Woodard & Curran

Purified Water Feasibility Study

FINAL

AUGUST

2023

ACWD
ALAMEDA COUNTY WATER DISTRICT

San Francisco
Water Power Sewer

USD
TREAT
PROTECT
PRESERVE
est.1918
TRI-CITY WASTEWATER

Woodard & Curran in partnership with Trussell Technologies and Limnotech

PURIFIED WATER FEASIBILITY STUDY

Final

Woodard & Curran

Trussell

In Partnership with Limnotech

No. 0011242

Alameda County Water District

San Francisco Public Utilities Commission

Union Sanitary District

2175 N California Blvd | Suite 315
Walnut Creek, California 94596
925.627.4100

August 2023

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LIST OF ABBREVIATIONS

ACWD	Alameda County Water District
ACFC&WCD	Alameda County Flood Control and Water Conservation District
AF	acre-foot
AFY	acre-feet per year
AMEL	Average monthly Effluent Limitation
AOP	advanced oxidation process
ARP	Aquifer Reclamation Program
AWPF	advanced water purification facility
BAC	biological activated carbon
BAF	biologically active filtration
BARR	Bay Area Regional Reliability
BNR	Biological Nitrogen Removal
CalAm	California American Water Company
CAS	conventional activated sludge
CBOD	Carbonaceous Biochemical Oxygen Demand
CCI	construction cost indices
CEQA	California Environmental Quality Act
CIP	Clean In Place
CPUC	California Public Utilities Commission
CTR	California Toxics Rule
DDW	Division of Drinking Water
DMBI	Demonstration Mid-Basin Injection
DPR	direct potable reuse
DWTP	Drinking Water Treatment Plant
EBDA	East Bay Dischargers Authority
EBRPD	East Bay Regional Park District
EFM	Enhanced Flux Maintenance
ENR	Engineering News Record
EQ	equalization
ETSU	Enhanced Treatment and Site Upgrade
FAT	full advanced treatment
gfd	gallons per square foot per day
gpm	Gallons per minute
GWR	groundwater recharge
GWRS	Groundwater Replenishment System
HTWTP	Harry Tracy Water Treatment Plant
IPR	Indirect Potable Reuse
K-M-M-L Basins	Kraemer-Miller-Moralina-La Palma Basins
LACSD	Los Angeles County Sanitation District
LOX	liquid oxygen
LRVs	log reduction values

M1W	Monterey One Water
MCC	motor control center
MDEL	Maximum Daily Effluent Limitation
MDL	method detecting limit
MF	microfiltration
MGD	million gallons per day
MJBSP	Manual J. Bernardo Softening Plant
ML	minimum level
MPWMD	Monterey Peninsula Water Management District
MRL	method reporting limit
MSJWTP	Mission San Jose Water Treatment Plant
NCPWF	North City Pure Water Facility
NCWRP	North City Water Reclamation Plant
NDF	Newark Desalination Facility
NDMA	Nitrosodimethylamine
NDN	nitrification/ denitrification
NEPA	National Environmental Policy Act
North City Project	North City Pure Water Project
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OCSD	Orange County Sanitation District
OCWD	Orange County Water District
PDR	Preliminary Design Report
PFOA	perfluorooctanoate
PFOS	perfluorooctane sulfonate
POTWs	publicly owned treatment works
PT	Peralta-Tyson
PT GW Facility	Peralta-Tyson Groundwater Facility
PWM/ GWR	Pure Water Monterey Groundwater Replenishment Project
RL	reporting limit
RO	reverse osmosis
ROWD	Report of Waste Discharge
RTP	Regional Treatment Plant
RWA	raw water augmentation
RWQCB	Regional Water Quality Control Board
RWS	Regional Water System
SAT	soil aquifer treatment
SFPUC	San Francisco Public Utilities Commission
SRF	State Revolving Fund
SVWTP	Sunol Valley Water Treatment Plant
SWA	surface water augmentation
SWP	State Water Project

TAF	thousand acre-feet
TAFY	thousand acre-feet per year
Talbert Barrier	Talbert Seawater Intrusion Barrier
tMBR	tertiary membrane bioreactor
TSS	Total Suspended Solids
TUc	chronic toxicity units
TWA	treated water augmentation
USD	Union Sanitary District
USEPA	United States Environmental Protection Agency
UWMP	Urban Water Management Plan
WIFIA	Water Infrastructure Finance and Innovation Act
WPCF	Water Pollution Control Facility
WQO	Water Quality Objective
WTP #2	Water Treatment Plant Number 2
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

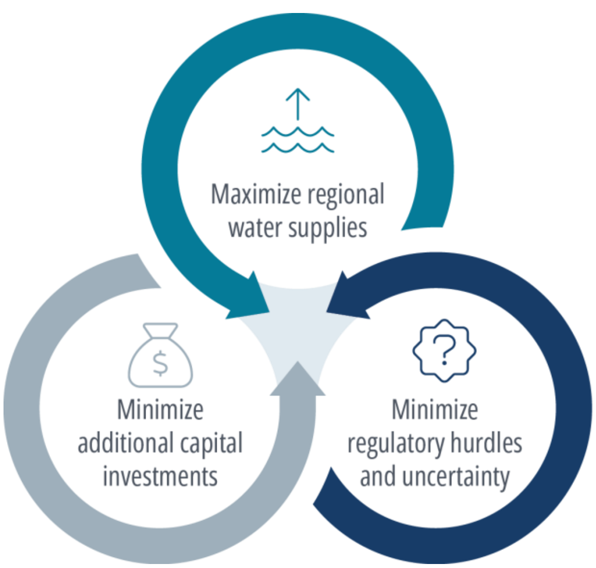
STUDY NEED AND GOALS

Alameda County Water District (ACWD), San Francisco Public Utilities Commission (SFPUC) and Union Sanitary District (USD), referred to collectively as the Partners, are jointly investigating potential potable reuse projects that would use wastewater from USD's system to provide purified water for ACWD and/or SFPUC to increase regional water supplies. The purpose of this Study was to identify and analyze potable reuse project concepts in order to provide ACWD, USD, and SFPUC with sufficient information to prioritize project alternatives and determine the next steps to continue to evaluate a purified water project and agency partnerships. The potable reuse options considered were recharge of purified water to the groundwater basin, and delivery of purified water to ACWD's Water Treatment Plant #2 (WTP #2) as a supplemental raw water supply.

MAXIMIZING USE OF EXISTING INFRASTRUCTURE

One of the underlying goals of the Study was to leverage existing Partner assets to identify alternatives that best utilize and integrate with existing infrastructure. The assets ranged from daily availability of wastewater from USD to recharge capacity of the groundwater basin managed by ACWD. The suite of assets was evaluated with balancing three pillars in mind – maximize regional water supplies; minimize regulatory hurdles and uncertainty; and minimize additional capital investments. These pillars require balance as they tend to have conflicting priorities. As an example, delivery of purified water to WTP #2, a form of direct potable reuse, may maximize regional water supplies but at the expense of regulatory certainty as there are no final regulations for direct potable reuse (anticipated at the end of 2023).

From the evaluation of Partner assets, three key elements arose as the differentiators for developing alternatives – where to connect new supplies to the ACWD water system, the volume of diurnal storage to capture wastewater flows throughout the day, and the need to maintain compliance with USD's existing wastewater discharge permit (NPDES Permit).

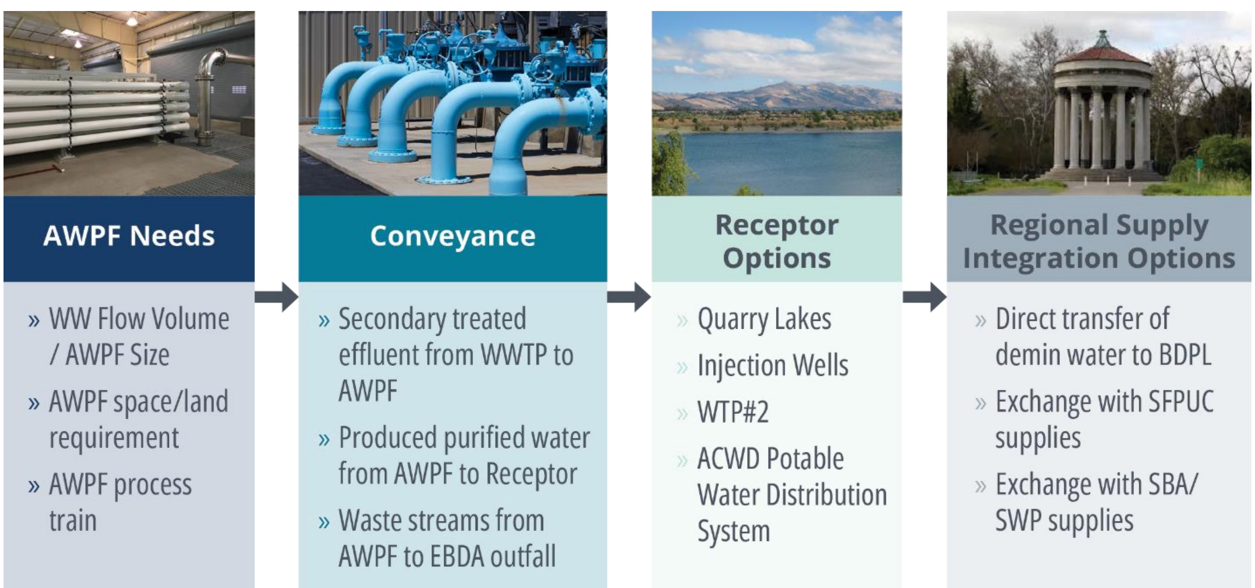


DEVELOPMENT OF ALTERNATIVES

Based on the information identified in the evaluation of Partners assets (Chapter 3) and supplemented by additional input and feedback from the Regulatory Summary (Chapter 2), Limnological Investigation (**Appendix B**) and Lessons Learned from Other Agencies (Chapter 4), preliminary concepts were developed, consisting of the following major elements:

- Advanced water purification facility (AWPF) – treatment facility to convert secondary wastewater to purified water. Facility production volume and treatment process train depends on the type of receptor selected.
- Conveyance – multiple conveyance lines are needed to bring:
    - Secondary effluent from the USD Alvarado Wastewater Treatment Plant to Advanced Water Purification Facility location
    - Purified water produced by the Advanced Water Purification Facility to the Receptor (e.g., Quarry Lakes, WTP #2)
    - Waste streams from the Advanced Water Purification Facility to disposal locations
- Receptor – locations or facilities where purified water is introduced in the ACWD water supply system.
- Regional Supply Integration Options – depending on the receptor locations within the ACWD water supply system and different purified water volumes, various options existing for expanding regional water supplies through use of purified water in the ACWD water supply system.

Figure ES-1: Preliminary Concept Elements

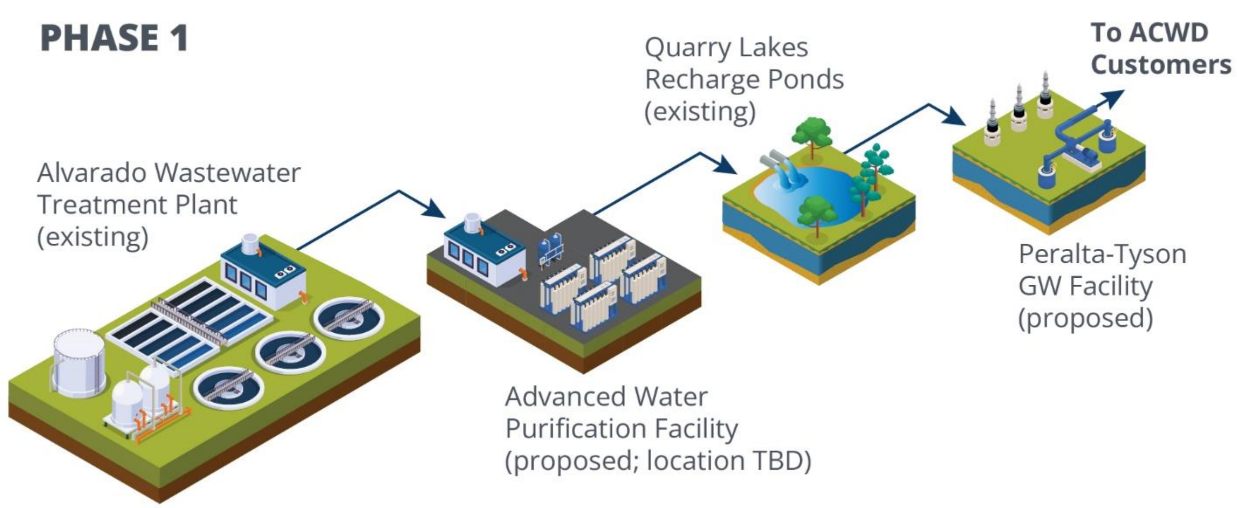


Through workshops and discussions with the Partners, alternatives were proposed and screened. A phased approach was developed that would begin with a groundwater recharge project at Quarry Lakes and then expand in the future to provide raw water augmentation to WTP #2 once regulatory requirements are better defined. This phased approach would be limited to 13 MGD of purified water to minimize wastewater equalization storage as well as minimize potential impacts to the existing NPDES discharge permit. This phased approach was carried forward as the preferred concept. Two variations to the preferred concept were considered as USD is currently assessing whether to implement all or part of the Enhanced Treatment and Site Upgrade (ETSU) Program which would provide major upgrades to the Alvarado Wastewater Treatment Plant. The impacts to secondary effluent water quality resulting from decisions around the ETSU Program are important differentiators.

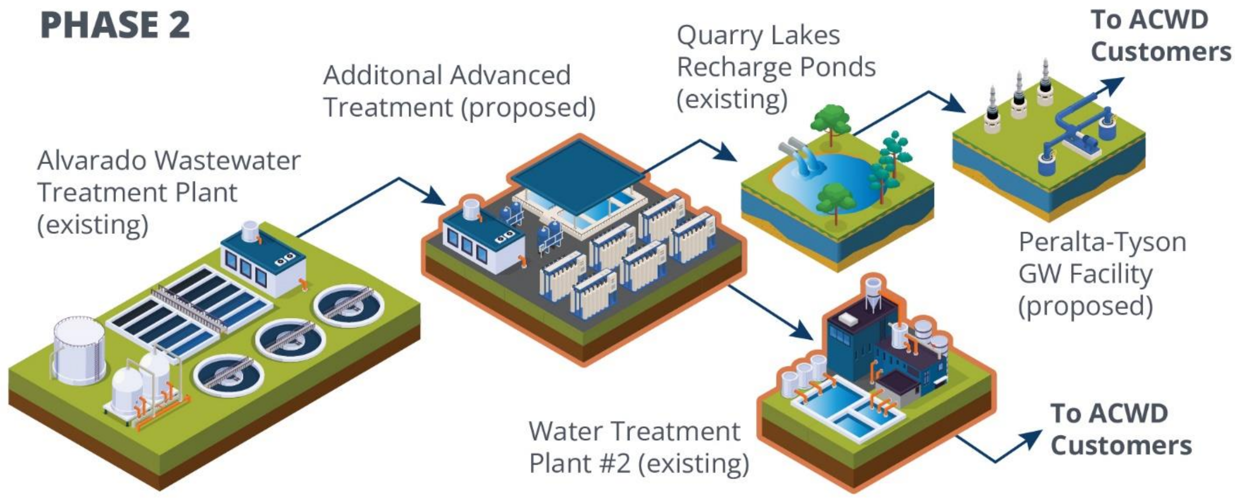
EVALUATION OF ALTERNATIVES

Alternative A is a two-phase concept that balances the needs and goals of the Partners. Alternative A assumes that USD proceeds with all Phase 1 planned treatment upgrades from the ETSU Program.

- **Alternative A, Phase 1:** In Phase 1, 9 million gallons per day (MGD) of secondary treated effluent from USD would be sent to an AWPF for treatment suitable for groundwater recharge. From the AWPF, 6.8 MGD of purified water would be sent to Quarry Lakes for recharge into the groundwater basin; the remaining balance of flows would be sent back to USD as waste streams for retreatment (membrane filtration backwash) or disposal (reverse osmosis concentrate). Waste flows would be sent back either through the existing USD collection system or via dedicated pipelines; both were investigated in this Study. In this phase, ACWD would also construct the previously planned Demineralization Plant at the Peralta-Tyson site and utilize the additional demineralized groundwater to offset SFPUC supplies which would be replaced as a result of the proposed Alternative A1. The ultimate Phase 1 yield after extraction from the basin and treatment through the proposed Peralta-Tyson Groundwater Facility would be 5.4 MGD.



- **Alternative A, Phase 2:** In Phase 2, an additional 6.5 MGD of secondary treated effluent from USD would be sent to a 1.1 million gallon (MG) equalization tank and then to an expanded AWPF for treatment suitable for augmenting raw water supplies at WTP #2. From the AWPF, 4.9 MGD of purified water would be sent to WTP #2 for additional treatment and integration into the ACWD potable distribution system. In this phase, sending purified water to WTP #2 offsets use of State Water Project supplies which would curtail ACWD's use of State Water Project supplies to allow for use by others.



Alternative B (Without ETSU Program in Place)

Alternative B assumes that USD will not be completing their Phase 1 treatment upgrades. Instead, additional treatment steps necessary to make purified water suitable for use at Quarry Lakes and Water Treatment Plant #2 are included as part of the purified water project.

The first phase of Alternative B would be similar to Alternative A except that secondary effluent from USD would be sent to a tertiary membrane bioreactor (tMBR) first before the AWPF treatment steps. The tMBR would provide some of the same polishing of the secondary effluent, specifically for nutrients, which would have occurred as part of the ETSU Program. The tMBR would be located at or adjacent to USD's Alvarado WWTP and therefore separate from the AWPF location, unless the AWPF is also located adjacent to USD's Alvarado WWTP. In the second phase the tMBR would be expanded to accept additional secondary effluent to support the additional volumes. All other aspects of Alternative B would be the same as Alternative A.

Facility Siting Assumptions

For budgeting purposes and feasibility evaluation the location of the AWPF is assumed to be at Pit #2, near Paseo Padre Parkway and the railroad tracks just south of Quarry Lakes. This site was selected for evaluation as part of this study because the land is currently owned by ACWD; a full real estate and siting assessment for the AWPF was not included in this Study and should be undertaken in a future phase of work. Pit #2 will need to be drained and filled as part of the site preparations for the AWPF; this was included on a prorated basis in the AWPF costs. For the tMBR facilities needed under Alternative B, the tMBR would be co-located at the Alvarado WWTP; the exact location at the Alvarado WWTP is to be determined in a future phase of work.

Table ES-1: Facilities Included by Alternative and by Phase and Yields

	Alternative A	Alternative B
Phase 1		
Alvarado WWTP Upgrades	ETSU Phase 1	No Upgrades
AWPF Location	Filling in Pit #2 or acquire property near USD	Filling in Pit #2 or acquire property near USD
WWTP Effluent Conveyance	From Alvarado WWTP to AWPF, upsized for future Phase 2	From Alvarado WWTP to AWPF, upsized for future Phase 2
Effluent Equalization	None	None
Additional WW Treatment prior to AWPF	None	tMBR
AWPF Processes	Membrane Filtration Reverse Osmosis Advanced Oxidation Process	Membrane Filtration Reverse Osmosis Advanced Oxidation Process
AWPF Return Flow Conveyance	RO Concentrate and other waste conveyed to EBDA/WWTP, upsized for future Phase 2	RO Concentrate and other waste conveyed to EBDA/WWTP, upsized for future Phase 2
Purified Water Conveyance	From AWPF to Quarry Lakes	From AWPF to Quarry Lakes
Purified Water Receptor	Quarry Lakes Utilize Peralta Tyson Demin Plant for Extracted Groundwater	Quarry Lakes Utilize Peralta Tyson Demin Plant for Extracted Groundwater
Phase 1 Yield	5.4 MGD (6,048 AF)	
Phase 2		
Effluent Equalization	1.1 MGD	1.1 MGD
AWPF Processes	Ozone Biological Activated Carbon Membrane Filtration Reverse Osmosis Advanced Oxidation Process	Ozone Biological Activated Carbon Membrane Filtration Reverse Osmosis Advanced Oxidation Process
AWPF Return Flow Conveyance	Added in Phase 1	Added in Phase 1
Purified Water Conveyance	From AWPF to WTP #2	From AWPF to WTP #2
Purified Water Receptor	WTP #2	WTP #2
Phase 2 Yield	4.9 MGD (5,488 AF)	
Phase 1 and Phase 2		
Phase 1 and 2 Yield	**10.3 MGD (11,536 AF)**	

325,851 gallons equals 1 acre-foot (AF)

Table ES-2: Project Cost Estimates Alternative A with Prorated Pit #2 (Phase 1 & 2) ($2022)

	Total Costs Phase 1 & 2
Total Construction	$ 429,454,000
Total Capital	$ 695,722,000
Annualized Capital	**$ 35,495,000**
Annual O&M	**$ 13,928,000**
Total Annual Cost	**$ 49,423,000**
Average Yield (AFY)	11,536
Capital Unit Cost ($/AF)	$3,080
O&M Unit Cost ($/AF)	$1,210
Unit Cost ($/AF)	**$4,280**

1. *Total capital cost is annualized assuming 3% interest over a 30-year period.*
2. *The total costs cover all new costs associated with the new water supplies from Phase 1 & 2. Because these supplies would replace existing supplies, the additional costs paid for treatment and distribution of existing supplies (e.g. at WTP #2) are not included herein.*

KEY RECOMMENDED NEXT STEPS

Further investigations would be required to verify that the assumptions made for the Project are reasonable. Listed are some of the key recommended next steps that have been identified to move forward with the Project; Chapter 11 includes a longer list of specific next steps that are recommended in addition to these key steps:

- Real estate investigation to identify the best location for the AWPF
- Determine ownership, financial sponsorship, and revenue allocation between Partners.
- Develop public outreach approach.
- Develop a more detailed water quality model for Quarry Lakes with extended data set.
- Monitor hourly wastewater flow for extended period to confirm projection of water usage behavior.

SPECIAL CONSIDERATIONS FOR QUARRY LAKES

One key element of recharging purified water through Quarry Lakes is understanding potential impacts to the Lakes water quality and existing uses as a recreational and habitat area. This Study included a limnological (lake science) study to start to characterize existing Quarry Lakes water quality and the effect of addition of purified water.

Limnological Study Results

- Purified water would improve water quality in Quarry Lakes
- Short - and long-term water quality monitoring plans developed
- Monitoring plans will help gather new water quality data for Quarry Lakes, including understanding blue-green algae issues

Next Steps

- Complete a more detailed model as additional water quality data is gathered
- Continue to implement short-term water quality monitoring plan
- Implement long-term water quality monitoring plan

1. INTRODUCTION AND BACKGROUND

1.1 Introduction

Alameda County Water District (ACWD), San Francisco Public Utilities Commission (SFPUC) and Union Sanitary District (USD), referred to collectively as the Partners, desire to investigate potential potable reuse projects that would utilize wastewater from USD's system to provide purified water for ACWD and/or SFPUC. The purpose of this Study is to identify and analyze potable reuse project concepts in order to provide ACWD, USD, and SFPUC with sufficient information to prioritize project alternatives and determine the next steps to continue to evaluate a purified water project and agency partnerships.

This Study builds off of previous studies undertaken by ACWD and USD to evaluate the possibility of producing recycled water. From 1993 to 2010, the agencies evaluated non-potable reuse opportunities, however, implementation of a recycled water project was deferred due to a lack of major customers and uncertain future demands. In 2016, the agencies completed their first indirect potable reuse (IPR) study which recommended a 4 million gallons per day (MGD) IPR project that would utilize ACWD effluent for groundwater recharge through Quarry Lakes or injection wells. In 2017, the Bay Area Regional Reliability (BARR) Study introduced the concept of creating an intertie with SFPUC, thus creating an additional significant customer for purified water produced by a potable reuse. With SFPUC as a partner, this Study investigated larger volume project options to generate regional water supply.

Potable reuse projects range from IPR to direct potable reuse (DPR) with various levels of buffers between treated wastewater and the potable water system. Within DPR, raw water can be augmented with purified water prior to entering the water treatment plant (Raw Water Augmentation (RWA)) or treated water can be augmented with purified water in the distribution system (Treated Water Augmentation (TWA)). Within IPR, groundwater basins can be augmented with purified water via groundwater injection or percolation (Groundwater Recharge (GWR)), or surface water reservoirs can be augmented with purified water (Surface Water Augmentation (SWA)).

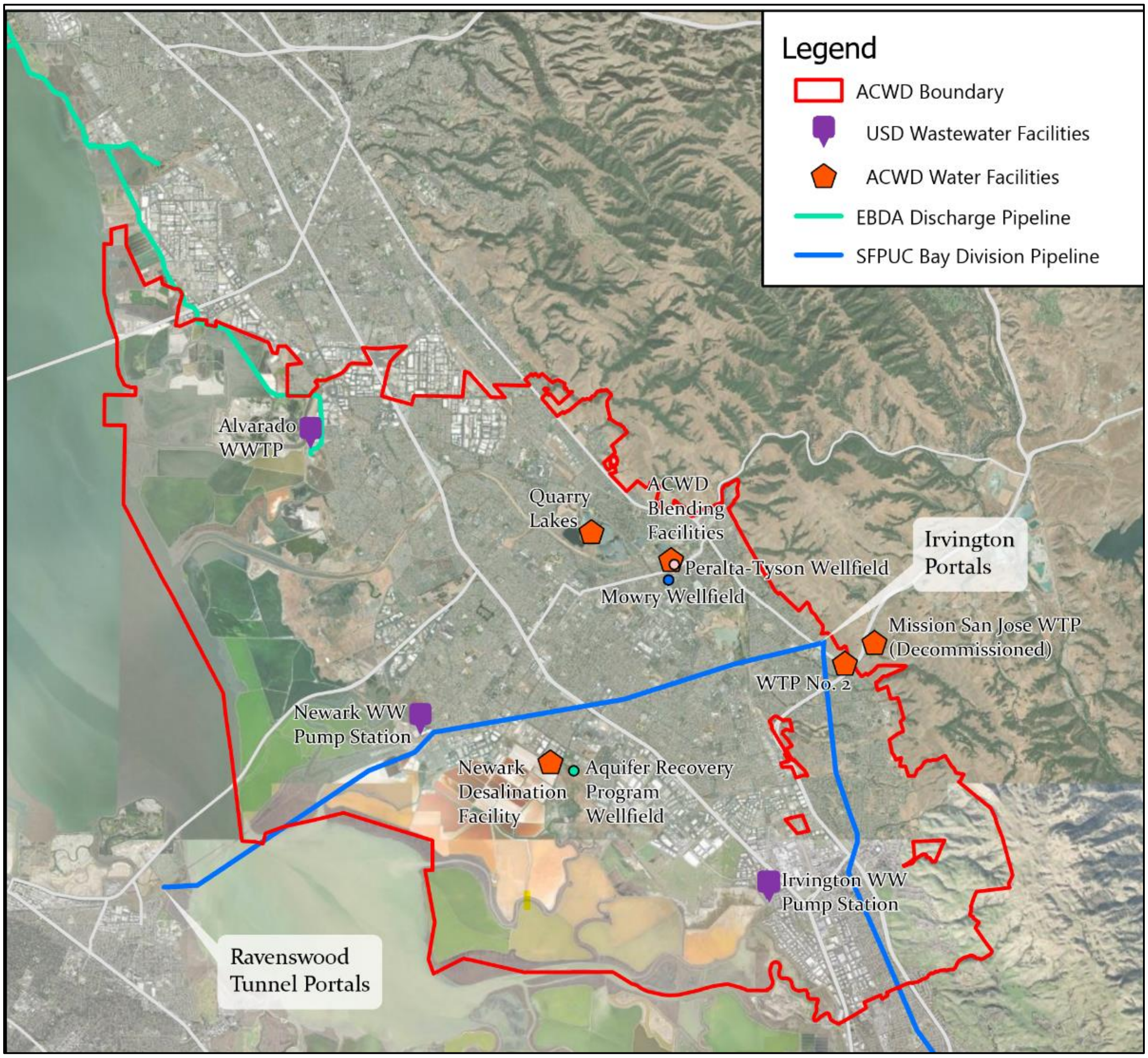
Due to the lack of appropriate surface water reservoirs in the vicinity of ACWD's service area (Figure 1-1), surface water augmentation will not be considered in this study (note the Quarry Lakes are groundwater recharge basins and not surface water reservoirs). Potable reuse options will consist of groundwater recharge, raw water augmentation, and treated drinking water augmentation.

1.2 Report Structure

The contents of this report are organized as follows:

- Chapter 2 – Regulatory Review
- Chapter 3 – Partners' Interests and Constraints
- Chapter 4 – Lessons Learned from Other Agencies
- Chapter 5 – Alternatives Development
- Chapter 6 – Treatment Process Evaluation
- Chapter 7 – Conveyance Facilities Evaluation
- Chapter 8 – ACWD Groundwater Facilities Evaluation
- Chapter 9 – Cost Summary
- Chapter 10 – Environmental Consideration and Potential Effects
- Chapter 11 – Implementation

Figure 1-1: Study Area



1.3 Background

ACWD, in partnership with SFPUC and USD, is serving as the non-federal project sponsor. While SFPUC and USD are critical partners in this potential purified water project, the majority of the new facilities identified in the project would likely be part of ACWD's system. This section provides summaries of each of the Study Partners and their service areas.

1.3.1 Statement of Problems and Needs

ACWD faces many challenges regarding its water supply. Droughts, population growth, and legal and environmental constraints combine to reduce water supply reliability, particularly concerning imported water. ACWD relies heavily on imported water for its water supply, as described further in the following sections.

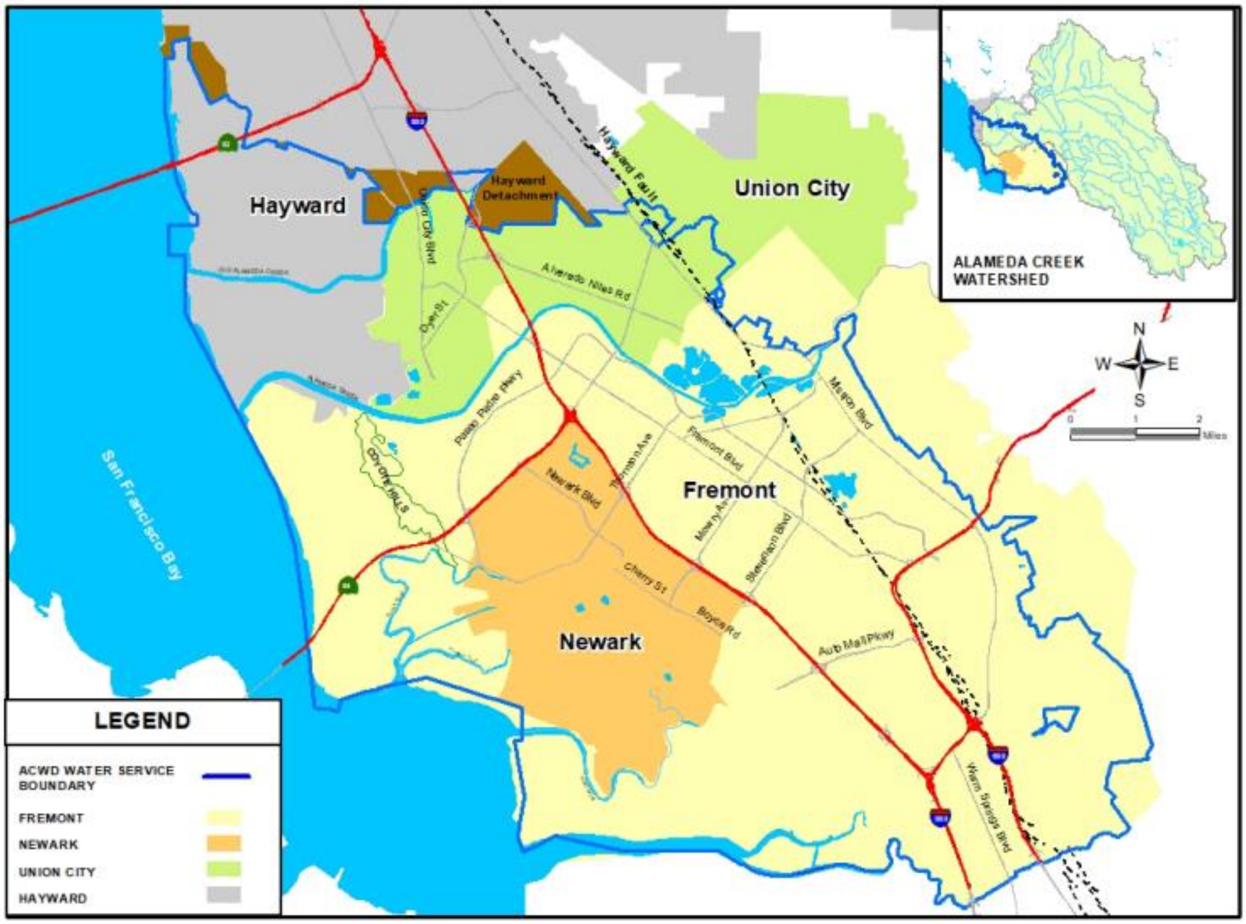
1.3.2 ACWD

ACWD is a retail water purveyor with a service area of approximately 105 square miles generally encompassing the Cities of Fremont, Newark, and Union City (Figure 1-2). ACWD was originally created to protect the groundwater basin, conserve the waters of the Alameda Creek Watershed, and develop supplemental water supplies, primarily for agricultural use. Today, ACWD provides water primarily to urban customers: approximately 67% of supplies are used by residential customers, with the balance (approximately 33%) utilized by commercial, industrial, institutional, and large landscape customers.

ACWD currently imports 40% of its water supplies used for distribution from the State Water Project (SWP) (26%) and from SFPUC's Regional Water System (RWS) (14%). The remaining 60% of ACWD water supplies are local supplies, including local groundwater from Niles Cone, desalinated brackish groundwater, and surface water from the Del Valle Reservoir (ACWD, 2021). Several factors, including increased protections for the Delta smelt and salmonids, climate change, and sea-level rise impacts on the Delta, are decreasing the reliability of imported supplies during dry, normal, and even wet water years. The availability and reliability of these supplies further decreased during drought years.

ACWD currently operates one surface water treatment plant, Water Treatment Plant Number 2 (WTP #2), that began operations in 1993; a second surface water treatment plant, Mission San Jose WTP #1, ran from 1976 up until recently being decommissioned and no longer in use. Untreated surface water is conveyed from the Sacramento-San Joaquin Delta or Lake Del Valle via the South Bay Aqueduct. The water is treated at WTP #2 and then delivered to customers. There are two production wellfields used by ACWD to provide groundwater to customers – the Mowry Wellfield and the Peralta-Tyson Wellfield. To balance overall hardness ACWD blends a large portion of their water supplied by SFPUC with groundwater extracted from the Peralta-Tyson and Mowry Wellfields at ACWD's Blending Facility to lower overall hardness and then delivered to customers. SFPUC delivers water directly to ACWD via turnouts on the SFPUC Bay Division Pipelines in the Cities of Fremont and Newark.

Figure 1-2: ACWD Service Area



Source: ACWD 2020 UWMP

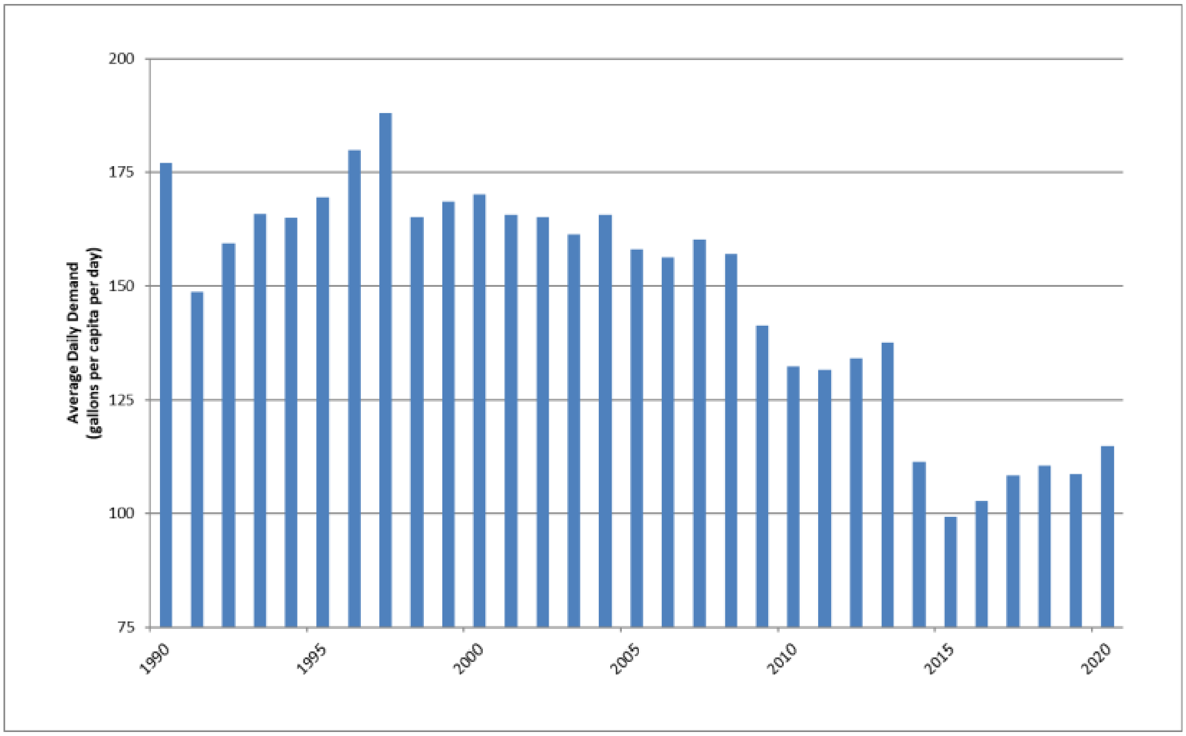
In 2003, ACWD commissioned the Newark Desalination Facility (NDF) to treat brackish groundwater using reverse osmosis (RO) technology to remove salts and minerals. Brackish water is extracted using a subset of the Aquifer Reclamation Program (ARP) wells. The facility was expanded to increase permeate production capacity from 5 to 10 MGD for a total production of up to 12.5 MGD. The 10 MGD permeate water produced at the NDF is blended with 2.5 MGD well water, chemically conditioned, and pumped directly into the distribution system.

Because the supply used for a brackish desalination facility is limited by the availability of fresh water to recharge the Niles Cone Groundwater Basin, the current brackish desalination program is effectively at full capacity. Having purified water available to recharge the groundwater basin could potentially open up flexibility and increased use of NDF.

<u>Projected Water Supplies and Demands</u>

In the years prior to 2010, ACWD had observed declining demand due to a prevailing economic downturn, successive dry year conditions, and statewide water use efficiency campaigns. Water consumption trends were increasing between 2010 and 2013 and ACWD experienced a substantive reduction in water demand during the 2014-2016 drought years with only a moderate demand rebound during the subsequent years up to 2020, as many of the customers' behavioral changes and water use efficiency efforts have remained permanent. Figure 1-3 provides a summary of the trends in per capita water use in ACWD's service area from 1990 to 2020 (ACWD, 2021).

Figure 1-3: Water Use Trends – Per Capita Water Use: Distribution System and Private Groundwater



Source: ACWD 2020 UWMP

ACWD planning for water supplies and water production facilities begins with a detailed water demand forecast. ACWD completed its analysis of the projected water supply availability and demands under average year, single dry year, and multiple dry year conditions. Table 1-1 summarizes the water supply and demand projections from ACWD's 2020 UWMP. As indicated in Table 1-1, ACWD will have sufficient supplies to meet projected future water demands under normal year conditions before 2045. However, there are single dry year and multi-year shortages expected throughout the planning horizon as well as in 2045 under the multiple dry year scenario.

Table 1-1: ACWD Water Supply and Demand Comparison (AFY)

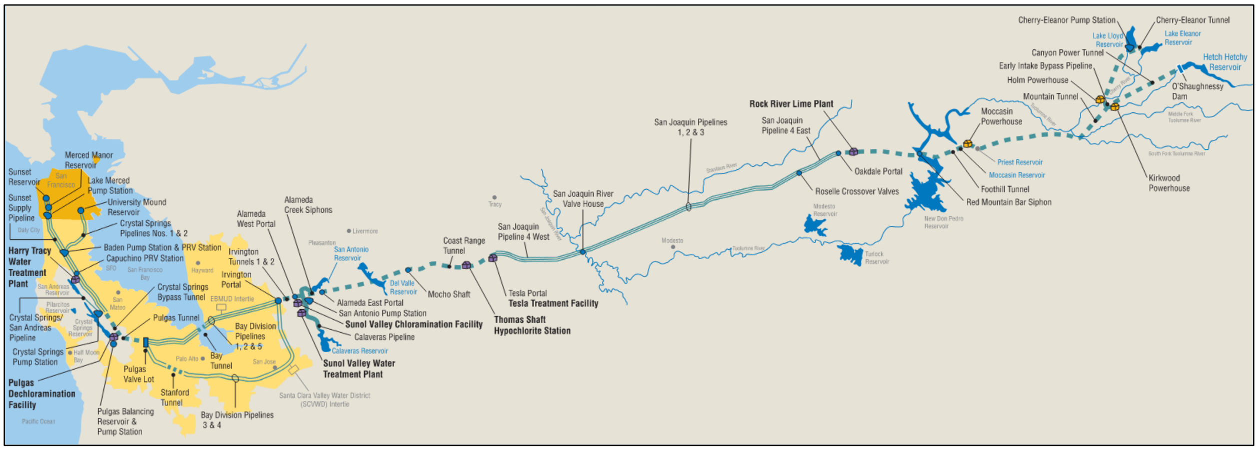
Supply/ Demand	2025	2030	2035	2040	2045
Normal Year					
Imported Supplies	36,300	36,300	36,300	36,300	36,300
Local Supplies	31,900	31,900	32,000	32,000	31,900
Banking/ Transfers	N/A	N/A	N/A	N/A	N/A
Total Supply	**68,200**	**68,200**	**68,300**	**68,300**	**68,200**
Distribution System Demand	44,600	44,200	44,000	44,100	52,100
Groundwater System Demand	16,300	16,200	16,100	16,000	15,500
Total Demand	**60,900**	**60,400**	**60,100**	**60,100**	**67,600**
Supply/ Demand Comparison	**7,300**	**7,800**	**8,200**	**8,200**	**600**
Single Dry Year					
Imported Supplies	9,800	9,900	9,900	9,900	10,700
Local Supplies	29,300	29,300	29,300	29,400	28,100
Banking/ Transfers	13,500	13,500	13,500	13,500	13,500
Total Supply	**52,600**	**52,700**	**52,700**	**52,800**	**52,300**
Distribution System Demand	44,600	44,200	44,000	44,100	52,100
Groundwater System Demand	13,600	13,500	13,400	13,300	11,800
Total Demand	**58,200**	**57,700**	**57,400**	**57,400**	**63,900**
Supply/ Demand Comparison	**-5,600**	**-5,000**	**-4,700**	**-4,600**	**-11,600**
Multiple Dry Year					
Imported Supplies	16,140	15,840	15,560	15,280	15,200
Local Supplies	27,660	27,900	28,100	28,260	28,280
Banking/ Transfers	15,400	15,400	15,400	15,400	14,460
Total Supply	**59,200**	**59,140**	**59,060**	**58,940**	**57,940**
Distribution System Demand	43.640	44,400	44,040	44,040	48,900
Groundwater System Demand	13,200	13,100	13,020	12,680	11,360
Total Demand	**56,860**	**57,500**	**57,060**	**56,720**	**60,260**
Supply/ Demand Comparison	**2,340**	**1,640**	**2,000**	**2,220**	**-2,320**

Source: Adapted from ACWD 2020 UWMP; Multiple Dry Year information averaged from UWMP tables 9-4 to 9-8.

1.3.3 SFPUC

Over 2.7 million people in San Francisco and across three other Bay Area counties rely on water supplied by the SFPUC, a department of the City and County of San Francisco. The SFPUC serves both retail and wholesale customers (Figure 1-4) through its Regional Water System (RWS). The RWS supplies surface water from the Tuolumne River watershed, collected in Hetch Hetchy Reservoir in Yosemite National Park, and from local reservoirs in the Alameda and Peninsula watersheds. The RWS draws an average of 85% of its supply from the Tuolumne River watershed, which feeds into an aqueduct system delivering water 167 miles by gravity to Bay Area reservoirs and customers. The remaining 15% of the RWS supply is drawn from local surface waters in the Alameda and Peninsula watersheds. The split between these resources varies from year to year depending on the water year hydrology and operational circumstances.

Figure 1-4: SFPUC Water Supply Map



The Hetch Hetchy Reservoir is the largest unfiltered water supply on the West Coast, and one of only a few large unfiltered municipal water supplies in the nation. The water originates from well-protected wilderness areas in Yosemite National Park, which flows down the Tuolumne River to Hetch Hetchy Reservoir. This water meets or exceeds all federal and State criteria for watershed protection. Water from Hetch Hetchy Reservoir is protected in pipes and tunnels as it is conveyed to the Bay Area and requires pH adjustment to control pipeline corrosion and disinfection for bacteria control. Based on the SFPUC's disinfection treatment practice, extensive bacteriological quality monitoring, and high operational standards, the U.S. Environmental Protection Agency (USEPA) and the SWRCB Division of Drinking Water (DDW) determined that the Hetch Hetchy water source meets federal and State drinking water quality requirements without the need for filtration.

All water derived from sources other than Hetch Hetchy Reservoir is treated at one of two treatment plants: the Sunol Valley Water Treatment Plant (SVWTP) or the Harry Tracy Water Treatment Plant (HTWTP). The SVWTP primarily treats water from the Alameda System reservoirs and has both a peak capacity and sustainable capacity of 160 MGD. Treatment processes include coagulation, flocculation, sedimentation, filtration, disinfection, fluoridation, corrosion control treatment, and chloramination. Fluoridation, chloramination, and corrosion control treatment can also be provided for the combined Hetch Hetchy System and SVWTP water at the Sunol Valley Chloramination Facility. The HTWTP treats water from the Peninsula System reservoirs and has a peak capacity of 180 MGD and a sustainable capacity of 140 MGD. Treatment processes include ozonation, coagulation, flocculation, filtration, disinfection, fluoridation, corrosion control treatment, and chloramination.

<u>Projected Water Supplies and Demands</u>

Approximately two thirds of the SFPUC's water supply is delivered to wholesale customers, and the remaining one third is delivered to retail customers. In 2020, the SFPUC delivered approximately 198 MGD of RWS supplies to its entire water service area, with an additional 2.3 MGD in local groundwater and recycled water provided to retail customers. Based on the recent 2020 UWMP projections, SFPUC would be able to meet its demand even in single dry years or multiple dry years. However, SWRCB adopted amendments to the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan Amendment) in 2018 to establish water quality objectives to maintain the health of the Bay-Delta ecosystem, which requires the release of 30-50% of the "unimpaired flow" from February through June in every year type. If the SWRCB implements the Bay-Delta Plan Amendment on the Tuolumne River as adopted, SFPUC would no longer be able to meet the single dry years or multiple dry years demand as presented in Table 1-2. This, along with other planning goals, has spurred the development of SFPUCs Alternative Water Supply program. The goal of the Alternative Supply Planning Program is to evaluate all potential sources of future water supply and begin the hard work of bringing some of those sources online so they are available in the coming decades. SFPUC is studying the feasibility of six Bay Area regional projects (including this Study). Most of these projects will require extensive partnerships with water and wastewater utilities. In addition to the Alternative Water Supply Program, the SFPUC is considering three San Joaquin Valley-area collaborations and the potential for purified water and innovations in San Francisco.

Table 1-2: Projected Supply and Demand Adjusted for Regional Water System (AFY)

Supply/ Demand	2025	2030	2035	2040	2045
Supply - Retail	75,300	75,600	76,800	79,000	82,600
Supply - Wholesale	163,500	165,700	170,100	175,100	182,400
Total Supply	**238,800**	**241,300**	**246,900**	**254,100**	**265,000**
Demand- Retail	75,300	75,600	76,800	79,000	82,300
Demand- Wholesale	167,500	174,500	179,700	185,000	191,100
Total Demand	**242,800**	**250,100**	**256,500**	**264,000**	**273,400**
Supply/ Demand Comparison	**-4,000**	**-8,800**	**-9,600**	**-9,900**	**-8,400**

Source: Supplies Adapted from SFPUC 2020 UWMP; Demand Adapted from SFPUC Alternative Water Supply Plan Draft

1.3.4 USD

USD owns and operates twin large diameter force mains, the Irvington Pump Station, and the Newark Pump Station, to convey wastewater from their service area to the Alvarado Wastewater Treatment Plant (WWTP). The Alvarado WWTP currently meets their National Pollutant Discharge Elimination System (NPDES) permit requirements for secondary treatment by using conventional activated sludge (CAS) as its biological liquid treatment process. USD's liquid treatment process also includes primary and secondary clarification, and chlorination.

USD is a member agency of the East Bay Dischargers Authority (EBDA), and USD's contract allows them to discharge to the EBDA outfall. The EBDA system consists of approximately 11.5 miles of pipelines ranging in diameter from 48 inches to 96 inches, four pump stations, a dechlorination facility, and a 7-mile outfall into San Francisco Bay. USD's contractual discharge capacity is 42.9 mgd. USD also has the capability to discharge to Old Alameda Creek during peak wet weather events when the capacity in the EBDA pipeline is exceeded and to Hayward Marsh. The East Bay Regional Park District (EBRPD), which owns and operates the Hayward Marsh, has indicated that it will cease operations at the Hayward Marsh.

USD recently completed the 2019 Enhanced Treatment and Site Upgrade (ETSU) Program Plan which is designed to incorporate near- and long-term capital improvement projects with the secondary process upgrades as the WWTP transitions to a new era of managing nutrients, biosolids, and effluent/recycled water, all while anticipating sea level rise. The ETSU Program identified current annual average flows for the Alvarado WWTP to be 23.4 MGD.

2. POTABLE REUSE REGULATORY REVIEW

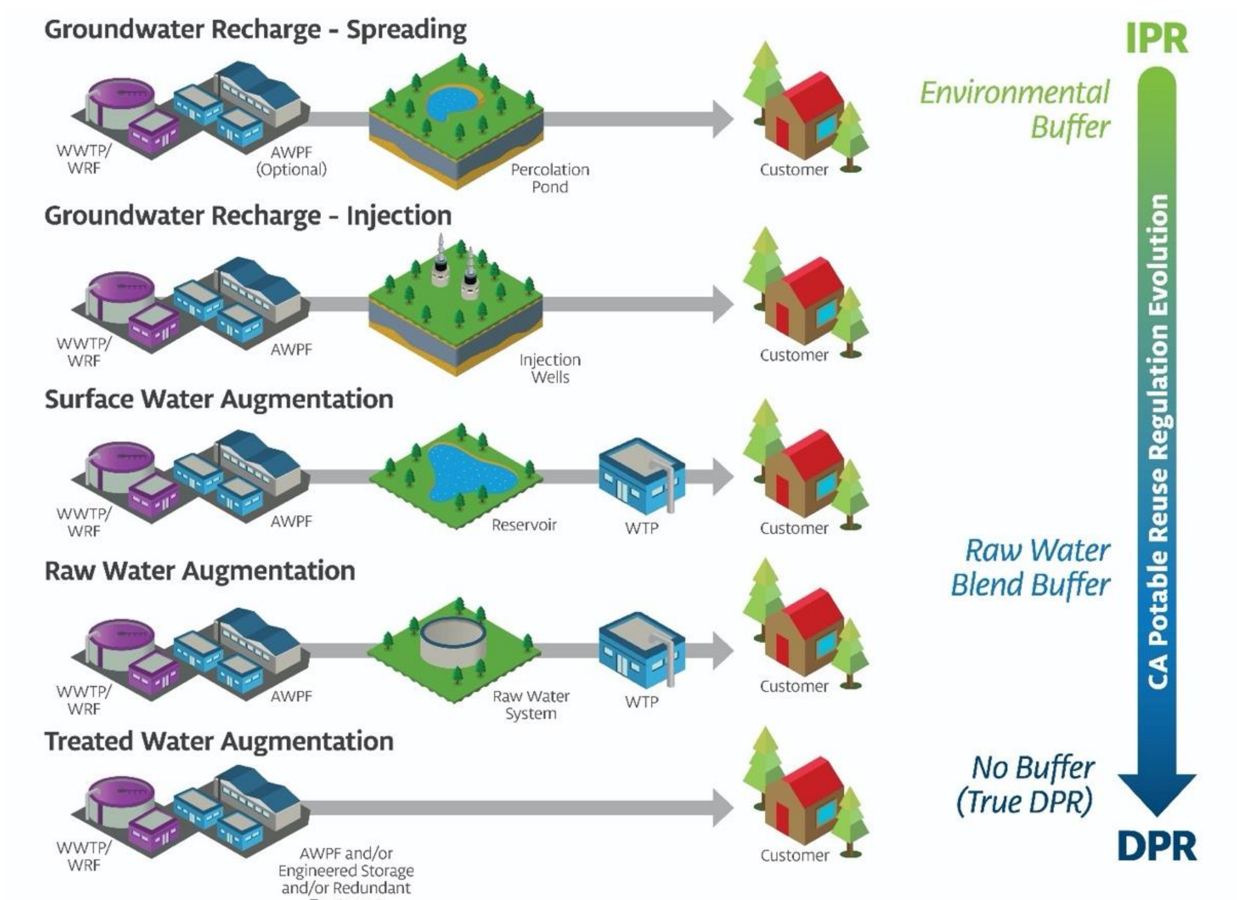
2.1 Introduction

This section provides an overview of the different forms of potable reuse and associated regulatory requirements along with specific considerations for a potable reuse project that would discharge to San Francisco Bay. See **Appendix A** for an expanded review of potable reuse regulations.

2.1.1 Potable Reuse Approaches

The spectrum of potable reuse approaches is commonly distinguished by the degree of *separation* between the treatment and ultimate consumption of purified water. This separation may be physical (e.g., when purified water travels through a groundwater aquifer), temporal (e.g., when water is retained in a tank or a reservoir), or both. IPR projects are characterized by the use of one of two environmental buffers—a groundwater aquifer or a surface water reservoir—that increase the separation between treatment and consumers. DPR projects are defined by the *absence* of a significant environmental buffer. The State of California recognizes five forms of IPR and DPR that are depicted in Figure 2-1 all requiring a multitude of pathogen and chemical control requirements. See **Appendix A** for detailed information on potable reuse requirements including both regulated and unregulated constituents (e.g. PFAS).

Figure 2-1: Forms of Potable Reuse in California



2.2 Indirect Potable Reuse

The unplanned (or de facto) reuse of treated wastewater as a water supply is common in many water systems in the U.S. and throughout the world, with some drinking water treatment plants using water sources that contain a high fraction of wastewater effluent from upstream communities (NRC, 2012). This discussion focuses on planned potable water reuse as defined in California regulations. The first form of IPR distinguished by California regulations is Groundwater Recharge (GWR), which can be achieved by two different approaches: surface spreading and subsurface injection (Title 22, Chapter 3, Articles 5.1 and 5.2, respectively). The second form of IPR is Surface Water Augmentation (SWA) which introduces purified water directly into a surface water reservoir that is used as a source of domestic drinking water supply.

One of the benefits of pursuing IPR projects in California is the *regulatory certainty* associated with the existence of final, adopted regulations for both GWR and SWA. This streamlines the permitting process by providing clarity on the requirements for IPR implementation. In the case of GWR, there are also multiple *precedents* given that permitted California GWR projects have been producing water for nearly 60 years. Based on this experience, the regulatory community has first-hand knowledge of the challenges with GWR allowing them to adapt the requirements to address these needs.

2.2.1 Groundwater Recharge

There are two forms of GWR, as identified by the regulations: (1) surface spreading and subsurface injection. The minimum treatment requirements for surface spreading include secondary treatment, tertiary filtration, and disinfection prior to being applied in a spreading basin (CDPH, 2014). As the tertiary treated water percolates through the soil to the aquifer, further control and attenuation of multiple contaminants is provided through soil aquifer treatment (SAT). Because subsurface (or direct) injection bypasses SAT, higher degrees of treatment are required at the advanced water purification facility (AWPF) prior to injection into the aquifer.

GWR is the form of potable reuse with the longest history in California. The seminal surface spreading and subsurface injection projects—Los Angeles County Sanitation District's (LACSD's) Montebello Forebay project and Orange County Water District's (OCWD's) Water Factory 21 and Groundwater Replenishment System (GWRS)—have been in operation for 60 and 45 years, respectively. While the initial draft regulations for GWR were first developed in 1976, it was not until 2014 that the regulations were finalized. Leaving these regulations in draft form allowed the regulators to periodically update and adapt the requirements based on their decades of experience permitting and evaluating these projects. This extended period of regulatory development was not available for either the SWA or DPR regulations since both were given short deadlines (less than 10 years) for completion under legislative mandates. Even with a final regulation in place, the lack of precedent SWA projects will likely require additional regulatory interactions for permitting. The permitting effort will likely require even greater interactions for DPR since there is neither regulatory certainty (i.e., no finalized regulation until December 2023) nor project precedents in California.

2.2.2 Surface Water Augmentation

The regulations governing SWA became effective in October 2018. Unlike GWR, however, there are currently no operating SWA projects in the State. Nevertheless, the pioneering projects (the San Diego Pure Water Program and the East County Advanced Water Purification Program) are providing the industry with first-hand knowledge of SWA's unique challenges. Working through these first projects has helped the regulators understand what issues (both foreseen and unforeseen) must be dealt with during permitting. In

2020, the City of San Diego received the state's first SWA permit for the North City Pure Water Project. This key milestone also helps future projects by gaining better regulatory clarity on the permitting requirements for SWA.

The California Water Code, Chapter 7 entitled "Water Reclamation" previously defined SWA in Section 13561(d) as:

> *"…the planned placement of recycled water into a surface water reservoir used as a source of domestic drinking water supply."*

While the SWA regulations were in the process of approval, Assembly Bill No. 574 (AB574) amended the sections of the California Water Code that establish terminology for potable reuse. The term "surface water augmentation" was changed to "reservoir augmentation," and was defined as:

> *"…the planned placement of recycled water into a raw surface water reservoir used as a source of domestic drinking water supply for public water system or into a constructed system conveying water to such a reservoir."*

For the purposes of this report, the terms SWA and reservoir augmentation are interchangeable and have the same meaning as the newly defined reservoir augmentation.

As discussed in Chapter 1.1, due to the lack of appropriate surface water reservoirs in the vicinity of ACWD's service area, SWA will not be considered in this study (Quarry Lakes are not a surface water body serving a surface water treatment plant). While information in this Chapter is mainly provided for general interest, the environmental discharge requirements for SWA may provide important context for the Quarry Lakes. Because the Lakes are classified as a body of water with multiple beneficial uses, recharging the groundwater aquifer using these Lakes may require a different permitting approach than standard spreading basins. Some of these requirements may be more similar to SWA than GWR. Additional discussions with the San Francisco Bay Regional Water Quality Control Board (RWQCB) and EBRPD are recommended to determine the appropriate environmental discharge requirements for the project.

2.3 Direct Potable Reuse

The SWRCB released draft criteria for DPR in March 2021 and then revised the criteria in August 2021 as they began engaging with the State DPR Expert Panel (SWRCB, 2021). After receiving the Expert Panel's findings on the draft criteria, the SWRCB published their response with proposed revisions in June 2022. On July 21, 2023, the SWRCB released the final draft DPR regulations to begin the formal rulemaking process (SWRCB 2023).The draft criteria include stricter requirements than IPR to compensate for the protections that are lost from bypassing the environment. The criteria can be broken down into four major categories: 1) pathogen control, 2) chemical control, 3) monitoring and control, and 4) technical, managerial, and financial capacity.

Compared to IPR, DPR projects have stricter requirements for nearly all of these categories. A detailed discussion of these requirements is available in **Appendix A**. One example of this difference is the level of treatment needed for IPR and DPR. Most categories of IPR require full advanced treatment (FAT), which is the treatment of the entire flow of water through both RO and an advanced oxidation process (AOP). The draft DPR criteria specify higher levels of treatment, namely, pre-treatment with ozone and biological activated carbon (BAC) followed by FAT.

State regulations defines two types of DPR—Raw Water Augmentation (RWA) and Treated Water Augmentation (TWA)—that are differentiated depending on whether the reuse project is providing a raw source water upstream of a surface water treatment plant, or a finished water directly into a public water system's distribution system. RWA also encompasses projects that provide raw source water into an environmental buffer that cannot meet the IPR requirements. While the draft regulations do not explicitly call out separate criteria for RWA and TWA, several sections have been modified to account

One benefit of DPR is that it does not restrict projects to areas with access to groundwater aquifers or reservoirs. From this perspective, both TWA and RWA forms of DPR appear permittable options for ACWD. For example, TWA effluent could be introduced directly into the distribution system or added as a treated water source at ACWD's Blending Facility. Alternatively, RWA effluent could be used as source waters into ACWD's WTP #2. Many agencies in California are considering the RWA form of DPR to continue leveraging investments they have made in existing treatment plant infrastructure. The main challenges in pursuing DPR include the lack of regulatory certainty (though draft criteria are on track to be finalized by the end of 2023) and the lack of permitting precedents.

2.4 Emerging Regulations for San Francisco Bay Discharges

Advanced water treatment processes utilizing technologies such as reverse osmosis (RO) or nanofiltration produce reject water called concentrate or brine, which carries rejected constituents into a waste stream for disposal. RO concentrate combined with normal effluent flow produces higher concentrations of chemical constituents to be discharged and could alter the NPDES permit compliance. This section is a discussion of applicable emerging regulations and potential impacts on RO concentrate disposal.

2.4.1 Current NPDES Permit

USD currently discharges virtually all of its average dry weather flow effluent via the EBDA deep water outfall to Lower San Francisco Bay. EBDA is a joint powers authority of five public agencies, all of which share a common outfall. USD, as a member of EBDA, does not have an individual NPDES permit for discharge into the Lower San Francisco Bay, but is listed as a co-permittee under EBDA's NPDES permit No. CA0037869 and adopted Order No R2-2017-0016 for use in this Study (recently superseded by Order No. R2-2022-0023). Therefore, USD is required to meet the conditions of the EBDA permit, including the requirement for monitoring and reporting constituents contained in the USD-generated effluent.

The 2016 IPR Study evaluated RO concentrate disposal via the EBDA outfall and assessed impacts on NPDES permit compliance. The study compared estimated concentrations of key constituents in an assumed RO concentrate flow of 0.71-MGD against effluent limits and water quality objectives in adopted Order No R2-2012-0004. The assumed concentrate flow was based on a RO rejection rate of 15%, consistent with a purified flow rate of 4-MGD. The study concluded that the limiting parameter for the existing NPDES permit was bis(2-ethylhexyl)phthalate, based on the water quality objective for aquatic life. USD is currently reevaluating the measured bis(2-ethylhexyl)phthalate values. If the values cannot be validated, the compound may cease to exceed effluent limits. No other constituents were expected to exceed effluent limits or water quality objectives.

In May 2017, the Regional Board adopted Order No R2-2017-0016 which superseded Order No R2-2012-0004. Respective effluent limits and water quality objectives for the key constituents were not revised between the Orders, and therefore, the study's conclusions are still applicable for current NPDES requirements. Chapter 3.2.1 includes further discussion of RO concentrate disposal at higher volumes and mitigations for bis(2-ethylhexyl)phthalate management. While effluent limits are not likely to change in the near future with the exception of the issues identified below, the characteristics of EBDA's effluent may change as a result of increased water recycling, as effluent flows decrease and concentrate additions increase. Therefore, the compliance risks associated with RO concentrate should be reassessed as the time for implementation nears.

In addition to the EBDA common outfall, USD also has the capability to discharge to Old Alameda Creek during wet weather; however, RO concentrate would not be discharged to this location because it is connected to the WWTP via a separate outfall. In the past USD also discharged effluent to Hayward Marsh but ceased discharge in August 2019 due to planned maintenance being carried out by the EBRPD.

2.4.2 Nutrient Watershed Permit

Limits on nutrient loading to San Francisco Bay are not included in the current NPDES permit. As a precursor to potential effluent limits, the current Nutrient Watershed Permit Order No. R2-2019-0017 includes estimates of nutrient load targets that dischargers may be expected to meet in 2024 and beyond based on recent nutrient discharge performance and anticipated population growth (Table F-5. Dry Season Total Inorganic Nitrogen Load Discharges — Current Performance and 2024 Load Targets). The load targets were determined by adding a 15 percent buffer to the current nutrient discharge performance (i.e., the maximum dry season average between May 1, 2014, and September 30, 2017) to account for population growth. EBDA's current total inorganic nitrogen performance and 2024 total inorganic nitrogen load targets are 8,400 kg N/day and 9,600 kg N/day, respectively. Since the load targets, and therefore, potential future effluent limits, have been expressed on a mass-basis, the RO concentrate disposal from the advanced treatment process would have no impact on compliance feasibility.

2.4.3 Statewide Chronic Toxicity Numeric Objectives

In 2019, SWRCB released draft statewide numeric water quality objectives for aquatic toxicity (SWRCB, 2019). EPA approved the draft statewide provisions on May 1, 2023. For dischargers in the San Francisco Bay region, only chronic toxicity numeric effluent limits will apply, based on these new provisions and applied when a new NPDES permit is issued.

Chronic toxicity testing is based on inhibited growth or reproduction of an indicator species in a range of effluent concentrations. Under the current toxicity policy in the region's Water Quality Control Plan (Basin Plan), the response of the organism is translated to a numerical value called "chronic toxicity units," (TUc) with 1 TUc roughly corresponding to toxicity present in 100% effluent and 10 TUc corresponding to toxicity in 10% effluent. Because it is a deep-water discharger, the current EBDA permit contains a threshold limit of 10 TUc. As indicated in the 2016 IPR Study, test results between 2011 through 2015 resulted in values no higher than 2 TUc (roughly speaking, toxicity at 50% effluent). Under the 2017 NPDES Permit, this suggests that while RO concentrate disposal may increase the likelihood of observing chronic toxicity, the combined effluent is not expected to exceed the limit of 10 TUc.

Under the adopted statewide toxicity provisions with numeric limits, disposal of RO concentrate increases the compliance risk to USD and to EBDA that any observed toxicity will result in a permit violation, rather than just accelerated monitoring. Shallow water discharges to Old Alameda Creek or Hayward Marsh are not recommended as USD would not be able to obtain the dilution credits likely needed to maintain permit compliance.

As a deep-water discharger, EBDA is eligible for dilution credits to be applied when calculating water quality-based effluent limits. Dilution credits are available because the EBDA deep water outfall achieves a modeled initial dilution of at least 79:1 (per Order No. R2-2017-0016), and it is the RWQCB's policy to grant deep water dischargers dilution credits of 10:1 for non-bioaccumulative pollutants. Since blended effluent chronic toxicity levels cannot be predicted, further discussion with EBDA member agencies would be needed to document and justify needed dilution credits and determine appropriate monitoring protocols. This is especially relevant now that the new statewide toxicity provisions have been adopted . In the future, the EBDA common outfall may be used to discharge brine from projects being planned by other entities (including non-EBDA members), so the approach to justifying dilution credits would not be specific to this project.

2.5 Potable Reuse Summary

The five potable reuse approaches described herein are differentiated by the degree of physical and/or temporal separation between the treatment and ultimate consumption of purified water. Of the five forms of potable reuse, three forms are classified as IPR and two as DPR. IPR projects utilize groundwater aquifers or surface water reservoirs as environmental buffers to increase the physical and temporal separation between treatment and consumers. DPR projects will reduce or completely bypass the use of an environmental buffer. As the protections afforded by the environment decrease, DPR systems will need to compensate by including additional treatment and management barriers.

Another differentiating factor between the potable reuse approaches is the level of *regulatory certainty* associated with each approach. In California, GWR and SWA projects have the greatest *regulatory certainty* due to the existence of final, adopted regulations for these approaches. In addition to *regulatory certainty,* GWR projects also have multiple *precedents* in California, having produced water in the State for nearly 60 years. While there are currently no operating SWA projects in the State, San Diego's North City Pure Water Project obtained the State's first SWA permit in 2020. This precedent is expected to help future SWA projects by providing greater regulatory clarity on the permitting requirements for SWA. While discharging into Quarry Lakes is not considered a form of SWA, some environmental discharge requirements associated with SWA projects could apply to this recharge approach. Because the Lakes are classified as a body of water with beneficial uses and are not standard spreading basins, recharging the groundwater aquifer using these Lakes may be an unprecedented application. Consequently, it may require additional discussions with the RWQCB and EBRPD to determine appropriate environmental discharge requirements for the project.

In contrast, regulations have not been finalized for RWA and TWA projects in California, though the SWRCB released draft DPR criteria in 2021 and are on track to finalize the regulations by the end of 2023. Nevertheless, DPR has greater risks due to the lack of *regulatory certainty* and *project precedents*. As a result, developing an RWA or TWA project would require more extensive permitting efforts and may require additional studies to demonstrate the project's ability to protect both environmental and public health.

3. PARTNER INTERESTS AND CONSTRAINTS

3.1 Partner Interests and Assets

This chapter summarizes the interests and facilities that each Partner brings to the development of a potable reuse project.

3.1.1 ACWD

ACWD is interested in maximizing the available water for local and regional use. With that driving goal in mind, ACWD also wants to avoid any major regulatory hurdles or uncertainty and minimize capital investment.

By maximizing the volume of purified water produced by a potable reuse project, ACWD hopes to enhance its supply reliability, especially in dry year and multi dry year events. Further, through the development of a select project, ACWD hopes to have more flexibility with its contracted import supplies (SFPUC and SWP) to achieve increased water supply independence. ACWD appreciates the efforts and investments other agencies throughout California have made in advancing their cutting-edge projects and is interested in following in their footsteps. ACWD is not interested in breaking new ground, recognizing the regulatory uncertainty and investments required.

In keeping with its goal of responsible financial management, ACWD wants to limit capital investment as much as possible while continuing to provide its customers with reliable water service. To this end, ACWD would like to maximize the use of its existing assets, such as the Mission San Jose Water Treatment Plant (MSJWTP) or to re-purpose the abandoned Alvarado-Niles pipeline.

3.1.2 SFPUC

Like ACWD, SFPUC's primary interest is to identify the maximum potential available water supply within its retail and wholesale service areas. SFPUC wants to increase both the volume of water available and the reliability of that water, especially in dry and multi-dry years. In the coming years, SFPUC faces the potential need to significantly increase its environmental flow releases from the Tuolumne River watershed, which would affect dry year supply availability. Other regulatory drivers may also impact supply availability. Therefore, the primary objective in identifying water supply from this project is to secure dry year supplies for existing customers. In dry years, SFPUC typically relies on stored water, which provides for more flexibility in timing deliveries. As such, SFPUC could take water generated from a potable reuse project at any point during dry years. A second objective for SFPUC is identifying potential sources of supply that can serve the Cities of San Jose and Santa Clara in all year-types. The potential available supply from this potable reuse project will be vetted by SFPUC against these objectives based on volume and availability.

At this stage, SFPUC wants to explore the broadest range of potable reuse project options, including the use of injection wells and DPR. While SFPUC wants to provide water to its customers at a financially responsible rate, its main focus in this initial exploration of potable reuse is to identify the maximum available supply and potential delivery options, limitations, and planning level cost estimates. Thus, SFPUC does not want to constrict the exploration of options due to cost or near-term regulatory hurdles in this preliminary feasibility analysis.

3.1.3 USD

USD has been an advocate for beneficial reuse through a collaboration with the Partners. Given the other planned projects USD has outlined in their ETSU Program, USD is primarily interested in cost and operational considerations related to a potential potable reuse project. USD supports the concept of providing the treated wastewater effluent needed for the project while keeping with their goal of responsible financial management and minimizing the cost of service to ACWD and USD's shared customer base. USD would like to minimize costs impacts to their operations from the potential project and at a minimum, would prefer any option to be cost neutral. If there are additional operational or capital costs to be borne by USD, revenue from the reuse of wastewater would be required to offset those costs. Additionally, USD is limited in its ability to modify regulatory changes to their operations, including changes to discharge permits or the EBDA Joint Power Authority.

For the purposes of this Study, it is assumed that the Phase 1 projects from the ETSU Program maybe be implemented prior to projects identified in this Study and that, conservatively, the available flow for a reuse project would be the current annual average flow of 23 MGD. Wastewater flows are expected to gradually increase in the future. Average daily wastewater flow in 2028 is expected to be approximately 25.8 MGD, increasing to 29.1 MGD in 2040, and finally increasing to 33 MGD in 2058 (Hazen and Sawyer, 2019). Although wastewater flows are expected to increase, it is prudent to plan for current flow levels to avoid over-sizing facilities.

3.1.4 Partners' Assets

The Partners have a variety of existing assets that could be incorporated into a potable reuse project. These assets include:

- ACWD Newark Desalination Facility
- ACWD/EBRPD Quarry Lakes recharge ponds
- ACWD groundwater production wells
- ACWD WTP #2 (operational)
- ACWD MSJWTP (decommissioned)
- ACWD potable water distribution system
- SFPUC Bay Division Pipelines
- USD Alvarado Wastewater Treatment Plant
- USD capacity in EBDA outfall

3.2 Constraints and Potential Mitigations

This Chapter presents the various opportunities that exist within the Study Area as well as the constraints (physical and regulatory) that may limit the ability to maximize reuse of all of USD's available wastewater flow. This Chapter also proposes potential mitigations that could be incorporated into the project to overcome the constraints. Potential mitigations are assessed qualitatively using two parameters: ease of implementation and cost implication.

Ease of implementation refers to frequency, repeatability, and complexity of the potential mitigation. For example, constructing a new groundwater extraction well would be considered "easy to implement" as it is a common practice around California and within ACWD's service area, and follows a known set of steps to complete.

Cost implication relies on applying experience from other settings to assess the relative additional cost needed to incorporate the potential mitigation in above and beyond the baseline costs of a potable reuse project. Baseline costs of a potable reuse project refer to components that would be common to all project alternatives such as the need for advanced treatment; ion exchange to remove copper from the waste stream produced by the AWPF would be an example of an additional treatment cost that is above the baseline. Likely cost is particularly examined as it relates back to the value of the investment to increase overall project yield. For example, incorporating a $10 million mitigation to increase yield by 10 MGD would be more favorable than a $10 million mitigation that only increases yield by 1 MGD.

3.2.1 Reverse Osmosis Concentrate Disposal

As noted in Chapter 2.4.1, USD currently discharges the majority of its average dry weather flow effluent via the EBDA deep water outfall and is required to meet the conditions of the EBDA permit. USD's current average dry weather effluent flow rate is 23 MGD; with no recycled water use or future flow commitments the full 23 MGD of dry weather flow is assumed to be available for reuse under this project.

With a feed rate of 23 MGD and a recovery rate of 75-95%, the AWPF may produce up to 1.2-5.7 MGD of RO concentrate for disposal through the EBDA outfall. The 2016 IPR study included a RO concentrate evaluation that identified constituents that would exceed applicable discharge water quality objectives or effluent limitations at various AWPF flow rates. At 4 MGD (0.71 MGD of RO concentrate disposal), the limiting parameter for the existing NPDES permit was bis(2-ethylhexyl)phthalate, based on the water quality objective for aquatic life. Effluent limitations for this parameter could incorporate dilution credits, in which case a separate treatment step to address RO concentrate would not be required. As AWPF flow rate increases, production of RO concentrate also increases, which could potentially result in additional constituents exceeding the applicable water quality objective or EBDA permit effluent limitation. Table 3-1 shows the results of this analysis along with potential mitigations for each constituent limit exceedance.

Although there is not currently a water quality objective for perfluorooctanoate (PFOA)/ perfluorooctane sulfonate (PFOS) in San Francisco Bay based on protecting aquatic life or based on protecting human health due to fish consumption, this is a contaminant of emerging concern that should be considered in the next phase of work. It is expected that the RO process included in the AWPF treatment train destroys some PFOA/PFOS meaning the mass in the RO concentrate may be lower than the secondary effluent - but more information is needed to determine if additional treatment is needed for the RO concentrate should a potable reuse project alternative be selected for further consideration.

Table 3-1: RO Concentrate Analysis Results

Flow Rate (MGD)	Constituent	Limit Exceeded[a]	Effluent Concentration[a]	Potential Mitigation
4.0	Bis (2-Ethylhexyl) Phthalate	WQO	MEC	Grant dilution credits
6.7	Total suspended solids (TSS)	AMEL	95th percentile	Move point of compliance
10.2	TSS	AMEL	99th percentile	Move point of compliance
11.1	Ammonia (as N)	AMEL	95th percentile	Ammonia removal
13.7	Ammonia (as N)	MDEL	99th percentile	Ammonia removal
14.3	Nickel	WQO	MEC, 95th percentile	Grant dilution credits
15.5	Biochemical oxygen demand (CBOD)	AMEL	95th percentile	Move point of compliance
15.7	Cyanide	AMEL	95th percentile	Regulatory negotiation
18.0	CBOD	MDEL	99th percentile	Move point of compliance
19.5	Cyanide	MDEL	95th percentile	Regulatory negotiation
21.9	Copper	AMEL	95th percentile	Regulatory negotiation
22.3	Copper	MDEL	95th percentile	Regulatory negotiation
22.7	Zinc	WQO	MEC	Grant dilution credits

Notes

a) WQO = Water Quality Objective; AMEL = Average Monthly Effluent Limitation; MDEL = Maximum Daily Effluent Limitation; MEC = Maximum Effluent Concentration

Potential Mitigations

Grant Dilution Credits – Granting dilution credits is a regulatory approach to mitigating exceeding discharge limits for bis(2-ethylhexyl)phthalate, nickel, and zinc. Dilution credits are available because the EBDA deep water outfall achieves a modeled initial dilution of at least 79:1 (per Order No. R2-2017-0016), and it is the policy of the Regional Water Quality Control Board (RWQCB) to grant deep water dischargers dilution credits of 10:1 for non-bioaccumulative pollutants. Bis(2-ethylhexyl)phthalate, nickel and zinc are non-bioaccumulative, but dilution factors up to 10 could be granted to prevent limit exceedance. For example, the 2006 EBDA permit previously had dilution credits for nickel (Order No. R2-2006-0053).

Moving Point of Compliance – The RO Concentrate is expected to contain TSS and CBOD at concentrations exceeding the federal secondary treatment standards contained at 40 CFR §133.102. The NDPES permit will need to be modified such that the sampling point for determining compliance for technology-based effluent limitations (i.e., CBOD, TSS, and pH) is the end of USD's secondary treatment train, rather than the point at which flow is routed to EBDA. This approach has been used in other NPDES permits for discharge containing RO concentrate, such as the permit for Monterey One Water (Order No. R3-2018-0017, NPDES NO. CA0048551).

Ammonia Removal – Phase 1 of USD's ETSU Program has the potential year-round Biological Nitrogen Removal (BNR) operation, which can achieve approximately 50% effluent total Nitrogen load reduction for the year. It could also achieve significant ammonia removal during both dry weather and wet weather. Implementing year-round BNR would likely reduce ammonia loading such that it does not become a limiting constraint on purified water production.

Regulatory Negotiation - Copper and cyanide concentrations in RO concentrate are not easily reduced via regulatory or engineering methods. The effluent limits for these constituents cannot be increased under the current regulatory framework since the dilution credits for both copper and cyanide are already maxed out at 10:1 dilution. However, it may be possible to negotiate with the Regional Board and/or other EBDA dischargers to get additional dilution credits for these constituents based on the contributory flows of the other publicly owned treatment works (POTWs) that discharge to the EBDA outfall. Conservatively, limiting the production of purified water to 15.5 MGD stays below the threshold of needing to renegotiate with the Regional Board.

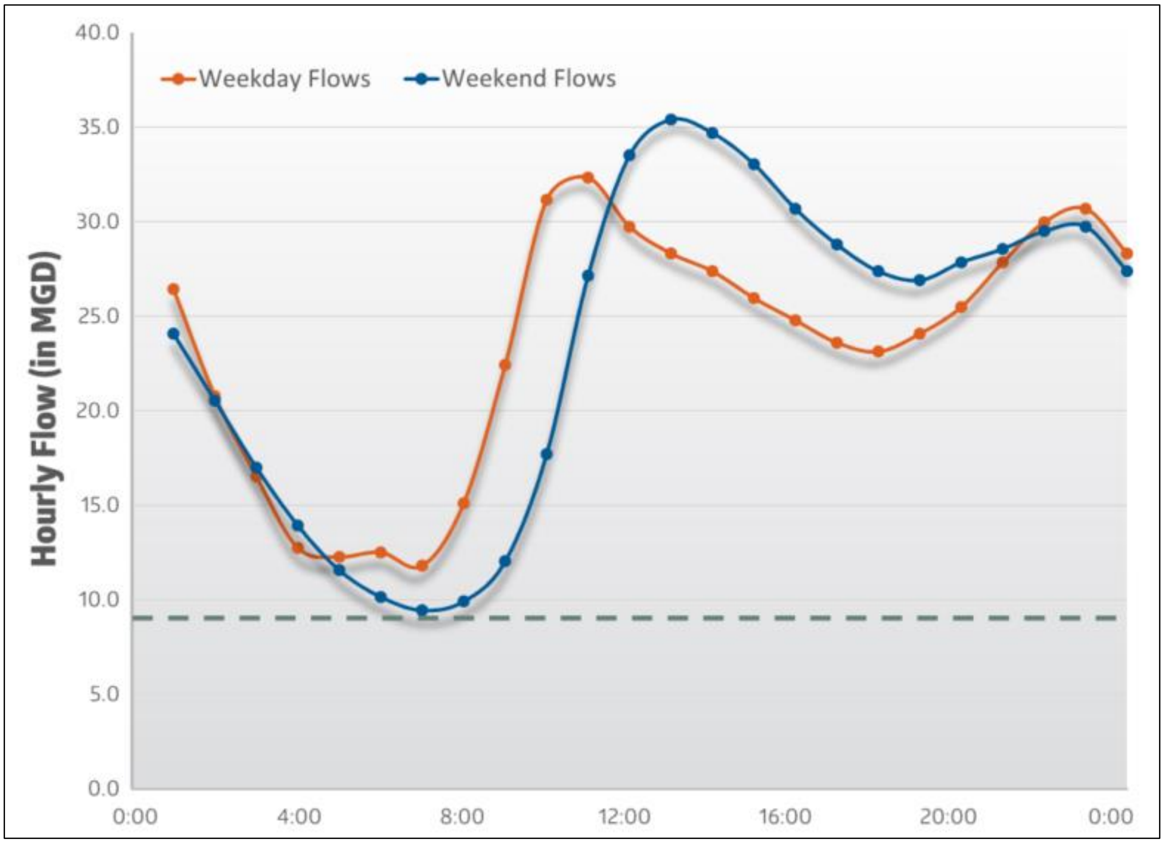
Table 3-2: Potential Mitigation to RO Concentrate Volume

Potential Mitigation	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation *● – Easy* *●●● – Hard*	Cost Implication *● – Low* *●●● – High*
Grant Dilution Credits	4.0 (Bis-2) 14.3 (Nickel) 22.7 (Zinc)	●	●
Moving Point of Compliance	6.7	●	*None*
Ammonia Removal	11.1	●	●●
Regulatory Negotiation	15.7 (Cyanide) 21.9 (Copper)	●●	●

3.2.2 Diurnal Fluctuation in Treated Wastewater Availability

USD's 2018 average daily flow was 23 MGD with a total annual flow of 8,391 MG. Minimum hourly flows at USD are on average approximately 9 MGD, and maximum hourly flows are approximately 35 MGD (Figure 3-1).

Figure 3-1: USD Diurnal Pattern



<u>**Potential Mitigations**</u>

Flow Equalization - Full equalization of the USD average dry weather flows would require 3.8 million gallons (MG) of storage. Adding storage at the WWTP site may be difficult as equalization basins take up space and are expensive to construct.

Table 3-3: Effluent Flow Rates at Various Flow Equalization Levels

	Constant Feed to AWPF
With No Flow Equalization (0 MG of Equalization Storage)	9 MGD
Partial Flow Equalization (2.5 MG of Equalization Storage)	20 MGD
Complete Flow Equalization (3.8 MG of Equalization Storage)	23 MGD

Increasing Recovery Rate – Recovery rate is the purified water production per unit wastewater feed from the AWPF processes, additional water losses are anticipated depending on the end use (groundwater storage and recovery). Maximizing AWPF efficiency to increase the recovery rate could yield additional purified water with the same volume of wastewater feed. Typical recovery rates for similar projects range from 75%-85%. Preliminary analysis specific to this project indicates that a normal 2-stage RO process should be able to operate with a maximum recovery rate of about 84%. This rate could be increased to about 95% with the use of closed-circuit desalination. This could increase purified water production by 1 to 2.5 MGD (depending on the feed flow). Additionally, recovery rates may be improved with lower levels of turbidity and TSS in the feed water.

Table 3-4 shows the expected WWTP effluent flow rate, or AWPF feed rate, expected at varying levels of flow equalization and recovery rates. Flow equalization has a more significant impact on increasing flow rates than maximizing recovery rates.

Table 3-4: Purified Water Production Rates at Various Recovery Rates

	Minimum Recovery Rate (75%)	Expected Recovery Rate (84%)	Maximum Recovery Rate (95%)
With No Flow Equalization (9 MGD feed)	6.8 MGD	7.6 MGD	8.6 MGD
Partial Flow Equalization (20 MGD feed)	15 MGD	16.8 MGD	19 MGD
Complete Flow Equalization (23 MGD Feed)	17.3 MGD	19.3 MGD	21.9 MGD

Table 3-5: Potential Mitigation to Available Treated Wastewater Volume

Potential Mitigation	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation *● – Easy* *●●● – Hard*	Cost Implication *● – Low* *●●● – High*
Flow Equalization (2.5 MG total)	7.6 without equalization (16.8 MGD with 2.5 MG of storage)	●	●●
Flow Equalization (3.8 MG total)	16.8 without full equalization (19.3 MGD with 3.8 MG of storage)	●●	●●●
Increase Recovery Rate from AWPF Process	8.6 (without flow equalization) 21.9 (with complete flow equalization)	●●	●●●

3.2.3 Land Availability for New AWPF

In order to produce high quality water for reuse, an AWPF will be required to supplement the treatment at the USD Alvarado WWTP. USD is currently planning to upgrade their existing treatment facility to maintain treatment capacity and allow for better water quality in the future. In 2016, USD completed an initial WWTP site use study (RMC, 2016) to investigate the potential plant configurations both with and without the inclusion of an adjacent AWPF. Since the completion of the 2016 WWTP Study, USD investigated available land near the Alvarado WWTP and found the land acquisition to be challenging. As shown in Figure 3-2 the updated USD site use master plan (2019) and preferred alternative does not currently include space allocated for an AWPF.

Figure 3-2: USD Alvarado WWTP Plant Upgrade Layout at Buildout

Source: Enhanced Treatment and Site Upgrade Program (Woodard & Curran, August 2019)

Additional land would be required to construct staff space along with the AWPF treatment facilities. If additional treatment process steps were required for DPR or equalization storage for flows above 9 MGD, the need for land will increase further.

An approximate footprint for the AWPF treatment train was determined based on a review of recently planned or constructed advanced treatment facilities. As detailed in Table 3-6, a standalone, DPR facility will require a minimum of roughly 0.33 acres per MGD for the treatment train and ancillary facilities (not including parking or storage). This translates to approximately 3 - 6 acres for a 9 MGD plant or 6.6 – 13.2 acres for a 20 MGD plant.

Table 3-6: Footprint Required for Treatment Processes

Treatment Process	Footprint with Ancillary Facilities (Square Feet per MGD)
Microfiltration (MF) / Ultra Filtration (UF)	840
Reverse Osmosis (RO)	930
Ultraviolet (UV) / Advanced Oxidation Process (AOP)	190
Chemicals	590
IPR Total	2,550 (0.06 acres)
IPR Lot Size[1]	*0.23 – 0.46 acres / MGD*
Ozone	410
Biologically Active Carbon (BAC)	650
DPR Total	3,610 (0.08 acres)
DPR Lot Size[1]	*0.33 – 0.66 acres / MGD*

Notes:

1. Based on previous experience and reference treatment plants, a factor of 4 to 8 should be applied to the calculated area to determine the approximate lot size needed. This factor accounts for spacing of treatment components and parking.

Potential Mitigations

Co-locating – Co-locating an AWPF with existing ACWD or USD facilities outside of the WWTP could limit amount of staff space needs, efficiently use operational and maintenance resources, and share chemical storage areas, etc. This mitigation strategy will not address the land required for equalization storage to produce flows over 9 MGD.

Site Reuse – ACWD's MSJWTP has been temporarily decommissioned but there has not yet been a decision as to how the facility or site will be used moving forward. The plant could be reused to site a new AWPF for this project. The existing plant was 8-10 MGD (CDM Smith, 2016) and sits on approximately 5.5 acres. ACWD has indicated that the useful life of the MSJWTP facilities has been expended and that reuse or repurposing of any remaining facilities should not be considered. If the plant was removed and replaced, the site could fit up to a 23 MGD IPR facility or 16.5 MGD DPR facility.

New Plant/Site – Likely to be the most expensive option, a brand new AWPF at a new site would require the least complicated site layout and effort required to reuse existing facilities. The challenge becomes finding a suitable location which is large enough and available to use or purchase. Ideally the new site would be located near existing facilities and at a similar elevation to avoid the need for excessive additional infrastructure such as long pipelines or high horsepower pumps.

Vacant land in the ACWD and USD service area is limited as the region is mostly developed. A brand-new treatment plant site would likely be limited to open areas in the hills on the eastern edge of the ACWD or USD service areas or would require demolition and redevelopment of an existing structure. An additional land availability study could be conducted to identify potential parcels for acquisition and use. For planning and cost estimating purposes of this Study, a site already owned by ACWD or USD is assumed as the location of a new AWPF.

Table 3-7: Potential Mitigation to Land Availability

Potential Mitigation	**Limit of Purified Water Produced without Mitigation (MGD)**	**Ease of Implementation** ***● – Easy*** ***●●● – Hard***	**Cost Implication** ***● – Low*** ***●●● – High***
Consolidation	Will vary based on treatment train selected but the membrane facilities and UV-reactors do not require overhead cranes and can be placed on upper-level floors in a stacked arrangement.	●●	●●●
Co-location	Footprint reduction is limited to the size of the ancillary facilities such as office space and parking. There must still be space at the site for new process facilities.	●	●
Site Reuse	MSJWTP site is approximately 5.5 acres which could be used for a 23 MGD IPR or 16.5 MGD DPR facility.	●●	●●●
New Plant/Site	Lot Size (acre) / IPR (MGD) / DPR (MGD) 1 / 4.3 / 3.0 2 / 8.5 / 6.0 3 / 12.8 / 9.0 4 / 17.1 / 12.1 5 / 21.4 / 15.1 6 / 25.6 / 18.1 7 / 29.9 / 21.1	●●●	●●●

3.2.4 Groundwater Basin Capacity and Retention Time

The Niles Cone Groundwater Basin exists almost exclusively within ACWD's boundaries, although certain aquifer layers (including the Newark Aquifer and Centerville-Fremont Aquifer) appear to extend beyond these boundaries. The groundwater basin is divided by the Hayward Fault since the fault is a relatively impermeable barrier that impedes the flow of water. The portion of the groundwater basin on the west side of the Hayward fault ("Below Hayward Fault Sub-basin") includes aquifers that will experience saline intrusion if groundwater levels fall below sea level in the Newark Aquifer, which may then migrate downward from the Newark Aquifer to the deeper aquifers. Saline water may also migrate downward from the Newark Aquifer into the deeper aquifers through abandoned and improperly sealed water wells. An overview of the basin location and ACWD production wells is shown in Figure 3-3. Figure 3-4 shows the configuration of the Niles Cone Groundwater Basin as well as the path of possible saline intrusion. A purified water project that included groundwater recharge may be constrained both by the capacity of the Niles Cone Groundwater Basin to accept and produce the additional water and by the retention time in the Basin required to meet purified water quality standards.

The difference between the volume of the new water supplied and the net water supply enhancement, reflected as a percent of the IPR supply delivered to ACWD, is termed as "realization rate". It is a function of water supply benefit as it reflects as a percent of the IPR supply delivered to ACWD. The 2016 IPR Study showed that adding 4 MGD of purified water to the groundwater basin with current demand and operations would result in a realization rate of 27%. This means 73% of the purified water added to the groundwater basin would be "lost" to saline outflow and reduces the capture of Alameda Creek watershed supply (and therefore the enhancement of water supply would be only 27% of the amount of water added to the groundwater basin). However, this realization rate is increased to 53% if demand increased from near-term (42.1 MGD) to build-out conditions (48.3 MGD). Since demand for water will increase with SFPUC as a project partner, realization rates would be anticipated to further increase though there will still always be a portion lost to saline outflow.

