PURE WATER PROJECT
LAS VIRGENES-TRIUNFO
Bringing Our Water Full Circle

Final

Advanced Water Purification Facility Conceptual Design Report

February 2023

Jacobs

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LAS VIRGENES-TRIUNFO

Bringing Our Water Full Circle

Conceptual Design Report

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Las Virgenes-Triunfo Joint Powers Authority

February 2023

Executive Summary

Project Background

The Pure Water Project Las Virgenes-Triunfo (PWP or Project) represents a unique opportunity to proactively address three major challenges facing the Las Virgenes-Triunfo Joint Powers Authority (JPA):

1) Comply with more stringent regulatory requirements for discharge to Malibu Creek
2) Balance seasonal variation in recycled water demand
3) Create a valuable resource to supplement the region's water supplies, supported by California's reservoir water augmentation regulations

The fundamental plan is to build an Advanced Water Purification Facility (AWPF) to treat tertiary effluent from the Tapia Water Reclamation Facility (Tapia WRF) for indirect potable reuse, and convey the purified water to the Las Virgenes Reservoir, where it will be blended with Metropolitan Water District of Southern California (Metropolitan) supply. Water from the Las Virgenes Reservoir will continue to be subsequently treated at the Westlake Filtration Plant (WFP) prior to distribution. Additionally, four pipelines will be constructed to convey source water, purified water, reverse osmosis concentrate (ROC), and residuals (Figure ES-1).

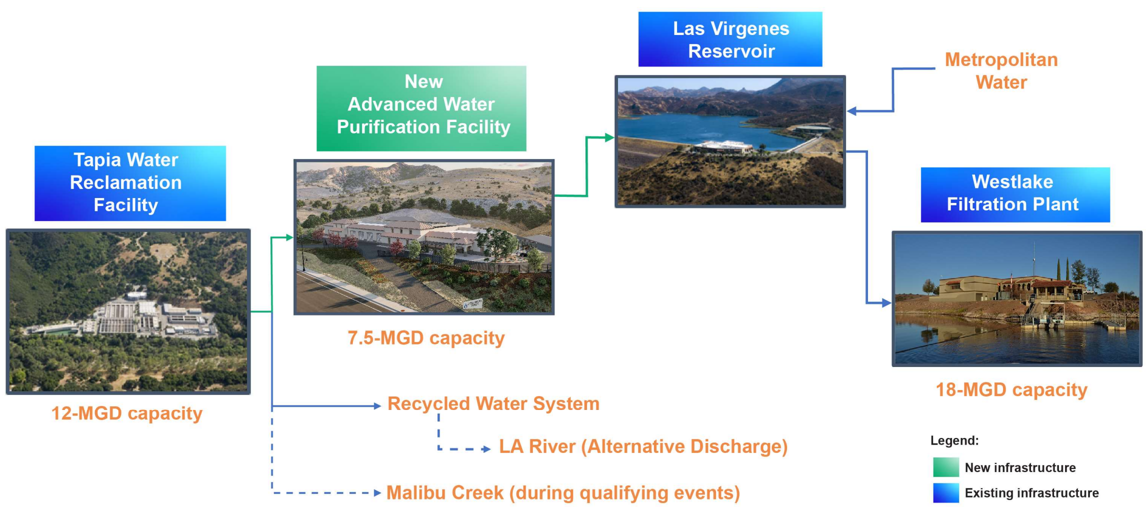


Figure ES-1. Pure Water Project Las Virgenes – Triunfo Major Elements

The following special considerations impact design, cost, and operability of the AWPF:

- **Regulatory Compliance**: PWP is a regulatory compliance project for Tapia WRF effluent, which impacts flow management, schedule, reliability, and redundancy requirements for the AWPF.
- **Water Availability**: The JPA intends to continue distribution of *California Code of Regulations* (CCR) Title 22 standards (CCR Title 22, Social Security, Division 4, Environmental Health) for disinfected tertiary recycled water to existing users, which impacts the seasonal and daily availability of water to the AWPF.
- **Water Quality Parameters**: The basis of the design is Tapia WRF effluent and Demonstration Facility performance.
- **Seasonal Operation:** The AWPF will operate with sequential removal of individual process units from service, followed by extended periods of offline time when treatment equipment will need to be drained or preserved. The design will need to accommodate preservation of membranes, as well as flushing and draining of systems and piping during seasonal downtime.
- **Site Conditions**: The 30800 Agoura Road site is at the base of Ladyface Mountain in Agoura Hills. The aesthetics of the AWPF building, the commitment to the environment, and blending into the corridor are important to the JPA.

Conceptual Design Report Purpose

The JPA has elected to deliver their new AWPF using the progressive design-build delivery model. As a prerequisite to the procurement of a design-builder, this *Conceptual Design Report* is provided to support planning efforts and serves as a baseline for design efforts. The purpose of this report is to:

- Establish influent water quality and performance goals
- Summarize conceptual design and facility sizing criteria
- Present conceptual layouts
- Establish a project budget and schedule

The *Conceptual Design Report* serves as the basis of understanding for the AWPF, but the concepts are subject to further refinement by the design-builder and JPA during design.

Basis of Design

This section describes the basis of design, including:

- Regulatory framework
- Flow characteristics
- Water quality parameters
- Planned process facilities
- Site development

Regulatory Framework

The Pure Water Project is being implemented as a Surface Water Source Augmentation Project for indirect potable reuse in California. The Project will use a reservoir to provide the environmental buffer between advanced water treatment of tertiary treated wastewater and a water treatment plant that supplies water into a drinking water system. CCR Title 22's *California's Surface Water Augmentation Regulations* require full advanced treatment. This consists of continuous treatment of an oxidized wastewater using a reverse osmosis (RO) and advanced oxidation processes; discharge of the purified water into a drinking water reservoir with specified dilution and retention time requirements; and subsequent treatment at a surface water treatment plant. The combined processes provide a multiple barrier approach that must meet a required level of chemical control, pathogen reduction, dilution, and detention time.

Based on the anticipated dilution factor and detention time in Las Virgenes Reservoir for the planned operating scenarios, the AWPF must provide continuous treatment using full advanced treatment to meet the pathogen log reduction value targets of 9-8-9 for virus, *Giardia,* and *Cryptosporidium*, respectively. In addition to meeting the log reduction criteria, the AWPF needs to meet the following treatment requirements:

- *Safe Drinking Water Act* drinking water maximum contaminant levels and action levels for lead and copper
- 126 pollutants reviewed on a Project-specific basis; pollutants may require limits or monitoring, depending on effluent and receiving water quality
- *California Toxics Rule*, which includes a number of numerical limits that are more stringent than drinking water notification levels, such as for N-nitrosodimethylamine, bromoform, dichlorobromomethane, and chlorodibromomethane
- Requirements in the National Pollutant Discharge Elimination System (NPDES) permit for discharge of ROC to the Calleguas Salinity Management Pipeline
- An industrial pretreatment and enhanced pollutant source control program

The compliance date for operation of the new AWPF is November 16, 2030. This is the date when the new NPDES permit limits for the Tapia WRF take effect for discharge of final effluent to Malibu Creek.

Flow Characteristics

AWPF sizing is based on 12 million gallons per day (MGD) from the Tapia WRF, with 4.5 MGD planned for discharge by alternate means, leaving up to 7.5 MGD for treatment by the AWPF that will produce up to 6.0 MGD of purified water.

Tapia WRF effluent will be the main source of water for the new AWPF and currently serves an extensive recycled water distribution system. The amount of recycled water flow produced by Tapia WRF that will be available for the AWPF will be determined by the following factors:

- Wastewater generation
- Water conservation
- Reduction in inflow and infiltration
- Seasonal demands for recycled water
- Flow variation due to precipitation and irrigation demands

The historical irrigation demand patterns are variable, as they are based on unpredictable precipitation and atmospheric conditions. In general, there are more demands over the summer months and fewer in the winter. As shown for the average daily flows on Figure ES-2, the demand for recycled water varies seasonally, with projected available water for the AWPF shown in the blue. During the summer, the recycled water system demand exceeds the available recycled water; therefore, it is supplemented from the drinking water system. This deficit situation is shown by the gray line on Figure ES-2 as periods when there would be no available water for the new AWPF. The variability and availability of surplus recycled water flow is a unique consideration for the AWPF.

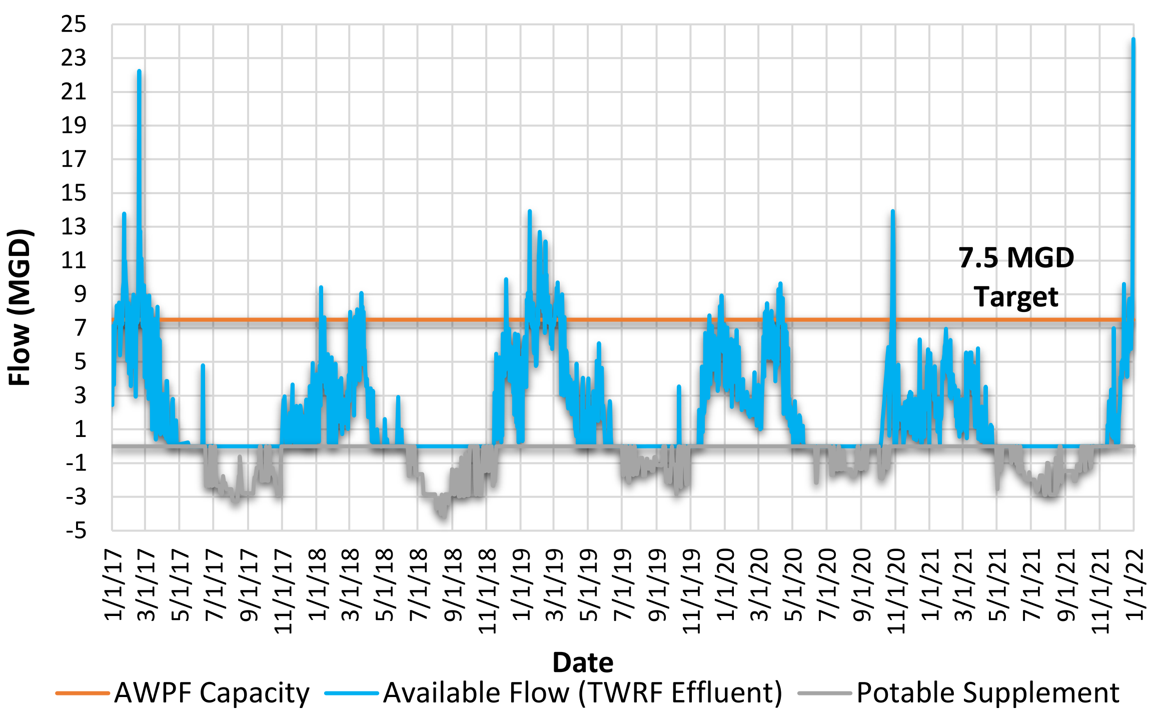


Figure ES-2. Available Flow to the Advanced Water Purification Facility, 2017-2021

Water Quality Parameters

The water quality results from the first year of the Pure Water Demonstration Facility testing and performance (July 2020 to September 2021) and the historical Tapia WRF effluent water quality (January 2018 to June 2021) were reviewed and evaluated to provide a basis of design for the AWPF. Subsequent sampling and testing from the ongoing Demonstration Facility operation will be made available to the design-builder for design.

Planned Process Facilities

The AWPF will use a full advanced treatment process consisting of membrane filtration (MF), RO, and ultraviolet advanced oxidation (UV-AOP) processes. All of these elements are located inside a building, as shown on Figure ES-3; while the chemicals, post-treatment systems, Purified Water Pump Station (PWPS), and residuals waste handling systems are located outside the plant building. An influent equalization basin with MF feed pumps and strainers is located next to a centralized liquid chemical facility, both separate from the main treatment plant building. All outdoor equipment is located under canopy to protect from sun exposure. The general arrangement of the equipment for each process facility was developed with consideration for operations and maintenance and matches the general flow of water and residuals within the AWPF.

This conceptual design was based on the following process facilities to achieve the flow capacity and treatment objectives for the AWPF:

- **Influent Equalization and MF Feed Pump Station,** which will attenuate source water flows and pressurize water through the MF system.
- **MF System,** comprising feed strainers, MF racks, and ancillary systems to provide filtration of suspended solids, organics, and pathogens, while also providing pretreatment for the downstream RO process.
- **RO System,** comprising cartridge filters, RO skids, and ancillary systems to remove dissolved constituents and serve as a pathogen barrier for bacteria, protozoa, and viruses.
- **UV-AOP System,** which provides disinfection and log reduction of all target pathogens.
- **Post-treatment for water stabilization,** consisting of partial decarbonation and chemical addition to stabilize the purified water to minimize scaling and corrosion, provide a disinfection residual, and mitigate algae growth in the Las Virgenes Reservoir.
- **PWPS** to convey the purified water from the AWPF to the Las Virgenes Reservoir.
- **Residuals waste handling systems** to manage various waste streams generated from each liquid treatment process and neutralize the streams prior to discharge to the sewer.
- **Chemical feed and storage systems** to provide chemicals needed to achieve treatment goals and optimize individual process performance.

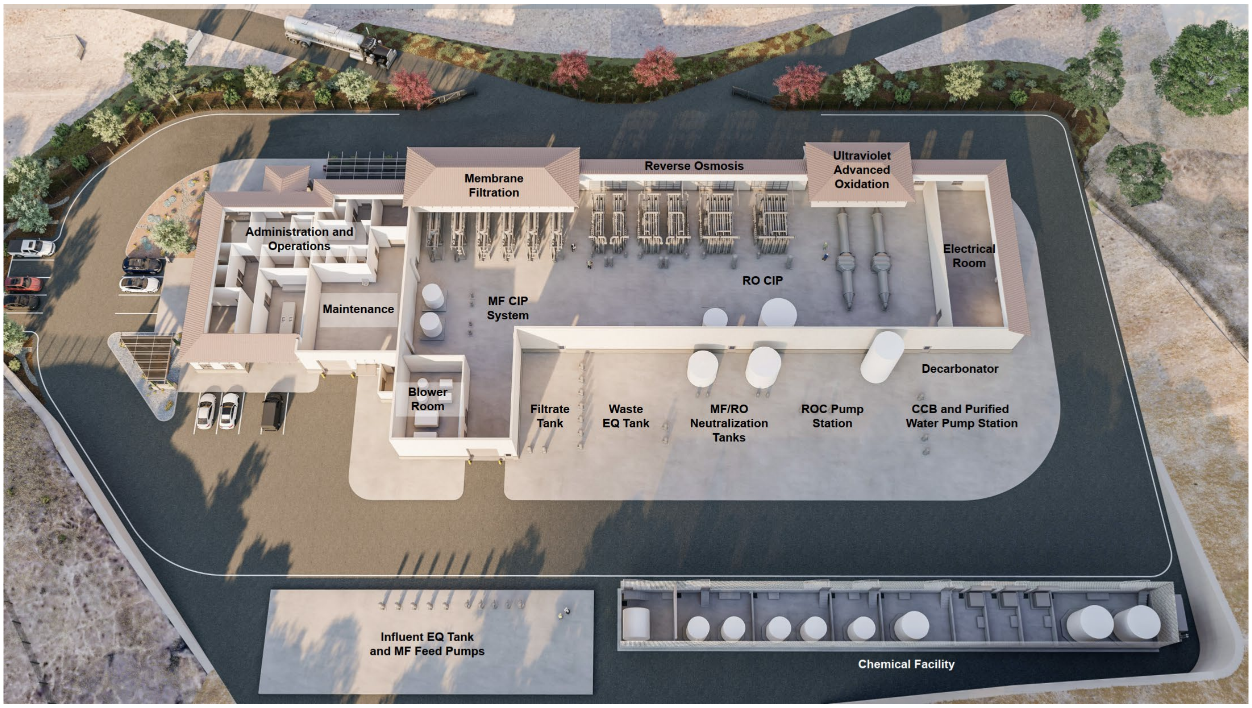


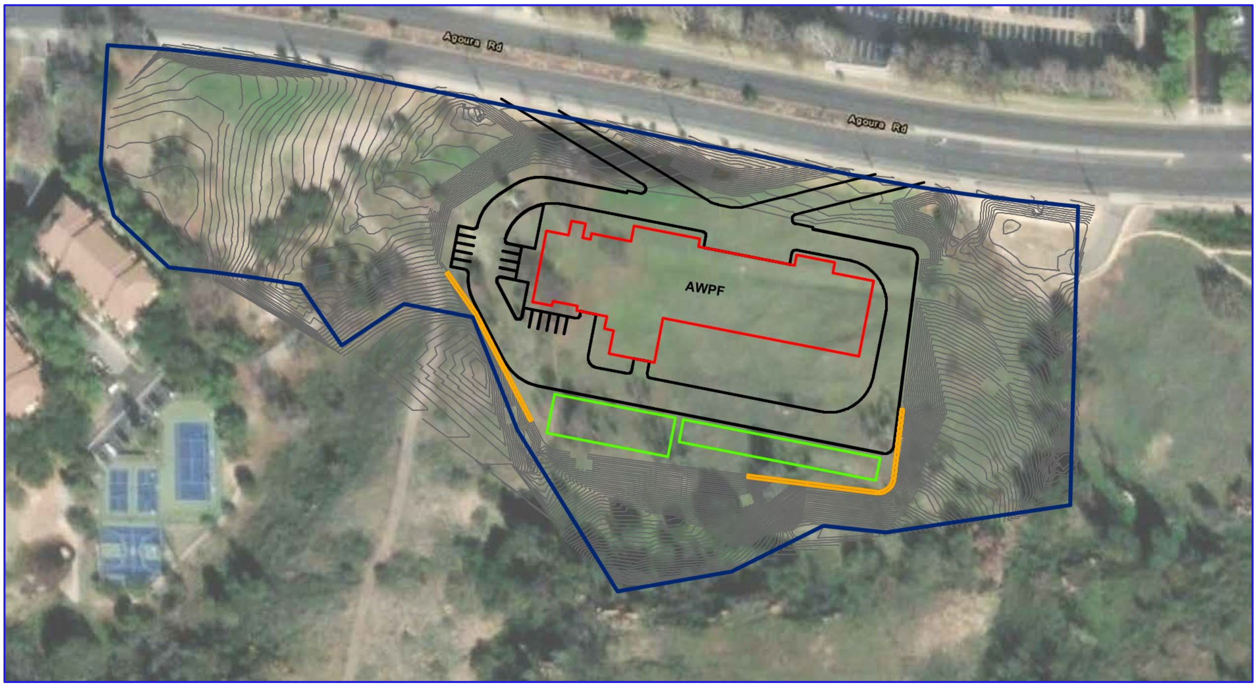
Figure ES-3. Conceptual Advanced Water Purification Facility Layout

Site Development

The proposed site is located on an empty lot in a business park and retail zone along Agoura Road in Agoura Hills. The site is undeveloped and encompasses approximately 7 acres. Figure ES-4 provides the conceptual design layout for the AWPF.

Development of the conceptual AWPF layout considered the JPA's 10 policy principles established in 2016:

- *Involve the City and the community in the development and design of facilities.*
- *Preserve the natural beauty of the site.*
- *Reserve a portion of the property for public benefit in coordination with the City of Agoura Hills.*
- *Minimize the impact to oak trees and other natural resources on the property.*
- *Design the facilities with architecture compatible with the surrounding area.*
- *Minimize the overall footprint of the facility.*
- *Provide the onsite treatment and capture of stormwater.*
- *Keep the community and recreational users informed of any project-related activities that may impact them.*
- *Minimize the potential for noise or light to emanate from the site.*
- *Use renewable energy sources to offset demands at the site.*



Sources: ESRI World Topo Map; ESRI World Street Map

Figure ES-4. Conceptual Plant Layout on 30800 Agoura Road

Cost Estimate and Schedule

Table ES-1 presents the Class 4 conceptual cost estimate for the AWPF, which accommodates the functional requirements defined in Sections 2 through 11 of this report.

Table ES-1. Advanced Water Purification Facility Cost Estimate

Component	Cost ($)
AWPF Construction Cost	133,150,000
Nonconstruction Cost ▪ Engineering and Pre-construction Phase Services ▪ Services during Construction and Commissioning	19,960,000 13,300,000 6,660,000
Construction and Nonconstruction [a]	**153,110,000**
Escalation [b]	22,400,000
Total AWPF Capital Costs	**175,510,000**

[a] June 2022 dollars.

[b] Based on a 3% inflation rate and midpoint of construction in December 2026.

The annual operations and maintenance cost at startup for a purified water production rate of 2,100 acre-feet per year is estimated at $4,890,000 for the AWPF and concentrate disposal to the Calleguas Salinity Management Pipeline.

Table ES-2 provides the AWPF project schedule.

Table ES-2. Advanced Water Purification Facility Schedule

Milestone	Date
AWPF	
Procurement	March 2023 – February 2024
Design and Construction	February 2024 – November 2027
Commissioning and Operation	November 2027 – May 2028
Regulatory	
Compliance Deadline	By November 16, 2030

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Acronyms and Abbreviations

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
μg/L	microgram(s) per liter
μm	micrometer(s)
AACE	AACE International
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADA	Americans with Disabilities Act of 1990
AFT	Applied Flow Technology
AFY	acre-foot (feet) per year
AHJ	Authority Having Jurisdiction
AHRI	Air Conditioning, Heating, and Refrigeration Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
Arrow	AFT Arrow
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	ASTM International
AWPF	Advanced Water Purification Facility
AWS	American Welding Society
AWT	advanced water treatment
AWWA	American Water Works Association
BAC	biological activated carbon
BDCM	bromodichloromethane (also known as dichlorobromomethane, DCBM)
bgs	below ground surface
BMP	best management practice
BOD	biological oxygen demand
BWPS	Backwash Waste Pump Station
Cal/OSHA	California Occupational Safety and Health Administration
Calleguas SMP	Calleguas Salinity Management Pipeline
Caltrans	California Department of Transportation
Carollo	Carollo Engineers, Inc.

CBC	California Building Code
CBEES	California Building Energy Efficiency Standards
CCB	chlorine contact basin
CCL	critical control limit
CCP	critical control point
CCR	California Code of Regulations
CDBM	chlorodibromomethane (also known as dibromochloromethane, DBCM)
CEB	chemically enhanced backwash
CEC	California Energy Code
CFC	California Fire Code
CIP	clean-in-place
CMC	California Mechanical Code
CMU	concrete masonry unit
CPC	California Plumbing Code
CT	concentration and time
CTR	California Toxics Rule
CWC	California Water Code
DBB	design, bid, build
DBCM	dibromochloromethane (also known as chlorodibromomethane, CDBM)
DBP	disinfection by-product
DCBM	dichlorobromomethane (also known as bromodichloromethane, BDCM)
DDW	California Division of Drinking Water
Demo	Pure Water Demonstration Project
DOL	direct online
DPR	direct potable reuse
E. coli	Escherichia coli
EBCT	empty bed contact time
EED	electrical energy dose
EFM	enhanced flux maintenance
EI	Expansion Index
EPA	U.S. Environmental Protection Agency
FAT	full advanced treatment
Fathom	AFT Fathom
fps	foot (feet) per second
FRP	fiber-reinforced plastic
ft/s	foot (feet) per second
ft^2	square foot (feet)

ft^3	cubic foot (feet)
g	gravity
GAC	granular activated carbon
GIS	geographic information system
gpd	gallon(s) per day
gpd/ft^2	gallon(s) per day per square foot
gph	gallon(s) per hour
gpm	gallon(s) per minute
gpm/ft^2	gallon(s) per minute per square foot
Guidance Manual	*Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources*
H:V	horizontal to vertical
HDPE	high-density polyethylene
HGL	hydraulic grade line
HI	Hydraulic Institute
hp	horsepower
HRT	hydraulic residence time
HVAC	heating, ventilation, and air conditioning
I&C	instrumentation and control
I/I	inflow and infiltration
ICC	International Code Council
ICP-MS	inductively coupled plasma mass spectrometer
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IMSDesign	Integrated Membrane Solutions Design
IPR	indirect potable reuse
ISA	International Society of Automation
IT	Internet Technology
Jacobs	Jacobs Engineering Group Inc.
JPA	Las Virgenes-Triunfo Joint Powers Authority
kW	kilowatt(s)
kWh/kgal	kilowatt(s) per kilogallon
LACFC	Los Angeles County Fire Code Amendments
LACHM	Los Angeles County Hydrology Manual
lb	pound(s)
lb/d	pound(s) per day
LCP	local control panel
LED	light-emitting diode

LF	linear foot (feet)
LID	low-impact development
Los Angeles RWQCB	Los Angeles Regional Water Quality Control Board
LOX	liquid oxygen
LPHO	low-pressure high-output
LRFD	load and resistance factor design
LRV	log reduction value
LSI	Langelier Saturation Index
LVMWD	Las Virgenes Municipal Water District
MC	maintenance clean
MCC	motor control center
MCL	maximum contaminant level
Metropolitan	Metropolitan Water District of Southern California
MF	membrane filtration
mg/L	milligram(s) per liter
mg/L as N	milligram(s) per liter as nitrogen
mg/L as P	milligram(s) per liter as phosphorus
mg/min/L	milligram(s) per minute per liter
MGD	million gallons per day
MIC	microbially induced corrosion
mJ/cm^2	millijoule(s) per square centimeter
MODRAT	Modified Rational Method
MP	medium-pressure
MWELO	Model Water Efficient Landscape Ordinance
NAVD 88	North American Vertical Datum of 1988
ND	not detected
NDMA	N-nitrosodimethylamine
NEC	National Electrical Code
NFPA	National Fire Protection Association
ng/L	nanogram(s) per liter
NIPS	nonsolvent induced phase separation
No.	number
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
O&M	operations and maintenance
ORP	oxidation-reduction potential
OSHA	U.S. Occupational Safety and Health Administration

PCS	plant control system
PDB	progressive design-build
PI	Plasticity Index
PLC	programmable logic controller
ppm	part(s) per million
psf	pound(s) per square foot
psi	pound(s) per square inch
psig	pound(s) per square inch gauge
PVDF	polyvinylidene fluoride
PWP or Project	Pure Water Project Las Virgenes-Triunfo
PWPS	Purified Water Pump Station
Q_{25}	25-year storm flow
RC	recovery clean
Reclamation	U.S. Bureau of Reclamation
RO	reverse osmosis
ROC	reverse osmosis concentrate
RWPS	Recycled Water Pump Station
s.u.	standard unit(s)
SCADA	supervisory control and data acquisition
SCE	Southern California Edison
scfm	standard cubic foot (feet) per minute
scfm/gpm	standard cubic foot (feet) per minute gallon per minute
SDI	silt density index
SMACNA	Sheet Metal and Air Conditioning Contractor’s National Association
SWA	surface water augmentation
SWD	side water depth
SWPPP	Stormwater Pollution Prevention Plan
SWQDV	stormwater quality design value
SWRCB	California State Water Resources Control Board
SWSAP	Surface Water Source Augmentation Project
Tapia WRF	Tapia Water Reclamation Facility
TDH	total dynamic head
TDS	total dissolved solids
THM	trihalomethanes
TIPS	thermally induced phase separation
TMDL	total maximum daily load
TMP	transmembrane pressure

TMS	The Masonry Society
TOC	total organic carbon
TP	total phosphorous
Trojan	Trojan Technologies
TSS	total suspended solids
TTHM	total trihalomethanes
TWSD	Triunfo Water & Sanitation District
UPS	uninterrupted power supply
UV	ultraviolet
UV-AOP	ultraviolet advanced oxidation process
UVLED	ultraviolet light-emitting diode
UVT	ultraviolet transmission
VFD	variable frequency drive
W	watt(s)
WaterSecure	Australian WaterSecure Innovations Ltd.
WaterVal	Water Research Australia Limited
WFP	Westlake Filtration Plant

1. Introduction

The Las Virgenes-Triunfo Joint Powers Authority (JPA) is delivering a series of project elements under the Pure Water Project Las Virgenes-Triunfo (PWP or Project). The JPA is a partnership between Las Virgenes Municipal Water District (LVMWD) and the Triunfo Water & Sanitation District (TWSD), established in 1964 to cooperatively treat wastewater for these two neighboring areas that share the Malibu Creek watershed. The JPA collects, conveys, and treats wastewater from residents in western Los Angeles and eastern Ventura counties, including in the following cities (Figure 1-1):

- Agoura Hills
- Calabasas
- Hidden Hills
- Oak Park
- Thousand Oaks
- Westlake Village

LVMWD serves as the administering agency for the JPA. The Jacobs Engineering Group Inc. (Jacobs) Team, consisting of Jacobs, Woodard & Curran, and Katz & Associates, is serving as the Project Manager/Owner's Adviser and is assisting the JPA with management and delivery of the Project.

1.1 Project Background and Purpose

The JPA owns and operates the Tapia Water Reclamation Facility (Tapia WRF), located in the Santa Monica Mountains along Malibu Canyon Road. The Tapia WRF has a permitted capacity of 12 million gallons per day (MGD) for average daily wastewater flow from primarily domestic sources. The facility treats wastewater to *California Code of Regulations* (CCR), Title 22 standards (CCR Title 22, Social Security, Division 4, Environmental Health) for disinfected tertiary recycled water, for use primarily for nonresidential landscape irrigation, such as roadway medians, parks, and golf courses within Agoura Hills, Calabasas, Hidden Hills, Oak Park, and Westlake Village. Nearly all of the recycled water produced at the Tapia WRF is used for irrigation during the summer, and the recycled water system is often augmented with potable water as demand exceeds available supply. Surplus recycled water is either discharged to Malibu Creek in the winter and used in nearby sprayfields, or sent to the Los Angeles River in the summer (LVMWD 2021a).

The Tapia WRF operates pursuant to a federal National Pollutant Discharge Elimination System (NPDES) permit. The Los Angeles Regional Water Quality Control Board (Los Angeles RWQCB) adopted the NPDES Permit Number (No.) CA0056014, Order No. R4-2017-0124 on June 1, 2017. The NDPES permit prohibits discharge to Malibu Creek from April 15 to November 15, except under an operational emergency or qualifying storm event, for protection of habitats in Malibu Creek and Malibu Lagoon (Los Angeles RWQCB 2017a). Regional Board Resolution No. R16-009 (May 16, 2017) amended the Water Quality Control Plan for the Los Angeles Region to incorporate more stringent seasonal nitrogen and phosphorus total maximum daily loads (TMDLs) for discharge to Malibu Creek to address benthic community impairments (Los Angeles RWQCB 2017b), as summarized in Table 1-1.

This amendment addressed benthic community impairments to comply with U.S. Environmental Protection Agency (EPA)-established *Malibu Creek and Lagoon Sedimentation and Nutrients TMDL to Address Benthic Community Impairments* (EPA 2013).

The JPA considered a multipronged approach to address these more stringent EPA water quality standards for discharge of recycled water into Malibu Creek, as compliance was determined to be expensive and impactful to sewage treatment rates for customers. The JPA has expressed its commitment to creek stewardship, but with common-sense solutions to water quality issues (JPA 2016).

Table 1-1. Malibu Creek Discharge Limits for Tapia Water Reclamation Facility

Parameter	Period	Average Monthly	Seasonal Average
Total Ammonia as Nitrogen	Current limit	2.5 mg/L (250 lb/d)	--
Nitrate + Nitrite as Nitrogen	Current limit	8 mg/L (800 lb/d)	--
Total Nitrogen [a]	Summer: April 15 to November 15	--	1 mg/L
Total Nitrogen [b]	Winter: November 16 to April 14	--	4 mg/L
Total Phosphorus [a]	Summer: April 15 to November 15	--	0.1 mg/L
Total Phosphorus [b]	Winter: November 16 to April 14	--	0.2 mg/L

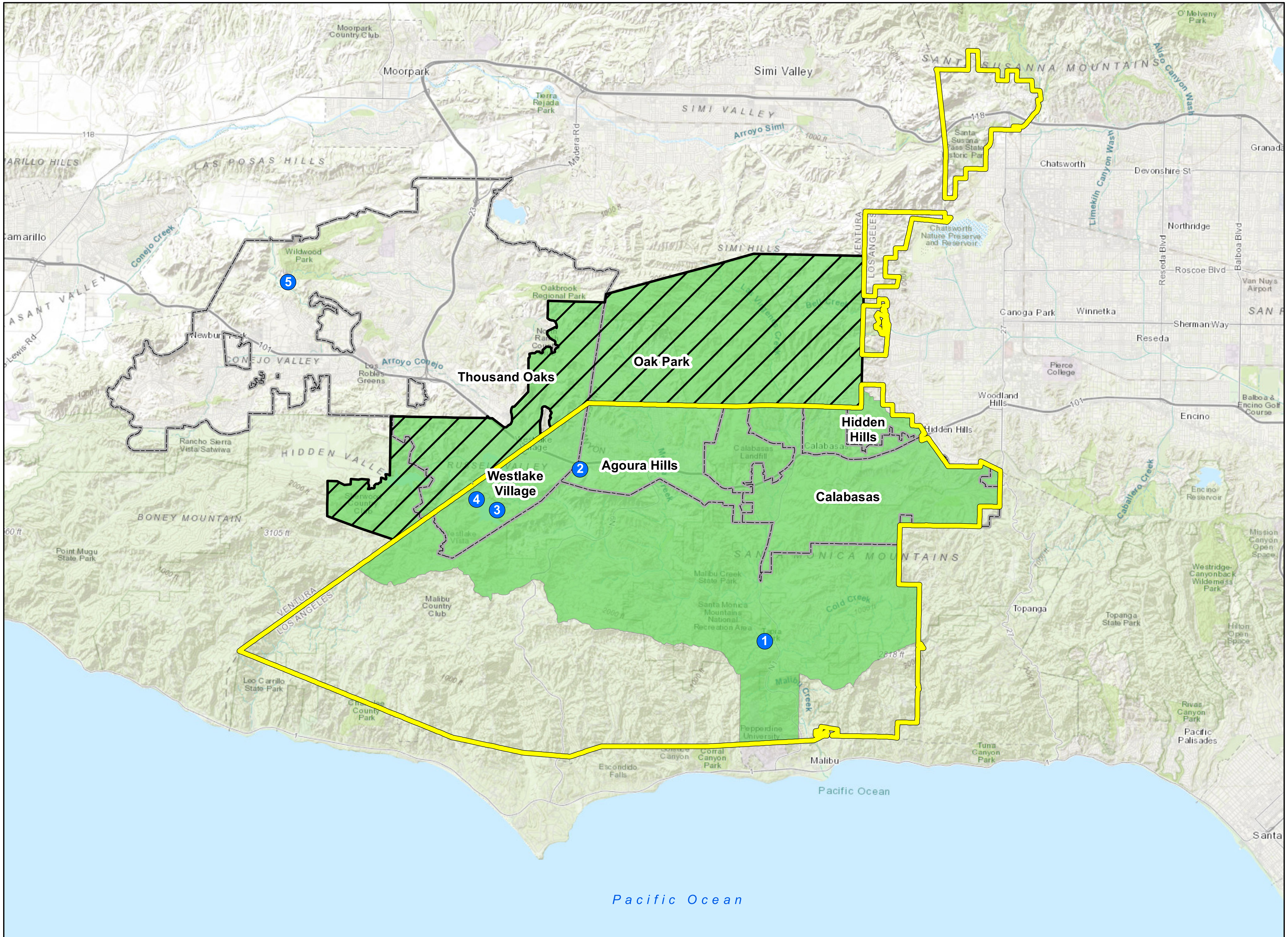
[a] Effective in Year 2022, 5 years from date of Resolution No. R16-009 (May 16, 2017).

[b] Effective in Year 2030, 13.5 years from date of Resolution No. R16-009 (May 16, 2017).

-- = not applicable

lb/d = pound(s) per day

mg/L = milligram(s) per liter



Legend

- LVMWD Potable Water Service Area
- LVMWD Sewer Service Area
- Trifuno Water and Sanitation District
- City Limits
- 1 - Tapia Water Reclamation Facility
- 2 - Advanced Water Purification Facility
- 3 - Reservoir
- 4 - Westlake Filtration Plant
- 5 - Salinity Management Pipeline

Sources:
ESRI World Street Map/World Topo Map;
LVMWD, 2022

0 1 2 4
Miles
1 inch = 2 miles

Figure 1-1

Las Virgenes Municipal Water District Service Area

Pure Water Project Las Virgenes - Triunfo

Jacobs

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As part of a robust 18-month stakeholder participation process, the JPA evaluated several options to beneficially use surplus recycled water to improve regional water supply reliability and drought resilience, while eliminating discharge into the creek. On August 1, 2016, the JPA Board voted to explore the preferred alternative, indirect potable reuse (IPR), which would create a local, reliable water supply for the region (JPA 2016). A subsequent Title XVI feasibility study conducted under a U.S. Bureau of Reclamation (Reclamation) grant identified the preferred Project alternative as the IPR project, now known as the PWP, over a seasonal storage project, the Encino Reservoir Project (Kennedy Jenks Consultants 2018). The PWP represents a unique opportunity to proactively address three major challenges facing the JPA:

1) Comply with more stringent regulatory requirements for discharge to Malibu Creek.
2) Balance seasonal variation in recycled water demand.
3) Create a valuable resource to supplement the region's water supplies, supported by California's reservoir water augmentation regulations.

The fundamental plan is to build an Advanced Water Purification Facility (AWPF) to treat tertiary effluent from the Tapia WRF for IPR, and convey the purified water to the Las Virgenes Reservoir, where it will be blended with the existing Metropolitan Water District of Southern California (Metropolitan) supply in the reservoir. Water from the Las Virgenes Reservoir will be subsequently treated at the Westlake Filtration Plant (WFP) prior to distribution (Figure 1-2), as is currently done with water from this reservoir. Additionally, four pipelines will be constructed to convey:

1) Source water
2) Purified water
3) Reverse osmosis concentrate (ROC)
4) Residuals

The compliance date for operation of the new AWPF is November 16, 2030, the date when the new NPDES permit limits for the Tapia WRF take effect for discharge of final effluent to Malibu Creek (Los Angeles RWQCB 2017a).

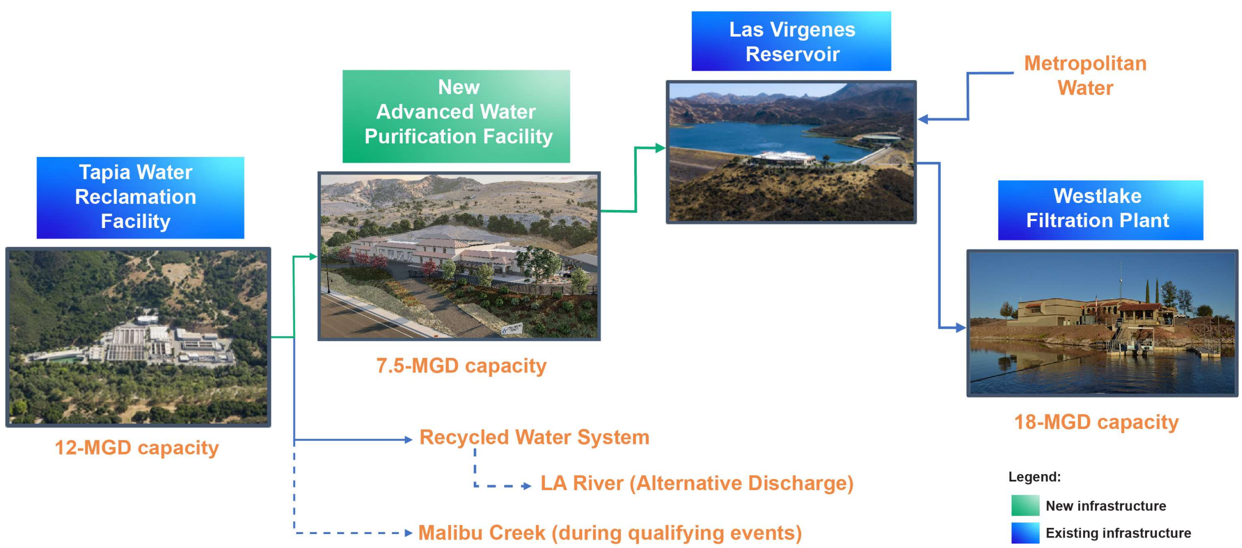


Figure 1-2. Pure Water Project Las Virgenes-Triunfo Major Elements

The following elements comprise an integrated, one water approach for the PWP (Figure 1-3):

- **Tapia WRF –** Employs preliminary, primary, and secondary treatment with nutrient removal, filtration, and disinfection to produce CCR Title 22 disinfected tertiary recycled water for non-potable reuse and to comply with current NPDES requirements for discharge of surplus recycled water to Malibu Creek. Recycled water usage includes irrigation of parks, golf courses, and landscaping. Tapia WRF effluent will be the main source water for the new AWPF.
- **AWPF –** Will provide full advanced treatment (FAT) that consists of membrane filtration (MF), reverse osmosis (RO), and ultraviolet advanced oxidation process (UV-AOP) to meet reservoir augmentation requirements for IPR.
- **Las Virgenes Reservoir –** Purified water from the AWPF will be conveyed to the Las Virgenes Reservoir, which is currently filled with potable water from Metropolitan.

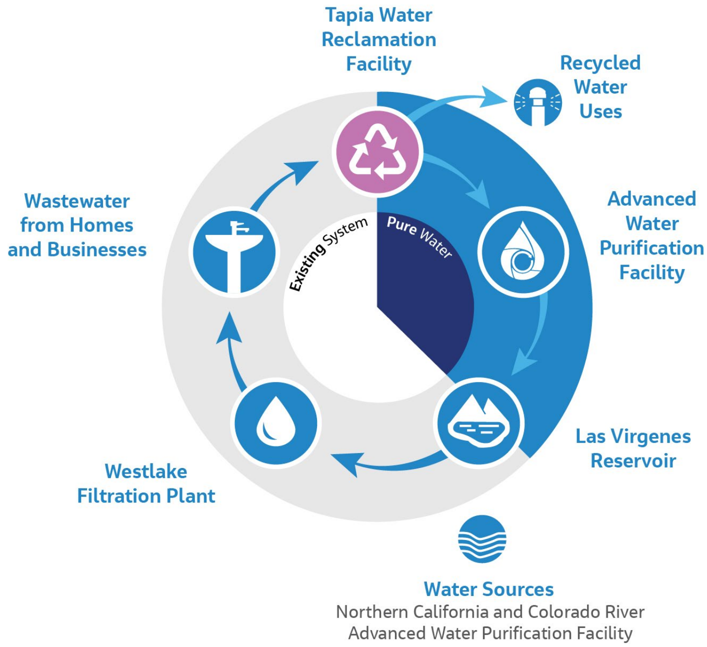


Figure 1-3. One Water Approach

- **WFP –** Employs diatomaceous earth media filtration and free chlorine primary disinfection (followed by ammonia addition for residual chloramination) and will continue to treat water from the Las Virgenes Reservoir for distribution to customers.
- **Conveyance –** Major pipelines include:
  - Source Water Line: Extends the existing recycled water system to provide source water to the AWPF
  - Purified Water Line: Conveys purified water from the AWPF to the Las Virgenes Reservoir for blending with Metropolitan water
  - ROC Line: Conveys ROC from the AWPF to the Calleguas Salinity Management Pipeline (Calleguas SMP) for ultimate ocean discharge
  - Residuals Line: Conveys residuals from the AWPF to the existing trunk sewer

Tapia WRF will provide disinfected tertiary recycled water to a new 7.5-MGD AWPF. However, there is no available effluent flow in the summer due to the effective recycled water program. Seasonal variation in flow to the AWPF will complicate operations and create an underused asset for half of the year. Achieving a steady-state operating flow to the AWPF would improve systemwide operational efficiency and continuously produce a valuable purified water product. In support of this goal, the JPA will continue to consider feasible options for augmenting sources of influent water to the Tapia WRF or directly to the AWPF.

1.2 Pure Water Demonstration Facility

The JPA constructed a Pure Water Demonstration Facility, which included a FAT pilot system, to support the full-scale design through assessment of water quality and treatment performance (Carollo 2019). Carollo Engineers, Inc. (Carollo) conducted pilot testing from June 2020 to July 2021 and documented the results in the *Purification System Performance Report* (Carollo 2022). Subsequent performance data from July 2021 to August 2022 have also been reviewed. This information has been used to support development of this *Conceptual Design Report*.

1.3 Facility Siting

The JPA conducted a siting study to identify potential locations for the new Advanced Water Treatment Plant (Woodard & Curran 2018). In 2022, a *Programmatic Environmental Impact Report* updated these findings with technical and environmental considerations and recommended the JPA proceed with the 30800 Agoura Road location for the new AWPF (Jacobs 2022). Figure 1-4 shows the overall site topography and conceptual layout. The topography of the site provides unique considerations discussed in Section 11.

1.4 Conceptual Design Report Purpose

The JPA has elected to deliver their new AWPF using the progressive design-build (PDB) delivery model. As a prerequisite to the procurement of a design-builder, this *Conceptual Design Report* is provided to support planning efforts and serves as a baseline for design efforts. The purpose of this AWPF *Conceptual Design Report* is to:

- Establish influent water quality and performance goals
- Summarize unit process design criteria
- Develop conceptual facility sizing criteria
- Present conceptual layouts

The *Conceptual Design Report* serves as the basis of understanding for the Project, but the concepts are subject to further refinement by the design-builder and the JPA during design.

1.5 Scope of Work

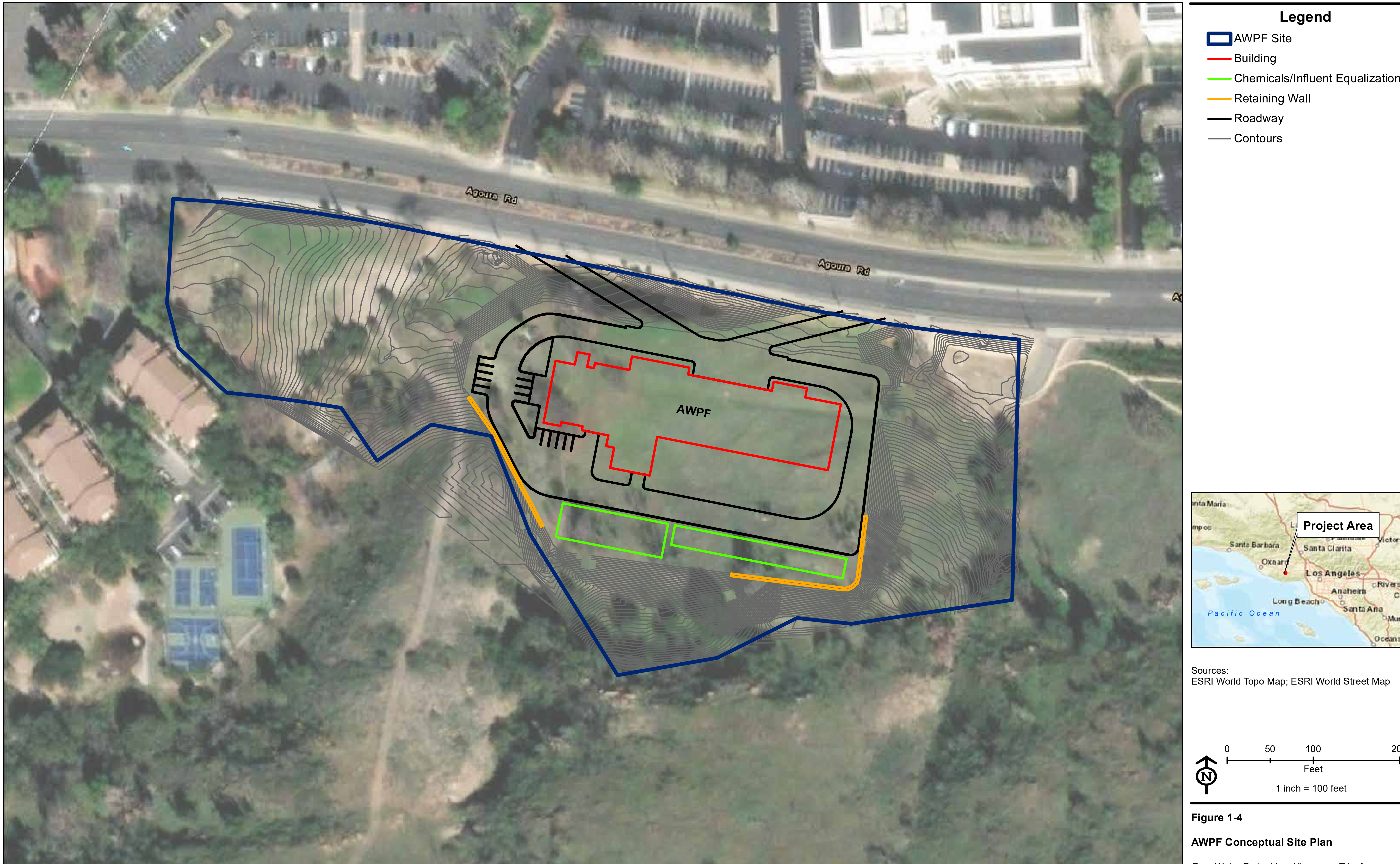
The scope of work includes development of conceptual-level design criteria for the AWPF and includes the following processes:

- Influent equalization
- MF
- RO
- UV-AOP
- Post-treatment water stabilization
- Residuals management
- Chemical feed and storage

The *Conveyance Pipelines Alignment Study* (Woodard & Curran 2023) identifies the recommended alignment for each conveyance line, which totals approximately 18 miles of pipeline for delivery of:

- Source water from the existing recycled water system to the AWPF for treatment (0.8 mile)
- Purified water from the AWPF to the Las Virgenes Reservoir for storage (2.7 miles)
- ROC from the AWPF to the Calleguas SMP for ultimate discharge to the ocean (13.7 miles)
- Residuals from the AWPF to the sanitary sewer for disposal (1.1 miles)

The ROC is dependent on the AWPF design for performance; therefore, it will be part of the PDB contract along with the AWPF. The remaining conveyance pipelines will be delivered separately using a design, bid, build (DBB) approach and will interface directly with the AWPF project.



Sources:
ESRI World Topo Map; ESRI World Street Map

Figure 1-4

AWPF Conceptual Site Plan

Pure Water Project Las Virgenes –Triunfo

Jacobs

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1.6 Ancillary Projects

The design criteria contained in this *Conceptual Design Report* were developed considering the following anticipated ancillary projects associated with the PWP:

- Tapia WRF equalization
- Tapia WRF preformed monochloramine disinfection
- Recycled Water Pump Station (RWPS) West upgrade
- Las Virgenes Reservoir hypolimnetic oxygenation system
- AWPF conveyance pipelines

1.7 Report Organization

The *Conceptual Design Report* is organized as follows:

- Section 1 provides Project background information and describes the purpose of this report.
- Section 2 describes plant flows and water quality conditions that define the basis of design.
- Section 3 describes the process facilities that comprise the treatment strategy, critical control points (CCPs), and proposed seasonal operational approach.
- Section 4 presents the conceptual design for the plant hydraulics.
- Section 5 presents the conceptual design of the MF process, including a description of the process design criteria, conceptual layout and design characteristics, and operational strategies.
- Section 6 presents the conceptual design of the RO process, including a description of the process design criteria, conceptual layout and design characteristics, and operational strategies.
- Section 7 presents the conceptual design of the UV-AOP process, including a description of the process design criteria, conceptual layout and design characteristics, and operational strategies.
- Section 8 presents the conceptual design of the post-treatment facilities for purified water stabilization and conveyance to the Las Virgenes Reservoir.
- Section 9 presents the conceptual design of the facilities managing residuals, including MF backwash waste, clean-in-place (CIP) wastes, process drains, and ROC.
- Section 10 presents the conceptual design of the chemical storage and feed facilities, including a description of the process design criteria, conceptual layout and design characteristics, and operational strategies.
- Section 11 presents a summary of the civil site and desktop geotechnical evaluations, as well as discipline design guidelines for the following disciplines:
  - Site civil
  - Architectural
  - Structural
  - Process mechanical
  - Building mechanical
  - Fire protection
  - Electrical
  - Instrumentation and control (I&C)
- Section 12 presents the preliminary schedule and construction cost estimate for the AWPF.
- Section 13 lists the references used to develop this report.

2. Basis of Design

This section presents the basis of design for the AWPF and includes the following elements:

- Introduction
- Regulatory Requirements
- Effluent Quality Objectives and Performance Goals
- Approach to Pathogen Reduction
- Flow Characteristics
- Water Quality
- Futureproofing the AWPF

2.1 Introduction

Regulatory and end-user requirements set limits on the quality of purified water and residuals that will be generated by the new AWPF. *California Water Code* (CWC) Section 13561 defines the two types of potable recycled water use: IPR and direct potable reuse (DPR). In California, requirements for IPR have been established by the California State Water Resources Control Board (SWRCB). DPR requirements are currently in draft form, with issuance anticipated in 2023. The implementation of projects requires coordination with both the Los Angeles RWQCB and the California Division of Drinking Water (DDW).

The two main approaches to IPR in California are groundwater replenishment (using an aquifer to provide an environmental buffer between advanced water treatment [AWT] of treated wastewater and groundwater wells that supply water into a drinking water system) and reservoir water augmentation (using a reservoir to provide an environmental buffer between AWT and a water treatment plant that supplies water into a drinking water system). Reservoir water augmentation is also known as surface water augmentation (SWA). The PWP is being implemented as a Surface Water Source Augmentation Project (SWSAP). The SWRCB adopted SWA regulations in March 2018. The *Regulations Related to Recycled Water*, taken from CCR Titles 17 and 22, address recycled water and IPR, including SWA (State of California 2017).

2.2 Regulatory Requirements

For a SWSAP, continuous treatment is required using FAT, the treatment of an oxidized wastewater using RO and an advanced oxidation treatment process that, at a minimum, meets the following specified criteria:

- Use an RO membrane that has achieved a rejection of sodium chloride of no less than 99.0% and an average (nominal) rejection of sodium chloride of no less than 99.2%, as demonstrated through Method A of ASTM International's (ASTM's) *Method D4194-03 (2014), Standard Test Methods for Operating Characteristics of Reverse Osmosis and Nanofiltration Devices* (ASTM 2017) using specified test conditions.
- During the first 20 weeks of full-scale RO operation, the membrane must produce a permeate with no more than 5% of sample results having a total organic carbon (TOC) concentration greater than 0.25 mg/L. An alternative surrogate parameter, with corresponding limit approved by the SWRCB, may also be used. In all cases, verification must be achieved by monitoring no less frequently than weekly.
- For RO, at least one form of continuous performance monitoring is required for operations, with operational parameter limits and alarm settings specified to indicate when integrity has been compromised.
- For the oxidation process, onsite testing must demonstrate that the full-scale process will provide no less than 0.5-log reduction of 1,4-dioxane based on an approved testing protocol using spiking (or challenge) tests at the normal full-scale operating conditions.
- For operation of the oxidation process, at least one surrogate or operational parameter must be monitored continuously during operation, with associated alarms that indicate when the process is not operating as designed.

2.2.1 Pathogen Reduction Requirements

Pathogen reduction requirements vary for groundwater replenishment and reservoir water augmentation projects. Table 2-1 provides a summary of the main pathogen reduction and treatment requirements for a SWSAP, depending on the dilution ratio or proportion of recycled water to volume in the reservoir.

Table 2-1. Pathogen Reduction and Treatment Requirements for Reservoir Augmentation

Parameter		LRVs (based on Dilution Factor and Detention Time)					
Dilution Factor	Units	≤1% recycled water by volume (1:100 dilution)			≤10% recycled water by volume (1:10 dilution)		
Detention Time	days	60-119	120-179	≥180	60-119	120-179	≥180
Virus[a]	log	9	8	8	10	9	9
Giardia[a]	log	8	7	7	9	8	8
Cryptosporidium[a]	log	9	8	8	10	9	9
Multibarrier Approach (treatment processes for each pathogen)	No.	2	2	2	3	3	3
Additional SWRCB approval required	-	Yes	Yes	No	Yes	Yes	No

[a] A separate 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.

< = less than

≤ = less than or equal to

≥ = greater than or equal to

LRV = log reduction value

2.2.2 Additional Treatment Requirements

The AWPF needs to meet the following additional treatment requirements for a SWSAP:

- Meet *Safe Drinking Water Act* drinking water maximum contaminant levels (MCLs) and action levels for lead and copper, and specifically, meet the following limits:
  - Inorganic chemicals per Table 64431-A, Chapter 15
  - Radionuclide chemicals per Tables 64442 and 64443, Chapter 15
  - Organic chemicals per Table 64444-A, Chapter 15
  - Disinfection by-products (DBPs) per Table 64533-A, Chapter 15.5
- Review 126 pollutants on a Project-specific basis; pollutants may require limits or monitoring, depending on effluent and receiving water quality.
- Wastewater management agency must have an industrial pretreatment and enhanced pollutant source control program.

2.2.3 California Toxics Rule Requirements

On May 18, 2000, EPA promulgated numeric water quality criteria for priority toxic pollutants and other provisions for water quality standards to be applied to waters in California, known as the *California Toxics Rule* (CTR), based on the determination that the numeric criteria are necessary in California to protect human health and the environment.

The CTR fills a gap in California water quality standards that was created in 1994 when a state court overturned the state's water quality control plans containing water quality criteria for priority toxic pollutants. Thus, California had been without numeric water quality criteria for many priority toxic pollutants as required by the *Clean Water Act*, necessitating this action by EPA. These federal criteria are legally applicable in California for inland surface waters, enclosed bays, and estuaries for all purposes and programs under the *Clean Water Act*.

The CTR requirements are understood to be applicable to the PWP because of the planned discharge of purified water to Las Virgenes Reservoir, which is a designated surface water body in the *Water Quality Control Plan Los Angeles Region – Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties* (Los Angeles RWQCB 2020). The CTR requirements include a number of numerical limits, but the water quality constituents shown in Table 2-2 are those known to be of concern for the PWP, based on Tapia WRF effluent data and Demonstration Facility performance.

