios. It then evaluates the Program's resilience benefits by comparing the changes in water supply reliability, water cost, and other factors, with conditions without the Program's implementation.

To realize the Program's resiliency benefits, Program facilities must be resilient to climate and seismic hazards. The TM also explores the potential future changes in regional climate and seismic risks, and assesses the hazard and its impact to Program facilities. Climate and seismic hazards are mapped, and each major Program component is evaluated for its vulnerability to these hazards. This document then provides recommendations to improve the Program's infrastructure resiliency. This assessment of potential Program vulnerabilities was completed for the Resiliency Analysis workshop held with Los Angeles Department of Water and Power (LADWP) and Los Angeles Sanitation & Environment (LASAN) on August 8, 2024.

The Master Plan (MP) Team has reviewed University of California, Los Angeles's (UCLA's) preliminary findings to evaluate the resiliency benefits (Barsch et al 2024). During 2023 and 2024, coordination meetings have taken place between the MP Team and UCLA to align their respective approaches and assumptions, where possible. The approach described in this TM is informed by those discussions and reviews, and in some cases, specific assumptions are fully incorporated. However, because the effort by UCLA is conducted independently from the MP, the efforts are not identical. Further efforts are recommended to integrate assumptions and findings.

This TM documents the analytical approach, assumptions, and findings of the Program resilience analysis and offers recommendations for consideration in the MP and subsequent steps.

2. Resilience Analysis Approach

This section provides an overview of the resilience analysis approach, including definitions of resilience for the City and considerations when conducting a resilience analysis. The section summarizes the approach for the Program resilience benefits analysis and vulnerability assessment.

2.1 Definitions of Resilience for City of Los Angeles

Water resource and supply planning defines resilience in many ways. One of the most common definitions was provided by the State of California in the California Adaptation Planning Guide (State of California 2022, 2024):

- *"The capacity of natural and built systems to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience."*

State of California (2022, 2024)

The City has described resiliency in a similar manner:

- Resiliency is *"the ability to withstand unforeseen events such as earthquakes and recover or restore service timely after a major outage*."

Program Vision, Mission, and Goals (LADWP, 2024)

- "*The capacity to survive, adapt, and thrive in the face of chronic stresses and acute shocks, and to even transform as conditions require*."

Resilient Los Angeles, Office of LA Mayor (2018)

The MP Team considers resilience as a system's ability to prepare for disruptions, to recover or restore service timely after a major outage, and to adapt and grow from the disruptive experience, which is the focus of this TM.

2.2 Resilience Planning Process

Resilience planning involves several considerations and a structured process to evaluate and improve a system's resiliency. The considerations are framed around three main questions:

1. What are the major risk drivers for the system?
2. What are the potential impacts to the system from these risk drivers?
3. What interventions or adaptation strategies can be implemented to lessen the magnitude or duration of the potential impact?

This assessment focuses on the addressing the uncertainty related to the following considerations:

- Climate and hydrology impacts on water supplies
- Earthquake impacts on water delivery infrastructure
- Water demands

Water demands and their impact on the Program are addressed in the companion *Operation NEXT Assessment Tool Results TM* (Jacobs 2024).

The assessment includes two main efforts, described further in the following sections:

1. A "resilience benefits analysis" that describes some Program resilience benefits related to future uncertainty
2. A "Program vulnerability assessment" that assesses the Program component vulnerability to climate and seismic hazards

3. Resilience Benefits Analysis

This section describes the resilience scenarios, metrics, and results of the resilience benefits analysis. The resilience benefits analysis evaluates Program benefits related to major natural system stressors on the City's water system:

- Climate and hydrology extremes and uncertainty
- Earthquake risks to water infrastructure

Scenarios were developed for these system stressors to meet the following objectives:

- Describe the uncertainties and possible outcomes.
- Develop quantitative estimates of the changes.

ONAT water system modeling was performed for each scenario for the two systems:

1. The existing City water system
2. The future system with the Program in place

The changes in various resilience metrics with the Program were evaluated, and the benefits are described here.

The ONAT model results are intended solely for illustrative purposes. These results have been generated based on assumptions available at the time of development. Projections in this document do not reflect any commitment by LADWP to a future supply portfolio, supply proportions, operations, or strategy. Nothing in this document should be construed as an intent or agreement to future purchases or limits. Results are hypothetical only and subject to change by LADWP.

3.1 Resiliency Scenarios

Six scenarios are being considered for the MP. These scenarios investigate exogenous factors (outside the control of LADWP) that may impact the future water supply system and Program, and are important planning considerations:

1. **Current Trends Scenario:** Adjusted historical water supply conditions to reflect current operations, infrastructure, and projected future demands
    a. **Extreme Drought Scenario (Jacobs 2024a):** Most extreme droughts from the historical record (1922 to 2023) or derived from historical records
    b. **Pluvial Scenario (Jacobs 2024a):** Most extreme pluvial (wet) period from the historical record (1922 to 2023) or derived from historical records
2. **Future Climate Change Scenario:** Future climate projections affecting water supply availability for Los Angeles Aqueduct (LAA) and Metropolitan Water District of Southern California (Metropolitan)
3. **Emergency and Seismic Scenario:** Loss of supply from either LAA or Metropolitan, or both, because of a major seismic event representing a time of failure for a specific location in the system, followed by a recovery period (which may be as long as 2 years)
4. **Demand Uncertainty Scenario:** Exploration of future alternative water demand projections, considering population projections and water use efficiency factors

Scenarios 1a, 1b, and 4 are presented in the companion *Operation NEXT Assessment Tool Results TM* (Jacobs 2024). This TM focuses on Scenario 4 – Future Climate Change and Scenario 5 – Emergency and

Seismic Scenarios. Together, Scenarios 2 and 3 explore trends and uncertainties related to natural system processes (climate and seismic) and City water use (demands).

3.1.1 Scenario 4 – Future Climate Change

Signs of climate change have been observed in several hydrological processes:

- Rising temperatures
- Earlier snowmelt
- Increasing sea levels
- Hydrological extremes in flood and drought

For this assessment, historical drought and pluvial periods were assessed for the LAA available supply. Figure 3-1 shows the most significant historical droughts from 1922 to 2023. The figure shows the cumulative deficit (annual flow below long-term mean) and the duration of the historical droughts. The long-term mean was estimated to be approximately 235,500 acre-feet per year (AFY). The most significant droughts in this observed record occurred in 2012 to 2016, 1987 to 1992, and 1959 to 1961. This analysis also considers other statewide droughts in 1975 to 1977 and 2020 to 2022.

Future potential changes to LAA water availability and Metropolitan water availability are assessed using information from 20 downscaled climate model projections. These downscaled projections were obtained from Cal-Adapt (California Energy Commission 2024), and include climatological and hydrological variables for the entire state of California. Hydrological projection information was compiled for the Owens River watershed, and was correlated and corrected based on the historical LAA water availability data provided by LADWP. In this manner, 20 alternative LAA water supply availability traces were derived based on the future climate projections, and were compared to the historical observed information.

After evaluating each trace's drought and pluvial characteristics, two representative projections were identified that represent the driest and wettest of the ensemble of projections. Figure 3-2 shows the 5-year moving average of the historical and driest/wettest projections. As the figure shows, the future projections show the potential for longer dry and wet periods than historical occurrences. However, using these projections, the downscaled climate model projections were not found to produce more severe short-term droughts than what has been observed in the past 100 years.

For this scenario, the drought impacts were assessed by using both the historical drought sequences and the driest of the future climate model projections. The future climate models are not particularly well-suited to capture short-term dry extremes, but they do capture longer droughts. Therefore, the historical droughts representing the conditions that had occurred were combined with the projected future conditions as input for the LAA supply. Changes to the Colorado River Aqueduct and State Water Project supply to Metropolitan were also adjusted, based on recent studies of these supplies (Reclamation 2022 and Department of Water Resources 2024).

Figure 3-1. Cumulative Historical Flow Deficits (Droughts) for LAA Available Supply

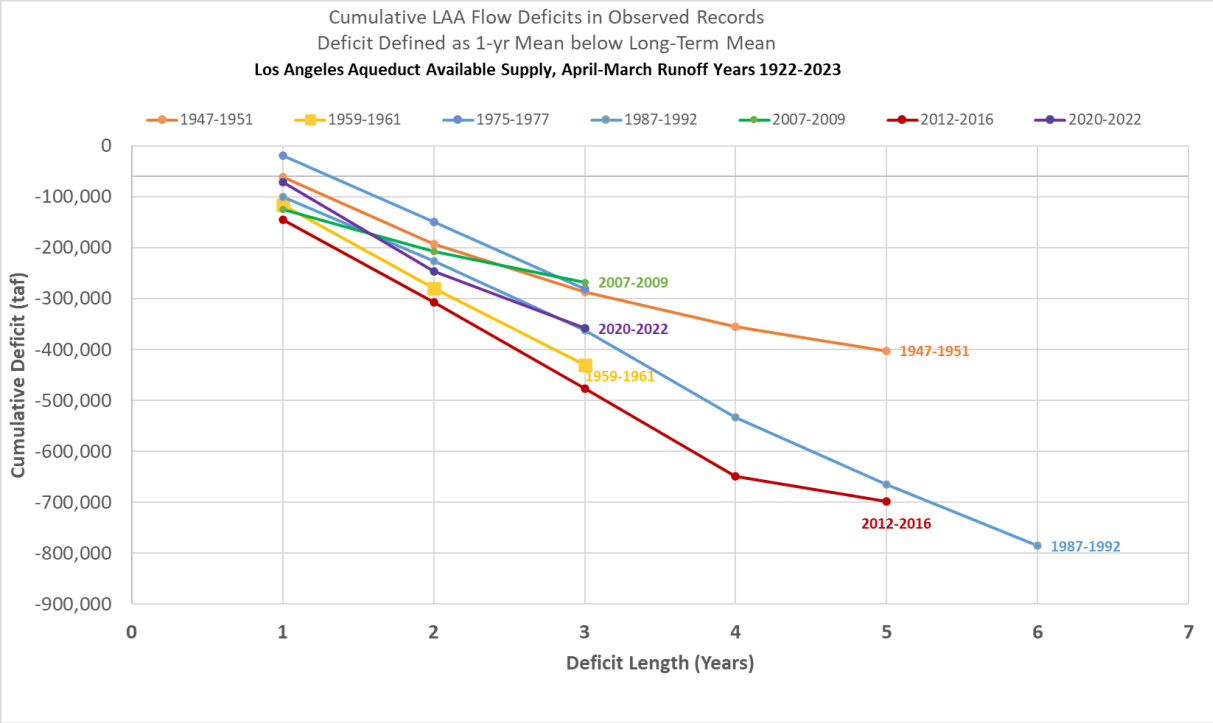
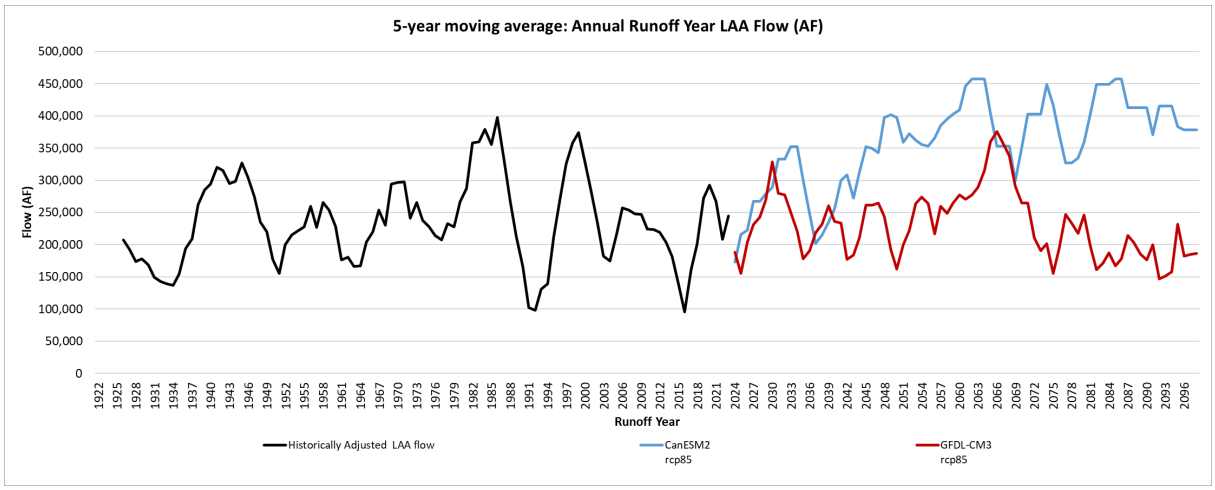


Figure 3-2. Projected Annual Water Available from LAA as 5-Year Moving Average for Driest and Wettest Projections (Acre-feet)



Note: GFDL-CM3 RCP8.5 refers to the driest of the climate model projections, while CanESM2 RCP85 represents one of the wettest of the projections.

3.1.2 Scenario 5 – Emergency and Seismic Risks

Most major imported water infrastructure for Southern California crosses active fault zones. Figure 3-3 shows the major faults and the 30-year probability of occurrence of an event in the Los Angeles region. Major seismic impacts that can affect water and wastewater systems and components include:

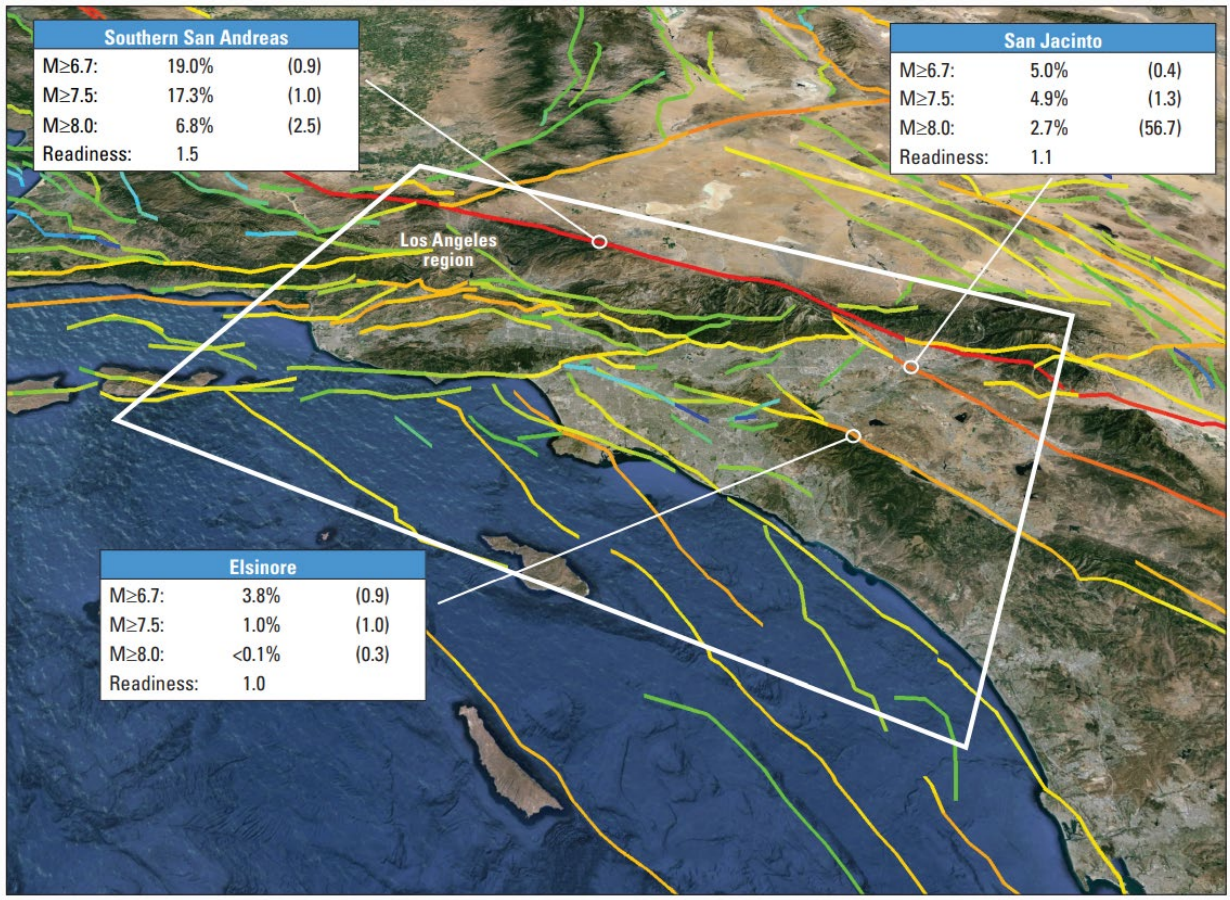
- Transient ground deformation
- Fault rupture

- Liquefaction
- Differential settlement
- Landslides
- Cyclic mobility

The analysis for Scenario 5 focused on disruptions in service for the imported water supply, based on the significant risk such disruptions would pose. Portions of the LAA, California Aqueduct, and Colorado River Aqueduct are susceptible to seismic-caused failures. This scenario assumed a large earthquake, similar to the Great Shakeout event (USGS 2018), occurs and causes sustained interruptions at the three major imported water supplies (Figure 3-4). It assumes a conservative estimate of up to 24 months of outages for these systems. For this scenario, it is assumed that the Pure Water Los Angeles facilities are functional post-earthquake and can continue to provide local water supply despite disturbances in the City water and wastewater systems that are anticipated to be much shorter in duration.

The seismic hazard scenario is not assigned a specific probability of occurrence, but is determined to be a plausible extreme possibility. ONAT modeling inputs are modified to reflect the outages of imported water supplies. While the timing of any seismic event is not known, for modeling purposes, the event has been placed after 2050, when the Program would be at full capacity (based on the assumed phasing at the time of the analysis).

Figure 3-3. Major Faults in the Los Angeles Region and Estimated 30-year Probability of Occurrence
(values in parenthesis indicate the factor by which the likelihoods have increased from prior modeling; M is magnitude).



Source: USGS (2015)

Figure 3-4. Select Earthquake Faults and Water Aqueducts in California

3.2 Resilience Metrics

The metrics in Table 3-1 were developed to evaluate the Program's resilience benefits. These metrics provide a snapshot of the potential resilience benefits that may be derived from the Program.

Table 3-1. Resilience Metrics

Program Benefits/Impacts	Metric
Maximize reuse of locally generated wastewater	Total produced water (MGD) and percent of wastewater used (%)
Resiliency of water supply during critical scenarios	Reduction in potential water shortages during critical resilience scenarios (AF)
Economic benefits of water cost savings during critical scenarios	Cost savings during critical resilience scenarios ($)

AF = acre-foot (feet)
MGD = million gallons per day

The analysis of water cost changes used the following assumptions.

- The unit water cost of existing supplies was obtained from an LADWP Board Letter titled *Estimated Water Supply Cost, Water Quality Improvement, and Owens Valley Regulatory Expenditures for*

January 1, 2023, through December 31, 2023 (LADWP 2022), and converted to dollars per AF for each supply source. Table 3-2 summarizes the water cost assumptions used in this analysis.

- The Program water supply cost was assumed to be equal to the range developed by Metropolitan for Pure Water Southern California (Metropolitan 2023). This was selected as a comparable program with publicly-available estimated costs in dollars per acre-foot.
- ONAT model simulations were first performed with existing supplies and the assumptions for the scenario. These simulations were then repeated with Program facilities and operations.
- Unit costs were applied to each water supply source annual delivery. Any shortages after the full use of known supply sources were assumed to be met first by conservation of up to 20% of the demand. Remaining shortages were assumed met, to the extent possible, by replacement supplies that could include emergency wells, truck hauling, or bottled water delivery. These emergency replacement supplies were only assumed to provide water up to the health and safety demand (estimated at approximately 60% of normal demand).
- Program-derived cost benefits are computed as the cost difference between the "no Program"- and "Program"-simulated water costs.
- Cost are current 2024 value costs and do not include escalation, financing, or discounting. Note that the UCLA study, referenced in Section 1, is expected to include additional economic analyses of different scenarios (Barsch et al 2024).

Table 3-2. Summary of Cost Assumptions Used in Resilience Benefits Analysis

Water Supply Source	Estimated Unit Cost ($/acre-foot)	Reference
Local Groundwater	$799	LADWP (2022)
LAA Supply	$958	LADWP (2022)
MWD Purchased Water	$1,238	LADWP (2022)
Recycled Water	$2,051	LADWP (2022)
Pure Water Los Angeles Program[a]	$2,800 - $3,600	Metropolitan (2023)
Water Conservation	$50-1,300 (likely range of $500-750)	LADWP (2015); Reclamation (2012); AWE (2018)
Emergency/Replacement Supplies	$5,000 – $7,000 (up to $200,000 for truck hauling and water stations)	Reclamation (2012); (UCLA 2024)

Reclamation = U.S. Bureau of Reclamation

[a] The Pure Water Los Angeles Program water supply cost was assumed to be equal to the range developed by Metropolitan for Pure Water Southern California (Metropolitan 2023). This was selected as a comparable program with publicly available estimated costs in dollars per acre-foot.

3.3 Resilience Analysis Results

This section summarizes the results of the modeling, as well as the analysis used to develop the resilience benefits.

3.3.1 Historical Climate

The Program provides a new independent local water supply that may reduce the need to purchase imported water supplies. With the Program, the model simulations indicate the City's dependence on purchased imported supply could decrease from approximately 33% to between 9 and 14%. The model results also indicate the reuse of City wastewater flows could also increase from 10% to 49% with the Program. These estimates are based on initial modeling and assumptions that may change.

During an extreme dry period with greater demands (initial demands), the potential exists for shortages under the current water supply portfolio (Figures 3-5a and 3-5b). This shortage is related to the simulation of a potential Metropolitan supply shortage during an intense, extended drought similar to the one from 2012 to 2016. The simulated cumulative shortage is approximately 330,000 AF over the extended 5-year drought occurring in the late part of the simulation period. While the drought period shows low available LAA supply during all 5 years, shortages are only projected for the last 2 years, which are represented by simulation years 72 and 73 on Figures 3-5a and 3-5b.

Once the Program is operational, the new ATRW supply provides a significant amount of new local water. This new supply is particularly useful during future simulated droughts. It can also be used to offset future Metropolitan purchases, depending on future operational needs and demands. The new ATRW provides enough new water during the simulated droughts to eliminate shortages.

Based on the assumptions described previously, annual water supply costs are generally higher with the Program than under the current portfolio, but the new local water supply source is more reliable (Figures 3-6a and 3-6b). On average, the water supply portfolio cost is higher with the Program. However, under the critical dry periods in this scenario, the Program benefit is approximately 330,000 AF of reliable water supply, and a corresponding cost savings of more than $1.6 billion (B) over 2 years. If multiple droughts of similar severity occur during the life span of the Program, these cost savings could be greater.

Figures 3-5b and 3-6b show the results when City demands are assumed to be relatively similar to current levels, at approximately 500,000 AFY. As these figures show, shortages are projected to be less, at approximately 100,000 AF, and with cost savings in the range of $500 to 700 million.

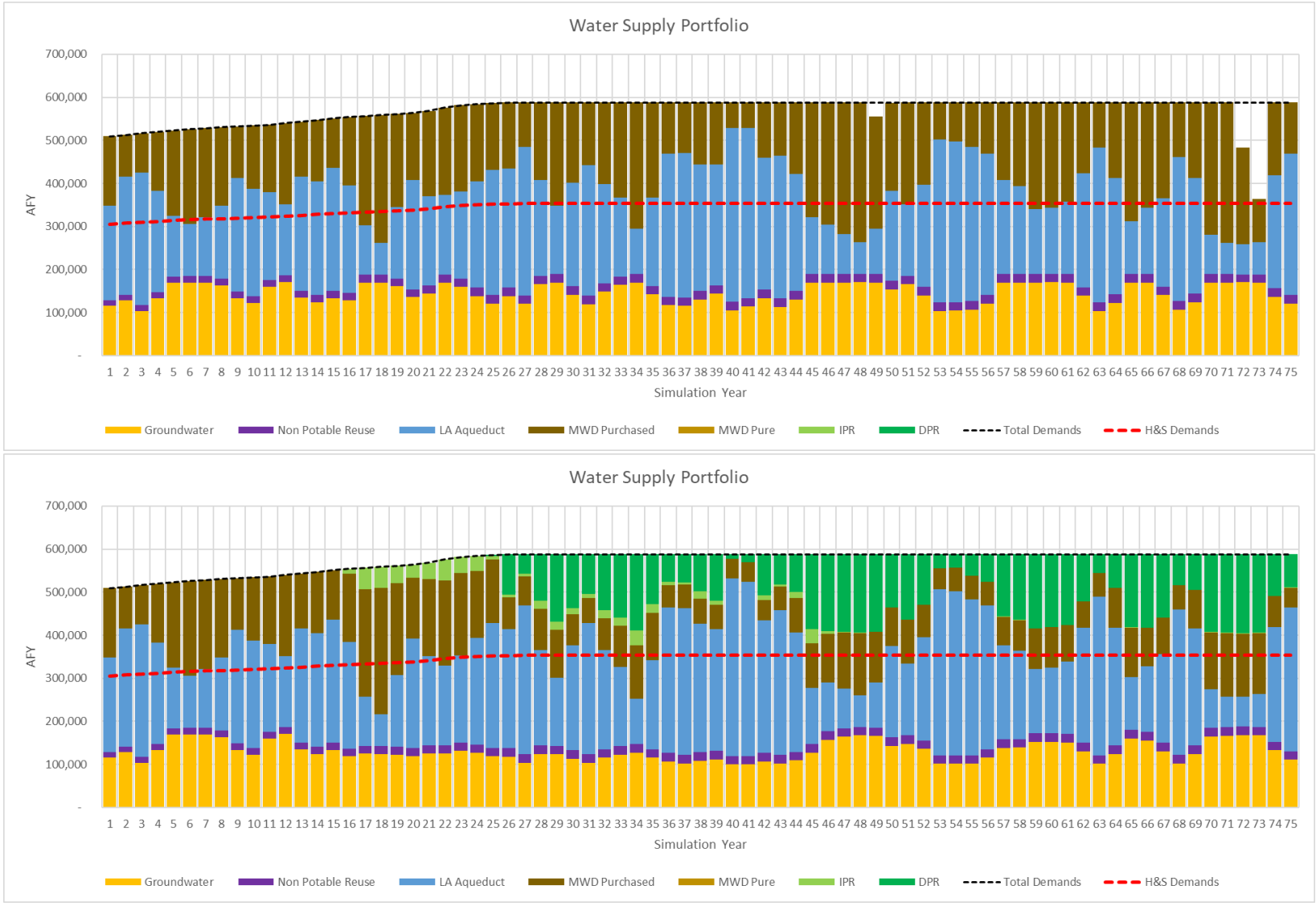
3.3.2 Climate Scenarios

This assessment used 20 global climate projections to analyze future climate change. The projections indicate that droughts of longer duration may occur in the future. One such drought occurs in the latter part of the simulation period (simulation years 68 through 72) (Figure 3-7). While this drought is not as severe as the droughts in the historical climate, it does extend for more than 5 years and causes simulated shortages in a 4-year period. The cumulative simulated shortage over this period is more than 200,000 AF.

As the bottom panel of Figure 3-7 shows, the Program provides a new independent supply that could reduce or eliminate potential shortages during a future simulated drought period. The reuse of the City's wastewater flows could also increase from 9% to 46%, allowing for new local supplies to offset lower-priority supplies in some scenarios. The Program eliminates the simulated shortages of the extended drought period with an estimated associated cost savings of up to $1.1B of supply costs over five years by providing water during critical periods.

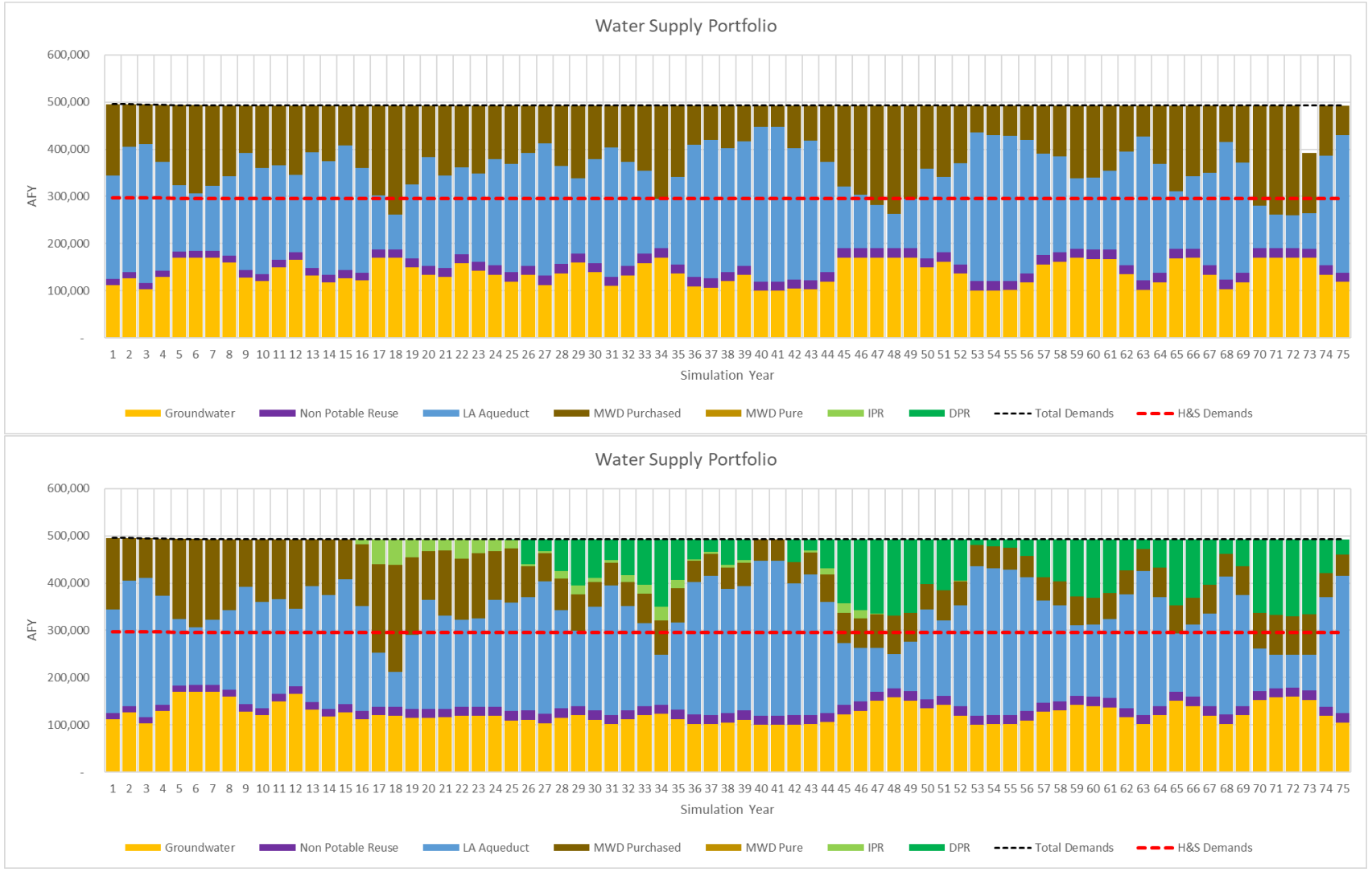
At present, the historical droughts of 2012 to 2016 and 1987 to 1992 remain good proxies and stress tests for future drought planning along with climate projections.

Figure 3-5a. Water Supply Portfolio Results for Existing System (top) and with the Program (bottom): Historical Climate (Initial Demands)



H&S = Health and safety

Figure 3-5b. Water Supply Portfolio Results for Existing System (top) and with the Program (bottom): Historical Climate (Mid Demands)



H&S = Health and safety

Figure 3-6a. Water Supply Cost Results for Existing System (top) and with the Program (bottom): Historical Climate (Initial Demands)

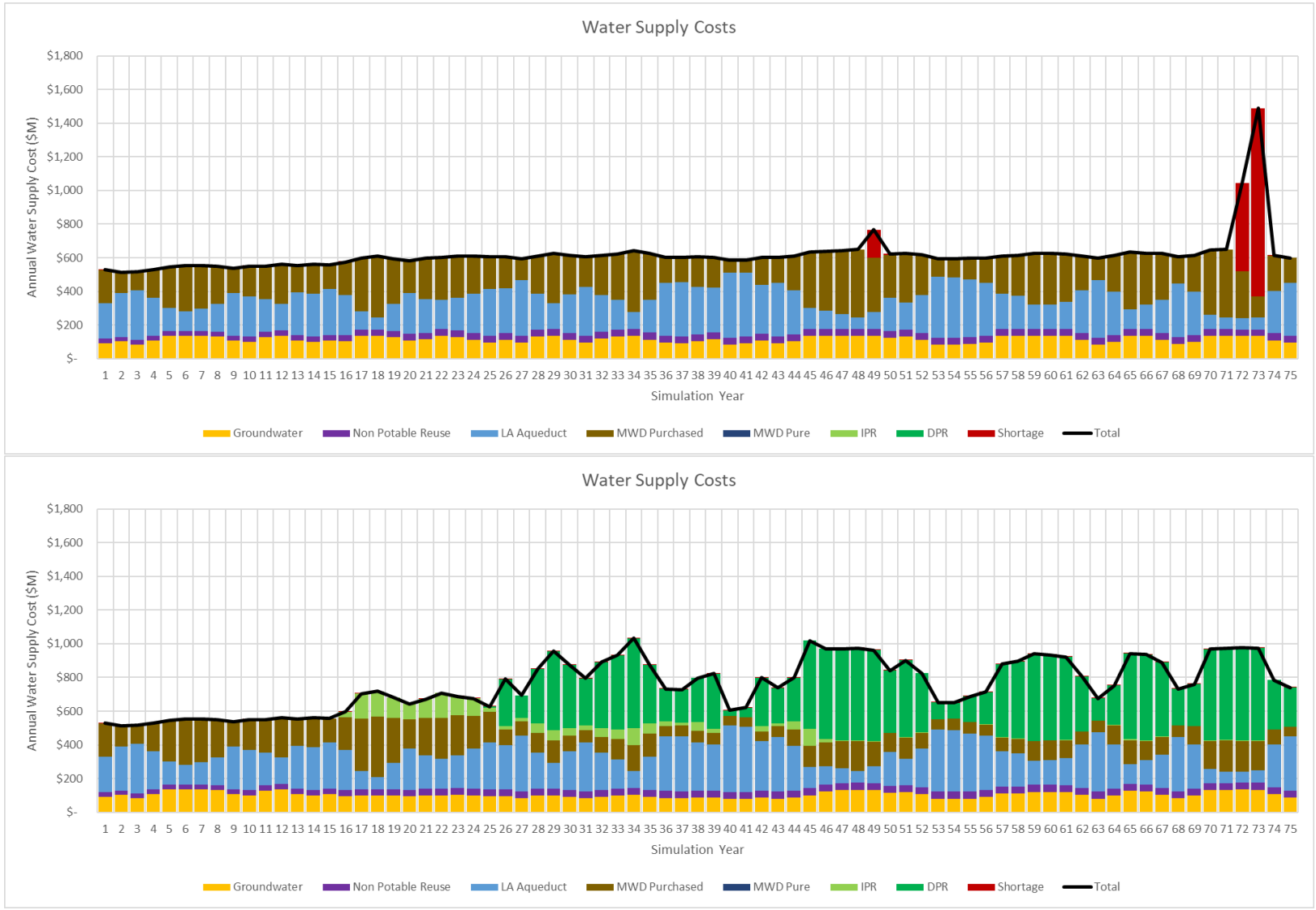


Figure 3-6b. Water Supply Cost Results for Existing System (top) and with the Program (bottom): Historical Climate (Mid Demands)

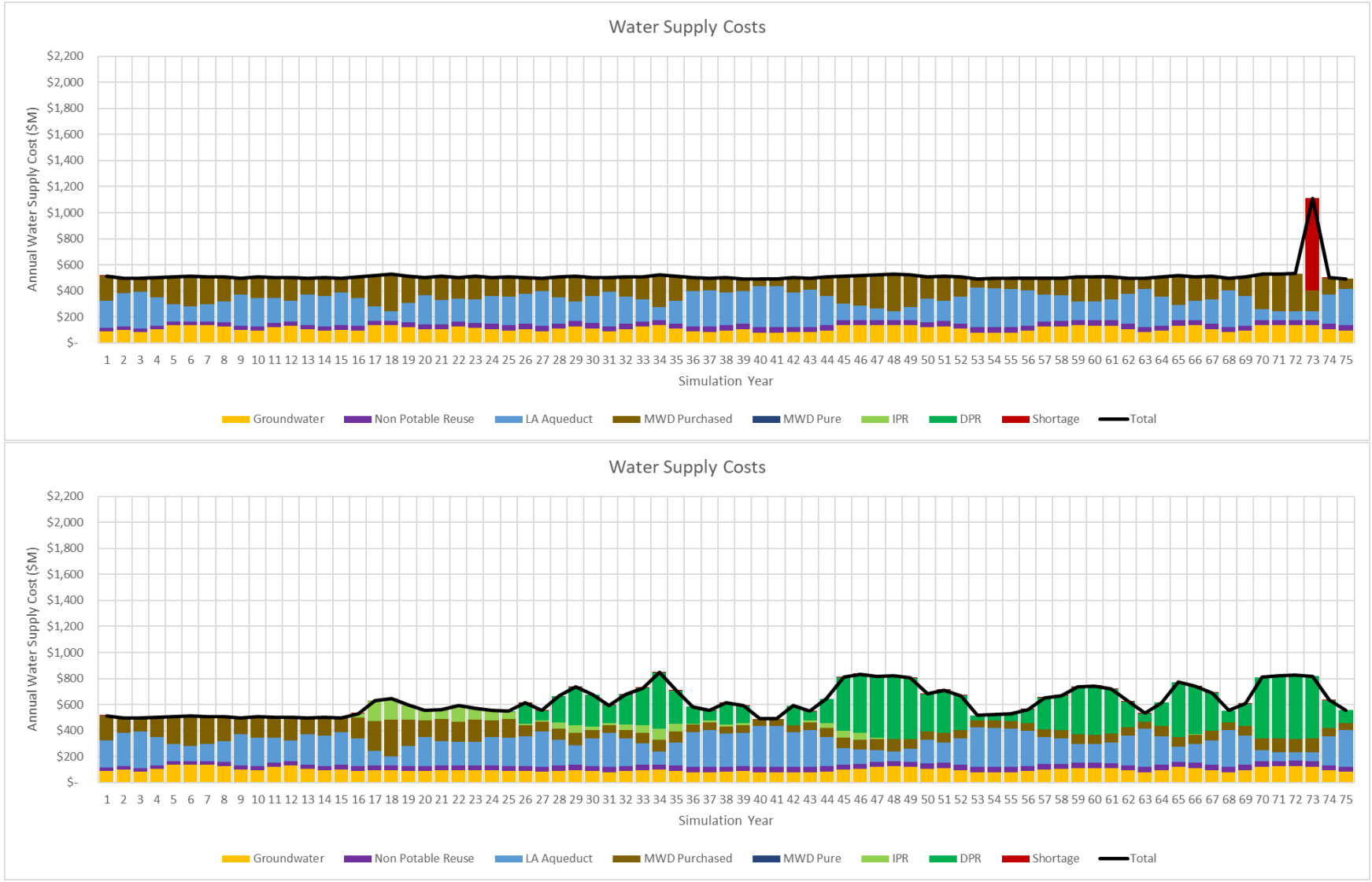
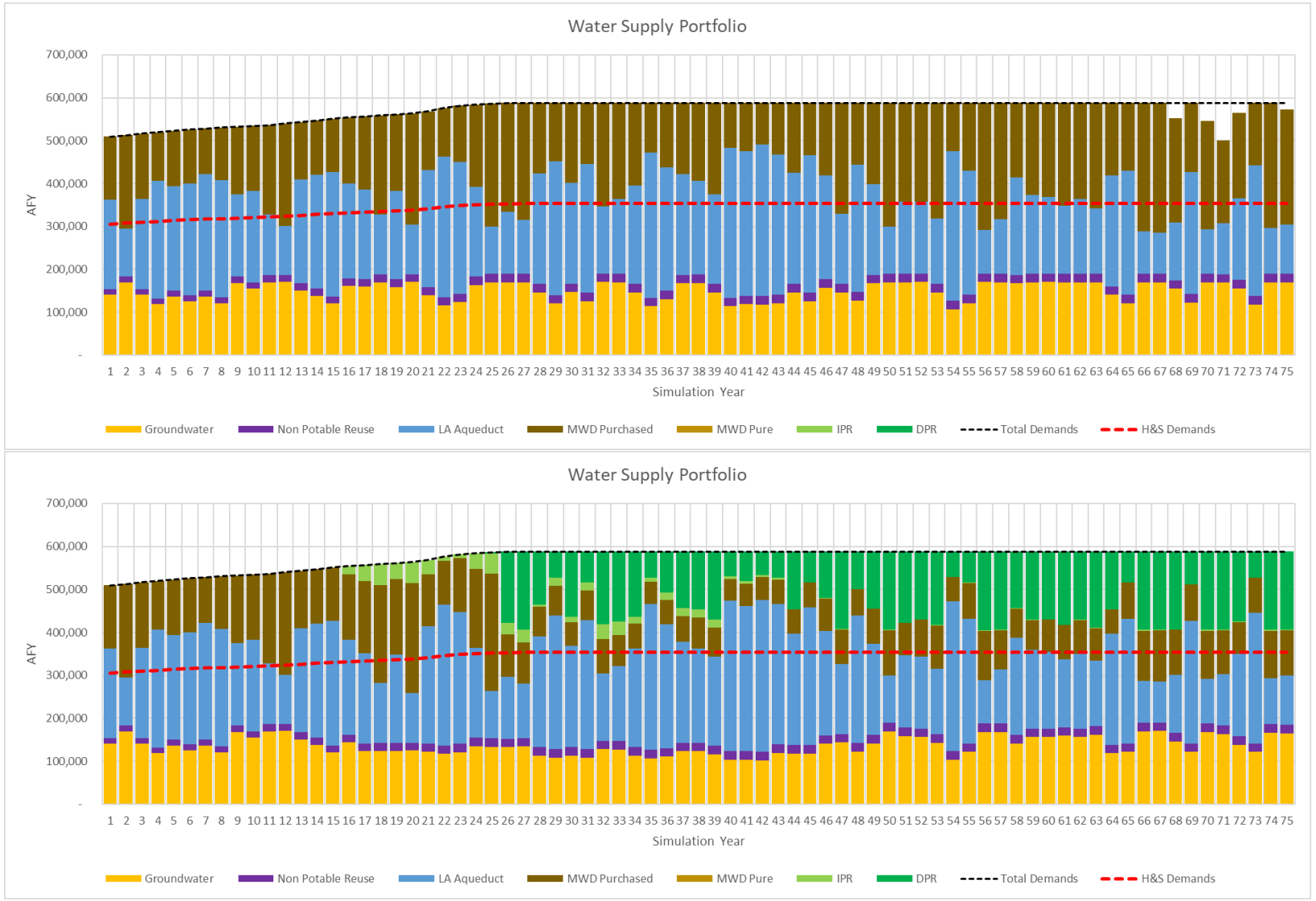
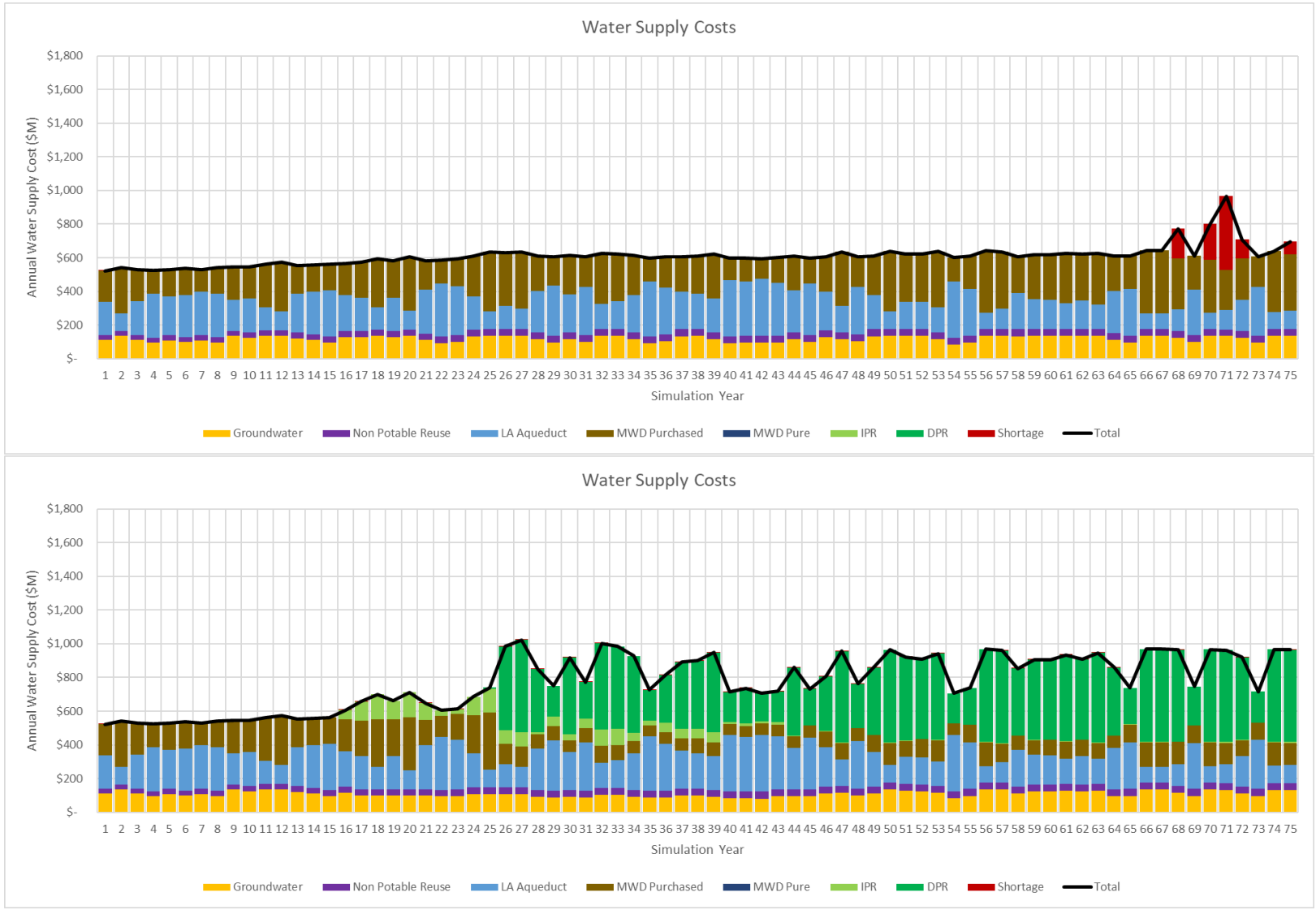


Figure 3-7. Water Supply Portfolio Results for Existing System (top) and with the Program (bottom): Future Climate Projection - DRY



H&S = Health and safety

Figure 3-8. Water Supply Cost Results for Existing System (top) and with the Program (bottom): Future Climate - DRY



3.3.3 Earthquake Scenario

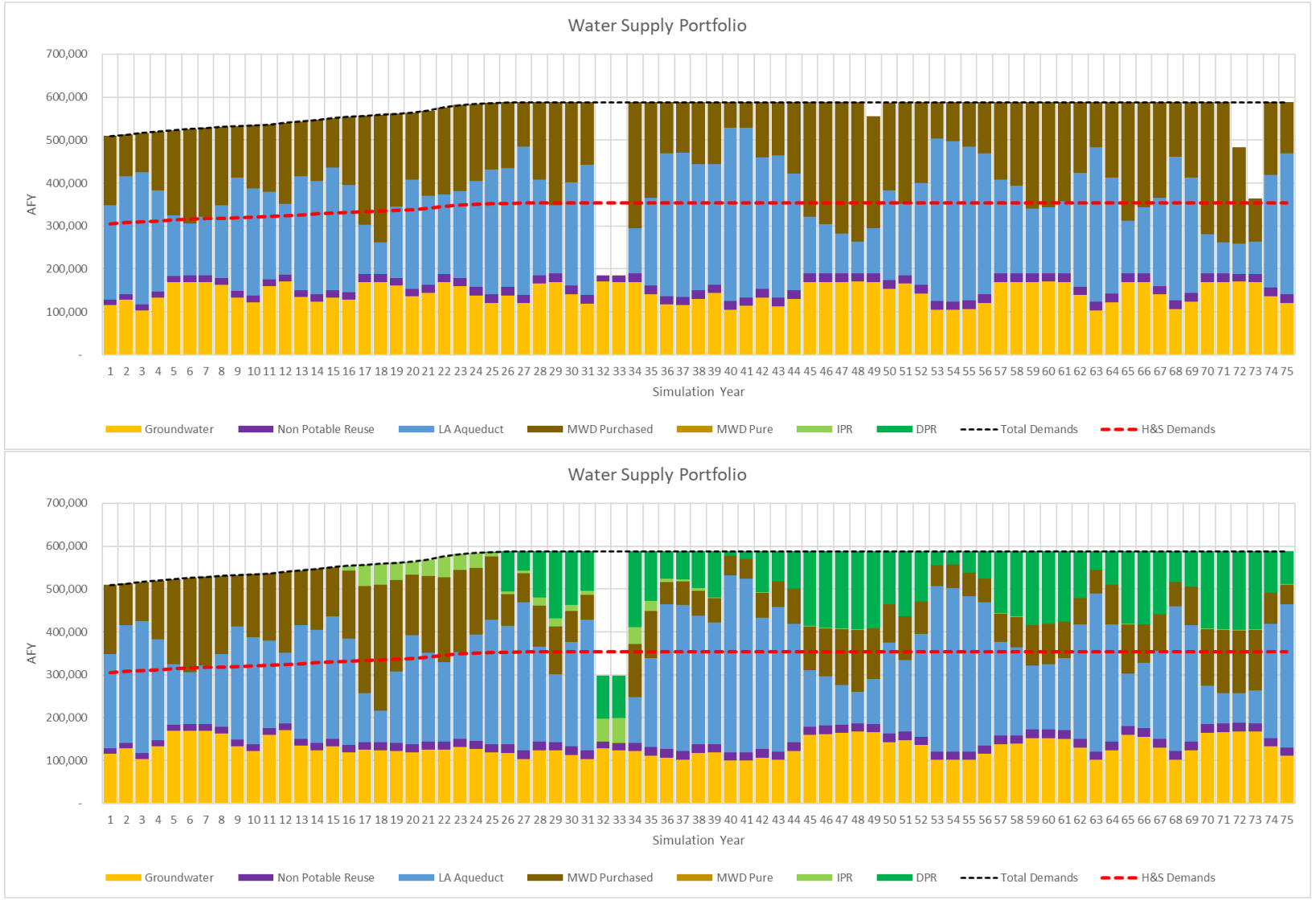
This analysis assessed the risks of an earthquake on the imported water supply aqueducts, as described in Section 3.1.2.

The earthquake scenario causes a substantial disruption to the City's reliable water supply. Shortages of more than 400,000 AFY are possible during the 2 years of imported water supply outage without the Program (Figure 3-9). However, the target demands during these emergency periods would very likely be reduced substantially, to meet health and safety levels. The supply deficit to meet health and safety demands would likely be about 200,000 AFY during these years.

With the Program, the new AWPF and infrastructure are assumed to be substantially more seismically resilient and built to a higher standard, so the water would be available during an imported water supply outage. Using these assumptions, the Program could supply approximately 150,000 AFY of seismically resilient water during these periods. With the Program, the total shortage is reduced to approximately 250,000 AFY and the health and safety shortage is reduced to approximately 50,000 AFY.