Additionally, the realization rate may be increased through groundwater reoperation. ACWD uses trigger groundwater elevations to guide decisions on when to release or import surface water supplies for supplemental groundwater recharge, as shown in Figure 3-5. When the addition of 4 MGD of purified water was modeled with a four-foot groundwater reoperation, the realization rate increased to 89%. A larger purified water project may require reoperation to increase acceptance rates, but having access to a guaranteed, consistent supply of recharge water may provide the confidence to reoperate the basin at lower levels without negatively impacting the groundwater basin or sustainability criteria. At a minimum, the 4 MGD modeling conducted in the 2016 IPR Study confirmed basin capacity for additional purified water but showed that there could be some loss of recharged purified water to the brackish portion of the aquifers.

Figure 3-3: Groundwater Basin and Existing Production Wells

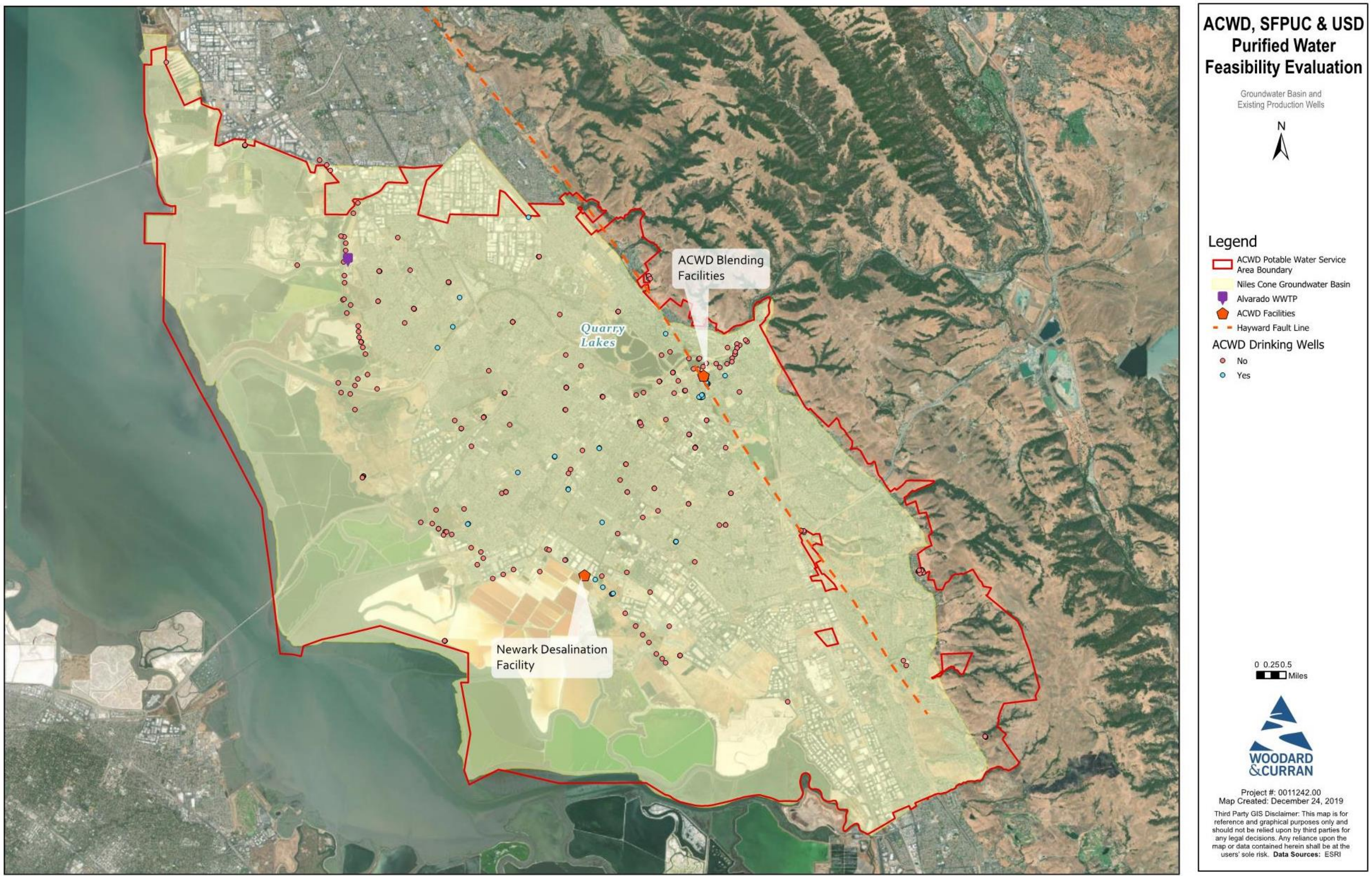
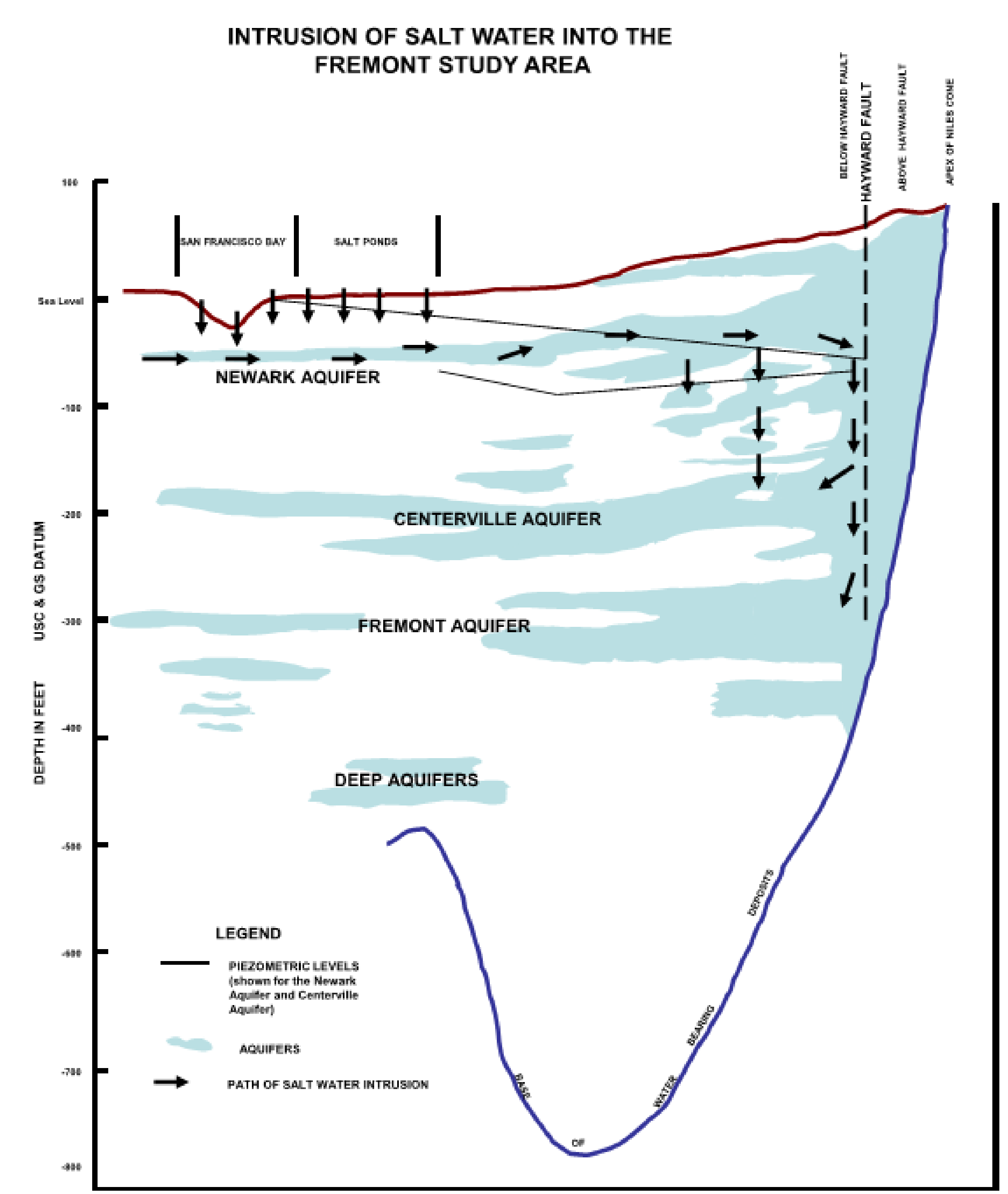
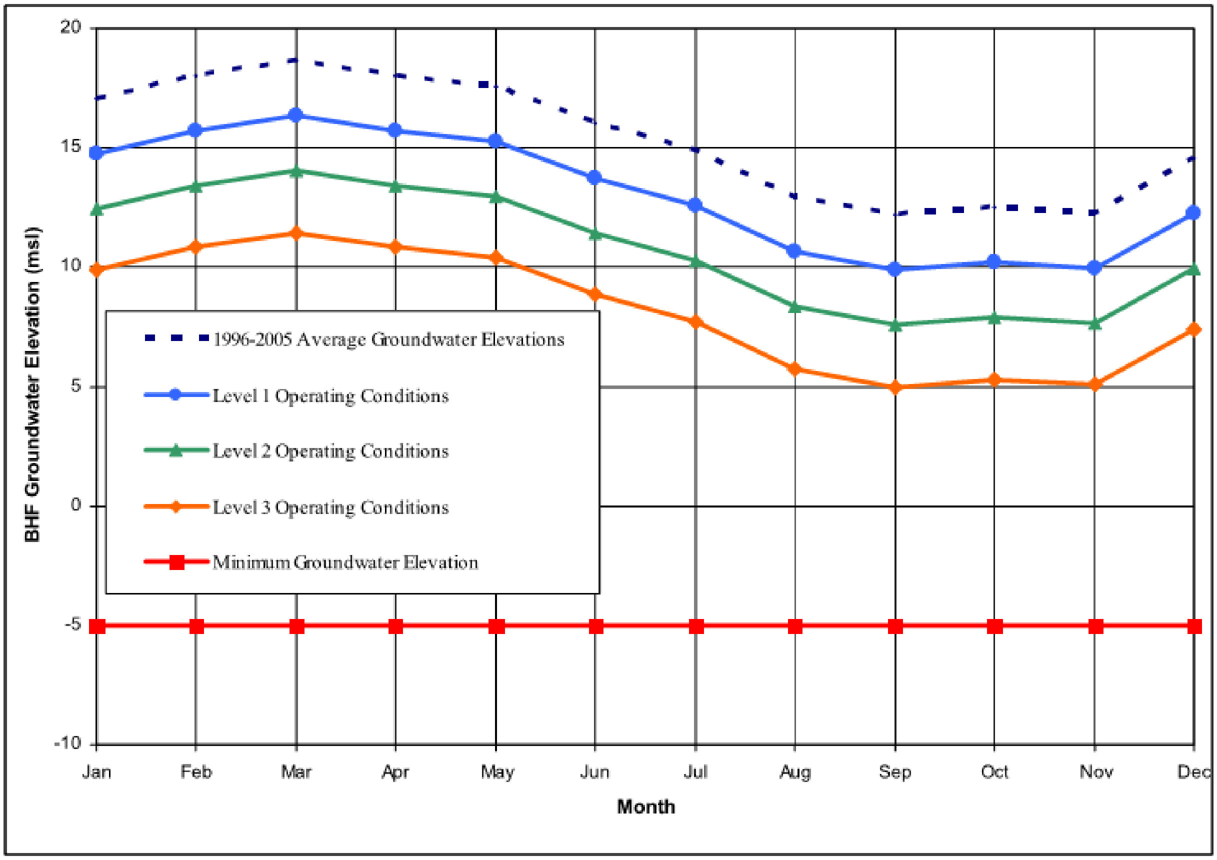


Figure 3-4: Niles Cone Groundwater Basin Aquifers and Saline Intrusion



Source: State of California Dept. of Water Resources. 1968. Bulletin No. 118-1 *Evaluation of Groundwater Resources, South Bay, Volume 1: Fremont Study Area.* August, 1968. Sacramento, Calif.

Figure 3-5: Below Hayward Fault Groundwater Basin – Operating Assumptions

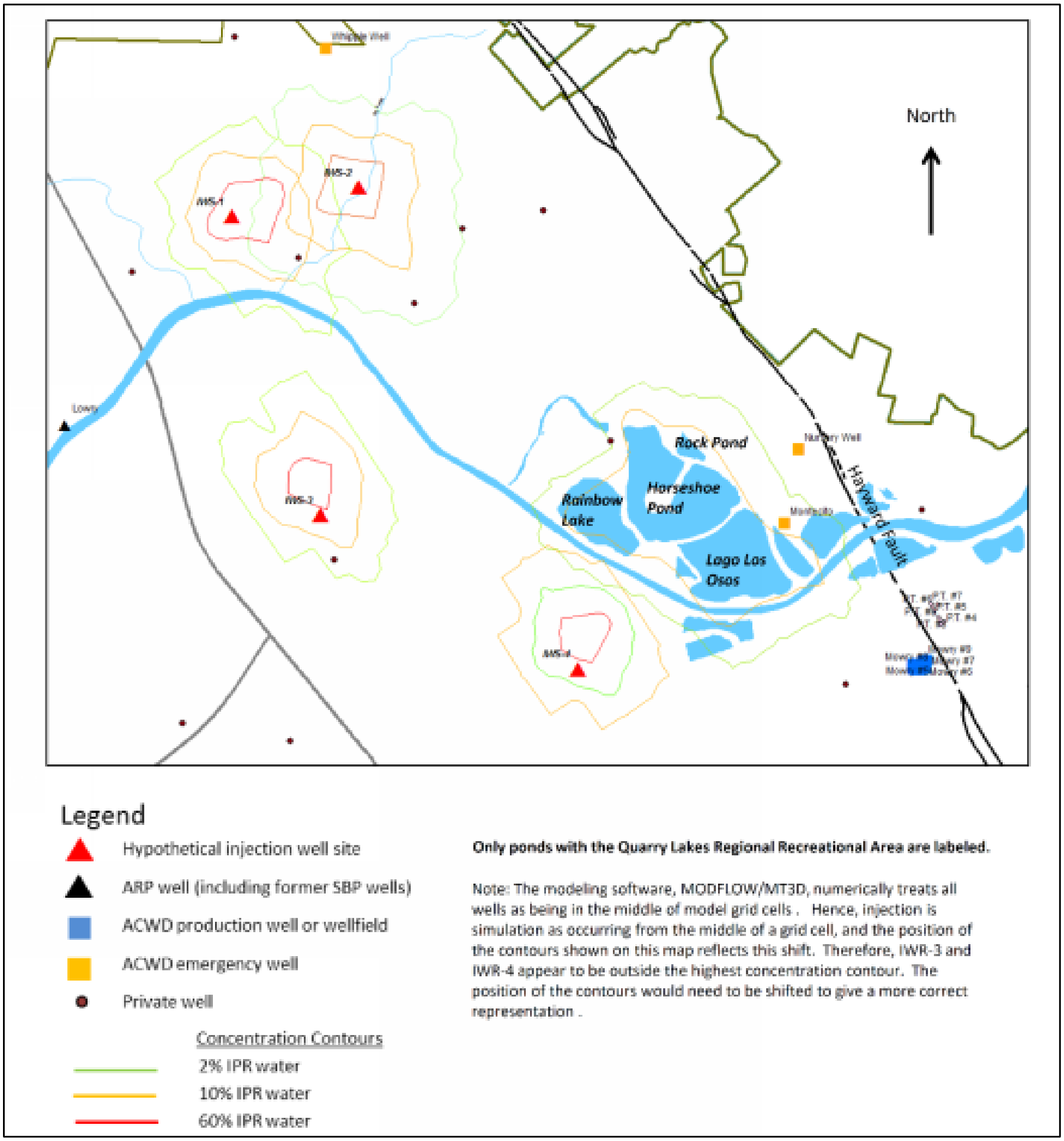


Source: Integrated Resources Planning Study: 10-Year Review, 2006.

Because the regulations for groundwater recharge were new at the time of the study, the 2016 IPR Study established a criterion of seven months of retention time in the groundwater basin based on receiving 0.5-log credit for virus reduction for every month of residence time and a target of achieving at least 3-log credits for virus reduction; this is a month longer than is necessary under the regulations (6-months of modeled retention time for 3-log credits for virus reduction). Previous modeling for a 4 MGD project with infiltration through Quarry Lakes shows that aquifer retention time would be over seven months. In fact, the travel limit for the Quarry Lakes IPR recharge did not reach the Mowry Wellfield within one year, which is consistent with the results of an actual tracer study performed in 1999. However, a larger project with more percolation/injection and more extraction may decrease actual retention time.

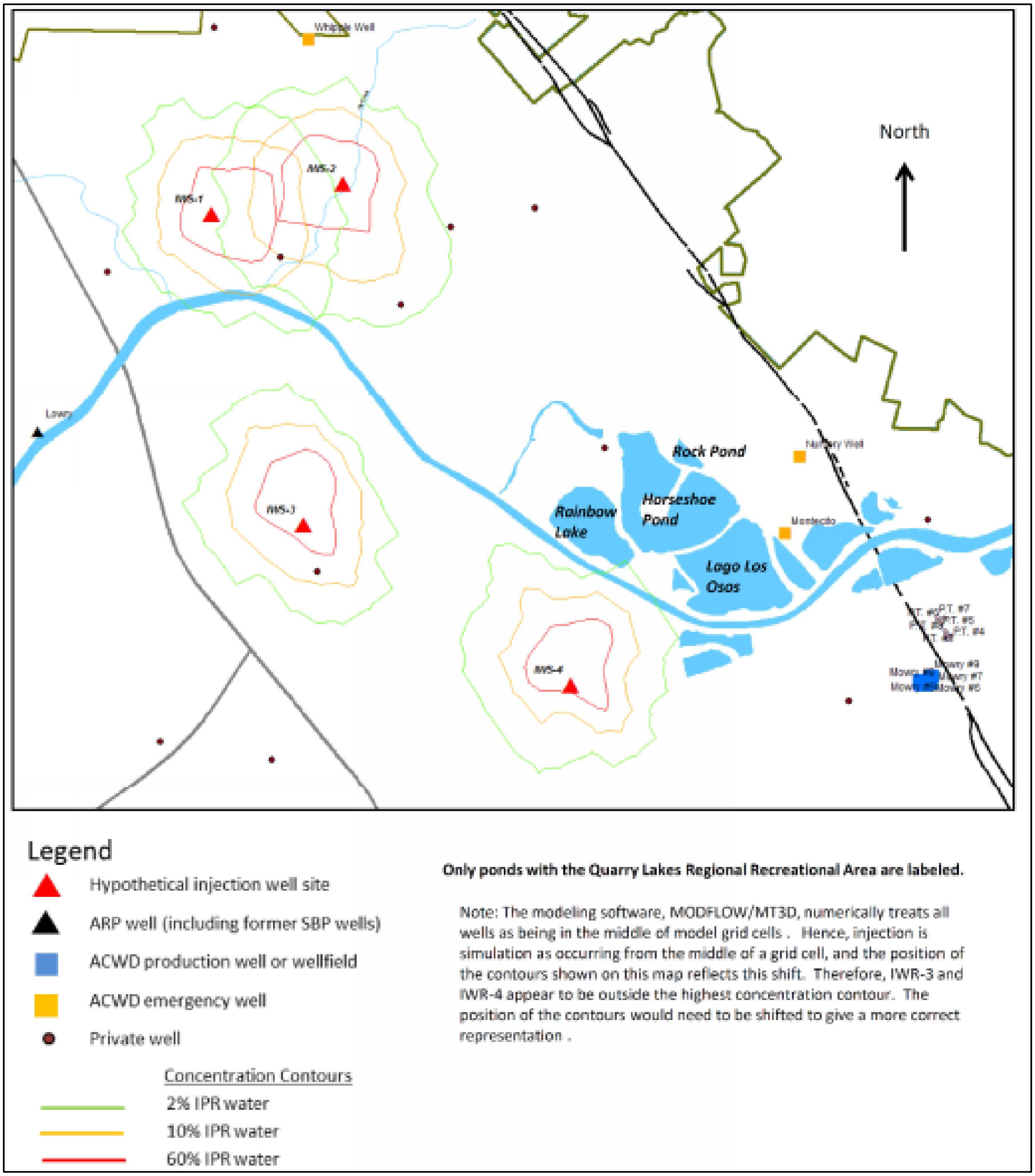
The use of injection wells instead of infiltration through Quarry Lakes may introduce additional constraints. One constraint is that the area within ACWD is very developed–even more so since the 2016 IPR Study--so finding locations to site wells will likely be challenging. In addition, three of the four injection sites modeled for a 4 MGD project may have a retention time of less than seven months before they reach private wells. These private wells are probably not used for drinking water, but additional inquiry would be needed to verify their use. The concentration contours in the Newark and Centerville Aquifers and their proximity to local wells from the 2016 IPR Study are shown in Figure 3-6 and Figure 3-7. Additional groundwater modeling would be needed to estimate retention time for a purified water project larger than 4 MGD.

Figure 3-6: Concentration Contours in Newark Aquifer After Seven Months of Modeling Simulation



Source: ACWD Staff for the 2016 IPR Study

Figure 3-7: Concentration Contours in Centerville Aquifer after Seven Months of Model Simulation



Source: ACWD Staff for the 2016 IPR Study

Potential Mitigations

Select a DPR project – Select an alternative that would avoid the use of infiltration through Quarry Lakes or groundwater injection wells. This would avoid all groundwater-related constraints.

Strategically Site Injection Wells – The 2016 IPR Study proposed locating injection wells based on land availability near the Alvarado-Niles Pipeline and not based on extraction or retention considerations. If injection wells are used in the project, siting these wells could critically impact both realization rates and retention time. Siting injection wells close to existing wellfields may improve realization rates; ACWD would need to confirm this via groundwater modeling and with corresponding reoperation of the groundwater basin (see next section). However, this would also reduce groundwater retention time since the water would travel a shorter distance between injection and extraction. Injection wells should be sited to mitigate whichever constraint most limits project size.

Groundwater Reoperation – As a standard operating procedure, ACWD uses trigger groundwater elevations to decide when to increase groundwater production or recharge groundwater. The standard procedures were developed to protect groundwater supplies and give operators simple rules to follow to decide whether to pump or recharge. Groundwater reoperation would include modifying or re-evaluating the groundwater recharge trigger. Modeling results indicate that a four-foot reoperation is optimal for a 4 MGD purified water project that helps to baseload the basin, but greater reoperation may be undertaken to improve the realization rate of larger recharge projects. Lower groundwater elevations may be achieved without negatively impacting the groundwater basin or sustainability criteria with a constant recharge source such as purified water.

Supplemental Treatment Processes – The minimum required retention time for groundwater recharge projects is 2 months. Up to 4 additional months (for a total of 6 months) can be credited for providing treatment, specifically for virus reduction. In lieu of using retention time in the groundwater basin to achieve all the required pathogen reductions, additional steps can be added to the treatment process. For example, chlorine disinfection can be added to help meet virus and giardia reduction requirements.

Increase Groundwater Production – To create more groundwater basin capacity for recharge, increasing groundwater production (see Chapter 3.2.5) in the necessary parts of the basin could be undertaken. Either increase ability for NDF for blending to meet greater percentage of distribution demands or build groundwater facility well field in the southern end of the distribution system.

Table 3-8: Potential Mitigation to Groundwater Basin Capacity and Retention Time

Potential Mitigation	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation ● – *Easy* ●●● – *Hard*	Likely Cost ● – *Low Cost* ●●● – *High Cost*
Strategically Site Injection Wells	TBD, > 4 MGD	●●	●●
Groundwater Reoperation	TBD, > 4 MGD	●	●
Supplemental Treatment	TBD, > 4 MGD	●	●●●
Increase Groundwater Production	TBD, > 4 MGD	●●	●●

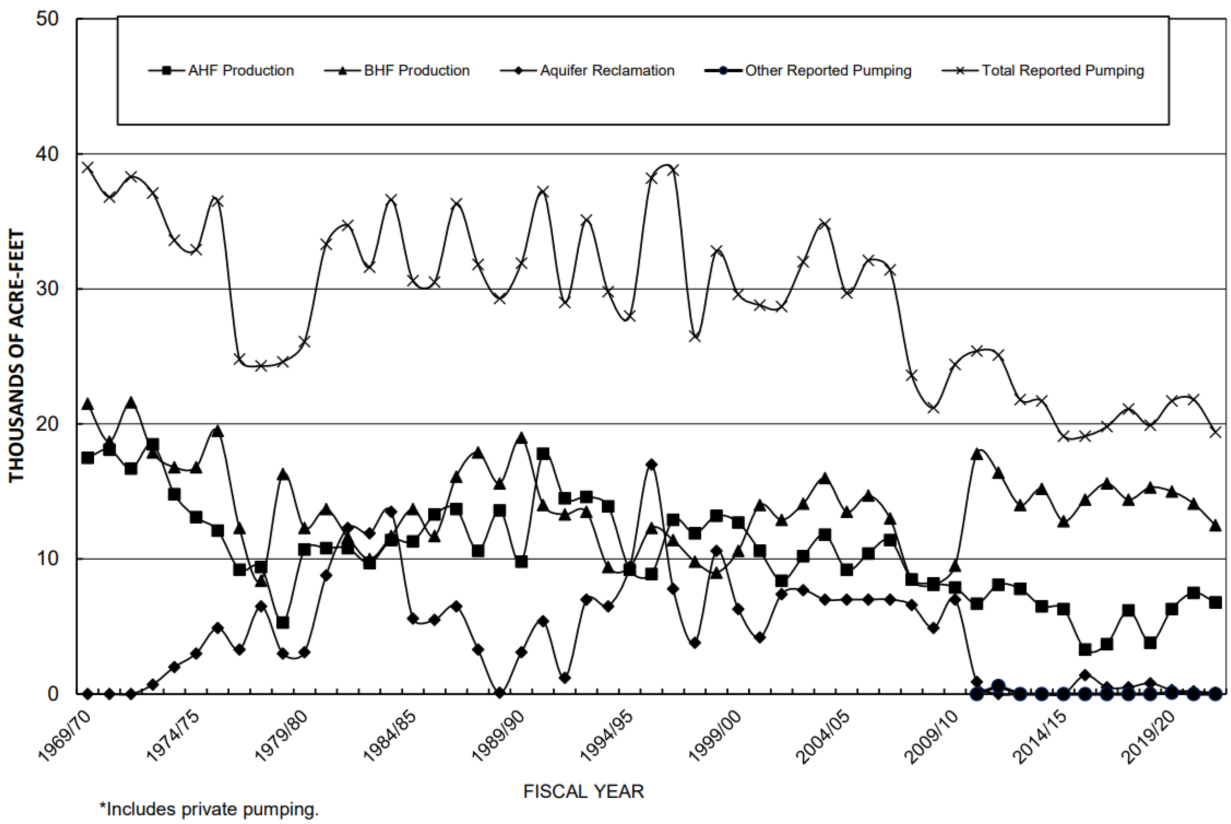
3.2.5 Groundwater Extraction Capacity

The production well capacity may limit the volume of usable purified water or necessitate the construction of additional wells. ACWD has operated two wellfields to extract groundwater for decades. The Peralta-Tyson Wellfield is located east of the Hayward Fault and has eight wells, each with a pumping capacity of approximately 3.2 MGD, and a total capacity of approximately 25 MGD. The Mowry Wellfield is located at west of the Hayward Fault and has eight wells. Of these eight wells, seven have a pumping capacity of approximately 3 MGD and one has a pumping capacity of approximately 1.5 MGD and a total capacity of approximately 22.5 MGD. The total production capacity of Peralta-Tyson and Mowry wells is approximately 47.5 MGD.

Historically, ACWD has extracted up to 35.7 MGD, although recent extraction levels have been closer to 17.9-22.3 MGD. In fiscal year (FY) 2021/2022, total groundwater pumping amounted to 17.3 MGD, with 17.2 MGD considered "production" and 0.1 MGD considered aquifer reclamation (ACWD 2023). ACWD's aquifer ARP restores water quality in certain parts of the basin in which the groundwater has become brackish due to saline intrusion from the San Francisco Bay. Brackish water is pumped out of the groundwater basin and replaced with higher-quality recharge water. Some of this brackish water is fed through the NDF and some of the brackish water is discharged to the Bay. Of the 17.2 MGD produced, 11.2 MGD was produced Below the Hayward Fault compared to 6.1 MGD that was produced Above the Hayward Fault. Pumping projections over the next couple of years show a slight decrease down to 13.6 MGD of total pumping. Figure 3-8 shows ACWD's historical groundwater pumping since FY 1969/1970 (in AF).

One known challenge for a project is getting water to the correct locations in ACWD's existing water distribution system. The distribution system is currently fed from multiple locations (Blender facility, NDF, WTP #2) that are all generally in the north end of the system. Trying to increase groundwater extractions at the Blender facility or at NDF is limited by the distribution system's ability to accept more water at these locations. Increasing size of existing distribution, paralleling of new distribution lines, or developing groundwater facilities in the southern part of the service area could all be ways to overcome this limitation.

Figure 3-8: Historical ACWD Groundwater Pumping: FY 1969/1970 - FY 2021/2022



Source: ACWD Survey Report on Groundwater Conditions (2023)

<u>Potential Mitigations</u>

Select a DPR project – Select an alternative that would avoid the use of infiltration through Quarry Lakes or groundwater injection wells. This would avoid all groundwater-related constraints.

Construct Additional Wells in Existing Wellfields – The construction of additional wells in the two existing well fields would increase ACWD's extraction capacity. Given that the total pumping capacity exceeds recent levels of extraction by up to 38 TAFY (or 25 MGD), the need for additional wells is unlikely.

Expand Distribution System – Given the limitations to moving water to the southern end of the distribution system, expand the distribution system through upsizing and paralleling of existing water distribution lines to carry additional groundwater to the south.

Construct Southern Wellfield - construct a new wellfield in the southern part of the ACWD service area to better balance use of the basin.

Table 3-9: Potential Mitigation to Groundwater Extraction Capacity

Potential Mitigation	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation ● – *Easy* ●●● – *Hard*	Cost Implication ● – *Low* ●●● – *High*
Construct Additional Extraction Wells at Existing Wellfields	46.5	●	●●
Expand Distribution System	Unknown but assumed to be current levels	●●	●●●
Construct Southern Wellfield	Unknown	●●	●●

3.2.6 Quarry Lakes Recharge Capacity

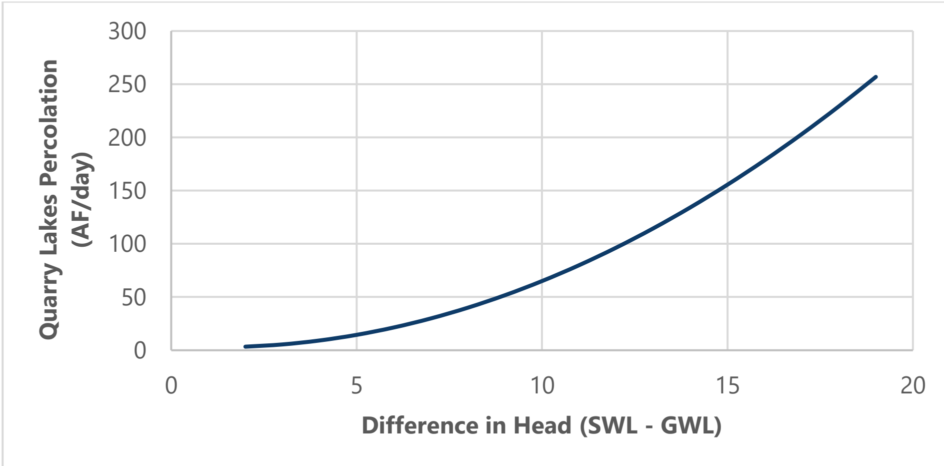
The gravel quarries for which Quarry Lakes Regional Recreation Area is named were established in the mid-19th century. After quarrying ended, the previous pits were converted for groundwater recharge by ACWD for surface water diverted from Alameda Creek. The complex of ponds that make up Quarry Lakes are interconnected via a series of channels and pipes. An overview of the Quarry Lakes system is included in Figure 3-10.

ACWD currently diverts local runoff and SWP water conveyed from the South Bay Aqueduct to the Lakes (at Shinn Pond) for recharge. Local runoff is currently the primary recharge source and SWP water is only diverted for recharge during dry years (roughly once every three years). Any purified water deliveries for recharge will need to be coordinated with the other existing or potential future sources of recharge water in order to maximize recharge at the lakes and avoid overflowing any of the facilities.

The Quarry Lakes straddles the Hayward Fault and provides recharge to both the AHF and BHF sub-basins. On the BHF side, the Quarry Lakes are bathymetrically incised into the Newark Aquifer. Most leakage from the Newark Aquifer to the Centerville-Fremont and Deep aquifers is understood to occur within the greater vicinity of the Quarry Lakes as the shallow-most aquitards appear to be absent just west of the Hayward Fault in the hydrogeologic region called the forebay area, ACWD has established an empirical relationship between the Quarry Lakes/Newark indicator well's groundwater elevation differential and the percolation rate (shown in Figure 3-9). Based on this model, percolation rates can range from zero to 250 acre-feet/day (zero to 80 MGD) with an average percolation rate of roughly 25 acre-feet/day (8 MGD). In order to maintain higher percolation rates, the lake levels must be increased and/or the groundwater level decreased.

The groundwater analysis completed by ACWD as part of the 2016 study showed that the realization rate at the lakes was 100% at an IPR recharge rate of 6.7 MGD and decreased to 97% at an IPR recharge rate of 13.4 MGD. While not evaluated as part of the 2016 study, it is expected that if the recharge rate was increased past 13.4 MGD the efficiency would continue to decrease though this may be counteracted by increased extractions. Further analysis is recommended to confirm that any additional decrease in efficiency (losses to the Bay) as recharge increases are minimal and that there is not a threshold for limiting returns.

Figure 3-9: Quarry Lake Levels (Head) versus Recharge Rate



Potential Mitigations

Select a DPR project – Select an alternative that would not require the delivery of advanced treated water to the Lakes.

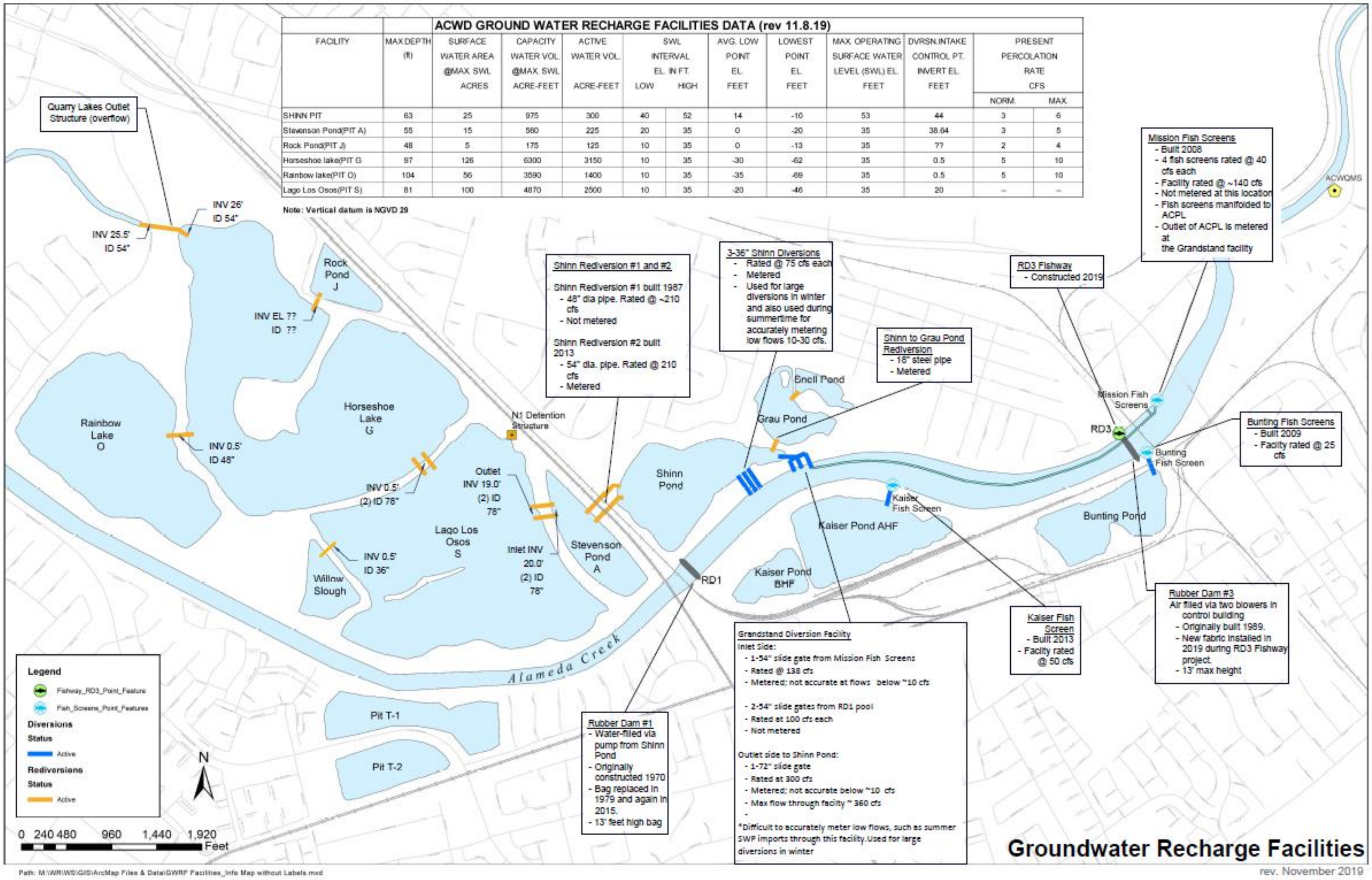
Develop injection wells to supplement Lakes recharge rate – Develop injection wells to bypass (year-round) or supplement (during the wet season) the limiting recharge rate at Quarry Lakes. Wells could be sized and tested to ensure that there would be sufficient recharge capacity for this project. Well locations and screening for the deeper aquifers should be chosen to avoid increasing the groundwater levels near the Lakes which would reduce the percolation rate.

Develop extraction wells closer to Lakes – Develop extraction wells close to Lakes to increase recharge rate. By lowering groundwater levels near the lakes, the recharge model indicates that the recharge rate would increase. At this time, it is difficult to quantify the extraction well capacity and location that would be required to sufficiently decrease the groundwater level to result in the desired increase to the recharge rate. As discussed previously, this would need to be done in coordination with ensuring the required retention within the aquifer is met per regulatory requirements.

Table 3-10: Potential Mitigation to Quarry Lakes Recharge Capacity

Potential Mitigation	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation • – *Easy* ••• – *Hard*	Cost Implication • – *Low* ••• – *High*
Construct new injection wells	8 MGD (Size injection wells to meet any additional recharge above 8 MGD)	•••	•
Construct new extraction wells	Cannot quantify at this time. Additional groundwater modeling required.	•	••

Figure 3-10: Quarry Lakes System



FACILITY	MAX DEPTH (ft)	SURFACE WATER AREA @MAX SWL ACRES	CAPACITY WATER VOL @MAX SWL ACRE-FEET	ACTIVE WATER VOL. ACRE-FEET	SWL INTERVAL EL. IN FT. LOW	SWL INTERVAL EL. IN FT. HIGH	AVG. LOW POINT EL. FEET	LOWEST POINT EL. FEET	MAX. OPERATING SURFACE WATER LEVEL (SWL) EL. FEET	DVRSN.INTAKE CONTROL PT. INVERT EL. FEET	PRESENT PERCOLATION RATE CFS NORM.	PRESENT PERCOLATION RATE CFS MAX.
SHINN PIT	63	25	975	300	40	52	14	-10	53	44	3	6
Stevenson Pond(PIT A)	55	15	560	225	20	35	0	-20	35	38.64	3	5
Rock Pond(PIT J)	48	5	175	125	10	35	0	-13	35	??	2	4
Horseshoe lake(PIT G	97	126	6300	3150	10	35	-30	-62	35	0.5	5	10
Rainbow lake(PIT O)	104	56	3590	1400	10	35	-35	-69	35	0.5	5	10
Lago Los Osos(PIT S)	81	100	4870	2500	10	35	-20	-46	35	20	–	–

3.2.7 Quarry Lakes Water Quality Objectives

Quarry Lakes functions as both a water resource supply and recreational area, making its water quality of high importance. The Quarry Lakes Recreation Unit includes Horseshoe Lake and Rainbow Lake and the turf, beach, swimming, and picnic areas around those lakes. Visitors can swim in the designated beach, picnic, play volleyball, fish, and enjoy non-gasoline powered watercraft. The Natural Unit includes Willow Slough and Lago Los Osos and the surrounding areas, where visitors can hike, observe nature, walk dogs and ride bicycles. No water contact of any type is allowed in Willow Slough and Lago Los Osos.

Quarry Lakes is located within the boundaries of the San Francisco Regional Water Board jurisdiction and is thus covered under the region's Water Quality Control Plan (Basin Plan). As described in the Basin Plan, general, region-wide water quality objectives apply to Quarry Lakes because it is a surface water. 20 objectives are defined for surfaces waters covering the following constituents:

- Bacteria
- Bioaccumulation
- Biostimulatory Substances
- Color
- Dissolved Oxygen
- Floating Material
- Oil and Grease
- Population and Community Ecology
- pH
- Radioactivity
- Salinity
- Sediment
- Settleable Material
- Suspended Material
- Sulfide
- Tastes and Odors
- Temperature
- Toxicity
- Turbidity
- Un-Ionized Ammonia

Additional details about each objective can be found in the Basin Plan.

In addition, Quarry Lakes has additional water quality objectives based on specific beneficial uses supported by the lakes. The beneficial uses specifically identified in Basin Plan Table 2-1 for Quarry Lakes include:

- Groundwater Recharge (GWR)
- Commercial and sport fishing (COMM)
- Cold freshwater habitat (COLD)
- Warm freshwater habitat (WARM)
- Wildlife habitat (WILD)
- Water contact recreation (REC-1)
- Noncontact water recreation (REC-2)

Because Quarry Lakes feeds the groundwater basin, water quality objectives based on state and federal drinking water maximum contaminant levels (MCLs) are applicable to the Quarry Lakes. Additional water quality objectives apply based on recreation and aquatic life beneficial uses as well.

Preventing excess algal growth in Quarry Lakes is key to protecting the aquatic life and water recreation beneficial uses. ACWD and its partner the EBRPD, are aware of the need to reduce nutrient levels (phosphorous and nitrogen specifically) in Quarry Lakes to minimize nutrient loading and subsequent harmful algal blooms. Nitrogen is thought to be the limiting nutrient for Lower San Francisco Bay, and there is a drinking water MCL for nitrate (10 mg/L). As a result, much of the planning work to date has focused on nitrogen rather than phosphorus. Phosphorous is likely the limiting water quality parameter for Quarry

Lakes, but there is no drinking water MCL for phosphorus. It is expected that the treatment train for the AWPF and potential improvements at the Alvarado WWTP would limit the nutrient levels in the product water to well below 10 mg/L of total nitrogen, which is sufficient to meet the drinking water MCL (RMC/Woodard & Curran 2016). The limnological evaluation completed for this Study, included as **Appendix B**, identified additional water quality monitoring that needs to occur at Quarry Lakes in order to develop enough data to create a more detailed model of the lake system and water quality impacts. Based on a screening-level water quality model, it was confirmed that the purified water is expected to improve the quality of Quarry Lakes (see **Appendix B**) for phosphorus, and by extension for chlorophyll *a*. The evaluation also determined that on-site natural treatment at Quarry Lakes to further decrease nutrient levels (e.g., polishing wetlands) would not be necessary.

Like high nutrient levels, bacteria (measured as total coliform or Escherichia coli (E. coli)) could be a concern for both the supply and recreation function of Quarry Lakes. Given State requirements for disinfection for groundwater recharge reuse, bacteria are not likely to be a limiting factor because the treatment train will be required to provide a level of disinfection that will protect all beneficial uses including recreation and water supply.

Potential Mitigations

Select a DPR project – Select an alternative that would not require the delivery of advanced treated water to the Lakes.

Develop injection wells to avoid recharging through lake system – Avoid impacting the lake water quality by directly injecting water to the groundwater basin.

Increased nutrient removal as part of AWPF treatment train – The target nutrient concentration in the Lakes and the level of additional treatment needed at the AWPF will be determined based on the results of Task 4 (Limnological Analysis).

Table 3-11: Potential Mitigation to Quarry Lakes Water Quality Objectives

Potential Mitigation	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation ● – *Easy* ●●● – *Hard*	Cost Implication ● – *Low* ●●● – *High*
Add injection wells	Additional groundwater modeling needed to determine upper limit of injection capacity.	●	●
Increased nutrient removal as part of AWPF treatment train	Based on treatment train selected and influent concentration.	●●●	●●

3.2.8 Newark Desal Facility Capacity

The NDF produces potable water by removing salts and other minerals from brackish groundwater. To produce 12.5 MGD of potable water, the facility blends 10 MGD of RO product water with 2.5 MGD of fresh groundwater. The supply used for the desal facility is generally limited by the availability of fresh water to recharge the Niles Cone Groundwater Basin. In addition to its own capacity, the NDF is also limited by source wells and distribution system constraints in the vicinity of the facility. Accordingly, the current brackish desalination program is currently at full capacity. However, the capacity of the program could be increased with the introduction of purified water as an additional groundwater basin replenishment source. Additionally, the NDF currently runs at a reduced rate in winter due to low customer demand. The increased demand for water from SFPUC as part of a purified water project could increase current production rates to utilize the facility’s maximum capacity year-round.

Similar to increased groundwater extractions, there are limitations to increased use of NDF water based on the distribution system’s ability to move water from the north to the south. Overcoming distribution system limitations to push more water to the south could also increase use of NDF water (at current or with an expanded capacity).

ACWD discharges the RO concentrate from the facility into Line F, a tributary to Plummer Creek which is a brackish water slough discharging into south San Francisco Bay. The expansion of the desal facility may be further constrained by restrictions on discharging the RO concentrate.

Potential Mitigations

Increase Newark Desal Facility Capacity – Since the Newark Desalination Facility capacity is frequently limited by the availability of freshwater to recharge the groundwater basin, upgrading facilities to increase capacity and reliability is likely possible with the addition of purified water as a groundwater recharge source.

Expand Distribution System – Given the limitations to moving water to the southern end of the distribution system, expand the distribution system through upsizing and paralleling of existing water distribution lines to carry additional NDF water to the south.

Bypass the distribution system with a new, isolated pipe – To avoid impacts to the ACWD distribution system and existing customers as well as avoiding any operational complexity, a new pipeline could be constructed from the NDF to directly connect with the BDPL to increase use of the NDF.

Table 3-12: Potential Mitigation to Newark Desal Facility Flowrate

Potential Mitigation	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation ● – *Easy* ●●● – *Hard*	Cost Implication ● – *Low* ●●● – *High*
Increase Newark Desal Facility Capacity	10	●	●●●
Expand Distribution System	Unknown but assumed to be current levels	●●	●●●
Bypass the distribution system with a new, isolated pipe.	Constructability and capacity Diameter (in) / Max Flow (MGD) 12 / 2.5 16 / 4.5 18 / 5.7 20 / 7.1	●●●	●●

	24 10.2		

3.2.9 ACWD Niles Spine Pipeline Capacity

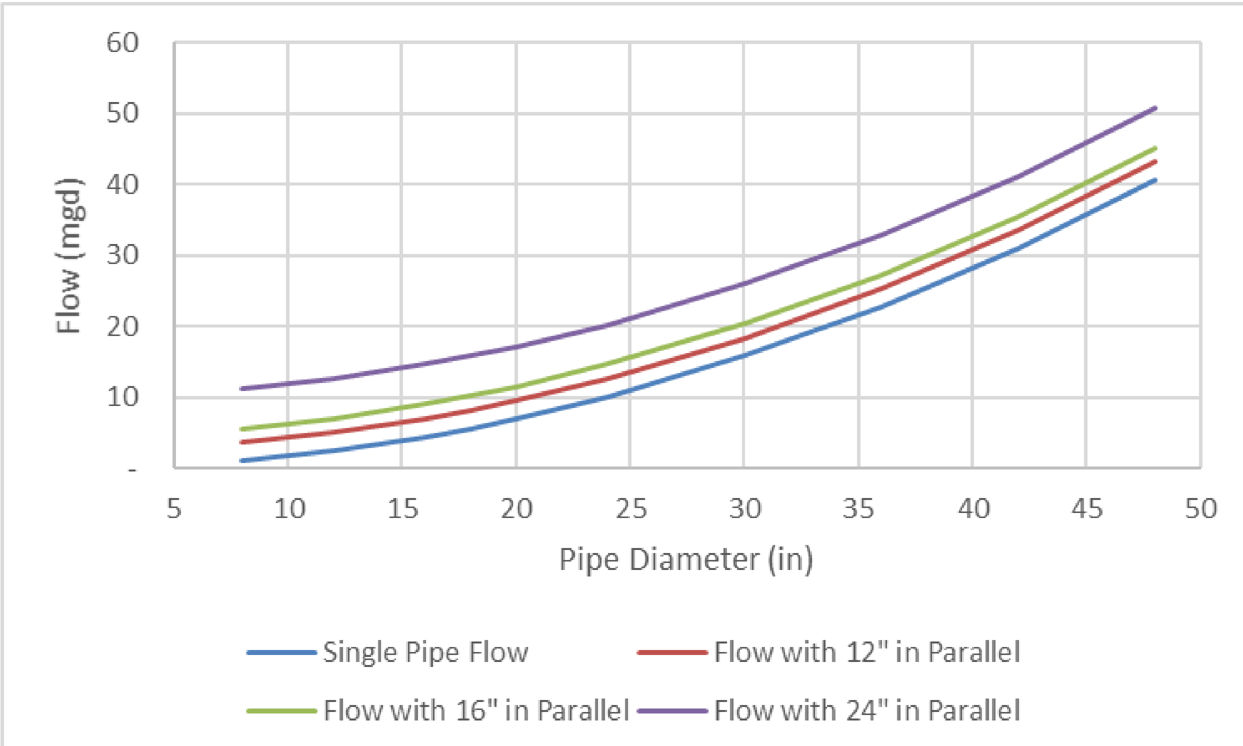
The 2016 IPR Study examined the possibility of reusing an existing ACWD water line (Niles Spine) that will be abandoned as part of water system improvements. The Niles Spine pipe diameter varies between 12- and 16-inches and runs a significant length between the Alvarado WWTP and Quarry Lakes along Alvarado Niles Road (confirmed by Rekha Ippagunta, ACWD project engineering). An overview of the Niles Spine pipeline alignment is included in Figure **3**-**11** including notation of the phased improvement timelines.

Construction of Phase 1 of the Alvarado-Niles Pipeline Seismic Improvement Project completed in 2021 and included the installation of approximately 1.7 miles of new pipeline along Smith Street and Alvarado-Niles Road, between Union City Boulevard and Central Avenue (excluding the portion of the pipeline proposed within the Caltrans right-of-way at the Interstate 880 interchange). Any future use of the older (out of service) pipeline will require that prior discharge points (hydrant and service laterals) be properly abandoned. In addition, the disconnection of several side street distribution mains means that the existing pipeline will essentially have 6-inch to 12-inch outlets at various different locations. Phase 2 of the project will begin after completion of Phase 1 and is roughly the same scale (length, number of outlets, etc.) as Phase 1. There are some small sections of the Spine pipeline which are currently designated for removal as part of the Seismic Improvement Project.

Following completion of the Seismic Improvement Project, the Niles Spine pipeline could be repurposed to deliver purified water to either Quarry Lakes or new injection wells. Alternatively, the pipeline could be reused as a RO Concentrate line if the AWPF is sited nearby. Both options may require coordination with the Division of Drinking Water who regulates the separation requirements from potable water mains. Given a minimum project size of 4 MGD, a significant portion of the Niles Spine pipeline is undersized. Based on ACWD's design criteria for pipe sizing with the maximum velocity not to exceed 5 feet per second, a 12-inch pipeline has a capacity of about 2.5 MGD and a 24-inch pipeline has a capacity of about 10 MGD. To convey a flow of 20 MGD, a 36-inch pipe would be required. The pipeline size required for a range of project sizes, either in parallel to the existing pipe or as the only conveyance pipe, is included in Figure 3-12.

Figure 3-11**: Alvarado-Niles Spine Pipeline Alignment**

Figure 3-12: Pipeline Diameter Required versus Project (Flow) Size



Note: Available wastewater from Alvarado WWTP is limited to 23 MGD.

Potential Mitigations

Upsize the smaller sections of the repurposed Alvarado-Niles pipeline – To meet the design criteria for a 9 MGD flow, smaller sections of the Niles Spine pipe would need to be replaced with a 24-inch pipe. Depending on the size of the pipeline, pipe bursting or open cut technology would be utilized.

Install a parallel pipe along all or part of the Niles Spine alignment – To meet the design criteria for a 9 MGD flow, a 20-inch pipe would be needed in parallel to an existing 12-inch segment and a 16-inch pipe would be needed in parallel to an existing 16-inch segment.

Install a new larger diameter pipe and do not reuse the repurposed Alvarado-Niles pipeline – Install a new pipe (24-inch pipe for 9 MGD; 36-inch for 20 MGD) to deliver water from the AWPF to the Quarry Lakes or injection wells.

Table 3-13: Potential Mitigation to ACWD Alvarado-Niles Spine Pipeline Capacity

Potential Mitigation	Limits to Purified Water Conveyed at Various Pipeline Diameters (MGD)	Ease of Implementation *● – Easy* *●●● – Hard*	Cost Implication *● – Low* *●●● – High*
Upsize the smaller sections of the Niles Spine pipeline	Diameter (in) — Max Flow (MGD) 12 (stet) — 2.5 16 — 4.5 18 — 5.7 20 — 7.1 24 — 10.2	●●	●●
Install a parallel pipe along all or part of the Niles Spine alignment	Pipe 1 (in) — Pipe 2 (in) — Max Flow (MGD) 12 — 16 — 7.1 12 — 20 — 9.6 12 — 24 — 12.7 12 — 30 — 18.4 16 — 20 — 11.6 16 — 24 — 14.7	●●	●●
Install a new larger diameter pipe and do not reuse the existing Spine	Diameter (in) — Max Flow (MGD) 12 — 2.5 16 — 4.5 18 — 5.7 20 — 7.1 24 — 10.2 30 — 15.9 36 — 22.8	●●	●●

3.2.10 ACWD Distribution System Capacity

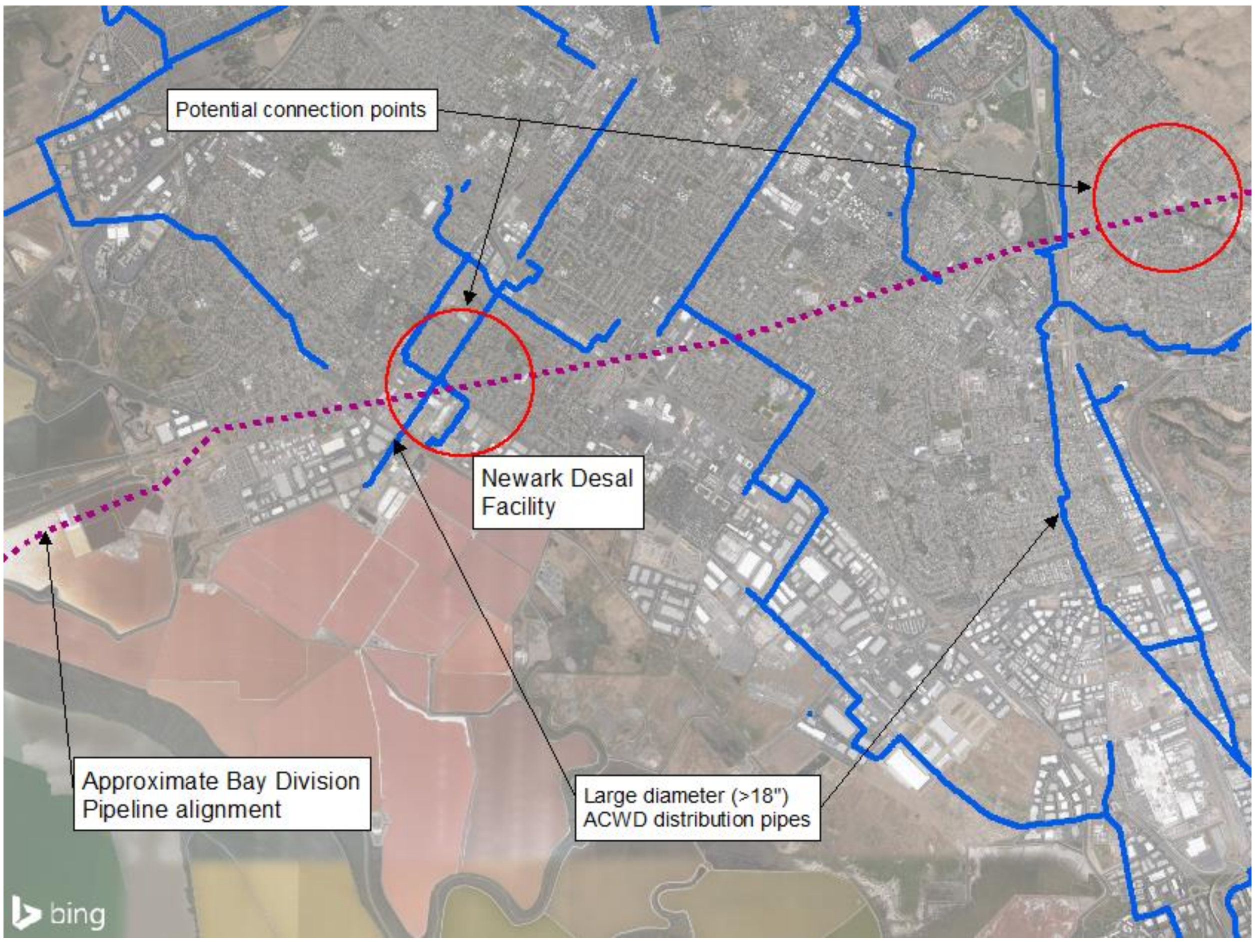
If the new supply source is directly connected to the ACWD potable water distribution system, a new connection could be made with SFPUC's Bay Division Pipeline (BDPL) as a means to transfer water between the partners. In one alternative, water from ACWD's Newark Desal Facility (NDF) would be transferred to the SFPUC BDPL. This connection could be made through an extension of ACWD's existing potable water distribution system near the NDF as the supply to that area of the systems is not thoroughly mixed with other supply sources. In particularly, ACWD's existing large diameter (over 18-inches) pipelines to the north of the NDF could be extended to facilitate the connection to the BDPL as it runs nearby.

In a second alternative, ACWD's distribution system could be connected to the BDPL in the eastern hills, near the BDPL Irvington Portal, which would provide SFPUC with additional operational flexibility. In this case, water transferred to the BDPL would be a mix of ACWD supplies, but primarily under the influence of WTP #2.

By connecting to the BDPL at either location, the demand in the northern region of the ACWD distribution system would greatly increase and potentially stress the facilities nearby and impact existing customer services. An overview of the ACWD facilities and approximate BDPL alignment are presented in Figure 3-13.

Per discussions with ACWD, the existing large pipelines in the area have adequate capacity to serve the BDPL in addition to existing customers. As an added benefit, the new connection may create mixing of supplies and/or reduce water age for ACWD's customers in the area. That said, both ACWD and SFPUC have indicated that there may be significant operational complexity, primarily overcoming the pressure differential between the two systems and compatibility of differing water sources, to directly link the systems regardless of its exact location.

Figure 3-13: Overview of ACWD Pipelines Near Bay Division Pipelines



Note: Connection point to the west under the influence of NDF and connection point on the east under the influence of WTP #2.

Potential Mitigations

Upsize pipes in the ACWD distribution system – To ensure adequate pipeline capacity, a critical portion of ACWD distribution pipeline could be upsized to facilitate conveyance of the additional flow to the BDPL.

Isolate the connection to the BDPL – To reduce operational complexity, the water transfer via a connection with the ACWD distribution system would isolate the new "demand" as much as possible. This could be achieved by constructing a special tank, fed by the distribution system, and pump station to feed the BDPL. While the space required for a pump station is small, a tank can have a large footprint and would therefore need to be carefully sited.

Bypass the distribution system with a new, isolated pipe – To avoid impacts to the ACWD distribution system and existing customers as well as avoiding any operational complexity, a new pipeline could be constructed from the NDF to directly connect with the BDPL.

Table 3-14: Potential Mitigation to ACWD Distribution System Capacity

Potential Mitigation	Limit	Ease of Implementation ● – *Easy* ●●● – *Hard*	Cost Implication ● – *Low* ●●● – *High*
Upsize pipes in the ACWD distribution system	If the pipeline upsize is significant, there may not be sufficient space in the existing alignment. The pipeline upsize will not address operational complexities related to the system connections.	●●	●●
Isolate the connection to the BDPL	Space to site a tank and pump station. Space required to be determined.	●	●●●
Bypass the distribution system with a new, isolated pipe.	Constructability and capacity Diameter (in) / Max Flow (MGD) 12 / 2.5 16 / 4.5 18 / 5.7 20 / 7.1 24 / 10.2	●●●	●●

3.2.11 SFPUC Bay Division Pipelines Capacity

SFPUC has three Bay Division Pipelines (BDPL) running through the ACWD service area (BDPL 1, 2 and 5) which serve water to the Peninsula through the Bay Tunnel. The combined capacity of these pipelines is roughly 180 MGD. Over the period of January 2017 to October 2019, average flows in the pipes are around 100 MGD. Average monthly flows are greatest during the summer (around 1.4 times average) and lowest during the winter months (around 0.6 of average).

In order to facilitate the addition of the continuous supply from the NDF, the operations of the BDPL may require adjusting so as to not exceed the pipeline capacity. While recent flow data indicate that there may be available capacity in the pipelines for most of the year, both ACWD and SFPUC have indicated that there may be significant operational complexity to adjust the operations of the BDPL. A more likely scenario would be to include storage for NDF product water to time deliveries from the NDF to the BDPLs at periods of low flows. Additional review of BDPL hourly flows are needed to determine storage requirements; this may require additional field data gathering by SFPUC.

Potential Mitigations

Construct storage for the NDF product water – Include storage of NDF product water to time deliveries to SFPUC to periods of low flow. It is unclear as to how much variation in flow there is over the course of a day, but it is assumed this storage would be timescale of a few hours (not full day or seasonal storage).

Adjust the BDPL operations – The timing of flow routed through the BDPLs could be monitored and adjusted, as needed, to facilitate a continuous flow from the NDF. SFPUC has indicated that there is minimal storage on the downstream side of the BDPL meaning that operations would potentially be altered upstream of the ACWD service area.

Table 3-15: Potential Mitigation to SFPUC Bay Division Pipelines Capacity

Potential Mitigation	Limit	Ease of Implementation ● – *Easy* ●●● – *Hard*	Cost Implication ● – *Low* ●●● – *High*
Construct storage for the NDF product water	Unknown; would need to analyze hourly BDPL flows to determine sizing of storage tank.	●●●	●
Adjust the BDPL operations	Unknown; would need to analyze hourly BDPL flows	●●	●

3.2.12 Water Treatment Capacity

If pursuing DPR project options (both RWA and TWA), the capacity of existing water treatment facilities must be considered. The production from WTP #2 for FY 2018/2019 was 19.6 MGD and the facility is considered to have a production capacity of 21 MGD. However, a capacity study conducted in 2016 indicated that ACWD can operate WTP #2 to produce and deliver up to 28 MGD with no modifications to the existing equipment or operating procedures[1]. The 2016 study recommended additional plant-scale studies at the treated water production rate of 28 MGD to confirm performance of the filters and backwash facilities and refine high-rate operating strategies. (CDM Smith, 2016). Thus, production could potentially be increased by approximately 7 MGD with no significant physical modifications; modifications to existing surface water supply feeds would likely need to be altered and/or demands increased to match up water supply with water demands. An RWA purified water project exceeding 8 MGD would require a physical expansion of facilities of WTP #2 and coordination with other existing water supplies and/or demands to adjust operations accordingly. Additionally, treatment facilities may need to be modified to accept purified water as influent water quality may be different from current sources.

1 Some modification of significance to WTP #2 may be required. Further analysis is required.

The MSJWTP is in the process of being decommissioned temporarily and its treatment facilities considered unusable for a DPR project. However, the site may be used to construct a new WTP facility if desired. If a large RWA DPR project is implemented and space is limited at WTP #2 for additional treatment capacity, this may be an attractive option. Alternatively, for a TWA DPR project, a new WTP designed for purified water as an influent could be sited at the Mission site.

Potential Mitigations

Expand WTP #2 – WTP #2 could increase production by approximately 8 MGD[1]. A DPR project larger than 8 MGD would require a physical and operational expansion of WTP #2.

Build New WTP at Mission Site – The Mission site could be used to construct an entirely new WTP. This would be an expensive mitigation but offers the benefit of available land and potentially minimal impact to ACWD's existing potable water operations.

Select an IPR Project – Selecting a groundwater recharge project would avoid the need for expanded WTPs.

Table 3-16: Potential Mitigation to WTP Capacity

Potential Mitigation	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation *● – Easy ●●● – Hard*	Cost Implication *● – Low* *●●● – High*
Expand WTP #2	8	●●	●●●
Build New WTP at Mission Site	TBD pending treatment train for RWA or TWA	●●	●●●

3.2.13 Summary of Mitigations

In total, there are 28 different mitigation strategies identified that can address the 13 constraints. A summary of the mitigation strategies is presented in Table 3-17.

[1] Some modification of significance to WTP #2 may be required. Further analysis is required.

Table 3-17: Mitigation Option Summary

	Potential Mitigation	Description	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation • – *Easy* ••• – *Hard*	Cost Implication • – *Low* ••• – *High*	RO Concentrate Volume	Available Wastewater Flow	Land Availability for New AWPF	Groundwater Basin Capacity and Retention Time	Groundwater Extraction Capacity	Quarry Lakes Recharge Capacity	Quarry Lakes Water Quality “ Capacity”	Newark Desal Facility Flowrate	ACWD Alvarado-Niles Spine Pipeline Capacity	ACWD Distribution System Capacity in Vicinity of NDF	SFPUC BDPL Capacity	WTP Capacity
1	Select a DPR project	Select an alternative that would not require the delivery of advanced treated water to Quarry Lakes and/or the groundwater basin.		•••	••				X	X	X	X					
2	Grant Dilution Credits	Regulatory approach to mitigating exceeding discharge limits.	4.0 MGD (Bis-2) 14.3 MGD (Nickel) 22.7 MGD (Zinc)	•	•	X											
3	Moving Point of Compliance	Move point of compliance to end of secondary treatment train.	6.7 MGD	•	None	X											
4	Ammonia Removal	Implement BNR to remove total Nitrogen loading	11.1 MGD	•	•	X											
5	Regulatory Negotiation	Negotiate with Regional Board to get additional dilution credits.	15.7 MGD (Cyanide) 21.9 MGD (Copper)	••	•	X											
6	Flow Equalization	Conversion of existing facilities at WWTP into equalization basins.	7.6 MGD (with expected recovery rate) (16.8 MGD with 2.5 MG of storage)	•	••		X										
7	Flow Equalization (3.8 MG total)	Additional flow equalization implemented at WWTP or in collection system.	16.8 MGD (with expected recovery rate) (19.3 MGD with 3.8 MG of storage)	••	•••		X										
8	Increase Recovery Rate from AWPF Process	Use closed-circuit desalination to increase recovery rate to 95%	8.6 MGD (without flow equalization) 21.9 MGD (with complete flow equalization)	••	•••		X										
9	Consolidation	Stacking facilities at the new AWPF to be more space efficient.	Varies based on treatment train selected.	••	•••			X									
10	Co-location	Co-locate an AWPF with existing ACWD or USD facilities outside of the WWTP to reduce the need for space for ancillary facilities.	Varies based on treatment train selected.	•	•			X									

	Potential Mitigation	Description	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation • – *Easy* ••• – *Hard*	Cost Implication • – *Low* ••• – *High*	RO Concentrate Volume	Available Wastewater Flow	Land Availability for New AWPF	Groundwater Basin Capacity and Retention Time	Groundwater Extraction Capacity	Quarry Lakes Recharge Capacity	Quarry Lakes Water Quality " Capacity"	Newark Desal Facility Flowrate	ACWD Alvarado-Niles Spine Pipeline Capacity	ACWD Distribution System Capacity in Vicinity of NDF	SFPUC BDPL Capacity	WTP Capacity
11	Site Reuse	Reuse the MSJWTP site.	MSJWTP site is approximately 5.5 acres which could be used for a 23 MGD IPR or 16.5 MGD DPR facility.	••	•••			X									
12	New Plant/Site	Identify a vacant lot or lot for redevelopment to build an AWPF.	Lot Size (acre) / IPR (MGD) / DPR (MGD) 1 / 4.3 / 3.0 2 / 8.5 / 6.0 3 / 12.8 / 9.0 4 / 17.1 / 12.1 5 / 21.4 / 15.1 6 / 25.6 / 18.1 7 / 29.9 / 21.1	•••	•••			X									
13	Strategically Site Injection Wells	Site injection wells to improve realization rate at existing wellfields or to increase groundwater retention time	TBD, > 4 MGD	••	••				X		X						
14	Groundwater Reoperation	Lower trigger groundwater levels to change when to extract and recharge groundwater.	TBD, > 4 MGD	•	•				X								
15	Supplemental Treatment	Add additional treatment steps to the purified water process train.	TBD, > 4 MGD	•	•••				X								
16	Construct Additional Extraction Wells at Existing Wellfields	The construction of additional wells would increase ACWD's extraction capacity.	46.5 MGD	•	••					X							
17	Expand Distribution System	Increase capacity to distribute flows to the southern end of the ACWD distribution system by paralleling water lines or creating a new wellfield	Unknown but assumed to be current levels	••	•••					X			X				
18	Construct Southern Wellfield	Increase capacity to distribute flows to the southern end of the ACWD distribution system by creating a new wellfield	Unknown	••	••					X							

	Potential Mitigation	Description	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation • – *Easy* ••• – *Hard*	Cost Implication • – *Low* ••• – *High*	RO Concentrate Volume	Available Wastewater Flow	Land Availability for New AWPF	Groundwater Basin Capacity and Retention Time	Groundwater Extraction Capacity	Quarry Lakes Recharge Capacity	Quarry Lakes Water Quality " Capacity"	Newark Desal Facility Flowrate	ACWD Alvarado-Niles Spine Pipeline Capacity	ACWD Distribution System Capacity in Vicinity of NDF	SFPUC BDPL Capacity	WTP Capacity
19	Develop injection wells to supplement Lakes recharge rate	Develop injection wells to bypass the limiting factors of Quarry Lakes.	8 MGD	•	•						X	X					
20	Increased nutrient removal as part of AWPF treatment train	Increase nutrient removal at the AWPF.	Based on treatment train selected and influent concentration.	•••	••							X					
21	Increase Newark Desal Facility Capacity	Increase capacity at the NDF.	10 MGD	•	•••								X				
22	Upsize the smaller sections of the pipeline	Upsize sections of the Alvarado-Niles Spine or ACWD distribution system to increase capacity.	Diameter (in) / Max Flow (MGD) 12 (stet) / 2.5 16 / 4.5 18 / 5.7 20 / 7.1 24 / 10.2	••	••									X	X		
23	Install a parallel pipe along all or part of the Niles Spine alignment	Install a parallel pipe along all or part of the Niles Spine alignment or along existing ACWD distribution pipe.	Pipe 1 (in) / Pipe 2 (in) / Max Flow (MGD) 12 / 16 / 7.1 12 / 20 / 9.6 12 / 24 / 12.7 12 / 30 / 18.4 16 / 20 / 11.6 16 / 24 / 14.7	••	••									X	X		
24	Install a new larger diameter pipe	Install a new pipe to bypass either the Niles Spine pipe or the ACWD distribution pipe.	Diameter (in) / Max Flow (MGD) 12 / 2.5 16 / 4.5 18 / 5.7 20 / 7.1 24 / 10.2 30 / 15.9 36 / 22.8	••	••								X	X	X		
25	Construct storage for the purified water	Construct storage to time deliveries of purified water to SFPUC during times of lower flows in the BDPLs.	Unknown; would need to analyze hourly BDPL flows to determine sizing of storage tank.	•••	•											X	

	Potential Mitigation	Description	Limit of Purified Water Produced without Mitigation (MGD)	Ease of Implementation ● – *Easy* ●●● – *Hard*	Cost Implication ● – *Low* ●●● – *High*	RO Concentrate Volume	Available Wastewater Flow	Land Availability for New AWPF	Groundwater Basin Capacity and Retention Time	Groundwater Extraction Capacity	Quarry Lakes Recharge Capacity	Quarry Lakes Water Quality " Capacity"	Newark Desal Facility Flowrate	ACWD Alvarado-Niles Spine Pipeline Capacity	ACWD Distribution System Capacity in Vicinity of NDF	SFPUC BDPL Capacity	WTP Capacity
26	Adjust the BDPL operations	Adjust the BDPL flows to facilitate a continuous flow from the NDF	Unknown; would need to analyze hourly BDPL flows	●	●											X	
27	Expand WTP #2	Increase production at WTP #2 for DPR option.	8 MGD	●●	●●●												X
28	Build New WTP at Mission Site	Construct new WTP to use with DPR option.	TBD pending treatment train for RWA or TWA	●●	●●●												X

3.3 Additional Considerations

The following additional considerations are important to the implementation of all potable reuse project alternatives, but are not specific to one of the partner's assets. These elements are likely to be considered for all potable reuse alternatives investigated in this Study.

3.3.1 Public Outreach to Ensure Public Acceptance

Public outreach to communicate with local constituents is a key component of ensuring public acceptance of utilizing purified water. Public outreach can begin as soon as the Partners are comfortable discussing a proposed project, or projects, with the local communities. This could start in the next phase of work (see Chapter 11).

3.3.2 Existing Water Supplies

ACWD has existing contracts and water rights that may impact if and how they can provide regional water supplies to SFPUC. This includes contractual minimums for water purchases existing in ACWDs contract with SFPUC, and ACWD's existing contract to State Water Project supplies. These contracts may need to be renegotiated or reassigned to reflect updated water supply needs once the purified water project is in place.

3.3.3 Governance

Given the current ownership and operation of different facilities, there will be a need to consider governance of a potable reuse project including ownership of facilities, capital cost financing and funding, ongoing operational costs and responsibilities, and liability for purified water quality. There are several entities that have worked through these questions as discussed in detail in Chapter 4 – Lessons Learned from Other Agencies.

4. LESSONS LEARNED FROM OTHER AGENCIES

This chapter summarizes lessons learned and recommendations for potable reuse project implementation based on survey results collected from Monterey One Water (M1W), OCWD, and the City of San Diego (San Diego), and the project team's experience with these and other potable reuse projects. These lessons learned and recommendations will aid in developing the project alternatives for this Study and will help in the future to develop implementation plans and next steps.

A survey was developed with the Partners, building on information from "Model Communication Plans for Increasing Awareness and Fostering Acceptance of Potable Reuse" (WRRF-1302) and questions/issues specific to the USD/ACWD/SFPUC potable reuse setting. The survey was organized into the following categories:

- Public Outreach
- Regulatory and Permitting Approaches
- Operational Considerations
- Cost/Revenue Allocation Between Partners
- Insurance, Liability and Indemnifications Between Agencies

M1W, OCWD, and San Diego were selected for the survey because of their successful implementation of potable reuse. Project summaries are provided in the following subsection. The complete list of survey questions is included in **Appendix C.**

4.1 Surveyed Project Background

This chapter provides a brief background on the projects and associated agencies surveyed. Water supply, wastewater management, and environmental drivers for each of the projects are summarized in Table 4-1.

Table 4-1: Project Drivers

Project	Water Supply	Wastewater Management	Environmental
Groundwater Replenishment System, Orange County	• Desired a reduced reliance on imported supply • Experienced a diminishing replenishment of local GW basin via Santa Ana River (upstream WW dischargers increasing water recycling and discharging less effluent to River)	Enabled Orange County Sanitation District to avoid an ocean outfall expansion	Improve groundwater quality by replenishment with advanced treated water
North City Pure Water, City of San Diego	Desired a reduced reliance on imported supply	Pt Loma WWTP consent decree stipulates TSS reduction in ocean discharge; latest consent decree requires the Pure Water program	Potential implications associated with Pt Loma WWTP Advanced Primary Treatment
Pure Water Monterey Groundwater Replenishment, Monterey Peninsula	• No access to imported supply options (Monterey Peninsula not connected to State or Federal Water Projects); e.g., not able to recharge import supplies to GW basin for replenishment • Complementary project to regional water supply project (desalination project); M1W will provide additional groundwater replenishment capacity, up to 6.4 MGD	Potential future ocean discharge regulations (i.e. a requirement to eliminate discharges to the ocean)	• Improve groundwater quality by replenishment with advanced treated water • Reduce water retailer diversions from the Carmel River • "Bank" GW for future drought years

Notes:
1. GW = groundwater
2. Pt Loma WWTP = Point Loma Wastewater Treatment Plant
3. TSS = Total Suspended Solids

Groundwater Replenishment System, Orange County, California

The Groundwater Replenishment System (GWRS) is a joint groundwater augmentation project incorporating both surface spreading and subsurface injection between OCWD and Orange County Sanitation District (OCSD). The GWRS serves Orange County and produces:

1) up to 39,205 acre-feet per year (AFY) (35 MGD) of purified water for injection into the Talbert Seawater Intrusion Barrier (Talbert Barrier);

2) up to 72,810 AFY (65 MGD) of purified water for surface water spreading at the Kraemer-Miller-Miraloma-La Palma Basins (K-M-M-L Basins); and
3) the GWRS also serves a small non-potable industrial demand.

Features of the GWRS setting are presented in Table 4-2.

Table 4-2: GWRS Project Setting

Agency	GWRS Project Lead Agency	WWTP Owner/ Operator	AWPF Owner/ Operator	Purified Water Conveyance	Receiving Water Body/ Infrastructure	Partnering Retail Water Agencies
OCSD		X				
OCWD	X		X	X	Groundwater Basin Manager/ Operator	
Ground-water Producers						X

OCSD owns and operates Plant No. 1 and No. 2 which provide secondary treated wastewater to the GWRS. OCWD owns and operates the GWRS facilities which includes the AWPF, Talbert Barrier, K-M-M-L Basins, non-potable facilities, and the Demonstration Mid-Basin Injection (DMBI) Project. OCWD is also responsible for management of the Orange County Groundwater Basin. OCSD and OCWD partner responsibilities are defined in a Joint Operating Agreement.

The GWRS began operation of its 70 MGD AWPF in 2008, with a 30 MGD expansion in 2015. OCWD is currently constructing the final expansion of GWRS to 130 MGD of overall production capacity. Construction began in 2019 and is estimated for completion in 2023.

North City Pure Water Project, San Diego, California

The North City Pure Water Project (North City Project) is a surface water augmentation project and the first phase of the Pure Water San Diego Program by the City of San Diego. When the North City Project is completed, it will provide:

1. up to 33,600 AFY (30 MGD) of purified water to augment raw imported water that currently sources Miramar Reservoir and
2. up to 4,480 AFY (4 MGD) of purified water for salinity management of San Diego’s non-potable system.

Features of the North City Pure Water Project setting are presented in Table 4-3. The North City Project is solely sponsored by the City of San Diego, which owns and operates water, wastewater, and recycled water facilities. North City Project facilities include the North City Water Reclamation Plant (NCWRP), North City Pure Water Facility (NCPWF), Miramar Reservoir, and Miramar Drinking Water Treatment Plant (DWTP).

The North City Project has run a large pilot since 2011; the full system is expected to be online in 2023.

Table 4-3: North City Project Setting

Agency	North City Project Lead Agency	WWTP Owner/ Operator	AWPF Owner/ Operator	Purified Water Conveyance	Receiving Water Body/ Infrastructure	Partnering Retail Water Agencies
City of San Diego Public Utilities Department	X	X	X	X	Reservoir Manager/ Operator	X
San Diego Metro Wastewater Joint Powers Authority[1]		X				

Notes:

1. Member agencies include Chula Vista, Coronado, Del Mar, El Cajon, Imperial Beach, La Mesa, National City and Poway; the Lemon Grove Sanitation District; the Padre Dam Municipal and Otay Water Districts; and the County of San Diego (on behalf of the Winter Gardens Sewer Maintenance District, and the Alpine, Lakeside and Spring Valley Sanitation Districts).

Pure Water Monterey Groundwater Replenishment Project, Monterey Peninsula, California

The Pure Water Monterey Groundwater Replenishment (PWM/GWR) Project is a groundwater augmentation project using subsurface injection operated by M1W, formerly the Monterey Regional Water Pollution Control Agency. The project serves Northern Monterey County and produces:

1. up to 3,500 AFY (3.1 MGD) of purified water for replenishment of the Seaside Groundwater Basin, which also serves as a drinking water supply;
2. up to 600 AFY (0.54 MGD) of purified water for landscape irrigation by the Marina Coast Water District (MCWD); and
3. up to 4,750 AFY (4.2 MGD) in normal/wet years of tertiary treated recycled water to augment the existing Castroville Seawater Intrusion Project's agricultural irrigation supply.

Features of the PWM/GWR setting are presented in Table 4-4.

In addition to M1W, major project participants include Monterey Peninsula Water Management District (MPWMD) and California American Water Company (CalAm). M1W owns and operates the Regional Treatment Plant (RTP), AWPF, transmission and injection facilities and was responsible for design and construction of the facilities. M1W sells the product water to MPWMD, who manages the Seaside Groundwater Basin. MPWMD sells groundwater to CalAm and MCWD. Partner responsibilities are defined by a Water Purchase Agreement between M1W, MPWMD, and CalAm and approved[1] by the California Public Utilities Commission (CPUC). Specifically,

- No water rights are conferred to CalAm through the WPA;
- CalAm's allotment is 3,500 AF of purified water delivered and measured by M1W at "Delivery Point" (the agreement's defined it as four injection wells in the Seaside Groundwater Basin);
- MPWMD charges CalAm monthly based on water delivered to Delivery Point and measured by M1W;
- M1W charges MPWD monthly based on water delivered to Delivery Point and measured by M1W.

The PWM/GWR project began operating in February 2020.

Table 4-4: PWM/GWR Project Setting

Agency	PWM/ GWR Project Lead Agency	WWTP Owner/ Operator	AWPF Owner/ Operator	Purified Water Conveyance	Receiving Water Body/ Infrastructure	Partnering Retail Water Agencies
Monterey One Water	X	X	X	X (Injection facilities)		
Monterey Peninsula Water Management District					Groundwater Basin Manager/ Operator	
Marina Coast Water District				X (Conveyance between AWPF and injection facilities)		X
California American Water Company						X

[1] Decision 16-09-01, September 22, 2016

4.2 Summary of Questionnaire responses

The following subsections include a summary discussion and recommendations/key takeaways, if applicable, for each of the five survey categories based on responses from OCWD, San Diego, and M1W. Detailed agency responses to the survey are included in **Appendix C.**

4.2.1 Public Outreach

Public Outreach - Key Takeaways

- A demonstration facility is the most effective tool for public outreach
- Bad press could have potentially been avoided if media was engaged earlier
- Public outreach needs to continue through project construction, possibly at more intensive levels than during the planning phases

Public Outreach - Recommendations

- Engage media and initiate public outreach early in conceptual project development (i.e. facilities planning/CEQA)
- Identify and engage project advocates/champions early in conceptual project development
- Invest in a demonstration facility for public outreach
- Prepare public-facing staff to engage with the public on the project
- Potable reuse projects should be identified as water supply projects

Potable Reuse Project Consideration

The type of potable reuse projects considered at the outset by each jurisdiction was dependent on the local physical (local groundwater basin, large surface reservoir) and institutional setting. Final project type refinement was dictated primarily by cost and regulatory considerations. OCWD and M1W have robust local groundwater basins, which made GWR the obvious choice. OCWD already had an operating seawater intrusion control barrier and determined that expanding GWR via surface spreading was their most cost-effective way to expand GWR. M1W chose subsurface injection over seawater intrusion barrier or surface spreading based on costs. San Diego has a limited groundwater basin but large reservoirs, so surface water augmentation was their obvious focus. Although RWA was considered for Phase 2, lack of approved regulation for that potable reuse pathway and a mandated RWQCB compliance deadline dictated a SWA strategy.

Community and Policymaker Support

Community support for these projects has been influenced by their relative timing (GWRS was the trailblazer), with both North City and PWM/GWR projects leveraging GWRS success in both advanced recycled water treatment and GWR application, and by the ability to clearly state their drivers. GWRS clearly addressed a diminishing replenishment of local groundwater by the Santa Ana River. San Diego initially tried to implement SWA in the 1990's, when the project was being driven by San Diego's Metropolitan Wastewater Commission, prompting the community to react to a "toilet-to-tap" perception. Only when San Diego's Public Utilities Department championed the project as essential for water supply reliability did the community and policymakers finally become supportive. PWM/GWR was championed initially by Monterey Regional Water Pollution Control Agency, but over time transitioned the message to water supply reliability by an agency name change to "Monterey One Water" and partnering with the local wholesale water agency.

It is also noted that community and policymaker support has evolved with each project. After initial hesitation by the City of Anaheim, the success of the initial phase of GWRS laid the groundwork for strengthening support for follow-up phases. San Diego's Pure Water program has consistently gained support as the water supply reliability message was solidified and SWA regulations were finally adopted. PWM/GWR has experienced a loss of policymaker support for an additional expansion phase due to perceived competition with a private regional seawater desalination project.

Community members and policymakers have been generally supportive of the three projects. Support has manifested as letters and resolutions from various levels of government. OCWD and San Diego have seen increased support as the GWRS and the North City Projects, respectively, have progressed.

Use of surveys to gauge community support were common by projects. For example, Pure Water San Diego did extensive surveying during their demonstration project phase and continually produce annual reports on the Pure Water Program summarizing design and construction milestones along with outreach program metrics (available at https://www.sandiego.gov/public-utilities/sustainability/pure-water-sd). .

Project Advocates

Each project has garnered support from key advocates/champions including community working groups formed by the agencies and other local and non-profit organizations. GWRS was championed by a 20-member Community Leadership Advisory Council consisting of business, minority, environmental, and scientific community leaders. Similarly, the North City Project was championed by the Water Reliability Coalition and Pure Water Working Group consisting of program stakeholders. PWM/GWR was championed by non-profit organizations such as the Surfrider Foundation, Public Water Now, Land Watch, and the Planning and Conservation League. In all cases, project champions were able to provide public support for projects including community outreach, speaking at Council/Board meetings and key hearings, and support through various media outlets.

Project Opponents

As noted, GWRS opposition occurred early in the project planning phase (late 1990's) from the Anaheim Public Utilities Commission (Anaheim PUC). The Anaheim PUC was concerned with the potential impact of a reuse project on the image of the Anaheim water supply. GWRS addressed the concerns through discussions and public meetings, and through a decision from the joint OCWD/OCSD oversight committee that PURIFIED WATER, equal in quality to the water used for subsurface injection, would be used for spreading applications like those within the City of Anaheim.

San Diego's first attempt at SWA in the 1990's was a case study in opposition. Public health and environmental justice ("effluent from the affluent") concerns prompted the City Council to shelve the initiative for nearly a decade (restarted in 2004). Recently, the main North City Project opposition has been to pipeline construction in neighborhoods. Concerns were expressed once pipeline alignments were presented in the project EIR and have been voiced through social media, letters to newspapers, and at City Council meetings. The City has formed Community Working Groups in the affected communities to engage the public in construction planning. The Community Working Groups have been successful in alleviating some concerns and participants have expressed that the experience and opportunity to provide feedback has been valuable.

PWM/GWR has experienced opposition on individual, community, and policymaker levels. Initially, individual opposition focused on concern for public health and water quality through letters to local newspapers and regulators. As a result, DDW and the Regional Board responded with conservative project regulations. Community groups voiced opposition to receiving what they perceived as "toilet water." To address community concerns, M1W conducted public outreach and provided tours of the demonstration facility to aid in understanding of the purified water process. Recently, policymaker and stakeholder support has shifted against an expansion of the PWM/GWR Project due to the perception that CalAm's regional desalination project is a better option for further local water supply development. Recently, the M1W Board did not approve a supplemental EIR for project expansion.

Demonstration Projects

Each of the full-scale projects was preceded by a demonstration project that served multiple purposes, including:

- Supporting regulatory approval
- Facilitating stakeholder and community engagement
- Providing operations staff with hands-on experience
- Providing design criteria for full-scale construction

These demonstration projects were a fundamental component of the stakeholder and community outreach process for each setting. Lead agencies structured outreach programs around the demonstration facilities, leveraging tours to advertise the project and inform the community.

The North City Project completed the 1 MGD North City Demonstration Pure Water Facility (NCDPWF) in 2011 at its North City Water Reclamation Plant. The NCDPWF served as a demonstration-scale treatment facility for water quality testing, monitoring, and redundancy demonstration, operator training, and a tool for public outreach and stakeholder coordination. The NCDPWF is shown in Figure 4-1. Virtual tours are available online at: https://www.sandiego.gov/public-utilities/sustainability/pure-water-sd/virtual-tour.

Figure 4-1: North City Demonstration Pure Water Facility

Source: https://www.sandiego.gov/public-utilities/sustainability/pure-water-sd/virtual-tour

M1W's permanent Demonstration Facility was completed in the Fall of 2015 at the site of the AWPF facility located within the footprint of the RTP. While the primary purpose of the Demonstration Facility was for operator training and water quality testing and pilot work, the Facility was also designed for public tours including product water tasting. The Demonstration Facility includes pre-straining, chloramination, ozonation, MF, RO, UV/AOP, and product water stabilization for an effluent flow of 15 gpm. M1W's Demonstration Facility is provided in Figure 4-2.

Figure 4-2: M1W Demonstration Facility

Source: https://www.sustainablesv.org/wp-content/uploads/2017/07/Monterey-Water-Purification-Demo-Facility.png

<u>Community Outreach</u>

All three projects started public outreach during the conceptual project phase and have continued their programs through design, construction, and operation. OCWD, M1W, and San Diego are leading their projects' outreach programs[1] with coordination from partner agencies, as needed. In the case of GWRS, it was decided that OCWD would lead outreach to present the project as a water supply project rather than as a wastewater treatment or disposal project. Outreach efforts and budgets have varied through the project phases but were typically most intensive during construction.

Outreach has included the development of informational materials in multiple languages, presentations to various demographics, the creation of focus groups, and social media campaigns; however, demonstration facility tours have been the most effective tool for public engagement.

Internal Project Communication

Internal agency communications have been an important component of project outreach. The agencies have provided project milestone updates, demonstration facility tours, and on-going informational presentations to staff. Providing sufficient information to public-facing staff (customer representatives, field staff, etc.) has been important so they can engage with the public on the projects and answer basic questions.

4.2.2 Regulatory and Permitting Approaches

Regulatory and Permitting Approaches - Key Takeaways

- DDW project concerns are project-specific
- Public opposition could affect the project approval process
- In the absence of finalized regulations, engage DDW to develop a project concept that meets their regulatory intent

Regulatory and Permitting Approaches - Recommedations

- Engage with regulators early in conceptual project development

Each of these projects had unique features that needed to be addressed before gaining regulatory approval and going through the permitting process. The degree of regulatory certainty at the time all three projects were started greatly impacted the level of concern DDW and RWQCB exhibited. OCWD was able to overcome the difficulty of not having regulatory certainty or precedents by having early and transparent discussions with the regulators and engaging an independent expert advisory panel early in the process. GWRS was the first GWR project to be tailored specifically to the setting and to emerging regulations. Its predecessor project, Water Factory 21 (which was strictly a seawater intrusion project), had been operated

[1] Websites for outreach materials from each program are:
https://www.sandiego.gov/public-utilities/sustainability/pure-water-sd
https://www.montereyonewater.org/261/Pure-Water-Monterey-Overview
https://www.ocwd.com/gwrs/

since the late 1970's and experienced local groundwater impact due to two constituents: N-Nitrosodimethylamine (NDMA) and 1,4 dioxane. With this background, the RO-based advanced treatment process had to be augmented with enhanced photolysis and advanced oxidation, yielding the full advanced treatment regime of MF/RO/UV-AOP for both injection and spreading, which is memorialized in the GWR Regulation, formulated in 2014. Up to that date, projects like GWRS were permitted under California Water Code Title 22 guidelines that allowed for GWR projects to be permitted on a case-by-case basis.