Table 2-2. California Toxic Rule Limits for Human Health and Notification Levels

Parameter	CTR for Human Health (µg/L)	DDW Notification Level or MCL (µg/L)
NDMA	0.0069	0.010
Bromoform	4.3	TTHM MCL = 80
Dichlorobromomethane (DCBM or BDCM)	0.56	TTHM MCL = 80
Chlorodibromomethane (DBCM or CDBM)	0.41	TTHM MCL = 80

µg/L = microgram(s) per liter
TTHM = total trihalomethanes

2.2.4 Calleguas Salinity Management Pipeline Requirements

The Calleguas SMP operates pursuant to a federal NPDES permit. The Los Angeles RWQCB adopted the NPDES Permit No. CA0064521, Order No. R4-2019-0075 on June 13, 2019. Discharge of ROC to the Calleguas SMP will need to meet the Waste Discharge Requirements in the NPDES permit.

2.3 Effluent Quality Objectives and Performance Goals

The AWPF must meet the treatment requirements shown in Section 2.2, including the LRV targets of 9-8-9 (for virus*, Giardia, and Cryptosporidium*, respectively) established for the facility. Section 2.2 identifies a number of treatment requirements, including:

- *Safe Drinking Water Act* requirements
- Lead and copper requirements
- Asbestos requirements
- Secondary MCL compliance
- Other priority contaminants

The SWA regulations include monitoring of a number of other contaminant classes during operation. This section highlights the most pertinent effluent quality objectives and performance goals.

For RO permeate, TOC must be less than 0.25 mg/L based on a 20-week sampling program at the start of operations. Per the applicable regulations, an operational strategy can be developed and approved thereafter. The UV-AOP system will be required to provide at least 0.5-log 1,4-dioxane reduction, requiring maintaining a sufficient ultraviolet (UV) dose and oxidation performance.

The CTR limits shown in Table 2-2 apply because of the purified water discharge to Las Virgenes Reservoir.

Following UV-AOP, chemical dosing will achieve finished water quality goals for pH, corrosivity, and alkalinity, as shown in Table 2-3.

Table 2-3. Finished Water Quality Goals

Parameter	Target Range	Considerations
pH	7.5 to 8.5	Receiving water pH will not be changed more than 0.2 pH units from natural conditions, with values between 6.5 and 8.5. Actual pH varies in the Las Virgenes Reservoir. Treatment will target pH of approximately 8.0 leaving the AWPF.
Corrosivity, LSI	-0.5 to + 0.5	No anticipated regulatory requirements; need to establish target for corrosion indices for conveyance of purified water to Las Virgenes Reservoir.
Alkalinity (mg/L as calcium carbonate)	50 to 100	No anticipated regulatory requirements; match LVMWD's goal for finished water alkalinity.

LSI = Langelier Saturation Index

2.4 Approach to Pathogen Reduction

This section describes the pathogen reduction approach for the AWPF conceptual design and alternative methods to achieve additional pathogen reduction, if needed.

2.4.1 Target Pathogen Log Reduction Values for the Advanced Water Purification Facility

The minimum treatment requirements for SWA must be met by the AWPF. Based on *Las Virgenes Reservoir Modeling Results* (Trussell Technologies 2019), dilution greater than 100:1 will be maintained beyond a 99.9% probability from probabilistic modeling with the inclusion of a diffuser. Coupled with modeling results showing reservoir detention time always more than 8.5 months (more than 180 days), the minimum pathogen log reduction requirements are as 8-7-8 for virus, *Giardia,* and *Cryptosporidium* reduction, respectively.

Per the regulations, two pathogen treatment barriers are required. The reservoir model has not yet been validated with reservoir tracer testing, nor does it consider extended AWPF operation through future source water augmentation. Based on experience gained on other California SWSAP projects, the basis of design conservatively provides an additional 1-log reduction for each of the three pathogens, with three barriers per pathogen (Table 2-4).

Table 2-4. Pathogen Log Reduction Value Targets

Pathogen	Minimum Requirement[a]	Basis of Design
Virus	8	9
Giardia	7	8
Cryptosporidium	8	9

[a] Based on reservoir conditions ≤1% recycled water by volume (1:100 dilution) and ≥180 days of detention.

For the AWPF, FAT will be provided with RO and UV-AOP. In addition, MF will be used as an additional pathogen barrier and pretreatment of the source water prior to RO. Thus, FAT will consist of MF, RO, and UV-AOP. Table 2-5 shows the pathogen LRVs for these processes:

- MF is expected to achieve at least 3.0-log reduction for *Giardia* and *Cryptosporidium*.
- RO is expected to achieve at least 1.5-log reduction for virus, *Giardia*, and *Cryptosporidium*.
- UV-AOP is expected to achieve 6.0-log reduction for virus, *Giardia*, and *Cryptosporidium*.

Table 2-5. Full Advanced Treatment Pathogen Log Reduction Values

Pathogen	MF	RO	UV-AOP	Total	Basis of Design
Virus	0	1.5	6	7.5	9
Giardia	3	1.5	6	10.5	8
Cryptosporidium	3	1.5	6	10.5	9

It is likely that more log credit can be achieved for MF or RO, but the LRVs shown are provided for conservatism at this planning stage of the Project. Other California utilities (Orange County Water District and Monterey One Water) are using daily strontium or sulfate monitoring, before and after RO, to achieve 0.5-1.0 additional log credit through RO. The analytical equipment to conduct strontium or sulfate analyses onsite at the AWPF is expensive and requires additional laboratory space, but given the potential for achieving greater LRV through RO, space in the laboratory shown in Section 11 – Discipline Design Guidelines, has been preserved for the laboratory equipment to perform one of these analyses.

2.4.2 Methods to Achieve Additional Virus Pathogen Reduction Credits

To provide a 9-log virus LRV, two approaches to achieving an additional 1.5-log credit for virus reduction have been considered (Table 2-6):

1) For the first option, 1.5-log credit can be achieved by dosing preformed monochloramine at the Tapia WRF and then maintaining the monochloramine residual concentration through the pipeline from the Tapia WRF to Reservoir 2, and subsequently to the AWPF. Monterey One Water received DDW approval for virus log reduction credits through chloramine disinfection in the purified water conveyance pipeline based on inactivation study results (Trussell Technologies 2021). Applicability to future water augmentation sources would need to be evaluated.
2) The second option is to provide a chlorine contact basin (CCB) to make use of the free chlorine residual present from chlorine-oxidant-based UV-AOP to provide virus log reduction credit in the CCB instead of the pipeline.

Alternative approaches that could also be evaluated by the design-builder include conducting testing to demonstrate virus reduction through filtration and disinfection at Tapia WRF. LVMWD and the design-builder will ultimately select the approach to achieve additional virus log reduction and perform the necessary demonstration testing to support selection.

Table 2-6. Considered Approaches to Meet Pathogen Log Reduction Value Targets

Pathogen	Pipeline[a] or CCB[b]	MF	RO	UV-AOP	Total
Virus	1.5	0	1.5	6	9.0
Giardia	0	3	1.5	6	10.5
Cryptosporidium	0	3	1.5	6	10.5

[a] Pipeline from Tapia WRF to the AWPF.

[b] CCB at the AWPF.

2.4.2.1 Pipeline Contactor for Virus Log Reduction Value

The pipeline from Tapia WRF to the AWPF is approximately 50,600 linear feet (LF) in length, with diameters ranging from 16 to 24 inches. The pipeline includes some stretches with two parallel pipeline alignments. From discussion with DDW regulators on April 27, 2022, DDW would award a baffle factor of 0.9 for a pipeline contactor. Assuming a maximum flow rate of 12 MGD from Tapia WRF to the AWPF, the total hydraulic residence time (HRT) is approximately 106 minutes. The calculated HRT assumes the shortest HRT for each segment with parallel lines.

The EPA's *Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources* (Guidance Manual) (EPA 1991) includes concentration and time (CT) (concentration of free chlorine times contact time) tables for virus inactivation credit in Table E-13. The CT required for 2-log virus inactivation credit with chloramine is 428 milligrams per minute per liter (mg/min/L) at 15 degrees Celsius (°C). The Water Research Australia Limited (WaterVal) (WaterSecure 2017) standards do not include CT tables for chloramine disinfection, and DDW has used CT tables from the WaterVal standards on other recent reuse projects.

From the April 27, 2022 discussion with DDW, a bench-scale study would be required to develop CT values for disinfection using preformed monochloramine because the Guidance Manual states that "EPA believes that chloramination conducted in the field, is more effective than using preformed chloramines…" (EPA 1991). For this *Conceptual Design Report*, the Guidance Manual Table E-13 was interpolated to estimate a required CT of 321 mg/min/L for 1.5-log virus inactivation. With a baffle factor of 0.9 and HRT of 106 minutes, a chloramine residual concentration of 3.4 mg/L will be required in the AWPF influent to meet the estimated CT required.

A bench-scale study will be required to establish CT requirements for the use of preformed monochloramine in the pipelines from the Tapia WRF to AWPF if virus inactivation with this approach to achieving LRVs is ultimately used for the PWP. Applicability to future water augmentation sources would need to be evaluated.

2.4.2.2 Chlorine Contact Basin for Virus Log Reduction Value

A CCB has been sized for this conceptual design to provide an additional 2-log reduction of virus with free chlorine, using the free chlorine residual present through UV-AOP. At a water temperature of 16°C, pH less than or equal to 8.5, and turbidity less than 0.2 nephelometric turbidity unit (NTU), the WaterVal CT for 2-log virus is greater than or equal to 9 mg/min/L (WaterSecure 2017). The CCB is sized to provide a CT ratio (ratio of CT achieved to CT required) of greater than or equal to 1.2, based on a free chlorine residual of 2.0 mg/L at the end of the CCB. For conservative spacing considerations, the conceptual design layout includes a CCB that is integrated with the purified water clearwell that supplies the Purified Water Pump Station (PWPS).

Planned future demonstration testing will be used to further investigate the formation of CTR-regulated DBPs with this approach, following the anticipated implementation of preformed monochloramine disinfection at Tapia WRF. Testing results conducted after issuance of this *Conceptual Design Report* will be made available.

2.5 Flow Characteristics

AWPF sizing is based on 12 MGD from the Tapia WRF, with 4.5 MGD planned for discharge by alternate means, leaving up to 7.5 MGD for treatment by the AWPF.

2.5.1 Tapia Water Reclamation Facility

While the JPA will continue to consider feasible options for augmenting sources of influent water to the Tapia WRF or directly to the AWPF (Jacobs 2021), the initial source of water to the AWPF will consist of disinfected tertiary effluent from the Tapia WRF. To produce Title 22 disinfected tertiary recycled water for non-potable reuse and to comply with current NPDES requirements for discharge of surplus recycled water to Malibu Creek, Tapia WRF employs the following processes:

- Preliminary treatment
- Primary sedimentation
- Biological nutrient removal activated sludge process

- Secondary clarification
- Tertiary granular media gravity filtration with coagulant (alum) and chlorine addition
- Chloramine disinfection through ammonia and chlorine addition
- Optional dechlorination

Recycled water usage includes irrigation of parks, golf courses, and landscaping.

The Tapia WRF is nominally rated for an average daily flow of 12 MGD, with a peak hour wet weather flow of 36 MGD. As shown on Figure 2-1, the Tapia WRF influent flow has decreased over time due to conservation in the community. In recent years, average annual daily flow rates have ranged from 7 to 8 MGD.

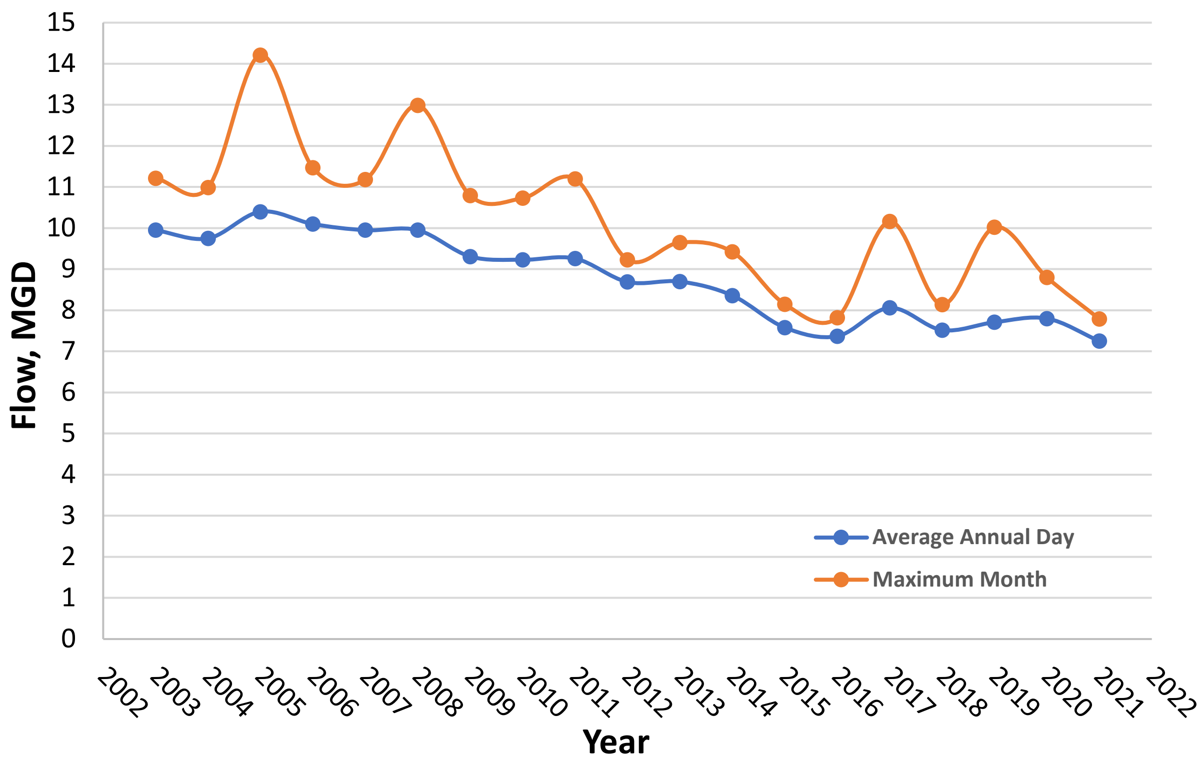

Figure 2-1. Tapia Water Reclamation Facility Influent Flow

2.5.2 Recycled Water System

Tapia WRF effluent is conveyed to the LVMWD recycled water system for distribution to users. The recycled water distribution system (Figure 2-2) serves 661 individual connections and includes:

- 3 open reservoirs
- 3 storage tanks
- 4 pump stations
- 62 miles of pipelines

Tapia WRF effluent is conveyed to Reservoir 2, an uncovered reservoir with shade balls. The recycled water from Reservoir 2 is then pumped to the eastern and western portions of the distribution system by the RWPS East and West. Source water will be conveyed to the AWPF via RWPS West. Under low reservoir level conditions, flow can bypass Reservoir 2 directly to the western system (LVMWD 2014).

Purified water from the AWPF will then be pumped to the Las Virgenes Reservoir and blended with Metropolitan water to serve as the supply to the WFP, which provides potable water to customers. The amount of tertiary recycled water flow produced by Tapia WRF that will be available for the AWPF will be determined by the following factors:

- Wastewater flows
- Water conservation
- Reduction in inflow and infiltration (I/I)
- Seasonal demands for recycled water
- Flow variation due to precipitation and irrigation demands

The historical irrigation demand patterns are variable, as they are based on unpredictable precipitation and atmospheric conditions. There are more demands over the summer months and fewer in the winter, although some irrigation demand still occurs in the winter. A comprehensive flow balance model was developed using 5 years of historical flow data from 2017 to 2021 for Tapia WRF and the recycled water system (LVMWD 2021b) to characterize flow management throughout the existing recycled water system under various flow scenarios and integration of the AWPF as a significant user (Jacobs 2023). Hydraulic analysis of the recycled water system was performed as part of the pipeline alignment study (Woodard & Curran 2023).

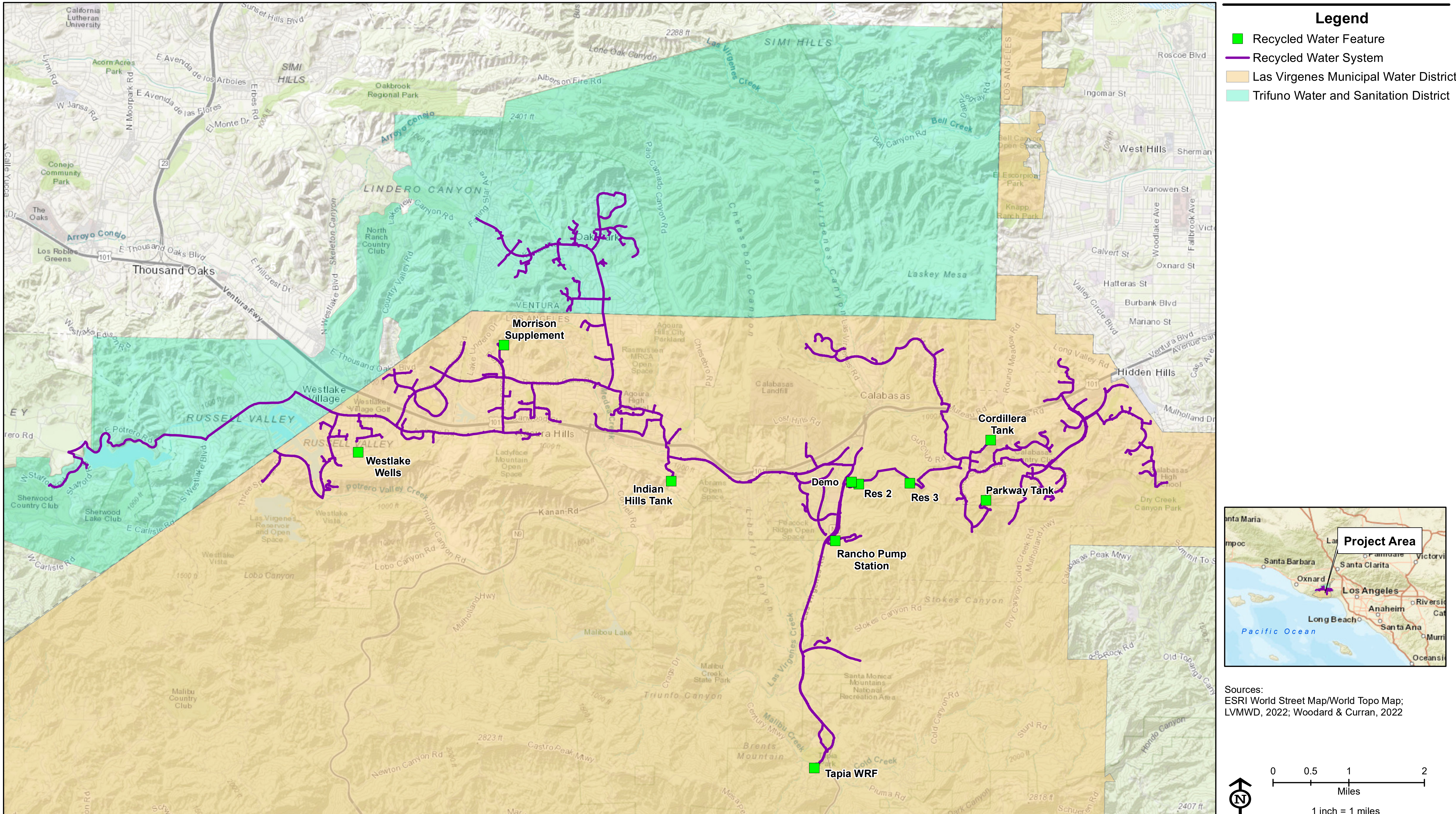

Figure 2-2

Existing Recycle Water System

Pure Water Project Las Virgenes - Triunfo

Jacobs

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During the NPDES Malibu Creek Discharge prohibition period from April 15 to November 15 each year, the recycled water demand for irrigation is high; and there is little to no available flow for the AWPF. Malibu Creek discharge from November 16 to the following April 14, outside the prohibition period, typically results in flow available for use by the AWPF, including wet weather periods of surplus flow. A detailed flow analysis was conducted to assess what the available flow to the AWPF (removing existing recycled water demands) would have been over the 5-year time period from January 2017 through December 2021. As shown for the average daily available flows on Figure 2-3, the demand for recycled water varies seasonally, with summertime demand peaks that are significantly higher than typical spring, fall, and winter demands. The average daily available flow exceeded 7.5 MGD each year, with wetter winters in 2017 and 2019 resulting in longer periods of flow rates of 7.5 MGD or more. During the summer, the recycled water system is supplemented from the drinking water system, as represented by the gray, supplement line for potable water that is shown as a flow deficit (LVMWD 2021b). The variability and availability of surplus recycled water flow is a unique consideration for the AWPF.

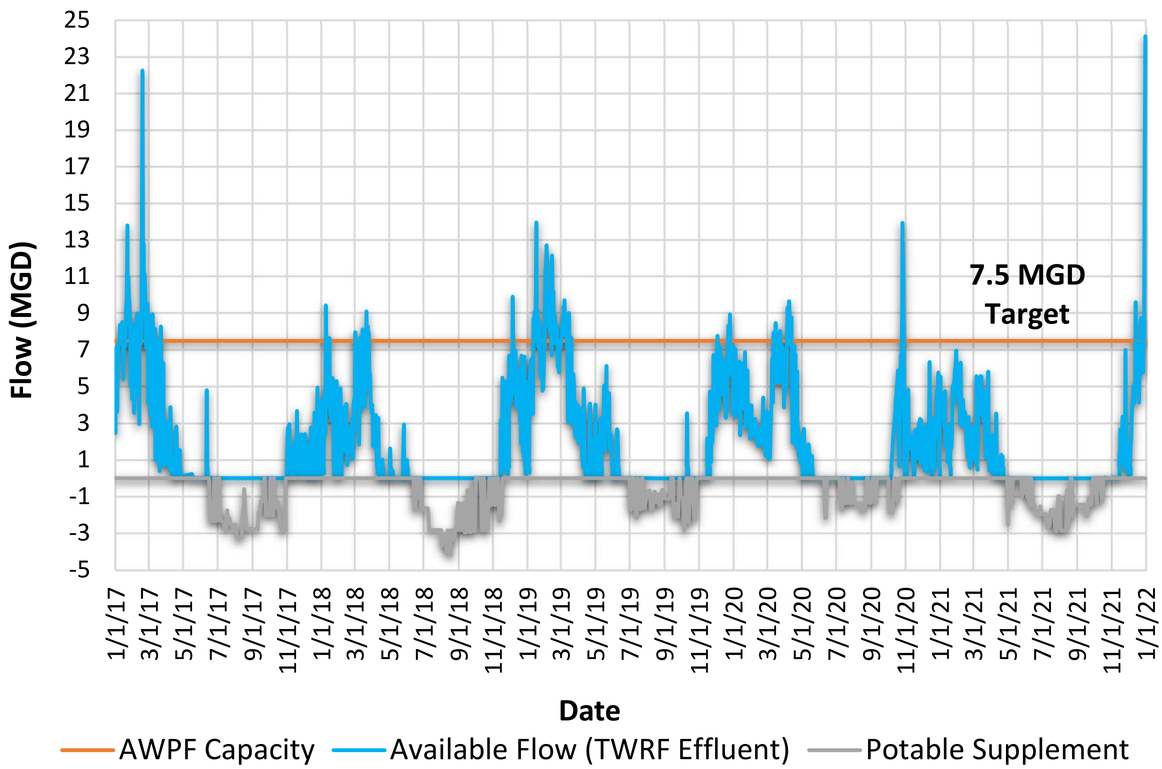

Figure 2-3. Available Flow to the Advanced Water Purification Facility, 2017-2021

Percentile distributions of the average daily flow data were used to characterize Tapia WRF's effluent flows sent to the recycled water system and Malibu Creek, which are summarized in Table 2-7. The effluent flow that was discharged to the creek represents the flow that would have been available for the AWPF.

Table 2-7. Tapia Water Reclamation Facility Effluent Average Day Flow, 2017-2021

Year	Effluent Flow Percentile Distribution (MGD)						
	10%	25%	50%	75%	95%	99%	100%
To Recycled Water System							
2017	0.64	3.54	5.88	7.51	8.78	9.51	10.0
2018	1.11	2.95	5.43	7.29	8.84	9.52	10.0
2019	0.47	1.19	5.31	6.94	7.94	8.36	9.17
2020	1.22	3.33	5.54	7.40	8.43	8.79	9.64
2021	1.33	3.45	5.79	7.45	8.73	9.29	9.64
To Malibu Creek							
2017	0.00	0.18	1.22	2.43	8.89	12.1	22.3
2018	0.00	0.69	1.21	3.13	6.68	8.17	9.90
2019	0.00	0.00	0.43	5.68	8.85	11.6	14.0
2020	0.00	0.00	0.02	3.12	7.40	8.97	11.8
2021	0.00	0.00	0.00	2.33	5.88	8.74	24.1

The potential flow to the AWPF was also examined in terms of flow percentile values during and outside of the prohibition period for the past 5 years (2017 to 2021), as shown on Figure 2-4. During the prohibition period, available flow to the AWPF would have occurred approximately 20% of the time. Flows of 1.0 MGD or more were available approximately 12% of the time. Outside of the prohibition period, flows of 1.0 MGD or more were available about 80% of the time. Flows greater than 7.5 MGD will require discharge to Malibu Creek during associated wet weather periods. Discharges will still be allowed under an operational emergency or qualifying storm event (Los Angeles RWQCB 2017a).

Overall, the available flow to the AWPF is highly variable, with time periods of months or longer in duration when no flow will be available. The AWPF is expected to operate throughout the period from November to April. Based on the available flow from Tapia WRF, operation at the design capacity will not be consistent, so the AWPF will need to be able to operate at variable flow. Use during the prohibition period may also be possible at lower flow rates and for limited periods of time.

The remaining sections of this report discuss the implications of the variable plant flow rates and low-flow operation, in particular, with respect to equalization and RO operations.

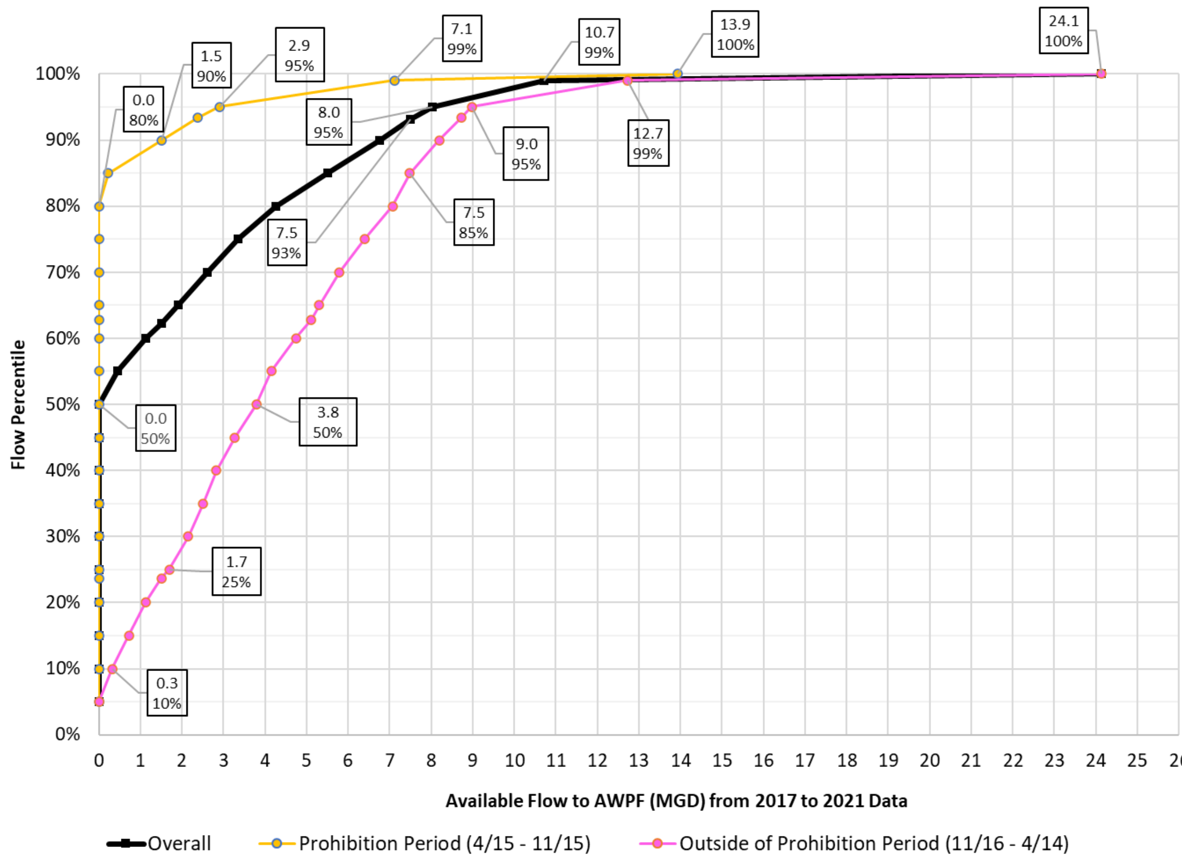

Figure 2-4. Potential Flow to the Advanced Water Purification Facility

2.5.3 Advanced Water Purification Facility Sizing

The AWPF was mainly selected as a regulatory approach with the benefit of producing purified water. Given flow will not be available for a portion of the year, it is important to balance the sizing of the facility with surplus discharge. In addition, LVMWD is considering potential projects to limit I/I, which could result in further reductions to Tapia WRF influent flow rates. Based on repair efforts for the Malibu Lake siphon, LVMWD is projecting a reduction in flow to the Tapia WRF of approximately 1 MGD. The frequency, volume, and nutrient loading of potential discharges to Malibu Creek were evaluated under a variety of flow scenarios and AWPF sizes, revealing that during heavy precipitation years, such as 2017 and 2019, there would have been sufficient flow to run the AWPF at 7.5 MGD influent flow, with 6.0 MGD of purified water for several months, and that a reduction in flow of 1 MGD had a minimal effect (Jacobs 2023). Appendix A provides figures from the analysis. As such, the decision was to maintain the 7.5-MGD AWPF capacity, while continuing to monitor flow within the system.

2.6 Water Quality

The Tapia WRF provides secondary treatment with nutrient removal, tertiary filtration, and disinfection in producing recycled municipal wastewater. Currently, the Tapia WRF effluent meets the requirements of CCR Title 22 Water Recycling Criteria[1] and can be classified as disinfected tertiary recycled water suitable for irrigation uses.

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[1] California Water Recycling Criteria, CCR Title 22, Division 4, Chapter 3.

An evaluation was conducted on data received from LVMWD for:

- Tapia WRF effluent quality data from January 2018 through June 2021; Appendix A provides a summary of the effluent quality data.
- Demonstration Facility water quality data from July 2020 through September 2021; Appendix A provides a summary of the data set. The *Purification System Performance Report* (Carollo 2022) also provides data on water quality and process performance.

Percentile distributions were used to characterize Tapia WRF's effluent water quality, as summarized in Tables 2-8 and 2-9.

Table 2-8. Summary of Tapia Water Reclamation Facility Effluent Water Quality Data

Parameter	Units	No.	Effluent Quality Percentile Distribution								
			1%	5%	10%	25%	50%	75%	90%	95%	99%
Discrete Samples[a]											
Ammonia	mg/L as N	13	0.7	0.7	0.7	1.0	1.3	1.5	1.8	2.6	3.6
BOD	mg/L	1	-	-	-	-	2.0	-	-	-	-
Nitrate	mg/L as N	13	5.3	5.7	6.2	7.0	7.7	8.8	9.6	9.7	9.8
Nitrite	mg/L as N	13	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.7
pH	s.u.	1,277	6.7	7.0	7.0	7.1	7.2	7.3	7.4	7.5	7.6
TOC	mg/L	43	6.2	6.5	6.7	7.2	7.6	8.2	9.1	9.7	16.6
Bromoform	µg/L	29	1.0	1.0	1.1	1.2	1.6	1.9	2.1	2.2	2.4
Chloroform	µg/L	29	9.4	11.0	11.0	18.0	23.0	31.0	44.6	52.2	53.7
DBCM	µg/L	29	1.3	1.4	2.3	3.5	4.7	8.2	12.2	14.2	17.9
DCBM	µg/L	30	4.8	5.7	7.7	10.3	13.0	18.8	31.0	33.8	39.6
TTHM[b]	µg/L	30	15.9	18.0	22.5	35.0	42.0	58.5	89.6	103.3	117.1
Composite Samples[a]											
Ammonia	mg/L as N	32	0.0	0.3	0.6	0.8	1.1	1.4	1.6	1.7	1.9
BOD	mg/L	296	0	2.0	2.0	2.4	3.4	5.1	7.2	8.2	10.0
Nitrate	mg/L as N	29	5.0	5.3	5.9	6.3	7.2	7.6	8.3	9.1	9.9
Nitrite	mg/L as N	29	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3
Orthophosphate	mg/L as P	33	1.6	1.7	1.7	2.1	2.5	2.7	2.9	3.1	3.3
TP	mg/L as P	26	1.8	1.8	1.9	2.0	2.5	2.7	2.9	3.0	3.1
TSS	mg/L	192	0	0.9	1.0	1.3	1.7	2.3	3.2	3.7	4.8

[a] Samples collected at Tapia WRF Effluent Pump Station.
[b] Tapia WRF TTHM discharge limit ≤ 80 µg/L as a monthly average. Individual values >80 µg/L do not represent noncompliance.
= not applicable
BOD = biochemical oxygen demand
mg/L as N = milligram(s) per liter as nitrogen
mg/L as P = milligram(s) per liter as phosphorus
s.u. = standard unit(s)
TP = total phosphorus
TSS = total suspended solids

Ammonia concentrations show some variability, with a discrete median value of 1.3 mg/L as N and values exceeding 3.0 mg/L occurring occasionally. The variability in ammonia has created difficulties in achieving consistent chloramine dosing at the desired chlorine-to-ammonia ratio at the Demonstration Facility influent. Effluent turbidity is monitored online, and average values were on the order of 1 NTU. Total nitrogen was typically less than 10 mg/L as N. Composite orthophosphate and TP concentrations were typically 2.5 mg/L as P, with values up to 3.3 mg/L as P. These levels of orthophosphate increase the potential for calcium phosphate precipitation in the RO system. The use of acid to reduce the RO feed pH, along with the use of an antiscalant, will be required for effective scaling control.

TTHM concentrations show variability, with a discrete median value of 42 µg/L and values up to 117 µg/L. The concentrations of DBCM and DCBM were up to 18 and 40 µg/L, respectively. These two trihalomethanes (THM) species are regulated under the CTR. Based on the Demonstration Facility performance, these species values need to be less than 5 µg/L entering the AWPF. LVMWD plans to convert Tapia WRF to preformed monochloramine disinfection, from in situ chloramine disinfection, to reduce DBP formation in the AWPF source water. Once implemented, additional sampling and testing will be conducted at the Demonstration Facility to further evaluate the implications of the CTR limits.

The Demonstration Facility receives Tapia WRF effluent and has been in operation since June 2020. Potable water supplementation to Reservoir 2, predominantly in the summer months, may impact the influent water quality at the facility. Appendix A provides water quality tables showing the data overall and for time periods with and without the potable water supplementation.

The data in Table 2-9 represent the basis of design for the AWPF conceptual design, including RO projections. The water quality data were extracted from sampling conducted at the Demonstration Facility, and the 90th percentile value was used. Further characterization of the influent water quality for the AWPF is being conducted from November 2022 through April 2023 through supplemental sampling and will be shared as part of the procurement process.

Table 2-9. Basis of Design Influent Water Quality

Parameter	Units	Basis of Design
Alkalinity [a]	mg/L as calcium carbonate	150
Aluminum	mg/L	0.019
Barium	mg/L	0.023
Boron	mg/L	0.400
Calcium	mg/L	67.0
Chloride	mg/L	160
Fluoride	mg/L	0.665
Iron	mg/L	0.012
Magnesium	mg/L	32.0
Manganese	mg/L	0.033
Nitrate as N	mg/L as N	9.2
Orthophosphate as P	mg/L as P	2.98
Potassium	mg/L	18.6
Silica	mg/L	22
Sodium	mg/L	137

Table 2-9. Basis of Design Influent Water Quality

Parameter	Units	Basis of Design
Strontium	mg/L	0.505
Sulfate [a]	mg/L	180
TOC [a]	mg/L	8.98
TSS [a]	mg/L	2.2
pH [a]	s.u.	7.3
Temperature [a]	°C	16 to 28
DBCM [b]	µg/L	5
DCBM [b]	µg/L	5

[a] Collected from MF influent prior to chemical addition; all other values are from influent to the RO process.

[b] Maximum concentration to meet CTR requirements after AWPF based on Demonstration Facility performance. Requires implementation of preformed monochloramine disinfection at Tapia WRF.

2.7 Futureproofing the Advanced Water Purification Facility

LVMWD requested that the conceptual design consider futureproofing the AWPF by considering potential future changes that could impact AWPF sizing. Considerations for futureproofing consisted of the potential treatment requirements for DPR, potential additional treatment facilities that may be needed with augmenting of the source water supply to the AWPF, or due to other regulatory changes. For the PWP, DPR was considered because of the benefits of a raw water augmentation DPR approach in which the purified water would feed a WFP without traveling through a reservoir that is subject to seasonal algal activity and CTR requirements.

2.7.1 Direct Potable Reuse Framework

DDW is developing draft regulations regarding DPR, which they define as: "…the planned introduction of recycled water either directly into a public drinking water system or, or into a raw water supply immediately upstream of a drinking water treatment plant" (DDW 2022).

In 2021, the State of California released the "A Proposed Framework of Regulating Direct Potable Reuse in California Addendum" (State of California 2021). This document included initial proposed treatment requirements for DPR, and those requirements may have implications on the AWPF if DPR were to be implemented in the future. Since the draft DPR regulatory document was released, an Expert Panel reviewed and commented on the proposed treatment requirements, and DDW responded (NWRI 2022). It is expected that revised draft criteria will be released with anticipated DPR regulations by the end of 2023.

The initial proposed treatment requirements for DPR include requirements for enhanced source control; wastewater treatment; and then, at an AWT facility, an expanded multiple barrier approach (compared to FAT) to treating pathogens and chemicals. This expanded approach would need to include the following in addition to RO and UV-AOP:

- Treatment with ozone and biological activated carbon (BAC) filters when the DPR purified water represents 10% or more of the water treatment plant flow. Alternatives to ozone and BAC would be addressed as part of the alternatives clause.

- Ozone and BAC located appropriately upstream of RO, designed with the following requirements recommended by the Expert Panel:
  - Ozone with a project-specific applied ozone dose
  - BAC contactors, using granular activated carbon (GAC) media, with a minimum empty bed contact time (EBCT) of 15 minutes
  - Ozone and BAC demonstration of performance using carbamazepine and sulfamethoxazole as ozone performance indicators, and acetone and formaldehyde as BAC performance indicators
- Provision of three chemical barriers to organic chemicals, which would typically include ozone and BAC, RO, and an advanced oxidation process.
- Continuous longitudinal mixing of the flow, between the terminus of the wastewater collection system and the entry to the drinking water distribution system, sufficient to attenuate a 1-hour elevated concentration by a factor of 10.
- Additional pathogen barriers for log reduction of virus, *Giardia*, and *Cryptosporidium* (20-14-15, respectively, proposed). A total of four pathogen barriers are required, which must include three diverse treatment mechanisms. These barriers can exist at a wastewater treatment plant, an AWT plant, or a water treatment plant. A pathogen barrier at an existing wastewater treatment plant or water treatment plant must be tested to validate LRVs. A minimum of 1.0-log reduction would be required for each barrier.

The Expert Panel concluded that ozone and BAC should be located upstream of RO. Facilities including ozone and BAC upstream of RO would also locate ozone and BAC upstream of MF to avoid RO fouling caused by biological sloughing from BAC filters and to reduce MF fouling. Processes other than ozone and BAC that achieve the same treatment goals can be proposed as alternatives if desired. These chemical barriers must meet the TOC limit of less than 0.1 mg/L typically, and never greater than 0.5 mg/L. The capacity of the ozone and BAC treatment facilities could potentially vary based on the maximum wastewater contribution.

The DPR regulatory requirements are also expected to address:

- Responsibilities
- Certification
- Response time
- Reporting
- Plan development

2.7.2 Direct Potable Reuse Treatment Considerations

The following additional treatment steps would be required at the AWPF for DPR:

- Ozone and BAC would require at least one additional booster pump station, as well as backwash waste and backwash supply facilities.
- Ozone facilities were assumed to consist of a liquid oxygen (LOX) storage, ozone generators, ozone destruct units, and an ozone contactor to provide 5 minutes of contact time.
- BAC facilities were assumed to consist of vertical pressure vessel filters with deep media sufficient to provide 15 minutes of EBCT.
- Ozone and BAC upstream of MF and RO would likely help to reduce membrane capital and operations and maintenance (O&M) costs, potentially allowing for operation at higher flux rates and reduced cleaning frequency.
- With ozone and BAC, there would be impacts on chemical system sizing. It is anticipated that dechlorination would be provided before ozonation, followed by rechloramination before MF for biofouling control.

- In addition to ozone and BAC, the AWPF would likely need an additional pathogen barrier for *Cryptosporidium*, such as chlorine dioxide or a separate and independent UV disinfection system.
- The longitudinal mixing requirement was assumed to be provided in existing storage, including Reservoir 2.

Although ozone and BAC were considered, alternative treatment approaches allowed under an alternatives clause may provide equivalent levels of treatment as ozone and BAC (such as GAC adsorption after UV-AOP). It is likely that alternative approaches would require extensive demonstration testing prior to potential approval.

2.7.3 Feasibility-level Direct Potable Reuse Facility Layouts

Based on the draft DPR treatment requirements, building footprints were estimated for ozone and BAC facilities, with ancillary features. Figure 2-5 shows the overall footprint of these combined facilities (17,800 square feet [ft^2]), which includes the following:

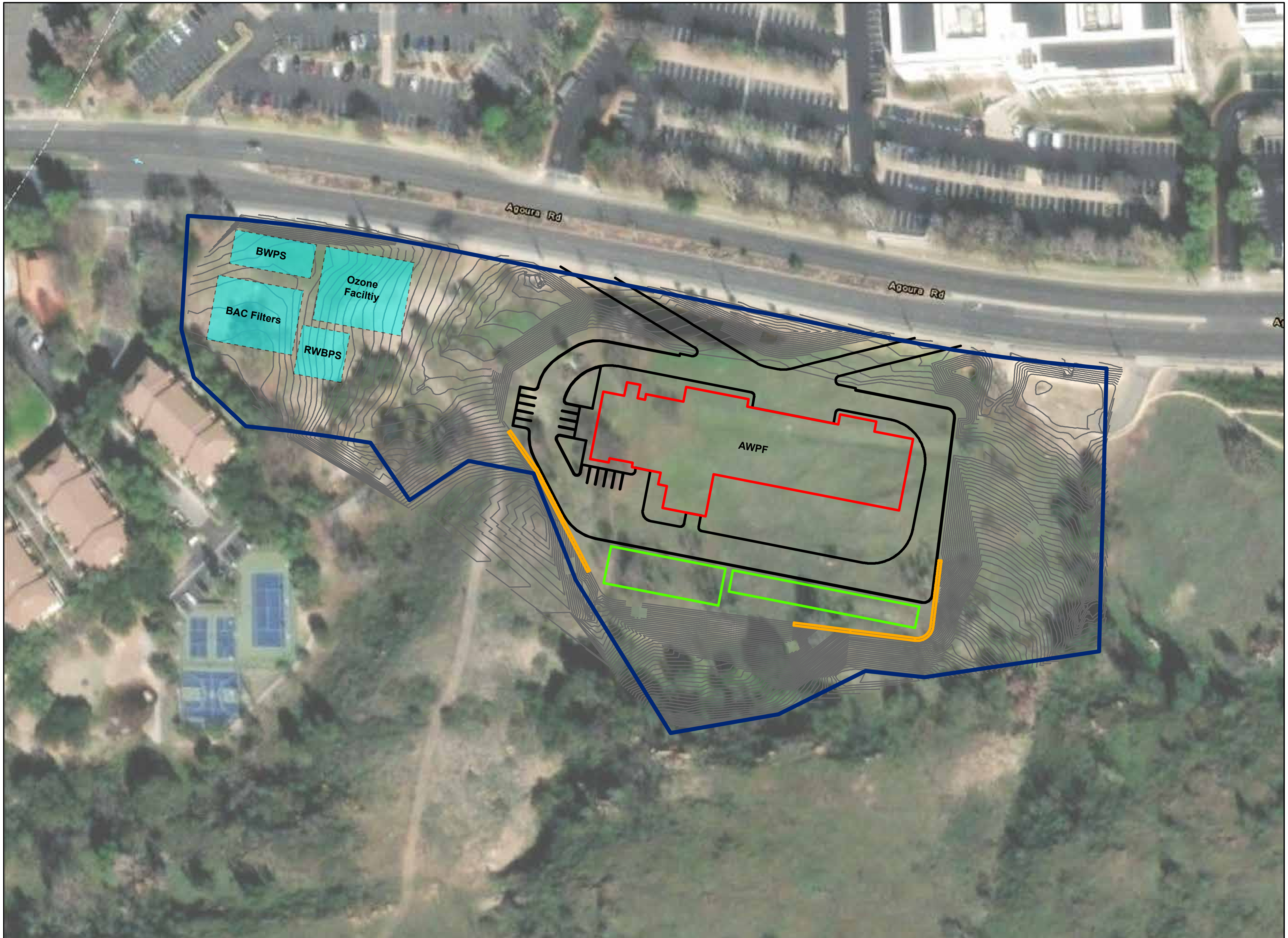
- Ozone (6,590 ft^2), to include:
  - Contactor, generator, and Electrical Room, Destruct Room, and LOX tank pad
  - Applied ozone dose of 10 mg/L
  - Serpentine contactor with 5-minute HRT
  - Side water depth (SWD) of 20 feet
  - One duty and one standby ozone generator with 625-lb/d capacity each
  - Two 10-foot-diameter LOX tanks
- BAC Filters (5,940 ft^2), assuming:
  - 7.5-MGD capacity (upstream of MF and RO)
  - 13 vertical pressure filters, each 12-foot diameter
  - Media depth of 8 feet
  - Filter loading rate of 3.9 gallons per minute per square foot (gpm/ft^2)
- RWPS (Booster) (2,500 ft^2), with three duty and one standby 100-horsepower (hp) horizontal centrifugal pumps
- Backwash Waste Pump Station (BWPS), including equalization basin (2,790 ft^2), with one duty and one standby 25-hp vertical turbine pumps and 250,000-gallon equalization basin
- Additional pathogen barrier using UV or chlorine dioxide (not shown)

This is not considered a preferable location for treatment facilities due to proximity to the neighboring community. However, as shown, the DPR treatment facilities could fit at this location.

For futureproofing, the same site location shown on Figure 2-5 could be considered for locating other treatment facilities if needed in the future, such as:

- GAC adsorbers (if needed for CTR compliance for DBP limits)
- Ion exchange (potential treatment for new augmentation source)
- Greensand filtration (if needed for iron and manganese removal for new augmentation source)
- Concentrate treatment (if required due to future regulatory changes or significant scaling issues)
- Other (due to potential future regulatory changes)

An additional option discussed during Project workshops would be to stack the AWPF in a multistory arrangement (such as, RO on a second level above MF), potentially making room for ozone and BAC facilities on the site plateau area where the entire facility is currently shown. This approach, which would have a major impact on the AWPF layout, was ruled out due to the high-profile of a multistory building, the impact on operations, and the uncertainty of future DPR implementation.



Legend

- AWPF Site
- Building
- Chemicals/Influent Equalization
- Retaining Wall
- Roadway
- Contours
- Future
- BWPS Backwash Pump Station
- RWBPS Raw Water Booster Pump Station

Sources:
ESRI World Topo Map; ESRI World Street Map

0 50 100 200
Feet
1 inch = 100 feet

Figure 2-5

Potential DPR Facilities Footprint

Pure Water Project Las Virgenes –Triunfo

Jacobs

3. Overall Process

This section describes the AWPF process facilities and includes the following elements:

- Process Overview
- Reliability and Redundancy
- Seasonal Operation Considerations
- Residual Disposal Requirements
- Critical Control Points

3.1 Process Overview

This conceptual design was based on the following process facilities to achieve the flow capacity and treatment objectives described in Section 2 – Basis of Design:

- **Influent Equalization and MF Feed Pump Station,** which will equalize source water flows and pressurize water through the MF system (Section 5)
- **MF System,** comprising feed strainers, MF racks, and ancillary systems to provide filtration of suspended solids, organics, and pathogens (*Giardia* and *Cryptosporidium)*, while providing pretreatment for the downstream RO process (Section 5)
- **RO System,** comprising cartridge filters, RO skids, and ancillary systems to remove dissolved constituents and serve as a pathogen barrier for bacteria, protozoa, and viruses (Section 6)
- **UV-AOP System,** which provides disinfection and log reduction of all target pathogens (Section 7)
- **Post-treatment for water stabilization,** consisting of partial decarbonation and chemical addition to stabilize the purified water to minimize scaling and corrosion, provide a disinfection residual, and mitigate algae growth in the Las Virgenes Reservoir (Section 8)
- **PWPS,** to convey the purified water from the AWPF to the Las Virgenes Reservoir (Section 8)
- **Residuals waste handling systems,** to manage various waste streams generated from each liquid treatment process (Section 9)
- **Chemical feed and storage systems,** to provide chemicals needed to achieve treatment goals and optimize individual process performance (Section 10)

3.1.1 Process Flow Diagram

Figure 3-1 presents the AWPF process flow diagram, which identifies the major elements for each process facility, including required chemicals to clean the membranes in the maintenance clean (MC) and recovery clean (RC) system, RO CIP system, and throughout the process in water stabilization and residual waste handling facilities. The conceptual design criteria for each of the process facilities is presented in subsequent sections of this report.

3.1.2 Overall Plant Layout

Figure 3-2 presents the overall plan view for the AWPF, with the roof and canopies removed for visualization. The main MF, RO, and UV-AOP system elements are located inside a building; while the post-treatment systems, PWPS, and residual waste handling systems are located outside the plant building, in belowground tanks or under canopies. An access road with parking loops around the main treatment area. Influent equalization with MF feed pumps and strainers are located under a canopy next to a centralized liquid chemical facility, both separate from the main treatment plant building. O&M facilities are shown adjacent to the major process areas. The general arrangement of the equipment for each process facility was developed with consideration for O&M staff and matches the general flow of water and residuals within the AWPF.

3.1.3 Residual Disposal Requirements

The AWPF will generate waste residuals that will require disposal. The process drains' backwash water generated by the strainers, MF, as well as MF and RO cleaning solutions, will be collected in an onsite waste equalization tank, neutralized, and pumped to the sewer. The sanitary waste flows will be discharged by gravity directly into an onsite maintenance hole and pumped to the sewer. The ROC will be directed to the ROC pump station, comprising a wet well and pumps that will convey the ROC through an estimated 13.2- to 14.5-mile-long pipeline to the Calleguas SMP.

3.2 Reliability and Redundancy

To provide reliability and redundancy, the conceptual design used N+1 for most process equipment within each system for the basis of design. This includes nearly all pumps and ancillary equipment. More redundancy was used for the MF system, with N+2 for space planning to accommodate membrane cleaning and mechanical maintenance.

It is anticipated that this facility will be operated seasonally, allowing for maintenance and cleaning of storage tanks. Therefore, no redundancy was planned for the following tanks:

- Flush tanks
- Backwash tank
- CIP tanks
- Neutralization tanks
- Equalization tanks

Redundancy was provided for most of the chemical storage tanks to facilitate full-load chemical deliveries and ensure availability of required chemicals for the process.

The conceptual design includes a standby generator to provide power for essential operations during an unscheduled power outage, namely MF backwashing and RO flushing for membrane protection and building systems. Full AWPF backup power is not included, as LVMWD has emergency disposal options.

3.3 Critical Control Points

Water quality monitoring will be integral to achieving successful operation of the AWPF. As such, CCPs will be used in the AWPF. CCPs are points within a treatment process that are designed to support proper process performance and exist to reduce, prevent, or eliminate human health hazards (WRF 2016). At each CCP, critical control limits (CCLs) are set for physical, chemical, or biological parameters that are frequently measured or monitored (either continuously with online instrumentation or intermittently by manual sampling) to assess whether the process is operating as intended.

Depending on the parameter, a CCL may be a minimum or maximum value that must be monitored at the CCP. For example, when the water quality or operating conditions at a CCP fall outside of the target, goals, or boundary conditions set by the CCL, an operational alarm will be activated to notify Operations that corrective actions need to be taken.

Table 3-1 summarizes the CCPs and recommended parameters to consider for the AWPF by treatment process.

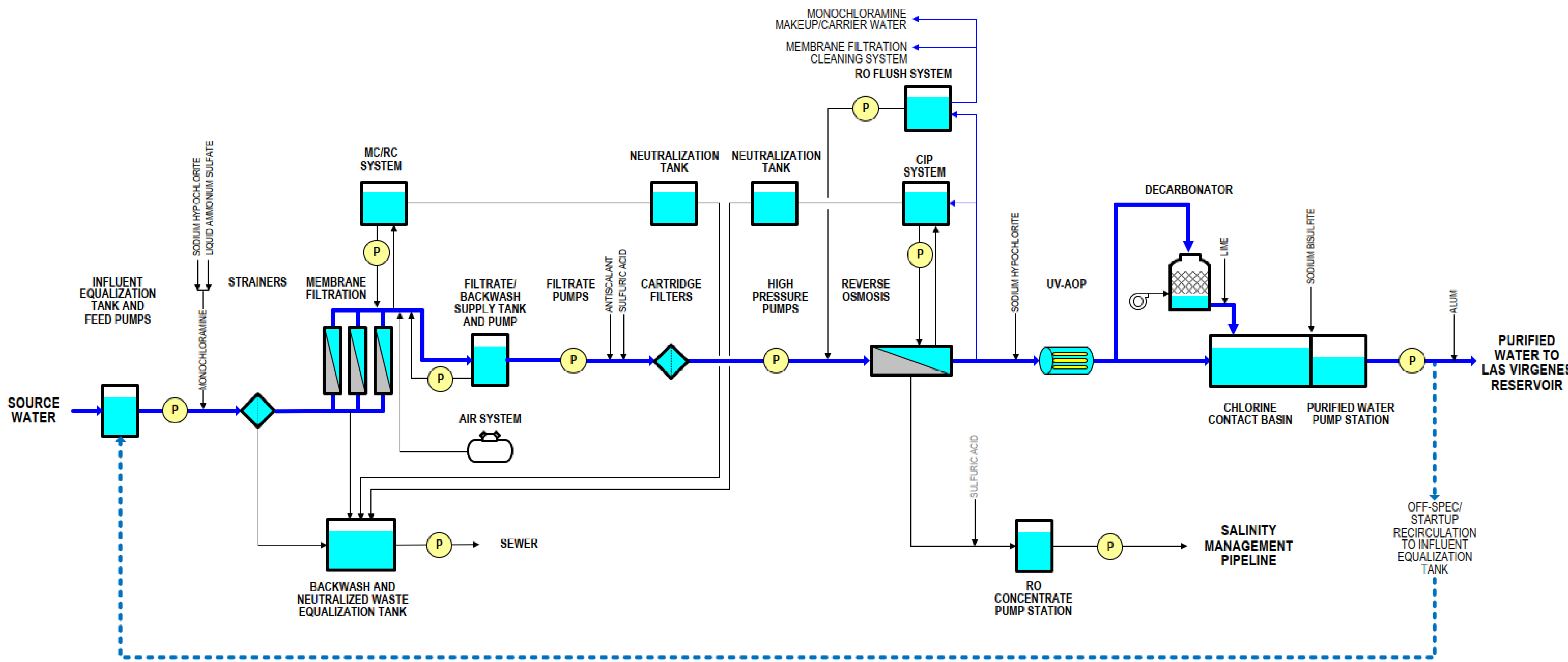


Figure 3-1. Advanced Water Purification Facility Process Flow Diagram

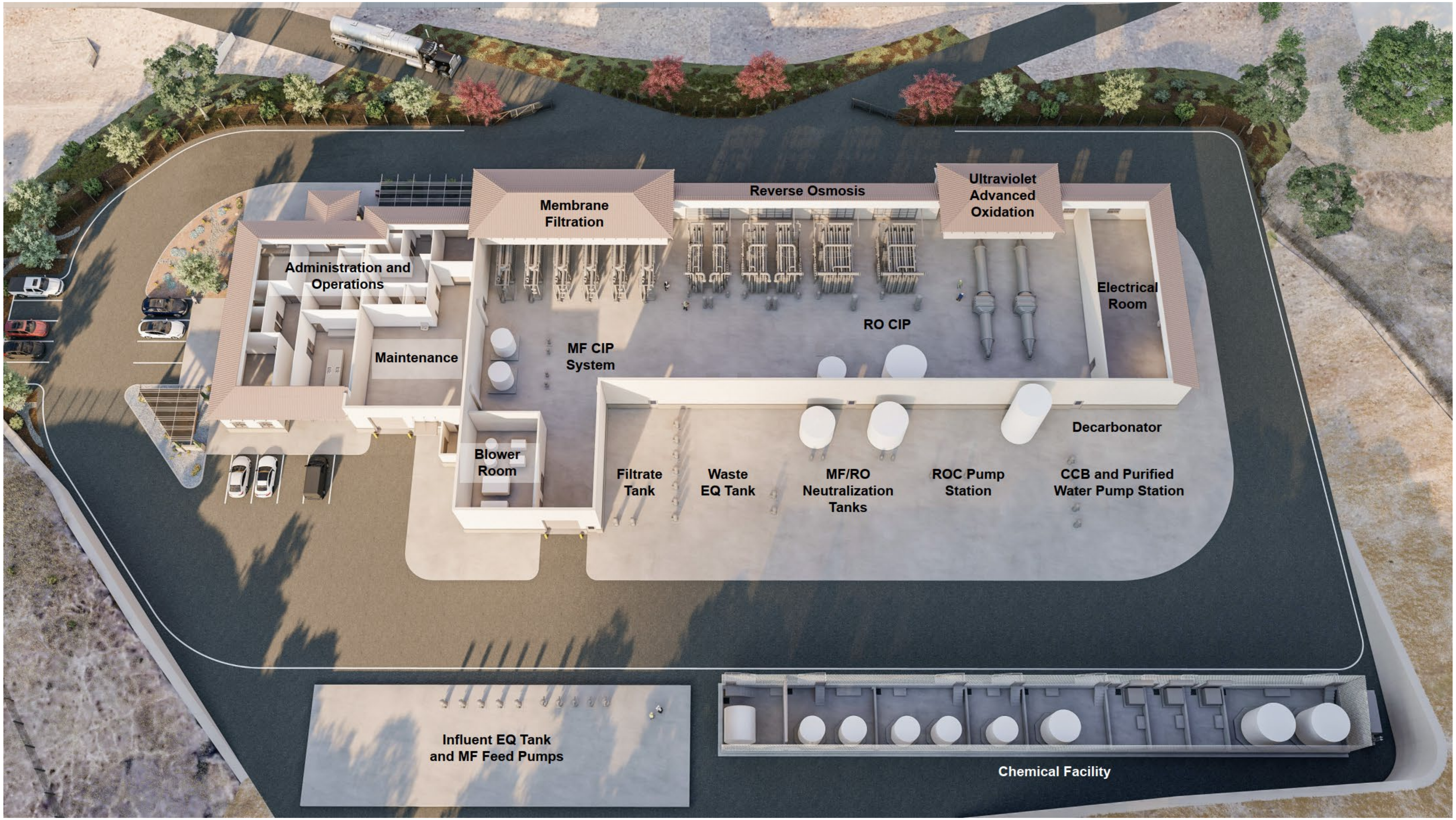


Figure 3-2 Advanced Water Purification Facility Rendering

Note: Image shows roof and canopies removed.