The replacement water cost savings associated with lesser shortages and less need for expensive and complex emergency water supplies with the Program in place are estimated at more than $1.1B for each major event (Figure 3-10). The water cost savings could be even greater, depending on the assumptions for alternative supplies available during the imported supply outages.

Figure 3-9. Water Supply Portfolio Results for Existing System (top) and with the Program (bottom): Earthquake Event



H&S = Health and safety

Figure 3-10. Water Supply Cost Results for Existing System (top) and with the Program (bottom): Earthquake Event

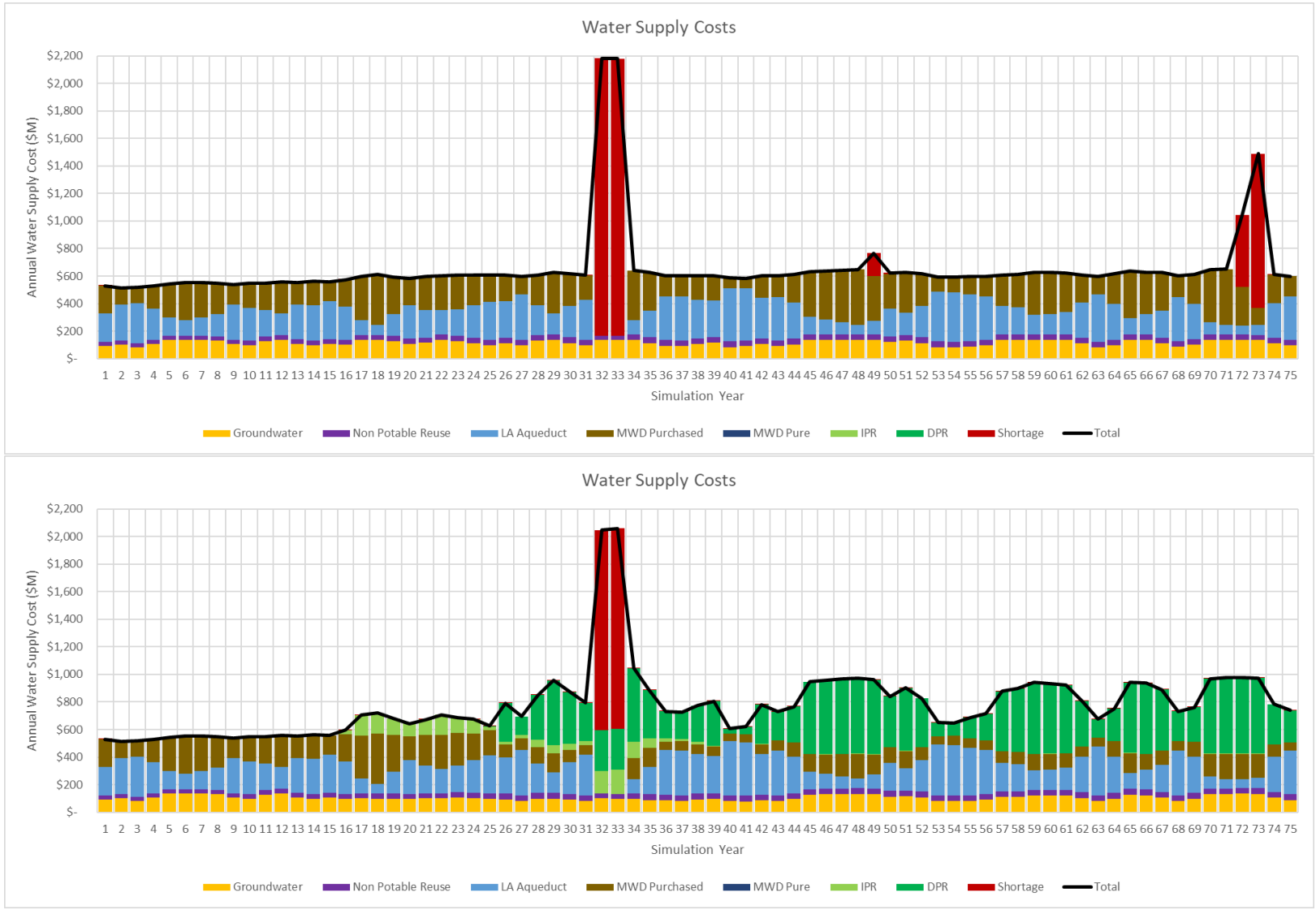


Table 3-3 summarizes the water supply, water cost, and wastewater reuse benefits. The Program provides a reliable water supply that can support both drought-related risks and potential earthquake risks. Through the analysis, it was found that the Program benefits depend greatly on the presence or absence of pluvial periods, or more available storage for ATRW supply in groundwater or delivery to others. The Program will save more water-related costs than alternative supply options during critical supply shortages.

Table 3-3. Summary Results for Resilience Scenarios

Program Benefits/Impacts	Metric	Reference (no Program)	Historical Hydrology (Scenario 1)	Climate Change Scenario (Scenario 4)	Seismic Scenario (Scenario 5)
Maximize reuse of locally generated wastewater	Total percent of LASAN wastewater used (%) (after Phase 3 implementation)	10%	46%	49%	46%
Resiliency of water supply during critical scenarios	Reduction in potential water shortages during critical resilience scenarios (AF)	N/A	330,000 AF (over 2 years)	200,000 AF (over 5 years)	225,000 AF (over 2 years)
Economic benefits of water cost savings during critical scenarios	Cost savings during critical resilience scenarios ($)	N/A	$1.6-2.3 B	$1.0-1.3B	$1.1-1.6B

N/A = not applicable

The Program was found to offer considerable resilience benefits in general, and more pronounced benefits under extreme drought and earthquake scenarios. Maximum utilization for purified recycled water is expected for seismic or other emergency scenarios, and though infrequent, a significant seismic event could disrupt traditional water supply sources, highlighting the critical importance of the Program. Some areas within LADWP's northern service area are served exclusively by the Los Angeles Aqueduct Filtration Plant (LAAFP), meaning that a disruption to current water supply sources poses risks to those areas in particular.

The Program is expected to generate water cost savings over alternative supply options during emergency supply shortages. The Program's projected potential cost savings for the scenarios examined underscore its potential to safeguard community well-being, even in the face of adversity.

Program benefits can be summarized as follows:

- If future climate and hydrology remain similar to historical conditions (such as in Scenario 1), the Program avoids a shortage of approximately 330,000 AF and saves $1.6 to 2.3B in water costs for each severe drought.
- Under the Climate Change scenario (Scenario 4), the Program avoids a shortage of approximately 200,000 AF and saves $1.0 to 1.3B in water costs for each severe drought event.
- For the Seismic scenario (Scenario 5), the Program lessens potential emergency shortages, and saves $1.1 to 1.6B for each major seismic event.

Potable reuse is a vital strategy for building seismic resilience by reducing reliance on more vulnerable, imported water sources. Pure Water Los Angeles will provide a reliable alternative water supply to the Van Norman Complex and the vicinity of the LAAFP to mitigate the risk of water shortages and to support critical infrastructure and public health and safety, even potentially in the face of catastrophic seismic events. By investing in this Program that maximizes water reuse, LADWP can not only mitigate some of the risks associated with natural disasters but also contribute to improving long-term water security and environmental sustainability.

4. Vulnerability of Program Facilities to Climate and Seismic Hazards

This section discusses the vulnerability of Program facilities to climate-related and seismic hazards.

4.1 Overview of Major Climate and Seismic Hazards

4.1.1 Summary of Climate and Seismic Data Sources

For the climate change analysis, the projected changes are estimated for two future 30-year periods, using a historical period as a reference point. The historical reference period for climate change analysis is 1995 (1981 to 2010).

Climate vulnerability is evaluated for various climate change scenarios by analyzing the projected changes in the following areas:

- Temperature
- Precipitation
- Flooding
- Sea level rise
- Wildfire

For the climate change analysis, the projected changes in the vulnerability metrics are estimated for two future 30-year periods, using a historical period as a reference point. The historical period is defined as 1981-2010, the near future period is defined as 2036-2065, and the late future period is defined as 2061-2090.

To analyze floods, two 50-year periods are used, with 1951 to 2000 serving as the historical reference point:

- Near Future: 2001 to 2050
- Late Future: 2050 to 2099

Because the wildfire probability data are available at decadal scale, the wildfire analysis uses three decadal periods:

- Historical: 1980 to 2009
- Near Future: 2030 to 2059
- Late Future: 2060 to 2089

The World Meteorological Organization uses a 30-year period to determine the average climate. The 50-year period is used for extreme events analyses, using longer periods of data for statistics of rare events.

Table 4-1 shows the primary climate and seismic data sources and their use in this assessment. The quantitative assessment uses indicator metrics and available climatological data, hydrological modeling results, and seismic data to assess vulnerability.

Table 4-1. Summary of Hydrometeorological Data Sources to Support Climate and Seismic Vulnerability Assessment

Data	Use in Analysis	Spatial and Temporal Resolution	Source
Precipitation and Temperature Projections from CMIP5 Downscaled Climate Model Simulations	Used to analyze extreme heat days and extreme precipitation	Daily data from 1950 to 2099	Cal-Adapt (https://cal-adapt.org/tools/local-climate-change-snapshot/)
Runoff and Baseflow Projections simulated by VIC model using CMIP5 Downscaled Climate Model Simulations	Used to analyze total runoff, drought, and flood	Daily data from 1950 to 2099	Cal-Adapt (located at https://cal-adapt.org/data/download/)
Wildfire scenario from CMIP5 Downscaled Climate Model Simulations	Used to analyze wildfire decadal probabilities	1/16-degree (~6 kilometer) resolution from 1952 to 2099	Cal-Adapt (https://cal-adapt.org/tools/wildfire/)
Sea Level Rise Projections and Coastal Flooding	Used to analyze coastal inundation and cliff retreat	Projected future inundation area and cliff retreat data	CoSMoS (Coastal Storm Modeling System) (https://data.usgs.gov/datacatalog/data/USGS:57f69341e4b0bc0bec06f568)
USGS Quaternary Faults, Seismic Hazard Zone Map, and 2023 National Seismic Hazard Model.	Use for seismic analysis	Seismic maps	Interactive U.S. Fault Map (https://www.usgs.gov/tools/interactive-us-fault-map), Seismic Hazard Zone Map (https://gis.data.ca.gov/search), and 2023 National Seismic Hazard Model (https://www.sciencebase.gov/catalog/item/644af897d34e45f6ddcd13b3)

CMIP5 = Coupled Model Intercomparison Project Phase 5

USGS = United States Geological Survey

VIC = variable infiltration capacity

The 20 individual downscaled General Circulation Model (GCM) projections were selected from 10 different CMIP5 GCMs and two different Representative Concentration Pathways (RCPs) (RCP 4.5 and RCP 8.5). The California Department of Water Resources (DWR) Climate Change Technical Advisory Group (CCTAG) chose these GCMs based on a regional evaluation of climate models' abilities to reproduce a range of historical climate conditions (DWR CCTAG 2015). These 20 climate projections were downscaled using a statistical downscaling method, called locally organized constructed analogs (LOCAs), at 1/16th degree (approximately 6 kilometers [km] [approximately 3.75 miles]) spatial resolution by Scripps Institution of Oceanography (Pierce et al. 2014).

Runoff and baseflow projections were obtained from Cal-Adapt, which simulated these by the VIC hydrologic model, using 20 CMIP5 LOCA downscaled climate models. The VIC model (Liang et al 1994, 1996; Nijssen et al 1997) is a spatially distributed hydrologic model that simulates land surface-atmosphere exchanges of moisture and energy at each model grid cell. The VIC model incorporates spatially distributed parameters describing the following items:

- Topography
- Soils
- Land use
- Vegetation classes

This VIC simulation was conducted at 1/16th degree spatial resolution by Scripps Institution of Oceanography and obtained from Cal-Adapt for this report (Pierce et al., 2018). Decadal wildfire

probabilities derived from monthly/annual wildfire projections were obtained from Cal-Adapt. The wildfire projections were produced by the University of California Merced (Thomas et al 2018).

The Coastal Storm Modeling System (CoSMoS) simulated flood hazard projections data under the following sea level rise points, with 100-year return period storm surge to identify the inundation of the coastline and low-lying areas

- 0.25 meters (m)
- 0.5 m
- 0.75 m
- 1.0 m
- 1.25 m
- 1.5 m
- 1.75 m
- 2.0 m
- 5.0 m

The CoSMoS cliff retreat projections data were used with various sea level rise points to identify cliff retreat of the coastline. The CoSMoS model simulation was conducted by U.S. Geological Survey (Barnard et al 2018).

The seismic hazards were identified using the USGS quaternary faults, a seismic hazard zone map representing liquefaction and landslides areas, and peak ground acceleration (PGA) from 2023 National Seismic Hazard Model (Petersen et al 2023).

4.1.2 Climate Hazards

The following sections summarize the climate hazards included in this assessment.

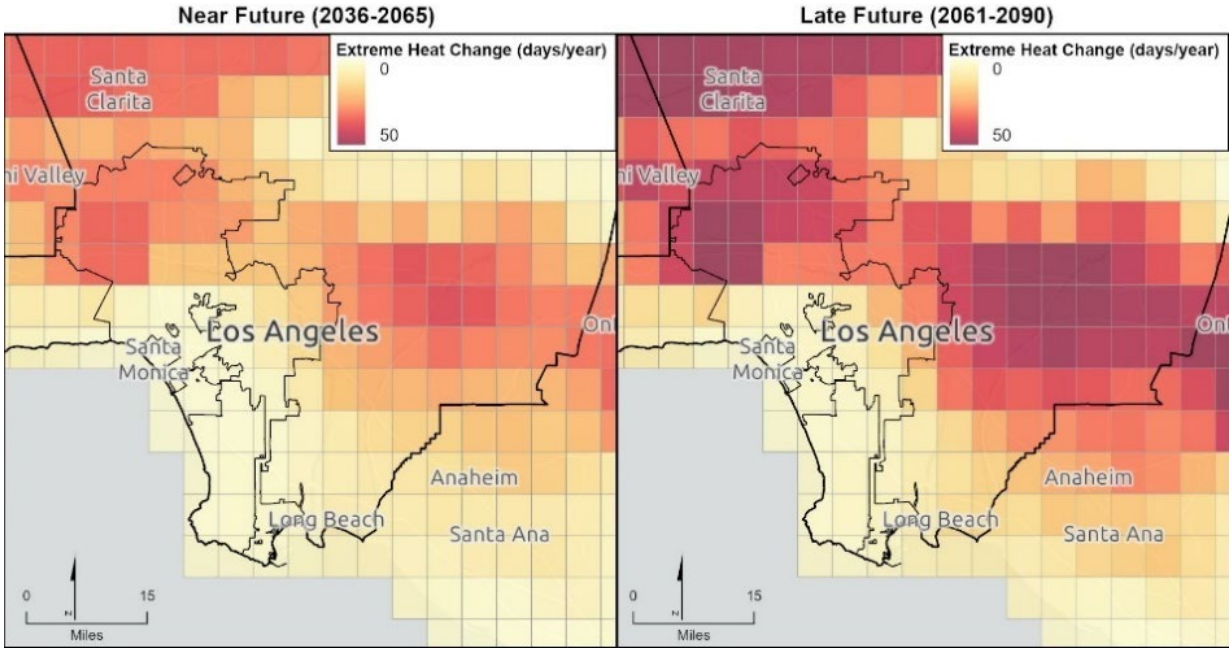
4.1.2.1 Extreme Heat Days

According to the National Oceanic and Atmospheric Administration (NOAA), the heat index is what the temperature feels like to the human body when relative humidity is combined with the air temperature. A heat index of 90 degrees Fahrenheit (°F) to 103°F is classified as requiring extreme caution and can cause the following ailments with prolonged exposure and/or physical activity (NOAA 2023):

- Heat stroke
- Heat cramps
- Heat exhaustion

With the projected increase in annual temperature, the daily maximum temperature is also expected to change in the future. For this analysis, an extreme heat day is defined as a day with a daily maximum temperature exceeding 95°F. Projections suggest an increase in extreme heat days of 16 and 25 days per year during the near and late futures, respectively (Figure 4-1). On average, there were 46 extreme heat days per year with temperatures warmer than 95°F during the historical period (1981 to 2010). The increase in the extreme heat days is most prevalent in the northern and northeastern regions of Los Angeles.

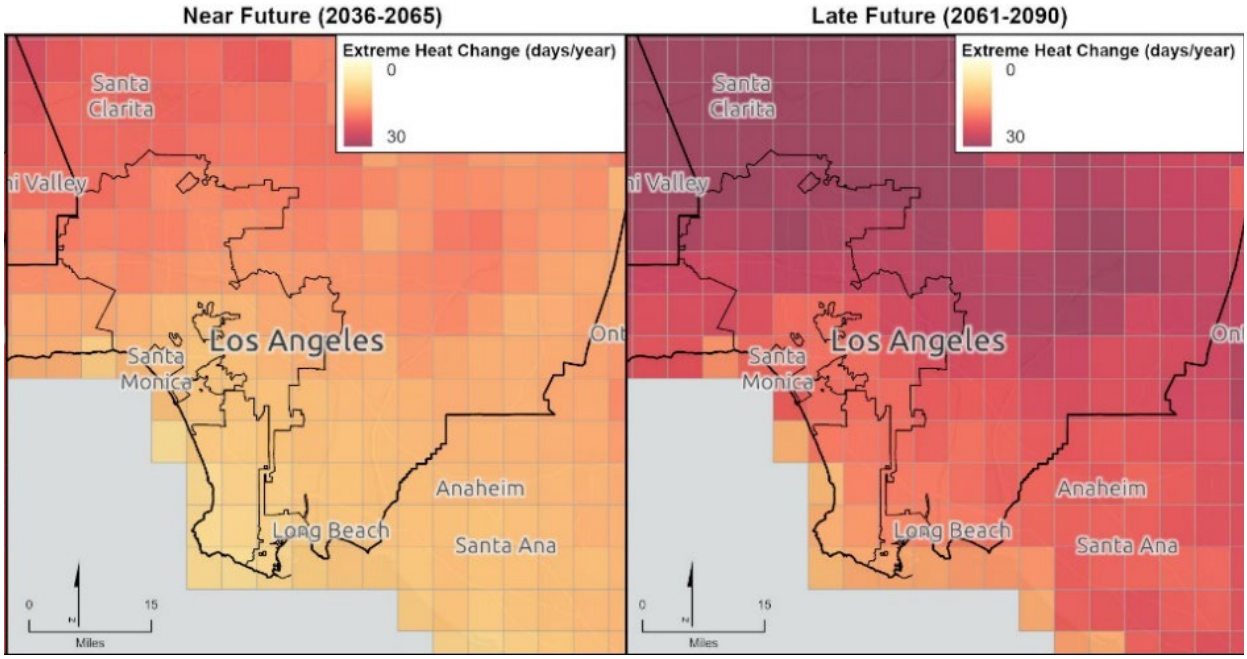
Figure 4-1. Projected Change in Extreme Heat Days above 95°F



Note: Projected change in Extreme Heat Days during Near Future (2036-2065, left, days/year) and Late Future (2061-2090, right, days/year) with respect to historic period (1981-2010). Median projected changes are computed using 20 climate model projections from 10 general circulation models under 2 emission scenarios: RCP 4.5 and RCP 8.5. An extreme heat day is defined as the day when daily maximum temperature is above 95°F.

Extreme heat days can also be defined based on the daily maximum temperature exceeding the 98th percentile of the historical temperature (a measure of increase above experienced temperatures). The increase in the extreme heat days based on the 98th percentile historical temperature is relatively uniform, compared to the spatial variation of 95°F, based extreme heat days (Figure 4-2). The projected increase in the average annual extreme heat days exceeding the 98th percentile historical temperature is 16 days per year for the near future period, and 27 days per year for the late future period, compared to the historical period. On average, 7 days per year experienced extreme heat days that exceeded the 98th percentile historical temperature during the historical period (1981 to 2010).

Figure 4-2. Projected Change in Extreme Heat Days above 98th Percentile Historical Temperature



Note: Projected change in Extreme Heat Days during Near Future (2036-2065, left, days/year) and Late Future (2061-2090, right, days/year) with respect to historic period (1981-2010). Median projected changes are computed using 20 climate model projections from 10 general circulation models under 2 emission scenarios: RCP 4.5 and RCP 8.5. An extreme day is defined as a day when daily maximum temperature is above the 98th percentile historical temperature.

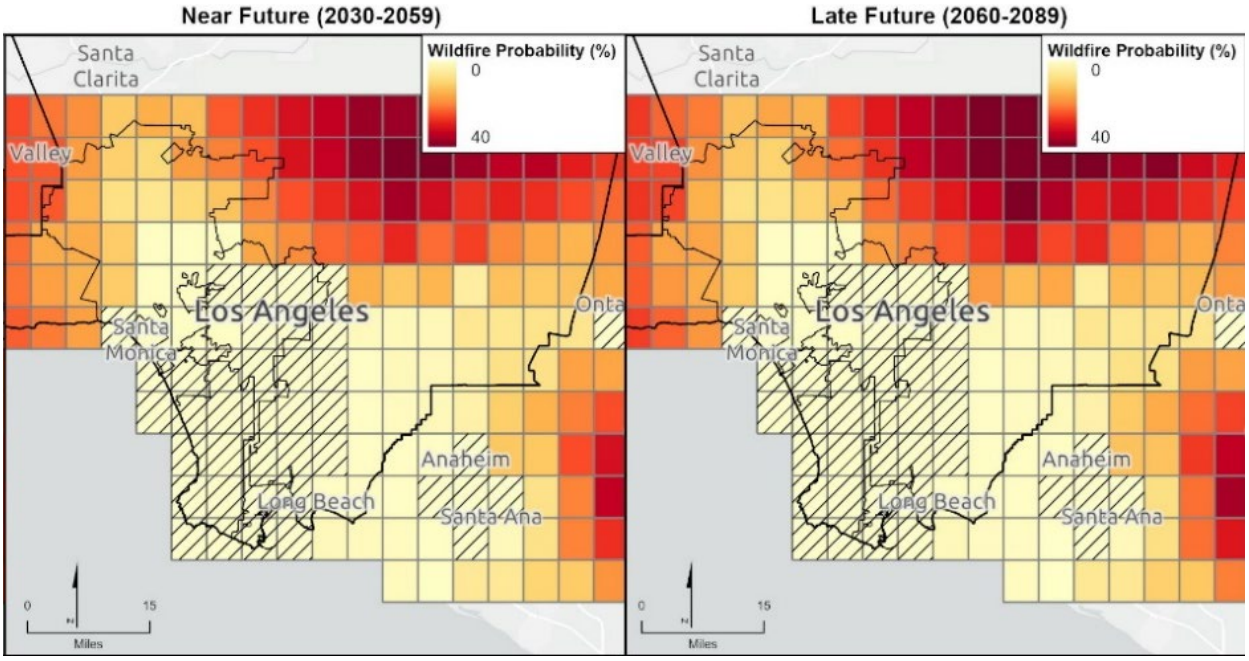
4.1.2.2 Wildfires

Climate change is generally expected to increase all key drivers of wildfire risk:

- Dry conditions (drought)
- Higher temperatures
- Longer fire seasons

However, other significant factors that contribute to wildfire risk include urban development and vegetation structure and abundance. The wildfire risk is analyzed using the decadal wildfire probability estimates. An average regional decadal wildfire probability of 13% is projected for the near future period, and an average of 14% is projected for the late future period (Figure 4-3). The average decadal wildfire probability during the historical period (1980 to 2009) is 15%. The wildfire probability is greater in the northern and northeastern regions of the Los Angeles than in the coastal regions.

Figure 4-3. Projected Change in Decadal Wildfire Probability

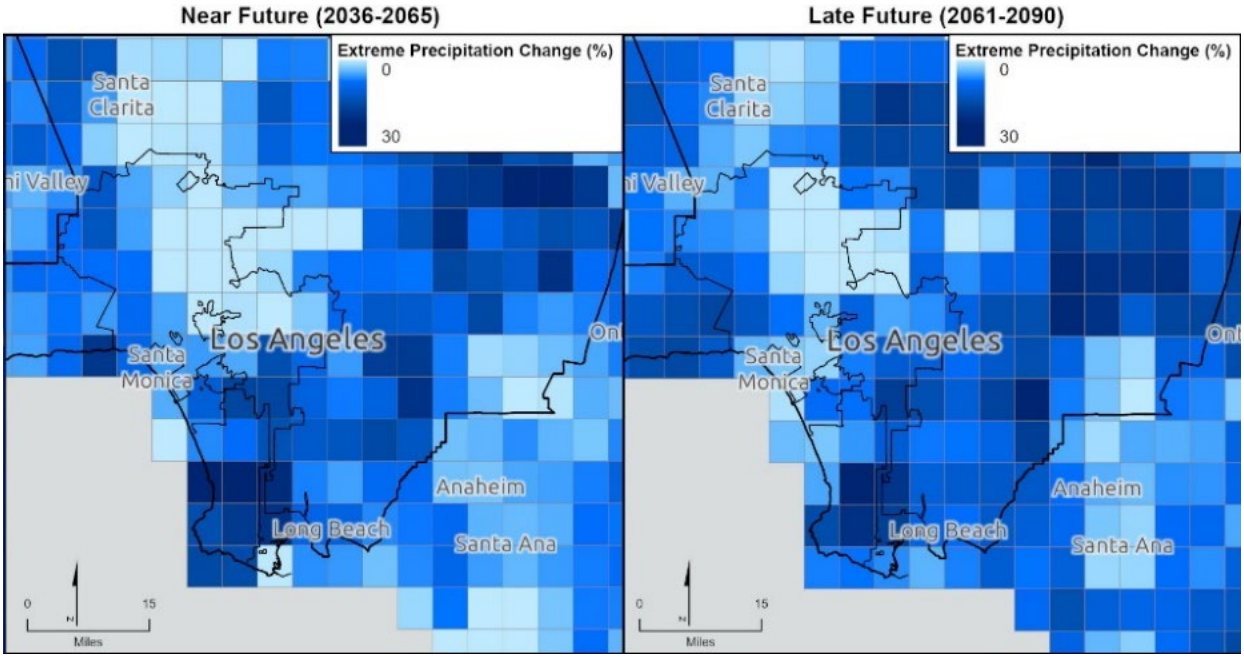


Note: Projected decadal wildfire probability during Near Future (2030-2059, left, %) and Late Future (2060-2089, right, %). Median projected probabilities are computed using 8 climate model projections from 4 general circulation models under 2 emission scenarios: RCP 4.5 and RCP 8.5. Decadal wildfire probability projections were obtained from Cal-Adapt. Locations outside of state and federal fire protection responsibility were excluded from these wildfire simulations. These areas are shown as hatched areas.

4.1.2.3 Extreme Precipitation

Extreme precipitation can be defined as 1% annual exceedance probability value of the daily maximum precipitation (referred to as a 100-year storm). The median of the 20 selected climate projections suggests increases in extreme precipitation by 7.3% and 9.4% for the near and late future periods, respectively, based on the historical reference period (Figure 4-4). The average extreme precipitation during the historical period (1981 to 2010) is 74 millimeters (mm).

Figure 4-4. Projected Change in Extreme Precipitation

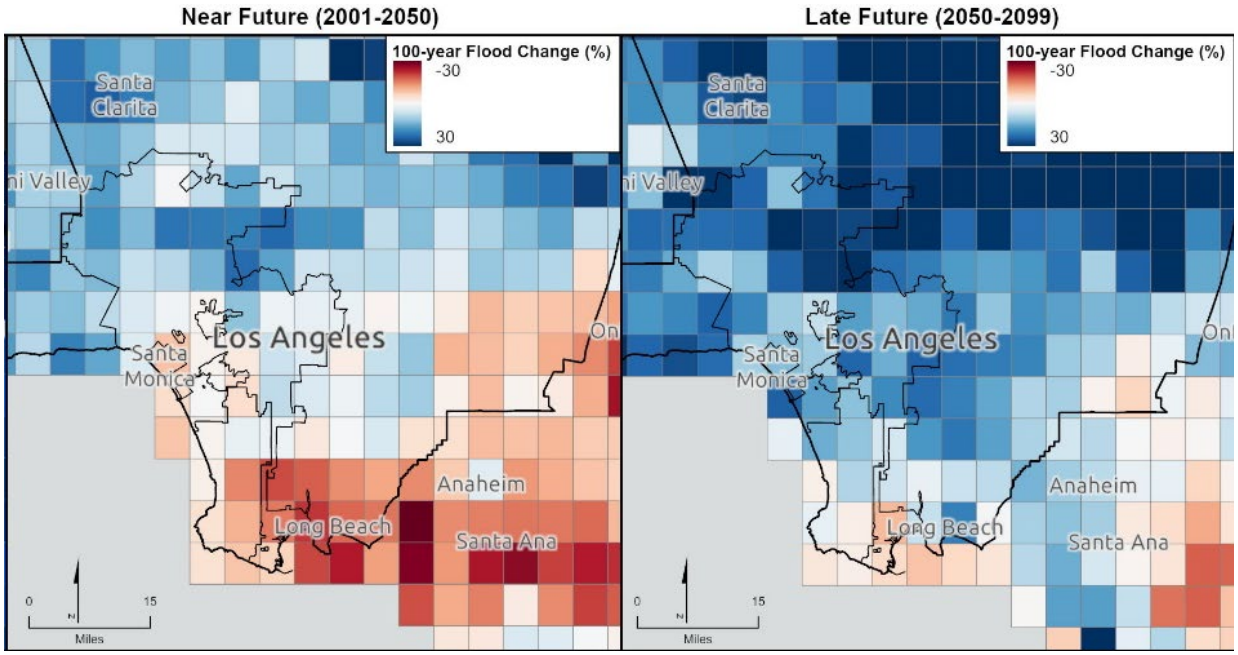


Note: Projected change in Extreme Precipitation during Near Future (2036-2065, left, %) and Late Future (2061-2090, right, %) with respect to historic period (1981-2010). Median projected changes are computed using 20 projections from 10 general circulation models under 2 emission scenarios: RCP 4.5 and RCP 8.5. Extreme precipitation is defined as 1% annual exceedance probability value of the daily maximum precipitation.

4.1.2.4 Floods

Increases in extreme precipitation will lead to more intense and frequent flooding. For watersheds with little or no snow accumulation, changes in flood volumes are associated with projected changes in extreme precipitation. Flood flows are defined as daily unimpaired flows equaling or exceeding the 1% annual exceedance probability (referred to as 100-year storm event). The daily unimpaired flows were simulated using the VIC hydrologic model at 1/16th degree spatial resolution by Scripps Institution of Oceanography; they were obtained from Cal-Adapt for this report (Pierce et al 2018). Based on the 20 climate model projections, the 100-year return period (1% annual exceedance) flood intensity is projected to increase by 4% in the near future period, and by 18.9% in the late future period, compared to the historical reference period (Figure 4-5). The average 100-year return period flood intensity during the historical period (1951 to 2000) is 60 mm.

Figure 4-5. Projected Change in 100-year Flood



Note: Projected change in flood during Near Future (2001-2050, left, %) and Late Future (2050-2099, right, %) with respect to historic period (1951-2000). Median projected changes are computed using 20 climate model projections from 10 general circulation models under 2 emission scenarios: RCP 4.5 and RCP 8.5. Flood is defined as 1% annual exceedance probability flow of daily total runoff (100-yr return period).

4.1.2.5 Sea Level Rise

Melting ice sheets and glaciers, as well as the thermal expansion of seawater associated with increased global temperatures, are the primary causes for increases in global mean sea levels in the past century. Sea level rise projections are typically developed by incorporating emissions pathways (like RCPs) to model the physical processes associated with sea level rise. Table 4-2 lists probabilistic sea level rise projections developed for the State of California Sea-Level Rise Guidance 2024 Update. Under future climate change, Los Angeles could experience a further 0.7-foot rise in sea level (Intermediate scenario) to 1.1 feet (High scenario) by 2050, and a rise of 2.8 feet (Intermediate scenario) to 6.3 feet (High scenario) by 2100 (California Ocean Protection Council 2024).

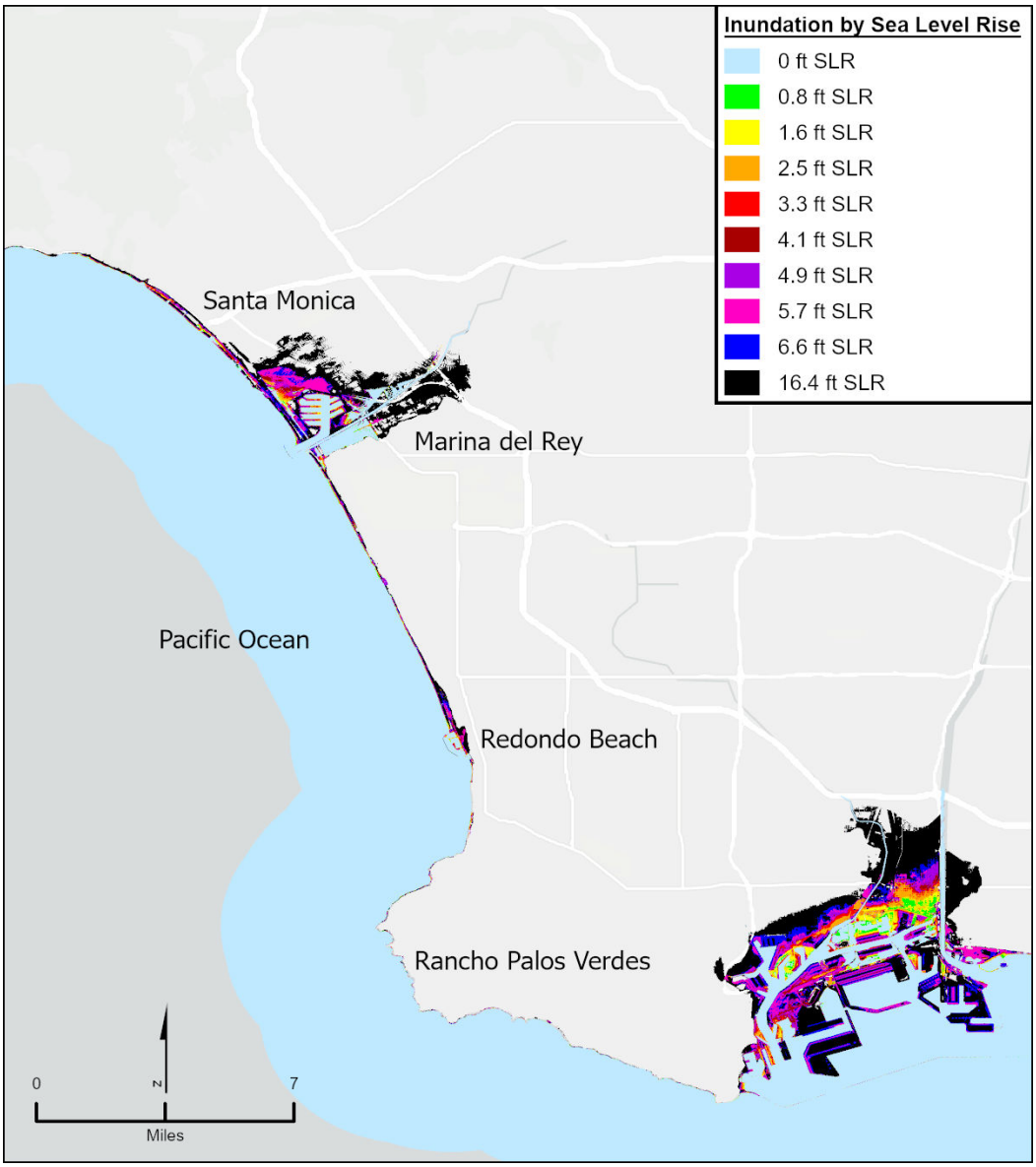
Table 4-2. Projected Sea Level Rise for Los Angeles (in feet)

YEAR	LOW	INT-LOW	INTERMEDIATE	INT-HIGH	HIGH
2020	0.1	0.2	0.2	0.2	0.2
2030	0.2	0.3	0.3	0.4	0.4
2040	0.3	0.4	0.5	0.6	0.7
2050	0.4	0.5	0.7	0.9	1.1
2060	0.4	0.6	0.9	1.4	1.8
2070	0.5	0.8	1.2	2.1	2.7
2080	0.5	0.9	1.6	2.8	3.8
2090	0.6	1.1	2.2	3.6	5.0
2100	0.6	1.3	2.8	4.5	6.3
2110	0.7	1.4	3.5	5.3	7.6
2120	0.7	1.6	4.0	6.0	8.6
2130	0.8	1.8	4.5	6.6	9.5
2140	0.8	1.9	5.0	7.1	10.4
2150	0.8	2.1	5.5	7.7	11.3

Source: California Sea Level Rise Guidance, 2024

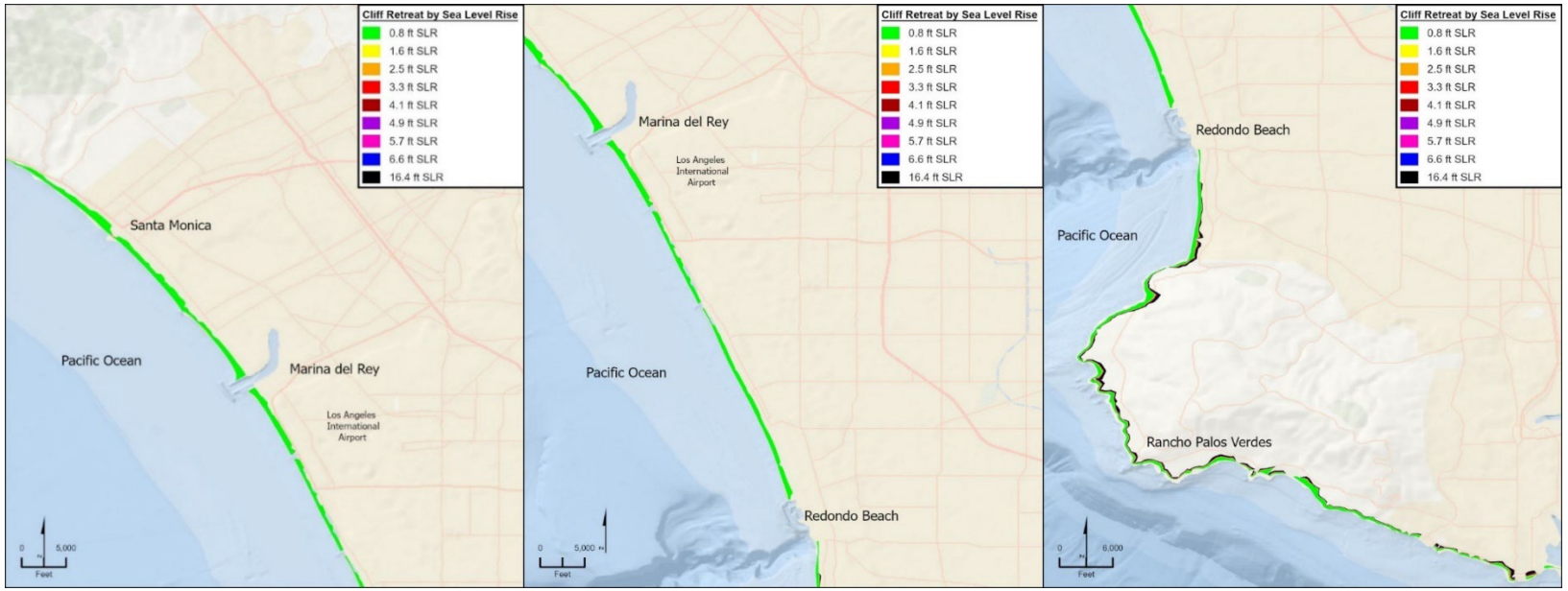
Figure 4-6 shows the projected inundation of the coastline and low-lying areas, based on 10 sea level rise scenarios with a 100-year return interval storm surge, and using the data obtained from USGS CoSMoS v3.0 Phase 2. Coastal hazards are expected to be exacerbated by climate change, including inundation under coastal flooding. Figure 4-7 shows the projected cliff retreat of the coastline and low-lying areas for the nine sea level rise scenarios using the data obtained from USGS CoSMoS v3.0 Phase 2.

Figure 4-6. Projected Inundation due to Sea Level Rise



Note: Projected inundation due to 10 sea level rise scenarios with 100-year return interval storm surge: 0 ft, 0.8 ft, 1.6 ft, 2.5 ft, 3.3 ft, 4.1 ft, 4.9 ft, 5.7 ft, 6.6 ft, and 16.4 ft. Flood Hazard data obtained from USGS CoSMoS v3.0 Phase 2.

Figure 4-7. Projected Cliff Retreat due to Sea Level Rise



Note: Projected cliff retreat for selected coastal regions of Santa Monica (left), Marina del Rey (center), and Redondo Beach (right) due to 9 sea level rise scenarios: 0.8 ft, 1.6 ft, 2.5 ft, 3.3 ft, 4.1 ft, 4.9 ft, 5.7 ft, 6.6 ft, and 16.4 ft. Cliff retreat data obtained from USGS CoSMoS v3.0 Phase 2.

4.1.3 Seismic Hazards

The general project area is underlain by a number of active fault lines, many of which have ruptured (generated an earthquake) during the last 100 years. In general, faults that have ruptured in the latest quaternary time (the last 15,000 years) are considered more likely to rupture again versus faults that have experienced older ruptures. In California, the Alquist-Priolo Earthquake Fault Zoning Act mandates that habitable structures may not be constructed on an active fault line (defined as having moved in the Holocene time, or last 12,000 years). Potentially active faults are faults that have moved between about 15,000 and 130,000 years ago.

Fault-induced ground rupture has historically been a cause of earthquake damage in Southern California. In particular, the area around the Los Angeles Aqueduct Filtration Plant (LAAFP) and Van Norman Reservoir experienced ground rupture during the 1971 Sylmar earthquake (CGS 1998).

Major seismic events can cause the following hazards that may damage Program facilities:

- Seismic shaking.
- Liquefaction and lateral spreading
- Land slides
- Seiches

This section summarizes these potential seismic hazards and how they might affect the Program.

4.1.3.1 Seismic Shaking

The Program conveyance alignments are within the seismically active region of Southern California, and may be subject to seismic ground shaking over time. Preliminary seismic data research and review took place for the northern and southern ends of the south to north alignments, and the eastern end of the west to east alignments, using USGS seismic design maps (ASCE 2023). Considering the conceptual level of the Program, this information is intended to provide a general frame of reference for the ground accelerations (the severity of ground shaking) that would be used during design of the project. The USGS parameter PGAM is the PGA, corrected for site effects (that is, subsurface conditions). PGA is an estimation of the maximum ground shaking a site can experience over a specified period of time. The period of time considered is a mean recurrence interval of about 2,475 years (2% probability of exceedance within a 50-year period). For conceptual purposes, the project alignments are classified as Site Class D (stiff soil). Using the 2017 USGS Seismic Design Maps, PGAM varies along the alignments, ranging from roughly 1.0g (g = acceleration due to gravity) near the northern end of the south to north alignments (near the LAAFP), to 0.8g near the southern end (near the Distribution System in the Harbor area) and at the eastern end of the west to east alignments.

Shaking may be increased or amplified by the type of topography (EPA 2018). For instance, ground shaking is worse in basins with soft sediments than in mountainous regions. The ground can also displace horizontally or vertically at the faults. This can cause surface ruptures and breaks in piping and other utility infrastructure that cross these ground displacements (EPA 2018).

4.1.3.2 Liquefaction and Lateral Spreading

Soil liquefaction occurs in the upper 50 to 75 feet below ground surface when saturated, loose soils lose their strength because of excess pore water pressure caused by earthquake ground shaking. Pore pressures develop when the space (pores) between the soil particles is filled with water, which exerts pressure on the soil particles, influencing how tightly the soil particles are pressed together. Before an earthquake, the pore water pressure is static, depending on the depth below the groundwater table. However, the shaking caused by an earthquake can increase the pore water pressure to a point where the soil loses strength, and the ground can be deformed.

The following primary factors affect the possibility of liquefaction in a soil deposit:

- Intensity and duration of the earthquake shaking
- Soil type
- Relative density of the soil
- Pressures of material above the soil
- Depth to groundwater

Liquefied soils can also exert additional dynamic pressures on retaining walls, which can cause them to tilt or slide. Liquefaction-induced ground failure has historically been a major cause of earthquake damage in Southern California. In particular, the area around the LAAFP and Van Norman Reservoir experienced liquefaction-induced ground failure during the 1971 Sylmar and 1994 Northridge earthquakes (CGS 1998).

Portions of each of the project alignments are in a liquefaction zone established by CGS (2023). The liquefaction zones are delineated in areas that have historically experienced liquefaction, or in areas where favorable liquefaction conditions may exist, including the presence of a shallow groundwater table and loose soils. These zones are established in areas that would require site-specific liquefaction investigation and evaluation before the construction of habitable structures.

Building structures can sink into the liquefied ground (EPA 2018). Buried pressurized pipes, such as water pipelines, could sink. Sewer pipes, manholes and pump stations (assets partially filled with air) for conveyance may float to the surface. After the earthquake, the liquefied soil will re-solidify, locking tilted buildings and broken connections into place (EPA 2018).

Lateral spreading could damage pipes, treatment facilities, wells, tanks, and other water and wastewater infrastructure (EPA 2018). If the liquefied material is below a slope, it and the ground surface could undergo significant downslope movement. This flow can particularly damage buried pipes and tanks.

Pipes often break or separate at the joints from liquefaction or lateral spreading. For example, during the Kobe, Japan, earthquake, more than half of the drinking water pipe failures were from joints pulling apart (EPA 2018).

4.1.3.3 Seiches

Seiches are waves generated within a large, closed body of water, caused either by subaqueous fault rupture or landslide events or by ground oscillations from distant earthquakes. The Van Norman Reservoir and other nearby closed water bodies could experience a seiche, which could impact the northern end of the south to north alignment options (CGS 2021).

4.1.3.4 Slope Stability

The Program conveyance alignments traverse relatively gently sloping land, except where the south to north alignments cross the Santa Monica Mountains. Through the Santa Monica Mountains, the alignments are along or near established roadways that have existed for many decades. It is likely that if significant landslide hazards were present in these areas, they would have already been remediated.

Portions of each of the potential south to north alignments are located in a landslide zone established by CGS (2023). The west to east alignments do not cross landslide hazard zones. The landslide zones are delineated in areas that have historically experienced land sliding, or in areas where favorable landslide conditions may exist, including steeply sloped areas. These zones are established in areas that would require site-specific landslide investigation and evaluation, after the LADWP alignment routing study takes place. Similarly, if significant landslide hazards were present near the alignments in the Santa Monica Mountains, they would have already been remediated.

4.1.3.5 Potential Damages

EPA's Earthquake Resilience Guide (2018) describes potential damages that have been observed from major seismic events, summarized here.

While the Program does not have a wastewater collection system or infrastructure, major damages to the wastewater collection and treatment systems could result in disruptions to wastewater flows and to the production of wastewater effluent suitable for the AWPF. Hence, the information is also summarized here for consideration as LADWP continues working with LASAN to increase the overall Program resiliency.

Water Pipes and Infrastructure

During a seismic event, pipes can be crushed or can crack or separate at brittle joints. Pipes often break or separate at the joints from strong ground shaking, liquefaction, or lateral spreading. Pipe materials used can also affect the types and likelihood of damages during a major seismic event. For example, cast iron pipes have been reported to have the highest break rate in both liquefaction and non-liquefaction areas, while asbestos cement pipes are known to have moderate to high vulnerability, especially in liquefaction areas. Pipelines are prone to failure at connections to aboveground structures, such as reservoirs, treatment plants, and pump stations, as well as at bridge crossings.

Ground rupture along a fault line at pipe crossings can result in separated piping. Aboveground structures can also be severely damaged due to ground rupture. Depending on the magnitude and type of fault displacement, damage due to ground rupture is typically limited to the fault crossing area. This differs from seismic shaking and liquefaction/lateral spreading, which can result in more regional damage.

Storage tanks can be damaged from the actual shaking, as well as the permanent ground deformation caused from seismic hazards, such as liquefaction, landslides, and ground rupture.

The types of damage include:

- Sliding off of the foundation
- Elephant foot buckling for steel tanks
- Stretching of bars for wood tanks
- Cracking or shearing of walls for concrete tanks

Liquids in tanks or reservoirs can also slosh and create forces on tank walls beyond the design capacity. During the 1994 Northridge earthquake, a water tank moved and caused the piping to sever. A steel tank at a utility in Los Angeles suffered elephant foot buckling from sloshing (EPA 2018).

Ground movement, including liquefaction-induced lateral spreading, can also cause damage to wells. The damage can include bent casings, distorted vertical shafts, and disabled well pumps.

Wastewater Collection System and Infrastructure

Wastewater pipes are more prone to damage than drinking water pipes, but in terms of function, damaged sewer pipes may still be operational with some leakage. Wastewater pipes are typically made of one or more of the following materials:

- Reinforced concrete
- Polyvinyl chloride
- Vitreous clay
- Fiberglass

Such pipes and maintenance holes may float in liquefied soils, causing severe problems.

Underground structures in liquefiable soils (such as wastewater pump stations and booster pumps) can float during a strong seismic event, which can sever pipe connections. An inoperable lift station can cause

wastewater to overflow and back up into residences and commercial buildings. Maintenance holes may also float and can impede roadway access.

Clarifiers at wastewater treatment plants could be damaged due to seiches (EPA 2018). U.S. Environmental Protection Agency (EPA) (2018) reported a case where unintended chemical spills in a wastewater collection system triggered by an earthquake event upset the biological treatment processes. Coupled with the loss of power to the blowers, the secondary treatment system was inoperable for several weeks.

Maintaining electric power is important for both water and wastewater operations. Earthquake damage to power lines, transformers, generators, and feeds will disrupt equipment functionality. Assets from both the power utility and the water and wastewater utility need to be assessed for possible failure and restoration.

Existing Water System

Two studies from LADWP were used to support understanding of the seismic hazards to future Program facilities. These studies evaluated seismic hazards for existing LADWP facilities and systems.

The first study (Davis 2009) consisted of a simulation that examined the potential impacts of a large earthquake of magnitude 7.8 occurring along the San Andreas fault line. This shakeout simulation determined vulnerabilities within the imported and local water systems, and estimated consequences of service outages that resulted from damage. It was determined that all imported water aqueducts (Los Angeles, California, and Colorado River Aqueducts) and one conveyance (Coachella Canal) would experience ruptures resulting in loss of imported water supply services. Within the local water system, regarding LADWP existing facilities and systems, an estimated 2,700 pipe repairs would result from the seismic event, more than twice the number of repairs that followed the 1994 Northridge Earthquake.

Based on the study, local system restoration depends on the restoration of the aqueducts, so is estimated to exceed 15 months. The study noted this exceeds the capacity of local supplies and would necessitate severe water rationing mandates of 25 to 70%. Costs of these repairs were estimated at $213B total with the greatest costs coming from those related to fire and business interruption (Davis 2009).

The second study (Lee 2022) used probabilistic modeling to evaluate water system vulnerability to seismic hazards. Pipe fragility was estimated using a study that had developed pipe fragility models based on observed damage to LADWP's pipelines during the San Fernando earthquake. Repair costs and timelines were sourced from several references that modeled repairs from past LADWP repair and maintenance data. For trunklines, repair information was used from historical earthquakes. The study concluded that the distribution system represents the most risk to the system because it covers more area and is more complex than trunklines that experience less exposure to seismic hazards. The overall system risk was also found to be dominated by ground shaking more than any other seismic hazard parameter. Catastrophic failures of surface fault rupture, liquefaction, or landslide could occur and result in more localized destructions with greater difficulty and cost to repair.