When San Diego reengaged with DDW and RWQCB in the late 2000's, no other agencies were seriously considering SWA. The Water Purification Demonstration Project, conducted between 2009 and 2013, provided the initial forum (centered on the 1 MGD Demonstration AWTP) for San Diego to coordinate with the regulators. San Diego found that developing a project concept that was in line with DDW's regulatory intent was key to permitting in the absence of finalized regulations. To ensure this, San Diego interacted with DDW frequently to understand their concerns and tailor their concept to address them. The demonstration facility was then used to prove out the concept through testing. Many of these early and subsequent discussions helped to inform the structure and requirements of the 2018 SWA Regulation. Over the years, the North City Pure Water Project has changed markedly, growing from 15,000 AFY to 30,000 AFY and switching receiving water bodies from the 240,000 AF San Vicente Reservoir to the 8,000 AF Miramar Reservoir. To achieve regulatory approval, Pure Water's advanced treatment scheme was augmented to include ozone and biologically active filtration (Ozone/BAF) to provide additional microbial and chemical barriers. North City Pure Water had the added regulatory challenge of discharging into a RWQCB Basin Plan delineated surface water body, incorporating an additional set of nutrient and California Toxics Rule (CTR) limits. San Diego worked closely with RWQCB staff over the course of the Demonstration testing period to address their concerns and assure Basin Plan and CTR compliance.

Although PWM/GWR was being formulated with existing GWR Regulations and the precedent of GWRS, its incorporation of agricultural tail and wash water as a supplemental source to the AWTP required additional testing at their Demonstration facility and perusal by DDW. Further, DDW and the RWQCB received public opposition letters, as mentioned in Chapter 0 , which led DDW and the RWQCB to move more slowly through the permitting process.

In all cases, early and close coordination with regulators was key, and the tailoring of Demonstration facility testing to regulator questions and concerns enabled the projects to ultimately be permitted.

4.2.3 Operational Considerations

Operational Considerations - Key Takeaways

- Level of service goals can be defined in a Joint Operating Agreement
- AWPFs are not typically intended for the same level of continuous service as a Surface Water Treatment Plant and may not be designed with the same level of backup/redundancy
- None of the projects are considering treated or raw water augmentation
- CECs including PFAS are addressed through robust treatment

Operational Considerations - Recommendations

- Define operational service goals early in partnering
- Plan for periods of time when the AWPF is offline/down

Advanced Treatment Ownership and Operation

Of the three projects, OCWD is the only AWPF owner/operator that relies on a partner wastewater agency (OCSD) to provide source water. OCSD owns and operates Plant No. 1 which provides secondary treated wastewater to the GWRS, which OCWD owns and operates. The agencies' roles and responsibilities are defined by a Joint Operating Agreement.

San Diego PUD owns and operates all the North City Pure Water facilities and has reorganized to add Pure Water Operations to its already existing water and wastewater facility operations.

M1W owns/operators the PWM/GWR through the injection to the groundwater basin; MPWMD buys the injected water from M1W and in turn sells the water to CalAm. The relationship between these three partners is formalized through a Water Purchase Agreement. Effectively, the water sales to MPWMD pay between 75% and nearly 100% of project costs depending on the particular component.

Level of Service Goals from Wastewater Treatment Plants including Source Control

Each project has implemented varying degrees of level of service goals from their associated wastewater treatment plants. OCWD and OCSD have included basic water quality requirements in their Joint Operating Agreement centered around turbidity. Other water quality requirements are kept more general to promote cooperation between the two agencies. No major treatment or operational changes were required at OCSD's Plant No. 1 for the sole benefit of the GWRS.

San Diego's NCWRP is being expanded to 54 MGD and upgraded to source the Pure Water AWTP. NCWRP features that were of particular importance for AWTP performance and permitting was wasting of residuals to the sanitary sewer (which goes to Pt. Loma WWTP, not the headworks of NCWRP), flow equalization, nitrification-denitrification (to address Total N limits to Miramar Reservoir), and bypassing Title 22 disinfection (potential for NDMA and trihalomethanes (THMs) formation).

M1W's RTP has made modifications to accommodate the PWM/GWR Project, including increasing the number of trickling filters in operation to lower effluent TOC and nitrite concentrations. In addition, the Water Purchase Agreement between M1W, MPWMD, and CalAm defines required product water delivery and allotted withdrawal quantities from the Seaside Groundwater Basin.

All project-associated wastewater agencies have performed or are in the process of performing a Local Limit Analysis to establish limits on dischargers to the wastewater treatment plants to fortify source water control measures.

Contingencies for Disruptions of Product Water Flow or Quality

Potable reuse projects discharging to either a groundwater basin or large reservoir can be designed as on-demand but not life-critical facilities, avoiding the level of design redundancies of baseload surface water treatment plants. However, these projects are expected to operate year-round, and contingencies for disruptions in flow and/or quality have been addressed operationally by the projects through securing alternative recharge and drinking water treatment sources.

Measures to address CEC's, Including PFAS

CEC's have been addressed by the projects through robust AWPF treatment processes based on Demonstration Facility operation and water quality monitoring. Since all of the types of potable reuse projects described herein require full advanced treatment with RO, PFAS is not expected to be an issue in AWPF product water (see discussion in Chapter 3).

Provisions for Future Expansion

GWRS was originally planned, with space allocated, for a three-phase expansion; the third phase expansion to 120 MGD is currently underway. PWM/GWR Project AWPF future expansion has been accounted for by space provisions. San Diego North City Pure Water is space constrained, however, their AWPF has ability to increase recovery to increase purified water production.

4.2.4 Cost/Revenue Allocation Between Partners

Cost-Revenue Allocation Between Partners - Key Takeaways

- There is no clear standard model for how agencies share costs for these types of projects, but cost sharing generally follows the principle of "beneficiary pays"
- Costs can be recovered through water sales from the producer to the wholesaler/retailer
- A variety of options for State and Federal grants, State and Federal low-interest loans, and bonds are available and can be used in various combinations to fund and finance projects

Cost-Revenue Allocation Between Partners - Recommendations

- Begin cost sharing discussions as part of early partnering - include both capital and operational costs in the discussions
- Idenfity desired benefit(s) for each partner

Wastewater Treatment Funding and Capital Cost Allocation Between Partners

Wastewater treatment related costs needed for the purified water projects generally were covered by the wastewater agency, without the aid of outside funding. San Diego funded their wastewater treatment plant improvements to support the North City Project by tapping into their wastewater enterprise funds (Metropolitan Wastewater and Municipal Wastewater).

AWPF Funding and Capital Cost Allocation Between Partners

AWPF funding and cost allocation between partners was unique for each of the three projects. Construction of the first phase of GWRS facilities was funded 50-50 by OCSD and OCWD, with the help of state and federal grants. This shared cost stemmed from OCSD gaining wet weather flow relief in its ocean outfall from flow diversions associated with GWRS. OCWD funded all subsequent expansions of the GWRS. OCSD does not charge OCWD for purchase of effluent nor does OCSD charge OCWD for residuals streams such as MF waste backwash and spent CIP cleaning solution flows returned to OCSD's Plant #1 for additional treatment or for RO concentrate discharged through the OCSD ocean outfall. San Diego expects to fund all AWPF construction costs through the City's Water Enterprise Fund, while M1W funded construction of PWM/GWR by utilizing a 1% State Revolving Fund (SRF) loan and will offset further costs through the water purchase agreement with MPWMD, which then sells groundwater to CalAm and MCWD.

Cost Recovery

Both OCWD and M1W expect to recover costs for their projects through water sales. Because GWRS replenishes the Orange County groundwater basin, OCWD funds its GWRS capital investment through groundwater fees charged to the region's groundwater extraction agencies (retail agencies), while M1W expects to recover costs through water sales to MPWMD. San Diego expects to recover wastewater related costs through the Metropolitan (regional facilities) and Municipal (City facilities) Wastewater Enterprise funds, and AWPF and conveyance costs through San Diego's Water Enterprise Fund, which are ultimately funded by ratepayers. All three projects received substantial financing support through Federal (Water Infrastructure Finance and Innovation Act (WIFIA)) and State (SRF) loans.

In summary, there are a variety of options for allocating costs for a water reuse project that involves multiple partners; however, in general any approach should consider the ‘beneficiary pays’ principle. Based on this principle, capital costs and ongoing operations costs for the project should each be allocated in accordance with the benefit the project provides to each partner. For example, a water reuse project may help a sanitation agency meet regulatory requirements regarding discharge quality and levels and provide additional water supply and enhanced reliability to a water agency. If there are multiple sanitation agencies or multiple water agencies involved, costs may need to be further allocated within those groups. Where feasible, project partners should try to monetize project benefits to support cost allocation. Given the challenges that may result from such an effort, additional considerations to assist in cost allocation could include:

1. Baseline costs for each agency without the project.
2. The cost of alternative approaches each partner could pursue to achieve the same or similar benefits. The project is only cost-effective if it is less expensive to each partner than their alternative options.
3. Project elements that only benefit certain partners.
4. The benefit the project provides toward meeting expected future regulations.
5. Facility ownership and operational responsibilities and control.
6. Additional considerations will be necessary in the event that a non-cost-based benefit exists, and a project is not cost-effective but is pursued for other externalities.

Finally, a project involving ACWD, SFPUC, and USD is unique in that there is a common customer base for ACWD/USD. These two agencies would thus be incentivized to find the lowest cost approach to collecting the combined revenue needed.

Insurance, Liability, and Indemnifications Between Agencies

Insurance, Liability, and Indemnifications Between Agencies - Key Takeaways

- Agreements between partners can be structured in a variety of ways requiring sole or collaborative responses to future questions or issues
- Some level of minimum requirements for water quality and performance should be included in an agreement

Insurance, Liability, and Indemnifications Between Agencies - Recommendations

- Begin liability and risk-sharing discussions in early partnering
- Be clear about how each partner expects future changes in supply or water quality needs to be handled

Similar to the cost sharing discussion, liability and indemnification between agencies is specific to each project. GWRS project responsibilities are defined by a Joint Operating Agreement that specifies that OCWD and OCSD will "meet and confer" about any necessary changes. The Joint Operating Agreement only specifies key water quality requirements (nitrogen, TOC, TSS, and turbidity) which allows for collaborative discussion between the agencies on other water quality issues. OCWD suggests that flow availability, key water quality constituents (nitrogen, TOC, TSS, and turbidity), and source control should be non-negotiable requirements of a Joint Operating Agreement.

M1W's Water Purchase Agreement with MPWMD and Cal Am does not include any provisions for changing water supply needs but rather states that M1W will provide a fixed amount of water for a fixed number of years that can be extended by joint agreement between the partners. In general, M1W has benefitted from their working relationships with both MPWMD and Cal Am. One issue that did arise, however, was disagreement about whether additional water resources should be secured by further expanding the AWPF or choosing a different project that would also bolster the community's water supply (Cal Am's desalination project). These site-specific issues (i.e., potable reuse vs. desalination) are not anticipated to be a problem for the majority of other joint projects.

5. ALTERNATIVES DEVELOPMENT

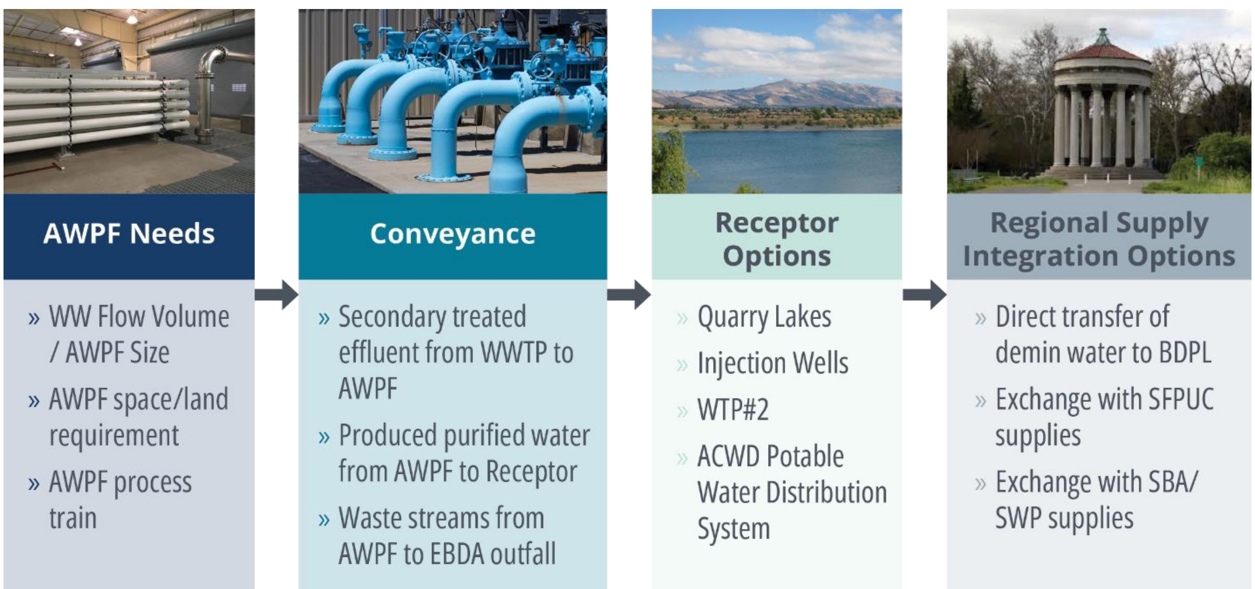
This chapter summarizes the process used to develop and select the alternatives put forth for further analysis. The alternatives were developed based on interests and constraints provided by the Partners through a series of conversations and workshops.

5.1 Alternatives Development Process

5.1.1 Development of Preliminary Concepts

Based on the information identified in Chapter 3 and supplemented by additional input and feedback from the Regulatory Summary (Chapter 2), Limnological Investigation (**Appendix B**) and Lessons Learned (Chapter 4), preliminary concepts were developed, consisting of the major elements identified in Figure 5-1.

Figure 5-1: Preliminary Concept Elements



Four preliminary concepts were brought forward for discussion at workshops with the Partners and the consultant team:

- **Concept 1: 13 MGD GWR Project Conveying Purified Water to Quarry Lakes.**

  Concept 1 would convey USD's secondary effluent to an AWPF and return AWPF waste stream to the Alvarado WWTP. The AWPF would include treatment processes in compliance with known regulations for groundwater recharge via surface spreading. Purified water would be conveyed to Quarry Lakes for surface recharge. Recharged groundwater could then be extracted for distribution via any of the three regional supply integration options. This concept is size limited to 15.5 MGD of wastewater effluent inflow based on the maximum volume of AWPF waste return flows that can be discharged through the EBDA's outfall within listed constituent concentration limits in the existing NPDES discharge permit. This concept would require 1.1 MG of equalization storage.

- **Concept 2: 19.3 MGD GWR Project Conveying Purified Water to Quarry Lakes.**

Like Concept 1, Concept 2 would convey USD's secondary effluent to an AWPF and return AWPF waste stream to the Alvarado WWTP. The AWPF would include treatment processes in compliance with known regulations for groundwater recharge via surface spreading. Purified water would be conveyed to Quarry Lakes for surface recharge. Recharged groundwater could then be extracted for distribution via any of the three regional supply integration options. Concept 2 maximizes use of all 23 MGD of available secondary effluent but would require modification of EBDA's NPDES discharge permit. This concept would require 3.8 MG of equalization storage.

- **Concept 3: 13 MGD Groundwater Recharge via Injection Wells.**

  Concept 3 would convey USD's secondary effluent to an AWPF and return AWPF waste stream to the Alvarado WWTP. The AWPF would include treatment processes in compliance with known regulations for groundwater recharge via subsurface injection. Purified water would be conveyed to approximately 6-7 injection wells for subsurface recharge. Recharged groundwater could then be extracted for distribution via any of the three regional supply integration options. Like Concept 1, this concept is size limited to 15.5 MGD of wastewater effluent inflow based on the maximum volume of AWPF waste return flows that can be discharged through the EBDA's outfall within listed constituent concentration limits in the existing NPDES discharge permit. This concept would require 1.1 MG of equalization storage.

- **Concept 4: 7.3 MGD of Raw Water Augmentation at WTP #2.**

  Concept 4 would convey USD's secondary effluent to an AWPF and return AWPF waste stream to the Alvarado WWTP. The AWPF would include treatment processes in compliance with future anticipated regulations for raw water augmentation. Purified water would be conveyed to WTP #2. The purified water would only offset SBA supplies that currently feed WTP #2 and would not be exchanged with SFPUC supplies. Concept 4 is limited to 9 MGD, the maximum volume of wastewater effluent that can be conveyed consistently to the AWPF without equalization storage. At this lower flow, the AWPF waste return flows can be discharged through the EBDA's outfall within listed constituent concentration limits in the existing NPDES discharge permit.

5.1.2 Evaluation of Preliminary Concepts

At workshops with the Partners and the consultant team, three primary evaluation criteria were identified: maximize regional water supplies; minimize regulatory hurdles and uncertainty; and minimize additional capital investments. A summary of the comparative evaluation is provided in Table 5-1.

Based on discussion at the workshop, Concept 2 was eliminated due to the increased costs associated with a larger AWPF, the need for almost 4 MG of equalization storage, and the potential impacts to the EBDA NPDES permit. Concept 3 was eliminated due to the increased capital cost of injection wells and the ongoing operations and maintenance needs.

The Partners then asked the consultant team to combine Concepts 1 and 4 to develop a phased approach that would begin with a groundwater recharge project at Quarry Lakes and then expand in the future to provide raw water augmentation to WTP #2 once regulatory requirements are better defined. This phased approach would be limited to 13 MGD of purified water to minimize equalization storage as well as minimize potential impacts to the existing NPDES discharge permit. This phased approach was carried forward as the preferred concept.

Table 5-1: High-Level Summary of Preliminary Concept Evaluation

Concept	Maximize Regional Water Supplies	Minimize Regulatory Hurdles	Minimize Additional Capital Investment
Concept 1: 13 MGD GWR via Quarry Lakes	• Can be used for all regional supply integration options • Does not use all effluent	• Groundwater recharge regulations are known • Minimizes potential impact to NPDES permit	• Requires secondary effluent equalization • Utilizes existing Quarry Lakes
Concept 2: 19.3 MGD GWR via Quarry Lakes	• Can be used for all regional supply integration options • Uses all available effluent (max project size)	• Groundwater recharge regulations are known • Larger AWPF return flows would impact NPDES permit	• Largest AWPF and capital investment • Requires secondary effluent equalization • Utilizes existing Quarry Lakes
Concept 3: 13 MGD GWR via injection wells	• Can be used for all regional supply integration options • Does not use all effluent	• Groundwater recharge regulations are known • Minimizes potential impact to NPDES permit	• Requires secondary effluent equalization • Requires new injection wells with ongoing O&M
Concept 4: 7.3 MGD RWA via WWTP #2	• Can be exchanged with SBA supplies only • Does not use all effluent	• No permitting precedents or codified regulations for Raw Water Augmentation • Minimizes potential impact to NPDES permit	• No secondary effluent equalization • Utilizes existing infrastructure at WTP #2 • Requires additional AWPF treatment processes

5.2 Preferred Concept for Further Study

The preferred concept is a two-phased parallel treatment train concept that balances the needs and goals of the Partners:

- **Phase 1: 6.8 MGD of Purified Water for Groundwater Recharge.** In Phase 1, 9.0 MGD of secondary treated effluent from USD would be sent to an AWPF for treatment suitable for groundwater recharge. From the AWPF, 6-7 MGD of purified water would be sent to Quarry Lakes for recharge into the groundwater basin; the remaining balance of flows would be sent back to USD as waste streams for retreatment (MF backwash) or disposal (RO concentrate). Waste flows would be sent back either through the existing USD collection system or via dedicated pipelines; both were investigated in this Study. In this phase, ACWD would also construct the previously planned Demineralization Plant at the Peralta-Tyson site and utilize the additional demineralized groundwater to offset SFPUC supplies which would be curtailed as a result of the proposed project. Note, ACWD is currently in design of a 6 MGD/15 MGD ion exchange (IX) treatment system potentially co-located at the Peralta-Tyson site, additional coordination or re-evaluation of the proposed location for a Demineralization Plant will be required.

- **Phase 2: 4.9 MGD of Purified Water for Raw Water Augmentation.** In Phase 2, an additional 6.5 MGD of secondary treated effluent from USD would be sent to a 1.1 MG equalization tank and then to an expanded AWPF for treatment suitable for RWA at WTP #2. From the AWPF, 4-5 MGD of purified water would be sent to WTP #2 for additional treatment and integration into the ACWD potable distribution system. In this phase, sending purified water to WTP #2 and SFPUC offsets use of SWP supplies which would curtail ACWD's use of SWP supplies to allow for use by others.

Figure 5-2: Schematic of Phase 1

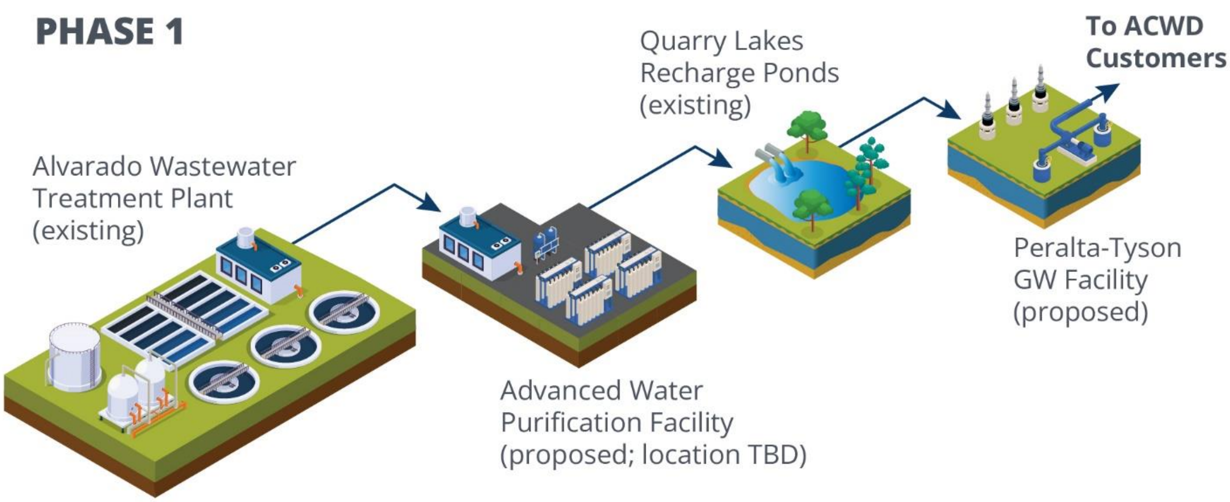
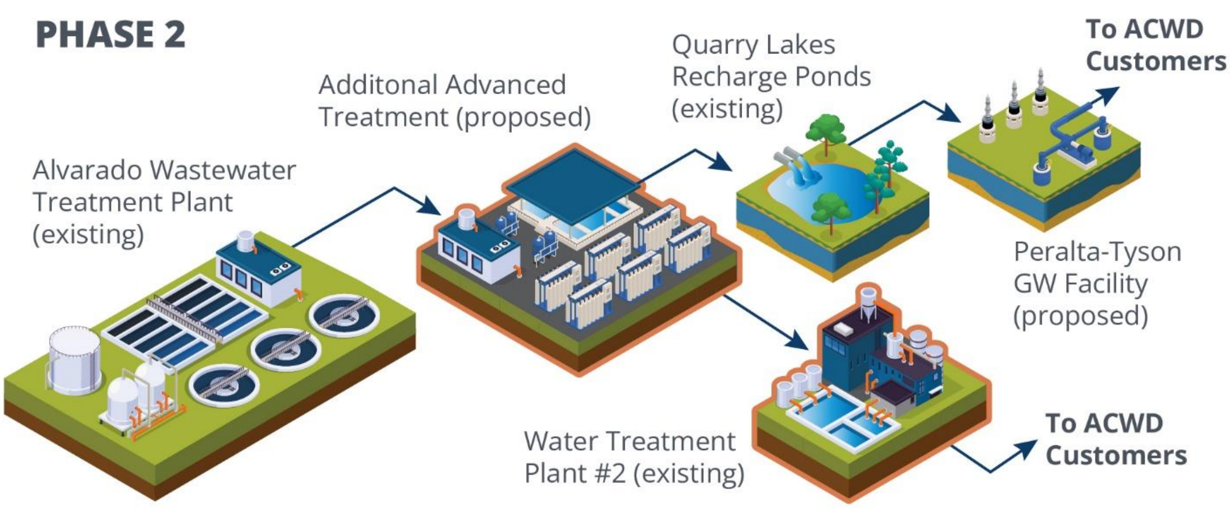


Figure 5-3: Schematic of Phase 2



As described in Chapter 3, USD is currently assessing whether to implement all or part of the ETSU Program which would provide major upgrades to the Alvarado WWTP. The impacts to secondary effluent water quality resulting from decisions around the ETSU Program are important differentiators. Therefore, the preferred concept was split into two alternatives for further study:

- **Alternative A:** Alternative A assumes that USD proceeds with their planned treatment upgrades from the ETSU Program, which, among other projects, includes an upgrade of the secondary process to include nitrification and partial denitrification. This process would reduce effluent ammonia levels to less than 2 mg/L as and provide source water appropriate for the AWPF.
- **Alternative B:** Alternative B assumes that USD does not proceed with their ETSU treatment upgrades. Because biological nutrient removal is required for both IPR and DPR, a tertiary membrane bioreactor (tMBR) would be included as pre-treatment before the AWPF treatment steps. The tMBR would be located at or adjacent to USD's Alvarado WWTP and therefore separate from the AWPF location, unless the AWPF is also located adjacent to USD's Alvarado WWTP. The tMBR would be constructed in Phase 1 and expanded in Phase 2 to accept additional secondary effluent to support the additional volumes.

5.2.1 Facility Siting Assumptions

For budgeting purposes and feasibility evaluation the location of the AWPF is assumed to be at Pit #2, near Paseo Padre Parkway and the railroad tracks just south of Quarry Lakes. This site was selected for evaluation as part of this study because the land is currently owned by ACWD; a full siting assessment for the AWPF was not included in the scope of this study and should be undertaken in a future phase of work. Pit #2 will need to be drained and filled as part of the site preparations for the AWPF; this will be included in the AWPF costs.

For the tMBR facilities needed under Alternative B, the tMBR would be co-located at the Alvarado WWTP per request of USD; the exact location at the Alvarado WWTP is to be determined in a future phase of work.

The Study includes the space requirements (in square feet) for the AWPF at Pit T2 and the tMBR at or near USD's Alvarado WWTP to facilitate future real estate investigations.

5.2.2 Facilities Overview

Table 5-2 provides an overview of the different facilities needed by phase for each Alternative. The subsequent technical evaluation of treatment, conveyance, and groundwater facilities are discussed in Chapters 6, 7, and 8, respectively.

Table 5-2: Facilities Included by Alternative and by Phase

	Alternative A (ETSU implemented at USD)	Alternative B
Phase 1 – 6.8 MGD of Purified Water for Groundwater Recharge		
Alvarado WWTP Upgrades	ETSU planned upgrades	None
Additional WW Treatment prior to AWPF	None	tMBR
AWPF Location	Filling in Pit #2 or acquire property near USD	Filling in Pit #2 or acquire property near USD
WWTP Effluent Conveyance	From Alvarado WWTP to AWPF, upsized for future Phase 2	From Alvarado WWTP to AWPF, upsized for future Phase 2
Effluent Equalization	None	None
AWPF Processes	MF/RO/AOP	MF/RO/AOP
AWPF Return Flow Conveyance	RO Concentrate and other waste conveyed to EBDA/WWTP, upsized for future Phase 2	RO Concentrate and other waste conveyed to EBDA/WWTP, upsized for future Phase 2
Purified Water Conveyance	From AWPF to Quarry Lakes	From AWPF to Quarry Lakes
Purified Water Receptor	Quarry Lakes Utilize Peralta Tyson Demin Plant for Extracted GW	Quarry Lakes Utilize Peralta Tyson Demin Plant for Extracted GW
Phase 2 – 4.9 MGD of Purified Water for Raw Water Augmentation		
Effluent Equalization	1.1 MGD	1.1 MGD
AWPF Processes	Ozone/BAC + MF/RO/AOP	Ozone/BAC + MF/RO/AOP
AWPF Return Flow Conveyance	Added in Phase 1	Added in Phase 1
Purified Water Conveyance	From AWPF to WTP #2	From AWPF to WTP #2
Purified Water Receptor	WTP #2	WTP #2

6. TREATMENT PROCESS EVALUATION

This chapter summarizes 1) the process trains that were considered for the Project phases, 2) the AWPF waste discharge water quality assessment, and 3) the corrosion potential of the RO concentrate on USD's portion of the EBDA pipeline. An opinion of probable cost for the capital costs and an estimate of O&M costs for these process train alternatives are also included in this chapter.

6.1 Tertiary MBR (Alternative B Only)

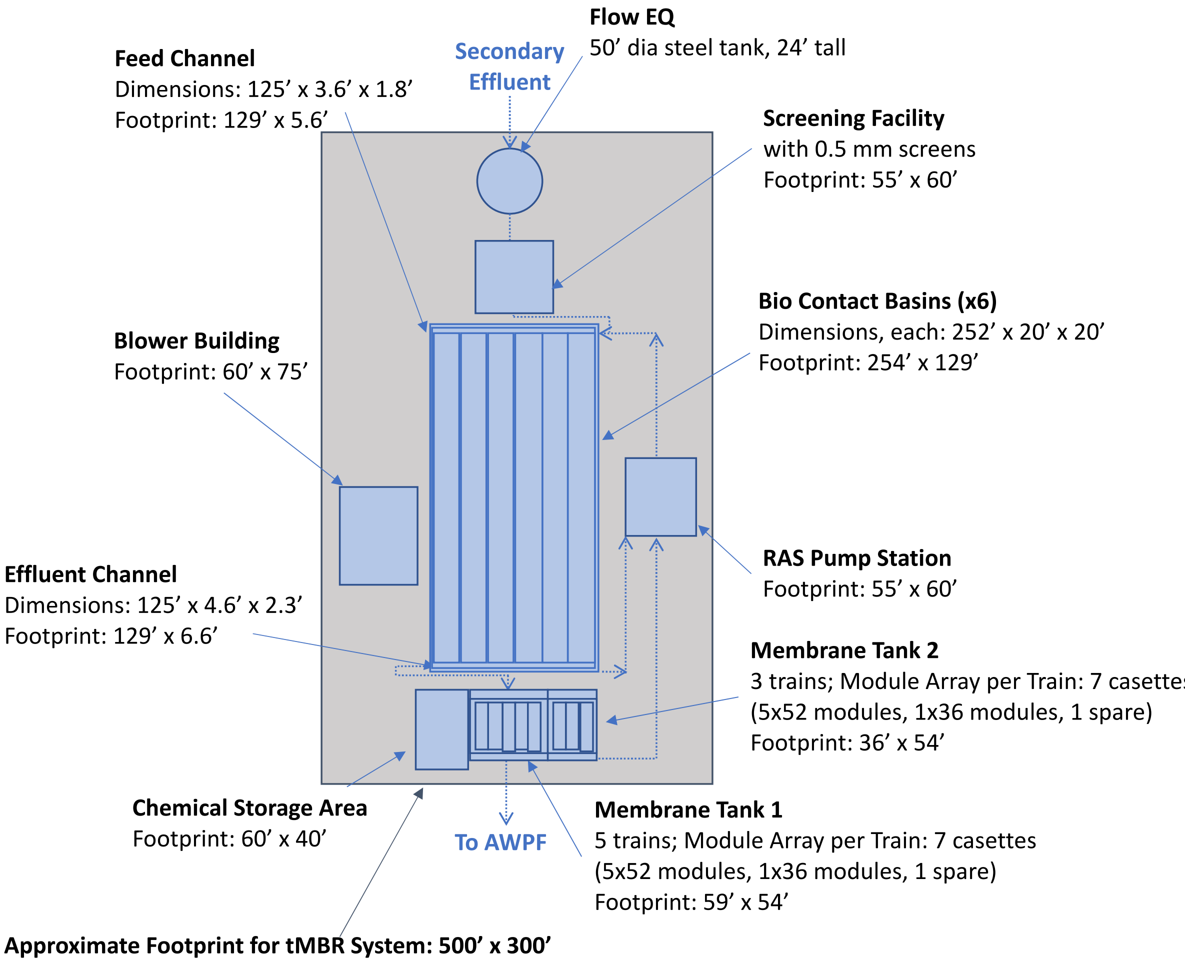
Two multi-phase purified water alternatives (Alternative A and Alternative B) were selected. Alternative A assumes that USD proceeds with their planned treatment upgrades from the ETSU Program, which, among other projects, includes an upgrade of the secondary process to include nitrification and partial denitrification. This process would reduce effluent ammonia levels to less than 2 mg/L as N. The control of nutrient concentrations is an important topic for ACWD's projects, both to satisfy public health requirements for potable reuse as well as environmental discharge compliance. As discussed in earlier chapters (Chapter 2 and Chapter 3), discharge of purified water into Quarry Lakes will be subject to strict nutrient limits to prevent biostimulatory effects (e.g., algae growth) and also to maintain compliance with the strict California Toxic Rule limits (particularly for disinfection by-products like NDMA). Complying with these limits would be challenging in a non-nitrified feed water. USD's existing secondary process does not include the ability to nitrify. Without a nitrified feed, the purified water produced by any AWPF alternatives described in this Chapter would not be able to meet the nutrient requirements for discharge into Quarry Lakes, and so would only be suitable for groundwater recharge through injection (bypassing Quarry Lakes). A nitrified feedwater is also a *de facto* requirement for DPR given a) the importance of ammonia removal for the stable operation of the BAC process and b) the benefit of high-quality secondary treatment to produce a stable feedwater with improved contaminant control. Because the receptors considered in this analysis are the Quarry Lakes, ACWD's WTP#2 and SFPUC Bay Division Pipeline, a nitrified feed flow is a pre-requisite to this Project.

Phase 1 of USD's ETSU Program includes the addition of a nitrification / partial denitrification (NDN) CAS process that will reduce ammonia levels to less than 2 mg/L as N (Hazen and Sawyer, 2019). For Alternative B, this Study evaluated an alternative to the CAS process in case USD does not implement Phase 1 of the ETSU Program. For Alternative B and in lieu of the ETSU project, an offsite tMBR process (located near USD's existing Alvarado WWTP site) was evaluated. The exact location of this tMBR was not determined for this stage of the Project and would need to be finalized in a future phase.

The tMBR system combines biological treatment with membrane filtration to produce high quality effluent. The tMBR will be designed for additional organics removal, full nitrification, and partial denitrification. The major goal of the tMBR process would be to produce a high-quality feedwater for the AWPF, including a reduction of the ammonia levels down to less than 2 mg/L as N from the current maximum concentration of 53 mg/L as N (as calculated from historical water quality data collected from the California Integrated Water Quality System (CIWQS) database between 2015-2021).

The proposed tMBR system is designed to treat a feed rate of 9 MGD in Phase 1 with expansion to 15.5 MGD in Phase 2. All infrastructure constructed during Phase 1 (including biological contact basins, membrane tanks, and blower building, etc.) will be constructed using Phase 2 sizing information. To expand the tMBR system to Phase 2, only new process equipment would need to be purchased and installed. A layout for the tMBR system is shown in Figure 6-1.

Figure 6-1: Phase 1 and 2 tMBR Layout



Secondary effluent from USD's Alvarado WWTP will be diverted to a 50' diameter steel flow EQ tank. A screening facility will contain a rotary drum screen with 0.5-mm screens to remove fine debris and aquatic snails that could damage the MBR membranes. After screening, the flow will be split between parallel biological contact basins (four constructed as part of Phase 1 and an additional two during Phase 2) designed in a Bardenpho configuration to promote organics removal, full nitrification, partial denitrification, and biological phosphorus removal. To achieve partial denitrification following full nitrification, an anoxic portion of the basin will be added to the MBR membrane tank where a carbon source (MicroC assumed for cost purposes) will be fed to promote the denitrification process. Following biological treatment, the flow will undergo solid-liquid separation by low-pressure membrane filtration in a separate membrane tank. The effluent will then be diverted to the AWPF for advanced treatment. The tMBR system is anticipated to have a recovery of 98%. The preliminary design criteria for the Phase 1 and Phase 2 tMBR system are included in Table 6-1.

Table 6-1: Phase 1 and Phase 2 tMBR Preliminary Design Criteria

Design Criteria	Value
Biological Contact Basins	
Flow (MGD)	Phase 1: 9 Phase 2: 15.5
Number of Basins in Use	Phase 1: 4 Phase 2: 6
Length, each (ft)	252
Width, each (ft)	20
Depth, each (ft)	20
Volume per basin (MG)	0.79
Total Volume (MG)	3.16
HRT (hours)	7
Solids retention time, or SRT (days)	10
Membrane System	
Flow (MGD)	Phase 1: 9 Phase 2: 15.5
Tank Length (ft)	50
Tank Width (ft)	91
Tank Depth (ft)	10
Tank Volume (MG)	0.34
Membrane Module Type	ZeeWeed 500D
No. of Trains in Use	Phase 1: 5 Phase 2: 8
No. of Modules per Train	296

6.2 Evaluate Process Trains to Produce Purified Water (Alternatives A and B)

Phase 1 is an IPR project that produces 6.8 MGD of purified water at the AWPF for groundwater recharge at the Quarry Lakes. Phase 2 uses a separate AWPF to treat 6.5 MGD of feedwater and send 4.9 MGD of purified water to WTP #2 for the RWA form of DPR. In this set up two types of purified water are created – one specifically for IPR and one specifically for DPR (see Figure 6-2). These phases are the same for Alternatives A and B with the only difference being a tMBR has been included as pre-treatment for Alternative B.

An alternative phasing option was also evaluated. Rather than constructing separate IPR and DPR process trains that collectively treat the 15.5 MGD feed rate, the Project could be constructed as a single process train that would ultimately treat 15.5 MGD of feedwater to a single type of purified water suitable for DPR. Like the other two-phased alternatives, this combined train alternative can be constructed in two phases, with the processes required for RWA added during the second phase of construction (see Figure 6-3).

Figure 6-2: Separate IPR and DPR Treatment Trains for AWPF

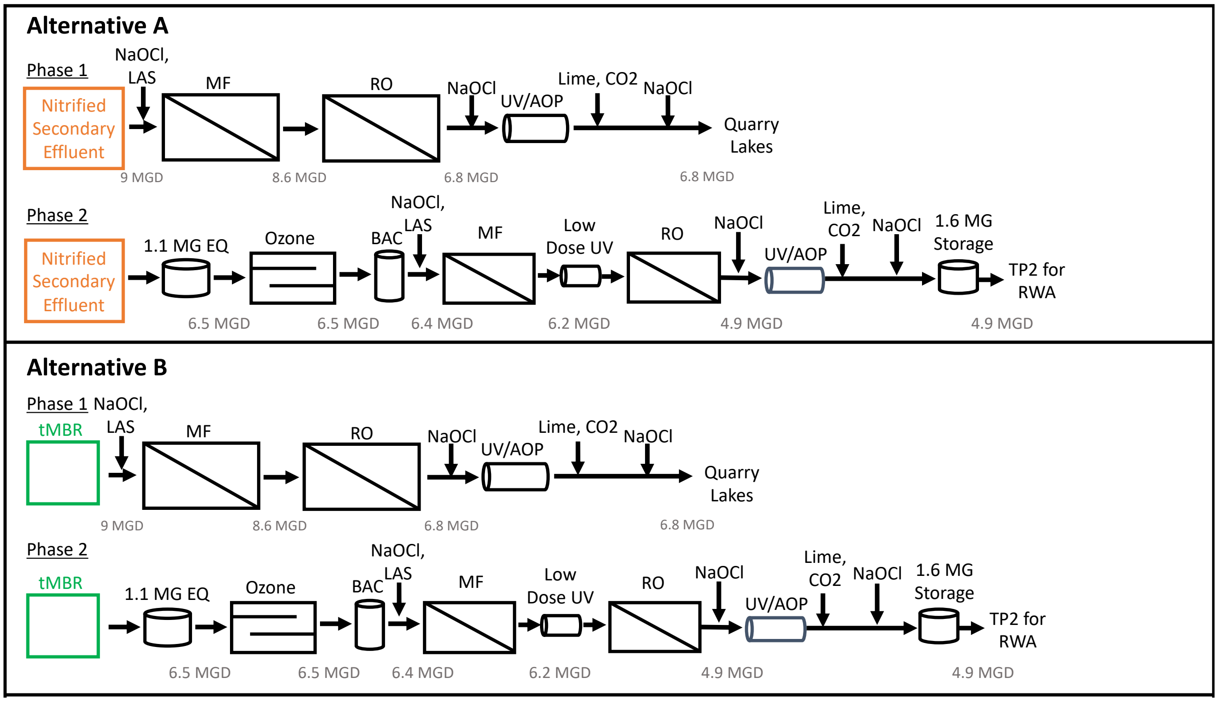


Figure 6-3: Combined IPR/DPR Treatment Trains for AWPF

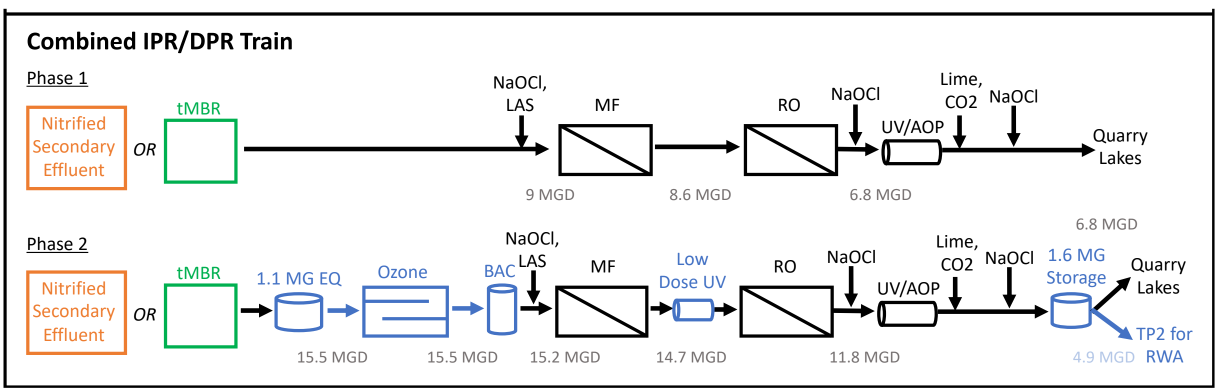


Figure Abbreviations:

- NaOCl: sodium hypochlorite
- LAS: liquid ammonium sulfate
- MF: membrane filtration
- RO: reverse osmosis
- UV/AOP: ultraviolet disinfection and advanced oxidation process
- CO2: carbon dioxide
- EQ: equalization storage

For preliminary analysis, the location of the AWPF is assumed to be on ACWD's Pit #2 site which will be drained and filled in for this Project. The location for the tMBR is assumed to be near USD's WWTP on a site that has not yet been purchased by the Partners. Layouts for the different phased alternatives are provided in **Appendix D**. The following sections review the selected alternatives for this Project.

6.2.1 Phase 1 AWPF Process Train

For groundwater recharge, the AWPF is required to achieve virus, *Giardia*, and *Cryptosporidium* (V/G/C) log reduction values (LRVs) of 12/10/10. For Phase 1, the process train consists of MF, RO, and UV/AOP using sodium hypochlorite as the oxidant. Post-treatment includes lime and carbon dioxide addition followed by free chlorine disinfection in the pipeline to Quarry Lakes and dechlorination prior to lake discharge.

In addition to the LRVs achieved by the process train, per Title 22 Section 60320.108 (f), additional logs of virus reduction will be achieved with each month of underground retention time to the nearest downgradient well. The virus reduction credit that is applied depends on the method for quantifying the underground retention time, as described in Chapter 2. Regardless of the quantification method, the underground retention time for all GWR projects must be at least 2 months to comply with regulations, meaning that all projects will receive at least 2 additional logs of virus reduction in the aquifer. This default value is shown for virus credit through underground retention in Table 6-1. If modeling shows that the underground retention time is higher than is currently assumed, the free chlorine disinfection CT may be reduced to provide less than the 2.5-logs of virus reduction currently assumed through this disinfection method.

Free chlorine disinfection will be required, at a minimum, as a secondary disinfectant, therefore the Project will also need to add a quenching facility located near the Quarry Lakes receptor to quench any remaining chlorine residual prior to discharge into the Lakes. This quenching facility is not included in the opinion of probable capital costs summarized in Chapter 6.5 but is included in the opinion of probable capital costs in Chapter 7. A summary of the LRVs achieved by the process train is summarized in Table 6-2.

Table 6-2: Phase 1 AWPF Pathogen Control

Pathogen	MF	RO	UV/AOP	NaOCl	Underground Retention	Total	Required
Virus	0	1.5	6	2.5	2	**12**	**12**
Giardia	4	1.5	6	0	0	**11.5**	**10**
Cryptosporidium	4	1.5	6	0	0	**11.5**	**10**

A process flow diagram for the Phase 1 AWPF is shown in Figure 6-4 and the flow balance through the process train is summarized in Table 6-3. An RO recovery rate of 80% was used based on modeling of the existing secondary effluent water quality information. The total product flowrate of the Phase 1 AWPF is 6.8 MGD. No secondary effluent equalization is required for this project phase because the feed rate of the Phase 1 AWPF (9 MGD) is below the minimum diurnal hourly flow treated by USD's WWTP. Preliminary design criteria for the Phase 1 AWPF process train, as developed to put together cost estimates for this Study, are summarized in Table 6-4.

Figure 6-4: Phase 1 AWPF Process Flow Diagram (Alternative A)

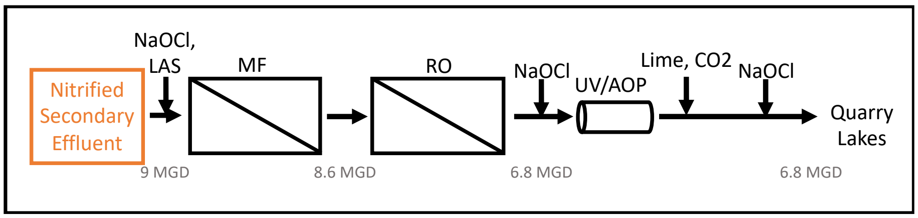


Table 6-3: Phase 1 AWPF Flow Balance

	MF	RO	UV/AOP	Post-Treatment
Feed Flow	9 MGD	8.6 MGD	6.8 MGD	6.8 MGD
Recovery	95%	80%	100%	100%
Product Flow	8.6 MGD	6.8 MGD	6.8 MGD	6.8 MGD
Waste Flow	0.45 MGD	1.7 MGD	0 MGD	0 MGD

Table 6-4: Phase 1 AWPF Preliminary Design Criteria

Design Criteria	Value
Chloramines	
Sodium Hypochlorite Dose (mg/L as Cl_2)	4
Liquid Ammonium Sulfate Dose (mg/L)	0.89
MF	
Number of Trains (duty + standby)	7 + 1
Feed Flow per Train (MGD)	1.3
Total Feed Flow (MGD)	9
Filtrate Flow per Train (MGD)	1.2
Total Filtrate Flow (MGD)	8.6
Max Instantaneous Flux (gfd)	25
MF recovery (%)	95
RO	
Number of Trains (duty + standby)	4 + 1
Feed Flow per Train (MGD)	2.1
Total Feed Flow (MGD)	8.6
Permeate Flow per Train (MGD)	1.7
Total Permeate Flow (MGD)	6.8
Max Instantaneous Flux (gfd)	10.2
RO recovery (%)	80%
UV/AOP	
Sodium Hypochlorite Dose (mg/L)	2.0
Number of Reactors (duty + standby)	1 + 1
Target NDMA Removal (log_{10} reduction)	2.4
UV Dose (mJ/cm^2)	2,000
Post-Treatment	
Lime Dose (mg/L as $Ca(OH)_2$)	70
Carbon Dioxide Dose (mg/L)	2.5
Sodium Hypochlorite Dose (mg/L as Cl_2)	2
Free Chlorine CT Required for 2.5-log Virus Reduction (mg-min/L) [1]	11.6

Notes:

1. Free chlorine CT may decrease if the underground retention time is shown to be longer than 2 months. The CT value is based on WaterVal Chlorine Disinfection Validation Protocol (Australian WaterSecure Innovations Ltd., 2017), assuming a turbidity of ≤0.2 NTU, a pH of 9, and a temperature of 15 deg C.

The layout for the Phase 1 AWPF, located on ACWD's existing Pit #2 location, is shown in **Appendix D.** For costing purposes, it was assumed that all the process equipment for MF, RO, and UV/AOP are within a single treatment building that also includes space for a control room, break room, offices, lab space, restroom, and other various spaces that are needed within the building for personnel. The MF feed and filtrate EQ tanks, the transfer pumps associated with those tanks, and the chemical storage and post treatment areas will be located on outdoor concrete pads.

6.2.2 Phase 2 AWPF Process Train

Phase 2 of the Project will require a second process train that is designed to produce water for raw water augmentation to ACWD's existing WTP #2. This process train will treat an additional 6.5 MGD of feed water through pre-treatment with Ozone-BAC followed by MF, UV disinfection, RO, UV/AOP, and post-treatment. Low-dose UV is included between the MF and RO process trains to achieve the 20/14/15 V/G/C LRVs required for DPR, particularly the virus and *Cryptosporidium* requirements. With the addition of ozone-BAC and low-dose UV, the Phase 2 AWPF process train will achieve V/G/C LRVs of 20.5/23.5/17.5, which meets the requirements for DPR. The LRVs achieved by the proposed process train are summarized in Table 6-5.

Table 6-5: Phase 2 AWPF Pathogen Control

Pathogen	Ozone	BAC	MF	Low-Dose UV	RO	UV/AOP	NaOCl	Total	Required
Virus	6	0	0	1	1.5	6	6	**20.5**	**20**
Giardia	6	0	4	5	1.5	6	1	**23.5**	**14**
Cryptosporidium	1	0	4	5	1.5	6	0	**17.5**	**15**

Because the feed rate for the Phase 1 and Phase 2 process trains exceeds the minimum hourly flow treated by USD's WWTP, a 1.1 MG secondary effluent equalization tank is required as part of the Phase 2 process train. To provide sufficient response time should any upsets occur within the Phase 2 AWPF process train, 8 hours of purified water storage will be added to the site for this alternative, which results in a 1.6 MG storage tank. A process flow diagram for the Phase 2 AWPF is shown in Figure 6-5 and the flow balance through the process train is summarized in Table 6-6. Note that the recovery through the MF system increases to 97% (from 95% for the Phase 1 AWPF) due to ozone-BAC pre-treatment. A more inclusive summary of the benefits of ozone-BAC pre-treatment will be discussed in Chapter 6.2.3. Preliminary design criteria for the Phase 2 AWPF process train, as developed to put together cost estimates for this Study, are summarized in Table 6-7.

Figure 6-5: Phase 2 AWPF Process Flow Diagram (Alternative A)

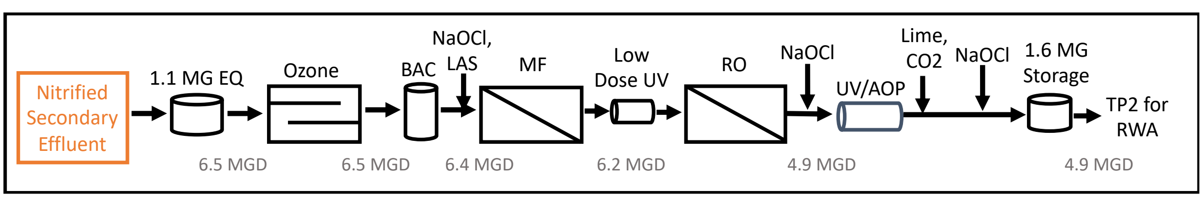


Table 6-6: Phase 2 AWPF Flow Balance

	Ozone	BAC	MF	Low-Dose UV	RO	UV/AOP	Post-Treatment
Feed Flow	6.5 MGD	6.5 MGD	6.4 MGD	6.2 MGD	6.2 MGD	4.9 MGD	4.9 MGD
Recovery	100%	98%	97%	100%	80%	100%	100%
Product Flow	6.5 MGD	6.4 MGD	6.2 MGD	6.2 MGD	4.9 MGD	4.9 MGD	4.9 MGD
Waste Flow	0 MGD	0.13 MGD	0.19 MGD	0 MGD	1.2 MGD	0 MGD	0 MGD

Table 6-7: Phase 2 AWPF Preliminary Design Criteria

Design Criteria	Value
Ozone	
Average Ozone Dose (mg/L)	14
Average Sodium Bisulfite Dose (mg/L)	2.4
Ozone Contact Time (min)	11
Estimated T_{10}/T	0.79
Number of Ozone Contactors	1
Volume per Contactor (gallons)	50,000
Average Channel Depth (ft)	8
Channel Width (ft)	7
Channel Length (ft)	30
Total Number of Channel Passes	4
BAC	
Number of Filter Cells	3
Dimension of Filter Cells, each	32’-0” x 14’-3”
Total Filter Area (sf)	1,368
Chloramines	
Sodium Hypochlorite Dose (mg/L as Cl_2)	2
Liquid Ammonium Sulfate Dose (mg/L)	0.44
MF	
Number of Trains (duty + standby)	3 + 1
Feed Flow per Train (MGD)	2.13
Total Feed Flow (MGD)	6.4
Filtrate Flow per Train (MGD)	2.06
Total Filtrate Flow (MGD)	6.2
Max Instantaneous Flux (gfd)	60
MF recovery (%)	97
Low-Dose UV	
Number of Reactors (duty + standby)	1 + 1
Target Logs of Virus Removal	1
UV Dose (mJ/cm^2)	58
RO	
Number of Trains (duty + standby)	3 + 1
Feed Flow per Train (MGD)	2.13
Total Feed Flow (MGD)	6.2
Permeate Flow per Train (MGD)	1.65
Total Permeate Flow (MGD)	4.9
Max Instantaneous Flux (gfd)	10.2
RO recovery (%)	80%
UV/AOP	
Sodium Hypochlorite Dose (mg/L)	1
Number of Reactors (duty + standby)	1 + 1
Target Logs of NDMA Removal	1.4

Design Criteria	Value
UV Dose (mJ/cm^2)	1,200
Post-Treatment	
Lime Dose (mg/L as $Ca(OH)_2$)	70
Carbon Dioxide Dose (mg/L)	2.5
Sodium Hypochlorite Dose (mg/L as Cl_2)	2
Free Chlorine CT Required for 6-log Virus Reduction (mg-min/L) [1]	25

Notes:

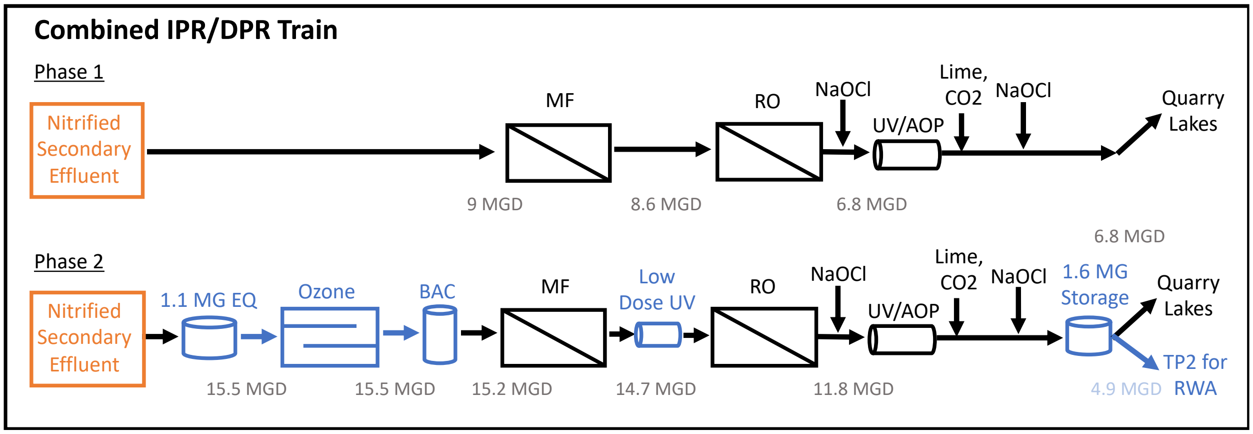
1. Based on extrapolated WaterVal Chlorine Disinfection Validation Protocol (Australian WaterSecure Innovations Ltd., 2017), assuming a turbidity of ≤0.2 NTU, a pH of 9, and a temperature of 15 deg C.

The layout for the Phase 2 AWPF—including a grayed-out Phase 1 AWPF layout—is shown in **Appendix D.** For costing purposes, it was assumed that a separate treatment building will be constructed for the Phase 2 alternative that houses the process equipment for ozone generation/destruct, MF, low-dose UV, RO, and UV/AOP along with space for a control room, break room, offices, lab space, restroom, and other various spaces that are needed within the building for personnel. A liquid oxygen (LOX) facility would be constructed as a concrete slab-on-grade that would house the LOX storage tank and vaporizers required for this alternative. An outdoor, buried ozone contactor is included in the layout along with an outdoor, buried BAC filter tank and storage space. As in the Phase 1 alternative layout, the MF feed and filtrate EQ tanks, the transfer pumps associated with those tanks, and the chemical storage area and post treatment area for Phase 2 will be located on outdoor concrete pads. A 1.1 MG secondary effluent EQ and 1.6 MG finished water steel tanks would be located on concrete pads.

6.2.3 Combined Train AWPF

Instead of building a second process train for expansion to Phase 2 AWPF flows, the Partners could construct a combined train that treats all Phase 1 and Phase 2 feed flows to DPR standards. This approach would be an alternative, not additive, to the two trains presented in Chapters 6.2.1 and 6.2.2. This combined train could still be constructed in phases, with the Phase 1 train treating water to groundwater recharge standards and consisting of the Phase 1 AWPF process train detailed in Chapter 6.2.1. Figure 6-6 shows how such phasing could work for a single combined IPR/DPR process train. Phase 2 would involve expanding the Phase 1 process train and adding additional treatment elements to meet the DPR standards. This would be achieved by adding 1) a 15.5 MGD ozone-BAC pre-treatment system, 2) a low-dose UV system, and 3) expanding the existing Phase 1 MF, RO, UV/AOP, and post-treatment processes.

Figure 6-6: Phasing of the Combined IPR/DPR Train AWPF (with Additions between Phase 1 and 2 shown in Blue)



As with the Phase 1 and 2 separate AWPF process trains, the 15.5 MGD feed AWPF developed for this combined train alternative would result in 6.8 MGD product flow to Quarry Lakes and 4.9 MGD product flow to WTP #2 and SFPUC Bay Division Pipeline. However, this combined train would also offer the Partners the added flexibility of being able to direct any portion of the 11.7 MGD product water to either of the two selected receptors for this Project or to any receptors identified in the future since all the water is treated to the strictest standards that are required for DPR. For example, this alternative would also allow for finished water to be sent directly to ACWD's Blending Facility for TWA, if desired.

Table 6-8 summarizes the pros and cons of a single, combined train AWPF at Phase 2 compared to having two separate process trains for groundwater recharge and RWA.

Table 6-8: Pros and Cons for Combined Train AWPF

Pros	Cons
• Less complex operations (operating only one train rather than two) • Benefits of Ozone-BAC pre-treatment improves performance and efficiency of all downstream processes (MF, RO, UV/AOP) • Increases flexibility to send finished water to Quarry Lakes (GWR), WTP#2 and SFPUC Bay Division pipeline (RWA), or Blending Facility (TWA) depending on seasonal needs/water quality • Requires a smaller footprint (1 larger train vs. 2 smaller trains) • Combined operations reduce monitoring and reporting requirements	• Requires larger ozone-BAC processes to treat the full flow • Perception of over-treating water • Requires constructing some elements of Phase 1 with sufficient capacity for future Phase 2 (e.g., upsizing inter-process piping, building, etc.)

The single combined process train provides ozone-BAC pre-treatment for the whole flow, which can lead to significant operational benefits to the downstream processes. These operational benefits result in both capital and operations and maintenance (O&M) cost savings. For example, the MF system will be able to operate at more than double the flux rate with ozone-BAC pre-treatment, meaning that the Phase 1 MF system does not need to be expanded for Phase 2. Other operational benefits result in reduced power, labor, and chemical costs. The quantitative benefits of Ozone-BAC pre-treatment are summarized in Table 6-9 and these benefits are included in the cost analysis summarized in Chapters 6.5 and 6.6.

Table 6-9: Quantitative Benefits of Ozone-BAC Pre-Treatment

MF	RO	UV/AOP

• Operate at higher flux—43 gallons per square foot per day (gfd) vs. 25 gfd—leading to lower MF equipment requirements
• Reduce frequency of membrane cleaning—e.g., Clean-In-Place[1] (CIP) and Enhanced Flux Maintenance (EFM)—to restore performance:
  o Full CIPs: 2 times a year vs. monthly
  o EFMs: none vs. once every 2-3 days
• Operate MF Feed Pumps at lower pressure reducing energy costs
• Operate at higher recovery (97% vs. 95%) leading to greater production at the same AWPF feed flowrate
• Reduce frequency of MF module replacement due to improved influent water quality (every 10 years to every 20 years)
	• Reduce CIP frequency (every 12 months vs. every 3 months)
	• Operate RO Feed Pumps at lower pressure reducing energy costs
	• Reduce frequency of RO membrane replacement due to improved influent water quality (from every 5 years to every 8 years)
	• Operate at potentially higher flux leading to lower RO equipment requirements
		• Operate UV lamps with less power (up to 50% reduction in power)
		• Reduce NaOCl dose leading to lower chemical costs

Notes:

1. Membranes foul and scale with organic and inorganic constituents that reduce performance over time. A CIP is used to restore performance by cleaning the membranes without having to remove them from the system. CIPs require the membrane system to be shut down so that the chemical solutions can be recirculated through the membranes over a period of hours. CIPs are typically a manual process, placing additional burden on operations staff. Furthermore, CIPs can interrupt production and result in additional chemical cost.

The combined AWPF train will achieve V/G/C LRVs of 20.5/23.5/17.5 (the same LRVs achieved by the Phase 2 AWPF), as summarized in Table 6-10. Because the LRVs exceed the requirements for both groundwater recharge at Quarry Lakes and RWA at WTP#2 and SFPUC Bay Division Pipeline, this combined train offers the Partners the added flexibility of being able to direct any portion of the product water produced by this train to either of the two selected receptors.

Table 6-10: Phase 2 Combined Train AWPF Pathogen Control

Pathogen	Ozone	BAC	MF	Low-Dose UV	RO	UV/AOP	NaOCl	Total	Required
Virus	6	0	0	1	1.5	6	6	**20.5**	**20 (RWA)** **12 (GWR)**
Giardia	6	0	4	5	1.5	6	1	**23.5**	**14 (RWA)** **10 (GWR)**
Cryptosporidium	1	0	4	5	1.5	6	0	**17.5**	**15 (RWA)** **10 (GWR)**

As mentioned in Chapter 6.2.2, because the feed flowrate to the Phase 2 combined train would exceed the minimum hourly flow treated by USD's WWTP, a 1.1 MG secondary effluent EQ tank is needed upon expansion to Phase 2. In addition, a 1.6 MG finished water tank would also need to be added to the site upon expansion to Phase 2 in order to provide sufficient response time between the AWPF and downstream WTP#2. A process flow diagram for the combined train AWPF at final build-out is shown in Figure 6-7 and the flow balance through the process train is summarized in Table 6-11. Preliminary design criteria for the Phase 2 combined AWPF process train, as developed to put together cost estimates for this Study, are summarized in Table 6-12. The process flow diagram, the flow balance through the process train, and the preliminary design criteria for the Phase 1 combined train AWPF are identical to those included in Chapter 6.2.1.

Figure 6-7: Phase 2 Combined Train AWPF Process Flow Diagram

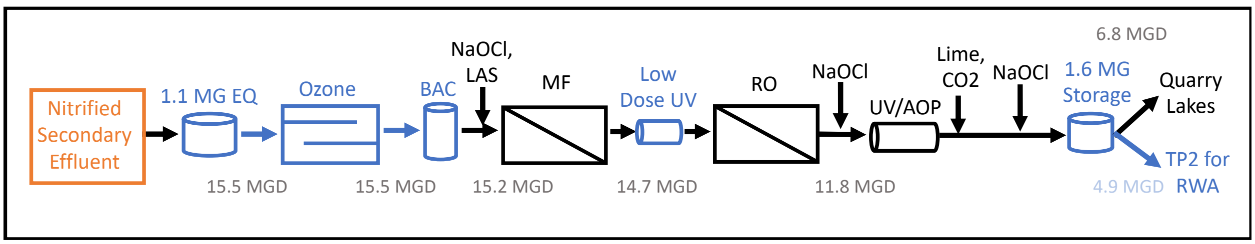


Table 6-11: Phase 2 Combined Train AWPF Flow Balance

	Ozone	BAC	MF	Low-Dose UV	RO	UV/AOP	Post-Treatment
Feed Flow	15.5 MGD	15.5 MGD	15.2 MGD	14.7 MGD	14.7 MGD	11.7 MGD	11.7 MGD
Recovery	100%	98%	97%	100%	80%	100%	100%
Product Flow	15.5 MGD	15.2 MGD	14.7 MGD	14.7 MGD	11.7 MGD	11.7 MGD	11.7 MGD

Table 6-12: Phase 2 Combined AWPF Preliminary Design Criteria

Design Criteria	Value
Ozone	
Average Ozone Dose (mg/L)	14
Average Sodium Bisulfite Dose (mg/L)	2.4

Design Criteria	Value
Ozone Contact Time (min)	11
Estimated T_{10}/T	0.79
Number of Ozone Contactors	1
Volume per Contactor (gallons)	118,400
Average Channel Depth (ft)	8
Channel Width (ft)	7
Channel Length (ft)	84
Total Number of Channel Passes	4
BAC	
Number of Filter Cells	7
Dimension of Filter Cells, each	32'-0" x 14'-3"
Total Filter Area (sf)	3,192
Chloramines	
Sodium Hypochlorite Dose (mg/L as Cl_2)	2
Liquid Ammonium Sulfate Dose (mg/L)	0.44
MF	
Number of Trains (duty + standby)	7 + 1
Feed Flow per Train (MGD)	2.2
Total Feed Flow (MGD)	15.2
Filtrate Flow per Train (MGD)	2.1
Total Filtrate Flow (MGD)	14.7
Max Instantaneous Flux (gfd)	43
MF recovery (%)	97
Low-Dose UV	
Number of Reactors (duty + standby)	2 + 1
Target Logs of Virus Removal	1
UV Dose (mJ/cm^2)	58
RO	
Number of Trains (duty + standby)	7 + 1
Feed Flow per Train (MGD)	2.1
Total Feed Flow (MGD)	14.7
Permeate Flow per Train (MGD)	1.7
Total Permeate Flow (MGD)	11.7
Max Instantaneous Flux (gfd)	10.2
RO recovery (%)	80%
UV/AOP	
Sodium Hypochlorite Dose (mg/L)	1
Number of Reactors (duty + standby)	1 + 1
Target Logs of NDMA Removal	1.4
UV Dose (mJ/cm^2)	1,200
Post-Treatment	
Lime Dose (mg/L as $Ca(OH)_2$)	70
Carbon Dioxide Dose (mg/L)	2.5

Design Criteria	Value
Sodium Hypochlorite Dose (mg/L as Cl_2)	2
Free Chlorine CT Required for 6-log Virus Reduction (mg-min/L) [1]	25

Notes:

1. Based on extrapolated WaterVal Chlorine Disinfection Validation Protocol (Australian WaterSecure Innovations Ltd., 2017), assuming a turbidity of ≤0.2 NTU, a pH of 9, and a temperature of 15 deg C.

The layout for Phase 1 and Phase 2 of the combined AWPF are included in **Appendix D**. For costing purposes, it was assumed that in Phase 1, the treatment building needed for Phase 2 build-out was constructed, with space left within the treatment building for equipment to be added in Phase 2 (ozone generation/destruct, additional RO trains). Similarly, the chemical storage area and post-treatment area constructed in Phase 1 would be sized for the final build-out Phase 2 space requirements. Space would be left on-site in Phase 1 for a LOX facility (concrete slab-on-grade for the LOX storage tank and vaporizers), an outdoor, buried ozone contactor, buried BAC filter tank and storage space, 1.1 MG secondary effluent EQ tank, and a 1.6 MG finished water tank.

6.3 AWPF Waste Discharge Water Quality Assessment

Under all Project alternatives, it is assumed the RO concentrate produced by the RO process at the AWPF will be discharged to the existing EBDA pipeline connection at USD's Alvarado WWTP, downstream of USD's permitting point. All other waste streams produced at the AWPF, including any strainer or screen waste, backwash waste, and waste generated by CIP procedures conducted on the MF and RO processes will be discharged to the sanitary sewer and/or via a direct waste line (see Chapter 7) that returns to the headworks of USD's Alvarado WWTP for additional treatment. The RO concentrate will flow from the AWPF to the Alvarado WWTP location via a dedicated RO concentrate pipeline, where it will commingle with disinfected secondary effluent, downstream of USD's permitting point prior to discharge via the EBDA pipeline.

The impact of RO concentrate discharge into the EBDA line was evaluated for future compliance with waste discharge requirements for point-source discharges into the San Francisco Bay including: 1) the California Toxics Rule (CTR; EPA 2011), 2) the Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan; SWRCB 2017a), and 3) the waste discharge requirements listed in the current EBDA NPDES permit (Order Ro. R2-2017-0016, NPDES No. CA0037869; SWRCB 2017b).

The CTR and Basin Plan WQOs apply to all dischargers in the San Francisco Bay Region, whereas the EBDA NPDES permit considers EBDA's specific discharge characteristics and quality to develop effluent limitations and monitoring requirements. The EBDA discharge water quality, results from mixing zone dilution studies, and the San Francisco Bay water quality impact what constituents receive effluent limitations and the concentration of those limits. Therefore, it is difficult to predict what the future effluent limitations will be when the RO concentrate is commingled with the secondary effluent. Due to anti-backsliding requirements, the future permit limitations will be at least equal to or more stringent than the current limitations. Although it is possible for the effluent limitations to decrease (become more stringent) because of future changes to discharge water quality or mixing zone dilution studies, the current NPDES permit effluent limitations are a good benchmark of comparison available now.

Only the constituents that have previously shown reasonable potential to be exceeded in the EBDA discharge based on historical water quality receive effluent limitations in the NPDES permit. Incorporating the RO concentrate will change the future discharge water quality and may result in additional constituents receiving effluent limitations. To provide a comprehensive assessment of future compliance, this analysis considered all the applicable WQOs in the CTR and Basin Plan in addition to evaluating compliance with existing effluent limitations in EBDA's NPDES permit.

6.3.1 Methodology for Compliance Assessment

The worst-case water quality for the commingled discharge – RO concentrate from the AWPF and the WWTP disinfected secondary effluent – was estimated considering the flowrates of the different waste streams and the maximum concentration for each constituent of interest. The historical maximum detected value for many constituents is used by the Regional Water Board to evaluate reasonable potential of WQO exceedance and determine whether effluent limitations are necessary. Although not all the constituents are regulated based on a maximum daily result, assuming the maximum detected value can provide a conservative assessment of future discharge compliance and identify potential constituents that may receive effluent limitations during future NPDES permit reissuance. Although the EBDA NPDES permit limits the concentrations of some key constituents (total ammonia, cyanide, copper, and dioxin-TEQ) at the EBDA common outfall rather than at the individual WWTPs, the analysis in this section was completed to examine whether this Project would increase the concentrations of the constituents regulated in the CTR and Basin Plan when examining only USD's contribution to the EBDA pipeline discharge.

Flowrates

To analyze worst-case conditions and consider seasonal variability of flow to USD's WWTP, the 5th percentile of the average daily secondary effluent flowrate (21.7 MGD) was assumed for all analysis. The Phase 1 RO concentrate flowrate was calculated assuming an MF recovery of 95% and an RO recovery of 80%, resulting in an RO concentrate flowrate of 1.7 MGD. The Phase 2 RO concentrate flowrate was calculated assuming a BAC recovery of 98%, an MF recovery of 97% (higher than the MF recovery assumed for Phase 2 because of Ozone-BAC pretreatment for Phase 2), and an RO recovery of 80%, resulting in a combined Phase 1 and Phase 2 RO concentrate flowrate of 2.9 MGD. Table 6-13 summarizes the different flowrates used in this analysis.

Table 6-13: Flowrates Used for Waste Discharge WQ Assessment

Waste Stream	Flowrate (MGD)
Secondary Effluent (5th percentile of average daily flow) [1]	21.7
Phase 1 AWPF Feed	9
Phase 1 RO concentrate	1.7
Phase 1 Total Waste Flow to Outfall for Disposal	21.7 – 9 + 1.7 = **14.4**
Phase 2 AWPF Feed	15.5
Phase 2 RO concentrate	2.9
Phase 2 Total Waste Flow to Outfall for Disposal	21.7 – 15.5 + 2.9 = **9.1**

Notes:

1. For the purposes of this evaluation, the 5th percentile of the average daily secondary effluent flowrate between 2015 and 2021 was used for these calculations. However, if Phase 2 of the Project is implemented in the future, this value will likely increase which will decrease the impact of the RO concentrate flow produced by the AWPF.

In both Phase 1 and Phase 2, the RO concentrate would undergo dilution in the pipeline when blended with the remaining secondary effluent. For Phase 1, a blend ratio of approximately 7.4:1 would occur based on a secondary effluent flow of 12.7 MGD and an RO concentrate flow of 1.7 MGD. For Phase 2, a blend ratio of approximately 2:1 would occur based on a secondary effluent flow of 6.2 MGD and an RO concentrate flow of 2.9 MGD. USD would like to maintain dilution of the RO concentrate at all times and recommends that RO concentrate blend ratios be included in the future AWPF design.

Concentrations

The maximum concentration for each constituent of interest was determined using historical water quality data collected between 2015 and 2021 (pulled from the CIWQS database). When estimating the potential concentration of constituents in the RO concentrate, 100% rejection of all constituents through the RO was considered. The resulting concentrations for each constituent were compared to the applicable WQOs in the CTR and Basin Plan as well as the current EBDA NPDES permit effluent limitations to assess compliance.

6.3.2 Waste Discharge Compliance Analysis Results

The results of the analysis were organized into four categories:

- Category 1: Constituents estimated to comply with CTR/Basin Plan objectives.
- Category 2: Constituents where a compliance estimate could not be determined due to unavailability of data in the 2015 to 2021 CIWQS Database.
- Category 3: Constituents where a compliance estimate could not be determined due to limitations of the analytical method reporting limit (MRL).
- Category 4: Constituents that may exceed the CTR/Basin Plan objectives depending on the quantity of secondary effluent discharge flow but that may be mitigated through other measures.

Table 6-14 shows a summary of the constituents that fall into Categories 2, 3, and 4; all other constituents are estimated to comply with the CTR/Basin Plan objectives (Category 1).

Table 6-14: Summary of Constituents in Categories 2, 3, and 4

Constituent	Category 2: Compliance Determination Not Possible due to Unavailable Data from 2015-2021 [1]	Category 3: Compliance Determination Not Possible due to MRL [2]	Category 4: May Exceed CTR/Basin Plan Objectives but May be Mitigated [3]
Chromium (IV)	✓		
Copper			✓
Cyanide			✓
2,3,7,8-TCDD	✓		
Acrylonitrile	✓	✓	
Chlorodibromomethane	✓		
Methyl Bromide	✓		
Tetrachloroethylene	✓		

Constituent	Category 2: Compliance Determination Not Possible due to Unavailable Data from 2015-2021 [1]	Category 3: Compliance Determination Not Possible due to MRL [2]	Category 4: May Exceed CTR/Basin Plan Objectives but May be Mitigated [3]
1,2-Trans-Dichloroethylene	✓		
Trichloroethylene	✓		
Benzidine		✓	
Benzo(a)Anthracene		✓	
Benzo(a)Pyrene		✓	
Benzo(b)Fluoranthene		✓	
Benzo(k)Fluoranthene		✓	
Bis(2-Ethylhexyl) Phthalate			✓
Chrysene		✓	
Dibenzo(a,h)Anthracene		✓	
3,3-Dichlorobenzidine		✓	
1,2-Diphenyhydrazine	✓	✓	
Hexachlorobenzene		✓	
Indeno(1,2,3-cd)Pyrene		✓	
Aldrin		✓	
Chlordane		✓	
4,4’-DDT		✓	
4,4’-DDE (linked to DDT)		✓	
4,4’-DDD		✓	
Dieldrin		✓	
Endrin		✓	
Heptachlor		✓	
Heptachlor Epoxide		✓	
Toxaphene		✓	
Ammonia			✓
TSS [4]			✓
CBOD [4]			✓
Dioxin-TEQ	✓		

Notes:

1. Data were unavailable for these constituents in the CIWQS database between 2015 to 2021. Secondary Effluent data for these constituents were available in the CIWQS database between 2011 to 2014 so the older data set was used for analysis in the ‘Explanation of Category 2 Constituents’ section. Secondary Effluent data for these constituents should be collected during detailed design to estimate the concentrations of these constituents in the combined waste stream.
2. Data for these constituents were reported as non-detect with MRLs higher than the California Toxics Rule and/or Basin Plan objective; therefore, it is not possible to demonstrate compliance or non-compliance for these constituents.
3. The concentrations for these constituents exceeded the California Toxics Rule and/or Basin Plan objectives; however, these exceedances may be mitigated through various measures including accounting for dilution

credits for the non-bio accumulative constituents and moving the point of compliance for a handful of constituents.

4. TSS and CBOD are not included in the Basin Plan/CTR objectives list but are included in this analysis because they have average monthly and average weekly limits in the EBDA NPDES permit. These constituents would exceed the limits in a combined waste discharge scenario. Therefore, these constituents are categorized as Category 4 constituents for this analysis.

Explanation of Category 2 Constituents

All constituents in Category 2 were not reported in the CIWQS database for USD's WWTP secondary effluent from 2015 to 2021. Therefore, a determination of compliance for these Category 2 constituents cannot be made using this data set. However, data for these constituents were available in the CIWQS database for USD's WWTP secondary effluent between 2011 to 2014. Using the data from the earlier period, none of these constituents appear to exceed the CTR and Basin Plan objectives. The results of this analysis are summarized in Table 6-15. Although these constituents are not estimated to exceed the objectives, some of these constituents begin to approach the objectives. A more recent and applicable dataset would need to be collected if this project moves forward into design.

Table 6-15: Constituents in Category 2 using 2011 to 2014 CIWQS Data

Category 2 Constituent	CTR/Basin Plan Objective	Projected Phase 1 Concentration [1]	Projected Phase 2 Concentration [1]
Chromium (IV) (µg/L)	50	8	14
2,3,7,8-TCDD (µg/L)	1.4E-08	<3.2E-13	<5.8E-13
Dioxin-TEQ (µg/L)	1.4E-08	2.0E-11 DNQ	3.6E-11 DNQ
Acrylonitrile (µg/L)	0.7	<1.8	<3.3
Chlorodibromomethane (µg/L)	34	0.4 DNQ	0.8 DNQ
Methyl Bromide (µg/L)	4,000	<0.8	<1.5
Tetrachloroethylene (µg/L)	8.9	<0.3	<0.6
1,2,-Trans-Dichloroethylene (µg/L)	140,000	<0.4	<0.7
Trichloroethylene	81	<0.2	<0.4
1,2-Diphenyhydrazine (µg/L)	0.54	<0.9	<1.7

Notes:

1. All concentrations listed as less than a number indicates that the constituent was not detected, meaning that the concentrations were never higher than the method detection limit (MDL) in all secondary effluent water quality data collected between 2011 to 2014. All concentrations listed as "DNQ" values indicate that the constituents were detected but not quantifiable as the concentrations were above the MDL but below the reporting limit (RL) and minimum level (ML). The "DNQ" values flagged in the secondary effluent concentrations were used to calculate the combined waste discharge concentration values through mass balance equations.

Explanation of Category 3 Constituents

The data for constituents in Category 3 were all reported as less than the MRL, but the MRL was higher than the CTR and/or Basin Plan objective. Nevertheless, the analytical methods used for the analyses complied with the Minimum Levels per the Basin Plan. This phenomenon is common in the implementation of the CTR and the Basin Plan where, for some constituents, analytical methods are not capable of measuring low enough to quantify the minimum toxicologically relevant concentrations. For these constituents, a discharge is only considered out of compliance with NPDES permit conditions if the monitoring results are 1) greater than the effluent limitation, 2) greater than or equal to the MRL, and 3) the analytical method used meets the defined Minimum Levels per the Basin Plan. Consequently, it is not possible to demonstrate compliance or non-compliance for these constituents. They may be subject to future reasonable potential analysis and review for additional actions. For example, a result that is less than the MRL in the *current* discharge does not necessarily mean the *future* discharge will be in compliance because the concentration may be detectable in the future commingled discharge. Therefore, the result of this analysis for all Category 3 constituents is indeterminate.

Explanation of Category 4 Constituents

The constituents that exceeded the CTR/Basin Plan objectives are summarized in Table 6-16; however, these exceedances could be explained or mitigated as summarized:

- Copper and cyanide have limits in the EBDA NPDES permit at levels higher than the CTR/Basin Plan objectives due to dilution credits for non-bioaccumulative constituents. Although the effluent limitations included in the current EBDA NPDES permit are subject to change during permit reissuance, the AMEL and MDEL included in the current permit are good benchmarks for this analysis. Neither of these constituents exceed the AMEL or MDEL included in the EBDA NPDES permit in either the Phase 1 or Phase 2 scenarios, and so are unlikely to limit the feasibility of these alternatives. Cyanide begins to approach the current average monthly limit included in the NPDES permit at an AWPF feed rate of 17.2 MGD. Because the maximum feed rate of the AWPF considered for this Project is 15.5 MGD, neither copper nor cyanide is anticipated to limit the feasibility of this Project.

- Bis(2-Ethylhexyl) Phthalate exceeded the WQO, but the exceedance was based on a single detected sample from all reported secondary effluent data collected between 2015 and 2021. The single detection had a value of 390 µg/L whereas the other four samples collected during this time period were non-detects with MDLs between 1.2 to 3.5 µg/L. Although this value was anomalously high, the testing laboratory could not find a reason to reject the value. In the next NPDES permit cycle, Bis(2-Ethylhexyl) Phthalate may be assigned an effluent limit. However, because the effluent limit will consider all collected data, the Project would most likely not exceed the limit established by this single anomalously high detected value.

- Similar to copper and cyanide, ammonia has limits in the EBDA NPDES permit at levels higher than the CTR/Basin Plan objective. The AMEL and MDEL included in the current permit are not exceeded under the Phase 1 flow scenario. Although the Phase 2 flow scenario does exceed the MDEL for ammonia listed in the EBDA NPDES permit, nitrification of the secondary effluent is a pre-requisite to producing purified water and it is assumed that nitrification to a secondary effluent ammonia level of less than 2 mg/L as N would be achieved either by USD's ETSU Program or by a tMBR upstream of the AWPF. However, a difference between ETSU and tMBR pre-treatment would be the amount of secondary effluent flow treated by the NDN process. If ETSU were implemented, the full secondary effluent flow (both the feed flow for the AWPF and the secondary effluent flow discharged to the EBDA pipeline) would be nitrified/denitrified to ammonia levels of less than 2 mg/L as N, resulting in Phase 1 and Phase 2 ammonia concentrations of less than 3 and 4.7 mg/L as N, respectively. If tMBR were implemented, only the feed flow to the AWPF would be nitrified/denitrified to ammonia levels of less than 2 mg/L, resulting in Phase 1 and Phase 2 ammonia concentrations of less than 49 and 40 mg/L as N, respectively. Because the ammonia concentrations for both Phase 1 and Phase 2 with both ETSU and tMBR are all below the AMEL and MDEL included in the current permit, it is unlikely that the ammonia limit will inhibit the feasibility of these alternatives.

- TSS and CBOD are above the limits listed in the EBDA NPDES permit because RO concentrate is expected to contain these constituents at levels exceeding the federal secondary treatment standards summarized in Title 40 of the Code of Federal Regulations §133.102 (EPA 2021). Because the NPDES permit's technology-based limits are intended to ensure proper treatment of wastewater, it is more appropriate to measure these constituents in the secondary effluent, prior to commingling with RO concentrate. Therefore, the location for RO concentrate discharge should be evaluated closely during detailed design. The RO concentrate shall be discharged downstream of the sampling point used to determine compliance for these constituents.

Table 6-16: Summary of Constituents in Category 4

Category 4 Constituent	CTR/Basin Plan Objective	EBDA NPDES Permit Limit	Phase 1 Concentration	Phase 2 Concentration
Copper (µg/L) [1]	8.2	Avg. Monthly: 53; Max Daily: 69	15.1	23.7
Cyanide (µg/L) [1]	2.9	Avg Monthly: 21; Max Daily: 40	11.1	17.6
Bis(2-Ethylhexyl) Phthalate (µg/L) [2]	6	–	587	925
Ammonia (mg/L as N) [3]	1.3	Avg. Monthly: 91; Max Daily:120	81	128
TSS (mg/L) [4]	–	Avg Monthly: 30; Avg Weekly: 45	81	128
CBOD (mg/L) [4]	–	Avg Monthly: 25; Avg Weekly: 40	29	45

Notes:

1. Copper and cyanide have limits in the EBDA NPDES permit at levels higher than the CTR/Basin Plan objectives due to dilution credits granted to non-bioaccumulative constituents. The Phase 1 and Phase 2 concentrations for both constituents are below the average monthly and max daily limits.
2. The Phase 1 and Phase 2 concentrations for Bis(2-Ethylhexyl) Phthalate were calculated using a single detected value (390 µg/L), which was collected outside of the 5-year permitting period. All other samples collected during the 2015-2021 period were non-detects with MDLs between 1.2-3.5 µg/L. Therefore, this detected value is anomalously high and more testing is recommended during design.
3. Nitrification is a pre-requisite to producing purified water and it is assumed that nitrification (either by ETSU or a tMBR) will reduce the secondary effluent ammonia level to <2 mg/L as N. The combined waste stream for Phases 1 and 2 with ETSU are anticipated to have ammonia concentrations of 3.0 and 4.7 mg/L as N, respectively, while the combined waste stream for Phases 1 and 2 with tMBR are anticipated to have

ammonia concentrations of 49 and 40 mg/L as N, respectively, when the secondary effluent is combined with the ROC waste stream prior to discharge to the EBDA forcemain.

4. TSS and CBOD are above the limits included in the EBDA NPDES permit. However, these constituents are included in the permit to ensure the secondary effluent treatment system is removing these constituents at levels required in the federal secondary treatment standards summarized in Title 40 of the CFR. Therefore, the NPDES permit will need to be revised to move the point of compliance for these constituents to the end of USD's secondary treatment train and not the point at which flow is directed to the EBDA pipeline.

6.4 RO Concentrate Corrosion Potential Evaluation

The Project Partners expressed concern about the potential for the new RO concentrate stream to cause corrosion issues in the EBDA pipeline. To address this, the quality of the future RO concentrate was estimated based on the water quality of the existing secondary effluent discharged by USD. Limited information about the condition of the EBDA line between USD and the City of Hayward Water Pollution Control Facility (WPCF) was available; however, the force main between the Alvarado WWTP and the City of Hayward WPCF was investigated (Kennedy Engineers, Inc., 1977). The existing pipeline is a 60" inner diameter reinforced concrete pipeline that was constructed in 1977. Because pipeline corrosion can occur both inside (driven by the quality of the water inside the pipeline) and outside (driven by the conditions and quality of the water and solids surrounding the pipeline) the pipeline, it is important to note that the pipeline runs along the Bay through various salt ponds and areas that appear to be influenced by high-salinity Bay waters.

When examining the major corrosion mechanisms associated with the RO concentrate, chloride and sulfate are the main constituents of concern. Sulfate is known to, over time and at high concentrations, corrode the concrete portion of the pipe while chloride permeates through the concrete to corrode the steel reinforcements in the pipe. As the reinforcing steel corrodes in the presence of chloride, the steel expands and causes further cracking of the concrete pipeline, which in turn exposes more reinforcing steel to the chloride present in the inside and outside of the pipeline. Because RO concentrate contains higher concentrations of these constituents than the existing secondary effluent, the presence of RO concentrate could potentially exacerbate the corrosion of the inner pipeline.

The concentrations of chloride and sulfate in the secondary effluent were based on a single water quality sample collected by USD in 2015. The concentrations of chloride and sulfate on the outside of the pipe were assumed to be equal to the concentrations of these constituents in the Bay and Ocean waters due to the proximity of the pipeline location to the Bay and Bay water-influenced areas. Table 6-17 summarizes the major contributors to corrosion potential and the concentrations of these constituents on both the inside and outside of the existing pipeline. Assuming that the pipeline has not had any failures or repairs since it was installed in 1977, it has maintained its integrity for 44 years to-date even when exposed to the high chloride and sulfate levels on the outside of the pipeline. In June 2022, EBDA staff confirmed that recent inspections showed the pipeline has maintained a high degree of structural integrity with minimal signs of corrosion damage.

Table 6-17: Corrosion Mechanisms and Existing Pipeline Conditions

Corrosion Mechanism	Concentration of Concern	Concentration before ROC Discharge
Sulfate	1,500 to 10,000 mg/L	• 110 mg/L inside pipeline

Corrosion Mechanism	Concentration of Concern	Concentration before ROC Discharge
		• 2,500 mg/L exposure to outside of pipeline
Chloride	No established guidelines delimiting maximum concentrations Pipeline has maintained its integrity for the last 44 years with 19,000 mg/L exposure outside of pipeline	• 320 mg/L inside pipeline • 19,000 mg/L exposure to outside of pipeline

Using the secondary effluent chloride and sulfate levels summarized and assuming an RO rejection of 100% for these constituents, the chloride and sulfate levels in the combined secondary effluent and RO concentrate waste stream were calculated at both the Phase 1 and Phase 2 AWPF sizes. Table 6-18 summarizes the calculated concentrations of chloride and sulfate due to the introduction of RO concentrate at both project sizes. It should be noted that the concentrations in the combined secondary effluent and RO concentrate flows shown in the table do not account for the potential backflow of wastewater from downstream EBDA dischargers (e.g., Hayward) that may provide further dilution of these combined streams during low diurnal flow periods.

Adding the RO concentrate flows will increase the chloride and sulfate levels inside the pipe by approximately 50% in Phase 1 and 125% in Phase 2. When compared to the concentrations on the outside of the pipeline, however, the blended flows are still one or more orders of magnitude lower than the Bay water. EBDA's investigation of its pipeline conducted in 2021 concluded that only isolated instances of corrosion were observed and generally only in the air-gap zones. Consequently, it is anticipated that RO concentrate introduction will not significantly impact the useful life of the pipeline.

Recommendations for future steps include a condition assessment of the EBDA pipeline to better characterize its current condition. It is also recommended that more chloride and sulfate data be collected from USD's secondary effluent during the design phase of this Project to provide a more thorough analysis of this potential issue.

Table 6-18: Corrosion Potential Analysis Due to Contribution of RO Concentrate in EBDA Pipeline

	USD Secondary Effluent	ROC	Combined Sec. Eff. and Phase 1 RO Concentrate	Combined Sec. Eff. And Phase 2 RO Concentrate
Flow (MGD)	Phase 1: 23-9 = 14 Phase 2: 23-15.5 = 7.5	Phase 1 Max: 1.7 Phase 2 Max: 2.9	15.7	10.4
Chloride (mg/L)	320	1,690	470	710
Sulfate (mg/L as SO4)	110	580	170	250

6.5 Opinion of Probable Total Capital Cost

An Opinion of Probable Total Capital Cost (Capital Cost) was prepared for the various process train alternatives summarized in the section above. Total Capital Cost represents the estimated cost to design, construct, and implement this capital project and consists of "Construction" and "Non-Construction" cost components.

A summary of the Total Construction costs and Non-Construction costs for the process train alternatives are provided in this chapter. A detailed methodology for developing the Total Project Cost is included **Appendix E**.

6.5.1 Total Construction Cost

The Total Construction Cost represents an estimate of the General Contractor's bid in a Design-Bid-Build procurement approach. Total Construction Cost includes Direct Construction Costs and General Contractor's administrative costs including insurance, Contractor's overhead and profit, bonding, and general conditions. For the purposes of this Study, costs reflect a project development level of 1% to 15% corresponding to a Class 4 Estimate with an excepted accuracy range of -20% to +30%[1].

Vendor supplied equipment pricing was provided for the major process equipment, including the following:

- Phase 1 and Phase 1 Combined Train AWPF:
  - MF system treating 9 MGD feed flow at 25 gfd flux and 95% recovery from Wigen
  - RO system treating 8.55 MGD feed flow at 80% recovery from Wigen
  - UV/AOP system treating 7.1 MGD feed flow for 2.4 logs NDMA removal with a UV dose of 2,000 mJ/cm^2 (K-143 UV reactor with 24 rows) from Wedeco
- Phase 1 tMBR:
  - tMBR system treating 9 MGD feed flow with 5 trains, with 7 cassette spaces per train, with 430 sf modules from Suez
- Phase 2 AWPF:
  - Ozone system treating 6.5 MGD feed flow with a PDOevo 900 ozone generator system from Wedeco
  - BAC system with three filter cells treating 6.5 MGD feed flow from Leopold
  - MF system treating 6.4 MGD feed flow at 60 gfd flux and 97% recovery from Wigen
  - Low Dose UV system treating 6.2 MGD feed flow through a single LBX1500e UV reactor that achieves 1-log virus inactivation from Wedeco
  - RO system treating 6.2 MGD feed flow at 80% recovery from Wigen
  - UV/AOP system treating 4.9 MGD feed flow for 1.4 logs NDMA removal with a UV dose of 1,200 mJ/cm2 (K-143 UV reactor with 10 rows) from Wedeco
- Phase 2 Combined Train AWPF:

[1] AACE Practice No. 56R-08 Cost Estimate Classification System as Applied to the Building and General Construction Industries, revised December 2012.