Table 3-1. Preliminary List of Advanced Water Purification Facility Critical Control Points

Process	CCP	Parameters	Considerations
Pipeline Chloramination *(if used)*	▪ Source water	▪ Total chlorine residual ▪ Temperature ▪ pH ▪ Flow rate	Virus LRV credit will be demonstrated to be ≥ 1.5 by maintaining CT with preformed monochloramine. Required CT will be determined from laboratory study, to be performed if pipeline chloramination is selected for disinfection credit.
MF	▪ LRV ▪ MF filtrate	▪ Pressure decay testing (membrane integrity testing) ▪ Turbidity	Pursuant to the *Membrane Filtration Guidance Manual* (EPA 2005), both direct and indirect integrity measurements will be required to demonstrate performance and pathogen removal by the MF system. Direct membrane integrity testing will be performed daily on each membrane rack using pressure decay testing, which will be used to calculate the LRV for G*iardia* and *Cryptosporidium*. Indirect membrane integrity monitoring will be achieved with continuous monitoring (every 15 minutes) of turbidity to reach ≤ 0.15 NTU in the MF filtrate from each individual membrane rack.
RO	▪ RO feed ▪ RO permeate	▪ Conductivity ▪ TOC ▪ Sulfate *(if used)* ▪ Strontium *(if used)*	Pursuant to the *Membrane Filtration Guidance Manual* (EPA 2005), the following indirect integrity monitoring can be used to demonstrate performance and log removal of viruses, *Giardia, and Cryptosporidium* by the RO system: ▪ Continuous monitoring (every 15 minutes) of conductivity ▪ Continuous monitoring of TOC has been approved by DDW to demonstrate log removal of pathogens Daily monitoring of other inorganic surrogates, such as sulfate or strontium, can also be performed and potentially provide the ability to demonstrate higher log removal of pathogens.
UV-AOP	▪ UV-AOP feed ▪ UV-AOP product	▪ UV transmittance ▪ Chlorine residual (free and total) ▪ UV dose ▪ Power ▪ Flow rate	UV-AOP feed transmittance will be ≥95% at all times. The design free chlorine residual, UV dose, power, and flow rate will be maintained to exceed the UV-AOP system settings required to receive log reduction credit and 1,4 dioxane destruction.
CCB *(if used)*	▪ Purified water	▪ Free chlorine residual ▪ Temperature ▪ pH ▪ Flow rate	Virus LRV credit will be demonstrated to be ≥ 1.5 by a maintaining free chlorine CT of 9 mg/min/L based on CT tables from the Australian WaterVal standards (WaterSecure 2017) used by DDW on other recent municipal reuse projects, if a CCB is selected for disinfection credit.

3.4 Seasonal Operation Considerations

The AWPF will operate under variable flow conditions with an annual offline season, typically occurring in the summer months when recycle water demand is high between April 15 and November 15. As such, the treatment processes will experience higher than typical offline time compared to other reuse facilities. An operating strategy will need to be developed to allow for sequential removal of individual process units from service, followed by extended periods of offline time when treatment equipment will need to be drained or preserved. Table 3-2 provides a list of considerations for seasonal operation that can be used to develop a framework for the overall AWPF operating strategy.

Table 3-2. Seasonal Operation Considerations

Treatment Process	Seasonal Operation Considerations
MF	▪ Operate with all duty racks in service when possible. At lower-flow conditions, operate at lower flux with all or most duty racks in service while maintaining minimum flux requirements from the membrane supplier. ▪ Cycle racks in and out of service to keep membrane fibers wet and mitigate stagnant contact with raw water. ▪ Maintain maintenance cleaning frequency even at lower flows, as recommended by the membrane supplier. ▪ Determine CIP frequency by degree of fouling as determined by temperature-corrected permeability decline, which may vary seasonally based on changes in flow. ▪ Preserve membrane racks with chlorine during the AWPF offline season. Perform weekly chlorine residual checks, and refresh chlorine as needed. ▪ Drain pre-strainers per manufacturer recommendations, and drain feed and MF permeate piping during the AWPF offline season to minimize biogrowth and MIC. ▪ Perform planned MF system maintenance during the AWPF offline season.
RO	▪ Number of RO skids required will be determined based on flow conditions. ▪ Operate with all duty racks in service when possible. At lower-flow conditions, reduce online time by cycling operation between racks, and perform routine flushing until flows drop enough so that one RO skid can be removed from service and preserved with sodium bisulfite. ▪ Preserve RO skids sequentially as flows reduce seasonally until all skids are preserved and the AWPF commences the offline season. ▪ During the offline season, perform weekly pH checks. If pH drops to 3 or less, replace the preservation solution. Best practice is to change preservations solution once per month. ▪ Drain cartridge filter housings, remove filter elements per manufacturer recommendations, and drain feed lines and RO permeate line to minimize biogrowth and MIC. ▪ At minimum flow conditions, consider operating single RO skid at reduced recovery to increase ROC flow in the ROC conveyance infrastructure as a strategy to mitigate potential scale formation. ▪ Determine CIP frequency by degree of fouling and scaling as quantified by changes in normalized performance parameters (differential pressure, water transport coefficient, salt transport coefficient). ▪ Perform planned RO system maintenance during the AWPF offline season.

Table 3-2. Seasonal Operation Considerations

Treatment Process	Seasonal Operation Considerations
UV-AOP	▪ Operate the UV-AOP system with one duty reactor train in service and one reactor train in standby. ▪ Operate the duty reactor train to provide the design dose at all times. At lower-flow conditions, program the UV-AOP system to provide the design dose with lower power settings and reduced lamp banks in service. ▪ Drain UV-AOP reactor trains at the start of the AWPF offline season. Consult manufacturer for instructions. ▪ Perform planned UV-AOP system maintenance during the AWPF offline season.
Chemical Systems	▪ Program chemical feed pumps to automatically flow-pace chemical dosing. Base dose trimming on online analytical instrumentation (pH). ▪ Perform routine calibration as AWPF flows decrease and increase. ▪ Consider usage and duration of AWPF offline season when ordering bulk chemical deliveries, particularly for chemicals that are subject to degradation (sodium hypochlorite). ▪ Flush chemical feed lines at the start of the AWPF offline season. Perform routine maintenance during the AWPF offline season.
Tanks and Pump Stations	▪ Use the AWPF offline season to perform routine maintenance, inspections, and cleaning of tanks and pump stations within the AWPF.
ROC Pipeline	▪ During the offline season, flush with recycled water to remove salts. ▪ Conduct routine inspection and maintenance as necessary.

MIC = microbially induced corrosion

4. Hydraulics

This section describes the conceptual hydraulic design for the AWPF and includes the following elements:

- Influent Flow Rates
- Flow Distribution
- Hydraulic Calculations
- Conceptual Hydraulic Profile

Bentley Systems' MicroStation was used to develop the AWPF's conceptual hydraulic profile.

4.1 Influent Flow Rates

Table 4-1 presents the influent flows for the AWPF.

Table 4-1. Advanced Water Purification Facility Influent Flow Conditions

Flow Condition	Units	Influent Flow
Maximum	MGD	7.5
Average	MGD	3.2
Minimum	MGD	1.0

4.2 Flow Distribution

The energy and hydraulic grade line (HGL) elevations upstream and downstream of the hydraulic elements in the AWPF were calculated. The hydraulic analysis began at the water surface datum elevation at the downstream end of the treatment process. The hydraulic calculations proceeded upstream from this datum elevation, one element at a time, calculating the headloss through each element. In the event of a flow split, the calculation proceeded along the path with the highest headloss. The North American Vertical Datum of 1988 (NAVD 88) is used for the AWPF. The hydraulic model is separated into several segments because the hydraulic profile resets at each pump station, making each segment hydraulically independent.

Recycled water will flow from the Indian Hills Tanks and enter the AWPF through the below-grade influent equalization tank, where it breaks head under atmospheric conditions. The vertical turbine feed pumps at the influent equalization tank will lift the flow, which feeds the strainers located at-grade directly above the influent equalization tank. The screened flow will be conveyed from the strainers to the MF system in the AWPF building for further treatment, and the resulting filtrate will be stored in a below-grade filtrate tank adjacent to the building. Vertical turbine filtrate pumps will then lift the filtrate and feed it back to the AWPF building through the cartridge filters, and the RO high-pressure pumps downstream of the cartridge filters will boost to the pressure required by the RO system. Permeate from the RO system will undergo disinfection in the UV-AOP system and post-treatment in the decarbonator and CCB, which overflows into the PWPS over a weir.

4.3 Hydraulic Calculations

The hydraulic profile was calculated from the downstream end of the AWPF at the PWPS and working upstream to the head of the AWPF at the influent equalization tank. The calculation considers the headloss through each hydraulic element within the AWPF, including major piping, fittings, and equipment, as well as the heads provided by the pump stations, namely the following:

- Influent equalization tank and feed pumps
- Filtrate tank and pumps
- RO high-pressure pumps
- PWPS

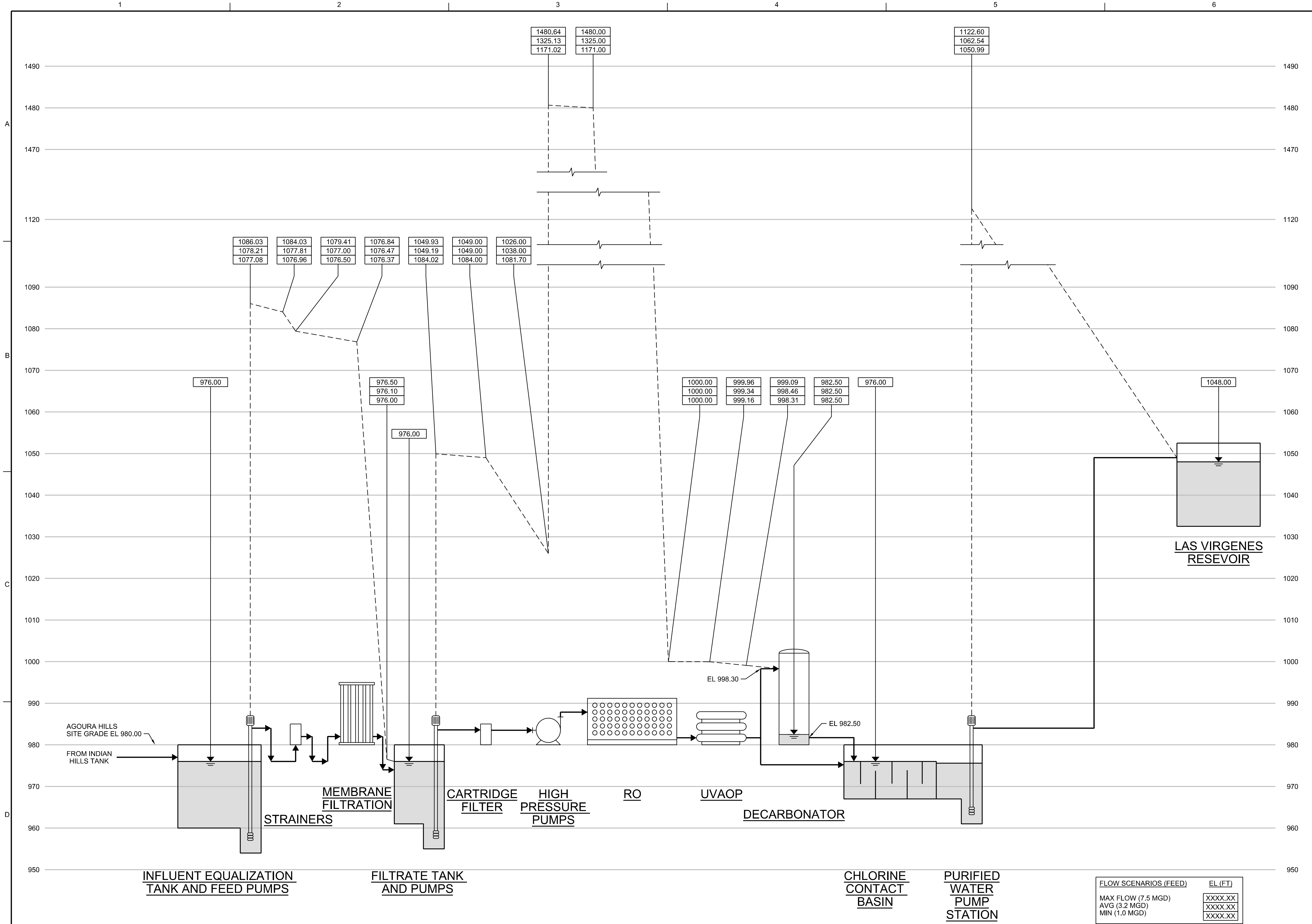
The headloss and head addition at each stage of the process directly impact the stage immediately upstream and downstream, respectively.

Some of the main criteria used in the hydraulic calculations are:

- The overall finished grade elevation at the Agoura Road site is 980 feet.
- The AWPF will be fed by gravity flow from the Indian Hills Tank.
- The maximum water surface elevation at Las Virgenes Reservoir to the PWPS pumps is 1,048 feet.
- A freeboard of 3 feet and minimum pump submergence of 6 feet was assumed for the influent equalization tank, filtrate tank, and PWPS.
- Piping friction and minor losses were calculated using the Darcy-Weisbach equation, nominal pipe diameters, and the absolute roughness for cement mortar lining, as a conservative assumption. Pipe material will be determined during detailed design.

4.4 Conceptual Hydraulic Profile

A conceptual hydraulic profile presented on Figure 4-1 was prepared for the AWPF to establish the HGL through the AWPF based on the flow conditions in Table 4-1.



PURE WATER PROJECT LAS VIRGENES-TRIUNFO

ADVANCED WATER PURIFICATION FACILITY
AGOURA HILLS, CALIFORNIA

DSGN J ZHANG
DR T NGUYEN

Jacobs

GENERAL
MECHANICAL
HYDRAULIC PROFILE

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2022
PROJ	W9Y31200
DWG	AWPF-M-3001
FIGURE	

CONCEPTUAL DESIGN

5. Membrane Filtration

This section presents the conceptual design of the MF process for the AWPF and includes the following elements:

- Process Description and Design Considerations
- Process Design Criteria
- Conceptual Layout
- Operational Strategies

5.1 Process Description and Design Considerations

The purpose of the MF system, consisting of a microfiltration or ultrafiltration system, is to:

- Minimize fouling of the downstream RO process through the removal of particulate and colloidal matter in the influent
- Provide a barrier to the passage of pathogenic microorganisms, including bacteria and protozoa

RO membrane manufacturers require feed water turbidity and silt density index (SDI) values to be less than 1 NTU (the goal is 0.2 NTU) and less than 4 SDI (the goal is 3 SDI or less), respectively. This is to minimize fouling by particulate and colloidal matter, hence, minimize the need for chemical cleaning. MF provides RO feed water quality that meets these turbidity and SDI requirements.

The MF system described in this section consists of the following major components shown on Figure 5-1:

- Feed pump station
- Strainers
- MF valve and rack assemblies containing hollow-fiber membrane modules
- Filtrate tank and filtrate pumps
- Backwash and compressed air systems
- Membrane cleaning and neutralization system
- Waste equalization, including pump station (Section 9 – Residuals, provides more details)

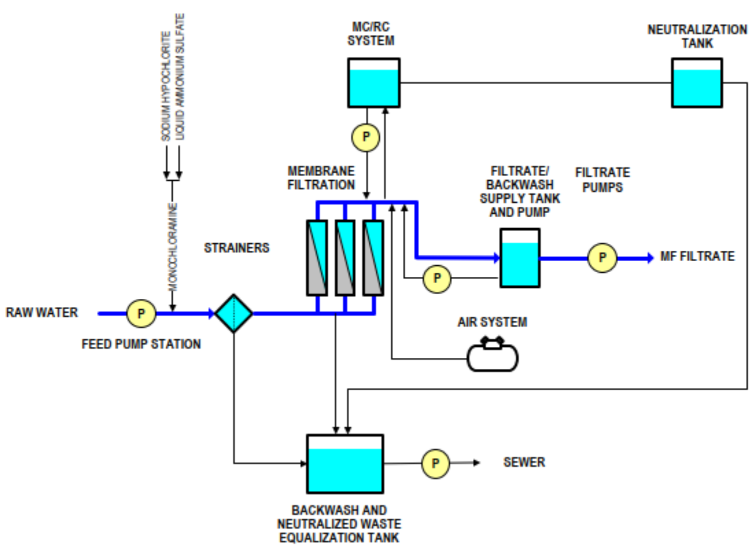


Figure 5-1. Membrane Filtration Process Flow Diagram

The MF system conceptual design was guided by the first year results of the JPA's Pure Water Demonstration Project (Demo) (Carollo 2022), which evaluated three low-pressure hollow-fiber membrane modules, namely:

- Dow DuPont SFD-2880XP
- Pall UNA-620A
- Toray HFUG 2020AN

The main findings from the Demo are summarized as follows:

- While typical MF systems for tertiary effluent have flux values in the range of 25 to 35 gallons per day per square foot (gpd/ft^2), an average flux of 40 gpd/ft^2 appeared to be sustainable treating Tapia WRF effluent for all three modules tested.
- The target recovery of 95% was achieved by all modules.
- One MC per week and one RC per month for the MF system cleans were deemed to be sufficient for all modules.

Based on the first year Demo results, the design criteria for the MF system were established. An N+2 design was adopted for redundancy and reliability. Two suppliers (Pall and H2O Innovation) were engaged to develop the representative conceptual design. An interchangeable rack design was assumed to allow flexibility and support competitive bidding for future module replacements. Interchangeable racks are designed around two or three membrane modules with similar size, performance, and operational requirements.

Pall supplies a proprietary microfiltration rack that can be interchangeable with direct retrofit membrane modules of similar characteristics (as manufactured by Toray and others), while H2O Innovation offered an interchangeable rack that can fit both the Dow DuPont and Toray modules evaluated, as well as other similar-sized ultrafiltration modules in the marketplace. The conceptual design was developed to accommodate both rack designs for all three modules tested at the Demo.

Table 5-1 summarizes the design criteria for the overall MF system.

Table 5-1. Membrane Filtration System Design Criteria

Parameter	Units	Value
No. of Trains	each	6 (4 duty, 2 standby [a])
Feed Flow Capacity	MGD	7.5 (maximum) 1.0 (minimum)
Filtrate Flow Capacity	MGD	7.1 (maximum) 0.95 (minimum)
Minimum Recovery	%	95
Maximum Instantaneous Flux	gpd/ft^2	40 (2 trains offline [a])
Temperature Range	°C	16-28
Minimum Spare Module Space	%	10
Minimum Chemical Cleaning Frequency	days	30

[a] N+2 design based on one rack offline for cleaning or membrane integrity testing and one rack offline for mechanical maintenance.

5.2 Process Design Criteria

This section describes the MF process design criteria.

5.2.1 Influent Equalization and Membrane Filtration Feed Pump Station

Recycled water from Tapia WRF will flow by gravity from the Indian Hills Tank to the below-grade influent equalization tank at the AWPF. A feed pump station will be required to convey the recycled water from the influent equalization tank and pressurize the feed water through the strainers and, subsequently, the MF system. Table 5-2 and Table 5-3 summarize the design criteria for the influent equalization tank and MF feed pumps, respectively.

Table 5-2. Influent Equalization Tank Design Criteria

Parameter	Units	Value
Length	ft	120
Width	ft	35
SWD (Usable)	ft	16
Depth	ft	25[a]
Workable Volume	gallons	502,691
HRT	hr	1.6 [b]

[a] Depth includes 16 ft of usable SWD, 3 ft of freeboard, and an additional 6-ft-deep sump for minimum pump submergence.

[b] Based on maximum AWPF feed flow of 7.5 MGD.

ft = foot (feet)

hr = hour(s)

Table 5-3. Membrane Filtration Feed Pump Design Criteria

Parameter	Units	Value
No. of Pumps	each	5 (4 duty, 1 standby)
Pump Type	-	Vertical turbine
Pump Capacity, Each	gpm	1,300
	MGD	1.85
Pump Capacity, Total	gpm	5,200
	MGD	7.5
Pump TDH	ft	115
Motor Size	hp	50
Drive	-	VFD

gpm = gallon(s) per minute

TDH = total dynamic head

VFD = variable frequency drive

5.2.2 Strainers

MF systems are designed to filter small suspended solids and particles. Larger-size suspended solids, particularly those that are sharp and abrasive, can accumulate if allowed to enter the fiber bundle, causing fiber damage (including breakage) and a buildup of solids. As such, the MF feed water will be screened by automatic backwashing strainers to remove these larger solids.

Feed water enters the automatic strainers through an inlet on the inside of a cylindrical screen and flows radially outward. Particulates and debris larger than the screen mesh size collect on the inner surface of the screen. The automatic strainers perform a self-cleaning flush periodically based on either a timer or differential pressure so that solids are dislodged from the inner surface of the straining element and discharged to waste.

Warranties from the various MF module manufacturers typically require a screen mesh size of 200 to 300 micrometers (µm).

Table 5-4 summarizes strainer design criteria.

Table 5-4. Strainer Design Criteria

Parameter	Units	Value
No. of Strainers	each	5 (4 duty, 1 standby)
Strainer Type	-	Automatic backwashing
Strainer Capacity, Each	gpm	1,300
Strainer Capacity, Total	gpm	5,200
Screen Size	µm	200-300
Pressure Drop at Rated Flow, Clean	psig	2
Suction and Discharge Flange Size	inches	8
Maximum Operating Pressure	psig	145

psig = pound(s) per square inch gauge

5.2.3 Membrane Filtration Racks and Modules

The heart of the MF system is the membrane filter rack, which typically consists of a valve rack and a module rack. The valve rack contains the control valves and I&C for the associated module rack. The module rack consists of piping headers that complete the following actions:

- Structurally support the membrane modules
- Supply feed water
- Collect filtrate
- Supply filtrate and air during backwash
- Supply and convey away chemical cleaning solutions during MC and RC

The valve and module racks for one filter rack connect to each other in series and to a valve rack by a set of pipe spools.

The conceptual design was developed to accommodate both proprietary and interchangeable module rack designs for the Dow DuPont, Pall, and Toray modules that were tested in the Demo. Table 5-5 summarizes the specifications for the modules.

Of note, the Toray module tested in the Demo was the HFUG 2020AN, which has a higher packing density compared to Toray's long-standing standard ultrafiltration module, the HFU 2020AN. Otherwise, both modules have identical exterior physical characteristics and connections. During the Demo, some operational challenges were encountered with the HFUG 2020AN module, which were investigated with a membrane autopsy by American Water Chemicals, Inc. following the completion of the *Purification System Performance Report* (Carollo 2022). As such, the HFU 2020AN module was chosen as the basis of design to provide a more conservative footprint for the module racks and is also presented in Table 5-5.

Table 5-5. Membrane Module Specification

Parameter	Units	Pall UNA-620A	Dow DuPont SFD-2880XP	Toray HFUG 2020AN	Toray HFU 2020AN
Membrane Material	-	PVDF	PVDF	PVDF	PVDF
Membrane Casting	-	TIPS	NIPS	TIPS	TIPS
Type	-	Microfiltration	Ultrafiltration	Ultrafiltration	Ultrafiltration
Nominal Pore Size	µm	0.1	0.03	0.01	0.01
Module Length	inches	93	92.9	85	85
Module Diameter	inches	6.5	8.9	8.5	8.5
Membrane Area (per module)	ft^2	538	829	969	775

NIPS = nonsolvent induced phase separation

PVDF = polyvinylidene fluoride

TIPS = thermally induced phase separation

Both the HFU and HFUG modules may ultimately be acceptable pending the outcome of investigations underway by LVMWD. Table 5-6 summarizes the design criteria for the three module racks. For sizing purposes, an 89% online factor is the basis of design. An online factor is the percent of time the membrane is running during normal operation, considering the required offline time for routine backwashing and membrane cleaning.

Table 5-6. Membrane Rack Design Criteria

Parameter	Units	Pall UNA-620A	Dow DuPont SFD-2880XP	Toray HFU 2020AN
No. of Racks	each	6 (4 duty, 2 standby)	6 (4 duty, 2 standby)	6 (4 duty, 2 standby)
Total Feed Flow	MGD	7.5	7.5	7.5
Total Filtrate Flow	MGD	7.1	7.1	7.1
Recovery	%	95	95	95
Filtrate Capacity per Rack	MGD	1.78	1.78	1.78
Online Factor	%	89	89	89
Average Flux	gpd/ft^2	34.9	34.3	34.6
Maximum Instantaneous Flux	gpd/ft^2	39.1	38.4	38.7
Installed Modules per Rack	No.	100	66	70
Empty Spaces per Rack (capped)	No.	12	10	10
Spaces per Rack	No.	112	76	80
Spare Capacity[a]	%	12	15.1	14.5
Module Area	ft^2	538	829	775
Membrane Area per Rack	ft^2	53,800	54,714	54,250
Total Modules	No.	600	396	420
Total Membrane Area	ft^2	322,800	328,284	325,500

[a] A minimum spare capacity of 10% was used. The actual number of spare module spaces was calculated based on rounding up the total module spaces to the closest multiple of 4 based on a quad rack design with 4 modules per row. The actual space capacity is presented in this table.

5.2.4 Filtrate Tank and Filtrate Pumps

The filtrate is conveyed from each membrane rack through a manifold to a below-grade filtrate tank that will serve as the RO feed tank and backwash supply tank. The filtrate pumps will pressurize the water through the pre-RO cartridge filters. Table 5-7 and Table 5-8 summarize the design criteria for the filtrate tank and filtrate pumps, respectively.

The filtrate pumps will be VFD-driven, vertical turbine pumps located at-grade, directly on top of the filtrate tank. The filtrate pumps are sized for the flow to one medium-sized RO train each. When one small RO train (alone) is operating, filtrate pump pressure will be greater than listed in the table.

The backwash pumps (described in Section 5.3.5) will also be vertical turbine pumps and co-located at-grade directly above the filtrate tank.

Table 5-7. Filtrate Tank Design Criteria

Parameter	Units	Value
Length	ft	46
Width	ft	30
SWD (Usable)	ft	6
Depth	ft	15 [a]
Workable Volume	gallons	61,939
HRT	minutes	12.6 [b]

[a] Depth includes 6 ft of usable SWD, 3 ft of freeboard, and an additional 6 ft for minimum pump submergence.

[b] Based on maximum AWPF feed flow of 7.5 MGD.

Table 5-8. Filtrate Pump Design Criteria

Parameter	Units	Value
No. of Pumps	each	7 (6 duty, 1 standby)
Pump Type	-	Vertical turbine
Pump Capacity, Each	gpm	980
	MGD	1.4
Pump Capacity, Total	gpm	4,930
	MGD	7.1
Pump TDH	ft	65
Motor Size	hp	25
Drive	-	VFD

5.2.5 Backwash and Compressed Air System

As filtration progresses, solids accumulate on the membrane surface, increasing the resistance to flow across the membrane and increasing the required transmembrane pressure (TMP) needed to maintain the desired filtrate flow. Based on either a preset time (typically 20 to 30 minutes) or a preset volume of filtrate processed, the filtration process is stopped and the membrane rack placed into a backwash sequence, which uses filtrate and air scour to remove the accumulated solids from the membrane modules. Specifically, the backwash sequence pumps filtrate through the fiber from the lumen side to the feed side and supplies air to the feed side at the bottom of the module to create turbulence at the outer surface of the membrane fibers. In addition, at the end of the filtrate flow step, feed water (along with air scour) is supplied to the module to flush displaced solids.

The backwash system comprises two backwash pumps (one duty and one standby) and associated valves and controls (located on the valve rack). The backwash pumps will be located at-grade directly above the MF filtrate tank (Section 5.3.4) that supplies the backwash water. Table 5-9 summarizes the design criteria for the backwash pumps. Notably, there was a considerable difference in the backwash pumping capacity required by Pall (930 gpm at 40 pounds per square inch [psi]) and H2O Innovation (1,640 gpm at 40 psi), and the higher of the two capacities was assumed.

Table 5-9. Design Criteria for Backwash Pumps

Parameter	Units	H2O Innovation (Basis of Design)	Pall
No. of Pumps	No.	2 (1 duty, 1 standby)	2 (1 duty, 1 standby)
Pump Type	-	Vertical turbine	Vertical turbine
Pump Capacity	gpm	1,640	930
Pump TDH	ft	92	92
Motor Size	hp	60	40
Drive	-	VFD	VFD

The compressed air scour system comprises two air compressors and one air receiver. The system provides a source of pressurized air to the modules during air scour and:

- Operates pneumatic valve actuators, including those on the valve rack
- Pressurizes the feed or filtrate side of the membrane modules during membrane integrity testing

While Pall's design assumed air compressors and a receiver sized to perform these two functions as well as air scour, H2O Innovation's design required blowers to provide scour air during backwash. For a conservative footprint, the design assumes that both the air compressor and receiver system and blowers will be provided. Table 5-10 and Table 5-11 summarize the design criteria for the air compressor and receiver system and the blowers.

Table 5-10. Air Compressor and Receiver Design Criteria

Parameter	Units	Value
No. of Compressors	No.	2 (2 duty, 0 standby)
Compressor Type	-	Duplex
Capacity	scfm	72
Pressure	psig	125
Compressor Power	hp	5
No. of Receivers	No.	1
Receiver Capacity	gallons	120
Receiver Design Pressure	psig	80

scfm = standard cubic foot (feet) per minute

Table 5-11. Blower Design Criteria [a]

Parameter	Units	Value
No. of Blowers	No.	2 (1 duty, 1 standby)
Blower Type	-	Positive displacement or centrifugal
Capacity	scfm	400
Pressure	psig	13
Motor Size	hp	33

[a] For H2O Innovation only

5.2.6 Cleaning System

This section provides details about the cleaning system conceptual design. The make-up water for these systems should be either RO permeate or softened water, given the elevated levels of calcium and alkalinity in the MF filtrate.

5.2.6.1 Maintenance Clean

Backwash and air scour is not completely effective at removing accumulated foulants, particularly for precipitable metals, bacteria, and colloidal organics that cause nonbackwash reversible fouling. To more effectively remove these constituents, an MC is required. MC is also referred to as enhanced flux maintenance by Pall or chemically enhanced backwash by other suppliers.

During an MC, bases and oxidants are used to control biofouling and organic fouling, while acids are used to control inorganic fouling from dissolved metals and scaling. During the Demo, MCs were performed primarily with sodium hypochlorite at a frequency of once or twice a week. While the *Purification System Performance Report* recommended weekly MCs due to the generally low fouling rate of the membranes (Carollo 2022), the conceptual design was developed based on a conservative approach as follows:

- Twice a week MC using sodium hypochlorite
- Once a week MC using citric and sulfuric acid; citric is dosed for its chelating effect, while sulfuric acid may also be dosed to achieve the target pH of 2.0 or less if needed due to changes in the feed water quality

MCs will be conducted automatically by the MF system programmable logic controller (PLC) and sequentially on each rack. The chemical solution will be heated typically to 35°C prior to recirculation between the CIP tank and membrane rack for better cleaning effectiveness.

Table 5-12 lists the target MC frequency and chemical concentrations.

Table 5-12. Maintenance Clean Regime

Parameter	Units	Value
Hypochlorite MC Interval	days	3.5
Hypochlorite Target Concentration	mg/L	500
Citric Acid MC Interval	days	7
Target pH (with Sulfuric Acid)	-	2.0
Citric Acid Target Concentration	mg/L	2,000

5.2.6.2 Clean-in-Place

MCs do not fully remove foulants that are not displaced during backwashing and air scouring. When TMP increases to a ‘terminal’ value (determined by the membrane module supplier), an RC is necessary. An RC is very similar to an MC but with higher chemical concentrations and possibly lower (or higher) pH values and with longer contact time to achieve a more robust clean. RCs are semiautomatic: they are initiated by the plant Operator; but once initiated, all steps are performed automatically by the MF PLC.

RC of a membrane rack is normally a two-step operation. First, a heated alkaline RC is performed using a sodium hypochlorite and caustic solution to remove organic and biological foulants. A heated acid RC is performed using a combination of citric and sulfuric acid to remove acid-soluble inorganic foulants. The membrane rack is drained and flushed with filtrate, and backwashing may also be performed after each CIP step, depending on the membrane module selected. When the post-acid RC flush is completed, the rack can be returned to service.

The CIP system will be used to conduct both MCs and RCs and comprises the chemical batch tanks and recirculation pumps (one for acid and one for hypochlorite or hypochlorite and caustic). Table 5-13 lists the target RC frequency, solution pH, and chemical concentrations, while Table 5-14 summarizes design criteria for the CIP system. There was a considerable difference in the pumping capacity required by Pall (400 gpm at 40 psi) and H2O Innovation (1,100 gpm at 40 psi), and the higher of the two capacities was assumed.

Chemical transfer pumps will be located adjacent to their respective bulk storage tanks, in the centralized chemical storage and feed facility (described in Section 10).

Table 5-13. Recovery Clean Regime

Parameter	Units	Value
RC Interval	days	30
Hypochlorite or Caustic Target pH	s.u.	11.0
Hypochlorite Target Concentration	ppm	2,000
Acid Target pH	s.u.	2.0
Citric Acid Target Concentration	ppm	5,000

ppm = part(s) per million

Table 5-14. Clean-In-Place System Design Criteria

Parameter	Units	H2O Innovation (Basis of Design)	Pall
CIP Tanks			
No. of Tanks	No.	2 (1 for hypochlorite and caustic, 1 for acid)	2 (1 for hypochlorite and caustic, 1 for acid)
Tank Material	-	FRP and HDPE	FRP and HDPE
Tank Capacity	gallons	2,500	1,500
Tank Height	ft	8	4.5
Tank Diameter	ft	8	8
CIP Pumps			
No. of Pumps	No.	2 (1 duty, 1 standby) for hypochlorite and caustic 2 (1 duty, 1 standby) for acid	2 (1 duty, 1 standby) for hypochlorite and caustic 2 (1 duty, 1 standby) for acid
Pump Type	-	Horizontal centrifugal	Horizontal centrifugal
Pump Capacity	gpm	1,100	400
Pump TDH	ft	92	92
Motor Size	hp	40	15
Drive	-	VFD	VFD
CIP Heaters			
No. of Heaters per Tank	No.	1	
Heater Type	-	Immersion	
Heater Power Consumption	kW	80	
Heating Cycle Time	hr	4	

FRP = fiber-reinforced plastic

HDPE = high-density polyethylene

kW = kilowatt(s)

5.2.6.3 Neutralization System

All spent MC and RC waste solution will be transferred to the neutralization tank for pH neutralization using caustic, sodium bisulfite, and sulfuric acid. Mixing of the waste solution and the chemicals can be achieved using a recirculation pump or tank mixer. The solution will then flow by gravity to the waste equalization tank for disposal to the sewer. Table 5-15 summarizes the design criteria for the neutralization system.

Table 5-15. Neutralization System Design Criteria

Parameter	Units	Value
No. of Tanks	No.	1
Tank Material	-	FRP and HDPE
Tank Volume	gallons	9,000
Tank Height	ft	11
Tank Diameter	ft	12

5.3 Conceptual Layout

This section describes the MF conceptual layout.

5.3.1 Influent Equalization, Membrane Filtration Feed Pump Station, and Strainers

The MF feed pumps will be located directly above the below-grade influent equalization tank. The pumps will pressurize the raw water and convey it through the adjacent strainers and the buried header that crosses the roadway to the MF system located inside the AWPF process building. Both the pumps and strainers are located near the roadway, under a canopy, and can be easily accessed for maintenance or replacement.

5.3.2 Membrane Filtration Facility Layout

The membrane racks are located at the northern side of the building and can be easily viewed by visitors from the exterior of the building, if desired. Figure 5-3 shows the MF plan view, and Figure 5-2 provides a cross-section view of the membrane area.

The layout of the membrane racks was developed based on information provided by Pall and H2O Innovation. Pall supplies a proprietary rack for housing the Pall UNA-620A MF modules, but it can be interchangeable with membrane modules of similar characteristics from Toray and others; while H2O Innovation offers an interchangeable rack that can fit both the Dow DuPont SFD-2880XP and Toray HFU 2020AN (or Toray HFUG 2020AN) ultrafiltration modules, as well as other ultrafiltration membranes in the marketplace.

Pall offers both the quad rack and the newer transverse rack design, whereby the quad can accommodate four modules per row (approximately 4 feet wide), while the transverse can accommodate six modules per row (approximately 6 feet wide). The transverse rack design results in a smaller overall footprint, lower capital cost, and higher hydraulic capacity but also takes up more space laterally despite being shorter in length. On the other hand, H2O Innovation only offers the quad rack design (approximately 5 feet wide), which is longer than the Pall rack. The layout of the membrane racks was developed based on the length of the H2O Innovation rack while accommodating the width of the Pall transverse rack and providing at least 4 feet of clearance between each rack for module loading and unloading and maintenance.

The area immediately to the south of the membrane racks is allocated for MF feed and discharge header piping, which was assumed to be above grade. The CIP system is located close to the membrane racks to minimize the piping length between the cleaning system and the racks.

The southwestern corner of the MF process area will include a room to house the compressed air system and blowers (if blowers are required) to reduce noise in the main process area. The open area next to the CIP system will serve as a staging area for maintenance activities and can be used during membrane replacement or when fiber pinning is required.

The filtrate tank will be located outdoors with the backwash pumps and filtrate pump station located directly on top. The waste equalization tank and pump station will be located adjacent to the filtrate tank, as further described in Section 11. The aboveground neutralization tanks and ancillary equipment (including pumps) used to receive and neutralize MF and RO cleaning solutions are co-located outdoors adjacent to the waste equalization tank. Neutralized solutions from these tanks will gravity flow to the waste equalization tank. The filtrate tank, waste equalization, and neutralization system will be housed under a canopy.

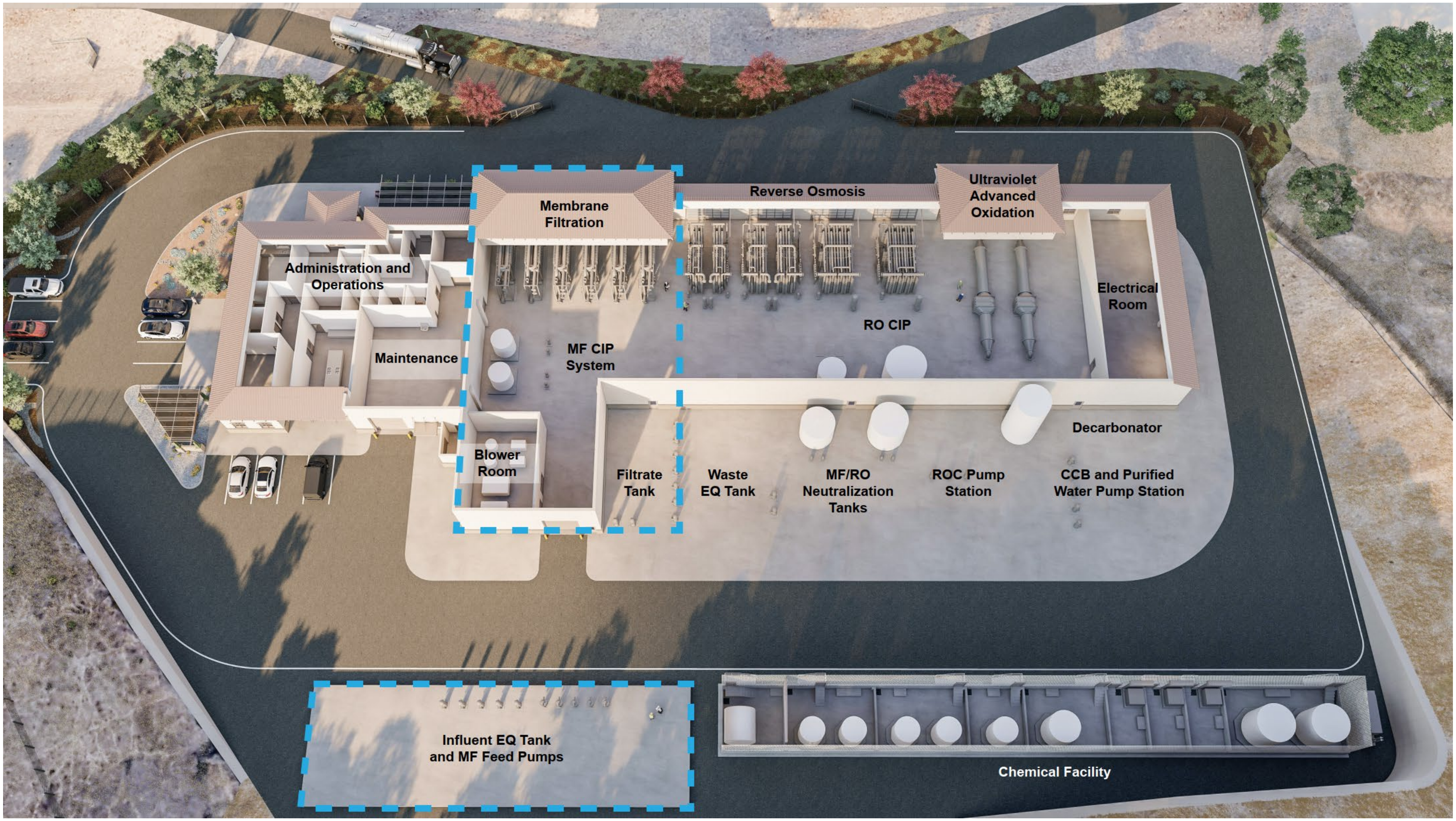


Figure 5-2. Membrane Filtration Conceptual Layout

Figure 5-3. Conceptual Membrane Filtration Section

5.4 Operational Strategies

Plant Operations will determine the target flow for the entire facility and will enter it as a set point into the plant control system (PCS). This flow set point will be determined based on the following factors:

- Season
- Recycled water system demand
- Effluent flows from the Tapia WRF
- Status of the different systems (that is, MF, RO) at the AWPF

The PCS will then feed this target flow set point to each separate subsystem and vendor control panel at the AWPF.

The influent equalization tank will accept recycled water from the west recycled water distribution system, which is supplied by RWPS West, with pressure maintained by the Indian Hills Tank. The equalization tank will be equipped with a flow control valve, flow meter, and level transmitter to allow for automatic filling of the equalization tank once plant Operators have started operation at the PCS. The MF feed pump station will be operated from the PCS to maintain a target discharge flow within a specific level range in the filtrate tank, such that the RO system can be operated to allow constant flow through individual RO skids.

The feed strainers will be controlled by the vendor-supplied local control panel (LCP) and will typically operate in AUTO mode, with backwash cycles initiated based on an Operator-selected time interval or a differential pressure set point.

Before entering the MF system, the influent will be continuously monitored for the following parameters:

- Oxidation-reduction potential (ORP)
- Monochloramine
- Free ammonia
- Total residual chlorine
- Turbidity

Set points will be established by the Operator and used to alarm the Operator when exceeded. Shutdown of the MF system may be initiated if the set points are exceeded.

The MF system and associated subsystems (membrane racks, CIP system, backwash system, compressed air system) will be automatically controlled by the vendor-supplied LCP. In AUTO mode, the racks will operate in production modes and will automatically cycle through backwashing, membrane integrity testing, and MC functions based on set points in the vendor PLC.

Under high-flow conditions, the MF system will operate with four duty racks online at times and the two remaining racks in standby mode. Under lower-flow conditions, the MF will operate with fewer duty racks online, while the remaining racks will be in standby mode. In both instances, one operational strategy will be to cycle each rack in and out of operation to keep the membrane fibers wet and mitigate stagnant contact with raw water. The online time for each rack will be directly related to the total feed flow and associated production required by the AWPF.

MCs, RCs, and neutralization will always be Operator initiated and then automatically performed and controlled by the vendor PLC. Prior to scheduled AWPF downtime when recycled water demands are high, membrane preservation (typically with chlorine, following an RC) will be Operator initiated to prevent biogrowth in the MF system. During extended downtime, the Operator will monitor the MF system for chlorine residual so that the conditions match preservation requirements by the membrane manufacturer.

The filtrate pumps will be controlled by the PCS in tandem with the RO high-pressure pumps. Both the filtrate pumps and RO high-pressure pumps will only be able to operate when the PCS verifies that RO permeate can be received by the downstream UV-AOP and decarbonator systems.

6. Reverse Osmosis

This section presents the conceptual design of the RO process for the AWPF and includes the following elements:

- Process Description and Design Considerations
- Process Design Criteria
- Conceptual Layout
- Operational Strategies

6.1 Process Description and Design Considerations

This section describes the RO system process and design considerations.

6.1.1 Process Description

RO is a pressure-driven membrane-separation process that employs the principles of osmosis to remove dissolved contaminants (for example, total dissolved solids [TDS] and organic compounds) from water. MF filtrate will be transferred by the filtrate pumps, then further pressurized by RO feed pumps that provide the driving force to cause permeation of the RO feed water through the RO membrane. The required feed pressure will depend on the TDS and temperature of the feed water (that is, osmotic potential), membrane water permeability, and product water recovery.

RO systems treating MF filtered municipal effluent typically operate between 80 to 85% recovery, where 80 to 85% of the feed water is converted to RO permeate. The remaining 15 to 20% is discharged to waste as an elevated salinity RO concentrate waste. RO operation during Demo testing was performed at both 80 and 85% recovery under two- and three-stage array configurations. Except for the two-stage, 85% recovery configuration, the *Purification System Performance Report* concluded that all the tested configurations were viable (Carollo 2022).

A three-stage RO system with a design recovery of 85% was used as the basis of design to maximize recovery. Design features include flux balancing for each stage, including permeate backpressure to Stage 1 using a throttling valve and boosting the pressure to Stage 3. Figure 6-1 is a process flow diagram for a three-stage RO system with pretreatment systems.

As shown, the Stage 1 concentrate is treated by Stage 2, and Stage 2 concentrate is boosted by a booster pump and then treated by Stage 3 to achieve the design recovery. A throttling valve on Stage 1 may also be installed to provide additional flux balancing. Permeate from each RO stage is combined and flows to the UV-AOP process for further treatment. Flow meters will be installed in the permeate piping dedicated to Stage 1, Stage 3, and the total combined piping in each RO skid to allow for monitoring and control of the feed pump and individual stage permeate flow, as well as to allow for data normalization by stage.

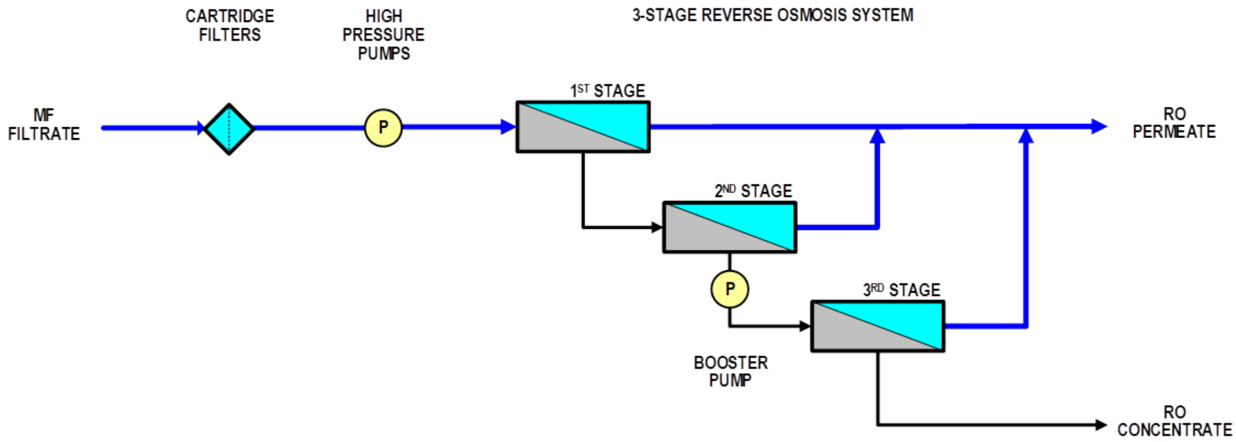


Figure 6-1. Process Flow Diagram for Three-stage Reverse Osmosis System

6.1.2 Design Flow Conditions

The AWPF will treat variable flow rates; as such, the RO system will be designed to treat between 0.95 and 7.1 MGD of MF filtrate and produce 0.6 to 6.0 MGD of RO permeate. This range is required due to the need to treat recycled water seasonally. To treat this wide range of flows, the RO system will consist of six individual RO skids:

- Two small RO skids (RO skids 1 and 2) at 0.6-MGD RO permeate capacity
- Two medium RO skids (RO skids 3 and 4) at 1.2-MGD RO permeate capacity
- Two large skids (RO skids 5 and 6) at 2.4-MGD RO permeate capacity

At the design permeate capacity of 6.0 MGD, five of the six RO skids will be in operation while a single large RO skid (RO skid 5 or 6) will be in standby. This corresponds with an AWPF influent feed capacity of approximately 7.5 MGD based on operation of the MF and RO system at their design recoveries (95 and 85%, respectively). At minimum flow conditions, one small RO skid (RO skid 1 or 2) will operate to produce 0.6 MGD based on a flux of 12 gpm/ft^2 while all the remaining RO skids are in standby or offline. Under design recovery conditions for the MF and RO systems, this corresponds to an AWPF influent feed capacity of approximately 0.95 MGD. Under minimum flow conditions, the RO system may also be operated at lower recovery conditions (for example, 70% recovery) to reduce scaling potential of the ROC while increasing the ROC flow as a strategy to mitigate scale formation within the ROC conveyance pipeline. This corresponds to an AWPF influent feed capacity of approximately 1.0 MGD.

Frequent changes within AWPF unit processes, particularly RO, can be difficult to manage. Variations in AWPF feed flow would result in shutdowns of individual RO skids. Extended shutdowns (longer than 48 hours) require membrane preservation (that is, pickling) to prevent biological growth. For short-term shutdowns that extend 1 to 2 days, RO membranes can be flushed with RO permeate. Flushing can also be performed daily to allow for daily cycling between two RO skids to avoid membrane preservation.

Minimizing flow changes to a target of two per day within the new AWPF to promote consistent RO process operation is a Project goal. This design criterion of two flow changes per day emphasizes the importance of upstream equalization at the new AWPF.

Figure 6-2 shows the AWPF feed and RO permeate flow rates for five RO operating scenarios, depending on influent feed. Figure 6-3 is a stacked chart showing the permeate flows from each skid size for a permeate production range of 0.6 to 6.0 MGD.

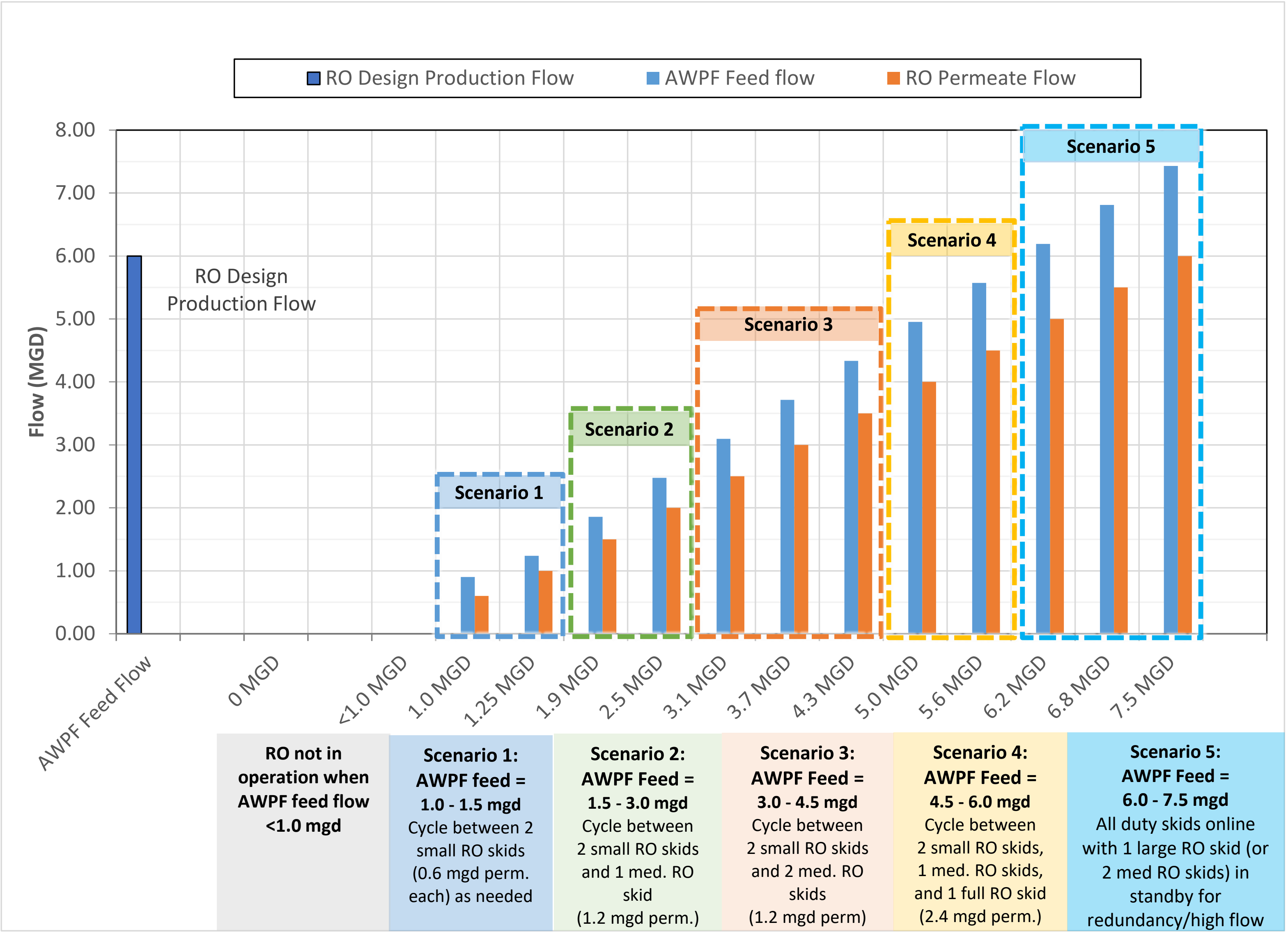
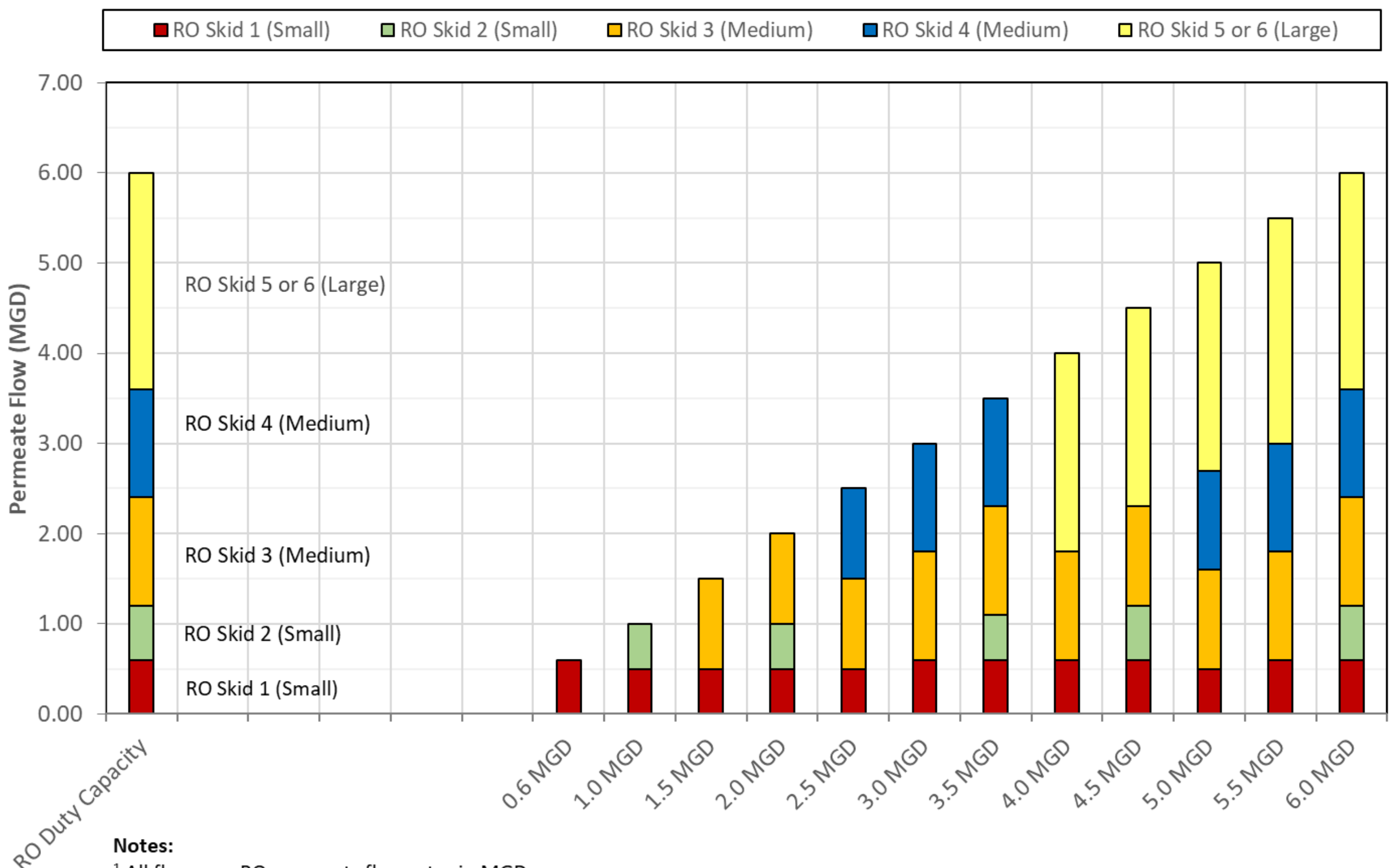


Figure 6-2. Advanced Water Purification Facility Feed and Reverse Osmosis System Flow Scenarios



Notes:
[1] All flows are RO permeate flow rates in MGD.
[2] Permeate capacities for small skid = 0.6 MGD, medium skid = 1.2 MGD, large skid = 2.4 MGD
[3] Assumes RO recovery = 85%, design flux = 12 gfd and skid turn down of +/- 8% by adjusting RO flux only.