The modeling results were tabulated and plotted as the average return period in years against the expected number of repairs in the pipeline type. It was observed that as the average return period increased, necessary repairs caused by ruptured surface displacement increased rapidly after an earthquake with a return period of 200 years. Landslides were judged to be of nonexistent to low-risk throughout the model periods (Lee 2022).

Table 4-3 summarizes the damages resulting from each hazard.

Table 4-3. Results of Modeled Scenarios for Seismic Hazards on the Existing LADWP Water System (Lee 2022)

Study	Return Period (Years)	Estimated Number of Pipeline Repairs				
		Shaking	Liquefaction	Surface Displacement	Landslide	Total
Trunk Lines	100	27	1	0	0	28
	500	63	3	4	0	70
	2,500	92	4	11	0	107
	10,000	106	5	13	0	124
Distribution Lines	100	1,351	44	0	2	1,397
	500	3,321	141	46	5	3,513
	2,500	4,876	232	189	8	5,305
	10,000	5,679	293	321	11	6,304

4.2 Program Facilities

The Program infrastructure has been categorized into three types of systems:

1. Water Treatment/Purification
2. Conveyance
3. Groundwater Recharge

Table 4-4 summarizes LADWP's major systems and components for the Program. This assessment considered each system. Figure 4-8 shows the locations of the Program facilities evaluated in this TM. Figure 4-8 (and Figure 4-9 through Figure 4-15) shows two booster pump stations per south to north alignment, but a third pump station has been assumed for planning and cost estimating. The pump station locations will be established by the future conveyance alignment study.

For each Program facility being considered as part of the alternatives, the exact location is yet to be determined. Future studies, such as the conveyance alignment study, will establish their specific locations. This TM is based on preliminary assessments of the facilities' locations, as part of the alternatives being considered.

Figure 4-8. Major Program Systems and Components

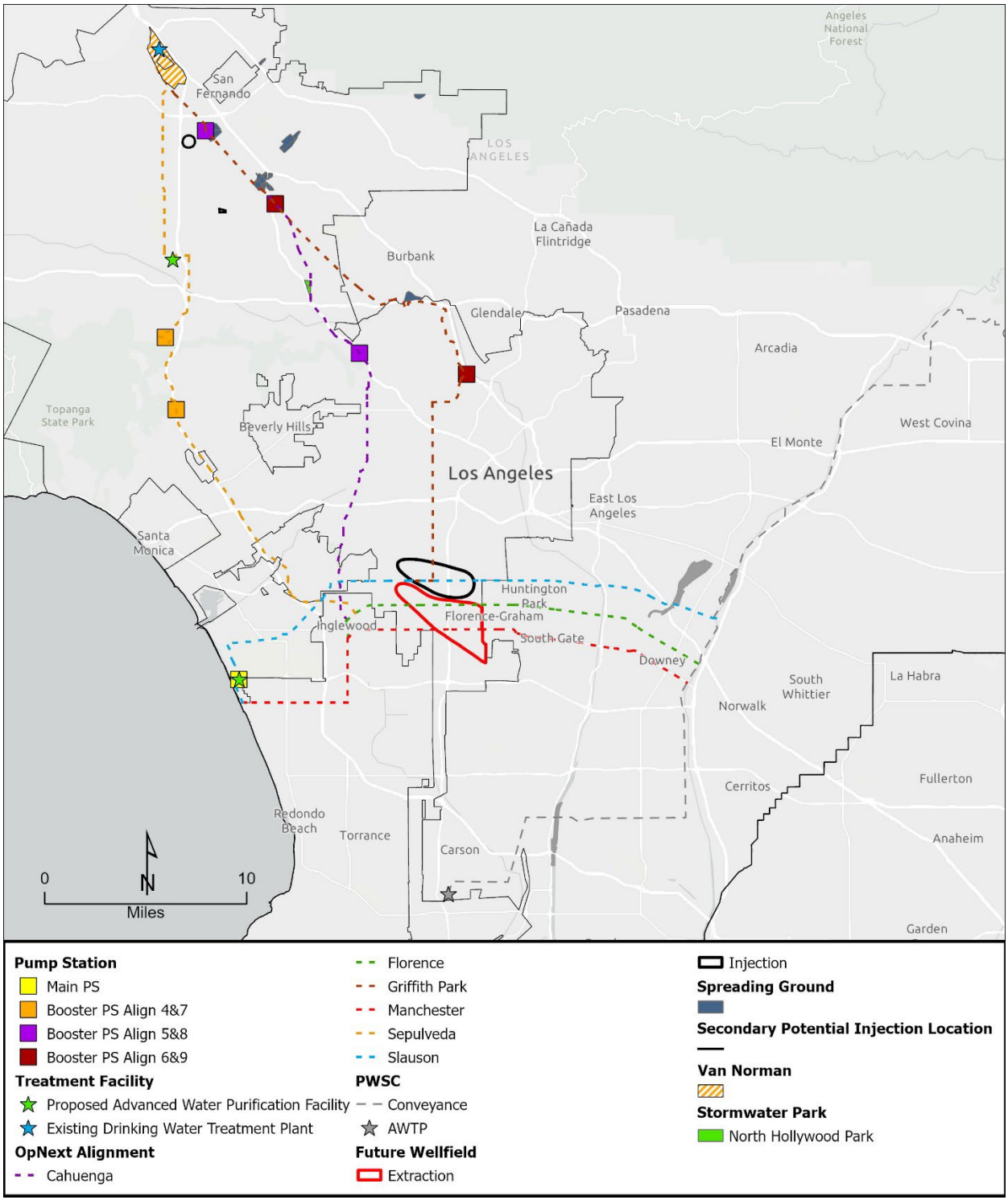


Table 4-4. Program Systems and Components

System	Component	Facilities
Water Treatment/Purification	Proposed Water Reclamation Facility/Advanced Water Purification Facility	Hyperion AWPF and DCT AWPF
Water Treatment/Purification	Existing Drinking Water Treatment Plant	LAAFP
Water Treatment/Purification	Van Norman	Van Norman Complex and Los Angeles Reservoir
Conveyance	Sepulveda Alignment	14 Segments
Conveyance	Cahuenga Alignment	15 Segments
Conveyance	Griffith Park Alignment	20 Segments
Conveyance	Slauson Alignment	9 Segments
Conveyance	Florence Alignment	9 Segments
Conveyance	Manchester Alignment	8 Segments
Conveyance	Pure Water Southern California Connection Segment	PWSC Conveyance
Conveyance	Main Pump Stations	Hyperion AWPF PS
Conveyance	Booster Pump Stations	Getty PS, Sepulveda/Skirball PS, Hollywood Bowl PS, Pacoima Spreading Grounds PS, Roscoe & Sheldon PS, and Los Feliz & Riverside PS
Groundwater Recharge	Stormwater Parks	North Hollywood Park
Groundwater Recharge	Future Wellfield	Extraction and Injection
Groundwater Recharge	Spreading Grounds	Pacoima S.G., Hansen S.G., Lopez S.G., Branford S.G., Tujunga S.G., Headworks S.G., and Tujunga Gallery S.G.
Groundwater Recharge	Secondary Potential Injection Location	Secondary Potential Injection Locations

4.3 Vulnerability Assessment Methodology

The following steps were followed to assess the vulnerability of the Program facilities and operations:

1. Develop climate change and seismic vulnerability metrics.
2. Identify Program systems and facilities.
3. Evaluate the vulnerability of Program systems to climate and seismic hazards.
4. Assign vulnerability rating to Program facilities.

The following sections describe each type of vulnerability.

4.3.1 Climate Vulnerability

Extreme Heat Days: Program facilities' vulnerability to extreme heat days is estimated using the extreme heat days climate vulnerability metrics. Extreme heat days are defined based on the daily maximum temperature exceeding 95°F or 98th percentile historical temperature, separately. The change in the extreme heat days per year value for near and late futures is derived for each Program facility from the overlapping 6-km grid. The vulnerability rating is then assigned to each Program facility based on the extreme heat days change values for near and late future periods.

Wildfire: Program facilities' vulnerability to wildfire is estimated using the wildfire probability climate vulnerability metrics. The wildfire probability value for near and late futures is derived for each Program facility from the overlapping 6-km grid. For watersheds and groundwater basins, the wildfire probability value is estimated using the basin averaged wildfire data. The vulnerability rating is then assigned to each facility based on the wildfire probability values for near and late future periods.

Extreme Precipitation: Program facilities' vulnerability to extreme precipitation is estimated using the 1% annual exceedance probability precipitation value of daily maximum rainfall. The change in the 99th percentile values of the daily maximum precipitation value for near and late futures are derived for each Program facility from the overlapping 6-km grid. For watersheds and groundwater basins, the change in extreme precipitation value is estimated using the basin averaged daily precipitation. The vulnerability rating is then assigned to each facility facilities based on the extreme precipitation change values for near and late future periods.

Pluvial Flooding: Program facilities' vulnerability to pluvial flooding is estimated using the extreme precipitation climate vulnerability metrics. Pluvial flooding refers to the flooding caused by high-intensity and short-duration precipitation events (Miller and Hutchins 2017). The flooding threat is estimated by combining the projected extreme precipitation with the slope of the facility available for runoff. The extreme precipitation is estimated as the 1% annual exceedance probability precipitation value of daily maximum rainfall for the 30-year periods. The slope for each facility is calculated using the average slope of the neighboring grids from 1 meter in the digital elevation model. The relation between the projected change in extreme precipitation and slope is developed for each facility for the near and late future periods. The vulnerability rating is then assigned to each facility based on the relation between extreme precipitation change and slope. The facilities at a steep gradient and low precipitation change are assigned a low vulnerability rating, while facilities at low slope and high precipitation change assigned a high vulnerability rating.

Floodplain Flooding: Program facilities' vulnerability to floodplain (fluvial) flooding is estimated using the flood climate vulnerability metrics. The Federal Emergency Management Agency (FEMA) flood maps, combined with the 1% and 0.2% annual exceedance probability flow estimates, are used for the vulnerability assessment. The facilities near the FEMA flood maps' 100-year and 500-year floodplain zones are further analyzed to develop the vulnerability rating. The rate of change of floodplain width adjacent to a facility is estimated by correlating the historical 1% and 0.2% annual exceedance flood value and floodplain widths for 100-year and 500-year floods from FEMA maps, respectively. The projected changes in exceedance flood value for future periods are then used to calculate the projected floodplain width changes for 100-year and 500-year floods. The rate of change of floodplain width for future periods is assumed to be the same as for the historical period. The inundation of the Program facility by 500-year floodplain, 100-year floodplain, or floodway defines the vulnerability rating for near and late future periods.

Coastal Flooding and Cliff Retreat: Program facilities' vulnerability to coastal flooding is estimated using the inundation of the coastline and low-lying region under the impact of climate change and sea level rise. The inundation of the Program facilities is evaluated based on rises in sea level ranging from 0 m to 5 m with 100-year return interval storm surge. The vulnerability rating is then assigned to the LADWP facilities based on the specific sea level rise causing the inundation of the facility.

This assessment includes cliff retreat of the coastline and low-lying region under the sea level rise scenarios. Cliff retreat associated with rises in sea level ranging from 0.25 m to 5 m is evaluated. The vulnerability rating is then assigned to the facilities based on the specific sea level rise level at the facility.

4.3.2 Seismic Vulnerability

Program facilities' vulnerability to seismic hazards is estimated using information about the following contributors:

- Quaternary faults
- Liquefaction

- Landslides
- PGA(g)

The number of quaternary faults crossing a facility is identified by overlaying the facility with the quaternary faults map. The faults' impact on the facility are assigned the following ratings:

- 0 when a facility is not on any fault
- 1 when a facility is over a single fault
- 2 when a facility is above multiple faults

The impact of the liquefaction zone on the facility is analyzed by assigning the following ratings:

- 1 when a facility is in a liquefaction zone
- 0 when a facility is not in a liquefaction zone

The impact of the landslide zone on the facilities is analyzed the same as liquefaction zone. The PGA for the Los Angeles region varies from 0.78g to 1.05g. Based on the ShakeMap classification (Wald et al 1999), a PGA less than 0.65g can cause moderate/heavy potential damage, while the PGA exceeding 0.65g can cause heavy or very heavy potential damage. The impact of the PGA on the facility is analyzed by assigning the following ratings:

- 1 to heavy or very heavy potential damage
- 0 if there is no heavy or very heavy potential damage

The seismic vulnerability rating is then assigned to Program facilities based on the sum vulnerability ratings of quaternary faults, liquefaction zone, landslide zone, and PGA.

Table 4-5 summarizes the climate and seismic vulnerability metrics.

Table 4-5. Details of the Climate and Seismic Vulnerability Metrics

No.	Vulnerability Category	Vulnerability Indicator	Metric	Analysis Notes
1	Temperature	Extreme Heat	Projected change in number of Extreme Heat Days per Year when daily maximum temperature is above 95°F and 98th percentile Historical temperature (days per year)	Historical: 1981-2010 Near Future: 2036-2065 Late Future: 2061-2090
2	Precipitation	Extreme Precipitation	Projected change in 1% annual exceedance probability precipitation value of daily maximum rainfall (%)	Historical: 1981-2010 Near Future: 2036-2065 Late Future: 2061-2090
3	Floods	Extreme Flow	Projected changes in 1% annual exceedance probability flows based on daily unimpaired flow (%)	Historical: 1951-2000 Near Future: 2001-2050 Late Future: 2050-2099
4	Sea Level Rise	Exposure to flooding inundation in coastline and low-lying area.	Exposure to inundation under storm surge flooding given various levels of sea level rise	10 sea level rise scenarios
5	Sea Level Rise	Cliff retreat of coastline and low-lying area.	Cliff retreat under various levels of sea level rise	9 sea level rise scenarios

No.	Vulnerability Category	Vulnerability Indicator	Metric	Analysis Notes
6	Wildfire	Wildfire Burn Probability	Projected decadal wildfire probabilities (%)	Decadal analysis periods; Historical: 1980-2009 Near Future: 2030-2059 Late Future: 2060-2089
7	Seismic Hazard	Seismic Hazard Region	Exposure to seismic impacts under quaternary faults, liquefaction, landslides, and PGA	Combined rating for the four seismic metrics

4.3.3 Vulnerability Ratings

Five vulnerability rating classes are used to report Program facilities' vulnerability to climate and seismic hazards.

1. Low
2. Moderate-low
3. Moderate
4. Moderate-high
5. High

The vulnerability rating is assigned to each facility separately for near and late future periods. Table 4-6 lists the vulnerability metrics used to develop these ratings. These ratings are similar as those currently used in a recent State of California watershed resilience assessment and similar efforts for utilities in California.

Table 4-6. Vulnerability Rating Overview

Rating	Extreme Heat (Change in Days> 95°F)	Extreme Heat Days (Change in days > 98th percentile)	Extreme Precipitation (change in 1% annual probability)	Pluvial Flooding	Floodplain Flooding	Coastal Flooding/ Cliff Retreat	Wildfire (decadal wildfire probability %)	Seismic Hazard
	(days/year change)	(days/year change)	(% change)	Condition	Condition	Condition	(%) or condition	Condition
Low	<10	<5	<5	Low extreme precipitation changes and steep slope for runoff	Not Inundated	Inundated/Eroded by 6.7-foot sea level rise (2100 High scenario)	<5	1
Moderate-Low	10-20	5-10	5-10	N/A	Not Inundated but close to 500-yr floodplain	Inundated/Eroded by 3.3-foot sea level rise (2100 Intermediate scenario)	5-15	2
Moderate	>20-30	>10-20	>10-15	Moderate extreme precipitation changes and gentle slope for runoff	Inundated by 500-yr floodplain	Inundated/Eroded by 1.6-foot sea level rise (2050 High scenario)	>15-25 or within historical wildfire perimeter	3
Moderate-High	>30-40	>20-30	>15-20	N/A	Inundated by 100-yr floodplain	Inundated/Eroded by 0.8-foot sea level rise (2050 Intermediate scenario)	>25-35	4
High	>40	>30	>20	High extreme precipitation changes and flat slope for runoff	Within Floodway	Inundated/Eroded without sea level rise	>35	5

> = greater than

< = less than

4.4 Vulnerability Assessment Results

4.4.1 Climate Vulnerability

The Program climate vulnerability was developed by analyzing the types of infrastructure listed in Table 4-4. Each facility's vulnerability rating is based on the impact of the specific hazard(s) within each analysis.

4.4.1.1 Extreme Heat Vulnerability

Program facilities' vulnerability to extreme heat days is based on the change in the number of days exceeding the 95°F and 98°F daily maximum temperature in the late future period. The number of days exceeding the temperature limit are grouped, and levels of risk are assigned (Figure 4-9).

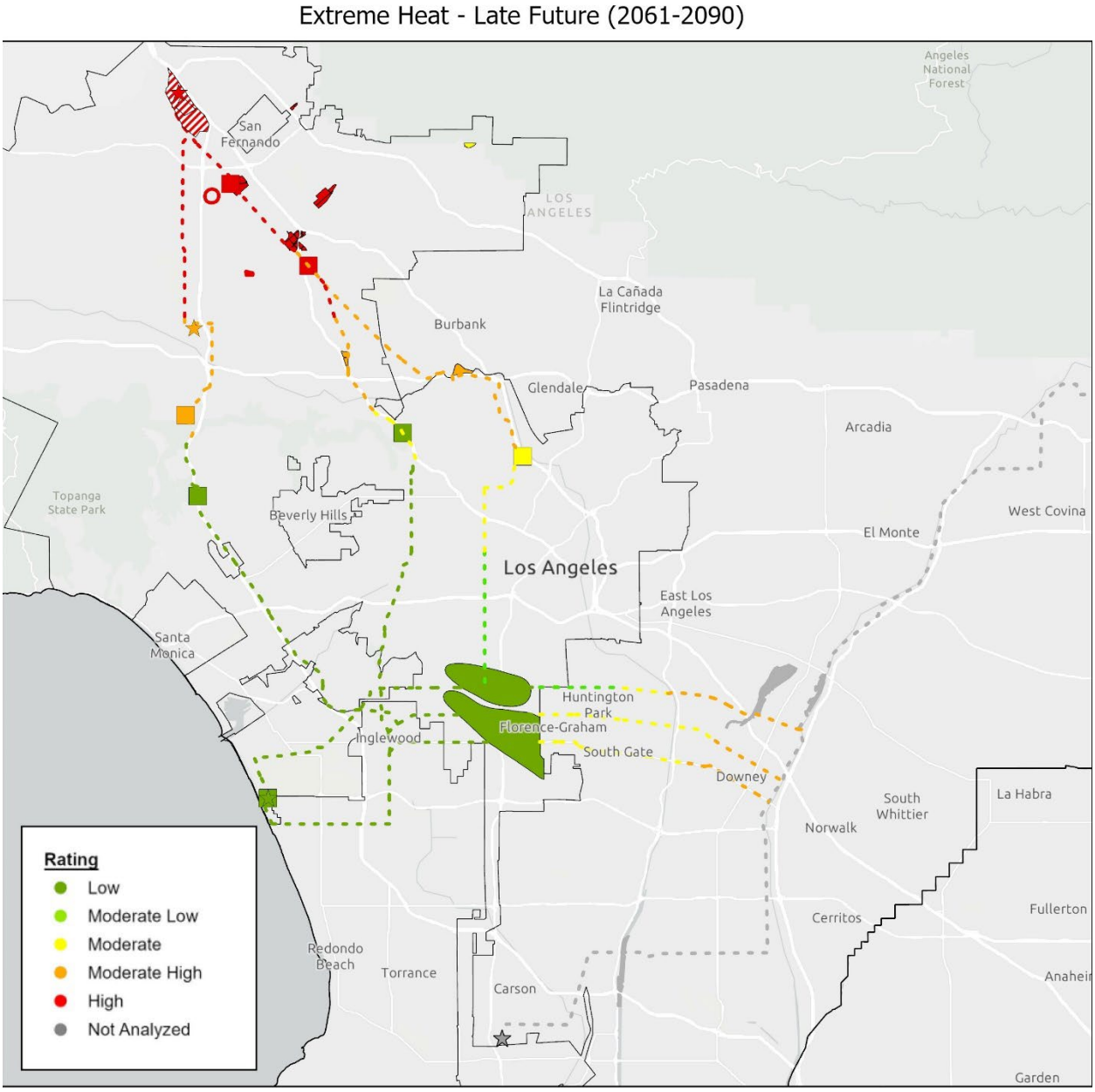
For the 95°F assessment, facilities with a projected increase of fewer than 10 extreme heat days have low vulnerability (dark green). Facilities with an increase of 10 to 20 days have moderate low vulnerability (light green), facilities with an increase of more than 20 to 30 days have moderate vulnerability (yellow), facilities with an increase of more than 30 to 40 days have moderate high vulnerability (orange), and facilities with increases exceeding 40 days are highly vulnerable (red) to extreme heat days.

When assessing Program facilities' heat vulnerability using the number of days exceeding a daily maximum temperature of 95°F, a correlation of less vulnerability near the North West coast is used, which increases with distance inland. Each alignment contains conveyance sections with moderate or higher vulnerabilities. The whole Program has a moderate vulnerability rating, and portions closest to the Van Norman Complex (the Sepulveda, Cahuenga, and Griffith Park alignments) have high vulnerability. Most facilities near the foothills of the Angeles National Forest have high vulnerability ratings for days exceeding 95°F. This includes the following facilities:

- LAAFP
- Van Norman Complex

The AWPF, which is assumed to be located at HWRP for the purpose of this analysis, has low vulnerability to extreme heat.

Figure 4-9. Vulnerability of Program System to Extreme Heat Days above 95°F



Similarly, for the assessment considering extreme heat as days above 98th percentile historical daily maximums, facilities with a projected increase in extreme heat days of fewer than 5 days have low vulnerability (dark green). Facilities with an increase of 5 to 10 days have moderate low vulnerability (light green), facilities with an increase of more than 10 to 20 days have moderate vulnerability (yellow), facilities with an increase of more than 20 to 30 days have moderate high vulnerability (orange), and facilities with increases exceeding 30 days are highly vulnerable (red) to extreme heat days (Figure 4-10).

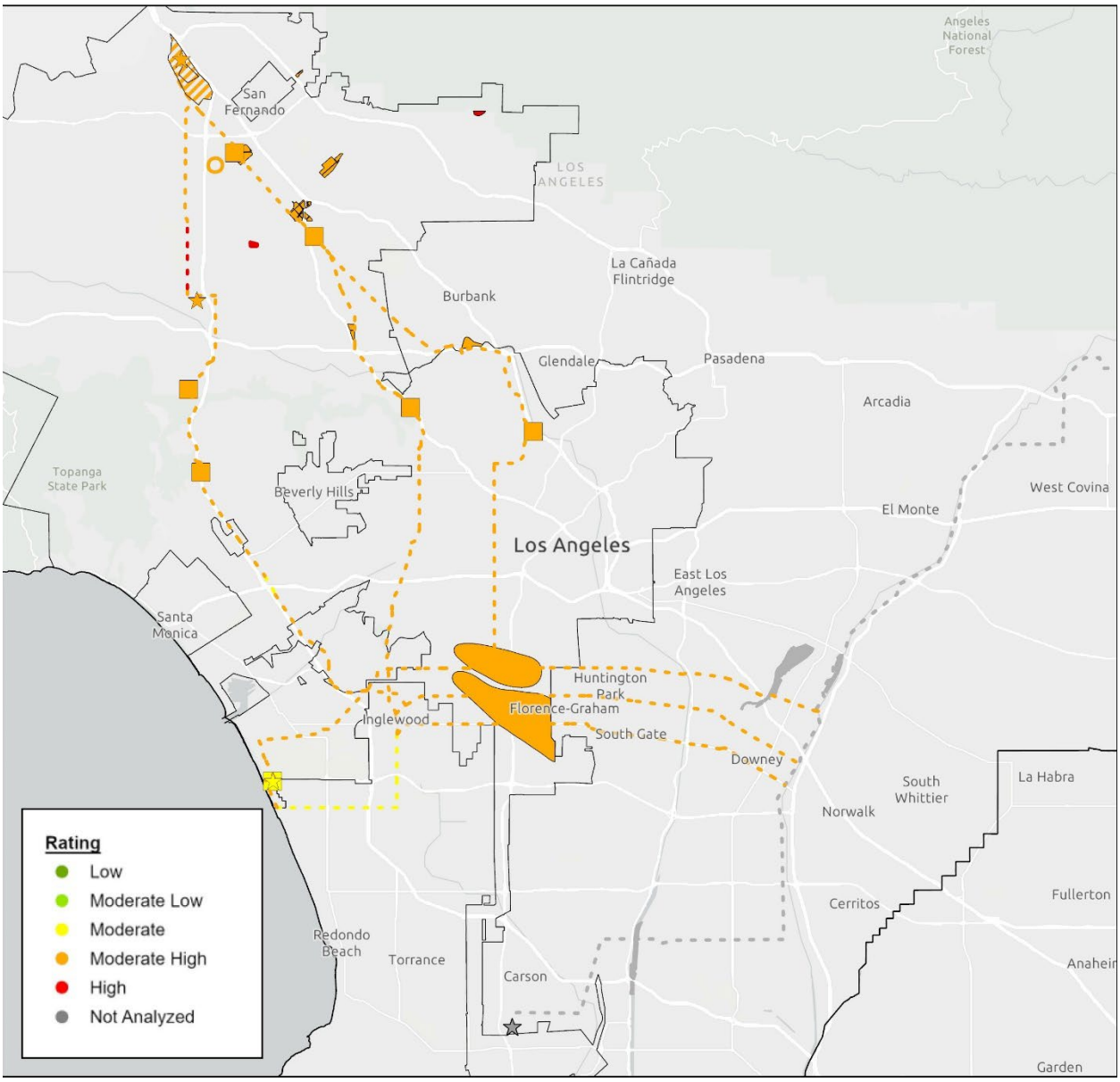
Each facility is expected to experience an increase in temperature, resulting in moderate to high vulnerability in the future (Figure 4-10). Most Program facilities will experience moderate-high risk of daily maximum temperature exceeding 98th percentile historical daily maximum, with the following exceptions:

- Coastal facilities with moderate vulnerability, including:
  - HWRP
  - Some conveyance systems

The conveyance systems with moderate vulnerability are portions of the Manchester alignment south of HWRP. Sections of the Sepulveda conveyance running south to north also experience both moderate and high vulnerability.

Each facility has moderate or higher vulnerability to extreme heat with a daily maximum average exceeding 98th percentile daily maximum in the late future term.

Figure 4-10. Vulnerability of Program System to Extreme Heat Days above 98th Percentile Historical Temperature

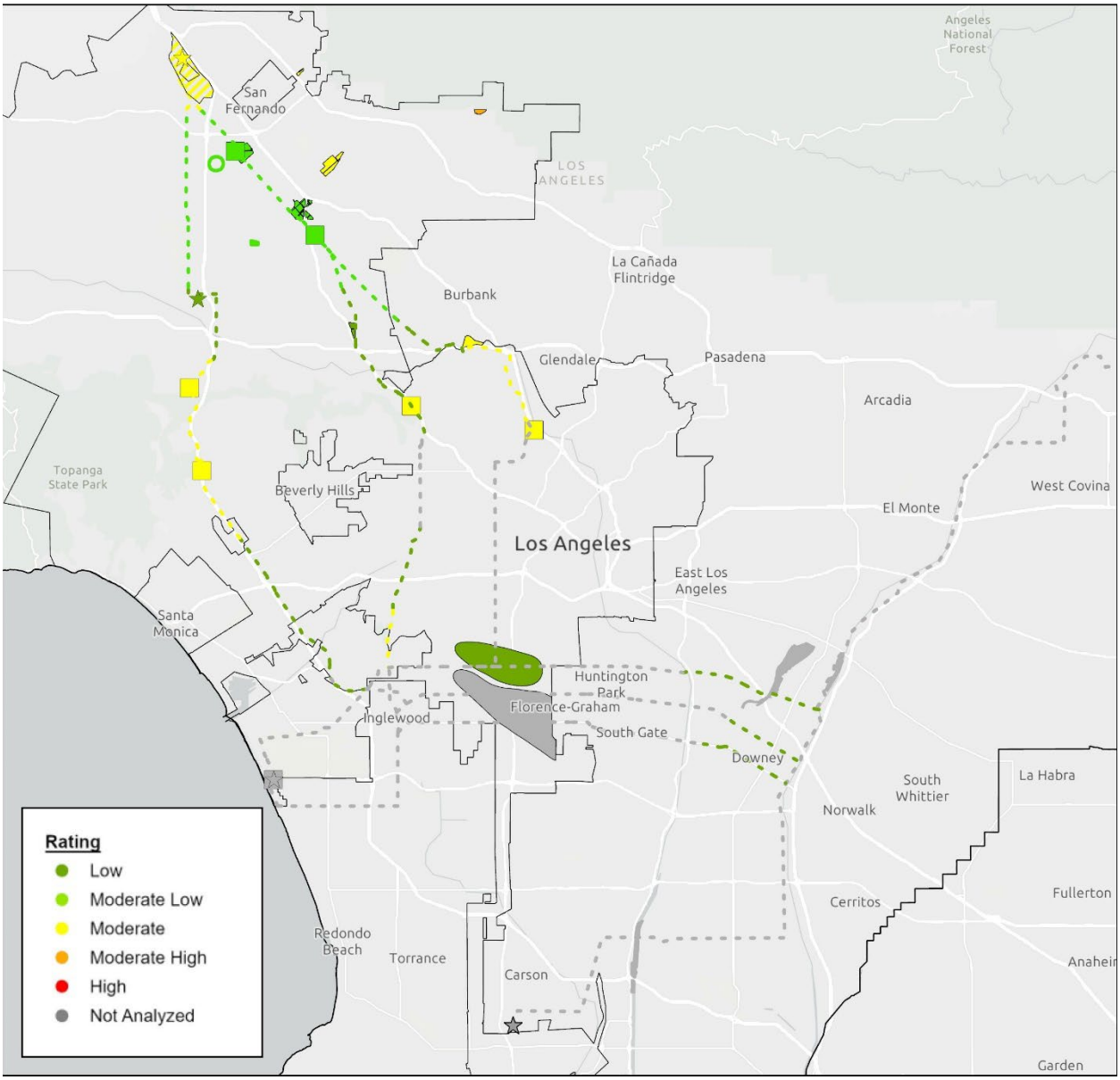


4.4.1.2 Wildfire Vulnerability

Program facilities' vulnerability ratings were estimated using the CAL FIRE historical wildfire perimeter data (Figure A-2 in Appendix A) and UC Merced projected wildfire probability. The facilities in the historical wildfire perimeter regions were assigned a vulnerability rating of moderate, which was changed to moderate-high or high, based on the projected wildfire probability. The facilities outside the historical wildfire perimeter regions were assigned a vulnerability rating based only on the projected wildfire probability. Table 4-7 describes the probability range of the projected wildfire probability used for the vulnerability rating.

Most facilities have a moderate or lower vulnerability to wildfire, except some spreading grounds that abut the foothills of the Angeles National Forest. There are no facilities with high vulnerability to wildfire.

Figure 4-11. Vulnerability of Program System to Wildfire
Wildfire - Late Future (2060-2089)

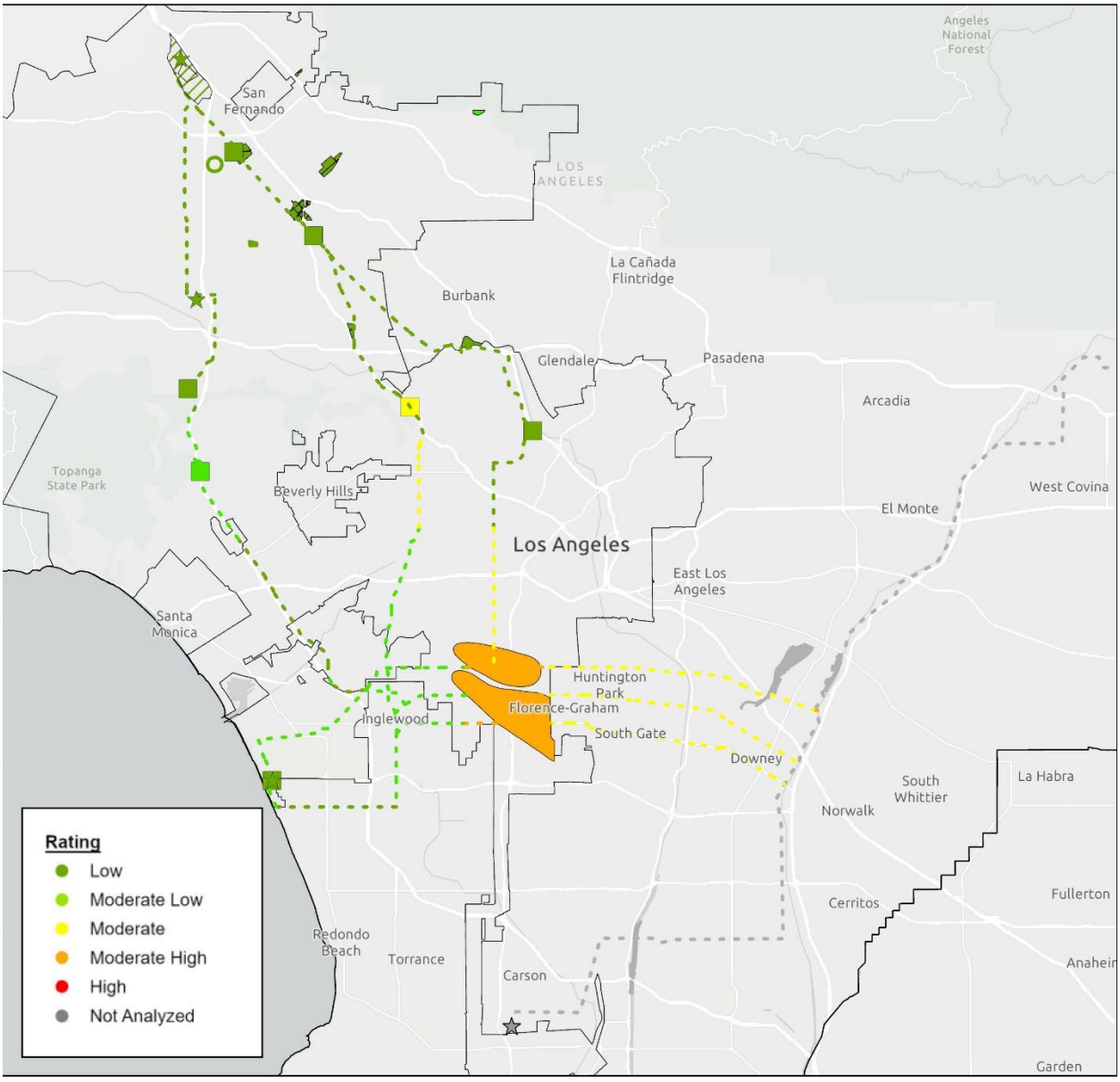


4.4.1.3 Extreme Precipitation Vulnerability

Program facilities' vulnerability to extreme precipitation are based on an increase in the 99th percentile precipitation (Figure 4-12). For the assessment, facilities with a projected increase in extreme precipitation of less than 5% have low vulnerability (dark green), 5% to 10% have moderate low vulnerability (light green), more than 10% to 15% have moderate vulnerability (yellow), more than 15% to 20% have moderate high vulnerability (orange), and exceeding 20% are highly vulnerable (red) to extreme precipitation.

Most of the higher risk is concentrated to the east and southeast. Of the south to north alignments, only short sections of Cahuenga and Griffith Park will experience moderate vulnerability. The eastern conveyance sections of the Slauson, Florence, and Manchester alignments are also rated for moderate vulnerability.

Figure 4-12. Vulnerability of Program System to Extreme Precipitation
Extreme Precipitation - Late Future (2061-2090)



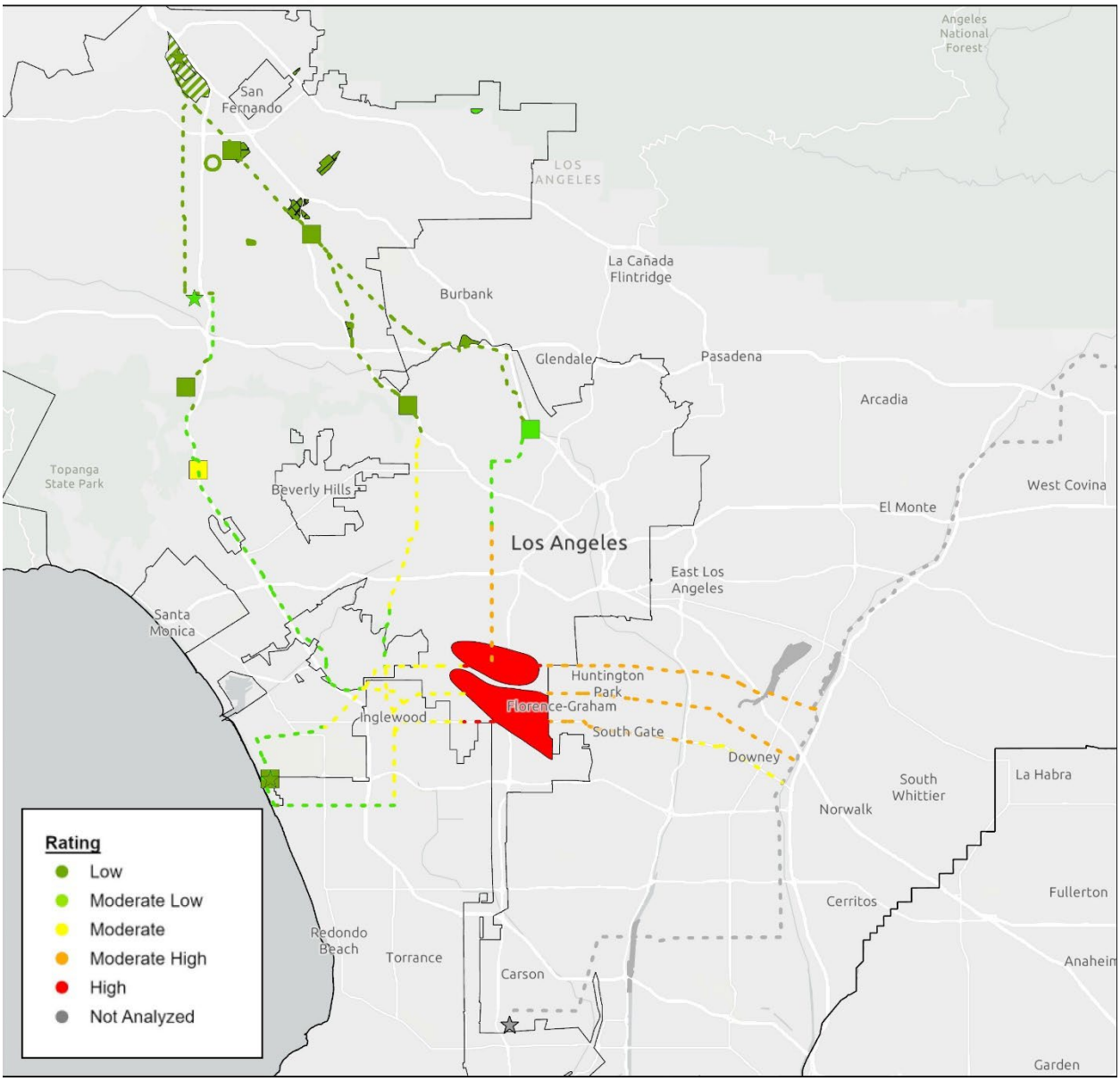
4.4.1.4 Pluvial Flooding Vulnerability

Program facilities' vulnerability to pluvial flooding is derived from localized flooding potential. That potential is estimated by combining the projected extreme precipitation with the slope available for runoff (Figure 4-13). The facilities at steep gradients and with low precipitation changes are assigned low vulnerability ratings (green). Facilities at a flat slope and with high precipitation changes are highly vulnerable (red). Because the extreme precipitation is projected to increase for the eastern and

southeastern regions, those zones are more vulnerable to pluvial flooding, while facilities in the northern region are less vulnerable.

The results for the pluvial flooding risk assessment resemble those from the extreme precipitation assessment. Variation is likely caused by the addition of topography when assessing vulnerability. Facilities at high risk of pluvial flooding include the future wellfields, AWPF, and short sections on the Manchester and Slauson alignments at the future wellfield site.

Figure 4-13. Vulnerability of Program System to Pluvial Flooding



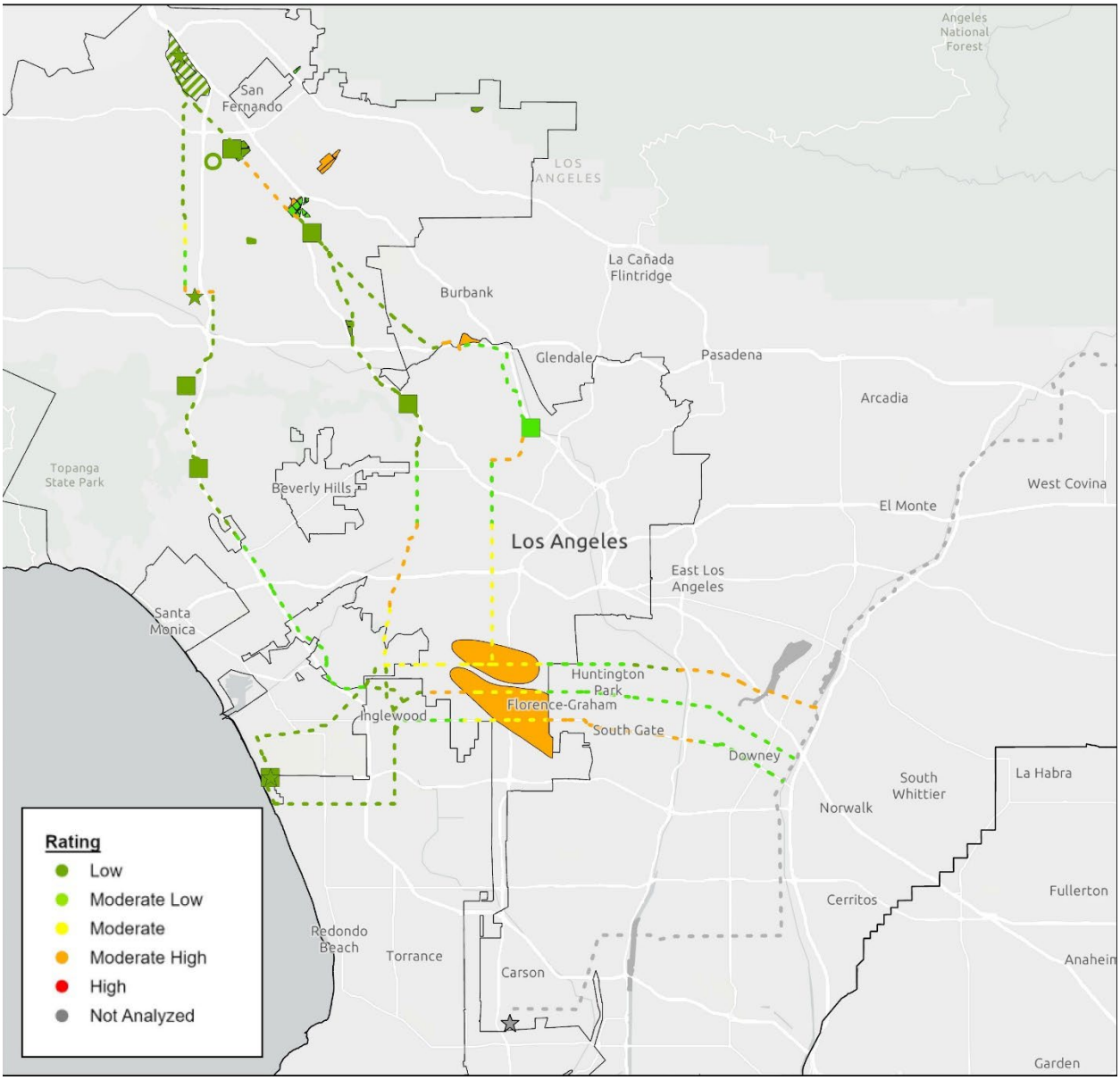
4.4.1.5 Floodplain Flooding Vulnerability

Program facilities' vulnerability to floodplain (fluvial) flooding is estimated using FEMA flood maps, combined with 1% and 0.2% annual exceedance probability flow estimates for the future period

(Figure 4-14). The facilities that are not inundated by floodplain have low vulnerability (green). Those inundated by the 500-year floodplain have moderate vulnerability (yellow), and those inundated from the floodway have high vulnerability (red) to floodplain flooding.

Floodplain flooding vulnerability is not as great as that for pluvial vulnerability, with similar affected areas for higher vulnerability. There is generally low vulnerability, except for the future wellfields, some portions of the alignments, the Program conveyance, and a few spreading grounds.

Figure 4-14. Vulnerability of Program System to Floodplain Flooding



4.4.1.6 Coastal Flooding and Cliff Retreat Vulnerability

Program facilities' vulnerability to the coastal flooding is estimated based on how inundated the coastline and low-lying regions become with climate change and rises in sea level. First, facilities are evaluated that

will be inundated by rises in sea levels ranging from 0 foot to 16 feet with 100-year return interval storm surge. Facilities are then assigned a vulnerability rating based on the specific sea level rise causing their inundation.

Each scenario of sea level rise from the CoSMoS dataset has been used for the analysis. However, the sea level rise scenarios used for the vulnerability rating are based on the Sea Level Rise Guidance as described in Table 4-2 of Section 4.1.1.5. Facilities only affected by the worst-case sea level rise scenario of 16.4 feet were given a null rating equating to lack of risk, as were facilities unaffected by sea-level rise. Those inundated by 6.7 feet of sea level rise were assigned a low rating. Facilities inundated by 1.6 feet of sea level rise were rated as moderate, and facilities inundated by tidal flooding without sea level rise were rated as high.

The Program facilities' vulnerability assessment included the cliff retreat of the coastline and low-lying region under the sea level rise scenarios. Cliff retreat associated with sea level rise ranging from 0.8 foot to 16 feet was evaluated. The vulnerability rating was then assigned to the facilities based on their specific height of sea level rise.

The coastal inundation is not projected to affect Program facilities. While Terminal Island Water Reclamation Plant is not specifically a Program facility, it does provide recycled water to LADWP. The Terminal Island Water Reclamation Plant is projected to be inundated by 6.7 feet of sea level rise with 100-year return interval storm surge. The Sea Level Rise Guidance projects this to happen in the year 2100 High scenario. No Program facilities will be prone to erosion, based on the cliff retreat scenarios analyzed in this TM.

The OneWater LA 2040 Plan (LADWP 2018) evaluated climate hazards, including coastal flooding and cliff retreat associated with sea level rise, and provided a detailed evaluation of risks to HWRP. It was found that Vista Del Mar, the coastal road between HWRP and the ocean, provides protection against the coastal flooding hazards, including tsunami impacts (LADWP 2018).

4.4.2 Seismic Vulnerability

Each facility's seismic vulnerability is rated based on the compounded impacts of quaternary fault crossings, whether it is within a liquefaction or landslide zone, and the level of damage expected from PGA. The rating scale weights these factors and then sums them to result in a rating that falls between 1 (low; green) and 5 (high; red) (Figure 4-15). Quaternary crossings are weighted so if a facility only crosses one fault, 1 point is added, and if it crosses two faults or more, 2 points are added to the rating. If the facility is within a liquefaction or landslide zone, 1 point is added for each zone. Finally, a damage rating of "heavy" because of PGA contributes 1 point to the rating, while any other damage level will not incur points.

All three south to north alignments (Cahuenga, Griffith Park, and Sepulveda) are vulnerable to seismic hazards, in part because the alignments are conceptually assumed to include the LAAFP to Rinaldi Road pipeline segment near the Van Norman Complex. Further evaluation is recommended as part of LADWP's future conveyance alignment study.

Two out of three west to east alignments (Florence and Slauson) and the Van Norman Complex, have moderate to high vulnerability to seismic hazards. The moderate-highly impacted facilities are outside the landslide hazard zones, except the Van Norman Complex. The facilities that are moderately impacted by seismic hazards include:

- Spreading grounds
- Van Norman reservoirs
- Future injection wellfields
- A stormwater park

The pump stations have low or moderately low seismic vulnerability.

Although the south to north alignments are vulnerable, the Coliseum Street to Slauson Avenue segment of the Cahuenga alignment is at the highest risk, because it crosses six quaternary faults. When evaluating alignments (including various pipeline segments of differing lengths), the following factors were assessed:

- Total number of faults
- Percentage of pipeline length within liquefaction and landslide hazard zones
- Percentage of pipeline length in PGA zones

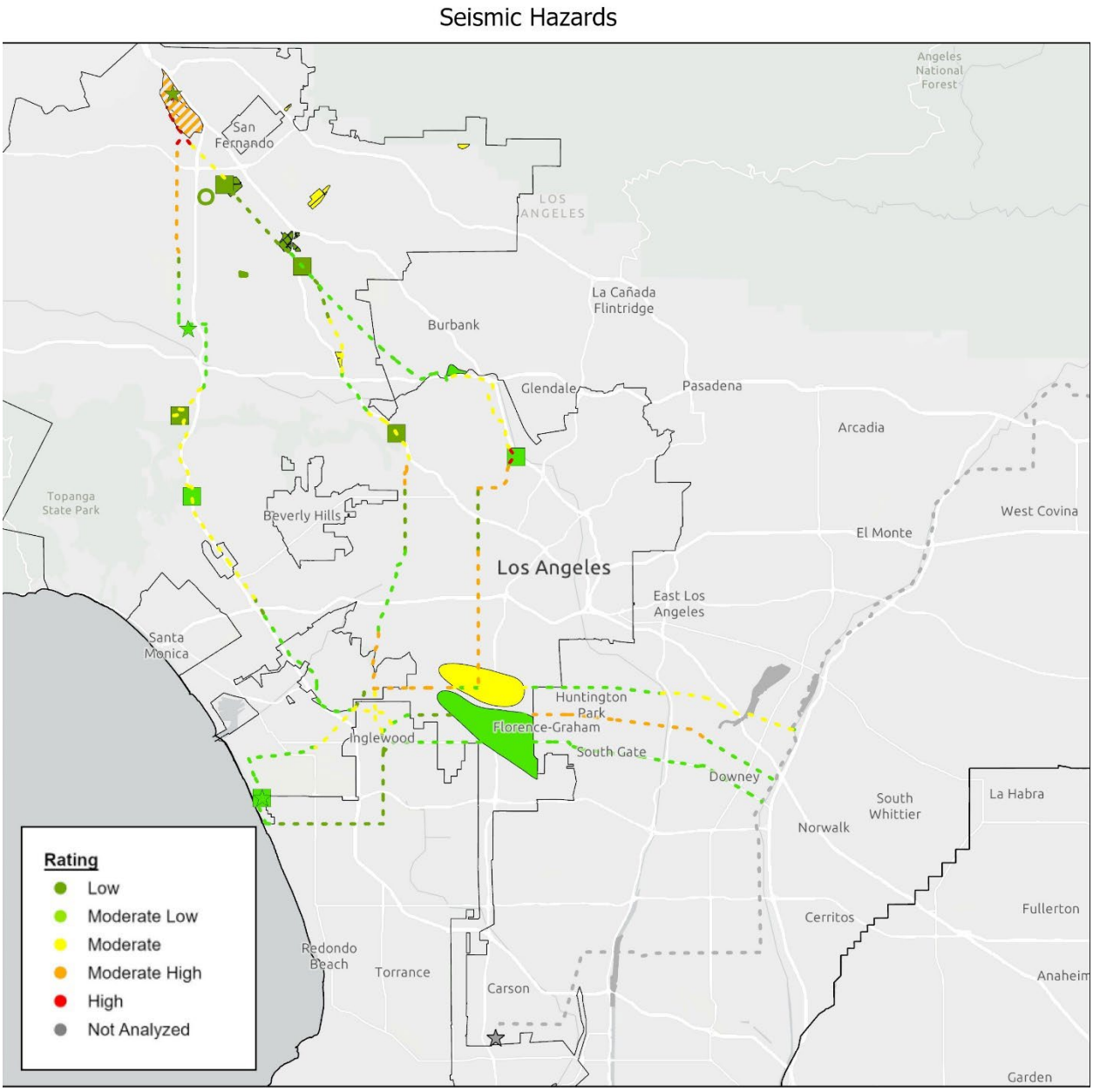
The summary seismic vulnerability rating of the south to north alignments are as follows:

- Moderate (3.0) for Sepulveda
- Moderate-high (4.0) for Cahuenga and Griffith Park alignments

Similarly, the summary seismic vulnerability ratings for west to east alignments are as follows:

- Low (1.0) for Manchester alignment
- Low-moderate (2.0) for Florence alignment
- Moderate-high (4.0) for Slauson alignment

Figure 4-15. Vulnerability of Program System to Seismic Hazards



4.4.3 Summary

Table 4-7 summarizes the vulnerability assessments. This table establishes each facility's overall vulnerability rating, based on the individual climate and seismic risk factors.