  - Ozone system treating 15.5 MGD feed flow with a PDOevo 1500 ozone generator system from Wedeco
  - BAC system with seven filter cells treating 15.5 MGD feed flow from Leopold
  - MF system treating 15.2 MGD feed flow at 43 gfd flux and 97% recovery from Wigen
  - Low Dose UV system treating 14.7 MGD feed flow through two LBX1500e UV reactors that achieves 1-log virus inactivation from Wedeco
  - RO system treating 14.7 MGD feed flow at 80% recovery from Wigen
  - UV/AOP system treating 11.8 MGD feed flow for 1.4 logs NDMA removal with a UV dose of 1,200 mJ/cm2 (K-143 UV reactor with 24 rows) from Wedeco
- For Phase 2 tMBR:
  - Cost to expand the tMBR system in Alternative B1 into a tMBR system treating 15.5 MGD feed flow with 10 trains, with 6 cassette spaces per train, with 430 sf modules from Suez

Other process equipment costs were estimated based on previously provided vendor quotes for other similar-sized projects.

Crew-based labor and machinery production estimates were used to develop the construction costs. Labor and materials were adjusted to San Francisco Bay Area pricing and applicable state and local taxes were applied. Prevailing wages were assumed. After discrete labor, equipment, and machinery were estimated and totaled, and multipliers for insurance, Contractor's overhead and profit, bonding, and general conditions were applied to develop a Construction Cost subtotal (see **Appendix F** for additional detail on each component of the cost estimate).

Assumptions used to develop the process train alternatives construction cost include the following:

- General Assumptions:
  - $1,000,000 placeholder for new electrical service for Phase 1 costs
  - Estimated electrical and instrumentation/controls costs as 30% of equipment costs
  - Process building assumed to be prefabricated steel building
  - All tanks assumed to be stainless steel
  - All foundations assumed to be founded on structural piles
  - Assumed 20-ft wide road around facilities; assumed gravel finish
  - Assumed security fence around facilities
  - Assumed 2-year construction for all phases except tMBR Phase 2 assumed to be 8 months
- Assumptions for Pit 2:
  - Assumed 348 acre-ft/114,000,000 gallons for dewatering based on Pit 2 high level
  - Assumed continuous dewatering of excavation throughout construction

- Assumed fill to EL 55 (NGVD29)
- Fill assumed to be dirt
- Assumed 6-month construction period

6.5.2 Non-Construction Costs

Non-Construction costs represent the additional costs to implement the Project. For the purposes of this study, non-construction costs included legal and administration, preliminary design including environmental documentation and permitting, final design, engineering services during construction, construction management, and an Owner's reserve for change orders. These costs do not include any of the District's required labor to implement the work. Non-construction costs were calculated as percentages of the Construction subtotal.

6.5.3 Opinion of Probable Total Project Cost

The Opinion of Probable Total Project Cost is the summation of Construction and Non-Construction costs. A summary of all project costs is provided in Table 6-19 and Table 6-20. All costs are presented in February 2022 dollars. Pit 2 sitework costs included in these tables are costs associated with dewatering and filling the existing Pit with soil to prepare the site for Phase 1 construction. The costs included for Phase 2 (Phase 2 AWPF, Phase 2 Combined Train, and Phase 2 tMBR) are the costs that it would take to add additional equipment and infrastructure to the process trains constructed during Phase 1.

6.6 Conceptual Estimate of O&M Costs

The following basis and assumptions were used to develop the conceptual estimate of O&M costs for the process train alternatives. A summary of annual O&M costs is presented in Table 6-22 and Table 6-23.

- A labor rate of $139/hr. was assumed based on the previous 2015/2016 Study (no escalation was assumed from this rate).
- An electrical rate of $0.20/kWh was assumed based on recent Pacific Gas & Electric (PG&E) rates.
- Chemical costs ($/dry lb.) were assumed based on recent Projects of similar sizes and by reaching out to chemical suppliers in the area for non-standard chemicals including MicroC for tMBR operations.
- Consumable costs include costs for equipment that are replaced on roughly an annual basis. Costs for larger equipment that are replaced upon reaching the end of useful life are not included in this estimate.

To compare the 15.5 MGD feed two-train O&M costs to the 15.5 MGD feed combined train O&M costs, the Phase 1 + Phase 2 AWPF O&M costs ($8,270,000) should be compared to the Phase 2 Combined Train AWPF O&M cost ($6,970,000) for a cost comparison of the two Phase 2 alternatives. If ETSU is not implemented, the Phase 1 and Phase 2 tMBR O&M costs should be added to the other costs to obtain the full O&M cost for those alternatives with tMBR.

6.7 Summary of Capital and O&M Costs

Adding ozone-BAC pre-treatment to the combined Phase 1 and Phase 2 flows requires constructing larger ozone and BAC processes which increases the capital cost, as discussed in Chapter 6.2.3. Ozone-BAC pre-treatment leads to significant operational benefits to the downstream processes, however, which result in both capital and O&M cost savings. The largest capital savings come from constructing a single AWPF train housed in a single Treatment Building and not requiring expansion of the Phase 1 MF system for Phase 2 flows. This MF benefit is due to the ability to increase the flux rate through the system due to improved feedwater quality resulting from ozone-BAC pre-treatment.

In addition to the capital savings from constructing a combined Phase 1 and Phase 2 train, O&M cost savings also contribute to the lower $/acre-foot (AF) of purified water costs summarized in Table 6-26(the costs included in this table do not include the total cost of the Project but rather only the costs associated with the AWPF process trains – all other costs associated with this Project are summarized in Chapters 7 through 9 of this Report). Because the ozone-BAC pre-treatment improves the water quality ahead of the MF process, the largest O&M cost savings come from the downstream treatment processes. The major O&M cost savings are summarized herein:

- Pre-chloramination upstream of MF: With ozone-BAC pre-treatment, the sodium hypochlorite and liquid ammonium sulfate doses can be reduced which results in annual chemical savings
- MF and RO: These processes require decreased MF module replacement frequency, lower power costs due to a reduction in power required to pump the ozone-BAC pre-treated water through the MF membranes, and additional chemical and labor savings due to the reduction in membrane cleaning frequency
- UV/AOP: The UV/AOP process requires much less power and oxidation chemical due to the enhanced water quality allowing the installed UV lamps to operate at 50% power and requiring a lower dose of sodium hypochlorite for oxidation.

Due to the benefits of ozone-BAC pre-treatment on the downstream processes, it is recommended that the Partners consider phasing the Project to include a single combined Phase 1 and Phase 2 train at ultimate build-out.

Table 6-19: Opinion of Probable Capital Cost – Separate IPR & DPR Trains (Alternative A or B) ($2022)

Description	Factor	Pit 2 Site Work	Phase 1 IPR AWPF	Phase 2 DPR AWPF
Construction Subtotal[1]		**$28,326,000**	**$ 55,571,000**	**$ 79,954,000**
Level of Definition Contingency	25%	$ 7,082,000	$ 13,893,000	$ 19,989,000
Direct Construction Cost		**$35,408,000**	**$ 69,464,000**	**$ 99,943,000**
Subtotal Other Construction Costs		**$ 9,100,000**	**$ 17,853,000**	**$ 25,685,000**
Total Construction Cost		**$44,508,000**	**$ 87,317,000**	**$125,628,000**
Bid Market Adjustment	15%	$ 6,676,000	$ 13,098,000	$ 18,844,000
Legal/Administration	5%	$ 2,225,000	$ 4,366,000	$ 6,281,000
Environmental and Permitting	5%	$ 2,225,000	$ 4,366,000	$ 6,281,000
Design	10%	$ 4,451,000	$ 8,732,000	$ 12,563,000
Engineering Services During Construction	5%	$ 2,225,000	$ 4,366,000	$ 6,281,000
Construction Management	12%	$ 5,341,000	$ 10,478,000	$ 15,075,000
Owner's Reserve for Change Orders	10%	$ 4,451,000	$ 8,732,000	$ 12,563,000
Non-Construction Cost		**$27,594,000**	**$ 54,138,000**	**$77,888,000**
Total Capital Cost		**$72,102,000**	**$141,455,000**	**$203,516,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$57,682,000	$113,164,000	$162,813,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$93,733,000	$183,891,000	$264,571,000

Notes:

1. Costs do not include the cost of a quenching facility located near the Quarry Lakes. A quenching facility is included in the opinion of probable total capital cost presented in Chapter 7 of this Report.
2. See Appendix F for more detailed cost information.

Table 6-20: Opinion of Probable Capital Cost – Combined Trains (Alternative A or B) ($2022)

Description	Factor	Pit 2 Site Work	Phase 1 Combined Train AWPF	Phase 2 Combined Train AWPF
Construction Subtotal[1]		**$28,326,000**	**$ 66,872,000**	**$ 48,136,000**
Level of Definition Contingency	25%	$ 7,082,000	$ 16,718,000	$ 12,034,000
Direct Construction Cost		**$35,408,000**	**$ 83,590,000**	**$ 60,170,000**
Subtotal Other Construction Costs		**$ 9,100,000**	**$ 21,483,000**	**$ 15,463,000**
Total Construction Cost		**$44,508,000**	**$105,073,000**	**$ 75,633,000**
Bid Market Adjustment	15%	$ 6,676,000	$ 15,761,000	$ 11,345,000
Legal/Administration	5%	$ 2,225,000	$ 5,254,000	$ 3,782,000
Environmental and Permitting	5%	$ 2,225,000	$ 5,254,000	$ 3,782,000
Design	10%	$ 4,451,000	$ 10,507,000	$ 7,563,000
Engineering Services During Construction	5%	$ 2,225,000	$ 5,254,000	$ 3,782,000
Construction Management	12%	$ 5,341,000	$ 12,609,000	$ 9,076,000
Owner's Reserve for Change Orders	10%	$ 4,451,000	$ 10,507,000	$ 7,563,000
Non-Construction Cost		**$27,594,000**	**$ 65,146,000**	**$ 46,893,000**
Total Capital Cost		**$72,102,000**	**$170,219,000**	**$122,526,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$57,682,000	$136,175,000	$ 98,021,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$93,733,000	$221,284,000	$159,284,000

Notes:

1. Costs do not include the cost of a quenching facility located near the Quarry Lakes. A quenching facility is included in the opinion of probable total capital cost presented in Chapter 7 of this Report.
2. See Appendix F for more detailed cost information.

Table 6-21: Opinion of Probable Capital Cost – Tertiary MBR Additional Costs for Alternative B Only ($2022)

Description	Factor	Phase 1 tMBR	Phase 2 tMBR
Construction Subtotal[1]		**$ 40,708,000**	**$ 6,883,000**
Level of Definition Contingency	25%	$ 10,177,000	$ 1,721,000
Direct Construction Cost		**$ 50,885,000**	**$ 8,604,000**
Subtotal Other Construction Costs		**$ 13,078,000**	**$ 2,210,000**
Total Construction Cost		**$ 63,963,000**	**$10,814,000**
Bid Market Adjustment	15%	$ 9,594,000	$ 1,622,000
Legal/Administration	5%	$ 3,198,000	$ 541,000
Environmental and Permitting	5%	$ 3,198,000	$ 541,000
Design	10%	$ 6,396,000	$ 1,081,000
Engineering Services During Construction	5%	$ 3,198,000	$ 541,000
Construction Management	12%	$ 7,676,000	$ 1,298,000
Owner's Reserve for Change Orders	10%	$ 6,396,000	$ 1,081,000
Non-Construction Cost		**$ 39,656,000**	**$ 6,705,000**
Total Capital Cost		**$103,619,000**	**$17,519,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$ 82,895,000	$14,015,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$134,705,000	$22,775,000

Notes:

1. Costs do not include the cost of a quenching facility located near the Quarry Lakes. A quenching facility is included in the opinion of probable total capital cost presented in Chapter 7 of this Report.
2. See Appendix F for more detailed cost information.

Table 6-22: Estimate of Annual O&M Costs – Separate IPR & DPR Trains (Alternative A or B) ($2022)

Description	Phase 1 IPR AWPF	Phase 2 DPR AWPF	Phases 1 + 2 AWPF
Consumables	$ 560,000	$ 350,000	$ 910,000
Power	$1,990,000	$1,330,000	$3,320,000
Chemicals	$1,700,000	$ 870,000	$2,570,000
Labor	$ 610,000	$ 860,000	$1,470,000
Estimated Annual O&M Cost	**$4,860,000**	**$3,410,000**	**$8,270,000**

Notes:

1. See Appendix F for more detailed cost information.

Table 6-23: Estimate of Annual O&M Costs - Combined Trains (Alternative A or B) ($2022)

Description	Phase 1 Combined Train	Phases 1+ 2 Combined Train
Consumables	$ 560,000	$ 565,000
Power	$1,990,000	$ 3,150,000
Chemicals	$1,700,000	$ 2,055,000
Labor	$ 610,000	$ 1,200,000
Estimated Annual O&M Cost	**$4,860,000**	**$ 6,970,000**

Notes:

1. See Appendix F for more detailed cost information.

Table 6-24: Estimate of Annual O&M Costs – Tertiary MBR (Alternative B only) ($2022)

Description	Phase 1 tMBR	Phases 1 + 2 tMBR
Consumables	$ 400,000	$ 600,000
Power	$ 800,000	$1,200,000
Chemicals	$3,600,000	$6,100,000
Labor	$ 600,000	$ 900,000
Estimated Annual O&M Cost	**$5,400,000**	**$8,800,000**

Notes:

1. See Appendix F for more detailed cost information.

Table 6-25: Summary of Capital and O&M Costs for Separate IPR & DPR Trains [1] ($2022)

Description [2]	Phase 1 Separate AWPF	Phase 2 Separate AWPF	Phases 1 + 2 Separate AWPFs
Average Yield (MGD) [3]	**6.8**	**4.9**	**11.7**
Average Yield (AF)	7,660	5,540	13,200
Total Construction Cost	**$ 87,317,000**	**$125,628,000**	**$212,945,000**
Cost per gallons per day	$ 13	$ 25	$ 18
Non-Construction Cost	**$ 54,138,000**	**$ 77,888,000**	**$132,026,000**
Total Capital Cost	**$141,455,000**	**$203,516,000**	**$344,971,000**
Annualized Capital Costs [4]	**$ 7,217,000**	**$ 10,383,000**	**$ 17,600,000**
Cost per gallons per day	$ 21	$ 41	$ 29
Cost per AF	$ 942	$ 1,875	$ 1,333
Annualized O&M Costs [5]	**$ 4,860,000**	**$ 3,410,000**	**$ 8,270,000**
Cost per AF	$ 634	$ 616	$ 627
Annualized Capital + O&M Costs	**$ 12,077,000**	**$ 13,793,000**	**$ 25,870,000**
Cost per AF	$ 1,576	$ 2,491	$ 1,960

Notes:

1. The purpose of this table is to provide a comparison of the capital and O&M costs related to the Separate and Combined Process Train alternatives. Because the Pit 2 site work is common to both phased alternatives, this table does not include the costs associated with Pit 2 site work. This table does not include the costs for the whole project but only the costs for the AWPF. All other costs associated with the Project (i.e., pipelines, pump stations, demineralization facility, etc.) are summarized in Chapters 7 to 9.
2. Costs do not include the cost of a quenching facility located near the Quarry Lakes. A quenching facility is included in the opinion of probable total capital cost presented in Chapter 7 of this Report.
3. The average yield included in this Table is the average yield of each phase of the AWPF. The average yield for the Phase 1 AWPF (and Phase 1+2 AWPF) do not include yield lost through the downstream demineralization facility and is therefore different than the average yield included in Chapter 9.
4. Annualized Capital Costs are calculated using a 3% interest rate over a 30-year period.
5. Annualized O&M Costs for Phase 2 Combined AWPF are not available because the Phase 2 Combined AWPF is an expansion of the Phase 1 Combined AWPF and is not a separate AWPF train. The Phase 1 and 2 Combined AWPF O&M Costs represent the O&M costs for the combined facility.
6. See Appendix F for more detailed cost information.

Table 6-26: Summary of Capital and O&M Costs for Combined Process Trains [1] ($2022)

Description [2]	Phase 1 Combined AWPF	Phase 2 Combined AWPF	Phase 1 + 2 Combined AWPF
Average Yield (MGD) [3]	**6.8**	**4.9**	**11.7**
Average Yield (AF)	7,660	5,540	13,200
Total Construction Cost	**$105,073,000**	**$ 75,633,000**	**$180,706,000**
Cost per gallons per day	$ 15	$ 15	$ 15
Non-Construction Cost	**$ 65,146,000**	**$ 46,893,000**	**$112,039,000**
Total Capital Cost	**$170,219,000**	**$122,526,000**	**$292,745,000**
Annualized Capital Costs [4]	**$ 8,684,000**	**$ 6,251,000**	**$ 14,936,000**
Cost per gallons per day	$ 25	$ 25	$ 25
Cost per AF	$ 1,133	$ 1,129	$ 1,131
Annualized O&M Costs [5]	**$ 4,860,000**	**--**	**$ 5,400,000**
Cost per AF	$ 634	--	$ 528
Annualized Capital + O&M Costs	**$ 13,544,000**	**--**	**$ 21,906,000**
Cost per AF	$ 1,768	--	$ 1,659

Notes:

1. The purpose of this table is to provide a comparison of the capital and O&M costs related to the Separate and Combined Process Train alternatives. Because the Pit 2 site work is common to both phased alternatives, this table does not include the costs associated with Pit 2 site work. This table does not include the costs for the whole project but only the costs for the AWPF. All other costs associated with the Project (i.e., pipelines, pump stations, demineralization facility, etc.) are summarized in Chapters 7 to 9.
2. Costs do not include the cost of a quenching facility located near the Quarry Lakes. A quenching facility is included in the opinion of probable total capital cost presented in Chapter 7 of this Report.
3. The average yield included in this Table is the average yield of each phase of the AWPF. The average yield for the Phase 1 AWPF (and Phase 1+2 AWPF) do not include yield lost through the downstream demineralization facility and is therefore different than the average yield included in Chapter 9.
4. Annualized Capital Costs are calculated using a 3% interest rate over a 30-year period.
5. Annualized O&M Costs for Phase 2 Combined AWPF are not available because the Phase 2 Combined AWPF is an expansion of the Phase 1 Combined AWPF and is not a separate AWPF train. The Phase 1 and 2 Combined AWPF O&M Costs represent the O&M costs for the combined facility.
6. See Appendix F for more detailed cost information.

7. CONVEYANCE FACILITIES EVALUATION

7.1 Introduction

This chapter presents the evaluation of the various distribution facilities—pipelines, pump stations, and storage tanks—required for the preferred alternative presented in Chapter 5. This includes facilities to move the source water to the AWPF as well as the product water and waste streams from the AWPF. Preliminary cost estimates were also developed.

7.2 Purpose and Approach

In Chapter 5, various facilities were evaluated, including potential pipelines, associated pump station and storage needs, were evaluated. For the purposes of this study, it has been assumed that the AWPF will be sited near Quarry Lakes at the Pit #2 location (see Chapter 6) and that if ETSU is not implemented, the additional MBR treatment will be sited at the Alvarado WWTP. Whether ETSU is implemented or not, the origin of the AWPF source water will be the Alvarado WWTP. Of the six alignments, one conveys feed water for the AWPF, three convey waste streams from the AWPF, and two convey product water from the AWPF. The six alignments are outlined in the following sections and a conceptual illustration of the alignments is presented in Figure 7-1.

Alignment 1: Alvarado WWTP Secondary/Tertiary Effluent to the AWPF

Alignment 1 will transport the WWTP effluent to the AWPF to serve as the source water for the recycled water project. As detailed in Chapter 6, the flow is expected to be about 9 MGD during Phase 1 and 15.5 MGD during Phase 2.

Alignment 2: AWPF MF Waste to USD Collection System

Alignment 2 will convey MF waste from the AWPF to the USD wastewater collection system, with flows estimated to be about 0.45 MGD during Phase 1 and 0.65 MGD after Phase 2. Based on initial review of USD's collection system hydraulic model, the 18-inch wastewater main in Peralta Boulevard has about 1.7 MGD of capacity under future peak wet weather conditions which is more than adequate to convey the projected AWPF MF waste stream. A more detailed review of the collection system capacity will be required should the preferred alternative move forward before final approval of this concept from USD. Given the comparative length of this alignment to the much longer Alignment 3, Alignment 2 is the preferred alignment for disposal of the AWPF MF waste.

Alignment 3: AWPF MF Waste to Alvarado WWTP

Alignment 3 serves as an alternative to Alignment 2 in the event the USD wastewater collection system does not ultimately have capacity to convey the AWPF MF waste. Instead, a new pipeline will be constructed to transport the MF waste (0.45 MGD and 0.65 MGD during Phase 1 and Phase 2, respectively) from the AWPF back to the Alvarado WWTP headworks.

Alignment 4: AWPF RO Waste to EBDA Pipeline

Alignment 4 will convey the AWPF RO concentrate, estimated to be about 1.7 MGD during Phase 1 and nearly 3 MGD after Phase 2 as detailed in Chapter 6, to the EBDA outfall pipeline located near the Alvarado WWTP.

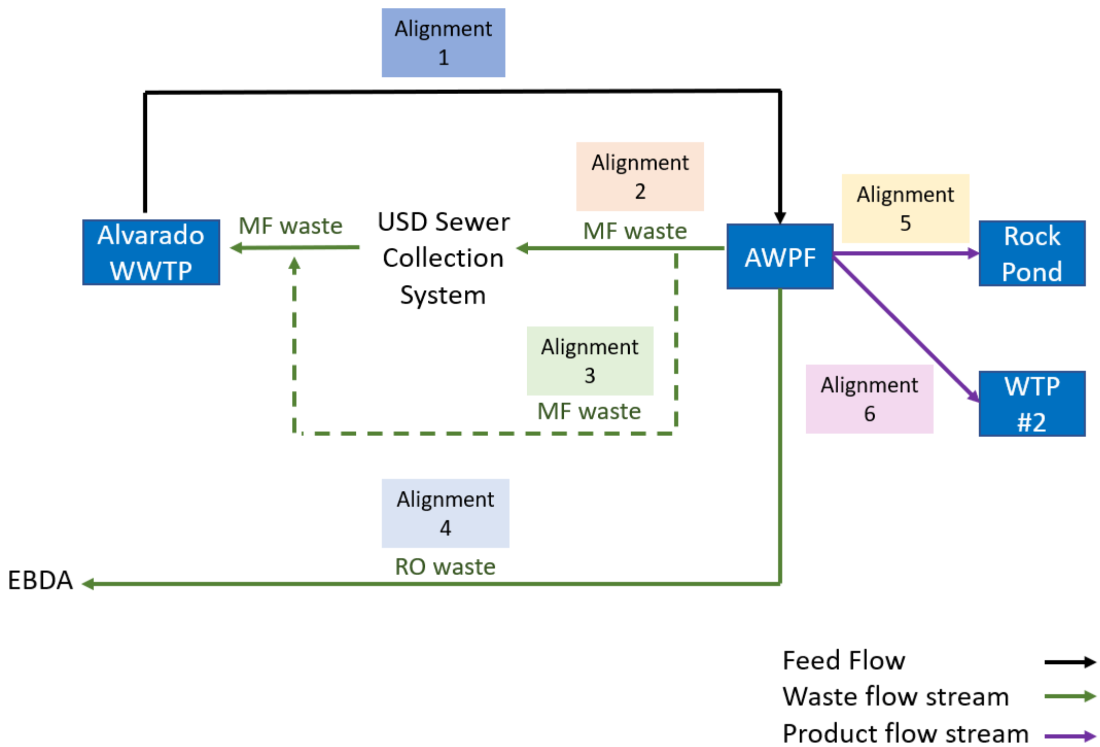
Alignment 5: AWPF Phase 1 IPR Product Water to Rock Pond

Alignment 5 will convey the 6.8 MGD of Phase 1 AWPF IPR product water to Rock Pond for recharge into the groundwater basin and eventual extraction and use in the ACWD's potable water system (see Chapter 8). Rock Pond was chosen as the designated recharge location based on initial review of the Quarry Lakes hydrogeology, which indicated that Rock Pond is the ideal location to facilitate recharge throughout the entire Quarry Lakes system. It is anticipated that the product water will require some quenching (dichlorination) prior to discharge to Rock Pond.

Alignment 6: AWPF Phase 2 DPR Product Water to WTP #2

Alignment 6 will convey the Phase 2 AWPF DPR product water, about 4.9 MGD, from the AWPF to WTP #2 for introduction to the ACWD distribution system.

Figure 7-1: Conceptual Pipeline Alignments



7.3 Alignment Evaluation

7.3.1 Planning and Design Assumptions

For each of the alignments, a number of planning and design assumptions were used when sizing the facilities. In addition to the numerical assumptions, presented in Table 7-1, the following assumptions were made when preparing the pipeline alignments and facility sizing:

- Facilities that are to be used for both Phase 1 and Phase 2 of the project were sized for their ultimate buildout use under Phase 2 conditions (Alignments 1, 2, 3 and 4).
- Construction within greenway pathways was not considered due to the institutional complexity of coordinating with additional agencies and anticipated difficulties of constructing within a levee (e.g., greenway pathways sited on the tops of levees along Alameda Creek). There could be possible cost-savings from the dedicated right-of-way, but this would need to be evaluated against the anticipated construction difficulties in a future phase of work.
- Construction around interstate interchanges was avoided due to Caltrans' history of not approving alignments crossing interchanges when there are opportunities to circumnavigate those locations.
- Based on discussions with ACWD staff, it was determined that no additional storage would be required at WTP #2 to facilitate the introduction of the AWPF product water into the supply. Therefore, the only storage required for each alignment is the wet well—sized per Hydraulic

Institute standards—for each pump station to allow for constant pumping of the predicted flow rate. The DDW-required detention of the AWPF product water is provided by the storage tank described in Chapter 6.

- Pipe material was assumed to be HDPE DR 17. While internal diameters were considered for pipe sizing and hydraulic calculations, all diameters listed in this chapter are the nominal pipe diameters.

Table 7-1: Planning and Design Assumptions

Criteria	Values
System Pressure	
Minimum Pressure (in pipelines)	10 psi
Maximum Pressure (in pipelines)	120 psi
Delivery Pressure (Quarry Lakes, WTP #2)	5 - 15 psi
Delivery Peaking Factors	
Peak Day Demand (Quarry Lakes, WTP #2)	1.0 MGD
Pipeline	
Velocity	3 – 5 fps
Pump Station	
Configuration	• Optimized to minimize total pump station horsepower • Assumes one standby pump of equal size to one duty pump
Storage Requirements	
Diurnal/Seasonal Storage	N/A
Pump Station Wet well	Per Hydraulic Institute standards

7.3.2 Facility Sizing and Alignments

Details of the facilities required for each of the six alignments are included in the following section. A map illustrating the alignments is presented in Figure 7-2 and a summary of the required facilities is presented in Table 7-2.

Alignment 1: Alvarado WWTP secondary effluent to the AWPF

As previously described, Alignment 1 will convey effluent from the Alvarado WWTP to the AWPF. The pipe alignment extends a little over seven miles, requiring some deviation from the most direct route in order to avoid crossing an I-880 interchange. The pipeline leaves the WWTP on Veasy Street and turns on Horner Street, heading eastward until it hits Alvarado Boulevard. The pipeline alignment follows Alvarado Boulevard heading southeast, crossing the railway near Jenkinson Lake Way before crossing Alameda Creek near I-880 and then turning southwest along Deep Creek Road. The alignment then crosses Deep Creek and turns east onto Creekwood Drive before crossing I-880 and Deep Creek (again) to Pecos Court. From here the alignment turns onto Santee Road and Mohawk River Street heading northeast to Ferry Lane before turning southeast onto Fremont Boulevard. Eventually the alignment turns northeast onto Thornton Avenue and finally turning southeast onto Paseo Padre Parkway to reach the proposed AWPF location.

The pipeline was sized at 36-inches to convey the 15.5 MGD Phase 2 flow. Based on initial review of this alignment, it was assumed that crossings of Alameda Creek and Deep Creek would be completed using horizontal directional drilling and the crossings of the railroad and I-880 would be constructed using the jack and bore method. The pump station required for this alignment was sized to include three 150 hp duty pumps (for a total of 450 hp in duty pumps) and one 150 hp standby pump with a wet well capacity of 55,000 gallons.

Alignment 2: AWPF MF Waste to USD Collection System

Alignment 2 will convey MF waste from the AWPF to USD's wastewater collection system near the intersection of Paseo Padre Parkway and Peralta Boulevard. This pipeline is expected to start on the northern side of the AWPF and continue along Paseo Padre Parkway for a half mile until it reaches the noted intersection to tie into USD's 18-inch collection main.

This pipeline was sized at 8-inches to convey the 0.65 MGD Phase 2 flow. The pump station required for this alignment was sized to include one 3 hp duty pump and one 3 hp standby pump with a wet well capacity of 2,500 gallons.

While typical open cut installation has been assumed, it is possible that a trenchless crossing may be required for installation of the pipeline under the railway overpass on Paseo Padre Parkway if it is determined that the overpass support columns cannot be avoided or may be adversely impacted by open cut installation. Additionally, it is possible that this conveyance line could be installed as a gravity main (with no required pump station or storage) based on a preliminary review of the topography of this area. Both the need for a trenchless crossing and the possibility of installing a gravity main should be reviewed during pre-design.

Alignment 3: AWPF MF Waste to Alvarado WWTP

Alignment 3, an alternative to Alignment 2, conveys MF waste from the AWPF to the Alvarado WWTP headworks. The proposed pipeline alignment is nearly identical to that of Alignment 1, with the flow direction reversed and the pipe extending slightly farther along the western edge of the Alvarado WWTP to reach the headworks (7.5 miles total).

This pipeline was sized at 8-inches to convey the 0.65 MGD Phase 2 flow. As with Alignment 1, it was assumed that horizontal directional drilling would be required to cross the creeks and jack and bore will be required to cross the railway and I-880. The pump station required for this alignment was sized to include one 30 hp duty pump and one 30 hp standby pump with a wet well capacity of 2,500 gallons. It should be noted that if the Alvarado WWTP requires the AWPF to hold delivery of its waste stream to better sync with the treatment plant's typical diurnal flows than the size of this tank will need to be increased.

Alignment 4: AWPF RO Waste to EBDA Pipeline

Alignment 4 conveys RO concentrate from the AWPF to the EBDA pipeline. Like Alignment 3, the proposed pipeline alignment is nearly identical to that of Alignment 1 with the flow direction reversed. In order to reach the EBDA pipeline, the Alignment 4 pipe is also slightly shorter than the Alignment 1 pipeline (6.8 miles), stopping at the intersection of Horner Street and Union City Boulevard to tie into the EBDA pipeline.

This pipeline was sized at 18-inches to convey the 3.0 MGD Phase 2 flow. As with Alignment 1, it was assumed that horizontal directional drilling would be required to cross the creeks and jack and bore will be required to cross the railway and I-880. The pump station required for this alignment was sized to include one 40 hp duty pump and one 40 hp standby pump with a wet well capacity of 14,500 gallons.

Alignment 5: AWPF Phase 1 IPR Product Water to Rock Pond

Alignment 5 conveys the Phase 1 IPR product water from the AWPF to the Rock Pond Recharge Point at Quarry Lakes. The pipeline alignment starts at the northwest corner of the AWPF site, traveling southwest along Paseo Padre Parkway and turning northeast onto Isherwood Way. The pipe cuts through a parking lot to head northeast on Roeding Avenue before finally turning southeast onto Lotus Pond Common to arrive at Rock Pond. This pipeline alignment is 2.2 miles long and crosses Alameda Creek via a bridge crossing (after turning onto Isherwood Way). The bridge crossing is the preferred creek crossing method, but trenchless construction may be needed if the bridge is determined to not be usable during pre-design (based on construction or institutional complexity).

This pipeline was sized at 28-inches to convey the 6.8 MGD Phase 1 flow. The pump station required for this alignment was sized to include one 40 hp duty pump and one 40 hp standby pump with a wet well capacity of 31,000 gallons assuming a constant flow sent to Rock Pond. Additionally, a dechlorination facility will be required to remove excess chlorine prior to the product water being introduced to Quarry Lakes. The facility will need to treat the 6.8 MGD flow and is expected to require 14 gpd of sodium bisulfite for the process.

Alignment 6: AWPF Phase 2 DPR Product Water to WTP #2

Alignment 6 conveys Phase 2 DPR product water from the AWPF to WTP #2. Starting at the AWPF, the pipeline alignment heads eastward along Paseo Padre Parkway for about 3.5 miles before turning northeast onto Driscoll Road. The alignment then turns east on Harrington Street to cut through a residential area ending at the entrance to WTP #2 at Via San Dimas and Mission Boulevard. Unlike the other alignments, this 5.1-mile alignment includes significant elevation change and construction in a residential area (to avoid construction in Mission Boulevard).

This pipeline was sized at 24-inches to convey the 4.9 MGD Phase 2 flow. As with Alignment 2, a trenchless crossing was not assumed for installation of the pipeline under the railway overpass on Paseo Padre Parkway however this assumption should be revisited during pre-design. Micro-tunneling was assumed for a second railway crossing, crossing of the SFPUC Bay Division pipeline, and of Mission Creek. The pump station required for this alignment was sized to include two 150 hp duty pumps (for a total of 300 hp in duty pumps) and one 150 hp standby pump with a wet well capacity of 10,500 gallons assuming a constant flow sent to WTP #2. As previously noted, there is additional storage planned at the AWPF to provide the required detention time for the DPR product water.

Figure 7-2: Proposed Pipelines Alignments

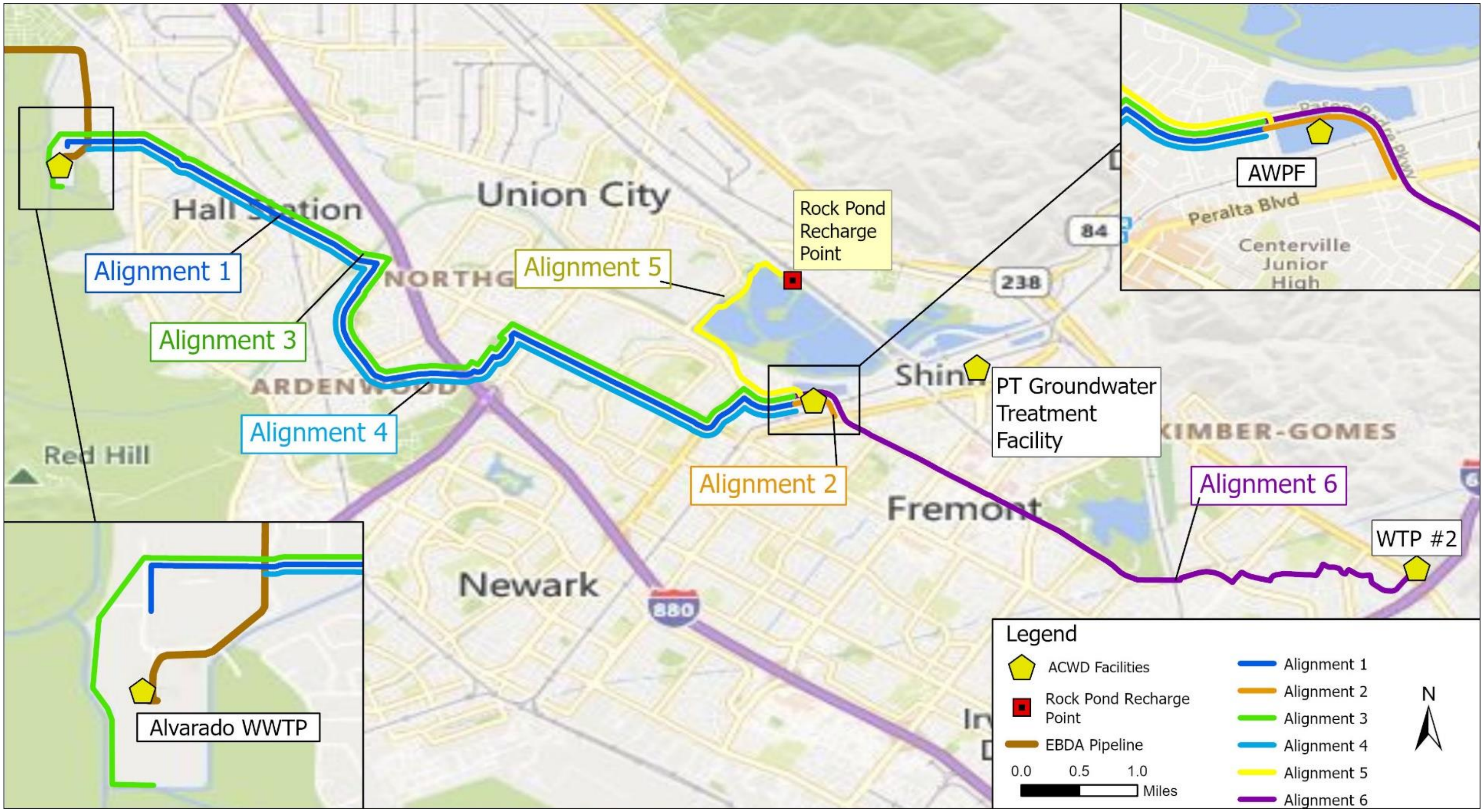


Table 7-2: Pipelines and Pumps Details of Proposed Alignments

Alignment					Pipeline		Pump Station			Wet well
	From	To	Flow Type	Flow [MGD]	Length [miles]	Diameter [in][1]	Configuration	Pump Power, Each [hp]	Total Station Pump Power (Duty + Standby) [hp]	Storage [gallons]
1	Alvarado WWTP	AWPF	Secondary/ Tertiary Effluent	15.5	7.1	36	3 Duty, 1 Standby	150	600 (450 + 150)	54,500
2	AWPF	Collection System	MF waste	0.65	0.5	8	1 Duty, 1 Standby	3	6 (3 + 3)	2,500
3	AWPF	Alvarado WWTP Headworks	MF waste	0.65	7.5	8	1 Duty, 1 Standby	30	60 (30 + 30)	2,500
4	AWPF	EBDA Pipeline	RO Concentrate	3.0	6.8	18	1 Duty, 1 Standby	40	80 (40 + 40)	14,500
5	AWPF	Rock Pond	Phase 1 IPR product water	6.8	2.2	28	1 Duty, 1 Standby	20	40 (20 + 20)	31,000
6	AWPF	WTP #2	Phase 2 DPR product water	4.9	5.1	24	2 Duty, 1 Standby	150	450 (300 + 150)	10,500

Notes:

1. Refers to nominal pipe diameter. HDPE DR17 pipe has been assumed.

7.4 Opinion of Probable Total Capital Cost

An Opinion of Probable Total Capital Cost (Total Capital Cost) was prepared for the pipeline alignments, pump stations and wet wells. Total Capital Cost represents the estimated total cost to design, construct, and implement this capital project. Costs assume a project development level of 1% to 15% corresponding to a Class 4 Estimate with an excepted accuracy range of -20% to +30%[1].

A summary of the basis for construction and non-construction (implementation) costs for the pipelines, pump stations, and wet wells is provided in this section. A detailed methodology for developing the Total Capital Cost is included **Appendix G**.

For the purposes of developing a Total Capital Cost, it was assumed that Alignment 2 would be selected for disposal of the MF waste. A Total Capital Cost for Alignment 3 was also prepared (see **Appendix G**) for consideration in case Alignment 2 is determined to be unviable.

7.4.1 Total Construction Cost

The Total Construction Cost represents an estimate of the General Contractor's bid in a Design-Bid-Build procurement approach. Cost estimates include multipliers for level of definition contingency, insurance, Contractor's overhead and profit, bonding, and general conditions and were prepared assuming San Francisco Bay Area pricing. See **Appendix G** for additional detail on each component of the Total Capital Cost.

Assumptions used to develop the pipelines, pump stations, and wet wells construction costs include the following:

- Pipelines
  - It was assumed that any construction occurring west of I-880 would encounter Bay Mud conditions. For pipe constructed in Bay Mud, increased allowances were applied to account for the increased cost associated with shoring, hauling/disposal of trench spoils, purchase/hauling of backfill material, groundwater management, and reduced production rates.
  - Blowoffs were assumed to be located at low points along the pipe alignments.
  - Air release valves were assumed to be located at high points along the pipe alignments.
  - Isolation valves were assumed to be installed every 2,000 linear feet of pipe.
  - Special traffic considerations were assumed for a two-block radius around hospital facilities (with emergency rooms).

[1] AACE Practice No. 56R-08 Cost Estimate Classification System as Applied to the Building and General Construction Industries, revised December 2012.

- A 6-inch overlap was assumed for repaving of the trenches, consistent with the more conservative standard (from Union City) for the various agencies to be coordinated with.
- For those pipelines crossing fault lines, a 30 percent markup on the base unit price was applied to account for the use of a seismically resilient technology such as flexible joints or Kubota's resilient ductile iron pipes.
- For those pipes crossing creeks an initial assumption of a microtunneling or horizontal direction drill crossing was assumed. For those crossings of railroads and highways, it was assumed that the pipeline would be installed using jack and bore with a casing. For Alignment 5 it was assumed that the pipeline could be hung on an existing bridge crossing Alameda Creek as that method would be significantly cheaper than the alternatives. The selected installation method should be reviewed during pre-design based on site details and coordinating agency interests.
- It is possible that the pipelines for Alignments 1, 3 and 4 could be installed in a shared trench which would reduce the project cost, however it has been assumed that each would have separate trenches for costing purposes given the planning level of the alignments presented in this plan. Possible construction of a shared trench should be considered during pre-design.

- Pump Stations
  - No special assumptions were made.
- Wet wells
  - No special assumptions were made.
- Dechlorination Facility
  - This facility was not costed out in detail. An allowance for the facility was included in the Alignment 5 cost estimate.

7.4.2 Non-Construction Costs

Non-construction (implementation) costs represent the additional costs to implement the Project. For the purposes of this study, bid market adjustment, legal & administration, environmental documentation and permitting, design, engineering services during construction, construction management, and an Owner's reserve for change orders were the assumed non-construction costs. These costs do not include any of the District's required labor to implement the work. Non-construction costs were calculated as percentages of the Construction subtotal. See **Appendix G** for additional detail on each non-construction cost component.

7.4.3 Opinion of Probable Total Capital Cost

The Opinion of Probable Total Capital Cost is the summation of Construction and Non-construction costs. A summary of the project costs for Alignments 1, 2, 4, 5 and 6, including the expected accuracy range, is provided in Table 7-3. Since Alignment 3 is the alternative to Alignment 2, that project cost will not be incorporated into the total cost for the preferred alternative (see Chapter 9). All costs are presented are in 2022 dollars.

Table 7-3: Opinion of Probable Total Capital Cost ($ 2022)[1]

	%	Alignment 1: Alvarado WWTP Effluent to AWPF[2]	Alignment 2: AWPF MF Waste to USD Collection System[2]	Alignment 4: AWPF RO Waste to EBDA Outfall[2]	Alignment 5: AWPF IPR Product to Rock Pond	Alignment 6: AWPF DPR Product to WTP 2
Gross Construction Cost	--	$47,404,000	$3,507,000	$30,578,000	$18,285,000	$22,067,000
Level of Development Contingency	25%	$11,851,000	$877,000	$7,645,000	$4,571,000	$5,517,000
Direct Construction Cost		**$59,255,000**	**$4,384,000**	**$38,223,000**	**$22,856,000**	**$27,584,000**
Subtotal Other Construction Costs		**$15,230,000**	**$1,127,000**	**$9,823,000**	**$5,875,000**	**$7,089,000**
Total Construction Cost		**$74,485,000**	**$5,511,000**	**$48,046,000**	**$28,731,000**	**$34,673,000**
Bid Market Adjustment	15%	$11,173,000	$827,000	$7,207,000	$4,310,000	$5,201,000
Legal/Administration	5%	$3,724,000	$276,000	$2,402,000	$1,437,000	$1,734,000
Environmental and Permitting	5%	$3,724,000	$276,000	$2,402,000	$1,437,000	$1,734,000
Design	10%	$7,449,000	$551,000	$4,805,000	$2,873,000	$3,467,000
Engineering Services During Construction	5%	$3,724,000	$276,000	$2,402,000	$1,437,000	$1,734,000
Construction Management	12%	$8,938,000	$661,000	$5,766,000	$3,448,000	$4,161,000
Owner's Reserve for Change Orders	10%	$7,449,000	$551,000	$4,805,000	$2,873,000	$3,467,000
Non-Construction Cost		**$46,181,000**	**$3,418,000**	**$29,789,000**	**$17,815,000**	**$21,498,000**
Total Capital Cost[3,4]		**$120,666,000**	**$8,929,000**	**$77,835,000**	**$46,546,000**	**$56,171,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$96,533,000	$7,143,000	$62,268,000	$37,237,000	$44,937,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$156,866,000	$11,608,000	$101,186,000	$60,510,000	$73,022,000

Notes:

1. The cost of Alignment 3 is not presented in this summary table as it has been assumed that Alignment 2 will be carried forward for MF waste disposal. The cost estimate for Alignment 3 is included in Appendix G for reference in case Alignment 2 is determined to be unviable.
2. Assumes Phase 2 sizing.
3. See Appendix G for additional cost details.
4. ENR CCI: 14395.70 (San Francisco as of Feb. 2022)

7.5 Estimate of Operations and Maintenance (O&M) Costs

The following basis and assumptions were used to develop the conceptual estimate of O&M costs for the pipelines, pump stations and wet wells. A summary of annual O&M costs is presented in Table 7-4 with a detailed breakdown included in **Appendix G.**

- Pipelines
  - Assumes two percent of construction cost for annual maintenance.
- Pump Stations
  - Assumes two percent of construction cost for annual maintenance.
  - Assumes pumps are operated 24 hours a day, 365 days per year. This is conservative as the pumps are likely to be taken out of service for maintenance periodically.
- Wet wells
  - Assumes two percent of construction cost for annual maintenance.
- Dechlorination Facility
  - Assumes 14 gpd of sodium bisulfate based on the detention time (based on the flowrate and alignment) for Alignment 5.

Table 7-4: Estimate of O&M Costs ($ 2022)

Description[1]	Alignment 1[2]	Alignment 2[2]	Alignment 4[2]	Alignment 5	Alignment 6
	Estimate of O&M Costs				
Consumables	$1,490,000	$110,000	$961,000	$575,000	$693,000
Power	$588,000	$4,000	$52,000	$26,000	$392,000
Chemicals	--	--	--	$8,000	--
Estimated Annual O&M Cost	**$2,078,000**	**$114,000**	**$1,013,000**	**$609,000**	**$1,085,000**

Notes:
1. The cost of Alignment 3 is not presented in this summary table as it has been assumed that Alignment 2 will be carried forward for MF waste disposal. The cost estimate for Alignment 3 is included in Appendix G for reference in case Alignment 2 is determined to be unviable.
2. Assumes Phase 2 sizing.

8. ACWD GROUNDWATER FACILITIES EVALUATION

8.1 Introduction

The Alternatives A1 and B1 indirect potable reuse projects described in Chapters 5 and 6 are anticipated to produce approximately 7,600 AFY or 8,000 AFY of purified water, respectively, for recharge into the Niles Cone Groundwater Basin (Basin) via Quarry Lakes. This additional annual recharge volume will provide an opportunity for ACWD to increase utilization of its local groundwater supply and decrease its dependence on imported water from the SFPUC, specifically as relates to blending to meet hardness goals and, more recently, to meet PFAS goals. The hardness goals of this project is unrelated to the secondary MCL.

Historically, Basin groundwater hardness concentrations have exceeded the ACWD's drinking water quality hardness goals. In order to meet ACWD's hardness goals while increasing groundwater usage as part of Alternatives A1/B1, a RO demineralization treatment facility is needed to treat a portion of ACWD's groundwater flow. The replacement of imported water from SFPUC with RO demineralized groundwater is necessary to maximize regional water supplies from the Alternatives. More recently, SFPUC water has also been needed to meet PFAS goals; work is occurring parallel to this Study to evaluate PFAS wellhead treatment options. The demineralized groundwater would replace the imported SFPUC water currently used for blending at ACWD's existing Peralta-Tyson (PT) Blending Facility. The PT Blending Facility is located at the PT Wellfield site, east of Quarry Lakes.

In 2004, ACWD prepared the "Peralta-Tyson Groundwater Treatment Facility – Preliminary Design Report" (PT GW Facility PDR) to plan for a groundwater demineralization facility at ACWD's PT Wellfield site. The demineralization facility is formally referred to as the PT Groundwater Treatment Facility (PT GW Facility).

The purpose of this evaluation is to reassess the findings of the PT GW Facility PDR and to revise its assumptions and design criteria to complement the Alternative A1/B1 projects and meet ACWD's current groundwater management needs. An updated estimate of probable cost for the PT GW Facility is presented at the end of the Chapter.

8.2 PT GW Facility PDR Summary

This Chapter is a summary of the PT GW Facility PDR including defining assumptions, RO design criteria, phasing strategy and facility sizing, concentrate management, and cost estimate.

8.2.1 Defining Assumptions

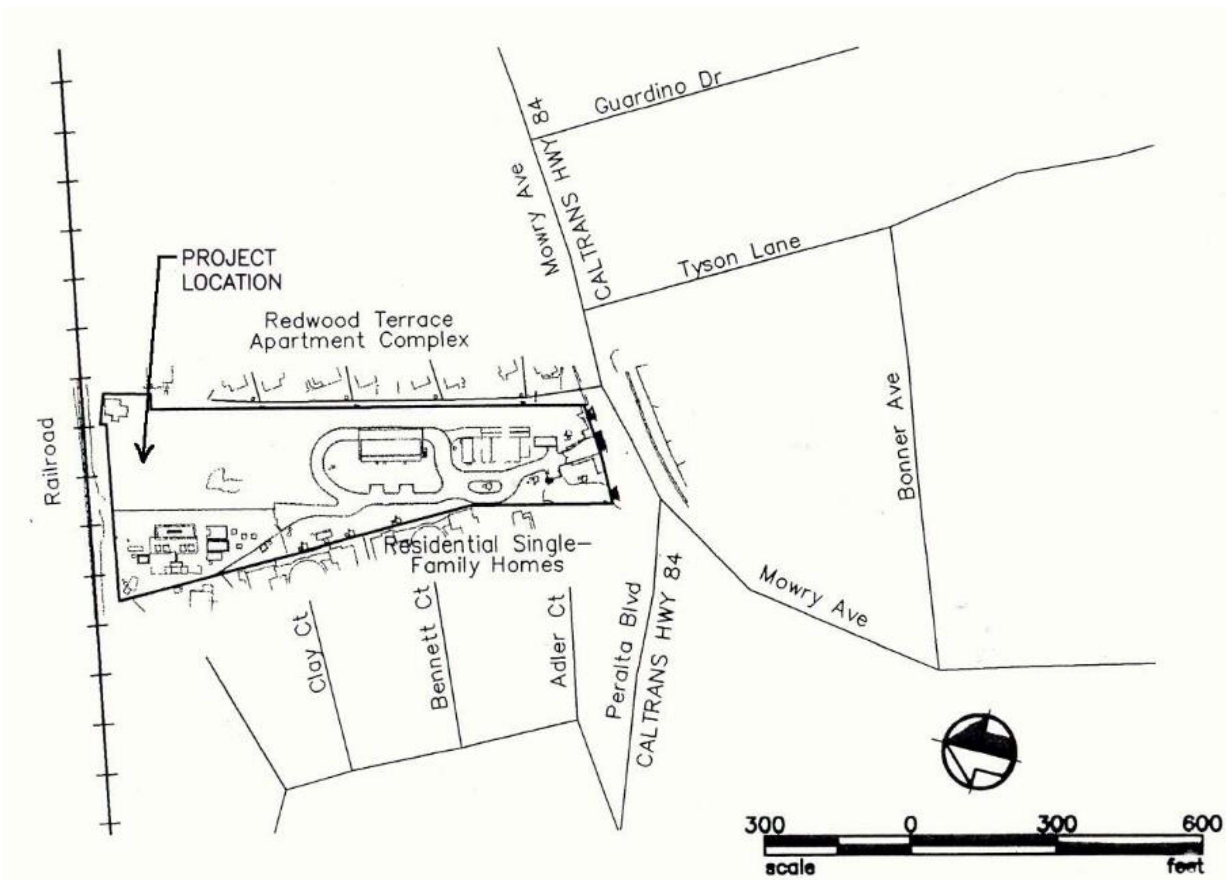
The defining assumptions of the PT GW Facility PDR include the following:

- The PT GW Facility would be located at the District's PT Wellfield site in Fremont, CA, east of Quarry Lakes. See Figure 8-1 for the project location. In addition, ACWD is currently in design of a 6 MGD/15 MGD ion exchange (IX) treatment system potentially co-located at the PT Facility site, additional coordination or re-evaluation of the proposed location will be required.
- The proposed facility would use a RO process to treat potable groundwater with a total dissolved solids (TDS) concentration of about 550 mg/L to produce permeate with a TDS of about 45 mg/L. The low TDS permeate would be blended with raw groundwater at the PT Blending facility to meet District annual average hardness goals of 150 mg/L (as $CaCO_3$). The

maximum summer hardness goal of 175 mg/L (as $CaCO_3$) quoted in the PT GW Facility PDR has been noted as out-of-date by ACWD staff and is removed from further discussion and consideration.

- The PT Facility would be constructed in phases with an initial production capacity of 4 MGD (Phase I), expandable to a future capacity of 14 MGD (Phase II) by increments of 2 MGD.
- The RO process would be operated at a recovery rate of 80% and would produce approximately 1 MGD of concentrate. Concentrate would be discharged to the Bay through Alameda County Flood Control and Water Conversation District (ACFC&WCD) Flood Line D via the Farwell ARP well. Concentrate would be conveyed to the Farwell ARP well via existing 8" Manuel J. Bernardo Softening Plant (MJBSP) pipeline. The MJBSP was located at the PT Well field site and was decommissioned in the 1990's.
- The cost estimate was based on a Phase I (4 MGD) production design capacity. This facility included provisions for future expansion to Phase II.

Figure 8-1: Project Location



Source: PT GW Facility PDR, 2004

8.2.2 Reverse Osmosis Design Criteria

The PT GW Facility would use a RO treatment process to reduce TDS to approximately 45 mg/L. The resulting low hardness permeate would be blended with raw groundwater at the PT Blending Facility. Table 8-1 is a summary of the RO treatment design from the PT GW Facility PDR.

Table 8-1: RO Design Criteria

Parameter	Value for Phase I
Permeate Flowrate	4 MGD
Skid Size	2 MGD each (Two skids for Phase I)
Pretreatment Requirements	
Cartridge Filters	5-micron nominal pore size
Antiscalant	King Lee Technologies *PreTreat Plus 0100* or equivalent, 6- 11 mg/L initially One 5,500 gal storage tank
Acid	Hydrochloric Acid, 0 – 18 mg/L One 5,500 gal storage tank
Membrane System	
Configuration	2-stage (34 x 17), 8-inch diameter, 40-inch long, spiral wound, thin film composite RO
Feed Pressure	70 - 160 psi, delivered by a 250 to 300-HP, 3600 rpm horizontal feed pumps with a recommended maximum pump pressure of 150 psi equipped with VFD motors; 1 pump per skid (no spare)
Water Recovery	80%
Clean Membrane Flux	14 gfd
Pathogen Protection Goal	Increased Protection
Hardness Removal Goal	95 %
Post-Treatment Requirements	
CO_2 Removal	Decarbonation Towers
pH adjustment	NaOH, fed from existing Blending Facility equipment
Permeate booster pumps	125-HP; 1 pump per skid (no spare)

Source: PT GW Facility PDR, 2004

8.2.3 Phasing Strategy and Facility Sizing

The PT GW Facility would be constructed in phases with an initial production capacity of 4 MGD (Phase I), expandable to a future capacity of 14 MGD (Phase II) by increments of 2 MGD. The initial process building would be constructed to accommodate a plant capacity of up to 6 MGD. For every 2-MGD increase in plant capacity, one 2-MGD RO skid would be added along with its associated feed pump, permeate booster pumps and cartridge filter. A summary of the planned phasing for major pipelines and process equipment is presented in Figure 8-2.

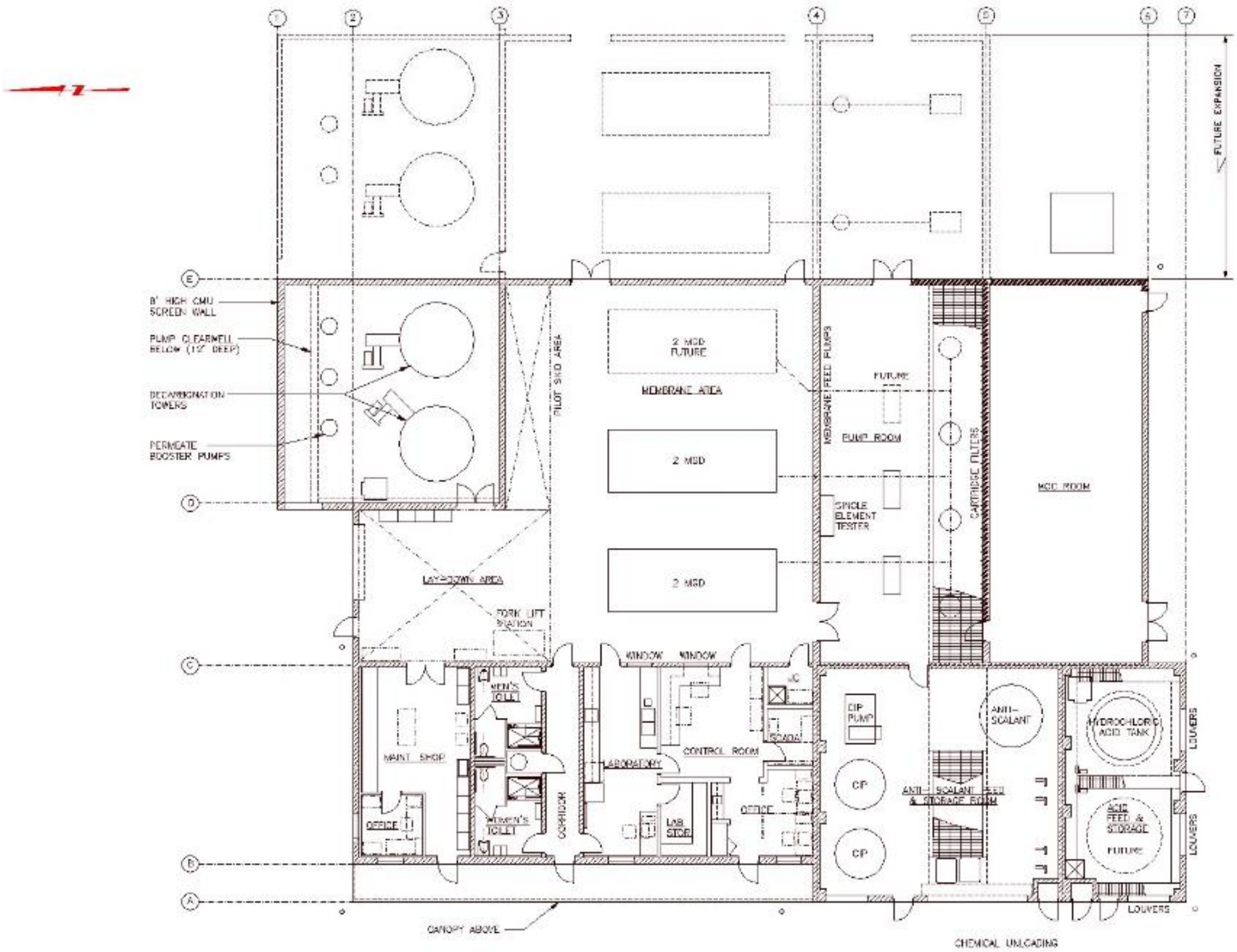
Table 8-2: Major Pipelines and Process Equipment Phasing

Description	Diameter	Sized For	Notes
Pipelines			
Raw Water Pipeline	24-inch	Phase II	From PT/Mowry Wellfields to process building.
Permeate Pipeline	24-inch	Phase II	From process building to PT Blending Facility.
Concentrate Pipeline	24-inch	Phase II	From process building to concentrate basin.
Existing MJBSP Pipeline	8-inch	Phase I	
Process Equipment			
RO Skid	-	Phase I	
RO Feed Pump	-	Phase I	
CIP System	-	Phase II	
Decarbonation Towers	-	6 MGD	
Permeate Clearwell	-	6 MGD	
Permeate Booster Pumps	-	Phase I	
Chemical Systems	-	Phase II	Antiscalant, acid, etc.
Cartridge Filters	-	Phase I	
Concentrate Discharge Pumps	-	Phase I	At concentrate basin. Pumps concentrate from basin to Farwell ARP site.
Energy recovery turbines	-	Phase I	One per skid; boosts interstage pressure.

The Phase I process building would be constructed to accommodate three, 2-MGD RO trains for a production capacity of up to 6 MGD with overall dimensions of 133-ft by 99-ft. The building would be located on the northern portion of the property. For additional capacity, an extension would be built on the east side of the building.

Process equipment located in the building would include cartridge filters, RO feed pumps, RO skids, decarbonation towers, membrane CIP system, and chemical storage. Additional facilities would include a maintenance shop, offices, locker rooms, control room, laboratory, and motor control center (MCC) room. The building layout is shown in Figure 8-2.

Figure 8-2: Process Building Layout



Source: PT GW Facility PDR, 2004

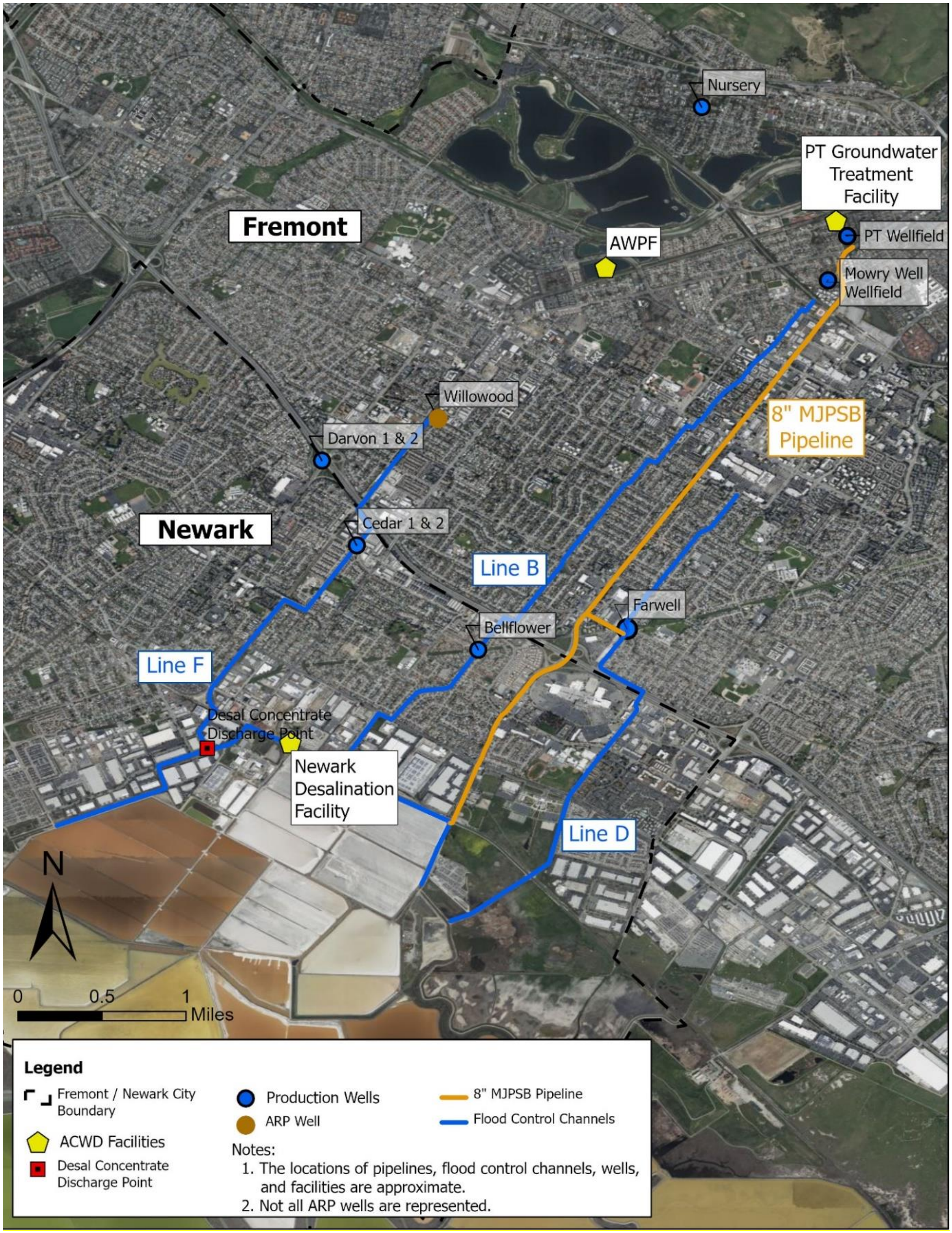
8.2.4 RO Concentrate Management

For the Phase I PT GW Facility, the RO process would produce approximately 1 MGD of concentrate at recovery rate of 80%. The combined RO concentrate would be collected at an on-site concentrate basin and pumped to the Farwell ARP well for Bay discharge through ACFC&WCD Flood Line D. The concentrate flow would be conveyed through the existing 8-inch MJBSP pipeline for approximately 2.75 miles. See Figure 8-3 for the MJBSP pipeline alignment.

The MJBSP pipeline has a capacity of approximately 1 MGD. For facilities larger than 4 MGD, a new pipeline would have to be constructed to a nearby flood control channel, or the MJBSP pipeline would have to be used in conjunction with another discharge alternative to meet the discharge requirements.

The PT GW Facility PDR did not resolve the issue of concentrate discharges for larger PT GW Facility sizes and assumed that would be reviewed by a future designer. Additionally, the current condition of the MJBSP pipeline is unknown and is assumed to be aged beyond its useful life.

Figure 8-3: Existing MJBSP Pipeline Alignment



Additional Information on RO Concentrate Management Permitting

The landscape for RO Concentrate Management Permitting has evolved since 2004 when the PT GW Facility PDR was written.

NPDES Permitting for RO Concentrate from the PT GW Facility

It will be important to consider the NPDES permitting requirements while developing the waste discharge approach and outfall design because these decisions will be heavily influenced by permit requirements. For example, all point-source discharges to the San Francisco Bay are subject to the 10 to 1 dilution prohibition, which prohibits discharges that achieve less than a 10 to 1 dilution upon initial discharge. A direct surface discharge (such as a stormwater channel) entering the Bay will not achieve a 10 to 1 dilution. An outfall with specially designed diffusers would be required. There are exceptions to this prohibition that are allowed, and depending on project goals (e.g., expanding potable water sources or treating PFAS), the EPA may be more lenient and/or motivated to find a permitting solution for the project.

NPDES permitting may take 14 to 20 months from initiating Report of Waste Discharge (ROWD) development through the RWQCBs adoption of the permit. The variation of timing is dependent on the complexity of the ROWD. For example, if a mixing zone and dilution credit study is required to quantify initial mixing of the discharge and receiving water, the ROWD application would take longer to develop. Submittal of the ROWD can occur as soon as all required information is available. This includes treatment process descriptions, receiving water dilution, estimated worst-case discharge conditions (considering both water quality and flow variation), process flow diagram, project area map, solid waste disposal approach, project implementation schedule, and more. This information would likely be known around the 60% design phase. The NPDES permit must be adopted prior to the discharge of any water from the facility, and therefore should be done before plant startup. A typical timeline for NPDES permitting is as follows:

- 1 – 7 months: develop ROWD
- 6 months: RWQCB develops Administrative Draft permit for internal review
- 4 months: RWQCB develops Tentative Order and posts it for public review and comment
- 3 months: RWQCB revises Tentative Order and develops Final Order for review and approval at a Permit Adoption Hearing

Additional Environmental Permitting

A new outfall and/or new point source discharge requires federal environmental permitting documentation (Environmental Impact Statement) in addition to the standard Environmental Impact Report. It also requires oversight and approval by the EPA. This point alone adds a significant hurdle to overcome prior to project implementation. In addition, the specific permits and variations of those permits are strongly dependent on project details—specifically, where and how the treatment facilities and new brine waste pipeline would be installed. Permits that may be applicable to the project include:

- Clean Water Act Section 404
- RWQCB Section 401
- US Fish and Wildlife Service, Endangered Species Act Section 7

- National Marine Fisheries Services Section 7
- State Historic Preservation Officer (SHPO) Cultural Landscapes
- California Code, Fish and Game Code 1602
- San Francisco Bay Conservation and Development Commission permits

These permits (1) regulate the discharge of dredged or fill material into waters of the US, (2) minimize impacts on endangered species and their habitats, (3) preserve cultural landscapes, (4) regulate changes to the natural flow of water, and (5) protect and preserve the San Francisco Bay and shoreline. Many of these permits involve the coordination of multiple agencies, including the US Army Corps of Engineers, US Fish and Wildlife Service, National Marine Fisheries Service, SHPO, and the RWQCB. Some agencies are able to process permit applications more quickly than others; however, it is safe to assume at least 12 to 18 months would be needed to obtain the necessary permits prior to initiating project construction.

Efforts to obtain the above permits could start as soon as basic project components are defined. Early and frequent communication with the relevant agencies is critical for minimizing schedule delays. Even when the project is loosely defined, participation in an Interagency Meeting through the US Army Corps of Engineers can be helpful to identify the applicable permits and corresponding agencies that will be involved in the project permitting. Once the relevant permits are identified, the application can be submitted at various stages of design depending on the level of project development needed to provide the required application materials. As a conservative estimate, application materials would likely be available at the 60% design level. Based on this assumption, these environmental permitting efforts would begin at the 60% design level and extend 12 to 18 months, with construction beginning at the end of that timeline.

In addition to the schedule impacts associated with obtaining the environmental permits, the permits may also require adjustments to the project schedule. For example, if it is determined that the project will impact an endangered species, the permit may include specific limitations for where and when construction can be done to minimize project impacts on the endangered species. These limitations may include restricting construction to specific months of the year to avoid nesting season or other sensitive times for the endangered species. The restrictions and schedule impacts are difficult to predict and quantify until the relevant permits are identified.

Recommendations on Next Steps for RO Concentrate Management for PT GW Facility

As described, developing a new discharge location and conveyance outfall for RO concentrate from the PT GW Facility would require significant environmental permitting efforts that would impact the cost and schedule of the project. An alternative option, such as joining the East Bay Discharger's Authority and their existing outfall, should also be considered in the next phase of work. Although it may be more expensive given the associated pipeline costs, it may be an easier and more reliable option than developing a new outfall.

8.2.5 Cost Estimate

This Chapter is a summary of the PT GW Facility PDR construction and O&M cost estimates for the Phase I (4 MGD) PT GW Facility.

Construction Cost Estimate

The total construction cost was estimated at $9,809,700 (2004 dollars), including a 20 percent contingency. The construction cost is representative of a conceptual Class 4 estimate with an anticipated accuracy range of -20% to +30% as described by the Association for the Advancement of Cost Engineering (AACE). The PT GW Facility PDR construction cost backup is included as reference in **Appendix H**.

Operations and Maintenance Cost Estimate

Annual O&M costs were estimated at $1,227,000 (2004 dollars) and were assumed to include power, chemicals, staffing, contract services, laboratory services, concentrate disposal, and RO membrane replacement. It was assumed that ACWD operators from the PT Blending Facility would also staff the PT GW Facility. Therefore, no labor costs were included in the estimate. Table 8-3 is a summary of the annual O&M costs for the Phase I (4 MGD) PT GW Facility. Limited explanation was included in the PT GW Facility PDR on the details of the Annual O&M Estimate.

Table 8-3: Phase I (4 MGD) Facility Annual O&M Costs ($ 2004)

Cost Item	Annual Cost
Power	$457,000
Chemicals	$193,000
Staffing	$0
Contract Services	$10,000
Laboratory Services	$8,000
Concentrate Disposal (1 MGD)	$59,000
Total Annual O&M Cost	**$727,000**

8.3 Revised Planning Criteria for 6 MGD PT Groundwater Treatment Facility

The following PT GW Facility design criteria and assumptions were determined based on discussions with ACWD staff:

- Groundwater pumped out of the Basin as influent to the PT GW Facility for demineralization will be equal to the groundwater recharged into the Basin as part of either Alternative A1/B1 project. This new pumped production flow will be in-addition to the raw groundwater currently being used for blending with SFPUC water at the PT Blending Facility. Alternative A1 recharge flows/PT GW Facility influent flows are estimated at 6.8 MGD (7,600 AFY). Alternative B1 flows are estimated at 7.1 MGD (8,000 AFY). See Chapters 5 and 6 for additional information on the Alternative A1 and B1 projects.

  Figure 8-4 was taken from the "Survey Report on Groundwater Conditions" prepared by the District in February 2020 and is a depiction of the forecasted 2020/2021 Niles Cone Groundwater Basin water supply/demand inventory based on current operating conditions. 2020/2021 forecasted flows were selected for illustrative purposes only.

  Figure 8-5 is an adaptation of Figure 8-4, and shows how the water supply/demand inventory would be modified due to the recharge/additional pumping from the Alternative A1 Project. In this example, District wellfield pumping would double and use of imported SFPUC water would decrease by approximately 70%.

- For the purposes of this Task, the PT GW Facility was sized for 6 MGD production capacity with no provisions for future expansion. Average annual production will be dependent on which Alternative is selected and is estimated at 6,100 AFY (5.4 MGD) at a facility online factor of 91% for Alternative A1 and 6,400 AFY (5.7 MGD) at a facility online factor of 95% for Alternative B1.
- Product water produced by the Alternative A1/B1 project has been modeled to recharge the Newark Aquifer. Therefore, influent groundwater for the PT GW Facility will be pumped from the Mowry Wellfield only, due to its location below the Hayward Fault. It is assumed that the Mowry Wellfield has the capacity to produce an additional 6.8 to 7.1 MGD (7,600 to 8,000 AFY).
- Current Mowry Wellfield water quality data was not reviewed. It is assumed that the ground water quality has not changed significantly since the 2004 Report, and therefore, RO design assumptions have not been revised. RO design criteria assume a 2-stage design, 80% recovery, and 95% hardness removal.
- The blended water hardness goal is 150 mg/L on an annual average basis. ACWD does not currently have a summer-specific hardness goal.
- It is assumed that the 8-inch MJBSP pipeline is beyond its useful life and a new 10-inch pipeline from the PT GW Facility to the Farwell ARP site is needed to discharge up to 1.5 MGD of RO concentrate. The new pipe was sized for a velocity of approximately 5 feet per second and for a hydraulic retention time of less than 15 hours based on the properties of the assumed antiscalant described in the PT GW Facility PDR. The planning-level alignment of the new 10-inch concentrate pipeline was assumed to be parallel to the MJBSP pipeline (see Figure 8-6).

Figure 8-4: Water Supply/ Demand Inventory FY 2020/21 (Forecast)

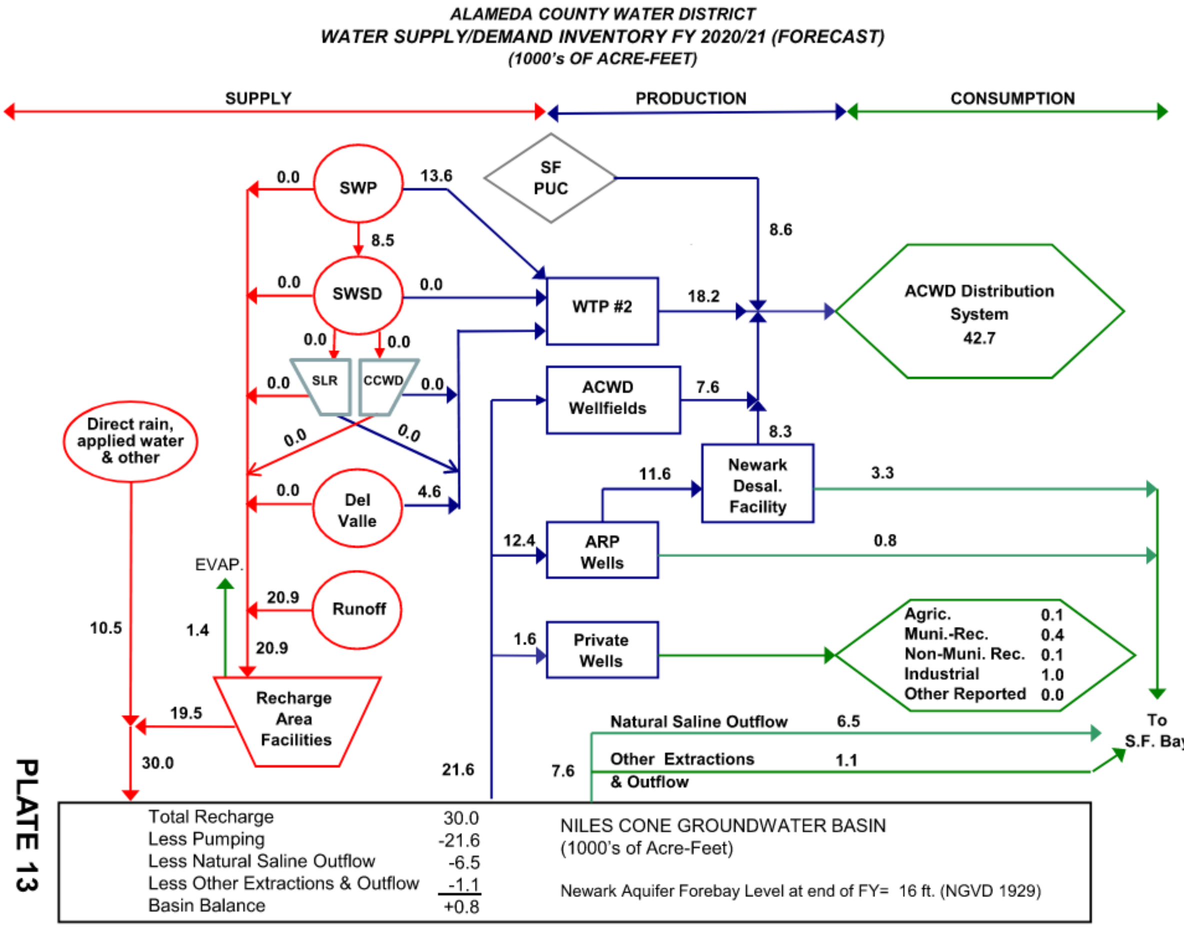
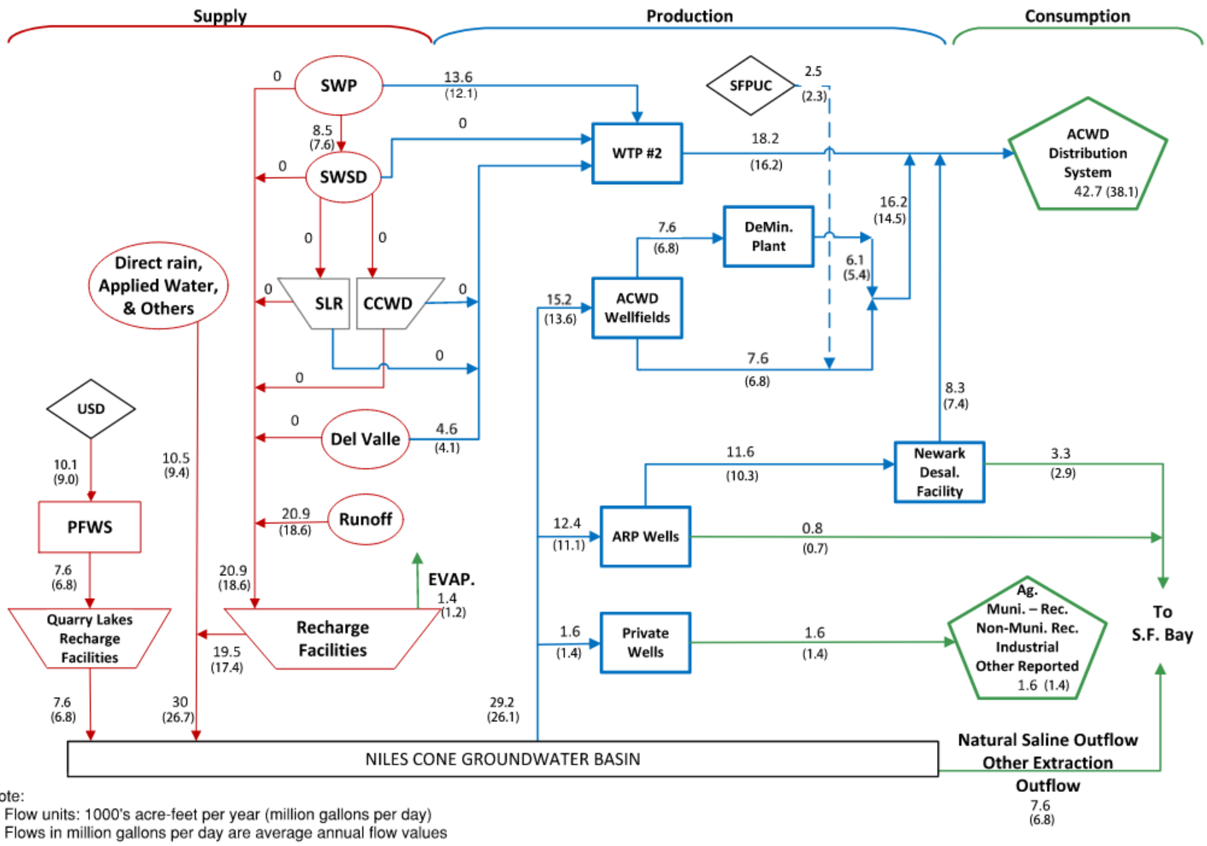
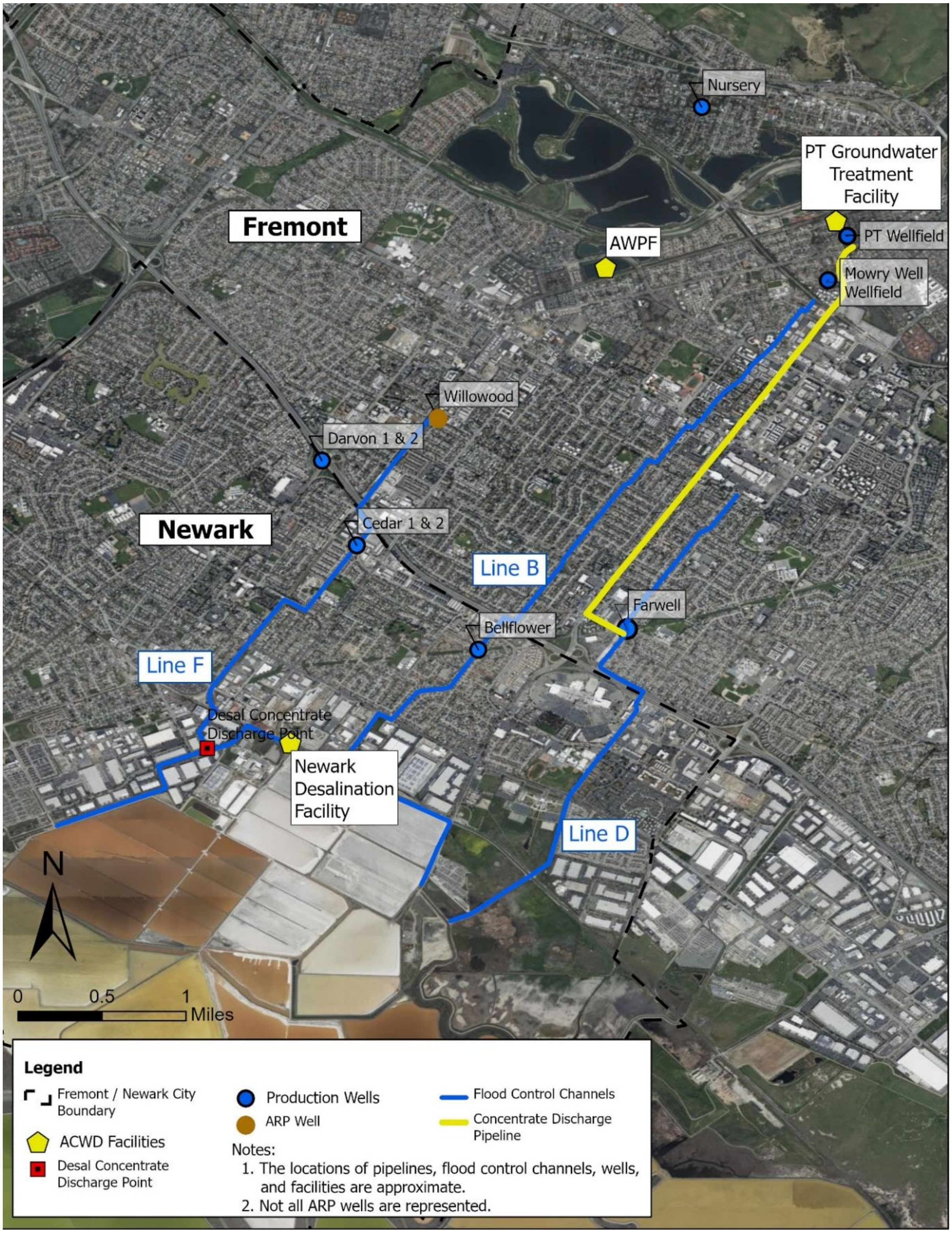


Figure 8-5: Adapted Water Supply/ Demand Inventory FY 020/21 (Forecast) – with Alternative A1 Project Flows)



Note:
1. Flow units: 1000's acre-feet per year (million gallons per day)
2. Flows in million gallons per day are average annual flow values

Figure 8-6: Concentrate Disposal Pipeline Alignment



8.4 Opinion of Probable Total Capital Cost

An Opinion of Probable Total Capital Cost (Capital Cost) was prepared for the 6 MGD PT GW Facility. Capital Cost represents the estimated total cost to design, construct, and implement this capital project and consists of “Total Construction” and “Non-Construction” cost components.

A summary of the Total Construction costs and Non-Construction costs for the 6 MGD PT GW Facility are provided in this chapter. A detailed methodology for developing the Total Project Cost is included **Appendix E.**

8.4.1 Total Construction Cost

The Total Construction Cost represents an estimate of the General Contractor’s bid in a Design-Bid-Build procurement approach. Total Construction Cost includes Direct Construction Costs and General Contractor’s administrative costs including insurance, Contractor’s overhead and profit, bonding, and general conditions. For the purposes of this Study, costs reflect a project development level of 1% to 15% corresponding to a Class 4 Estimate with an excepted accuracy range of -20% to +30%[1].

To determine Total Construction Cost, Direct Construction Costs were summed and multipliers for insurance, Contractor’s overhead and profit, bonding, and general conditions were applied (see **Appendix I** for additional detail on each component of the cost estimate).

Direct Construction Costs

Direct Construction Costs were developed by modifying the Phase I (4-MGD) facility cost described in Chapter 0 and developing new costs for the concentrate disposal pipeline and major yard piping (downsized from 24 MGD to match a 6 MGD PT GW Facility).

These costs were summed and Level of Definition Contingency of 25% was applied to determine Direct Construction Cost. A 25% Level of Definition Contingency is consistent with a Class 4 project and should decrease with project development.

Modified Facility Construction Cost

The following assumptions were used to modify the Phase I (4-MGD) facility costs for the 6-MGD facility. The bulleted items were either added or subtracted from the Phase I (4-MGD) facility direct construction cost estimate of $6,900,864 (in 2004 dollars) using the unit costs provided in the MWH Report.

The resulting 6-MGD facility construction cost total was then escalated to February 2022 dollars. Escalation to February 2022 dollars was based on San Francisco area Engineering News-Record (ENR) construction cost indices (CCIs) of 8088.25 for 2004 (average) and 14395.70 for February 2022. An accounting for these cost modifications is summarized in Table 8-4.

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[1] AACE Practice No. 56R-08 Cost Estimate Classification System as Applied to the Building and General Construction Industries, revised December 2012.

Cost modifications include:

- Costs for a third RO treatment train and related appurtenances were added for the 6 MGD facility. These equipment items include:
    - RO Unit
    - RO Unit Small Valves/Piping
    - Static Mixer
    - Energy Recovery Turbine
    - RO Feed Pump
    - Permeate Booster Pump
- Costs for major yard piping sized for the Phase II (24 MGD) facility were removed from the 2004 construction cost and resized and costed separately. These include:
    - 24" C200 raw water pipeline and valves from the Wellfield to the Process Building
    - 24" C900 permeate pipeline from the Process Building to the Blending Facility
    - 24" HDPE concentrate pipeline from the Process Building to the concentrate basin
    - 24" HDPE permeate overflow pipeline from the Process Building to the concentrate basin
- The 70 kilowatt (kw) solar energy system was removed from the 2004 construction cost estimate. This system was estimated at a construction cost of $560,000 (2004 dollars). It was assumed that this system was superfluous to the treatment facility and that ACWD could determine the need for a solar energy system during detailed design.

Table 8-4: 6 MGD Modified Facility Construction Cost ($2022)

Description	Each	Length (LF)	Unit Cost ($)	Total Cost
4 MGD Facility Total Construction Cost (2004 Dollars)				**$6,900,864**
RO Treatment Train Addition				**$550,783**
RO Unit	1		$357,500	$357,500
RO Unit Small Valves/Piping	1		$40,000	$40,000
Static Mixer	1		$16,800	$16,800
Energy Recovery Turbine	1		$38,700	$38,700
RO Feed Pump - Centrifugal pump (300 Hp)	1		$71,283	$71,283
Permeate Booster Pump - Vertical Turbine pump (125 Hp)	1		$26,500	$26,500
Yard Piping Subtraction				**($278,040)**
24" Feedwater Pipeline		520	$230	($119,600)
24" BFV	3		$10,250	($30,750)
24" CV	4		$8,250	($33,000)
24" 90-deg elbow	3		$5,750	($17,250)
24" 45-deg elbow	5		$4,750	($23,750)
24" Tee	1		$6,250	($6,250)
24" Rest Jts	2		$3,600	($7,200)
24" RW		620	$50	($31,000)
24" Overflow Pipeline		280	$33	($9,240)
Solar Energy System Subtraction				**($560,000)**
Solar Energy System	1		$560,000	($560,000)
6 MGD Facility Construction Cost (2004 Dollars)				**$6,613,607**
6 MGD Facility Construction Cost (Feb 2022 Dollars)				**$11,888,678**

<u>New Construction Cost Items</u>

Construction costs for a new concentrate disposal pipeline and resized major yard piping have been developed separately from MWH cost estimate approach above for consistency with other pipeline costs presented in Chapter 7.

Crew-based labor and machinery production estimates were used to develop the construction costs. Labor and materials were adjusted to San Francisco Bay Area pricing and applicable state and local taxes were applied. Prevailing wages were assumed. After discrete labor, equipment, and machinery were estimated and totaled, multipliers for insurance, Contractor’s overhead and profit, bonding, and general conditions were applied to develop a Construction Cost subtotal (see **Appendix I** for additional detail on each component of the cost estimate).

Assumptions for the new concentrate disposal pipeline and yard piping include:

- The new 10-inch HDPE concentrate pipeline would follow the alignment of the 8-inch MJBSP from the PT Groundwater Treatment Facility to the Farwell ARP site via Mowry Avenue for discharge at Flood Line D (see Figure 8-6). Pipeline length is approximately 2.75 miles.
  - Blowoffs were assumed to be located at low points along the pipe alignments.
  - Air release valves were assumed to be located at high points along the pipe alignments.
  - Isolation valves were assumed to be installed every 2,000 linear feet of pipe.
  - Special traffic considerations were assumed for a two-block radius around Washington Hospital.
  - It was assumed that the pipeline would cross the Hayward Fault near the PT GW Facility. A 30 percent markup on the base unit price was applied to an assumed fault zone length of 400 feet to account for the use of a seismically resilient technology such as flexible joints or Kubota's resilient ductile iron pipes.
  - No trenchless technologies were assumed for the construction of the pipeline.
- Major yard piping would be reduced in diameter to the following based on velocities calculated from initial pipe sizing and Phase II flows:
  - 16" C200 raw water pipeline and valves from the Wellfield to the Process Building
  - 16" C900 permeate pipeline from the Process Building to the Blending Facility
  - 16" HDPE concentrate pipeline from the Process Building to the concentrate basin
  - 16" HDPE permeate overflow pipeline from the Process Building to the concentrate basin

8.4.2 Non-Construction Costs

Non-Construction costs represent the additional costs to implement the Project. For the purposes of this study, legal & administration, preliminary design including environmental documentation and permitting, final design, engineering services during construction, construction management, and an Owner's reserve for change orders were the assumed non-construction costs. These costs do not include any of ACWD's required labor to implement the work. Non-construction costs were calculated as percentages of the Construction subtotal.