Figure 6-3. Reverse Osmosis System Permeate Flow Scenarios

Combined permeate from all the RO skids will be further treated through UV-AOP. Because of its low level of calcium, alkalinity, and pH, the RO permeate will be aggressive, having an LSI in the range of -5.3 to -5.0; therefore, the RO will require post-treatment for stabilization following treatment by UV-AOP. The ROC from all RO skids will be collected in the ROC wet well and pump station.

The design criteria for the UV-AOP and water stabilization are described in Section 7 – Ultraviolet Advanced Operation and Section 8 – Post-treatment Water Stabilization and Purified Water Pump Station of this report. The design criteria for the ROC waste handling facilities are described in Section 9 – Residuals.

6.2 Process Design Criteria

The RO system will treat MF filtrate provided by the filtrate pumps (described in Section 5 – Membrane Filtration) and comprises the following major components:

- Pretreatment systems
- High-pressure pumps and RO membrane skids
- CIP and CIP neutralization systems
- RO flushing system

6.2.1 Pretreatment Systems

The RO pretreatment system, designed to limit fouling and scaling in the RO skids, includes chemical addition and cartridge filtration. Sulfuric acid and antiscalant will be dosed to the RO feed water to control the precipitation of sparingly soluble salts as they are concentrated in the RO system.

At 85% recovery, a sulfuric acid dose of 77 mg/L is necessary to decrease the RO feed water pH from 7.3 to a target pH of 6.2. This pH, in combination with an antiscalant dose of 2 to 3 mg/L, is required to mitigate precipitation of calcium carbonate, calcium phosphate, and silica based on antiscalant projections developed using software from two prominent antiscalant suppliers (AWC Proton and Avista Advisor) using the water quality basis of design presented in Section 2 – Basis of Design. Appendix B shows the antiscalant projection outputs from AWC Proton, which was the most conservative of the two types of projection software. If the phosphorus levels in the AWPF feed were reduced, the acid addition required to control scaling would be reduced.

Acid and antiscalant will be dosed into a static mixer upstream of the cartridge filters. Chemical metering pumps will be arranged as one duty and one standby for each chemical. The acid will be stored in a tank, and the antiscalant will be stored in totes. Chemical feed and storage facilities for both RO pretreatment chemicals will reside in the centralized chemical storage and feed facility that is further described in Section 10 – Chemical Handling Facilities.

Cartridge filtration is recommended to provide pre-filtration upstream of the RO process and protect RO elements from particle fouling and deposition in the unlikely case of solids passage through the MF membranes or introduced into the MF filtrate break tank. In addition, cartridge filtration will provide a safeguard against solids introduced through construction or maintenance activities.

For space planning, the number of units was selected based on maintaining N+1 redundancy while considering the design loading rate for the cartridge filters. Both the maximum design loading rate (with duty units only) and average design loading rate (with all units online) were evaluated. Ultimately, the average design loading rate determined the total number of units shown in Table 6-1, which summarizes the design criteria for the cartridge filters.

Table 6-1. Cartridge Filter Design Criteria

Parameter	Units	Value
No. of Cartridge Filter Housings	No.	3 (2 duty, 1 standby)
Pressure Rating	psi	150
Maximum Headloss and Pressure Drop	psi	15
Orientation	-	Horizontal
Material	-	Type 316 L stainless steel
Flow Capacity	-	-
Capacity per Housing	MGD gpm	5.07 3,520
Total System Capacity	MGD gpm	10.14 7,040
Cartridge Filters per Housing	No.	220
Loading Rate per Filter Element	gpm per 10-inch length	4 (design) 5 (maximum allowable)
Element Filter Pore Size	µm	5
Element Diameter	inches	2.5
Element Length	inches	40
Element Type	-	All food-grade polypropylene

6.2.2 High-pressure Pumps and Reverse Osmosis Skids

Each RO skid will have a dedicated high-pressure feed pump with VFD to pressurize the pretreated RO feed water and maintain the RO feed pressure required to achieve the design recovery and permeate flow to account for variations in water temperature (16 to 28°C), membrane aging (0 to 5 years), and membrane fouling. The following approach was used to develop the basis of design for the three-stage RO system:

- Standard 8-inch-diameter RO elements having the following characteristics that provide proven performance on wastewater effluents: low-fouling membrane surface, membrane area of 400 ft^2, and a 34-mil feed spacer.
- A design recovery of 85%, an average design flux of 12.0 gpd/ft^2, and a three-stage design. Under minimum flow conditions, the RO system may be also operated at lower recovery conditions (for example, 70% recovery) to reduce scaling potential of the ROC while increasing the ROC flow as a strategy to mitigate scale formation within the ROC conveyance pipeline.
- RO membrane software model projections were conducted using Hydranautics - A Nitto Group Company's Integrated Membrane Solutions Design (IMSDesign) with the basis of design water quality presented in Section 2 – Basis of Design. The membrane projection results showed that RO feed pressure is estimated to range between 94 and 150 psig. This pressure range accounts for the boundary conditions of temperature, membrane age, and membrane fouling. A safety factor of approximately 45% was applied to account for differences between projected and actual feed pressures, resulting in a maximum design feed pressure of 215 psig. Flux balancing will be achieved through permeate backpressure to Stage 1 and interstage booster pumping of second stage concentrate to Stage 3. Energy recovery using a hydraulic turbocharger may be considered in the future as substitute for Stage 3 boosting. Appendix B provides the membrane projections used for the basis of design.

Table 6-2 presents the design criteria for the RO high-pressure pumps and RO skids.

Table 6-2. High-pressure Pump and Reverse Osmosis Skid Design Criteria

Parameter	Units	Small Skid	Medium Skid	Large Skid	Total
High-pressure Pumps					
No. of Pumps	No.	2 (2 duty, 0 standby)	2 (2 duty, 0 standby)	2 (1 duty, 1 standby)	6 (5 duty, 1 standby)
Flow per Pump	MGD gpm	0.7 490	1.41 980	2.8 1,960	Varies by skid
Total Duty Capacity	MGD gpm	1.4 980	2.8 1,960	2.8 1,960	7.06 4,900
TDH	ft	437 (with 58-ft suction pressure)			
Type	-	Vertical turbine			
Efficiency	%	75	77	78	Varies by skid
Motor Size	hp	75	150	300	
Drive	-	Variable frequency			
Wetted-end Material	-	316 stainless steel			
RO Skids					
Recovery	%	85			
Flux	gpm/ft^2	12.0			
No. of Skids	No.	2 (2 duty, 0 standby)	2 (2 duty, 0 standby)	2 (1 duty, 1 standby)	6 (5 duty, 1 standby)
Skid Permeate Capacity	MGD	0.6	1.2	2.4	Varies by skid
Array[a]	-	12 x 6 x 3	24 x 12 x 6	48 x 24 x 12	Varies by skid
Elements per Vessel	No.	6			
Element Area	ft^2	400			
Element Area per Skid	ft^2	50,400	100,800	201,600	Varies by skid
Vessel Configuration	No.	12 vessels high 2 vessels wide	12 vessels high 4 vessels wide	12 vessels high 7 vessels wide	Varies by skid
Total Feed Flow	MGD gpm	1.4 980	2.8 1,960	2.8 1,960	7.06 4,900
Total Permeate Flow	MGD gpm	1.2 833	2.4 1,667	2.4 1,667	6.00
Total Concentrate Flow	MGD gpm	0.2 147	0.4 294	0.4 294	1.06 735

[a] The array presents the number of vessels by stage as follows: Stage 1 vessels x Stage 2 vessels x Stage 3 vessels.

6.2.3 Reverse Osmosis Clean-in-Place System and Neutralization System

The basis of design includes a single RO CIP system to allow for in situ cleaning of RO skids (Table 6-3). The CIP system consists of the following components:

- One tank
- One pump
- One cartridge filter housing

- Interconnecting piping
- Valves
- I&C

The CIP system will be able to clean each stage of an RO skid separately and be initiated manually by the Operator. The tank will be fitted with a flanged immersion heater and an eductor system to allow batching of dry-fed chemicals if needed. The cleaning pump is used to recirculate the tank contents for mixing and feed the cleaning solution to the vessels in the skid being cleaned. The CIP system is sized to clean a maximum of 24 pressure vessels at a time, requiring that Stage 1 of the large skid will be cleaned in two steps.

Heated low and high pH CIPs will be performed. Low pH CIPs will use a combination of citric and sulfuric acid to remove acid-soluble inorganic foulants. High pH CIPs will be performed using sodium hydroxide. Chemical transfer pumps will be located adjacent to their respective bulk storage tanks in the centralized chemical storage and feed facility (described in Section 10). If generic cleaning formulations do not improve RO performance as anticipated, the CIP system will accommodate the addition of specialty chemicals, like sodium dodecyl benzene sulfonate or other proprietary cleaners.

Spent CIP acid solutions will be transferred to the neutralization tank, the pH will be neutralized, and then it will be pumped to the waste equalization basin for disposal to the sewer. The RO neutralization tank will be sized to hold the volume of a full CIP, including rinse water. A neutralization pump will be included as part of the RO neutralization system to recirculate the water during neutralization and provide for pumping for disposal.

Table 6-3. Reverse Osmosis Clean-in-Place and Neutralization System

Parameter	Units	Value
CIP Tank		
No. of Tanks	No.	1
Tank Material and Type	-	FRP, vertical
Capacity	gallons	3,500
Tank Diameter	ft	9
Tank Height	ft	8
Heater Type	-	Immersion heater
Heater Power	kW	150
CIP Pumps		
No. of Pumps	No.	1 duty + 1 shelf spare
Pump Type	-	Horizontal centrifugal
Pump Capacity	gpm	960
Pump TDH	ft	150
Motor Size	hp	50
Drive	-	VFD
CIP Cartridge Filter		
No.	No.	1
Type	-	Horizontal

Table 6-3. Reverse Osmosis Clean-in-Place and Neutralization System

Parameter	Units	Value
Headloss and Pressure Drop	psi	15
Orientation	-	Horizontal
Material	-	Type 316 L stainless steel
Cartridge Filters per Housing	No.	60
Loading Rate per Filter Element	gpm per 10-inch length	4 (design) 5 (maximum allowable)
Element Filter Pore Size	µm	5
Element Length	inches	2.5
Element Diameter	inches	40
Element type		All food-grade polypropylene
Neutralization Tank		
No. of Tanks	No.	1
Tank Material and Type	-	FRP, vertical
Capacity	gallons	13,500
Tank Diameter	ft	13
Tank Height	ft	16
Neutralization Pumps		
No. of Pumps	No.	1 duty + 1 shelf spare
Pump Type	-	Horizontal centrifugal
Pump Capacity	gpm	1,000
Pump TDH	ft	35
Motor Size	hp	15
Drive	-	DOL

DOL = direct online

6.2.4 Reverse Osmosis Flush System

Flushing of the RO skids will be performed using water from an RO flush system comprising an RO permeate storage tank and flush pump to provide a source of oxidant-free permeate. A shelf spare flush pump is recommended at a minimum to provide reliability for the flushing system.

The flush system will be used to flush RO skids when they are taken out of service and are offline for a period of 30 minutes or more. A skid flush will be accomplished by introducing permeate through the flush feed valve on the suction side of RO feed pump. Each flushing event will take approximately 10 minutes. The flush system will consist of a pump and interconnecting piping, valves, and I&C. Table 6-4 lists the main components of the flush system. The flush tank will also be equipped with take-off connections and pumps to provide RO permeate for carrier water for monochloramine pre-formation and for CIP makeup water for the MF and RO systems.

Table 6-4. Reverse Osmosis Flush System Design Criteria

Parameter	Units	Value
Flush Tank		
No. of Tanks	No.	1
Flush Time	minutes	10 minutes for small RO skid 20 minutes for medium RO skid 30 minutes for large RO skid
Flush Flow	gpm	120
Minimum Tank Volume Required	gallons	14,000 for two largest RO skids
Tank Diameter	ft	14
Tank Height	ft	14
Tank Volume Assumed	gallons	16,000
Tank Material and Type	-	FRP, vertical
Flush Pumps		
No. of Pumps	No.	1 duty + 1 shelf spare
Type of Pump	-	Horizontal centrifugal
Pump Capacity	gpm	120
Pump TDH	ft	138
Motor Size	hp	20
Drive	-	DOL

6.3 Conceptual Layout

Figure 6-4 is a conceptual rendering of the RO facility and includes the following components:

- Cartridge filters (not shown in this view)
- High-pressure feed pumps
- RO skids
- CIP system
- Neutralization system
- Flush system

Figure 6-5 provides a section view of the RO system.

The cartridge filters will be located on the southern side of the RO area in the process building, while the RO skids and high-pressure feed pumps will be located at the northern side of the building. Roll-up doors will be located on the northern side of the building and can be clear to allow for viewing by visitors during site tours.

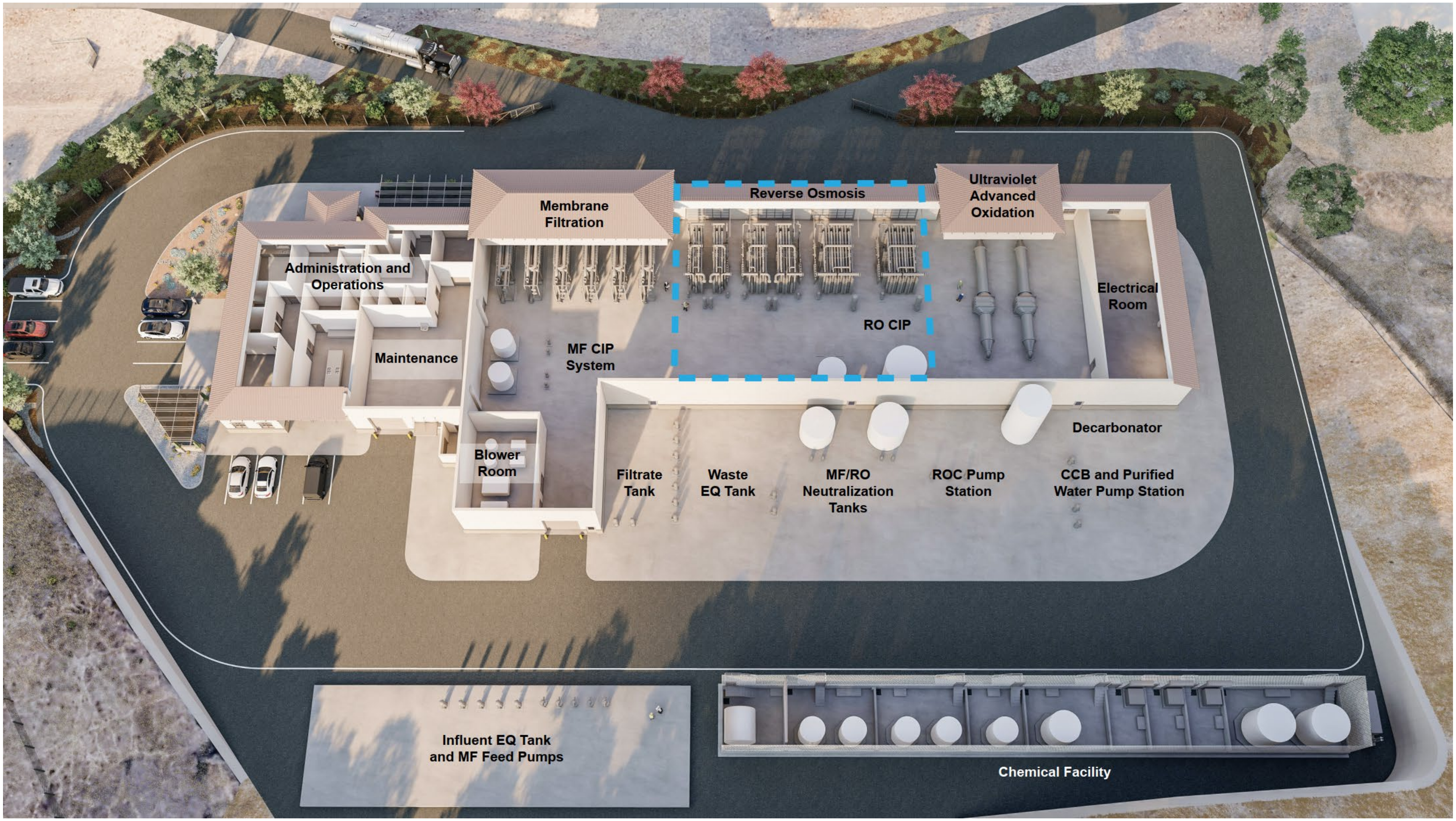


Figure 6-4. Reverse Osmosis System Facility Layout

The CIP system and flush system are located close to the RO skids to minimize the piping length between these systems and the RO skids. The neutralization tanks for the RO will be co-located outdoors next to the MF neutralization tank between the waste equalization tank. Section 9 – Residuals describes the RO concentrate waste facilities. The neutralization system, waste equalization tank, ROC wet well, and pump station will be housed under a canopy.

Figure 6-5. Conceptual Reverse Osmosis System Cross Section

6.4 Operational Strategies

The number of RO skids required will be determined by Plant Operations and the flow set point. The RO system will be controlled and operated automatically by the PCS. The RO high-pressure pumps will operate in tandem with the upstream filtrate pumps based on the level in the MF filtrate tank. Both the filtrate pumps and RO high-pressure pumps will only be able to operate when the PCS verifies that RO permeate can be received by the downstream UV-AOP and decarbonator systems. The MF filtrate (RO feed) will be continuously monitored for ORP, residual total chlorine, and turbidity. Conductivity of the RO permeate from each skid will be continuously monitored as well. When an RO skid shuts down, the PCS will initiate an automatic RO permeate flush on that individual skid.

7. Ultraviolet Advanced Oxidation

This section presents the conceptual design of the UV-AOP process for the AWPF and includes the following elements:

- Process Description and Design Considerations
- Process Design Criteria
- Conceptual Layout
- Operational Strategies

7.1 Process Description and Design Considerations

The recycled water system and the AWPF will include treatment processes to achieve disinfection goals, as described in Section 2 – Basis of Design. At the AWPF, RO permeate water will be disinfected by an UV-AOP that will be designed to achieve 6-log reduction of the target pathogens, as well as other performance goals stipulated by regulations. Following UV-AOP, the flow will be split, with some flow passing through a decarbonator, and some flow bypassing the decarbonator before recombining.

7.2 Process Design Criteria

This section describes the UV-AOP process design criteria.

7.2.1 Process Description

UV-AOP provides a multibarrier approach to destroy contaminants in water. The UV light destroys photosensitive contaminants by photolysis and converts a chemical oxidant into a hydroxyl radical to destroy oxidizable contaminants. This process addresses multiple contaminants of concern, including NDMA and 1,4-dioxane, while also achieving disinfection.

The UV-AOP system will be designed to achieve greater than or equal to 0.5-log reduction of 1,4-dioxane and up to 2-log removal of NDMA to meet California IPR requirements, as well as the CTR limit of less than 0.69 nanogram per liter (ng/L) of NDMA.

Lamp configurations and lamp types differ for closed-vessel UV reactors. Lamps can be oriented parallel, perpendicular, or diagonal to the process flow to maximize effective dose delivery. There are two types of lamps used in larger municipal applications: low-pressure high-output (LPHO) and medium-pressure (MP). LPHO lamps are the more predominant lamp type due to their lower energy consumption and longer lifetime. The reactors evaluated in this report incorporate LPHO lamps.

Sodium hypochlorite was evaluated as the oxidant for UV-AOP. Using sodium hypochlorite requires an influent pH of less than 6.0 for efficient hydroxyl radical formation, which is consistent with the anticipated RO permeate water quality. Sodium hypochlorite is also readily used at most treatment facilities, and it generally costs less than other oxidants. It was assumed that sodium hypochlorite will be used pending further testing of oxidants at a later date during bench- and demonstration-scale testing. Hydrogen peroxide has also been considered as an alternative oxidant, but this would require additional chemical storage and quenching as described herein.

7.2.2 Water Quality

Data from the *Purification System Performance Report* (Carollo 2022) were used to support this evaluation. A limited set of water quality data measured at the RO permeate and the UV-AOP feed and outlet were used to support initial estimates of scavenging demand and anticipated water quality by vendors for UV-AOP sizing. Table 7-1 summarizes these water quality results. Continued collection of data will be useful for manufacturers during bidding. The dichloramine value listed in Table 7-1 is representative of current conditions and could be reduced by implementing preformed monochloramine dosing at Tapia WRF and at the AWPF.

Table 7-1. Anticipated UV-AOP Influent Water Quality

Parameter	Units	Concentration
Alkalinity	mg/L as calcium carbonate	5-8[a]
pH	s.u.	5.5-6.0[b]
Monochloramine	mg/L	1.9
Dichloramine	mg/L	1.2
Hypochlorous acid	mg/L	2.0
Hypochlorite	mg/L	0.01
Bicarbonate	mg/L	10.0
Carbonate	mg/L	0.0003
TOC	mg/L	0.05
Nitrate	mg/L	<1[c]
Nitrite	mg/L	0.005
Ammonia	mg/L	<1[d]
Bromide	mg/L	0.005
Iron	mg/L	ND
Manganese	µg/L	0.2[c]

[a] Measured in UV-AOP outlet.

[b] Demonstration Facility average was 5.5 at UV-AOP feed.

[c] Measured in RO permeate.

[d] Average coming into the Demonstration Facility. Anticipate lesser concentrations out of RO.

ND = not detected

7.2.3 Process Design Criteria

Typical UV design criteria include the following factors:

- Design flow rate
- UV transmittance (water quality)
- Scavenging demand (water quality)
- Performance requirements or UV dose
- Lamp aging factor
- Assumed level of redundancy

Table 7-2 summarizes the design criteria recommended for the UV-AOP system.

Table 7-2. UV-AOP Design Criteria

Parameter	Units	Value
Type of UV System	-	LPHO (assumed)
Design Flow	MGD	6
Minimum Flow	MGD	0.6
Oxidant	-	Sodium hypochlorite
Oxidant Dose	mg/L	1-5
Minimum EED	kWh/kgal	0.36
UV Dose	mJ/cm^2	>1,600
UV Transmittance	No.	95% (RO permeate)
Sleeve Fouling Factor	-	Vendor specific, typically not applicable post-RO
Lamp Aging Factor	-	Vendor specific
Redundancy	-	N+1
1,4-Dioxane Removal	-	≥ 0.5 log removal
NDMA Removal	-	1.5 and 2.0 log removal

EED = electrical energy dose

kWh/kgal = kilowatt(s) per kilogallon

mJ/cm^2 = millijoule(s) per square centimeter

The most conservative UV-AOP system is based on conservative ultraviolet transmission (UVT) data available from the Tapia WRF effluent under the current Tapia WRF disinfection approach, along with a scenario in which the purified water would be required to meet the CTR limit for NDMA. Based on limited water quality data available for NDMA in the Tapia WRF effluent with the current Tapia WRF disinfection approach, 2-log NDMA destruction would be required to meet the CTR limit for NDMA.

A second scenario is shown in the footnotes to Table 7-3 in which the UV-AOP system would be designed to provide 1.5-log NDMA removal, consistent with the target established in the *Purification System Performance Report* (Carollo 2022). This would be the anticipated appropriate performance target following a shift to the use of preformed monochloramine for disinfection at the Tapia WRF.

7.2.4 Reactor Comparison

UV-AOP facility layouts were based on proposals from Trojan Technologies (Trojan) and Xylem-Wedeco. Both vendors used LPHO lamps in closed-vessel reactors and provided N+1 redundancy. All layouts shown are based on 2.0-Log NDMA removal.

Xylem-Wedeco proposed two K-143 800-watt (W) reactors in a duty and standby configuration. Trojan proposed their Flex100 and Flex200 reactors. All of the proposed reactors require a horizontal configuration. The Trojan PHOX reactor was also considered, which allows for stacked reactors. Table 7-3 compares the different reactors considered.

Table 7-3. Reactor Comparison for 2-log NDMA Removal

		2-log NDMA Removal			
		Wedeco K-143 800 W	Trojan Flex200	Trojan Flex100	Trojan UVPHOX
Parameter	**Units**	**Value**			
Reactor Flange Size	inches	48	48	36	20
No. of Reactors	No.	2 (1 duty, 1 standby)	2 (1 duty, 1 standby)	3 (2 duty, 1 standby)	12 (2 trains)
No. of Lamps per Reactor	No.	156[a]	96	112[b]	72[c]
Lamp Power (each)	W	800	1,000	500	260
No. of Rows of Lamps	No.	13	10	16	-
Total No. of Lamps	No.	312[a]	192	336[b]	864
No. of Intensity Sensors per Reactor	No.	13	6	7	1 (12 total)
Oxidant Dose (sodium hypochlorite)	mg/L	2.0	2.1	1.55	2.0
UV Dose	mJ/cm^2	1,700[d]	>1,600[e]	>1,600[e]	>1,600
Total Connected Load	kW	275[f]	214[g]	202[h]	225
Reactor Length	ft	20.5	8.3	9.5	12.3
Reactor Height	ft	8.1	6.6	4.6	13.6
Estimated Building Length	ft	45	~52	~54	~30
Estimated Building Width	ft	42	~43	~45	~50

[a] Number of lamps per reactor will decrease by 36 for 1.5-log NDMA removal. Total number of lamps will decrease by 72 for both reactors.

[b] Number of lamps per reactor will decrease by 16 for 1.5-log NDMA removal. Total number of lamps will decrease by 48 for all three reactors.

[c] There are 2 reactors per vessel and 3 stacked vessels per train. Each reactor has 72 lamps. Each vessel has 144 lamps, totaling 432 lamps per train.

[d] UV dose will decrease to 1,300 mJ/cm^2 for 1.5-log NDMA removal.

[e] UV dose will decrease to >1,000 mJ/cm^2 for 1.5-log NDMA removal.

[f] Total connected load will decrease to 210 kW for 1.5-log removal NDMA.

[g] Total connected load will decrease to 206 kW for 1.5-log removal NDMA.

[h] Total connected load will increase to 210 kW for 1.5-log removal NDMA, with fewer lamps operating at higher power.

~ = approximately

7.3 Conceptual Layout

Figure 7-1 shows a conceptual facility plan highlighting the UV-AOP equipment. Figure 7-2 is a rendering of the UV-AOP equipment. This layout is based on a combination of maximum dimensions required for the various reactors considered in Table 7-3 for Xylem-Wedeco. The layout reflects a horizontal configuration of one duty and one standby reactor. Space was reserved for typical maintenance activities, like lamp replacement. Wall and floor space was also reserved adjacent to the reactors for power and control panels. This approach also considers additional space needs for upstream and downstream pipe length requirements for instrumentation, including for:

- Free chlorine
- Total chlorine
- pH
- UVT
- Flow meters

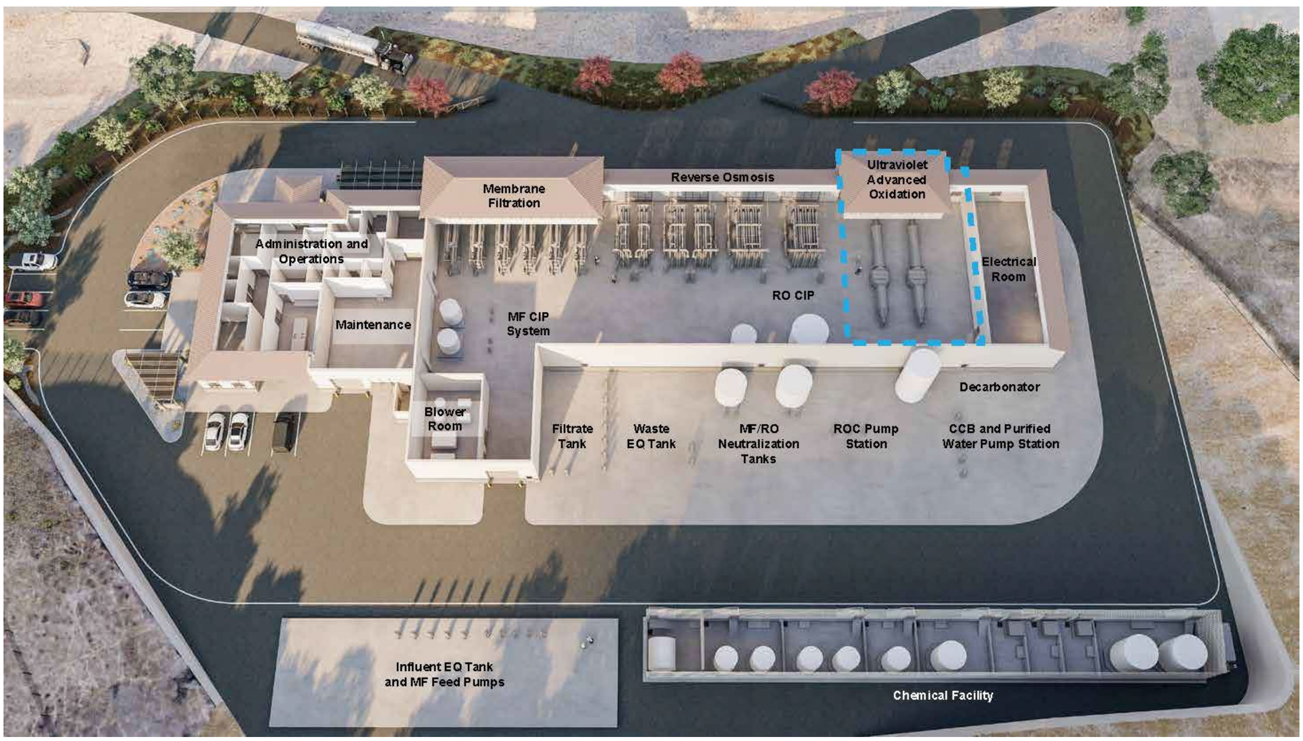


Figure 7-1. Ultraviolet Advanced Oxidation Process Conceptual Layout

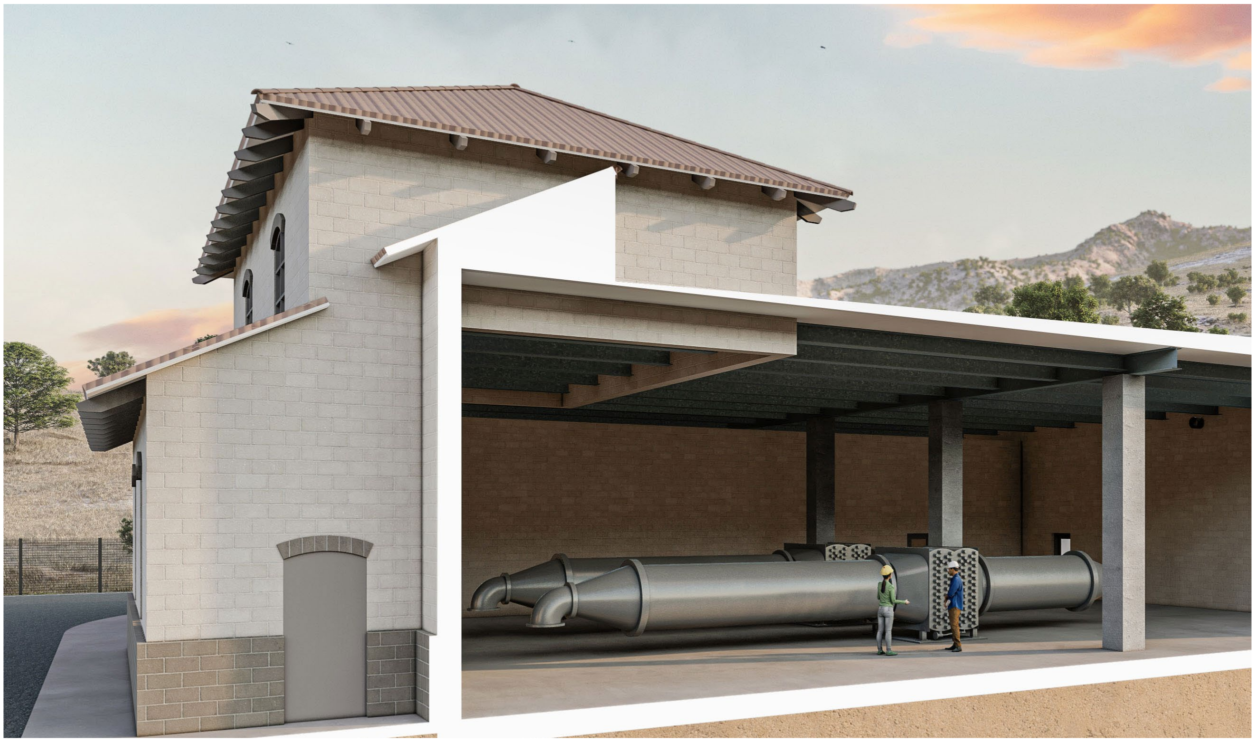


Figure 7-2. Ultraviolet Advanced Oxidation Process Cross Section

7.4 Operational Strategies

The UV reactors will be controlled by the vendor-provided LCP. The vendor LCP will have the capability to modulate and control the flow to each reactor train. The LCP will activate and modulate the number of lamp rows that are on, as well as the lamp power setting, for the duty reactor based on the influent flow, UVT, and measured UV intensity. The LCP will also monitor the pH and chlorine residual of the influent flow. Chlorine residual and UVT will also be monitored at the reactor effluent.

On April 27, 2022, the JPA, Jacobs, Woodard & Curran, and the DDW regulator team met (virtually) and discussed the off-specification requirements for UV-AOP, among other topics. During the meeting, the following requirements for UV-AOP in a SWSAP application were discussed and confirmed as the applicable requirements:

- If the pathogen targets are not met, consistent with CCR Section 60320.308, within 24 hours of occurrence, investigate the cause, and initiate corrective action. If the failure is longer than 4 consecutive hours or more than 8 hours total over 7 days, notify the SWRCB and Los Angeles RWQCB within 24 hours. For shorter-duration failures, report the failures by the 10th day of the next month. It was noted that UV-AOP failures are likely to be short-duration, such as less than 10 minutes for a power related failure.
- Per CCR 60320.308, Part (d), if the failure is longer than 4 consecutive hours or more than 8 hours total over 7 days, and the failure is reported to the SWRCB and Los Angeles RWQCB, and pathogen reduction provided by the overall treatment train is decreased from the required 8/7/8 (for viruses, *Giardia*, and *Cryptosporidium*, respectively) by more than 2 logs, and the Utility is not otherwise directed by the SWRCB and Los Angeles RWQCB, then delivery to the reservoir must be discontinued.

7.5 UV-AOP State of the Industry

Two manufacturers, Aquisense and Typhon, are rapidly progressing ultraviolet light-emitting diode (UVLED) development. The light-emitting diode (LED) lamps offer a number of advantages, some of which include:

- Increased durability
- Higher power density
- Mercury-free
- Require less maintenance due to longer lamp life and no anticipated fouling

Both manufacturers are working to improve lamp efficiency, which is currently less than 5% and will have significant impacts on disinfection performance. Most of their installations are small-scale, point-of-entry treatment systems. Neither manufacturer is currently able to propose a system for a UV-AOP application, but as the technology continues to develop and lamp efficiencies improve, UVLED reactors could be considered in the future for AWT systems.

7.6 Disinfection By-products Considerations

Due to CTR requirements, LVMWD is considering implementing preformed monochloramine at the Tapia WRF and AWPF. Preformed monochloramine would be dosed upstream of the tertiary filters to provide biogrowth control through the filters, and the residual would be carried through the Tapia WRF chlorine contact channel, the pipeline to the AWPF, and potentially through MF and RO processes at the AWPF. Once this approach is implemented, DBP formation testing is recommended through UV-AOP and through simulated chlorine contact following UV-AOP with this strategy. It is believed to be possible to achieve the CTR requirements with this approach, but the potential viability of a CCB as described in Section 2 – Basis of Design should be assessed.

If LVMWD does not elect to implement preformed monochloramine addition at the Tapia WRF, the UV-AOP system would need to be sized for 2.0-log NDMA destruction. In addition, the use of free chlorine as the oxidant for UV-AOP may not be feasible; in which case, hydrogen peroxide would be used instead.

Thus, a hydrogen peroxide system was sized for consideration. The hydrogen peroxide system would require an additional footprint of 28 feet by 42 feet for a system with two storage tanks, two chemical metering pumps, and secondary containment, all consistent with the chemical system design approaches described in Section 10 – Chemical Handling Facilities. This sizing assumes 35% active hydrogen peroxide. The use of hydrogen peroxide would also require chemical quenching of the hydrogen peroxide residual with sodium hypochlorite or sodium bisulfite. The chemical system for the selected approach would need to be resized based on the additional dose points and increased chemical usage.

8. Post-treatment Water Stabilization and Purified Water Pump Station

This section presents the conceptual design of the post-treatment water stabilization and PWPS for the AWPF and includes the following elements:

- Process Description and Design Considerations
- Process Design Criteria
- Conceptual Layout
- Operational Strategies

8.1 Process Description and Design Considerations

The post-treatment water stabilization system will consist of a packed tower and forced-draft decarbonator with chemical addition, all located downstream of the UV-AOP. Post-treatment is required to reduce the carbon dioxide level, increase pH, and increase calcium and alkalinity levels to provide a stable, finished water prior to discharge to the Las Virgenes Reservoir. This is necessary because the upstream RO process will remove nearly all of the alkalinity and calcium present in the AWPF influent, and acidification of the RO feed water produces high levels of carbon dioxide and acidic pH in the RO permeate. Only a portion of the UV-AOP effluent will be decarbonated to maintain a target level of carbon dioxide in the treated water prior to chemical addition. The remaining carbon dioxide will be converted to bicarbonate ion to achieve the desired LSI (-0.5 to +0.5) in the plant finished water.

Liquid lime was used as the basis of design for post-treatment water stabilization and will be dosed to the decarbonator effluent to increase pH, alkalinity, and calcium levels to meet the finished water quality goals presented in Table 8-1. For comparison, the quality of the potable water supplemented to the Las Virgenes Reservoir and distributed to LVMWD customers is also presented.

The decarbonated effluent will flow into the planned, but optional, CCB, which will be adjacent to (separated by a weir) a downstream purified water wet well and pump station that will convey the purified water to Las Virgenes Reservoir. Aluminum chlorohydrate will be dosed inline downstream of the purified water pumps to provide phosphorus sequestration in the purified water.

Table 8-1. Finished Water Quality Goals and Potable Water Quality

Parameter	Units	AWPF Finished Water Target	Metropolitan (Jenson Plant)[a]	LVMWD (Delivery to Customers)[b]
pH	s.u.	Between 6.5 and 8.5	8.4	8.3
LSI	-	-0.5 to +0.5	Average = 0.4 Range = 0.32–0.48	Average = 0.42 Range = 0.11–0.84
Alkalinity	mg/L as calcium carbonate	100	Average = 82 Range = 79–86	Average = 105 Range = 80–132

[a] Based on 2020 data.

[b] Based on 2019 to 2020 data.

8.2 Process Design Criteria

This section describes the post-treatment design criteria.

8.2.1 Decarbonator

Decarbonator influent water quality data based on RO projections performed in IMSDesign for new and aged (5-year) membrane conditions were used to develop the conceptual design. To simulate the lowest alkalinity and pH in decarbonator influent, a temperature of 16°C was assumed in these projections. Decarbonator effluent water quality was estimated using WaterPro. Table 8-2 summarizes the post-treatment design criteria. Section 10 – Chemical Handling Facilities provides additional details about the post-treatment liquid lime chemical systems and associated design criteria.

Table 8-2. Post-treatment Design Criteria

Parameter	Units	Value
Percentage of UV-AOP Effluent Decarbonated	%	Up to 40
Decarbonator Influent Water Quality Characteristics		
Carbon dioxide	mg/L	83
Alkalinity	mg/L as calcium carbonate	5.3
pH	s.u.	5.1
Decarbonator Effluent Water Quality Characteristics		
Carbon dioxide (after blending with flow not treated by decarbonator)	mg/L	52
Alkalinity	mg/L as calcium carbonate	5.3
pH	s.u.	5.3
Decarbonator		
No. of Decarbonators	No.	1
Capacity	MGD	2.4 (design) 3.4 (maximum)
Maximum Loading Rate	gpm/ft^2	25
Minimum Air Flow Ratio	scfm/gpm	3.0
Carbon Dioxide Removal Efficiency	-	>95%
Diameter	ft	12
Height	ft	27
Packing	-	Polypropylene, minimum depth 8 ft
Liquid Distributor	-	Spray nozzles
Blowers		
No. of Blowers	No.	1 +1
Type of Blower	-	Forced draft
Blower Capacity	scfm	7,080
Motor Size	hp	7.5

scfm/gpm = standard cubic foot (feet) per minute gallon per minute

8.2.2 Chlorine Contact Basin and Dechlorination

As described in Section 2 – Basis of Design, the conceptual design conservatively includes space for a CCB to earn additional virus disinfection credit. The recombined flow from the decarbonation step enters the CCB, which is integrated with the purified water clearwell that supplies the PWPS.

A serpentine CCB was used for the basis of design and sized to provide an additional 2-log removal of virus with free chlorine, making use of the free chlorine residual present through UV-AOP. At a water temperature of 15°C, a pH of 8.5, and turbidity less than 0.2 NTU, the WaterVal CT for 2-log virus is 9 mg/min/L (WaterSecure 2017). The CCB was sized to provide a CT ratio (ratio of CT achieved to CT required) of at least 1.2, assuming a free chlorine residual of 2.0 mg/L at the end of the CCB. Table 8-3 summarizes the design criteria for the CCB. Based on these requirements, the clearwell dimensions will provide 69,700 gallons of contact volume.

Table 8-3. Chlorine Contact Basin Design Criteria

Parameter	Units	Value
Design Flow	MGD	6
Minimum Flow	MGD	1
Oxidant	-	Sodium hypochlorite
Free Chlorine Residual Concentration	mg/L	>2.0
pH	s.u.	<8.5
Temperature	°C	16
Turbidity	NTU	<0.2
CT Required (for 2.0-log virus)	mg/min/L	9.0
CT Ratio	-	>1.2
Contact Time	minutes	>9.0
Baffle Factor	-	>0.6
Clearwell Length	ft	34.5
Clearwell Width	ft	30
Clearwell Height	ft	15
Clearwell Volume	gallons	69,700

The CCB would be constructed adjacent to the downstream PWPS wet well and separated by a weir that will maintain the level in the CCB. The weir overflow will fill the PWPS wet well, which will operate with variable levels. Sodium bisulfite will be added at the weir to dechlorinate the purified water prior to pumping.

8.2.3 Purified Water Pump Station

The purified water from the AWPF will be used for SWA at the Las Virgenes Reservoir. The PWPS will deliver the purified water through a new 3.1-mile-long pipeline. The wet well for this pump station will be adjacent to the CCB, which will be separated by a weir. The PWPS was sized for a flow capacity of 6.0 MGD at a pressure of 69 psi (or 160 feet of TDH) at a pump discharge based on a conceptual piping alignment (Woodard & Curran 2023) and estimated head requirements to convey the purified water to the Las Virgenes Reservoir.

Table 8-4 and Table 8-5 summarize the design criteria for the PWPS wet well and pumps, respectively.

Table 8-4. Purified Water Pump Station Wet Well Design Criteria

Parameter	Units	Value
Length	ft	30
Width	ft	18
SWD (Usable)	ft	9
Depth	ft	18 [a]
Workable Volume	gallons	36,355
HRT	minutes	8.7 [b]

[a] Depth includes 9 ft of usable SWD, 3 ft of freeboard, and an additional 6 ft for minimum pump submergence.

[b] Based on maximum AWPF feed flow of 7.5 MGD.

Table 8-5. Purified Water Pump Station Pump Design Criteria

Parameter	Units	Value
No. of Pumps	No.	5 (4 duty, 1 standby)
Pump Type	-	Vertical turbine
Pump Capacity, each	gpm	1,320
	MGD	1.9
Total Pump Firm Capacity	gpm	4,200
	MGD	6.0
Pump TDH	ft	160
Motor Size	hp	75
Drive Type	-	VFD

8.2.4 Aluminum Chlorohydrate Addition

Aluminum chlorohydrate addition will provide phosphorus sequestration based on limnology considerations in the reservoir. A low dose (1 mg/L or less) will be added to sequester and bind the low levels of phosphate present in the purified water (post-RO), with the intent of mitigating algae growth at Las Virgenes Reservoir. Section 10 – Chemical Handling Facilities provides more details about the aluminum chlorohydrate chemical system and associated design criteria.

8.3 Conceptual Layout

Section 3 – Overall Process Flow Diagram presents the conceptual layout of these facilities. The UV-AOP product water will be split into two pipelines: one supplying the decarbonator and another to provide bypass directly to the CCB, following a high point for level control. The decarbonator-associated blower equipment will be located outside of the process building directly above the CCB. The height of the decarbonator will necessitate protruding above the canopy. The purified water wet well and PWPS will be located adjacent to the CCB, with the pumps located on the eastern side of the wet well and connected to a common discharge header that will convey the purified water to Las Virgenes Reservoir.

8.4 Operational Strategies

The PCS will control the decarbonator system (a flow control valve, flow meter, and dedicated blower). The PCS will automatically control the position of the modulating valve to achieve the flow split and percentage bypass around the decarbonator selected by the Operator. Water quality monitoring (online for pH and grab samples for pH, calcium hardness, and alkalinity) will be used to confirm the bypass to blend ratio is appropriate.

The purified water pumps, each equipped with a VFD, will be operated from the PCS to maintain the PWPS level prior to conveying water to Las Virgenes Reservoir.

Backflow preventers will be provided at the reservoir and at the PWPS to protect the pumps and processes of the AWPF. Transient analysis will need to be conducted during design to determine the appropriate surge mitigation measures required for the purified water pumps and conveyance.

9. Residuals

This section presents the conceptual design of the residual systems for the AWPF and includes the following elements:

- System Description and Design Considerations
- Design Criteria
- Operational Strategies

9.1 System Description and Design Considerations

The AWPF will generate waste residuals that will require disposal. The process drains and backwash water generated by the MF and RO system cleanings will be collected in an onsite waste equalization tank that will be neutralized and pumped to the sewer. The sanitary waste flows will be discharged by gravity directly into the onsite maintenance hole and then pumped to the sewer. The ROC will be directed to the ROC pump station, comprising a wet well and pumps, that will convey the ROC by an estimated 13.2- to 14.5-mile-long pipeline to the Calleguas SMP.

The following waste streams will be discharged to a below-grade waste equalization tank and pump station:

- MF pre-strainer backwash waste
- MF backwash waste
- MF MC and RC waste (neutralized)
- RO flush waste
- RO CIP waste (neutralized)
- Process drains, including sample stations and local drains

Table 9-1 provides a summary of the waste flows generated from each process facility and the respective discharge location. The waste frequency is also presented in the table. Process waste streams denoted as continuous and intermittent will be generated during normal operation on an hourly or daily basis, while process waste streams denoted as scheduled will be less frequent (weekly, monthly, or longer) and generally be initiated by Plant Operations.

Table 9-1. Advanced Water Purification Facility Residual Waste Flow Summary

Process Facility	Residual Waste Flow	Waste Frequency	Discharge Location
Various	Process drains	Continuous	Waste equalization tank, pumped to sewer
MF System	Strainer backwash water	Intermittent	
	MF backwash water	Intermittent	
	MF cleaning chemical solutions [a]	Scheduled	
RO System	RO cleaning chemical solutions [a]	Scheduled	
	RO flush water	Scheduled	
	ROC	Continuous	ROC pump station; pumped to Calleguas SMP
Administration and O&M Building	Sanitary	Intermittent	Onsite maintenance hole; pumped to sewer

[a] Chemically neutralized

Table 9-2 summarizes the quantities of the waste flows that will be discharged to the waste equalization pump station.

Table 9-2. Summary of Residual Flows

Waste Generated	Units	Average Condition	Maximum Condition
MF Backwash Waste	gpd	375,000	375,000
MF Chemical Cleaning Waste (from MCs and RCs)	gpd	9,000 [a]	18,000 [b]
RO Chemical Cleaning Waste (from CIPs)	gpd	6,000 [c]	18,000 [d]
Subtotal	gpd	390,000	411,000
Safety Factor [e]	-	1.2	1.2
Total	gpd	468,000	493,200
Average Waste Flow	gpm	325	343

[a] Assumes three MC skid volumes in a day.

[b] Assumes six MC skid volumes in a day.

[c] Assumes one skid cleaned in a day.

[d] Assumes three skids cleaned in a day.

[e] Includes strainer backwash, RO flush, and process drains.

gpd = gallon(s) per day

9.2 Design Criteria

This section describes the design criteria for the waste equalization and ROC pump stations.

9.2.1 Waste Equalization Pump Station

Table 9-3 summarizes the design criteria for the waste equalization pump station wet well. The wet well was sized to provide about 7 to 8 hours of storage at the maximum waste flow of 343 gpm from Table 9-2.

Table 9-3. Waste Equalization Pump Station Wet Well Design Criteria

Parameter	Units	Value
Length	ft	47
Width	ft	30
SWD (Usable)	ft	15
Depth	ft	24 [a]
Workable Volume	gallons	158,213
HRT	hours	7.7 [b]

[a] Depth includes 15 ft of usable SWD, 3 ft of freeboard, and an additional 6 ft for minimum pump submergence.

[b] Based on waste flow of 343 gpm from maximum condition in Table 9-2.

Table 9-4 summarizes the design criteria for the waste equalization pumps. The waste will be pumped through a new 8-inch-diameter connection to the existing 24-inch-diameter trunk sewer. Sanitary waste from the AWPF will be pumped from a maintenance hole to the 8-inch-diameter piping near the waste equalization pump station. Check valves will be provided on both lines at the connection point. The pumps are assumed to be sized to match the waste flow rate of 343 gpm under maximum conditions, but the pumping capacity could be increased, depending on the size of the connection to the existing 24-inch-diameter trunk sewer, as well as any capacity limits in the existing sewer. More pumping capacity would allow the size of the wet well to be optimized and also reduce the pumping hours required in a day.

Table 9-4. Waste Equalization Pump Station Pump Design Criteria

Parameter	Units	Value
No. of Pumps	No.	1 (1 duty, 1 standby)
Pump Type	-	Vertical turbine
Pump Capacity	gpm	343
Pump TDH	ft	25
Motor Size	hp	5
Drive Type	-	VFD

9.2.2 Reverse Osmosis Concentrate Pump Station

The ROC will be discharged to an ROC wet well into an enclosed space to reduce turbulence and offgassing of carbon dioxide, which could increase the potential for scaling. Then it will be pumped to the Calleguas SMP. Transient analysis will need to be conducted during design to determine the appropriate surge mitigation measures required for the ROC pump station and pipeline. Ongoing ROC pipe run testing is being conducted at the Demonstration Facility to characterize the potential scale and mitigation considerations. The ROC flow is expected to range from 200 to 740 gpm, depending on the number of RO trains in operation.

Table 9-5 and Table 9-6 summarize the design criteria for the ROC pump station wet well and pumps, respectively.

Table 9-5. Reverse Osmosis Concentrate Pump Station Wet Well Design Criteria

Parameter	Units	Value
Length	ft	27
Width	ft	20
SWD (usable)	ft	6
Depth	ft	15 [a]
Workable Volume	gallons	24,240
HRT	hours	0.55 [b]

[a] Depth includes 6 ft of usable depth, 3 ft of freeboard, and an additional 6 ft for minimum pump submergence.

[b] Based on maximum ROC flow of 740 gpm.

Table 9-6. Reverse Osmosis Concentrate Pump Station Pump Design Criteria

Parameter	Units	Value
No. of Pumps	No.	3 (2 duty, 1 standby)
Pump Type	-	Vertical turbine
Pump Material	-	Duplex stainless steel
Pump Capacity	gpm	600
Pump TDH	ft	270 [a]
Motor Size	hp	60
Drive Type	-	VFD

[a] Based on 220 ft of headloss through 8-inch internal diameter HDPE pipe approximately 13.2 to 14.5 miles in length, depending on the alignment and 50 ft of headloss across the backpressure valve at the end of the connection point.

9.3 Operational Strategies

The ROC pump station will send the concentrate to the Calleguas SMP through an approximately 13.2- to 14.5-mile-long, 8-inch internal diameter HDPE pipeline. The water quality must meet the Calleguas SMP NPDES permit requirements. The concentrate pumps, each equipped with a VFD, will be operated from the PCS to maintain an Operator-entered flow set point while maintaining the pump station wet well between Operator-entered high- and low-level set points. The PCS will monitor the pressure and flow in the discharge line.

The backwash and neutralized waste equalization tank will be provided with pumps, each equipped with a VFD, to discharge to existing sewer.

10. Chemical Handling Facilities

This section presents the conceptual design of the chemical handling facilities for the AWPF and includes the following elements:

- Process Description and Design Considerations
- Process Design Criteria
- Conceptual Layout
- Operational Strategies

10.1 Process Description and Design Considerations

Chemical handling comprises the storage, metering, and delivery of chemicals. The advanced treatment process requires several chemical systems for treatment, enhancement, and cleaning. Table 10-1 lists the chemicals anticipated to be used at the AWPF, with their respective purposes and application points.

Table 10-1. Chemicals at AWPF

Chemical	Application	Dose Location
Sodium Hypochlorite[a]	▪ Preformed monochloramine (MF and RO fouling control) ▪ UV-AOP oxidant ▪ MF cleaning	▪ MF strainer feed ▪ UV-AOP feed ▪ MF CIP system
Liquid Ammonium Sulfate	▪ Preformed monochloramine (MF and RO fouling control)	▪ MF strainer feed
Antiscalant	▪ Scale prevention	▪ RO feed
Sulfuric Acid	▪ Scale prevention	▪ RO feed ▪ MF CIP and neutralization systems ▪ RO CIP and neutralization systems ▪ ROC
Sodium Bisulfite	▪ MF CIP neutralization ▪ Dechlorination of purified water	▪ MF CIP system ▪ PWPS
Liquid Lime	▪ Post-treatment stabilization	▪ UV-AOP product
Aluminum Chlorohydrate	▪ Phosphorus sequestration	▪ Purified water
Sodium Hydroxide	▪ MF cleaning ▪ RO cleaning and neutralization	▪ MF CIP system ▪ RO CIP and neutralization systems
Citric Acid	▪ MF cleaning ▪ RO cleaning	▪ MF CIP system ▪ RO CIP system
Sodium Dodecyl Benzene Sulfonate[b]	▪ RO specialty cleaning	▪ RO CIP

[a] Design basis is delivered sodium hypochlorite; however, hypochlorite could be generated onsite in a similar-sized space.

[b] Facilities should be provided to add proprietary chemicals, like sodium dodecyl benzene sulfonate, should generic cleaning formulations not perform as needed. These chemicals will be provided in drums or totes with containment pallets.

10.1.1 Chemical Storage Sizing

Sizing of the chemical storage is based on the following factors:

- Storage duration for average chemical dose at maximum flow conditions, with batch feed criteria for cleaning and neutralization demands
- 30-day storage for stable chemicals, including:
  - Liquid ammonium sulfate
  - Antiscalant
  - Sodium bisulfite
  - Aluminum chlorohydrate
  - Sodium hydroxide
  - Citric acid
- 14-day storage for chemicals with degradative potential or higher handling or hazard classification considerations, including:
  - Sodium hypochlorite
  - Lime
  - Sulfuric acid
- Accommodation for a full truck delivery where possible
- Maximum 12-foot-diameter storage vessel for hauling considerations
- Totes for smaller demands
- Two storage tanks or totes for redundancy for most chemicals to facilitate maintenance and acceptance of full delivery loads; only one tank has been identified for sulfuric acid to minimize storage due to the hazard classification and for cleaning chemicals (sodium hydroxide and citric acid)

10.1.2 Equipment and Material Preferences

The metering pumps were sized to meet the demand requirements for each chemical, with one standby pump. Plant Operations has a preference for peristaltic, chemical metering pumps where appropriate.

Lined carbon-steel tanks are the basis for sulfuric acid and liquid lime storage due to classification. All other chemicals may use HDPE or FRP. HDPE tanks are lower cost, but often need more frequent replacement. FRP tanks have a longer lifespan at a higher cost.

10.1.3 Chemical Safety

Each chemical is housed in a separate containment area for potential spills, leaks, and rainwater collection, with a fire wall separation for sulfuric acid. The following components will also be provided:

- Emergency eye wash and showers
- Containment collection sumps
- Access stairs and platforms
- Fill stations
- Tote storage areas with forklift accessibility for replacement

Chemical safety and area classifications consider the *California Building Code* (CBC) and *California Fire Code* (CFC). Sprinklers are not anticipated in the sulfuric acid canopy due to an unsafe reaction with water. Omitting sprinklers in the sulfuric acid storage area must be approved by the Fire Marshal. For sulfuric acid volumes greater than 50 gallons, the area is classified as H-3 occupancy. The sulfuric acid tank will be placed at the end of the containment area for additional safety.