The findings of this assessment indicate many climate and seismic conditions affect the Program facilities' vulnerabilities. Most Program facilities have climate and/or seismic vulnerabilities.

- The AWPF has relatively low climate vulnerabilities, based on an analysis of coastal and localized flooding hazards. However, the importance of this facility requires a more integrated coastal hazards assessment that includes the combined effects of sea level rise, cliff retreat, and impacts of induced liquefaction during a seismic event.

- Many of the extreme heat and localized extreme precipitation vulnerabilities could be mitigated with further facility planning and design elements.
- All of the south to north alignments have climate and seismic vulnerabilities. However, the Sepulveda alignment is less vulnerable than the Cahuenga and Griffith Park alignments. The Sepulveda alignment has fewer fault crossings (half as many) and lower flood vulnerability than the other south to north alignments.
- All of the west to east pipeline alignments have climate and seismic vulnerabilities. However, the Florence alignment is less vulnerable than the Slauson and Manchester alignments related to climate vulnerabilities, primarily due to its lower flood vulnerability. The Manchester alignment is the least vulnerable of the west to east alignments related to seismic vulnerabilities and the Slauson alignment is most vulnerable.
- The Van Norman Complex has high and moderate vulnerability to extreme heat, seismic, and wildfire hazards. These should be considered in the subsequent planning and design of Program facilities in this location.
- While the potential future Program wellfields have not been finalized, they have a high vulnerability to extreme precipitation and floodplain flooding. These should be considered in the subsequent planning and design of Program facilities in this location.

Table 4-7. Summary of Vulnerability Rating for Each Climate and Seismic Risk Hazard by Facility

Pure Water Los Angeles	Extreme heat[a]	Wildfire	Extreme precipitation	Pluvial and floodplain	Flooding, coastal; cliff retreat	Earthquake, seismic
Proposed AWPF (HWRP)	L	--	L	L	L[b]	L/M
Sepulveda Alignment	M/H	M	L/M	L/M	--	M
Cahuenga Alignment	H	L/M	M	M	--	M/H
Griffith Park Alignment	H	L/M	L/M	M	--	M/H
Slauson Alignment	L/M	L/M	M	M	--	M/H
Florence Alignment	M/H	L/M	M	L/M	--	L/M
Manchester Alignment	M/H	L/M	M	M	--	L
VNC	H	M	L	L	--	M/H
Stormwater Parks	M/H	L	L	L	--	M
Future Wellfields	L	L	M/H	M/H	--	L/M
Spreading Grounds	M/H	M/H	L/M	M	--	L/M
Secondary Potential Injection Location	M/H	L	L	L	--	L

[a] *Days exceeding 95 degrees Fahrenheit*
[b] *Integrated coastal hazard-seismic assessment not conducted, but recommended to verify rating*
L = low risk L/M = low-medium risk M = medium risk M/H = medium high risk H = high risk

4.5 Recommendations to Increase Program Resiliency

4.5.1 Climate Vulnerability

Based on the findings of this assessment, a number of recommendations have been developed for next steps. These recommendations should be communicated, socialized, and reviewed with Program Management and Operations staff to facilitate a supported set of adaptation strategies.

- **Integrate Multiple Climate Vulnerabilities**: Vulnerabilities have been assessed individually. Specific climate vulnerabilities should be integrated into a compounded/weighted score developed by LADWP to support prioritization and facilitate multihazard resilience actions.
- **Develop Facility-Specific Actions (pluvial flooding, wildfire, and extreme heat vulnerabilities)**: Using the results from this assessment, the most vulnerable across these three categories should be identified, and facility-specific adaptation strategies should be developed. Actions for these hazards will likely be best addressed at the facility level.
- **Develop Regional Strategies**: This assessment has identified some important regions where multiple climate hazards are concentrated. These include the coastal zone at HWRP, flooding at Central Basin and future recharge wells, and wildfire in the foothills. LADWP and LASAN should consider whether regional strategies such as a regional coastal protection plan or wildfire resilience actions are more effective than facility-specific actions in these regions.
- **Update and Integrate LADWP and LASAN Design Standards:** Standards are a primary engineering driver for facilities design and operations. LADWP and LASAN should consider revisiting, reviewing, and updating design standards and policies, as appropriate, to account for highly likely changes in climate in which current and future facilities will operate (like more extreme precipitation, increase in extreme heat days, higher sea levels).
- **Coordinate with other City and Regional Climate Adaptation Strategies**: LADWP should align its efforts with those by all City departments and regional efforts, so LADWP actions are consistent and integrated.
- **Protect City Occupational Health**: LADWP should develop updated policies and protocols, to better protect worker health during extreme climate events, such as extreme heat and flooding.

The adoption of these recommendations would address potential vulnerabilities and enhance Program resilience.

As a further consideration regarding vulnerability, while designing infrastructure to address frequent scenarios offers efficiency, the threat of “black swan" events, defined as rare, high-impact occurrences with the potential to severely impact or limit entire systems, could also be considered. For critical infrastructure, such as water systems, addressing vulnerability and building resilience through approaches such as scenario planning or considering black swan events could add significant value, despite the additional cost.

4.5.2 Seismic Vulnerability

Seismic vulnerability could be reduced through the integration of design features that would help minimize damage and avoid catastrophic failure in a seismic event. A risk-based investment could be adopted when designing and sizing pipelines to withstand potential earthquake damage. This section provides design considerations the Program could adopt to increase seismic resiliency.

4.5.2.1 Pipelines

Jacobs uses the guidelines published by the American Lifelines Alliance as design criteria and guidance for pipelines in seismic zones and near fault lines. Technical best practices include:

- Designing steel pipe with thicker cylinders (using a diameter-to-thickness ratio of 90 or 100)
- Requiring stronger joints, such as double-welded lap joints or butt-welded joint,
- Using seismic/earthquake-resistant ductile iron pipe when crossing fault lines

Flexible joint connections (similar to those discussed here for tunnels) can also be installed at fault crossings. A geological study is recommended during pre-design to characterize fault crossings and seismic ground movements, to provide the designer with as much information as possible about the ground conditions.

4.5.2.2 Tunneling

Tunneling in a seismic region and through fault zones is not uncommon and has been successfully accomplished around the world, including in Los Angeles. A thorough geotechnical investigation and detailed analysis are required to determine the expected ground movement and to fully understand the prevailing conditions to inform the design. The tunnel structure is then designed to account for appropriate seismic loading and ground deformation.

Various methods can be employed to design tunnels in a seismic region to mitigate long-term risks. For example, flexible joints within the tunnel lining can promote small displacements along the tunnel axis to prevent high stress concentrations in one location. Tunnels can also be oversized to accommodate movement in a particular area, and allow access for inspection and repair following a seismic event. Joints between tunnels and other structures, such as shafts, can be also designed to accommodate any relative movement expected between the two structures.

4.5.2.3 Pump Stations and Treatment Facilities

Because the water produced under the Program would ultimately be used for potable purposes, pump stations and treatment facilities (including associated storage tanks and flow control stations) could be designated as Criticality Category IV. This category has essential seismic importance, per the Performance Based Seismic Design for LADWP Water System (LADWP 2019). Facilities identified as Category IV are expected to provide water to essential facilities for post-earthquake responses, public use, health, and safety, including post-earthquake firefighting. As a result, they are designed to remain functional during and following an earthquake.

Facilities designed to meet Criticality Category IV level are expected to have a low probability of failure, even when subjected to the 2,475-year return period shaking (LADWP 2021). These facilities may sustain some damage after a design-level event, but are expected to remain operational during the immediate aftermath of an earthquake. They may still require temporary shutdowns for repairs, but not on an emergency basis. The Program could incorporate the following design features, which were recommended in LADWP (2019):

- Provide two backup pumps with emergency power generators, and design all pumps and associated equipment for Criticality Category IV.
- Provide a bypass to a treatment plant to allow the main flow through the treatment plant to provide firefighting and emergency water supplies.
- Provide a bypass to a pump station with manifolds, to allow temporary pumps to be placed in case the primary pump station becomes unusable. This bypass line would allow the main flow through the pump station to provide firefighting and emergency water supplies
- Design the distribution mains connecting to pump stations to the same criticality as the pump station with isolation valves.

4.5.2.4 Performance Standards

Program seismic performance standards should be communicated and applied to all Program elements, including facilities producing source water.

5. Summary

This TM describes the assumptions, methods, and results of the MP resilience analysis. This analysis includes a resilience benefits analysis and a vulnerability assessment analysis. The Program offers considerable resilience benefits under extreme drought and earthquake scenarios, including:

- Using much of the wastewater as a new supply
- Reducing drought-related shortages
- Lessening the impact of earthquake-related outages on water supplies

The Program is likely to increase the average cost of the water supply portfolio, but will provide considerable cost savings during critical periods, because the ATRW supply would cost less than most emergency options.

The Program was found to offer considerable resilience benefits in general, and more pronounced benefits under extreme drought and earthquake scenarios. Maximum utilization for purified recycled water is expected for seismic or other emergency scenarios, and though infrequent, a significant seismic event could disrupt traditional water supply sources, highlighting the critical importance of the Program.

The Program is expected to generate water cost savings over alternative supply options during emergency supply shortages. The Program's projected potential cost savings during emergency scenarios, estimated at $1.0 to 2.3 billion for the scenarios examined, underscore its potential to safeguard community well-being, even in the face of adversity.

The vulnerability assessment identified several areas where Program facilities were vulnerable to climate and seismic events. Many facilities are vulnerable to flooding and wildfire risks, while virtually all future facilities will be challenged with extreme heat conditions. Sea level rise does not appear to cause vulnerability at HWRP, but an integrated coastal hazard assessment is recommended to better understand the implications of seismic events and increased sea levels on the coastal road.

Section 4.5 provided recommendations that should be incorporated into the next phase of Program planning and design to increase resiliency (especially considering the water supply resiliency benefits the Program provides).

Potable reuse is a vital strategy for building seismic resilience by reducing reliance on more vulnerable, imported water sources. Pure Water Los Angeles will provide a reliable alternative water supply to Van Norman Complex and the vicinity of the LAAFP to mitigate the risk of water shortages and to support critical infrastructure and public health and safety, even potentially in the face of catastrophic seismic events. By investing in this Program that maximizes water reuse, LADWP can not only mitigate some of the risks associated with natural disasters but also contribute to improving long-term water security and environmental sustainability.

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Appendix A
Climate Vulnerability Assessment – Supplemental Material

Appendix A: Climate Vulnerability Assessment – Supplemental Material

A detailed quantitative assessment took place to evaluate how vulnerable Pure Water Los Angeles Program (Program) systems and facilities are to projected future climate changes. The assessment uses indicator metrics and available climatological and hydrological modeling results to assess vulnerability.

Twenty individual climate projections were used to assess climate vulnerability. The California Department of Water Resources (DWR) Climate Change Technical Advisory Group (CCTAG) selected these 20 Coupled Model Intercomparison Project Phase 5 (CMIP5) global climate projections by as the most appropriate projections for California water resources evaluation and planning (DWR CCTAG 2015) (Table A-1). The global climate projections were selected with a three-step model screening process that assesses performance at the global, regional, and California spatial scales. The selected global climate projections are also a reasonable sample of the broader distribution of global climate projections.

The 20 climate model projections were generated with 10 global climate models and two emission scenarios, identified by the Intergovernmental Panel on Climate Change (IPCC) for the Fifth Assessment Report (IPCC 2014):

- One optimistic Representative Concentration Pathway (RCP) (4.5)
- One pessimistic RCP (8.5)

These projections were downscaled using the localized constructed analog (LOCA) method at 1/16th degree spatial resolution (Pierce et al 2014). The LOCA method is a statistical scheme that uses future climate projections, combined with historical analog events, to produce daily downscaled precipitation, and maximum and minimum temperature time series data. Pierce et al (2014) provides more details about the LOCA downscaling. Table A-1 lists the 10 global climate models.

Table A-1. DWR CCTAG Recommended CMIP5 Global Climate Models

Model Number	Model Name	Model Institution	Model Resolution[a]
1	ACCESS-1.0	Commonwealth Scientific and Industrial Research Organization and Bureau of Meteorology	192 x 145 (165 km)
2	CCSM4	National Center for Atmospheric Research	288 x 192 (110 km)
3	CESM1-BGC	National Science Foundation, Department of Energy, National Center for Atmospheric Research	288 x 192 (110 km)
4	CMCC-CMS	Centro Euro-Mediterraneo per I Cambiamenti Climatici	192 x 96 (165 km)
5	CNRM-CM5	Centre National de Recherches Météorologiques, Centre Européen de Recherche et Formation Avancées en Calcul Scientifique	256 x 128 (123 km)
6	CanESM2	Canadian Centre for Climate Modeling and Analysis	128 x 64 (247 km)
7	GFDL-CM3	Geophysical Fluid Dynamics Laboratory	144 x 90 (219 km)
8	HadGEM2-CC	Met Office Hadley Centre	192 x 145 (165 km)
9	HadGEM2-ES	Met Office Hadley Centre; additional HadGEM2-ES realizations contributed by Instituto Nacional de Pesquisas Espaciais	192 x 145 (165 km)
10	MIROC5	Atmosphere and Ocean Research Institute at the University of Tokyo, National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology	256 x 128 (123 km)

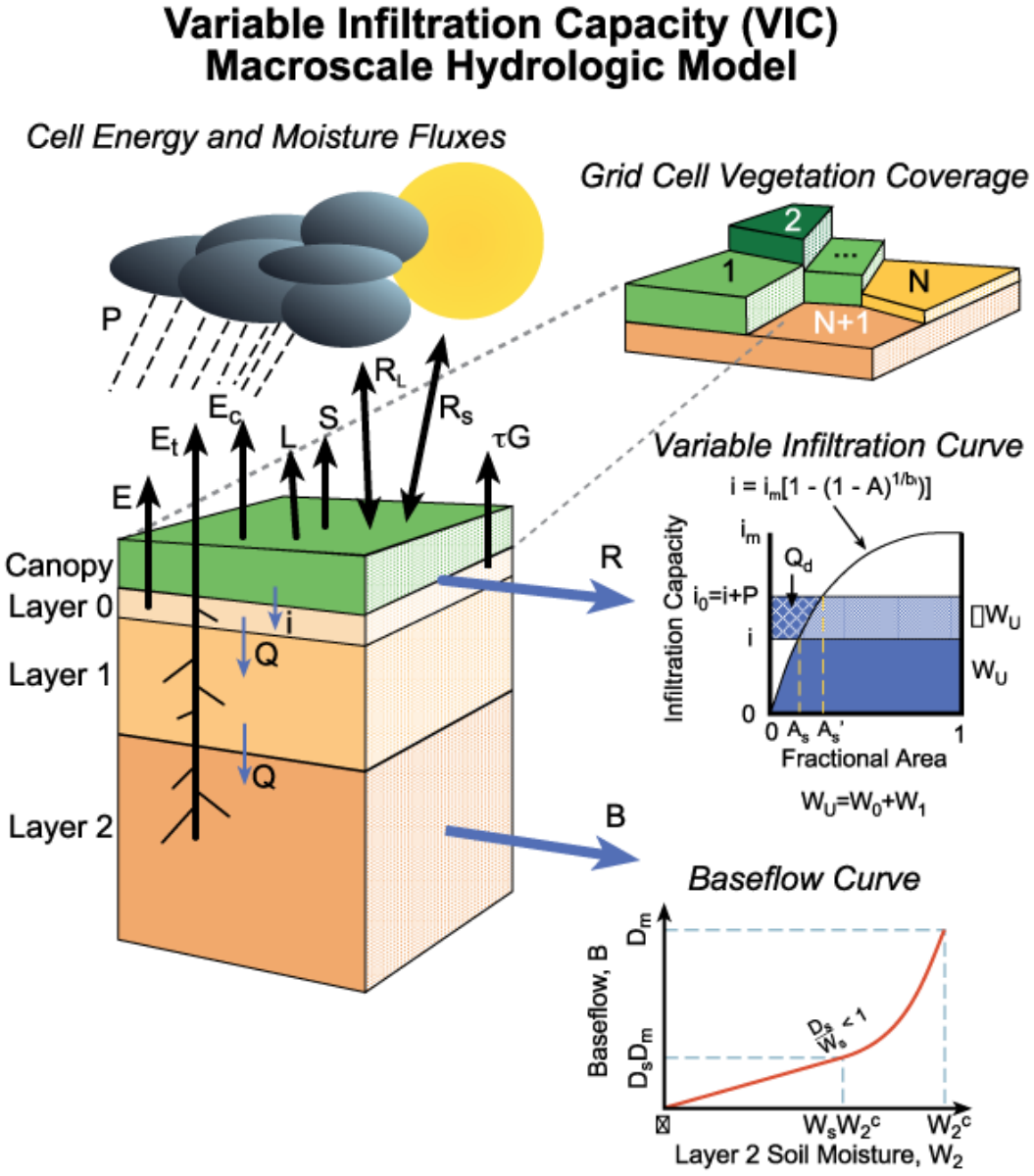
[a]Size of the model's atmospheric grid (number of longitudes by number of latitudes)
Models are listed alphabetically.
km = kilometer(s)

The hydrologic simulations were developed using the variable infiltration capacity (VIC) hydrologic model at 1/16th degree spatial resolution, developed by Scripps Institution of Oceanography, and obtained from Cal-Adapt for this report (Pierce et al 2018). The VIC model (Liang et al 1994, 1996; Nijssen et al 1997) is a spatially distributed hydrologic model that simulates land surface-atmosphere exchanges of moisture and energy at each model grid cell. The VIC model incorporates spatially distributed parameters describing the following criteria:

- Topography
- Soils
- Land use
- Vegetation classes

The model accepts input meteorological data directly from global or national gridded databases or from General Circulation Model projections. To compensate for the coarse discretization, VIC incorporates subgrid variability to describe variations in the land parameters, as well as precipitation distribution. Figure A-1 shows the hydrologic processes included in the VIC model.

Figure A-1. Hydrologic Processes Included in the VIC Model



Source: https://vic.readthedocs.io/en/master/Overview/ModelOverview/

The vulnerability assessment evaluated the degree to which each Program facility is susceptible to the adverse effects of climate and climate change. The vulnerability assessment was performed for future conditions, and incorporated climate change. For the climate change analysis, the projected changes in the vulnerability metrics are estimated for two future 30-year periods, based on a specified historical period. The analysis is conducted for the following periods:

- Near Future: 2050 (2036 to 2065)
- Late Future: 2075 (2061 to 2090)

The historical reference period for climate change analysis is 1995 (1981 to 2010). The sea level rise scenarios are analyzed through 2100.

Figure A-2. California Historical Fire Perimeters Overlaid with Program Facilities

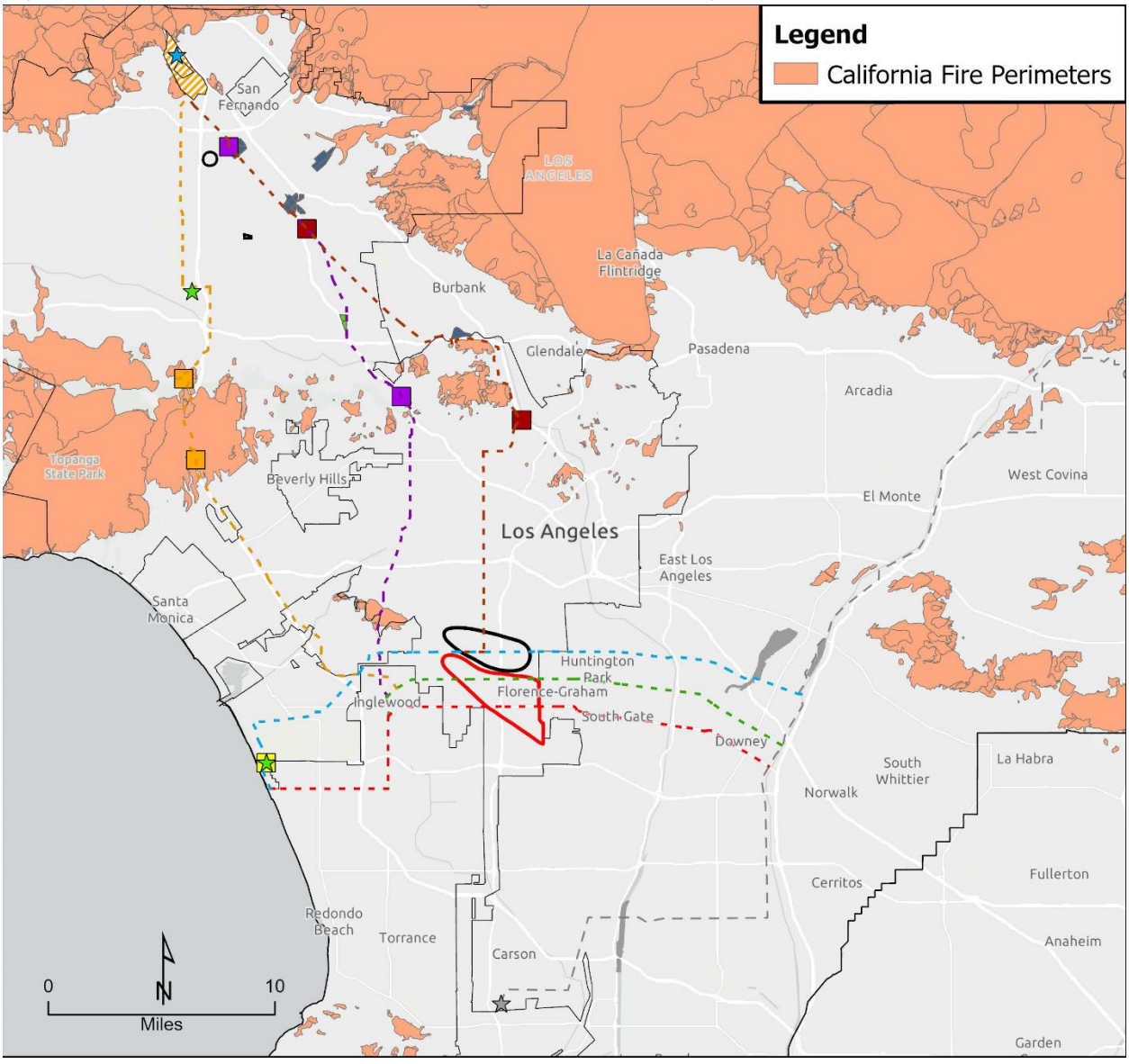
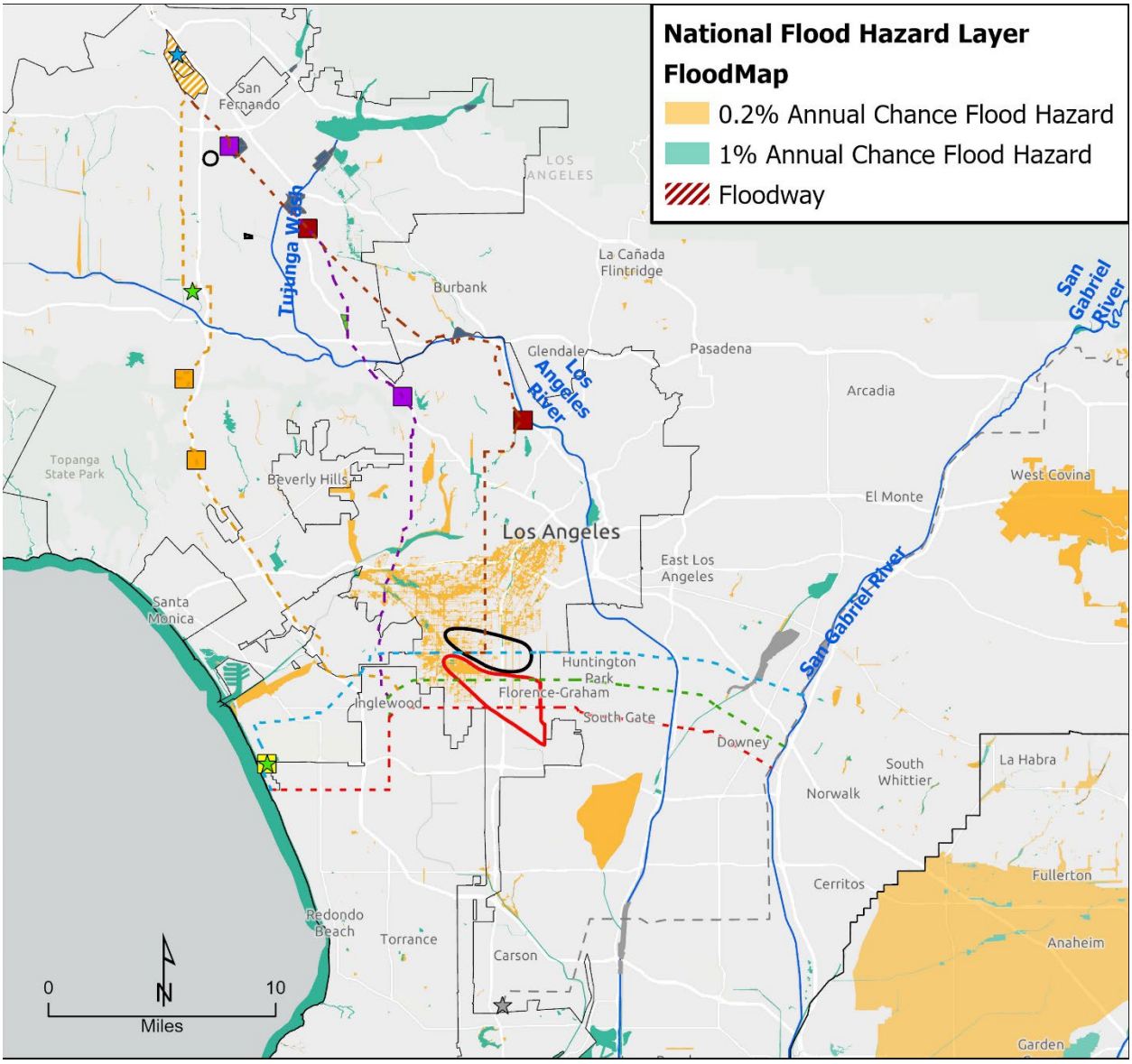
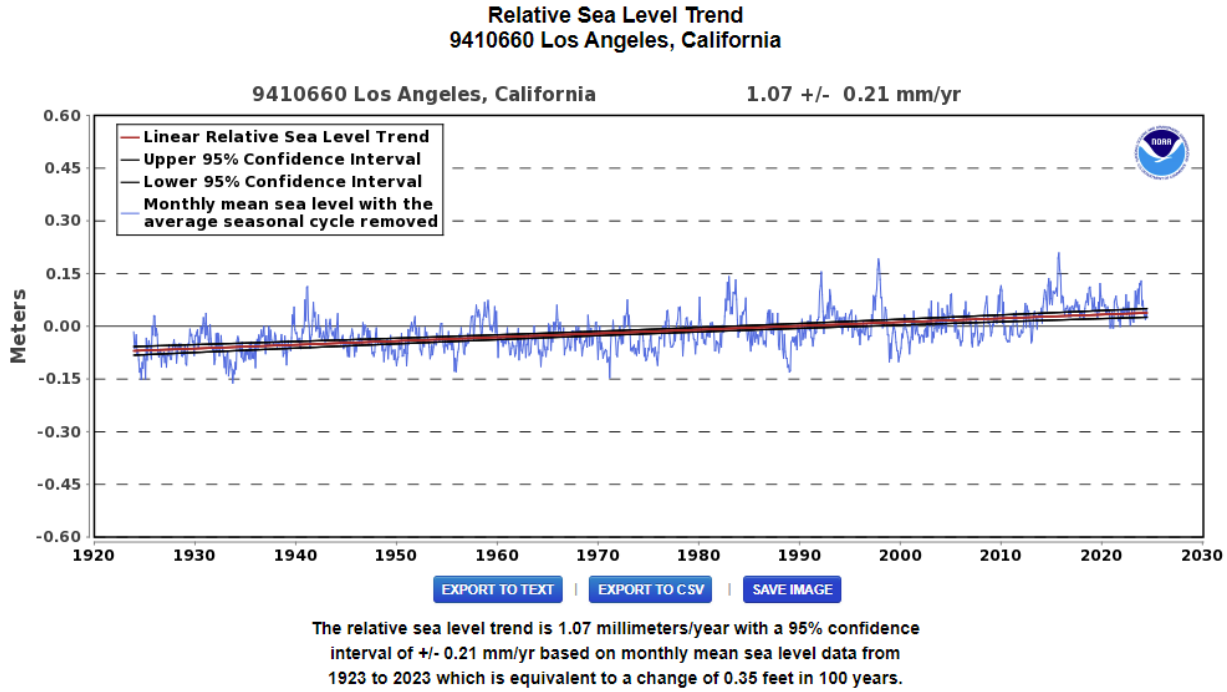


Figure A-3. National Flood Hazard Map Overlaid with Program Facilities



Los Angeles has experienced a 0.35-foot rise in sea level rise during the 20th century (NOAA 2024) (Figure A-4).

Figure A-4. Relative Sea Level Trend in Los Angeles



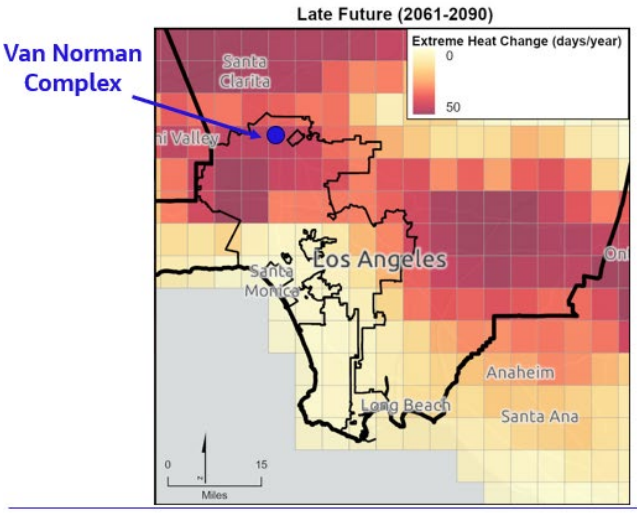
Figures A-5 through A-9 show detailed vulnerability assessments for specific facilities with climate metrics overlayed.

Figure A-5. Example Facility for Extreme Heat Vulnerability

Example Facility

Extreme Heat (>95F): Van Norman Complex

Change in Extreme Heat Days exceeding 95 F: 45 days/year



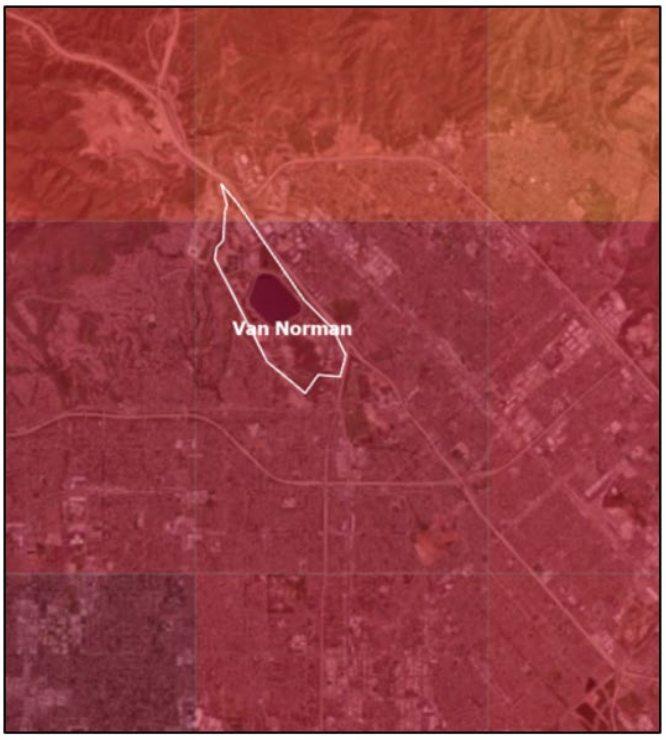


Figure A-6. Example Facility for Wildfire Vulnerability

Example Facility

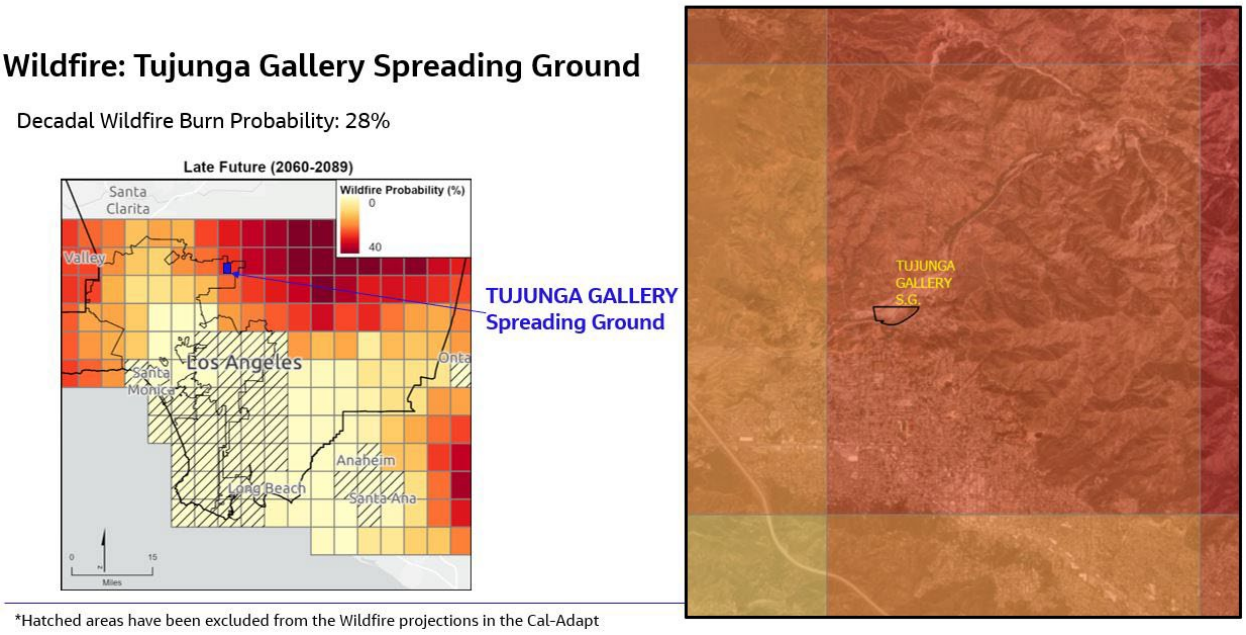


Figure A-7. Example Facility for Extreme Precipitation Vulnerability

Example Facility

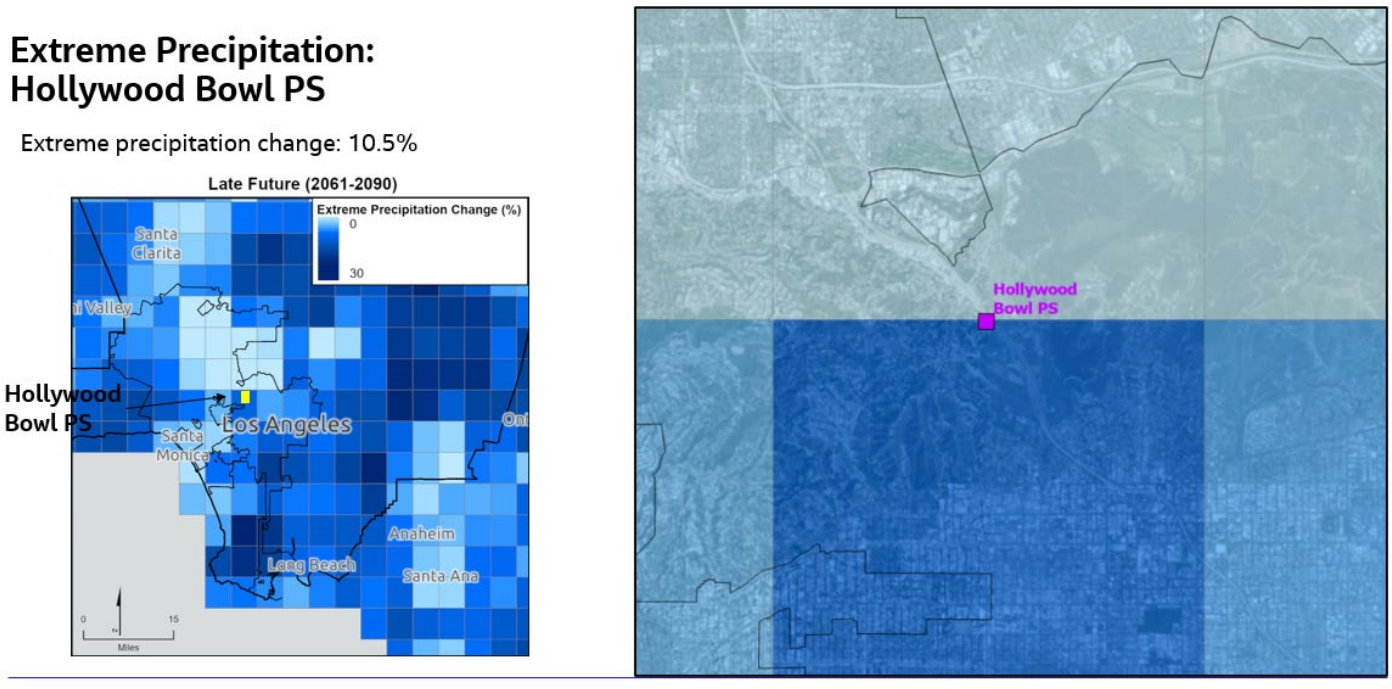


Figure A-8. Example Facility for Floodplain Flooding Vulnerability

Example Facility

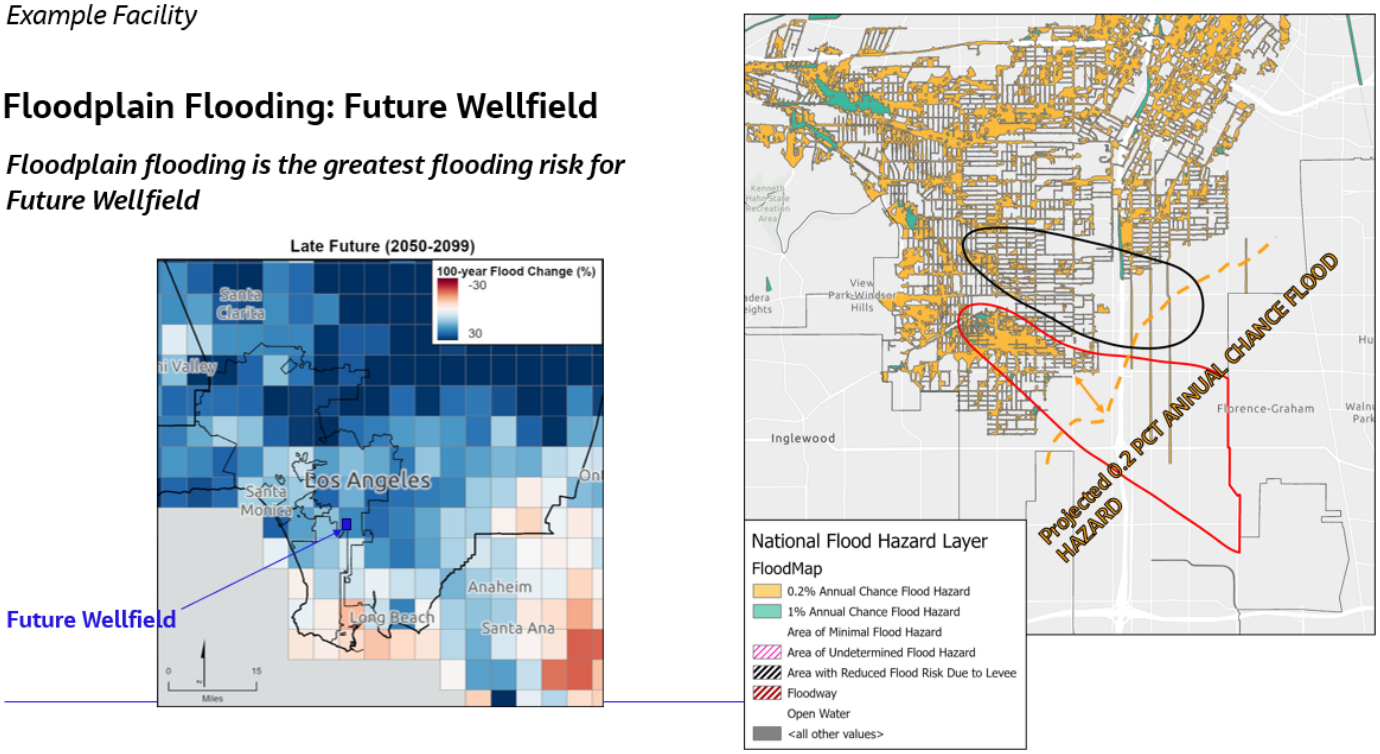


Figure A-9. Example Facility for Coastal Flooding Vulnerability

Example Facility

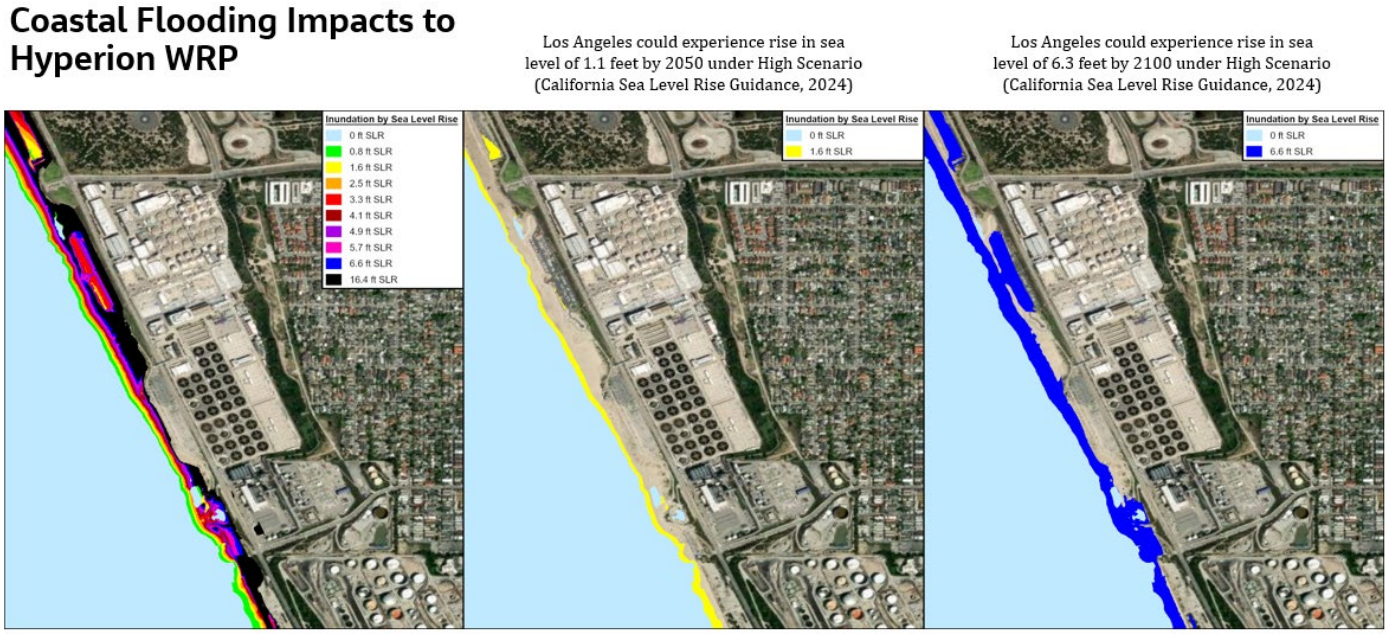
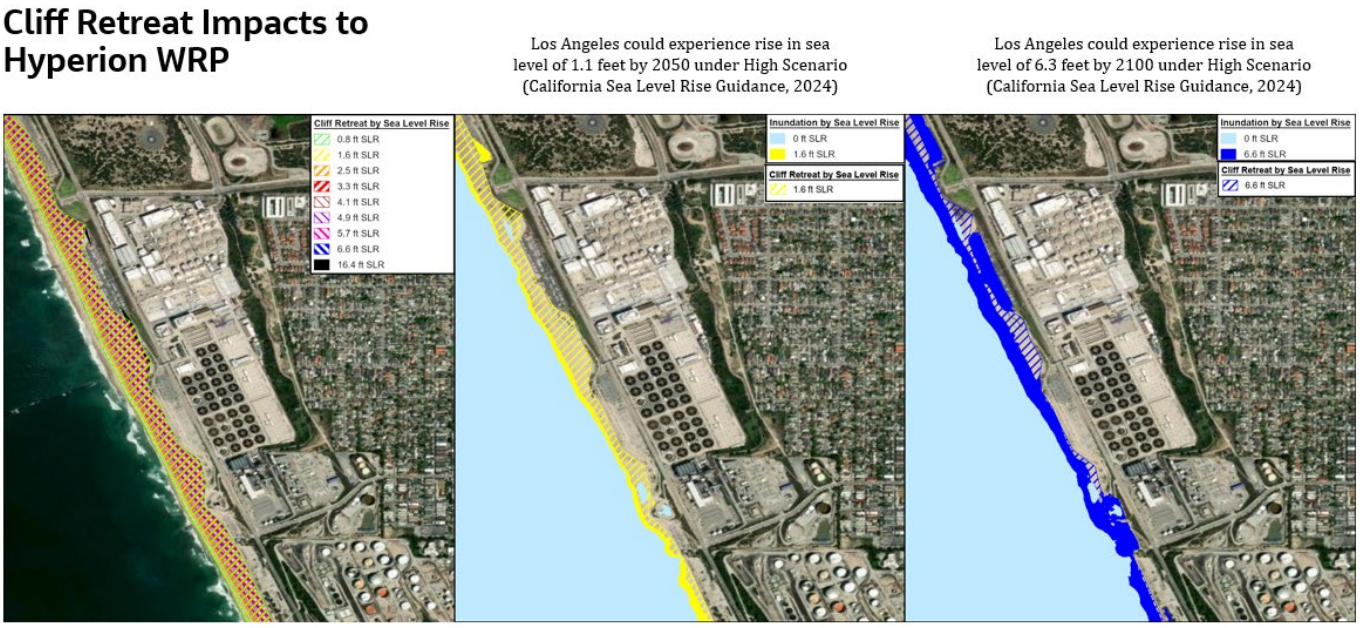


Figure A-10. Example Facility for Cliff Retreat Vulnerability

Example Facility



Appendix B
Seismic Vulnerability Assessment – Supplemental Material

Appendix B: PWLA Seismic Vulnerability Assessment – Supplemental Material

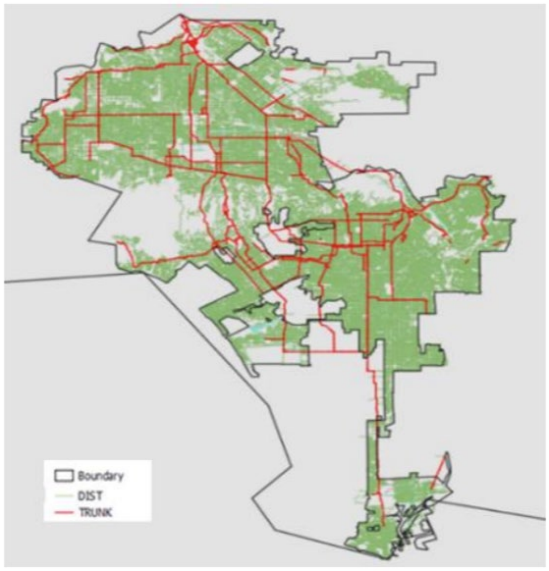
Los Angeles Water Supply Impacts from a M7.8 Earthquake San Andreas Fault Scenario – Davis, C.

Approximately 90% of the current Los Angeles water supply is provided by imported water, and the risk of seismic damage to the surrounding aqueducts is high. This study modeled the consequences of an M7.8 earthquake along the San Andreas fault and evaluated results of shaking and permanent ground movements to aqueducts and the pipe network. Fault ruptures occurred in the Los Angeles Aqueduct, California Aqueduct East Branch, Colorado River Aqueduct, and Coachella Canal resulting in a complete disruption of imported water. The model estimated a 4- to18-month period to return to service. Metropolitan estimates that there is a 6-month supply of local storage, but this duration is calculated based on implementation of severe rationing (25% of typical capacity). For the pipe network, the model estimated that a shakeout scenario would result in 2,700 required pipe repairs, over twice the number of repairs that followed the 1994 Northridge Earthquake. The restoration of the system is dependent on the restoration of the aqueducts and therefore was estimated at >15 months. This exceeds local supplies and would necessitate severe water rationing mandates of 25-70%. Costs of these repairs were estimated at $213.3 Billion total with the greatest costs coming from those related to fire and business interruption.

Probabilistic Seismic Risk Evaluation of the City of Los Angeles Water System Pipeline Network – Hu, Z. et. al.

The Uniform California Earthquake Rupture Forecast Version 3 (UCERF3) model was used to investigate seismic hazard risk in the Los Angeles water system network. The water system network damage potential was found by evaluating the system level damage incurred from the seismic model from varying seismic event scenarios. Total pipeline repairs and associated repair cost and time were derived for each scenario. The water system network was divided by trunklines and distribution piping which are shown in Figure B-1 from the report with trunklines in red and distribution lines in green.