8.4.3 Opinion of Probable Total Capital Cost

The Opinion of Probable Total Capital Cost is the summation of Construction and Non-Construction costs. A summary of all project costs is provided in Table 7-3. All costs are presented are in February 2022 dollars.

The Opinion of Probable Total Capital Cost is $54,616,000, with an expected accuracy range between $43,693,000 and $71,001,000.

Table 8-5: Opinion of Probable Total Capital Cost ($ 2022)

Description	Factor	Cost
Construction Subtotal[1]		**$21,456,000**
Level of Definition Contingency	25%	$5,364,000
Direct Construction Cost		**$26,820,000**
Subtotal Other Construction Costs		**$6,893,000**
Total Construction Cost		**$33,713,000**
Bid Market Adjustment	15%	$5,057,000
Legal/Administration	5%	$1,686,000
Environmental and Permitting	5%	$1,686,000
Design	10%	$3,371,000
Engineering Services During Construction	5%	$1,686,000
Construction Management	12%	$4,046,000
Owner's Reserve for Change Orders	10%	$3,371,000
Non-Construction Cost		**$20,903,000**
Total Capital Cost		**$54,616,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$43,693,000
Expected Accuracy Range, High Bound (Class 40	+30%	$71,001,000

Notes:

1. See Appendix I for Construction Cost information.

8.5 Conceptual Estimate of O&M Costs

- The following basis and assumptions were used to revise the conceptual estimate of O&M costs for the 6 MGD PT GW Treatment Facility. A summary of annual O&M costs is presented in Pipelines
    - Assumes two percent of construction cost for annual maintenance.
- Pump Stations
    - Assumes two percent of construction cost for annual maintenance.
    - Assumes pumps are operated 24 hours a day, 365 days per year. This is conservative as the pumps are likely to be taken out of service for maintenance periodically.
- Wet wells
    - Assumes two percent of construction cost for annual maintenance.
- Dechlorination Facility
    - Assumes 14 gpd of sodium bisulfate based on the detention time (based on the flowrate and alignment) for Alignment 5.

Table 7-4. A breakdown of O&M cost information is provided in **Appendix I.**

- Material quantities incurred in direct proportion to flow were scaled based on influent flow and facility online factor and multiplied by their respective units cost to determine annual costs. These include power, chemical consumption, laboratory services, and concentrate disposal. For the purposes of this O&M estimate, flows resulting from the Alternative B1 project and online factor of 95% were assumed.

- The unit cost for power was revised to $0.20 per kWh approximated based on an average of current PG&E rates.
- Costs for contract services and laboratory testing and the calculated unit cost for chemical consumption and concentrate disposal were escalated to February 2022 dollars from 2004 dollars based on the escalation method described in Chapter 0.
- Replacement costs for RO elements and decarbonation tower packing were added to the O&M cost. These costs were calculated based on the escalated material costs discounted over expected the material lifetime.
- Additional consumable replacement costs for equipment, electrical, and instrumentation were added to the O&M cost. These were calculated based on 2% of escalated Division 11, 16, and 17 totals, respectively.
- It was assumed that District operators from the PT Blending Facility would also staff the PT GW Facility. Therefore, no staffing costs were included in the O&M cost estimate.

Table 8-6: Estimate of O&M Costs ($ 2022)

Description	Cost	Notes
Consumables	$452,000	Includes RO membrane and decarbonation packing material replacement and equipment, electrical, and instrumentation consumables.
Power	$928,000	
Chemicals	$490,000	
Other	$189,000	Includes contract services, laboratory services, and concentrate disposal.
Total	**$2,059,000**	

9. COST SUMMARY

This chapter summarizes and compiles together the cost estimates presented in previous chapters to develop unit costs of water and discusses potential variations of project alternatives and their associated high-level costs.

9.1 Yields for Each Alternative Phase

In order to develop unit costs of water, the annual yield from each phase has to be established. Because the volume of secondary effluent from USD is reduced through the AWPF and PT GW Facility, the ultimate project yield is less than the initial amount of wastewater (see Chapter 8 for additional detail; recovery percentages through treatment noted on Figure 9-1). The yields of each phase are the same for Alternatives A and B. Figure 9-1 shows, by Phase, how the secondary effluent is reduced and the resulting yield from the final step. Table 9-1 translates the flows/facility capacities into an annual volume in acre-feet using an assumed 365 days of operation; during actual operation, it is likely the project will be periodically offline which would result in a slightly reduced yield.

Figure 9-1: Reduction of Flow as Water Moves Through Facilities

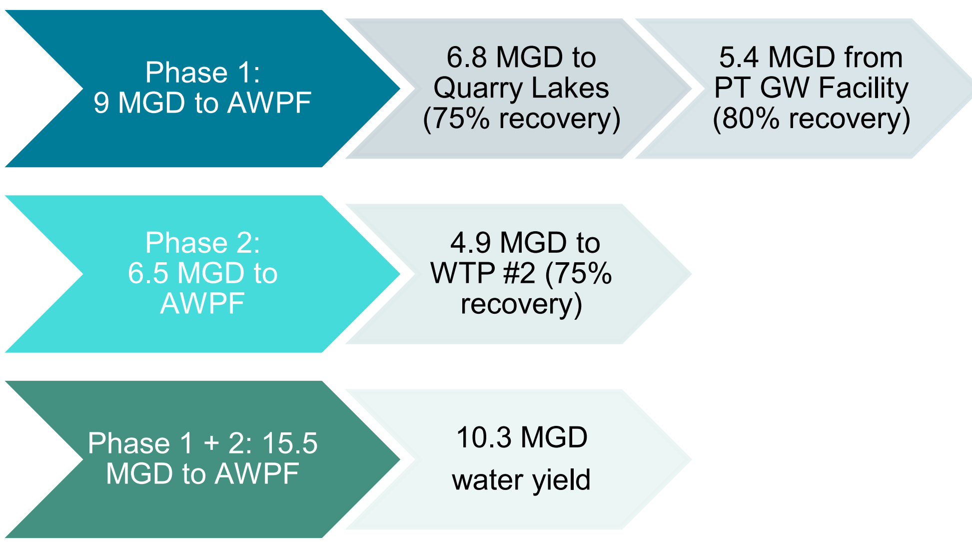


Table 9-1: Yields from each Alternative Phase

Stage	MGD	AFY
Alternative A/B, Phase 1	5.4	6,048
Alternative A/B, Phase 2	4.9	5,488
Alternative A/B, Ultimate (Phase 1 & 2)	10.3	11,536

9.2 Total Project Costs for Alternatives A and B

Chapter 5 contains the detailed description of the two alternatives – Alternative A and Alternative B. The detailed construction cost estimates for each project part are contained within Chapters 6 to 8. The following sections summarize the total capital costs and amortized costs to develop the unit costs (dollar per acre foot). The costs presented herein assume a combined process train that produces a single DPR-quality purified water at buildout.

9.2.1 Alternative A Total Project Cost

Alternative A is a two-phase concept. In Phase 1, 9 MGD of secondary treated effluent from USD would be sent to an AWPF for treatment and the product water would be recharged into the groundwater basin (via Quarry Lakes); in this phase, ACWD would also construct the previously planned Demineralization Plant at the Peralta-Tyson site and utilize the additional demineralized groundwater to offset SFPUC supplies. In Phase 2, an additional 6.5 MGD of secondary treated effluent from USD would be sent to an expanded AWPF for treatment suitable for raw water augmentation. The product water would then be sent to Water Treatment Plant #2 for integration into the ACWD potable distribution system. For Alterative A, it is assumed that USD has proceeded with the planned ETSU program.

Table 9-2 and Table 9-3 summarize the estimated cost for the selected Alternative A. The Total Capital Costs (Row 2) are amortized over a 30-year period at 3% interest to derive the Annualized Capital Cost (Row 3) (detailed estimates are presented in Chapters 6-8). The sum of Annual Capital Cost and Annual O&M cost (Row 4) is the Total Annual Cost (Row 5). In the bottom half of the tables, unit costs of the project (Row 7, 8, and 9) are calculated by dividing the Annualized Capital Cost, Annual O&M Cost, and Total Annual Cost by the average yield, respectively.

Table 9-2 shows the cost by project element needed to implement Phase 1 of Alternative A. Table 9-3 shows the cost needed to implement both Phase 1 and Phase 2, with the cost of Phase 1 summarized in the first column as the “starting point” of Phase 2.

Table 9-2: Alternative A Phase 1 Total Project Cost ($2022)

	Alvarado WWTP Effluent to AWPF (Alignment 1)	Pit 2 Site Work	Phase 1 Combined AWPF Train	MF Waste to USD Collection System (Alignment 2)	RO Waste to EBDA Outfall (Alignment 4)	Purified Water to Rock Pond (Alignment 5)	PT GW Facility	TOTAL (Phase 1)
Total Construction	$74,485,000	$ 44,508,000	$105,073,000	$5,511,000	$48,046,000	$28,731,000	$33,713,000	$340,067,000
Total Capital	$120,666,000	$ 72,102,000	$170,219,000	$8,929,000	$77,835,000	$46,546,000	$54,616,000	$550,913,000
Annualized Capital	**$6,156,000**	**$3,679,000**	**$8,684,000**	**$456,000**	**$3,971,000**	**$2,375,000**	**$2,786,000**	**$28,107,000**
Annual O&M	**$2,078,000**	**$ -**	**$4,860,000**	**$114,000**	**$1,013,000**	**$609,000**	**$2,059,000**	**$10,733,000**
Total Annual Cost	**$8,234,000**	**$3,679,000**	**$13,544,000**	**$570,000**	**$4,984,000**	**$2,984,000**	**$4,845,000**	**$38,840,000**
Average Yield (AFY)	6,048	6,048	6,048	6,048	6,048	6,048	6,048	6,048
Capital Unit Cost ($/AF)	$1,020	$610	$ 1,440	$ 80	$660	$390	$460	$4,650
O&M Unit Cost ($/AF)	$340	$ -	$ 800	$ 20	$170	$100	$340	$1,770
Unit Cost[5] ($/AF)	**$1,360**	**$610**	**$2,240**	**$90**	**$820**	**$490**	**$800**	**$6,420**

Notes:

1. For detailed AWPF cost, refer to Chapter 6.
2. For detailed alignments cost, refer to Chapter 7.
3. For detailed PT GW Facility cost, refer to Chapter 8.
4. Total capital cost is annualized assuming 3% interest over a 30-year period.
5. Due to varied average yield across phases, the unit costs by component do not sum to the total.

Table 9-3: Total Project Cost of Alternative A (Phases 1 & 2) ($2022)

	Total Phase 1 (see Table 9-2)	Phase 2 Combined AWPF Train	Purified Water to WTP #2 (Alignment 6)	TOTAL (Phases 1&2)
Total Construction	$340,067,000	$75,633,000	$34,673,000	$450,373,000
Total Capital	$550,913,000	$122,526,000	$56,171,000	$729,610,000
Annualized Capital	**$28,107,000**	**$ 6,251,000**	**$ 2,866,000**	**$37,224,000**
Annual O&M	**$10,733,000**	**$ 6,251,000**	**$ 1,085,000**	**$13,928,000**
Total Annual Cost	**$38,840,000**	**$8,361,000**	**$ 3,951,000**	**$51,152,000**
Average Yield (AFY)	6,048	5,488	5,488	11,536
Capital Unit Cost ($/AF)	$ 4,650	$ 1,140	$ 520	$3,230
O&M Unit Cost ($/AF)	$ 1,770	$ 380	$ 200	$1,210
Unit Cost ($/AF) [5]	**$ 6,420**	**$ 1,520**	**$ 720**	**$ 4,440**

Notes:

1. For detailed AWPF cost, refer to Chapter 6.
2. For detailed alignments cost, refer to Chapter 7.
3. For detailed PT GW Facility cost, refer to Chapter 8.
4. Total capital cost is annualized assuming 3% interest over a 30-year period.
5. Due to varied average yield across phases, the unit costs by component do not sum to the total.

9.2.2 Alternative B Total Project Cost

Alternative B is also a two-phase concept. The first phase of Alternative B would be similar to Alternative A except that the 9 MGD secondary effluent from USD would be sent to a tMBR first before the AWPF treatment steps. In the second phase, the tMBR would be expanded to accept additional secondary effluent to support the additional volumes. All other aspects of Alternative B would be the same as Alternative A, including ACWD constructing the previously planned Demineralization Plant at the Peralta-Tyson site during Phase 1.

Table 9-4 and Table 9-5 summarize the estimated cost for the selected Alternative B. The Total Capital Costs (Row 2) are amortized over a 30-year period at 3% interest to derive the Annualized Capital Cost (Row 3) (detailed estimates are presented in Chapters 6-8). The sum of Annual Capital Cost and Annual O&M cost (Row 4) is the Total Annual Cost (Row 5). In the bottom half of the tables, unit costs of the project (Row 7, 8, and 9) are calculated by dividing the Annualized Capital Cost, Annual O&M Cost, and Total Annual Cost by the average yield, respectively.

Table 9-4 shows the cost by project element needed to implement Phase 1 of Alternative A. Table 9-5 shows the cost needed to implement both Phase 1 and Phase 2, with the cost of Phase 1 summarized in the first column as the “starting point” of Phase 2.

Table 9-4: Alternative B Phase 1 Total Project Cost ($2022)

	Phase 1 Tertiary MBR	Pit 2 Site Work	Alvarado WWTP Effluent to AWPF (Alignment 1)	Phase 1 Combined AWPF Train	MF Waste to USD Collection Sys. (Alignment 2)	RO Waste to EBDA Outfall (Alignment 4)	Purified Water to Rock Pond (Alignment 5)	PT GW Facility	TOTAL (Phase 1)
Total Construction	$63,963,000	$44,508,000	$74,485,000	$66,298,000	$5,511,000	$48,046,000	$28,731,000	$33,713,000	$365,255,000
Total Capital	$103,619,000	$72,102,000	$120,666,000	$168,760,000	$8,929,000	$77,835,000	$46,546,000	$54,616,000	$653,073,000
Annualized Capital	**$5,287,000**	**$3,679,000**	**$6,156,000**	**$8,610,000**	**$456,000**	**$3,971,000**	**$2,375,000**	**$2,786,000**	**$33,319,000**
Annual O&M	**$5,400,000**	**$ -**	**$2,078,000**	**$4,900,000**	**$114,000**	**$1,013,000**	**$609,000**	**$2,059,000**	**$16,173,000**
Total Annual Cost	**$10,687,000**	**$3,679,000**	**$8,234,000**	**$13,510,000**	**$570,000**	**$4,984,000**	**$2,984,000**	**$4,845,000**	**$49,492,000**
Average Yield (AFY)	6,048	6,048	6,048	6,048	6,048	6,048	6,048	6,048	6,048
Capital Unit Cost ($/AF)	$ 870	$ 610	$ 1,020	$ 1,420	$ 80	$ 660	$ 390	$ 460	$ 5,510
O&M Unit Cost ($/AF)	$ 890	$ -	$ 340	$ 810	$ 20	$ 170	$ 100	$ 340	$ 2,670
Unit Cost[5] ($/AF)	**$ 1,770**	**$ 610**	**$ 1,360**	**$ 2,230**	**$ 90**	**$ 820**	**$ 490**	**$ 800**	**$ 8,180**

Notes:

1. For detailed AWPF cost, refer to Chapter 6.
2. For detailed alignments cost, refer to Chapter 7.
3. For detailed PT GW Facility cost, refer to Chapter 8.
4. Total capital cost is annualized assuming 3% interest over a 30-year period.
5. Due to varied average yield across phases, the unit costs by component do not sum to the total.

Table 9-5: Total Project Cost of Alternative B (Phases 1 & 2) ($2022)

	Total Phase 1 (see Table 9-4)	Phase 2 Tertiary MBR	Phase 2 Combined AWPF Train	Purified Water to WTP #2 (Alignment 6)	TOTAL (Phases 1 & 2)
Total Construction	$365,255,000	$8,604,000	$48,136,000	$34,673,000	$456,668,000
Total Capital	$653,073,000	$17,519,000	$122,526,000	$56,171,000	$849,289,000
Annualized Capital	**$33,319,000**	**$894,000**	**$6,251,000**	**$2,866,000**	**$43,330,000**
Annual O&M	**$16,173,000**	**$3,400,000**	**$2,110,000**	**$1,085,000**	**$22,768,000**
Total Annual Cost	**$49,492,000**	**$4,294,000**	**$8,361,000**	**$3,951,000**	**$66,098,000**
Average Yield (AFY)	6,048	5,488	5,488	5,488	11,536
Capital Unit Cost ($/AF)	$5,510	$160	$1,140	$520	$3,760
O&M Unit Cost ($/AF)	$2,670	$620	$380	$200	$1,970
Unit Cost[5] ($/AF)	**$8,180**	**$780**	**$1,520**	**$720**	**$5,730**

Notes:
1. For detailed AWPF cost, refer to Chapter 6.
2. For detailed alignments cost, refer to Chapter 7.
3. For detailed PT GW Facility cost, refer to Chapter 8.
4. Total capital cost is annualized assuming 3% interest over a 30-year period.
5. Due to varied average yield across phases, the unit costs by component do not sum to the total.

9.3 Additional Context for Differences Between This Study and Other Purified Water Projects

Several decisions related to the alternatives included in this study have consequences on the ability to compare these alternative costs against other purified water projects. This section provides additional context for the alternative costs to understand why there may be differences from other known projects.

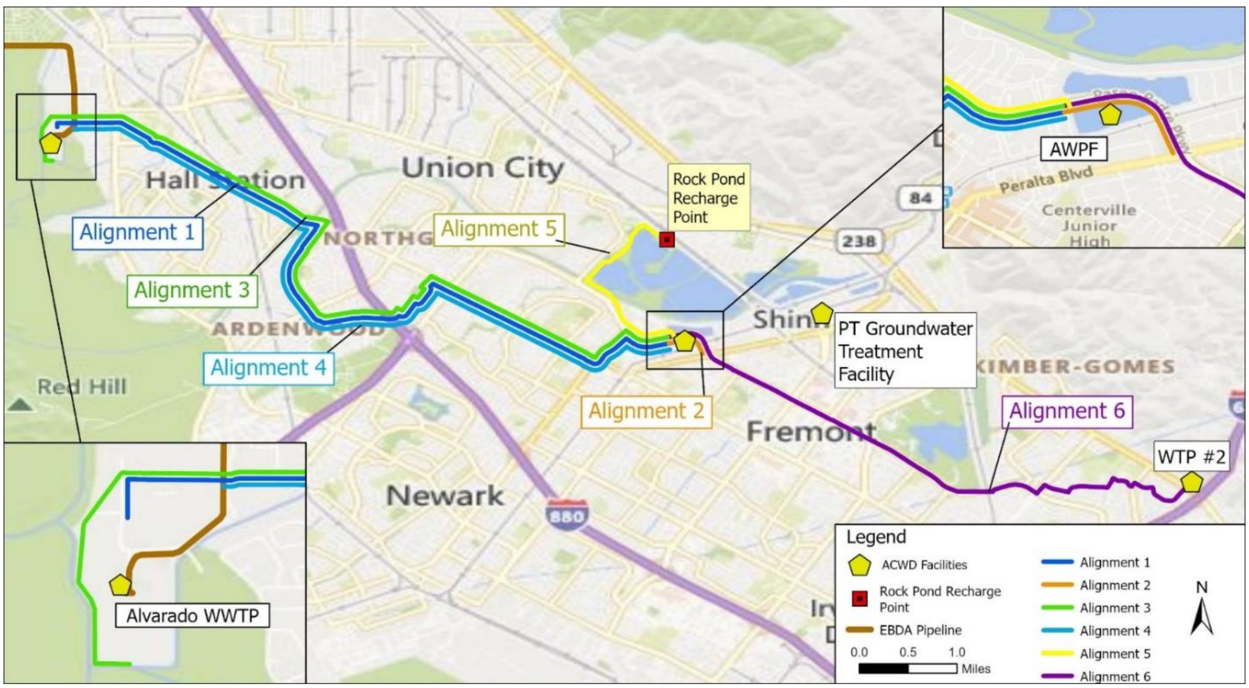
9.3.1 Upsizing in Phase 1 to Accommodate Phase 2 Expansion

The setup of the proposed project allows an incremental approach to implementation where Phase 2 (additional 6 MGD capacity) would come online at a later time. Consequentially, this means the costs have been developed based on the assumption that the Partners are committed to Phase 2 and that the conveyance structures are sized to accommodate the total/build-out capacity (total of 9 + 6 = 15 MGD). In other words, while the infrastructure would not initially be utilized at its full capacity, the cost of the full capacity is applied to Phase 1. This skews some of the overall project costs to Phase 1 for later benefit by Phase 2.

9.3.2 Off-Site Location of the AWPF

For the purposes of this feasibility study, the location of AWPF was decided collectively to be at Pit #2 near Quarry Lakes, which results in at least two longer distance pipelines (Alignment 1 and Alignment 4 as shown in Figure 9-2), conveying AWPF's source water and RO waste between AWPF and Alvarado WWTP area. The cost of the two alignments makes up 32% of the total construction/capital cost. The approach of having the AWPF located away from the main WWTP is being undertaken by other projects (e.g., Pure Water Soquel) but does come with added cost due to a net increase in pipelines. If adequate land can be acquired closer to the Alvarado WWTP, that would be expected to result in a lower project cost (see Chapter 9.4.1).

Figure 9-2: Proposed Pipelines Alignment



9.3.3 Inclusion of the Peralta-Tyson Groundwater Facility

The inclusion of the PT GW Facility (Demineralization Plant) on the water being extracted from the groundwater basin after recharge through Quarry Lakes is not typical of other purified water projects. Including this additional facility is an important component for ACWD to meet their water quality objectives but comes with two impacts to the project costs and benefits. The first is the additional capital cost of including the PT GW Facility and the ongoing operational costs for operating the additional facility. The second is that the inclusion of the PT GW Facility reduces the yield of Phase 1 (see Chapter 9.1) due to additional water lost through the type of treatment process at the PW GW Facility. If it was determined that the PT GW Facility was not needed to meet water quality objectives, the capital costs could be reduced, and the overall yield could be increased.

9.3.4 Inclusion of the Pit #2 Site Work Cost

The location of AWPF was decided collectively to be at Pit #2, which is already owned by ACWD and therefore could avoid a property purchase. But the property is currently covered by an abandoned pit that requires extensive site work (draining and filling) to rehabilitate this site. Pit #2 is not the only option for AWPF as there are potential other locations which do not require rehabilitation (more discussion in Chapter 9.4.1). Additionally, the acreage of Pit #2 totals about 15 acres, whereas the actual footprint of the AWPF is only half of the rehabilitated Pit #2 site (see illustration in Figure 9-3). Burdening the entire rehabilitation cost of Pit #2 results in the overestimation of the high unit cost. Applying the cost of Pit #2 rehabilitation proportionally to the project footprint would reduce the total construction cost and provide more insight into the actual unit price, as shown in Table 9-6. Alternative A with the prorated (scaled) costs for Pit #2 rehabilitation are presented Table 9-7 (Phase 1) and Table 9-8 (Phase 1 & 2). The ultimate decision on the use of Pit #2 may include other non-rehabilitation cost factors such as risk and liability to ACWD of keeping Pit #2 as an open water body.

Figure 9-3: Layout of AWPF on Rehabilitated Pit #2

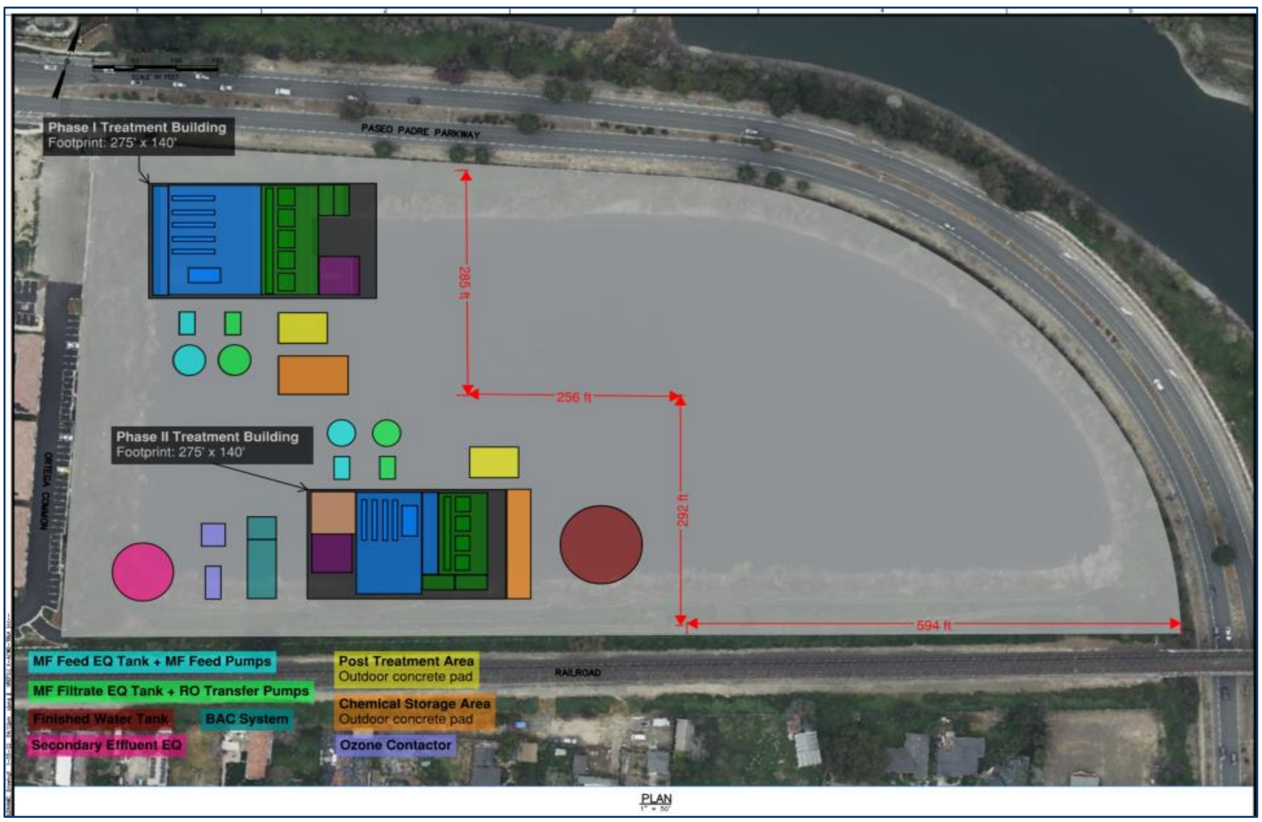


Table 9-6: Comparison of Cost with Pit #2 Cost Prorated for Project Footprint ($2022)

Without Proration	Phase 1	Phases 1 & 2
Capital Cost of Pit #2 Rehabilitation (Full)	$72,102,000	--
Annual Cost of Pit #2 (Full)	$3,679,000	--
Total Capital	$550,913,000	$729,610,000
Total Annual Cost	$38,840,000	$51,152,000
Unit Cost – Full ($/AF)	**$6,420**	**$4,430**
Prorated for 8 ac.	**Phase 1**	**Phases 1 & 2**
Capital Cost of Pit #2 Rehabilitation (Prorated)	$38,214,000	--
Annual Cost of Pit #2 (Prorated)	$1,950,000	--
Total Capital	$517,025,000	$695,722,000
Total Annual Cost	$37,111,000	$49,423,000
Unit Cost – Prorated ($/AF)	**$6,140**	**$4,280**

Table 9-7: Project Cost Estimates Alt. A Phase 1 with Prorated Pit #2 ($2022)

	Alvarado WWTP Effluent to AWPF (Alignment 1)	Pit 2 Site Work (Scaled)	Phase 1 Combined AWPF Train	MF Waste to USD Collection System (Alignment 2)	RO Waste to EBDA Outfall (Alignment 4)	Purified Water to Rock Pond (Alignment 5)	PT GW Facility	TOTAL (Prorated)
Total Construction	$74,485,000	$23,589,000	$105,073,000	$5,511,000	$48,046,000	$28,731,000	$33,713,000	$319,147,000
Total Capital	$120,666,000	$38,214,000	$170,219,000	$8,929,000	$77,835,000	$46,546,000	$54,616,000	$517,025,000
Annualized Capital	**$6,156,000**	**$1,950,000**	**$8,684,000**	**$456,000**	**$3,971,000**	**$2,375,000**	**$2,786,000**	**$26,378,000**
Annual O&M	**$2,078,000**	**$ -**	**$4,860,000**	**$114,000**	**$1,013,000**	**$609,000**	**$2,059,000**	**$10,733,000**
Total Annual Cost	**$8,234,000**	**$1,950,000**	**$13,544,000**	**$570,000**	**$4,984,000**	**$2,984,000**	**$4,845,000**	**$37,111,000**
Average Yield (AFY)	6,048	6,048	6,048	6,048	6,048	6,048	6,048	6,048
Capital Unit Cost ($/AF)	$1,020	$320	$1,440	$80	$660	$390	$460	$4,360
O&M Unit Cost ($/AF)	$340	$-	$800	$20	$170	$100	$340	$1,770
Unit Cost ($/AF)[5]	**$1,360**	**$320**	**$2,240**	**$90**	**$820**	**$490**	**$800**	**$6,140**

Notes:
1. For detailed AWPF cost, refer to Chapter 6.
2. For detailed alignments cost, refer to Chapter 7.
3. For detailed PT GW Facility cost, refer to Chapter 8.
4. Total capital cost is annualized assuming 3% interest over a 30-year period.
5. Due to varied average yield across phases, the unit costs by component do not sum to the total.

Table 9-8: Project Cost Estimates Alt. A with Prorated Pit #2 (Phases 1 & 2) ($2022)

	Total Phase 1 (see Table 9-7)	Phase 2 Combined AWPF Train	Purified Water to WTP #2 (Alignment 6)	TOTAL (Phases 1&2)
Total Construction	$ 319,147,000	$ 75,633,000	$ 34,673,000	$ 429,454,000
Total Capital	$ 517,025,000	$ 122,526,000	$ 56,171,000	$ 695,722,000
Annualized Capital	**$ 26,378,000**	**$ 6,251,000**	**$ 2,866,000**	**$ 35,495,000**
Annual O&M	**$ 10,733,000**	**$ 2,110,000**	**$ 1,085,000**	**$ 13,928,000**
Total Annual Cost	**$37,111,000**	**$ 8,361,000**	**$ 3,951,000**	**$ 49,423,000**
Average Yield (AFY)	6,048	5,488	5,488	11,536
Capital Unit Cost ($/AF)	$4,360	$1,140	$520	$3,080
O&M Unit Cost ($/AF)	$1,770	$380	$200	$1,210
Unit Cost ($/AF) [5]	**$6,140**	**$1,520**	**$720**	**$4,280**

Notes:
1. For detailed AWPF cost, refer to Chapter 6.
2. For detailed alignments cost, refer to Chapter 7.
3. For detailed PT GW Facility cost, refer to Chapter 8.
4. Total capital cost is annualized assuming 3% interest over a 30-year period.
5. Due to varied average yield across phases, the unit costs by component do not sum to the total.

9.4 Other Considerations to Lower Costs

There are two plausible ways of reducing the project cost: re-locating the AWPF and pursuing a DPR-only alternative. Each will be discussed in more detail in the following sections. Considering the scope of this project, cost estimates presented in this section were developed based on cost estimate components of Alternative A and should not be held to the same level of accuracy. If the partners are interested in pursuing either of the suggested approaches, a more detailed evaluation is recommended.

9.4.1 Alternate AWPF Location

Choosing an alternate location for the AWPF such that it is closer to the Alvarado WWTP bears great potential in lowering the total construction cost given that conveyance infrastructure makes up a significant portion of the total construction cost for the project. Among the six studied conveyances, the ones that convey source water and waste streams between the AWPF and Alvarado WWTP (Alignment 1, 2, and 4) are the longest pipelines. If the AWPF can be located close to the Alvarado WWTP, not only would the conveyance cost of three alignments decrease significantly, the reclamation site work at Pit #2 would no longer be needed (though land acquisition cost would likely apply). The following analysis identifies a currently vacant parcel next to the Alvarado WWTP, as shown in Figure 9-4, as an example alternative location for the AWPF to demonstrate the potential saving on construction cost. A map illustrating the new alignments is presented in Figure 9-5. In addition to relocating the AWPF, this option also assumes that once Phase 2 is completed, all product water will be treated to DPR standards.

With the AWPF closer to the Alvarado WWTP, Alignments 1, 3 and 4 are significantly shortened. For the purposes of this analysis, Alignments 1, 3, and 4 are shown as connecting the center of the vacant land to the center of the Alvarado WWTP, the headworks at the WWTP, and the EBDA pipeline, respectively, though the exact alignments will likely differ. Alignment 2, originally proposed to transport MF waste from AWPF to USD Collection System, is no longer applicable. Also, with the assumption that all product water will be of the same quality following completion of Phase 2 (regardless of IPR or DPR purposes), the most economic option would be to construct a shared product water pipeline (Alignment 7, whose routing is similar to the original Alignment 1). The product water pipeline would be shared from AWPF to Pit #2, at which point it would split and continue to Rock Pond (Alignment 5) and to WTP #2 (Alignment 6).

For each alignment, the following properties of the alignments remain unchanged as determined in Chapter 7: starting and ending facilities, diameter, and conveyed substances. A summary of the facilities for this project alternative is presented in Table 9-9. The lengths of the new Alignments 1, 3, and 4 are omitted as they depend on the exact location of the AWPF, which is unknown. The total power needed to accommodate the new Alignment 7 was calculated based on the flow rate, pipeline length and elevation change.

Figure 9-4: Example of an Alternate AWPF Location

Figure 9-5: New Pipelines Alignment Based on Alternate AWPF Location

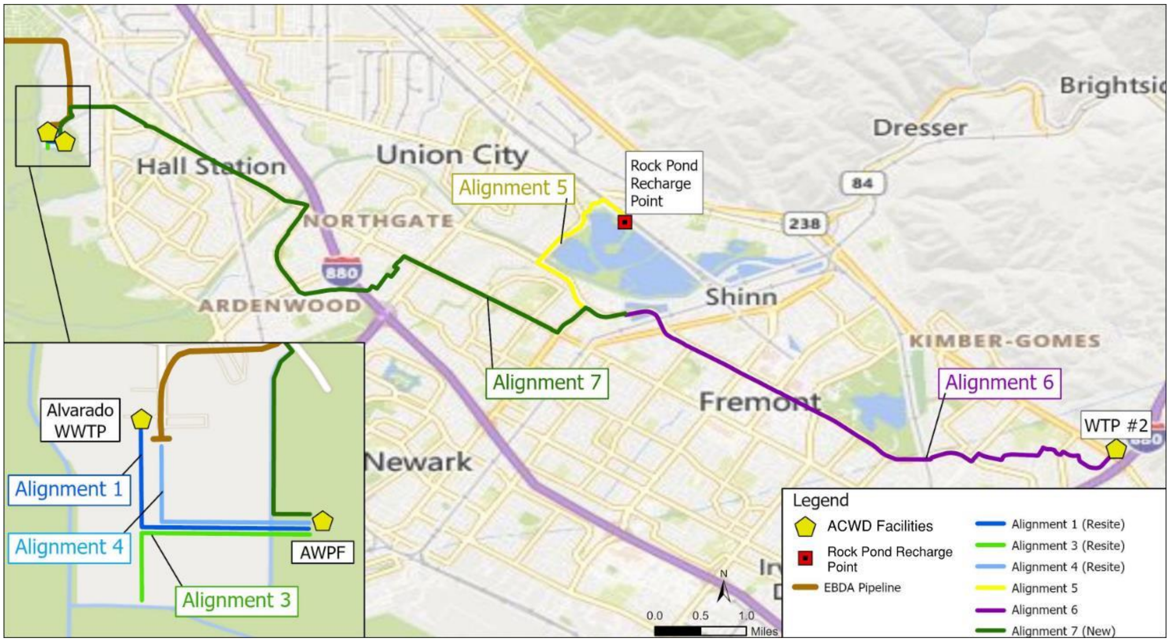


Table 9-9: Pipelines and Pumps Details of Proposed Alignments

Alignment					Pipelines		Pump Information
	From	To	Flow Type	Flow (MGD)	Length (miles)	Diameter (in) [2]	Total Power [Hp]
1[1]	Alvarado WWTP	AWPF	Secondary /Tertiary Effluent	15.5	--	36	--
3[1]	AWPF	Headwork @ Alvarado WWTP	MF waste	0.65	--	8	--
4[1]	AWPF	EBDA	RO Concentrate	3.0	--	18	--
7	AWPF	Pit #2	Phase ½ Product water	11.7	7.1	36	1200
5	Pit #2	Rock Pond	Phase 1 Product water	6.8	9.3	28	n/a[3]
6	Pit #2	WTP #2	Phase 2 Product water	4.9	12.2	24	n/a[3]

Notes:

1. Alignments 1, 3, and 4 do not have set lengths or pump station needs given that those are highly dependent on the location of the AWPF. If the AWPF is located adjacent to the Alvarado WWTP then the pipe lengths and pumping needs will be negligible compared to infrastructure needed for the other alignments.
2. Diameters refer to nominal pipe diameter. HDPE DR17 pipe has been assumed.
3. No pumps are needed for these alignments for this alternative as all pumping is incorporated into Alignment 7.

The total cost for the alternative AWPF location project concept was based on the cost of conveyances developed in Chapter 7, as presented in Table 9-10. All planning and design assumptions presented in Chapter 7 are still applicable, with the exception of the AWPF location. For this high-level cost estimate, the following assumptions were made:

- A $2M direct construction allowance was used to capture the costs for each of the source water and waste stream facilities (Alignments 1,3 & 4), assuming that the alternative AWPF is adjacent to the WWTP, and these pipelines are short (less than 0.5 miles).
- Pipe costs were scaled proportionally based on length, using alignments with the same diameter. The Bay Mud cost escalation was not scaled since the length of the alignment impacted by the Bay Mud construction conditions doesn't change.
- The pump station structure/facility costs remained constant for each new alignment (~$10M, see Chapter 7 for more details) while the pump equipment costs were scaled proportionally based on total horsepower.
- No pump costs were included for Alignment 5 and 6 because they have been accounted for in Alignment 7.
- Cost of Pit #2 reclamation no longer applies and the junction cost at Pit #2 is assumed to be negligible.

As shown in Table 9-11, relocating the AWPF to a location close to the Alvarado WWTP could result in capital savings of around 33% with combined IPR and DPR pipelines. While there is likely to be additional land acquisition costs, it is anticipated to be more favorable compared to the cost of Pit #2 rehabilitation.

Table 9-10: Opinion of Probable Capital Cost for Alternate AWPF Location (Alternative A, Phase 1) ($2022)

	Alvarado WWTP Effluent to AWPF (Alignment 1)	Phase 1 Combined AWPF Train	MF Waste to Alvarado WWTP (Alignment 3)	RO Waste to EBDA Outfall (Alignment 4)	Purified Water to Pit #2 (Alignment 7)	Purified Water to Rock Pond (Alignment 5)	PT GW Facility	Phase 1 TOTAL (Alternative Location)
Total Construction	$2,000,000	$105,073,000	$2,000,000	$2,000,000	$68,976,000	$14,196,000	$33,713,000	$227,958,000
Total Capital	$3,240,000	$170,219,000	$3,240,000	$3,240,000	$111,742,000	$22,999,000	$54,616,000	$369,296,000
Annualized Capital	**$165,000**	**$8,684,000**	**$165,000**	**$165,000**	**$5,701,000**	**$1,173,000**	**$2,786,000**	**$18,841,000**
Annual O&M	**$40,000**	**$4,860,000**	**$40,000**	**$40,000**	**$2,556,000**	**$292,000**	**$2,059,000**	**$9,887,000**
Total Annual Cost	**$205,000**	**$13,544,000**	**$205,000**	**$205,000**	**$8,257,000**	**$1,465,000**	**$4,845,000**	**$28,728,000**
Ave. Yield (AFY)	6,048	6,048	6,048	6,048	6,048	6,048	6,048	6,048
Capital Unit Cost ($/AF)	$30	$1,440	$30	$30	$940	$190	$460	$3,120
O&M Unit Cost ($/AF)	$10	$800	$10	$10	$420	$50	$340	$1,630
Unit Cost ($/AF)[5]	**$40**	**$2,240**	**$40**	**$40**	**$1,360**	**$240**	**$800**	**$4,750**

Notes:
1. For detailed AWPF cost, refer to Chapter 6.
2. For detailed alignments cost, refer to Chapter 7.
3. For detailed PT GW Facility cost, refer to Chapter 8.
4. Total capital cost is annualized assuming 3% interest over a 30-year period.
5. Due to varied average yield across phases, the unit costs by component do not sum to the total.
6. Assumes adequate land can be acquired closer to the Alvarado WWTP. **Cost for land acquisition is not included;** instead the cost gap between the Alternate Location Alternative and the Recommended Project Alternative can be used to help set the budget range for where purchasing a new property closer to the Alvarado WWTP is the economically superior choice.

Table 9-11: Comparison of Project Cost for Alternative A in Different Scenarios ($2022)

	Alternative A Alternate AWPF Location (Note 2)		Alternative A with Prorated Pit #2 (Recommended Project; Note 3)		Alternative A (Baseline)	
	Phase 1	Phase 1 & 2	Phase 1	Phase 1 & 2	Phase 1	Phase 1 & 2
Total Construction	$227,958,000	$330,671,000	$319,148,000	$ 429,454,000	$340,067,000	$450,373,000
Total Capital	$369,296,000	$535,692,000	$517,025,000	$ 695,722,000	$550,913,000	$729,610,000
Annualized Capital	**$18,841,000**	**$27,330,000**	**$26,378,000**	**$ 35,495,000**	**$28,107,000**	**$37,224,000**
Annual O&M	**$9,887,000**	**$12,539,000**	**$10,733,000**	**$ 13,928,000**	**$10,733,000**	**$13,928,000**
Total Annual Cost	**$28,728,000**	**$39,869,000**	**$37,111,000**	**$ 49,423,000**	**$38,840,000**	**$51,152,000**
Average Yield (AFY)	6,048	11,536	6,048	11,536	6,048	11,536
Capital Unit Cost ($/AF)	$3,120	$2,370	$4,360	$3,080	$4,650	$3,230
O&M Unit Cost ($/AF)	$1,630	$1,090	$1,770	$1,210	$1,770	$1,210
Unit Cost ($/AF)	**$4,750**	**$3,460**	**$6,140**	**$4,280**	**$6,420**	**$ 4,440**

Notes:
1. Total capital cost is annualized assuming 3% interest over a 30-year period.
2. Assumes adequate land can be acquired closer to the Alvarado WWTP. **Cost for land acquisition is not included;** instead the cost gap between the Alternate Location Alternative and the Recommended Project Alternative can be used to help set the budget range for where purchasing a new property closer to the Alvarado WWTP is the economically superior choice.
3. Assumes cost of Pit #2 rehabilitation is prorated proportionally to the project footprint.

9.4.2 Direct Potable Reuse Only (Single Phase)

A second variation to the proposed project would be to develop a single DPR alternative for the full flow, as a potential option to lower the total construction cost. In this alternative the location of AWPF remains at Pit #2 but all product water would be sent to WTP No. 2 and the need to recharge water at Rock Pond and treat extracted water at the PT GW Facility would be eliminated. Additionally, the average yield would increase because the recovery rate at the PT GW Facility no longer applies. A map illustrating this scenario of alternative alignments is presented in Figure 9-6. The proposed pipelines and pumps details of proposed alignments are summarized in Table 9-12.

The total cost of a DPR project was adapted from the total project cost detailed in Chapter 9.2.1. For the DPR alternative, the cost of Alignment 5 and the PT GW Facility were subtracted, while the cost of Alignment 6 was increased to reflect a higher flow and pump capacity. The cost of Alignment 3 is omitted as it is an alternative to Alignment 2. As shown in Table 9-13, the capital cost of a full DPR project decreases by around 37% compared to the total cost (Phases I & II) of the baseline Alternative A and the unit cost decreases by around 23% compared to baseline Alternative A.

Figure 9-6: New Pipelines Alignment Based on Alternative AWPF Location

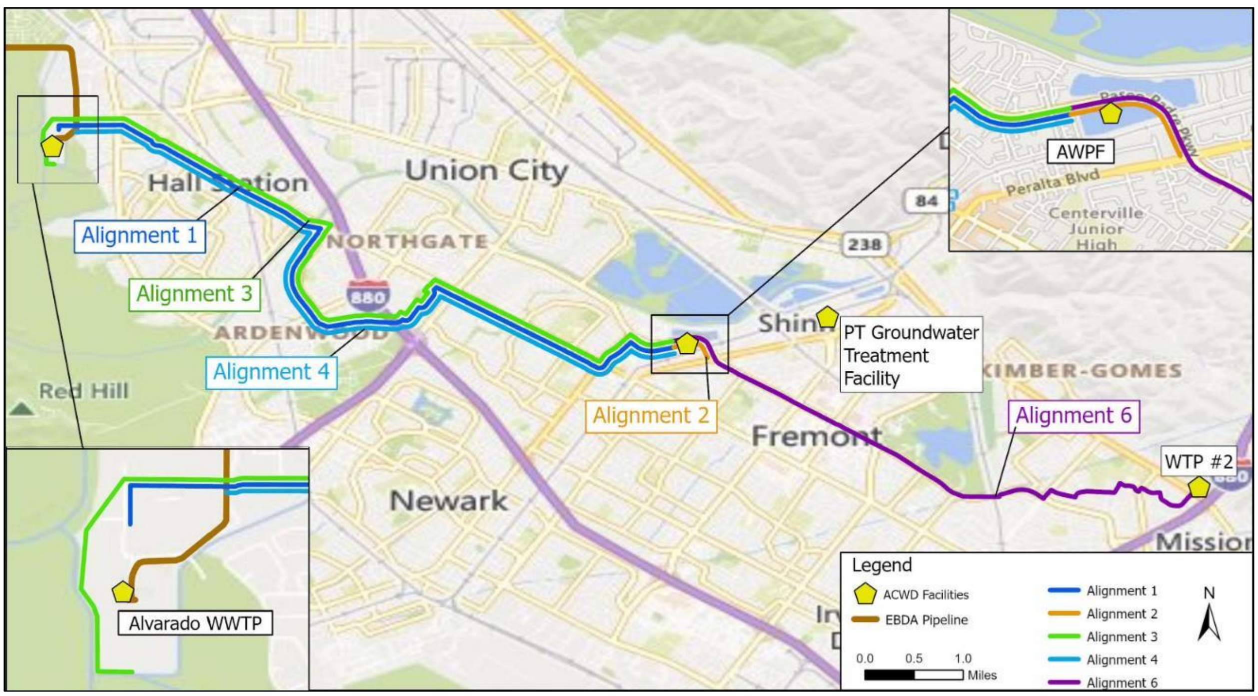


Table 9-12: Proposed Pipelines and Pumps Details of Proposed Alignments

Alignment					Pipelines		Pump Information
	From	To	Flow Type	Flow (MGD)	Length (miles)	Diameter (in)[1]	Total Power (Hp)
1	Alvarado WWTP	AWPF	Secondary /Tertiary Effluent	15.5	7.1	36	600
2	AWPF	Collection System	MF waste	0.65	0.5	8	6
3	AWPF	Headwork @ Alvarado WWTP	MF waste	0.65	7.5	8	60
4	AWPF	EBDA	RO Concentrate	3.0	6.8	18	80
6	AWPF	WTP #2	Phase 2 Product water	11.7	5.1	36	1,000

Note:

1. Diameters refer to nominal pipe diameter. HDPE DR17 pipe has been assumed.

Table 9-13: Opinion of Probable Capital Cost for a DPR Project (Alternative A) ($2022)

	Alvarado WWTP Effluent to AWPF (Alignment 1)	Pit T2 Site Work	Phase 1 & 2 Combined AWPF Train	MF Waste to USD Collection System (Alignment 2)	RO Waste to EBDA Outfall (Alignment 4)	Purified Water to WTP #2 (Alignment 6)	TOTAL (Full DPR)
Total Construction	$74,485,000	$ 44,508,000	$ 75,633,000	$ 5,511,000	$ 48,046,000	$ 35,069,000	$ 283,252,000
Total Capital	$120,666,000	$ 72,102,000	$ 122,526,000	$ 8,929,000	$ 77,835,000	$ 56,810,000	$ 627,628,000
Annualized Capital	**$ 6,156,000**	**$ 3,679,000**	**$ 6,251,000**	**$ 456,000**	**$ 3,971,000**	**$ 2,898,000**	**$ 32,021,000**
Annual O&M	**$ 2,078,000**	**$ -**	**$ 6,970,000**	**$ 114,000**	**$ 1,013,000**	**$ 1,681,000**	**$ 15,886,000**
Total Annual Cost	**$ 8,234,000**	**$ 3,679,000**	**$ 13,221,000**	**$ 570,000**	**$ 4,984,000**	**$ 4,579,000**	**$ 47,907,000**
Average Yield (AF) [1]	13,104	13,104	13,104	13,104	13,104	13,104	13,104
Unit Cost ($/AF)	**$630**	**$280**	**$1,010**	**$40**	**$380**	**$350**	**$2,690**

Notes:

1. 15.5 MGD of secondary effluent with 75% recovery through AWPF.

9.5 Recommended Project for the Purposes of this Study

For the remainder of this Study, the cost information presented in Table 9-8 for Alternative A (Phases 1 & 2) with combined treatment trains and with the prorated (scaled) costs for Pit #2 rehabilitation will be utilized as the Recommended Project. The final location of the AWPF is a decision to be confirmed at a later date by the Partners as the development of the project continues. The location of the AWPF can impact project costs but does not restrict or change the primary project benefit of developing new regional water supplies.

10. ENVIRONMENTAL CONSIDERATION AND POTENTIAL EFFECTS

This chapter summarizes the environmental considerations relevant to the project and discusses potential effects.

10.1 Potential Environmental Effects and Compliance/Permitting Requirements

A California Environmental Quality Act (CEQA) analysis will be completed for the Project. ACWD will prepare the required CEQA documents for public review and comment. After the public comment period ends and all comments have been addressed, the CEQA documents will be brought to the Board of Directors for approval. Once approval has been received, the CEQA documentation will be submitted to the State Clearinghouse and County Clerk.

10.1.1 CEQA/NEPA Compliance

Although environmental review has not been completed for the project, because of the urban location, it is not expected that the project would have significant impacts on endangered or threated species, natural resources, regulated water of the United States or cultural resources. Biological and cultural resources studies will be completed to determine whether any sensitive resources are present or potentially present. Construction would result in short-term traffic impacts, and air quality and noise impacts but would not be expected to have a significant adverse effect on public health or safety.

To evaluate the potential for environmental impacts, CEQA documentation will need to be completed before constructing the project. To obtain Title XVI funding, USBR will need to complete National Environmental Policy Act (NEPA) documentation. It is assumed that ACWD will be the lead agency for CEQA, though any of the Partners could assume the position; the other agencies would become responsible agencies through CEQA. The type of environmental documentation would be subject to confirmation by the Partners and USBR, and the level of documentation required will be influenced by the anticipated significant impacts caused by the proposed project components (e.g., pipeline alignments).

The proposed facilities would occur primarily within urban, built-up lands, consisting of residential, commercial, and industrial uses. The installation of pipeline alignments, primarily on roadways and within disturbed areas, and the use of trenchless methods to avoid known areas of wetlands would minimize potential impacts on sensitive resources. However, the AWPF is assumed to be located at Pit #2, a former quarry pit owned by ACWD. Pit #2 will need to be drained and filled as part of the site preparations for the AWPF. As a humanmade water feature, Pit #2 is not expected to be a water of the U.S., but this would need to be confirmed by a jurisdictional determination. Additionally, there are wetlands located to both the east and west of the existing Alvarado WWTP. The Eden Landing Ecological Reserve, containing restored salt marsh habitat, is directly west of the Alvarado WWTP, though project facilities would not affect the habitat in the reserve. If possible, facilities would be sited to avoid the seasonal wetlands located east of the Alvarado WWTP. However, it may be necessary to locate facilities in this area; if wetlands would be affected appropriate permitting would be obtained and compensatory mitigation would be incorporated in the project to ensure no net loss of wetlands.

Construction of the pipeline would require several creek crossings, all of which would either be constructed using trenchless technology or, for one crossing of Alameda Creek, as a bridge crossing on the existing bridge. The following creek crossings are assumed to be required:

- Alameda Creek at Alvarado Boulevard (trenchless);
- Alameda Creek at Isherwood Way (bridge crossing);
- Deep Creek at Creekwood Drive/Deep Creek Road (trenchless);
- Deep Creek at Pecos Court (trenchless);
- Laguna Creek at Paseo Padre Parkway/Grimmer Boulevard (trenchless); and
- Mission Creek at Palm Avenue (trenchless).

In addition to the creek crossings, there would also need to be a new discharge point constructed into Rock Pond at the Quarry Lakes Regional Recreation Area. Evaluation of potential effects on wetlands and waters of the U.S. would require additional detailed biological survey work.

It is likely that the appropriate level of CEQA document would be an Environmental Impact Report (EIR), which allows for a more robust public involvement process. NEPA, however, has a higher threshold for significance, and it is possible that documentation can be provided by an Environmental Assessment (EA) leading to a Finding of No Significant Impact (FONSI).

To comply with consultation requirements under both Section 7 of the Endangered Species Act and Section 106 of the National Historic Preservation Act, the project will need to define an Area of Potential Effect (APE) and conduct surveys to determine whether sensitive biological and cultural resources are present and could be affected by project construction and operation. Surveys would need to cover the footprint of all project facilities.

10.1.2 Endangered and Threatened Species - Section 7 Consultation

As NEPA lead agency, USBR will need to consult with both the U.S. Fish and Wildlife Service (USFWS), which has jurisdiction over terrestrial species and freshwater fish, including smelt, and with the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS), which has jurisdiction over anadromous fish, including steelhead.

Terrestrial Biota

Construction of facilities would occur in urbanized areas and is not expected to affect terrestrial biota. However, biological surveys would need to be conducted to determine the potential presence of species of concern. At the start of environmental review, USBR will need to request a list of species from USFWS, and consultation will be required to determine if the project affects any of those species. Based on species identified by the California Natural Diversity Data Base as occurring in the project area, consultation may need to include the following terrestrial species, which are listed in Table 10-1, along with their federal status.

Table 10-1: Federally Listed Terrestrial Species

Species/status	Habitat/(locations)
California tiger salamander (Ambystoma californiense) (FT/CT)	Grasslands and foothills
Western snowy plover (Charadrius nivosus nivosus) (FT)	Sandy beaches and salt pond levees
Monarch butterfly- California overwintering population (Danaus plexippus pop. 1) (FC)	Overwinter in groves along coast
Contra Costa goldfields (Lasthenia conjugens) (FE)	Vernal pools
Vernal pool tadpole shrimp (Lepidurus packardi), federally endangered (FE)	Vernal pools (in SF Bay National Wildlife Refuge in Fremont)
Alameda whipsnake (Masticophis lateralis euryxanthus) (FT/CT)	Chaparral/grassland vegetative mosaic
California Ridgway's rail (Rallus obsoletus obsoletus) (FE/CE)	Brackish marsh and salt marsh
California red-legged frog (*Rana draytonii*) (FT)	Riverine-floodplain habitats
Salt-marsh harvest mouse (*Reithrodontomys raviventris*) (FE/CE)	Salt marsh
California least tern (*Sternula antillarum browni*) (FE/CE)	Open beaches (Hayward Shore and Eden Landing)
California seablite (*Suaeda californica*) (FE)	Coastal salt marsh

Notes:

1. FE: federally listed as endangered; FT: federally listed as threatened; FC: candidate for federal listing.
2. CE: California endangered; CT: California threatened.

Aquatic Biota

Two federally listed fish species occur in San Francisco Bay and spawn in freshwater (Table 10-2). Steelhead are known to occur in Alameda Creek.

Table 10-2: Federally Listed Aquatic Species

Species/status	Habitat/(locations)
Steelhead – Central California coast DPS (Oncorhynchus mykiss irideus pop. 8) (FT)	San Francisco Bay and Alameda Creek
Longfin smelt (Spirinchus thaleichthys) (FC/CT)	Bays and estuaries, spawns in freshwater rivers

Notes:

1. FT: federally listed as threatened; FC: candidate for federal listing.
2. CT: California threatened.

Species listed above occur generally in aquatic habitats, salt marsh, vernal pools, and native grasslands/chaparral, which would not be affected by the project. The project is, thus, not expected to have significant effects on threatened or listed species. Though this would be confirmed by completing a biological resources study.

10.1.3 Wetlands and Jurisdictional Waters

A wetlands delineation would need to be conducted to confirm whether project facilities would affect wetlands or waters of the U.S. This survey would need to include any adjacent areas expected to be used for construction staging to confirm presence/absence of wetlands.

10.1.4 Streambed Alteration Agreement from California Department of Fish and Wildlife.

Creek crossings would require a Streambed Alteration Agreement from CDFW. This would be required even if the stream crossings are constructed using trenchless technology because the pipeline would be within the streambed and is thus within the jurisdiction of CDFW.

10.1.5 Incidental Take Permit from the California Department of Fish and Game

Several of the federally listed species discussed above are also listed as threatened or endangered in California. There are also three state-listed species that are not federally listed but could be affected by the project:

- Tricolored blackbird (Agelaius tricolor) (CT),
- California black rail (*Laterallus jamaicensis coturniculus*) (CT), and
- Bank swallow (Riparia riparia) (CT)

Although significant adverse impacts on California listed species are not expected, this would be confirmed through a biological resources assessment. If the project would directly affect these species through construction activities, then an Incidental Take Permit would be required. Due to the urban nature of the project area an Incidental Take Permit is not expected to be required.

10.1.6 Section 106 Consultation

Once a horizontal APE has been established, the project will also have to define a "vertical APE," which defines the depth to which the ground surface would be disturbed for the construction of facilities. A cultural resource survey would need to be conducted and a Cultural Resources Inventory and Evaluation Report would be prepared for USBR to submit to the State Historic Preservation Officer (SHPO). It may be advantageous to establish a Memorandum of Agreement between USBR and SHPO defining the process for protecting cultural resources.

10.1.7 Natural Resources

Because the project would be constructed in a developed urban area, substantial effects on natural resources would not be expected. As noted above, a biological resources assessment would be conducted to evaluate effects on terrestrial and aquatic biota.

10.1.8 Public Health and Safety

Construction of the project would entail short-term impacts on traffic, noise, and air quality in the project area, but no long-term adverse effects are expected. The project would not entail significant effects related to hazardous materials or hazardous waste. Groundwater recharge during project operations would conform with all relevant public health regulations.

10.2 Significant Environmental Effects

While the project would entail short-term construction impacts, these would be temporary and would be mitigated so as to minimize effects. Groundwater recharge with purified water is a known technology with established regulatory requirements and would not entail unique or unexpected environmental risks.

10.3 Status of Environmental Compliance

As noted previously the project would require completion of CEQA and NEPA documentation, which has not been completed to date. No environmental studies, reports or documentation have been prepared.

10.4 Other Information Available

Although documentation for the current project has not been prepared, environmental documentations for other projects prepared by USD and ACWD provide useful information about environmental resources in the project area. The following environmental documents provide pertinent information:

- ACWD. 2004. Alameda County Water District Peralta Tyson Groundwater Treatment Facility Initial Study and Mitigated Negative Declaration. July 19, 2004.
- ACWD. 2016. Initial Study with Mitigated Negative Declaration/Environmental Assessment with Finding of No Significant Impacts. Joint Lower Alameda Creek Fish Passage Improvements. December 2016.
- ACWD. 2018. CEQA Initial Study/Mitigated Negative Declaration; Alvarado-Niles Pipeline Seismic Improvement Project; Union City, Alameda County California, Alameda County Water District Project No. 21192. September 2018.
- USD. 2018. Initial Study for Primary Digester No. 7 Project. October 2018.

10.5 Water Supply and Water Quality

10.5.1 Water Supply

The project would provide up to 10.3 MGD of new regional water supply that would serve the region's customers. Secondary treated water from the Alvarado WWTP would supply the AWPF for advanced treatment. The WWTP has 23 MGD of available secondary effluent. The secondary treated wastewater currently produced at the WWTP would be sufficient to supply AWPF, which would provide the region with a drought-resistant water supply.

10.5.2 Water Quality Impacts Associated with Public Health

Purified water is highly treated recycled water suitable for delivery to existing groundwater basins or reservoir and later recovery for treatment and human use. In Phase 1, purified water will be recharged into groundwater basins, which act as an environmental buffer as the water travels from the recharge point to recovery wells. The treatment process is designed to comply with DDW's regulations and meet water quality standards. Note at the time of writing this report, there are final regulations for Phase 1 (IPR) but there are no adopted regulations for Phase 2 (DPR). It is understood that Phase 2 will not move forward until an adopted regulation is in place (anticipated in late 2023). For more details, refer to Chapter 2 and Chapter 6.

10.5.3 Water Quality Impacts Associated with Aquatic Habitat

The project would include a purified water discharge at Quarry Lakes, with the purpose of augmenting groundwater recharge through the lakes. The primary water quality concern at the Quarry Lakes is the potential for eutrophication and excess algal growth if nutrient levels are increased. Water quality impacts of lake discharge have been evaluated and given that the projected maximum total phosphorus concentration in the purified water is expected to be 0.040 mg/l, model results indicate that the purified water discharge will improve water quality in terms of phosphorus (and by extension, chlorophyll *a*, which is a measure of algal growth). For more details, refer to **Appendix B**.

10.6 Public Involvement

The public have the opportunities to be informed and involved in this project via the following public meetings:

- ACWD Board Meeting on April 9, 2019;
- ACWD Water Resources and Conservation Committee on March 27, 2019;
- SFPUC quarterly reports to the SFPUC Commission on the Alternative Water Supply Program beginning in June 2020;
- USD Board Meeting on August 12, 2019;
- USD Budget & Finance Committee on August 7, 2019.

10.7 Effects on Historic Properties

Previous environmental documents completed in the project area have not identified any historic properties. Construction would primarily be within existing roadways and would not affect historic structures. There is a possibility that excavation for pipelines could encounter previously unidentified, buried, prehistoric resources. Mitigation for unanticipated discoveries would ensure that any resources discovered during construction are treated appropriately.

11. IMPLEMENTATION

The purpose of this section is to demonstrate the ACWD Purified Water Feasibility Study (PWFS or Study) meets the requirements of a Title XVI Feasibility Study Report as defined by the United States Bureau of Reclamation (USBR), and the Water Recycling Funding Program (WRFP) Guidelines. A complete crosswalk between USBR requirements, WRFP guidelines and supplement information can be found in **Appendix J**. The following sections provide additional information to address any Title XVI Feasibility Study directives and WRFP guidelines that were not fully addressed in previous chapters. This section was prepared in conformance with the Reclamation Manual Directives and Standards WTR 11-01 entitled "Title XVI Water Reclamation and Reuse Program Feasibility Study Review Process", dated February 2017.

11.1 Non-Federal Funding Condition

If federal funding is not received, the Project may be delayed, and the Project cost may then increase due to inflation. The Partners would continue to apply for funding under other opportunities as described in **Chapter 11.7.3.** If federal funding is received, matching funds will be provided by the Partner's capital improvement program budget.

11.2 Project Alternatives

The Partners have explored extensive water supply options that would maximize reuse of available wastewater supplies. Three supply alternatives were developed for the Study:

1. Title XVI Project – Alternative A, Phases 1 & 2 with Combined Process Trains
2. New Local Seawater Desalination Plant
3. No Project – Continue purchase of imported water from SFPUC

11.2.1 Title XVI Project

The proposed Title XVI Project is Alternative A, Phases 1 & 2 with Combined Process Trains as discussed in Chapter 9.5. For simplicity in this comparison, it is assumed both phases are implemented at the same time.

11.2.2 Local Desalination Alternative

Another alternative to the Project would be for ACWD to implement its own local desalination facility. This alternative would include a new desalination plant in the ACWD service area, slant wells to extract saline intruded groundwater, land acquisition for the plant, a brine disposal line, and a product water line to convey treated water to the ACWD distribution system. The benefits of a desalination plant owned and operated by ACWD would be the creation of a drought-proof water supply and it would be under complete local control.

Issues associated with this supply alternative are brine disposal limitations and potential complications with California Coastal Commission requirements. Slant wells were assumed to reduce complications with seawater intakes. The desalination plant was assumed to be located on the south side of the ACWD service area where hydraulics of the distribution system could allow for introduction of new water. A brine disposal line to the USD Alvarado WWTP for use of the EBDA outfall was also assumed.

This alternative assumes operation during only 8 months of the year to ensure that the EBDA outfall has adequate capacity for disposal of brine. The EBDA outfall has capacity limitations during wet weather conditions and, unlike the potable reuse concepts, this alternative would not include a reduction in treated wastewater flows to the outfall which opens up capacity in the outfall. The production capacity of this desalination plant would be 8,000 AFY, but the plant would need to be sized larger than normally would be required for that capacity due to the fact that it would operate only part of the year.

11.2.3 No Project Alternative

Under a No Project Alternative, there would be limited expansion of recycled water production or distribution systems within the Study Area. ACWD would be subject to increasing frequent and more severe water shortfalls due to reduced reliability and/or yield from each existing supply. ACWD's supply shortages could be mitigated with the purchase of surface water on the open market and transported through State Water facilities. Anticipated future growth would generally be served with potable water, and ACWD may need to increase their water purchases, develop alternative supplies, implement other conservation programs, or complete other recycled water projects to free potable demand. With the No Project Alternative, certain near-term environmental impacts from the Title XVI Project would not occur, such as construction impacts or commitment of resources. However, additional construction and operation of potable water treatment and distribution facilities would be needed to serve additional planned demands. Additional available wastewater within the study area would not be beneficially reused under the No Project Alternative, and this water would continue to be discharged.

11.3 Economic Analysis

The following section provides an economic analysis of the Title XVI Project compared to other recycled water alternatives, as well as a "No Project" alternative. The year 2030 is the assumed mid-point of the project and therefore representative of the average cost of the Project. 2022 capital costs were amortized at a 3% interest rate over a 30-year period. Detailed Project costs are presented in **Appendix F** and **Appendix G** and discussed in Chapter 9.2.

11.3.1 Alternative Cost– Local Desalination Facility

An additional water supply alternative to the Title XVI Project would be a new seawater desalination facility within the Study Area, previously studied in 2014.

Major components of the desalination system include a RO pretreatment system, RO trains with high pressure pumps and energy recovery, clean in place system, and RO flush pumps located inside the facility. The 2014 study proposed the use of slanted coastal wells, as opposed to open-ocean seawater intake system, because subsurface intake systems offer greater environmental sensitivity and reduced requirements for pretreatment prior to RO.

Average seawater desalination project costs for the 8,000 AFY facility were escalated from 2014 dollars presented in the previous study to the year 2022 and amortized assuming a 3 percent interest rate over 30 years. Annual capital and O&M costs were escalated at 4% per year to 2030 for comparison to the Title XVI project. Table 11-1 presents the planning level costs for the seawater desalination alternative.

Table 11-1: Planning Level Costs – Local Seawater Desalination Facility

Component	Cost, 2022 $	Cost, 2030 $
Total Project Cost	$613,000,000	$839,000,000
Amortized Project Cost[1]	$31,277,396	$42,805,277
Annual O&M Cost[2]	$14,887,008	$20,373,898
Total Annual Cost of Water	$46,164,404	$63,179,174
Water Yield (AFY)	8,000	8,000
Unit Cost ($/AF)	**$5,771**	**$7,897**

Notes:
1. The annual capital costs are based on an assumed loan payment over 30 years at 3% interest, and do not reflect grant funding.
2. Escalated 4% annually.

11.3.2 Alternative Cost – "No Project" Alternative

Due to ACWD's supply shortage and lack of reliability, the non-recycled water alternative that would satisfy the same demand as the project is the potential to spot purchase additional water to cover the supply shortage. In the 2014 study, ACWD evaluated the potential for water transfer alternatives. In 2014 dollars a raw water transfer with Central San and CCWD was estimated to cost $2,010, Table 11-2 summarizes the escalated cost of water transfers in 2030 and 2060 to compare to the Project.

Table 11-2: Planning Level Costs – No Project Alternative

Alternative	Cost, 2030 $	Cost, 2060 $
Water Transfer ($/AF)	$3,765	$12,210

Notes:
1. Escalated 4% annually.

11.3.3 Alternatives Cost Comparison

A comparison of the unit costs for the three project alternatives are summarized in Table 11-3 and graphically depicted on Figure 11-1. The unit cost of water of the proposed Title XVI Project is less than the Local Seawater Desalination Facility alternative for the 30-year period from 2030 to 2060 and is less than the "No Project" alternative by 2048. The Title XVI Project is projected to become even more economical with time as shown by Figure 11-1.

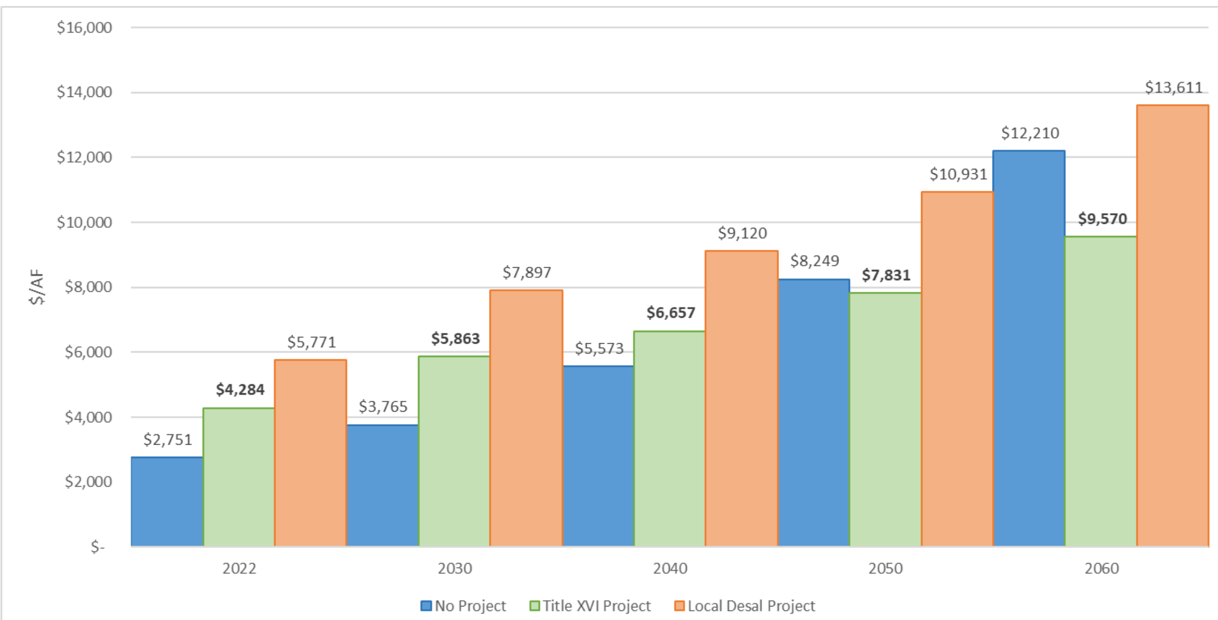
Table 11-3: Projected Unit Cost of Water – Comparison of Alternatives

Alternative	Water Source	Water Purveyor	New Water Supply (Y/N)	2030	2060
Title XVI Project	Recycled Water	ACWD, USD, SFPUC	Y	$5,863	$9,570
Seawater Desalination Facility	Desalinated Seawater	ACWD	Y	$7,897	$13,611
"No Project"	Water Transfer	Central San/ CCWD	N	$3,765	$12,210

Notes:

1. Escalated 4% annually.

Figure 11-1: Unit Cost of Water Comparison



11.4 Reduction, Postponement, or Elimination of New or Expanded Water Supplies and Reduction of Diversions from Natural Water Courses

Recycled water is used to offset demands for potable water, which are sourced from natural watercourses and groundwater. San Francisco Regional Water System (RWS) collects an average of 85% of its water from the Tuolumne River in the Sierra Nevada; the remaining 15% of the RWS supply originates from local surface waters in the East Bay and Peninsula (SFPUC, 2020). The availability of these surface waters is dependent on precipitation, regulatory restrictions, legislative restrictions, and operational conditions. Offsetting the use of these existing water supplies will help to reduce the need for purchased water or development of new supplies. Recycled water will improve reliability as it is not vulnerable to many of the threats that exist with surface water supplies.

In addition to the supply reliability benefits associated with reduced demands for potable water, the Project will also support continued flows in the natural watercourses. Protecting the natural water courses in the study area's source watercourses helps to support healthy ecosystems which can support habitat for native species and provide recreational opportunities.

The AWPF will provide ancillary groundwater basin benefits, such as higher groundwater levels, as well as supporting groundwater sustainability. Supplementing the groundwater basin reduces the potential for problems associated with low groundwater levels, such as subsidence. Subsidence can damage structures and infrastructure, decrease property value, and increase the need to secure other water supplies for emergency services. It also reduces the future value of the aquifer by permanently reducing the aquifer's capacity. Groundwater quality degradation (from continued groundwater pumping) could impact costs of emergency groundwater because of potential additional treatment requirements or reduce availability of groundwater for beneficial use.

11.5 Reduction of Demand on Existing Federal Water Supply Facilities

The non-local supply utilized by ACWD comes from the SWP facilities and the RWS. Although the Project would not reduce demand on federal facilities, it could indirectly reduce the demand on the shared state and federal supply from the SWP.

11.6 Legal and Institutional Requirements

11.6.1 Water Rights Issues

There are no anticipated water rights issues potentially resulting from implementation of the proposed Title XVI Project. USD, as a Study Partner, owns and operates the sources of recycled water supply, Alvarado WWTP, and therefore has rights to unused effluent. As discharger to San Francisco Bay, no downstream water rights holders exist that would be impacted by a change in wastewater discharge. This can be formally confirmed through consultation with the State Water Board Division of Water Rights.

11.6.2 Legal and Institutional Requirements

Wastewater treatment, wastewater discharges, and recycled water use within the Study Area are regulated by the SWRCB, RWQCB, and DDW. Relevant regulations from each of these agencies and policies are described in the following.

The RWQCB has primary authority to permit and regulate recycled water treatment and use within the Service Area. Recycled water discharges to groundwater (such as groundwater recharge) are regulated by the RWQCB pursuant to requirements established within the State of California Porter-Cologne Water Quality Act. Through authority delegated by the U.S. Environmental Protection Agency (EPA), the RWQCB also regulates recycled water or wastewater discharges to inland surface waters, estuarine waters, and marine waters in accordance with requirements established pursuant to the federal Clean Water Act.

NPDES Permits

Federally-regulated surface waters include rivers, streams, wetlands, lakes, reservoirs, lands subject to flooding with a 100-year storm, and other "navigable" surface waters. Through authority delegated by EPA, the RWQCB regulates the discharge of recycled water to federally-regulated surface waters through the issuance of NPDES permits. The NPDES permits include effluent concentration standards that implement applicable state water quality policies and standards, including those established within the Basin Plan, State of California Enclosed Bays and Estuaries Plan (SWRCB, 2009) and California Toxics Rule (CTR).

The CTR regulations are established by EPA within Title 40, Section 131 of the Code of Federal Regulations (40 CFR 131). The CTR establishes water quality standards for inland surface waters of California for the protection of aquatic habitat and the protection of human health. The CTR standards are applicable to recycled water discharges to federally regulated surface waters.

SWRCB Recycled Water Policy

In February 2009, the SWRCB adopted Resolution No. 2009-0011: Policy for Water Quality Control for Recycled Water (Recycled Water Policy). The purpose of the Recycled Water Policy is to increase the use of recycled water from municipal wastewater sources. The Recycled Water Policy is intended to streamline SWRCB and RWQCB permitting processes in order to expedite the implementation of recycled water projects. The Recycled Water Policy includes requirements for development of stakeholder-driven Salt and Nutrient Management Plans, streamlined permitting for landscape irrigation and groundwater recharge projects, guidance regarding anti-degradation analysis, and a research program for constituents of emerging concern (CECs).

The Salt and Nutrient Management Plan portion of the Recycled Water Policy requires every groundwater basin/sub-basin in California to prepare a groundwater management plan addressing salts and nutrients by 2014. The intent of the Recycled Water Policy is for "salts and nutrients from all sources to be managed on a basin-wide or watershed-wide basis in a manner that ensures attainment of water quality objectives and protection of beneficial uses through the development of regional or subregional Salt and Nutrient Management Plans rather than through imposing requirements solely on individual recycled water projects."

As discussed in Chapter 2, Regulations for DPR in California have not yet been finalized. The State has published both a "framework" (SWRCB 2019b) as well as a set of draft criteria for DPR (SWRCB 2021). Final criteria are to be established by the end of 2023. Meanwhile, SWRCB convened an expert panel for DPR whose insights can be used to guide DPR projects (NWRI 2020). Figure 11-2 summarizes key recommendations from the panel report for enhanced source control to better protect wastewater that will become purified water.

Figure 11-2: Key Elements of Enhanced Source Control for Direct Potable Reuse in California Recommended by the SWRCB-Convened Panel

KEY PROGRAM ELEMENTS	RECOMMENDATIONS / ENHANCEMENTS
Federal National Pretreatment Program	• The NPP is a solid foundation for enhanced source control for a DPR program. • Pretreatment programs should be required for all DPR systems with significant industrial users, regardless of size. This should be enforced through permits. • Source should be a component of an integrated water supply program. • The RWQCB and DDW should have a consistent, programmatic approach to enhanced source control for DPR.
Enhanced Local Limits	• Local limits must be designed to protect water quality for potable reuse. • Quantitative risk assessments should be conducted to design local limits and identify constituents of concern.
Enhanced Discharger Evaluation	• Risk assessments should be used to screen business applications and permits for constituents of concern. • Risk assessments should evaluate the discharge of concentrated waste into the DPR program. • Utilities should be required to maintain permit databases and annually update GIS maps of industrial users.
Enhance Collection System Monitoring	• Utilities should be required to evaluate the potential of establishing a sensor/software monitoring system in the collection system or at the WWTP to provide early warning of source control issues such as illegal or accidental discharges.
Enhance Education/Outreach	• Public education and outreach programs should be established regarding the control and disposal of hazardous constituents for industrial, commercial, and domestic dischargers.
Technical/ Managerial/ Financial Capacity	• DPR programs should be required to implement a continuous improvement plan as part of their ESCPs. • DPR programs should form and maintain a source control steering committee. • DPR programs should maintain a staffing plan and budget.

DDW Regulation

DDW regulates public water systems and establishes standards for recycled water treatment and reuse to protect public health. DDW serves as the primary permitting agency for public water systems. DDW implements applicable state and federal drinking water, source water, treatment, and distribution regulations through the issuance of water supply permits to municipal potable water purveyors.

The RWQCB serves as the primary permitting agency for recycled water treatment and use. DDW serves as a consulting agency in the RWQCB recycled water permitting process; recycled water WDRs issued by the RWQCB implement applicable DDW recycled water treatment and reuse regulations and requirements.

11.6.3 Interagency Agreements

Purified water projects require strong interagency cooperation and responsiveness when different agencies operate the WWTP, AWPF, and/or drinking water treatment facility as discussed in Chapters 4.2.3 and 4.2.4. An interagency agreement or memorandum of understanding (MOU) between the Partner agencies is critical for institutional, planning, management, regulatory, and technical collaboration as well as cost-sharing, needed to implement and operate a purified water project.

The guide to DPR projects (NWRI 2020) suggests the following specific topics that can be addressed through interagency cooperation and agreements:

- Water rights associated with wastewater effluent.
- Appropriate WWTP effluent water quality and quantity.

- An enhanced source control program and pretreatment to manage constituents in wastewater collection systems.
- Development of response plans between the entities operating the WWTP, AWPF, and the drinking water treatment facility to ensure effective planning, communication, and collaboration on technical, engineering, operational, and management topics.
- Assignment of funding for capital and operational expenses.
- Cooperation on addressing regulatory questions.
- Submission of joint grant proposals for project funding.
- Cooperation on public outreach and engagement efforts.

11.6.4 Regulatory and Environmental Permitting Requirements for Construction

All project components will be constructed and operated in compliance with applicable permits. Regulatory and environmental permits that may be required for the proposed Title XVI project is provided in Table 11-4. Permits will be acquired prior to construction or operation. It is expected that by identifying permitting and approvals early in the process, and conducting this Study in a cooperative manner, barriers to obtaining permits and approvals can be identified early in the process.

Table 11-4: Potential Regulatory and Environmental Permits

Agency	Type of Approval
Federal	
U.S. Fish and Wildlife Service	Federal Endangered Species Act Compliance (Section 7 Consultation)
U.S. Army Corps of Engineers	Clean Water Act, Section 404, Nationwide Permit(s)
State	
California Dept. of Fish & Wildlife	State Endangered Species Act Compliance Section 1600 Streambed Alteration Agreement
Regional Water Quality Control Board	NPDES Permit For Recharge to Groundwater Basin via Quarry Lakes General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Order 2012-0006-DWQ and NPDES No. CAS000002)
Division of Drinking Water	Amended Domestic Water Supply Permit
State Historic Preservation Office	Section 106 Consultation in compliance with the National Historic Preservation Act (Potential)
Local	
Bay Area Air Quality Management District	Authority to Construct Authority to Operate

11.7 Financial Capability of Sponsor

11.7.1 Project Schedule

The proposed implementation schedule for the project includes major tasks needed to implement the Title XVI Project. The proposed implementation schedule for the Title XVI Project is shown in Table 11-5. The Title XVI Project is anticipated to take approximately 13 years. There is an assumed gap year between the beginning of operation of the Phase 1 project and starting work on implementation for the Phase 2 project; this time could be reduced or expanded as desired.

Table 11-5: Title XVI Project - Implementation Schedule

Project Task	Duration	Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10		Year 11		Year 12		Year 13	
		H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
Interagency Agreement	12 months	■	■																								
Site Selection	12 months			■	■																						
Pilot Testing	12 months			■	■																						
Environmental - Programmatic	18 months				■	■	■																				
Permitting - IPR	18 months						■	■	■																		
Design - Phase 1	18 months							■	■	■																	
Construction - Phase 1	24 months										■	■	■	■													
Start Up and Testing - Phase 1	6 months														■												
Environmental - Supplemental	12 months																	■	■								
Permitting - DPR	24 months																	■	■	■	■						
Design - Phase 2	18 months																			■	■	■					
Construction - Phase 2	24 months																						■	■	■	■	
Start Up and Testing - Phase 2	6 months																										■

11.7.2 Willingness and Capability of the Study Partners to Fund the Project

All project entities are currently in discussion in regard to which facilities will be owned by which entity as well as long term project commitments for purchasing water. Contractually, these arrangements have not been established or determined at this time.

The Partners are public agencies with the financial capability to construct and operate/maintain the Title XVI Project components. The Project will be funded through the Study Partner's capital replacement and operating budgets, as well as development activity revenues. The Partners also have the capability to fund projects through debt issuance.

11.7.3 Project Funding Plan

There are a variety of financing methods available to finance capital improvements, replacements, and expansion of water supplies. These include pay-as-you-go (cash reserves and operating revenues), state revolving fund loans, grants, and tax-exempt borrowings, such as general obligation bonds, special tax bonds, assessment bonds, revenue bonds, bond pools, and certificates of participation.

Potential Funding Sources

There are several funding sources that the Partners may pursue:

- Grants of up to 25% of project costs or $30 million, whichever is less, are potentially available from Reclamation under its Title XVI program.
- State programs such as the Regional Resilience Grant Program could be available with a funding cap of $650,000 for planning and $3,000,000 for implementation.
- State Revolving Fund (SRF) loans, a low interest loan program administered by the State Water Resources Control Board. SRF loans typically have a lower interest rate than bonds but are paid back over a 30-year period. May be capped at $50,000,000 in FY24/25.
- Water Infrastructure Finance and Innovation Act (WIFIA) is a federal credit program administered by EPA for eligible water and wastewater infrastructure projects with no maximum funding cap and a 51% match.

- Traditional bond financing for the project, which typically has a higher interest rate but may be paid back over a 30-year period.

11.8 Next Steps

Further investigations would be required to verify that the assumptions made for the Project are reasonable. Listed are some of the recommended next steps that have been identified to move forward with the Project; there are many routine steps to implementation that are not included in this section as the focus is on aspects unique to the Study.

- Administrative:
  - Real estate investigation to identify the best location for the AWPF (currently assumed to be at Pit #2)
  - Determine if PT GW Facility will proceed as part of this project or as a standalone project.
  - Determine ownership, financial sponsorship, and revenue allocation between partners.
  - Develop public outreach approach.
- Technical:
  - Develop a more detailed water quality model for Quarry Lakes with extended data set.
  - Continue to implement short-term water quality monitoring plan of Quarry Lakes.
  - Implement long-term water quality monitoring plan of Quarry Lakes.
  - Monitor hourly wastewater flow for extended period to confirm projection of water usage behavior.
  - Conduct a capacity evaluation on USD's collection system after AWPF siting (for disposal of MF wastestream).
  - Conduct pilot study to validate the advanced treatment process.
  - Expand waste discharge water quality assessment. Future NPDES permit is expected to be equal to or more stringent than the current one. The constituents identified as Category 4 (may exceed CTR/Basin Plan Objectives) and Category 2 (Not Enough Data to Determine if CTR/Basin Plan Objectives would be exceeded) should be continuously monitored to facilitate a comprehensive assessment of future compliance. Refer to Chapter 6.3.2 for more details.
  - Investigate the impact of RO concentrate discharge into the EBDA line, including:
    - RO concentrate corrosion potential evaluation. Collect chloride and sulfate data from USD's secondary effluent during the design phase of this project to provide a more thorough analysis of the potential corrosion of EBDA pipelines.
    - Conduct a condition assessment of the EBDA pipeline to better characterize its current condition.
  - Update treatment process design as regulation evolves. There is no DPR regulation at the time this report is written. Current design also reflects the most up to date

technologies and design, no specific research need is identified at the moment. However, shall the new regulations on DPR go into effect, the partners need to review the current design to ensure compliance with future regulations.

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APPENDIX A: EXPANDED POTABLE REUSE REGULATORY REVIEW

APPENDIX A: EXPANDED POTABLE REUSE REGULATORY REVIEW

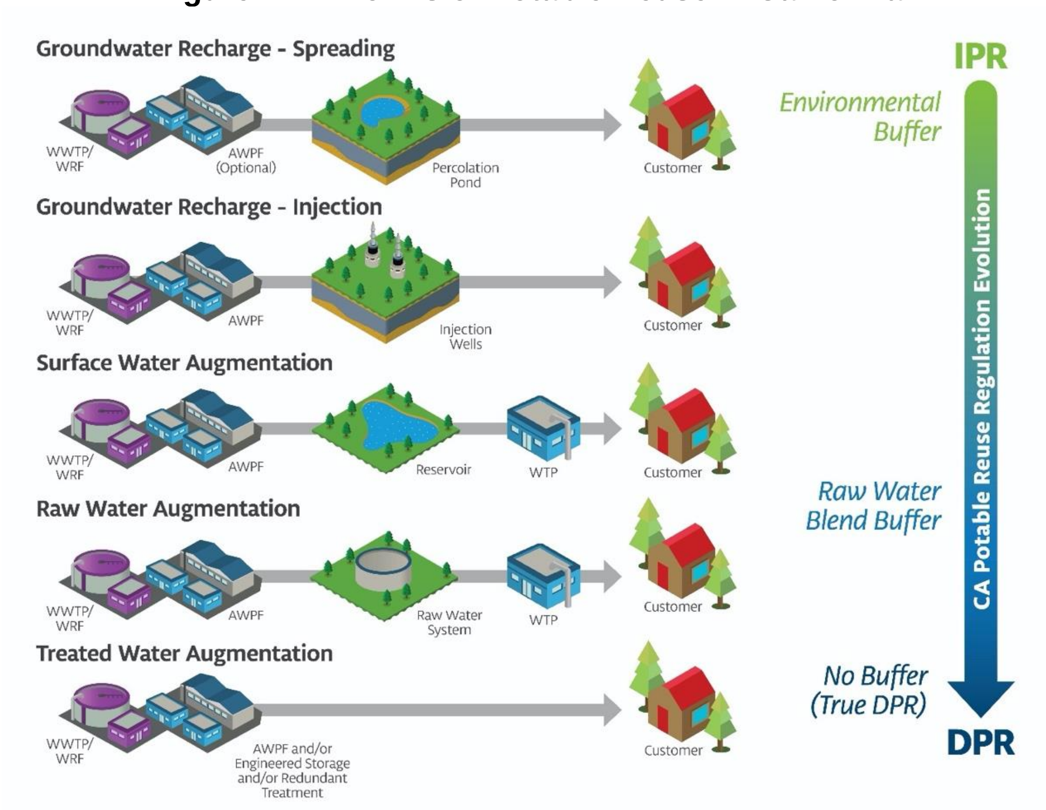
1. INTRODUCTION

This section describes potable reuse approaches and regulatory requirements associated with each of the approaches. The objective of this section is to provide an overview of regulatory requirements for the different forms of potable reuse so that readers can understand the pros and cons and challenges of pursuing different forms of potable reuse.

1.1 Potable Reuse Approaches

The spectrum of potable reuse approaches is commonly distinguished by the degree of *separation* between the treatment and ultimate consumption of purified water. This separation may be physical (e.g., when purified water travels through a groundwater aquifer), temporal (e.g., when water is retained in a tank or a reservoir), or both. Indirect potable reuse (IPR) projects are characterized by the use of one of two environmental buffers—a groundwater aquifer or a surface water reservoir—that increase the separation between treatment and consumers. Direct potable reuse (DPR) projects are defined by the *absence* of a significant environmental buffer. The State of California recognizes five forms of IPR and DPR that are depicted in Figure 1-1 .

Figure 1-1 – Forms of Potable Reuse in California



The first form of IPR distinguished by California regulations is groundwater recharge (GWR), which can be achieved by two different approaches: surface spreading and subsurface injection (Title 22, Chapter 3, Articles 5.1 and 5.2, respectively). The second form of IPR is surface water augmentation (SWA) which introduces purified water directly into a surface water reservoir that is used as a source of domestic drinking water supply.

Unlike IPR approaches that rely on an environmental buffer, DPR approaches reduce or completely bypass the use of an environmental buffer. California distinguishes two forms of DPR: raw water augmentation (RWA), which introduces purified water as a new source water to a drinking water treatment plant, and treated water augmentation (TWA), which supplies purified water directly to the distribution system. Because DPR projects do not typically incorporate environmental buffers, these projects cannot rely on the multiple benefits that the environment provides in terms of controlling contaminants and providing time to respond to upstream failures. As these benefits are reduced in more direct forms of potable reuse, different strategies may be needed to ensure public health protection.

The unplanned (or *de facto*) reuse of treated wastewater as a water supply is common in many water systems in the U.S., with some drinking water treatment plants using water sources that contain a high fraction of wastewater effluent from upstream communities (NRC 2012). This discussion focuses on planned potable water reuse as defined in California regulations.

In the following sections, the various forms of potable reuse are evaluated based on their requirements for the protection of both (1) public health and (2) environmental health.

2. INDIRECT POTABLE REUSE

One of the benefits of pursuing IPR projects in California is the *regulatory certainty* associated with the existence of final, adopted regulations for both GWR and SWA. This streamlines the permitting process by providing clarity on the requirements for IPR implementation. In the case of GWR, there are also multiple *precedents* given that permitted CA GWR projects have been producing water for nearly 60 years. Based on this experience, the regulatory community has first-hand knowledge of the challenges with GWR allowing them to adapt the requirements to address these needs.

The following sections describe the three different forms of IPR projects, and the regulatory requirements associated with each of these forms.