The remaining chemicals are either H-4 or nonhazardous; however, the more conservative H-3 classification is assumed throughout the chemical storage facility. Chemical piping will be routed underground to the process areas in secondary containment, potentially in piping trenches.

10.2 Process Design Criteria

The flow-paced chemical feed requirements are provided in Table 10-2 for each treatment and enhancement service and in Table 10-3 for post-treatment stabilization. Demands for the cleaning and neutralization systems are intermittent and addressed in the design characteristics section.

Table 10-2. Chemical Requirements for Treatment

AWPF Process Flow (MGD)	Dose (mg/L)	Feed Requirements (gph)	Application
Sodium Hypochlorite, 12.5%			
Preformed monochloramine: ▪ Minimum: 1 ▪ Average: 3.2 ▪ Maximum: 7.5	1.0 3.5 5.0	0.3 to 10.4	Dosed to MF strainer feed for MF and RO fouling control
UV-AOP oxidant: ▪ Minimum: 0.8 ▪ Average: 2.6 ▪ Maximum: 6.0	2.0 3.0 4.0	0.5 to 6.7	Dosed to UV-AOP feed as an oxidant
Liquid Ammonia Sulfate, 40%			
Preformed monochloramine: ▪ Minimum: 1 ▪ Average: 3.2 ▪ Maximum: 7.5	1.0 3.5 5.0	0.1 to 3.5	Dosed to MF strainer feed for MF and RO fouling control
Antiscalant, 100%			
Scale prevention: ▪ Minimum: 0.95 ▪ Average: 3.0 ▪ Maximum: 7.1	2.0 2.5 3.5	0.8 to 1.3	Dosed to RO feed for scale prevention
Sulfuric Acid, 93%			
RO scale prevention: ▪ Minimum: 0.95 ▪ Average: 3.0 ▪ Maximum: 7.1	2.0 2.5 3.5	0.8 to 1.3	Dosed to RO feed for scale prevention
ROC scale prevention: [a] ▪ Minimum: 0.2 ▪ Average: 0.5 ▪ Maximum: 1.0	250	1.2 to 6.1	Dosed to RO concentrate for scale prevention
Sodium Bisulfite, 38%			
Purified water dechlorination: ▪ Minimum: 0.8 ▪ Average: 2.6 ▪ Maximum: 6.0	3.0 3.0 4.5	0.2 to 2.3	Dosed to UV-AOP effluent for dechlorination

[a] Use of sulfuric acid for scale prevention in the ROC line is being evaluated as part of the pipe loop demonstration testing; this demand is not currently considered in sizing of the sulfuric acid storage requirements.

gph = gallon(s) per hour

Table 10-3. Chemical Requirements for Post-Treatment Stabilization

AWPF Process Flow (MGD)	Dose (mg/L)	Feed Requirements (gph)	Application
Liquid Lime, 45% [a]			
Post-treatment stabilization: ▪ Minimum: 0.8 ▪ Average: 2.6 ▪ Maximum: 6.0	 57 71 85	3 to 35	Dosed to UV-AOP effluent for conditioning
Aluminum Chlorohydrate			
Post-treatment stabilization: ▪ Minimum: 0.8 ▪ Average: 2.6 ▪ Maximum: 6.0	 0.37 0.74 1.5	0.01 to 0.3	Dosed to UV-AOP effluent for conditioning

[a] Due to the handling considerations of lime, calcium chloride and sodium hydroxide were also considered for post-treatment stabilization. While they are easier to handle, the quantities are greater and more costly due to a lower active chemical concentration. Appendix B provides a summary of the demands.

Table 10-4 summarizes the design characteristics for treatment chemicals, and Table 10-5 summarizes the design characteristics for post-treatment stabilization chemicals.

Table 10-4. Design Characteristics for Treatment Chemicals

AWPF Process Flow (MGD)	Capacity per Unit	No. of Units	Storage Duration (days)
Sodium Hypochlorite, 12.5%			
Bulk Storage Tank	3,000 gallons	2	Target: 14 Actual: 18
Metering Pumps: ▪ Preformed monochloramine ▪ UV-AOP oxidant Transfer Pumps: ▪ MF CIP system	 15 gph 15 gph 15 gph	 1 duty, 1 standby 1 duty, 1 standby 1 duty, 1 standby	--
Liquid Ammonia Sulfate, 40%			
Bulk Storage Tank	3,000 gallons	2	Target: 30 Actual: 102
Metering Pumps: ▪ Preformed monochloramine	 5.6 gph	 1 duty, 1 standby	--
Antiscalant, 100% [a]			
Storage Tote	300 gallons	2	Target:30 Actual: 86
Metering Pumps: ▪ Scale prevention	 5.6 gph	 1 duty, 1 standby	--

Table 10-4. Design Characteristics for Treatment Chemicals

AWPF Process Flow (MGD)	Capacity per Unit	No. of Units	Storage Duration (days)
Sulfuric Acid, 93%			
Bulk Storage Tank	5,300 gallons	1	Target: 14 Actual: 16
Metering Pumps: ▪ RO scale prevention ▪ ROC scale prevention [a]	 5.6 gph 15 gph	 1 duty, 1 standby 1 duty, 1 standby	--
Sodium Bisulfite, 38%			
Storage Tote	300 gallons	2	Target: 30 Actual: 30
Metering Pumps: ▪ Purified water dechlorination Transfer Pumps: ▪ MF CIP neutralization	 5.6 gph 15 gph	 1 duty, 1 standby 1 duty, 1 standby	--
Sodium Hydroxide, 25%			
Bulk Storage Tank	5,300 gallons	1	Based on demand per cleaning event [b]
Transfer Pumps: ▪ MF cleaning and RO cleaning and neutralization	15 gph	2 duty, 2 standby	--
Citric Acid, 25%			
Bulk Storage Tank	5,300 gallons	1	Based on demand per cleaning event [b]
Transfer Pumps: ▪ MF and RO CIP Systems	15 gph	2 duty, 2 standby	--

[a] Not included in storage volume due to ongoing pilot testing.
[b] Required volume based on MF MCs or one MF CIP and one RO CIP.

Table 10-5. Design Characteristics for Post-Treatment Stabilization Chemicals

AWPF Process Flow (MGD)	Capacity per Unit	Number of Units	Storage Duration (days)
Liquid Lime, 45% [a]			
Bulk Storage Tank	5,000 gallons	2	Target: 14 Actual: 14
Metering Pumps: ▪ Post-treatment stabilization	33.3 gph	2 duty, 1 standby	--
Aluminum Chlorohydrate			
Storage Tote	300 gallons	2	Target: 30 Actual: 89
Metering Pumps: ▪ Post-treatment stabilization	5.6 gph	1 duty, 1 standby	--

[a] Due to the handling considerations of lime, calcium chloride and sodium hydroxide were also considered for post-treatment stabilization. While they are easier to handle, the quantities are greater and more costly due to a lower active chemical concentration. Appendix B provides a summary of the demands.

10.3 Conceptual Layout

A new, centralized chemical handling facility was sized for the storage and feed of chemicals for the AWPF. The facility is located outside beneath a canopy, behind the main building, with screening material to provide shade and shield the view. The access road was aligned to facilitate chemical deliveries. Figure 10-1 shows the conceptual layout. Special considerations include:

- Safety codes
- Wildfire protection
- Seasonal flow fluctuations
- Plant shutdowns

10.4 Operational Strategies

The chemical handling facilities will have automatic system control through field control panels, process control panels, and the PCS. The PCS will automatically adjust the pump flow rates based on Operator-entered dose set points. Some chemicals may have dose rates trimmed based on analytical instrument readings and the corresponding Operator-entered set points. Each chemical storage tank will be provided with an ultrasonic level transmitter and level gauge to monitor the level in each chemical tank.

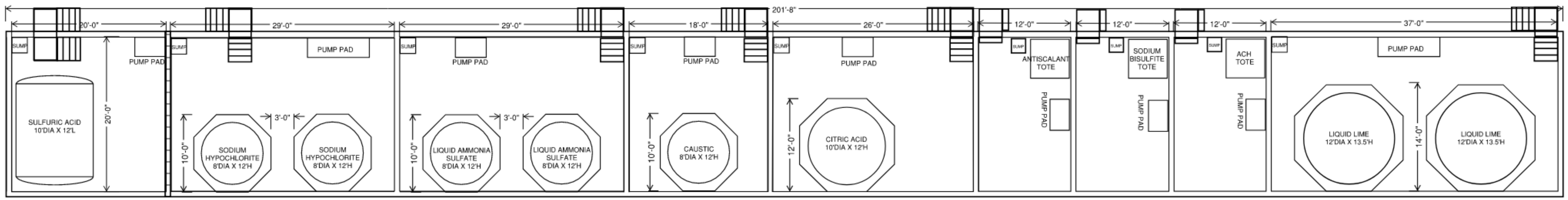


Figure 10-1. Conceptual Chemical Facility Layout

11. Discipline Design Guidelines

This section presents the general design guidelines for the conceptual design of the AWPF for the following disciplines:

- Guiding principles
- Site civil
- Landscape architecture
- Architectural
- Structural
- Process mechanical
- Building mechanical
- Fire protection
- Electrical
- I&C
- Geotechnical

A summary of the desktop geotechnical evaluation and recommendations is also provided. The applicable codes and standards, base mapping and site survey, and specific criteria to be considered in the design development are provided.

11.1 Guiding Principles

Development of the conceptual AWPF layout considered the JPA's 10 policy principles established in 2016:

- *Involve the City and the community in the development and design of facilities.*
- *Preserve the natural beauty of the site.*
- *Reserve a portion of the property for public benefit in coordination with the City of Agoura Hills.*
- *Minimize the impact to oak trees and other natural resources on the property.*
- *Design the facilities with architecture compatible with the surrounding area.*
- *Minimize the overall footprint of the facility.*
- *Provide the onsite treatment and capture of stormwater.*
- *Keep the community and recreational users informed of any Project-related activities that may impact them.*
- *Minimize the potential for noise or light to emanate from the site.*
- *Use renewable energy sources to offset demands at the site.*

During the certification of the Programmatic Environmental Impact Report, an Agoura Hills Council Member requested the following areas also be addressed in final design:

- Consider approaches to mitigate the bulk mass of the retaining walls so they are not as pronounced while driving along Agoura Road, such as:
  - Stagger the walls.
  - Use vegetative cover, green walls, and stone walls.
  - Use architectural treatment for the retaining wall.
- When planting new oak trees, plant within the City of Agoura Hills boundaries, to the extent feasible.
- Maintain access to the nearby hiking trail.

11.2 Site Civil

This section discusses the site civil requirements.

11.2.1 Codes and Standards

The site will be designed to conform to the following site civil-related codes and standards (the applicable edition for each will be verified by the final designer):

- Los Angeles County Fire Code
- *Los Angeles County Hydrology Manual* (LACHM)
- City of Agoura Hills Building Permit
- County of Los Angeles Building Permit

11.2.2 Base Mapping and Site Survey

Base maps were developed from the preliminary survey and mapping performed on January 12, 2022.

11.2.3 Existing Site Conditions

The AWPF site is located in Southern California on the border of Los Angeles and Ventura counties. The Agoura location is located on an empty lot in a business park and retail zone off of Agoura Road in Agoura Hills, located at 30800 Agoura Road (APN-2061-001-025). The site is undeveloped and encompasses approximately 7 acres (Figure 11-1). Site access is off Agoura Road, which is a four-lane road with a planted median. An existing driveway is located near the center of the parcel. To the east of the parcel is an existing detention basin, and the parcel is bordered on the west by apartments.

A channel, which is identified as Reach Code 18070104000702, runs through the parcel and discharges to a 4-foot bottom-width box culvert headwall (MTD Plan 1127) located at the northern side of the property under Agoura Road (Los Angeles County 2022). The site gradient is approximately 12% from the southeastern corner of the usable parcel to the northwestern corner of the proposed building location. The southeastern portion of the site has steep slopes. For example, the steepest slope from south to north is approximately 20%, with a maximum elevation of 1,033 feet and minimum elevation of 966 feet. An existing detention basin (1066084) is located on the eastern parcel boundary.

Several oak trees with diameter at breast height measurements larger than 36 inches were observed during surveys conducted on January 13 and 14, 2022. Specifically, coast live oak trees were noted on the flattened gravel portion of the site located adjacent to the apartment complex, and six valley oaks were observed along the hill backed by Lady Face Mountain.

No trees meeting the criteria of *Agoura Hills Heritage Tree Ordinance* were identified to be removed as part of the site development. Removal of other native tree species may occur as part of pre-construction site preparation or during construction. Implementation of specific oak tree, native tree, and heritage tree protection avoidance, minimization, and mitigation measures and mitigation plans will be prepared that would reduce impacts to a less than significant level by avoiding trees where feasible and replacing those that are removed. In total, five native tree species were identified during the survey:

1) Coast live oak
2) Cottonwood
3) Valley oak
4) Western sycamore
5) Willow

Two non-native tree species were also observed: Chinese elm and pepper tree.

11.2.4 Site Preparation and Grading

The proposed development for the site includes a raised, elevated, graded pad for the facility; an interior roadway; and entrance and exit ramps. The pad is 2.7 acres with a base elevation of 980 feet.

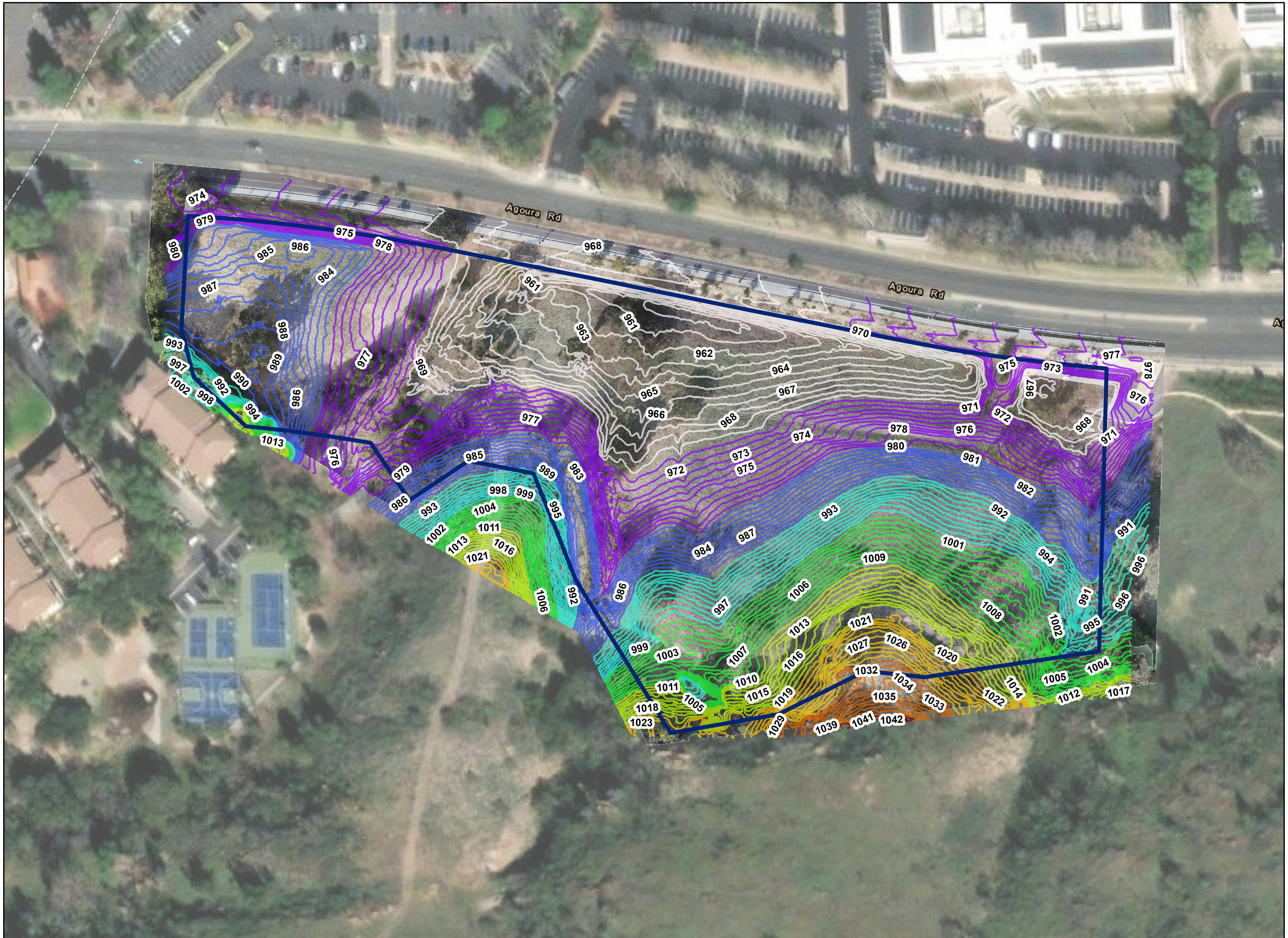
The elevation of the pad was chosen to:

- Consider existing steep and variable grades
- Constrain facilities between the existing natural channel to the west and detention basin to the east
- Mitigate stormwater runoff and prevent floods
- Optimize earthwork to reduce wall height and length
- Maintain grading within the parcel boundary
- Maximize space for treatment operations and the roadway for chemical delivery
- Maintain street offset for best management practices (BMPs) and visual aesthetics

Erosion control measures will be included in Project design and incorporated into the site work while construction activities are taking place. These measures will include silt fence at the toe of new slopes and stockpiles and downhill of disturbed areas. Temporary hydroseed will be applied to ground surfaces exposed during the wet season. Plastic sheet covering may also be used on erodible stockpiles and other disturbed areas where vegetation cannot be established in a timely manner. Sedimentation will be controlled through the following measures:

- A construction entrance
- A wheel wash
- A catch basin and inlet protection
- Additional BMPs, as applicable

All applicable local and state jurisdictional requirements will be followed and a Stormwater Pollution Prevention Plan (SWPPP) developed, including drawings showing temporary erosion control during construction. Erosion control measures will be developed based on Los Angeles County requirements. The SWPPP will be developed based on Los Angeles RWQCB standards.

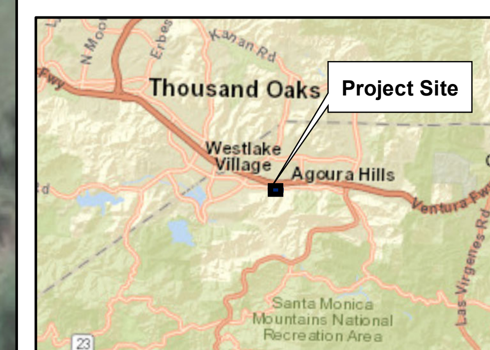


Legend

30800 Agoura Road Site

Elevation

960 - 970ft
971 - 980ft
981 - 990ft
991 - 1000ft
1001 - 1010ft
1011 - 1020ft
1021 - 1030ft
1031 - 1040ft
1041 - 1050ft



Sources:
ESRI World Imager; ESRI World Street Map

0 50 100 200
Feet
1 inch = 100 feet

Figure 11-1

30800 Agoura Road Site Topography

Pure Water Project Las Virgenes –Triunfo

Jacobs

\\dc1vs01\GISProj\L\LasVirgenes-Triunfo\MapFiles\Reports\Fig11-1_Agoura_Road_Site_Topography_2022-11-01.mxd

11.2.5 Retaining Wall

Due to the extreme slopes on the property, a retaining wall is required at the southeastern corner of the graded pad. The wall, shown on Figure 11-2, is 32 feet tall and would use 2H:1V (where H is horizontal and V is vertical) cut and fill slopes to match existing grade.

11.2.6 Site Clearing and Grubbing

The site will be cleared and grubbed prior to the start of construction.

Existing topsoil will be stockpiled for reuse in final grading.

Existing utilities will be located prior to excavating, through utility location services (USA where possible), existing geographic information system (GIS) data, and potholing when necessary.

Roots, stumps, and other buried wood material will be removed and disposed of in accordance with the specifications.

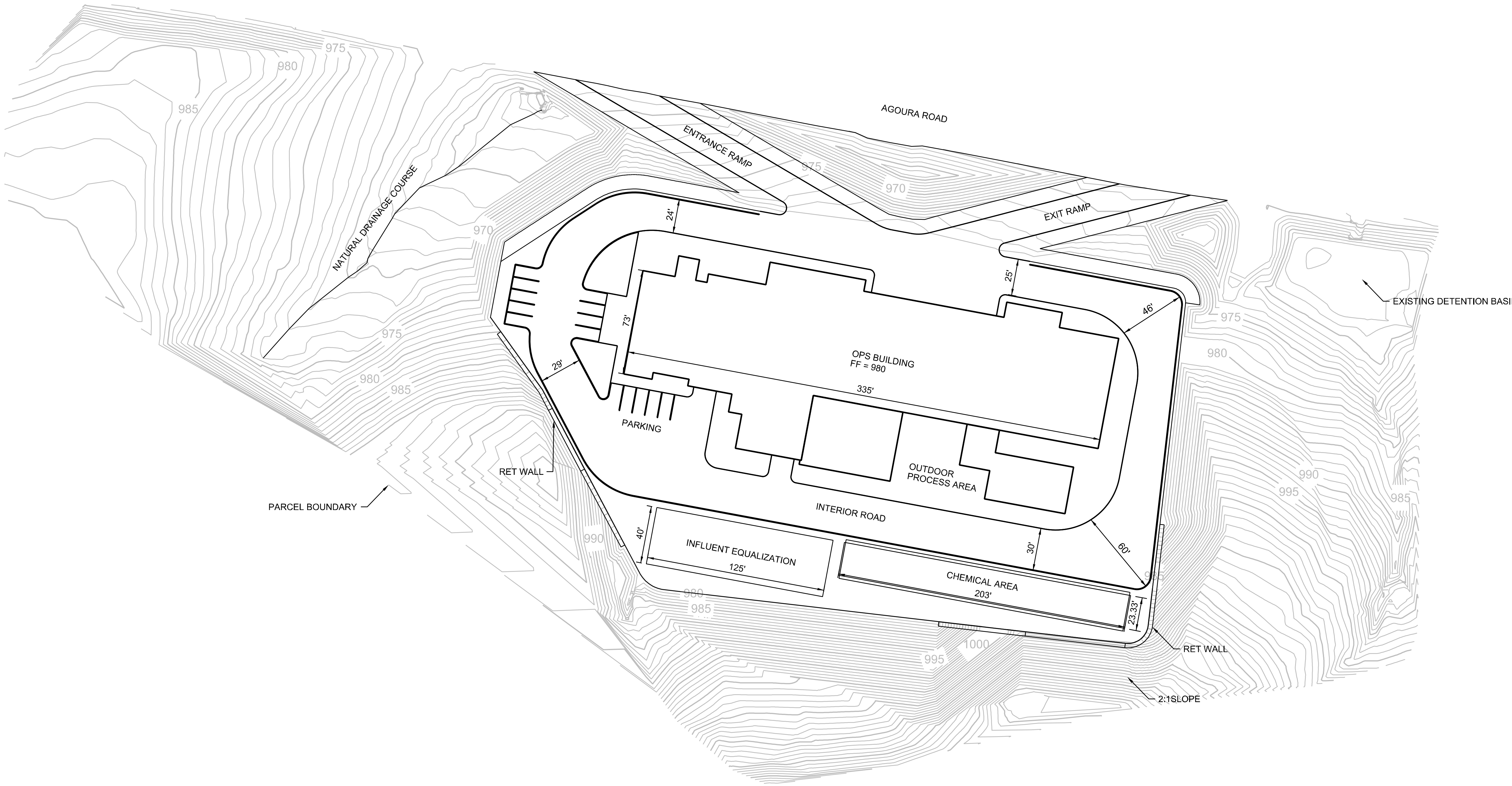
11.2.7 Storm Drainage

Los Angeles County design criteria were used for the Project. The hydrologic analysis is based on the design criteria outlined in the LACHM. The most pertinent design criteria are summarized as the following:

- Preliminary hydrology calculations were performed using Los Angeles County's HydroCalc program (Appendix A). This program uses the Modified Rational Method (MODRAT) to calculate runoff volume produced by the design storm. A minimum time of concentration of 5 minutes was used, in accordance with LACHM criteria.
- Onsite storm drains are designed for the 25-year, 24-hour storm event, in accordance with LACHM criteria.

This section presents the pre-Project and post-Project conditions of the site. The site is divided into four subareas:

1) Pad
2) Facility building
3) Interior roadway
4) Entrance and exit ramps



CIVIL SITE PLAN

1"=40'

ADVANCED WATER PURIFICATION FACILITY
AGOURA HILLS, CALIFORNIA

PURE WATER PROJECT LAS VIRGENES-TRIUNFO

DSGN
DR SMF

ADVANCE WATER PURIFICATION FACILITY
CIVIL
SITE PLAN

Jacobs

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2022
PROJ	W9Y31200
DWG	AWPF-C-2001
FIGURE	11-2

CONCEPTUAL DESIGN

Based on a developed area of 2.7 acres, the calculated runoff will increase from 14,200 cubic feet (ft^3) to 43,800 ft^3 for a 25-year storm, as shown in Table 11-1.

Table 11-1. Summary of Hydrologic Conditions

Drainage Area Description	Pervious Drainage Area (acres)	Impervious Drainage Area (acres)	Runoff Coefficient	Q_{25} (ft^3)
Pre-Project				
Pad	2.7	-	0.53	9,700
Ramps	0.13	-	0.53	4,400
Total Pre-Project	-	-	-	14,200
Post-Project				
Building Footprint	0	0.88	0.90	18,000
Ramps	0	0.13	0.90	2,500
Interior Roadway	0	0.85	0.90	16,300
Transition Areas	0.64	0	0.24	4,400
Total Post-Project	**-**	**-**	**-**	**43,800**
SWQDV	-	-	-	29,000

Notes:

Conditions are based on 25-year, 24-hour storm.

Pre-Project values are for the area of the proposed pad and roadway in the existing condition. This site is not currently developed.

Conservative runoff was used to estimate required retention volume. Further analysis will be required as the design progresses. A variety of BMPs will need to be implemented to capture and treat the runoff from the developed areas.

Q_{25} = 25-year storm flow

SWQDV = stormwater quality design value

11.2.8 Site Improvements – Access Roadways and Parking

The interior roadway design accommodates a 65-foot-long semi-trailer with a 60-foot turn radius (Caltrans 2018). The roadway circles the building with a minimum width of 24 feet and a maximum width of 30 feet. This satisfies the Los Angeles County Fire Code 503.2.1, which requires a 20-foot width minimum.

Two ramps would allow vehicles to enter and exit the site. The entrance and exit ramps have slopes of 5.8% and 3.5%, respectively, which is less than the Los Angeles County Fire Code D103.4 requirement, which requires a slope of less than 15%.

A fence will secure the property, and the entrance ramp will allow chemical delivery trucks to pull off Agoura Road while they wait to be admitted onsite.

11.3 Landscape Architecture

This section discusses the landscape architecture guidelines.

11.3.1 Codes and Standards

The landscape and irrigation will be designed to conform to the following related codes and standards, (the applicable edition for each will be verified by the final designer):

- CCR, Chapter 2.7 *Model Water Efficient Landscape Ordinance* (MWELO)
- California, *City of Agoura Hills Municipal Code*, specifically:
  - Landscape Standards: 9658.3 through 9658.6
  - Parking Lot Landscape: 9654.5
  - City Oak Tree Guidelines and Ordinance 9657 and Appendix A
- City of Agoura Hills *Architectural Design Standards & Guidelines* (Section IV A.1)
- *Agoura Hills Final Ladyface Mountain Specific Plan*
- *Agoura Village Specific Plan*
- *Low Impact Development (LID) Standards Manual*

11.3.2 Landscape Aesthetic Elements

Landscape aesthetic elements will be designed as follows:

- Using a comprehensive aesthetic for the following elements:
  - Wall types
  - Perimeter security fencing
  - Monument signage
  - Trellises
  - Pedestrian paving
  - Outdoor furnishings
  - Plant material
- Blending the aesthetic throughout the site with:
  - Overall building siting
  - Grading
  - Drainage
  - Vehicle access
  - Parking
- Using native and native-adaptive, City-approved, noninvasive plants and seeding that meet MWELO's water efficiency requirements.
- Developing a landscape plan that protects heritage trees and replaces trees to meet the City of Agoura Hills *Heritage Tree Ordinance*.
- Building landscape demonstration areas near the public entrance, highlighting a variety of planting themes and plant species, with ground mulch that integrates with low-impact stormwater capture, drainage, and irrigation techniques.
- Building outdoor gathering spaces, incorporating the following elements:
  - Benches
  - Tables
  - Seat walls
  - Potted plants
  - Waste receptacles
  - Enhanced paving
  - Trellises
  - A combination of shaded and unshaded areas
- Providing separate Operator outdoor space with flexible and movable furniture to facilitate lunch and breakout sessions, with a combination of shaded and unshaded areas
- Identifying and incorporating features to benefit the public on the western portion of the property.

11.4 Architectural

This section discusses the architectural requirements.

11.4.1 Codes and Standards

All facilities will be designed to conform to the following architectural design-related codes, standards, and regulations, as required by the local Authority Having Jurisdiction (AHJ) (the applicable edition for each will be verified by the final designer):

- CBC
- CFC
- *California Energy Code* (CEC)
- *California Plumbing Code* (CPC)
- *California Green Building Standards Code* (CalGreen)
- California Occupational Safety and Health Administration (Cal/OSHA) General Industry Safety Orders

Relevant local ordinances include:

- Architectural design requirements are provided in the *Agoura Hills Final Ladyface Mountain Specific Plan*, Chapter III, Section C.
- Additional architectural guidelines are included in the City of Agoura Hills *Architectural Design Standards & Guidelines*.

The design will also follow standards from the U.S. Occupational Safety and Health Administration (OSHA).

11.4.1.1 Preliminary Code Analysis

The preliminary code analysis presented here is based on the 2019 edition of CCR Title 24, Building Energy Efficiency Standards.

AWPF Building:

- Occupancy Group: Mixed; F-2 and B
- Construction Type: IIB
- Allowable Height (sprinklered): 35 feet (City of Agoura Hills 1991, Section IV A.4)
- Allowable No. of Stories (sprinklered): 4
- Allowable Area (sprinklered single-story): 92,000 ft^2
- Automatic Fire Suppression System: Required
- Accessibility: Building required to be accessible throughout, except where exemptions apply at process spaces in accordance with CBC Section 11B-203.5; an accessible route is required from the public way and accessible parking stalls to main entries
- Plumbing Fixtures (CPC Table 422.1): Toilets, lavatories, showers, service sinks, and drinking fountains as required for occupancy groups and associated building area; anticipating a minimum of:
  - One shower and one bathroom each for male and female
  - One drinking fountain (hi-lo)
  - One service sink
  - Emergency eyewash and safety showers at chemical storage and use locations

- Envelope Requirements:
  - Climate Zone 9 (City of Agoura Hills and Los Angeles County)
  - Prescriptive Requirements (CEC Table 140.3-B):
    - Walls (Mass Heavy): Maximum U-value of 0.690
    - Roof (Insulation Above Deck): Maximum U-value of 0.034
    - Floor (Slab on Grade – Unheated): Not applicable
- Solar Ready: Provide minimum roof area needed to satisfy CEC solar-ready requirements
- Hazardous Materials Storage: None

Chemical Storage Building:

- Occupancy Group: Mixed; H-3 and H-4
- Construction Type: IIB
- Allowable Height (sprinklered): 35 feet (City of Agoura Hills 1991, Section IV A.4)
- Allowable No. of Stories (sprinklered): H-3 = 2 and H-4 = 4
- Allowable Area (sprinklered single-story): H-3 = 14,000 ft^2 and H-4 = 70,000 ft^2
- Automatic Fire Suppression System: Required
- Accessibility: Exempt in accordance with CBC Section 11B-203.5
- Plumbing Fixtures (CPC Table 422.1): No specific requirements for H occupancy, but emergency eyewash and safety showers are required at chemical storage and use locations
- Envelope Requirements: None; building does not contain conditioned space
- Climate Hazardous Materials Storage: As listed in Table 11-2

Table 11-2. Chemical Occupancy Classification Summary

Chemical	Percent Solution (%)	Classification	Maximum Allowable Quantities Without H Occupancy Group (gallons)	Planned Maximum Storage (gallons)	Occupancy Group
Sulfuric Acid	93	Toxic, Corrosive, Reactive 2, Oxidizer 1	50 indoor 100 outdoor	5,300	H-3 occupancy group triggered
Sodium Hypochlorite	12.5	Corrosive	500 indoor 2,000 outdoor	6,000	H-4 occupancy group triggered
Liquid Ammonium Sulfate	40	Corrosive	500 indoor 2,000 outdoor	6,000	H-4 occupancy group triggered
Caustic	25	Corrosive	500 indoor 2,000 outdoor	5,300	H-4 occupancy group triggered
Aluminum Sulfate (Alum)	48.5	Corrosive	500 indoor 2,000 outdoor	600	H-4 occupancy group triggered
Liquid Lime	45	Corrosive	500 indoor 2,000 outdoor	10,000	H-4 occupancy group triggered
Citric Acid	50	Irritant	Not limited	5,300	–
Sodium Bisulfite	38	Irritant	Not limited	600	–
Antiscalant	100	Irritant	Not limited	600	–

11.4.2 Facility Programming for Non-process Needs

Preliminary programming for the non-process spaces is based on input gathered during a workshop with LVMWD Engineering and O&M staff held on December 15, 2021. Required spaces and functions are described in this section.

Space (Room) Name and Functional Description:

- Entry and Lobby: There will not be a dedicated receptionist. Provide an opportunity for visual display, visitor gathering, and orientation. LVMWD intends to display the mural that is currently located at the Demonstration Facility in the entryway of the new AWPF.
- Control Room:
  - Provide multipurpose space for 8 people.
  - Arrange workstations in a horseshoe shape, but furnishings must allow flexibility to rearrange desks and tables.
  - Provide space for document layout table, copier and printer, and file storage.
  - Video wall not required.
  - Line of sight to gate desirable but not required (security cameras will allow for gate monitoring).
  - The AWPF is not going to include an emergency operations center function.
- Laboratory: Provide sufficient space, laboratory-grade casework, and countertops and sinks for the following work area functions:
  - Electrode measurements
  - Turbidity
  - Titrations
  - Spectrophotometer measurements
  - Test kit storage and calibration
  - BOD analysis
  - Odor testing and sample preparation
  - Bacteriological analysis (coliforms and *Escherichia coli* [E.coli])
  - Sample preparation for subcontract laboratories
  - Glassware washing
  - Vacuum pump cabinet
  - Workstations (desks)

  The laboratory will have exterior windows or tubular skylight devices, or both, for daylighting and will have a safety shower and eyewash combination unit.

  Table 11-3 lists equipment to support daily and routine water processes, as well as laboratory equipment. Water quality testing for compliance monitoring will be performed at an offsite certified laboratory.

Table 11-3. Laboratory Testing and Equipment – Conceptual Design

Analytical Equipment	Support and Safety Equipment	Accessories
Ion-specific electrode meter	Full-size refrigerator	Drying racks (at sinks)
Turbidimeter	Ice machine	Soap dispensers (at sinks)
Auto titrator	Glassware washer	Paper towel holders (at sinks)
Spectrophotometer	Fume hood (4 foot)	Whiteboard
BOD meter	Pure water system	Map and certificate wall hangings
BOD incubator	Vacuum pump (in cabinet)	Coat hooks
Bacteriological incubator	Safety shower and eyewash combination	Safety eyewear holder
Water bath	Fire extinguisher	Utility cart
	Spill kit	Sample dipper holder (mop rack)
	First aid kit	
	Fire blanket	

- Trace Metals Room: Provide a separate laboratory room for trace metals analysis. Provide the following equipment:
  - Inductively coupled plasma mass spectrometer (ICP-MS)
  - Autosampler
  - Collision cell
  - Chiller
  - Computer software, installation, and training

  The room needs to include:
  - Bench space for sample preparation
  - Instrument vent
  - Fume hood for acid digestions
  - Space for gas cylinders
- Laboratory Storage: Provide a separate storage room for the following equipment:
  - Field equipment
  - Sample bottles
  - Coolers
  - Laboratory reagents and supplies
  - A utility cart

  In the laboratory, provide storage for:
  - Documents (file drawers)
  - Glassware (tall cabinet)
  - Chemicals (chemical cabinet)
  - Test kits (cabinets or shelving)
- Server Room: Provide space for server rack and servers, PLC, and an uninterrupted power supply (UPS). Provide a storage area (cabinet) for PLC equipment (PLC could be in separate room). Interior access from Control Room desirable but not required. The room must be lockable and include dedicated air conditioning. A dry chemical fire suppression system will be provided unless the Fire Marshall approves the approach of using a fire-rated enclosure and no fire suppression.

- Quiet Room: Provide an enclosed office for sensitive meetings, video conferences, or other private activities.
- Break Room: Provide movable tables and chairs to accommodate various use scenarios (eating, training, conferencing) for eight people. Either use a few tables or a long table that can serve as a conference table. Also provide:
  - Kitchenette with casework (base and wall cabinets)
  - Sink
  - Refrigerator
  - Coffee maker
  - Microwave
  - Dishwasher
- Restrooms:
  - Provide single-user restrooms in quantities required to meet code, including a minimum fixture count and accessibility requirements.
  - Provide separation from visitor use and employee use.
- Locker and Showers: Provide two single-user accessible shower and changing rooms with benches, adjacent to locker area, that can accommodate 10 full-height lockers (minimum size of 18 inches long by 18 inches wide by 72 inches high) and locker bench.
- In the Maintenance Shop, provide the following:
  - Space for mechanical department shop uses (big equipment, dirty equipment, and big spare parts)
  - A 12-foot-wide by 12-foot-high powered overhead door
  - An overhead monorail hoist
  - A work bench and wall storage
  - Space for personnel lift and forklift
  - Service sink for hand washing
  - Space for dedicated lockable spare part storage
- Oil Storage: Provide space for temporary storage of used oils, with a personnel door from shop and overhead door or double door for exterior access.
- Exterior Visitor Gathering Area: Provide space for tour groups (approximately 25 to 30 people) to gather before and after facility tours, including:
  - Shade trellis and canopy
  - Bench seating
  - Enhanced paving
  - Landscaping

  Provide adequate informational and wayfinding signage to support tours.
- Exterior Employee Break Area: Provide space for staff (five people minimum) to take breaks outside of the building, including shade canopy and incorporated with landscaping.

11.4.3 Design Guidelines

This section provides general design guidelines.

11.4.3.1 Architectural Theme

The design of the facility should incorporate architectural attributes that evoke contemporary Mediterranean and Spanish building design prevalent in the general Project locale. Example attributes include:

- Sloped red tile roofing
- Stucco wall finish

- Masonry walls
- Arched openings
- Divided lights
- Outdoor space connected to interior space

11.4.3.2 General Building Design

In general, building designs will accomplish the following:

- Present a unifying theme and human scale of design, including:
  - Avoid long, blank walls. Public-facing facades will be stepped in both horizontal and vertical directions to prevent large, undifferentiated wall surfaces. The unbroken façade length will not exceed 100 feet.
  - Emphasize visitor entryways and plazas.
- Reinforce the City of Agoura Hills semirural residential, low-profile character, with the following façade requirements:
  - The building façade will include architectural treatments to enhance the architectural appearance of the building, including:
    - Exposed rafter tails
    - Awnings and projections
    - Variations in roof forms and roof heights
    - Arched openings
  - Façade composition will include a base, middle, and cap with emphasis on horizontality.
- Colors:
  - Use earth-toned, subdued colors. Generally, the exterior color scheme will use earth tones that blend with surrounding natural landscape, including off-whites, siennas, umbers, beiges, tans, and browns.
  - Do not use reflective, bright, or shiny surfaces and colors.
- Use textured, natural-appearing finishes.
- Use windows for daylighting and to articulate the building façade.

11.4.3.3 Major Exterior Material Systems

Generally, exterior materials and finishes should be selected for the following considerations:

- Durability
- Low maintenance
- Fire and corrosion resistance
- Structural efficiency
- Ability to be aesthetically integrated throughout the facility

Major components will be as follows:

- Roofs:
  - Low-slope roof: Single-ply membrane roofing system over rigid insulation on metal deck
  - Mansard roofs: Sheet metal standing-seam roofing or concrete tile roofing on metal deck
  - Canopies: Sloped sheet metal standing-seam roofing
- Walls: Load-bearing concrete masonry units (CMUs) with architectural finish or cladding systems, or both

- Doors and Frames:
  - Steel, hollow-metal, with galvanized coating, factory primer, and field painted
  - Aluminum storefront system, with PVDF factory finish at entry points to administrative area of building
- Door Hardware:
  - Heavy-duty mortise-type locksets; stainless steel
  - Panic devices where required by code
  - Locations of electronic security access control to be determined during final design
- Overhead Doors:
  - Overhead Coiling Doors: Motorized, galvanized steel with PVDF factory finish
  - Overhead Sectional Doors: Motorized galvanized steel with PVDF factory finish and full-vision windows for daylighting
- Windows: Aluminum thermally broken frames with double-pane-insulated glass with Low-E coating
- Louvers:
  - Drainable blade type with insect screen, extruded aluminum, with factory finish
  - Sound-attenuating louvers should be used at high-noise spaces as required
- Signage:
  - Site entrance monument and building name signs
  - Site traffic and site directional signs
  - Safety, informational, and hazardous material signs as required by code and OSHA safety standards
  - Exterior wayfinding and informational signs for public tours

11.4.3.4 Major Interior Material Systems

Interior surfaces and finishes will be selected for appropriateness to the individual spaces. Consideration will be given to the need for the following activities and conditions:

- Washdown
- Corrosion resistance
- Slip resistance
- Light reflectance
- Comfort
- Maintenance

Major components will be as follows:

- Floors will be concrete subfloor with appropriate finish:
  - Ceramic tile in restrooms and locker and shower rooms
  - Clear, penetrating sealer at utilitarian and shop spaces
  - Resilient flooring at administrative spaces
- Walls:
  - Exposed CMU or CIP concrete; painted or sealed finish
  - Gypsum wallboard over metal stud framing; painted finish
  - Ceramic tile over cementitious backer board at restrooms and shower rooms

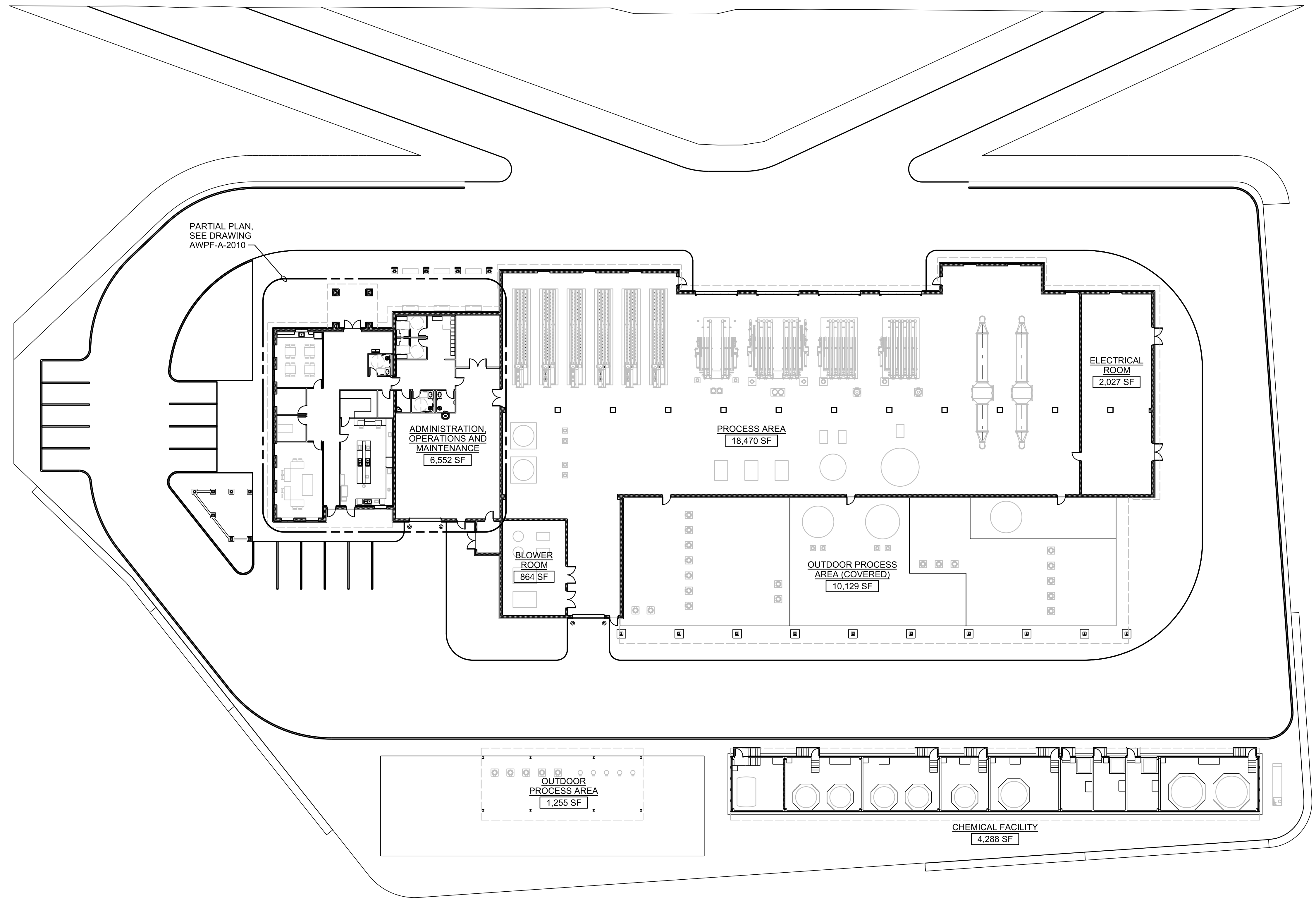
- Ceilings:
  - Suspended acoustical ceiling at administrative spaces, including:
    - Control Room
    - Laboratory
    - Break Room
    - Quiet Room
  - Gypsum wallboard over metal stud framing; painted at restroom and locker rooms
  - No ceiling at process and utilitarian spaces, including Maintenance Shop and Server Room
- Doors and Frames:
  - Steel hollow-metal with galvanized coating, factory primer, and field paint
  - Solid-core wood doors with steel hollow-metal frames at administrative spaces
- Signage:
  - Door nameplates
  - Safety, informational, and hazardous material signs as required by code and OSHA safety standards
- Safety Equipment:
  - Portable fire extinguishers as required by code
  - First aid cabinets for general building use

Refer to Section 11.7 - Building Mechanical for a discussion about emergency safety shower and eyewash provisions. Refer to Section 11.8 - Fire Protection for additional fire extinguisher requirements.

11.4.3.5 Conceptual Design Drawings and Renderings

For conceptual architectural design drawings and renderings, refer to the following:

- Figure 11-3. Architectural Site Plan
- Figure 11-4. Architectural Partial Plan (for Non-process Area)
- Figure 11-5. Enlarged Laboratory Plan



SITE PLAN

3/64"=1'-0"

ADVANCED WATER PURIFICATION FACILITY
AGOURA HILLS, CALIFORNIA

DSGN
DR J HOSTETLER

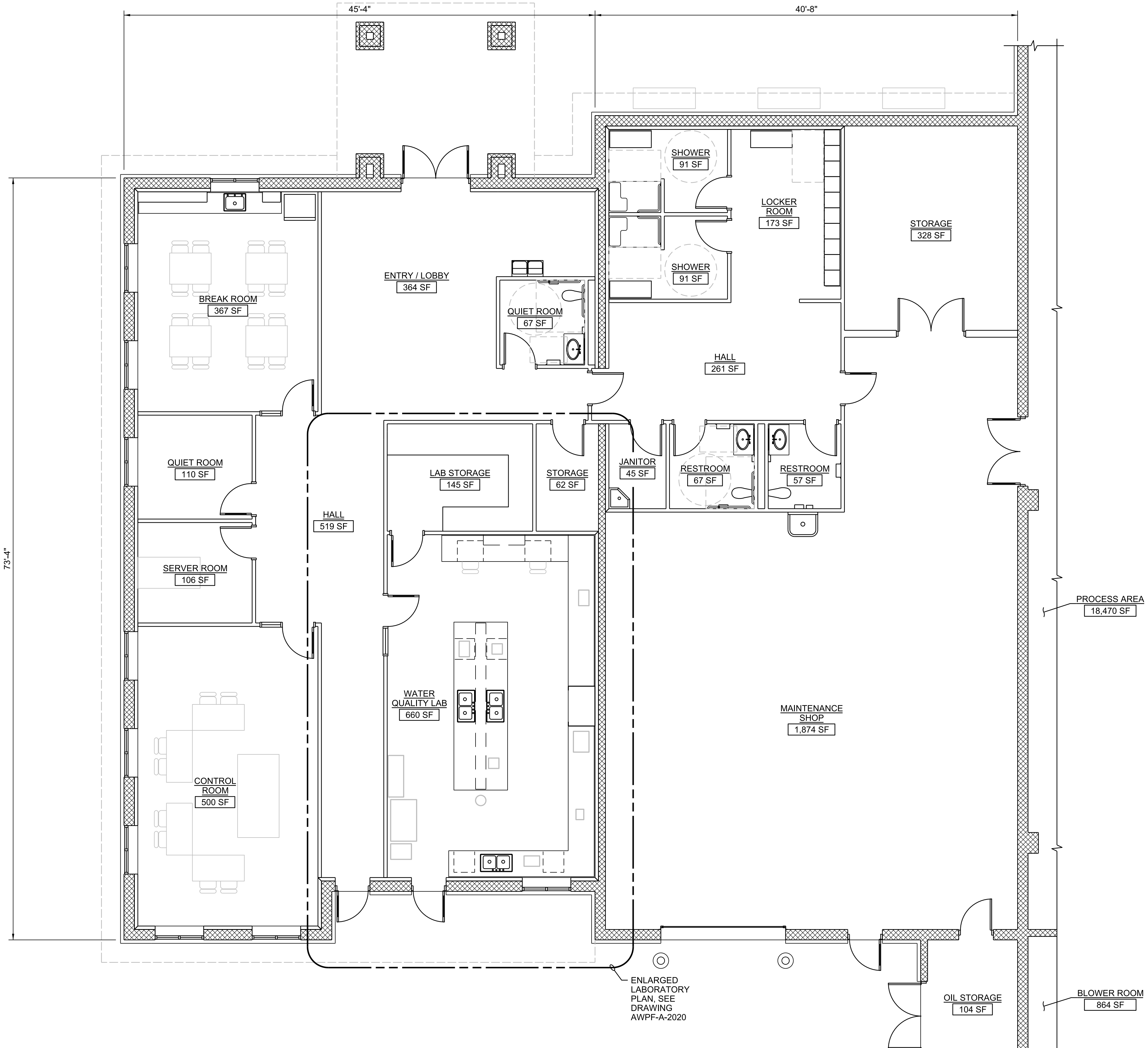
Jacobs

ADVANCE WATER PURIFICATION FACILITY
ARCHITECTURAL SITE PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2022
PROJ	W9Y31200
DWG	AWPF-A-2000
FIGURE	11-3

CONCEPTUAL DESIGN



PARTIAL PLAN

3/16"=1'-0"

ADVANCED WATER PURIFICATION FACILITY
AGOURA HILLS, CALIFORNIA

PURE WATER PROJECT LAS VIRGENES-TRIUNFO

DR J HOSTETLER
DSGN

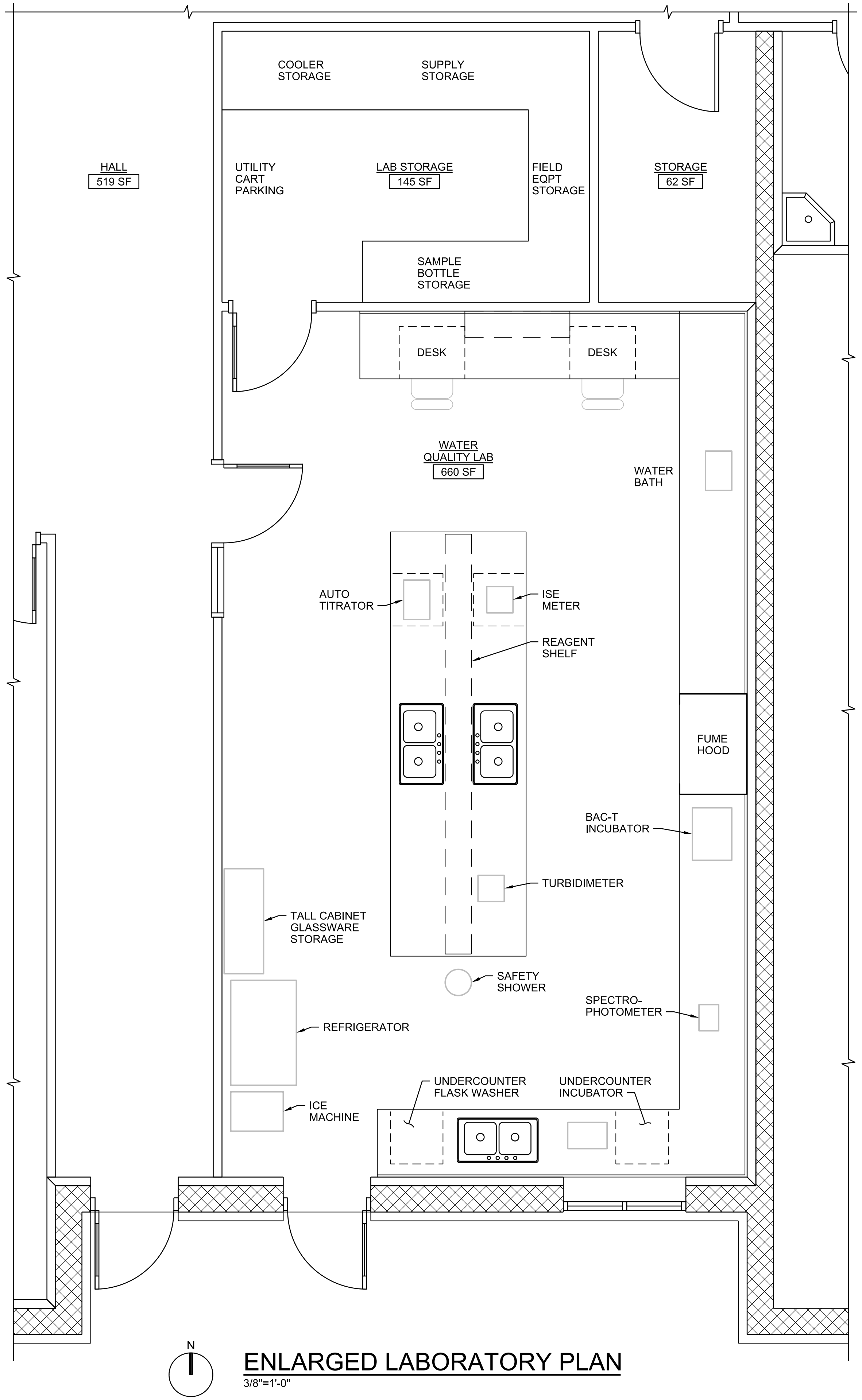
Jacobs

ADVANCE WATER PURIFICATION FACILITY
ARCHITECTURAL PARTIAL PLAN

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2022
PROJ	W9Y31200
DWG	AWPF-A-2010
FIGURE	11-4

CONCEPTUAL DESIGN



N

ENLARGED LABORATORY PLAN

3/8"=1'-0"

Jacobs

ADVANCE WATER PURIFICATION FACILITY

ARCHITECTURAL

ENLARGED LABORATORY PLAN

ADVANCED WATER PURIFICATION FACILITY

AGOURA HILLS, CALIFORNIA

DSGN

DR J HOSTETLER

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.

0 1"

DATE	NOVEMBER 2022
PROJ	W9Y31200
DWG	AWPF-A-2020
FIGURE	11-5

CONCEPTUAL DESIGN

11.5 Structural

This section discusses the structural requirements.

11.5.1 Codes and Standards

The strength, serviceability, and quality of the materials and design procedures will be designed to conform to the following structural-related codes and standards, as required by the local AHJ (the applicable edition for each will be verified by the final designer):

- CBC

Aluminum Association:

- *Aluminum Design Manual*

American Association of State Highway and Transportation Officials (AASHTO):

- [Load and Resistance Factor] *LRFD Design Bridge Design Specifications*

American Concrete Institute (ACI):

- *ACI 318, Building Code Requirements for Structural Concrete and Commentary*
- *ACI 350, Code Requirements for Environmental Engineering Concrete Structures*
- *ACI 350.3, Code Requirements for Seismic Analysis and Design of Liquid-Containing Concrete Structures*
- *ACI 350.4R, Design Considerations for Environmental Engineering Concrete Structures*
- *SPEC-301, Specifications for Structural Concrete*

American Institute of Steel Construction (AISC):

- *AISC 341, Seismic Provisions for Structural Steel Buildings*
- *AISC 360, Specification for Structural Steel Buildings*

American National Standards Institute (ANSI) and American Iron and Steel Institute (AISI):

- *ANSI/AISI S100, North American Specification for Design of Cold-Formed Steel Structural Members*

American Society of Civil Engineers (ASCE):

- ASCE/SEI *7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures*

American Welding Society (AWS):

- *AWS D1.1, Structural Welding Code-Steel*
- *AWS D1.2, Structural Welding Code-Aluminum*

International Code Council (ICC):

- Evaluation Service Reports as applicable for manufactured structural components

Steel Deck Institute:

- *Diaphragm Design Manual*

The Masonry Society (TMS):

- *402/602, Building Code Requirements and Specification for Masonry Structures*

Applicable References:

- Portland Cement Association, *Rectangular Concrete Tanks*

11.5.2 Design Guidelines

This section describes design loads and load combinations for the Project.

11.5.2.1 Design Loads

Load types as appropriate to the Project are listed and described in the following subsections.