Figure B-1. Trunklines and Distribution Piping



The hazard model parameters included shaking, liquefaction, surface rupture, and landslide. The scenario included a Modified Mercalli Intensity (MMI) of VIII (8) with two different levels of liquefaction ground deformation and one level of ground displacement caused by surface rupture. The specific data sources included in each of the hazard model parameters include:

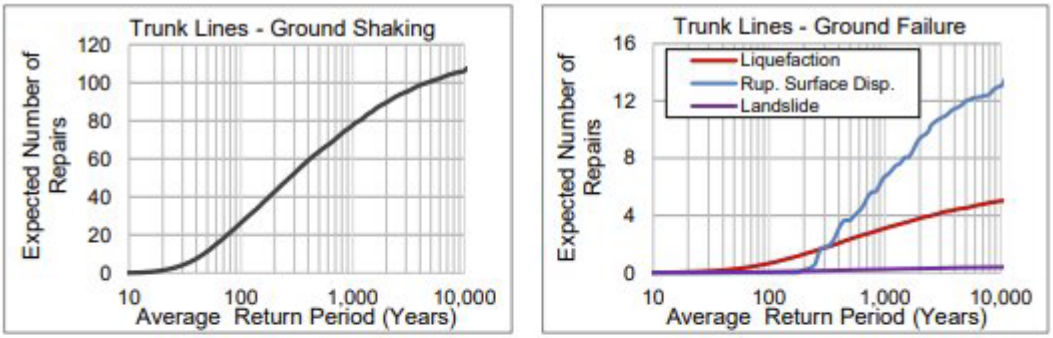
- Shaking – two ground motion parameters simulated with NGA West 2 GMMs: peak ground acceleration (PGA) and peak ground velocity (PGV).

- Liquefaction – subsurface profile sourced from available borehole and Standard Penetration Test (SPT) or Cone Penetration Test (CPT).
- Surface Rupture – fault zones selected from CGS Alquist-Priolo maps and USGS Quaternary Fault and Fold Database.
- Landslide – CGS mapped landslide zone used for earthquake-induced landslides and displacement was based on earthquake magnitude and PGA calculated using empirical equation.

Pipe fragility was sourced from a study that developed pipe fragility models based on observed damage to LADWP's pipelines during the San Fernando earthquake. Repair costs and timelines were sourced from several references that modeled repairs from past LADWP repair and maintenance data. For trunklines specifically, large repair information was used following past earthquakes (Figure 3 and Table 3).

It was concluded that the distribution system imparts the majority of risk to the system due to greater coverage and complexity and trunklines generally experiencing lower exposure to seismic hazards (Figure 4 and Table 4). The overall system risk was also found to be dominated by ground shaking above any other seismic hazard parameter. Catastrophic failures of surface fault rupture, liquefaction, or landslide will potentially occur and result in more localized destructions with higher difficulty and cost to repair.

The results of the model runs were tabulated and plotted as the average return period in years against the expected number of repairs in the pipeline type. It is observed that as the average return period increases, necessary repairs caused by ruptured surface displacement increases rapidly after 200 years. Landslides are of nonexistent to low-risk throughout the model periods.

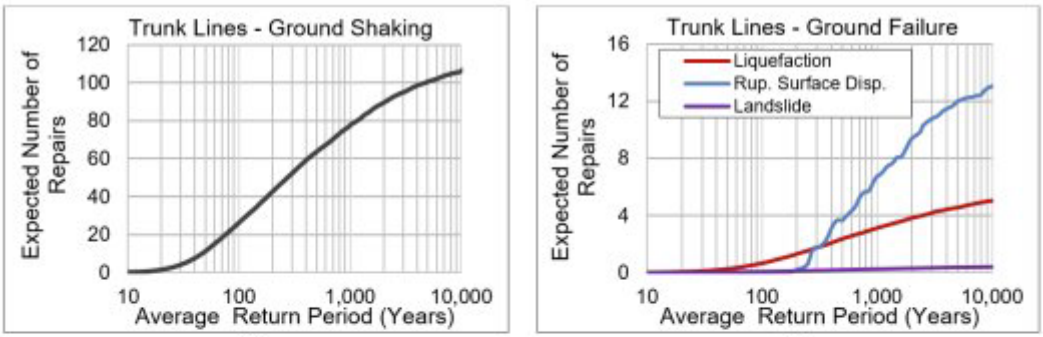


(a) (b)

Figure 3. System risk curves for trunk lines: a) ground shaking and b) ground failure.

Table 3. Expected Number of Repairs for Trunk Lines.

Return Periods (Years)	Expected Number of Repairs			
	Shaking	Liquefaction	Surface Displacement	Landslide
100	27	1	0	0
500	63	3	4	0
2,500	92	4	11	0
10,000	106	5	13	0



(a) (b)

Figure 4. System risk curves for distribution lines: a) ground shaking and b) ground failure.

Table 4. Expected Number of Repairs for Distribution Lines.

Return Periods (Years)	Expected Number of Repairs			
	Shaking	Liquefaction	Surface Displacement	Landslide
100	1,351	44	0	2
500	3,321	141	46	5
2,500	4,876	232	189	8
10,000	5,679	293	321	11

Cost, Schedule, and Phasing TM

Cost, Schedule, and Phasing Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
December 12, 2024

Executive Summary

Pure Water Los Angeles (Program) is capital intensive and requires the physical construction of new facilities and adaptation of existing facilities to meet the Program's treatment, conveyance, and process requirements for potable reuse. A purified recycled water production flow of 230 million gallons per day (MGD) is being considered for planning through the *California Environmental Quality Act* (CEQA) process, while the ultimate Program size will be determined through implementation of activities identified in the Program Implementation Roadmap in the Master Plan report.

Total estimated capital costs and operations and maintenance (O&M) costs were developed for nine alternatives (Table ES-1).

Table ES-1. Estimated Pure Water Los Angeles Costs

Approach	Alternative	Total Capital Cost ($ billions)[a]	Annual O&M Cost ($ millions)[b]
Approach I – IPR	1	17.4	338
	2	17.9	368
	3	12.7	305
Approach II – IPR + Post-AWPF DPR	4	21.3	411
	5	20.9	405
	6	21.6	409
Approach III – DPR at AWPF	7	25.4	462
	8	25.1	452
	9	25.8	460

[a] Based on 230-MGD purified recycled water production and capacity of each component.

[b] Based on 230-MGD purified recycled water production for MBR and AWPF, with average production for each storage and demand component based on ONAT scenario planning developed for the alternatives screening (Arcadis and Jacobs 2024).

Notes:

Class 5 level estimate in 2024 dollars, with a typical expected accuracy range of -50% to +10% for concept screening (AACE 2020).

AWPF = Advanced Water Purification Facility

DPR = direct potable reuse

IPR = indirect potable reuse

MBR = membrane bioreactor

ONAT = Operation NEXT Assessment Tool

The Program alternatives were assessed, screened, and shortlisted by the Los Angeles Department of Water and Power (LADWP) to Approach II – Post-AWPF DPR and Approach III – DPR at AWPF. Approach I will not be carried forward for additional analysis or CEQA review. A conceptual phasing schedule (Table ES-2) representing Approaches II and III with an overall timeline of 32 years was built to inform the anticipated Program duration and expenditures. A minimum of 28 projects is anticipated.

The Program will be implemented in three phases, focusing on the storage and demand options closest to the new AWPF for early delivery to align with Phase 1 of the Hyperion Water Reclamation Plant (HWRP) conversion to MBR treatment and an AWPF at or near HWRP. The basis for Approach II is IPR at the AWPF for Phases 1, 2, 3, with DPR at VNC for Phases 2 and 3. The basis for Approach III is IPR at the AWPF for Phase 1, with DPR at the AWPF for Phases 2 and 3. The phasing approach allows time for demonstration and approval of DPR options after reverse osmosis located north of San Fernando Basin (SFB), including a possible siting location at the Van Norman Complex (VNC) and construction of the long conveyance pipeline to the north that is aligned with Phase 2 production.

Table ES-2. Potential Phasing Implementation

Phase	MBR Completion Year	Added MBR Flow (MGD)	AWPF Completion Year	Added AWPF Flow (MGD)	Total AWPF Capacity (MGD)	Storage and Demand Locations
1	2039	60	2040	50	50	CB[a], SFB
2	2045	60	2046	50	100	CB[a], SFB, VNC
3	2055	152	2056	130	230	CB[a], SFB, VNC, Metropolitan

Source (LADWP 2024a)

[a] Infrastructure for CB will be delivered in three phases.

CB = Central Basin

Metropolitan = Metropolitan Water District of Southern California

As the Program advances, LADWP should continually refine the Program size, cost, phasing and schedule for implementation.

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Attachment

A Cost Estimates

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Acronyms and Abbreviations

AACE	AACE International
AWPF	Advanced Water Purification Facility
CB	Central Basin
CEQA	California Environmental Quality Act
CIP	capital improvement projects
DPR	direct potable reuse
ECLWRF	Edward C. Little Water Reclamation Facility
FSO	Financial Services Organization
FY	fiscal year
GWR	groundwater replenishment
Hazen	Hazen and Sawyer
HWRP	Hyperion Water Reclamation Plant
IPR	indirect potable reuse
LAAFP	Los Angeles Aqueduct Filtration Plant
LADWP	Los Angeles Department of Water and Power
LS	lump sum
MBR	membrane bioreactor
MCDA	Multi-Criteria Decision Analysis
Metropolitan	Metropolitan Water District of Southern California
MGD	million gallons per day
MP	Master Plan
O&M	operations and maintenance
ONAT	Operation NEXT Assessment Tool
PEIR	Programmatic Environmental Impact Report
Program	Pure Water Los Angeles
PWSC	Pure Water Southern California Program
P6	Oracle Primavera P6
ROW	right-of-way
RWA	raw water augmentation

SFB	San Fernando Basin
TM	technical memorandum
VNC	Van Norman Complex
WB	West Basin
WBS	work breakdown structure

1 Introduction

The Pure Water Los Angeles (Program) Master Plan (MP) evaluates potential alternatives for potable reuse to maximize the use of recycled water from the Hyperion Water Reclamation Plant (HWRP) and the anticipated Advanced Water Purification Facility (AWPF). To accomplish this, the MP initially developed nine Program alternatives based on three potable reuse approaches and a range of conveyance alignments. The Program is of significant size, duration, and cost. Total estimated capital costs and operations and maintenance (O&M) costs were developed for all nine alternatives. A conceptual phasing schedule representing shortlisted Approaches II and III was built to inform the anticipated Program duration and expenditures. Approach I was eliminated from further consideration through a Multi-Criteria Decision Analysis (MCDA).

The Program comprises a minimum of 28 substantial construction projects, and each will require the following activities:

- Planning
- Design
- Procurement
- Construction
- Construction management
- Commissioning

Projects may also require additional activities such as real estate acquisition, lease agreements and identification of easements and site mitigation approaches that are specific to each project's needs. Additionally, there are overarching Program requirements, such as the Programmatic Environmental Impact Report (PEIR) and Program management that will be at the Program level rather than project level.

The cost estimates and schedules establish the annual Program budget, which serves as one of the criteria in finalizing the preferred alternatives and sequencing of projects. This technical memorandum (TM) summarizes the Class 5 level cost estimate (AACE 2020) and the phasing schedule that represents the shortlisted Program alternatives.

2 Program Alternatives

Three potable reuse approaches were identified for developing Program alternatives based on the level and location of treatment, as follows:

- Approach I – Indirect potable reuse (IPR) treatment at the AWPF
- Approach II – IPR treatment at the AWPF, with direct potable reuse (DPR) treatment at or near the Van Norman Complex (VNC), where the Los Angeles Aqueduct Filtration Plant (LAAFP) is located in the San Fernando Valley
- Approach III – DPR treatment at the AWPF

The three approaches were used to develop nine Program alternatives, with the individual alternatives based on south–north conveyance alignments (Table 2-1).

Table 2-1. Program Alternatives

Potable Reuse Approach	Program Alternatives	South to North Conveyance Alignment
I – IPR at AWPF	1	Sepulveda
	2	Cahuenga
	3	Metropolitan Centric
II – IPR with Post-AWPF DPR	4	Sepulveda
	5	Cahuenga
	6	Griffith Park
III – DPR at AWPF	7	Sepulveda
	8	Cahuenga
	9	Griffith Park

Metropolitan = Metropolitan Water District of Southern California

Table 2-2 summarizes the storage and demand locations that could be integrated into each alternative.

Table 2-2. Program Alternative Storage and Demand Locations

Potable Reuse Approach	Program Alternatives	WB Connection	CB GWR	Metropolitan PWSC	SFB GWR	VNC RWA
I – IPR at AWPF	1, 2	💧	💧	💧	💧	-
I – IPR at AWPF	3	💧	💧	💧	-	-
II – IPR with Post-AWPF DPR	4, 5, 6	💧	💧	💧	💧	💧
III – DPR at AWPF	7, 8, 9	💧	💧	💧	💧	💧

- = not a potential location

💧 = a potential storage and demand location

CB = Central Basin

GWR = groundwater replenishment

PWSC = Pure Water Southern California Program

RWA = raw water augmentation

SFB = San Fernando Basin

WB = West Basin

The Program alternatives were assessed, screened, and shortlisted to the preferred Program alternatives using a MCDA approach (Arcadis and Jacobs 2024). Preferred Program alternatives were identified by Los Angeles Department of Water and Power (LADWP) as Approach II – Post-AWPF DPR and Approach III – DPR at AWPF. Approaches II and III were both moved forward for additional analysis and potentially for inclusion in the *California Environmental Quality Act* (CEQA) review. Approach I is not being carried forward into the additional analysis or CEQA review. Conceptual phasing is being considered for shortlisted Approaches II and III.

3 Cost

Cost estimates were prepared for each of the nine alternatives in accordance with the AACE International (AACE) *Recommended Practices for Cost Estimating* (2020). The end use of a cost estimate and project level of definition determine the quantity and quality of the information required, as well as the range of accuracy. As a project progresses, the scope is refined, and an increasing awareness of project-specific cost factors and site conditions is developed, allowing for more refined costs to be developed. The Program costs presented in this TM include both construction and non-construction costs.

The cost estimates for the Program have been prepared to Class 5 standards, which is consistent with the level of project definition during this stage of the overall Program. Although this estimate class has a wide range of accuracy, the impacting factors are common to all alternatives. As such, the relative comparison of the treatment alternatives is valid and suitable to capture differences between alternatives and support decision-making. A Class 5 cost estimate has an expected accuracy range of -20 to -50% on the low side and +30 to +100% on the high side for concept screening based on gross unit costs and parametric modeling techniques, for a project definition level up to 2% (AACE 2020). The accuracy tightens as the project definition evolves.

3.1 Capital Cost Considerations

The sum of the estimated construction and non-construction costs comprise the total estimated capital cost for each alternative. Typical contractor markups, Southern California market adjustment, and contingency to reflect the complexity of the modifications were applied to the construction and non-construction cost estimates to reflect the effort for delivery.

Direct construction cost estimates were developed using gross unit costs, parametric modeling techniques, and Jacobs' construction database values. Total construction cost estimates were developed using the markups developed by LADWP for Program cost estimating, as summarized in Table 3-1.

Table 3-1. Construction Cost Markups

Item	Factor (%)	Notes
Construction Cost Subtotal		Direct costs
Tax	9.5	Applied to equipment and materials
Location Adjustment Factor	112.9	Los Angeles; applied to direct costs
Mobilization	5[a]	Applied to direct costs
General Conditions	10[a]	Applied to direct costs
Art and Permit Fees	3[a]	Applied to direct costs
Complexity Index	10[a]	Applied to direct costs, and represents risk contingency
Subtotal 1		
Bonds and Insurance	3[a]	Applied to Subtotal 1
Contractor Profit	10[a]	Applied to Subtotal 1
Subtotal 2		
Project Definition	45[b]	Applied to Subtotal 2, and represents a Class 5 level estimate
Subtotal 3		
Delivery Factor	15[c]	Applied to Subtotal 3; 15% for treatment, none for conveyance
Total Construction Costs		Subtotal 4

[a] Source (LADWP 2024b)
[b] Increased from 30% based on level of project definition.
[c] Per LADWP direction based on potential project delivery approaches (design-bid-build, design-build).

As summarized in Table 3-2, non-construction costs were developed by applying the markups established by LADWP for the Program to the total construction costs to account for the following factors:

- Administration, including project and Program management
- Planning
- Engineering
- Services during construction
- Construction management
- Startup services

Table 3-2. Non-construction Cost Markups

Item	Factor
Program and Project Management, %	10
Planning, %	1
Design Engineer, %	10
Services during Construction, %	5
Bid and Award, %	0.5
Startup and Commissioning, %	0.5
Postconstruction, %	1
Construction Management, %	15
Land and ROW[a], LS	$5 million for each pump station, and $10 million for each treatment facility

[a] Source (LADWP 2021); TM3 (Hazen 2024) includes land costs for offsite AWPF.

LS = lump sum

ROW = right-of-way

3.2 Operations and Maintenance Cost Considerations

Annual O&M cost estimates were developed for each alternative, and the estimates include costs for the following items:

- Chemicals
- Labor
- Maintenance
- Power

The unit costs incorporated into the O&M cost estimates were coordinated with LADWP to match the TM3 (Hazen 2024) estimates to the extent possible.

3.3 Additional Considerations

Two main elements that were not included in the total capital cost estimates, but that should be considered in the Program budget, as they can have significant impacts, include escalation and risk contingency:

1. Escalation: Cost escalation for a Program of this size and duration can be a significant contributor to the overall cost. Construction costs are often compared using the *Engineering-News Record* 20-city construction cost index (BNP Media 2024). Similar to the construction cost index, the Consumer Price Index, an indicator of inflation, has changed less than 3% annually over the last 20 years, except for the last few years (2021 to 2023) during the COVID pandemic, and due to global events and labor force reduction through retirement. During this period, escalation was significantly higher due to market supply and demand imbalances. These imbalances are often corrected over significant time periods such that escalation tracks inflation values. LADWP developed guidance for the escalation values (LADWP 2024b).

Table 3-3. Escalation Rates

Item	Escalation Rate (%)
FY 2025	5
FY 2026	5
FY 2027	4
FY 2028 and beyond	3

Source (LADWP 2024b)

FY = fiscal year

2. Program risk contingency: Risk management is essential to supporting a large Program's success by informing schedules, cost estimates, and contingencies for both Program- and project-related risks. Risk is an uncertain event that, if it occurs, will have a positive (opportunity) or negative (threat) effect on one or more of a program's objectives. Based on the probability of occurrence and the effect if it occurs, a contingency is developed based on a monetized risk register. LADWP has indicated this will be developed and maintained by the Program team.

   In Program risk management, it is important to focus on the critical risks that have the potential to affect the success of the overall Program and to:

   - Minimize threats to the following Program factors:
     - Cost
     - Safety
     - Scope
     - Schedule
     - Reputation
     - Quality
   - Maximize opportunities to improve the Program's objectives in terms of the following potential influences:
     - Lower cost
     - Shorter durations
     - Enhanced scope
     - Higher quality without additional costs

It was recommended that a consensus on markups be established for consistency among the various consultant teams developing cost estimates for the Program. LADWP, Hazen and Sawyer (Hazen), and the Jacobs and Arcadis Team coordinated to establish aligned markups (LADWP 2024b).

3.4 Program Costs

Hazen developed the construction costs for the membrane bioreactor (MBR) and AWPF components, while the Jacobs and Arcadis Team developed the construction costs for the remaining treatment, well, and conveyance components. Hybrid AWPF siting at the HWRP and WB Edward C. Little Water Reclamation Facility (ECLWRF) was assumed to develop conservative costs for 230 million gallons per day (MGD), as represented by Alternative 6 (MBR + Hybrid APWF, IPR) and Alternative 13 (MBR + Hybrid AWPF, DPR). Consistent with TM3 (Hazen 2024), it was assumed that the identified sites could accommodate DPR treatment for the full available design flow production of 230 MGD.

Initial cost estimates were developed for the March 26, 2024, Alternatives Workshop 2 (Arcadis and Jacobs 2024) to compare alternatives. This TM includes updated cost estimates to incorporate aligned markups applied by the Hazen and Jacobs and Arcadis teams. In addition, a third booster pump station was included in each south–north alignment. Table 3-4 provides the updated estimated total capital cost,

and Table 3-5 provides the updated O&M cost estimates for the nine Program alternatives in Year 2024 dollars. The estimated capital and O&M costs are for full Program buildout of all three phases. The total capital costs reflect the infrastructure total capacity of 230 MGD. The O&M costs are for the average flows by component based on initial Operation NEXT Assessment Tool (ONAT) modeling (Arcadis and Jacobs 2024).

Attachment A provides the detailed summaries for the total costs, as well as the estimated direct construction costs for the conveyance and treatment components by the Jacobs and Arcadis Team. The Hazen detailed cost estimates are provided in TM3. Estimated capital and O&M costs are presented in 2024 dollars, with escalation to be considered separately.

Table 3-4. Total Estimated Capital Cost at Buildout of All Phases

Alternative	Approach I – IPR at AWPF ($)			Approach II – IPR with Post-AWPF DPR ($)			Approach III – DPR at AWPF ($)		
	1	2	3	4	5	6	7	8	9
HWRP MBR	5,140,850,000	5,140,850,000	5,140,850,000	5,140,850,000	5,140,850,000	5,140,850,000	5,140,850,000	5,140,850,000	5,140,850,000
AWPF	3,961,100,000	3,961,100,000	3,961,100,000	3,961,100,000	3,961,100,000	3,961,100,000	8,784,633,000	8,784,633,000	8,784,633,000
CB	696,700,000	696,700,000	696,700,000	696,700,000	696,700,000	696,700,000	696,700,000	696,700,000	696,700,000
SFB	1,399,500,000	1,399,500,000	--	1,399,500,000	1,399,500,000	1,399,500,000	1,399,500,000	1,399,500,000	1,399,500,000
VNC	--	--	--	928,200,000	928,200,000	928,200,000	--	--	--
System Conveyance	6,154,300,000	6,721,300,000	2,919,700,000	9,205,100,000	8,761,600,000	9,428,800,000	9,313,100,000	9,089,400,000	9,741,200,000
Total	**17,352,450,000**	**17,919,450,000**	**12,718,350,000**	**21,331,450,000**	**20,887,950,000**	**21,555,150,000**	**25,334,783,000**	**25,111,083,000**	**25,762,883,000**

Notes:

Costs are in Year 2024 dollars.

HWRP MBR and AWPF costs are by Hazen (2024).

- = not applicable

Table 3-5. Estimated Operations and Maintenance Cost at Buildout of All Phases

Alternative	Approach I – IPR ($)			Approach II – IPR + Post-DPR ($)			Approach III – DPR at AWPF ($)		
	1	2	3	4	5	6	7	8	9
HWRP MBR	110,800,000	110,800,000	110,800,000	110,800,000	110,800,000	110,800,000	110,800,000	110,800,000	110,800,000
AWPF	185,700,000	185,700,000	185,700,000	185,700,000	185,700,000	185,700,000	264,600,000	264,600,000	264,600,000
CB	8,010,000	8,010,000	8,010,000	8,860,000	8,860,000	8,860,000	8,130,000	8,130,000	8,130,000
SFB	6,160,000	6,160,000	--	6,160,000	6,160,000	6,160,000	6,160,000	6,160,000	6,160,000
VNC	--	--	--	27,100,000	27,100,000	27,100,000	--	--	--
System Conveyance	26,980,000	57,620,000	230,000	72,200,000	65,920,000	70,140,000	72,680,000	61,900,000	70,190,000
Total	**337,650,000**	**368,290,000**	**304,740,000**	**410,820,000**	**404,540,000**	**408,760,000**	**462,370,000**	**451,590,000**	**459,880,000**

Notes:

Costs are in Year 2024 dollars.

HWRP MBR and AWPF costs are by Hazen (2024).

4 Schedule and Phasing

The delivery of the Program will follow a programmatic management approach to provide a framework for coordination and implementation of related projects and activities. LADWP has created a framework and implementation roadmap than can be applied to the management of the Program. A series of meetings was held with LADWP to develop and refine the conceptual Program schedule (LADWP 2024a). The schedule was developed incorporating LADWP's typical project work breakdown structure (WBS), which includes:

- Planning
- Design
- Bid and Award
- Construction
- Post-construction

To address the Program's joint goal of urgently diversifying the City's water supply portfolio, the procurement strategy basis varies by Program component. As shown on Figure 4-1, progressive design-build was assumed for pump station and treatment infrastructure, whereas traditional design-bid-build was assumed for conveyance infrastructure. While these procurement strategies are the basis for cost and schedule development, the procurement approach for each project will be confirmed during the planning stage as a roadmap implementation activity. These procurement strategies are currently assumed, provided that the City and LADWP can prioritize collaborative project delivery where viable; for example, by implementing a programmatic collaborative delivery ordinance through City Council.

The HWRP conversion to MBR is planned to occur in three phases. Planned Pure Water Los Angeles Program phasing was updated during MP development, as shown in Table 4-1, and will provide source water to the AWPF. The assumptions about MBR conversion are subject to change based on the final analysis of phasing, packaging, and schedule, as well as timing with Pure Water Los Angeles storage and demand deliveries.

Table 4-1. Anticipated Phasing for HWRP Conversion and AWPF

Phase	MBR Completion Year	Added MBR Flow (MGD)	AWPF Completion Year	Added AWPF Flow (MGD)	Total AWPF Capacity (MGD)
1	2039	60	2040	50	50
2	2045	60	2046	50	100
3	2055	152	2056	130	230

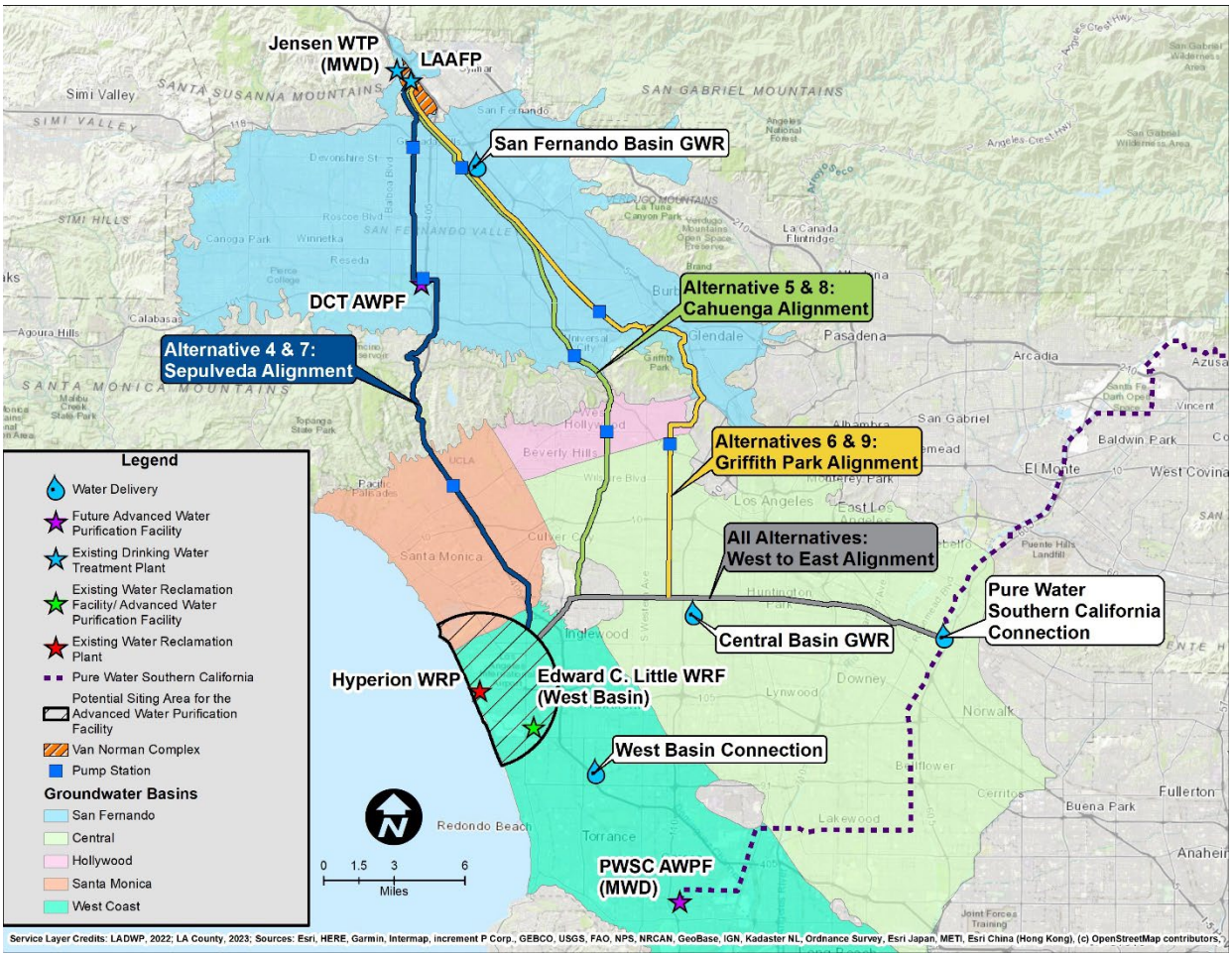
Source (LADWP 2024a)

Table 4-2 and Figure 4-1 summarize the storage and demand locations that could be integrated into the shortlisted alternatives.

Table 4-2. LADWP Pure Water Los Angeles Program Alternative Storage and Demand Locations

Potable Reuse Approach	Program Alternatives	WB Connection	CB GWR	Metropolitan PWSC	SFB GWR	VNC RWA	Metropolitan Jensen
II - IPR with Post-AWPF DPR	4, 5, 6	●	●	●	●	●	●
III – DPR at AWPF	7, 8, 9	●	●	●	●	●	●

Figure 4-1. Approach II, Alternatives 4-6, and Approach III, Alternatives 7-9



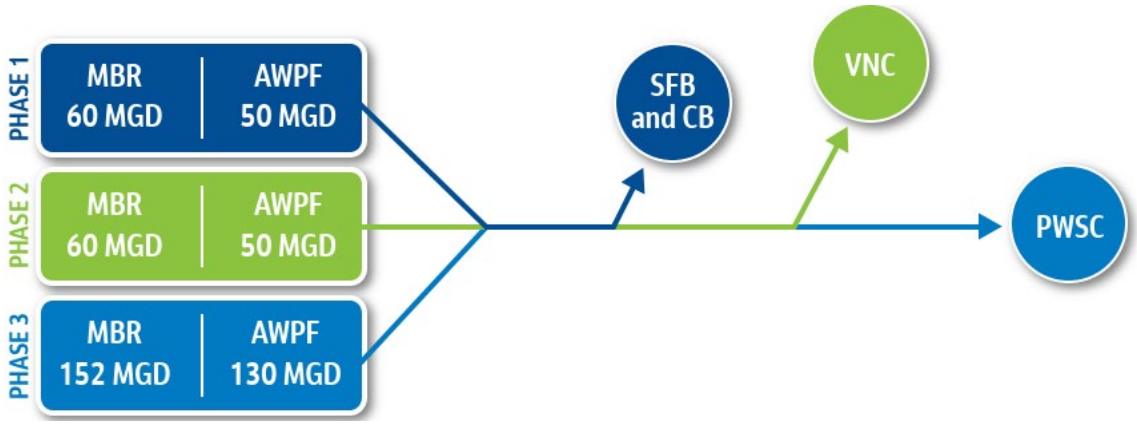
The schedule comprises delivery of the following components in phases (Figure 4-2) through a minimum of 28 projects, though the actual number may change as the Program progresses and is refined:

- HWRP MBR
- AWPF
- Conveyance
- Pump Stations
- CB
- SFB
- VNC

Conveyance projects were identified by construction method (tunneling or trenching). Figure 4-2 identifies the proposed phasing implementation. This approach focuses on LADWP's storage and demand options most accessible to the new AWPF for delivery to align with Phase 1 of the HWRP conversion to MBR and addition of an AWPF at or near HWRP, while allowing time for demonstration and approval of post-AWPF DPR options and construction of the long conveyance pipeline to the north to VNC that is aligned with Phase 2 production. Given the duration required to construct the pipeline to the north, partnerships could be pursued to use the advanced treated recycled water that would be available for Phases 1 and 2.

The basis for Approach II is IPR at the AWPF for Phases 1, 2, 3, with DPR at VNC for Phases 2 and 3. The basis for Approach III is IPR at the AWPF for Phase 1, with DPR at the AWPF for Phases 2 and 3.

Figure 4-2. Phasing



The main differences among the alternatives are the south to north alignments, as well as the treatment approaches for DPR. Completion of an alignment study will provide the information needed to refine the conveyance schedules. As such, one schedule (Figure 4-3) has been developed to encompass Program delivery in this TM based on Approach II, Alternative 6 (Griffith Park Alignment)

This schedule is a preliminary, high-level scenario and comes with complexity. Updates and revisions may occur as the Program progresses, and the number of projects may change based on evolving requirements and priorities. The Program Implementation Roadmap in Section 7 of the MP report describes additional analyses that will be important in further evaluating approaches and alternatives to advance the Program. The Program Implementation Roadmap identifies the governing considerations, future evaluations, and required decisions that will shape the Program schedule.

Fundamental to the Program's success is the development and maintenance of a Master Program Schedule that is used as a stakeholder agreed-upon tool for construction planning. The Master Program Schedule will further track the actual progress of activities; communicate Program status to stakeholders; and be subject to revision, as required to meet Program objectives.

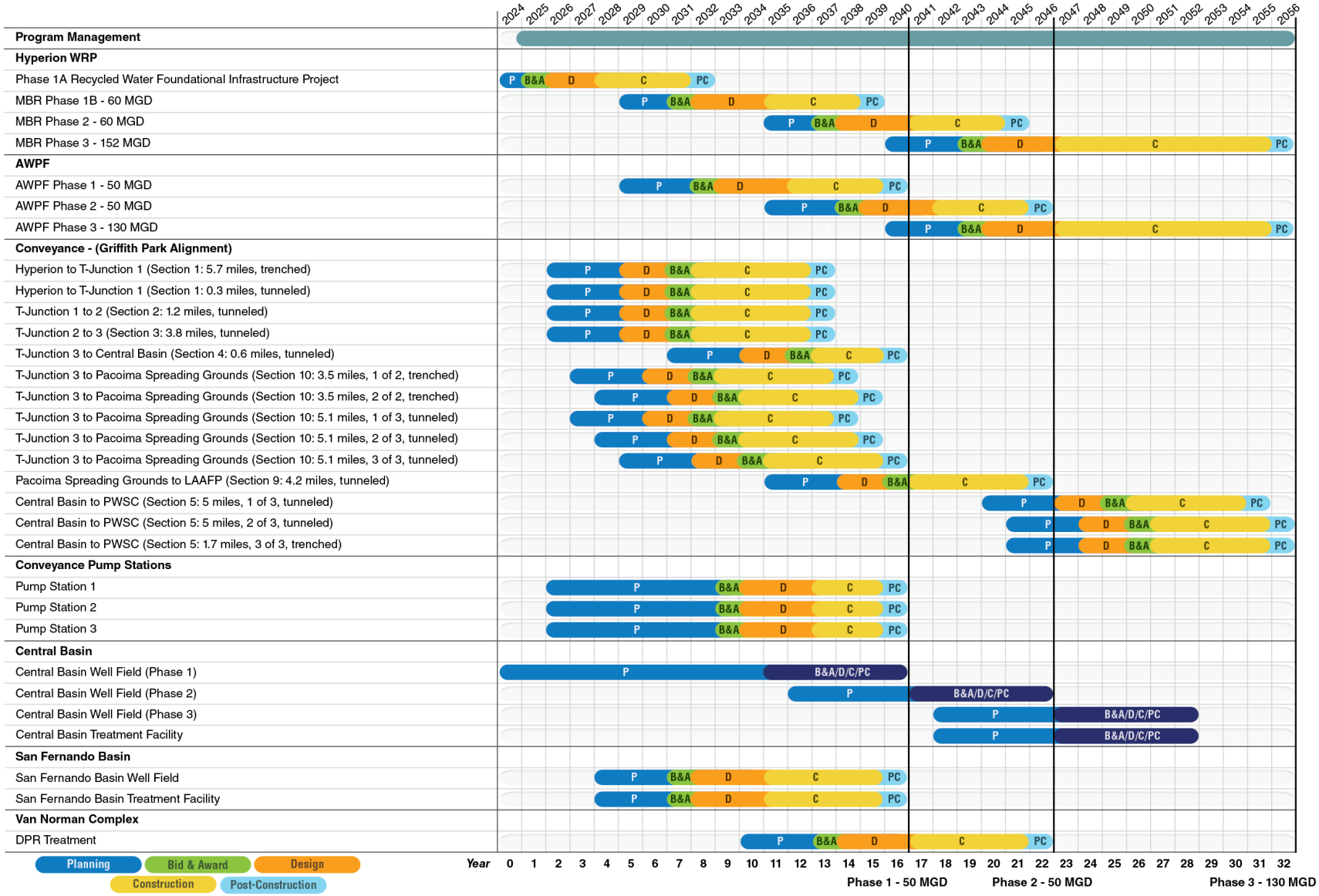
The Master Program Schedule will be developed to achieve the overarching Program milestone requirements for the delivery and treatment of advanced treated recycled water and consider the following factors:

- Availability and limitations on labor, material, and equipment resources
- Availability of capital resources and expenditure limitations
- Assignment of roles and human resources required to accomplish Program tasks

Depending on the Program approach, there are multiple potential Phase 1 concepts beyond what is shown in the MP. These Phase 1 alternatives may include a variety of concepts that will be further studied by LADWP, such as:

- Delivery of MBR-quality water to regional partners, pending institutional agreements. Phase 1 could be implemented under Approaches II or III.
- Delivery to the SFB using the Sepulveda alignment and existing East Valley Recycled Water Pipeline and Balboa Pump Station for IPR. Phase 1 could be implemented under Approaches II or III.
- Delivery to the SFB using the Cahuenga alignment for IPR. Phase 1 could be implemented under Approaches II or III.
- Delivery to the Stone Canyon Outlet, Stone-Hollywood trunkline, and Lankershim trunkline as DPR using treated water augmentation. Phase 1 could be implemented under Program Approach III but is being developed outside the MP.

Figure 4-3. Conceptual Program Schedule



5 Summary

It is an MP objective to provide a schedule that is developed to the extent possible, given scope, budget, and resource estimates, and expenditure limitations (that is, schedule leveling) based on available information about the planned projects. The Oracle Primavera P6 (P6) scheduling tool is being used for the development of a budgetary Capital Improvement Projects (CIP) Schedule. This will provide a schedule with the following information:

- A well-defined WBS and project activities
- Project phasing and sequencing
- Cost-loading and resource-loading
- Data that can ultimately be used for cash flow projections and leveling based on expenditure caps and resource availability

The budgetary CIP schedule is being developed in coordination with LADWP's Financial Services Organization (FSO) and staff.

An evaluation was conducted to identify the estimated costs and potential schedule phasing for delivery of this large, complex Program. As the Program progresses, there will be a number of next steps required to update the information presented in this TM, which include:

- Refining the individual project sizes
- Conducting public outreach
- Completing the conveyance routing study
- Finalizing flow demands and partnership agreements
- Confirming delivery approaches
- Refining phasing

With the phasing and routing determined, evaluation of construction conflicts and projects competing for resources is also recommended. These next steps will shape the Program's ultimate cost and duration.

Large infrastructure programs like Pure Water Los Angeles with a decadal time horizon and large geography are subject to uncertainty, so continuous refinements and updates will be required as the Program progresses.

6 References

AACE International (AACE). 2020. *18R-97: Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries*. August 7. https://www.pathlms.com/aace/courses/2928/documents/3803.

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Attachment A
Cost Estimates

Tables A-1 provides the total estimated capital cost of Pure Water Los Angeles by treatment and pump station component, and Table A-2 provides the total estimated capital cost by conveyance alternative.

Table A-1. Total Capital Cost by Treatment and Pump Station Component

Markups			MBR	AWPF IPR	AWPF DPR	Central Basin Wells	Central Basin GW Treatment	San Fernando Basin Wells	San Fernando Basin Treatment UV+GAC	Van Norman UV+GAC	1 Pump Station 230 mgd (N/S)
Construction Costs											
Subtotal of Project Cost (details on other sheets)							$55,491,000		$219,871,000	$227,170,000	$77,859,539
Tax (applied to 40% of Total Project Cost)	9.50%						$2,108,658		$8,355,098	$8,632,460	$2,958,662
Subtotal with Tax						$155,538,100	**$57,599,658**	**$154,514,366**	**$228,226,098**	**$235,802,460**	**$80,818,201**
With Location Adjustment Factor	112.9					$175,602,515	$65,030,014	$174,446,719	$257,667,265	$266,220,977	$91,243,749
Subtotal with Adjustment Factor						**$175,602,515**	**$65,030,014**	**$174,446,719**	**$257,667,265**	**$266,220,977**	**$91,243,749**
Mobilization	5%						$3,251,501		$12,883,363	$13,311,049	$4,562,187
General Conditions	10%						$6,503,001		$25,766,726	$26,622,098	$9,124,375
Art and Permit Fees (LADBS)	3%					$5,268,075	$1,950,900	$5,233,402	$7,730,018	$7,986,629	$2,737,312
Complexity Index (Risk Contingency)	10%					$17,560,251	$6,503,001	$17,444,672	$25,766,726	$26,622,098	$9,124,375
Subtotal 1						**$198,430,842**	**$83,238,418**	**$197,124,792**	**$329,814,099**	**$340,762,851**	**$116,791,999**
Bonds/Insurance	3%						$2,497,153		$9,894,423	$10,222,886	$3,503,760
Profit	10%						$8,323,842		$32,981,410	$34,076,285	$11,679,200
Subtotal 2						**$198,430,842**	**$94,059,412**	**$197,124,792**	**$372,689,932**	**$385,062,022**	**$131,974,959**
Project Definition (Class 5)	45%	6.384%				$76,625,260	$42,326,735	$101,291,392	$167,710,469	$173,277,910	$59,388,732
Subtotal 3						**$275,056,102**	**$136,386,148**	**$298,416,184**	**$540,400,401**	**$558,339,931**	**$191,363,691**
Design-Build Factor	15%					$41,258,415	$20,457,922	$44,762,428	$81,060,060	$83,750,990	$28,704,554
Subtotal 4						**$316,314,517**	**$156,844,070**	**$343,178,612**	**$621,460,461**	**$642,090,921**	**$220,068,245**
CONSTRUCTION COSTS			**$3,595,000,000**	**$2,770,000,000**	**$ 6,143,100,000**	**$316,314,517**	**$156,844,070**	**$343,178,612**	**$621,460,461**	**$642,090,921**	**$220,068,245**
Non-Construction Costs											
Program and Project Management	10%		$359,500,000	$277,000,000	$614,310,000	$31,631,452	$15,684,407	$34,317,861	$62,146,046	$64,209,092	$22,006,824
Planning	1%		$35,950,000	$27,700,000	$61,431,000	$3,163,145	$1,568,441	$3,431,786	$6,214,605	$6,420,909	$2,200,682
Design Engineering	10%		$359,500,000	$277,000,000	$614,310,000	$31,631,452	$15,684,407	$34,317,861	$62,146,046	$64,209,092	$22,006,824
Services During Construction	5%		$179,750,000	$138,500,000	$307,155,000	$15,815,726	$7,842,203	$17,158,931	$31,073,023	$32,104,546	$11,003,412
Bid & Award	0.5%		$17,975,000	$13,850,000	$30,715,500	$1,581,573	$784,220	$1,715,893	$3,107,302	$3,210,455	$1,100,341
Startup and Commissioning	0.5%		$17,975,000	$13,850,000	$30,715,500	$1,581,573	$784,220	$1,715,893	$3,107,302	$3,210,455	$1,100,341
Post-Construction	1%		$35,950,000	$27,700,000	$61,431,000	$3,163,145	$1,568,441	$3,431,786	$6,214,605	$6,420,909	$2,200,682
Construction Management	15%		$539,250,000	$415,500,000	$921,465,000	$47,447,178	$23,526,610	$51,476,792	$93,219,069	$96,313,638	$33,010,237
Land and ROW		LS				$10,000,000	$10,000,000	$10,000,000	$10,000,000	$10,000,000	$5,000,000
NON-CONSTRUCTION COSTS			**$1,545,850,000**	**$1,191,100,000**	**$2,641,533,000**	**$146,015,242**	**$77,442,950**	**$157,566,803**	**$277,227,998**	**$286,099,096**	**$99,629,345**
Total Capital Cost Estimate			**$5,140,850,000**	**$3,961,100,000**	**$8,784,633,000**	**$462,329,760**	**$234,287,020**	**$500,745,415**	**$898,688,459**	**$928,190,017**	**$319,697,590**

Sources:

AACE International (AACE). 2020. *18R-97: Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries*. August 7. https://www.pathlms.com/aace/courses/2928/documents/3803.

Hazen and Sawyer (Hazen). 2024. *Technical Memorandum 3 Treatment Alternatives Evaluation*. V 4. August16.

Notes:

AACE Class 5 Level estimate, with an accuracy range of (-20 to -50%) to (+30 to +100%).

MBR and AWPF construction costs were developed by Hazen (Hazen 2024).

Table A-2. Total Capital Cost by Conveyance Alternative

Markups			Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9
Construction Costs											
Subtotal of Project Cost (details on other sheets)			**$1,519,879,638**	**$1,685,746,236**	**$854,156,560**	**$2,412,399,901**	**$2,282,640,318**	**$2,477,843,864**	**$2,443,993,538**	**$2,378,549,575**	**$2,569,239,745**
Tax (applied to 10% of Total Project Cost)	9.50%		$14,438,857	$16,014,589	$8,114,487	$22,917,799	$21,685,083	$23,539,517	$23,217,939	$22,596,221	$24,407,778
Subtotal with Tax			**$1,534,318,495**	**$1,701,760,825**	**$862,271,047**	**$2,435,317,700**	**$2,304,325,401**	**$2,501,383,381**	**$2,467,211,477**	**$2,401,145,796**	**$2,593,647,522**
With Location Adjustment Factor	112.9		$1,732,245,580	$1,921,287,971	$973,504,012	$2,749,473,683	$2,601,583,377	$2,824,061,837	$2,785,481,757	$2,710,893,603	$2,928,228,052
Subtotal with Adjustment Factor			**$1,732,245,580**	**$1,921,287,971**	**$973,504,012**	**$2,749,473,683**	**$2,601,583,377**	**$2,824,061,837**	**$2,785,481,757**	**$2,710,893,603**	**$2,928,228,052**
Mobilization	5%		$86,612,279	$96,064,399	$48,675,201	$137,473,684	$130,079,169	$141,203,092	$139,274,088	$135,544,680	$146,411,403
General Conditions	10%		$173,224,558	$192,128,797	$97,350,401	$274,947,368	$260,158,338	$282,406,184	$278,548,176	$271,089,360	$292,822,805
Art and Permit Fees (LADBS)	3%		$51,967,367	$57,638,639	$29,205,120	$82,484,210	$78,047,501	$84,721,855	$83,564,453	$81,326,808	$87,846,842
Complexity Index (Risk Contingency)	10%		$173,224,558	$192,128,797	$97,350,401	$274,947,368	$260,158,338	$282,406,184	$278,548,176	$271,089,360	$292,822,805
Subtotal 1			**$2,217,274,343**	**$2,459,248,603**	**$1,246,085,136**	**$3,519,326,314**	**$3,330,026,723**	**$3,614,799,152**	**$3,565,416,649**	**$3,469,943,812**	**$3,748,131,907**
Bonds/Insurance	3%		$66,518,230	$73,777,458	$37,382,554	$105,579,789	$99,900,802	$108,443,975	$106,962,499	$104,098,314	$112,443,957
Contractor Profit	10%		$221,727,434	$245,924,860	$124,608,514	$351,932,631	$333,002,672	$361,479,915	$356,541,665	$346,994,381	$374,813,191
Subtotal 2			**$2,505,520,008**	**$2,778,950,922**	**$1,408,076,203**	**$3,976,838,735**	**$3,762,930,197**	**$4,084,723,041**	**$4,028,920,814**	**$3,921,036,508**	**$4,235,389,055**
Project Definition (Class V)	45%		$1,127,484,003	$1,250,527,915	$633,634,291	$1,789,577,431	$1,693,318,589	$1,838,125,369	$1,813,014,366	$1,764,466,428	$1,905,925,075
Subtotal 3			**$3,633,004,011**	**$4,029,478,836**	**$2,041,710,495**	**$5,766,416,166**	**$5,456,248,786**	**$5,922,848,410**	**$5,841,935,180**	**$5,685,502,936**	**$6,141,314,130**
Design-Build factor	15%										
Subtotal 4			**$3,633,004,011**	**$4,029,478,836**	**$2,041,710,495**	**$5,766,416,166**	**$5,456,248,786**	**$5,922,848,410**	**$5,841,935,180**	**$5,685,502,936**	**$6,141,314,130**
CONSTRUCTION COSTS			**$3,633,004,011**	**$4,029,478,836**	**$2,041,710,495**	**$5,766,416,166**	**$5,456,248,786**	**$5,922,848,410**	**$5,841,935,180**	**$5,685,502,936**	**$6,141,314,130**
Non-Construction Costs											
Program and Project Management	10%		$363,300,401	$402,947,884	$204,171,049	$576,641,617	$545,624,879	$592,284,841	$584,193,518	$568,550,294	$614,131,413
Planning	1%		$36,330,040	$40,294,788	$20,417,105	$57,664,162	$54,562,488	$59,228,484	$58,419,352	$56,855,029	$61,413,141
Design Engineering	10%		$363,300,401	$402,947,884	$204,171,049	$576,641,617	$545,624,879	$592,284,841	$584,193,518	$568,550,294	$614,131,413
Services During Construction	5%		$181,650,201	$201,473,942	$102,085,525	$288,320,808	$272,812,439	$296,142,420	$292,096,759	$284,275,147	$307,065,706
Bid & Award	0.5%		$18,165,020	$20,147,394	$10,208,552	$28,832,081	$27,281,244	$29,614,242	$29,209,676	$28,427,515	$30,706,571
Startup and Commissioning	0.5%		$18,165,020	$20,147,394	$10,208,552	$28,832,081	$27,281,244	$29,614,242	$29,209,676	$28,427,515	$30,706,571
Post-Construction	1%		$36,330,040	$40,294,788	$20,417,105	$57,664,162	$54,562,488	$59,228,484	$58,419,352	$56,855,029	$61,413,141
Construction Management	15%		$544,950,602	$604,421,825	$306,256,574	$864,962,425	$818,437,318	$888,427,261	$876,290,277	$852,825,440	$921,197,119
Land and ROW		LS	$0	$0	$0	$0	$0	$0	$0	$0	$0
NON-CONSTRUCTION COSTS			**$1,562,191,725**	**$1,732,675,900**	**$877,935,513**	**$2,479,558,951**	**$2,346,186,978**	**$2,546,824,816**	**$2,512,032,127**	**$2,444,766,263**	**$2,640,765,076**
Total Capital Cost Estimate			**$5,195,195,736**	**$5,762,154,736**	**$2,919,646,007**	**$8,245,975,117**	**$7,802,435,763**	**$8,469,673,226**	**$8,353,967,308**	**$8,130,269,199**	**$8,782,079,206**

Sources:

AACE International (AACE). 2020. *18R-97: Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries.* August 7. https://www.pathlms.com/aace/courses/2928/documents/3803.

Notes:

AACE Class 5 Level estimate, with an accuracy range of (-20 to -50%) to (+30 to +100%).