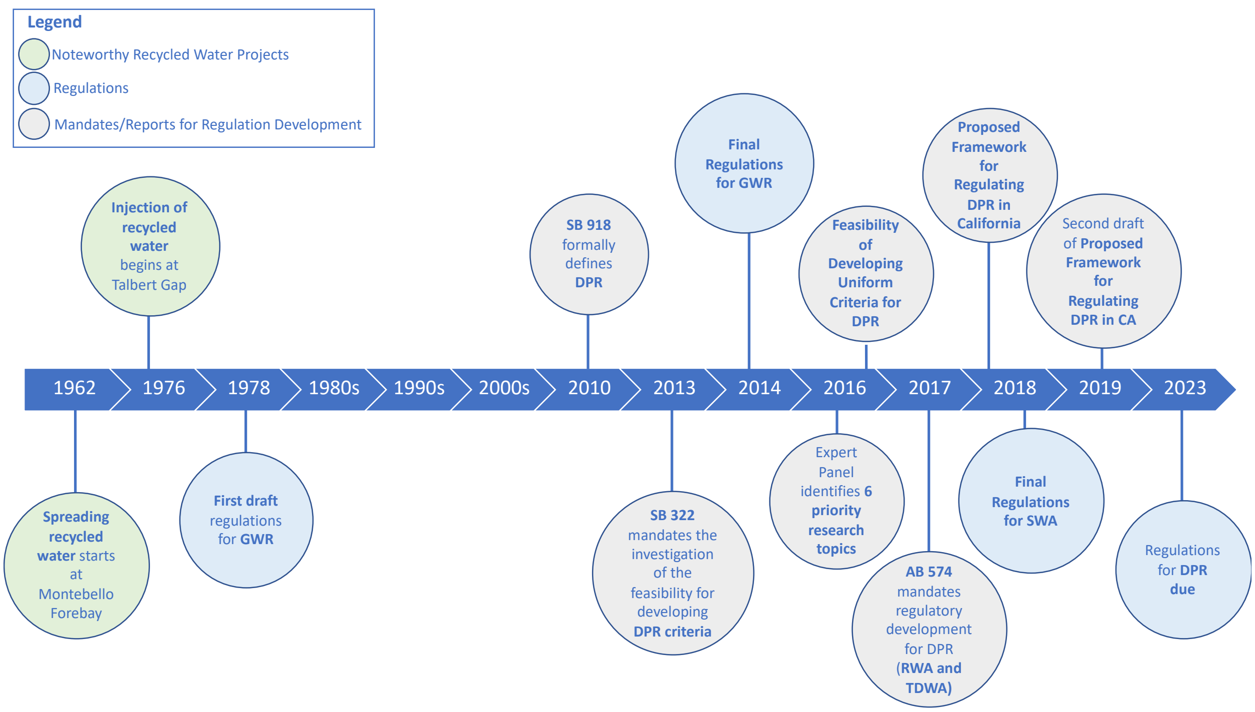
2.1 Groundwater Recharge

There are two forms of GWR, as identified by the regulations: surface spreading and subsurface injection. The minimum treatment requirements for surface spreading include secondary treatment, tertiary filtration, and disinfection prior to being applied in a spreading basin (DDW 2018). As the tertiary treated water percolates through the soil to the aquifer, further control and attenuation of contaminants is provided through soil aquifer treatment (SAT). Subsurface (or direct) injection bypasses SAT and therefore requires higher degrees of treatment at an advanced water purification facility (AWPF) prior to injection into the aquifer.

GWR is the form of potable reuse with the longest history in California, as summarized in Figure 2-1 The seminal surface spreading and subsurface injection projects—Los Angeles County Sanitation District's (LACSD's) Montebello Forebay project and Orange County Water District's (OCWD's) Water Factory 21 and Groundwater Replenishment System (GWRS)—have been in operation for 60 and 45 years, respectively. While the initial draft regulations for GWR were first developed in 1978, it was not until 2014 that the regulations were finalized. Leaving these regulations in draft form allowed the regulators to periodically update and adapt the requirements based on decades of experience permitting and evaluating these projects. This extended period of regulatory development is unlikely to be replicated again since both the SWA and future DPR regulations were given short deadlines (less than 10 years) for completion under legislative mandates. Even with a final regulation in place, the lack of precedent SWA projects will likely require additional regulatory interactions for permitting. The permitting effort will likely entail even greater interactions for DPR since there is neither regulatory certainty (i.e., final regulation anticipated for December 2023) nor project precedents in California.

The following section describes the key considerations for these two forms of GWR in terms of both public health and environmental protection.

Figure 2-1– History of GWR Regulations and Projects in CA



2.1.1 Public Health Protection Criteria

Because the two different forms of GWR – surface spreading and subsurface injection – employ different strategies for public health protection, the requirements are divided into two articles of the regulations: Article 5.1 for Surface Application and Article 5.2 for Subsurface Application (CDPH 2014). The following sections provide an overview of the key requirements with an emphasis on requirements that differ between the two forms of GWR.

2.1.1.1 Pathogenic Microorganism Control

In order to protect public health, GWR regulations focus first and foremost on minimizing the acute risk of infection from pathogenic microorganisms. The regulations include requirements for "12/10/10 V/G/C", or 12-log reduction of enteric virus, 10-fold reduction of *Giardia* cysts and 10-

log reduction of *Cryptosporidium* oocysts. The 12/10/10 requirements must be met by using a multiple-barrier approach: for each type of pathogen, a minimum of three treatment processes must be used, with each providing at least 1.0-log removal. To enforce the minimum number of treatment processes for each type of pathogen inactivation, each process can only be credited for a maximum of 6.0-log removal regardless of the log-removals the process actually provides.

For spreading applications—which typically use tertiary, disinfected recycled water—the majority of the pathogen reduction requirements are typically met in the environment. Per the regulation, spreading projects that provide a minimum of 6 months of retention time can satisfy the entire 10-log reduction requirement for both *Giardia* and *Cryptosporidium*. In addition to the virus reduction that occurs through tertiary treatment, spreading projects also receive an additional 1-log of virus reduction for each month the purified water spends in the aquifer. All of the currently permitted spreading projects provide a minimum of 6 months of retention time (and up to multiple years).

Subsurface injection projects cannot rely on SAT for *Giardia* and *Cryptosporidium* control meaning that the full 10-log reduction requirement must be met at the AWPF. Fortunately, the standard full advanced treatment (FAT) train used for GWR injection—RO and UV/AOP (with membrane filtration as pretreatment to RO)—can generally meet the 10-log requirement with standard monitoring and crediting approaches. Because the 12-log virus removal cannot typically be met at the AWPF, virus control is accomplished through a combination of treatment at the AWPF and attenuation in the aquifer. In addition to the virus reduction that occurs through the AWPF, subsurface injection projects also receive an additional 1-log of virus reduction for each month the purified water spends in the aquifer. For both forms of GWR, all treatment processes used to meet pathogen requirements must be validated to demonstrate their effectiveness via ongoing monitoring of a surrogate parameter.

2.1.1.2 Advanced Treatment Criteria

Advanced treatment criteria are specified for groundwater injection projects since they do not benefit from further environmental attenuation via SAT. The regulations specify FAT at the AWPF (Section 60320.201). Most FAT facilities designed for this purpose follow the treatment train installed at the OCWD GWRS, namely, membrane filtration through either microfiltration or ultrafiltration (MF/UF), RO, and an advanced oxidation process (typically high-dose ultraviolet irradiation with hydrogen peroxide (UV/H_2O_2) or hypochlorous acid (UV/HOCl).

2.1.1.3 Source Control

While the level of treatment for the two forms of GWR differs, there are no differences in source control requirements. Recycled water for GWR projects must be from a wastewater management agency that administers an industrial pretreatment and pollutant source control program. The source control program must include the following:

- an assessment of the fate of State and Regional Board-specified contaminants through both the wastewater and recycled wastewater treatment systems,
- source investigations and monitoring focused on State and Regional Board-specified contaminants,

- an outreach program to industrial, commercial, and residential communities in areas that supply the GWR project with wastewater for managing and minimizing contaminants at the source, and
- a current inventory of all contaminants assessed in the program, including any new contaminants that result from the introduction of new sources or changes to existing sources, that may be discharged into the wastewater collection system.

2.1.1.4 Chemical Control

In addition to pathogen control, chemical control is also regulated for GWR projects because some chemical contaminants, including: (1) nitrogen (N) compounds, (2) regulated contaminants, and (3) various unregulated contaminants may cause chronic and acute risks to public health. As a result, regular monitoring of these select chemical contaminants is required under GWR regulations:

- Total nitrogen must be sampled twice a week (either before or after surface application) with any exceedances over 10 mg/L as N requiring corrective action. If the GWR project shows consistently low levels of total nitrogen in the tested samples, reduced monitoring may be granted on a case-by-case basis.
- Regulated contaminants with MCLs (including inorganics, radionuclides, organic chemicals, disinfection-by-products (DBPs), and lead and copper) must be monitored quarterly, while other regulated contaminants with secondary maximum contaminant levels (SMCLs) must be measured at least annually, with any exceedances requiring corrective action.
- Additional chemical and contaminant monitoring requirements are in place for: (1) the priority toxic pollutants, (2) a list of site-specific, unregulated chemicals, and (3) constituents with notification levels (NLs). A Science Advisory Panel put together by the State Board developed a list of unregulated contaminants for monitoring, with its most recent recommendations provided in a report released in April 2018 (Drewes et al. 2018). One of the significant new additions to the monitoring requirements is the use of bioassays. Instead of targeting a specific chemical, bioassays look for a biological *effect* that might be triggered by one or many compounds. This type of non-targeted monitoring (NTA) is of growing interest for all forms of potable reuse, though particularly for DPR.

The FAT-based treatment train evolved to provide a high degree of protection against chemical contaminants. RO serves as the principal barrier to organic and inorganic constituents with additional polishing through the AOP that provides additional mechanisms of removal including both photolysis and advanced oxidation. The industry's experience with this treatment train has demonstrated excellent control of both regulated and unregulated constituents, including emerging contaminants like PFOA, PFOS, and other PFAS compounds. In addition, most GWR projects conduct additional studies to ensure that the introduction of the purified water does not cause leaching of aquifer contaminants into the groundwater.

2.1.1.5 Diluent Water and Recycled Water Contribution

Multiple strategies may be employed to produce a potable reuse source that is protective of public health. One approach is to blend purified water with other sources in order to meet water quality goals. This blending requirement is a key factor in spreading projects and takes the form of a requirement called the “recycled water contribution.” The water quality parameter that is used to determine how much blending is required is total organic carbon (TOC). The GWR regulations require that no more than 0.5 mg/L of TOC from the purified water may be present in the blended groundwater. The formula for the maximum recycled water contribution (RWC) is the following:

$$RWC = \frac{0.5\ mg/L}{TOC\ in\ recycled\ water\ (in \frac{mg}{L})}$$

A purified water with a TOC of 2.5 mg/L would therefore be limited to an RWC of 20 percent, meaning that diluent water would need to constitute the remaining 80 percent of the total water used to recharge the aquifer. The initial maximum RWC is 20 percent based on a running monthly average RWC using the total volume of purified water and credited diluent water over the past 120 months. Provisions exist in the regulations to increase the RWC but levels exceeding 50 percent require special permission. In practice, it is difficult to reduce the TOC of tertiary disinfected recycled water to the low levels that would allow for a 50% RWC.

While similar RWC requirements are included in the subsurface injection regulations, they do not limit projects that use the FAT process. Because the FAT treatment train employs RO, which must continuously produce effluent with a TOC level not exceeding 0.5 mg/L, FAT projects can comply with regulations that allow for an initial maximum RWC of 1.0 (i.e., no dilution).

2.1.1.6 Response Retention Time

Per regulations for both surface spreading and subsurface injection, the purified water applied by a GWR project is required to be retained underwater for no less than two months. In practice, nearly all of the permitted GWR projects provide 6 months to years of retention time. The minimum two-month *retention* time requirement is intended to allow for sufficient time to *identify and respond* to treatment failures. At the planning stage, modeling may be used to estimate the retention time provided by the aquifer. Each month of retention time estimated with modeling will only be credited for either (1) 0.5-month for numerical modeling, or (2) 0.25-month for analytical modeling, e.g., an 8-month retention time would be corrected to 4 months for numerical modeling and 2 months for analytical modeling.

Once the project is implemented, a tracer test must be conducted at the project site with an added tracer or a DDW-approved intrinsic tracer to demonstrate compliance with the minimum retention time requirements for the project. When using a tracer, the actual retention time is measured as the difference in time between when the tracer is added and when either: (1) 2 percent of the initially-introduced tracer concentration has reached the downgradient monitoring point, or (2) 10 percent of the peak tracer unit value arrives at the downgradient monitoring point. When crediting retention time with a DDW-approved intrinsic tracer, a maximum of 0.67 months is credited to a project for every estimated month of retention in the groundwater basin.

2.1.1.7 Alternatives

Flexibility is also built into the GWR regulations through the alternatives clause (Sections 60320.130 and 60320.230). This clause offers the ability to use an alternative to any requirement in the regulation as long as it satisfies the following conditions:

1. The alternatives are demonstrated to be equally or more protective of public health,

2. DDW has provided written approval of the proposed alternatives, and

3. The proposed alternatives have been discussed in a public hearing.

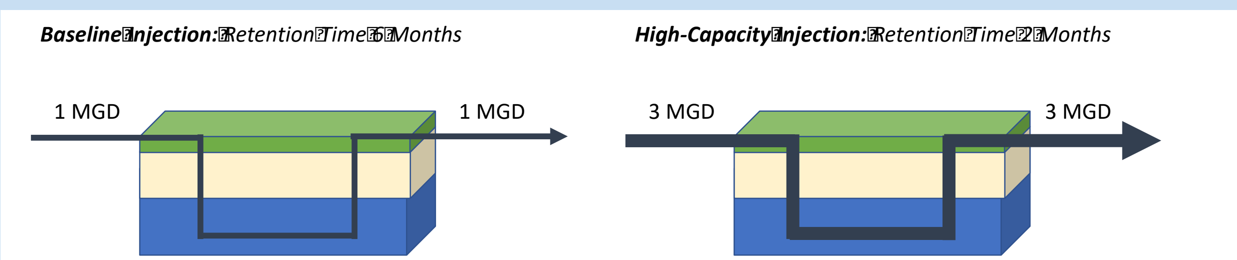
If alternatives are proposed for a project, independent advisory panels (IAPs) are required to review the public health protection provided by the proposed alternatives. The IAP must be composed of a toxicologist, geologist/hydrogeologist, an engineer with at least 3 years of experience in wastewater treatment and public drinking water supply, a microbiologist, and a chemist.

An example of a project that received permitting through this alternatives clause is shown in Figure 2-2.

Figure 2-2 –Baseline and High-Capacity Approach for Subsurface Injection GWR

Maximizing Aquifer Capacity in IPR

In locations that are constrained by smaller aquifers ($V_{aquifer}$), GWR projects can maximize their IPR project capacity (Q_{IPR}) by minimizing the retention time in the aquifer to the 2-month minimum ($t_{retention}$ = 2 months). While providing greater project capacity, this approach reduces both the treatment and response time provided by the aquifer. Accordingly, other elements of the projects—such as treatment and monitoring—may need to be enhanced to make up for these losses. In 2017, Padre Dam Municipal Water District became the first groundwater injection project to receive conceptual approval from DDW to operate at the 2-month retention time. In order to receive this conceptual approval, the Padre Dam project team developed and demonstrated their alternative approach, which included obtaining additional pathogen credits for disinfection at its water recycling facility and providing enhanced monitoring for key parameters. With oversight from both DDW and their IAP, Padre Dam proved this concept through a year-long demonstration study using a 0.1-million gallon per day facility to develop the data needed to permit and design the future full-scale GWR system.



2.1.1.8 Other Criteria

While the specific regulations for surface spreading and subsurface injection are different because subsurface injection does not receive the benefits of SAT, the major requirements for both forms of GWR designed to ensure high water quality and protection of public health are the same. These regulations are summarized in Table 2-1.

Table 2-1 – Summary of Additional Criteria for GWR Applications

Requirement	Description
General Requirements (§60320.100 and §60320.200)	General requirements include the following: • Preparing a compliance report that describes the project's ability to meet all regulatory requirements; • Complying with requirements for alternative water supplies and aquifer water quality and hydrogeological characterization; • Demonstrating the technical, managerial, and financial (TMF) capabilities of the project's partners; and • Obtaining the approvals needed to recommence a project if it is ever suspended.
Public Hearing (§60320.102 and §60320.202)	A public hearing is required to obtain the initial permit to operate a GWR project. Another public hearing must be held whenever there is a proposal to increase the maximum recycled municipal wastewater contribution for the project.
Laboratory Analysis (§60320.104 and §60320.204)	All laboratory analysis must be performed by DDW-approved, certified labs that use DDW-approved drinking water analysis methods.
Operations Plan (§60320.122 and §60320.222)	Each GWR project must submit an Operation Optimization Plan to DDW prior to start-up that identifies and describes operations and maintenance, monitoring, and analytical methods for the project to meet the GWR regulatory requirements.
Reporting (§60320.128 and §60320.228)	An annual report must be submitted to DDW by June of the following calendar year and Engineering Reports must be updated at least once every 5 years.

2.1.2 Environmental Discharge Criteria

In addition to public health protection, all GWR projects are required to provide adequate environmental protection. Recycled water discharges to the Niles Cone Groundwater Basin, part of the Santa Clara Valley Groundwater Basin, are regulated by the San Francisco Bay (SFB) Regional Board.

Permit limits for groundwater replenishment projects are set to ensure that GWR project discharges do not adversely affect beneficial uses or degrade water quality. Criteria governing discharge water quality to the environment are contained in the SFB Basin Plan and the Draft Niles Cone Salt and Nutrient Management Plan (SNMP), described in the following sections.

2.1.2.1 Basin Plan Criteria

The SFB Basin Plan lists both narrative and numeric objectives for groundwater that aim to maintain the existing high quality of groundwater in the region. These objectives are supplemented with basin-specific and/or site-specific objectives as needed. The following standards are specified for beneficial use of the groundwater:

- Water quality objectives for municipal groundwater (MUN):
  - Total Coliform: 7-day median < 1.1 most probable number (MPN)/100 milliliters (mL)
  - Organic and inorganic chemicals: Must comply with drinking water maximum contaminant levels (MCLs) and secondary MCLs (SMCLs) established in Table 64431-A (inorganic chemicals), Table 64433.2-A (fluoride), Table 64444-A (organic chemicals), Tables 64449-A and 64449-B (SMCLs: consumer acceptance limits) of Title 22
  - Radioactivity: Must comply with drinking water primary MCLs established in the Tables 64442 and 64443 of Title 22
  - Taste and odor: Must not contain taste- or odor-producing substances in concentrations that cause a nuisance or adversely affect beneficial uses
- Water quality objectives for agricultural supply: Additional water quality objectives are specified for agricultural use in Table 3-6 of the SFB Basin Plan.

In 2010, the State Water Board issued its Recycled Water Policy to promote use of recycled water throughout California. To ensure such use will not result in degradation of beneficial uses of groundwater, this policy called for local stakeholders to prepare salt and nutrient management plans (SNMPs) for their groundwater basins. ACWD completed a draft SNMP for the Niles Cone Groundwater Basin in 2016.[1] This draft SNMP referenced criteria for nitrate and TDS consistent with the SFB Basin Plan criteria for municipal and domestic supply. Basin Plan criteria for nitrogen and TDS are indicated in Table 2-2.

Table 2-1 – Basin Plan Water Quality Objectives for Niles Cone Groundwater Basin (Regional Board, SFB Region 2017) for nitrogen compounds and TDS

Parameter	Unit	Municipal and Domestic Supply	Agricultural Supply
Total dissolved solids (TDS)	mg/L	500	10,000 [a]
Nitrate	mg/L as NO_3	45	–
Nitrate and nitrite	mg/L as N	10	30
Nitrite	mg/L as N	1	–

[1] Preparation of a final SNMP plan has been deferred further evaluation of the District's goals for recycled water (i.e., this study), upgrade of the District's groundwater basin flow model, and update of the District's Alternative Plan per the Sustainable Groundwater Management Act.

[a] Provided limit is for livestock watering

2.2 Surface Water Augmentation

SWA regulations became effective in October 2018. Unlike GWR, however, there are currently no operating SWA projects in the State. Nevertheless, the pioneering projects (the San Diego Pure Water Program and the East County Advanced Water Purification Program) are providing the industry with first-hand knowledge of SWA's unique challenges. Working through these first projects has helped the regulators understand what issues (both foreseen and unforeseen) must be dealt with during permitting. In 2020, the City of San Diego received the State's first SWA permit for the North City Pure Water Project. This key milestone also helps future projects by gaining better regulatory clarity on the permitting requirements for SWA.

As discussed in Chapter 1, due to the lack of appropriate surface water reservoirs in the vicinity of ACWD's service area, surface water augmentation will not be considered in this study (Quarry Lakes are not a surface water body serving a surface water treatment plant). While information in this section is mainly provided for general interest, the environmental discharge requirements for SWA may provide important context for the Quarry Lakes. Because the Lakes are classified as a body of water with multiple beneficial uses, recharging the groundwater aquifer using these Lakes may require a different permitting approach than standard spreading basins. Some of these requirements may be more similar to SWA than GWR. Additional discussions with the Regional Board and East Bay Regional Park District are recommended to determine the appropriate environmental discharge requirements for the project.

The California Water Code, Chapter 7 entitled "Water Reclamation" previously defined SWA in Section 13561(d) as:

> *"…the planned placement of recycled water into a surface water reservoir used as a source of domestic drinking water supply."*

While the SWA regulations were in the process of approval, Assembly Bill No. 574 (AB574) amended the sections of the California Water Code that establish terminology for potable reuse. The term "surface water augmentation" was changed to "reservoir augmentation," and was defined as:

> *"…the planned placement of recycled water into a raw surface water reservoir used as a source of domestic drinking water supply for public water system or into a constructed system conveying water to such a reservoir."*

For the purposes of this TM, the terms SWA and reservoir augmentation are interchangeable and have the same meaning as the newly defined reservoir augmentation.

The following section describes the regulatory requirements for SWA including the public health criteria and environmental criteria.

2.2.1 Public Health Criteria

The public health categories for SWA projects are similar to those for GWR projects, including requirements for pathogenic microorganism control, chemical control, advanced treatment, source control, and monitoring requirements. One notable difference is the addition of requirements related to the surface water reservoir. Because the reservoir requirements for retention time and dilution both impact the degree of treatment required, they are discussed first.

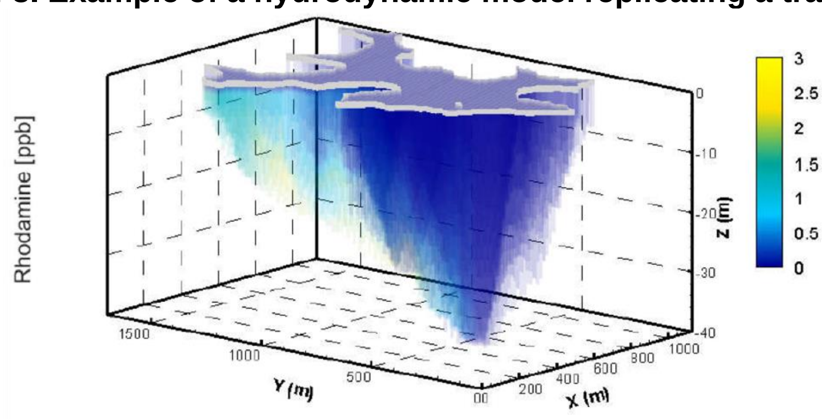
2.2.1.1 Dilution Criteria

One of the primary benefits of the reservoir is its ability to provide dilution. Dilution benefits public health by reducing the concentration of contaminants present in the recycled water. The SWA regulations require that the dilution and mixing criteria are met at all times under all operating conditions. The criteria specify that water withdrawn from the reservoir must contain no more than either of the following:

- 1 percent, by volume, of recycled municipal wastewater that was delivered to the reservoir during any 24-hour period (considered 100:1 dilution), or
- 10 percent, by volume, of recycled municipal wastewater that was delivered to the reservoir during any 24-hour period (considered 10:1 dilution) having been subjected to additional treatment producing no less than an additional 1-log reduction of enteric virus, *Giardia* cysts, and *Cryptosporidium* oocysts.

A SWA project must demonstrate that these dilution and mixing criteria are met under all operating conditions using hydrodynamic modeling. The modeling must simulate how different conditions (e.g., wind speed, wind direction, temperature, lake stratification, etc.) impact the dilution and mixing in the reservoir and verify its compliance with the SWA requirements. The hydrodynamic model must be validated with a tracer study prior to the project coming online, and again within 6 months of operation to validate the model. An example of a hydrodynamic model tracer study validation is illustrated in Figure 2-3. An independent advisory panel (IAP) is required to assist DDW in the review and approval of the results of the hydrodynamic modeling.

Figure 2-3. Example of a hydrodynamic model replicating a tracer study



2.2.1.2 Theoretical Retention Time Criteria

Another benefit of the reservoir is that it retains the purified water for a period and allows time for issues to be identified and addressed before the water is conveyed to the DWTP. The regulations specify that all SWA reservoirs must provide an initial theoretical retention time of no less than

180 days. The regulations define retention time as the total volume in the reservoir at the end of a month (V) divided by the total flow out of the reservoir during that month (Q). While a retention time (V/Q) of 180 days is required initially, the regulations do allow for alternative theoretical retention times. Projects can request alternatives as low as 120 days without additional treatment requirements, and as low as 60 days with the provision of additional treatment. Projects providing less than a 60-day V/Q would not meet the SWA regulations and would therefore be considered DPR projects.

2.2.1.3 Treatment Requirements

The baseline treatment requirements for SWA are full advanced treatment and are identical to the advanced treatment requirements for subsurface injection GWR projects. Within these requirements, the RO membranes selected must meet minimum requirements for salt rejection and total organic carbon (TOC) while the AOP must demonstrate at least 0.5-log destruction of 1,4-dioxane.

2.2.1.4 Pathogenic Microorganism Control

The pathogen log reduction requirements for SWA differ from GWR in that treatment is required both *before* the environmental buffer (at the WWTP and AWPF) and *after* it at the drinking water treatment plant (DWTP). The regulations specify two levels of treatment based on the degree of dilution provided by the reservoir:

1. For projects achieving a minimum 100:1 dilution of the recycled water, the log-reduction required prior to discharge is 8/7/8 for V/G/C. With a DWTP in compliance with the Surface Water Treatment Rules providing no less than 4/3/2 of V/G/C, the total pathogen reduction required is **12/10/10** (8/7/8 + 4/3/2). Treatment must be provided by at least two separate AWPF treatment processes, each achieving at least 1-log reduction with no more than 6-log credit for any process.

2. For projects achieving a minimum of 10:1 dilution of the recycled water, the log-reduction required prior to discharge is 9/8/9 for V/G/C for a total pathogen reduction of 13/11/11 (9/8/9 + 4/3/2). Treatment must be provided by at least three separate treatment processes, each achieving at least 1-log reduction with no more than 6-log credit for any process.

The project's theoretical retention time also impacts the pathogen reduction required. If a project proposes a theoretical retention time less than 120 days, the regulations require no less than 1-log reduction beyond what would otherwise be required based on the dilution provided. Table 2-3 summarizes the treatment requirements for SWA projects depending on the dilution and theoretical retention time in the reservoir.

Table 2-2. Summary of Treatment, Dilution, and Theoretical Retention Time Criteria for SWA

Dilution	V/Q (days)	Log Removal Credit (V/G/C)		Number of Treatment Processes	Additional Considerations
		WWTP/AWPF	Total		

100:1	≥ 180	8/7/8	12/10/10	2	--
	< 180 – 120	8/7/8	12/10/10		State Board Approval
	< 120 – 60	≥ 9/8/9	≥ 13/11/11		State Board Approval
10:1	≥ 180	9/8/9	13/11/11	3	--
	< 180 – 120	9/8/9	13/11/11		State Board Approval
	< 120 – 60	≥ 10/9/10	≥ 14/12/12		State Board Approval

The treatment processes must reliably achieve the required log reduction, and monitoring of the processes is required to ensure they are performing as expected. If the log reduction of virus, *Giardia,* or *Cryptosporidium* drops more than 2-log below the required levels for more than 4 consecutive hours, or for a total of 8 hours in a week, augmentation must be suspended. Written approval from the State and Regional Boards is required to reinstate production after a suspension.

2.2.1.5 Source Control Requirements

The source control requirements for SWA are the same as those for GWR projects, as described in Section 2.2.1.1.3 herein. The source control requirements for SWA projects are more detailed and complex than the requirements for pretreatment under NPDES permits. Pretreatment for NPDES permits focuses on the quality of the wastewater discharged to the environment (protection of environmental health). However, now that the discharge is becoming a direct source of water for a DWTP, the SWA source control requirements force an additional emphasis on chemicals that can impact public health (protection of public health).

2.2.1.6 Alternatives

The SWA regulations provide similar flexibility to the GWR regulations in the form of an “alternatives clause” that allows project sponsors to apply for alternatives. One important distinction is that this flexibility applies to some but not all of the requirements[1]. Of note, this flexibility does not extend to requirements related to the surface water reservoir.

[1] The SWA requirements are present in both Chapter 3 *Water Recycling Criteria* and Chapter 17 *Surface Water Treatment* of the Environmental Health division of the Title 22 Code of Regulations. Alternatives are allowed for any of the Chapter 3 requirements, but not for those in Chapter 17.

2.2.1.7 Other Criteria

In addition to the key requirements mentioned previously in this section, the regulations also specify a number of requirements for additional elements. A summary of these requirements is provided in Table 2-4.

Table 2-3: Summary of Other Criteria in the SWA Regulations

Section	Title	Description
Chapter 3. Article 5.3 Indirect Potable Reuse: Surface Water Augmentation		
60320.301	General Requirements	Includes development of a joint plan between water recycling agency and public water system; demonstration of "technical, managerial, and financial" capability; compliance
60320.302	Advanced Treatment Criteria	Requirements for FAT; process monitoring; demonstration testing; reporting
60320.304	Lab Analyses	Laboratory requirements for analysis of chemicals, both those with MCLs and those without
60320.306	Wastewater Source Control	Requirements for source control program
60320.308	Pathogenic Microorganism Control	Requirements for virus, *Giardia*, and *Cryptosporidium* removal through the advanced treatment process; options for alternative levels of treatment; responses to failures
60320.312	Regulated Contaminants and Physical Characteristics Control	Requirements for monitoring of various groups of regulated chemical contaminants; response to exceedances; monitoring
60320.320	Additional Chemical and Contaminant Monitoring	Requirements for additional chemical testing and reporting, including NLs and other contaminants of concern
60320.322	SWSAP Operation Plan	Identifies plan requirements including operations, maintenance, analytical methods, monitoring, reporting, and ongoing training
60320.326	Augmented Reservoir Monitoring	Monitoring requirements at the reservoir, including sampling locations and frequency
60320.328	Reporting	Includes results of monitoring, operations summary, responses to failure events
60320.330	Alternatives	Permits use of alternatives that provide equivalent or better protection of public health; requirements for approval of alternatives
Chapter 17. Article 9. Indirect Potable Reuse: Surface Water Augmentation		
64668.10	General Requirements and Definitions	Includes definitions, permit requirements, and other elements related to Article 5.3, Chapter 3; requirements for reservoir
64668.20	Public Hearings	Requirements for public interaction, including meetings, Web-accessible information, and customer notifications

Section	Title	Description
64668.30	SWSAP Augmented Reservoir Requirements	Requirements for reservoir as approved surface water supply; retention time requirements; tracer study and modeling requirements; dilution requirements

2.2.2 Environmental Criteria

The following section describes the environmental criteria for SWA projects.

2.2.2.1 Basin Plan Criteria

The majority of the reservoirs in Alameda County fall within the South Bay sub-basin of the San Francisco Bay basin. The reservoirs in Alameda County have many different beneficial uses. Specifically, the Alameda Creek Quarry Lakes have the following beneficial uses:

- COLD – Cold Freshwater Habitat: Uses of water that support cold water ecosystems, including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
- COMM – Commercial and Sport Fishing: Uses of water for commercial or recreational collection of fish, shellfish, or other organisms, including, but not limited to, uses involving organisms intended for human consumption or bait purposes.
- GWR – Groundwater Recharge: Uses of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting saltwater intrusion into freshwater aquifers.
- REC-1 – Water Contact Recreation: Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, whitewater activities, fishing, and uses of natural hot springs.
- REC-2 – Non-Contact Water Recreation: Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where water ingestion is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
- WARM – Warm Freshwater Habitat: Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
- WILD – Wildlife Habitat: Uses of waters that support wildlife habitats, including, but not limited to, the preservation and enhancement of vegetation and prey species used by wildlife, such as waterfowl.

The Basin Plan contains water quality objectives that are either numerical or narrative to maintain water quality within the region. Numerical water quality objectives are standards for pollutant concentrations, physical/chemical conditions of the water, and toxicity of the water to aquatic organisms. However, narrative objectives are general descriptions of water quality that must be attained through pollutant control and watershed management. There are both numerical and narrative water quality objectives for the reservoirs in Alameda County.

2.2.2.2 California Toxics Rule

The California Toxics Rule (CTR) was promulgated by the U.S. Environmental Protection Agency in 2000 (EPA 2000). The CTR specifies water quality standards for toxic constituents for inland surface waters of California.[1] Regulated surface waters with public water supply and aquatic life beneficial use designations are subject to the CTR standards. Water quality standards in the CTR for freshwater and saltwater are based on one of the following:

- Criterion maximum concentration (CMC): the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time (1 hour) without deleterious effects.
- Criterion continuous concentration (CCC): the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects.

In other words, the CMC standards are for the protection of aquatic life from *acute* effects and the CCC standards are for the protection of aquatic life from *chronic* effects. In addition, the CTR includes standards for the consumption of water and organisms. These standards are based on *chronic* effects.

CTR receiving water standards for the protection of aquatic habitat include standards for dissolved metals, cyanide, pentachlorophenol, polychlorinated biphenyls (PCBs), and chlorinated pesticides. CTR standards for the protection of human health (consumption of water plus organisms) include standards for dissolved metals, cyanide, asbestos, dioxins and furans, volatile organic compounds, acid-extractable compounds, base neutral compounds, PCBs, chlorinated pesticides, and DBPs. Typically FAT will reduce the majority of these compounds to compliant levels, however, there are two disinfection byproducts that have very strict limits that may require special consideration during design. The two constituents are bromodichloromethane with a limit of 0.56 µg/L and dibromochloromethane with a limit of 0.41 µg/L. Additionally, the CTR has a limit of 0.69 ng/L for NDMA. This limit is currently below the achievable detection limit for NDMA, so interaction with the RWQCB will be required to ensure compliance with this standard.

In 2000, the State Board adopted the State Implementation Policy (SIP) which provided standardized guidance to the Regional Boards for regulating discharges of toxic substance to receiving waters.[2] The SIP provides guidance to the Regional Boards for implementing the CTR receiving water standards in NPDES effluent limits while considering and designating receiving water mixing zones and dilution credits.

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[1] CTR standards are established within Title 40, Section 131.38 (40 CFR 131.38) of the *Code of Federal Regulations*.

[2] Procedures for CTR implementation are established by the State Board in *Policy for the Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SIP) (State Board 2000).

2.2.2.3 Other Criteria

There are other environmental criteria or requirements that must be considered when pursuing a SWA project. This includes the Thermal Plan, chlorine residual requirements, and the Antidegradation Policy.

The Thermal Plan is the State of California's Water Quality Control Plan for the Control of Temperature in Coastal and Interstate Waters and Enclosed Bays and Estuaries of California and was adopted by the State Board in 1971 and revised in 1972 and 1975. As the name implies, the Thermal Plan specifies standards for the temperature of discharges to state waters. The key provisions for inland surface water include:

- Thermal waste discharges having a maximum temperature greater than 2.8°C above the natural receiving water temperature are prohibited.
- Elevated temperature wastes shall not cause the temperature of warm interstate waters to increase by more than 2.8°C above natural temperature at any time or place.

For SWA projects, this is an important consideration due to the higher temperatures of wastewaters.

The EPA has established criteria for chlorine residual concentrations to protect freshwater aquatic life. This includes the following:

- CMC value of 19 µg/L
- CCC value of 11 µg/L

These criteria for chlorine residual are lower than the sensitivity of many chlorine analyzers, therefore, non-detect values from a chlorine analyzer are typically considered to be sufficient to satisfy these requirements. Dechlorination must occur prior to discharge to a reservoir for any SWA project that utilizes free chlorination in the pipeline to the reservoir.

California also has a policy on antidegradation that requires that high-quality waters are maintained. The policy applies to all state waters. The policy states:

> *Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial uses of such water and will not result in water quality less than that prescribed in the policies.*

All SWA projects will require an evaluation of the reservoir's initial water quality prior to project implementation to ensure the new purified water does not degrade the quality of the reservoir.

3. DIRECT POTABLE REUSE

Unlike IPR projects, which rely on an environmental buffer to further improve purified water quality and provide additional time to respond to water quality issues, DPR projects reduce or eliminate the environmental buffer to create closer connections between the treatment and consumption of purified water. Generally, as the forms of reuse become more direct, the regulations have required higher levels of treatment to compensate for the protections that are lost by the water spending less time in the environment.

While the deadline for the final DPR regulations is not until the end of 2023, DDW released two drafts of proposed DPR criteria in March and August 2021 (SWRCB 2021). Additionally, as mandated by Assembly Bill 574, the State Board is engaging an Expert Panel to determine whether the draft DPR criteria are protective of public health. The State DPR Expert Panel held several meetings between August 2021 and February 2022 to review the draft DPR criteria and provided their findings to DDW in March 2022. On June 22, 2022, DDW published their response to the Expert Panel's findings with proposed revisions to the August 2021 version of the draft criteria (SWRCB 2022). On July 21, 2023, the State Board released the final draft DPR regulations to begin the formal rulemaking process (SWRCB 2023). While the draft criteria are not final, they confirm that DPR will include additional requirements above and beyond what is required in IPR.

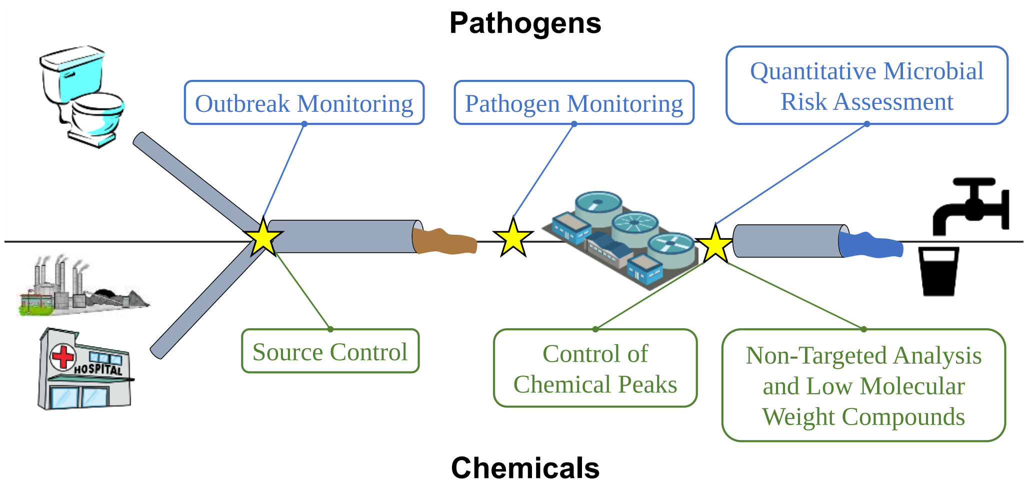
The RWA form of DPR is differentiated from TWA based on whether a project is providing a raw source water upstream of a surface water treatment plant (RWA) or a finished water directly into a public water system's distribution system (TWA). RWA also encompasses projects that provide raw source water into a reservoir that cannot meet the SWA requirements or into a groundwater aquifer that cannot meet the GWR requirements. While the draft regulations do not explicitly call out separate criteria for RWA and TWA, several sections have been modified to account for the different protections provided by the two forms of DPR.

The following sections provide an overview of the research supporting DPR regulatory development followed by a description of the four major categories of the current draft criteria including the latest revisions from DDW: a) pathogen control, b) chemical control, c) monitoring and control, and d) technical, managerial, and financial (TMF) capacity.

3.1 DPR Research

Because of the industry's lack of experience with DPR, six priority research topics were identified to further address knowledge gaps. All of these issues relate to the control of the two main public health threats: microbial pathogens and toxic chemicals (Figure 3-1). The pathogen research included three topics: developing additional information on the (1) typical and (2) outbreak concentrations of pathogens present in raw wastewater, as well as (3) the use of quantitative microbial risk assessment (QMRA) to determine the level of treatment needed to control those risks. The chemical research included three topics: (1) the need for enhanced source control, (2) an evaluation of strategies to control peaks of chemical contaminants, and (3) the use of non-targeted analysis to identify unknown contaminants or those more likely to pass through advanced treatment (low molecular weight compounds). While these topics are the key knowledge gaps driving research, the State has also provided perspective on the broader challenges of DPR in their DPR Regulatory Framework documents.

Figure 3-1– Six DPR research topics identified by the State expert panel



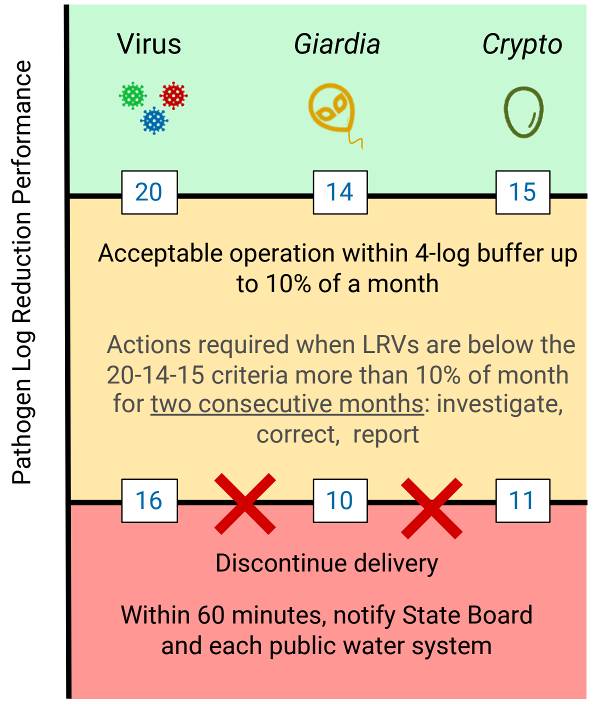
3.2 Pathogen Control

The two groups of contaminants that must be controlled to protect public health are pathogens and toxic chemicals. Of the two, pathogens can cause a public health impact (such as an infection or illness) after a single exposure. To prevent this acute effect, potable water systems need to reliably provide consistent levels of treatment.

While the draft criteria include the same three pathogens for DPR as IPR—enteric virus[1], *Giardia*, and *Cryptosporidium*—DPR requires significantly higher log reduction requirements. DPR systems must provide no less than 20/14/15 $\log_{10}$ reduction of virus / *Giardia* / *Cryptosporidium* (V/G/C), respectively, with an allowance to drop as low as 16/10/11 for up to 10% of the time in a month. Any drop in treatment below 16/10/11 for any period of time requires immediate diversion and notification to the State Water Board within 60 minutes (Figure 3-2). Based on DDW's calculations, 16/10/11 is the minimum pathogen reduction needed for public health protection. The additional 4 logs to achieve 20/14/15 serve as beneficial redundancy to mitigate the impact of failure events (State Water Resources Control Board 2021a).

[1] Whereas DDW used enterovirus to establish the enteric virus log reduction values (LRVs) for IPR, they used norovirus as the reference pathogen for the draft DPR criteria.

Figure 3-2. Summary of Pathogen Requirements in Draft DPR Criteria



Like IPR, the DPR criteria were based on maintaining risk below minimum thresholds. Rather than using the annual risk goal of 10^{-4} infections per person per year, DDW used a daily risk goal of $2.7x10^{-7}$ infections per person per day. The rationale for this switch was that it ensures more consistent treatment performance since individual days with poorer performance (and higher risk) cannot be buffered out with additional days of better performance.

The treatment train must use at least four processes that each achieve no less than 1 log of pathogen control for each pathogen. Furthermore, processes must provide three mechanisms of control for *each* pathogen: UV disinfection, membrane physical removal, and chemical inactivation. All credited processes will be required to undergo a validation study and the performance of each must be linked to an online surrogate monitoring framework. For many unit processes—particularly advanced treatment processes—the requirement for validation and monitoring will be straightforward since existing monitoring and crediting frameworks exist for disinfection (e.g., UV, chlorine, O_3) and membrane processes (e.g., MBR, MF, and RO). One challenge will be for projects seeking to credit upstream wastewater treatment plants or RWA projects seeking credit for downstream surface (or other drinking) water treatment plants. The default 4/3/2 credits from surface water treatment plants in compliance with the Surface Water Treatment Rule will not automatically be granted and additional validation studies will be required. Modifications in the 2023 final draft also include pathogen crediting for the use of non-treatment barriers including reservoirs, groundwater aquifers, and blending. A summary of the pathogen control requirements is presented in Table 3-1.

Table 3-1 – Proposed requirements for pathogen control in the draft DPR criteria

Criteria	Requirement
Minimum pathogen log redundancy for virus / *Giardia / Cryptosporidium*	16/10/11
Level of redundancy in addition to minimum requirements	4-log_{10}
Total log reduction requirements with redundancy	20/14/15
Allowable variability in treatment train performance	From 20/14/15 down to 16/10/11 for up to 10% of the time in a month
Response triggers	• Immediate diversion if pathogen treatment falls below 16/10/11 • If treatment is <u>above</u> 16/10/11 but less than 20/14/15 for more than 10% of the month on two consecutive months, project must evaluate cause, take corrective action, and report to State Board
Unit process requirements	• At least 4 processes providing no less than 1-log pathogen control • Three different mechanisms of control including UV disinfection, membrane physical separation, and chemical inactivation
Validation and monitoring	• All processes must be validated • Performance must be linked to a surrogate that is monitored continuously

3.3 Chemical Control

As the lack of an environmental buffer drove the need for additional *pathogen* control, it also drives the need for additional chemical control in DPR. Compared to IPR, DPR has a reduction in the following benefits due to the lack of environmental buffers:

- Dispersion and mixing: as pulses of off-spec water travel through the aquifer or mix with other waters in the aquifer or reservoir, any peaks of chemicals become attenuated. Tracer studies completed for both GWR and SWA projects provide quantitative evidence of this important mechanism of chemical peak attenuation (City of San Diego 2019, Clark et al. 2014).

- Chemical attenuation: in the environment, multiple mechanisms for attenuation of chemicals are possible including adsorption, oxidation/reduction reactions, photolysis, and biodegradation (Amy and Drewes 2007, NRC 2012, Trussell et al. 2018).

The State Board conducted research to understand how to address two principal chemical challenges: (a) chemical peaks that enter a potable reuse train, and (b) unknown, low-molecular weight compounds that may pass through full advanced treatment (FAT) trains. Using information from these research topics, the draft criteria rely on multiple elements to protect against toxic chemicals including treatment, mixing, blending, monitoring, and source control enhancements (State Water Resources Control Board 2021b).

For treatment, the draft DPR criteria require two additional processes—ozone (O_3) and biological activated carbon (BAC)—as pre-treatment ahead of RO and UV/AOP. Design and performance criteria for the O_3 and the BAC processes include the use of a) an O_3 to total organic carbon (TOC) ratio of greater than 1:1 to control O_3 dosing and b) a BAC empty bed contact time (EBCT) of at least 15 minutes. Furthermore, the O_3 process must demonstrate one-log reduction of two indicator compounds—1) carbamazepine and 2) sulfamethoxazole—and the BAC process must demonstrate one-log reduction of additional indicators—1) formaldehyde, and 2) acetone. Projects may also propose alternatives to the 1:1 O_3:TOC ratio and 15-minute EBCT if they can demonstrate 1-log reductions of the relevant indicator compounds.

The criteria also impose new, stricter response levels in the RO permeate based on TOC thresholds. The maximum effluent TOC remains at 0.5 mg/L (in line with IPR requirements), but have additional intermediate triggers at 0.1, 0.15, and 0.25 mg/L that are intended to detect issues related to reduced RO performance and the entrance of chemical peaks. While not explicit in the draft criteria, meeting low TOC levels will likely require several barriers to organics including a) a secondary process providing biological nutrient removal, b) O_3/BAC for additional transformation and reduction of TOC, and finally c) RO using high-rejection brackish water membranes. While the default TOC critical limit is 0.5 mg/L, projects that include blending of purified effluents with other approved water sources may propose a higher critical limit. In such cases, projects must determine the wastewater contribution, which is the percentage of purified water in the blended water, and then calculate the critical limit, which is equal to 0.5 mg/L divided by the wastewater contribution. For example, a project that blends purified water in a 1:1 ratio with another source of water would have a wastewater contribution of 0.5, and the resulting TOC critical limit would be 0.5 mg/L divided by 0.5, or 1 mg/L.

Beyond treatment, projects must demonstrate sufficient dispersion (i.e., longitudinal mixing) within the system to reduce a one-hour peak of chemicals by a factor of ten. The draft criteria also include new requirements for continuous monitoring of chemicals of acute concern (e.g., nitrite and nitrate) in the finished water prior to entry into the distribution system. For chemicals of chronic concern, the draft DPR criteria require an enhancement in the scope, frequency, and number of monitoring locations compared to IPR.

The criteria also significantly expand requirements for source control. This includes the need for an early warning system for source water monitoring, public notifications, and community outbreak surveillance, the use of local limits for public health protection, and a multi-stakeholder source control committee. An independent body must audit these elements of the source control program and provide a written report every five years. A summary of the chemical control requirements is presented in Table 3-2.

Table 3-2. Requirements for Chemical Control in the Draft DPR Criteria

Criteria	Requirement
Treatment train requirements	Train must include: • O_3/BAC pre-treatment • RO

	• UV/AOP
O_3/BAC performance and design criteria	• O_3:TOC ratio > 1:1 and BAC EBCT ≧ 15 minutes or an approved alternative • Demonstrate 1-log reduction of carbamazepine and sulfamethoxazole through O_3 • Demonstrate 1-log reduction of formaldehyde and acetone through BAC
RO and UV/AOP performance and design criteria	• Design and performance criteria equivalent to IPR requirements • New operational triggers at TOC of 0.1, 0.15, and 0.25 mg/L
Longitudinal mixing	• Sufficient longitudinal mixing for 10-fold reduction of 1-hour peak
Monitoring	• Continuous monitoring of nitrate/nitrite; weekly monitoring of perchlorate and lead • Chronic contaminant monitoring increased in scope of chemicals, frequency of measurements, and number of locations
Source control	• Early warning system including online source water monitoring • Expansion of local limits to include contaminants of public health concern • Source control committee and continuous improvement process

3.4 Monitoring and Control

The passage of water through the environment provides retention time, which is a key benefit of IPR projects. Failures and other water quality excursions can be detected and addressed throughout this retention time. As long as the period the water spends in the environment is longer than the period to identify and address a failure, this approach is feasible. In DPR settings—particularly TWA—the proximity between treatment and consumption can reduce response times by multiple orders of magnitude (i.e., from months to hours). New approaches for addressing this steep reduction in failure response time are needed for DPR.

One of the key technical challenges for DPR will be developing new monitoring and control systems that can rapidly integrate performance data and respond to off-spec events. This will be particularly necessary for TWA systems that have minimal time (e.g., minutes to hours) between treatment and consumption. Though IPR systems use continuous monitoring of unit treatment processes, much of the data integration and evaluation occurs over longer periods. This approach has sufficed for IPR since systems provide retention times in the environment. Since TWA is characterized by a lack of significant retention time, monitoring and control will need significant enhancements. The goal of Water Research Foundation project 4954, "Integration of High-Frequency Performance Data for Microbial and Chemical Compounds in Potable Reuse Treatment Systems," is to develop and test a data analytics system that provides rapid integration and response to performance data. Such monitoring and control systems will likely be essential elements of future DPR systems.

While the draft DPR criteria do not explicitly reference this challenge, they provide clarity on the requirements for response time and how it will be calculated. A response time calculation will be required for each unit process that provides pathogen or chemical control to the point of diversion. DPR systems must also ensure they can divert or respond to treatment or water quality issues before 10% of the water has passed through the system, i.e., the response time must be less than t_{10} to the diversion point. The system must discontinue delivery in response to reduced pathogen control, but also exceedances of acute chemical contaminants (nitrate, nitrite, and TOC). A summary of the monitoring and control requirements is presented in Table 3-3.

Table 3-1. Requirements for monitoring and control in draft DPR criteria

Topic	Requirement
Response time	• t_{10} must be calculated from each unit process to a downstream diversion point • Must demonstrate system response time is < t_{10} to diversion point
Immediate diversion triggers	• Pathogen LRV < 16/10/11 • Nitrate or nitrite > Maximum Contaminant Level • TOC > 0.5 mg/L or alternative critical TOC limit

3.5 Technical, Managerial, and Financial (TMF) Capacity

The 1996 federal Safe Drinking Water Act requires states to incorporate TMF capacity into public water system operations. In response to this requirement, California enacted Section 116540 of the Health and Safety Code, which states:

> *"No public water system that was not in existence on January 1, 1998, shall be granted a permit unless the system demonstrates to the DDW that the water supplier possesses adequate financial, managerial and technical capability to assure the delivery of pure, wholesome, and potable drinking water. This section shall also apply to any change of ownership of a public water system that occurs after January 1, 1998."*

DDW expressed that the TMF requirements for DPR would be more restrictive than for IPR in their Proposed Framework for Regulating Potable Reuse:

> *"The technical, managerial, and financial (TMF) capacity required to build, maintain, monitor, and operate a potable reuse project increases with the complexity and sophistication of the system required. The complexity and sophistication is a function of the number and types of treatment processes, monitoring methods, and control points. These increase as the type of potable reuse goes from IPR to DPR." (State Water Resources Control Board 2019)*

The TMF capacity requirements in the draft DPR criteria extend to all agencies participating in the project's Joint Plan, from wastewater collection, treatment, monitoring, and distribution. The criteria specify several requirements for TMF, operator certification, and staffing requirements as shown in Table **3-2** 3-4.

Table 3-2. Requirements for TMF in draft DPR criteria

Topic	Requirement

Engineering Report (§64669.30)	Must include new topics beyond typical Engineering Report requirements: • Description of facilities, staffing, and support services • Cost estimate and funding sources for capital replacement, O&M, energy costs, personnel costs, and 20-year life cycle costs • Description of management and accounting resources
Operator Certification and Staffing (§64669.35)	• T5 chief operator and T3 shift operator overseeing entire DPR treatment train • Advanced Water Treatment Operation (AWT) Certification 5 requirement for chief operators and AWT3 for shift operators for any facility providing chemical control • 24/7 onsite staffing for chief and shift operator for any facility providing pathogen and/or chemical control

4. EXAMPLES OF CURRENT DPR PROJECTS AND LESSONS-LEARNED

There are currently multiple DPR projects at various stages of planning in California. One conclusion that can be drawn is that multiple elements may contribute to public health protection in DPR, such as treatment, monitoring, storage, and blending. Metropolitan Water District (MWD), for example, is evaluating an RWA project that would provide significant (i.e., 10-fold or greater) blending with other imported and local source waters. Under most other scenarios, it would not be feasible for agencies to blend 50 MGD of purified water with >450 MGD of other water. This high degree of blending provides a public health benefit that may allow MWD to reduce the stringency of other requirements, such as treatment. The regulations should allow for the fact that public health protection may be the result of the *balancing* of many different elements.

Similarly, the City of San Diego is evaluating an RWA project for Phase 2 of their Pure Water Program. The Phase 2 project would discharge purified water into Murray Reservoir before surface water treatment at the Alvarado Water Treatment Plant. While this reservoir would not meet the criteria of the SWA regulations, it would provide a substantial 20-day retention time that can provide significant degrees of dilution and contaminant peak attenuation. As with MWD, the public health benefits of this element (i.e., the environmental buffer) may allow San Diego to decrease the rigor of other public health elements, such as the stringency of automated shutdowns.

Even though there are only a few DPR projects in planning, it is clear that multiple approaches to public health protection may be pursued. A one-size-fits-all approach to the regulations would not allow for the nuances that have already been observed in the existing projects. If and how the regulations develop to account for these differences remains undetermined.

5. POTABLE REUSE SUMMARY

The five potable reuse approaches described in the sections above are differentiated by the degree of physical and/or temporal separation between the treatment and ultimate consumption of purified water. Of the five forms of potable reuse, three forms are classified as IPR and two as DPR. IPR projects utilize groundwater aquifers or surface water reservoirs as environmental buffers to increase the physical and temporal separation between treatment and consumers. DPR projects will reduce or completely bypass the use of an environmental buffer. As the protections afforded by the environment decrease, DPR systems will likely need to compensate by including additional treatment and management barriers.

Another differentiating factor between the potable reuse approaches is the level of *regulatory certainty* associated with each approach. In California, GWR and SWA projects have the greatest *regulatory certainty* due to the existence of final, adopted regulations for these approaches. In addition to *regulatory certainty,* GWR projects also have multiple *precedents* in California, having produced water in the State for nearly 60 years. While there are currently no operating SWA projects in the State, the City of San Diego received the State's first SWA permit for the North City Pure Water Project in 2020. This precedent is expected to help future SWA projects by providing greater regulatory clarity on the permitting requirements for SWA. While discharging into Quarry Lakes is not considered a form of SWA, some environmental discharge requirements associated with SWA projects could apply to this recharge approach. Because the Quarry Lakes are classified as a body of water with beneficial uses and are not standard spreading basins, recharging the groundwater aquifer using these Quarry Lakes may be an unprecedented application. Consequently, it may require additional discussions with the Regional Board and East Bay Regional Park District to determine appropriate environmental discharge requirements for the project.

In contrast, regulations have not yet been developed for RWA and TWA projects in California, meaning that neither *regulatory certainty* nor *precedents* exist for these approaches. As a result, developing an RWA or TWA project would require more extensive permitting efforts and may require additional studies to demonstrate the project's ability to protect both public and environmental health.

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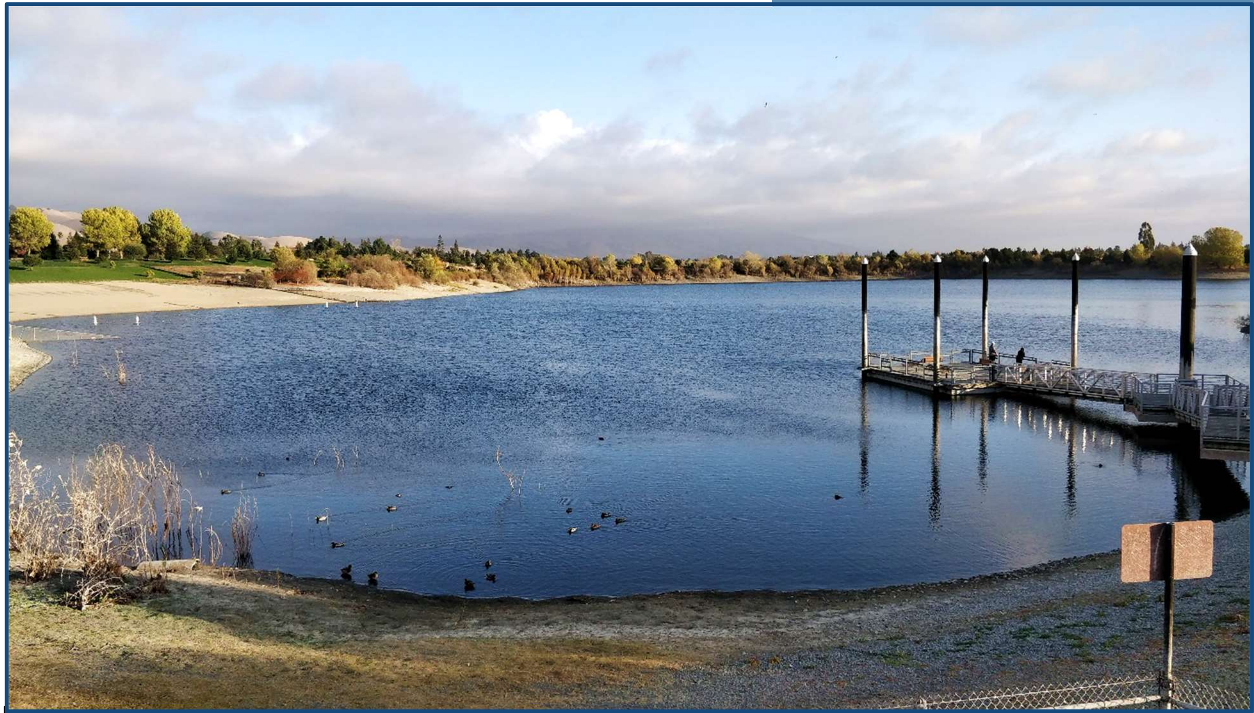
APPENDIX B: LIMNOLOGICAL REPORT



Task 4 – Water Quality Feasibility Report

Quarry Lakes

Purified Water Feasibility Study

Prepared for:
Woodard and Curran

January 8, 2021

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617 S. Olive Street, Suite 1000
Los Angeles, CA 90014
213.282.4440
www.limno.com

Task 4 – Water Quality Feasibility Report

Quarry Lakes

Purified Water Feasibility Study

Prepared for:

Woodard and Curran

January 8, 2021

Prepared by:
Steve Skripnik, PE
Dave Dilks, PhD
Dendy Lofton, PhD, CLM
Justin Ibershoff, PE
Derek Schlea, PE

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1 Project Summary

Alameda County Water District (ACWD), in conjunction with the San Francisco Public Utilities Commission and Union Sanitary District, is considering a plan to incorporate purified water (advanced treated recycled water) from the Union Sanitary District's Alvarado Wastewater Treatment Plant as a water source for the Quarry Lakes system, which in turn will infiltrate for indirect potable reuse (IPR).

The purpose of this task is to follow up on a number of issues identified by ACWD and Union Sanitary District (USD), in coordination with East Bay Regional Park District (EBRPD), regarding IPR implementation. Specifically, this task addresses the effect of new source water on aquatic ecosystems at Quarry Lakes Regional Park. Quarry Lakes Regional Park is a partnership between ACWD and EBRPD, where water supply uses are managed by ACWD and recreational and wildlife uses are managed by EBRPD. The purpose of this report is to evaluate the high-level feasibility of establishing a purified water discharge at Quarry Lakes, using data available at this time, and pending planned monitoring as described in the Sampling and Monitoring Plan. An overview map of Quarry Lakes is shown in Figure 1-1.

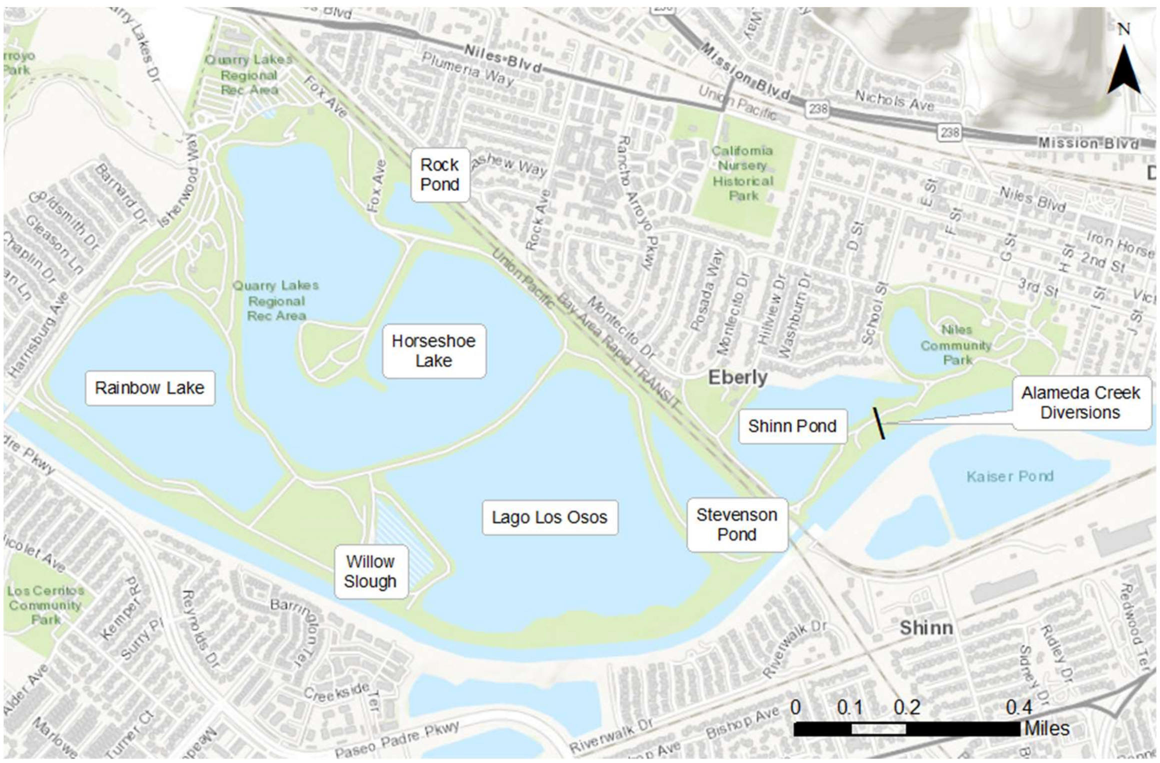

Figure 1-1. Quarry Lakes Map.

A screening level approach was used to evaluate the general feasibility of considering a surface water discharge at Quarry Lakes for the surface discharge project, the recommended project from the 2015/2016 Recycled Water Feasibility Study. Limited data and the preliminary state of this alternative require a high-level, order of magnitude evaluation of the feasibility of the project.

This report is a summary of findings related to Task 4 of the Purified Water Feasibility Evaluation for Quarry Lakes, specifically the results and findings related to three activities:

- Development of a screening-level water quality model (Subtask 4.4)
- Evaluation of on-site natural treatment options (Subtask 4.5)

- Development of a Sampling and Monitoring Plan (Subtask 4.2), included as **Appendix A**

First, a screening-level water quality model was developed to evaluate the water quality response of Quarry Lakes to the introduction of a purified water discharge. Given that the projected maximum total phosphorus (TP) concentration in the purified water is expected to be 0.04 mg/l, model results indicate the purified water discharge will improve water quality in terms of phosphorus (and by extension, chlorophyll *a*). The discharge through Rock Pond results in maintenance of current Horseshoe Lake water quality for discharge concentrations up to 0.09 mg/l. Details of this analysis are contained in Section 2 of this report. It should be noted that this is a screening-level model subject to limitations described in Section 2 and further modeling (supported by additional data) may be required to draw further conclusions.

Second, an evaluation of on-site natural treatment was completed to determine the effectiveness and feasibility of additional natural treatment regarding nutrients. Because the water quality modeling analysis determined that the proposed discharge water quality would improve water quality in the lakes, there would not be a need for additional on-site natural treatment to further decrease nutrient loads to Quarry Lakes, should future nutrient monitoring be consistent with the limited past nutrient data. Should future discharge water quality projections differ, the analysis of potential on-site natural treatment calculated the expected level of phosphorus reduction given a range of influent TP concentrations and flow rates. Using established empirical models, achieving a TP reduction of 25% (0.04 mg/l to 0.03 mg/l) at the proposed flow rate of 4 MGD would require a well-maintained treatment wetland exceeding 40 acres. A full range of results are discussed in Section 3.

Third, a Sampling and Monitoring Plan was developed to provide a roadmap for collecting adequate water quality data to meet the goals and needs of evaluating the proposed discharge's impact on lake water quality and general maintenance and improvement of lake quality. In order to establish a baseline to evaluate the potential impacts of the advanced treated effluent on the existing water quality of the Quarry Lakes, a recent comprehensive dataset is required. If additional assessment is required to support a permit for the discharge, this data can then be used to support a eutrophication model that can be used to evaluate in higher detail the water quality effects of a new Quarry Lakes water source. The Sampling and Monitoring Plan addresses the following goals:

1. Characterize water quality in Quarry Lakes to a level of understanding suitable for constraining a eutrophication model of the system.
2. Understand the time-variable water quality within the backwater of the impounded Alameda Creek, during diversion periods.
3. Provide recommendations for a long-term, ongoing water quality monitoring program to ensure that the water quality of the Quarry Lakes supports beneficial uses.

The Sampling and Monitoring Plan is included as an appendix to this report.

2 Water Quality Model

Summary

LimnoTech applied the U.S. Army Corps of Engineers BATHTUB water quality model to evaluate the water quality response of Horseshoe Lake to the introduction of a purified water discharge. We conducted model simulations over a range of assumed purified water effluent phosphorus concentrations. Results indicate that effluent phosphorus concentrations lower than 0.06 mg/l will improve water quality in Horseshoe Lake relative to current conditions for effluent discharged directly into the lake. We also examined a scenario where the purified water was discharged to Rock Pond, allowing it to serve as a *de facto* settling basin prior to it being delivered to Horseshoe Lake. BATHTUB model results indicate that discharge of effluent phosphorus concentrations lower than 0.09 mg/l to Rock Pond will improve water quality in Horseshoe Lake.

Given that the projected maximum total phosphorus concentration in the purified water is expected to be 0.04 mg/l, model results indicate that the purified water discharge will improve water quality in terms of phosphorus (and by extension, chlorophyll *a*). This result can be intuitively confirmed without use of a model. Given that the purified water is being used to supplement water being added to the lakes from Alameda Creek, there will be a net water quality benefit as long as the phosphorus concentration in the purified water is less than the phosphorus concentration in water from Alameda Creek.

This section specifically addresses work performed under Subtask 4.4 of the Purified Water Feasibility Study.

This chapter describes the above analyses, and is divided into sections of:

- Model Theory and Assumptions
- Model Inputs
- Application to Model Scenarios
- Conclusions

Model Theory and Assumptions

The modeling software BATHTUB (Version 6.1) was selected to link phosphorus loads with in-lake water quality. BATHTUB was developed for the U.S. Army Corps of Engineers (Walker, 2006) and has been used successfully in many lake studies throughout the United States. BATHTUB is a steady state water quality model designed for application to lakes and reservoirs. The program formulates steady-state water and nutrient mass balances accounting for nutrient sedimentation. BATHTUB also provides the capacity to predict eutrophication-related parameters chlorophyll *a*, secchi depth, and hypolimnetic oxygen depletion rate via literature-based empirical correlations to predicted nutrient concentrations. The limited historical observed water quality data for Quarry Lakes lends itself to using a literature-based empirical model, such as BATHTUB.

This application of BATHTUB relies on two assumptions:

- Phosphorus is the water quality parameter of primary concern, and
- Simulations conducted solely on Horseshoe Lake and Rock Pond are protective to the Quarry Lakes as a whole.

Phosphorus is the sole water quality parameter being investigated at this point, for three reasons. First, it is the only relevant water quality parameter for which Quarry Lakes water quality data exist, such that model predictions for other parameters would be extremely speculative. Second, preliminary indications are that phosphorus will be the limiting nutrient controlling algal growth, meaning that algal growth will not be sensitive to changes in nitrogen. The expected nitrogen:phosphorus ratio in the proposed purified water effluent ranges from 29 to 66, a level that is highly indicative of phosphorus limitation. Third, the model is currently being applied to examine relative water quality impacts, i.e. defining the maximum effluent nutrient concentration that will maintain existing water quality. Given that predicted chlorophyll *a* concentrations in BATHTUB increase monotonically as a function of in-lake phosphorus concentration, and a scenario that maintains (or decreases) in-lake phosphorus concentration will maintain (or decrease) in-lake chlorophyll *a* concentrations.

Water quality impacts related to other parameters are unlikely unless the pH of the RO water significantly deviates from neutral. Alkalinity is recommended to be monitored and evaluated as documented in the Sampling and Monitoring Plan (Appendix A) , which will document the buffering capacity of the lakes in anticipation of any significant pH variations.

The second assumption is that simulations conducted on Horseshoe Lake and Rock Pond (i.e. excluding explicit consideration of the other lakes) are protective to the Quarry Lakes as a whole. The Quarry Lakes are hydraulically connected, so some movement of water is expected between lakes. Our BATHTUB model does not consider these connections, beyond the connection between Rock Pond and Horseshoe Lake for the scenario considering discharge to Rock Pond. This assumption will be protective for purposes of examining Horseshoe Lake, as it assumes all nutrient loads delivered to the lake remain in that lake and ignores the dilution affect that will occur when Horseshoe Lake water mixes with the other lakes. In addition, this approach is protective of the other lakes insofar that if water quality in Horseshoe Lake is maintained (or improved), water quality in other lakes will also be maintained.

Model Inputs

The BATHTUB model requires inputs for:

- Model Options
- Global Variables
- Reservoir Geometry
- External Loads

Model Options

BATHTUB provides a multitude of model options to estimate nutrient and nutrient response concentrations in a reservoir. The Canfield and Bachmann (1981) method was used to describe phosphorus settling. As discussed above, the model options for total nitrogen and chlorophyll *a* were set to “Not Simulated”.

Global Variables

The global variables required by BATHTUB consist of:

- The averaging period for the analysis
- Precipitation, evaporation, and change in lake levels
- Atmospheric phosphorus loads

BATHTUB is a steady state model, whose predictions represent concentrations averaged over some period of time. For lakes with residence times less than a year, specification of the length of time over which inputs and outputs should be averaged is an important consideration. This was not an issue for Horseshoe

Lake and Rock Pond, both of which have residence times of several years. Therefore, the averaging period used for this analysis was set to represent average annual conditions.

Precipitation inputs were taken from the Union City station of the California Irrigation Management Information System (CIMIS) and correspond to a value of 420 mm/year for both Horseshoe Lake and Rock Pond. Evaporation rates were also set at 420 mm/year for both lakes to maintain a hydraulic balance. Atmospheric phosphorus loads were specified at the default BATHTUB value of 30 mg-P/m^2/yr for both lakes.

Reservoir Geometry

BATHTUB requires that the surface area and water depth be specified. These values were calculated from available bathymetry data for both lakes and shown in Table 2-1. While more detailed bathymetry data is available for Horseshoe Lake and Rock Pond, this level of detail is appropriate for the application of this model.

Table 2-1. Specified Geometry for Horseshoe Lake and Rock Pond

	Horseshoe Lake	Rock Pond
Surface Area, km^2	0.46	0.023
Mean Depth, m	10.8	6.8

External Loads

External loads were specified in terms of rate of inflow, and flow-weighted average TP concentrations. Inflow volume to Horseshoe Lake was set equal to the calculated percolation loss rate of 12 cfs, providing for a balance with the percolation rates of Horseshoe Lake, Rock Pond, and Rainbow Lake. Because of the lack of data for total phosphorus concentration in Alameda Creek, flow-weighted average total phosphorus concentrations were back-calculated using the BATHTUB model. Specifically, BATHTUB was run iteratively using different flow-weighted average total phosphorus concentrations as model input, until the input concentration was found that resulted in model predictions matching the observed in-lake phosphorus concentration. An in-lake concentration of 0.032 mg/l was calculated from the five total phosphorus samples available from Horseshoe Lake, treating the non-detects at the detection limit of 0.020 mg/L (Table 2-2)

Table 2-2. Total Phosphorus Sample Results for Horseshoe Lake

Date	TP Result, mg/L
5/16/2012	<0.020
12/12/2012	0.064
11/5/2013	<0.020
5/16/2012	<0.020
11/5/2013	0.035
Average	**0.032**

The BATHTUB results indicate that an inflow concentration of 0.06 mg/l to Horseshoe Lake is required to provide an in-lake concentration of 0.032 mg/l. This calculated inflow concentration compares well to observed phosphorus concentration in Lago Los Osos, which has a median observed phosphorus concentration of 0.067 mg/l.

Application to Model Scenarios

The model was applied to consider two different types of scenarios:

1. Discharge to Horseshoe Lake
2. Discharge to Rock Pond, allowing it to serve as a *de facto* settling basin prior to it being delivered to Horseshoe Lake

Inputs and results for each scenario are discussed below.

Discharge to Horseshoe Lake

The first scenario, considering a purified water discharge to Horseshoe Lake, required three changes to model inputs. First an additional external load was created representing the discharge. The external load was calculated based on preliminary purified water discharge water quality projections shown in Figure 2-1.

Constituent	Secondary Effluent WQ [1]	ROP WQ	
		Best-Case Scenario	Worst-Case Scenario
NH_3 (mg/L as N)	2.5	0.2 [2]	0.2 [2]
NO_3^- (mg/L as N)	12	0.64 [3]	2.4 [3]
NO_2^- (mg/L as N)	0.5	0.03	
Total Phosphorus (mg/L as P)	3 to 4	0.03 - 0.04	
Ortho-PO_4^{3-} (mg/L as P)	3	0.03	

[1] Secondary Effluent Data from Table 7-7 of USD's Secondary Treatment Process Improvements Final Report (Hazen, 2019).

[2] Listed ROP value is the modeled ammonia concentration; however, we anticipate that ammonia would be removed by breakpointing prior to discharge to the lakes.

[3] Nitrate rejection by RO decreases with increasing membrane age. A new membrane rejects nitrate at about 95% (0.64 mg/L as N). Membranes are typically replaced when the performance degrades, corresponding to a drop in nitrate rejection to around 80%(2.4 mg/L as N).

Figure 2-1: Projected Purified Water Discharge Water Quality (Source: Trussell Technologies, Inc.) (ROP = Reverse Osmosis Product Water)

The discharge rate was set at the specified design flow of 4 MGD. Second, a range of possible discharge TP concentrations from 0.030 to 0.100 mg/L were modeled. Finally, the assumed external flow from Alameda Creek was reduced by 4 MGD to maintain a hydraulic balance. These BATHTUB-predicted in-lake concentrations for each of the effluent concentrations examined is shown in Table 2-3.

While the model evaluation was limited to evaluating a discharge rate of 4 MGD, high discharge rates and non-displacement of Alameda Creek flow would both make future effluent limits more stringent, but likely only slightly more.

Table 2-3. BATHTUB Model Results for Discharge to Horseshoe Lake

Effluent TP, mg/L	Horseshoe Lake TP, mg/L
0.030	0.024
0.040	0.027
0.050	0.029
0.060	0.032
0.070	0.034
0.080	0.036

0.090	0.038
0.100	0.040

Discharge to Rock Pond

The second scenario considered a purified water discharge to Rock Pond, allowing it to serve as a *de facto* settling basin prior to it being delivered to Horseshoe Lake. The BATHTUB model was run sequentially in this scenario, 1) simulating the total phosphorus concentration in Rock Pond, and 2) routing the discharge into Horseshoe Lake at the phosphorus concentration predicted for Rock Pond. The BATHTUB-predicted TP concentrations in Horseshoe Lake for each of the effluent concentrations examined is shown in Table 2-4.

Table 2-4. BATHTUB Model Results for Discharge to Rock Pond

Effluent TP, mg/L	Horseshoe Lake TP, mg/L
0.030	0.023
0.040	0.025
0.050	0.027
0.060	0.028
0.070	0.029
0.080	0.031
0.090	0.032
0.100	0.033

Conclusions

The results in Table 2-3 indicate that effluent phosphorus concentrations of 0.06 mg/l will maintain water quality in Horseshoe Lake relative to current conditions for effluent discharged directly into the lake. Furthermore, effluent TP concentrations lower than 0.06 mg/l will improve water quality in Horseshoe Lake. As shown in Table 2-4, routing the discharge through Rock Pond results in maintenance of current Horseshoe Lake water quality for discharge concentrations up to 0.09 mg/l. Given that the projected maximum total phosphorus concentration in the purified water is expected to be 0.040 mg/l, model results indicate that the purified water discharge will improve water quality in terms of phosphorus (and by extension, chlorophyll *a*).

This finding of expected water quality improvement can be achieved independent of the BATHTUB model application. Given that the purified water is being used to supplement water being added to the lakes from Alameda Creek, there will be a net water quality benefit as long as the phosphorus concentration in the purified water is less than the phosphorus concentration it is replacing. Phosphorus concentrations in Lago Los Osos (which is “upstream” of Horseshoe Lake) in on the order of 0.067 mg/l, so purified water discharges less than this concentration can be reasonably assumed to improve water quality.

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3 On-site Natural Treatment Options

Summary

LimnoTech conducted a screening level assessment on the use of on-site natural treatment options for additional treatment of phosphorus, focusing on treatment wetlands for improving purified water phosphorus concentrations for potential future discharge to Quarry Lakes. Other in-lake treatment options such as alum application, aeration, dredging, etc. are highly dependent on in-lake water quality conditions which are not well characterized at this time and therefore were not considered in this analysis. Any selection of future treatment options should be based on an evaluation of the complete range of monitoring data proposed in the short-term monitoring plan (Appendix A). The assessment included examination of key design factors influencing phosphorus concentration reductions achieved by wetlands, phosphorus removal estimates based on empirical models, and operation and maintenance considerations.

Our initial order-of-magnitude estimates suggest a 40 acre wetland would be needed to achieve a phosphorus concentration reduction of 25% (assuming a 4 MGD inflow at 0.040 mg-P/l, the design parameters provided for the proposed discharge). Alternative wetland sizes, design flows, and treatment objectives are also presented below to provide an understanding of the range of possible treatment and space required for treatment.

This section specifically addresses work performed under Subtask 4.5 of the Purified Water Feasibility Study.

Key Design Factors

Important design factors influencing phosphorus removal by natural wetland include the phosphorus concentration of water flowing into the wetland (C_i), the surface area of the wetland (A), and the rate of water flowing into the wetland (Q). The rate of water flowing into the wetland and the wetland surface area combine to form an important factor for treatment wetlands, the hydraulic loading rate (HLR = Q/A). A first-order model developed by Kadlec and Knight (1996) uses these factors, as well as a removal rate constant (k_A), and background concentration (C^*). Removal rate constants, which are expressed as long-term, average annual removal, are a simplified method used to account for various other design factors influencing phosphorus removal including wetland vegetation, substrate characteristics, and flow-type (i.e., surface flow or subsurface flow).

Two recent review papers investigating hundreds of treatment wetlands from around the world both reported similar findings regarding the correlation between both the inflow concentration and HLR on wetland phosphorus removal. Treatment wetlands typically more efficiently remove phosphorus when inflow concentrations are relatively high, and vice-versa; removal rates are typically lower when the inflow concentration is relatively low (Kadlec 2016; Land et al. 2016). Phosphorus concentration reductions achieved by wetlands are typically inversely proportional to the HLR. As HLR increases (i.e., more inflow volume per unit area), the phosphorus concentration reduction decreases (Kadlec 2016; Land et al. 2016). The majority of HLRs reported by Kadlec (2016) for 37 large constructed wetlands were less than 5 cm/day. The median HLR was 1.0 in/day for the large wetlands (>99 acres) and 1.3 cm/day for 87 small wetlands (0.61 to 82 acres) included in the review paper (Kadlec 2016).

To illustrate the order of magnitude of wetland surface area that would be needed for the Quarry Lakes site to achieve similar HLRs as those reported in the literature, we developed the curves shown in Figure

3-1. For example, if an HLR of 5 cm/day were desired for an inflow rate of 4 MGD, then a wetland surface area of 75 acres would be needed.

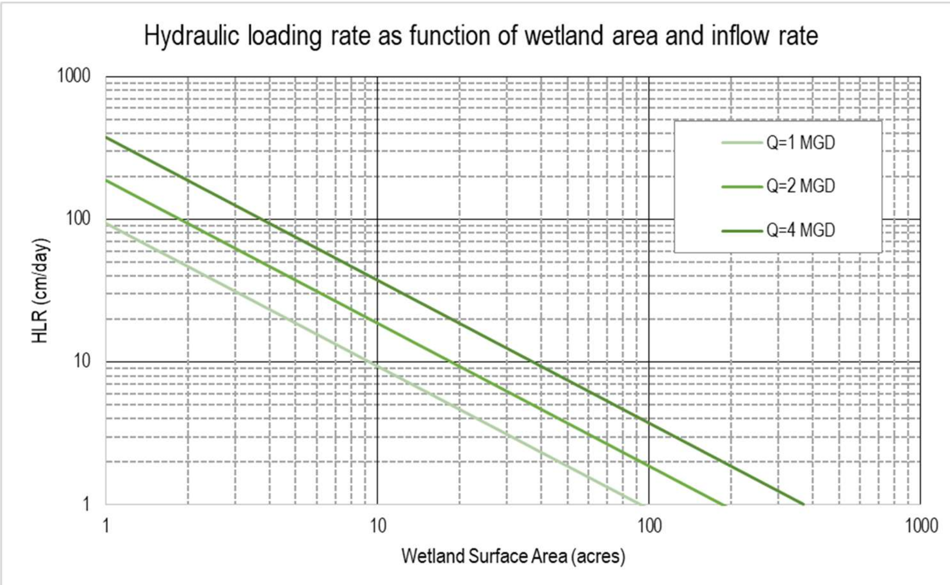

Figure 3-1: Relationship between HLR and wetland surface area for three different wetland inflow rates.

Phosphorus Reduction Estimates

Mitsch and Jørgensen (2004) summarize various methods for estimating pollutant removal by treatment wetlands, including the above-mentioned Kadlec and Knight (1996) first-order empirical model. Although these simple methods can be applied to various other pollutants, here we focused on phosphorus assuming that algal growth in Quarry Lakes is primarily phosphorus-limited. We demonstrated two simple methods for computing wetland effluent concentrations (C_o) as a function of influent concentration and HLR. As mentioned previously, the first, more commonly used empirical model also includes use of removal rate constant and background concentration.

Model #1: $C_o = (C_i - C^*) * \exp(-k_A / HLR) + C^*$

Model #2: $C_o = 0.195 * C_i^{0.91} * HLR^{0.53}$

To illustrate potential phosphorus concentration reductions at the Quarry Lakes site as a function of HLR, we developed the curves shown in Figure 3-2, which assume an inflow concentration of 0.040 mg/l and a background concentration of 0.006 mg/l. Although there is considerable variability in removal rate constants reported in the literature for individual wetland studies, we found relatively consistent median values reported by Mitsch and Jørgensen (2004) at 12 m/year and Kadlec (2016), which reported median removal values of 12.3 m/year and 14.6 m/year for small and large wetlands, respectively. The analysis in Figure 3-2 includes one curve of an assumed k_A of 12 m/year, and curves for 50% higher and 50% lower assumed k_A (i.e., 6 and 18 m/year). At relatively high HLRs, there is less spread in the concentration reductions than at low HLRs, where the assumed k_A matters more. Both models suggest that in order to achieve concentration reductions of 50% or more, relatively low HLRs are needed (i.e., 5 cm/day or lower).

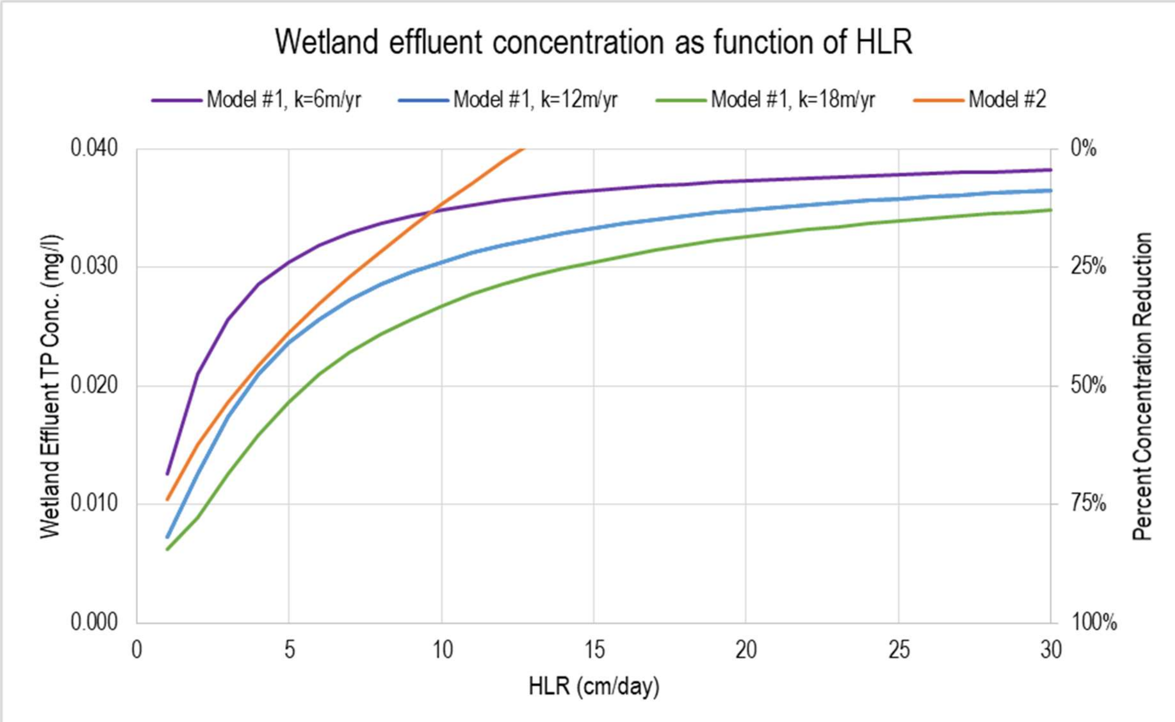

Figure 3-2: Wetland effluent concentrations as a function of HLR predicted by two different empirical models, assuming a TP influent concentration of 0.040 mg/l.

Wetland Sizing for Quarry Lakes

Using the first-order empirical model described by Kadlec and Knight (1996) and assuming a removal rate constant of 12 m/year and background concentration of 0.006 mg/l, we developed a screening-level matrix of potential wetland surface areas needed at the Quarry Lakes site for three independent input variables: the inflow concentration (i.e., the purified water effluent phosphorus concentration), the desired outflow concentration leaving the wetland (also expressed as a percent reduction), and the inflow rate. Table 3-1 shows the results of this analysis. For a relatively modest concentration reduction of 25%, approximately 10-40 acres of wetland surface area would be needed for inflow rates of 1-4 MGD. For a larger concentration reduction of 75%, approximately 50-250 acres of wetland surface area would be needed for the same inflow rates.

Inflow rates exceeding 4 MGD were not explicitly calculated. Rates exceeding 4 MGD will result in larger required wetland surface area needed holding other variables constant.

Table 3-1: Potential wetland surface areas needed as a function of inflow concentration, desired outflow concentration, and inflow rate.

Inflow TP Conc. (mg/l)	Outflow TP Conc. (mg/l)	Reduction	Wetland Surface Area Needed (acres) Inflow = 1 MGD	Inflow = 2 MGD	Inflow = 4 MGD
0.040	0.030	25%	10	20	40
	0.020	50%	25	50	101
	0.010	75%	61	122	244
0.060	0.045	25%	9	19	37
	0.030	50%	23	46	92
	0.015	75%	51	102	204
0.080	0.060	25%	9	18	36
	0.040	50%	22	44	89
	0.020	75%	47	95	189

Operation and Maintenance Considerations

As alluded to previously, the empirical model used to estimate wetland phosphorus removal performance simplifies many complex factors into a single removal rate constant. In reality, wetland removal rates change in space and time (Kadlec 2016). Some studies have suggested that the ability of treatment wetlands to continually remove phosphorus diminishes as the wetland ages, though there are relatively fewer long-term research sites (Kadlec 2016; Land et al. 2016). For example, the wetland soils may become saturated with phosphorus and will no longer have the ability to adsorb soluble phosphorus from the inflow. In order to ensure that the treatment wetland continues to function as intended for the long-term, both routine operation and maintenance activities as well as "enhanced" activities targeted at maintaining optimal phosphorus removal will likely be required. Some of the following activities may be applicable at the potential Quarry Lakes site:

- Routine operation and maintenance
  - Manage wetland and transitional vegetation
  - Weed and invasive species control
  - Mosquito and nuisance wildlife control
  - Maintain pumping system
  - Removal of trash and debris
  - Inspection and periodic repair of various structural elements
- Enhanced operation and maintenance
  - Maintain desired HLR via pumping and/or water level control
  - Perform period vegetation harvest
  - Removal of accumulated sediments and organic matter
  - Monitor phosphorus sorption capacity and perform periodic soil amendments

Observations and Conclusions

Empirical models based on case studies show that an HLR of less than 10 cm/day is required to achieve TP reductions of greater than 25%. The area of wetland treatment necessary to achieve this reduction, at TP concentrations and flow rates that are proposed for the future discharge (TP = 0.04 mg/l and 4 MGD flow) would require wetland areas exceeding 40 acres. Wetland treatment is most space-efficient when treating TP concentrations orders of magnitude greater than those proposed here at flow rates lower than proposed. As described above, total wetland area and the ongoing operation and maintenance of that area grow significantly as TP concentrations approach zero and flow rates increase.

There may be little need for additional on-site natural nutrient treatment beyond the proposed in-plant purified water treatment. This observation is limited at this point due to minimal existing in-lake nutrient data. This high-level analysis shows that the area required for meaningful nutrient reductions may exceed the area available on-site at the Quarry Lakes facility.

Following additional nutrient monitoring as proposed in the Sampling and Monitoring Plan, the utility of implementing natural treatment should be reevaluated.

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Appendix A: Sampling and Monitoring Plan

617 S. Olive Street, Suite 1000
Los Angeles, CA 90014
213.282.4440
www.limno.com

Memorandum

From:	Dendy Lofton, PhD Justin Ibershoff, PE Steve Skripnik, PE	**Date:**	January 8, 2021,
		Project:	Purified Water Sampling and Monitoring Plan
To:	Carrie Del Boccio, PE, Woodard and Curran Click here to enter text.		