Dead Loads

Dead loads will include the weight of all structure construction materials, including:

- Walls
- Floors
- Roofs
- Ceilings
- Stairways
- Built-in partitions
- Finishes
- Cladding
- Other similar structural and architectural items

Fixed-service equipment, including cranes, will be added to the total deadload. Equipment, pads, fixed equipment, and similar items will be considered superimposed dead loads.

Collateral Dead Loads

An allowance of 5 pounds per square foot (psf) will be provided for suspended utilities, including:

- Small-diameter mechanical piping
- Lights
- Ducts
- Conduit
- Cable trays

Piping, conduit, and cable tray loads exceeding the 5-psf allowance will be included as individual loads. An additional allowance of 5 psf will be provided for fire sprinkler systems, where applicable.

Live Loads and Deflection Criteria

Table 11-4 summarizes the design live loads. Actual equipment weights will be used where the minimum per square foot loading is exceeded.

Table 11-4. Design Live Loads

Parameter	Design Criteria
Roof Live Load (Nonreducible) Additional Bottom Chord Live Load Roof Mechanical and Electrical Allowance Solar Allowance	20 psf 10 psf 5 psf 10 psf
Floor Live Loads (includes mechanical and electrical allowance)	
Office Floor	100 psf
Electrical Room	300 psf, or 2,000-lb concentrated load, whichever produces the worst stresses in the design element
Laboratory and Control Room Mechanical Room Mechanical Rooms where equipment may be moved	150 psf, or 2,000-lb concentrated load, whichever produces the worst stresses in the design element 200 psf 300 psf, or 4,000-lb concentrated load, whichever produces the worst stresses in the design element
Corridors, Exits, Stairs	100 psf
Elevated Walkways and Platforms	100 psf
Heavy Storage	250 psf
Vehicle Access	AASHTO HS 20
Allowable Deflections (deflection to span ratio)	
Vertical Deflections	
Under Running Monorail Hoist Girder	L/600
Monorail Supporting Structure	L/450
Steel Floor Plates and Grating (Live Load)	L/360
Elements Supporting Masonry Construction	L/720 (3/8-inch maximum above windows)
Roofs Without Ceilings (total)	L/240
Roofs With Ceilings (total) Mechanical Rooms where equipment may be moved Electrical Rooms, Laboratory, and Control Rooms	L/360 L/360 L/360
Steel Roof Deck (total)	L/240
Live Load Only	L/360
Lateral Deflections	
Hoist Girders and Runways	L/450

lb = pound(s)

Seismic Loads

The seismic design of building structures will be performed in accordance with the CBC and ASCE 7. Seismic design of non-building structures, such as tanks, will be designed in accordance with the CBC, ASCE 7, and ACI 350.3. Seismic design of nonstructural components that are permanently attached to structures will be designed in accordance with CBC and ASCE 7.

Wind Loads

Design wind loads will be computed in accordance with CBC Chapter 16 and ASCE 7.

Rain Loads

Rain loads will be computed in accordance with the CBC and ASCE 7.

Snow Loads

Snow loads will be calculated in accordance with the CBC and ASCE 7.

Impact Loads

For structures carrying live loads that induce impact, the assumed live loads will be increased as indicated in this section. Refer to applicable codes previously listed. Other considerations include:

- Follow the AASHTO *Standard Specifications for Highway Bridges* for impact forces caused by moving vehicular wheel loads.
- Light machinery supports (shaft or motor driven) 20% minimum or manufacturer’s recommendation.
- Reciprocating machinery or power-driven unit supports 50% minimum or manufacturer’s recommendation.
- Monorail cranes (powered) 25%.

Vibratory Loads

Consideration will be given to equipment vibration and its effect on the supporting structure. The basic approach to controlling vibration produced by equipment will be as follows:

- Locate vibrating equipment at grade where possible.
- Isolate equipment from surrounding slab where possible.
- Provide foundation blocks and structural support systems with a mass of 3 times the weight of the equipment, or 10 times the mass of the rotating element.
- Include mechanical methods to mitigate vibration where possible (vibration isolation pads and dampening systems).

For large reciprocating equipment located on suspended slabs, a more precise evaluation of equipment operating frequencies in comparison to support system fundamental frequencies for transient and steady-state response will be completed. The ratio of the operating equipment forcing function frequency to the natural frequency of the supporting structure will be kept out of the range of 0.5 to 1.5, preferably greater than 1.5, to limit the possibility of resonant behavior.

Test Loads

Supports for piping and other mechanical systems that require testing at pressures or force levels exceeding normal operating loads will be designed for the test pressures. Test pressures will be as set forth in the system specifications.

Thermal Loads

Thermal loads will be considered for all facilities.

Liquid Loads

Water-holding basins will be designed for maximum liquid levels and loading conditions as identified in Section 11.5.2.2, Load Combinations. Maximum loads from any combination of full or empty tank cells will be applied.

Earth Loads

Below-grade structures and water-holding basins will be designed for worst-case load combinations of full height of backfill plus a minimum 2-foot soil surcharge with tanks empty in areas with traffic adjacent to the basin. Additional surcharge loads will be applied to account for unique conditions due to adjacent structure proximity and traffic or equipment loading and not necessarily applied to all structures.

Buoyancy Loads

Buoyancy will be considered for all below-grade facilities. Design factors of safety will follow ACI 350.4R Section 3.1 guidelines.

11.5.2.2 Load Combinations

Load combinations will be in accordance with CBC and ASCE 7. Masonry, structural steel, concrete, and aluminum may be designed to the allowable stress design combinations of the CBC.

Design Water Surface and Backfill Combinations

Water-retaining structures will be designed for the following four load cases:

- **Load Case I**: Design operating liquid surface elevation with no backfill (leakage testing). Use “Severe” environmental exposure criteria for crack control provisions of ACI 350.
- **Load Case II**: Backfill at finished grade with surcharge in areas with adjacent traffic (minimum 2-foot soil surcharge) with no liquid inside tank. Use “Severe” environmental exposure criteria for crack control provisions of ACI 350.
- **Load Case III**: Keep hydrodynamic loading conditions at operating liquid surface elevations. Combinations of basin cells being full or empty will be considered. Per ACI 350, use an environmental durability factor of 1.0 for seismic load cases.
- **Load Case IV**: Design to the maximum liquid surface—wall overtopping or passive overflow elevation plus 1 foot. Use “Normal” environmental exposure criteria for crack control provisions of ACI 350.

11.6 Process Mechanical

This section discusses the process mechanical requirements.

11.6.1 Codes and Standards

Applicable codes and standards from the following organizations pertain to the design of piping, valves and process equipment:

- American Water Works Association (AWWA)
- American Society of Mechanical Engineers (ASME)
- ANSI
- Hydraulic Institute (HI)
- *Standard Specifications and Drawings for Pipelines, Facilities, and General Electrical Work* (LVMWD 2021c)

11.6.2 Design Guidelines

This section provides general process mechanical design guidelines.

11.6.2.1 Layout and Access

Certain conventions should be followed to make the facility optimally functional, operable, and maintainable. When developing layouts, observe the following guidelines:

- Provide required space for equipment removal, replacement, and maintenance in the layout on the drawings.
- Mount equipment and panels on equipment pads to protect them from washdown water.
- Provide a minimum clearance of 4 feet on sides around rotating equipment greater than 10 hp.
- Leave at least 4 feet of clearance between the outermost extremities of adjacent pieces of equipment or between a wall and a piece of equipment.
- Leave a clearance of 4 feet in front of any other equipment face or panel requiring maintenance.
- Make sure pressure vessels are at least 2 feet from the back wall and 3 feet apart. Provide enough space in front of the vessel for the face piping plus 4 feet.
- For pumps, compressors, and other rotating equipment where parallel units are provided, confirm the orientation of the drive and the rotation are identical.
- Provide adequate headroom for removal of vertical turbine pumps; or specify shafts, shaft enclosure tubes (where applicable), and columns in specific-length sections that are removable.
- Provide ladders and hatches to access and remove equipment.
- Provide motorized hoists, monorails, or cranes where equipment component weights exceed 2,000 lb or when frequent lifting for maintenance is necessary.
- Provide adequate lifting headroom for equipment. Include an allowance for sling length or lifting beams between equipment lift points and crane or hoist hook.
- Provide lifting eyes, in accordance with the standard details, above equipment not otherwise provided with lifting means.
- Place washdown stations in logical areas to facilitate clean up and pipe flushing. Provide utility stations so that the maximum length of hose required is 50 feet.
- Locate piping so that it is not a tripping or collision hazard or a barrier to equipment access.
- Locate minimal piping above blowers, compressors, or pumps to facilitate lifting.
- In general, lay out piping close to walls where it can be easily supported, particularly in spaces with high ceilings.
- If piping must be run close to a wall, but not supported from it, leave at least 2 feet of clearance between the outermost pipe flange and the wall.
- To permit purging of air from the pipeline while it is being filled with water, locate a manual vent valve on the highest point of every pipeline to be filled with liquid or that is to be hydrostatically tested.
- To permit water drainage, locate a manual drain valve on the lowest point of every pipeline.
- Pipe supports and seismic bracing are generally not shown on the layout drawings. Verify, however, that adequate space is available for installation of these supports.
- Provide flexible connections to permit easy assembly and disassembly of piping and connections to equipment.
- When laying out piping, keep the placement of anchors and expansion joints in mind. These must be located on the drawings.

- If piping reducers are required on the suction side of pumps, provide eccentric reducers that are flat on top.
- Make sure wall penetrations are perpendicular to the wall.
- Make an effort to keep valves within Operator reach (below 8 feet). For any valve more than 8 feet above the operating floor, provide a chain operator.
- Do not place swing check valves in vertical piping runs.
- Install an easy disassembly coupling or pipe joint within 4 diameters of valves.
- Provide thrust restraint for sleeves and other couplings that are not capable of internal thrust restraint.
- Allow ample space for valve and gate actuators.
- Provide adequate clearances for rising stem valves and gates.
- Provide sufficient straight runs for flow meters and other I&C elements.

11.6.2.2 Hydraulic Calculations

During final design, Applied Flow Technology (AFT) Fathom (Fathom) or AFT Arrow (Arrow) or other design software may be used to determine pipe sizing.

Fathom is a software package that performs steady-state, incompressible, Newtonian fluid flow and energy analysis in an easy-to-use graphical environment for most piping systems (such as, simple to complex networks, recirculating loops, heat transfer pipes, and heat exchanges). Multiple- or single-pump systems can be modeled by assigning the required flows or pump curves for the pumps. Fathom can model control valves such as pressure control on either side of the valve, flow and pressure drop controls, and check valves (AFT 2023).

11.6.2.3 Pumps

There will be several pump types being used in this Project, such as:

- Horizontal end-suction centrifugal pumps
- Vertical turbine pumps
- Peristaltic metering pumps
- Submersible pumps

11.6.2.4 Piping

Ductile iron piping systems wall thickness should be designed in accordance with *AWWA C150, Thickness Design of Ductile Iron-Pipe*. *AWWA Manual M41, Manual of Water Supply Practices – Ductile Iron Pipe and Fittings* provides design guidance on buried ductile iron piping design for pressure class and thrust restraint.

Fabricated welded steel piping should be designed in accordance with *AWWA Manual M11, Steel Pipe – A Guide for Design and Installation*.

Pipe manufacturers and fabricators also provide design information, and they should be consulted early in the Project.

A preliminary Piping Schedule indicating piping services planned for the facility will be developed during early stages of design. The schedule will be organized by identifying service symbol (legend) and will identify materials, coatings, linings, and test pressures to be used for these services. Updates will be made as design progresses, to ultimately become the Piping Schedule included in the construction documents.

Pipeline velocities will be determined as follows:

Gravity Pipelines:

- Normal velocity: 4 to 5 fps
- Maximum velocity: (say, to carry gravel): 8 to 9 fps
- Minimum velocity: (say, to carry sand): 2 fps

Pressure Pipelines:

- Normal liquid velocity: 5 to 8 feet per second (fps)
- Maximum liquid velocity: 10 to 12 fps
- Minimum liquid velocity: 2 to 3 fps

The maximum and minimum liquid velocities noted may be exceeded occasionally. However, this is the design range to be used for normal maximum and minimum flows. Absolute minimum and maximum liquid line velocities seldom should be less than 0.5 fps or more than 15 fps. Gases in pressure systems may flow at normal velocities, ranging from 2,000 to 8,000 fps with reasonable pressure losses, but this depends on the fluid, pipe size, and system pressure. More detailed guidance is provided in *Technical Paper No. 410* (Crane 2022). The Arrow software also provides an easy method to develop piping sizing and for spotting system elements with the most significant losses.

11.6.2.5 Valves

A preliminary Valve Schedule indicating valve type and services planned for the facility will be developed during early design stages. The schedule will be organized by identifying valve types and service (Open or Close, or Modulating), and will identify materials, coatings, linings, and operating pressures to be used for these services. Updates will be made as the design progresses.

11.7 Building Mechanical (HVAC and Plumbing)

This section discusses the building mechanical requirements, including for heating, ventilation, and air conditioning (HVAC) and plumbing.

11.7.1 Codes and Standards

HVAC and plumbing systems will be designed to conform to the following codes and standards (the applicable edition for each will be verified by the final designer):

- *California Mechanical Code* (CMC)
- CPC
- *California Building Energy Efficiency Standards* (CBEES)
- *California Green Building Standards* (CalGreen)

Standards from the following organizations will also be applicable:

- ANSI
- American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
- Air Moving and Conditioning Association (AMCA)
- Air Conditioning, Heating, and Refrigeration Institute (AHRI)
- Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

11.7.2 Design Guidelines

This section summarizes the HVAC and plumbing design guidelines.

11.7.2.1 Outdoor Design Conditions

Weather data are referenced from the CBEES, *Reference Appendices*, Joint Appendix JA2-Reference Weather/Climate Data (California Energy Commission 2019). The weather data for Thousand Oaks listed in JA2 will be used for the Project. Table 11-5 summarizes these weather data.

Table 11-5. Project Weather Data

Weather Data Location[a]	Thousand Oaks, California
Weather Data Location Elevation	810 feet above mean sea level
CBEES Climate Zone	9
ASHRAE 90.1 Climate Zone	3B
Winter Design Temperature[b]	32°F dry bulb
Summer Design Temperature[c]	98°F dry bulb and 69°F mean coincident wet bulb

[a] Closest JA2 reference city to the Project site.

[b] 0.2% annual frequency of occurrence.

[c] 0.1% annual frequency of occurrence.

°F = degree(s) Fahrenheit

ASHRAE 90.1 = *ANSI/ASHRAE/IES Standard 90.1-- Energy Standard for Buildings Except Low-Rise Residential Buildings*

11.7.2.2 Indoor Design Conditions

Table 11-6 lists the indoor design temperatures for the rooms within the facility. These temperatures will be used for sizing the HVAC equipment. There is no humidity control for any of the rooms in the facility.

Table 11-6. Indoor Design Temperatures

Area	Occupied	Temperature	
		Summer	Winter
Administration and Operations	Yes	75°F	70°F
Maintenance Area	Yes	78°F	68°F
Server Room	No	78°F	68°F
Process Areas (Indoor)	No	Ambient temperature + 10°F[a]	45°F[b]
Electrical Rooms	No	85°F	Not heated[c]

[a] Areas use ventilation for heat removal.

[b] Freeze protection only.

[c] Heat rejection from electrical equipment leveraged to keep room above freezing.

11.7.2.3 HVAC Design

The HVAC systems for the Project include the following components:

- A variable refrigerant flow system
- Packaged air conditioning units
- Split-system air conditioning units
- Exhaust fans

- Ventilation supply fans
- An energy recovery unit
- Electric duct heaters

The equipment will be roof mounted and suspended from the roof structure. The equipment selected for the Project will meet the energy code efficiency requirements. Ventilation air for occupied rooms will be provided at the rates dictated by the CBEES. Ventilation supply fans will be sized to maintain process area temperatures at approximately 10°F greater than the ambient summer design temperature based on equipment and envelope loads. No equipment redundancy will be provided for the HVAC systems, and the HVAC equipment will be controlled via a BACnet-based direct digital control system.

11.7.2.4 Plumbing Design

The plumbing systems for the Project include the following systems and components:

- Potable water
- Domestic hot water
- Non-potable water
- Tepid water
- Sanitary drainage
- Oil-water separator
- Process drainage
- Sanitary vents

Water-efficient, low-flow type, and *Americans with Disabilities Act of 1990* (ADA)-compliant plumbing fixtures meeting the CPC and *California Green Building Standards Code* requirements will be used for the Project. Where domestic hot water is needed, either an electric tank-type water heater or a point-of-use instantaneous water heater will be provided. Non-potable water service, for pump seals and washdown usage, will be sourced from the facility's potable water system. Reduced-pressure zone assemblies or double check valves will be provided for cross-connection protection between the two systems.

Combination emergency showers and eyewashes will be provided in the process areas. These showers and eyewashes will be provided with tepid water per *ANSI/ISEA Standard Z358.1, American National Standard for Emergency Eyewash and Shower Equipment*. Tepid water is defined as having a temperature between 60 and 100 °F, and tepid water at 80 °F will be used for the Project. There will be indoor-type and outdoor-type showers and eyewashes, and the outdoor showers and eyewashes will be freeze-protected type.

11.8 Fire Protection

This section discusses the fire protection requirements.

11.8.1 Codes and Standards

Fire protection systems will be designed to conform to the following codes and standards, as required by the local AHJ (the applicable edition for each will be verified by the final designer):

- CFC
- *Los Angeles County Fire Code Amendments* (LACFC)

Standards from the National Fire Protection Association (NFPA) should also be followed.

11.8.2 Design Guidelines

The fire protection systems will be designed in accordance with applicable NFPA standards, and the CFC, CBC, and LACFC amendments. These systems include:

- Fire hydrants
- A fire protection sprinkler system
- Fire extinguishers
- A fire detection alarm system

11.8.2.1 Fire Hydrants

The quantity of fire hydrants and their locations will meet the requirements of the CFC and LACFC amendments. The facility’s construction type and occupancy, and the incorporation of automatic fire protection sprinkler systems will determine the required fire flow volume and flow duration as directed by the CFC. The fire hydrant flow volume will be 1,250 gpm at a minimum 20 psig for a duration of 2 hours per LACFC amendments.

11.8.2.2 Fire Protection Sprinkler System

Automatic fire protection sprinkler systems will be provided for the facility. There will be two types of systems: wet and dry. The wet systems will be provided within the facility with the exception of the Server Room and Electrical Room. It is not planned to provide sprinkler systems for these rooms due to the nature of their contents; however, if required, a dry chemical fire suppression system can be provided for the Server Room and a double interlock pre-action system for the Electrical Room.

Dry-type systems will be provided for the canopies. The systems will be designed and installed per NFPA requirements. A dedicated fire riser room is not required, so the fire riser will enter the facility in a mechanical room or the process area. Access to the fire riser will be via a facility exterior access door.

11.8.2.3 Portable Fire Extinguishers

All areas will be provided with portable fire extinguishers suitable for the hazard to be protected. Portable fire extinguisher quantities and locations will be in accordance with *NFPA 10, Standard for Portable Fire Extinguishers* and the CFC. Locations will be indicated on architectural floor plans.

11.8.2.4 Fire Detection Alarm System

The facility will have a fire alarm system as required by applicable codes. The fire alarm system will be an independent, standalone system and not an integral part of any other type of security or control system. The system will include:

- Fire alarm control panels
- Alarm-initiating devices
- Alarm notification appliances
- Signaling devices

The fire alarm system will be UL listed, addressable, zoned, and non-coded with full control, supervisory alarm signal, and display. The system will have 24-hour battery backup per *NFPA 72, National Fire Alarm and Signaling Code* requirements.

11.9 Electrical

This section discusses the electrical requirements.

11.9.1 Codes and Standards

Electrical systems will be designed to conform to the following codes and standards (the applicable edition for each will be verified by the final designer):

- National Electrical Code (NEC)
- Cal/OSHA, CCR, Title 8, Electrical Safety Orders
- *California Electrical Code* with Los Angeles County Code Amendments (Title 27 - Electrical Code)
- *Standard Specifications and Drawings for Pipelines, Facilities, and General Electrical Work* (LVMWD 2021c)

Institute of Electrical and Electronics Engineers (IEEE):

- *IEEE 141, Recommended Practice for Electrical Power Distribution for Industrial Plants*
- *IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems*
- *IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)*
- *IEEE 399, Recommended Practice for Industrial and Commercial Power System Analysis (Brown Book)*
- *IEEE 519, Standard for Harmonic Control in Electrical Power Systems*

Illuminating Engineering Society (IES):

- *The Lighting Handbook*

NFPA:

- *NFPA 70E, Standard for Electrical Safety in the Workplace®*

Standards from the National Electrical Manufacturers Association and Insulated Cable Engineers Association may also apply to the Project.

11.9.2 Design Guidelines

This section discusses the electrical design guidelines.

11.9.2.1 General Description

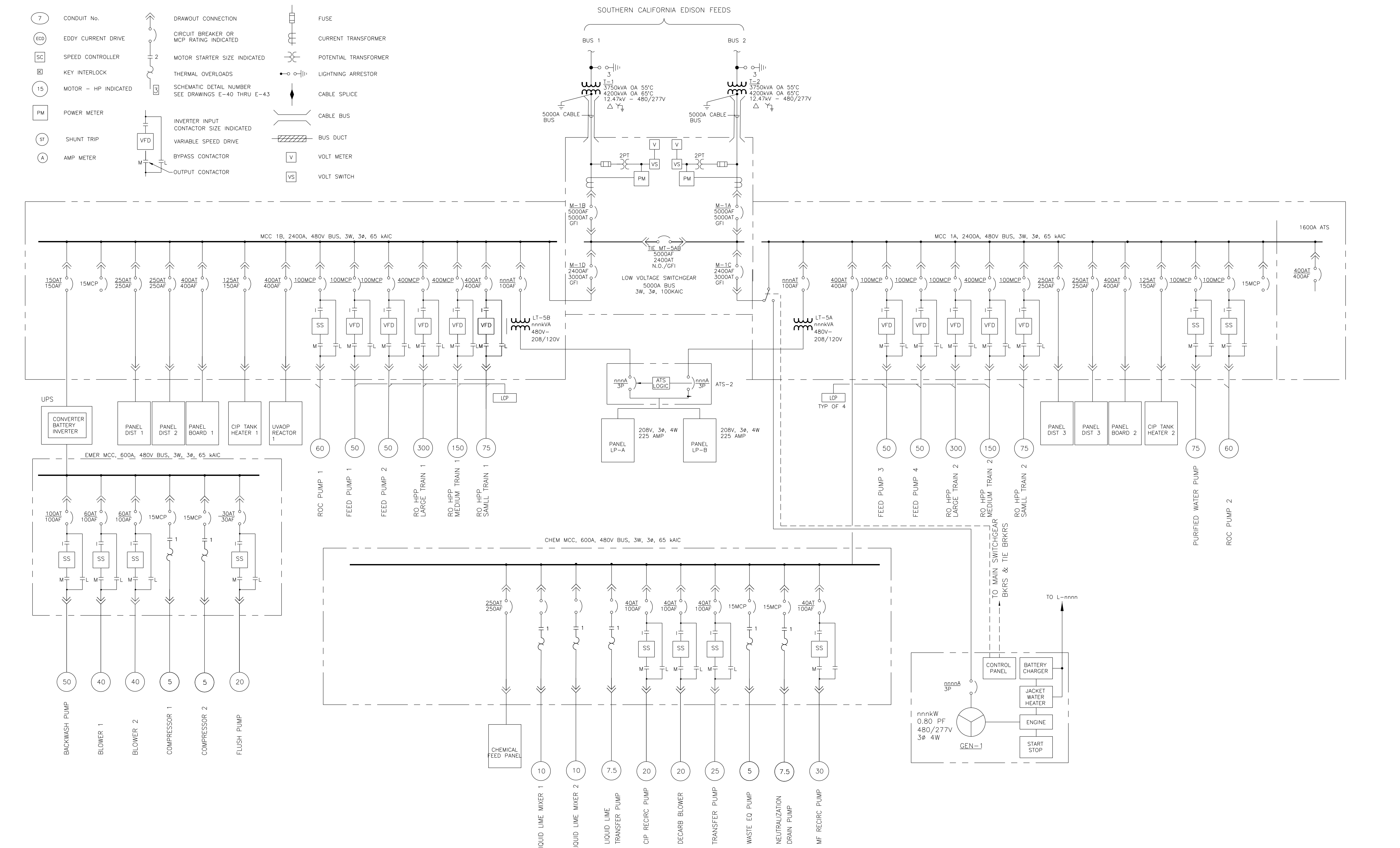
The electrical system will be designed to balance loading on each half of the incoming power system (Figure 11-6). If one source feed should fail, the system will be designed for full operation on the remaining feed. Critical loads will be UPS backed. Step-down transformers will reside outside of the Electrical Room near the eastern wall to reduce cable lengths to the switchgear.

11.9.2.2 Superior Reliability

The electrical equipment and systems will be designed to minimize outages and failures. Switchgear will be main-tie-main with inputs for generator backup of critical loads. The power reliability and availability will be confirmed with Southern California Edison (SCE) during the design phase.

11.9.2.3 High Availability

Design is based on a dual independent feed from SCE, each able to supply the system independently. The power reliability and availability will be confirmed with SCE during the design phase.



ADVANCED WATER PURIFICATION FACILITY
AGOURA HILLS, CALIFORNIA

DSGN
DR S GRIEBEL

Jacobs

ADVANCE WATER PURIFICATION FACILITY
ELECTRIAL
ONE-LINE DIAGRAM

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2022
PROJ	W9Y31200
DWG	AWPF-E-0001
FIGURE	11-6

CONCEPTUAL DESIGN

11.9.2.4 Safety

Plant electrical equipment will meet or exceed the required short-circuit ratings to protect the safety of plant personnel and equipment. Plant transformers will not be overloaded under a 100% operating condition. All plant equipment will be grounded in accordance with applicable safety standards. Main switchgear will have arc flash venting or other arc suppression design for personnel safety.

11.9.2.5 Good Power Quality

Plant electrical systems will be designed to minimize voltage and current distortion levels, as specified in IEEE design standards. Mitigating measures, such as 18-pulse VFDs for units 50 hp and greater, along with electronic power factor correction, will assure a clean electrical system with a near unity power factor.

11.9.2.6 Improved Efficiency

Use proven, state-of-the-art technology in designing and specifying efficient components, equipment, and systems. This includes using the following components:

- Adjustable speed drives
- Premium efficiency motors and transformers
- Efficient lighting systems
- Energy management systems

11.9.2.7 Flexibility

Specify standard, commercially available equipment to facilitate easy acquisition of spare parts.

11.9.2.8 Future Expansion

For future load growth and expansion, provide the following:

- Extra floor space
- Reserved transformer capacity
- Spare raceways
- Spare positions in switchgear line-ups
- Power centers

11.9.3 Space Requirements

The Electrical Room design will have main switchgear and panelboards along the eastern wall, with VFDs and controls on the western wall. Space for motor control centers (MCCs), double-backed, will be available in the center of the room, allowing for 6.5-foot clearance between equipment. In-room cable tray and conduits will be used for equipment cable connections. Equipment layout will be modified for rear access dependent switchgear if selected.

11.10 Instrumentation and Control

This section discusses the I&C requirements.

11.10.1 Codes and Standards

I&C systems will be designed to conform to the following codes and standards (the applicable edition for each will be verified by the final designer):

- NEC
- *PLC Programming Standards* (LVMWD 2019a)
- *HMI-SCADA Programming Standards* (LVMWD 2020)
- *Tag Naming Standards* (LVMWD 2019b)

Applicable codes and standards from the following organizations also pertain to the design of I&C systems:

- International Society of Automation (ISA)
- NFPA

11.10.2 Design Guidelines

The following design guidelines apply:

- Equipment Control and Monitoring: On or Off status and Local and Remote status of equipment will be monitored by the supervisory control and data acquisition (SCADA) system. Process “Enable” and “Permissive” interlock functions will be implemented in the PLC software. However, personnel and equipment safety functions will be hardwired. The plant PLC will be programmed to provide the start–stop signals and the analog signals to control the drives and valves.
- Equipment Protection: The controls and interlocks for protecting equipment, such as high discharge pressure, will be hardwired to the equipment starter. Local “Reset” pushbuttons will be provided to reset alarm-lockout functions as required at the MCCs or locally at the equipment.
- Personnel Safety: All controls and interlocks provided for personnel safety will be hardwired to the equipment starter. Types of personnel safety interlocks are conveyor trip wires and stop-lockout devices. Personnel safety devices will typically send a signal to the SCADA system when activated to alert Operations staff. Local “Reset” pushbuttons will be provided to reset lockout functions as required at the MCCs or locally at the equipment.
- Pilot Light Colors: To be coordinated with LVMWD’s Operator Interface Standards.
- Surge Protection: All analog field-mounted instrument loops will be provided with surge suppressors. Power line surge suppressors will be provided for all control panels.
- Security: All door switches for the PLC panels and network cabinets, as well as to the SCADA system network closets and offices, will be monitored at the SCADA system.

11.10.3 Programmable Logic Controller and SCADA System Guidelines

LVMWD will provide a list of pre-approved system integrators to perform the PLC and SCADA system programming work. The control system will be designed and configured with the following requirements at a minimum:

- The SCADA system will be based on the Wonderware (Aveva) platform.
- The standard for the PLC hardware will be Rockwell Automation’s ControlLogix and CompactLogix platforms.
- The SCADA system Historian will be sized to have 20% surplus of tags.
- SCADA system and Historian (based on SQL servers) hardware will be configured and installed similar to the installations at other LVMWD facilities.
- WIN-911 software will be used for the alarming software, and Labworks will be used for the Laboratory Information Management System.

11.10.4 Communication Networks and Cybersecurity

The communication network between the AWPF site and the other LVMWD facilities will be designed based on LVMWD’s Communication Roadmap.

The business and SCADA system networks at the plant will be segregated, and network connections to the internet will be firewalled with multifactor authentication for remote access. The firewall hardware and the remote access protocols will be based on LVMWD’s Information Technology (IT) Department standards. Field control and SCADA system networks will be on separate virtual local area networks.

11.11 Geotechnical

Jacobs performed a desktop preliminary geotechnical evaluation based on available published geologic, groundwater, and seismic data; existing geotechnical investigations; and reports for the site. This section summarizes Jacobs' evaluation on subsurface conditions, preliminary geotechnical recommendations.

11.11.1 Topography

The AWPF Agoura Road site is located at the foothills of the northern side of the Santa Monica Mountains. The site terrain consists of gentle hills and gullies (generally inclined at 3H:1V to 5H:1V), with elevations that range from approximately 955 feet above sea level at the northern portion of the site to 1,030 feet at the southern portion of the site. The hillside steepens significantly to the south, where slopes steeper than 2H:1V are present. The Agoura Road embankment fill slope descends to the northern end of the site. The fill slope appears to be inclined at 2H:1V and on the order of 5 to 15 feet tall.

11.11.2 Regional Geology

The AWPF Agoura Road site is situated in the Santa Monica Mountains, which are an east–west trending mountain range in the Transverse Ranges geomorphic province. The Transverse Ranges geomorphic province is generally characterized by east–west trending geologic structure and mountains. Nearby active faults include the Malibu Coast fault (over 6 miles south of the site) and the Chatsworth Fault (located over 5 miles northeast of the site). Both faults exhibit an overall east–west trend, consistent with that of the Transverse Ranges province (Gorian 2014).

11.11.3 Local Geology

Based on our site visit and review of existing geotechnical reports for the property (Gorian 2014), the AWPF Agoura Road site is predominantly underlain by older alluvial soils, and Calabasas Formation bedrock underlies the older alluvium. In the low-lying portion of the site, near Agoura Road, colluvial and young alluvial soils mantle the older alluvium. The Agoura Road embankment fill slope descends to the northern end of the site. The fill slope appears to be inclined at 2H:1V and on the order of 5 to 15 feet tall.

Immediately south of the southeastern portion of the site, a steeper hillside is present, and this area is mapped as the Conejo Volcanics Formation. Based on interpretation of the seismic lines previously conducted onsite, the onsite materials are anticipated to be easily to moderately rippable to depths of 32 to 43 feet below current grades at the site (Gorian 2014).

Several small structures, built between 1903 and 1961, were present on the northwestern portion of the site and were demolished sometime before 1989 (Gorian 2000). No evidence of these structures was observed during our site visit or during the previous investigation (Gorian 2014).

Based on the previous investigations onsite (Gorian 2014), the subsurface materials have been described as follows:

- Artificial fill soils – The Agoura Road embankment fills or other significant fills not encountered during the previous investigations.
- Colluvial and young alluvial soil – Encountered locally onsite, 2 to 7 feet thick, mixture of sand, silt, and clay, with (Conejo Volcanic derived) gravel and cobbles; pores and rootlets were noted.
- Older alluvial soils – Observed to be 6 to 36 feet thick onsite, silty clay with interbedded silty fine to coarse sand and clayey fine sand. The unit grades with depth to silty clay and clayey fine to coarse sand. The old alluvial and Calabasas Formation bedrock contact was generally identified by a layer consisting of fine to coarse sand and gravel with some cobbles.
- Calabasas Formation bedrock – Encountered at depths of 10 to 43 feet below ground surface (bgs), silty claystone to claystone, locally interbedded with clayey siltstone and fine-grained sandstone. Bedding within the formation is described as being massive and where defined, non-fissile.
- Conejo Volcanics bedrock – Not encountered during the previous investigations and not anticipated in the upper 20 feet or more at the site.

11.11.4 Groundwater Condition

For the AWPF Agoura Road site, during the subsurface exploration performed (Gorian 2014) groundwater was encountered in boring B-1 at 24 feet bgs in a silty fine to coarse sand layer within the older alluvium, and as seepage in boring B-3 from 15.3 feet to 16.9 feet bgs. The seepage was observed just above the contact with the underlying bedrock. In addition, the *Seismic Hazards Zone Report* (CGS 2000a) indicates historically high groundwater at a depth of 10 feet along Agoura Road.

The groundwater table may fluctuate due to seasonal variations, nearby construction, irrigation, and numerous other human-caused and natural influences.

11.11.5 Faulting and Seismicity

Faults designated as active faults under the *Alquist-Priolo Earthquake Fault Zoning Act* have the potential for ground surface rupture during an earthquake event (CGS 2018). This designation indicates the faulting has resulted in surface offsets in Holocene time (around the last 12,000 years), and the fault's location is well defined. Potentially active faults may not be identified as active according to the Act simply because their locations are not well defined or they have not been confirmed to have had surface ruptures during the Holocene time. A potentially active fault is defined by the Act as a fault that has experienced surface displacement within the Quaternary period (between approximately 12,000 years and 1.6 million years) but has not been confirmed to have younger Holocene displacements (CGS 2018).

Although the State of California has not prepared an official Alquist-Priolo Earthquake Fault Zone Map for the Thousand Oaks quadrangle (within which the AWPF Agoura Road site is located) (CGS 2018), no known Holocene- or Quaternary-aged faults are mapped adjacent to or crossing the site (USGS and CGS 2020; Campbell et al. 2014). Therefore, the risk for fault-induced ground rupture at the site is low.

Nearby active faults include the Malibu Coast fault (over 6 miles south of the site) and the Chatsworth Fault (located over 5 miles northeast of the site). These and other regional faults are considered in the seismic analysis presented in Section 11.10.7.

11.11.6 Landslides

No evidence of landsliding was observed during our site visit. There are no landslides mapped at the site (Campbell et al. 2014), and landslides were not encountered during the previous investigations (Gorian 2014). In addition, the site is not mapped in an Earthquake-Induced Landslide Zone of required in investigation (CGS 2000b). Therefore, the potential for landslides and associated hazards at the site are considered low. Section 11.10.10 provides more information about design slopes.

11.11.7 Seismic Design Parameters

The following seismic design parameters for the site are per the CBC (CBSC 2022; ASCE 2022):

- Site Latitude = 34.143936°N and Site Longitude = 118.791619°W
- Soil Profile: Site Class D (Stiff Soil)
- Risk Category: IV
- Mapped Spectral Acceleration Parameters: S_S = 1.440 gravity (g) and S_1 = 0.509 g
- Site Modified Peak Ground Acceleration: PGA_M = 0.662 g

The seismic parameters need to be re-evaluated after the future site-specific geotechnical investigation is performed. Depending on the subsurface profile and shear wave velocity, a site-specific seismic analysis might be required.

11.11.8 Liquefaction and Seismic Settlement

Liquefaction is a seismic phenomenon in which loose, saturated, fine-grained granular soils behave like a fluid when subjected to high-intensity ground shaking. Liquefaction occurs when the following three general conditions exist: (1) shallow groundwater, (2) low-density sandy soils, and (3) high-intensity ground motion. Studies indicate that saturated, loose and medium-dense, near-surface, cohesionless soils exhibit the highest liquefaction potential; whereas, dry, dense, cohesionless soils and cohesive soils exhibit low to negligible liquefaction potential. However, fine-grained soils with Plasticity Index (PI) values of less than about 5 should be considered liquefiable, unless shown otherwise through detailed in situ and laboratory testing (Boulanger and Idriss 2006). Effects of liquefaction on level ground include sand boils, settlement, and bearing capacity failures below structural foundations. Effects on sloping ground may include lateral spreading.

The site is not within an area shown to have a potential for secondary seismic settlement and liquefaction on the Seismic Hazards Zones map (CGS 2000b). However, the site is situated on older alluvial soil, and the potential for liquefaction at the Project site is considered moderate due to the presence of loose to medium-dense soils and a relatively shallow groundwater table. Therefore, further geotechnical site investigation is needed to fully characterize the subsurface soil conditions and determine the liquefaction susceptibility at the site.

11.11.9 Subsurface Soil Conditions

The onsite near-surface material generally consists of silty and clayey sands and sandy silt soils. From the previous investigation (Gorian 2014), two soil sample collected from borings B-3 at 25 feet and B-6 at 9 feet bgs were tested for Expansion Index (EI) in accordance with *ASTM D4829, Standard Test Method for Expansion Index of Soils*. The EI of the representative near-surface sample indicates a high potential for expansion. The PI of the onsite clayey and silty soils range from 80 to 177. According to the 2022 CBC (CBSC 2022), soils with a PI of 15 or greater may be expansive. Remediation, such as overexcavation and replacement with inexpensive granular soils under structure foundations, may be required.

Considering potential fills might be needed to achieve design grade and will be generated partially by cuts within the Project area, additional EI testing should be conducted on the subgrade and fill materials generated, and at rough grade, to determine the expansive nature of the exposed material that could influence the proposed structure foundations at the site.

Collapsible soils are distinguished by their potential to undergo a decrease in volume upon an increase in moisture content without an increase in external loads. No collapse testing data are available for review. Because of the cohesive nature of the onsite soil, the collapse potential at the site is expected to be low.

No corrosion data or testing data are available from the previous investigations. Corrosion testing will be required in the future investigation. A Corrosion Engineer should be consulted to review the test results and provide corrosion design recommendations.

11.11.10 Foundation Design Considerations

Based on the subsurface soil conditions, it appears that the proposed plant site is suitable for construction of the proposed facilities from a geotechnical standpoint. The selection of an appropriate foundation system for the proposed structures is based on the anticipated structural loads, estimated differential settlement, and constructability of proposed foundations. A shallow foundation system consisting of continuous-strip footings for structure walls, spread footings for columns, slab-on-grade floors, or rigid mat foundations is expected to be used to support the proposed facilities. Spread and continuous-strip footings will be at least 3.0 feet wide and embedded at least 2.0 feet below the lowest adjacent finished grade. The proposed shallow foundation system will provide sufficient capacity to support the proposed facilities.

According to Section 3.5.14 of the *Manual for Preparation of Geotechnical Reports* (Los Angeles County 2013), soils underlying a building situated on a cut and fill transition pad should be overexcavated a minimum of 3 feet below the bottom of the proposed footings. The overexcavation should extend horizontally outside the foundation footprints to a minimum distance equal to the depth of overexcavation.

The depth of overexcavation discussed is based on the data available from the previous geotechnical reports used in this desktop study and the assumption that the facility site will be situated on a cut and fill transition pad. The depth and extent of the overexcavation may vary dependent on future geotechnical investigation and the subgrade conditions exposed during construction.

Manufactured slopes, cut or fill, will be constructed at a maximum gradient of 2H:1V or flatter within the proposed development area. It is anticipated that a retaining wall will be constructed along the western side of the property to retain the cut slopes along the property line. The type and height of the retaining wall will be evaluated during the development of the site grading plan. Typical retaining walls, such as soil nail, tie back, or cantilever CIP gravity walls, are considered feasible based on the conditions and constrains at the site.

11.11.11 Construction Considerations

The onsite excavated granular soils with an EI value of less than 20 can be used as the engineered fill to construct the pad if it is free of organics, debris, and oversized materials greater than 3 inches in any dimension. Any imported fill materials should be sampled and tested for approval by a Geotechnical Engineer prior to transportation to the site.

The overexcavated areas should be backfilled with engineered fill materials placed and spread in layers not to exceed 8 inches in loose-lift thickness and be moisture-conditioned within 2% of optimum moisture content. The engineered fill should be compacted to a minimum 95% percent relative compaction below structures and roadways in accordance with *ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))*.

The top 6 inches of the excavated foundation subgrade should be scarified, moisture-conditioned within 2% of optimum moisture content, and recompacted to 95% percent relative compaction in accordance with ASTM D1557. The exposed subgrade will be observed and inspected by a Geotechnical Engineer to verify that the exposed conditions are adequate for foundation support and construction.

The previous geotechnical investigation by Gorian (2014) included three shallow seismic refraction traverse surveys. The survey data indicate p-wave velocities of:

- 1,310 to 1,550 feet per second (ft/s) from the surface to 5 to 6.5 feet bgs
- 2,150 to 2,690 ft/s from 5 to 32 to 43 feet bgs
- At least 7,000 ft/s for depths greater than 32 to 43 feet bgs

The seismic refraction traverse surveys indicate the surficial soil is easily rippable. At a depth of about 5 feet bgs, the earth material is moderately rippable to at least 32 feet bgs. Based on the conceptual site layout plan shown on Figure 11-2, the material underlying the site in the area of the proposed cuts is not composed of hard rock. Consequently, the proposed design grades should be able to be obtained without blasting or heavy ripping.

11.11.12 Future Geotechnical Investigation

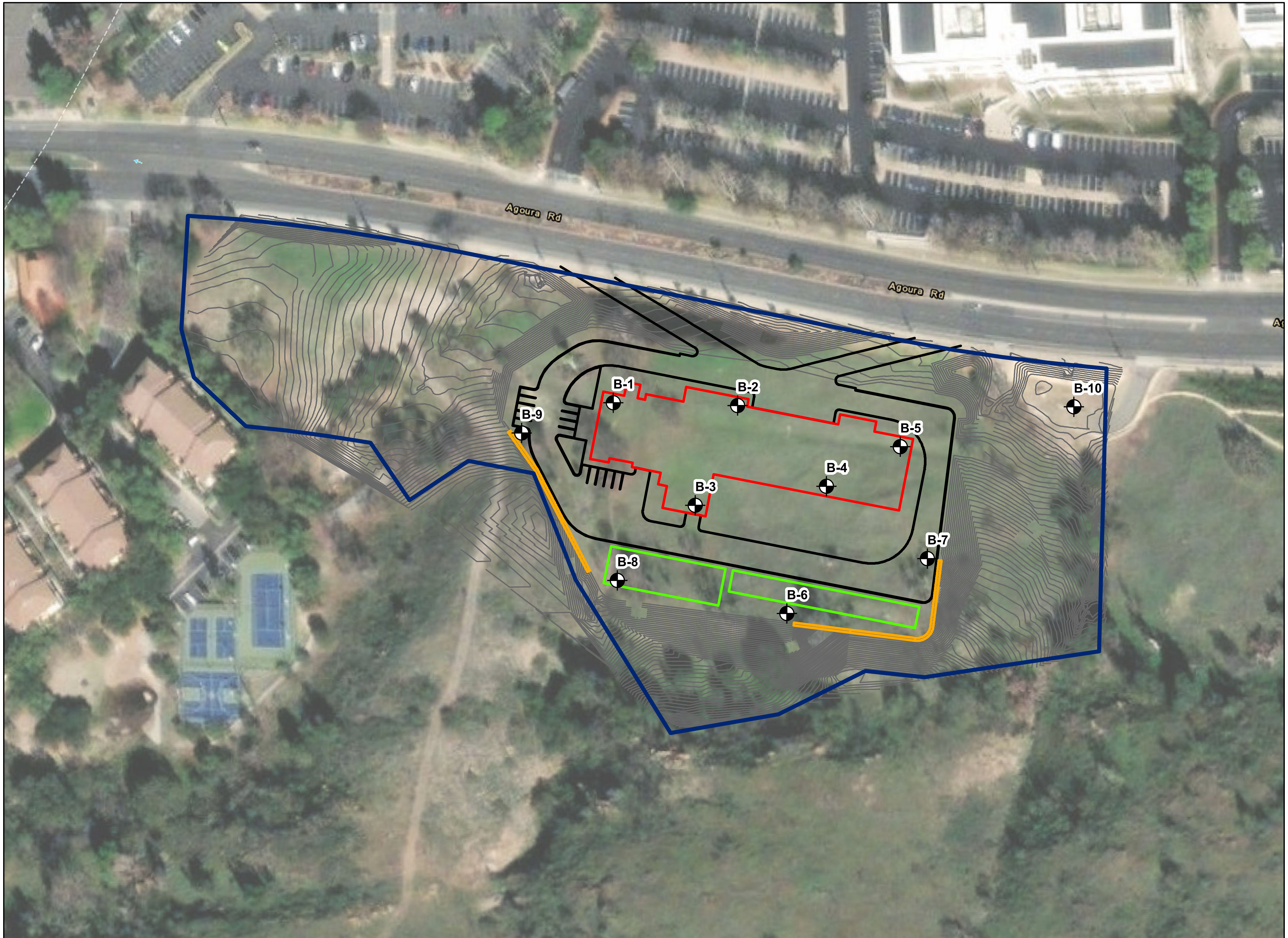
Future additional geotechnical investigation will be required as the Project proceeds. Borings will be drilled within the footprints of structure and retaining wall foundations. In situ soil infiltration (permeability) testing will be conducted at the proposed infiltration basin site. Laboratory testing on the samples collected from the borings should be conducted depending on the subsurface conditions encountered to obtain site-specific geotechnical data for design.

We recommend a total of 10 borings be conducted at the site, including:

- 5 for the AWPF structure
- 2 for the retaining wall
- 3 for the yard piping and access road

Borings for the structure and retaining wall will be drilling to the minimum depth of 75 feet bgs, and borings for the access road and yard piping will be drilled to the minimum depth of 25 feet bgs. The borings will be sampled at 5-foot intervals using standard penetration testing and modified California ring samplers alternately. Figure 11-7 shows the boring locations, which are preliminary and will be refined once the final site layout plan is further developed by the design-builder.

The drilling methods can be hollow-stem auger or mud rotary wash. Based on the anticipated subsurface conditions, we recommend mud rotary wash drilling be used for the structure borings, and hollow-stem auger be used for the access road and yard piping borings.



Legend

- B-X Preliminary Boring Location
- AWPF Site
- Building
- Chemicals/Influent Equalization
- Retaining Wall
- Roadway
- Contours

Sources:
ESRI World Topo Map; ESRI World Street Map

0 50 100 200
Feet
1 inch = 100 feet

Figure 11-7

Preliminary Boring Locations

Pure Water Project Las Virgenes –Triunfo

Jacobs

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12. Project Cost Estimate and Schedule

This section presents the delivery method, cost estimate, and schedule for the AWPF conceptual design and includes the following elements:

- Project Delivery Approach
- Project Capital Cost Estimate
- O&M Costs
- Project Schedule
- Coordination Needs

12.1 Project Delivery Approach

Typically, the JPA uses the traditional DBB project delivery contracting model to select, award, and deliver design and construction projects. The JPA reviewed project delivery approaches in July 2021 to deliver the various elements of the PWP and has elected to deliver the AWPF using a PDB collaborative delivery approach. In December 2022, the JPA agreed to add the ROC pipeline to the AWPF PDB procurement package.

12.2 Project Capital Cost Estimate

Jacobs developed a construction cost estimate for the AWPF based on the conceptual design evaluation using its Replica parametric design model. The model was supported by vendor quotes for major equipment and the company construction cost database from compilation of delivered projects and RSMeans. Construction costs include allowances for overall site work, PCS, yard electrical, and yard piping based on past experience for a facility of this size. Contractor markups were applied for general conditions, overhead and profit, contingency, and location escalation costs to develop the final construction costs. Nonconstruction costs for the progressive design-builder include markups for engineering design and pre-construction phase services and engineering services during construction. Capital costs were calculated as a sum of construction and nonconstruction costs.

The conceptual cost estimate for the AWPF is provided in Table 12-1 and is considered to be a Class 5 estimate, as defined by the AACE International (AACE). The expected accuracy range for this estimate is -15 to -30% on the low side and +20 to +50% on the high side. Appendix C provides more details.

12.3 Operations and Maintenance Costs

The annual O&M cost at startup for a purified water production rate of 2,100 acre-feet per year (AFY) is estimated at $4,430,000 for the AWPF and $456,000 for concentrate disposal to the Calleguas SMP. Appendix C provides additional details.

12.4 Funding

The JPA is seeking funding through low-interest federal and state loans and various grant opportunities. If successful, it is anticipated that the PWP will need to comply with federal requirements.

Table 12-1. Advanced Water Purification Facility Conceptual Cost Estimate

Unit Process or Cost Parameter	Cost Factor	Cost ($)
Process and Non-process Elements		
MF System [a]	--	13,400,000
RO System [a]	--	19,300,000
UV-AOP System [a]	--	4,630,000
Chemicals	--	2,650,000
Finished Water Decarbonator and Pumping	--	5,750,000
Administration and O&M Space	--	6,770,000
Standby Generator	--	240,000
Subtotal		52,740,000
Additional Project Costs		
Overall Sitework	6%	3,170,000
PCS	5%	2,640,000
Yard Electrical	9%	4,750,000
Yard Piping	8%	4,220,000
Tax	9%	3,640,000
Subtotal		71,160,000
Contractor Markups [b]		
Overhead	10%	7,110,000
Profit	10%	7,820,000
Mobilization, Bonds, Insurance	6%	5,160,000
Contingency	30%	27,400,000
Subtotal With Markups	--	118,650,000
Location Adjustment Factor	112.3	14,500,000
Construction Cost [c]		**133,150,000**
Nonconstruction Costs		
Engineering and Pre-construction Phase Services	10%	13,300,000
Services during Construction	5%	6,660,000
Nonconstruction Costs [c]		19,960,000
Escalation		
Escalation [d]	--	22,400,000
Total AWPF Capital Costs		**175,510,000**

[a] Integrates process building costs.

[b] Markups are on the cumulative subtotal.

[c] June 2022 dollars.

[d] Based on a 3% inflation rate and midpoint of construction in December 2026.

12.5 Project Schedule

The compliance date for operation of the new AWPF is November 16, 2030. This is the date when the new NPDES permit limits for the Tapia WRF take effect for discharge of final effluent to Malibu Creek (Los Angeles RWQCB 2017a). Table 12-2 summarizes the preliminary schedule.

Table 12-2. Project Schedule

Milestone	Date
AWPF	
Procurement	March 2023 – February 2024
Design and Construction	February 2024 – November 2027
Commissioning and Operation	November 2027 – May 2028
Regulatory	
Compliance Deadline	By November 16, 2030

12.6 Coordination Needs

Several projects will be implemented in parallel with the anticipated AWPF schedule summarized in Table 12-2. The design-builder will need to coordinate schedule and design implications for the following projects:

- Conveyance projects to:
  - Extend the recycled water pipeline to the new AWPF
  - Convey purified water from the AWPF to Las Virgenes Reservoir
  - Dispose of residuals to the sewer
- Implementation of preformed monochloramines at Tapia WRF
- Implementation of hypolimnetic oxygenation at Las Virgenes Reservoir
- Upgrade of RWPS West to increase capacity from 7.5 to 10 MGD and install VFDs

The conveyance pipelines will be completed prior to substantial completion of the AWPF to support commissioning of the AWPF. Conveyance of ROC to the Calleguas SMP for ultimate discharge to the ocean will be part of the PDB scope. The *Conveyance Pipelines Alignment Study* (Woodard & Curran 2023) identifies the recommended alignment for each conveyance line.