Pure Water Los Angeles Master Plan
Central Basin Distributed Injection and Extraction Wells

Basis of Estimate					
Total Injection Rate	38	MGD	59	cfs	
Total Extraction Rate	18	MGD	28	cfs	
Injection Rate per Well	1,000	gpm			
Extraction Rate per Well	2,000	gpm			
Number of Injection Wells	27				
Number of Extraction Wells	7				
Injection Wells					
Materials	316 SST				
Diameter	18	inch			
Injection Rate	1,000	gpm			
Backwashing Rate	2,000	gpm			
Total depth	1,500	feet			
DTSW	150	feet			
Specific Capacity	21	gpm/ft			
Pumping Level	245	feet			
Discharge Pressure	0	PSI	With air gap to storm or sanitary sewer		
TDH	245	Feet			
Injection Specific Cap	12	55% of pumping SC			
Injection Level	67	feet			
Power Requirements					
WHP	124	HP			
BHP	165	HP	75% plant efficiency		
Overall	183	HP	90% drive efficiency		
	137	KW			
Online Factor	0.89%	Assumes backwashing 1.5 hours per week			
Hours	78	hours/year/well			
Electrical costs	$0.15	per KWH/well	**$1,602**		**per year/well**
Extraction Wells					
Materials	316 SST				
Diameter	18	inch			
Extraction Rate	2,000	gpm			
Total depth	1,500	feet			
DTSW	150	feet			
Specific Capacity	21	gpm/ft	avg SC of MWF wells at end of testing		
Pumping Level	245	feet			
Discharge Pressure	35	PSI	Assumption		
TDH	260	Feet			
Power Requirements					
WHP	132	HP			
BHP	175	HP	75% plant efficiency		
Overall	195	HP	90% drive efficiency		
	145	KW			
Online Factor	100%				
Hours	8,760	hours/year/well			
Electrical costs	$0.15	per KWH/well	**$190,980**		**per year/well**

Pure Water Los Angeles Master Plan
Central Basin Injection Wells Construction Costs

Well Construction	**Number**	**Units**	**Units Costs**	**Extended Costs**
Mobilization	1	LS	$200,000	$200,000
Sound Control	1	LS	$100,000	$100,000
Drill and Install Conductor Casing	50	LF	$750	$37,500
Pilot Borehole Drilling	1450	LF	$100	$145,000
Geophysical Logging	1	LS	$11,000	$11,000
Ream Pilot Borehole	1450	LF	$100	$145,000
Caliper Logging	1	LS	$10,000	$10,000
Well Construction	1500	LF	$825	$1,237,500
Mechanical Well Development	1	LS	$75,000	$75,000
Pumping Well Development	1	LS	$25,000	$25,000
Aquifer Testing/Flowmeter Testing	1	LS	$30,000	$30,000
Video/Gyro	1	LS	$7,500	$7,500
Disinfection	1	LS	$10,000	$10,000
Disposal of Drilling Waste	1	LS	$100,000	$100,000
Subtotal				$2,133,500
Equipping	**Number**	**Units**	**Units Costs**	**Extended Costs**
Mobilization	1	LS	$200,000	$200,000
Electrical Service and Improvements	1	LS	$400,000	$400,000
Down Well Flow Control Valve, Eductor, and Mechanical	1	LS	$200,000	$200,000
Well Pump, 2000 gpm 500 foot setting	1	LS	$200,000	$200,000
Mechanical Installation, Piping and Appurtenances	1	LS	$300,000	$300,000
Well Enclosure and Civil Improvements	1	LS	$850,000	$850,000
Security	1	LS	$100,000	$100,000
I&C	1	LS	$200,000	$200,000
Subtotal				$2,450,000
Cost Per Well			June 2023	**$4,583,500**
Number of Wells				27
Costs All Wells			June 2023	**$123,754,500**
ENR CCI Escalation Factor				1.00712
Subtotal of Project Costs (Costs All Wells)			Escalated to March 2024	**$124,635,227**

Notes:

Well Construction:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021)

Equipping:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021, 2022)

ENR Cost Indexes in Los Angeles: June 2023 (15112.29); March 2024 (15219.84)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
Central Basin Extraction Wells Construction Costs

Well Construction	Number	Units	Units Costs	Extended Costs
Mobilization	1	LS	$200,000	$200,000
Sound Control	1	LS	$100,000	$100,000
Drill and Install Conductor Casing	50	LF	$750	$37,500
Pilot Borehole Drilling	1450	LF	$100	$145,000
Geophysical Logging	1	LS	$11,000	$11,000
Ream Pilot Borehole	1450	LF	$100	$145,000
Caliper Logging	1	LS	$10,000	$10,000
Well Construction	1500	LF	$825	$1,237,500
Mechanical Well Development	1	LS	$75,000	$75,000
Pumping Well Development	1	LS	$25,000	$25,000
Aquifer Testing/Flowmeter Testing	1	LS	$30,000	$30,000
Video/Gyro	1	LS	$7,500	$7,500
Disinfection	1	LS	$10,000	$10,000
Disposal of Drilling Waste	1	LS	$100,000	$100,000
Subtotal				$2,133,500
Equipping	**Number**	**Units**	**Units Costs**	**Extended Costs**
Mobilization	1	LS	$200,000	$200,000
Electrical Service and Improvements	1	LS	$400,000	$400,000
Well Pump, 2000 gpm 500 foot setting	1	LS	$200,000	$200,000
Mechanical Installation, Piping and Appurtenances	1	LS	$300,000	$300,000
Well Enclosure and Civil Improvements	1	LS	$850,000	$850,000
Security	1	LS	$100,000	$100,000
I&C	1	LS	$200,000	$200,000
Subtotal				$2,250,000
Cost Per Well			June 2023	**$4,383,500**
Number of Wells				**7**
Costs All Wells			June 2023	**$30,684,500**
ENR CCI Escalation Factor				1.00712
Subtotal of Project Costs (Costs All Wells)			Escalated to March 2024	**$30,902,873**

Notes:

Well Construction:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021)

Equipping:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021)

ENR Cost Indexes in Los Angeles: June 2023 (15112.29); March 2024 (15219.84)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
Central Basin Injection and Extraction Wells Capital Costs (March 2024$)

Item			Value
Subtotal of Project Costs (All Wells)			
Injection Wells			$124,635,227
Extraction Wells			$30,902,873
Tax (applied to 40% of Total Project Cost)	9.50%		
Subtotal with Tax			$155,538,100
With Location Adjustment Factor	112.9		$175,602,515
Subtotal with Adjustment Factor			**$175,602,515**
Mobilization	5%		
General Conditions	10%		
Art and Permit Fees (LADBS)	3%		$5,268,075
Complexity Index (Risk Contingency)	10%		$17,560,251
Subtotal 1			**$198,430,842**
Bonds/Insurance	3%		
Profit	10%		
Subtotal 2			**$198,430,842**
Project Definition (Class V)	45%	6.384%	$76,625,260
Subtotal 3			**$275,056,102**
Design-Build Factor	15%		$41,258,415
Subtotal 4			**$316,314,517**
CONSTRUCTION COSTS			**$316,314,517**
Non-Construction Costs			
Program and Project Management	10%		$31,631,452
Planning	1%		$3,163,145
Design Engineering	10%		$31,631,452
Services During Construction	5%		$15,815,726
Bid & Award	0.5%		$1,581,573
Startup and Commissioning	0.5%		$1,581,573
Post-Construction	1%		$3,163,145
Construction Management	15%		$47,447,178
Land and ROW	LS		$10,000,000
NON-CONSTRUCTION COSTS			**$146,015,242**
Total Capital Cost Estimate			**$462,329,760**

Notes:

* Incorporates markups from LADWP *Operation NEXT Program's Cost Escalation and Markups Technical Memorandum* (March 21, 2024)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
Central Basin Injection and Extraction Wells O&M Costs

Flow at 100% Capacity

Extraction Wells		
Power	$1,042,753	per year
Equipment Replacement and Repair	$70,000	all wells/year, 2% of equipping costs
Periodic Well Rehabilitation	$100,000	1 well per year (staggered rehab)
Labor	$130,000	0.25% LOE operator, two at $130/hr (1000 hr/yr)
	$1,812,717	Includes 35% contingency
Injection Wells		
Power	$33,729	per year
Equipment Replacement and Repair	$378,000	all wells/year, 2% of equipping costs
Periodic Well Rehabilitation	$300,000	3 wells per year (staggered rehab)
Labor	$390,000	0.75% LOE operator, two at $130/hr (2000 hr/yr)
	$1,487,334	Includes 35% contingency

Concept Study - Basis for Approach II, Alternative 6
February 2024 ONAT Results for Alternatives Screening - 1990 Start Hydrology

Alternative	**CB Total LADWP Extractions**	**CB Total LADWP Extractions**	
Alt 1	26,200	23	
Alt 2	26,200	23	
Alt 3	26,300	23	
Alt 4	16,100	14	
Alt 5 & 6	16,100	14	Approach II, Alternative 6
Alt7	13,400	12	
Alt 8 & 9	13,400	12	

GoldSim 14.0.0383

Simulation Filename: OpNextGS_v1.031; Simulation Start Time: 3/14/2024

Injection Capacity, MGD	38
Extraction Capacity, MGD	18

Alternative	**Injection**		**Extraction**	
	Power	**Total**	**Power**	**Total**
Alt 1	$20,747	$1,088,747	$1,042,753	$1,342,753
Alt 2	$20,747	$1,088,747	$1,042,753	$1,342,753
Alt 3	$20,826	$1,088,826	$1,042,753	$1,342,753
Alt 4	$12,749	$1,080,749	$832,096	$1,132,096
Alt 5 & 6	$12,749	$1,080,749	$832,096	$1,132,096
Alt7	$10,611	$1,078,611	$692,552	$992,552
Alt 8 & 9	$10,611	$1,078,611	$692,552	$992,552

Assumption: Injection = Extraction

$2,212,845 **Total**

Pure Water Los Angeles Master Plan
Central Basin Groundwater Treatment Construction Costs

Scope of Project		Conceptual Treatment Processes
Design Flow		**18 MGD**
Adsorptive Filtration (Includes Tanks, System Piping, Actuated Valves, Instrumentation, and Automatic PLC Control Panel)		$11,101,000
GAC Contactors (Includes Tanks, System Piping, Actuated Valves, Instrumentation, and Automatic PLC Control Panel)		$23,568,000
Backwash Equalization Tank (including a backwash pump)		$282,000
Rectangular Clearwell (includes baffles)		$1,514,000
High Lift Pump Station (includes high lift pumps, surge protection basin, and electrical room)		$4,612,000
Chemical Building (includes containment, corridor and electrical area for chlorine, fluoridation, ammonium sulfate)		$1,938,000
SUBTOTAL - PROJECT COST		$43,015,000
Additional Project Costs		
Demolition	0.0%	$0
Overall Sitework	6.0%	$2,581,000
Plant Control System	6.0%	$2,581,000
Yard Electrical/SCADA	9.0%	$3,872,000
Yard Piping	8.0%	$3,442,000
SUBTOTAL with Additional Project Costs		$55,491,000
Tax (applied to 40% of Total Project Cost)	9.50%	$2,108,658
Subtotal with Tax		$57,599,658
With Location Adjustment Factor	112.9	$65,030,014
Subtotal with Adjustment Factor		$65,030,014
Mobilization	5%	$3,251,501
General Conditions	10%	$6,503,001
Art and Permit Fees (LADBS)	3%	$1,950,900
Complexity Index (Risk Contingency)	10%	$6,503,001
Subtotal 1		$83,238,418
Bonds/Insurance	3%	$2,497,153
Profit	10%	$8,323,842
Subtotal 2		$94,059,412
Project Definition (Class V)	45%	
Subtotal 3		$136,386,148
Design-Build Factor	15%	$20,457,922
Subtotal 4		$156,844,070
CONSTRUCTION COSTS		**$156,844,070**
Non-Construction Costs		
Program and Project Management	10%	$15,684,407
Planning	1%	$1,568,441
Design Engineering	10%	$15,684,407
Services During Construction	5%	$7,842,203
Bid & Award	0.5%	$784,220
Startup and Commissioning	0.5%	$784,220
Post-Construction	1%	$1,568,441
Construction Management	15%	$23,526,610
Land and ROW		$10,000,000
NON-CONSTRUCTION COSTS		**$77,442,950**
Total Capital Cost Estimate		**$234,287,020**

* Incorporates markups from LADWP *Operation NEXT Program's Cost Escalation and Markups Technical Memorandum* (March 21, 2024)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
Central Basin Extraction Treatment O&M Cost

Annual O&M Costs

	CB (18 MGD)	Annual O&M (Alt 4-9)
Power	$ 2,984,000	$ 2,381,171
GAC Media Replacement	$ 1,235,000	$ 1,235,000
Pyrolusite Media Replacement	$ 204,190	$ 204,190
Sodium hypochlorite	$ 144,881	$ 115,612
Hydrofluorosilicic Acid	$ 64,719	$ 51,644
Ammonium sulfate	$ 46,119	$ 36,802
Labor	$ 540,800	$ 540,800
Equipment maintenance	$ 354,000	$ 354,000
Subtotal	$ 5,573,708	$ 4,919,219
Contingency (35%)	$ 1,950,798	$ 1,721,726
TOTAL	$ 7,524,506	$ 6,640,945

Note:
Concept Study - Basis for Approach II, Alternative 6
Based on an average annual flow per ONAT scenario modeling of 22 cfs (14 MGD)

Pure Water Los Angeles Master Plan
San Fernando Injection Wells

Basis of Estimate					
Total Injection Rate	50	MGD	77	cfs	
Injection Rate per Well	1,000	gpm			
Number of Injection Wells	35				
Injection Wells					
Materials	316 SST				
Diamater	18	inch			
Injection Rate	1,000	gpm			
Backwashing Rate	2,000	gpm			
Total depth	1,500	feet			
DTSW	150	feet			
Specific Capacity	21	gpm/ft			
Pumping Level	245	feet			
Discharge Pressure	0	PSI	With air gap to storm or sanitary sewer		
TDH	245	Feet			
Injection Specific Cap	12	80% of pumping SC			
Injection Level	67	feet			
Power Requirements					
WHP	124	HP			
BHP	165	HP			
Overall	183	HP			
	137	KW			
Online Factor	0.89%	Assumes backwashing 1.5 hours per week			
Hours	78	hours/year/well			
Electrical costs	$0.12	per KWH/well	**$1,249**		**per year/well**

Pure Water Los Angeles Master Plan
San Fernando Basin Injection Wells Construction Costs

Well Construction	Number	Units	Units Costs	Extended Costs
Mobilization	1	LS	$200,000	$411,765
Sound Control	1	LS	$100,000	$205,882
Drill and Install Conductor Casing	50	LF	$750	$77,206
Pilot Borehole Drilling	1450	LF	$100	$298,529
Geophysical Logging	1	LS	$11,000	$22,647
Ream Pilot Borehole	1450	LF	$100	$298,529
Caliper Logging	1	LS	$10,000	$20,588
Well Construction	1500	LF	$825	$2,547,794
Mechanical Well Development	1	LS	$75,000	$154,412
Pumping Well Development	1	LS	$25,000	$51,471
Aquifer Testing/Flowmeter Testing	1	LS	$30,000	$61,765
Video/Gyro	1	LS	$7,500	$15,441
Disinfection	1	LS	$10,000	$20,588
Disposal of Drilling Waste	1	LS	$100,000	$205,882
				$4,392,500
Equipping	**Number**	**Units**	**Units Costs**	**Extended Costs**
Mobilization	1	LS	$200,000	$411,765
Electrical Service and Improvements	1	LS	$400,000	$823,529
Down Well Flow Control Valve, Eductor, and Mechanical	1	LS	$200,000	$411,765
Well Pump, 2000 gpm 500 foot setting	1	LS	$200,000	$411,765
Mechanical Installation, Piping and Appurtenances	1	LS	$300,000	$617,647
Well Enclosure and Civil Improvements	1	LS	$850,000	$1,750,000
Security	1	LS	$100,000	$205,882
I&C	1	LS	$200,000	$411,765
				$4,632,353
Cost Per Well			June 2023	**$9,024,853**
Number of Wells				**17**
Costs All Wells			June 2023	**$153,422,500**
ENR CCI Escalation Factor				1.00712
Subtotal of Project Costs (Costs All Wells)			Escalated to March 2024	**$154,514,366**

Notes:
Well Construction:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021)

Equipping:
All costs are installed costs, and include contractor mark up and general conditions
All unit costs for well installation based on as-bid costs for similar projects (2021, 2022)

ENR Cost Indexes in Los Angeles: June 2023 (15112.29); March 2024 (15219.84)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
San Fernando Basin Injection Wells Capital Costs (March 2024$)

Item			Value
Subtotal of Project Costs (All Wells)			
Injection Wells			$154,514,366
Tax (applied to 40% of Total Project Cost)	9.50%		
Subtotal with Tax			$154,514,366
With Location Adjustment Factor	112.9		$174,446,719
Subtotal with Adjustment Factor			**$174,446,719**
Mobilization	5%		
General Conditions	10%		
Art and Permit Fees (LADBS)	3%		$5,233,402
Complexity Index (Risk Contingency)	10%		$17,444,672
Subtotal 1			**$197,124,792**
Bonds/Insurance	3%		
Profit	10%		
Subtotal 2			**$197,124,792**
Project Definition (Class V)	45%	6.384%	$101,291,392
Subtotal 3			**$298,416,184**
Design-Build Factor	15%		$44,762,428
Subtotal 4			**$343,178,612**
CONSTRUCTION COSTS			**$343,178,612**
Non-Construction Costs			
Program and Project Management	10%		$34,317,861
Planning	1%		$3,431,786
Design Engineering	10%		$34,317,861
Services During Construction	5%		$17,158,931
Bid & Award	0.5%		$1,715,893
Startup and Commissioning	0.5%		$1,715,893
Post-Construction	1%		$3,431,786
Construction Management	15%		$51,476,792
Land and ROW	LS		$10,000,000
NON-CONSTRUCTION COSTS			**$157,566,803**
Total Capital Cost Estimate			**$500,745,415**

* Incorporates markups from LADWP *Operation NEXT Program's Cost Escalation and Markups Technical Memorandum* (March 21, 2024)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
San Fernando Basin Injection Wells O&M Costs

Flow at 100% Capacity

Injection Wells		
Power	$43,723	per year
Equipment Replacement and Repair	$490,000	all wells/year, 2% of equipping costs
Periodic Well Rehabilitation	$300,000	3 wells per year (staggered rehab)
Labor	$390,000	0.75% LOE operator, two at $130/hr (2000 hr/yr)
	$1,652,026	Includes 35% contingency

Concept Study - Basis for Approach II, Alternative 6
February 2024 ONAT Results for Alternatives Screening - 1990 Start Hydrology

Alternative	**SFB Total LADWP Extractions (AFY)**	**SFB Total LADWP Extractions (MGD)**	
Alt 1	103,900	93	
Alt 2	105,400	94	
Alt 3	84,900	76	
Alt 4	64,000	57	
Alt 5 & 6	64,000	57	Approach II, Alternative 6
Alt7	55,700	50	
Alt 8 & 9	55,700	50	

GoldSim 14.0.0383

Simulation Filename: OpNextGS_v1.031; Simulation Start Time: 3/14/2024

Pure Water Los Angeles Master Plan
San Fernando Basin Extraction Treatment Cost (2024$)

Description	SFB (48 MGD)	Notes
Sand Separator	$1,900,000	2000 gpm, 18 (17+1), NHW, 40% install, CCI correction for July 2016 to 2024
Cartridge Filters	$5,960,000	2880 gpm, 12 (12+0), NHW, 40% install, 1.27 CCI correction for July 2016 to Feb 2023
UV AOP and Peroxide Equipment	$23,520,000	Estimate from Trojan email (2/29/2024) scaled from 4 reactors to 7 reactors w/ 40% installation July 2016 to Feb 2023
GAC Equipment	$22,751,000	See Detailed GAC costs
Backwash Storage Tank	$9,280,000	Based on NHW Cast In-Place tank for approx. 400,000 gal, including misc. improvements, CCI correction
Metals	$640,000	1% of the installed equipment cost
Mechanical	$15,860,000	25% of the installed equipment cost
Electrical	$9,520,000	15% of the installed equipment cost
Instrumentation and Control	$6,350,000	10% of the installed equipment cost
Process Subtotal	**$95,781,000**	
UV Reactor Building	$11,310,000	
Peroxide Building	$3,330,000	
Building Subtotal	**$14,640,000**	
Subtotal	**$110,421,000**	
Site Civil and Yard Piping	$27,610,000	25% of the Subtotal for potential spreading basin filing
Site Electrical and Control	$16,570,000	15% of the Subtotal
Site Civil and Electrical Subtotal	**$44,180,000**	
Conveyance	$65,270,000	15000 LF of 54" pipe, Jacobs spreadsheet
Conveyance Subtotal	**$65,270,000**	
Subtotal of Project Costs	**$219,871,000**	
Tax (applied to 40% of Total Project Cost)	$8,355,098	9.50%
Subtotal with Tax	$228,226,098	
With Location Adjustment Factor	$257,667,265	112.9
Subtotal with Adjustment Factor	$257,667,265	
Mobilization	$12,883,363	5%
General Conditions	$25,766,726	10%
Art and Permit Fees (LADBS)	$7,730,018	3%
Complexity Index (Risk Contingency)	$25,766,726	10%
Subtotal 1	$329,814,099	
Bonds/Insurance	$9,894,423	3%
Profit	$32,981,410	10%
Subtotal 2	$372,689,932	
Project Definition (Class V)	$167,710,469	45%
Subtotal 3	$540,400,401	
Design-Build Factor	$81,060,060	15%
Subtotal 4	$621,460,461	
CONSTRUCTION COSTS	**$621,460,461**	
Non-Construction Costs		
Program and Project Management	$62,146,046	10%
Planning	$6,214,605	1%
Design Engineering	$62,146,046	10%
Services During Construction	$31,073,023	5%
Bid & Award	$3,107,302	0.5%
Startup and Commissioning	$3,107,302	0.5%
Post-Construction	$6,214,605	1%
Construction Management	$93,219,069	15%
Land and ROW	$10,000,000	
NON-CONSTRUCTION COSTS	**$277,227,998**	
Total Capital Cost Estimate	**$898,688,459**	

* Incorporates markups from LADWP *Operation NEXT Program's Cost Escalation and Markups Technical Memorandum* (March 21, 2024)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
San Fernando Basin Extraction Treatment O&M Cost (2024$)

Concept Study - Basis for Approach II, Alternative 6

Annual O&M Costs

	SFB (48 MGD)	Annual O&M (Alt 4-9)
Power	$ 5,072,000	$ -
Consumables	$ 4,682,000	$ -
Chemicals	$ 2,124,000	$ -
Labor	$ 3,203,000	$ -
General Maintenance	$ 3,299,000	$ 3,299,000
Water Quality Monitori	$ 1,250,000	$ -
Subtotal	$ 19,630,000	$ 3,299,000
Contingency (35%)	$ 6,871,000	$ 1,155,000
	$ 26,500,000	$ 4,500,000

Note:
Based on an average annual flow per ONAT scenario modeling of 111 cfs (72 MGD), which will be treated by existing capacity of 145 cfs (94 MGD)

Pure Water Los Angeles Master Plan
Raw Water Augmentation - LAAFP DPR Treatment Cost (2024$)

Description	LAAFP (163 MGD)	Notes
UV AOP and Peroxide Equipment	$17,640,000	Estimate from Trojan email (2/29/2024) w/ 40% installation, added 6th UV reactor to be conservative
GAC Equipment	$81,820,000	See Jacobs Detailed GAC spreadsheet (15 min EBCT in a building)
Pumps	$4,540,000	
Metals	$1,040,000	1% of the installed equipment cost
Mechanical	$26,000,000	25% of the installed equipment cost
Electrical	$15,600,000	15% of the installed equipment cost
Instrumentation and Control	$10,400,000	10% of the installed equipment cost
Process Subtotal	**$157,040,000**	
UPS Building	$2,690,000	
UV Reactor Building	$8,790,000	
Peroxide Building	$3,030,000	
Pump Station	$4,540,000	
Building Subtotal	**$19,050,000**	
Subtotal	**$176,090,000**	
Site Civil and Yard Piping	$24,660,000	14% of the Subtotal
Site Electrical and Control	$26,420,000	15% of the Subtotal
Site Civil and Electrical Subtotal	**$51,080,000**	
Subtotal	**$227,170,000**	
Subtotal of Project Costs	**$227,170,000**	
Tax (applied to 40% of Total Project Cost)	$8,632,460	9.50%
Subtotal with Tax	$235,802,460	
With Location Adjustment Factor	$266,220,977	112.9
Subtotal with Adjustment Factor	$266,220,977	
Mobilization	$13,311,049	5%
General Conditions	$26,622,098	10%
Art and Permit Fees (LADBS)	$7,986,629	3%
Complexity Index (Risk Contingency)	$26,622,098	10%
Subtotal 1	$340,762,851	
Bonds/Insurance	$10,222,886	3%
Profit	$34,076,285	10%
Subtotal 2	$385,062,022	
Project Definition (Class V)	$173,277,910	45%
Subtotal 3	$558,339,931	
Design-Build Factor	$83,750,990	15%
Subtotal 4	$642,090,921	
CONSTRUCTION COSTS	**$642,090,921**	
Non-Construction Costs		
Program and Project Management	$64,209,092	10%
Planning	$6,420,909	1%
Design Engineering	$64,209,092	10%
Services During Construction	$32,104,546	5%
Bid & Award	$3,210,455	0.5%
Startup and Commissioning	$3,210,455	0.5%
Post-Construction	$6,420,909	1%
Construction Management	$96,313,638	15%
Land and ROW	$10,000,000	
NON-CONSTRUCTION COSTS	**$286,099,096**	
Total Capital Cost Estimate	**$928,190,017**	

* Incorporates markups from LADWP *Operation NEXT Program's Cost Escalation and Markups Technical Memorandum* (March 21, 2024)
AACE Class 5 Level estimate with an accuracy range of (-20 to -50%) to (+30 to +100%)

Pure Water Los Angeles Master Plan
Raw Water Augmentation - LAAFP DPR Treatment O&M Cost (2024$)

Concept Study - Basis for Approach II, Alternative 6

Annual O&M Costs

	VNC (163 MGD)	Annual O&M (Alt 4-6)
Power	$ 5,217,000	$ 3,999,000
Consumables	$ 12,144,000	$ 9,308,000
Chemicals	$ 1,442,000	$ 1,106,000
Labor	$ 2,330,000	$ 1,786,000
General Maintenance	$ 3,407,550	$ 3,408,000
Water Quality Monitori	$ 500,000	$ 500,000
Subtotal	$ 25,040,550	$ 20,107,000
Contingency (35%)	$ 8,765,000	$ 7,038,000
	$ 33,800,000	$ 27,100,000

Note:
Based on an average annual flow per ONAT scenario modeling of 193 cfs (125 MGD)

Economic Benefits TM

Economic Benefits Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
December 16, 2024

Executive Summary

Overview

The Pure Water Los Angeles (Program) Master Plan (MP) evaluates potential alternatives for potable reuse to maximize the use of recycled water from the Hyperion Water Reclamation Plant (HWRP) and the anticipated Advanced Water Purification Facility (AWPF). To accomplish this, the MP developed nine Program alternatives based on three potable reuse approaches and a range of conveyance alignments. The Program alternatives were assessed, screened, and shortlisted to Alternatives 4 through 9 (Arcadis and Jacobs 2024a). Each shortlisted alternative offers many direct and indirect benefits.

Among these benefits, the Program is of significant size, duration, and capital cost and will support local and regional economies by generating jobs, supporting businesses and the environment, and contributing to the well-being of the citizens of Los Angeles and Southern California. As described in this technical memorandum (TM), investment in construction of the Program will put thousands of Californians to work for needed jobs, spanning from construction to a broad range of other industries that will support the implementation of the Program. The overall goal of this economic impact assessment is to understand the benefits of the Program in terms of job creation at the local and regional levels.

Analysis Approach

The Program will provide widespread economic impact not only in Los Angeles County, but also in the Southern California region and beyond. The purpose of this TM is to summarize the following two elements:

1. Review and validate the job creation analysis conducted previously by the Los Angeles Department of Water and Power (LADWP) using the following approaches, based on the original scope from the Concept Study (LADWP 2021):
    - Regional Input-Output Modeling System II (RIMS II) analysis
    - California Air Resources Board (CARB) analysis model, which is updated periodically (CARB 2024)
2. Develop an independent economic analysis with an updated data set to estimate potential jobs to be created or supported by the Program for the following two regions, based on the Program alternatives developed in the Pure Water Los Angeles MP:
    - **Region 1:** Los Angeles County, as represented by the Los Angeles-Long Beach-Glendale California Metropolitan Division (MD), as defined by the Employment Development Department (EDD), State of California (EDD 2024)

      Region 2: The five-county region comprising the following counties: Los Angeles, Orange, Riverside, San Bernardino, and Ventura

Validation

LADWP's initial economic assessment for the Program concept using the RIMS II and CARB models was validated based on previous information available at the time. However, the results of those analyses were found to no longer be up to date, as LADWP's analysis used multipliers based on the 2016 regional data and only considered Region 1. The CARB model used multipliers for 2019 regional data, and the multipliers were for the State of California, as opposed to specific regions. Moreover, the estimated Program budget has been updated since LADWP's analysis based on Program evolution.

All three models (LADWP's RIMS II and the RIMS II update, and CARB) used the RIMS II multipliers from the U.S. Bureau of Economic Analysis as the basis for the analysis. It was found that all three models were able to account for the jobs created through direct, indirect, and induced impacts of the Program

investment. However, the results from each of the models were different because of differences in Program costs, year of multipliers, and regions considered for the economic impact analysis.

The job estimates from LADWP's RIMS II were comparable to the job estimates developed by Jacobs' independent analysis conducted using the same cost estimates. Based on the outcome of the validation, LADWP recommended proceeding with the RIMS II model with the updated Program costs, multipliers, and regions to conduct the job creation analysis.

Results

The RIMS II model was used to assess the economic impact for the screened Program Alternatives 4 through 9. Job creation was determined under various scenarios for Regions 1 and 2. The results presented in the TM represent the number of jobs created or supported based on the updated 2022 RIMS II Type II multipliers for Region 2. Attachment A provides the full analysis results.

Estimates of Jobs Created or Supported by the Program Expenditure

Figure ES-1 summarizes the total jobs created or supported through construction spending by Program alternatives for Region 2. For this analysis, a created job is defined as full-time equivalent (FTE) for one person for 1 calendar year. The creation of jobs as part of the Program offers LADWP and its partners the opportunity to implement a workforce development program for the benefit of the City of Los Angeles (City) long-term. In addition, LADWP and partners could develop educational and job training and upskilling programs for disadvantaged communities (DACs).

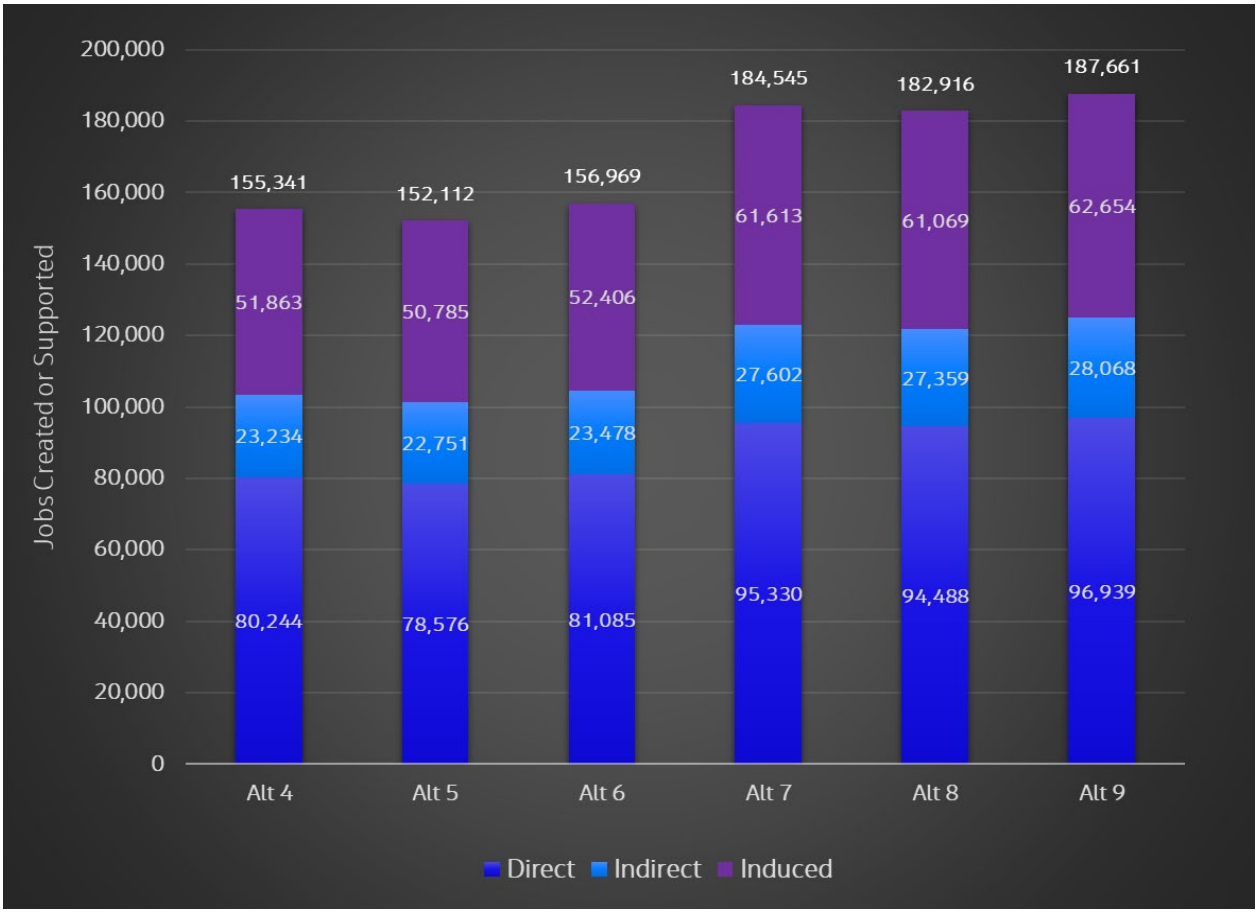

Figure ES-1. Total Jobs Created or Supported by Program Alternative
Region 2, Scenario 2, Type II

In this assessment, all direct jobs are assumed to be created in the construction industry. Indirect and induced jobs will be created across numerous industries within the region as a result of spending on Program-related supplies and materials, as well as household spending in the greater economy.

Figure ES-2 shows the number of jobs created or supported by Program component in Region 2. The total economic impact is the sum of direct, indirect, and induced effects.

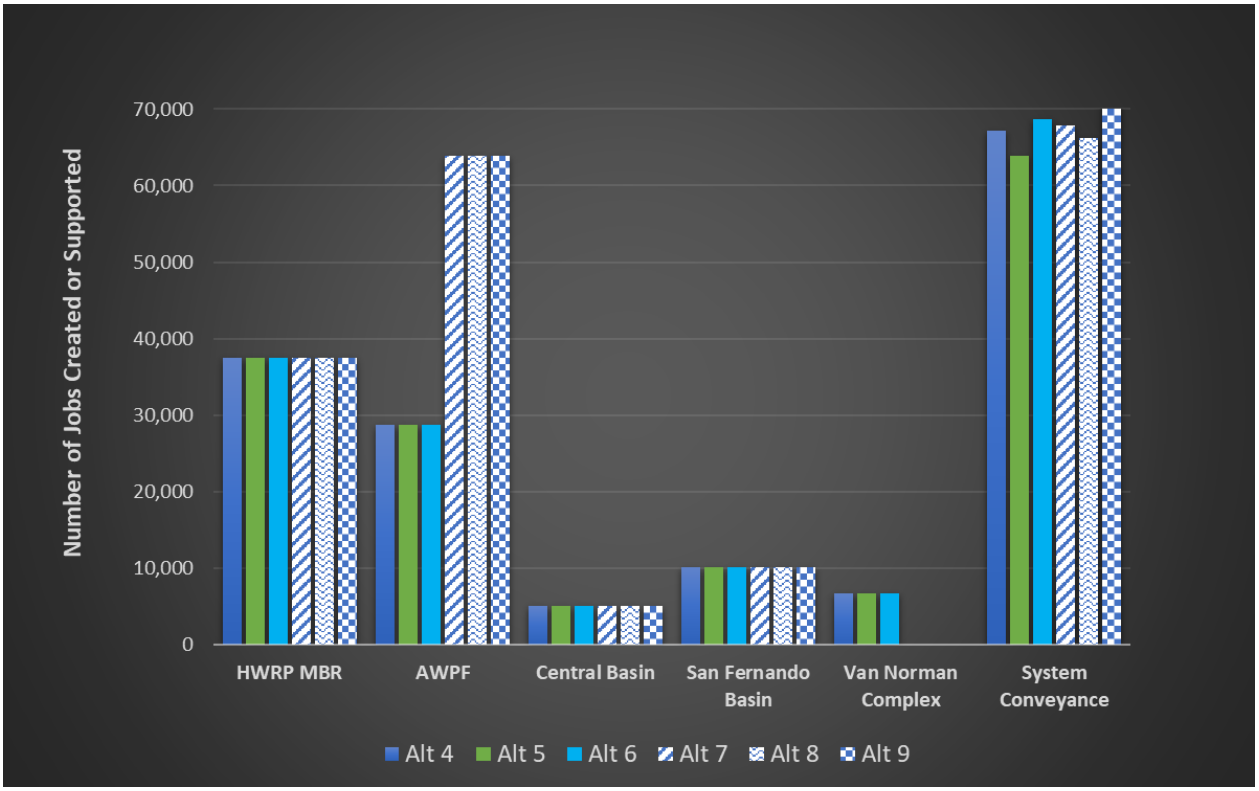

Figure ES-2. Number of Jobs Created or Supported by Program Component
Region 2, Scenario 2, Type II

The HWRP membrane bioreactor (MBR), Central Basin, and San Fernando Basin components create the same number of jobs across the six different alternatives. These three components will account for approximately 53,000 jobs across all the alternatives.

The Conveyance System component is the largest job creator and is estimated to create between approximately 64,000 and 71,000 jobs, depending on the alternative and conveyance alignment.

For Approach II, the indirect potable reuse (IPR) and direct potable reuse (DPR) components at the AWPF and Van Norman Complex would create approximately 36,000 jobs. For Approach III, the IPR and DPR components at the AWPF would create approximately 64,000 jobs. The difference between the two approaches is the type and capacity of the DPR treatment.

Estimates of O&M Jobs Created or Supported by the Program

After construction is completed and operations and maintenance (O&M) begin, the Program will continue to have a positive recurring impact on the regional economy. The ongoing O&M annual requirements will result in an employment (direct, indirect, and induced) impact, with a combination of creating new jobs and helping sustain existing jobs in the Southern California region.

Similar to capital construction jobs, the total economic impact is the sum of direct, indirect, and induced effects. Based on the Region 2 analysis, approximately 1,700 to 1,940 jobs would be created or supported

by direct, indirect, and induced impacts based on the O&M expenditures for Alternatives 4 through 9. The job creation estimates for Alternatives 4 through 6 are similar, and job creation estimates for Alternatives 7 through 9 are similar. Alternatives 7 through 9 will result in nearly 15% additional jobs compared to Alternatives 4 through 6.

Direct Economic and Extended Benefits of the Program

The Program will provide an array of direct and indirect (extended) benefits to the people who live and work in Los Angeles County and the Southern California region, which includes the following counties: Los Angeles, Orange, Riverside, San Bernardino, Ventura.

Based on the qualitative assessments, Table ES-2 summarizes the local and regional direct and extended benefits resulting from the Program's construction expenditures and recurring O&M expenditures.

Table ES-1. Benefits and Local and Regional Impacts of the Program

Category	Benefit Type	Benefits and Impacts
Local and Regional Impacts	Economic benefit	▪ Create new jobs, and support existing jobs ▪ Boost the local economy with the increase in spending from earnings
	Diverse and resilient economy	▪ Diversify sources of incomes and jobs under various trades ▪ Generate tax revenues, goods, and services to boost both local and regional economies
	Local jobs creation and support of existing jobs	▪ Support existing high-paying, high-quality jobs ▪ Promote additional jobs as increased income circulates through the economy ▪ Amplify economic linkages among various sectors through O&M and green jobs
	Local skilled workforce	▪ Reduce local unemployment ▪ Develop a workforce, and train personnel for O&M and green jobs ▪ Develop educational, job training, and upskilling programs for DACs ▪ Create green jobs to maintain green infrastructure ▪ Provide opportunities to local youth and people re-entering the community after incarceration
	Stable and secure local and regional economies	▪ Boost local and regional economies through a more resilient and sustainable water supply ▪ Better secure a water future to meet household, industry, agriculture, industrial, and commercial demands
Sustainable Urban Environment and Economic Value	Localization of jobs and GHG emissions avoided	▪ Reduce the need for long-distance commutes and transportation of goods, thereby reducing or avoiding GHG emissions ▪ Save time and travel costs
	Impact on human health	▪ Implement a community project, such as community beautification or creation of parks and green space, to improve the quality of life for all communities, specifically for DACs ▪ Add public active and passive recreation spaces, and enhance the environment ▪ Increase property values ▪ Improve the health and well-being of people

GHG = greenhouse gas

Summary and Conclusions

Based on validation of LADWP's economic assessment using the RIMS II and CARB models, the RIMS II tool was found to be appropriate to use for the economic impact analysis of the Program. The independent economic analysis using RIMS II shows that Program implementation will result in economic impacts in terms of job creation, an opportunity for workforce development, and economic growth and other benefits throughout Los Angeles County and the Southern California region. The job opportunities created by Program investment will require local actions to develop new strategies to hire, train, and retain a skilled workforce, including local workers, youth, and people re-entering the community after incarceration, across the entire spectrum of occupations needed to implement the Program.

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Acronyms and Abbreviations

AACE	AACE International
AWPF	Advanced Water Purification Facility
BEA	U.S. Bureau of Economic Analysis
CARB	California Air Resources Board
CB	Central Basin
City	City of Los Angeles
DAC	disadvantaged community
DPR	direct potable reuse
EDD	Employment Development Department
FTE	full-time equivalent
GDP	gross domestic product
GHG	greenhouse gas
HWRP	Hyperion Water Reclamation Plant
I/O	input and output
IPR	indirect potable reuse
LA Metro	Los Angeles County Metropolitan Transportation Authority
LADWP	Los Angeles Department of Water and Power
MBR	membrane bioreactor
MD	Metropolitan Division
MP	Master Plan
O&M	operations and maintenance
Program	Pure Water Los Angeles Program
RIMS II	Regional Input-Output Modeling System II
SFB	San Fernando Basin
TM	technical memorandum
VNC	Van Norman Complex

1. Introduction

The Pure Water Los Angeles Program (Program) Master Plan (MP) evaluates potential alternatives for potable reuse to maximize the use of recycled water from the Hyperion Water Reclamation Plant (HWRP) and the anticipated Advanced Water Purification Facility (AWPF). The Program is a water resources management strategy to generate water supply by advanced treatment of recycled water to further diversify the local water supply portfolio in Los Angeles, add new water treatment and conveyance infrastructure, and provide a multitude of direct and indirect benefits. The MP developed nine Program alternatives based on three potable reuse approaches and a range of conveyance alignments. The Program alternatives were assessed, screened, and shortlisted to Alternatives 4 through 9 for further evaluation (Arcadis and Jacobs 2024a).

The Program is of significant size, duration, and capital cost, and will support local and regional economies by generating jobs and enhancing the reliability and resiliency of water supplies to support businesses and the environment. From 2026 through 2056, the estimated investment ranges between $21 and $26 billion in 2024 dollars to deliver the Program, including planning, engineering, construction, and other costs, and between $405 and $462 million in 2024 dollars in annual operations and maintenance (O&M) expenditures. The planned expenditures will contribute to the economic growth in the region.

As a result, the Program will have both immediate and ongoing impacts on the local and regional economies by providing a variety of benefits because of the capital investment, including creating and supporting existing jobs and other social and environmental benefits (Figure 1-1). The benefits provided by the Program will be realized in Los Angeles and will also expand across a wider region, such as Southern California and beyond.

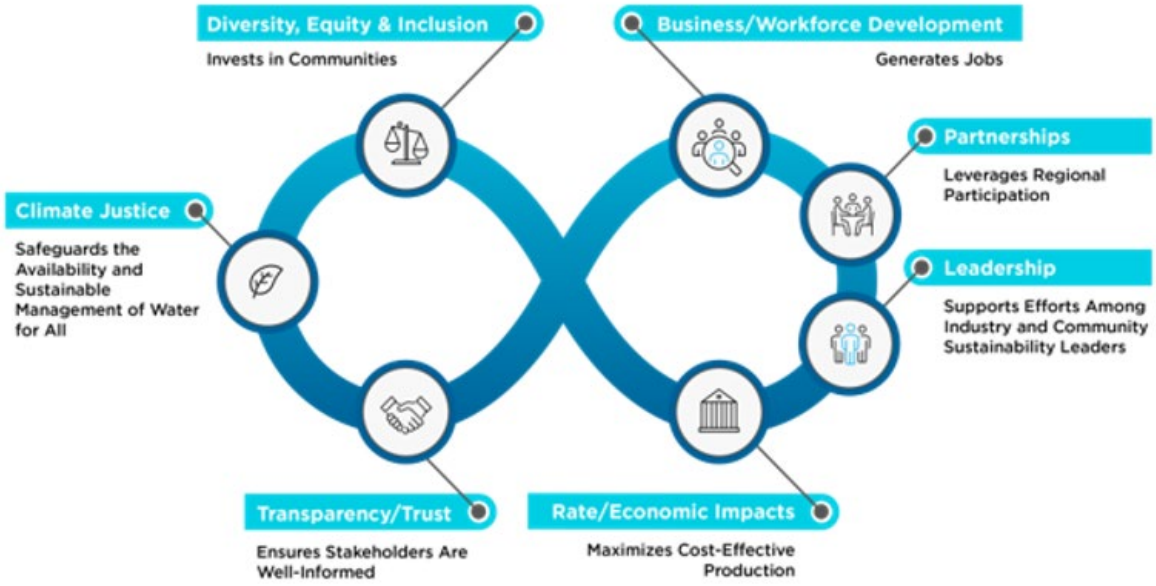

Figure 1-1. Program Benefits

Source: LADWP

There will be long-term benefits achieved over the life of the Program. Jobs could be created in the following industries:

- Water production
- Water treatment
- Water supply infrastructure and conveyance
- Groundwater management and storage

Some of the benefits include providing people with skills for direct short-term and long-term employment, thereby supporting the well-being of families. To holistically capture total economic benefits accrued from the Program, understanding the realm of benefits and their impact to improve quality of life is important. The economic analysis in terms of job creation is quantified, while the details of some other economic and related benefits are discussed qualitatively in this technical memorandum (TM).

The purpose of this TM is to summarize the following two elements:

1. Review and validate the job creation analysis conducted by the Los Angeles Department of Water and Power (LADWP) using the following approaches, based on the original scope from the Concept Study (LADWP 2021):
    - Regional Input-Output Modeling System II (RIMS II) analysis
    - California Air Resources Board (CARB) analysis model, which is updated periodically (CARB 2024)
2. Develop an independent economic analysis from the investment for Program Alternatives 4 through 9 developed in the Pure Water Los Angeles MP using the RIMS II model with an updated data set to estimate potential jobs to be created or supported by the Program at the local (Los Angeles County) and regional levels.

1.1 Validation

The RIMS II and CARB analyses conducted by LADWP were validated to select which tool would be used to estimate jobs for the screened Program alternatives. Jacobs conducted an independent analysis using an updated RIMS II model. Attachment A provides the full analysis results, and Attachment B provides the validation of LADWP's job estimates with the RIMS II analysis and CARB model analysis.

All three models (LADWP's RIMS II, the updated RIMS II, and CARB) used the RIMS II multipliers from the U.S. Bureau of Economic Analysis (BEA) as the basis for the analysis. It was found that all three models were able to account for the jobs created through direct, indirect, and induced impacts of the Program investment. However, the results from each of the models were different because of differences in Program costs, year of multipliers, and regions considered for the economic impact analysis.

LADWP's analysis used multipliers based on the 2016 regional data and considered 100% spending in Region 1, Los Angeles County, for the RIMS II model. The job estimates from LADWP's RIMS II were comparable to the job estimates developed by Jacobs' independent analysis conducted using the same cost estimates and regional basis. However, the estimated Program budget has been updated since LADWP's analysis based on Program evolution, and spending is expected to extend outside of Los Angeles County.

The CARB model used multipliers for 2019 regional data, and the multipliers were for the State of California as opposed to specific regions. This led to higher job creation estimates than for the updated RIMS II model.

Based on the outcome of the validation analysis, LADWP recommended proceeding with the RIMS II model with the updated Program costs, multipliers, and regions to conduct the job creation analysis. The RIMS II model was deemed an appropriate tool to conduct the job creation analysis for any region comprising one or more counties and for any industry or a group of industries.

The RIMS II model accounts for the jobs created through direct, indirect, and induced impacts of the Program investment. The accessibility of the main data sources for estimating regional RIMS II multipliers makes it a relatively cost-effective tool without needing to conduct expensive surveys. RIMS II provides detailed industry-level multipliers that help avoid aggregation errors that can occur when dissimilar industries are grouped together. In addition, RIMS II multipliers are updated to reflect local data and are used in a wide variety of impact studies, such as for Los Angeles County Metropolitan Transportation Authority (LA Metro) and California High Speed Rail.

1.2 Economic Impacts

Economic impacts of a project or program can be evaluated for a region at a county level or for a wider geographical area. For example, the changes of a positive stimulus or a negative shock in the economy of a region can result in regional economic impacts. Regional economic impacts are influenced by changes in the economy of a small region. The magnitude of economic impacts is determined by interactions between linkages within the local and regional economies and the leakage (that is, Program spending that escapes the region of the analysis) from this economy to the larger economy.

Economic linkages are relationships between industries, businesses, factors of production, and government created by trade and other exchanges, such as taxes, within and among regions. Economic linkages create multiplier effects in a regional economy as money is circulated by trade. The magnitude of impacts resulting from economic linkages are limited by the amount of leakage that occurs from the region.

1.2.1 Economic Impact Assessment

Economic impacts are often analyzed using input and output (I/O) models that measure commodity flows from producers to intermediate and final users. I/O models account for industries producing goods and services for final demand, and purchasing goods and services from other producers. These other producers, in turn, purchase goods and services.

In this Program, LADWP's spending on construction is the direct impact on the local and regional economies. Construction spending also includes goods and services needed to operate construction businesses, resulting in an indirect effect. Direct and indirect spending generate employment, creating additional income for households that generate additional spending (for example, on food, entertainment, and household goods), which is the induced impact (Figure 1-2). The total economic impact is the sum of direct, indirect, and induced effects.

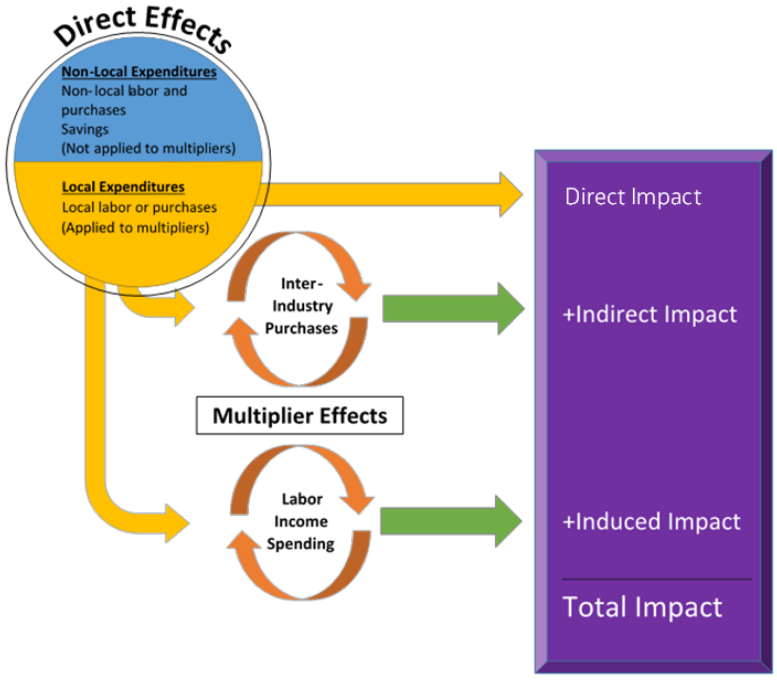

Figure 1-2. Direct, Indirect, and Induced Impacts of the Program

There are many regional economic analysis modeling systems consisting of data as well as analytical software. Attachment C provides details about these models. With variations in capabilities, these tools

provide results on direct, indirect, and induced changes in employment and income based on the investments.