SUBJECT: Task 4 – Quarry Lakes Water Quality Sampling and Monitoring Plan

Overview and Purpose

Alameda County Water District, in conjunction with the San Francisco Public Utilities Commission and Union Sanitary District, is considering a plan to incorporate purified water (advanced treated recycled water) from the Union Sanitary District Alvarado Wastewater Treatment Plant as a water source for the Quarry Lakes system, which in turn will infiltrate for indirect potable reuse. The San Francisco Bay Basin Plan lists the Quarry Lakes (as Alameda Creek Quarry Ponds) with beneficial uses including fishing, cold and warm freshwater habitat, contact and non-contact recreation, terrestrial wildlife habitat and groundwater recharge. Any change to the quality of water sources entering the Quarry Lakes needs to be evaluated for impacts to these beneficial uses. To conduct this evaluation, a comprehensive dataset for the Quarry Lakes and the Alameda Creek diversion water needs to be collected at a high spatial and temporal frequency. Therefore, the purpose of this memorandum is to describe a comprehensive monitoring program that can support a thorough evaluation of the potential new discharge on existing water quality in the Quarry Lakes system.

Existing data characterizing the Quarry Lakes has been reviewed, but recent water quality data for the system is sparse and generally insufficient for supporting an evaluation of the potential impacts on water quality. Hydrology and geography components of a CE-QUAL-W2 water quality model was developed, but further development was placed on hold pending the collection of additional water quality data. Historically, water quality sampling within the Quarry Lakes has typically involved bacteria sampling near the swimming beach, cyanobacteria, occasional surface sonde measurements, and temperature and dissolved oxygen vertical profiles and algae speciation from the 1990s and 1970s. In order to establish a baseline to evaluate the potential impacts of the advanced treated effluent on the existing water quality of the Quarry Lakes, a recent comprehensive dataset is required. If additional assessment is required to support a permit for the discharge, this data can then be used to support a eutrophication model that can be used to evaluate the water quality effects of a new Quarry Lakes water source.

This memorandum describes a water quality monitoring plan with several goals:

1. Characterize water quality in Quarry Lakes to a level of understanding suitable for constraining a eutrophication model of the system.

2. Understand the time-variable water quality diverted in Quarry Lakes from Alameda Creek.
3. Provide recommendations for a long-term, ongoing water quality monitoring program to ensure that the water quality of the Quarry Lakes supports beneficial uses.

This plan is limited to lakes below the Hayward Fault, located hydraulically between the Alameda Creek diversion and the Horseshoe Lake swimming area. Understanding the water quality in these areas is important to understanding the drivers for protecting beneficial uses such as fishing and swimming in the system as they relate to the proposed purified water discharge.

Expected outcomes from implementation of this monitoring plan will include:

- a comprehensive dataset that will be used to evaluate the impacts of a potential purified water discharge into the Quarry Lakes system
- characterization of the temporal changes in water quality of impounded Alameda Creek during diversion periods and opportunities to enhance water quality through modified diversion timing
- data to drive development of a long-term monitoring program that will enable diagnostic detection of acute water quality changes and assessment of whether the lakes are supporting their beneficial uses.

This memorandum details this information by describing a Short-term Lake Characterization Monitoring Program and a Long-term Routine Monitoring Program.

Short-term Lake Characterization Monitoring Program

The short-term sampling program includes collection of data from all of the Quarry Lakes and from incoming diversion water from Alameda Creek (Figure 1). Details of the recommended monitoring plan are described below and are divided into discussion of water quality within Quarry Lakes and water quality of the diversion from Alameda Creek.

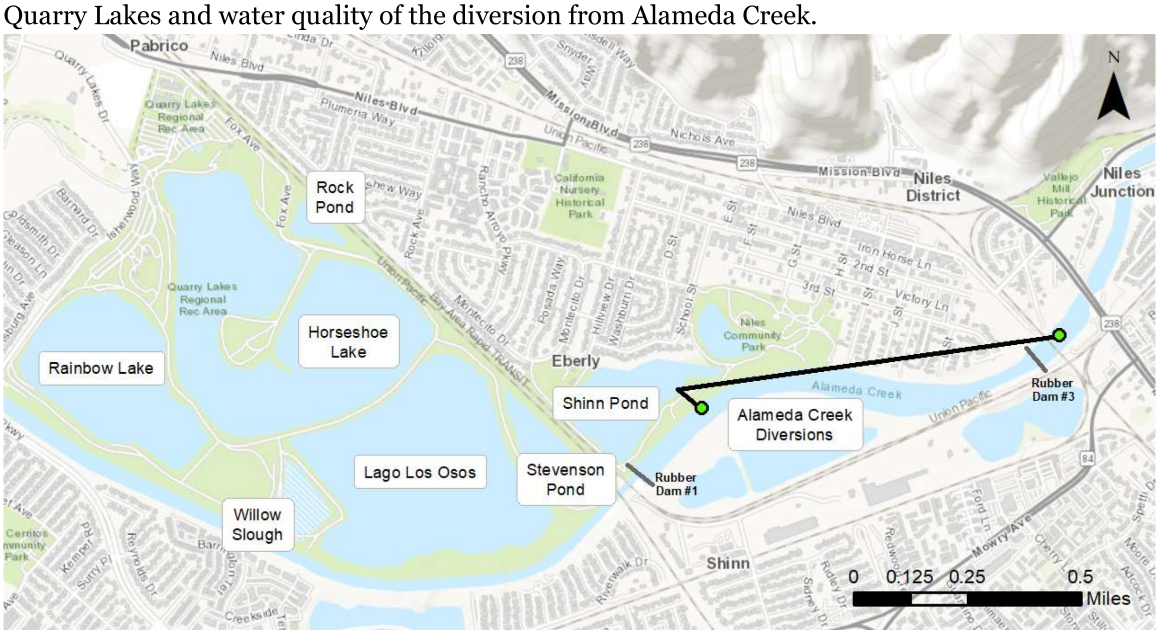


Figure 1. Quarry Lakes Map.

Quarry Lakes

Each lake in the system should be sampled at the depth and frequency specified in Table 1. Samples should be collected from a location near the maximum lake depth determined from the lake bathymetry (Figure 2). If the maximum depth occurs in more than one location in a lake, then the zone with the larger water volume representing that depth is recommended for sampling. GPS coordinates of these locations should be recorded, and locations established as long-term sampling stations for ongoing water quality monitoring and assessment (discussed in more detail below).

Table 1. Quarry Lakes Sampling Depths and Frequency.

<table>
<tr><th>Sampling Location</th><th>Field Sonde Measurement Depth</th><th>Grab Sample Depth</th><th>Frequency</th></tr>
<tr><td>Horseshoe Lake Northwest Basin (Pit G)</td><td rowspan="8">1-m intervals*</td><td rowspan="8">Two depths:

1) Epilimnion @ 0.5-1 m from the surface

2) Hypolimnion @ 1-2 m from the sediment surface*</td><td rowspan="8">May through November: Every two weeks

December through April: Once per month</td></tr>
<tr><td>Horseshoe Lake Southeast Basin (Pit G)</td></tr>
<tr><td>Lago Los Osos (Pit S)</td></tr>
<tr><td>Stevenson Pond (Pit A)</td></tr>
<tr><td>Shinn Pond</td></tr>
<tr><td>Rainbow Lake (Pit O)</td></tr>
<tr><td>Rock Pond (Pit J)</td></tr>
<tr><td>Willow Slough</td></tr>
</table>

*Avoid disturbance of bottom sediments during sample collection and measurement.

Field measurements and grab samples should be collected from each sampling station in each sampling event. Where possible, field sonde measurements and grab samples should be collected simultaneously from opposite sides of the boat to minimize interference among depth intervals. Alternatively, field sonde measurements should be collected prior to grab samples since these measurements are collected at smaller depth intervals than the grab samples. Field sonde measurements should be collected at 1-meter vertical intervals at each sampling location. Grab samples should be collected from the epilimnion (0.5 to 1.0 meter below the water surface) and the hypolimnion (1.0 to 2.0 meters above the sediment surface). Care should be exercised to avoid sediment disturbance from the sonde or the water sampling device when sampling in the hypolimnetic bottom waters. A handheld sonar depth finder can be quite valuable for navigating to the desired depths and avoiding sediment disturbance during sample collection. The parameters for laboratory analysis of the grab samples are listed in Table 2, along with the rationale for each parameter in terms of modeling needs.

Water quality monitoring in the Quarry Lakes is recommended to occur every two weeks during the extended algae growing season (May through November) and once per month outside of the growing season (December through April). Surface water samples and hypolimnetic samples should be collected with a Van Dorn Sampler or similar water sample collection device that will collect a discrete water sample.

Depending on the protocols implemented at the laboratory, some of the parameters listed in Table 2 may need to be filtered in the field to avoid microbial transformation of constituents in the sample bottles (e.g., dissolved nutrients and carbon) which can cause inaccurate reporting.

We recommend consultation with the processing laboratory prior to sampling to ensure that field sampling protocols are in alignment with laboratory procedures.

Figure 2. Bathymetry map for the Quarry Lakes.

Table 2. Quarry Lakes Water Quality Parameters and Modeling Rationale.

Method	Parameter	Modeling Rationale
Grab Samples	Chlorophyll-a	Provides an indicator of algal abundance; provides a calibration target for the model.
	Total Phosphorus as P	Calibration target for representing sum of organic and inorganic P state variables, representing the phosphorus nutrient cycle.
	Orthophosphate as P	Nutrient required for algal growth and calibration target representing inorganic P state variable.
	Total Nitrogen as N	Calibration target for representing sum of organic and inorganic N state variables.
	Nitrate + Nitrite as N	Nutrient form that can be utilized for algal growth and calibration target representing a model state variable.
	Ammonia + Ammonium as N	Nutrient form that can be utilized for algal growth and calibration target representing a model state variable.
	Total Kjeldahl Nitrogen (TKN)	Allows organic N to be determined (TKN minus ammonia) for use as a calibration target in representing the nitrogen cycle.
	Total Suspended Solids	State variable needed to represent how sunlight, needed for algal growth, penetrates through the water column.
	Total organic carbon	Measures sum of dissolved and particulate carbon and supports calibration representation of the carbon cycle.
	Dissolved organic carbon	Needed to represent the carbon cycle and oxygen-demanding degradation of organic matter.
	Alkalinity	Measure the buffering capacity of the lakes.
Field Sonde Measurements	Temperature	State variable and calibration target needed to represent algal and nutrient cycle temperature-dependent processes, as well as effect of temperature on dissolved oxygen saturation in the water column.
	Dissolved Oxygen	State variable and calibration target of primary regulatory interest.
	pH	Common field measurement that may not be used by the model.
	Specific Conductivity	Common field measurement that may be used in the modeling effort as a tracer state variable, depending on availability of supporting data.
	Turbidity	Common field measurement that may be used in the modeling effort to inform how light extinction is represented.
Other Field Measurement	Secchi disk depth	Not a model parameter, but is a measurement of water transparency.

Alameda Creek Diversion

Alameda Creek is the primary surface water source for Quarry Lakes during the ephemeral flow period, which is typically January through March each year. An inflatable dam downstream of the diversion creates an impoundment during periods of diversion. Past operations have allowed the first flush, the first rain event of the wet season, to pass the inflatable dam, except under extremely dry conditions. The surface runoff contains pollutants, including nutrients, that have been accumulating over the summer dry period and likely contains higher concentrations of nutrients relative to conditions following first flush. This may be supporting excess algal growth in both Alameda Creek and Quarry Lakes.

In order to evaluate the optimal conditions for Alameda Creek flow diversion into the Quarry Lakes, the temporal variability of the water quality of the Alameda Creek diversion water should be monitored. These monitoring suggestions will establish a baseline characterization of the water quality entering the Quarry Lakes system from Alameda Creek.

Water diverted to Quarry Lakes from Alameda Creek will be sampled upstream of the RD1 and RD3 pools, at a location that remains temporally consistent given changes in diversion location.. Parameters to be monitored are listed in Table 3 below along with the rationale for collecting the data and recommended frequency of collection. It is assumed that flow is metered at this location. The combination of flow rate and nutrient concentration can be used to calculate nutrient loads (mass/time) contributed to Quarry Lakes from Alameda Creek.

Table 3. Alameda Creek Diversion Water Quality Parameters and Rationale.

Method	Frequency	Parameter	Rationale
Grab Samples	When diverting: Every two weeks	Total Phosphorus as P	Represents the total pool of phosphorus.
		Orthophosphate as P	Represents soluble reactive fraction that is most readily available for algal uptake.
	Also: Immediately following first runoff event after summer dry period or as close to beginning of diversion period as possible	Total Nitrogen as N	Represents the total pool of nitrogen.
		Nitrate + Nitrite as N	Represents the dissolved inorganic fractions of nitrogen that are most readily available for algal uptake.
		Ammonia + Ammonium as N	
		Total Organic Carbon	Represents the total organic carbon in the system, which impacts many biogeochemical processes including consumption of oxygen during decomposition.

Water quality sampling at the Alameda Creek Diversion site is proposed to occur every two weeks during the January to March period, when diversion rates are highest. This will help to quantify the nutrient loads entering the Quarry Lakes and form a more complete understanding of the variable water quality in Alameda Creek. Sampling is proposed to occur monthly during the April to December period or the period that the inflatable dams are activated.. Additionally, one separate sampling event should occur during the first runoff event after each summer dry period in order to characterize the first flush nutrient loads entering the Quarry Lakes. Grab samples should be collected using an appropriate hand-held sampling device (e.g. dip sampler).

Short-term Sampling Duration

Short-term sampling of the Quarry Lakes and the Alameda Creek Diversion water should be monitoring as described above for a minimum of one year. If the proposed purified water discharge effluent limits are lower than that of Alameda Creek (as measured through one full year of monitoring data), then a eutrophication model may not be needed to demonstrate that the purified water discharge will not degrade existing water quality. In the latter case, the data analysis may be sufficient to support a permit for the new discharge without utilization of a model (pending regulatory approval). If the proposed purified water discharge limits are greater than that nutrient load from Alameda Creek, a eutrophication model will likely be needed to demonstrate water quality impacts of the discharge in support of a permit. Consequently, a second year of a data would be recommended to calibrate a model that meets regulatory requirements.

Early Conclusions from the Short-term Sampling

A partial dataset from October 2020 to June 2021 was provided as a preview of the one year short term sampling duration. The dataset includes:

- monthly depth profiles of Horseshoe Lake measuring temperature, DO, pH, conductivity, turbidity, Secchi Depth, and visual observations
- twice monthly samples at Alameda Creek Diversion measuring all parameters suggested in this sampling plan

Early conclusions and recommendations from the partial data set are:

- continue to expand monthly depth profiles to other lakes (see Table 2)
- TP concentrations from Alameda Creek Diversions are in the range of <0.02 to 0.82 mg/L which provides early confirmation that effluent TP concentrations (projected as 0.03-0.04 mg/L) are within the range of ambient TP concentrations; this should be confirmed with all seasonal variations. This indicates that a eutrophication model may not be needed since the effluent TP is lower than ambient TP concentrations.

Long-term Routine Monitoring Program

The short-term monitoring program described above is spatially and temporally comprehensive in order to achieve the specified diagnostic objectives. A long-term routine monitoring plan does not need to be as comprehensive since the primary objective is to monitor and assess whether the system is continuing to support beneficial uses over time.

The parameters listed in Table 4 should be included in a long-term routine monitoring program. However, through implementation of the short-term monitoring plan, considerable gains in understanding of the baseline water quality in the entire Quarry Lakes ecosystems will be achieved. As a result, the sampling locations (i.e. number of lakes, and within lake sites), depth and frequency of long-term routine monitoring can be guided by results of the short-term monitoring plan described above. One of the main goals of the short-term monitoring program is to establish an understanding of the spatial variability of water quality across the Quarry Lakes system, and the variability in water quality over time. Once the short-term monitoring program is completed, it may be determined that there is either very little variability or significant variability. The understanding gained by implementing the short-term monitoring program will be important to establish the spatial and temporal frequency of sampling for the long-term plan in a way that is meaningful but less taxing on staff resources. It is likely that the required sampling frequency and locations will decrease due to increased understanding of system hydrodynamics. Therefore, we recommend using the results of the short-term monitoring plan assessment to design an appropriate long-term routine monitoring program.

Table 4. Parameters for inclusion into a long-term monitoring program.

Method	Parameter	Locations, Depth and Frequency
Grab Samples	Chlorophyll-a	To be determined through assessment of the data collected in the short-term monitoring plan described above.
	Total Phosphorus as P	
	Orthophosphate as P	
	Total Nitrogen as N	
	Total Suspended Solids	
	Bacteria	
	Cyanotoxins	
Field Sonde Measurements	Temperature	
	Dissolved Oxygen	
	pH	
	Specific Conductivity	
	Turbidity	
Other Field Measurement	Secchi disk depth	

APPENDIX C: AGENCY SURVEY SUMMARY

No.	Question	Responses		
Public Outreach		**Orange County Water District**	**Monterey One Water**	**City of San Diego**
1	What types of potable reuse has your agency considered? What were your reasons for considering these types of reuse and not the others?	Groundwater augmentation, only. No other potable reuse options were considered since the District manages a large groundwater basin that can store water for extraction by retail water supply agencies. The District does not manage surface water supplies.	Groundwater augmentation (injection, surface spreading, and seawater intrusion barrier) only. Seawater intrusion barrier injection and surface spreading determined to be cost prohibitive.	Groundwater and surface water augmentation were considered for Phase 1 and GWR was ruled out because of the lack of groundwater basins to recharge into in the project vicinity. Raw water augmentation was not considered during Phase 1 but was considered for Phase 2; the timeline for regulations and the mandated RWQCB compliance deadline dictated a SWA strategy. The City may consider treated water augmentation once greater regulatory certainty for TWA is available in the future.
2	Was/is your community (or members of the public) supportive of potable reuse? Were/are policymakers supportive of potable reuse? In both cases, how was this support manifested? Have there been shifts in policymakers support for the project? How have you dealt with that?	Yes - community was/is generally supportive. Community opposition has not been organized. Yes - policymakers have been uniformly supportive. OCWD garnered letters and resolutions of support from various levels of government. Yes - There have been shifts in policymaker support. Initially the City of Anaheim Public Utilities expressed doubts about the GWRS. Concerns were addressed by OCWD staff and Board members in meetings with the City Public Utilities Commission.	Mixed - community was/is generally supportive. Project faced some public opposition. Mixed - policymakers were/are generally in favor of the project. To gain support, Board members, the Mayor, City council members, and County health staff and agency staff toured West Basin and Orange County projects. Tour groups visited the facilities in operation and drank purified water, which helped to facilitated acceptance. Yes - There have been shifts in policy maker support. Initially, project had strong support from all stakeholders and policymakers, including a private desalination provider. However, as the project pursued approval for future expansion, the expansion was categorized as an alternative to desalination. As a result, the Board decided in an 11-to-10 vote against certifying the supplemental EIR for the expansion project. The expansion project is not moving forward.	Community/public support in potable reuse has increased significantly since the City launched an education and outreach program in 2010. Based on research polling conducted by the San Diego County Water Authority (SDCWA), support for adding purified water to the local drinking water supply increased from 26 percent in 2004 to 73 percent in 2015, and it has stayed relatively high in the years since. Additionally, support has been seen from responses to brief surveys taken after demonstration facility tours, newspaper articles and community comments, from conversations at events, presentations, etc. and through various other metrics. Policymakers have also been supportive. Current and former Mayor have expressed their support, and the City Council has voted to approve reports and move forward with various steps to advance the program. Support has grown and some policymakers have helped to champion the program.
3	Do you have any champions or key advocates for the project? If so, who? How did these champions/advocates emerge? Were they identified by your staff and targeted for outreach or did they come forward organically? Was having this champion helpful in terms of gaining project support?	OCWD staff served as the main champions of the project. The communications director was the main project advocate during the planning and development. A Newport Beach physician and environmental activist was the main community champion. He had served on a key advisory panel for OCWD through the National Water Research Institute and became familiar with the District's commitment to water quality protection and expertise in operating advanced water purification facilities and water quality assurance laboratory. His confidence in OCWD and the District's ability and commitment to operate a safe project and monitor water quality to assure safety enabled him to influence many others to be supportive of the GWRS. He was identified by staff as an important voice for public support and was also helpful in building regulatory support for the project. He served on the GWRS Community Leadership Advisory Council (the CLAC) composed of business, minority, environmental, and scientific leaders. The CLAC consisted of 20 members who assisted in outreach efforts and third-party media relations activities. The 20 members were seen as advocates for the project.	Champions and key advocates include: -Public Water Now - group favored water supply in the region to be publicly owned so they preferred this project to the desalination option. -Surfrider Foundation - supportive and opposed to desalination -Land Watch - supportive because initial project delivered water to Salinas Valley. -Planning & Conservation League - support of both potable reuse and desalination projects. Potable reuse was shown to be faster, lower cost, and with a lower environmental impact. Champions and advocates were helpful because they were able to reach more of the community. Including letters of support also strengthened funding requests.	The Water Reliability Coalition (WRC), a local broad-based affiliation of environmental, consumer, business, labor, ratepayer and technical organizations, was formed in 2011 to support new local water supply and the advancement of Pure Water. The City has engaged with the WRC to provide information and updates throughout the process, and they have expressed support at Council meetings and in other forums. The City formed a Pure Water Working Group in 2014 that was made up of a variety of program stakeholders. Its members were provided presentations, tours, etc. about various aspects of the program and were empowered to be champions of the program. Additionally, various community leaders have voiced their support both individually and as a representative of their organization. Having these champions has been very important for building support. Quotes from the champions have been shared on the website and through social media, and logos from all the groups that support the program are included in a “supporters” slide at the end of community presentations. They have also spoke at Council meetings and other key hearings, etc. in favor of the program and have given the program more credibility in the community.
4	Were/are there opponents of your project? If yes, what were key concerns? How or where were those concerns expressed? At what point in the project progress were there concerns identified? Initial outreach efforts? Project approval? Have you been successful in alleviating opponents' concerns? If so how: changing design or providing additional information? If not, is there anything in retrospect, you would have done differently?	There were always individual opponents to the GWRS project, but never active organized opposition with key water quality concerns to address. Some percentage of the population never becomes comfortable with potable reuse as a concept. The City of Anaheim Public Utilities opposition mentioned above was expressed early in the project planning phase. The key concern appeared to be the potential impact of the project on the image of the Anaheim water supply, which is important partly because it is the water source for Disneyland. The concerns of the City were raised at public meetings but not in the media. The City's concerns were addressed through presentations and discussions with the City's own Public Utilities Commission. A key factor in alleviating concern was the decision by the OCWD/OCSD joint oversight committee that the GWRS project would produce only the highest quality of water for both surface spreading in Anaheim and injection in Fountain Valley and Huntington Beach. Because the water produced by the project was measurably better than all existing sources of recharge water for the groundwater basin, that addressed concerns.	Initial opposition was from a few individuals who wrote letters to local newspapers. Regulators responded by being more conservative in developing regulations for this project. Community groups were concerned with the image of purified water as "toilet water." To address concerns M1W conducted public outreach to some of the churches in the area and invited select members of the community to the demonstration facility to expand their understanding of the advanced water purification processes. Community members were given the opportunity to drink the purified water produced at the facility. Since this public outreach was conducted, community opposition comments have decreased. The demonstration facility has been very helpful in education and outreach. Major private and public agency opposition to the facility expansion has increased as opponents believe the project does not produce enough water whereas desalination could produce an unlimited supply. M1W has not been successful in alleviating these concerns and have not been able to gain approval for the expansion project.	There is individual opposition due to "yuck" factor, but no organized opposition. Main community opposition is from members who are concerned about the program infrastructure (pipelines) being constructed in their neighborhoods. These concerns have been expressed through social media, articles in local publications, comments at City Council, etc. These concerns started once the City completed the EIR process and shared the preferred project alignment. The City has alleviated some of the concerns by forming Community Working Groups in each of the communities that will be impacted by construction. The community members in these groups have been engaged to provide feedback and recommendations on construction planning and have expressed that they find participating to be valuable.

Public Outreach (continued)		Orange County Water District	Monterey One Water	City of San Diego
5	What types of community outreach and communication with the public did you do or are you doing? What did you do that you felt was successful or worked well? What did you do that was not successful? At what point in the planning process did you begin public outreach? Did you conduct focus groups to develop your communication plan? If so, how was input from these focus groups used? Did you adjust your approach for specific audiences (e.g. elderly, multi-cultural, etc.)	Community outreach began 10 years before the GWRS came on line, during the planning phase of the project. Outreach has been mostly face to face via presentations to all types of community groups; medical, religious, environmental, business and service organizations. Efforts have been made to reach all ethnic and cultural groups and to address concerns of every demographic, including seniors, expectant mothers, and children. After facilities were constructed, tours of the facilities became an important outreach tool. Focus groups and surveys were used to determine what factors may be of concern to the community. Those feedback sources were used to identify what issues needed to be addressed in presentations. One of the most successful outreach methods was through mass media. After the New York Times ran a story about the GWRS, other media outlets became interested in the project, including National Geographic and other high profile outlets.	M1W's primary outreach tool is the demonstration facility. The facility was designed as a mini-version of the full-scale facility for outreach – wall/floor colors, photos, kitchen sinks, etc. Tours of the demo facility coupled with a pure water taste test allowed community members to see the equipment/water firsthand, better understand the treatment technologies, and have their questions answered on demand. Tours have been the key component of successful outreach. M1W also took their pre-tour presentation into the community, talking to as many community groups as possible (chambers of commerce, rotary clubs, homeowners' associations, etc.). M1W began public outreach during the Concept, Planning, and Permitting phase of the project. M1W utilized an outreach consultant (Data Instincts) who specializes in potable reuse. The company partnered with other industry professionals (Katz & Associates) to conduct focus group testing and M1W piggybacked on their research. The research and focus group testing informed M1W's outreach plan in terms of content (word choice, phrasing). The community's water supply was facing a significant court-ordered cutback, so M1W had the benefit of community members being relatively open to new solutions.	The education and outreach program includes a wide variety of outreach activities and tactics, including informational materials, tours of the demonstration facility, community event participation, speakers bureau presentations, social media, and youth and multicultural outreach. Facility tours have been particularly important to gain understanding and support for the program. The outreach program started at the beginning for the demonstration phase, even before the demonstration facility was constructed. In-depth interviews with project stakeholders and community leaders were used as the basis for the development of the communication plan.
6	What types of internal staff outreach and communication did you do or are you doing? What did you do that you felt was successful or worked well? What did you do that was not successful?	Regular presentations and discussions at OCWD staff meetings have helped make all staff feel like a part of the GWRS project. As a result all staff have been able to serve as ambassadors for OCWD and GWRS.	M1W would have liked to have completed more internal staff outreach and communication during the project. M1W offered demo facility and construction site tours for staff members, celebrated project milestones, and discussed the project during required all-staff meetings. However, staff were not uniformly informed about the project goals and drivers. M1W recommends working with any and all staff who have direct communication with customers (especially field staff who interact with the public and customer representatives) to ensure project buy-in and that they can answer basic project questions.	Internal communication has been an important part of the outreach program. This has included providing presentations at new employee onboardings, participating in the City's water academy staff training program and providing presentations for staff throughout the department, as well as including program milestones and other information in employee newsletters. Additionally, facility tours for staff have been offered regularly and that has worked particularly well in increasing understanding for the program among internal audiences. Interactive activities have been more successful than published informational materials.
7	How have you coordinated public outreach with other agencies involved in the project?	Outreach has been coordinated with partner agency, Orange County Sanitation District (OCSD). However it was recognized early on that OCWD should be the face of the project as a water supply project rather than a wastewater treatment or disposal project. Outreach has also been coordinated with retail water agencies that receive the groundwater recharged by GWRS and have seen water quality benefits. Both OCWD and OCSD are engaged in active outreach for the GWRS.	M1W handled the majority of the outreach. Project partners would occasionally present on the project from their angle of involvement – i.e., the water management company would share info on water supply and demand to help setup why potable reuse was needed.	The City has led its own public outreach program but has coordinated with the San Diego Water Authority (SDCWA) and other water utilities to share ideas for outreach and education. Some stakeholder agencies have partnered with the City at various times for events and community forums.
8	What is your public outreach budget? Did particular phases of the project involve more investment in public outreach than others? If so, which?	GWRS outreach has included five phases since 1997. -Phase 1 -Approximately 18 months and coincided with the development and approval of the project environmental impact report. -Phase 2 - Approximately 12 months and consisted of the development of a speaker's bureau and an outreach program. -Phase 3 - Phase 3 focused on an increase in public information efforts that included public workshops, polling, direct mail and media relations. Phase 3 budget was approximately $600,000. -Phase 4 - Phase four of the outreach lasted throughout the construction of the initial GWRS project and included a comprehensive outreach plan that included face-to-face presentations, acquiring letters of support, construction outreach, a robust media effort, new and revamped communications tools such as brochures, minority outreach, etc. Likely the most expensive outreach phase. -Phase 5 - Phase 5 started a few months prior to the project coming online when a positive article about the GWRS appeared in the New York Times. Phase 5 included enhanced branding, a robust tour program of the working plant, an active speakers bureau, water tastings, securing project and outreach awards, and passing legislation to bottle GWRS water. Active outreach is ongoing.	During design and construction, outreach costs were shared with the Monterey Peninsula Water Management District, the District that purchases water from M1W (75%/25%). However, M1W is now bringing all outreach efforts under the general M1W outreach budget. Because M1W invested early in the demo facility, they are planning for minimal fiscal resources for continued Pure Water Monterey outreach. M1W plans to do some educational videos for their website, continue tours of the demo facility, and host public presentations, as needed. M1W estimates they will spend about $30k over 2-3 years to further develop the potable reuse outreach materials now that the project is online (videos, new brochures, digital content). Future outreach costs will be minimal - staff time needed to design brochures, host tours, attend community events, etc. Project phases required varying levels of investment in public outreach. These phases included environmental/permitting work, certain elements of construction, and about 8 months before the project started injecting water. M1W made sure to be involved with any required environmental and regulatory processes that require public review. While technical staff presented technical project information, outreach staff helped to coordinate and translate technical concepts. Anything that involved the public included an outreach staff member. Injection well construction required 24/7 drilling. Extra outreach to neighboring communities was needed to support drilling, though almost no calls or complaints were received. At/near project complete, the number of tour requests and questions on the water quality greatly increased.	The City has invested in public outreach since the launch of the Water Purification Demonstration Project. As the Pure Water Program now enters construction, the tours, presentations and other activities are continuing. Currently, outreach activities are focused on construction relations.

Regulatory and Permitting Approaches		Orange County Water District	Monterey One Water	City of San Diego
9	What were/are DDW's key concerns regarding your project? What were/are the Regional Board's key concerns regarding your project?	At project conception, requirements for groundwater replenishment using recycled water were still in draft form with numerous revisions and versions. At that time groundwater recharge with recycled water was allowed by Title 22 and approved on a case-by-case basis. DDW's concerns focused on assuring that product water would be consistently high quality (safe, wholesome and potable). DDW has relied on rigorous source control, reliable treatment controlled through sophisticated SCADA, and comprehensive monitoring of water quality. AOP was added to the project after experience at Water Factory 21 with 1,4-dioxane. A commitment to 24 hour staffing added to confidence that OCWD could respond appropriately to any disturbance in performance. Regional Board concerns were largely addressed through satisfying DDW concerns, with a few exceptions. First, there were Regional Board concerns about emergency discharge to the Santa Ana River during peak flow periods when water would be subject to less thorough treatment (no RO) in order to provide storm flow relief to OCSD and protect the OCSD outfall from damage. As GWRS currently has sufficient capacity to provide peak flow relief to OCSD, though the capability and permit coverage is maintained for unforeseen contingencies as a part of the commitment to OCSD. The second Regional Board concern was assuring that the project's TDS and nitrate met Basin Plan Requirements at the time.	DDWs main concern was M1W's alternative source waters . When DDW was the Department of Public Health, they required GWR projects to have dilution water. It was proposed that M1W would use Blanco Drain or agricultural washwater. The plan was to construct 2 identical advanced water purification facilities (1 using the Blanco Drain/Ag Washwater as the sourcewater and the other using secondary effluent). The product water (after RO) from the Blanco Drain/Ag Washwater plant would be sent to the other AWPF to be used as dilution water. DDW and the public had no issues with this approach but as the project developed to only include the 1 AWPF and after DDW started receiving the public opposition letters, DDW did require additional testing. M1W conducted additional testing to examine how DDT and other constituents were removed through the AWPF to assuage their concerns. The results of the studies helped gain DDW approval for the project. DDW was also concerned with the project's underground travel time and virus crediting. Because of the opposition letters from a few members of the public, DDW did build in more conservatism to the regulatory requirements for this project. Gaining approval from the Regional Board was slowed by the public opposition letters. The Regional Board was mostly concerned about concerns from the Monterey Bay Sanctuary and NOAA would have.	The biggest challenge with DDW was permitting the project in the absence of finalized regulations. Most of the regulatory/permitting discussions occurred before the final SWA regulations were completed in 2018 and therefore, the project was not able to benefit from precedents set by other agencies. As a result of engaging with DDW early in the regulatory development process, the project influenced how DDW evaluated and approached SWA-specific issues. For example, original draft regulations would not have allowed for a 60-day reservoir retention time, which was ultimately permitted for Miramar Reservoir. Through parallel efforts with WateReuse, these discussions with DDW influenced SWA regulations which benefitted the project and also expanded options for future SWA projects.
10	Were there any concessions made in the project plans to facilitate regulatory approval? If so, what was the impact to the project? If faced with the decision again, would you make the same decision, or would you advocate more rigorously for your original plan?	One concession made to make approval easier was to commit to using only fully RO-AOP water for both injection and spreading. While the spreading of tertiary disinfected water was an option, it would have created more concerns and opposition/hurdles by regulators. The impact of the decision was a marginal increase in the cost of the water used for spreading. Most of the water would have required RO treatment to satisfy Regional Board TDS and nitrogen limits for the groundwater basin; the amount that could have received less treatment would have been less than 20 percent. That less treated water would likely have required an additional process (e.g., GAC) that would have complicated the overall operation. As a result, the net cost of providing uniform "FAT" quality for both injection and speeding was not significant. Furthermore, use of highly treated water for both applications helped to avoid environmental justice issues where some communities would receive better quality water and more benefit from the project. OCWD would make the same decision to go with 100% RO-AOP ("FAT") treatment for injection and spreading.	M1W did not have to make any major concessions to the project plans to facilitate regulatory approval.	When the Miramar Reservoir concept was first presented to DDW, draft regulations did not allow for projects that provided only 60 days in a reservoir. At that time, the cut-off between SWA and DPR was between four and six months. Since the project did not have defined treatment goals during testing and design, the concept was adapted to provide a high degree of treatment redundancy for both pathogens and chemicals. Without defined requirements from DDW, this approached allowed the project to proceed with greater confidence about the public health protectiveness of the system.
11	Based on your agency's experience with blazing the permitting path for potable reuse projects, what recommendations would you offer to an agency considering being the first to permit a raw water or treated water augmentation project in advance of the statewide regulations? What recommendations would you offer to other agencies to help navigate the permitting process for a potable reuse project?	Early and transparent discussions with regulators helped make the regulatory/permit development process more of a partnership. It also allowed regulators' concerns to be addressed early in the planning process. Early involvement of an independent expert advisory panel helped greatly, especially given the draft nature of the regulations at the time. Every project is unique, with different concerns. Even with the Title 22 regulations in place for groundwater recharge and surface water augmentation, there is a long schedule for DDW approval. Factoring in RWQCB concerns for Basin Plan compliance (e.g., salinity), securing a permit takes considerable time. Public support is crucial component of a potable reuse project.	Not applicable	Without the certainty of finalized regulations, the project concept was developed to match what was believed to be DDW's regulatory intent for a SWA project. It was important that the concept would continue to be permittable even as DDW worked through finalizing regulations. In addition to reviewing draft regulations, the project team engaged with DDW early in conceptual develop to understand their concerns for SWA. The project concept was developed based on this understanding and a demonstration facility was built to prove the concept through testing. Throughout the testing period, the project team met regularly with regulators to share results and solicit feedback. The approach was refined until DDW confirmed that the concept was consistent with their regulatory vision. Detailed design and permitting efforts were pursued after gaining DDW's approval of the conceptual project. A strong partnership with DDW was key to successful permitting, along with the multiple strategies to demonstrate the project's soundness including seeking additional credit for pathogen removal at the North City Water Reclamation Plant, pursuing higher RO credit through the use of novel surrogates, and undertaking extensive modeling of Miramar Reservoir. While pursuing these strategies, the City was in regular communication with both DDW and the Independent Advisory Panel. A similar approach would be recommended for future projects pursuing new forms of potable reuse.

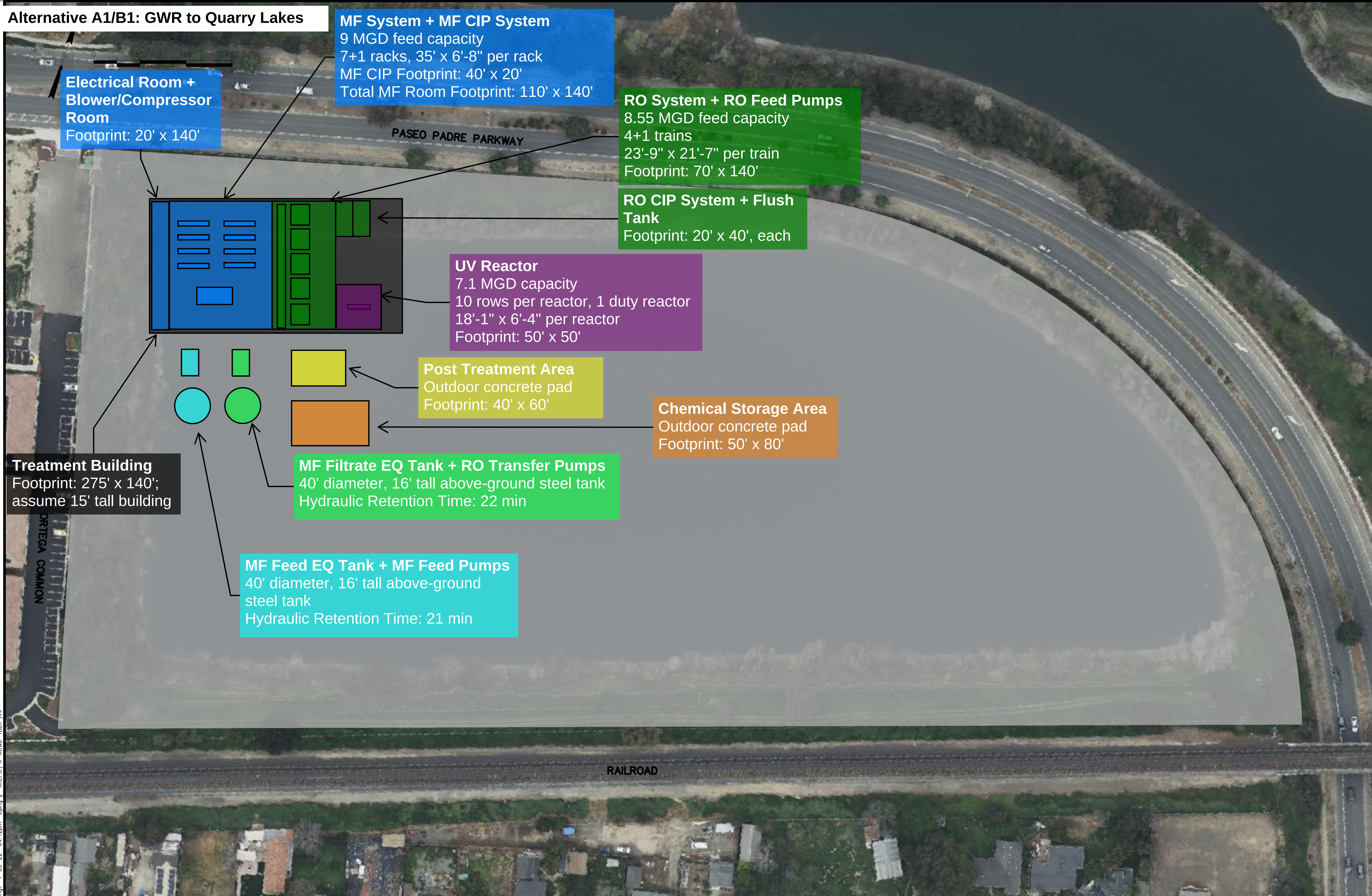
Operational Considerations		Orange County Water District	Monterey One Water	City of San Diego
12	How was ownership and operation of the advanced treatment facilities decided? If there is dual/multi-agency ownership, what is the process for approving changes to the facilities? What formal structure do you have for documenting roles/relationships?	It was decided during the project conceptual design and pre-design that OCWD would own and operate the AWPF. This is because OCSD did not and does not currently produce or convey recycled water. OCWD had a long history operating WF-21 since the 1970s. During design and construction of the original GWRS 70 mgd facilities, a joint committee of 3 OCSD and 3 OCWD board members approved any change orders or budget revision, followed by full approve by both full boards. However, once the facility went into operation all changes to the facility are the sole responsibility of OCWD with no approval needed from OCSD. There is a formal Joint Operating Agreement that spelled out roles and responsibilities.	M1W owns, operates, and maintains the advanced water purification facility, the sourcewater facilities, and the injection facilities. Marina Coast Water District owns the pipeline between the purification and injection facilities. Once the purified water is produced at the AWPF, the water is owned by the Monterey Peninsula Water Management District (MPWMD) because they have the rights to put the water into the seaside groundwater basin. The water is owned by MPWMD until it's pumped out of the basin by CalAm from their own wells. The formal structure for documenting these roles/relationships is the water purchase agreement signed by M1W, Cal Am, and MPWMD.	Not applicable
13	Have level of service goals or guarantees been established for the water delivered from the wastewater treatment plant to the water purification facilities? If so, what are they? Were changes to the wastewater treatment plant operations required to meet these goals/guarantees?	There are basic water quality requirements established in the Joint Operating Agreement centered around turbidity. The term "specification influent" is used in the agreement. "Specification Influent" means secondary treated sewage that does not exceed (a) an average of 5 NTU over a 30-day period; (b) an average of 10 NTU for a 24-hour period; or (c) an instantaneous turbidity of 50 NTU at any time. For the initial operating agreement/period, OCSD paid for a portion of UV O&M costs, due to the presence of NDMA; this eventually ended. OCSD subsequently adopted levels of service for NDMA (150 ng/L) and 1,4-dioxane (10 ug/L) for their secondary effluent supplied to GWRS as influent, which corresponded the original UV-AOP system treatment design criteria for removal in order to meet the Notification Levels for these compounds at the time. Further into the future, OCSD adopted a local limit for 1,4-dioxane discharges to the sewer. The other water quality requirements were kept more general in nature on purpose with language that both agencies would work cooperatively with each other if water quality issues on either side effects the treatment process or economics for either agency. Also, there is language that if a new contaminant is discovered that may be of concern to GWRS, both agencies would meet on how to best treat for the contaminant and who would pay for its treatment. OCSD did not require any major treatment or operational changes to meet these requirements. OCSD did later change their activated sludge process to a nitrification/partial denitrification (NdN) from CBOD only removal, which has benefited GWRS. However, this was done by OCSD to save on solids handling/treatment costs and not driven by improving quality to GWRS. OCSD did build a new sewer lift station called the Steve Anderson Lift Station to mitigate diurnal flow variations at their Plant 1 facility. This was not built for water quality improvements to GWRS, but to provide steady influent to GWRS over a 24-hour period such that it can operated at is design capacity.	M1W is both the wastewater provider and the purified water producer. For this project, M1W has made some modifications to the WWTP including increasing the number of trickling filters in operation to lower TOC and nitrite.	Yes, reclaimed water produced from the North City Water Reclamation Plant must meet certain criteria prior to pumping to the new Purified Water Facility. Some these criteria currently exist as part of the reclaimed water system. No major changes in operations are needed to meet these goals.
14	What contingencies have been made for disruptions in flow? What contingencies have been made for disruptions in water quality?	OCWD has other sources of water for replenishment of the Orange County groundwater basin. Those sources include Santa Ana River flows and imported water through MWD. There are no other formal contingencies for interruption of flow from OCSD to OCWD; it is not designed with nor is it intended to be operated with the same level of backup/redundancy as compared to a sewage treatment or water treatment plant. If any of the "specification influent" conditions are not met or other significantly adverse water quality deviations occur, OCWD would shut down GWRS. The only water quality contingency is a commitment to address any issue quickly. Also, OCSD currently has the ability to feed the GWRS from one of three separate Plant No.1 wastewater treatment processes (2 activated sludge facilities and 1 trickling filter facility) which helps mitigate water quality concerns). OCWD does maintain online TOC-based critical control points on the RO system which serve the dual purpose of documenting a surrogate for pathogen removal and well as bulk organics removal performance. Sequential response actions, up to and including GWRS plant shutdown, have been established based to the duration and magnitude of TOC excursions.	For disruptions in flows, M1W assumes the AWPF will be operated 90% of the time, with 10% downtime for operations/maintenance activities. Before producing water, M1W thought this was a low operation target but after operating the facility, this seems to be an appropriate target. M1W also has operating and drought reserves that allow for certain amounts of disruption in sourcewater flow or operating the plant. For disruptions in water quality, M1W has the following contingencies: -an oversized ozone unit so they can treat elevated TOC levels -10-ft diameter trickling filters in service which are slightly oversized -the ability to enhance primary treatment at the WWTP (although this isn't being implemented right now) -provisions to add iron at the pump station to help reduce phosphates from our ag washwater M1W is building facilities to send ag washwater to ponds for treatment before treating the water at the AWPF, which should help prevent spikes of phosphate from entering the AWPF.	The North City Drinking Water Plant will receive flows from three independent sources. If one of the sources is disrupted the plant is expected to operate at reduced flow. The North City Water reclamation plant and the Purified Water facility are designed to allow for variations in influent wastewater/water quality and therefore disruptions resulting from variations in water quality is minimized.

Operational Considerations (continued)		Orange County Water District	Monterey One Water	City of San Diego
15	Have specific source control measures been implemented to support potable reuse beyond existing local limits?	Below is a summary of the source control measures implemented by OCSD in support of GWRS as well as those mandated in regulations governing GWRS. -OCSD has adopted a "Level of Service" (LOS) within its strategic plan for both NDMA and 1,4-dioxane effluent concentrations to protect GWRS. They were originally set at 150 ppt for NDMA and 1,4-dioxane at 10 ppb based on the treatment efficiency of GWRS. In order to maintain the LOS for these compounds, OCSD monitoring is required. -OCSD has adopted local limits for NDMA, 1,4-dioxane, and TOC to protect GWRS. OCSD monitoring is required to assess compliance and the effectiveness of these limits. -The State GRRP regulations that cover GWRS have narrative source control program requirements for the project are called out specifically. OCSD has prepared a fact sheet which describes specifically how they carry out this obligation for the project, which includes a description of monitoring efforts and is available upon request.	Last year, M1W conducted a source water sampling and analysis campaign and conducted a Local Limit Analysis (which included consideration of water quality influent design assumptions for our purification facility and new source waters as influent to our regional treatment plant). This work culminated in a Local Limits Report. Our Board also adopted a new Wastewater Ordinance regulating dischargers into our facilities as recommended by the Local Limits Report. Monterey One Water continues to ensure that hauled saline wastes (i.e., concentrate from water treatment processes) by-passes our treatment process and combines with the reverse osmosis membrane reject water from our Advanced Water Purification Facility before discharge through our ocean outfall. The source generator of hauled saline wastes are required to submit analytical results of their wastewater to Monterey One Water's Source Control Division for approval before being brought to our treatment plant to ensure continued compliance with our NPDES permit.	Currently the city is conducting a Local Limit Study, this study will establish limits on industrial dischargers and will provide the monitoring requirements and guidance for dischargers into the metro system.
16	Has your agency adopted precautionary measures to address contaminants of emerging concern (CECs), including PFAS? If so, what are they?	The Joint Operating Agreement has language for both OCWD and OCSD to meet and confer on how to deal with new contaminants that could effect GWRS water quality. The original decision to build the project with 100% RO + AOP treatment has been very effective in addressing/removing CECs, including PFAS. The OCWD laboratory brought early LC-MS/MS methods online so we could test for CECs internally with the beginning of GWRS operations in 2008.	M1W has conducted studies looking at destruction of DDTs through the ozone processes to dispel some source water concerns. DDW also required lots of testing as part of the regulatory requirements that M1W is continuing to conduct.	The proposed treatment process at the North City Water Reclamation Plant as well as the Purified Water Facility utilizes treatment processes such as secondary process and O3/BAC, membranes, AOP processes that removes CECs and latest studies have shown that activated carbon and RO, two processes that are included in our proposed treatment train for Pure Water are effective at removing PFAS.
17	What provisions, if any, have been made to maintain flexibility for future expansions? Have you considered future conversion to raw water or treated water augmentation? If so, how is that incorporated into your project plans?	The GWRS was designed to allow for two separate, 30 mgd expansions with infrastructure piping and space allocated for ultimate build out flows of 130 mgd. However, each expansion to date has included process improvements based on current OCSD water quality and observations of GWRS treatment issues. The flexibility comes in having space allocated for expansions, but actual details of each process being left open to possible changes. There are no plans for future conversion to raw water or treated water augmentation. As a groundwater management agency with a highly utilized large groundwater basin, we are set up well both institutionally and physically for groundwater recharge. OCSD will continue to be responsible for all wastewater collection, treatment and disposal in our service area.	M1W built the AWPF with space for future units to allow for expansion. For example, the pump stations have been built with room for a spare pump, and the RO and UV treatment processes have room for a future additional unit. These allocated spaces could be used for any future expansions. However, M1W would also like to look into ways to improve their recovery through the RO system to further supplement the local water supply by either adding a third-stage RO train or conducting heat distillation of the RO concentrate. M1W has cogen facility engines that produce lots of excess heat that potentially could be used to distill RO concentrate to get more water. M1W hasn't considered future conversion to RWA or TWA because that would be cost prohibitive. To accomplish RWA or TWA, M1W would need a new miles-long pipeline. Also, peak production at the AWPF does not occur when there's peak demand at the WTP so the water would need to be stored to better time delivery. M1W's opinion is that the cheapest storage they have available is in the groundwater basins so RWA/TWA are not on the table.	Due to site constraints, the planned facilities can handle limited amount of influent wastewater/water, however the pure water facility can go into higher water recovery which will result in higher water production. No, future conversion to raw water or treated water augmentation is not incorporated into current plans.
18	Are there any elements you wish you would have incorporated in the initial design to improve operations or facilitate future expansion?	More flexibility in the infrastructure design to allow for use of both pressure driven and vacuum driven MF/UF processes. Hydraulic design and basic infrastructure only allows for a submersible/vacuum drive MF/UF product. Design use of a better distribution pipeline material other than mortar to protect against corrosion from use of stabilized ultrapure water. The complexity of stabilizing ultrapure water when diurnal variations in influent flows were significant and underestimated. Additionally, injection and surface spreading benefit from different levels of stabilization. Some of this was helped by replacing lime delivery system during the 1st/Initial Expansion project. Finally, the GWRS distribution pipeline to our spreading facility telescopes to smaller diameter. A single, large diameter would be preferred.	No response	No response

Cost/Revenue Allocation Between Partners		Orange County Water District	Monterey One Water	City of San Diego
19	Which agencies are funding or funded improvements needed to support potable reuse, if any, at the existing wastewater treatment plant? What is the basis for cost allocation, if any, among agencies? How is the funding, if any, from agencies other than the owner of the wastewater treatment plant occurring (direct capital investment, repayment through fees)?	As stated in a prior question no major improvements were made at OCSD to support potable reuse other than construction of a sewer lift station called the Steve Anderson Lift Station to improve diurnal flow variations at OCSD Plant 1. The original GWRS project construction itself which was funded 50-50 between OCSD and OCWD less grants received. The original GWRS project cost $480M with $192 million paid by OCSD and $192M paid by OCWD and the remainder paid by state and federal grants. OCWD has paid for all capital for subsequent expansions, including the capital for necessary improvements at OCSD's site to support the Final Expansion (e.g., Plant 2 Headworks Segregation, Flow Equalization, Pump Station, and Pipeline Rehabilitation. OCSD is funding its regular capital investments through sewer fees to their customers. This is similar to OCWD funding its capital investment via groundwater fees charged to entities that pump groundwater.	M1W paid for all the upgrades at the WWTP including adding additional trickling filters. No outside funding was provided for these upgrades.	12 Partner Agencies are contributing their fair share of the Metro Wastewater expenses which consists of the cities of El Cajon, La Mesa, Lemon Grove, Chula Vista, National City, Del Mar, Poway, Coronado, Imperial Beach; Special Districts Otay, Padre Dam and County of San Diego. The cost allocation is based on Strength Based Billing within three parameters of Flow, TSS and COD. The City of San Diego is the sole owner of the entire wastewater treatment and collection system. How each agency funds their portion annual contribution is a question that is beyond the scope of the City of San Diego.
20	Which agencies are funding the advanced treatment facilities? What is the basis for the cost allocation, if any, among agencies?	The advanced treatment facility original construction at 70 mgd capacity was funded 50:50 between OCSD and OCWD less grant monies received. However, the two subsequent expansions to the GWRS from 70 to 100 mgd in 2015 and from 100 to 30 mgd to be completed in 2023 are solely funded by OCWD.	Historically, 12 years ago, M1W was initially paying 100% of all costs associated with the AWPF. However, once they teamed up with MPWMD, the costs were split 50%/50%. Now, MPWMD pays close to 75%, with M1W paying the other 25%. There are also some items where MPWMD pays the full 100%. Some additional funding was provided by the Water Master for some of the DDW-requested studies and other funding was provided at the state and federal level for studies through Water Smart and another organization. M1W is paying for construction of the AWPF using a 1% direct loan.	City of San Diego water fund
21	How are costs for construction and operation of the advanced treatment facilities being recovered?	Beyond capital grants, cost recovery by OCWD is through the sale of groundwater.	M1W is recovering the cost for construction/operation of the AWPF through water sales. M1W sells water to MPWMD who then sells the water to Cal Am through the water purchase agreement.	We plan on funding our construction costs through a variety of sources including proceeds from Federal (WIFIA) and State (SRF) loans, revenue bonds, Bond Anticipation Notes (BANs), commercial paper, proceeds from grants, and cash. Our operating costs are covered through our Water and Wastewater system revenues
22	Does the wastewater agency charge for its effluent/recycled water/advanced treated water? If so, what is the charge and what is its basis?	OCSD does not charge OCWD for supply secondary effluent to GWRS, nor does it charge for taking back residual streams from GWRS. This was agreed upon during pre-design and established in the Joint Operating Agreement. For very limited direct uses of GWRS water (e.g., non-potable uses such as industrial cooling, toilet flushing, or irrigation), customers are charged the documented annual cost to OCWD produce the water.	M1W charges MPWMD the cost of treating the water past secondary treatment. M1W has started billing MPWMD but they have yet to bill Cal Am as MPWMD is working to build up and operating reserve before allowing Cal Am to extract the water from the basin. M1W is the water producer. We "make" the water and inject it into the Seaside Groundwater Basin; therefore, we have to sell it to the entity with jurisdiction over the Basin – MPWMD. MPWMD then has the authority to sell the water to the water distributor – California American Water (Cal Am). MPWMD will add on some administrative fees from the cost of water, but roughly it will be $2,200/AF.	No
28	In hindsight are there any measures you could have taken to minimize your capital investment either in initial implementation or overall as you continued to expand your system?	We don't think any appreciable measures could be taken to minimize capital investment. OCWD believes OCSD's contribution of 50% of initial capital costs was appropriate. OCWD also believes solely paying for the subsequent expansions is reasonable, since those subsequent expansions don't provide as much additional benefit to OCSD as the original GWRS at 70 mgd capacity. The original GWRS at 70 mgd capacity provided adequate storm flow relief to OCSD, which was the primary rational for OCSD wanting to partner and pay half the capital costs.	Not applicable	Not applicable

Insurance, liability and indemnifications between agencies		Orange County Water District	Monterey One Water	City of San Diego
29	What are each agency's responsibilities with respect to the quality of the water delivered to the end user?	In the case of OCWD the water from GWRS is not directly fed to an end customer (with very limited non-potable exceptions listed previously). However, the water is used to supply an aquifer that is used to by retail water agencies. OCWD is ultimately responsible for water quality delivered to the groundwater aquifer from use of GWRS water for aquifer replenishment.	No response	Not applicable
30	How is the agreement between your agencies structured to provide flexibility for future changes (changing regulations, water supply needs)?	There is general language in our Joint Operating Agreement to allow for both agencies to "meet and confer" on any needed changes. This means both agencies agree changes may be needed, but at this time it is not defined as to who is responsible for cost to implement those changes. A discussion will be held to determine responsibility at the time an issue arises.	There is no set agreement for this flexibility. M1W would expect to make any changes necessary to the WWTP to meet any changing regulations. These changes would be added into the cost of the water that they sell to MPWMD. For changing water supply needs, there are no provisions in the water purchasing agreement. The agreement states that M1W will provide a fixed amount of water for a fixed number of years (which can be extended). The agreement does not include a clause to increase the amount of water within that agreement.	Not applicable
31	What recommendations would you offer to wastewater and/or water utilities negotiating a contract for potable reuse program? Are there any specific terms and conditions you consider non-negotiable?	Some assurance of flow availability is non-negotiable. It is recommended to specify general water quality requirements as much as possible, while not being too specific on too many individual water quality parameters. Key constituents would be nitrogen concentration, TOC, and TSS or turbidity. We would consider source control not meeting the state standard as non-negotiable, as well as the associated monitoring to demonstrate it; these should be agreed upon in writing. We would also consider turbidity or some other form of solids quality non-negotiable.	No response	Not applicable

APPENDIX D: ALTERNATIVE LAYOUTS



PLAN
1" = 50'

WOODARD & CURRAN

0" — 1" VERIFY SCALES BAR IS ONE INCH LONG ON FULL SIZE DRAWING. IF NOT ONE INCH LONG ON THIS DRAWING, ADJUST SCALES ACCORDINGLY

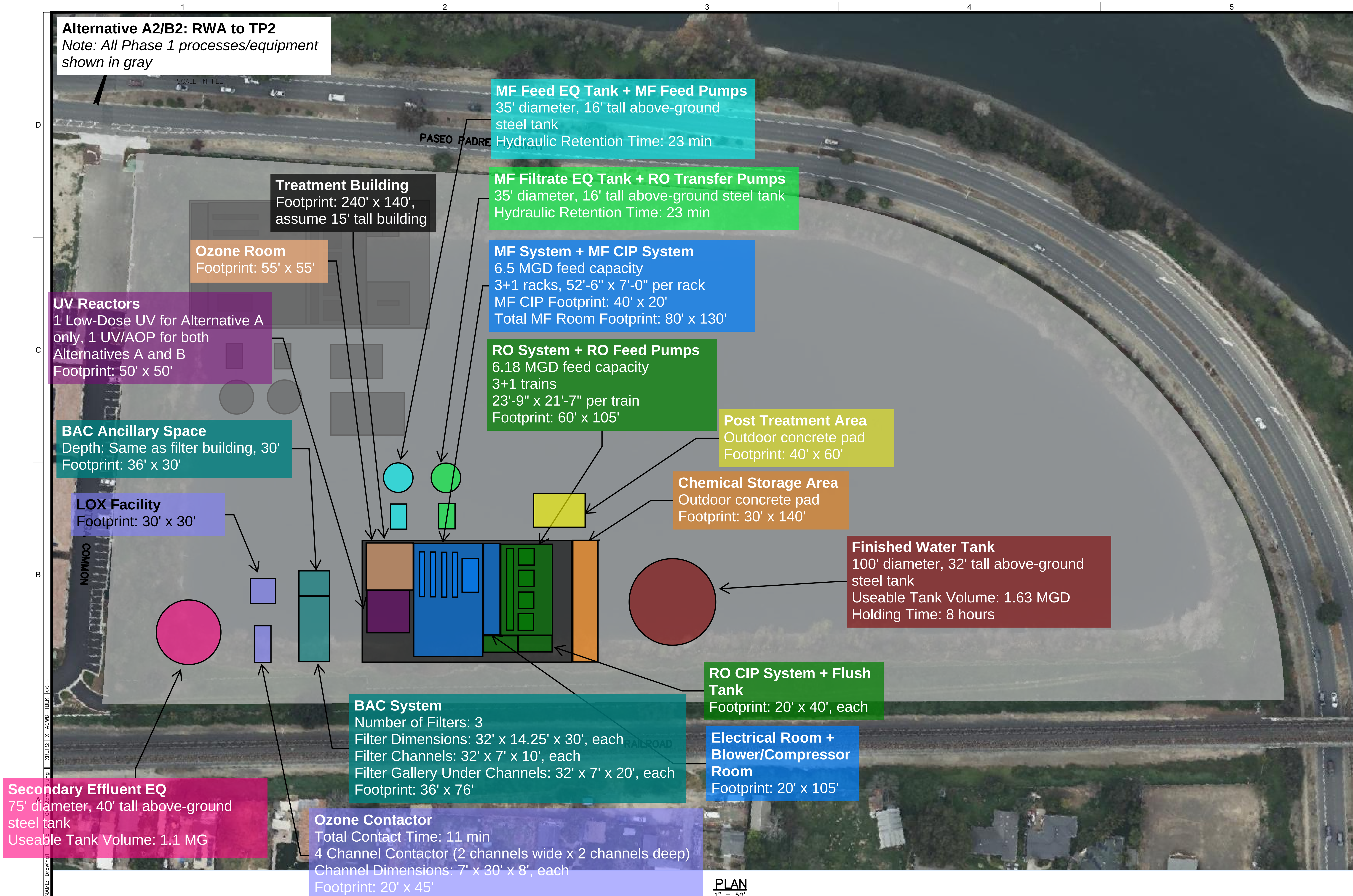
PRELIMINARY PLANNING LEVEL DRAWINGS

NOTICE:
EXISTING UTILITY LOCATIONS SHOWN ARE APPROXIMATE AND SUBJECT TO CHANGE BASED ON FIELD VERIFICATION DURING FUTURE PHASES OF WORK. NOT ALL UTILITIES ARE SHOWN. DETAILED DESIGN AND FIELD INVESTIGATION NECESSARY TO DEVELOP FUTURE CONSTRUCTION CONTRACT DOCUMENTS.

PURIFIED WATER FEASIBILTY EVALUATION

SHEET NUMBER

Last Saved By: sjung 1-05-22 03:51pm



WOODARD & CURRAN

VERIFY SCALES
BAR IS ONE INCH LONG ON FULL SIZE DRAWING. IF NOT ONE INCH LONG ON THIS DRAWING, ADJUST SCALES ACCORDINGLY

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PURIFIED WATER FEASIBILTY EVALUATION

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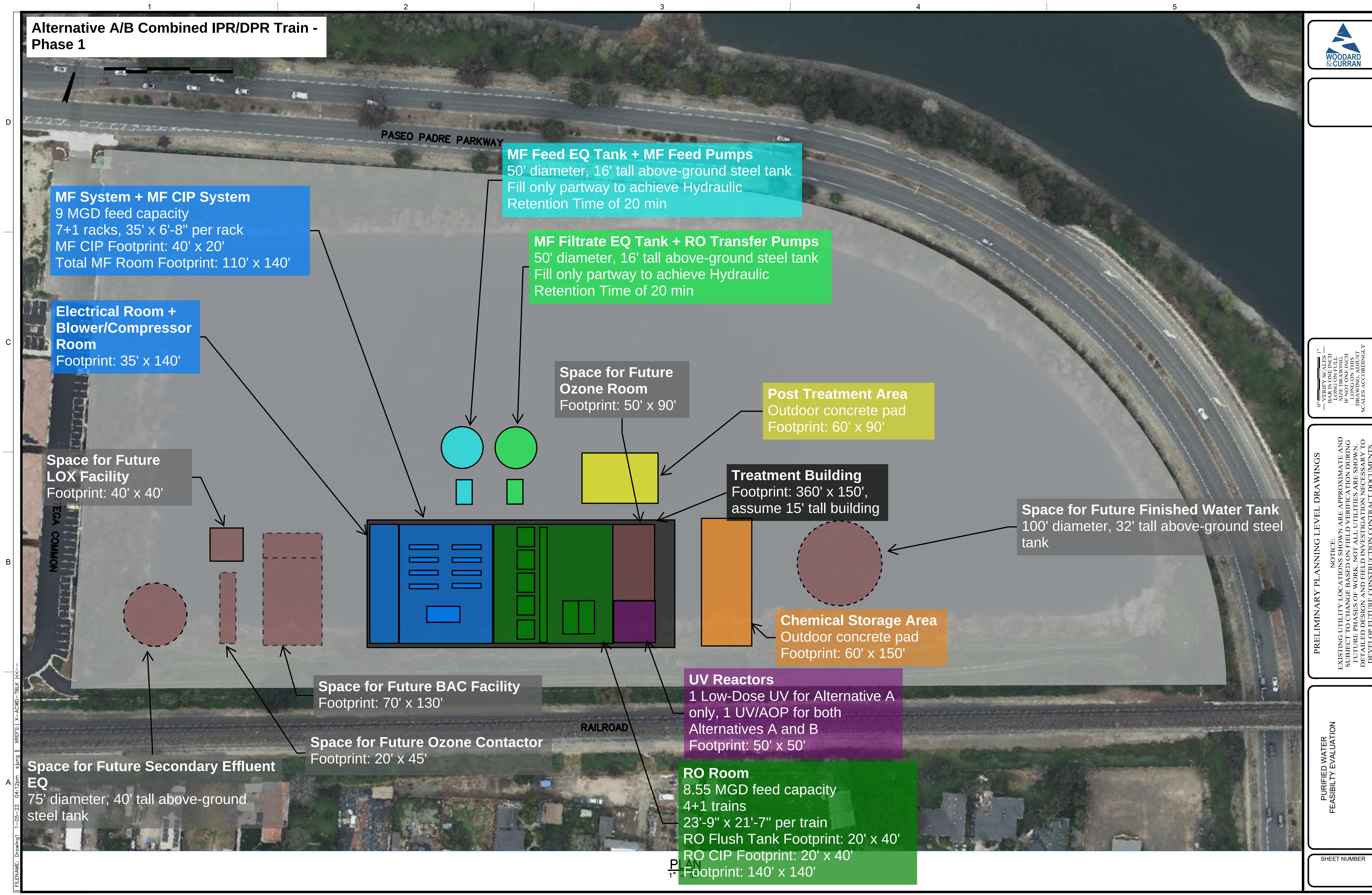
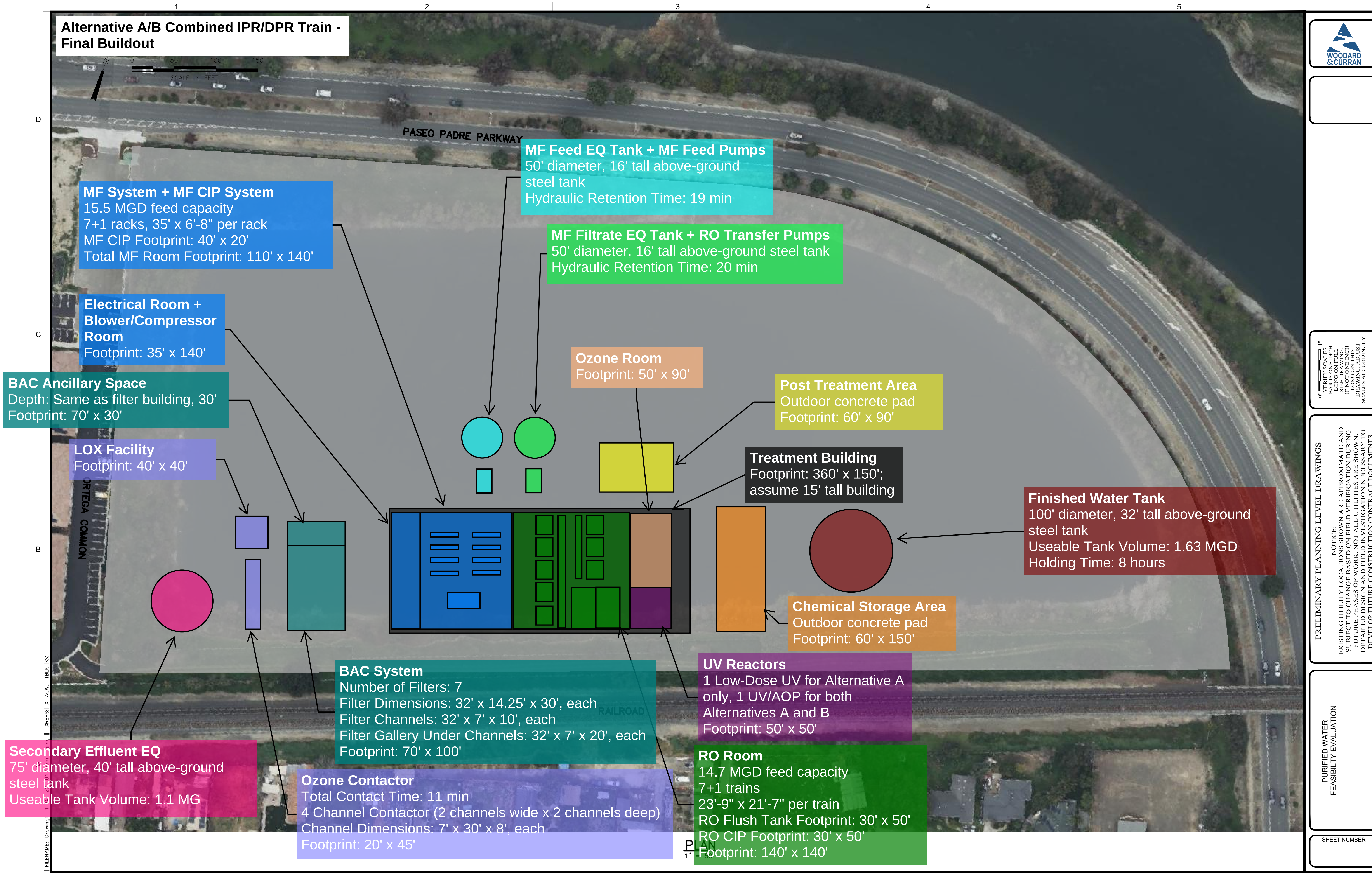

Alternative A/B Combined IPR/DPR Train - Phase 1
PASEO PADRE PARKWAY
MF Feed EQ Tank + MF Feed Pumps
50' diameter, 16' tall above-ground steel tank
Fill only partway to achieve Hydraulic Retention Time of 20 min
MF System + MF CIP System
9 MGD feed capacity
7+1 racks, 35' x 6'-8" per rack
MF CIP Footprint: 40' x 20'
Total MF Room Footprint: 110' x 140'
MF Filtrate EQ Tank + RO Transfer Pumps
50' diameter, 16' tall above-ground steel tank
Fill only partway to achieve Hydraulic Retention Time of 20 min
Electrical Room + Blower/Compressor Room
Footprint: 35' x 140'
Space for Future Ozone Room
Footprint: 50' x 90'
Post Treatment Area
Outdoor concrete pad
Footprint: 60' x 90'
Space for Future LOX Facility
Footprint: 40' x 40'
Treatment Building
Footprint: 360' x 150', assume 15' tall building
Space for Future Finished Water Tank
100' diameter, 32' tall above-ground steel tank
Chemical Storage Area
Outdoor concrete pad
Footprint: 60' x 150'
UV Reactors
1 Low-Dose UV for Alternative A only, 1 UV/AOP for both Alternatives A and B
Footprint: 50' x 50'
Space for Future BAC Facility
Footprint: 70' x 130'
RAILROAD
Space for Future Ozone Contactor
Footprint: 20' x 45'
Space for Future Secondary Effluent EQ
75' diameter, 40' tall above-ground steel tank
RO Room
8.55 MGD feed capacity
4+1 trains
23'-9" x 21'-7" per train
RO Flush Tank Footprint: 20' x 40'
RO CIP Footprint: 20' x 40'
Footprint: 140' x 140'
PLAN
WOODARD & CURRAN
PRELIMINARY PLANNING LEVEL DRAWINGS
NOTICE: EXISTING UTILITY LOCATIONS SHOWN ARE APPROXIMATE AND SUBJECT TO CHANGE BASED ON FIELD VERIFICATION DURING FUTURE PHASES OF WORK. NOT ALL UTILITIES ARE SHOWN. DETAILED DESIGN AND FIELD INVESTIGATION NECESSARY TO DEVELOP FUTURE CONSTRUCTION CONTRACT DOCUMENTS.
PURIFIED WATER FEASIBILITY EVALUATION
SHEET NUMBER
Last Saved By: sjung 1-05-22 03:51pm



Alternative A/B Combined IPR/DPR Train - Final Buildout
SCALE IN FEET
PASEO PADRE PARKWAY
ORTEGA COMMON
RAILROAD
MF System + MF CIP System
15.5 MGD feed capacity
7+1 racks, 35' x 6'-8" per rack
MF CIP Footprint: 40' x 20'
Total MF Room Footprint: 110' x 140'
MF Feed EQ Tank + MF Feed Pumps
50' diameter, 16' tall above-ground steel tank
Hydraulic Retention Time: 19 min
MF Filtrate EQ Tank + RO Transfer Pumps
50' diameter, 16' tall above-ground steel tank
Hydraulic Retention Time: 20 min
Electrical Room + Blower/Compressor Room
Footprint: 35' x 140'
BAC Ancillary Space
Depth: Same as filter building, 30'
Footprint: 70' x 30'
LOX Facility
Footprint: 40' x 40'
Ozone Room
Footprint: 50' x 90'
Post Treatment Area
Outdoor concrete pad
Footprint: 60' x 90'
Treatment Building
Footprint: 360' x 150';
assume 15' tall building
Finished Water Tank
100' diameter, 32' tall above-ground steel tank
Useable Tank Volume: 1.63 MGD
Holding Time: 8 hours
Chemical Storage Area
Outdoor concrete pad
Footprint: 60' x 150'
BAC System
Number of Filters: 7
Filter Dimensions: 32' x 14.25' x 30', each
Filter Channels: 32' x 7' x 10', each
Filter Gallery Under Channels: 32' x 7' x 20', each
Footprint: 70' x 100'
UV Reactors
1 Low-Dose UV for Alternative A only, 1 UV/AOP for both Alternatives A and B
Footprint: 50' x 50'
Secondary Effluent EQ
75' diameter, 40' tall above-ground steel tank
Useable Tank Volume: 1.1 MG
Ozone Contactor
Total Contact Time: 11 min
4 Channel Contactor (2 channels wide x 2 channels deep)
Channel Dimensions: 7' x 30' x 8', each
Footprint: 20' x 45'
RO Room
14.7 MGD feed capacity
7+1 trains
23'-9" x 21'-7" per train
RO Flush Tank Footprint: 30' x 50'
RO CIP Footprint: 30' x 50'
Footprint: 140' x 140'
PLAN
WOODARD & CURRAN
PRELIMINARY PLANNING LEVEL DRAWINGS
NOTICE:
EXISTING UTILITY LOCATIONS SHOWN ARE APPROXIMATE AND SUBJECT TO CHANGE BASED ON FIELD VERIFICATION DURING FUTURE PHASES OF WORK. NOT ALL UTILITIES ARE SHOWN. DETAILED DESIGN AND FIELD INVESTIGATION NECESSARY TO DEVELOP FUTURE CONSTRUCTION CONTRACT DOCUMENTS.
PURIFIED WATER FEASIBILITY EVALUATION
SHEET NUMBER
Last Saved By: sjung 1-05-22 03:51pm

APPENDIX E: OPINION OF PROBABLE TOTAL CAPITAL COST METHODOLOGY

1. INTRODUCTION

This section describes the cost estimating methodology used to prepare the Opinion of Probable Total Capital Costs for Chapters 6, 7, and 8. The Opinion of Total Capital Cost represents the estimated total cost to design, construct, and implement the capital project and consists of "Construction" and "Non-Construction" cost components.

1.1 Total Construction Cost

The Total Construction Cost represents an estimate of the General Contractor's bid in a Design-Bid-Build procurement approach. Total Construction Cost includes Direct Construction Costs and General Contractor's administrative costs including insurance, Contractor's overhead and profit, bonding, and general conditions. All costs in this study reflect a project development level of 1% to 15% corresponding to a Class 4 Estimate with an excepted accuracy range of -10% to +30%, as defined by the Association for the Advancement of Cost Engineering (AACE). Table 1-1 is a summary of AACE project class definitions.

Table 1-1: AACE Project Definitions[1]

AACE Class	Project Definition	End Usage for the Estimate	Cost Methodology	Expected Accuracy Range
Class 5	0% - 2%	Functional Area, or Concept Screening	Square Footage Factoring, Parametric Models, Judgement, or Analogy	Low: -20% to -30% High: +30% to +50%
Class 4	1% - 15%	Schematic Design or Concept Study	Parametric Models, Assembly Driven Models	Low: -10% to -20% High: +20% to +30%
Class 3	10% - 40%	Design Development, Budget Authorization, Feasibility	Semi-detailed Unit Costs with Assembly Level Line Items	Low: -5% to -15% High: +10% to +20%
Class 2	30% - 75%	Control or Bid/Tender, Semi-Detailed	Detailed Unit Cost with Forced Detailed Take-off	Low: -5% to -10% High: +5% to +15%
Class 1	65% - 100%	Check Estimate or Pre-bid/Tender, Change Order	Detailed Unit Cost with Detailed Take-off	Low: -3% to -5% High: +3% to +10%

[1] AACE Practice No. 56R-08 Cost Estimate Classification System as Applied to the Building and General Construction Industries, revised December 2012.

1.1.1 Direct Construction Cost

Construction quantity take-offs were performed based on a conceptual design. Unit costs for the site work and civil construction items were developed using Interactive Cost Estimate[1] (ICE) software. ICE unit costs are adjusted to construction prices for the San Francisco Bay Area and assumes prevailing labor wages. For some large equipment items, estimates for the equipment were provided directly from the equipment vendors and shipping and installation costs were then applied. For all items, taxes, trade markups, and profit was applied as applicable.

A subtotal was created from the individual takeoff items and Level of Definition Contingency of 25% was applied to determine Direct Construction Cost. A 25% Level of Definition Contingency is consistent with a Class 4 project and should decrease with project development.

1.1.2 Construction Cost Multipliers

Construction cost multipliers were applied to the Direct Construction Cost to determine Total Construction Cost. Construction cost multipliers were calculated as percentages of the Direct Construction Cost and include:

- General Liability Insurance (1.0%) – General liability insurance acquired by the General Contractor.
- Builder's Risk Insurance (0.2%) – Builder's risk Insurance acquired by the General Contractor.
- Trade Contractor Overhead (10%) – Overhead associated with off-site administrative costs such as cost estimating and accounting.
- Trade Contractor Profit (12%) – General Contractor's markup.
- Performance & Payment Bond (2.5%) – Assumed bonding required by the Owner. Calculated based on direct construction cost.

1.2 Non-Construction Costs

Non-construction costs include the costs to design and implement the construction project. Non-construction costs were calculated as percentages of the Total Construction Cost and include:

- Big Market Adjustment (15%) – Contingency for variable bid environment.
- Legal/Administration (5%) – Owner costs required to administer construction contract.

[1] ICE is general contractor design cost estimating software based on crews' (task specific labor and equipment) production rates, construction systems and Unit Price Catalog Database (UPC Database). The Unit Price Catalog is sourced from several industry standard refences, including RS Means (Gordian), Epic (Vision InfoSoft), Harrison Cost, LLC, BNi Building News and others.

- Environmental and Permitting (5%) – Cost to prepare environmental documentation and permitting. This contingency is intended to include environmental impact report (EIR) preparation, construction permitting, and IPR-specific permitting. IPR-specific permitting is estimated at two years. For DPR alternatives, this allowance is intended to cover the Title 22 report and DDW permitting documents. DPR-specific permitting is also estimated at about two years. See Chapter 9 for implementation plan and project schedule.

- Design (10%) – Costs to prepare detailed design (drawings and specifications) for bid, including bidding assistance.

- Engineering Services During Construction (5%) – Costs for design engineer to review submittals, respond to requests for information (RFIs), attend site visits, and prepare construction design clarifications.

- Construction Management (12%) – Costs to retain a construction management firm to oversee and track construction activities, provide inspection services, and receive, respond to, and route all correspondence to and from the General Contractor.

- Owner's Reserve for Change Orders (10%) – Contingency for construction change orders.

1.3 Opinion of Probable Total Capital Cost

The Opinion of Probable Total Capital Cost is the summation of Construction and Non-Construction costs. An expected accuracy range of -20% to +30% is included with each estimate.

1.3.1 Limitations

The Opinion of Probable Total Capital Cost provided is based on a conceptual project definition, respective project assumptions, vendor information, industry standard tools, plausible multipliers based on other similar civil construction project experience, and experience and judgment by Woodard & Curran.

Planning and design are not complete. Additionally, Woodard & Curran has no control over market factors (e.g., the cost of labor, materials, equipment, or services) nor over the General Contractor's methods of determining prices, over-competitive bidding, or market conditions. Woodard & Curran does not guarantee that proposals, bids, or actual project costs will not vary from Opinions of Total Capital Costs.