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PURE WATER PROJECT
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Appendix A

Appendix A
Water Quality

A.1 Influent Water Quality (6/30/20 - 9/8/2021)

A.2 Water Quality Seasonal Variation with Metropolitan Potable Water Augmentation

Appendix A.1
Influent Water Quality

Table A-1. Las Virgenes-Triunfo Pure Water Demonstration Facility Water Quality Summary 6/30/2020 - 9/8/2021

Parameter	Units	Raw Water				UF Feed				RO Feed			
		N	10th %tile	50th %tile	90th %tile	N	10th %tile	50th %tile	90th %tile	N	10th %tile	50th %tile	90th %tile
Alkalinity (W)	mg/L as $CaCO_3$	0	-	-	-	18	124	140	150	0	-	-	-
Alkalinity (E)	mg/L as $CaCO_3$	0	-	-	-	16	120	120	130	0	-	-	-
Aluminum, Total (E)	ug/L	0	-	-	-	17	55	80	99.5	16	ND	ND	ND
Aluminum, Total (W)	ug/L	1	88	88	88	18	59.2	82	116	18	11.4	14	18.6
Barium, Total (E)	ug/L	0	-	-	-	1	15	15	15	5	13.4	16	19.4
Barium, Total (W)	ug/L	1	23	23	23	0	-	-	-	4	12.4	18.5	23.2
Bicarbonate Alkalinity (W)	mg/L as $CaCO_3$	0	-	-	-	0	-	-	-	0	-	-	-
Biochemical Oxygen Demand (W)	mg/L	0	-	-	-	5	2.6	2.6	2.6	0	-	-	-
Biochemical Oxygen Demand (E)	mg/L	0	-	-	-	9	ND	ND	ND	0	-	-	-
Boron, Total (E)	mg/L	0	-	-	-	1	0.38	0.38	0.38	5	0.37	0.38	0.392
Boron, Total (W)	mg/L	1	370	370	370	0	-	-	-	4	0.36	0.365	0.398
Bromate (W)	ug/L	1	ND	ND	ND	0	-	-	-	0	-	-	-
Bromate (E)	ug/L	0	-	-	-	1	1.3	1.3	1.3	0	-	-	-
Bromide (W)	ug/L	0	-	-	-	0	-	-	-	0	-	-	-
Calcium, Total (E)	mg/L	0	-	-	-	1	61	61	61	17	61	67	69.4
Calcium, Total (W)	mg/L	0	-	-	-	0	-	-	-	4	60.61	63.3	66.55
Carbonate Alkalinity (W)	mg/L as $CaCO_3$	0	-	-	-	0	-	-	-	0	-	-	-
Chemical Oxygen Demand (W)	mg/L	0	-	-	-	5	13.48	25	28.4	0	-	-	-
Chemical Oxygen Demand (E)	mg/L	0	-	-	-	9	14.8	18	20.6	0	-	-	-
Chloride, Total (E)	mg/L	0	-	-	-	1	150	150	150	5	150	160	160
Chloride, Total (W)	mg/L	1	170	170	170	0	-	-	-	4	153	160	167
Fluoride, Total (E)	mg/L	0	-	-	-	1	0.66	0.66	0.66	5	0.636	0.66	0.676
Fluoride, Total (W)	mg/L	0	-	-	-	0	-	-	-	4	0.526	0.62	0.665
Iron, Total (E)	mg/L	0	-	-	-	17	0.0108	0.012	0.0132	16	ND	ND	ND
Iron, Total (W)	mg/L	1	15	15	15	19	0.0104	0.014	11.2038	19	0.0083	0.0099	0.012
Magnesium, Total (E)	mg/L	0	-	-	-	1	27	27	27	5	29.2	31	32
Magnesium, Total (W)	mg/L	0	-	-	-	0	-	-	-	4	28.2	29.95	31.21

Table A-1. Las Virgenes-Triunfo Pure Water Demonstration Facility Water Quality Summary 6/30/2020 - 9/8/2021

Parameter	Units	Raw Water				UF Feed				RO Feed			
		N	10th %tile	50th %tile	90th %tile	N	10th %tile	50th %tile	90th %tile	N	10th %tile	50th %tile	90th %tile
Manganese, Total (E)	ug/L	0	-	-	-	17	19	33	44.5	16	13.5	21.5	33
Manganese, Total (W)	ug/L	1	30	30	30	19	10.85	19	78	19	0.00894	0.016	0.0452
Nitrate (W)	mg/L as N	0	-	-	-	0	-	-	-	0	-	-	-
Nitrate (E)	mg/L as N	0	-	-	-	17	7.18	7.8	9.02	16	7.4	7.85	9.2
Nitrate (calc) (E)	mg/L as NO_3	0	-	-	-	1	31	31	31	0	-	-	-
Nitrite (W)	mg/L as N	0	-	-	-	0	-	-	-	0	-	-	-
Nitrite (E)	mg/L as N	0	-	-	-	17	0.26	0.26	0.26	16	ND	ND	ND
Nitrogen, Total (W)	mg/L as N	0	-	-	-	18	8.94	9.8	12	18	8.51	9.95	11.3
Orthophosphate (E)	mg/L as P	0	-	-	-	0	-	-	-	12	2.31	2.6	2.98
pH (W)		0	-	-	-	0	-	-	-	0	-	-	-
Potassium, Total (E)	mg/L	0	-	-	-	1	17	17	17	5	17	17	18.6
Potassium, Total (W)	mg/L	0	-	-	-	0	-	-	-	4	15.3	16.5	17.7
Silica, Total (E)	mg/L	0	-	-	-	16	17	18	18.5	16	17	17.5	18.5
Silica, Total (W)	mg/L	0	-	-	-	19	19	20	22	19	15.8	20	22
Sodium, Total (E)	mg/L	0	-	-	-	1	120	120	120	5	120	130	136
Sodium, Total (W)	mg/L	0	-	-	-	0	-	-	-	4	130	130	137
Specific Conductance (W)	umho/cm	0	-	-	-	0	-	-	-	0	-	-	-
Specific Conductance (E)	umho/cm	0	-	-	-	1	1200	1200	1200	0	-	-	-
Strontium, Total (E)	mg/L	0	-	-	-	0	-	-	-	9	0.386	0.41	0.454
Strontium, Total (W)	ug/L	0	-	-	-	0	-	-	-	6	370	450	505
Sulfate (E)	mg/L	0	-	-	-	1	180	180	180	9	210	220	240
Sulfate (W)	mg/L	1	200	200	200	0	-	-	-	6	195	210	210
TKN (W)		0	-	-	-	18	1.36	2.2	4.3	18	0.888	1.8	2.94
Total Dissolved Solids (W)	mg/L	0	-	-	-	0	-	-	-	0	-	-	-
Total Dissolved Solids (E)	mg/L	1	790	790	790	1	720	720	720	0	-	-	-
Total Organic Carbon (E)	mg/L	0	-	-	-	9	6.82	7	7.46	16	6.3	6.6	7.06
Total Organic Carbon (W)	mg/L	0	-	-	-	5	5.85	7.1	8.98	19	5.4	6.4	7.78
Total Suspended Solids (W)	mg/L	1	1	1	1	18	0.48	0.75	2.2	0	-	-	-
Total Suspended Solids (E)	mg/L	0	-	-	-	16	ND	ND	ND	0	-	-	-

(W) = Weck

(E) = Eurofins

Notes: Data from Appendix B of the Demonstration Process Performance Report (Carollo 2021)

Appendix A.2
Water Quality Seasonal Variation with Metropolitan Potable Water Augmentation

Table A-2. Water Quality Seasonal Variation due to MWD Potable Water Augmentation (90th Percentiles)

Parameter	Units	Raw Water				UF Feed				RO Feed			
		N	Potable	N	No Potable	N	Potable	N	No Potable	N	Potable	N	No Potable
Alkalinity (W)	mg/L as $CaCO_3$	0	-	0	-	16	150	2	140	0	-	0	-
Alkalinity (E)	mg/L as $CaCO_3$	0	-	0	-	1	120	15	130	0	-	0	-
Aluminum, Total (E)	ug/L	0	-	0	-	1	110	16	99	1	ND	15	ND
Aluminum, Total (W)	ug/L	1	88	0	-	16	118	2	82	16	18.6	2	ND
Barium, Total (E)	ug/L	0	-	0	-	0	-	1	15	0	-	5	19.4
Barium, Total (W)	ug/L	1	23	0	-	0	-	0	-	3	23.8	1	18
Bicarbonate Alkalinity (W)	mg/L as $CaCO_3$	0	-	0	-	0	-	0	-	0	-	0	-
Biochemical Oxygen Demand (W)	mg/L	0	-	0	-	4	2.60	1	ND	0	-	0	-
Biochemical Oxygen Demand (E)	mg/L	0	-	0	-	1	ND	8	ND	0	-	0	-
Boron, Total (E)	mg/L	0	-	0	-	0	-	1	0.38	0	-	5	0.392
Boron, Total (W)	mg/L	1	370	0	-	0	-	0	-	3	0.368	1	0.410
Bromate (W)	ug/L	1	ND	0	-	0	-	0	-	0	-	0	-
Bromate (E)	ug/L	0	-	0	-	0	-	1	1.3	0	-	0	-
Bromide (W)	ug/L	0	-	0	-	0	-	0	-	0	-	0	-
Calcium, Total (E)	mg/L	0	-	0	-	0	-	1	61	0	-	17	69.4
Calcium, Total (W)	mg/L	0	-	0	-	0	-	0	-	3	66.2	1	64.8
Carbonate Alkalinity (W)	mg/L as $CaCO_3$	0	-	0	-	0	-	0	-	0	-	0	-
Chemical Oxygen Demand (W)	mg/L	0	-	0	-	4	28.6	1	23	0	-	0	-
Chemical Oxygen Demand (E)	mg/L	0	-	0	-	1	15	8	20.9	0	-	0	-
Chloride, Total (E)	mg/L	0	-	0	-	0	-	1	150	0	-	5	160
Chloride, Total (W)	mg/L	1	170	0	-	0	-	0	-	3	168	1	160
Fluoride, Total (E)	mg/L	0	-	0	-	0	-	1	0.66	0	-	5	0.676
Fluoride, Total (W)	mg/L	0	-	0	-	0	-	0	-	3	0.626	1	0.68
Iron, Total (E)	mg/L	0	-	0	-	1	ND	16	0.0132	1	ND	15	ND
Iron, Total (W)	mg/L	1	15	0	-	17	11.2	2	ND	17	0.012	2	ND
Magnesium, Total (E)	mg/L	0	-	0	-	0	-	1	27	0	-	5	32
Magnesium, Total (W)	mg/L	0	-	0	-	0	-	0	-	3	30.82	1	31
Manganese, Total (E)	ug/L	0	-	0	-	1	7.1	16	44.8	1	5.9	15	33.2
Manganese, Total (W)	ug/L	1	30	0	-	17	90.8	2	19.2	17	0.0554	2	0.0162

Table A-2. Water Quality Seasonal Variation due to MWD Potable Water Augmentation (90th Percentiles)

Parameter	Units	Raw Water				UF Feed				RO Feed			
		N	Potable	N	No Potable	N	Potable	N	No Potable	N	Potable	N	No Potable
Nitrate (W)	mg/L as N	0	-	0	-	0	-	0	-	0	-	0	-
Nitrate (E)	mg/L as N	0	-	0	-	1	8.9	16	9	1	9.2	15	9
Nitrate (calc) (E)	mg/L as NO_3	0	-	0	-	0	-	1	31	0	-	0	-
Nitrite (W)	mg/L as N	0	-	0	-	0	-	0	-	0	-	0	-
Nitrite (E)	mg/L as N	0	-	0	-	1	ND	16	0.26	1	ND	15	ND
Nitrogen, Total (W)	mg/L as N	0	-	0	-	16	12	2	9.07	16	11.5	2	8.6
Orthophosphate (E)	mg/L as P	0	-	0	-	0	-	0	-	0	-	12	2.98
pH (W)		0	-	0	-	0	-	0	-	0	-	0	-
Potassium, Total (E)	mg/L	0	-	0	-	0	-	1	17	0	-	5	18.6
Potassium, Total (W)	mg/L	0	-	0	-	0	-	0	-	3	16.8	1	18
Silica, Total (E)	mg/L	0	-	0	-	1	20	15	18	1	20	15	18
Silica, Total (W)	mg/L	0	-	0	-	17	22	2	19.9	17	22	2	19
Sodium, Total (E)	mg/L	0	-	0	-	0	-	1	120	0	-	5	136
Sodium, Total (W)	mg/L	0	-	0	-	0	-	0	-	3	138	1	130
Specific Conductance (W)	umho/cm	0	-	0	-	0	-	0	-	0	-	0	-
Specific Conductance (E)	umho/cm	0	-	0	-	0	-	1	1200	0	-	0	-
Strontium, Total (E)	mg/L	0	-	0	-	0	-	0	-	1	0.37	8	0.456
Strontium, Total (W)	ug/L	0	-	0	-	0	-	0	-	4	511	2	426
Sulfate (E)	mg/L	0	-	0	-	0	-	1	180	1	230	8	240
Sulfate (W)	mg/L	1	200	0	-	0	-	0	-	4	210	2	210
TKN (W)		0	-	0	-	16	4.5	2	1.84	16	3.06	2	1.54
Total Dissolved Solids (W)	mg/L	0	-	0	-	0	-	0	-	0	-	0	-
Total Dissolved Solids (E)	mg/L	1	790	0	-	0	-	1	720	0	-	0	-
Total Organic Carbon (E)	mg/L	0	-	0	-	1	7	8	7.49	1	6.4	15	7.07
Total Organic Carbon (W)	mg/L	0	-	0	-	4	9.14	1	7.3	17	7.8	2	7.64
Total Suspended Solids (W)	mg/L	1	1	0	-	16	2.2	2	ND	0	-	0	-
Total Suspended Solids (E)	mg/L	0	-	0	-	1	ND	15	ND	0	-	0	-

(W) = Weck

(E) = Eurofins

Potable water was supplemented to Reservoir 2 between 6/30/2020 to 10/20/2020 and 4/25/2021 to 9/8/2021

Notes: Data from Appendix B of the Demonstration Process Performance Report (Carollo 2021)

PURE WATER PROJECT
LAS VIRGENES-TRIUNFO
Bringing Our Water Full Circle

Appendix B

Appendix B
Calculations

B.1 Tapia Water Reclamation Facility Influent Flows

B.2 Antiscalant Projections

B.3 RO Projections

B.4 Flow Balance

B.5 Post Treatment WaterPro Calculations

B.6 ROC Stabilization WaterPro Calculations

B.7 Electrical Load Summary Table

Appendix B.1
Tapia Water Reclamation Facility Influent Flows

Appendix B. 1 Flows

Appendix B.1 contains historical flow data for Tapia Water Reclamation Facility (Tapia WRF) and an assessment of expected historical discharges if the Advanced Water Purification Facility (AWPF) was in operation.

Figures B-1 and B-2 show projected discharges to Malibu Creek (flow and number of days) based on the size of the AWPF from 2017 to 2020.

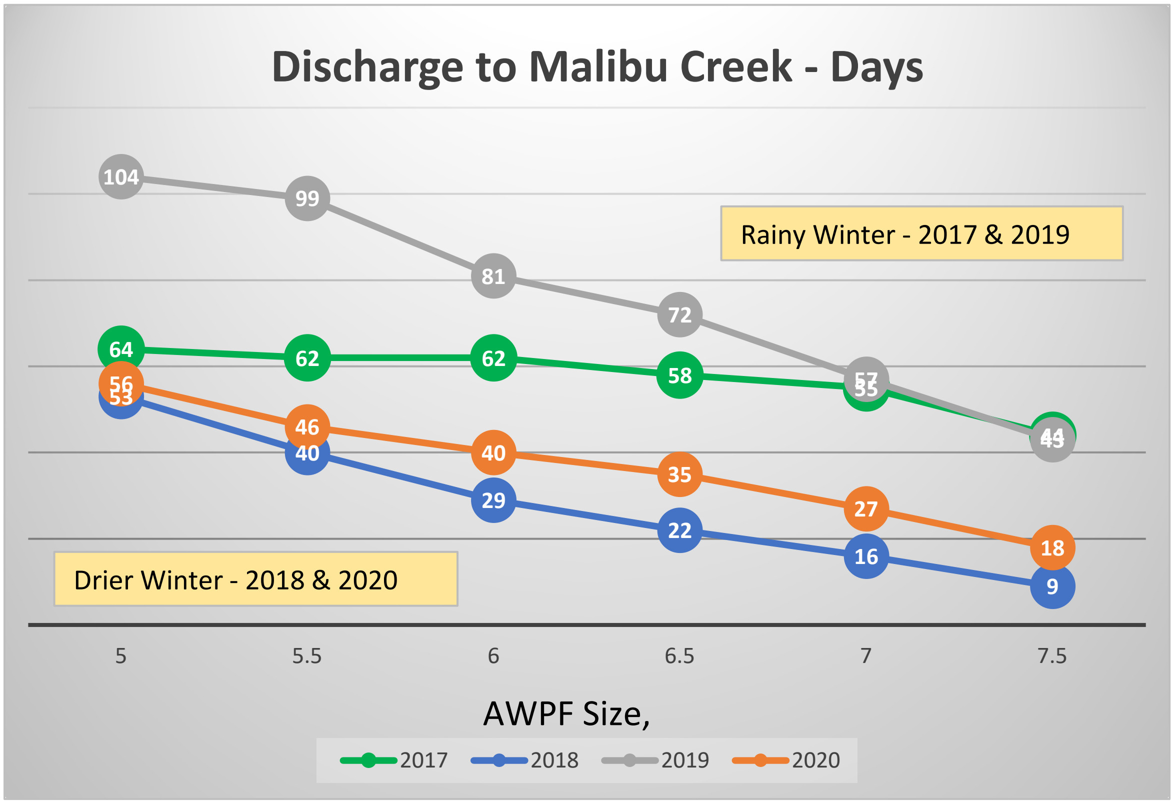

Figure B-1. Projected Discharge Days Based on Size of Advanced Water Purification Facility

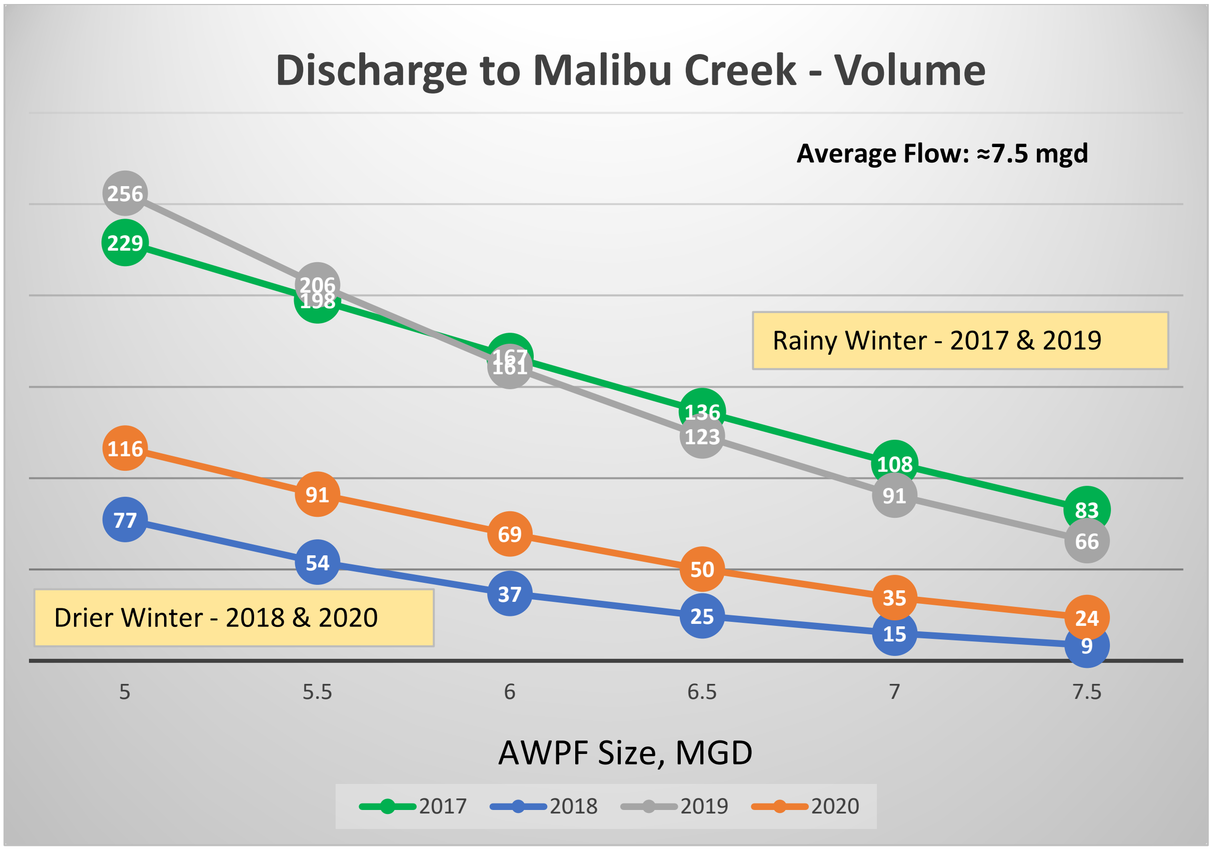

Figure B-2. Projected Discharge Volume Based on Size of Advanced Water Purification Facility

	Tapia WRF Influent Flow						
	Average Day	Maximum Month		Maximum Day		Max Week	Peak Hour
Year	Flow, mgd	Flow, mgd	Occurrence	Flow, mgd	Occurrence	Flow, mgd	Flow, mgd
2003	9.95	11.21	February/March	19.25	19-Jan		-
2004	9.75	10.99	December	19.28	29-Dec	12.73	-
2005	10.40	14.21	February/March	25.04	10-Jan	18.78	-
2006	10.10	11.47	April	13.86	3-Jan	12.21	-
2007	9.95	11.18	January	13.05	7-Jan	11.81	-
2008	9.95	12.99	January/February	19.39	28-Jan	15.75	-
2009	9.31	10.79	February	12.97	17-Feb	11.69	-
2010	9.23	10.73	January/February	15.07	23-Dec	12.71	-
2011	9.26	11.20	March/April	18.90	21-Mar	14.14	-
2012	8.69	9.23	June/July	11.00	12-Apr	9.71	-
2013	8.70	9.65	June/July	11.02	7-Sep	10.50	-
2014	8.36	9.42	April/May	12.57	1-Mar	10.26	-
2015	7.58	8.15	June/July	9.36	7-Jul	9.09	-
2016	7.37	7.82	June	8.86	14-Jun	8.16	-
2017	8.06	10.16	February/March	19.21	18-Feb	13.50	-
2018	7.52	8.14	March	10.08	6-Dec	8.91	-
2019	7.71	10.02	February	13.19	17-Jan	11.89	25.09
2020	7.80	8.8	April	10.88	9-Apr	10.33	15.28
2021	7.38	9.00	December	21.85	31-Dec	12.4	-

	Tapia WRF Influent Flow - Monthly Averages (MGD)											
Year	January	February	March	April	May	June	July	August	September	October	November	December
2003	9.58	10.87	10.56	10.07	9.96	9.60	9.90	10.61	9.60	9.47	9.86	9.47
2004	8.82	9.23	9.30	8.89	9.95	10.04	10.06	10.26	10.23	9.63	9.53	10.92
2005	13.25	13.84	11.95	10.48	9.49	9.36	9.72	10.11	9.35	9.62	9.02	8.84
2006	10.43	10.13	10.90	11.16	11.00	10.08	9.91	9.91	10.06	9.11	8.71	9.75
2007	11.13	9.49	9.63	9.74	9.35	9.94	10.53	10.52	10.28	9.20	9.90	9.67
2008	12.64	10.96	9.56	9.23	9.65	10.00	9.74	9.67	9.75	9.33	9.10	9.78
2009	9.65	10.78	9.49	8.93	8.89	8.98	10.21	9.82	9.14	8.62	8.35	8.90
2010	9.85	9.90	9.59	9.78	9.02	9.01	9.13	8.96	8.91	8.27	8.51	9.91
2011	9.56	9.55	10.93	9.81	9.42	8.81	9.58	9.21	9.34	8.18	8.35	8.42
2012	8.53	8.52	8.87	8.83	8.70	8.90	9.17	8.90	8.91	8.39	8.22	8.34
2013	8.71	8.70	8.57	8.23	8.72	9.27	9.15	8.69	8.82	9.17	8.11	8.24
2014	8.30	8.34	8.91	9.32	8.78	8.75	8.56	8.56	7.96	7.58	7.23	7.98
2015	7.91	7.62	7.92	7.43	7.37	7.55	7.86	7.59	7.68	7.80	7.32	6.88
2016	7.53	7.30	7.27	7.08	7.12	7.82	7.45	7.62	7.51	7.37	7.14	7.22
2017	8.92	10.18	8.58	7.85	8.01	8.13	7.63	7.76	7.79	7.74	7.11	7.25
2018	7.68	7.53	8.11	7.56	7.29	7.82	7.68	7.58	7.52	7.29	6.85	7.29
2019	8.48	10.06	8.88	7.67	7.38	7.29	7.02	7.19	7.13	7.13	6.95	7.50
2020	7.36	7.20	7.86	8.80	7.89	8.19	8.36	7.96	7.88	7.53	7.17	7.34
2021	7.41	7.75	7.63	7.37	7.79	7.55	7.22	7.19	7.04	5.59	7.01	9.00

Appendix B.2
Antiscalant Projections

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Membrane Aqueous Chemistry Calculator

Version: 6.051.01 **release date:** Jan 19, 2022
Name: RO Chemical Pretreatment

Projection By: Michael Hwang
Client name: LVT
Project Id: 23928
Project: PWP_LVT_AWPF_90th%tile
Reference:
Location: United States / California / Calabasas

	Unit	
Source:		Wastewater (MF/UF Pretreatment)
Feed Temperature:	°C	25.000
Raw Water Flow/Train:	gal/min	1302.083
Permeate Flow/Train:	gal/min	1106.771
Average Flux Rate:	gfd	11.860
Recycling Flow:	gal/min	0.000
Salt Passage Increase:	%	0.000

	Unit	
Feed Pressure:	psi	72.644
Total Δ Pressure:	psi	37.835
Brine Pressure:	psi	61.460
Permeate Pressure:	psi	0.000
System Recovery:	%	85.000
Internal Recovery:	%	85.000
Element Age:	Years	0
Specific Power:	kWh/kgal	0.768

Cations	Balanced Feed (mg/L)	pH Adjusted Feed (mg/L)	Reject (mg/L)	Permeate (mg/L)
Ca^{2+}	67.00	67.00	440.09	1.16
Mg^{2+}	32.00	32.00	210.91	0.43
Ba^{2+}	0.02	0.02	0.13	0.00
Sr^{2+}	0.51	0.51	3.36	0.01
Na^{+}	137.00	137.00	864.52	8.61
K^{+}	17.70	17.70	111.70	1.11
Fe^{2+}	0.00	0.00	0.00	0.00
Fe^{3+}	0.01	0.01	0.06	0.00
Al^{3+}	0.02	0.02	0.12	0.00
Mn^{2+}	0.03	0.03	0.20	0.00
NH3/NH4 - N	0.00	0.00	0.00	0.00

Anions	Balanced Feed (mg/L)	pH Adjusted Feed (mg/L)	Reject (mg/L)	Permeate (mg/L)
$HCO_3^-(CaCO_3)$	149.06	74.20	439.61	6.74
$CO_3^{2-}(CaCO_3)$	0.94	0.04	1.84	0.00
CO_2	12.58	78.81	94.42	78.54
TIC (C)	39.32	39.32	131.50	23.05
Ortho-PO_4^{3-}	9.20	9.20	59.89	0.25
SO_4^{2-}	180.00	255.59	1680.85	4.07
F^-	0.67	0.67	4.29	0.03
Cl^-	169.81	169.81	1093.71	6.77
Br^-	0.00	0.00	0.00	0.00
SiO_2	22.00	22.00	144.52	0.38
NO_3^--N	9.20	9.20	54.37	1.23
NO_2^--N	0.00	0.00	0.00	0.00
Sulfides (S^{2-})	0.00	0.00	0.00	0.00
B	0.40	0.40	0.52	0.38
As(III)	0.00	0.00	0.00	0.00
As(V)	0.00	0.00	0.00	0.00
TOC (ppm C)	0.00	0.00	0.00	0.00
H.ORG (mEq/L)	0.00	0.00	0.00	0.00
TDS:	856.420	841.700	5383.840	36.750
Cond (µs/cm):	0.000	1147.248	6357.425	50.188
pH:	7.300	6.200	6.790	5.220
Flow: gal/day		0.000	0.000	1593750.000

Summary	Product:	Dosage:
pH adjusted using:	H_2SO_4	77.176 mg/L
Selected product:	AWC A-110	1.471 mg/L

AWC® PROTON®

Membrane Aqueous Chemistry Calculator

Version: 6.051.01 **release date:** Jan 19, 2022

Name: RO Chemical Pretreatment

Projection By: Michael Hwang
Client name: LVT
Project Id: 23928
Project: PWP_LVT_AWPF_90th%tile
Reference:
Location: United States / California / Calabasas

	Unit	Stage 1	Stage 2	Stage 3
Total Elements:		168	112	56
Total Vessels:		24	16	8
Elements / Vessels:		7	7	7
Flow Factor:		1.000	1.000	1.000
Feed Pressure:	psi	72.64	70.27	72.31
Permeate Throttle/ Backpressure:	psi	0.00	0.00	0.00
Interstage Boost Pressure:	psi	0.00	14.22	12.43
Piping Losses:	psi	0.00	0.00	0.00
Concentrate Pressure:	psi	56.06	59.88	61.46
Feed Flow:	gal/min	54.25	42.64	40.84
Concentrate Flow:	gal/min	28.42	20.42	24.41

Hydraulics Details

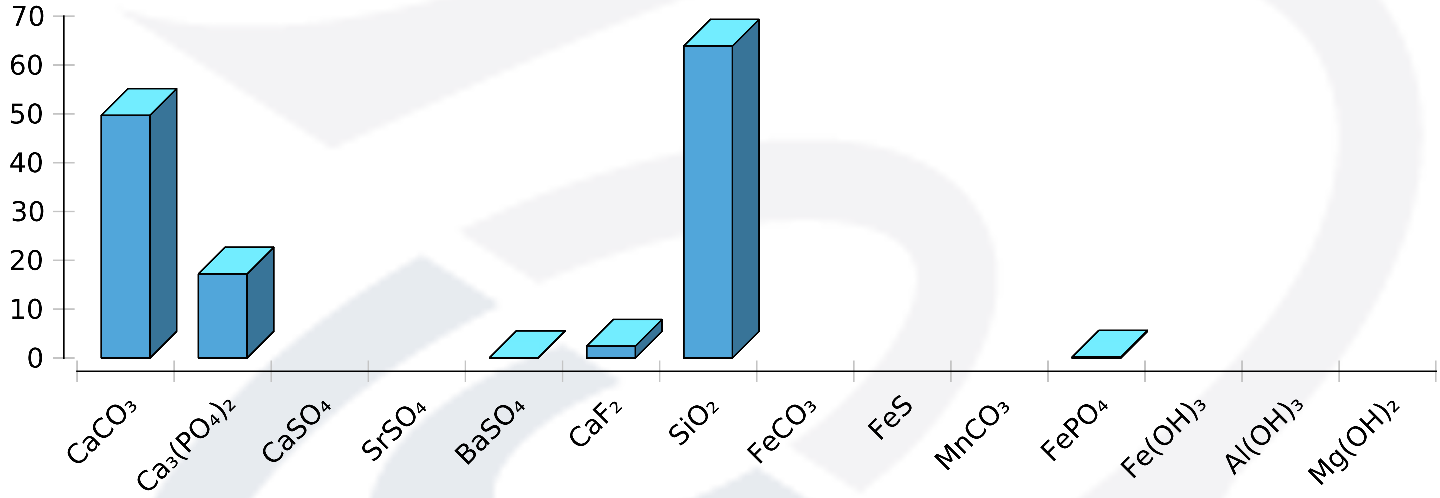
	Membrane Model:	Permeate Flow:	Average Flux:	System Recovery:	β	Feed Flow / PV:	Concentrate Flow / PV:	Δ Pressure:	Osmotic Pressure:	Net Driving Pressure:
		gal/min	gfd	%		gal/min	gal/min	psi	psi	psi
Stage1		619.92	13.28	47.61	1.13	54.25	28.42	16.59	11.61	53.90
1	BW30XFRLE-400/34i	4.38	15.76	8.07	1.14	54.25	49.88	3.56	6.90	63.96
2	BW30XFRLE-400/34i	4.11	14.80	8.25	1.14	49.88	45.76	3.08	7.47	60.07
3	BW30XFRLE-400/34i	3.87	13.94	8.46	1.13	45.76	41.89	2.66	8.10	56.57
4	BW30XFRLE-400/34i	3.65	13.16	8.72	1.13	41.89	38.24	2.28	8.81	53.38
5	BW30XFRLE-400/34i	3.45	12.44	9.03	1.13	38.24	34.78	1.95	9.62	50.46
6	BW30XFRLE-400/34i	3.27	11.76	9.39	1.12	34.78	31.51	1.65	10.54	47.73
7	BW30XFRLE-400/34i	3.09	11.13	9.81	1.12	31.51	28.42	1.39	11.61	45.15
Stage2		355.42	11.42	52.10	1.12	42.64	20.42	10.40	23.50	46.36
1	BW30XFRLE-400/34i	3.84	13.82	9.00	1.13	42.64	38.80	2.35	13.03	56.07
2	BW30XFRLE-400/34i	3.61	12.98	9.29	1.13	38.80	35.19	1.99	14.25	52.68
3	BW30XFRLE-400/34i	3.38	12.19	9.62	1.13	35.19	31.81	1.68	15.65	49.44
4	BW30XFRLE-400/34i	3.17	11.41	9.97	1.12	31.81	28.64	1.41	17.24	46.30
5	BW30XFRLE-400/34i	2.96	10.64	10.32	1.12	28.64	25.68	1.18	19.06	43.19
6	BW30XFRLE-400/34i	2.74	9.87	10.67	1.11	25.68	22.94	0.98	21.14	40.03
7	BW30XFRLE-400/34i	2.52	9.06	10.98	1.11	22.94	20.42	0.80	23.50	36.78
Stage3		131.43	8.45	40.23	1.09	40.84	24.41	10.85	37.88	34.29
1	BW30XFRLE-400/34i	3.10	11.15	7.58	1.11	40.84	37.75	2.21	25.96	45.25
2	BW30XFRLE-400/34i	2.83	10.18	7.50	1.10	37.75	34.92	1.93	27.81	41.33
3	BW30XFRLE-400/34i	2.57	9.26	7.37	1.09	34.92	32.34	1.70	29.74	37.58
4	BW30XFRLE-400/34i	2.33	8.37	7.19	1.09	32.34	30.02	1.49	31.75	33.98
5	BW30XFRLE-400/34i	2.09	7.52	6.96	1.08	30.02	27.93	1.32	33.79	30.53
6	BW30XFRLE-400/34i	1.86	6.71	6.68	1.07	27.93	26.06	1.17	35.85	27.23
7	BW30XFRLE-400/34i	1.65	5.94	6.33	1.06	26.06	24.41	1.04	37.88	24.10

Membrane Aqueous Chemistry Calculator

Version: 6.051.01 **release date:** Jan 19, 2022
Name: RO Chemical Pretreatment

Projection By: Michael Hwang
Client name: LVT
Project Id: 23928
Project: PWP_LVT_AWPF_90th%tile
Reference:
Location: United States / California / Calabasas

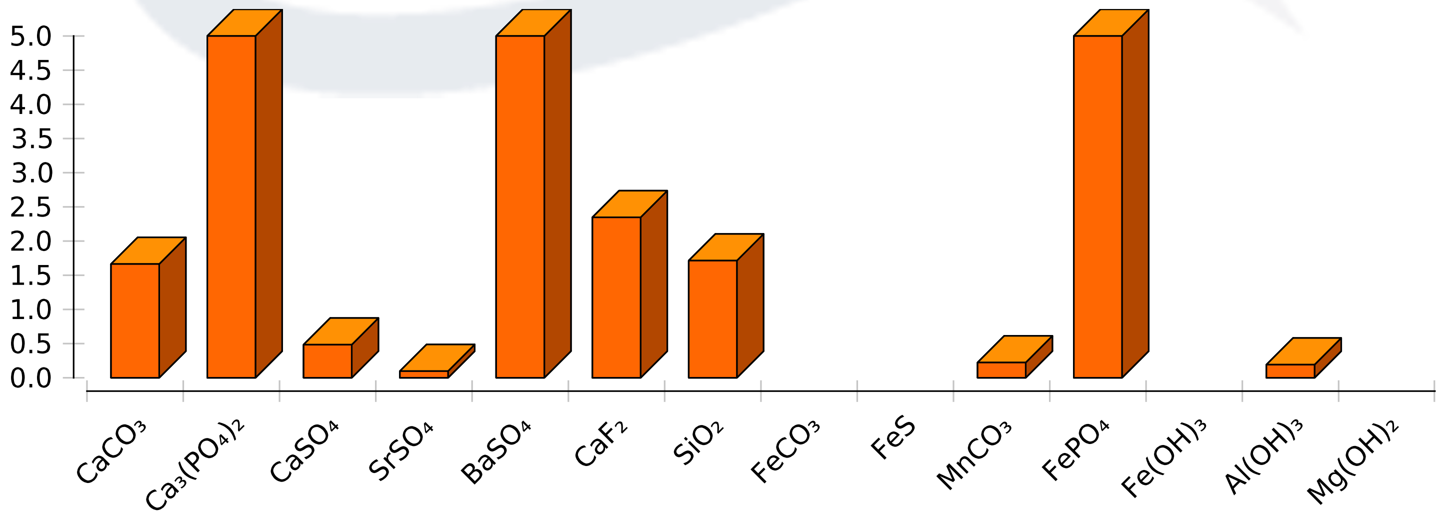
Summary Scale - Precipitation Potentials (mg/L) (when no antiscalant is used)



Summary Scale - Precipitation Potentials (mg/L)

$CaCO_3$	$Ca_3(PO_4)_2$	$CaSO_4$	$SrSO_4$	$BaSO_4$	CaF_2	SiO_2	$FeCO_3$	FeS	$MnCO_3$	$FePO_4$	$Fe(OH)_3$	$Al(OH)_3$	$Mg(OH)_2$
49.693	17.213	0	0	0.085	2.426	63.881	0	0	0	0.183	0	0	0

Summary Scale - X Saturation (when no antiscalant is used)



Summary Scale - X Saturation

$CaCO_3$	$Ca_3(PO_4)_2$	$CaSO_4$	$SrSO_4$	$BaSO_4$	CaF_2	SiO_2	$FeCO_3$	FeS	$MnCO_3$	$FePO_4$	$Fe(OH)_3$	$Al(OH)_3$	$Mg(OH)_2$
1.664	256.178	0.484	0.097	6.759	2.347	1.714	0	0	0.223	15532882.	0	0.192	0

If no antiscalant is used, the following scales may form:

$CaCO_3$	Saturation is 1.66 X; [Saturation Index is 0.22], Precipitation Potential: 49.69 mg/l
$Ca_3(PO_4)_2$	Saturation is 256.18 X; [Saturation Index is 2.41], Precipitation Potential: 17.21 mg/l
$FePO_4$	Saturation is 1.5532882E7 X; [Saturation Index is 7.19], Precipitation Potential: 0.18 mg/l
$AlPO_4$	Saturation is 124.54 X; [Saturation Index is 2.10], Precipitation Potential: 0.61 mg/l
$Ca_8H_2(PO_4)_6.5H_2O$	Saturation is 132.69 X; [Saturation Index is 2.12], Precipitation Potential: 44.65 mg/l
$BaSO_4$	Saturation is 6.76 X; [Saturation Index is 0.83], Precipitation Potential: 0.09 mg/l
CaF_2	Saturation is 2.35 X; [Saturation Index is 0.37], Precipitation Potential: 2.43 mg/l
$CaSi_2O_4(OH)_2$	Saturation is 9.80 X; [Saturation Index is 0.99], Precipitation Potential: 0.24 mg/l
$Al_2Si_2O_5(OH)_4$	Saturation is 1,140,618.59 X; [Saturation Index is 6.06], Precipitation Potential: 0.65 mg/l
SiO_2	Saturation is 1.71 X; [Saturation Index is 0.23], Precipitation Potential: 63.88 mg/l

Membrane Aqueous Chemistry Calculator

Version:	6.051.01	**release date:**	Jan 19, 2022
Name:	RO Chemical Pretreatment		

Projection By:	Michael Hwang
Client name:	LVT
Project Id:	23928
Project:	PWP_LVT_AWPF_90th%tile
Reference:	
Location:	United States / California / Calabasas

Critical Indices

Membrane Aqueous Chemistry Calculator

Version:	6.051.01	release date:	Jan 19, 2022
Name:	RO Chemical Pretreatment		

Projection By:	Michael Hwang
Client name:	LVT
Project Id:	23928
Project:	PWP_LVT_AWPF_90th%tile
Reference:	
Location:	United States / California / Calabasas

Chemical dosing:	AWC A-110	H_2SO_4
Calculated Dosage:	1.471 mg/L	77.176 mg/L
Total Dosage (modified by user):	1.471 mg/L	N/A
% Concentration:	N/A	100.000%
Density:	1.270 g/cm3	1.839 g/cm3
Dosing Pump:	5.707 ml/min	206.838 ml/min
Hours of Operation/Day:	24 hour(s)	24 hour(s)
Days of Operation/Week:	7 day(s)	7 day(s)
Consumption per:		
Day	23.010 lbs	1207.623 lbs
Week	161.073 lbs	8453.360 lbs
4 Weeks	644.294 lbs	33813.439 lbs
Year	8398.830 lbs	440782.335 lbs
5 Years	41994.148 lbs	2203911.676 lbs

Cleaning Chemicals:	High pH Cleaner	Low pH Cleaner
Chemical:	AWC C-227	AWC C-234
Concentration:	2 %	2 %

Other options may be available. It is recommended that you discuss CIP system design constraints with your AWC representative when selecting cleaning chemicals.

Insert your additional comments below:

Comments...

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Membrane Aqueous Chemistry Calculator

Version:	6.058.08	**release date:**	Mar 7, 2022
Name:	RO Chemical Pretreatment		

Projection By:	Michael Hwang
Client name:	LVT
Project Id:	23928
Project:	PWP_LVT_AWPF_90th%tile
Reference:	
Location:	United States / California / Calabasas

	Unit	
Source:		Wastewater (MF/UF Pretreatment)
Feed Temperature:	°C	15.000
Raw Water Flow/Train:	gal/min	1302.083
Permeate Flow/Train:	gal/min	1106.771
Average Flux Rate:	gfd	11.860
Recycling Flow:	gal/min	0.000
Salt Passage Increase:	%	0.000

	Unit	
Feed Pressure:	psi	96.167
Total Δ Pressure:	psi	41.209
Brine Pressure:	psi	75.293
Permeate Pressure:	psi	0.000
System Recovery:	%	85.000
Internal Recovery:	%	85.000
Element Age:	Years	0
Specific Power:	kWh/kgal	0.984

Cations	Balanced Feed (mg/L)	pH Adjusted Feed (mg/L)	Reject (mg/L)	Permeate (mg/L)
Ca^{2+}	67.00	67.00	442.99	0.65
Mg^{2+}	32.00	32.00	211.95	0.24
Ba^{2+}	0.02	0.02	0.13	0.00
Sr^{2+}	0.51	0.51	3.38	0.00
Na^{+}	137.00	137.00	885.61	4.89
K^{+}	17.70	17.70	114.42	0.63
Fe^{2+}	0.00	0.00	0.00	0.00
Fe^{3+}	0.01	0.01	0.06	0.00
Al^{3+}	0.02	0.02	0.13	0.00
Mn^{2+}	0.03	0.03	0.20	0.00
NH3/NH4 - N	0.00	0.00	0.00	0.00

Anions	Balanced Feed (mg/L)	pH Adjusted Feed (mg/L)	Reject (mg/L)	Permeate (mg/L)
HCO_3^-($CaCO_3$)	149.31	78.16	479.83	4.21
CO_3^{2-}($CaCO_3$)	0.69	0.04	1.90	0.00
CO_2	14.85	77.72	94.21	77.37
TIC (C)	39.97	39.97	141.10	22.13
Ortho-PO_4^{3-}	9.20	9.20	60.55	0.14
SO_4^{2-}	180.00	251.71	1665.29	2.26
F^-	0.67	0.67	4.37	0.02
Cl^-	169.81	169.81	1110.70	3.77
Br^-	0.00	0.00	0.00	0.00
SiO_2	22.00	22.00	145.48	0.21
NO_3^--N	9.20	9.20	57.40	0.70
NO_2^--N	0.00	0.00	0.00	0.00
Sulfides (S^{2-})	0.00	0.00	0.00	0.00
B	0.40	0.40	1.02	0.29
As(III)	0.00	0.00	0.00	0.00
As(V)	0.00	0.00	0.00	0.00
TOC (ppm C)	0.00	0.00	0.00	0.00
H.ORG (mEq/L)	0.00	0.00	0.00	0.00
TDS:	856.570	842.560	5476.880	21.250
Cond (µs/cm):	0.000	1154.634	6535.196	28.953
pH:	7.300	6.300	6.900	5.090
Flow: gal/day		0.000	0.000	1593750.000

Summary	Product:	Dosage:
pH adjusted using:	H_2SO_4	73.216 mg/L
Selected product:	AWC A-110	1.552 mg/L

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Membrane Aqueous Chemistry Calculator

Projection By:	Michael Hwang
Client name:	LVT
Project Id:	23928
Project:	PWP_LVT_AWPF_90th%tile
Reference:	
Location:	United States / California / Calabasas

Version: 6.058.08 **release date:** Mar 7, 2022

Name: RO Chemical Pretreatment

	Unit	Stage 1	Stage 2	Stage 3
Total Elements:		168	112	56
Total Vessels:		24	16	8
Elements / Vessels:		7	7	7
Flow Factor:		1.000	1.000	1.000
Feed Pressure:	psi	96.17	90.31	87.14
Permeate Throttle/ Backpressure:	psi	0.00	0.00	0.00
Interstage Boost Pressure:	psi	0.00	12.17	8.17
Piping Losses:	psi	0.00	0.00	0.00
Concentrate Pressure:	psi	78.14	78.97	75.29
Feed Flow:	gal/min	54.25	42.64	40.84
Concentrate Flow:	gal/min	28.42	20.42	24.41

Hydraulics Details

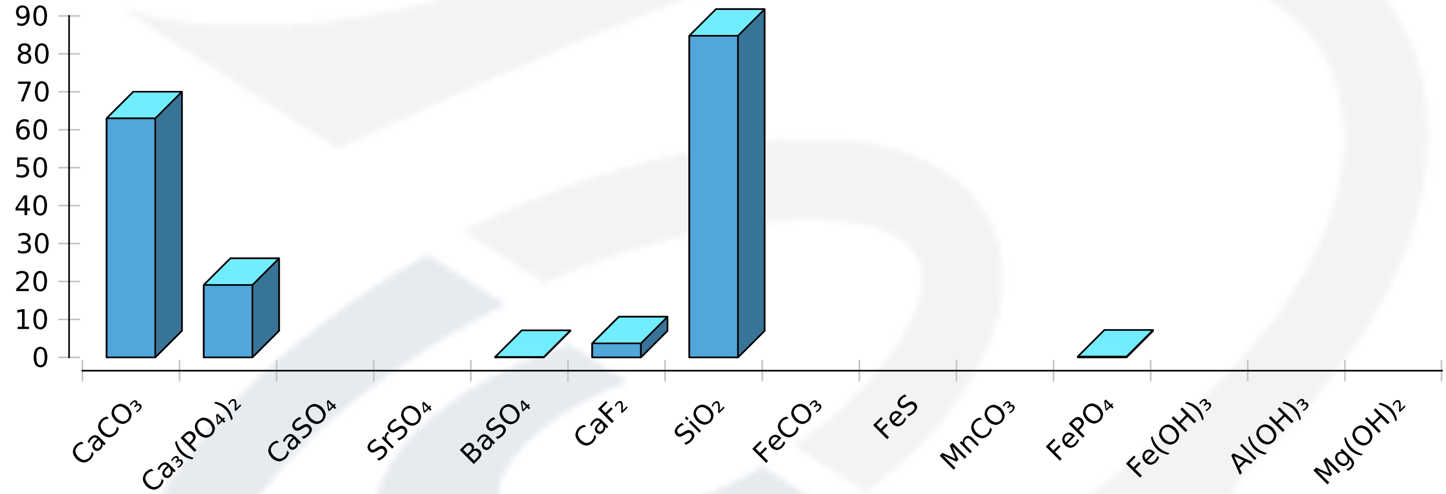
	Membrane Model:	Permeate Flow:	Average Flux:	System Recovery:	β	Feed Flow / PV:	Concentrate Flow / PV:	Δ Pressure:	Osmotic Pressure:	Net Driving Pressure:
		gal/min	gfd	%		gal/min	gal/min	psi	psi	psi
Stage1		619.92	13.28	47.61	1.16	54.25	28.42	18.03	11.69	76.61
1	BW30XFRLE-400/34i	4.21	15.15	7.76	1.17	54.25	50.04	3.85	6.86	87.38
2	BW30XFRLE-400/34i	4.01	14.43	8.01	1.16	50.04	46.04	3.35	7.42	83.23
3	BW30XFRLE-400/34i	3.83	13.78	8.32	1.16	46.04	42.21	2.90	8.04	79.47
4	BW30XFRLE-400/34i	3.66	13.19	8.68	1.16	42.21	38.54	2.49	8.76	76.06
5	BW30XFRLE-400/34i	3.51	12.64	9.11	1.16	38.54	35.03	2.13	9.59	72.92
6	BW30XFRLE-400/34i	3.37	12.14	9.62	1.15	35.03	31.66	1.80	10.55	69.99
7	BW30XFRLE-400/34i	3.24	11.65	10.22	1.15	31.66	28.42	1.51	11.69	67.20
Stage2		355.42	11.42	52.10	1.15	42.64	20.42	11.34	23.72	65.88
1	BW30XFRLE-400/34i	3.67	13.19	8.60	1.16	42.64	38.97	2.54	12.95	76.09
2	BW30XFRLE-400/34i	3.49	12.58	8.97	1.15	38.97	35.48	2.17	14.14	72.54
3	BW30XFRLE-400/34i	3.33	11.99	9.39	1.15	35.48	32.14	1.84	15.51	69.17
4	BW30XFRLE-400/34i	3.17	11.42	9.87	1.15	32.14	28.97	1.55	17.11	65.88
5	BW30XFRLE-400/34i	3.01	10.85	10.41	1.15	28.97	25.96	1.29	18.96	62.59
6	BW30XFRLE-400/34i	2.85	10.27	10.99	1.14	25.96	23.10	1.07	21.15	59.23
7	BW30XFRLE-400/34i	2.68	9.66	11.61	1.14	23.10	20.42	0.87	23.72	55.68
Stage3		131.43	8.45	40.23	1.11	40.84	24.41	11.84	38.15	48.73
1	BW30XFRLE-400/34i	2.90	10.44	7.10	1.12	40.84	37.94	2.39	25.72	60.22
2	BW30XFRLE-400/34i	2.71	9.74	7.13	1.12	37.94	35.24	2.11	27.49	56.20
3	BW30XFRLE-400/34i	2.52	9.07	7.15	1.11	35.24	32.72	1.86	29.39	52.32
4	BW30XFRLE-400/34i	2.34	8.42	7.15	1.11	32.72	30.38	1.64	31.42	48.54
5	BW30XFRLE-400/34i	2.16	7.78	7.11	1.10	30.38	28.22	1.44	33.56	44.86
6	BW30XFRLE-400/34i	1.99	7.15	7.04	1.09	28.22	26.23	1.28	35.81	41.25
7	BW30XFRLE-400/34i	1.82	6.54	6.92	1.09	26.23	24.41	1.13	38.15	37.70

Membrane Aqueous Chemistry Calculator

Version: 6.058.08 **release date:** Mar 7, 2022
Name: RO Chemical Pretreatment

Projection By: Michael Hwang
Client name: LVT
Project Id: 23928
Project: PWP_LVT_AWPF_90th%tile
Reference:
Location: United States / California / Calabasas

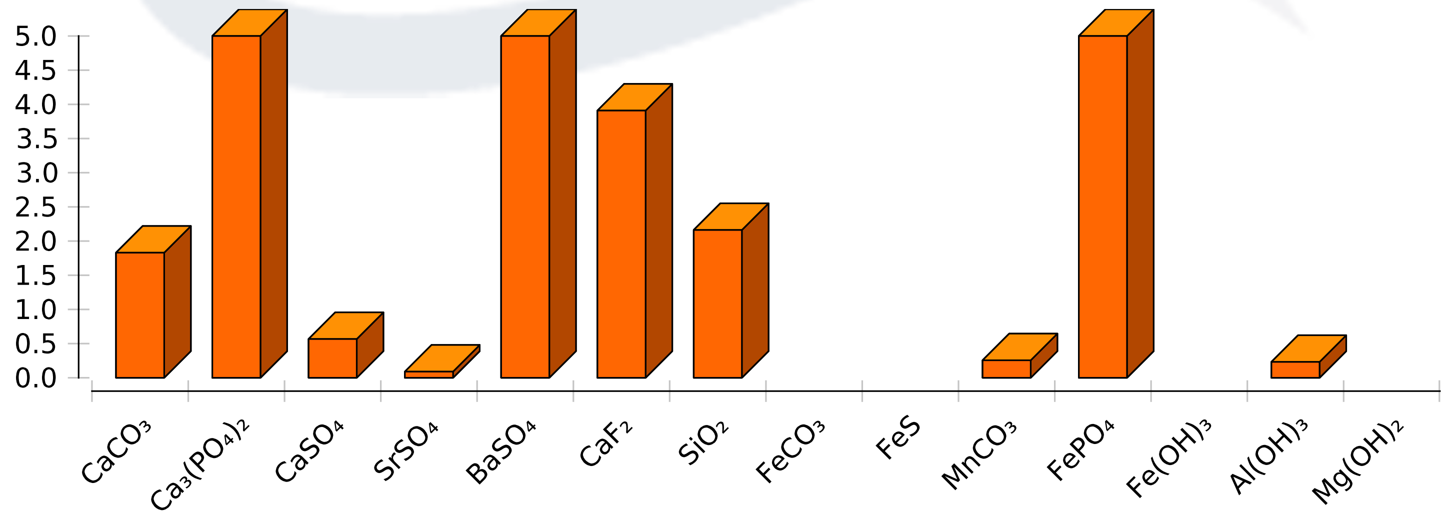
Summary Scale - Precipitation Potentials (mg/L) (when no antiscalant is used)



Summary Scale - Precipitation Potentials (mg/L)

$CaCO_3$	$Ca_3(PO_4)_2$	$CaSO_4$	$SrSO_4$	$BaSO_4$	CaF_2	SiO_2	$FeCO_3$	FeS	$MnCO_3$	$FePO_4$	$Fe(OH)_3$	$Al(OH)_3$	$Mg(OH)_2$
63.003	19.081	0	0	0.091	3.688	84.777	0	0	0	0.194	0	0	0

Summary Scale - X Saturation (when no antiscalant is used)



Summary Scale - X Saturation

$CaCO_3$	$Ca_3(PO_4)_2$	$CaSO_4$	$SrSO_4$	$BaSO_4$	CaF_2	SiO_2	$FeCO_3$	FeS	$MnCO_3$	$FePO_4$	$Fe(OH)_3$	$Al(OH)_3$	$Mg(OH)_2$
1.83	325.199	0.567	0.09	11.443	3.909	2.162	0	0	0.256	17648384.	0	0.232	0

If no antiscalant is used, the following scales may form:

$CaCO_3$	Saturation is 1.83 X; [Saturation Index is 0.26], Precipitation Potential: 63.00 mg/l
$Ca_3(PO_4)_2$	Saturation is 325.20 X; [Saturation Index is 2.51], Precipitation Potential: 19.08 mg/l
$FePO_4$	Saturation is 1.7648385E7 X; [Saturation Index is 7.25], Precipitation Potential: 0.19 mg/l
$AlPO_4$	Saturation is 184.97 X; [Saturation Index is 2.27], Precipitation Potential: 0.66 mg/l
$Ca_8H_2(PO_4)_6.5H_2O$	Saturation is 144.50 X; [Saturation Index is 2.16], Precipitation Potential: 48.84 mg/l
$BaSO_4$	Saturation is 11.44 X; [Saturation Index is 1.06], Precipitation Potential: 0.09 mg/l
CaF_2	Saturation is 3.91 X; [Saturation Index is 0.59], Precipitation Potential: 3.69 mg/l
MgF_2	Saturation is 1.06 X; [Saturation Index is 0.03], Precipitation Potential: 0.17 mg/l
$CaSi_2O_4(OH)_2$	Saturation is 24.33 X; [Saturation Index is 1.39], Precipitation Potential: 0.26 mg/l
$Al_2Si_2O_5(OH)_4$	Saturation is 7.6706791E7 X; [Saturation Index is 7.88], Precipitation Potential: 0.70 mg/l
SiO_2	Saturation is 2.16 X; [Saturation Index is 0.33], Precipitation Potential: 84.78 mg/l

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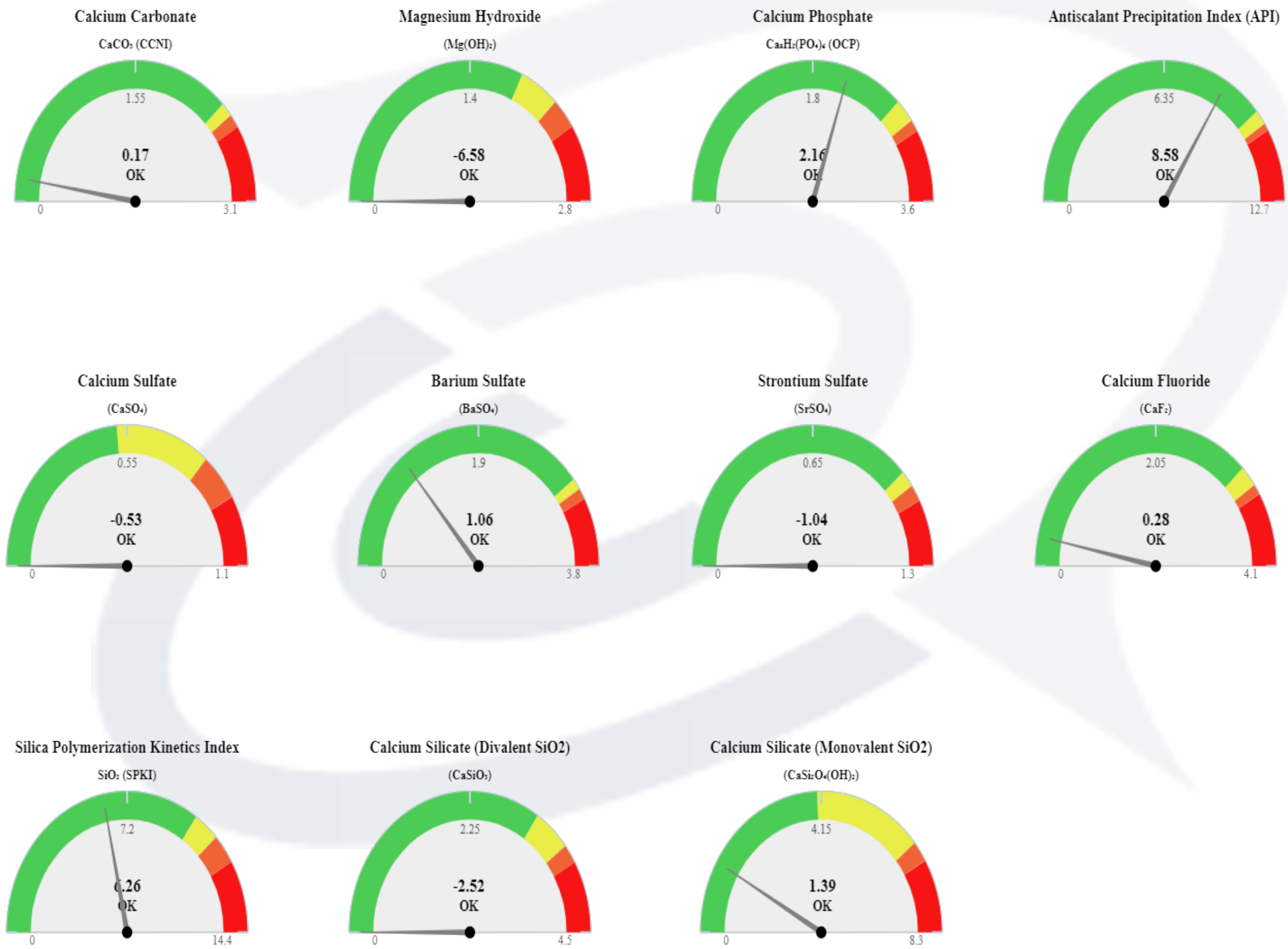
Membrane Aqueous Chemistry Calculator

Version:	6.058.08	**release date:**	Mar 7, 2022
Name:	RO Chemical Pretreatment		

Projection By:	Michael Hwang
Client name:	LVT
Project Id:	23928
Project:	PWP_LVT_AWPF_90th%tile
Reference:	
Location:	United States / California / Calabasas

Critical Indices



Membrane Aqueous Chemistry Calculator

Version:	6.058.08	**release date:**	Mar 7, 2022
Name:	RO Chemical Pretreatment		

Projection By:	Michael Hwang
Client name:	LVT
Project Id:	23928
Project:	PWP_LVT_AWPF_90th%tile
Reference:	
Location:	United States / California / Calabasas

Chemical dosing:	AWC A-110	H_2SO_4
Calculated Dosage:	1.552 mg/L	73.216 mg/L
Total Dosage (modified by user):	1.552 mg/L	N/A
% Concentration:	N/A	100.000%
Density:	1.270 g/cm3	1.839 g/cm3
Dosing Pump:	6.022 ml/min	196.224 ml/min
Hours of Operation/Day:	24 hour(s)	24 hour(s)
Days of Operation/Week:	7 day(s)	7 day(s)
Consumption per:		
Day	24.278 lbs	1145.658 lbs
Week	169.946 lbs	8019.603 lbs
4 Weeks	679.785 lbs	32078.410 lbs
Year	8861.478 lbs	418164.990 lbs
5 Years	44307.391 lbs	2090824.949 lbs

Cleaning Chemicals:	High pH Cleaner	Low pH Cleaner
Chemical:	AWC C-227	AWC C-234
Concentration:	2 %	2 %

Other options may be available. It is recommended that you discuss CIP system design constraints with your AWC representative when selecting cleaning chemicals.

Insert your additional comments below:

Comments...