The economics analysis presented in this TM is based on RIMS II, the regional economic model developed and maintained by BEA. Regional I/O multipliers, called RIMS II multipliers, allow estimates of how an increase in economic activity will impact other industries located in the region through direct, indirect, and induced effects. The estimates at the regional level are possible because the multipliers are based on BEA data at the national and regional levels. The next section discusses the details of RIMS II.

1.2.2 RIMS II and Economic Impact Analysis

BEA's RIMS II I/O model produces Type I and Type II multipliers used in economic impact studies to estimate the total economic impact of a project on a region. BEA updates the multipliers annually based on a detailed set of industry accounts that measure the goods and services produced by each industry and the use of these goods and services by industries and final users. The annual RIMS II multipliers use current-year regional data in combination with the most-recent-year national benchmark I/O tables. The RIMS II Type I multipliers estimate interindustry impacts in the form of direct and indirect impacts of the investment; whereas the RIMS II Type II multipliers estimate direct, indirect, and induced economic impacts of the investment (BEA n.d.a) (Figure 1-3).

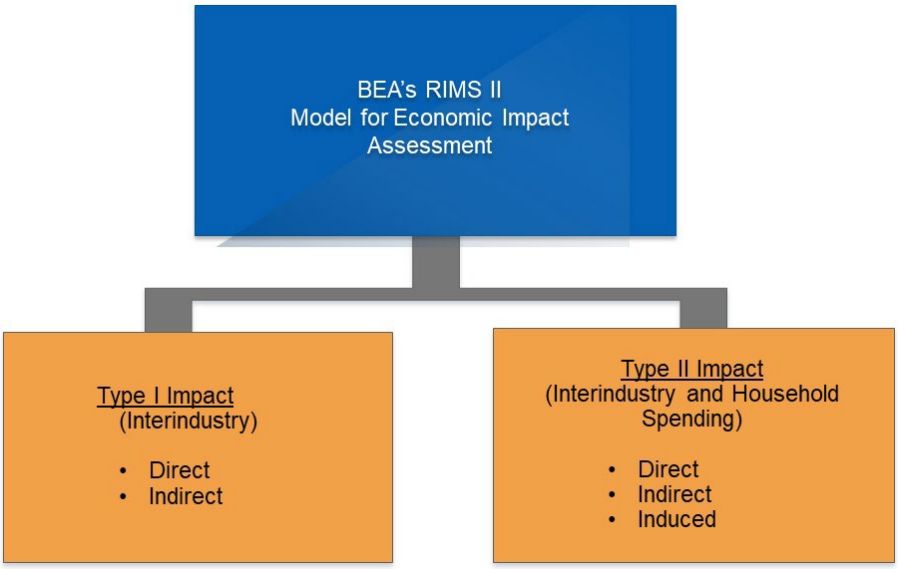

Figure 1-3. RIMS II Multipliers and Direct, Indirect, and Induced Effects of the Program

The RIMS II multiplier model assumes there will be economic input and output within a region where a project is being completed. Job creation from a new project results from the interconnected activities directly and indirectly involved with the project. For example, the construction of a pipeline project creates demand for intermediate inputs from a supporting industry, such as the supplier of pipeline materials. Increased demand for materials due to construction of a pipeline project generates demand for additional resources, such as the need for raw materials and personnel. Increased employment and labor income opportunities in all industries directly and indirectly connected to the pipeline project will lead to higher household spending, resulting in additional demand for goods (for example, household materials) and services (for example, traveling, spending at restaurants) throughout the region.

The regional impacts of the project expenditures will be captured using the Type II multipliers, which estimate induced jobs created by household spending. Therefore, construction of a project will generate an economic impact throughout the region, resulting in an increase in jobs, earnings, and local gross domestic product (GDP) in the region.

1.2.3 Local and Regional Growth Impact Analysis

Regional RIMS II I/O multipliers are used to evaluate the economic impact of the Program locally and regionally during and after construction. The multipliers are based on a detailed set of industry accounts that measure the goods and services produced by each industry and the use of these goods and services by industries and final users. The final demand employment multipliers are the total jobs per $1 million change in output in each industry. A change in output is used with these multipliers to estimate job impacts. Multipliers are calculated for more than 370 detailed industries and 64 aggregates of the detailed industries (BEA n.d.b).

2. Economic Analysis Approach and Methodology

This section describes the approach and methodology used for the economic analysis.

2.1 RIMS II Analysis Approach

Figure 2-1 summarizes the steps to use RIMS II to estimate the economic impact of the Program. It is followed by a description of the steps and the approach used for the RIMS II analysis.

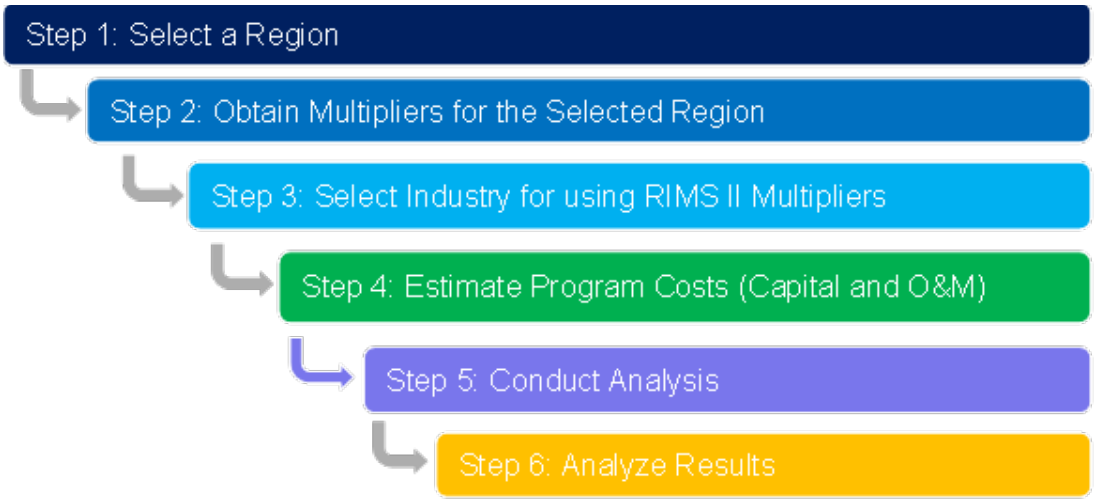

Figure 2-1. RIMS II Analysis Approach

Step 1: Select a Region. Selecting the region for the economic analysis is the first important step. The location where the spending will occur needs to be specified so the multipliers for the appropriate region can be obtained from BEA and used for the analysis. The region should include local economic interdependencies, as well as the area where most of the workers reside and spend their earnings. The boundary of a region describes an area for the direct, indirect, and induced impacts for the economic evaluations resulting from the Program investment.

The selection of the region for the analysis was dependent on the following two goals:

1. Use the same region for the analysis as LADWP's job creation analysis used previously to validate the analysis.
2. Select an appropriate region that will be reflective of the geographical area where the economic impact is expected to be realized.

LADWP's job creation analysis used the Los Angeles-Long Beach-Glendale Metropolitan Division (MD) region that represents Los Angeles County. However, workers living in neighboring counties commute to Los Angeles County for work. Therefore, the Program's economic impact will go beyond Los Angeles County, and the independent economic impact assessment of the Program was conducted for the following two regions (Figure 2-2):

- ***Region 1:*** Los Angeles County, as represented by the Los Angeles-Long Beach-Glendale California MD
- ***Region 2:*** The five-county region comprising the following counties:
  1) Los Angeles
  2) Orange
  3) Riverside
  4) San Bernardino
  5) Ventura

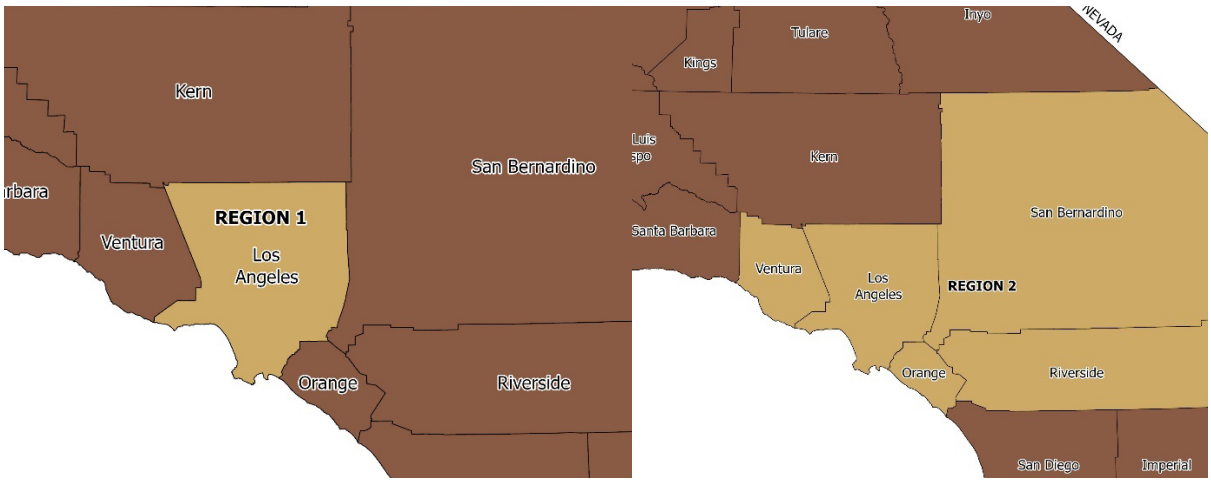

Figure 2-2. Maps Showing Region 1 and Region 2

Step 2: Obtain multipliers for the selected region. The most current or updated RIMS II Type I and Type II multipliers were obtained from BEA for Region 1 and Region 2. The updated multipliers are based on the 2017 national benchmark I/O data and 2022 regional data. These multipliers were released in May 2024.

Step 3: Select industry for using RIMS II multipliers. Investment or spending must be classified by spending category consistent with the industry classifications used by RIMS II. The planned expenditure to develop the Program (including construction, engineering, and other costs) and operation of the projects under the Program would result in new construction- and O&M-related employment, as well as increases in sales tax revenues related to construction and O&M expenditures. The RIMS II Type I and Type II multipliers were used for the following industries:

- Nonresidential structures industry (detailed RIMS II industry code 2332E0) and Architectural, Engineering and Related Services industry (detailed RIMS II industry code 541300) to model the economic impacts associated with Program construction
- Water, sewage, and other systems industry (detailed RIMS II industry code 221300) to model the economic impacts associated with Program O&M

Expenditures for nonresidential structures include:

- Planning
- Design
- Implementation
- All construction-related activities

Step 4: Estimate Program capital and O&M costs. The Program costs or the time of expenditure needs to be specified to determine the time period of the economic analysis. Because the RIMS II multipliers used in this assessment use the 2022 regional data, the economic impact analysis requires expenditure inputs in 2022 dollars. To use the model, the Program costs in 2024 dollars were converted to 2022 dollars using the implicit price deflators for GDP from BEA's national income and product accounts (BEA 2024).

To develop the economic impact analysis for various cost components of the Program, the Program costs by component were used. The analysis was developed for each Program component, as well as for the total Program cost. The Program infrastructure components include:

- HWRP membrane bioreactor (MBR)
- AWPF
- Central Basin (CB)
- San Fernando Basin (SFB)

- Van Norman Complex (VNC)
- System conveyance

Table 2-1 presents the estimated Program total capital cost in 2024 dollars for each component for Program Alternatives 4 through 9. Table 2-2 presents the estimated O&M costs in 2024 dollars for each component for Program Alternatives 4 through 9.

Table 2-1. Estimated Program Total Expenditure (Capital Cost) Used for the Economic Analysis

Component	Approach II - IPR + Post-AWPF DPR, $			Approach III – DPR, $		
	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9
Hyperion MBR	5,140,850,000	5,140,850,000	5,140,850,000	5,140,850,000	5,140,850,000	5,140,850,000
AWPF	3,953,950,000	3,953,950,000	3,953,950,000	8,785,920,000	8,785,920,000	8,785,920,000
CB	696,700,000	696,700,000	696,700,000	696,700,000	696,700,000	696,700,000
SFB	1,399,500,000	1,399,500,000	1,399,500,000	1,399,500,000	1,399,500,000	1,399,500,000
VNC	928,200,000	928,200,000	928,200,000	--	--	--
System Conveyance	9,220,100,000	8,776,600,000	9,443,800,000	9,328,100,000	9,104,400,000	9,756,200,000
Total	**21,339,300,000**	**20,895,800,000**	**21,563,000,000**	**25,351,070,000**	**25,127,370,000**	**25,779,170,000**

Notes:

Year 2024 dollars.

-- = not applicable

DPR = direct potable reuse

IPR = indirect potable reuse

Table 2-2. Estimated Program Total O&M Expenditures Used for the Economic Analysis

Component	Approach II - IPR + Post-AWPF DPR, $			Approach III – DPR, $		
	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9
Hyperion MBR	110,800,000	110,800,000	110,800,000	110,800,000	110,800,000	110,800,000
AWPF	185,700,000	185,700,000	185,700,000	264,600,000	264,600,000	264,600,000
CB	8,860,000	8,860,000	8,860,000	8,130,000	8,130,000	8,130,000
SFB	6,160,000	6,160,000	6,160,000	6,160,000	6,160,000	6,160,000
VNC	27,100,000	27,100,000	27,100,000	--	--	--
System Conveyance	72,200,000	65,920,000	70,140,000	72,680,000	61,900,000	70,190,000
Total	**410,820,000**	**404,540,000**	**408,760,000**	**462,370,000**	**451,590,000**	**459,880,000**

Notes:

Year 2024 dollars

-- = not applicable

Construction cost estimates conform to the AACE International (AACE) *Recommended Practices for Cost Estimating* (AACE 2020) and were provided in Year 2024 dollars. For this Class 5 level estimate, the typical expected accuracy range is -20 to - 50% on the low side and +30 to +100% on the high side for concept screening based on gross unit costs and parametric modeling techniques, for a project definition level up to 2%. The accuracy tightens as the project definition evolves. The detailed cost estimates are documented in the *Cost, Schedule, and Phasing TM* (Jacobs and Arcadis 2024).

Step 5: Conduct analysis. Analyses for both Region 1 and Region 2 were conducted with the new set of RIMS II 2022 multipliers (Table 2-3) to estimate job creation impacts.

Table 2-3. Details of the Job Creation Analysis

Analysis Type	Multipliers	Region	Notes
Revised (RIMS II) analysis with new multipliers	2017 benchmark I/O table for the nation and 2022 regional data	1 and 2	The revised definition of "nonresidential structures" category is included in the RIMS II multipliers released in 2024. Multipliers were calculated for 376 detailed industries, and nonresidential structures were categorized into 3 detailed structure types and 1 other type.

This assessment assumed construction jobs will be created during the construction phase, and O&M jobs will be created and supported during the operations phase (that is, after construction is completed and facilities are in operation). These estimates include short-term and temporary employment generated during construction of projects and the long-term and permanent employment generated by project operation during the life of the Program. Using the corresponding full-time equivalent (FTE) ratios for each industry, the full-time and part-time jobs are converted into a single FTE job category under RIMS II analysis.

Table 2-4 and Figure 2-3 show the results of the analyses conducted for the screened Program alternatives.

Table 2-4. LADWP Pure Water Los Angeles Program Alternatives

Potable Reuse Approach	Program Alternatives	South to North Conveyance Alignment	Components
II – IPR with Post-AWPF DPR	4	Sepulveda	▪ Hyperion MBR ▪ AWPF ▪ CB ▪ SFB ▪ VNC ▪ System Conveyance
	5	Cahuenga	
	6	Griffith Park	
III – DPR at AWPF	7	Sepulveda	
	8	Cahuenga	
	9	Griffith Park	

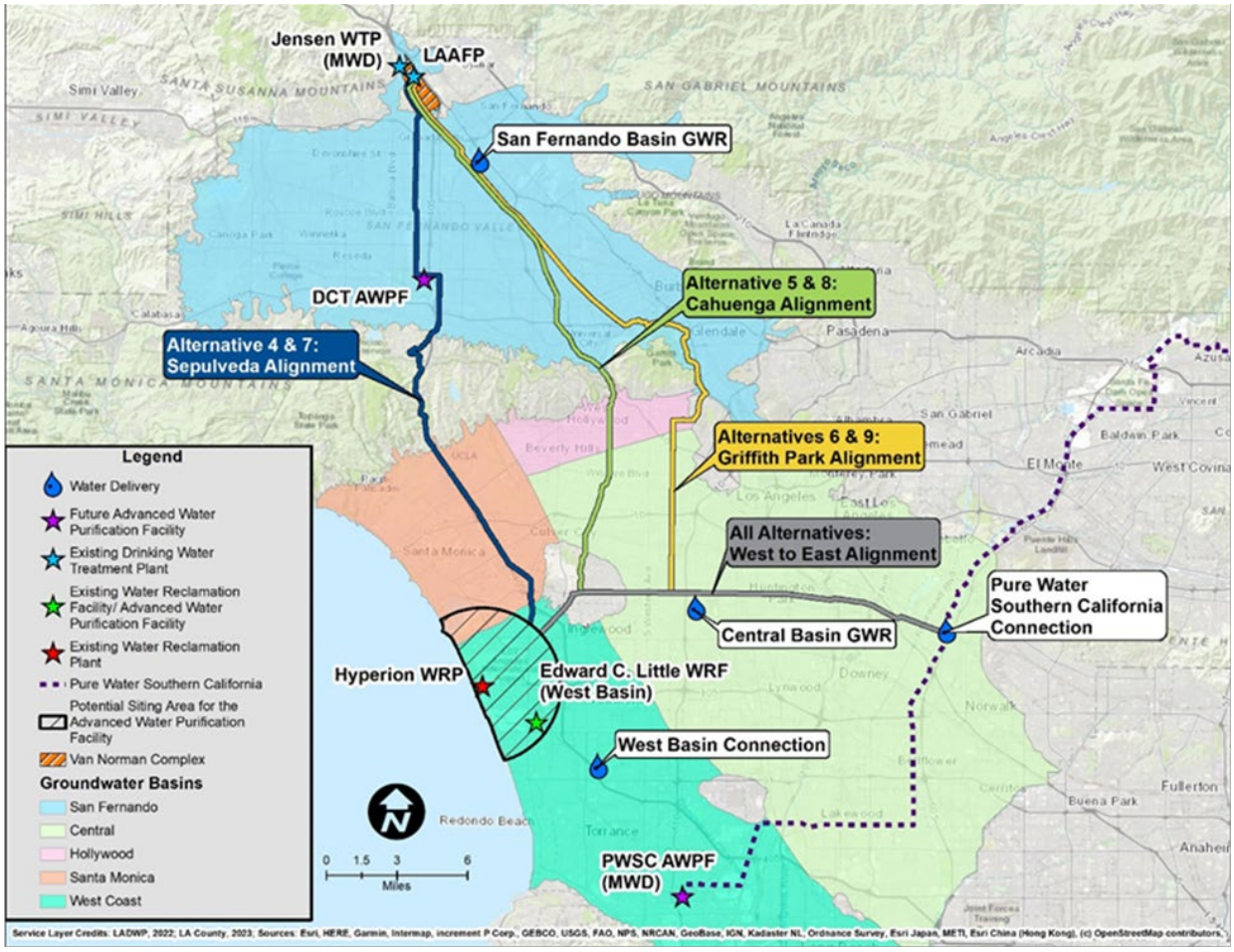

Figure 2-3. Assessed Screened Program Alternatives

Step 6: Analyze results. The results were analyzed for various Program alternatives and scenarios. The analyses were conducted by Program component, as well. Table 2-5 summarizes the results analyzed using the RIMS II analysis.

Table 2-5. Results Presented for the Job Creation Analysis

Model Conditions	Results	Notes
Alternatives	4 through 6 and 7 through 9	Based on alignments
Scenarios	1 and 2	Based on the percent of investment in regions
Scenario	1	Assumes 100% investment made in Region 1 or Region 2
Scenario	2	Assumes 45% investment made in Region 1 or 75% investment in Region 2, as discussed in the next section
Multipliers and Results	Types I and II	Type I: Direct + Indirect Type II: Direct + Indirect + Induced
Components	Conveyance and Treatment (includes recharge)	Includes 5 components of treatment, including recharge, and 1 component of conveyance

2.2 Assumptions for the Economic Analysis

To model the impact of the Program, certain assumptions must be made. For example, some of the materials for the Program may be purchased outside the regions selected for the analysis (for example, from other California counties or from other states or countries). As a result, the full Program investment should not be used for estimating the benefits achieved through the Program investment in the two regions because this leakage of investment will result in generating jobs outside the regions.

The Program includes the following three components:

1. Labor
2. Material (infrastructure)
3. Equipment (construction equipment)

Based on the information about these three components, it was anticipated that some percentage of the total Program expenditure would occur outside the regions. RIMS II analysis assumes a single region (which can be a single county or a multiple county region), and any goods and services sourced outside the region are considered a leakage and excluded from the impact estimates. For estimating jobs created or supported within the regions, the net investment (that is, the difference between the total investment and the leakages from the regions) was determined.

The net investment within the two regions was based on discussions with LADWP. Table 2-6 presents those percentages, which implies that a total of 45% of the treatment and conveyance costs will be spent within Region 1, and 75% will be spent within Region 2. With the leakage consideration included in the analysis, the actual benefits of the Program will be less than 100% of the Program expenditure (total investment), which was assumed under Scenario 1.

Table 2-6. Program Cost Allocations by Region

Location	Treatment and Conveyance (%)
Inside Region 1	45
Inside Region 2	75

3. Results and Discussion

This section provides results of the economic impact analysis conducted with:

- 2022 RIMS II Type II multipliers, which include direct, indirect, and induced jobs created or supported by the Program investment
- Region 2, the five-county region comprising the following counties:
  1) Los Angeles
  2) Orange
  3) Riverside
  4) San Bernardino
  5) Ventura
- Scenario 2, with 75% investment in Region 2

Attachment A presents the economic impact analysis results for Type I and II multipliers, applied for Scenarios 1 and 2 for Regions 1 and 2.

3.1 Results of Updated RIMS II Economic Analysis

This section describes the results of the independent economic impact analysis conducted using updated RIMS II multipliers. LADWP's RIMS II analysis used RIMS II multipliers for the 2016 regional data, and the CARB model used 2019 regional data. The update included the following:

- Used RIMS II Type I and Type II Multipliers for 2022including:
  - LADWP's RIMS II model analysis used multipliers for 2016.
  - LADWP's CARB model analysis used multipliers for 2019.
- Deflated capital and O&M costs for the Program to 2022 dollars to apply the 2022 multipliers. The CARB model had inconsistencies with the year of GDP deflator and the year of the RIMS II multipliers.
- Estimated FTE ratios for the indirect and induced impacts using 22 industries per BEA's method of analysis using RIMS II multipliers. The LADWP RIMS II analysis used FTE ratios for one industry only.
- Performed analysis for Region 1 and Region 2, as follows:
  - LADWP's RIMS II model analysis was conducted only for Region 1.
  - LADWP's CARB model analysis was conducted for the State of California.

3.1.1 Estimates of Jobs Created or Supported by the Program in Region 2, Scenario 2, Type II

Figure 3-1 shows the number of jobs created and supported based on the updated RIMS II Type II multipliers for Region 2. Based on the Type II multipliers, approximately 152,000 to 157,000 jobs would be created and supported by direct, indirect, and induced impacts based on the construction expenditures for Alternatives 4, 5, and 6. Alternatives 7, 8, and 9 are estimated to generate approximately 183,000 to 188,000 direct, indirect, and induced jobs. The job creation estimates for Alternatives 4 through 6 are similar, and the job creation estimates for Alternatives 7 through 9 are similar.

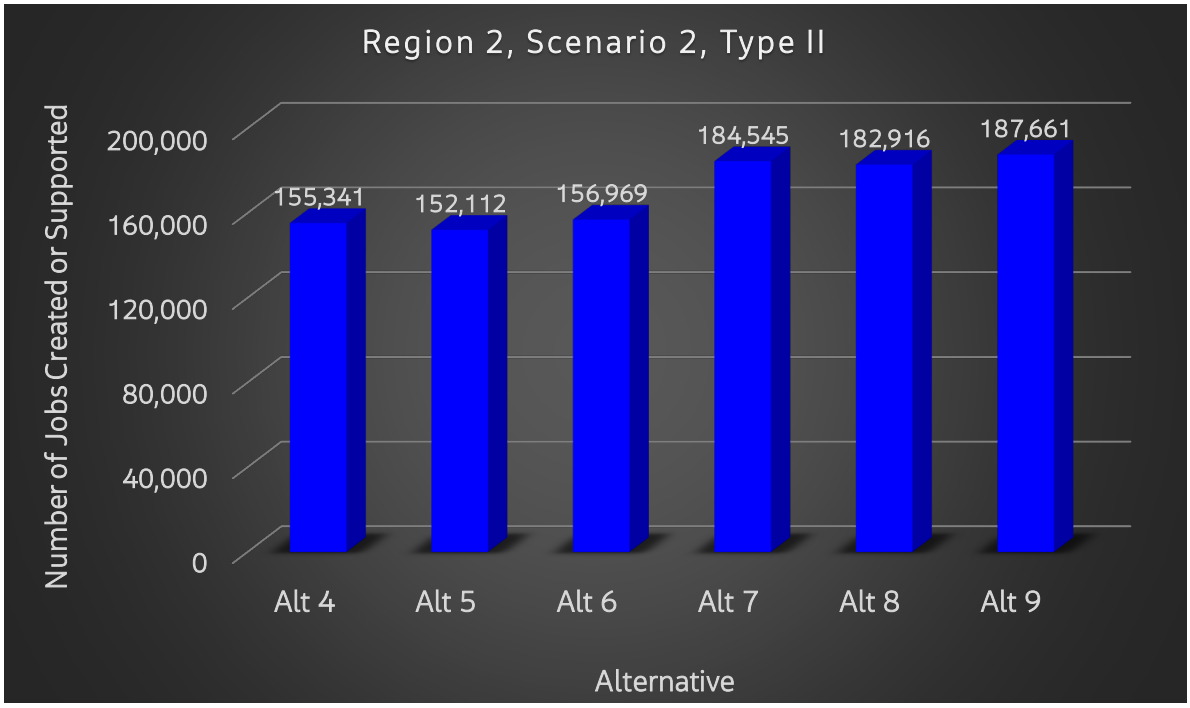

Figure 3-1. Number of Jobs Created or Supported by the Program: Region 2, Scenario 2, Type II

Table 3-1 presents the number of jobs supported by Program components in Region 2. The jobs include direct, indirect, and induced jobs. The Hyperion MBR, CB, and SFB components create the same number of jobs across the six different alternatives and will account for approximately 53,000 jobs. The Conveyance System component is the largest job creator and is estimated to create approximately 64,000 jobs for Alternative 5 and 71,000 jobs for Alternative 9.

For Approach II, the IPR and DPR components at the AWPF and VNC would create approximately 36,000 jobs. For Approach III, the IPR and DPR components at the AWPF would create approximately 64,000 jobs. The difference between the two approaches is the type and capacity of the DPR treatment. The VNC component is not a part of Alternatives 7 through 9, so it does not create any economic impact under those alternatives.

Attachment A provides details about the economic analysis results for both Types I and II for Region 2, Scenarios 1 and 2, including data.

Table 3-1. Number of Jobs Created or Supported by Program Components for Alternatives 4 through 9, Region 2, Scenario 2

Alternative	Type	Hyperion MBR	AWPF	CB	SFB	VNC	System Conveyance	Total
4	II	37,423	28,783	5,072	10,188	6,757	67,118	155,341
5	II	37,423	28,783	5,072	10,188	6,757	63,889	152,112
6	II	37,423	28,783	5,072	10,188	6,757	68,746	156,969
7	II	37,423	63,958	5,072	10,188	0	67,904	184,545
8	II	37,423	63,958	5,072	10,188	0	66,275	182,916
9	II	37,423	63,958	5,072	10,188	0	71,020	187,661

Notes:

Type II = Direct + indirect + induced

3.1.2 Estimates of Direct, Indirect, and Induced Jobs in Region 2, Scenario 2, Types I and II

Table 3-2 summarizes the total direct, indirect, and induced jobs created through Program spending by alternative for Region 2 under Scenario 2. The values presented are for Scenario 2, which assumes 75% of Program spending occurs within the five-county region. All direct jobs are in the construction industry. Attachment A provides detailed job estimates, with direct, indirect, and induced jobs split by industry for each alternative in Region 2 under Scenario 2.

Table 3-2. Total Direct, Indirect, and Induced Jobs for Alternatives 4 through 9, Region 2, Scenario 2

Alternative	Direct	Indirect	Induced	Type I	Type II
4	80,244	23,234	51,863	103,478	155,341
5	78,576	22,751	50,785	101,327	152,112
6	81,085	23,478	52,406	104,563	156,969
7	95,330	27,602	61,613	122,932	184,545
8	94,488	27,359	61,069	121,847	182,916
9	96,939	28,068	62,654	125,008	187,661

Notes:

Type I = Direct + indirect
Type II = Direct + indirect + induced

3.1.3 Job Creation Analysis with Two Industries in Region 1, Scenario 2, Type II

The job creation estimates can be developed based on individual industries considered for the analysis. The results presented in Section 3.1 assumed the total Program spending would occur in one industry (that is, nonresidential structures). However, based on the Program cost estimates, it was determined that 70% of total Program spending can be considered for the construction industry, and the remaining 30% of the spending can be applied to the Architectural, Engineering, and Related Services industry (detailed RIMS II industry code 541300) to estimate the split between construction-related and professional jobs. Attachment A provides detailed job estimates by the two industries considered for the analysis for each alternative in Region 1 under Scenario 2.

3.2 Economic Impact of Ongoing Operations

After construction is completed and O&M starts, the Program will have a positive recurring impact on the regional economy. The ongoing O&M annual costs will result in an employment impact (direct, indirect, and induced), with a combination of creating new jobs and helping sustain existing jobs in the Southern California region.

Table 3-3 presents the number of jobs created by the Program based on annual O&M spending with updated (2022) RIMS II Type II multipliers for Region 2. Based on the Type II multipliers, approximately 1,700 to 1,940 jobs would be created and supported by direct, indirect, and induced impacts based on the O&M expenditures for Alternatives 4 through 9. The job estimates for Alternatives 4 through 6 are similar, and job estimates for Alternatives 7 through 9 are similar. The difference between the two approaches is the type and capacity of the DPR treatment.

Table 3-3. Number of Jobs Created by Annual O&M Spending by Program Component for Alternatives 4 through 9, Region 2, Scenario 2

Alternative	Type	Hyperion MBR	AWPF	CB	SFB	VNC	System Conveyance	Total
4	II	467	783	37	26	114	305	1,732
5	II	467	783	37	26	114	278	1,705
6	II	467	783	37	26	114	296	1,723
7	II	467	1,116	34	26	0	307	1,950
8	II	467	1,116	34	26	0	261	1,904
9	II	467	1,116	34	26	0	296	1,939

Notes:

Type II = Direct + indirect + induced

3.3 Assumptions and Limitations of Input and Output Models

Regional I/O multipliers are based on a detailed set of industry accounts that measure the goods and services produced by each industry and the use of these goods and services by industries and final users. These details allow for estimates of the impact of an initial change in economic activity on industries in a region. Attachment D describes the assumptions and limitations of the I/O models.

3.4 Potential Economic Benefits of the Program

This section summarizes the economic benefits directly created and anticipated to be achieved by the Program.

The cost and benefits of the Program are subject to many influences. Urbanization is one of the pressing environmental, economic, and social issues in various parts of the city and county, particularly the neighborhoods that have been economically depressed and have needs for resources to improve the quality of life of residents. The Program will provide an array of long-lasting benefits for the people who live and work in Los Angeles and neighboring areas. LADWP and their partners can jointly develop programs to bring local small and large businesses and jobs to disadvantaged communities (DACs).

Along with the monetary impacts, the development of the Program and use of recycled water brings extensive direct and tangible benefits in multiple forms for all customers and residents:

- Communities and businesses benefit from sustainable potable and non-potable water supplies.
- Additional potable water supplies offer environmental benefits to the agencies and the ecosystems where water is imported from.
- The economic impact of the Program could continue to maintain or enhance the quality of life of customers and residents, as well as the communities in the region.

3.4.1 Local and Regional Benefits

The Program creates an avenue for economic growth by creating new jobs and sustaining existing jobs with a wide range of job skills and trades. The total economic impact of LADWP's spending on the Program will result in local and regional communities benefiting from employment opportunities, business opportunities, and increased economic activity.

Figure 3-2 is an overview of the economic and tangible benefits resulting from the Program. As shown, the interlinkages of economic benefits to support existing jobs or create new jobs not only impacts the health and well-being of communities but also helps develop a sustainable urban environment.

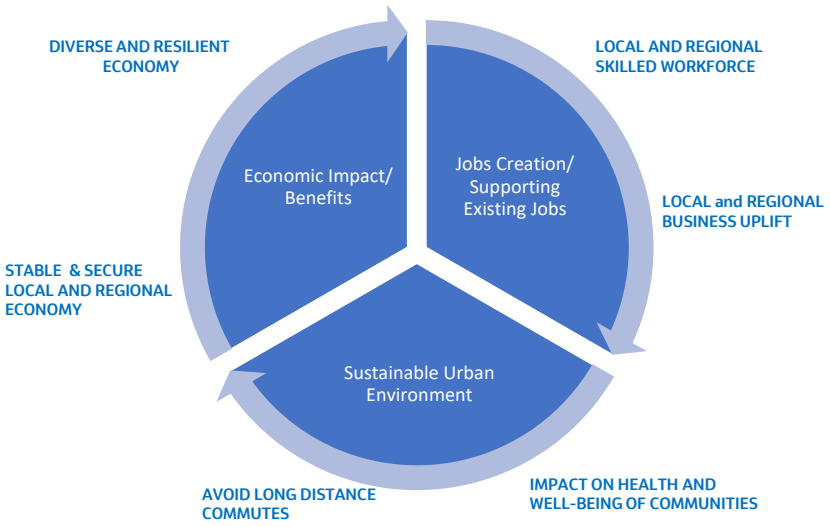

Figure 3-2. Direct Economic and Extended Benefits of the Program

3.4.1.1 Economic Impacts

The Program's construction expenditures will provide a positive and widespread economic impact throughout Los Angeles County and the Southern California region, as discussed here:

- **Diverse and Resilient Economy:** The planned Program expenditures related to construction, engineering, and other related costs and O&M of water infrastructure and facilities will result in economic output throughout Los Angeles County and the region. Diversified sources of incomes and jobs created and supported by the Program will generate tax revenues, goods, and services and boost the local and regional economies. Given that more diverse local economies are more resilient (Wagner and Deller 1993), impacts on local jobs would make a significant difference in local and regional economies and generate revenues. Diversification of jobs for various trades, including treatment plant operators, technicians, and waterworks mechanics, would enhance the capacity of the local and regional economies.
- **Stable and Secure Local and Regional Economies:** Water is essential for all human activities. In general, consumer goods, food, and services are subject to vulnerabilities, including availability of water to provide essential services and businesses and supply disruptions that could be due to insufficient local water supply, natural calamities (including droughts impacting local and distant water supplies), water quality issues, and other stressors or threats, such as climate change.
- **Resilient and Sustainable Water Supply:** The Program will generate resilient and sustainable water supply benefits to uplift, secure, and sustain the local and regional economies by adding new jobs, including green jobs, or supporting existing jobs and further securing the ability to provide water for essential services and businesses. A local and regional water-related economy will provide a secure water future that meets local household, industrial, commercial, and agricultural water demands.

The planned expenditures for the Program will help new and existing businesses and develop employment opportunities for communities in Los Angeles County and the region. To provide equitable benefits, especially creating opportunities for minority businesses and DACs, regional and local opportunities will be created. The incentives are not only to invest in human capital and improve the quality of life, but also to provide business communities with a source of income and permanent jobs that lead to more stable local and regional economies. Reducing the amount of money leaving the region provides more capital available for local projects that create benefits to final users and communities directly and indirectly impacted by the Program.

3.4.1.2 Create Jobs and Support Existing Jobs and Economic Linkages

The Program offers the following benefits in creating and supporting jobs:

- **Range of Job Skills and Trades:** The Program will support, create, or maintain high-paying, high-quality jobs that that will be created or supported locally. For example, the construction projects will include the need for various trade-specific jobs, such as:
  - Construction workers
  - Project managers
  - Mechanics
  - Welders
  - Technicians

  The Program will also provide job opportunities for those working in the architectural, engineering, environmental services, real estate, and other professional services industries. The creation or support of local jobs, transportation of materials, construction, and O&M will amplify economic linkages among various sectors and generate additional jobs as income circulates through the local economy. The Program will create a mix of entry-level and high-skilled jobs, including green jobs, for various trades. Moreover, job creation will reach beyond LADWP and the city and county of Los Angeles.
- **Workforce Development and Upskilling:** Developing a local skilled workforce for the Program will help alleviate local and regional unemployment. A program created by local partnerships among multiple agencies focused on developing the required construction and O&M skills can be developed and housed in an educational institute, such as a community college. Such a program can help prepare skilled workers for construction and O&M, which will provide benefits to other industries and programs that have similar needs. Once the workforce and base of trained personnel is developed, LADWP will be able to recruit skilled employees locally. Some of the new jobs will be green jobs, which will strengthen the green sector economy and create sustainable and environment-friendly communities for the built and physical environments of the city and beyond. These workforce development programs can be sited to better accommodate DAC and equity needs.
- **Investment in the Local Economy:** To maximize local employment and opportunities for local workers, policies must be designed to hire locally and provide growth opportunities for local businesses. Similar to other LADWP programs, LADWP can use the Program to attract labor in conjunction with labor partners, and also purchase local materials as practical and allowable by LADWP policy. However, it is anticipated that some of the construction materials, such as pumps, pipes, and valves, may be purchased outside the region or from another state or country.

3.4.1.3 Sustainable Urban Environment

The localization of jobs reduces the need for long-distance commutes and transportation of goods, and provides savings in travel and transportation costs. In addition, LADWP's equity strategy may provide approaches to use Program investment as a catalyst for developing a sustainable urban environment.

4. Summary and Conclusions

LADWP's economic assessment that used both RIMS II and CARB models was validated. It was anticipated that Program impacts will not only be realized in Los Angeles County (that is, Region 1) but in a wider geographical area. Therefore, a five-county region using the commuting pattern of the people living and working in Los Angeles County was selected (that is, Region 2). An independent economic impact assessment of the Program using the updated RIMS II multipliers was conducted for Regions 1 and 2 under Scenario 1, assuming 100% Program spending occurs either within Region 1 or Region 2; and Scenario 2, assuming 45% of Program spending occurs within Region 1 and 75% within Region 2.

The Program is of significant size, duration, and capital cost and will support local and regional economies by generating jobs and providing reliable and resilient water supplies to support businesses and the environment. From 2026 through 2056, the estimated investment ranges between $21 and $26 billion in 2024 dollars for delivery of the Program, including planning, engineering, construction, and other costs. Between $405 and $462 million in 2024 dollars is estimated in annual O&M expenditures. The planned expenditures will contribute to the economic growth in the region while providing a more climate-resilient water supply. As a result, the Program will have both immediate and ongoing impacts on the Los Angeles and Southern California economies by providing a more diversified, sustainable, and resilient water portfolio and a variety of benefits as a result of capital investment, including creating jobs or supporting existing jobs.

Program construction and O&M will have a marked recurring impact on the local and regional economies. The economic analysis shows that the implementation of the Program will result in widespread economic impact in terms of job creation and economic growth throughout Los Angeles County and the entire Southern California region, focused in the following counties:

- Los Angeles
- Orange
- Riverside
- San Bernardino
- Ventura

There will be long-term benefits achieved over the life of the Program. The creation of jobs will span across the water resource sector. Program-related jobs will provide people with skills that will benefit them with direct employment during project construction and operations. LADWP's spending on construction contractors is the direct impact on the local and regional economies. The construction contractors then spend this money on goods and services that they need to operate their businesses, resulting in an indirect effect. Direct and indirect spending generate employment, creating additional income for households that generate even more spending (for example, on food, entertainment, and household goods), which is the induced impact.

The findings show that the Program construction investment would generate approximately 152,000 to 157,000 jobs under Alternatives 4, 5, and 6 and approximately 183,000 to 188,000 jobs for Alternatives 7, 8, and 9 under Scenario 2, which assumes 75% of Program spending will occur within Region 2, the five-county region. This investment would boost the local and regional economies by increasing GDP of the region, making it a more attractive place to live, work, and do business.

The job opportunities created by the Program investment will require local actions to develop new strategies to hire, train, and retain a skilled workforce, including local workers, youth, and people re-entering the community after incarceration, across the entire spectrum of occupations.

Table 4-1 summarizes the local and regional direct and extended benefits resulting from the Program's construction and recurring O&M expenditures.

Table 4-1. Benefits and Local and Regional Impacts of the Program

Category	Benefit Type	Benefits and Impacts
Local and Regional Impacts	Economic benefit	▪ Create new jobs, and support existing jobs ▪ Boost local economy with the increase in spending from earnings
	Diverse and resilient economy	▪ Diversify sources of incomes and jobs under various trades ▪ Generate tax revenues, goods, and services to boost the local and regional economies
	Local jobs creation and support of existing jobs	▪ Support or maintain existing high-paying, high-quality jobs ▪ Promote additional jobs as increased income circulates through the economy ▪ Amplify economic linkages among various sectors through O&M and green jobs
	Local skilled workforce	▪ Reduce local unemployment ▪ Develop the workforce, and train personnel for O&M and green jobs ▪ Develop educational, job training, and upskilling programs for DACs ▪ Create green jobs to maintain green infrastructure ▪ Provide opportunities to local youth and people re-entering the community after incarceration
	Stable and secure local and regional economies	▪ Boost local and regional economies through a more resilient and sustainable water supply ▪ Better secure a water future to meet household, industry, agriculture, industrial, and commercial demands
Sustainable Urban Environment and Economic Value	Localization of jobs and GHGs avoided	▪ Reduce the need for long-distance commutes and transportation of goods, thereby reducing or avoiding GHG emissions ▪ Save time and travel costs
	Impact on human health	▪ Implement a community project, such as community beautification or creation of parks and green space to improve the quality of life for all communities, specifically for DACs ▪ Add public active and passive recreation space, and enhance the environment ▪ Increase property values ▪ Improve the health and well-being of people

GHG = greenhouse gas

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Attachment A
Economic Analysis Results

Attachment A. Economic Analysis Results

The results presented in Section 3.1 are based on a total project expenditure occurring in one industry (nonresidential structures).

This attachment provides the economic analysis results from the RIMS II assessment for construction expenditure impacts in Regions 1 and 2, for Scenarios 1 and 2. The results are provided in the following sections:

- Construction Spending Impacts in Regions 1 and 2
- Detailed Job Estimates by Industry and Alternative in Region 2

For comparison purposes, this section also provides the job creation analysis using two industries for Alternatives 4 through 9 for Region 1 and Scenario 2 because industries have different multipliers. It was assumed that 70 percent of the total Program spending would occur within the construction industry and the remaining 30 percent of the spending would be applied to the Architectural, Engineering and Related Services industry.

- Two Industries, Program Spending Impacts in Region 1

When the total job creation estimates were separated by component, industry, and impact, fractions of job estimates resulted. The separated job creation estimates have been rounded to whole numbers in the body of the TM to align summations. The calculated, unadjusted values are reflected in this attachment and are based on the total job creation estimates.

Construction Spending Impacts in Regions 1 and 2

Table A-1 shows the job estimates by Program component for Alternatives 4 through 9 in Region 1, Scenario 1 and Types I and II.

Table A-2 shows the job estimates by Program component for Alternatives 4 through 9 in Region 1, Scenario 2 and Types I and II.

Table A-3 shows the job estimates by Program component for Alternatives 4 through 9 in Region 2, Scenario 1 and Types I and II.

Table A-4 shows the job estimates by Program component for Alternatives 4 through 9 in Region 2, Scenario 2 and Types I and II.

Table A-1. Job Estimates by Program Component for Alternatives 4 through 9, Region 1, Scenario 1

Alternative	Type	Hyperion MBR	AWPF	Central Basin	San Fernando Basin	Van Norman Complex	System Conveyance	Total
Alternative 4	I	25,180	19,366	3,412	6,855	4,546	45,160	104,519
Alternative 5	I	25,180	19,366	3,412	6,855	4,546	42,988	102,347
Alternative 6	I	25,180	19,366	3,412	6,855	4,546	46,256	105,615
Alternative 7	I	25,180	43,033	3,412	6,855	0	45,689	124,169
Alternative 8	I	25,180	43,033	3,412	6,855	0	44,593	123,073
Alternative 9	I	25,180	43,033	3,412	6,855	0	47,786	126,266
Alternative 4	II	34,902	26,844	4,730	9,502	6,302	62,597	144,877
Alternative 5	II	34,902	26,844	4,730	9,502	6,302	59,586	141,866
Alternative 6	II	34,902	26,844	4,730	9,502	6,302	64,116	146,396
Alternative 7	II	34,902	59,650	4,730	9,502	0	63,331	172,114
Alternative 8	II	34,902	59,650	4,730	9,502	0	61,812	170,595
Alternative 9	II	34,902	59,650	4,730	9,502	0	66,237	175,020

Table A-2. Job Estimates by Program Component for Alternatives 4 through 9, Region 1, Scenario 2

Alternative	Type	Hyperion MBR	AWPF	Central Basin	San Fernando Basin	Van Norman Complex	System Conveyance	Total
Alternative 4	I	11,331	8,715	1,536	3,085	2,046	20,322	47,034
Alternative 5	I	11,331	8,715	1,536	3,085	2,046	19,344	46,056
Alternative 6	I	11,331	8,715	1,536	3,085	2,046	20,815	47,527
Alternative 7	I	11,331	19,365	1,536	3,085	0	20,560	55,876
Alternative 8	I	11,331	19,365	1,536	3,085	0	20,067	55,383
Alternative 9	I	11,331	19,365	1,536	3,085	0	21,504	56,820
Alternative 4	II	15,706	12,080	2,129	4,276	2,836	28,169	65,195
Alternative 5	II	15,706	12,080	2,129	4,276	2,836	26,814	63,840
Alternative 6	II	15,706	12,080	2,129	4,276	2,836	28,852	65,878
Alternative 7	II	15,706	26,842	2,129	4,276	0	28,499	77,451
Alternative 8	II	15,706	26,842	2,129	4,276	0	27,815	76,768
Alternative 9	II	15,706	26,842	2,129	4,276	0	29,807	78,759

Table A-3. Job Estimates by Program Component for Alternatives 4 through 9, Region 2, Scenario 1

Alternative	Type	Hyperion MBR	AWPF	Central Basin	San Fernando Basin	Van Norman Complex	System Conveyance	Total
Alternative 4	I	33,238	25,565	4,505	9,049	6,001	59,613	137,971
Alternative 5	I	33,238	25,565	4,505	9,049	6,001	56,746	135,103
Alternative 6	I	33,238	25,565	4,505	9,049	6,001	61,059	139,417
Alternative 7	I	33,238	56,806	4,505	9,049	0	60,311	163,909
Alternative 8	I	33,238	56,806	4,505	9,049	0	58,865	162,463
Alternative 9	I	33,238	56,806	4,505	9,049	0	63,079	166,677
Alternative 4	II	49,898	38,377	6,762	13,584	9,009	89,491	207,121
Alternative 5	II	49,898	38,377	6,762	13,584	9,009	85,186	202,816
Alternative 6	II	49,898	38,377	6,762	13,584	9,009	91,662	209,292
Alternative 7	II	49,898	85,277	6,762	13,584	0	90,539	246,060
Alternative 8	II	49,898	85,277	6,762	13,584	0	88,368	243,888
Alternative 9	II	49,898	85,277	6,762	13,584	0	94,695	250,215

Table A-4. Job Estimates by Program Component for Alternatives 4 through 9, Region 2, Scenario 2

Alternative	Type	Hyperion MBR	AWPF	Central Basin	San Fernando Basin	Van Norman Complex	System Conveyance	Total
Alternative 4	I	24,929	19,173	3,378	6,786	4,501	44,710	103,478
Alternative 5	I	24,929	19,173	3,378	6,786	4,501	42,559	101,327
Alternative 6	I	24,929	19,173	3,378	6,786	4,501	45,795	104,563
Alternative 7	I	24,929	42,604	3,378	6,786	0	45,234	122,932
Alternative 8	I	24,929	42,604	3,378	6,786	0	44,149	121,847
Alternative 9	I	24,929	42,604	3,378	6,786	0	47,310	125,008
Alternative 4	II	37,423	28,783	5,072	10,188	6,757	67,118	155,341
Alternative 5	II	37,423	28,783	5,072	10,188	6,757	63,890	152,112
Alternative 6	II	37,423	28,783	5,072	10,188	6,757	68,747	156,969
Alternative 7	II	37,423	63,958	5,072	10,188	0	67,905	184,545
Alternative 8	II	37,423	63,958	5,072	10,188	0	66,276	182,916
Alternative 9	II	37,423	63,958	5,072	10,188	0	71,021	187,661

Detailed Job Estimates by Industry and Alternative in Region 2

This section provides the economic analysis results from the RIMS II assessment for direct, indirect, and induced Construction Spending impacts by Industry in Region 2 for Scenario 2.

Table A-5 shows the direct, indirect, and induced job estimates by industry for Alternative 4.

Table A-6 shows the direct, indirect, and induced job estimates by industry for Alternative 5.

Table A-7 shows the direct, indirect, and induced job estimates by industry for Alternative 6.

Table A-8 shows the direct, indirect, and induced job estimates by industry for Alternative 7.

Table A-9 shows the direct, indirect, and induced job estimates by industry for Alternative 8.

Table A-10 shows the direct, indirect, and induced job estimates by industry for Alternative 9.