Appendix B.3
RO Projections

Permeate Throttling (Variable), Booster Pump

Project name	Las Virgenes			Page : 1/3
Calculated by	Alt		Permeate flow/train	1.200 mgd
HP Pump flow	980.56 gpm		Raw water flow/train	1.412 mgd
Feed pressure	157.7 psi		Permeate recovery	85.00 %
Feed temperature	16.0 °C(60.8°F)		Element age	5.0 years
Feed water pH	6.20		Flux decline %, first year	12.0
Chem dose, mg/l, 100 %	78.3 H2SO4		Fouling factor	0.76
Specific energy	1.74 kwh/kgal		SP increase, per year	10.0 %
Pass NDP	114.5 psi		Inter-stage pipe loss	3.000 psi
Average flux rate	11.9 gfd			
			Feed type	Waste MF/UF

Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Flow / Vessel Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Stagewise Pressure Boost psi	Stagewise Pressure Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	496.2	40.8	20.2	12.4	10.8	13.2	1.14	25	0	146.9	7.3	ESPA2-LD	144	24 x 6M
1-2	227.9	40.3	21.4	11.4	10.9	12.4	1.12	12	0	133.1	20	ESPA2-LD	72	12 x 6M
1-3	109.5	42.7	24.5	10.9	12.2	12.2	1.1	12	25	142.9	52.2	ESPA2-LD	36	6 x 6M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1	Concentrate 2	Concentrate 3
Hardness, as CaCO3	298.65	298.65	1.864	1984.9	1139.2	1984.9
Ca	67.00	67.00	0.418	135.5	255.6	445.3
Mg	32.00	32.00	0.200	64.7	122.1	212.7
Na	137.00	137.00	4.058	275.6	516.5	892.4
K	18.00	18.00	0.664	36.2	67.6	116.5
NH4	0.00	0.00	0.000	0.0	0.0	0.0
Ba	0.020	0.020	0.000	0.0	0.1	0.1
Sr	0.510	0.510	0.003	1.0	1.9	3.4
H	0.00	0.00	0.014	0.0	0.0	0.0
CO3	0.23	0.01	0.000	0.0	0.2	0.5
HCO3	183.00	83.97	3.384	169.3	315.7	545.5
SO4	236.00	312.72	1.780	632.5	1193.2	2079.4
Cl	170.00	170.00	3.840	342.6	643.2	1114.1
F	0.67	0.67	0.077	1.3	2.4	4.0
NO3	9.50	9.50	1.500	18.6	33.4	55.0
PO4	9.20	9.20	0.052	18.6	35.1	61.2
OH	0.00	0.00	0.000	0.0	0.0	0.0
SiO2	22.00	22.00	0.369	44.4	83.5	144.9
B	0.40	0.40	0.367	0.5	0.5	0.6
CO2	14.99	86.58	86.58	86.58	86.58	86.58
TDS	**885.53**	**862.99**	**16.71**	**1740.79**	**3270.98**	**5675.57**
pH	**7.30**	**6.20**	**4.85**	**6.48**	**6.73**	**6.95**

Saturations	**Raw Water**	**Feed Water**	**Concentrate**	**Limits**
CaSO4 / ksp * 100, %	5	6	66	400
SrSO4 / ksp * 100, %	2	3	32	1200
BaSO4 / ksp * 100, %	157	200	1748	10000
SiO2 saturation, %	20	20	136	140
CaF2 / ksp * 100, %	4	4	432	50000
Ca3(PO4)2 saturation index	0.6	-1.1	1.0	2.4
CCPP, mg/l	-8.84	-125.93	169.19	
Langelier saturation index	-0.37	-1.81	0.50	2.5
Ionic strength	0.02	0.02	0.13	
Osmotic pressure, psi	6.6	6.0	39.5	

Email : imsd-support@hydranauticsprojections.net www.membranes.com +1 760 901 2500

Permeate Throttling (Variable), Booster Pump

Project name Las Virgenes

Calculated by	Alt		Permeate flow/train	1.200 mgd
HP Pump flow	980.56 gpm		Raw water flow/train	1.412 mgd
Feed pressure	157.7 psi		Permeate recovery	85.00 %
Feed temperature	16.0 °C(60.8°F)		Element age	5.0 years
Feed water pH	6.20		Flux decline %, first year	12.0
Chem dose, mg/l, 100 %	78.3 H2SO4		Fouling factor	0.76
Specific energy	1.74 kwh/kgal		SP increase, per year	10.0 %
Pass NDP	114.5 psi		Inter-stage pipe loss	3.000 psi
Average flux rate	11.9 gfd		Feed type	Waste MF/UF

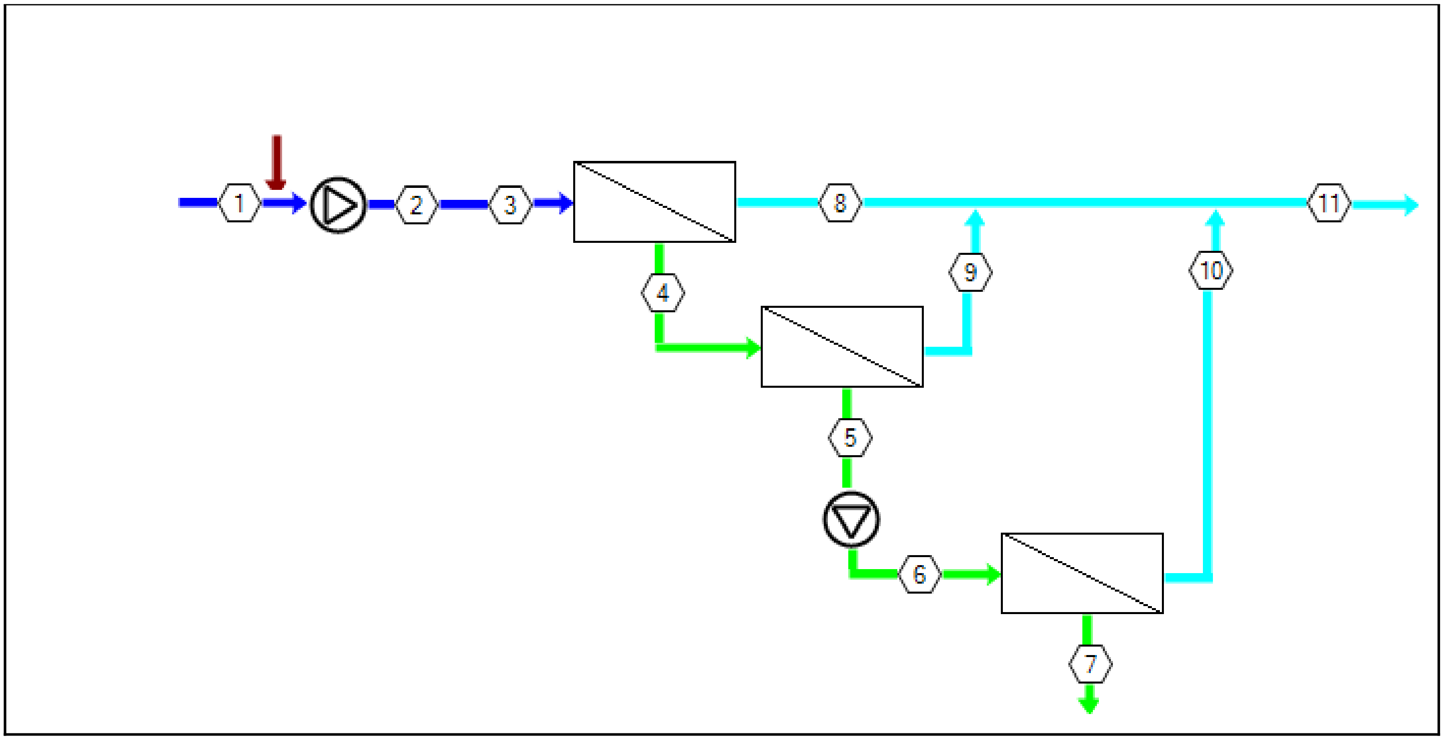
Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Flow / Vessel Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Stagewise Pressure Boost psi	Stagewise Pressure Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	496.2	40.8	20.2	12.4	10.8	13.2	1.14	25	0	146.9	7.3	ESPA2-LD	144	24 x 6M
1-2	227.9	40.3	21.4	11.4	10.9	12.4	1.12	12	0	133.1	20	ESPA2-LD	72	12 x 6M
1-3	109.5	42.7	24.5	10.9	12.2	12.2	1.1	12	25	142.9	52.2	ESPA2-LD	36	6 x 6M

Pass - Stage	Element no.	Feed Pressure psi	Pressure Drop psi	Conc Osmo. psi	NDP psi	Permeate Water Flow gpm	Permeate Water Flux gfd	Beta	TDS	Ca	Mg	Na	Cl
										Permeate (Passwise cumulative)			
1-1	1	157.7	2.53	6.6	125.4	3.7	13.2	1.09	4.8	0.113	0.054	1.109	1.046
1-1	2	155.2	2.21	7.3	122.2	3.6	12.8	1.09	5.1	0.122	0.058	1.197	1.129
1-1	3	153	1.91	8.1	119.4	3.5	12.5	1.1	5.6	0.132	0.063	1.297	1.224
1-1	4	151.1	1.63	9.2	116.7	3.4	12.2	1.11	6	0.145	0.069	1.416	1.336
1-1	5	149.4	1.36	10.5	114	3.3	12	1.13	6.6	0.159	0.076	1.558	1.47
1-1	6	148.1	1.12	12.1	111.3	3.2	11.7	1.14	7.3	0.177	0.085	1.733	1.636
1-2	1	143.9	2.5	13.3	118.1	3.4	12.4	1.08	7.7	0.187	0.09	1.832	1.73
1-2	2	141.4	2.2	14.6	114.6	3.3	12	1.09	8.2	0.2	0.095	1.951	1.842
1-2	3	139.3	1.92	16.1	111.1	3.2	11.6	1.09	8.8	0.214	0.102	2.093	1.976
1-2	4	137.3	1.66	17.9	107.7	3.1	11.2	1.1	9.5	0.232	0.111	2.263	2.137
1-2	5	135.7	1.42	20.1	104.1	3	10.8	1.11	10.3	0.253	0.121	2.468	2.332
1-2	6	134.3	1.19	22.8	100.4	2.9	10.4	1.12	11.3	0.279	0.133	2.72	2.57
1-3	1	155.1	2.72	24.7	118.1	3.4	12.2	1.08	11.9	0.294	0.14	2.86	2.703
1-3	2	152.3	2.41	26.9	113.5	3.3	11.7	1.08	12.6	0.311	0.148	3.026	2.86
1-3	3	149.9	2.13	29.4	108.9	3.1	11.2	1.08	13.4	0.331	0.158	3.221	3.045
1-3	4	147.8	1.87	32.3	104.2	3	10.7	1.09	14.3	0.355	0.17	3.452	3.264
1-3	5	145.9	1.64	35.6	99.3	2.8	10.2	1.09	15.4	0.384	0.183	3.727	3.525
1-3	6	144.3	1.42	39.4	94.3	2.7	9.6	1.1	16.7	0.418	0.2	4.057	3.838

Permeate Throttling (Variable), Booster Pump

Project name Las Virgenes

Temperature : 16.0 °C Element age, P1 : 5.0 years



Stream No.	Flow (gpm)	Pressure (psi)	TDS (mg/l)	pH	Econd (µs/cm)
1	981	0	886	7.30	1584
2	981	158	863	6.20	1631
3	981	158	863	6.20	1631
4	484	147	1741	6.48	3026
5	256	133	3271	6.73	5340
6	256	155	3271	6.73	5340
7	147	143	5676	6.95	8831
8	496	25.0	7.34	4.49	23.4
9	228	12.0	20.0	4.93	37.8
10	109	12.0	52.2	5.35	90.4
11	833	12.0	16.7	4.85	33.0

Permeate Throttling (Variable), Booster Pump

Project name	Las Virgenes			Page : 1/3
Calculated by	Alt		Permeate flow/train	1.200 mgd
HP Pump flow	980.56 gpm		Raw water flow/train	1.412 mgd
Feed pressure	101.1 psi		Permeate recovery	85.00 %
Feed temperature	28.0 °C(82.4°F)		Element age	0.0 years
Feed water pH	6.20		Flux decline %, first year	12.0
Chem dose, mg/l, 100 %	72.7 H2SO4		Fouling factor	1.00
Specific energy	1.14 kwh/kgal		SP increase, per year	10.0 %
Pass NDP	57.7 psi		Inter-stage pipe loss	3.000 psi
Average flux rate	11.9 gfd			
			Feed type	Waste MF/UF

Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Flow / Vessel Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Stagewise Pressure Boost psi	Stagewise Pressure Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	516.1	40.8	19.3	12.9	10.5	14.5	1.15	25	0	90.6	7.2	ESPA2-LD	144	24 x 6M
1-2	217	38.7	20.6	10.9	10.1	12.8	1.11	12	0	77.5	22.2	ESPA2-LD	72	12 x 6M
1-3	100.7	41.2	24.4	10.1	11.6	12.6	1.1	12	25	87.9	58.7	ESPA2-LD	36	6 x 6M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1	Concentrate 2	Concentrate 3
Hardness, as CaCO3	298.65	298.65	1.930	1986.7	1180.1	1986.7
Ca	67.00	67.00	0.433	141.3	264.8	445.7
Mg	32.00	32.00	0.207	67.5	126.4	212.9
Na	137.00	137.00	4.201	287.4	534.8	892.5
K	18.00	18.00	0.687	37.7	70.0	116.5
NH4	0.00	0.00	0.000	0.0	0.0	0.0
Ba	0.020	0.020	0.000	0.0	0.1	0.1
Sr	0.510	0.510	0.003	1.1	2.0	3.4
H	0.00	0.00	0.014	0.0	0.0	0.0
CO3	0.30	0.01	0.000	0.1	0.2	0.8
HCO3	183.00	91.27	3.741	192.0	357.8	597.1
SO4	236.00	307.20	1.779	647.8	1214.3	2044.8
Cl	170.00	170.00	3.905	357.2	666.2	1114.9
F	0.67	0.67	0.077	1.4	2.5	4.0
NO3	9.50	9.50	1.525	19.3	34.6	54.9
PO4	9.20	9.20	0.053	19.4	36.4	61.2
OH	0.00	0.00	0.000	0.0	0.0	0.0
SiO2	22.00	22.00	0.378	46.3	86.5	145.0
B	0.40	0.40	0.385	0.4	0.5	0.5
CO2	12.58	78.96	78.96	78.96	78.96	78.96
TDS	**885.60**	**864.78**	**17.38**	**1818.80**	**3397.06**	**5694.38**
pH	**7.30**	**6.20**	**4.86**	**6.50**	**6.75**	**6.95**

Saturations	**Raw Water**	**Feed Water**	**Concentrate**	**Limits**
CaSO4 / ksp * 100, %	4	6	60	400
SrSO4 / ksp * 100, %	2	3	29	1200
BaSO4 / ksp * 100, %	157	197	1724	10000
SiO2 saturation, %	17	16	111	140
CaF2 / ksp * 100, %	4	4	434	50000
Ca3(PO4)2 saturation index	0.8	-0.9	1.3	2.4
CCPP, mg/l	-8.84	-132.59	192.94	
Langelier saturation index	-0.14	-1.54	0.77	2.5
Ionic strength	0.02	0.02	0.13	
Osmotic pressure, psi	6.9	6.3	41.5	

Permeate Throttling (Variable), Booster Pump

Project name	Las Virgenes			Page : 2/3
Calculated by	Alt		Permeate flow/train	1.200 mgd
HP Pump flow	980.56 gpm		Raw water flow/train	1.412 mgd
Feed pressure	101.1 psi		Permeate recovery	85.00 %
Feed temperature	28.0 °C(82.4°F)		Element age	0.0 years
Feed water pH	6.20		Flux decline %, first year	12.0
Chem dose, mg/l, 100 %	72.7 H2SO4		Fouling factor	1.00
Specific energy	1.14 kwh/kgal		SP increase, per year	10.0 %
Pass NDP	57.7 psi		Inter-stage pipe loss	3.000 psi
Average flux rate	11.9 gfd			
			Feed type	Waste MF/UF

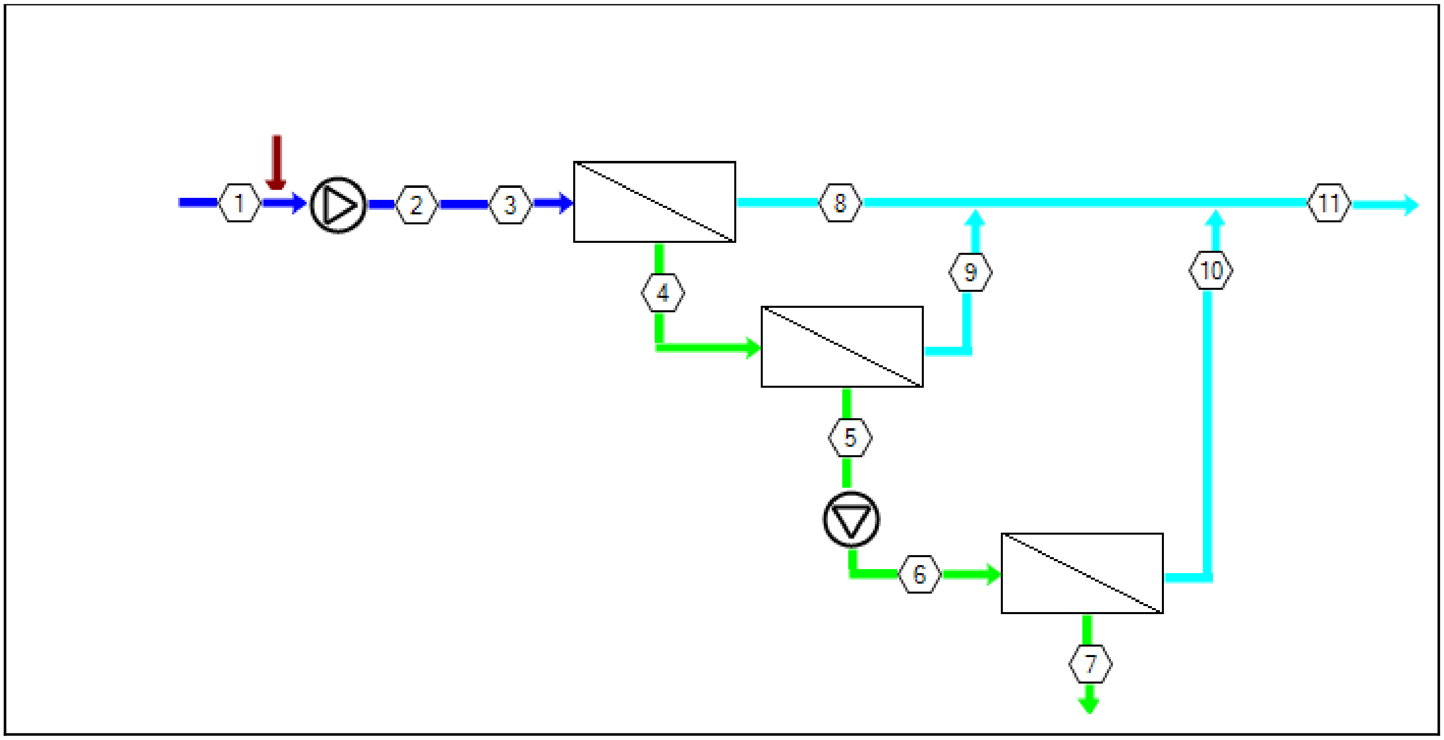
Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Flow / Vessel Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Stagewise Pressure Boost psi	Stagewise Pressure Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	516.1	40.8	19.3	12.9	10.5	14.5	1.15	25	0	90.6	7.2	ESPA2-LD	144	24 x 6M
1-2	217	38.7	20.6	10.9	10.1	12.8	1.11	12	0	77.5	22.2	ESPA2-LD	72	12 x 6M
1-3	100.7	41.2	24.4	10.1	11.6	12.6	1.1	12	25	87.9	58.7	ESPA2-LD	36	6 x 6M

Pass - Stage	Element no.	Feed Pressure psi	Pressure Drop psi	Conc Osmo. psi	NDP psi	Permeate Water Flow gpm	Permeate Water Flux gfd	Beta	TDS	Permeate (Passwise cumulative) Ca	Mg	Na	Cl
1-1	1	101.1	2.52	7	68.4	4	14.5	1.1	4.4	0.101	0.048	0.991	0.918
1-1	2	98.6	2.17	7.8	65.1	3.8	13.8	1.1	4.8	0.111	0.053	1.088	1.008
1-1	3	96.4	1.85	8.8	62.2	3.7	13.2	1.11	5.3	0.123	0.059	1.201	1.113
1-1	4	94.5	1.56	10	59.5	3.5	12.6	1.12	5.8	0.136	0.065	1.334	1.236
1-1	5	93	1.3	11.4	56.7	3.3	12	1.13	6.4	0.153	0.073	1.493	1.385
1-1	6	91.7	1.06	13.3	53.9	3.2	11.4	1.15	7.2	0.173	0.083	1.691	1.568
1-2	1	87.6	2.35	14.6	60.6	3.5	12.8	1.09	7.7	0.184	0.088	1.794	1.664
1-2	2	85.3	2.05	16.1	57	3.3	12	1.09	8.2	0.197	0.094	1.923	1.784
1-2	3	83.2	1.78	17.8	53.5	3.1	11.2	1.1	8.8	0.213	0.102	2.082	1.931
1-2	4	81.5	1.53	19.8	50	2.9	10.5	1.1	9.6	0.233	0.111	2.273	2.109
1-2	5	79.9	1.32	22.1	46.4	2.7	9.7	1.1	10.5	0.257	0.123	2.506	2.325
1-2	6	78.6	1.13	24.7	42.8	2.5	8.9	1.11	11.7	0.286	0.137	2.787	2.587
1-3	1	99.5	2.58	27	60.5	3.5	12.6	1.08	12.3	0.301	0.144	2.929	2.72
1-3	2	96.9	2.26	29.5	55.7	3.2	11.6	1.1	13	0.319	0.152	3.103	2.881
1-3	3	94.6	2	32.2	51	2.9	10.6	1.1	13.8	0.34	0.163	3.311	3.076
1-3	4	92.6	1.77	35.1	46.3	2.7	9.6	1.08	14.8	0.366	0.175	3.56	3.308
1-3	5	90.9	1.57	38.2	41.7	2.4	8.6	1.08	16	0.397	0.19	3.854	3.582
1-3	6	89.3	1.4	41.4	37	2.1	7.6	1.08	17.4	0.433	0.207	4.199	3.903

Permeate Throttling (Variable), Booster Pump

Project name Las Virgenes

Temperature : 28.0 °C Element age, P1 : 0.0 years



Stream No.	Flow (gpm)	Pressure (psi)	TDS (mg/l)	pH	Econd (µs/cm)
1	981	0	886	7.30	1585
2	981	101	865	6.20	1628
3	981	101	865	6.20	1628
4	464	90.6	1819	6.50	3134
5	247	77.5	3397	6.75	5502
6	247	99.5	3397	6.75	5502
7	147	87.9	5694	6.95	8820
8	516	25.0	7.25	4.47	23.5
9	217	12.0	22.2	4.97	40.9
10	101	12.0	58.7	5.39	101
11	833	12.0	17.4	4.86	33.7

Appendix B.4
Flow Balance

Pure Water Project Las Virgenes - Triunfo
Flow Balance for Maximum Flow Condition
Conceptual Design

Large Skids

Duty Skids	1	skids
Feed Capacity	2.82	mgd/skid
Permeate Capacity	2.40	mgd/skid
Flux	11.90	gfd

Medium Skids

Duty Skids	2	skids
Feed Capacity	1.42	mgd/skid
Permeate Capacity	1.21	mgd/skid
Flux	12.00	gfd
Total Feed Capacity	7.08	mgd
	4,918	gpm
Total Permeate Capacity	6.02	mgd
	4,181	gpm

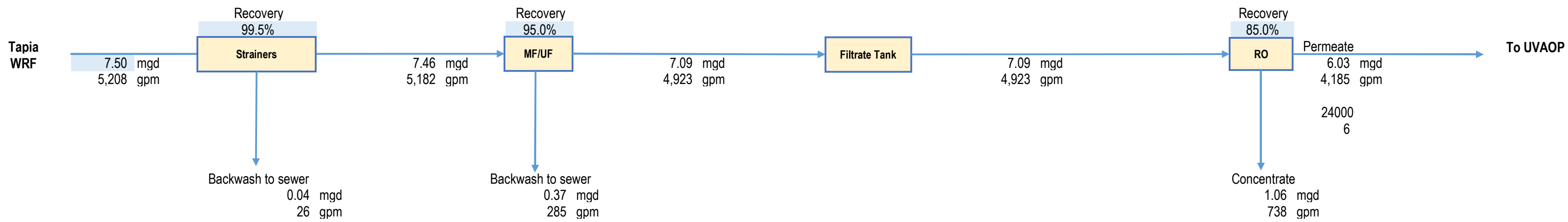
Small Skids

Duty Skids	2	skids
Feed Capacity	0.71	mgd/skid
Permeate Capacity	0.60	mgd/skid
Flux	11.90	gfd

Skid Array	Vessels	Elements	Area (ft2)
Stg 1	48	288	115,200
Stg 2	24	144	57,600
Stg 3	12	72	28,800
	84	504	201,600

Skid Array	Vessels	Elements	Area (ft2)
Stg 1	24	144	57,600
Stg 2	12	72	28,800
Stg 3	6	36	14,400
	42	252	100,800

Skid Array	Vessels	Elements	Area (ft2)
Stg 1	12	72	28,800
Stg 2	6	36	14,400
Stg 3	3	18	7,200
	21	126	50,400



Appendix B.5
Post Treatment WaterPro Calculations

Water!Pro™

Treating Drinking Water

Step 1: Initial Water Characteristics

Save Steps 1, 3 & 5 Data | Retrieve Steps 1, 3 & 5 Data

Enter source water characteristics.

Client ID:	CaCl2 + NaOH			
Customer Info:	Las Virgenes Pure Water			
Plant Flow Rate =	4167	gpm	6,000,000 gal/day	
TDS =	27	mg/L	0.00068	mol/L, Ionic Strength
pH =	5.30	field pH is recommended		
Total Alkalinity =	8.0	mg/L as $CaCO_3$	0.16 meq/L	
Calcium (Total) =	0.7	mg/L Ca^{2+}	1.75	mg/L as $CaCO_3$
Water Temperature =	25.0	°C (temp. at which pH was analyzed)		
Field Water Temperature =	25.0	°C (operating temperature at facility)		
Cl^- =	7.0	mg/L	9.9	mg/L as $CaCO_3$
SO_4^{2-} =	3.0	mg/L	3.1	mg/L as $CaCO_3$
Mg^{2+} =	0.4	mg/L	1.6	mg/L as $CaCO_3$

If alkalinity is unknown, then enter target DIC and click **"Find Alk"** button.

Target DIC	6.7	mg/L as C	55.8	mg/L as $CaCO_3$

Enter source water characteristics (optional)

UVA-254 =		1/cm, UV Absorption	%UVT: 100.0
DOC =		mg/L as C (Dissolved Organic Carbon)	
Raw Water Turbidity =		NTU	SUVA = -

Step 2: Initial Results (Before Chemical Addition)

Theoretical initial water characteristics, corrosion indices & metals after temperature correction.

pH =	5.30		42.2	uS/cm (Electrical Conductivity)		
Acidity =	189.3	mg/L as $CaCO_3$	0.474	mg/L, Atmospheric equilibrium $CO_{2(aq)}$	3.78 meq/L	
Carbon Dioxide (CO_2) =	79.5	mg/L as $CO_{2(aq)}$	21.7	mg/L as C, dissolved inorganic carbon	3.61 meq/L	
DIC =	197	mg/L as $CaCO_3$	23.7	mg/L as C, dissolved inorganic carbon	3.94 meq/L	

Corrosion Indices	Calcite	<Select Cystalline Form	Recommended
Aggressive Index (AI) =	6.4	Extremely aggressive conditions for asbestos cement piping	>12
Ryzner Index (RI) =	15.61	Tendency to dissolve CaCO3 (for steel piping)	6.5-7.0
Langelier Index, Calcite =	-5.16	Tendency to dissolve CaCO3 (for steel and cast iron piping)	>0
CCPP =	-145	mg/L as $CaCO_3$, Calcium Carbonate Precipitation Potential	4-10 mg/L
$B_{H20} + B_{CO3}$ =	0.36	mM/pH, Buffer intensity from water and carbonate species	
$(Cl^- + SO_4^{2-})$/Alk =	1.6	Larson's Ratio for steel and cast iron piping	< 5.0

Select water temp. for Pb & Cu and select copper solid(s) for calculations

● Field Temperature ○ Temperature @ 25C ☑ Cupric Hydroxide ☐ Malachite ☐ Tenorite ☑ Cupric Phosphate

Copper II at Field Temp. =	N/A	Value not available		
Lead II at Field Temp. =	12.7	mg/L as lead II at dissolution; Lead Carbonate (cerussite)	CSMR:	2.33
pH_{25} =	5.30	pH of water if measured at 25°C		

Pb & Cu Guidance — Click button for Guidance on Lead & Copper Treatment Applies to data in Steps 2 or 6

Step 3: Chemical Interim Addition: Source Water Treatment

Source Water Treatment - Pre-Oxidation/ Acid/Base Addition

Sodium Hypochlorite (NaOCl)		mg/L	0.00	mg/L as $CaCO_3$
Hydrochloric Acid (HCl)		mg/L	0.00	mg/L as $CaCO_3$
Sulfuric Acid (H_2SO_4)		mg/L	0.00	mg/L as $CaCO_3$
Carbon Dioxide (CO_2) ±		mg/L	0.00	mg/L as $CaCO_3$
$Ca(OH)_2$ (100% hydrated Lime)	0.0	mg/L	0.00	mg/L as $CaCO_3$
CaO (100% Quicklime)		mg/L	0.00	mg/L as $CaCO_3$
Soda Ash (Na_2CO_3)		mg/L	0.00	mg/L as $CaCO_3$
Caustic Soda (NaOH)	0.0	mg/L	0.00	mg/L as $CaCO_3$
Sodium Bicarbonate ($NaHCO_3$)		mg/L	0.00	mg/L as $CaCO_3$

Source Water Treatment - Coagulant Addition

Primary Coagulant	Secondary Coagulant
Aluminum Sulfate*14.3H20	ACH (12.5% Al, 83% Basicity)

Aluminum Sulfate*14.3H20		mg/L	0.00	mg/L as $CaCO_3$
ACH (12.5% Al, 83% Basicity)		mg/L	0.00	mg/L as $CaCO_3$

Step 4: Interim Results (After Chemical Addition)

Theoretical interim water characteristics

pH =	5.30	pH of water after chemical addition and before release of CO_2				
Total Alkalinity =	8.0	mg/L as $CaCO_3$	0.16	meq/L		
Total Calcium =	0.7	mg/L Ca^{2+}	1.7	mg/L as $CaCO_3$		
Acidity =	189.3	mg/L as $CaCO_3$	3.78	meq/L		
Carbon Dioxide (CO_2) =	79.5	mg/L as $CO_{2(aq)}$	21.7	mg/L as C	3.61 meq/L	
CCPP =	-145.1	mg/L as $CaCO_3$, Calcium Carbonate Precipitation Potential				

DOC Reduction after Coagulant/Acid/Base Addition

DOC =	-	mg/L as C	DOC Removed =	-	mg/L as C	
% of DOC Reduced =	-	after coagulant/acid/base treatment				
Nonsorbable DOC =	-	mg/L as C	1.4 mg TSS/NTU removed			
Aluminum Added =	0.000	mMol/L, 0.00 mg/L	$0.00	$ per million gallons		
Ferric Added =	0.000	mMol/L, 0.00 mg/L	$0.00	$ per million gallons		
Sludge Production =	0	lbs per MG	0.0 Kg/1000 m^3	0 lb/day	0 Kg/day	

Step 5: Chemical Addition: Finished Water Treatment

Soda Ash (Na_2CO_3)		mg/L	0.00	mg/L as $CaCO_3$
Potash (K_2CO_3)		mg/L	0.00	mg/L as $CaCO_3$
Caustic Soda (NaOH)	74.0	mg/L	92.59	mg/L as $CaCO_3$
Potassium Hydroxide (KOH)		mg/L	0.00	mg/L as $CaCO_3$
Sodium Bicarbonate ($NaHCO_3$)		mg/L	0.00	mg/L as $CaCO_3$
$CaCO_3$ (Limestone)		mg/L	0.00	mg/L as $CaCO_3$
$Ca(OH)_2$ (100% hydrated Lime)		mg/L	0.00	mg/L as $CaCO_3$
Calcium Chloride ($CaCl_2$)	20.0	mg/L	7.22	mg/L as Ca^{2+}
Orthophosphate as PO_4^{3-}		mg/L	0.00	mg/L as P^{3+}
Carbon Dioxide (CO_2) ±		mg/L	0.00	mg/L as $CaCO_3$

Disinfection & Fluoridation

Chlorine Gas (Cl_2)		mg/L	0.00	mg/L as $CaCO_3$
Sodium Hypochlorite (NaOCl)	0.7	mg/L	0.12	mg/L as $CaCO_3$
Calcium Hypochlorite ($Ca(OCl)_2$)		mg/L	0.00	mg/L as $CaCO_3$
Hydrofluosilicic Acid (H_2SiF_6)		mg/L	0.00	mg/L as F^-
Sodium Silicofluoride (Na_2SiF_6)		mg/L	0.00	mg/L as F^-

Step 6: Final Results (After Corrosion Control & Disinfection Treatment)

						Recommended
pH =	8.67	pH of water after chemical addition and before release of CO_2				6.8-8.0 or 8.5-9.3
Total Alkalinity =	100.7	mg/L as $CaCO_3$	2.01	meq/L		
Total Calcium =	7.9	mg/L Ca^{2+}	19.8	mg/L as $CaCO_3$		**After precipitation**
Acidity =	96.6	mg/L as $CaCO_3$	1.93	meq/L		pH = 8.44 unit
Carbon Dioxide (CO_2) =	0.4	mg/L as $CO_{2(aq)}$	0.11	mg/L as C	0.02 meq/L	Alk = 98.1 mg/L
DIC =	197	mg/L as $CaCO_3$	23.7	mg/L C, DIC	3.94 meq/L	CO_2 = 0.66 aq, mg/L

Corrosion Indices			Recommended
Aggressive Index (AI) =	11.9	Moderately aggressive conditions for asbestos cement piping	>12
Ryzner Index (RI) =	8.09	Tendency to dissolve CaCO3 (for steel piping)	6.5-7.0
Langelier Index, Calcite =	0.29	Tendency for deposition of CaCO3 (for steel and cast iron piping)	>0
CCPP =	2.65	mg/L as $CaCO_3$, Calcium Carbonate Precipitation Potential	4-10 mg/L
$B_{H20} + B_{CO3} + B_{PO4}$ =	0.133	mM/pH, Buffer intensity from water, carbonate, and PO_4 species	
$(Cl^- + SO_4^{2-})$/Alk =	0.31	Larson's Ratio for steel and cast iron piping	< 5.0

Copper II at Field Temp. =	0.05	mg/L as copper II at dissolution; Cupric Hydroxide, light blue/blue-green		
Lead II at 25C =	0.172	mg/L as lead II at dissolution; Basic Lead Carbonate (hydrocerussite)	CSMR:	6.70
pH_{25} =	8.67	pH of water if measured at 25°C		

Water!Pro™

Treating Drinking Water

Step 1: Initial Water Characteristics

Enter source water characteristics.

Save Steps 1, 3 & 5 Data | Retrieve Steps 1, 3 & 5 Data

Client ID:	Lime		
Customer Info:	Las Virgenes Pure Water		
Plant Flow Rate =	4167	gpm	6,000,000 gal/day
TDS =	27	mg/L	0.00068 mol/L, Ionic Strength
pH =	5.30	field pH is recommended	
Total Alkalinity =	8.0	mg/L as $CaCO_3$	0.16 meq/L
Calcium (Total) =	0.7	mg/L Ca^{2+}	1.75 mg/L as $CaCO_3$
Water Temperature =	25.0	^oC (temp. at which pH was analyzed)	
Field Water Temperature =	25.0	^oC (operating temperature at facility)	
Cl^- =	7.0	mg/L	9.9 mg/L as $CaCO_3$
SO_4^{2-} =	3.0	mg/L	3.1 mg/L as $CaCO_3$
Mg^{2+} =	0.4	mg/L	1.6 mg/L as $CaCO_3$

If alkalinity is unknown, then enter target DIC and click **"Find Alk"** button.

Target DIC	6.7	mg/L as C	55.8 mg/L as $CaCO_3$

Enter source water characteristics (optional)

UVA-254 =		1/cm, UV Absorption	%UVT: 100.0
DOC =		mg/L as C (Dissolved Organic Carbon)	
Raw Water Turbidity =		NTU	SUVA = -

Step 2: Initial Results (Before Chemical Addition)

Theoretical initial water characteristics, corrosion indices & metals after temperature correction.

pH =	5.30		42.2	uS/cm (Electrical Conductivity)	
Acidity =	189.3	mg/L as $CaCO_3$	0.474	mg/L, Atmospheric equilibrium $CO_{2(aq)}$	3.78 meq/L
Carbon Dioxide (CO_2) =	79.5	mg/L as $CO_{2(aq)}$	21.7	mg/L as C, dissolved inorganic carbon	3.61 meq/L
DIC =	197	mg/L as $CaCO_3$	23.7	mg/L as C, dissolved inorganic carbon	3.94 meq/L

Corrosion Indices	Calcite	<Select Cystalline Form	Recommended
Aggressive Index (AI) =	6.4	Extremely aggressive conditions for asbestos cement piping	>12
Ryznar Index (RI) =	15.61	Tendency to dissolve CaCO3 (for steel piping)	6.5-7.0
Langelier Index, Calcite =	-5.16	Tendency to dissolve CaCO3 (for steel and cast iron piping)	>0
CCPP =	-145	mg/L as $CaCO_3$, Calcium Carbonate Precipitation Potential	4-10 mg/L
$B_{H20} + B_{CO3}$ =	0.36	mM/pH, Buffer intensity from water and carbonate species	
$(Cl^- + SO_4^{2-})$/Alk =	1.6	Larson's Ratio for steel and cast iron piping	< 5.0

Select water temp. for Pb & Cu and select copper solid(s) for calculations

● Field Temperature | ○ Temperature @ 25C | ☑ Cupric Hydroxide | ☐ Malachite | ☐ Tenorite | ☑ Cupric Phosphate

Copper II at Field Temp. =	N/A	Value not available		
Lead II at Field Temp. =	12.7	mg/L as lead II at dissolution; Lead Carbonate (cerussite)	CSMR:	2.33
pH_{25} =	5.30	pH of water if measured at 25^oC		

Pb & Cu Guidance — **Click button for Guidance on Lead & Copper Treatment Applies to data in Steps 2 or 6**

Step 3: Chemical Interim Addition: Source Water Treatment

Source Water Treatment - Pre-Oxidation/ Acid/Base Addition

Sodium Hypochlorite (NaOCl)		mg/L	0.00	mg/L as $CaCO_3$
Hydrochloric Acid (HCl)		mg/L	0.00	mg/L as $CaCO_3$
Sulfuric Acid (H_2SO_4)		mg/L	0.00	mg/L as $CaCO_3$
Carbon Dioxide (CO_2) ±		mg/L	0.00	mg/L as $CaCO_3$
$Ca(OH)_2$ (100% hydrated Lime)	0.0	mg/L	0.00	mg/L as $CaCO_3$
CaO (100% Quicklime)		mg/L	0.00	mg/L as $CaCO_3$
Soda Ash (Na_2CO_3)		mg/L	0.00	mg/L as $CaCO_3$
Caustic Soda (NaOH)	0.0	mg/L	0.00	mg/L as $CaCO_3$
Sodium Bicarbonate ($NaHCO_3$)		mg/L	0.00	mg/L as $CaCO_3$

Source Water Treatment - Coagulant Addition

Primary Coagulant	Secondary Coagulant
Aluminum Sulfate*14.3H20	ACH (12.5% Al, 83% Basicity)

Aluminum Sulfate*14.3H20		mg/L	0.00	mg/L as $CaCO_3$
ACH (12.5% Al, 83% Basicity)		mg/L	0.00	mg/L as $CaCO_3$

Step 4: Interim Results (After Chemical Addition)

Theoretical interim water characteristics

pH =	5.30	pH of water after chemical addition and before release of CO_2			
Total Alkalinity =	8.0	mg/L as $CaCO_3$	0.16	meq/L	
Total Calcium =	0.7	mg/L Ca^{2+}	1.7	mg/L as $CaCO_3$	
Acidity =	189.3	mg/L as $CaCO_3$	3.78	meq/L	
Carbon Dioxide (CO_2) =	79.5	mg/L as $CO_{2(aq)}$	21.7	mg/L as C	3.61 meq/L
CCPP =	-133.7	mg/L as $CaCO_3$, Calcium Carbonate Precipitation Potential			

DOC Reduction after Coagulant/Acid/Base Addition

DOC =	-	mg/L as C	DOC Removed =	-	mg/L as C
% of DOC Reduced =	-	after coagulant/acid/base treatment			
Nonsorbable DOC =	-	mg/L as C	1.4 mg TSS/NTU removed		
Aluminum Added =	0.000	mMol/L, 0.00 mg/L	$0.00	$ per million gallons	
Ferric Added =	0.000	mMol/L, 0.00 mg/L	$0.00	$ per million gallons	
Sludge Production =	0	lbs per MG	0.0 Kg/1000 m^3	0 lb/day	0 Kg/day

Step 5: Chemical Addition: Finished Water Treatment

Soda Ash (Na_2CO_3)		mg/L	0.00	mg/L as $CaCO_3$
Potash (K_2CO_3)		mg/L	0.00	mg/L as $CaCO_3$
Caustic Soda (NaOH)	0.0	mg/L	0.00	mg/L as $CaCO_3$
Potassium Hydroxide (KOH)		mg/L	0.00	mg/L as $CaCO_3$
Sodium Bicarbonate ($NaHCO_3$)		mg/L	0.00	mg/L as $CaCO_3$
$CaCO_3$ (Limestone)		mg/L	0.00	mg/L as $CaCO_3$
$Ca(OH)_2$ (100% hydrated Lime)	66.0	mg/L	89.20	mg/L as $CaCO_3$
Calcium Chloride ($CaCl_2$)		mg/L	0.00	mg/L as Ca^{2+}
Orthophosphate as PO_4^{3-}		mg/L	0.00	mg/L as P^{3+}
Carbon Dioxide (CO_2) ±		mg/L	0.00	mg/L as $CaCO_3$

Disinfection & Fluoridation

Chlorine Gas (Cl_2)		mg/L	0.00	mg/L as $CaCO_3$
Sodium Hypochlorite (NaOCl)	0.7	mg/L	0.20	mg/L as $CaCO_3$
Calcium Hypochlorite ($Ca(OCl)_2$)		mg/L	0.00	mg/L as $CaCO_3$
Hydrofluosilicic Acid (H_2SiF_6)		mg/L	0.00	mg/L as F^-
Sodium Silicofluoride (Na_2SiF_6)		mg/L	0.00	mg/L as F^-

Step 6: Final Results (After Corrosion Control & Disinfection Treatment)

						Recommended
pH =	8.05	pH of water after chemical addition and before release of CO_2				6.8-8.0 or 8.5-9.3
Total Alkalinity =	97.4	mg/L as $CaCO_3$	1.95	meq/L		
Total Calcium =	36.4	mg/L Ca^{2+}	91.0	mg/L as $CaCO_3$		**After precipitation**
Acidity =	99.9	mg/L as $CaCO_3$	2.00	meq/L		pH = 7.73 unit
Carbon Dioxide (CO_2) =	1.63	mg/L as $CO_{2(aq)}$	0.44	mg/L as C	0.07 meq/L	Alk = 92.9 mg/L
DIC =	197	mg/L as $CaCO_3$	23.7	mg/L C, DIC	3.94 meq/L	CO_2 = 3.32 aq, mg/L

Corrosion Indices			Recommended
Aggressive Index (AI) =	12.0	Moderately aggressive conditions for asbestos cement piping	>12
Ryznar Index (RI) =	7.34	Tendency to dissolve CaCO3 (for steel piping)	6.5-7.0
Langelier Index, Calcite =	0.36	Tendency for deposition of CaCO3 (for steel and cast iron piping)	>0
CCPP =	4.50	mg/L as $CaCO_3$, Calcium Carbonate Precipitation Potential	4-10 mg/L
$B_{H20} + B_{CO3} + B_{PO4}$ =	0.111	mM/pH, Buffer intensity from water, carbonate, and PO_4 species	
$(Cl^- + SO_4^{2-})$/Alk =	0.13	Larson's Ratio for steel and cast iron piping	< 5.0

Copper II at Field Temp. =	0.17	mg/L as copper II at dissolution; Cupric Hydroxide, light blue/blue-green		
Lead II at Field Temp. =	0.22	mg/L as lead II at dissolution; Lead Carbonate (cerussite)	CSMR:	2.44
pH_{25} =	8.05	pH of water if measured at 25^oC		

Appendix B.6
ROC Stabilization WaterPro Calculations

Water!Pro™

Treating Drinking Water

Step 1: Initial Water Characteristics

Enter source water characteristics.

Save Steps 1, 3 & 5 Data | Retrieve Steps 1, 3 & 5 Data

Client ID:			
Customer Info:	LVT Demo ROC		
Plant Flow Rate =	1	gpm	1,440 gal/day
TDS =	5706	mg/L	0.14265 mol/L, Ionic Strength
pH =	7.30	field pH is recommended	
Total Alkalinity =	827.0	mg/L as $CaCO_3$	16.53 meq/L
Calcium (Total) =	444.0	mg/L Ca^{2+}	1108.83 mg/L as $CaCO_3$
Water Temperature =	26.0	°C (temp. at which pH was analyzed)	
Field Water Temperature =	26.0	°C (operating temperature at facility)	
Cl^- =	1108.0	mg/L	1564.0 mg/L as $CaCO_3$
SO_4^{2-} =	2059.0	mg/L	2145.4 mg/L as $CaCO_3$
Mg^{2+} =	212.0	mg/L	873.0 mg/L as $CaCO_3$

If alkalinity is unknown, then enter target DIC and click **"Find Alk"** button.

Target DIC	215.0	mg/L as C	1791.6 mg/L as $CaCO_3$

Enter source water characteristics (optional)

UVA-254 =		1/cm, UV Absorption %UVT: 100.0
DOC =		mg/L as C (Dissolved Organic Carbon)
Raw Water Turbidity =		NTU SUVA = -

Step 2: Initial Results (Before Chemical Addition)

Theoretical initial water characteristics, corrosion indices & metals after temperature correction.

pH =	7.30		8915.6	uS/cm (Electrical Conductivity)	
Acidity =	964	mg/L as $CaCO_3$	0.461	mg/L, Atmospheric equilibrium $CO_{2(aq)}$	19.26 meq/L
Carbon Dioxide (CO_2) =	61.8	mg/L as $CO_{2(aq)}$	16.9	mg/L as C, dissolved inorganic carbon	2.81 meq/L
DIC =	1,791	mg/L as $CaCO_3$	215	mg/L as C, dissolved inorganic carbon	35.79 meq/L

Corrosion Indices	Calcite	<Select Cystalline Form	Recommended
Aggressive Index (AI) =	13.1	Non-aggressive water for asbestos cement piping	>12
Ryznar Index (RI) =	5.33	Tendency for deposition of CaCO3 (for steel piping)	6.5-7.0
Langelier Index, Calcite =	0.99	Tendency for deposition of CaCO3 (for steel and cast iron piping)	>0
CCPP =	276	mg/L as $CaCO_3$, Calcium Carbonate Precipitation Potential	4-10 mg/L
$B_{H2O} + B_{CO3}$ =	3.05	mM/pH, Buffer intensity from water and carbonate species	
$(Cl^- + SO_4^{2-})$/Alk =	4.5	Larson's Ratio for steel and cast iron piping	< 5.0

Select water temp. for Pb & Cu and select copper solid(s) for calculations

(●) Field Temperature ( ) Temperature @ 25C ☑ Cupric Hydroxide ☐ Malachite ☐ Tenorite ☑ Cupric Phosphate

Copper II at Field Temp. =	6.16	mg/L as copper II at dissolution; Cupric Hydroxide, light blue/blue-green
Lead II at Field Temp. =	0.206	mg/L as lead II at dissolution; Lead Carbonate (cerussite) CSMR: 0.54
pH_{25} =	7.31	pH of water if measured at 25°C

Pb & Cu Guidance — **Click button for Guidance on Lead & Copper Treatment**
Applies to data in Steps 2 or 6

Step 3: Chemical Interim Addition: Source Water Treatment

Source Water Treatment - Pre-Oxidation/ Acid/Base Addition

Sodium Hypochlorite (NaOCl)		mg/L	0.00	mg/L as $CaCO_3$
Hydrochloric Acid (HCl)		mg/L	0.00	mg/L as $CaCO_3$
Sulfuric Acid (H_2SO_4)	350.0	mg/L	357.19	mg/L as $CaCO_3$
Carbon Dioxide (CO_2) ±		mg/L	0.00	mg/L as $CaCO_3$
$Ca(OH)_2$ (100% hydrated Lime)		mg/L	0.00	mg/L as $CaCO_3$
CaO (100% Quicklime)		mg/L	0.00	mg/L as $CaCO_3$
Soda Ash (Na_2CO_3)		mg/L	0.00	mg/L as $CaCO_3$
Caustic Soda (NaOH)		mg/L	0.00	mg/L as $CaCO_3$
Sodium Bicarbonate ($NaHCO_3$)		mg/L	0.00	mg/L as $CaCO_3$

Source Water Treatment - Coagulant Addition

Primary Coagulant	Secondary Coagulant
Aluminum Sulfate*14.3H20	ACH (12.5% Al, 83% Basicity)

Aluminum Sulfate*14.3H20		mg/L	0.00	mg/L as $CaCO_3$
ACH (12.5% Al, 83% Basicity)		mg/L	0.00	mg/L as $CaCO_3$

Step 4: Interim Results (After Chemical Addition)

Theoretical interim water characteristics

pH =	6.27	pH of water after chemical addition and before release of CO_2			
Total Alkalinity =	469.8	mg/L as $CaCO_3$	9.39	meq/L	
Total Calcium =	444.0	mg/L Ca^{2+}	1108.8	mg/L as $CaCO_3$	
Acidity =	1,321.2	mg/L as $CaCO_3$	26.40	meq/L	
Carbon Dioxide (CO_2) =	374	mg/L as $CO_{2(aq)}$	102	mg/L as C	17.00 meq/L
CCPP =	-98.8	mg/L as $CaCO_3$, Calcium Carbonate Precipitation Potential			

DOC Reduction after Coagulant/Acid/Base Addition

DOC =	-	mg/L as C	DOC Removed = -	mg/L as C
% of DOC Reduced =	-	after coagulant/acid/base treatment		
Nonsorbable DOC =	-	mg/L as C	1.4 mg TSS/NTU removed	
Aluminum Added =	0.000	mMol/L, 0.00 mg/L	\$0.00	\$ per million gallons
Ferric Added =	0.000	mMol/L, 0.00 mg/L	\$0.00	\$ per million gallons
Sludge Production =	0	lbs per MG	0.0 Kg/1000 m^3	0 lb/day 0 Kg/day

Step 5: Chemical Addition: Finished Water Treatment

Soda Ash (Na_2CO_3)		mg/L	0.00	mg/L as $CaCO_3$
Potash (K_2CO_3)		mg/L	0.00	mg/L as $CaCO_3$
Caustic Soda (NaOH)		mg/L	0.00	mg/L as $CaCO_3$
Potassium Hydroxide (KOH)		mg/L	0.00	mg/L as $CaCO_3$
Sodium Bicarbonate ($NaHCO_3$)		mg/L	0.00	mg/L as $CaCO_3$
$CaCO_3$ (Limestone)		mg/L	0.00	mg/L as $CaCO_3$
$Ca(OH)_2$ (100% hydrated Lime)		mg/L	0.00	mg/L as $CaCO_3$
Calcium Chloride ($CaCl_2$)		mg/L	0.00	mg/L as Ca^{2+}
Orthophosphate as PO_4^{3-}		mg/L	0.00	mg/L as P^{3+}
Carbon Dioxide (CO_2) ±		mg/L	0.00	mg/L as $CaCO_3$

Disinfection & Fluoridation

Chlorine Gas (Cl_2)		mg/L	0.00	mg/L as $CaCO_3$
Sodium Hypochlorite (NaOCl)		mg/L	0.00	mg/L as $CaCO_3$
Calcium Hypochlorite ($Ca(OCl)_2$)		mg/L	0.00	mg/L as $CaCO_3$
Hydrofluosilicic Acid (H_2SiF_6)		mg/L	0.00	mg/L as F^-
Sodium Silicofluoride (Na_2SiF_6)		mg/L	0.00	mg/L as F^-

Step 6: Final Results (After Corrosion Control & Disinfection Treatment)

						Recommended
pH =	6.27	pH of water after chemical addition and before release of CO_2				6.8-8.0 or 8.5-9.3
Total Alkalinity =	469.8	mg/L as $CaCO_3$	9.39	meq/L		
Total Calcium =	444.0	mg/L Ca^{2+}	1108.8	mg/L as $CaCO_3$		**After precipitation**
Acidity =	1,321.2	mg/L as $CaCO_3$	26.40	meq/L		pH = - unit
Carbon Dioxide (CO_2) =	374	mg/L as $CO_{2(aq)}$	102	mg/L as C	17.00 meq/L	Alk = - mg/L
DIC =	1,791	mg/L as $CaCO_3$	215	mg/L C, DIC	35.79 meq/L	CO_2 = - aq, mg/L

Corrosion Indices			Recommended
Aggressive Index (AI) =	11.8	Moderately aggressive conditions for asbestos cement piping	>12
Ryznar Index (RI) =	6.85	Approximately at CaCO3 saturation	6.5-7.0
Langelier Index, Calcite =	-0.29	Tendency to dissolve CaCO3 (for steel and cast iron piping)	>0
CCPP =	-98.8	mg/L as $CaCO_3$, Calcium Carbonate Precipitation Potential	4-10 mg/L
$B_{H2O} + B_{CO3} + B_{PO4}$ =	10.3	mM/pH, Buffer intensity from water, carbonate, and PO_4 species	
$(Cl^- + SO_4^{2-})$/Alk =	7.90	Larson's Ratio for steel and cast iron piping	< 5.0
Copper II at Field Temp. =	56.20	mg/L as copper II at dissolution; Cupric Hydroxide, light blue/blue-green	
Lead II at Field Temp. =	0.383	mg/L as lead II at dissolution; Lead Carbonate (cerussite)	CSMR: 0.46
pH_{25} =	6.28	pH of water if measured at 25°C	

Appendix B.7
Electrical Load Summary Table

Pure Water Project Las Virgenes - Triunfo
Planning Phase - Advanced Water Purification Facility Electrical Loads
Conceptual Design Update

Scenario	Scenario - Startup, 2,100 AF/YR production					Scenario - Full Capacity at 7.5 mgd, 6,700 AF/YR production				
Model Name	**Total Equipment HP**	**Annual Equipment Power (kWh)**	**Total Building Area (SF)**	**Annual Building Power (kWh)**	**Total Annual Usage (kWh)**	**Total Equipment HP**	**Annual Equipment Power (kWh)**	**Total Building Area (SF)**	**Annual Building Power (kWh)**	**Total Annual Usage (kWh)**
MF-UF	580	1,296,399			1,296,399	580	1,894,377			1,894,377
RO	1,584	3,543,566			3,543,566	1,584	5,173,609			5,173,609
UV AOP	369	825,490			825,490	369	1,205,216			1,205,216
Vertical Turbine PS: FWPS	300	671,130			671,130	300	979,850			979,850
Liquid Chemical: CL2	6	13,423			13,423	6	19,597			19,597
Liquid Chemical: NH3	2	4,474			4,474	2	6,532			6,532
Liquid Chemical: Sulfuric	5	11,186			11,186	5	16,331			16,331
Recarbonation: CO2	20	44,742			44,742	20	65,323			65,323
Liquid Chemical: LiqLime	15	33,557			33,557	15	48,993			48,993
Liquid Chemical: NaOH	4	8,948			8,948	4	13,065			13,065
Liquid Chemical: SBS	2	4,474			4,474	2	6,532			6,532
Liquid Chemical: Alum	2	4,474			4,474	2	6,532			6,532
Waste EQ pumps	5	11,186			11,186	5	16331			16,331
BUILDING LOADS										
Process Area			21,600	189,216	189,216			21,600	189,216	189,216
OM Building: O_M			2,000	18,442	18,442			2,000	18,442	18,442
OM Building: Admin			3,800	35,040	35,040			3,800	35,040	35,040
Chemical Storage Area			4,250	37,230	37,230			4,250	37,230	37,230

SUBTOTAL	2,894	6,473,049	31,650	279,928	6,752,977	2,894	9,452,287	31,650	279,928	9,732,215
Contingency - for Planning					25%					25%
Total					8,441,221					12,165,269

Emergency Generator:	160 HP		2,814 kW		4,055 kW
Critical Process Loads:	119 KW	Facility Demand	2.8 MW		4.1 MW

PURE WATER PROJECT
LAS VIRGENES-TRIUNFO
Bringing Our Water Full Circle

Appendix C

Appendix C
Cost Estimate Detail

Advanced Water Purification Facility Construction Cost Estimate			
Process Facility	**Description**	**Factor**	**Cost**
Microfiltration System	Influent Pump Station		$ 1,350,000
	Microfiltration Membranes		$ 10,000,000
	Backwash Equalization		$ 2,000,000
Reverse Osmosis System	Booster Pump Station		$ 3,380,000
	Reverse Osmosis Membranes		$ 13,570,000
	Concentrate pump station		$ 2,370,000
UV Disinfection	UV System		$ 4,630,000
Chemicals	Sodium Hypochlorite		$ 450,000
	Liquid Ammonia Sulfate		$ 370,000
	Sulfuric Acid		$ 290,000
	Sodium Bisulfite		$ 190,000
	Liquid Lime		$ 500,000
	Alum		$ 160,000
	Sodium Hydroxide		$ 330,000
	Citric Acid		$ 360,000
Finished Water	Decarbonator		$ 1,110,000
	Pump Station		$ 4,630,000
Non-Process Building	Administration		$ 2,920,000
	Operations and Maintenance		$ 3,850,000
Standby Generator			$ 240,000
Subtotal-Project Cost			**$ 52,700,000**
Additional Project Costs			
Overall Sitework		6%	$ 3,170,000
Plant Control System		5%	$ 2,640,000
Yard Electrical		9%	$ 4,750,000
Yard Piping		8%	$ 4,220,000
Subtotal-With Additional Project Costs			**$ 67,480,000**
Tax		9%	$ 3,643,920
Subtotal			$ 71,123,920
Contractor Markups			
Overhead		10%	$ 7,120,000
Subtotal			$ 78,243,920
Profit		10%	$ 7,830,000
Subtotal			$ 86,073,920
Mobilization/Bonds/Insurance		6%	$ 5,170,000
Subtotal			$ 91,243,920
Contingency		30%	$ 27,380,000
Subtotal			**$ 118,623,920**
Location Adjustment Factor		112.3	
TOTAL			**$ 133,214,662**