Table A-5. Direct, Indirect, and Induced Job Estimates by Industry for Alternative 4, Region 2, Scenario 2

Industry	Direct jobs	Indirect Jobs	Induced Jobs	Type I Jobs	Type II Jobs
Agriculture, forestry, fishing and hunting	-	4	128	4	131
Mining, quarrying, and oil and gas extraction	-	128	19	128	147
Utilities*	-	133	270	133	403
Construction	80,244	221	642	80,465	81,107
Durable goods manufacturing	-	6,338	655	6,338	6,993
Nondurable goods manufacturing	-	910	1,327	910	2,237
Wholesale trade	-	2,762	1,398	2,762	4,160
Retail trade	-	1,513	7,029	1,513	8,542
Transportation and warehousing*	-	2,410	2,183	2,410	4,592
Information	-	371	907	371	1,278
Finance and insurance	-	545	3,785	545	4,329
Real estate and rental and leasing	-	1,673	7,031	1,673	8,704
Professional, scientific, and technical services	-	2,732	2,315	2,732	5,047
Management of companies and enterprises	-	590	568	590	1,158
Administrative and support and waste management and remediation services	-	2,078	2,608	2,078	4,686
Educational services	-	41	1,930	41	1,970
Health care and social assistance	-	10	8,869	10	8,879
Arts, entertainment, and recreation	-	95	1,268	95	1,363
Accommodation	-	76	798	76	874
Food services and drinking places	-	227	3,916	227	4,143
Other services*	-	381	3,695	381	4,076
Households	-	-	523	-	523
Total	**80,244**	**23,234**	**51,863**	**103,478**	**155,341**

Table A-6. Direct, Indirect, and Induced Job Estimates by Industry for Alternative 5, Region 2, Scenario 2

Industry	Direct jobs	Indirect Jobs	Induced Jobs	Type I Jobs	Type II Jobs
Agriculture, forestry, fishing and hunting	-	4	125	4	129
Mining, quarrying, and oil and gas extraction	-	126	19	126	144
Utilities*	-	130	264	130	394
Construction	78,576	216	629	78,792	79,421
Durable goods manufacturing	-	6,206	641	6,206	6,847
Nondurable goods manufacturing	-	891	1,299	891	2,190
Wholesale trade	-	2,704	1,369	2,704	4,073
Retail trade	-	1,482	6,883	1,482	8,364
Transportation and warehousing*	-	2,360	2,137	2,360	4,497
Information	-	363	888	363	1,251
Finance and insurance	-	533	3,706	533	4,239
Real estate and rental and leasing	-	1,638	6,885	1,638	8,523
Professional, scientific, and technical services	-	2,675	2,267	2,675	4,942
Management of companies and enterprises	-	577	556	577	1,134
Administrative and support and waste management and remediation services	-	2,035	2,554	2,035	4,588
Educational services	-	40	1,889	40	1,929
Health care and social assistance	-	9	8,685	9	8,694
Arts, entertainment, and recreation	-	93	1,242	93	1,335
Accommodation	-	75	781	75	856
Food services and drinking places	-	222	3,835	222	4,057
Other services*	-	373	3,619	373	3,991
Households	-	-	512	-	512
Total	**78,576**	**22,751**	**50,785**	**101,327**	**152,112**

Table A-7. Direct, Indirect, and Induced Job Estimates by Industry for Alternative 6, Region 2, Scenario 2

Industry	Direct jobs	Indirect Jobs	Induced Jobs	Type I Jobs	Type II Jobs
Agriculture, forestry, fishing and hunting	-	4	129	4	133
Mining, quarrying, and oil and gas extraction	-	130	19	130	149
Utilities*	-	134	273	134	407
Construction	81,085	223	649	81,308	81,957
Durable goods manufacturing	-	6,404	662	6,404	7,066
Nondurable goods manufacturing	-	919	1,341	919	2,260
Wholesale trade	-	2,791	1,413	2,791	4,203
Retail trade	-	1,529	7,102	1,529	8,631
Transportation and warehousing*	-	2,435	2,205	2,435	4,641
Information	-	375	916	375	1,291
Finance and insurance	-	550	3,824	550	4,375
Real estate and rental and leasing	-	1,690	7,105	1,690	8,795
Professional, scientific, and technical services	-	2,760	2,339	2,760	5,099
Management of companies and enterprises	-	596	574	596	1,170
Administrative and support and waste management and remediation services	-	2,100	2,635	2,100	4,735
Educational services	-	41	1,950	41	1,991
Health care and social assistance	-	10	8,962	10	8,972
Arts, entertainment, and recreation	-	96	1,282	96	1,377
Accommodation	-	77	806	77	883
Food services and drinking places	-	229	3,958	229	4,187
Other services*	-	385	3,734	385	4,119
Households	-	-	528	-	528
Total	**81,085**	**23,478**	**52,407**	**104,563**	**156,969**

Table A-8. Direct, Indirect, and Induced Job Estimates by Industry for Alternative 7, Region 2, Scenario 2

Industry	Direct jobs	Indirect Jobs	Induced Jobs	Type I Jobs	Type II Jobs
Agriculture, forestry, fishing and hunting	-	5	152	5	156
Mining, quarrying, and oil and gas extraction	-	153	23	153	175
Utilities*	-	158	321	158	478
Construction	95,330	262	763	95,592	96,355
Durable goods manufacturing	-	7,529	778	7,529	8,307
Nondurable goods manufacturing	-	1,081	1,576	1,081	2,657
Wholesale trade	-	3,281	1,661	3,281	4,942
Retail trade	-	1,798	8,350	1,798	10,148
Transportation and warehousing*	-	2,863	2,593	2,863	5,456
Information	-	441	1,077	441	1,518
Finance and insurance	-	647	4,496	647	5,143
Real estate and rental and leasing	-	1,987	8,353	1,987	10,340
Professional, scientific, and technical services	-	3,245	2,750	3,245	5,995
Management of companies and enterprises	-	700	675	700	1,375
Administrative and support and waste management and remediation services	-	2,468	3,098	2,468	5,567
Educational services	-	48	2,292	48	2,340
Health care and social assistance	-	11	10,537	11	10,548
Arts, entertainment, and recreation	-	113	1,507	113	1,619
Accommodation	-	91	948	91	1,038
Food services and drinking places	-	270	4,653	270	4,922
Other services*	-	452	4,390	452	4,843
Households	-	-	621	-	621
Total	**95,330**	**27,602**	**61,613**	**122,932**	**184,545**

Table A-9. Direct, Indirect, and Induced Job Estimates by Industry for Alternative 8, Region 2, Scenario 2

Industry	Direct jobs	Indirect Jobs	Induced Jobs	Type I Jobs	Type II Jobs
Agriculture, forestry, fishing and hunting	-	5	150	5	155
Mining, quarrying, and oil and gas extraction	-	151	22	151	173
Utilities*	-	156	318	156	474
Construction	94,488	260	756	94,748	95,504
Durable goods manufacturing	-	7,463	771	7,463	8,234
Nondurable goods manufacturing	-	1,071	1,562	1,071	2,634
Wholesale trade	-	3,252	1,646	3,252	4,898
Retail trade	-	1,782	8,276	1,782	10,058
Transportation and warehousing*	-	2,838	2,570	2,838	5,408
Information	-	437	1,068	437	1,505
Finance and insurance	-	641	4,456	641	5,098
Real estate and rental and leasing	-	1,970	8,279	1,970	10,249
Professional, scientific, and technical services	-	3,216	2,726	3,216	5,942
Management of companies and enterprises	-	694	669	694	1,363
Administrative and support and waste management and remediation services	-	2,447	3,071	2,447	5,518
Educational services	-	48	2,272	48	2,320
Health care and social assistance	-	11	10,444	11	10,455
Arts, entertainment, and recreation	-	112	1,494	112	1,605
Accommodation	-	90	940	90	1,029
Food services and drinking places	-	267	4,612	267	4,879
Other services*	-	448	4,352	448	4,800
Households	-	-	616	-	616
Total	**94,488**	**27,359**	**61,069**	**121,847**	**182,916**

Table A-10. Direct, Indirect, and Induced Job Estimates by Industry for Alternative 9, Region 2, Scenario 2

Industry	Direct jobs	Indirect Jobs	Induced Jobs	Type I Jobs	Type II Jobs
Agriculture, forestry, fishing and hunting	-	5	154	5	159
Mining, quarrying, and oil and gas extraction	-	155	23	155	178
Utilities*	-	160	326	160	487
Construction	96,939	267	776	97,206	97,982
Durable goods manufacturing	-	7,657	791	7,657	8,448
Nondurable goods manufacturing	-	1,099	1,603	1,099	2,702
Wholesale trade	-	3,336	1,689	3,336	5,025
Retail trade	-	1,828	8,491	1,828	10,319
Transportation and warehousing*	-	2,911	2,637	2,911	5,548
Information	-	448	1,096	448	1,544
Finance and insurance	-	658	4,572	658	5,230
Real estate and rental and leasing	-	2,021	8,494	2,021	10,515
Professional, scientific, and technical services	-	3,300	2,797	3,300	6,097
Management of companies and enterprises	-	712	686	712	1,398
Administrative and support and waste management and remediation services	-	2,510	3,151	2,510	5,661
Educational services	-	49	2,331	49	2,380
Health care and social assistance	-	12	10,715	12	10,726
Arts, entertainment, and recreation	-	115	1,532	115	1,647
Accommodation	-	92	964	92	1,056
Food services and drinking places	-	274	4,731	274	5,005
Other services*	-	460	4,464	460	4,924
Households	-	-	632	-	632
Total	**96,939**	**28,068**	**62,653**	**125,008**	**187,661**

Two Industries, Program Spending Impacts in Region 1

This section provides the job creation analysis with two industries (that is, Nonresidential Structures and Architectural, Engineering and Related Services), for Alternatives 4 through 9 for Region 1 and Scenario 2.

Table A-11 shows the job estimates by Program component for Industry 1 (Nonresidential Structures) for Alternatives 4 through 9.

Table A-12 shows the job estimates by Program component for Industry 2 (Architectural, Engineering and Related Services) for Alternatives 4 through 9.

Table A-11. Job Estimates by Program Component for Alternatives 4 through 9, Region 1, Scenario 2, Industry 1 (Nonresidential structures)

Alternative	Type	Hyperion MBR	AWPF	Central Basin	San Fernando Basin	Van Norman Complex	System Conveyance	Total
Alternative 4	Type I	7,932	6,100	1,075	2,159	1,432	14,225	32,924
Alternative 4	Type II	10,994	8,456	1,490	2,993	1,985	19,718	45,636
Alternative 5	Type I	7,932	6,100	1,075	2,159	1,432	13,541	32,239
Alternative 5	Type II	10,994	8,456	1,490	2,993	1,985	18,770	44,688
Alternative 6	Type I	7,932	6,100	1,075	2,159	1,432	14,570	33,269
Alternative 6	Type II	10,994	8,456	1,490	2,993	1,985	20,197	46,115
Alternative 7	Type I	7,932	13,555	1,075	2,159	0	14,392	39,113
Alternative 7	Type II	10,994	18,790	1,490	2,993	0	19,949	54,216
Alternative 8	Type I	7,932	13,555	1,075	2,159	0	14,047	38,768
Alternative 8	Type II	10,994	18,790	1,490	2,993	0	19,471	53,737
Alternative 9	Type I	7,932	13,555	1,075	2,159	0	15,052	39,774
Alternative 9	Type II	10,994	18,790	1,490	2,993	0	20,865	55,131

Table A-12. Job Estimates by Program Component for Alternatives 4 through 9, Region 1, Scenario 2, Industry 2 (Architectural, Engineering and Related Services)

Alternative	Type	Hyperion MBR	AWPF	Central Basin	San Fernando Basin	Van Norman Complex	System Conveyance	Total
Alternative 4	Type I	3,435	2,642	466	935	620	6,161	14,260
Alternative 4	Type II	5,077	3,905	688	1,382	917	9,105	21,074
Alternative 5	Type I	3,435	2,642	466	935	620	5,865	13,963
Alternative 5	Type II	5,077	3,905	688	1,382	917	8,667	20,636
Alternative 6	Type I	3,435	2,642	466	935	620	6,311	14,409
Alternative 6	Type II	5,077	3,905	688	1,382	917	9,326	21,294
Alternative 7	Type I	3,435	5,871	466	935	0	6,233	16,940
Alternative 7	Type II	5,077	8,677	688	1,382	0	9,212	25,035
Alternative 8	Type I	3,435	5,871	466	935	0	6,084	16,791
Alternative 8	Type II	5,077	8,677	688	1,382	0	8,991	24,814
Alternative 9	Type I	3,435	5,871	466	935	0	6,519	17,226
Alternative 9	Type II	5,077	8,677	688	1,382	0	9,635	25,458

Attachment B
Validation

Attachment B. Validation of LADWP's Job Creation Analysis

This attachment summarizes the validation of LADWP's economic assessment of the Program concept. LADWP performed job creation analysis for the Program using the following methods:

- RIMS II Analysis
- CARB Analysis

LADWP used RIMS II to determine potential jobs created or supported by the Program. The analysis included estimates of direct, indirect, and induced impacts for Region 1. The RIMS II model was able to account for the jobs created through direct, indirect, and induced impacts of the Program investment. The job estimates were comparable to the job estimates developed by Jacobs' independent analysis conducted using the same cost estimates. Therefore, it was concurred that RIMS II model was appropriate to conduct the job creation analysis.

The CARB model provides an estimate of job co-benefits of California Climate Investments. A job co-benefit results when the project expenditure creates or supports employment directly or indirectly. It was anticipated by LADWP that the CARB model may be a better fit for the Program compared to the RIMS II model due to considerations of multiple industry analysis. However, Jacobs investigated the model details upon receiving the calculation details from the model developers and found inconsistencies in the analysis. Although the CARB model utilizes the RIMS II multipliers, the results were not the same as those obtained through the RIMS II independent analysis. Jacobs conveyed the discrepancies resulting in different analysis results and subsequently decided to continue to use RIMS II model for the analysis, with LADWP concurrence.

Validation of the RIMS II Method Analysis

LADWP used RIMS II to determine potential jobs created or supported by the Program. The analysis included estimates of direct, indirect, and induced impacts for Region 1. The RIMS II model was able to account for the jobs created through direct, indirect, and induced impacts of the Program investment. Table B-1 presents a summary of the RIMS II model assumptions. The results of the analysis showed 104,363 jobs will be created or supported (which includes 44,659 jobs from indirect impacts and 32,274 jobs from induced impacts) and 313 jobs (which includes 158 jobs from indirect impacts and 105 jobs from induced impact) once the Program is completed and operational (Table B-1).

Table B-1. LADWP's Analysis Assumptions with RIMS II Model With 2016 Multipliers

Category	Model Assumption and Details
Industries Assumed	▪ For construction expenditures - nonresidential structures ▪ For O&M - water, sewage, and other systems
Capital and O&M Cost	▪ $10.7B (2021 dollars) and $70M (2021 dollars)
RIMS II Multipliers	▪ For 2016 based on 2007 benchmark I/O table for the nation and 2016 local regional data
Region for the Analysis	▪ Region 1 (LA-Long Beach-Glendale, CA Metropolitan Division)
FTE Ratio	▪ A single FTE ratio used for construction and O&M activities
Deflation Factor	▪ Deflated the Program cost from 2022 dollars to 2016 dollars to use the RIMS II 2016 Type I and Type II multipliers ▪ 3%

Table B-2. LADWP's Analysis Results with the RIMS II Model for Region 1

Type of Jobs	RIMS II Model Type I[a]	RIMS II Model Type II[b]
Labor and Construction Jobs	72,088	104,363
O&M Jobs	208	313

[a]Type I – Inter-industry effects. Direct and indirect impacts.

[b]Type II – Inter-industry and household effects. Direct, indirect, and induced impacts.

Notes:

Job numbers represented for work outside of the Hyperion WRP fence line.

Table B-3 presents a summary of the RIMS II model results for Region 1 based on Jacobs' independent analysis conducted for validation purposes. The results of the analysis showed 102,800 jobs will be created or supported (which includes jobs from indirect and induced impacts) and 255 jobs (which includes indirect and induced impacts) once the Program is completed and operational. These results are comparable to LADWP's analysis results presented in Table B-2. The differences in the number of jobs created by LADWP and Jacobs' analysis is attributed to the assumptions made and the data used for the analysis. For example, LADWP's analysis was conducted using the 2016 RIMS II multipliers, however, Jacobs' analysis was based on the 2020 RIMS II multipliers.

Table B-3. Jacobs' Analysis Results with the RIMS II Model for Region 1

Type of Jobs	Industry	Cost Category	Cost ($ million)[c]	Duration of Jobs	Jobs created/ Supported
Type I[a]	Nonresidential structures	Capital	11,146	35+ years	73,156
	Water, sewage, and other systems	O&M	75	Permanent	172
Type II[b]	Nonresidential structures	Capital	11,146	35+ years	102,800
	Water, sewage, and other systems	O&M	75	Permanent	255

[a]Type I – Inter-industry effects. Direct and indirect impacts.

[b]Type II – Inter-industry and household effects. Direct, indirect, and induced impacts.

[c]Cost in 2020 dollars. Also, costs do not include Hyperion conversion to an AWPF.

Region 1 - Los Angeles-Long Beach-Glendale, California MD (multipliers are based on the 2012 benchmark I/O table for the nation and 2020 regional data)

Job numbers represented for work outside of the Hyperion WRP fence line.

Validation of the CARB Analysis

The CARB model provides an estimate of job co-benefits of California Climate Investments. A job co-benefit results when the project expenditure creates or supports employment directly or indirectly, as discussed here.

It was anticipated by LADWP that the CARB model is a better fit for the Program compared to the RIMS II model due to several factors as discussed here. However, Jacobs investigated the model details after requesting the "Unlocked" model from the developers and found inconsistencies in the analysis. In the unlocked version of the model, Jacobs' staff was able to review the details of the calculations and validate the results provided by LADWP. Table B-4 presents a summary of the CARB model assumptions.

Table B-4. Model Assumptions, Details Used in the CARB Model, and the Jobs Estimated

Category	Model Assumption and Details
Program Expenditure	▪ Construction: $12,459,950,261 (in 2022 dollars) ▪ O&M: $86,154,026 (in 2022 dollars)
Industries Assumed	▪ 85% of the Program budget used for primary activities (construction of water treatment and distribution systems, which is the same as the nonresidential structures in the RIMS II model). ▪ 15% of the Program budget used for secondary activities (architectural or engineering design services). ▪ For O&M, 100% of Program budget used for water, sewage, and other systems.
RIMS II Multipliers	▪ The model used 2019 multipliers, although the assessment report suggests these were the 2021 multipliers. However, as confirmed with BEA staff, BEA has not yet released the 2021 multipliers. Thus, this seems to be a typo in the CARB model manual.
Region for the Analysis	▪ State of California
Cost Deflator	▪ Because the model uses 2019 RIMS II multipliers, the model deflates the Program cost to 2019 dollars from 2022 dollars. ▪ However, while reviewing the model calculations, it was found that the in-built deflator could only deflate from 2020, not from 2022. ▪ Although anticipated, the model was not performing the correct calculations, as understood from the manual. This error was also reported to CARB staff for correction and further evaluation was stopped.
Estimated Jobs Created and Supported	▪ Construction: 166,958 ▪ O&M: 447

Notes:

Job numbers represented for work outside of the Hyperion WRP fence line.

Summary

- LADWP's economic assessments using RIMS II and CARB models were validated. All three models (LADWP's RIMS II, CARB, and updated RIMS II) used the RIMS II multipliers from the BEA as the basis for the analysis. It was found that these three models accounted for the jobs created through direct, indirect, and induced impacts of the Program investment.
- The job estimates from LADWP's RIMS II were comparable to the job estimates developed by Jacobs' independent analysis conducted using the same cost estimates. Based on the outcome of the validation, it was concurred that RIMS II model was the appropriate model to conduct the job creation analysis for the Program alternatives.

It is expected that the results from all three models will be comparable, provided the model inputs and assumptions are consistent. However, the results from each model were different because of different project costs, multipliers from different years, and different regions considered for the economic impact analysis. Table B-5 contains a summary of the assumptions used for validating the models.

The results presented in the validation step were found to be no longer up to date. LADWP's analysis used multipliers based on the 2016 regional data, however, for the analysis presented in this TM is based on the updated multipliers based on the 2022 regional data. LADWP's economic analysis only considered Region 1.

The CARB model used multipliers for 2019 regional data and the multipliers were for the State of California as opposed to Regions (1 and 2) considered in this updated analysis presented in this TM.

Moreover, the amount of Program spending in the regions was updated when compared to the previous analyses. In addition, the Program costs for various alternatives and components were better defined over time, which was not considered in LADWP's analysis.

Table B-5. Details of the Job Creation Analysis

Analysis Type	Multipliers	Region	Notes
LADWP's Validation Analysis (RIMS II)	2012 benchmark I/O table for the nation and 2020 regional data	1	Multipliers calculated for 372 detailed industries
LADWP's Validation Analysis (CARB)	2019 multipliers	State of California	Assumed two industries: ▪ 85% of the Program budget used for primary activities (construction of water treatment and distribution systems, which is the same as the nonresidential structures in the RIMS II model). ▪ 15% of the Program budget used for secondary activities (architectural or engineering design services).
Revised (RIMS II) analysis with new multipliers	2017 benchmark I/O table for the nation and 2022 regional data	1 and 2	The revised definition of "nonresidential structures" category is included in the RIMS II multipliers released in 2024; Multipliers calculated for 376 detailed industries (nonresidential structures broken into 3 detailed structure types and 1 other)

Attachment C
Input and Output Model Summary

Attachment C. Summary of the Input and Output Models

This attachment summarizes models that are available for economic assessments. There are many regional economic analysis modeling systems (consisting of data as well as analytical software) available for use in regional economic analysis, such as REMI, IMPLAN, and RIMS II. These modeling systems are input and output (I/O) models, with RIMS II, IMPLAN, and JEDI being static models and REMI being a dynamic integrated I/O and econometric model. These models are summarized as follows:

- The Regional Economic Models Inc. (REMI) model is a dynamic forecasting and policy analysis tool that can be referred to as an econometric model, and I/O model, or a dynamic structural model. REMI models contain detailed industries, including inter-industry relationships. REMI models are dynamic to understand economic changes over time. REMI models are used extensively to measure proposed legislative and other programs and inform and guide the policymaking process. REMI PI is a commercial model that uses hybrid techniques, combining aspects of I/O and computable general equilibrium techniques, and produces net job estimates (REMI 2019).
- The IMPLAN (where the IM means impact analysis, and PLAN means planning) economic model was originally developed by the U.S. Forest Service in cooperation with the Federal Emergency Management Agency and the U.S. Department of the Interior's Bureau of Land Management in the 1970s. In 1984, the U.S. Forest Service partnered with the University of Minnesota to expand and update IMPLAN data products (IMPLAN 1983). It has subsequently been transformed to serve as a solution-provider for anyone interested in understanding their economy better.
- IMPLAN is used by federal, state, and local government agencies to help make informed decisions and assess the potential impacts of policies and tax decisions on the economy. IMPLAN captures the effect of spending as it ripples through an economy. In addition to a set of industry multipliers, it provides users with the ability to define industries, economic relationships, and projects to be analyzed. It can be customized for any county, region, or state. The model assesses the "multiplier effects" caused by increasing or decreasing spending in various parts of the economy.
- The model is used primarily to assess the economic impacts of facilities or industries, or changes in the level of economic activity within the specified geographic area. It can also be used to estimate the contribution of some existing activity within a specified geographic area.
- The Jobs and Economic Development Impacts (JEDI) models, developed by the National Renewable Energy Laboratory for the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, use an I/O methodology to estimate jobs, earnings, and economic impacts that will accrue to the region through analysis of the building and operating of selected types of renewable electricity generation and fuel plants (Lantz et al. 2013). The JEDI model's job estimates do not consider net effects on jobs, such as displacement of other jobs by the construction of a renewable energy plant, or economic impacts of potentially changing electricity or fuel prices.
- The Regional Input-Output Multiplier System II (RIMS II) model was developed by the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) in the early 1970s as a tool to help economists analyze the potential impacts of economic activities on regional economies (BEA 2013). It uses regional multipliers to help users estimate jobs, output, and earnings.
- Usage of RIMS II multipliers has grown steadily as economic impact studies took on a greater importance and as a diverse group of users, including researchers, state and local government officials, civic leaders, and planners, have explored the utility of this model.

- As a part of understanding the California Climate Investments to reduce greenhouse gas (GHG) emissions, California Air Resources Board (CARB) staff developed methodologies for estimating GHG emission reductions and other economic, environmental, and public health benefits of projects, referred to as "co-benefits." The CARB model is an I/O modeling method similar to RIMS II. As a part of the co-benefit analysis, CARB staff developed a Job Co-benefit Modeling Tool to estimate jobs supported by California Climate Investments projects in January 2019 (CARB 2023).

  In this tool, a job is defined as one full-time equivalent (FTE) employee position over 1 year, equal to approximately 2,000 hours of work. Jobs supported by California Climate Investments include direct, indirect, and induced employment (CARB 2021).

  Job creation is defined to include the direct jobs resulting from the Program investment, the indirect jobs in industries supplying good and services to the directly affected industries, and induced jobs resulting from changes in local spending patterns as a result of increased income created from direct and indirect jobs.

  The method for assessing job co-benefits using the tool are quantitative, based on the RIMS II I/O model. The tool requires the following inputs:

  - Project name, project start year, administering agency, and program
  - Total project budget
  - Primary, secondary, and tertiary project activities
  - Share of the project associated with the primary, secondary, and tertiary project activities

  Any portion of the project budget not associated with the top three activities (that is, primary, secondary, and tertiary) is automatically accounted for using average employment values across all RIMS II industries.

  The CARB tool uses an adjustment factor for retail-based projects. The adjustment factor is calculated based on the producers' and purchasers' values. RIMS II multipliers are applied to producers' values (that is, production costs of goods and services, not including retail and wholesale markup or transportation costs).

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Attachment D
RIMS II Model Assumptions and Limitations

Attachment D. RIMS II Model Assumptions and Limitations

This attachment summarizes the assumptions and limitations for the RIMS II model.

Assumptions

The following are the input and output (I/O) assumptions that underpin the RIMS II analysis:

- ***Backward linkages:*** I/O models measure the impact of an industry's production on other industries in two ways. In a backward-linkage model, an increase in demand for output results in an increase in demand for inputs. In a forward-linkage model, an increase in the supply of inputs results in the supply of output. RIMS II is a backward-linkage model.
- ***Industry homogeneity***: I/O models assume that all businesses in an industry use the same production process. If the production process of the business initially affected by a change in economic activity is not consistent with the production process of the industry in the national I/O accounts, using RIMS II multipliers will yield inaccurate impact estimates.
- ***No regional feedback***: RIMS II is a single-region I/O model. It ignores any feedback that may exist among regions.
- ***No time dimensions***: The length of time that it takes for the total impact of an initial change in economic activity to be completely realized is unclear because time it is not explicitly included in I/O models. The actual adjustment period varies and is dependent on the initial change in economic activity and the industry structure that is unique to each region.
- ***No supply constraints***: I/O-based multipliers assume that industries can increase their demand for inputs and labor as needed to meet additional demand without facing higher prices.
- ***Fixed patterns of purchase***: I/O-based multipliers assume that that industries do not change the relative mix of inputs used to produce output. They also assume that industries must double their inputs to double their output. If industries can increase their output without hiring as many workers as the model assumes, then using the model's multipliers will produce inflated impact estimates.
- ***Uses local inputs when available***: The method used by RIMS II to develop regional multipliers assumes that firms will purchase inputs from firms in the region before using imports. If a construction equipment manufacturer is located in an area that purchases its materials from outside the region, then the impact of a change in equipment production on the local economy will be smaller than the impact estimated by the full multiplier. The purchases from outside the local area are often called leakages because they represent money that no longer circulates in the local economy.
- ***Full-time and part-time jobs***: The model's estimates of employment impacts are counts of both full- and part-time jobs.
- ***Job estimate***: Jobs created and supported is the total change in number of jobs that occur in all industries for each $1 million of output delivered by the corresponding industry.
- ***Nature of estimate***: The estimated jobs are not cumulative, but the job estimates are based on the number of jobs created in year 1 of operation and then maintained every year thereafter, fluctuating only with respect to the annual operations and maintenance (O&M).

Limitations

The following are some limitations of all I/O models, including the RIMS II model. As shown here, some of these limitations are linked to the assumptions that underpin these I/O models.

- **Static model** – This model estimates the impact of an economy based on the year presented by the data set. The year of data used to calculate the multipliers essentially controls the model's relationships between output, earnings, value added, and employment. The model does not account for year-to-year variations in industries and their interdependent relationships among industries.
- **Fixed production patterns** – The RIMS II model assumes that inputs and labor are used in fixed proportion by all firms in each industry, without any substitution of inputs. In other words, the model assumes that an industry must double its inputs to double its output without substitution. In addition, RIMS II assumes that the prices of goods and services are constant, and are not affected by fluctuations to the economy, such as supply chain problems.
- **Time scale** – The length of time that it takes for the economy to settle at its new equilibrium after an initial change in economic activity is unclear because time is not explicitly included in regional I/O models. So, for all applications the RIMS II model assumes one-time investment and estimates the number of jobs created or supported in a single year. The model is unable to estimate the impacts of factors such as the supply chain impacts on a long-term investment across the years.
- **Region dependence** – The RIMS II model estimates are dependent on the selection of a defined region for multipliers. This is because RIMS II analysis assumes a single region, and any goods and services sourced outside the region are considered a leakage and excluded from the impact estimates. The RIMS II model ignores any feedback that may exist among regions.
- **Trade-specific job classifications** – The RIMS II model estimates the total number of jobs created by an investment as economic impact, but it doesn't provide trade-specific job classifications.
- **Multipliers** – The RIMS II model requires two sets of multipliers to estimate direct, indirect, and induced impacts. Industries in the multiplier cannot be modified with new local industry functions or trade flows. The multipliers do not account for price elasticities, or changes in consumer or industry behavior based on a direct effect.
- **Multiplier region** - The multipliers produced by the RIMS II model are customized to account for the economic activity in any set of contiguous U.S. counties. The county is the smallest area that is available to calculate the multipliers for the assessment of economic impact. A smaller region, like the city and parcel level, could better represent economic activities in some instances. Particularly where population and areas are large in the county level, a smaller size for the multipliers estimates for some industries could be useful. However, the smaller the region, the more leakage; hence, the smaller the multipliers.
- **Full-time employment** - Because the RIMS II employment multipliers are not based on measures of FTE employment, they tend to be higher for the industries that employ more part-time workers. Information on the impact of part-time employment is available at the national level in U.S. Department of Commerce's Bureau of Economic Analysis' (BEA's) national income and product accounts in terms of FTE estimates (BEA 2022a, 2022b). Also note that because all RIMS II Type II multipliers include the effects of household spending, the difference in full- to part-time employment can heavily influence the value of these multipliers, particularly for industries that pay high wages.
- **Fiscal impact** – The RIMS II model does not include information needed for estimating fiscal impact (such as taxes).

References

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Funding TM

Funding
Technical Memorandum

Final

Los Angeles Department of Water and Power

Pure Water Los Angeles Master Plan
October 3, 2024

Executive Summary

The Pure Water Los Angeles Program (Program) is of significant size, duration, and capital cost. Implementation of the Program will require an assessment of costs, benefits, and delivery logistics to identify the appropriate sequencing of projects that meets the City of Los Angeles' operational, financial, and affordability targets. Funding applications are coordinated with the Mayor's office to align pursuits and capitalize on synergies for the benefit of rate payers. Given the complex nature of the Los Angeles Department of Water and Power's (LADWP's) rate structure, the Financial Services Organization's financial forecasting will inform the final selection of projects and schedules for feasibility and cost effectiveness.

An effective long-term funding strategy for the Program will focus on the lowest cost funding and financing options, including low interest loans, grants, and debt service restructuring, to minimize ratepayer impacts. Alternative funding, which is outside of the traditional sources such as bonds, can help support rate impact optimization. The funding landscape was assessed to identify the variety of sources available to potentially support Program funding. There are currently unprecedented opportunities for water and wastewater project funding and financing for planning, design, and construction. To maximize access to nontraditional reuse funding programs, it is crucial to demonstrate connections between Program and funding opportunity objectives and goals. While there are currently unprecedented opportunities for funding, the competition is high and project readiness leads to a higher probability of funds capture.

LADWP will continuously evaluate funding conditions and opportunities throughout the life of the Program to adapt implementation to changes in circumstances. This iterative approach will allow the Program to remain flexible and responsive to evolving financial conditions, market trends, and Program requirements. Regular reviews will facilitate alignment of the funding strategy with LADWP goals and affordability targets.

This technical memorandum summarizes the initial evaluation of potential Program funding opportunities, with the objective of providing information for LADWP to use in developing the necessary long-term funding strategy.

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Acronyms and Abbreviations

AF	acre-foot (feet)
AFY	acre-foot (feet) per year
AWPF	Advanced Water Purification Facility
BABAA	Build America, Buy America Act
BIL	Bipartisan Infrastructure Law
CalEnviroScreen	California Community Environmental Health Screening Tool
CEJST	Climate and Economic Justice Screening Tool
CIP	capital improvement program
DAC	Disadvantaged Community
DBE	disadvantaged business enterprise
EPA	U.S. Environmental Protection Agency
FSO	Financial Services Organization (of LADWP)
FY	fiscal year
HWRP	Hyperion Water Reclamation Plant
IIJA	Infrastructure Investment and Jobs Act
LADWP	Los Angeles Department of Water and Power
LASAN	Los Angeles Sanitation & Environment
LRP	Local Resource Program
Metropolitan	Metropolitan Water District of Southern California
OEHHA	Office of Environmental Health Hazard Assessment
Program	Pure Water Los Angeles Program
Reclamation	U.S. Bureau of Reclamation
SDWA	Safe Drinking Water Act
SRF	State Revolving Fund
SWRCB	State California Water Resources Control Board
U.S.	United States
WIFIA	Water Infrastructure Finance and Innovation Act
WRD	Water Replenishment District of Southern California

1 Introduction

The Pure Water Los Angeles Master Plan is evaluating how to maximize the use of recycled water from the Hyperion Water Reclamation Plant (HWRP) and the anticipated Advanced Water Purification Facility (AWPF) as part of potential alternatives for potable reuse. The funding landscape was assessed to identify sources available to potentially fund the Pure Water Los Angeles Program (Program), which has the following unique conditions:

- Significant size and capital cost compared to typical projects
- Extended timeline with annual cash flow constraints
- City governance structure delineating LADWP and Los Angeles Sanitation & Environment (LASAN) roles and responsibilities
- Position of the Program within the Water System's long-term CIP

Development of an effective funding strategy with pursuit of alternative funding sources should consider:

- Funding needs, sources, and limits
- Terms and conditions governing the use of the funds
- Timelines for applications, award decisions, and expenditure of funds
- Viability of the funding source over the planned implementation period
- Funding program requirements, such as reporting and performance monitoring

Development of a long-term funding strategy is critical to optimize the opportunities for the Program by focusing on most viable funding sources, least expensive funding sources, and debt service structuring within a targeted rate impact. This technical memorandum summarizes an initial evaluation of the matrix of potential funding opportunities for the Program, with the objective of providing information for LADWP to use in developing the necessary long-term funding strategy.

2 Funding

This section summarizes the funding opportunities and requirements.

2.1 Recent Funding Opportunities

There are currently unprecedented opportunities for water and wastewater project funding and financing:

- Grant and loan programs supported by the *Infrastructure Investment and Jobs Act* (IIJA) for safe drinking water, clean water, and resilience
- State Revolving Funds (SRFs)
- U.S. Environmental Protection Agency (EPA) *Water Infrastructure Finance and Innovation Act* (WIFIA) financing
- U.S. Bureau of Reclamation (Reclamation)

The IIJA, now referred to as the *Bipartisan Infrastructure Law* (BIL), will provide $550 billion in guaranteed spending, with $266 billion allocated to water, environment, and energy. The BIL includes the following (Jacobs 2022):

- Most of the water infrastructure dollars will flow through the Drinking Water and Clean Water SRF programs administered by the EPA.
- The IIJA's appropriations for SRFs for fiscal year (FY)22 through FY26 represent a substantial increase over regular annual appropriations for these programs.
- Authorization for Reclamation to create the Large-Scale Water Recycling Program to fund recycled water projects with a total cost greater than $500 M.
- EPA recommends prioritization for projects that serve Disadvantaged Communities (DACs).
- The use of this money is currently subject to the following requirements, which may have some impacts on overall project cost and schedule:
  - Davis Bacon wage rates
  - American Iron and Steel material use
  - Disadvantaged business enterprise (DBE) good faith efforts
  - Cross-cutting federal authorities (EPA 2003)
  - California Environmental Quality Act-Plus and National Environmental Policy Act
  - *Build America, Buy America Act* (BABAA)
- The WIFIA and SRFs have issued waivers for BABAA requirements for projects that initiated design planning before May 14, 2022 (EPA 2024b). Given the timeline, BABAA is likely to apply to the Program.

With the immediate disbursement of these appropriations, LADWP would need to engage with its congressional delegation to encourage sustained levels of funding for programs.

Table 2-1 summarizes the state programs and amounts that will be funded from the BIL.

Table 2-1. State Water Infrastructure Programs

Program[a]	FY22$	FY23$	FY24$	FY25$	FY26$	Total$
Drinking Water SRF Appropriation	1.9B	2.2B	2.4B	2.6B	2.6B	11.7B
Clean Water SRF Appropriation	1.9B	2.2B	2.4B	2.6B	2.6B	11.7B
Emerging Contaminants (through Drinking Water SRF)	800M	800M	800M	800M	800M	4B
Emerging Contaminants (through Clean Water SRF)	100M	225M	225M	225M	225M	1B
Emerging Contaminants (through Small and Disadvantaged Program)	1B	1B	1B	1B	1B	5B
Lead Pipe (through Drinking Water SRF)	3B	3B	3B	3B	3B	15B

Source: EPA 2024a.

[a]Funded by EPA and administered by the States

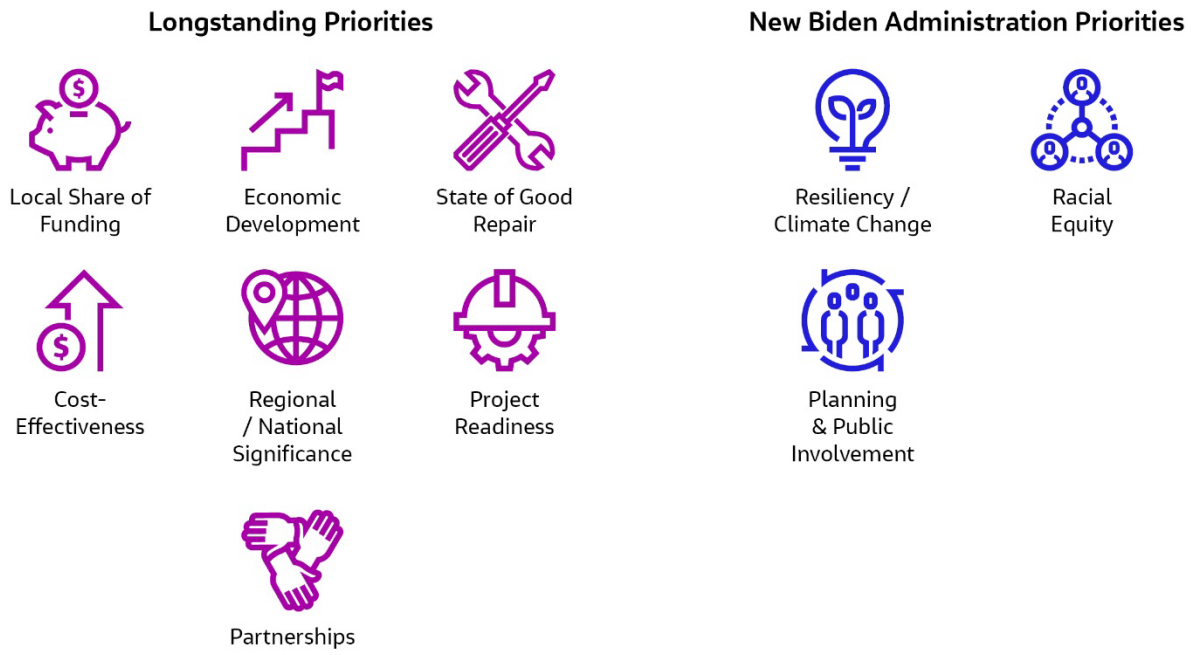
B = billion(s)

M = million(s)

2.2 Funding Priorities

Federal funding priorities (Figure 2-1) identify the criteria by which funding agencies make award decisions. Highlighting the project elements aligned with these priorities in funding applications will increase the likelihood of a project being selected for funding.

Figure 2-1. Alternative Funding Priorities



2.2.1 Disadvantaged Community Funding

Disadvantaged communities (DACs) in California are specifically targeted for investments of proceeds from the state's Cap-and-Trade Program. Similarly, under many United States (U.S.) federal government local assistance programs, preference is given to the DACs. The U.S. federal government applies benefit to cost analysis and related economic decision tools to determine which people, projects, and locations receive funds that facilitate improvements to infrastructure (Walls 2021).

The *Safe Drinking Water Act* (SDWA) requires Drinking Water SRF programs to provide between 12% and 35% of their annual federal capitalization grant as DAC additional subsidy in the forms of grants, negative interest loans, loan principal forgiveness, and through buying, refinancing, or restructuring debt (EPA 2022a).

The BIL amended the SDWA to expand the forms of additional subsidy states may provide for projects serving DACs, specifying the following allowable forms (EPA 2022a):

- Grants
- Negative interest loans
- Other loan forgiveness
- Buying, refinancing, or restructuring debt

It also stipulated that loans with zero or higher interest rates are not considered additional subsidy. The BIL also increased the minimum amount of DAC additional subsidy that states must provide, from 6% to 12% of their annual federal capitalization grant (EPA 2022a).

President Biden signed Executive Order 14008 in January 2021, with the federal government establishing a goal that 40% of the overall benefits of certain federal investments flow to DACs that are marginalized, underserved, and overburdened by pollution under the Justice40 Initiative (The White House n.d.). Through the President's *Inflation Reduction Act*,, and the *American Rescue Plan*, federal agencies are making historic levels of investment to advance environmental justice. This federal investment will help address decades of underinvestment in DACs by funding solutions for:

- Climate change
- Clean and efficient energy
- Training and workforce development
- Remediation and reduction of legacy pollution
- Development of critical clean water and wastewater infrastructure

BIL Focus for Disadvantaged Communities

- EPA has interpreted the BIL language to mean that the new, additional subsidization in the programs should be prioritized for disadvantaged communities, as defined by the states.
- States retain the right to define affordability criteria and disadvantaged communities, even though EPA has provided much more guidance on aspects they should consider.
- Although strongly encouraged, the additional subsidization is not limited just to disadvantaged communities and in the case of the CWSRF, additional subsidy could also be provided to other applicants where the rate impacts justify providing such subsidization.
- States can define neighborhoods within a system as needing special attention as a basis for providing additional subsidization.

These investments will bring critical resources to communities that have been overburdened by legacy pollution and environmental hazards. EPA issued a guidance memorandum on the award and administration of SRF provisions, with the following highlights for DACs (EPA 2022).

2.2.2 Disadvantaged Community Identification

There are a variety of tools and methodologies available for conducting community assessments and identifying DACs. Tool selection will be influenced by the funding source. Under the SDWA, a DAC is defined as "the service area of a public water system that meets affordability criteria established after public review and comment by the State in which the public water system is located."

States currently use a range of socioeconomic indicators to define DACs. A DAC in California is defined in Water Code 79505.5 as a community with an annual median household income that is less than 80% of the statewide annual median household income.

Senate Bill 535 directed at least a quarter of the proceeds go to projects that provide a benefit to DACs and at least 10% of funds go to projects located within those communities. The California Community Environmental Health Screening Tool (CalEnviroScreen) is a regulatory tool developed by the California Office of Environmental Health Hazard Assessment (OEHHA) to scale environmental justice factors statewide and define DACs in California. It translates the science of "cumulative impacts," whereby underrepresented communities are also more vulnerable to negative environmental health impacts, into a science-based screening tool used in policy and program implementation. CalEnviroScreen has guided significant public investments aimed at improving environmental conditions in California's DACs and ameliorating environmental injustice (OEHHA 2021).

To inform how agencies guide the benefits of the Justice40 Initiative, in January 2023, the White House issued additional guidance (Executive Office of the President 2023) to federal agencies about how to use the Climate and Economic Justice Screening Tool (CEJST), which is a mapping tool that helps identify DACs (CEQ n.d.). The tool identifies communities as disadvantaged or partially disadvantaged if they are in a census tract that meets the threshold for at least one of the tool's categories of burden and corresponding economic indicators or are on the lands of a federally recognized Native American Tribe.

Broadening the definition of DACs would facilitate inclusion of disparities within large urban service areas similar to those that would be served by the Program.

2.3 Funding Sources

Table 2-2 summarizes the current feasible funding sources for water infrastructure projects. These sources should be considered for the Program's funding source strategy.

Table 2-2. Available Funding Sources

Category	Type	Description	Requirements and Conditions	Funding	Repayment
Federal	Low-interest loans	▪ **WIFIA – EPA.** Program from EPA provides low-interest supplemental loans for water and wastewater capital programs (EPA n.d.a).	▪ Project size > $20 M. ▪ Reimbursement for allowable expenditures. ▪ Rolling Letter of Interest application process. ▪ Full loan application submittal within 1 year after selection; loan closure within 6 months. ▪ Ability to refinance after loan closure, before withdrawal, which can be used to offset volatile economic conditions.	▪ Capacity to fund large projects, with an approximate limit of $2 billion per loan annually. ▪ Fund up to 49% of the project cost. ▪ Interest rate determined on day of loan closure, approximately equal to the U.S. Treasury rate of a similar maturity. ▪ To allow for maximized impact, consider applying for multiple year, high allocations by partitioning the Program into separate projects or packages.	▪ Deferral of 5 years after project completion, which allows for rate smoothing. ▪ 30-year repayment term.
	Grants	▪ **Reclamation Title XVI**. Water recycling and reuse program, provides funding for the planning, design, and construction of water recycling and reuse projects (Reclamation n.d.a).	▪ Rolling Notice of Funding Opportunity. ▪ Approved feasibility study is a prerequisite for funding application.	▪ Up to $30 M. ▪ 25% federal cost share.	▪ No repayment.
	Grants	▪ **Reclamation Large-Scale Water Recycling Program**. Initiated in 2023 under authority from BIL, incentivizes large water reuse and drought resilient projects through $450 M for 5 years (Reclamation n.d.b).	▪ Project size ≥ $500 M. ▪ Rolling Notice of Funding Opportunity.	▪ No cap per award. ▪ 25% federal cost share.	▪ No repayment.
	Grants	▪ Landscape is varied, with potential opportunities from several different sources.	▪ Smaller in size typically, but should be evaluated case by case. ▪ Recommend regular searches, as the opportunities and requirements are ever evolving.	▪ Varies.	▪ No repayment.
State	Low-interest loans	▪ **SRF**. Program within SWRCB was designed to offer low-interest financing to water and wastewater projects in California (SWRCB n.d.). ▪ Includes the Clean Water and Drinking Water SRFs. ▪ Includes the Water Recycling Program.	▪ Reimbursement for allowable expenditures.	▪ No published project size limit, but allocation is determined case by case and depends on available funding. ▪ Will fund projects in entirety or offer partial funding. ▪ Interest rate determined as one-half General Obligation Bond Rate at funding approval.	▪ Deferral of 1 year after construction completion. ▪ 30-year repayment term.
	Grants	▪ Landscape in California is varied, with potential opportunities from several different sources. ▪ Includes the Water Recycling Funding Program.	▪ Smaller in size typically, but should be evaluated case by case. ▪ Recommend regular searches, as the opportunities and requirements are ever evolving.	▪ Varies.	▪ No repayment.
Market	Municipal bonds	▪ Most traditional form of CIP financing.	▪ Range and financing terms are set by the borrower and are dependent on the agency's financial health.	▪ Varies.	▪ Decided by issuer.
Other	Metropolitan LRP	▪ **LRP.** Program from Metropolitan intended to incentivize water supply reliability projects that offset demands for imported water provided by Metropolitan to its member agencies (Metropolitan 2022). ▪ Offset may be insignificant or may not be available, given project timing. ▪ Program target capacity is 170,000 AFY, with a current committed allocation of 62,000 AFY.	▪ Reimbursement for project water produced. ▪ Incentive tier selected by applicant from three available payment structures. ▪ Timeline: - Construction start within 2 years of contract. - Operation start within 4 years of contract. - 25 years of water production. ▪ Performance provisions: - Produce 50% of AFY in the first 4 years. - Produce 75% of AFY in the second 4 years.	▪ Incentive Amount and Payment Period: - Option 1 – Sliding Scale: ▪ $340/AF ▪ 25 years - Option 2 – Sliding Scale: ▪ $475/AF ▪ 15 years (produce for 25 years) - Option 3 – Fixed Incentive Rate ▪ $305/AF ▪ 25 years	▪ Not applicable.
	Partnerships	▪ Agreements with other agencies to provide cost-effective infrastructure solutions for rate payers. ▪ Current potential partners include regional and local entities, such as LASAN, West Basin, WRD, and Metropolitan.	▪ Evaluate opportunities for shared costs and benefits.	▪ Varies.	▪ Not applicable.

> = greater than
≥= greater than or equal to
AF = acre-foot (feet)
AFY= acre-foot (feet) per year
CIP = capital improvement program
LASAN = Los Angeles Sanitation & Environment
LRP = Local Resource Program
Metropolitan = Metropolitan Water District of Southern California
Reclamation = U.S. Bureau of Reclamation
SWRCB = State California Water Resources Control Board
WRD = Water Replenishment District of Southern California

2.4 Pure Water Project Alternative Funding

Many utilities are benefiting from alternative funding sources to support financing of their Pure Water Projects. Table 2-3 summarizes these sources by potable reuse project.

Table 2-3. Southern California Pure Water Project Alternative Funding

Pure Water Project	WIFIA	SRF	Reclamation	Other Grants	LRP
DC Tillman AWPF[a, b, c, d]	●		●	Pending	●
East County AWPF Program[e]	●	●	●	●	●
Pure Water Project Las Virgenes-Triunfo[a, d]	●	Pending	●		●
Pure Water San Diego[f]	●	●			
Pure Water Southern California[c]			●		
Ventura Pure Water Program[c,g]	●		●		

[a] Source: (SWRCB 2024)

[b] Source: (EPA n.d.b)

[c] Source: (WateReuse n.d.)

[d] Source: (Metropolitan 2024)

[e] Source: (Padre Dam MWD n.d.)

[f] Source: (San Diego n.d. and LADWP comment)

[g] Source: (City of Ventura 2024)

2.5 Funding Strategy

An effective long-term funding strategy for the Program will focus on the lowest cost funding and financing options, including low interest loans, grants, and debt service restructuring, to minimize ratepayer impacts. Alternative funding can help support rate impact optimization. The following elements should be considered when developing a funding strategy:

- Scope, schedule, and construction packaging of each project within the Program, including:
  - Allow for multiple funding applications and efficient delivery
  - Prioritization within the Water System's overall capital improvement program (CIP)
  - Definition and identification of benefiting communities, including DACs
- Identification of expected project benefits
- Funding program priorities to assess opportunities for alignment, focus, and early coordination
- Annual cashflow for ideal Program delivery and acceptable rate impact
- The congressional earmark process, which will take lead time and significant outreach and advocacy
- Mechanism for continuous review and update of the funding strategy as different sources and requirements continue to emerge

Implementation of the Program will require an assessment of costs, benefits, and delivery logistics to identify the appropriate sequencing of projects that meets the City of Los Angeles' operational, financial and affordability targets. Given the complex nature of LADWP's rate structure, FSO's financial forecasting will inform the final selection of projects and schedules for feasibility and cost effectiveness.

The recommended approach to Program funding includes tracking and identifying the most viable funding sources, coordinating with project managers, coordinating with federal and state agencies such as the Division of Financial Assistance, and collaborating with FSO to provide rate impact analyses and financial forecasting to develop a specific funding strategy. This iterative approach will facilitate development of a comprehensive and affordable funding picture for the Program and aligns with the Water System's current methodology.

These big building blocks of the funding picture establish a framework for further collaboration with FSO. Their expertise and market knowledge will help determine the most suitable financial instruments that are appropriate for the then current credit rating, existing debt service, and other applicable factors. They will also be able to define the specific type of loans and bonds that should be used, such as a rate reduction bond, and explore options like deferred repayment schedules and debt shaping, which can further optimize the funding picture. The goal is to develop a funding strategy that aligns with the financial goals and objectives.

Throughout the funding process, LADWP should continuously evaluate the options and strategy and make necessary adaptations as circumstances change. This iterative approach will allow the Program to remain flexible and responsive to evolving financial conditions, market trends, and Program requirements. Regular reviews will confirm that the funding strategy remains aligned with LADWP goals and maintains its affordability.

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