APPENDIX F: DETAILED COST ESTIMATE – TREATMENT ALTERNATIVES

Purified Water Feasibility Study

Opinion of Probable Capital Cost

Date: 2022.06.03

Facilities: Advanced Water Purification Facilities (Ch 6)

Project number: 0011242.00

Phase 1 AWPF

ENR CCI (San Francisco, February 2022): 14395.70

	%		$
Gross Construction Cost	--	$	55,570,941
Level of Development Contingency	25%	$	13,893,000
Direct Construction Cost		**$**	**69,463,941**
General Liability Insurance	1%	$	695,000
Builders' Risk Insurance	0.2%	$	139,000
Trade Contractor Overhead	10%	$	6,946,000
Trade Contractor Profit	12%	$	8,336,000
P&P Bond	2.5%	$	1,737,000
Subtotal Other Construction Costs		**$**	**17,853,000**
Total Construction Cost		**$**	**87,316,941**
Bid Market Adjustment	15%	$	13,098,000
Legal/Administration	5%	$	4,366,000
Environmental and Permitting	5%	$	4,366,000
Design	10%	$	8,732,000
Engineering Services During Construction	5%	$	4,366,000
Construction Management	12%	$	10,478,000
Owner's Reserve for Change Orders	10%	$	8,732,000
Non-Construction Cost		**$**	**54,138,000**
Total Capital Cost		**$**	**141,454,941**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$	113,164,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$	183,891,000

Detail - With Taxes and Insurance

Partial Report

Group 1: Phase
Group 2: Divisions

Estimator : K. Rosner
Project Size : 0 SQFT

Phase 1 AWPF

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Phase 1 - Groundwater Recharge to Quarry Lakes									
General Conditions									
Contractor General Conditions	24	MO	1,654,526	192,271	88,104	111,735		85,276.512	2,046,636
**** Total General Conditions**			**1,654,526**	**192,271**	**88,104**	**111,735**			**2,046,636**
Sitework									
Building Piles, 30' depth, 5' spacing	48,720	LNFT	1,849,647	4,268,974		821,240		142.444	6,939,861
Tank Piles, 30' depth, 5' spacing	3,420	LNFT	129,840	299,669		57,649		142.444	487,158
Yard Piping & Site Utilities	1	LS			1,413,000			1,413,000.000	1,413,000
Access Road, 850 LF x 18' wide	25,000	SQFT			125,000			5.000	125,000
Misc. Site Improvements	1	LS			63,000			63,000.000	63,000
Landscaping	1	LS			100,000			100,000.000	100,000
Security Fence	1,800	LNFT			99,000			55.000	99,000
**** Total Sitework**			**1,979,487**	**4,568,643**	**1,800,000**	**878,889**			**9,227,019**
Concrete									
Chemical Storage Pad (50' x 80')	4,000	SQFT			160,000			40.000	160,000
Post Treatment Pad (40' x 60')	2,400	SQFT			96,000			40.000	96,000
**** Total Concrete**					**256,000**				**256,000**
Pre-Engineered Metal Buildings - Complete									
Treatment Building, 275' x 140' x 15'	38,500	SQFT			13,860,000			360.000	13,860,000
**** Total Pre-Engineered Metal Buildings - Com**					**13,860,000**				**13,860,000**
Equipment									
Microfiltration Equipment	1	LSUM	902,265			67,275	5,163,750	6,133,290.000	6,133,290
Reverse Osmosis Equipment	1	LSUM	1,082,718			82,800	5,278,500	6,444,018.000	6,444,018
Chemical Storage Tanks, Pumps, Etc.	1	LSUM	72,181				286,875	359,056.200	359,056
UV Disinfection Equipment	1	LSUM	451,133			31,050	2,409,750	2,891,932.500	2,891,933
Post Treatment System	1	LSUM	144,362			10,350	573,750	728,462.400	728,462
MF Feed Pumping Equipment	1	LSUM	7,218				34,425	41,643.120	41,643
RO Transfer Pumping Equipment	1	LSUM	7,218				34,425	41,643.120	41,643
**** Total Equipment**			**2,667,095**			**191,475**	**13,781,475**		**16,640,045**
Special Construction									
Circular Steel Tank (40' dia. x 16' high) - MF Feed	132,000	GAL			400,620			3.035	400,620
Circular Steel Tank (40' dia. x 16' high) - MF Filtrate	132,000	GAL			400,620			3.035	400,620
**** Total Special Construction**					**801,240**				**801,240**
Mechanical									
Process Pipe, Fittings, Valves, Etc.	1	LS			4,350,000			4,350,000.000	4,350,000
**** Total Mechanical**					**4,350,000**				**4,350,000**

Estimate Detail - Alameda County Water District - Water Reuse Facility

Detail - With Taxes and Insurance

Partial Report

Group 1: Phase
Group 2: Divisions

Estimator : K. Rosner
Project Size : 0 SQFT

Phase 1 AWPF

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Electrical									
New Electrical Service	1	LSUM			1,000,000			1,000,000.000	1,000,000
Electrical & Controls	1	LSUM			7,390,000			7,390,000.000	7,390,000
**** Total Electrical**					**8,390,000**				**8,390,000**
*** Total Phase 1 - Groundwater Recharge to Qu**			**6,301,109**	**4,760,914**	**29,545,344**	**1,182,099**	**13,781,475**		**55,570,941**

Purified Water Feasibility Study

Opinion of Probable Capital Cost

Date: 2022.02.25

Facilities: Advanced Water Purification Facilities (Ch 6)

Project number: 0011242.00

Phase 2 AWPF

ENR CCI (San Francisco, February 2022): 14395.70

	%		$
Gross Construction Cost	--	$	79,954,000
Level of Development Contingency	25%	$	19,989,000
Direct Construction Cost		**$**	**99,943,000**
General Liability Insurance	1%	$	999,000
Builders' Risk Insurance	0.2%	$	200,000
Trade Contractor Overhead	10%	$	9,994,000
Trade Contractor Profit	12%	$	11,993,000
P&P Bond	2.5%	$	2,499,000
Subtotal Other Construction Costs		**$**	**25,685,000**
Total Construction Cost		**$**	**125,628,000**
Bid Market Adjustment	15%	$	18,844,000
Legal/Administration	5%	$	6,281,000
Environmental and Permitting	5%	$	6,281,000
Design	10%	$	12,563,000
Engineering Services During Construction	5%	$	6,281,000
Construction Management	12%	$	15,075,000
Owner's Reserve for Change Orders	10%	$	12,563,000
Non-Construction Cost		**$**	**77,888,000**
Total Capital Cost		**$**	**203,516,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$	162,813,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$	264,571,000

Detail - With Taxes and Insurance

Partial Report

Group 1: Phase
Group 2: Divisions

Estimator : K. Rosner
Project Size : 0 SQFT

Phase 2 AWPF

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Phase 2 - Raw Water Augmentation to WTP 2									
General Conditions									
Contractor General Conditions	24	MO	1,654,526	192,271	88,104	111,735		85,276.512	2,046,636
**** Total General Conditions**			**1,654,526**	**192,271**	**88,104**	**111,735**			**2,046,636**
Sitework									
Building Piles, 30' depth, 5' spacing	85,260	LNFT	3,236,883	7,470,705		1,437,170		142.444	12,144,757
Concrete Struct. Piles, 30' depth, 5' spacing	4,650	LNFT	176,537	407,445		78,382		142.444	662,364
Tank Piles, 30' depth, 5' spacing	20,430	LNFT	775,622	1,790,130		344,375		142.444	2,910,127
Yard Piping & Site Utilities	1	LS			2,091,000			2,091,000.000	2,091,000
Access Road, 850 LF x 18' wide	30,000	SQFT			150,000			5.000	150,000
Misc. Site Improvements	1	LS			75,000			75,000.000	75,000
Landscaping	1	LS			100,000			100,000.000	100,000
Security Fence	1,700	LNFT			93,500			55.000	93,500
**** Total Sitework**			**4,189,041**	**9,668,280**	**2,509,500**	**1,859,926**			**18,226,747**
Concrete									
BAC Filter Concrete Structure (36' x 76')	1,060	CUYD			2,332,000			2,200.000	2,332,000
Ozone Contactor Concrete Structure (20' x 45')	340	CUYD			646,000			1,900.000	646,000
Chemical Storage Pad (30' x 140')	4,200	SQFT			168,000			40.000	168,000
Post Treatment Pad (40' x 60')	2,400	SQFT			96,000			40.000	96,000
**** Total Concrete**					**3,242,000**				**3,242,000**
Pre-Engineered Metal Buildings - Complete									
Treatment Building, 240' x 140' x 15'	33,600	SQFT			12,096,000			360.000	12,096,000
**** Total Pre-Engineered Metal Buildings - Com**					**12,096,000**				**12,096,000**
Equipment									
Microfiltration Equipment	1	LSUM	451,133			31,050	2,409,750	2,891,932.500	2,891,933
Reverse Osmosis Equipment	1	LSUM	1,082,718			82,800	4,475,250	5,640,768.000	5,640,768
Chemical Storage Tanks, Pumps, Etc.	1	LSUM	72,181				286,875	359,056.200	359,056
UV Disinfection Equipment	1	LSUM	406,019			31,050	1,606,500	2,043,569.250	2,043,569
UV Disinfection (Low Dose) Equipment	1	LSUM	45,113				229,500	274,613.250	274,613
BAC Treatment System	1	LSUM	631,586			46,575	2,983,500	3,661,660.500	3,661,661
Ozone Disinfection Equipment	1	LSUM	1,172,945			87,975	5,737,500	6,998,419.500	6,998,420
Post Treatment System	1	LSUM	126,317				459,000	585,317.100	585,317
MF Feed Pumping Equipment	1	LSUM	7,218				34,425	41,643.120	41,643
RO Transfer Pumping Equipment	1	LSUM	7,218				34,425	41,643.120	41,643
LOX Storage & Vaporizer Equipment	1	LSUM	126,317				459,000	585,317.100	585,317
**** Total Equipment**			**4,128,765**			**279,450**	**18,715,725**		**23,123,940**
Special Construction									

Phase 2 AWPF

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Circular Steel Tank (35' dia. x 16' high)	115,000	GAL			350,060			3.044	350,060
Circular Steel Tank (35' dia. x 16' high)	115,000	GAL			350,060			3.044	350,060
Circular Steel Tank (75' dia. x 40' high)	1,320,000	GAL			1,250,040			0.947	1,250,040
Circular Steel Tank (100' dia. x 32' high)	1,880,000	GAL			1,601,760			0.852	1,601,760
**** Total Special Construction**					**3,551,920**				**3,551,920**
Mechanical									
Process Pipe, Fittings, Valves, Etc.	1	LS			6,400,000			6,400,000.000	6,400,000
**** Total Mechanical**					**6,400,000**				**6,400,000**
Electrical									
Electrical & Controls	1	LSUM			11,267,000			11,267,000.000	11,267,000
**** Total Electrical**					**11,267,000**				**11,267,000**
*** Total Phase 2 - Raw Water Augmentation to**			**9,972,332**	**9,860,551**	**39,154,524**	**2,251,111**	**18,715,725**		**79,954,243**

Purified Water Feasibility Study

Opinion of Probable Capital Cost

Date: 2022.06.03

Facilities: Advanced Water Purification Facilities (Ch 6)

Project number: 0011242.00

Phase 1 Combined Train AWPF

ENR CCI (San Francisco, February 2022): 14395.70

	%		$
Gross Construction Cost	--	$	66,871,743
Level of Development Contingency	25%	$	16,718,000
Direct Construction Cost		**$**	**83,589,743**
General Liability Insurance	1%	$	836,000
Builders' Risk Insurance	0.2%	$	167,000
Trade Contractor Overhead	10%	$	8,359,000
Trade Contractor Profit	12%	$	10,031,000
P&P Bond	2.5%	$	2,090,000
Subtotal Other Construction Costs		**$**	**21,483,000**
Total Construction Cost		**$**	**105,072,743**
Bid Market Adjustment	15%	$	15,761,000
Legal/Administration	5%	$	5,254,000
Environmental and Permitting	5%	$	5,254,000
Design	10%	$	10,507,000
Engineering Services During Construction	5%	$	5,254,000
Construction Management	12%	$	12,609,000
Owner's Reserve for Change Orders	10%	$	10,507,000
Non-Construction Cost		**$**	**65,146,000**
Total Capital Cost		**$**	**170,218,743**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$	136,175,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$	221,284,000

Detail - With Taxes and Insurance | **Partial Report** | Group 1: Phase
Group 2: Divisions

Estimator : K. Rosner
Project Size : 0 SQFT

Phase 1 Combined Train AWPF

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Phase 1 - Groundwater Recharge to Quarry Lakes									
General Conditions									
Contractor General Conditions	24	MO	1,654,526	192,271	88,104	111,735		85,276.512	2,046,636
**** Total General Conditions**			**1,654,526**	**192,271**	**88,104**	**111,735**			**2,046,636**
Sitework									
Building Piles, 30' depth, 5' spacing	67,890	LNFT	2,577,433	5,948,700		1,144,376		142.444	9,670,509
Tank Piles, 30' depth, 5' spacing	5,940	LNFT	225,511	520,478		100,127		142.444	846,116
Yard Piping & Site Utilities	1	LS			1,731,000			1,731,000.000	1,731,000
Access Road, 850 LF x 18' wide	45,000	SQFT			225,000			5.000	225,000
Misc. Site Improvements	1	LS			113,000			113,000.000	113,000
Landscaping	1	LS			100,000			100,000.000	100,000
Security Fence	2,500	LNFT			137,500			55.000	137,500
**** Total Sitework**			**2,802,945**	**6,469,178**	**2,306,500**	**1,244,502**			**12,823,125**
Concrete									
Chemical Storage Pad (60' x 150')	9,000	SQFT			360,000			40.000	360,000
Post Treatment Pad (60' x 90')	5,400	SQFT			216,000			40.000	216,000
**** Total Concrete**					**576,000**				**576,000**
Pre-Engineered Metal Buildings - Complete									
Treatment Building, 360' x 150' x 15'	54,000	SQFT			19,440,000			360.000	19,440,000
**** Total Pre-Engineered Metal Buildings - Com**					**19,440,000**				**19,440,000**
Equipment									
Microfiltration Equipment	1	LSUM	902,265			67,275	5,163,750	6,133,290.000	6,133,290
Reverse Osmosis Equipment	1	LSUM	1,082,718			82,800	5,278,500	6,444,018.000	6,444,018
Chemical Storage Tanks, Pumps, Etc.	1	LSUM	72,181				286,875	359,056.200	359,056
UV Disinfection Equipment	1	LSUM	406,019			31,050	2,409,750	2,846,819.250	2,846,819
Post Treatment System	1	LSUM	144,362			10,350	573,750	728,462.400	728,462
MF Feed Pumping Equipment	1	LSUM	7,218				34,425	41,643.120	41,643
RO Transfer Pumping Equipment	1	LSUM	7,218				34,425	41,643.120	41,643
**** Total Equipment**			**2,621,982**			**191,475**	**13,781,475**		**16,594,932**
Special Construction									
Circular Steel Tank (50' dia. x 16' high) - MF Filtrate EQ	235,000	GAL			450,025			1.915	450,025
Circular Steel Tank (50' dia. x 16' high) - MF Feed EQ	235,000	GAL			450,025			1.915	450,025
**** Total Special Construction**					**900,050**				**900,050**
Mechanical									
Process Pipe, Fittings, Valves, Etc.	1	LS			4,400,000			4,400,000.000	4,400,000
**** Total Mechanical**					**4,400,000**				**4,400,000**

Detail - With Taxes and Insurance

Partial Report

Group 1: Phase
Group 2: Divisions

Estimator : K. Rosner
Project Size : 0 SQFT

Phase 1 Combined Train AWPF

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Electrical									
New Electrical Service	1	LSUM			1,000,000			1,000,000.000	1,000,000
Electrical & Controls	1	LSUM			9,091,000			9,091,000.000	9,091,000
** Total Electrical					**10,091,000**				**10,091,000**
* Total Phase 1 - Groundwater Recharge to Qu			**7,079,453**	**6,661,449**	**37,801,654**	**1,547,712**	**13,781,475**		**66,871,743**

Purified Water Feasibility Study

Opinion of Probable Capital Cost

Date: 2022.02.25

Facilities: Advanced Water Purification Facilities (Ch 6)

Project number: 0011242.00

Phase 2 Combined Train AWPF

ENR CCI (San Francisco, February 2022): 14395.70

	%	$	
Gross Construction Cost	--	$	48,136,000
Level of Development Contingency	25%	$	12,034,000
Direct Construction Cost		**$**	**60,170,000**
General Liability Insurance	1%	$	602,000
Builders' Risk Insurance	0.2%	$	120,000
Trade Contractor Overhead	10%	$	6,017,000
Trade Contractor Profit	12%	$	7,220,000
P&P Bond	2.5%	$	1,504,000
Subtotal Other Construction Costs		**$**	**15,463,000**
Total Construction Cost		**$**	**75,633,000**
Bid Market Adjustment	15%	$	11,345,000
Legal/Administration	5%	$	3,782,000
Environmental and Permitting	5%	$	3,782,000
Design	10%	$	7,563,000
Engineering Services During Construction	5%	$	3,782,000
Construction Management	12%	$	9,076,000
Owner's Reserve for Change Orders	10%	$	7,563,000
Non-Construction Cost		**$**	**46,893,000**
Total Capital Cost		**$**	**122,526,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$	98,021,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$	159,284,000

Phase 2 Combined Train AWPF

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Phase 2 - Raw Water Augmentation to WTP 2									
General Conditions									
Contractor General Conditions	24	MO	1,654,526	192,271	88,104	111,735		85,276.512	2,046,636
**** Total General Conditions**			**1,654,526**	**192,271**	**88,104**	**111,735**			**2,046,636**
Sitework									
Concrete Struct. Piles, 30' depth, 5' spacing	10,950	LNFT	415,715	959,468		184,577		142.444	1,559,759
Tank Piles, 30' depth, 5' spacing	17,550	LNFT	666,283	1,537,777		295,828		142.444	2,499,888
Yard Piping & Site Utilities	1	LS			1,224,300			1,224,300.000	1,224,300
Access Road, 850 LF x 18' wide	5,000	SQFT			25,000			5.000	25,000
Misc. Site Improvements	1	LS			13,000			13,000.000	13,000
Landscaping	1	LS			10,000			10,000.000	10,000
Security Fence	200	LNFT			11,000			55.000	11,000
**** Total Sitework**			**1,081,998**	**2,497,245**	**1,283,300**	**480,405**			**5,342,948**
Concrete									
BAC Filter Concrete Structure (70' x 100')	2,500	CUYD			5,500,000			2,200.000	5,500,000
Ozone Contactor Concrete Structure (20' x 85')	640	CUYD			1,216,000			1,900.000	1,216,000
**** Total Concrete**					**6,716,000**				**6,716,000**
Equipment									
Reverse Osmosis Equipment	1	LSUM	451,133			31,050	2,409,750	2,891,932.500	2,891,933
UV Disinfection (Low Dose) Equipment	1	LSUM	81,204				459,000	540,203.850	540,204
BAC Treatment System	1	LSUM	902,265			67,275	5,852,250	6,821,790.000	6,821,790
Ozone Disinfection Equipment	1	LSUM	1,082,718			82,800	6,196,500	7,362,018.000	7,362,018
Post Treatment System	1	LSUM	36,091				229,500	265,590.600	265,591
LOX Storage & Vaporizer Equipment	1	LSUM	225,566				918,000	1,143,566.250	1,143,566
**** Total Equipment**			**2,778,976**			**181,125**	**16,065,000**		**19,025,101**
Special Construction									
Circular Steel Tank (100' dia. x 32' high)	1,880,000	GAL			1,601,760			0.852	1,601,760
Circular Steel Tank (75' dia. x 40' high)	1,320,000	GAL			1,250,040			0.947	1,250,040
**** Total Special Construction**					**2,851,800**				**2,851,800**
Mechanical									
Process Pipe, Fittings, Valves, Etc.	1	LS			5,500,000			5,500,000.000	5,500,000
**** Total Mechanical**					**5,500,000**				**5,500,000**
Electrical									
Electrical & Controls	1	LSUM			6,654,000			6,654,000.000	6,654,000
**** Total Electrical**					**6,654,000**				**6,654,000**
*** Total Phase 2 - Raw Water Augmentation to**			**5,515,501**	**2,689,516**	**23,093,204**	**773,265**	**16,065,000**		**48,136,485**

Purified Water Feasibility Study

Opinion of Probable Capital Cost

Date: 2022.02.25

Facilities: Advanced Water Purification Facilities (Ch 6)

Project number: 0011242.00

Phase 1 tMBR

ENR CCI (San Francisco, February 2022): 14395.70

	%		$
Gross Construction Cost	--	$	40,708,000
Level of Development Contingency	25%	$	10,177,000
Direct Construction Cost		**$**	**50,885,000**
General Liability Insurance	1%	$	509,000
Builders' Risk Insurance	0.2%	$	102,000
Trade Contractor Overhead	10%	$	5,089,000
Trade Contractor Profit	12%	$	6,106,000
P&P Bond	2.5%	$	1,272,000
Subtotal Other Construction Costs		**$**	**13,078,000**
Total Construction Cost		**$**	**63,963,000**
Bid Market Adjustment	15%	$	9,594,000
Legal/Administration	5%	$	3,198,000
Environmental and Permitting	5%	$	3,198,000
Design	10%	$	6,396,000
Engineering Services During Construction	5%	$	3,198,000
Construction Management	12%	$	7,676,000
Owner's Reserve for Change Orders	10%	$	6,396,000
Non-Construction Cost		**$**	**39,656,000**
Total Capital Cost		**$**	**103,619,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$	82,895,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$	134,705,000

Detail - With Taxes and Insurance

Partial Report

Group 1: Phase
Group 2: Divisions

Estimator : K. Rosner
Project Size : 0 SQFT

Phase 1 tMBR

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Phase 1 - Groundwater Recharge to Quarry Lakes									
General Conditions									
Contractor General Conditions	24	MO	1,654,526	192,271	88,104	111,735		85,276.512	2,046,636
**** Total General Conditions**			**1,654,526**	**192,271**	**88,104**	**111,735**			**2,046,636**
Sitework									
Building Piles, 30' depth, 5' spacing	10,920	LNFT	414,576	956,839		184,071		142.444	1,555,486
Concrete Struct. Piles, 30' depth, 5' spacing	49,680	LNFT	1,886,093	4,353,092		837,422		142.444	7,076,607
Tank Piles, 30' depth, 5' spacing	2,970	LNFT	112,756	260,239		50,063		142.444	423,058
Yard Piping & Site Utilities	1	LS			1,062,000			1,062,000.000	1,062,000
Misc. Site Improvements	1	LS			60,000			60,000.000	60,000
Landscaping	1	LS			100,000			100,000.000	100,000
**** Total Sitework**			**2,413,425**	**5,570,170**	**1,222,000**	**1,071,556**			**10,277,151**
Concrete									
Screening Facility Pad (55' x 60')	3,300	SQFT			132,000			40.000	132,000
Bio Contact Basins Concrete Structure (252' x 129' x 20')	4,000	CUYD			8,800,000			2,200.000	8,800,000
Membrane Tanks Concrete Structure (96' x 54')	800	CUYD			1,520,000			1,900.000	1,520,000
Chemical Storage Pad (60' x 40')	2,400	SQFT			96,000			40.000	96,000
**** Total Concrete**					**10,548,000**				**10,548,000**
Pre-Engineered Metal Buildings - Complete									
Blower Building, 60' x 75' x 15'	4,500	SQFT			1,620,000			360.000	1,620,000
RAS Pump Station Building (55' x 60')	3,300	SQFT			1,188,000			360.000	1,188,000
**** Total Pre-Engineered Metal Buildings - Com**					**2,808,000**				**2,808,000**
Equipment									
MBR Equipment	1	LSUM	1,082,718			82,800	5,508,000	6,673,518.000	6,673,518
**** Total Equipment**			**1,082,718**			**82,800**	**5,508,000**		**6,673,518**
Special Construction									
Circular Steel Tank (50' dia. x 24' high) - Flow EQ	350,000	GAL			550,200			1.572	550,200
**** Total Special Construction**					**550,200**				**550,200**
Mechanical									
Process Pipe, Fittings, Valves, Etc.	1	LS			2,000,000			2,000,000.000	2,000,000
**** Total Mechanical**					**2,000,000**				**2,000,000**
Electrical									
Electrical & Controls	1	LSUM			5,804,000			5,804,000.000	5,804,000
**** Total Electrical**					**5,804,000**				**5,804,000**
*** Total Phase 1 - Groundwater Recharge to Qu**			**5,150,670**	**5,762,441**	**23,020,304**	**1,266,091**	**5,508,000**		**40,707,506**

Purified Water Feasibility Study

Opinion of Probable Capital Cost

Date: 2022.02.25

Facilities: Advanced Water Purification Facilities (Ch 6)

Project number: 0011242.00

Phase 2 tMBR

ENR CCI (San Francisco, February 2022): 14395.70

	%	$	
Gross Construction Cost	--	$	6,883,000
Level of Development Contingency	25%	$	1,721,000
Direct Construction Cost		**$**	**8,604,000**
General Liability Insurance	1%	$	86,000
Builders' Risk Insurance	0.2%	$	17,000
Trade Contractor Overhead	10%	$	860,000
Trade Contractor Profit	12%	$	1,032,000
P&P Bond	2.5%	$	215,000
Subtotal Other Construction Costs		**$**	**2,210,000**
Total Construction Cost		**$**	**10,814,000**
Bid Market Adjustment	15%	$	1,622,000
Legal/Administration	5%	$	541,000
Environmental and Permitting	5%	$	541,000
Design	10%	$	1,081,000
Engineering Services During Construction	5%	$	541,000
Construction Management	12%	$	1,298,000
Owner's Reserve for Change Orders	10%	$	1,081,000
Non-Construction Cost		**$**	**6,705,000**
Total Capital Cost		**$**	**17,519,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$	14,015,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$	22,775,000

Estimate Detail - Alameda County Water District - Water Reuse Facility

Detail - With Taxes and Insurance

Partial Report

Group 1: Phase
Group 2: Divisions

Estimator : K. Rosner
Project Size : 0 SQFT

Phase 2 tMBR

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Phase 2 - Raw Water Augmentation to WTP 2									
General Conditions									
Contractor General Conditions	8	MO	551,509	64,090	29,368	37,245		85,276.512	682,212
**** Total General Conditions**			**551,509**	**64,090**	**29,368**	**37,245**			**682,212**
Equipment									
MBR Equipment	1	LSUM	631,586			46,575	3,901,500	4,579,660.500	4,579,661
**** Total Equipment**			**631,586**			**46,575**	**3,901,500**		**4,579,661**
Mechanical									
Process Pipe, Fittings, Valves, Etc.	1	LS			695,000			695,000.000	695,000
**** Total Mechanical**					**695,000**				**695,000**
Electrical									
Electrical & Controls	1	LSUM			926,000			926,000.000	926,000
**** Total Electrical**					**926,000**				**926,000**
*** Total Phase 2 - Raw Water Augmentation to**			**1,183,094**	**64,090**	**1,650,368**	**83,820**	**3,901,500**		**6,882,873**

Purified Water Feasibility Study

Opinion of Probable Capital Cost

Date: 2022.02.25

Facilities: Advanced Water Purification Facilities (Ch 6)

Project number: 0011242.00

Pit 2 Site Work

ENR CCI (San Francisco, February 2022): 14395.70

	%		$
Gross Construction Cost	--	$	28,326,000
Level of Development Contingency	25%	$	7,082,000
Direct Construction Cost		**$**	**35,408,000**
General Liability Insurance	1%	$	354,000
Builders' Risk Insurance	0.2%	$	71,000
Trade Contractor Overhead	10%	$	3,541,000
Trade Contractor Profit	12%	$	4,249,000
P&P Bond	2.5%	$	885,000
Subtotal Other Construction Costs		**$**	**9,100,000**
Total Construction Cost		**$**	**44,508,000**
Bid Market Adjustment	15%	$	6,676,000
Legal/Administration	5%	$	2,225,000
Environmental and Permitting	5%	$	2,225,000
Design	10%	$	4,451,000
Engineering Services During Construction	5%	$	2,225,000
Construction Management	12%	$	5,341,000
Owner's Reserve for Change Orders	10%	$	4,451,000
Non-Construction Cost		**$**	**27,594,000**
Total Capital Cost		**$**	**72,102,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$	57,682,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$	93,733,000

Estimate Detail - Alameda County Water District - Water Reuse Facility

Detail - With Taxes and Insurance | **Partial Report** | Group 1: Phase | Group 2: Divisions

Estimator : K. Rosner
Project Size : 0 SQFT

Pit 2 Site Work

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Phase 0 - Site Preparation									
General Conditions									
Contractor General Conditions	6	MO	413,632	48,068	22,026	27,934		85,276.512	511,659
**** Total General Conditions**			**413,632**	**48,068**	**22,026**	**27,934**			**511,659**
Sitework									
Pump Groundwater @ Pit 2	114,000,000	GAL			2,280,000			0.020	2,280,000
Dewatering During Fill Operation	1	LS			2,500,000			2,500,000.000	2,500,000
Clean Up and Prep Pit Bottom	696,000	SQFT	202,839	34,377		161,793		0.573	399,008
Hauling Debris & Unsuitables	1,000	CUYD			10,000			10.000	10,000
Purchase Fill Material	1,400,000	CUYD		6,174,000				4.410	6,174,000
Trucking For Fill Material (assume 1 hr cycle time)	1,400,000	CUYD			14,000,000			10.000	14,000,000
Spread & Compact Fill Material	1,400,000	CUYD	2,083,578	98,784		268,500		1.751	2,450,862
**** Total Sitework**			**2,286,417**	**6,307,161**	**18,790,000**	**430,293**			**27,813,870**
*** Total Phase 0 - Site Preparation**			**2,700,048**	**6,355,229**	**18,812,026**	**458,226**			**28,325,529**

Chapter 6 - O&M Cost Summary

	Phase 1 AWPF	Phase 2 AWPF	Phase 1+2 AWPF	Phase 1 Combined Train	Phase 1+2 Combined Train	Phase 1 tMBR	Phase 2 tMBR
Consumables	**$ 560,000**	**$ 350,000**	**$ 910,000**	**$ 560,000**	**$ 565,000**	**$ 400,000**	**$ 600,000**
tMBR	$ -	$ -	$ -	$ -	$ -	$ 400,000	$ 600,000
O3	$ -	$ 60,000	$ 60,000	$ -	$ 80,000	$ -	$ -
BAC	$ -	$ 20,000	$ 20,000	$ -	$ 20,000	$ -	$ -
Chloramines	$ 10,000	$ -	$ 10,000	$ 10,000	$ 5,000	$ -	$ -
MF	$ 210,000	$ 40,000	$ 250,000	$ 210,000	$ 100,000	$ -	$ -
Low Dose UV	$ -	$ 30,000	$ 30,000	$ -	$ 50,000	$ -	$ -
RO	$ 210,000	$ 120,000	$ 330,000	$ 210,000	$ 230,000	$ -	$ -
UV/AOP	$ 100,000	$ 60,000	$ 160,000	$ 100,000	$ 30,000	$ -	$ -
Product water stabalization	$ 30,000	$ 20,000	$ 50,000	$ 30,000	$ 50,000	$ -	$ -
Power	**$ 1,990,000**	**$ 1,330,000**	**$ 3,320,000**	**$ 1,990,000**	**$ 3,150,000**	**$ 800,000**	**$ 1,200,000**
tMBR	$ -	$ -	$ -	$ -	$ -	$ 800,000	$ 1,200,000
O3	$ -	$ 300,000	$ 300,000	$ -	$ 720,000	$ -	$ -
BAC	$ -	$ -	$ -	$ -	$ 10,000	$ -	$ -
Chloramines	$ -	$ -	$ -	$ -	$ -	$ -	$ -
MF	$ 160,000	$ 60,000	$ 220,000	$ 160,000	$ 130,000	$ -	$ -
Low Dose UV	$ -	$ 30,000	$ 30,000	$ -	$ 60,000	$ -	$ -
RO	$ 1,510,000	$ 870,000	$ 2,380,000	$ 1,510,000	$ 2,070,000	$ -	$ -
UV/AOP	$ 320,000	$ 70,000	$ 390,000	$ 320,000	$ 160,000	$ -	$ -
Product water stabalization	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Chemicals	**$ 1,700,000**	**$ 870,000**	**$ 2,570,000**	**$ 1,700,000**	**$ 2,055,000**	**$ 3,600,000**	**$ 6,100,000**
tMBR	$ -	$ -	$ -	$ -	$ -	$ 3,600,000	$ 6,100,000
O3	$ -	$ 140,000	$ 140,000	$ -	$ 330,000	$ -	$ -
BAC	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Chloramines	$ 140,000	$ 50,000	$ 190,000	$ 140,000	$ 115,000	$ -	$ -
MF	$ 640,000	$ 20,000	$ 660,000	$ 640,000	$ 50,000	$ -	$ -
Low Dose UV	$ -	$ -	$ -	$ -	$ -	$ -	$ -
RO	$ 420,000	$ 310,000	$ 730,000	$ 420,000	$ 730,000	$ -	$ -
UV/AOP	$ 30,000	$ 10,000	$ 40,000	$ 30,000	$ 20,000	$ -	$ -
Product water stabalization	$ 470,000	$ 340,000	$ 810,000	$ 470,000	$ 810,000	$ -	$ -
Labor	**$ 610,000**	**$ 860,000**	**$ 1,470,000**	**$ 610,000**	**$ 1,200,000**	**$ 600,000**	**$ 900,000**
tMBR	$ -	$ -	$ -	$ -	$ -	$ 600,000	$ 900,000
O3	$ -	$ 160,000	$ 160,000	$ -	$ 240,000	$ -	$ -
BAC	$ -	$ 20,000	$ 20,000	$ -	$ 20,000	$ -	$ -
Chloramines	$ -	$ -	$ -	$ -	$ -	$ -	$ -
MF	$ 200,000	$ 200,000	$ 400,000	$ 200,000	$ 200,000	$ -	$ -
Low Dose UV	$ -	$ 70,000	$ 70,000	$ -	$ 110,000	$ -	$ -
RO	$ 200,000	$ 200,000	$ 400,000	$ 200,000	$ 300,000	$ -	$ -
UV/AOP	$ 140,000	$ 140,000	$ 280,000	$ 140,000	$ 220,000	$ -	$ -
Product water stabalization	$ 70,000	$ 70,000	$ 140,000	$ 70,000	$ 110,000	$ -	$ -
Total	**$ 4,860,000**	**$ 3,410,000**	**$ 8,270,000**	**$ 4,860,000**	**$ 6,970,000**	**$ 5,400,000**	**$ 8,800,000**

APPENDIX G: DETAILED COST ESTIMATE – CONVEYANCE

Purified Water Feasibility Study

Operations & Maintenance Costs

Date: 2022.2.23

Facilities: Conveyance Facilities (Ch 7)

Project number: 0011242.00

ENR CCI: 14395.70 (San Francisco as of Feb. 2022)

	%	Alignment 1	Alignment 2	Alignment 3	Alignment 4	Alignment 5	Alignment 6
Gross Construction Cost	--	$ 47,404,000	$ 3,507,000	$23,138,000	$ 30,578,000	$18,285,000	$ 22,067,000
Level of Development Contingency	25%	$ 11,851,000	$ 877,000	$ 5,785,000	$ 7,645,000	$ 4,571,000	$ 5,517,000
Direct Construction Cost		**$ 59,255,000**	**$ 4,384,000**	**$28,923,000**	**$ 38,223,000**	**$22,856,000**	**$ 27,584,000**
General Liability Insurance	1%	$ 593,000	$ 44,000	$ 289,000	$ 382,000	$ 229,000	$ 276,000
Builders' Risk Insurance	0.2%	$ 119,000	$ 9,000	$ 58,000	$ 76,000	$ 46,000	$ 55,000
Trade Contractor Overhead	10%	$ 5,926,000	$ 438,000	$ 2,892,000	$ 3,822,000	$ 2,286,000	$ 2,758,000
Trade Contractor Profit	12%	$ 7,111,000	$ 526,000	$ 3,471,000	$ 4,587,000	$ 2,743,000	$ 3,310,000
P&P Bond	2.5%	$ 1,481,000	$ 110,000	$ 723,000	$ 956,000	$ 571,000	$ 690,000
Subtotal Other Construction Costs		**$ 15,230,000**	**$ 1,127,000**	**$ 7,433,000**	**$ 9,823,000**	**$ 5,875,000**	**$ 7,089,000**
Total Construction Cost		**$ 74,485,000**	**$ 5,511,000**	**$36,356,000**	**$ 48,046,000**	**$28,731,000**	**$ 34,673,000**
Bid Market Adjustment	15%	$ 11,173,000	$ 827,000	$ 5,453,000	$ 7,207,000	$ 4,310,000	$ 5,201,000
Legal/Administration	5%	$ 3,724,000	$ 276,000	$ 1,818,000	$ 2,402,000	$ 1,437,000	$ 1,734,000
Environmental and Permitting	5%	$ 3,724,000	$ 276,000	$ 1,818,000	$ 2,402,000	$ 1,437,000	$ 1,734,000
Design	10%	$ 7,449,000	$ 551,000	$ 3,636,000	$ 4,805,000	$ 2,873,000	$ 3,467,000
Engineering Services During Construction	5%	$ 3,724,000	$ 276,000	$ 1,818,000	$ 2,402,000	$ 1,437,000	$ 1,734,000
Construction Management	12%	$ 8,938,000	$ 661,000	$ 4,363,000	$ 5,766,000	$ 3,448,000	$ 4,161,000
Owner's Reserve for Change Orders	10%	$ 7,449,000	$ 551,000	$ 3,636,000	$ 4,805,000	$ 2,873,000	$ 3,467,000
Non-Construction Cost		**$ 46,181,000**	**$ 3,418,000**	**$ 22,542,000**	**$ 29,789,000**	**$ 17,815,000**	**$ 21,498,000**
Total Capital Cost		**$ 120,666,000**	**$ 8,929,000**	**$ 58,898,000**	**$ 77,835,000**	**$ 46,546,000**	**$ 56,171,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$ 96,533,000	$ 7,143,000	$ 47,118,000	$ 62,268,000	$ 37,237,000	$ 44,937,000
Expected Accuracy Range, High Bound (Class 4)	+30%	$ 156,866,000	$ 11,608,000	$ 76,567,000	$ 101,186,000	$ 60,510,000	$ 73,022,000

Estimate Detail - ACWD SFPUC Pipeline Alignment Evaluation

Detail - With Taxes and Insurance

Group 1: Area
Group 2: Divisions

Estimator : JBrockington
Project Size : 0 SQFT

Description	Quantity	UM	Labor	Material	Subcontract	Cons. Eqp.	Proc. Eqp.	Unit Cost	Total Cost
Alignment #1									
General Requirements									
General Requirements	18.00	MO	592,317.36	107,170.56		418,355.28		62,102.40	1,117,843
**** Total General Requirements**	**1.00**	**LS**	**592,317.36**	**107,170.56**		**418,355.28**		**1,117,843.20**	**1,117,843**
Earthwork									
Excavate pipe trench w/backhoe	55,556.00	CUYD	1,392,918.64	123,271.89		184,403.98		30.61	1,700,595
Machine backfill pipe trench	61,754.00	CUYD	1,318,931.74	116,725.57		174,610.45		26.08	1,610,268
Excess pipe excavation soil	9,818.00	CUYD	74,063.06	10,438.50		102,157.91		19.01	186,659
Brace pipe trench w/jacks	600,000.00	SQFT	4,669,092.00	556,851.00		1,388,928.60		11.02	6,614,872
Bay Mud Construction Factor:	22,500.00	LNFT	1,663,353.90	276,897.15	562,500.00	494,812.80		133.23	2,997,564
>Offsite Hauling and Disposal		****							
>Import Suitable Backfill Material		****							
>Over Excavation Due to Groundwater		****							
>Reduced Production Rates		****							
>Additional Trench Shoring		****							
HDD Crossing (Qty-2)	1,200.00	LNFT	87,055.34	86,121.86		174,476.16		289.71	347,653
Jack & Bore Crossing (Qty-2)	650.00	LNFT	78,591.67	77,748.88		157,513.18		482.85	313,854
Launching and Receiving Pits	4.00	SETS	31,158.67	2,636.74		10,088.35		10,970.94	43,884
**** Total Earthwork**	**1.00**	**LS**	**9,315,165.03**	**1,250,691.58**	**562,500.00**	**2,686,991.43**		**13,815,348.05**	**13,815,348**
Site Construction									
Trench Paving, 6' wide	13,346.00	TONS	681,050.32	991,800.89		209,377.74		141.03	1,882,229
* Asphalt pavement area *	25,000.00	SQYD							
Traffic Control - Low	16,000.00	LNFT	1,199,461.76	17,011.20		54,316.80		79.42	1,270,790
Traffic Control - High	21,000.00	LNFT	1,967,866.95	27,909.00		89,113.50		99.28	2,084,889
**** Total Site Construction**	**1.00**	**LS**	**3,848,379.03**	**1,036,721.09**		**352,808.04**		**5,237,908.16**	**5,237,908**
Utilities									
36" HDPE DR17 Sewer Pipe	37,500.00	LNFT	2,609,607.00	7,799,984.06		1,291,680.00		312.03	11,701,271
Blowoffs	20.00	EACH	15,579.34	12,707.83		5,044.18		1,666.57	33,331
Gate Valves, 36"	19.00	EACH	74,001.85	233,521.25		23,959.84		17,446.47	331,483
Clearwell Tank	54,500.00	GAL	212,272.05	78,321.51		68,726.90		6.59	359,320
* Drainage pipe length *	37,500.00	LNFT							
Intersection Crossings (Allowance)	61.00	EACH	424,496.07	26,460.92		210,113.28		10,837.22	661,070
>Assumes Pipe Crew & Equipment 2-Days Per Intersection		****							
**** Total Utilities**	**1.00**	**LS**	**3,335,956.30**	**8,150,995.58**		**1,599,524.19**		**13,086,476.07**	**13,086,476**
Wastewater Treatment Equipment									
Pump Station #1	1,200.00	SQFT	7,788,880.73	659,117.42		2,521,833.18	2,855,961.36	11,521.49	13,825,793
Pumps, 150 HP (3-Duty, 1-Standby)	4.00	EACH	62,317.34	237,891.00		20,176.70		80,096.26	320,385
**** Total Wastewater Treatment Equipment**	**1.00**	**LS**	**7,851,198.08**	**897,008.42**		**2,542,009.89**	**2,855,961.36**	**14,146,177.74**	**14,146,178**
*** Total Alignment #1**	**37,500.00**	**LNFT**	**24,943,015.80**	**11,442,587.23**	**562,500.00**	**7,599,688.83**	**2,855,961.36**	**1,264.10**	**47,403,753**

Detail - With Taxes and Insurance

Group 1: Area
Group 2: Divisions

Estimator : JBrockington
Project Size : 0 SQFT

Description	Quantity	UM	Labor	Material	Subcontract	Cons. Eqp.	Proc. Eqp.	Unit Cost	Total Cost
Alignment #2									
General Requirements									
General Requirements	2.00	MO	65,813.04	11,907.84		46,483.92		62,102.40	124,205
**** Total General Requirements**	**1.00**	**LS**	**65,813.04**	**11,907.84**		**46,483.92**		**124,204.80**	**124,205**
Earthwork									
Excavate pipe trench w/backhoe	1,284.00	CUYD	32,192.88	2,849.04		4,261.91		30.61	39,304
Machine backfill pipe trench	1,688.00	CUYD	36,052.03	3,190.61		4,772.85		26.08	44,015
Excess pipe excavation soil	34.00	CUYD	256.48	36.15		353.78		19.01	646
Brace pipe trench w/jacks	41,600.00	SQFT	323,723.71	38,608.34		96,299.05		11.02	458,631
**** Total Earthwork**	**1.00**	**LS**	**392,225.10**	**44,684.13**		**105,687.58**		**542,596.81**	**542,597**
Site Construction									
Trench Paving, 4' wide	618.00	TONS	35,246.90	51,329.41		10,836.10		157.63	97,412
* Asphalt pavement area *	1,156.00	SQYD							
Traffic Control - High	2,600.00	LNFT	243,640.67	3,455.40		11,033.10		99.28	258,129
**** Total Site Construction**	**1.00**	**LS**	**278,887.57**	**54,784.81**		**21,869.20**		**355,541.58**	**355,542**
Utilities									
8" HDPE DR17 Sewer Pipe	2,600.00	LNFT	36,166.61	57,200.12		11,709.62		40.41	105,076
Blowoffs	2.00	EACH	1,557.93	1,270.78		504.42		1,666.57	3,333
Gate Valves, 8"	1.00	EACH	1,298.28	995.86		420.35		2,714.49	2,714
Clearwell Tank	2,500.00	GAL	9,737.25	3,592.73		3,152.61		6.59	16,483
* Drainage pipe length *	2,600.00	LNFT							
Intersection Crossings (Allowance)	1.00	EACH	6,958.95	433.79		3,444.48		10,837.22	10,837
**** Total Utilities**	**1.00**	**LS**	**55,719.02**	**63,493.28**		**19,231.47**		**138,443.78**	**138,444**
Wastewater Treatment Equipment									
Pump Station #2	200.00	SQFT	1,501,339.54	127,047.64		486,093.94	220,199.42	11,673.40	2,334,681
Pumps, 3 HP (1-Duty, 1-Standby)	2.00	EACH	3,894.83	5,980.50		1,261.04		5,568.19	11,136
**** Total Wastewater Treatment Equipment**	**1.00**	**LS**	**1,505,234.37**	**133,028.14**		**487,354.98**	**220,199.42**	**2,345,816.91**	**2,345,817**
*** Total Alignment #2**	**2,600.00**	**LNFT**	**2,297,879.10**	**307,898.19**		**680,627.16**	**220,199.42**	**1,348.69**	**3,506,604**

Detail - With Taxes and Insurance

Group 1: Area
Group 2: Divisions

Estimator : JBrockington
Project Size : 0 SQFT

Description	Quantity	UM	Labor	Material	Subcontract	Cons. Eqp.	Proc. Eqp.	Unit Cost	Total Cost
Alignment #3									
General Requirements									
General Requirements	20.00	MO	658,130.40	119,078.40		464,839.20		62,102.40	1,242,048
**** Total General Requirements**	**1.00**	**LS**	**658,130.40**	**119,078.40**		**464,839.20**		**1,242,048.00**	**1,242,048**
Earthwork									
Excavate pipe trench w/backhoe	19,654.00	CUYD	492,771.67	43,609.79		65,236.44		30.61	601,618
Machine backfill pipe trench	25,940.00	CUYD	554,022.24	49,031.02		73,345.78		26.08	676,399
Excess pipe excavation soil	515.00	CUYD	3,884.95	547.55		5,358.66		19.01	9,791
Brace pipe trench w/jacks	636,800.00	SQFT	4,955,462.98	591,004.53		1,474,116.22		11.02	7,020,584
Bay Mud Construction Factor:	24,800.00	LNFT	1,833,385.63	305,202.19	620,000.00	545,393.66		133.23	3,303,981
>Offsite Hauling and Disposal		****							
>Import Suitable Backfill Material		****							
>Over Excavation Due to Groundwater		****							
>Reduced Production Rates		****							
>Additional Trench Shoring		****							
HDD Crossing (Qty-2)	1,200.00	LNFT	87,055.34	86,121.86		174,476.16		289.71	347,653
Jack & Bore Crossing (Qty-2)	650.00	LNFT	78,591.67	77,748.88		157,513.18		482.85	313,854
Launching and Receiving Pits	4.00	SETS	31,158.67	2,636.74		10,088.35		10,970.94	43,884
**** Total Earthwork**	**1.00**	**LS**	**8,036,333.16**	**1,155,902.55**	**620,000.00**	**2,505,528.45**		**12,317,764.16**	**12,317,764**
Site Construction									
Trench Paving, 4' wide	9,443.00	TONS	481,879.08	701,751.52		148,145.81		141.03	1,331,776
* Asphalt pavement area *	17,689.00	SQYD							
Traffic Control - Low	19,300.00	LNFT	1,446,850.75	20,519.76		65,519.64		79.42	1,532,890
Traffic Control - High	21,000.00	LNFT	1,967,866.95	27,909.00		89,113.50		99.28	2,084,889
**** Total Site Construction**	**1.00**	**LS**	**3,896,596.77**	**750,180.28**		**302,778.95**		**4,949,556.01**	**4,949,556**
Utilities									
8" HDPE DR17 Sewer Pipe	39,800.00	LNFT	553,627.35	875,619.40		179,247.22		40.41	1,608,494
Blowoffs	20.00	EACH	15,579.34	12,707.83		5,044.18		1,666.57	33,331
Gate Valves, 8"	20.00	EACH	25,965.56	19,917.28		8,406.96		2,714.49	54,290
Clearwell Tank	2,500.00	GAL	9,737.25	3,592.73		3,152.61		6.59	16,483
* Drainage pipe length *	39,800.00	LNFT							
Intersection Crossings (Allowance)	50.00	EACH	347,947.60	21,689.28		172,224.00		10,837.22	541,861
**** Total Utilities**	**1.00**	**LS**	**952,857.10**	**933,526.52**		**368,074.97**		**2,254,458.59**	**2,254,459**
Wastewater Treatment Equipment									
Pump Station #3	200.00	SQFT	1,328,104.64	112,388.01		430,005.07	438,280.41	11,543.89	2,308,778
Pumps, 30 HP (1-Duty, 1-Standby)	2.00	EACH	12,982.78	47,844.00		4,203.48		32,515.13	65,030
**** Total Wastewater Treatment Equipment**	**1.00**	**LS**	**1,341,087.42**	**160,232.01**		**434,208.55**	**438,280.41**	**2,373,808.40**	**2,373,808**
*** Total Alignment #3**	**39,800.00**	**LNFT**	**14,885,004.85**	**3,118,919.77**	**620,000.00**	**4,075,430.13**	**438,280.41**	**581.35**	**23,137,635**

Detail - With Taxes and Insurance

Group 1: Area
Group 2: Divisions

Estimator : JBrockington
Project Size : 0 SQFT

Description	Quantity	UM	Labor	Material	Subcontract	Cons. Eqp.	Proc. Eqp.	Unit Cost	Total Cost
Alignment #4									
General Requirements									
General Requirements	17.00	MO	559,410.84	101,216.64		395,113.32		62,102.40	1,055,741
**** Total General Requirements**	**1.00**	**LS**	**559,410.84**	**101,216.64**		**395,113.32**		**1,055,740.80**	**1,055,741**
Earthwork									
Excavate pipe trench w/backhoe	37,438.00	CUYD	938,658.08	83,070.29		124,265.89		30.61	1,145,994
Machine backfill pipe trench	47,352.00	CUYD	1,011,336.20	89,503.34		133,888.56		26.08	1,234,728
Excess pipe excavation soil	2,363.00	CUYD	17,825.53	2,512.34		24,587.41		19.01	44,925
Brace pipe trench w/jacks	577,600.00	SQFT	4,494,779.23	536,061.90		1,337,075.27		11.02	6,367,916
Bay Mud Construction Factor:	21,100.00	LNFT	1,559,856.32	259,667.99	527,500.00	464,024.45		133.23	2,811,049
>Offsite Hauling and Disposal		****							
>Import Suitable Backfill Material		****							
>Over Excavation Due to Groundwater		****							
>Reduced Production Rates		****							
>Additional Trench Shoring		****							
HDD Crossing (Qty-2)	1,200.00	LNFT	87,055.34	86,121.86		174,476.16		289.71	347,653
Jack & Bore Crossing (Qty-2)	650.00	LNFT	78,591.67	77,748.88		157,513.18		482.85	313,854
Launching and Receiving Pits	4.00	SETS	31,158.67	2,636.74		10,088.35		10,970.94	43,884
**** Total Earthwork**	**1.00**	**LS**	**8,219,261.05**	**1,137,323.33**	**527,500.00**	**2,425,919.26**		**12,310,003.64**	**12,310,004**
Site Construction									
Trench Paving, 5' wide	10,706.00	TONS	546,330.34	795,610.70		167,960.29		141.03	1,509,901
* Asphalt pavement area *	20,056.00	SQYD							
Traffic Control - Low	15,100.00	LNFT	1,131,992.04	16,054.32		51,261.48		79.42	1,199,308
Traffic Control - High	21,000.00	LNFT	1,967,866.95	27,909.00		89,113.50		99.28	2,084,889
**** Total Site Construction**	**1.00**	**LS**	**3,646,189.32**	**839,574.02**		**308,335.27**		**4,794,098.62**	**4,794,099**
Utilities									
18" HDPE DR17 Sewer Pipe	36,100.00	LNFT	585,845.96	3,248,995.67		189,683.28		111.48	4,024,525
Blowoffs	20.00	EACH	15,579.34	12,707.83		5,044.18		1,666.57	33,331
Gate Valves, 18"	18.00	EACH	35,053.51	110,615.33		11,349.40		8,723.24	157,018
Clearwell Tank	14,500.00	GAL	56,476.05	20,837.83		18,285.14		6.59	95,599
* Drainage pipe length *	36,100.00	LNFT							
Intersection Crossings (Allowance)	50.00	EACH	347,947.60	21,689.28		172,224.00		10,837.22	541,861
**** Total Utilities**	**1.00**	**LS**	**1,040,902.45**	**3,414,845.94**		**396,585.99**		**4,852,334.39**	**4,852,334**
Wastewater Treatment Equipment									
Pump Station #4	650.00	SQFT	4,200,029.22	355,418.48		1,359,858.10	1,570,832.04	11,517.14	7,486,138
Pumps, 40 HP (1-Duty, 1-Standby)	2.00	EACH	12,982.78	62,020.00		4,203.48		39,603.13	79,206
**** Total Wastewater Treatment Equipment**	**1.00**	**LS**	**4,213,012.00**	**417,438.48**		**1,364,061.58**	**1,570,832.04**	**7,565,344.10**	**7,565,344**
*** Total Alignment #4**	**36,100.00**	**LNFT**	**17,678,775.66**	**5,910,398.42**	**527,500.00**	**4,890,015.43**	**1,570,832.04**	**847.02**	**30,577,522**

Detail - With Taxes and Insurance

Group 1: Area
Group 2: Divisions

Estimator : JBrockington
Project Size : 0 SQFT

Description	Quantity	UM	Labor	Material	Subcontract	Cons. Eqp.	Proc. Eqp.	Unit Cost	Total Cost
Alignment #5									
General Requirements									
General Requirements	6.00	MO	197,439.12	35,723.52		139,451.76		62,102.40	372,614
**** Total General Requirements**	**1.00**	**LS**	**197,439.12**	**35,723.52**		**139,451.76**		**372,614.40**	**372,614**
Earthwork									
Excavate pipe trench w/backhoe	13,867.00	CUYD	347,678.07	30,769.16		46,027.97		30.61	424,475
Machine backfill pipe trench	16,883.00	CUYD	360,584.33	31,911.74		47,736.96		26.08	440,233
Excess pipe excavation soil	1,362.00	CUYD	10,274.38	1,448.08		14,171.84		19.01	25,894
Brace pipe trench w/jacks	187,200.00	SQFT	1,456,756.70	173,737.51		433,345.72		11.02	2,063,840
Suspended Bridge Crossing	350.00	LNFT	72,864.33	5,060.83		52,743.60		373.34	130,669
**** Total Earthwork**	**1.00**	**LS**	**2,248,157.81**	**242,927.32**		**594,026.09**		**3,085,111.23**	**3,085,111**
Site Construction									
Trench Paving, 6' wide	4,164.00	TONS	237,488.83	345,850.58		73,012.17		157.63	656,352
* Asphalt pavement area *	7,800.00	SQYD							
Traffic Control - Low	5,700.00	LNFT	427,308.25	6,060.24		19,350.36		79.42	452,719
Traffic Control - High	6,000.00	LNFT	562,247.70	7,974.00		25,461.00		99.28	595,683
**** Total Site Construction**	**1.00**	**LS**	**1,227,044.78**	**359,884.82**		**117,823.53**		**1,704,753.12**	**1,704,753**
Utilities									
28" HDPE DR17 Sewer Pipe	11,700.00	LNFT	227,847.79	2,144,609.99		73,771.07		209.08	2,446,229
Blowoffs	7.00	EACH	5,452.77	4,447.74		1,765.46		1,666.57	11,666
Gate Valves, 28"	6.00	EACH	23,369.00	57,795.55		7,566.26		14,788.47	88,731
Clearwell Tank	31,000.00	GAL	120,741.90	44,549.85		39,092.36		6.59	204,384
* Drainage pipe length *	11,700.00	LNFT							
Intersection Crossings (Allowance)	12.00	EACH	83,507.42	5,205.43		41,333.76		10,837.22	130,047
**** Total Utilities**	**1.00**	**LS**	**460,918.88**	**2,256,608.56**		**163,528.92**		**2,881,056.37**	**2,881,056**
Wastewater Treatment Equipment									
Pump Station #5	800.00	SQFT	5,033,627.58	425,960.01		1,629,755.13	2,104,084.58	11,491.78	9,193,427
Pumps, 20 HP (1-Duty, 1-Standby)	2.00	EACH	12,982.78	31,010.00		4,203.48		24,098.13	48,196
Dechlorination System Allowance	1.00	ALLO			1,000,000.00			1,000,000.00	1,000,000
**** Total Wastewater Treatment Equipment**	**1.00**	**LS**	**5,046,610.36**	**456,970.01**	**1,000,000.00**	**1,633,958.61**	**2,104,084.58**	**10,241,623.55**	**10,241,624**
*** Total Alignment #5**	**11,700.00**	**LNFT**	**9,180,170.96**	**3,352,114.23**	**1,000,000.00**	**2,648,788.91**	**2,104,084.58**	**1,562.83**	**18,285,159**

Estimate Detail - ACWD SFPUC Pipeline Alignment Evaluation

Detail - With Taxes and Insurance

Estimator : JBrockington
Project Size : 0 SQFT

Group 1: Area
Group 2: Divisions

Description	Quantity	UM	Labor	Material	Subcontract	Cons. Eqp.	Proc. Eqp.	Unit Cost	Total Cost
Alignment #6									
General Requirements									
General Requirements	13.00	MO	427,784.76	77,400.96		302,145.48		62,102.40	807,331
**** Total General Requirements**	**1.00**	**LS**	**427,784.76**	**77,400.96**		**302,145.48**		**807,331.20**	**807,331**
Earthwork									
Excavate pipe trench w/backhoe	29,334.00	CUYD	735,471.87	65,088.52		97,366.73		30.61	897,927
Machine backfill pipe trench	36,656.00	CUYD	782,892.80	69,286.08		103,645.44		26.08	955,824
Excess pipe excavation soil	2,182.00	CUYD	16,460.14	2,319.90		22,704.07		19.01	41,484
Brace pipe trench w/jacks	432,000.00	SQFT	3,361,746.24	400,932.72		1,000,028.59		11.02	4,762,708
Fault Line Crossing (Add 30% for Seismic Resiliency)	1,000.00	LNFT	72,546.12	60,002.14		145,396.80		277.95	277,945
Microtunnel Crossing (Qty-3)	800.00	LNFT	72,546.12	71,768.22		145,396.80		362.14	289,711
Launching and Receiving Pits	3.00	SETS	23,369.00	1,977.55		7,566.26		10,970.94	32,913
**** Total Earthwork**	**1.00**	**LS**	**5,065,032.29**	**671,375.12**		**1,522,104.70**		**7,258,512.12**	**7,258,512**
Site Construction									
Trench Paving, 5' wide	8,010.00	TONS	456,840.90	665,288.93		140,448.48		157.63	1,262,578
* Asphalt pavement area *	15,000.00	SQYD							
Traffic Control - Low	12,000.00	LNFT	899,596.32	12,758.40		40,737.60		79.42	953,092
Traffic Control - High	15,000.00	LNFT	1,405,619.25	19,935.00		63,652.50		99.28	1,489,207
Traffic Control - Special	4,000.00	LNFT	499,775.60	7,088.00		22,632.14		132.37	529,496
**** Total Site Construction**	**1.00**	**LS**	**3,261,832.07**	**705,070.33**		**267,470.72**		**4,234,373.11**	**4,234,373**
Utilities									
24" HDPE DR17 Sewer Pipe	27,000.00	LNFT	478,003.01	3,230,181.68		154,765.00		143.07	3,862,950
Blowoffs	14.00	EACH	10,905.54	8,895.48		3,530.92		1,666.57	23,332
Gate Valves, 24"	14.00	EACH	54,527.68	116,250.29		17,654.62		13,459.47	188,433
Clearwell Tank	10,500.00	GAL	40,896.45	15,089.47		13,240.96		6.59	69,227
* Drainage pipe length *	27,000.00	LNFT							
Intersection Crossings (Allowance)	57.00	EACH	396,660.26	24,725.78		196,335.36		10,837.22	617,721
Fault Line Crossing (Allowance)	800.00	LNFT	111,343.23	6,940.57		55,111.68		216.74	173,395
**** Total Utilities**	**1.00**	**LS**	**1,092,336.16**	**3,402,083.26**		**440,638.54**		**4,935,057.97**	**4,935,058**
Wastewater Treatment Equipment									
Pump Station #6	400.00	SQFT	2,484,221.31	210,221.93		804,325.00	1,093,072.07	11,479.60	4,591,840
Pumps, 150 HP (2-Duty, 1-Standby)	3.00	EACH	46,738.01	178,418.25		15,132.53		80,096.26	240,289
**** Total Wastewater Treatment Equipment**	**1.00**	**LS**	**2,530,959.32**	**388,640.18**		**819,457.52**	**1,093,072.07**	**4,832,129.09**	**4,832,129**
*** Total Alignment #6**	**27,000.00**	**LNFT**	**12,377,944.60**	**5,244,569.86**		**3,351,816.96**	**1,093,072.07**	**817.31**	**22,067,403**

Purified Water Feasibility Study

Operations & Maintenance Costs

Facilities: Conveyance Facilities (Ch 7)

Date: 2022.2.23

Project number: 0011242.00

ENR CCI: 14395.70 (San Francisco as of Feb. 2022)

		Alignment 1	Alignment 2	Alignment 3	Alignment 4	Alignment 5	Alignment 6
Total Construction Cost	--	$ 74,485,000	$ 5,511,000	$ 36,356,000	$ 48,046,000	$ 28,731,000	$ 34,673,000
Consumables Cost	2% of Construction Cost	**$ 1,490,000**	**$ 110,000**	**$ 727,000**	**$ 961,000**	**$ 575,000**	**$ 693,000**
Total Duty Pump	*hp*	450	3	30	40	20	300
Total Duty Pump Power	*kW = hp * 0.746*	335.7	2.2	22.4	29.8	14.9	223.8
Annual Electricity Demand	*kWh = kW * 365 * 24*	2,940,732	19,605	196,049	261,398	130,699	1,960,488
Annual Power Cost	$0.2 / kWh	**$ 588,000**	**$ 4,000**	**$ 39,000**	**$ 52,000**	**$ 26,000**	**$ 392,000**
Annual Chemical Demand	*Sodium Bisulfite (gpd)*	0	0	0	0	14	0
Annual Chemical Cost	***$1.64 * gpd * 365***	**$ -**	**$ -**	**$ -**	**$ -**	**$ 8,000**	**$ -**
Total Annual O&M Cost	**$**	**$ 2,078,000**	**$ 114,000**	**$ 766,000**	**$ 1,013,000**	**$ 609,000**	**$ 1,085,000**

APPENDIX H: PT GW FACILITY PDR COST ESTIMATE (2004)

Alameda County Water District
Peralta-Tyson Groundwater Treatment Plant
Engineering Estimate - 30% Design Level

Project name	ACWD - Peralta-Tyson GWTP
Architect	MWH
Labor rate table	Labor West Basin
Equipment rate table	MWHC Equipment v1
Bid date	12/29/2003
Report format	Sorted by 'Area/Group phase/Phase' 'Detail' summary Allocate addons Combine items

Spreadsheet Level	Takeoff Quantity	Total Cost/Unit	Total Amount	Labor Cost/Unit	Labor Price	Labor Amount	Material Price	Material Amount	Sub Cost/Unit	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount
001 Area 1														
1000.000 GENERAL CONDITIONS														
1000.100 Contractor Mobe & GCs														
Mobe/Demobilization Expenses	1.50 ls	25,000.00 /ls	37,500	20,000.00 /ls	20,000.00 /ls	30,000	/ls				5,000.00 /ls	7,500	-	-
Prime Contractor GCs (8%)	1.00 ls	475,000.00 /ls	475,000	380,000.00 /ls	380,000.00 /ls	380,000	25,000.00 /ls	25,000	50,000.00	***50,000***	20,000.00 /ls	***20,000***	-	-
1210.100 Allowances														
Solor Energy System (70 kw)	1.00 ls	560,000.00 /ls	560,000	0.00 /ls	0.00	0	-	-	560,000.00	***560,000***	-	-	/ls	
1250.100 Owner Offices														
None	1.00 ls	0.01 /ls	0	0.01 /ls	0.01 /ls	***0***	-	-	-	-	/ls		-	-
1570.100 Temporary Controls														
Traffic Control (at Prkg Area)	1.00 ls	1,500.00 /ls	1,500	-	-	-	-	-	1,500.00	***1,500***	-	-	-	-
Temporary Environmental Controls	1.00 ls	2,750.00 /ls	2,750	1,500.00 /ls	1,500.00 /ls	***1,500***	750.00 /ls	***750***	-	-	500.00 /ls	***500***	/ls	
1640.100 Owner-Furnished Products														
None	1.00 ls	0.01 /ls	0	0.01 /ls	0.01 /ls	***0***	-	-	-	-	-	-	0.00 /ls	0
1770.100 Closeout Procedures														
Project Closeout	200.00 hr	85.00 /hr	17,000	75.00 /hr	75.00 /hr	15,000	-	-	-	-	10.00 /hr	2,000	/hr	
1820.100 Demonstration & Training														
Equipment Testing & Plant Startup	500.00 hr	65.00 /hr	32,500	65.00 /hr	65.00 /hr	32,500	-	-	-	-	-	-	/hr	
MW Manuals & Startup Support	150.00 hr	75.00 /hr	11,250	65.00 /hr	65.00 /hr	9,750	-	-	-	-	10.00 /hr	1,500	/hr	
Startup Chemicals & Supplies	3.00 ls	[illegible]	[illegible]	[illegible]	-	-	3,500.00 /ls	10,500	-	-	-	-	/ls	
2000.000 SITEWORK														
2110.210 Demo/Sitework														
Surface Demo Allowance (See Backup)	1.00 ls	[illegible]	[illegible]	[illegible]	-	-	-	-	75,000.00	***75,000***	-	-	-	-
Site Clearing / OG Compaction / Rough Grade	3.00 Ac	[illegible]	[illegible]	[illegible]	750.00 /Ac	2,250	-	-			750.00 /Ac	2,250	-	-
Over Excavation @ Bldg	1,600.00 cy	[illegible]	[illegible]	[illegible]	4.00 /cy	6,400	-	-			4.00 /cy	6,400	-	-
Parking Earthworks	1,000.00 cy	[illegible]	[illegible]	[illegible]	3.50 /cy	3,500	-	-			3.50 /cy	3,500	-	-
FG/Compact Paving Areas	6,000.00 sy	1.40 /sy	8,400	0.65 /sy	0.65 /sy	3,900	-	-			0.75 /sy	4,500	-	-
Place/Compact Base Course at Paving - 6"	1,000.00 cy	24.50 /cy	24,500	2.00 /cy	2.00 /cy	2,000	20.00 /cy	20,000			2.50 /cy	2,500	-	-
New Paving - 4"	1,250.00 Tn	84.00 /Tn	105,000	-	-	-	-	-	84.00	***105,000***	-	-	-	-
New Conc C&G	2,100.00 lf	17.00 /lf	35,700	7.00 /lf	7.00 /lf	14,700	8.00 /lf	16,800			2.00 /lf	4,200	-	-
Ftg Excavation/FG (On-site disposal)	700.00 cy	12.00 /cy	8,400	6.00 /cy	6.00 /cy	4,200	-	-			6.00 /cy	4,200	-	-
CW Excavation (Includes haul-off)	350.00 cy	12.00 /cy	4,200	6.00 /cy	6.00 /cy	2,100	-	-			6.00 /cy	2,100	-	-
Shoring Allowance (Yard Piping/CW/Bldg)	1.00 ls	11,000.00 /ls	11,000	5,000.00 /ls	5,000.00 /ls	***5,000***	3,500.00 /ls	***3,500***			2,500.00 /ls	***2,500***	-	-
Trench Excavation	500.00 cy	16.00 /cy	8,000	8.00 /cy	8.00 /cy	4,000	-	-			8.00 /cy	4,000	-	-
Backfill Allowance (Native)	1,000.00 cy	9.00 /cy	9,000	5.00 /cy	5.00 /cy	5,000	-	-			4.00 /cy	4,000	-	-
Pipe Bollards	12.00 ea	245.00 /ea	2,940	125.00 /ea	125.00 /ea	1,500	100.00 /ea	1,200			20.00 /ea	240	-	-
2511.101 Yard Piping - C200														
24" FW	520.00 lf	230.00 /lf	119,600	40.00 /lf	154.00 /ch	20,800	160.00 /lf	83,200	-	-	30.00 /lf	15,600	-	-
24" B-Fly Valve	3.00 ea	10,250.00 /ea	30,750	1,000.00 /ea	154.00 /ch	3,000	9,000.00 /ea	27,000	-	-	250.00 /ea	750	-	-
24" Check Valve	4.00 ea	8,250.00 /ea	33,000	1,000.00 /ea	154.00 /ch	4,000	7,000.00 /ea	28,000	-	-	250.00 /ea	1,000	-	-
24" 90	3.00 ea	5,749.98 /ea	17,250	749.98 /ea	154.00 /ch	2,250	4,500.00 /ea	13,500	-	-	500.00 /ea	1,500	-	-
24" 45	5.00 ea	4,750.01 /ea	23,750	750.01 /ea	154.00 /ch	3,750	3,500.00 /ea	17,500	-	-	500.00 /ea	2,500	-	-
24" Tee	1.00 ea	6,249.98 /ea	6,250	749.98 /ea	154.00 /ch	750	5,000.00 /ea	5,000	-	-	500.00 /ea	500	-	-
30" Spool Piece	1.00 ea	2,250.00 /ea	2,250	500.00 /ea	154.00 /ch	500	1,500.00 /ea	1,500	-	-	250.00 /ea	250	-	-
12" Check Valve	4.00 ea	4,850.01 /ea	19,400	650.01 /ea	154.00 /ch	2,600	4,000.00 /ea	16,000	-	-	200.00 /ea	800	-	-
24" Rest Jts	2.00 ea	3,599.98 /ea	7,200	749.98 /ea	154.00 /ch	1,500	2,500.00 /ea	5,000	-	-	350.00 /ea	700	-	-
Blending Sta Piping Allowance	1.00 ls	14,000.00 /ls	14,000	2,500.00 /ls	154.00 /ch	2,500	11,000.00 /ls	11,000	-	-	500.00 /ls	500	-	-
2512.201 Yard Piping - PVC														

Assume "feed water", though report calls raw water out as HDPE; change all circled to 16" based on velocities

24" Permeate -> change to 16"

Orange line on figure 6-1 tees before going to PT and Mowry lines; assume it's part of this configuration - no change

24" Permeate OF to conc basin -> change to 16"

16" conc to conc basin (though report calls this out as 24") - no change

Assume "SD" is storm drain and "PW" is potable water. no change to these

Spreadsheet Level	Takeoff Quantity	Total Cost/Unit	Total Amount	Labor Cost/Unit	Labor Price	Labor Amount	Material Price	Material Amount	Sub Cost/Unit	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount
2512.201 Yard Piping - PVC														
24" SD C900	310.00 lf	45.00 /lf	13,950	15.00 /lf	154.00 /ch	4,650	20.00 /lf	6,200	-	-	10.00 /lf	3,100	-	-
12" SD C900	315.00 lf	26.00 /lf	8,190	10.00 /lf	154.00 /ch	3,150	6.00 /lf	1,890	-	-	10.00 /lf	3,150	-	-
24" RW C900	620.00 lf	50.00 /lf	31,000	15.00 /lf	154.00 /ch	9,300	20.00 /lf	12,400	-	-	15.00 /lf	9,300	-	-
8" SD C900	25.00 lf	25.00 /lf	625	10.00 /lf	154.00 /ch	250	5.00 /lf	125	-	-	10.00 /lf	250	-	-
12" RW C900	90.00 lf	41.00 /lf	[illegible]	[illegible]	[illegible] /ch	1,800	6.00 /lf	540	-	-	15.00 /lf	1,350	-	-
Manholes	3.00 ea	4,000.04 /ea	[illegible]	[illegible]	[illegible] /ch	1,500	3,300.00 /ea	9,900	-	-	200.00 /ea	600	-	-
Concentrate Basin	1.00 ea	2,900.00 /ea	[illegible]	[illegible]	[illegible] /ch	400	2,250.00 /ea	2,250	-	-	250.00 /ea	250	-	-
Catch Basins	2.00 ea	2,500.00 /ea	[illegible]	[illegible]	[illegible] /ch	1,000	1,750.00 /ea	3,500	-	-	250.00 /ea	500	-	-
12" SD C900 - Pipe Sleeves	150.00 lf	31.00 /lf	[illegible]	[illegible]	[illegible] /ch	2,250	6.00 /lf	900	-	-	10.00 /lf	1,500	-	-
8" SD C900	50.00 lf	30.00 /lf	[illegible]	[illegible]	[illegible] /ch	750	5.00 /lf	250	-	-	10.00 /lf	500	-	-
4" SD C900	50.00 lf	39.00 /lf	1,950	25.00 /lf	154.00 /ch	1,250	4.00 /lf	200	-	-	10.00 /lf	500	-	-
4" PW - Copper	75.00 lf	30.00 /lf	2,250	18.00 /lf	[illegible]	[illegible]	7.00 /lf	525	-	-	5.00 /lf	375	-	-
24" OF HDPE	280.00 lf	33.00 /lf	9,240	15.00 /lf	[illegible]	[illegible]	8.00 /lf	2,240	-	-	10.00 /lf	2,800	-	-
16" Conc HDPE	280.00 lf	33.00 /lf	9,240	15.00 /lf	[illegible]	[illegible]	8.00 /lf	2,240	-	-	10.00 /lf	2,800	-	-
Small Dia Piping Allowance - Sample Taps/Plt H2O	[illegible]	[illegible]	50,000	25,000.00 /ls	[illegible]	[illegible]	25,000.00 /ls	25,000	-	-	0.00	0	-	-
2900.990 Landscaping Sub														
Sub - Landscaping (NIC)	[illegible]	[illegible]	0	0.01 /ls	[illegible]	[illegible]	-	-			-	-	-	-
3000.000 CONCRETE														
3000.110 CIP Concrete														
Concrete CIP - Ftgs on Ground	[illegible] cy	[illegible] /cy	116,025	225.00 /cy	225.00 /cy	61,425	90.00 /cy	24,570	85.00	23,205	25.00 /cy	6,825	-	-
Concrete CIP - Ftg Walls <4'	74.00 cy	525.00 /cy	38,850	325.00 /cy	325.00 /cy	24,050	90.00 /cy	6,660	85.00	6,290	25.00 /cy	1,850	-	-
Concrete CIP - Ret Wall	21.00 cy	550.00 /cy	11,550	350.00 /cy	350.00 /cy	7,350	90.00 /cy	1,890	85.00	1,785	25.00 /cy	525	-	-
Concrete CIP - Basin Walls	27.00 cy	625.00 /cy	16,875	425.00 /cy	425.00 /cy	11,475	90.00 /cy	2,430	85.00	2,295	25.00 /cy	675	-	-
Concrete CIP - SOG	470.00 cy	425.00 /cy	199,750	225.00 /cy	225.00 /cy	105,750	90.00 /cy	42,300	85.00	39,950	25.00 /cy	11,750	-	-
Concrete CIP - Elev Slab	40.00 cy	700.00 /cy	28,000	500.00 /cy	500.00 /cy	20,000	90.00 /cy	3,600	85.00	3,400	25.00 /cy	1,000	-	-
Concrete CIP - Equip Pads	15.00 cy	800.00 /cy	12,000	600.00 /cy	600.00 /cy	9,000	90.00 /cy	1,350	85.00	1,275	25.00 /cy	375	-	-
Concrete CIP - Pipe Trenches	35.00 cy	650.00 /cy	22,750	450.00 /cy	450.00 /cy	15,750	90.00 /cy	3,150	85.00	2,975	25.00 /cy	875	-	-
Concrete CIP - Set Anchor Bolts	150.00 ea	27.50 /ea	4,125	20.00 /ea	20.00 /ea	3,000	5.00 /ea	750	0.00	0	2.50 /ea	375	-	-
Concrete CIP - Chemical Containment Vault	1.00 ea	3,850.00 /ea	3,850	500.00 /ea	500.00 /ea	500	3,000.00 /ea	3,000	0.00	0	350.00 /ea	350	-	-
Concrete CIP - Chem Truck Containment Area	40.00 cy	442.50 /cy	17,700	350.00 /cy	350.00 /cy	14,000	90.00 /cy	3,600			2.50 /cy	100	-	-
4000.000 MASONRY														
4000.108 CMU Walls														
10" CMU - Interior	5,000.00 sf	8.36 /sf	41,775	3.63 /sf	55.00 /mh	18,150	4.50 /sf	23,625	-	-	-	-	-	-
4220.124 Block- 12" Decorative														
12" Block Split Face	10,000.00 sf	9.74 /sf	97,378	4.49 /sf	920.00 /cd	44,878	5.00 /sf	52,500	-	-	-	-	-	-
Cast Stone Parapet Detail	550.00 lf	27.00 /lf	14,850	6.00 /lf	920.00 /cd	3,300	20.00 /lf	11,550	-	-	-	-	-	-
5000.000 METALS														
5000.925 Structural Steel Buy														
Trench Drain at Truck Containment Area	40.00 lf	48.00 /lf	1,920	8.00 /lf	8.00 /lf	320	35.00 /lf	1,400	-	-	5.00 /lf	200	-	-
Metal Joists at Roof	13,200.00 sf	5.68 /sf	75,000	0.00 /sf	0.00	0	0.00 /sf	0	5.68	***75,000***	0.00	0	-	-
6000.000 WOOD & PLASTICS														
6090.500 FRP														
FRP Grating	720.00 sf	28.00 /sf	20,160	8.00 /sf	8.00 /sf	5,760	20.00 /sf	14,400	-	-	-	-	-	-
7000.000 THERMAL & MOIST PROTECT														
7100.100 Waterproofing														
Waterproofing Allowance	1.00 ls	20,000.00 /ls	20,000	0.00 /ls	0.00 /mh	0	0.00 /ls	0	20,000.00	***20,000***	-	-	-	-
7530.100 Roofing- Membrane														
Sgl Ply Roofing System w/ Rigid Insulation	13,200.00 sf	5.68 /sf	75,000	-	-	-	-	-	5.68	***75,000***	-	-	-	-
7620.100 Flashing- Aluminum														
Aluminum Parapet Flashing	450.00 lf	3.40 /lf	1,532	2.33 /lf	46.67 /mh	1,050	1.00 /lf	482	-	-	-	-	-	-
7720.100 Roof Accessories														
Roof Hatch 2'6"x 3'0"	1.00 ea	740.00 /ea	740	140.00 /ea	46.67 /mh	140	600.00 /ea	600	-	-	-	-	-	-
Parapet Ladders	3.00 ea	1,052.50 /ea	3,157	250.00 /ea	46.67 /mh	750	750.00 /ea	2,408	-	-	-	-	-	-
7920.200 Exterior Caulking														
Sub - Exterior Caulking	1.00 ls	15,000.00 /ls	15,000	-	-	-	-	-	15,000.00	***15,000***	-	-	-	-
8000.000 DOORS & WINDOWS														

Spreadsheet Level	Takeoff Quantity	Total Cost/Unit	Total Amount	Labor Cost/Unit	Labor Price	Labor Amount	Material Price	Material Amount	Sub Cost/Unit	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount
8110.200 Doors- Hol Metal Frames														
HM Ext Door 3x7	13.00 ea	1,050.00 /ea	13,650	250.00 /ea	55.00 /mh	3,250	800.00 /ea	10,400	-	-	-	-	-	-
HM Ext Door 3x7 w/ Glass	3.00 ea	1,200.00 /ea	3,600	250.00 /ea	55.00 /mh	750	950.00 /ea	2,850	-	-	-	-	-	-
HM Ext Door 3x7 - Interior	15.00 ea	850.00 /ea	12,750	200.00 /ea	55.00 /mh	3,000	650.00 /ea	9,750	-	-	-	-	-	-
8360.100 Doors- Overhead														
Overhead Doors Elec Operated	2.00 ea	2,300.00 /ea	4,600	-	-	-	-	-	2,300.00	4,600	-	-	-	-
8520.100 Windows- Aluminum														
Aluminum Windows Fixed	64.00 sf	50.00 /sf	3,200	15.00 /sf	46.67 /mh	960	35.00 /sf	2,240	-	-	-	-	-	-
8600.100 Skylights														
Removable Skylights - Dome	675.00 sf	26.00 /sf	17,550	3.50 /sf	46.67 /mh	2,363	20.00 /sf	13,500	-	-	2.50 /sf	1,688	-	-
Fixed Skylights	225.00 sf	21.00 /sf	4,725	3.50 /sf	46.67 /mh	788	15.00 /sf	3,375	-	-	2.50 /sf	563	-	-
9000.000 FINISHES														
9250.020 Interior Drywall Systems														
Interior Wall Studs & GWB	150.00 lf	27.00 /lf	4,050	10.00 /lf	10.00 /lf	1,500	15.00 /lf	2,250	0.00	0	2.00 /lf	300	/lf	
9510.400 Ceilings- Panels 2x4														
2 x 4 Ceiling Plain Tile	1,500.00 sf	3.61 /sf	5,413	0.93 /sf	46.67 /mh	1,400	2.50 /sf	4,013	-	-	-	-	-	-
9650.100 Flooring- Resilient														
Standard VCT Tile	1,500.00 sf	1.84 /sf	2,766	0.56 /sf	46.67 /mh	840	1.20 /sf	1,926	-	-	-	-	-	-
9910.200 Painting- Interior														
Paint Walls - Allowance	1.00 ls	10,000.00 /ls	10,000	-	-	-	-	-	10,000.00	***10,000***	-	-	-	-
9960.010 Paint Pipe														
Paint Pipe - Standard Paint	1.00 ls	7,500.30 /ls	7,500	0.00 /ls	0.00 /mh	0	75.00 /gal	0	7,500.00	***7,500***	-	-	-	-
9960.100 Special Coatings														
Sub - Special Coatings (Allowance)	1.00 ls	25,000.00 /ls	25,000	-	-	-	-	-	25,000.00	***25,000***	-	-	-	-
10000.000 SPECIALTIES														
10110.100 Chalkboards/Markerboards														
Chalkboards Porcelain Enam.	4.00 ea	593.34 /ea	2,373	93.34 /ea	46.67 /mh	373	500.00 /ea	2,000	-	-	-	-	-	-
10185.100 Shower Compartments														
Shower Stall	2.00 ea	625.34 /ea	1,251	275.34 /ea	46.67 /mh	551	350.00 /ea	700	-	-	-	-	-	-
10210.100 Louvers Metal Operable														
Alum Louvers Fixed	500.00 sf	42.33 /sf	21,167	23.33 /sf	46.67 /mh	11,667	19.00 /sf	9,500	-	-	-	-	-	-
Ridge Vents	10.00 ea	275.00 /ea	2,750	75.00 /ea	46.67 /mh	750	200.00 /ea	2,000	-	-	-	-	-	-
10430.100 Exterior Signs & Letters														
Signs - Office ID	7.00 ea	175.00 /ea	1,225	25.00 /ea	46.67 /mh	175	150.00 /ea	1,050	-	-	-	-	-	-
Signs - Exit Signs	10.00 ea	325.00 /ea	3,250	25.00 /ea	46.67 /mh	250	300.00 /ea	3,000	-	-	-	-	-	-
10500.100 Lockers Metal														
Lockers	20.00 ea	113.67 /ea	2,273	18.67 /ea	46.67 /mh	373	95.00 /ea	1,900	-	-	-	-	-	-
Locker Room Benches	3.00 ea	166.67 /ea	500	46.67 /ea	46.67 /mh	140	120.00 /ea	360	-	-	-	-	-	-
10520.100 Fire Cabinets														
Fire Hose Cabinet Wall Mount	8.00 ea	319.53 /ea	2,556	69.53 /ea	46.67 /mh	556	250.00 /ea	2,000	-	-	-	-	-	-
10520.200 Fire Control/Supression														
Fire Extinguisher CO2 20 lbs	8.00 ea	183.00 /ea	1,464	28.00 /ea	46.67 /mh	224	155.00 /ea	1,240	-	-	-	-	-	-
10530.100 Canopies														
Wall Hung Aluminum Canopies	200.00 sf	95.00 /sf	19,000	75.00 /sf	46.67 /mh	***15,000***	20.00 /sf	4,000	-	-	-	-	-	-
10670.100 Metal Storage Shelving														
Metal Industrial Shelves 10' (Maint Room)	10.00 ea	115.53 /ea	1,155	69.53 /ea	46.67 /mh	695	46.00 /sf	460	-	-	-	-	-	-
10810.200 Toilet Access by each														
Curtain Rods	2.00 ea	31.67 /ea	63	11.67 /ea	46.66 /mh	23	20.00 /ea	40	-	-	-	-	-	-
Soap Dispensers	2.00 ea	49.00 /ea	98	14.00 /ea	46.67 /mh	28	35.00 /ea	70	-	-	-	-	-	-
Towel Dispensers	2.00 ea	61.67 /ea	123	11.67 /ea	46.66 /mh	23	50.00 /ea	100	-	-	-	-	-	-
Waste Receptacles	2.00 ea	214.00 /ea	428	14.00 /ea	46.67 /mh	28	200.00 /ea	400	-	-	-	-	-	-
Bath Tissue Dispenser Single	2.00 ea	43.34 /ea	87	23.34 /ea	46.67 /mh	47	20.00 /ea	40	-	-	-	-	-	-
Bath Mirror Small	2.00 ea	115.00 /ea	230	35.00 /ea	46.67 /mh	70	80.00 /ea	160	-	-	-	-	-	-
10810.600 Grab Bars														
Grab Bars - Toilet	2.00 ea	89.54 /ea	179	69.54 /ea	46.67 /mh	139	20.00 /ea	40	-	-	-	-	-	-

Spreadsheet Level	Takeoff Quantity	Total Cost/Unit	Total Amount	Labor Cost/Unit	Labor Price	Labor Amount	Material Price	Material Amount	Sub Cost/Unit	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount
10810.600 Grab Bars														
Grab Bars - Shower	2.00 ea	91.67 /ea	183	46.67 /ea	46.67 /mh	93	45.00 /ea	90	-	-	-	-	-	-
11000.000 EQUIPMENT														
11020.100 Tanks														
Scale Inhibitor - 5500 Gal FRP	1.00 ea	18,700.01 /ea	18,700	500.01 /ea	55.00 /mh	500	18,000.00 /ea	18,000	-	-	200.00 /ea	200	-	-
Hydrochloric Acid - 5500 Gal FRP	1.00 ea	19,700.02 /ea	19,700	1,500.02 /ea	55.00 /mh	1,500	18,000.00 /ea	***18,000***	-	-	200.00 /ea	200	-	-
Cleaning Tanks - 4000 Gal FRP	2.00 ea	12,950.01 /ea	25,900	750.01 /ea	55.00 /mh	1,500	12,000.00 /ea	24,000	-	-	200.00 /ea	400	-	-
Caustic Soda - 50 Gal FRP	1.00 ea	1,550.02 /ea	1,550	350.02 /ea	55.00 /mh	350	1,000.00 /ea	1,000	-	-	200.00 /ea	200	-	-
Emergency Shower	3.00 ea	3,200.01 /ea	9,600	500.01 /ea	55.00 /mh	1,500	2,500.00 /ea	7,500	-	-	200.00 /ea	600	-	-
Tote Bins	2.00 ea	3,000.00 /ea	6,000	300.00 /ea	55.00 /mh	600	2,500.00 /ea	5,000	-	-	200.00 /ea	400	-	-
Static Mixer	1.00 ea	11,200.01 /ea	11,200	1,000.01 /ea	55.00 /mh	1,000	10,000.00 /ea	10,000	-	-	200.00 /ea	200	-	-
ERT Recycle Turbine	2.00 ea	38,700.01 /ea	77,400	3,500.01 /ea	55.00 /mh	7,000	35,000.00 /ea	70,000	-	-	200.00 /ea	400	-	-
11210.220 Pump- Centrifugal														
Centrifugal Pumps - Horz 300 Hp	2.00 ea	71,283.32 /ea	142,567	1,283.33 /ea	51.33 /mh	2,567	70,000.00 /ea	140,000	-	-	-	-	-	-
11210.500 Pump- Vertical Turbine														
Vertical Turbine Pumps - 125 Hp	2.00 ea	36,026.66 /ea	72,053	1,026.66 /ea	51.33 /mh	2,053	35,000.00 /ea	70,000	-	-	-	-	-	-
11210.550 Pump- Sump														
CIP Pump - 50 Hp (Horz) SS	2.00 ea	26,500.00 /ea	53,000	1,500.00 /ea	51.33 /mh	3,000	25,000.00 /ea	50,000	-	-	-	-	-	-
Concentrate Pumps - 100 Hp Vert Turbine SS	2.00 ea	19,000.00 /ea	38,000	1,500.00 /ea	51.33 /mh	3,000	17,500.00 /ea	***35,000***	-	-	-	-	-	-
11240.005 Chemical Feed & Meter														
Metering Pumps - 1/2 Hp	7.00 ea	2,984.00 /ea	20,888	484.00 /ea	48.40 /mh	3,388	2,500.00 /ea	17,500	-	-	-	-	-	-
11270.030 RO Unit														
RO Unit	2.00 ea	357,500.00 /ea	715,000	32,500.00 /ea	48.40 /mh	***65,000***	325,000.00 /ea	***650,000***	-	-	-	-	-	-
RO Unit Small Valves/Piping Allowance	2.00 ea	40,000.00 /ea	80,000	5,000.00 /ea	3.72 /mh	***10,000***	35,000.00 /ea	70,000	-	-	-	-	-	-
11270.040 Decarbonator														
Packing Matls	3,000.00 cf	36.50 /cf	109,500	1.50 /cf	48.40 /mh	4,500	35.00 /cf	105,000	-	-	-	-	-	-
Decarbonator Unit (25,000 Gal FRP) W/ MH	2.00 ea	93,500.00 /ea	187,000	3,500.00 /ea	48.40 /mh	7,000	90,000.00 /ea	180,000	-	-	-	-	-	-
12000.000 FURNISHINGS														
12310.100 Casework- Metal														
Parts Bins	10.00 ea	425.00 /ea	4,250	75.00 /ea	55.00 /mh	750	350.00 /ea	3,500	-	-	-	-	-	-
Sample Chamber	1.00 ea	549.98 /ea	550	199.98 /ea	55.00 /mh	200	350.00 /ea	350	-	-	-	-	-	-
Workbench	20.00 lf	85.00 /lf	1,700	35.00 /lf	55.00 /mh	700	50.00 /lf	1,000	-	-	-	-	-	-
Wall/Floor Cabinets	20.00 ea	396.67 /ea	7,933	46.67 /ea	46.67 /mh	933	350.00 /ea	7,000	-	-	-	-	-	-
Misc Office Specialties	3.00 ls	3,500.02 /ls	10,500	1,500.02 /ls	46.67 /mh	4,500	2,000.00 /ls	6,000	-	-	-	-	-	-
12350.130 Casework- Misc														
Laboratory/CR Casework	75.00 lf	120.00 /lf	9,000	40.00 /lf	46.67 /mh	3,000	80.00 /lf	6,000	-	-	-	-	-	-
Laboratory Shelves - 12"	1.00 ls	1,649.98 /ls	1,650	399.98 /ls	46.67 /mh	400	1,250.00 /ls	***1,250***	-	-	-	-	-	-
15000.900 MECHANICAL SUBCONTRACTOR														
15060.101 Plumbing/HVAC														
Bldg Plumbing/HVAC Allowance	13,200.00 sf	34.09 /sf	450,000	0.00 /sf	0.00 /mh	0	0.00 /sf	0	34.09	***450,000***	-	-	-	-
Roof Drain System	13,200.00 sf	2.65 /sf	35,000		/mh		/sf		2.65	***35,000***	-	-	-	-
15220.000 Process Piping/Equip														
15220.001 Process Piping														
Process Piping Allowance (5M x 8mos)	1.00 ls	784,999.98 /ls	785,000	349,999.98 /ls	56.00 /mh	350,000	435,000.00 /ls	435,000	-	-	-	-	-	-
16000.000 ELECTRICAL														
16000.001 Electrical Sub														
HV/LV - 15%	1.00 ls	900,000.00 /ls	900,000	0.00 /ls	0.00	0	-	-	900,000.00	***900,000***	-	-	-	-
17000.000 INSTRUMENTS & CONTROLS														
17000.001 Instruments & controls														
Instrumentation - 5%	1.00 ls	200,000.00 /ls	200,000	0.00 /ls	0.00 /mh	0	0.00 /ls	0	200,000.00	***200,000***	-	-	-	-

Estimate Totals

Estimate Totals

Labor	1,493,646		32,261.462	hrs	
Material	2,564,428				
Subcontract	2,689,775				
Equipment	153,015		350.000	hrs	
	6,900,864	**6,900,864**			
Material Sales Tax	211,565		8.250	%	C
Escalation Allowance	138,017		2.000	%	C
Sub Equivalent Markups	1,035,130		15.000	%	C
Builder's Risk Insurance	34,504		0.500	%	T
Subcontractor Bonds	40,347		1.500	%	C
General Liability Insurance	69,009		1.000	%	T
Contingency	1,380,173		20.000	%	T
	Total	***9,809,609***			

Alameda County Water District
Peralta-Tyson Groundwater Treatment Plant
Engineering Estimate - 30% Design Level

Project name	ACWD - Peralta-Tyson GWTP
Architect	MWH
Labor rate table	Labor West Basin
Equipment rate table	MWHC Equipment v1
Bid date	12/29/2003
Report format	Sorted by 'Area/Group phase/Phase' 'Detail' summary Allocate addons Combine items

Spreadsheet Level	Takeoff Quantity	Total Cost/Unit	Total Amount	Labor Cost/Unit	Labor Price	Labor Amount	Material Price	Material Amount	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount
001 Area 1													
1000.000 GENERAL CONDITIONS													
1000.100 Contractor Mobe & GCs		/ls	512,500	/ls		410,000		25,000	50,000		27,500		
1210.100 Allowances		/ls	560,000	/ls					560,000				
1250.100 Owner Offices		/ls	0	/ls		0							
1570.100 Temporary Controls		/ls	4,250	/ls		1,500		750	1,500		500		
1640.100 Owner-Furnished Products		/ls	0	/ls		0							
1770.100 Closeout Procedures		/ls	17,000	/ls		15,000					2,000		
1820.100 Demonstration & Training		/ls	54,250	/ls		42,250		10,500			1,500		
GENERAL CONDITIONS		/sf	1,148,000	/sf		468,750		36,250	611,500		31,500		
2000.000 SITEWORK													
2110.210 Demo/Sitework		/ls	316,440	/ls		54,550		41,500	180,000		40,390		
2511.101 Yard Piping - C200		/lf	273,450	/lf		41,650		207,700			24,100		
2512.201 Yard Piping - PVC		/lf	156,185	/lf		61,050		68,160			26,975		
2900.990 Landscaping Sub		/ls	0	/ls		0							
SITEWORK		/ls	746,075	/ls		157,250		317,360	180,000		91,465		
3000.000 CONCRETE													
3000.110 CIP Concrete		/cy	471,475	/cy		272,300		93,300	81,175		24,700		
CONCRETE		/sf	471,475	/sf		272,300		93,300	81,175		24,700		
4000.000 MASONRY													
4000.108 CMU Walls		/cf	41,775	/cf		18,150		23,625					
4220.124 Block- 12" Decorative		/ea	112,228	/ea		48,178		64,050					
MASONRY		/sf	154,003	/sf		66,328		87,675					
5000.000 METALS													
5000.925 Structural Steel Buy		/ton	76,920	/ton		320		1,400	75,000		200		
METALS		/sf	76,920	/sf		320		1,400	75,000		200		
6000.000 WOOD & PLASTICS													
6090.500 FRP		/ls	20,160	/ls		5,760		14,400					
WOOD & PLASTICS		/sf	20,160	/sf		5,760		14,400					
7000.000 THERMAL & MOIST PROTECT													
7100.100 Waterproofing		/sf	20,000	/sf					20,000				
7530.100 Roofing- Membrane		/sf	75,000	/sf					75,000				
7620.100 Flashing- Aluminum		/sf	1,532	/sf		1,050		482					
7720.100 Roof Accessories		/ea	3,897	/ea		890		3,008					

Spreadsheet Level	Takeoff Quantity	Total Cost/Unit	Total Amount	Labor Cost/Unit	Labor Price	Labor Amount	Material Price	Material Amount	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount
7920.200 Exterior Caulking		/lf	15,000	/lf					15,000				
THERMAL & MOIST PROTECT		/sf	115,429	/sf		1,940		3,489	110,000				
8000.000 DOORS & WINDOWS													
8110.200 Doors- Hol Metal Frames		/ea	30,000	/ea		7,000		23,000					
8360.100 Doors- Overhead		/ea	4,600	/ea					4,600				
8520.100 Windows- Aluminum		/ea	3,200	/ea		960		2,240					
8600.100 Skylights		/ea	22,275	/ea		3,150		16,875			2,250		
DOORS & WINDOWS		/sf	60,075	/sf		11,110		42,115	4,600		2,250		
9000.000 FINISHES													
9250.020 Interior Drywall Systems		/sf	4,050	/sf		1,500		2,250			300		
9510.400 Ceilings- Panels 2x4		/sf	5,413	/sf		1,400		4,013					
9650.100 Flooring- Resilient		/sf	2,766	/sf		840		1,926					
9910.200 Painting- Interior		/sf	10,000	/sf					10,000				
9960.010 Paint Pipe		/ea	7,500	/ea				0	7,500				
9960.100 Special Coatings		/sf	25,000	/sf					25,000				
FINISHES		/ls	54,729	/ls		3,740		8,189	42,500		300		
10000.000 SPECIALTIES													
10110.100 Chalkboards/Markerboards		/ea	2,373	/ea		373		2,000					
10185.100 Shower Compartments		/ea	1,251	/ea		551		700					
10210.100 Louvers Metal Operable		/sf	23,917	/sf		12,417		11,500					
10430.100 Exterior Signs & Letters		/ea	4,475	/ea		425		4,050					
10500.100 Lockers Metal		/ea	2,773	/ea		513		2,260					
10520.100 Fire Cabinets		/ea	2,556	/ea		556		2,000					
10520.200 Fire Control/Supression		/ea	1,464	/ea		224		1,240					
10530.100 Canopies		/ea	19,000	/ea		15,000		4,000					
10670.100 Metal Storage Shelving		/ls	1,155	/ls		695		460					
10810.200 Toilet Access by each		/ea	1,029	/ea		219		810					
10810.600 Grab Bars		/ea	362	/ea		232		130					
SPECIALTIES		/sf	60,356	/sf		31,206		29,150					
11000.000 EQUIPMENT													
11020.100 Tanks		/ea	170,050	/ea		13,950		153,500			2,600		
11210.220 Pump- Centrifugal		/ea	142,567	/ea		2,567		140,000					
11210.500 Pump- Vertical Turbine		/ea	72,053	/ea		2,053		70,000					
11210.550 Pump- Sump		/ea	91,000	/ea		6,000		85,000					
11240.005 Chemical Feed & Meter		/ls	20,888	/ls		3,388		17,500					
11270.030 RO Unit		/ea	795,000	/ea		75,000		720,000					
11270.040 Decarbonator		/ea	296,500	/ea		11,500		285,000					
EQUIPMENT		/sf	1,588,058	/sf		114,458		1,471,000			2,600		

Spreadsheet Level	Takeoff Quantity	Total Cost/Unit	Total Amount	Labor Cost/Unit	Labor Price	Labor Amount	Material Price	Material Amount	Sub Amount	Equip Price	Equip Amount	Other Price	Other Amount
12000.000 FURNISHINGS													
12310.100 Casework- Metal		/lf	24,933	/lf		7,083		17,850					
12350.130 Casework- Misc		/lf	10,650	/lf		3,400		7,250					
FURNISHINGS		/sf	35,583	/sf		10,483		25,100					
15000.900 MECHANICAL SUBCONTRACTOR													
15060.101 Plumbing/HVAC		/ls	485,000	/ls					485,000				
MECHANICAL SUBCONTRACTOR		/ls	485,000	/ls					485,000				
15220.000 PROCESS PIPING/EQUIPMENT													
15220.001 Process Piping		/ls	785,000	/ls		350,000		435,000					
PROCESS PIPING/EQUIPMENT		/ls	785,000	/ls		350,000		435,000					
16000.000 ELECTRICAL													
16000.001 Electrical Sub		/sf	900,000	/sf					900,000				
ELECTRICAL		/sf	900,000	/sf					900,000				
17000.000 INSTRUMENTS & CONTROLS													
17000.001 Instruments & controls		/ls	200,000	/ls					200,000				
INSTRUMENTS & CONTROLS			200,000						200,000				
001 Area 1		**/ls**	**6,900,864**	**/ls**		**1,493,646**		**2,564,428**	**#######**		**153,015**		

Estimate Totals

Labor	1,493,646		32,261.462	hrs	
Material	2,564,428				
Subcontract	2,689,775				
Equipment	153,015		350.000	hrs	
	6,900,864	6,900,864			
Material Sales Tax	211,565		8.250	%	C
Escalation Allowance	138,017		2.000	%	C
Sub Equivalent Markups	1,035,130		15.000	%	C
Builder's Risk Insurance	34,504		0.500	%	T
Subcontractor Bonds	40,347		1.500	%	C
General Liability Insurance	69,009		1.000	%	T
Contingency	1,380,173		20.000	%	T
	Total	***9,809,609***			

APPENDIX I: DETAILED COST ESTIMATE – PT GW FACILITY

Purified Water Feasibility Study

Opinion of Probable Capital Cost

Date: 2022.2.16

Facilities: Peralta-Tyson Groundwater Facility (Ch 8)

Project number: 0011242.00

ENR CCI (San Francisco, February 2022): 14395.70

	%	$	
Gross Construction Cost	--	$	21,456,000
Level of Development Contingency	25%	$	5,364,000
Direct Construction Cost		**$**	**26,820,000**
General Liability Insurance	1%	$	268,000
Builders' Risk Insurance	0.2%	$	54,000
Trade Contractor Overhead	10%	$	2,682,000
Trade Contractor Profit	12%	$	3,218,000
P&P Bond	2.5%	$	671,000
Subtotal Other Construction Costs		**$**	**6,893,000**
Total Construction Cost		**$**	**33,713,000**
Bid Market Adjustment	15%	$	5,057,000
Legal/Administration	5%	$	1,686,000
Environmental and Permitting	5%	$	1,686,000
Design	10%	$	3,371,000
Engineering Services During Construction	5%	$	1,686,000
Construction Management	12%	$	4,046,000
Owner's Reserve for Change Orders	10%	$	3,371,000
Non-Construction Cost		**$**	**20,903,000**
Total Capital Cost		**$**	**54,616,000**
Expected Accuracy Range, Low Bound (Class 4)	-20%	$	43,692,800
Expected Accuracy Range, High Bound (Class 4)	+30%	$	71,000,800

Estimate Recap - ACWD Task 9 Pipeline Estimate

Recap - With Taxes and Insurance | Group 1: Area

Estimator : K. Rosner

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
6 MGD Facility Construction Cost	**1**	**LS**			**11,888,678**			**11,888,678.000**	**11,888,678**
Concentrate Discharge Pipeline	**14,520**	**LNFT**	**5,334,002**	**1,949,120**	**191,682**	**1,149,121**		**593.934**	**8,623,925**
Raw Feedwater	**520**	**LNFT**	**182,174**	**85,223**		**77,417**		**663.105**	**344,814**
Permeate (Recycled Water)	**620**	**LNFT**	**206,243**	**110,818**		**83,913**		**646.732**	**400,974**
Permeate Overflow	**280**	**LNFT**	**97,248**	**59,462**		**40,444**		**704.121**	**197,154**
Total Gross Cost			**5,819,667**	**2,204,622**	**12,080,360**	**1,350,895**			**21,455,545**

Detail - With Taxes and Insurance

Estimator : K. Rosner

Group 1: Area
Group 2: Divisions

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
6 MGD Facility Construction Cost									
Special Construction									
6 MGD Facility Construction Cost (Adjusted for February 2022)	1	LS			11,888,678			11,888,678.000	11,888,678
**** Total Special Construction**	**1**	**LS**			**11,888,678**			**11,888,678.000**	**11,888,678**
*** Total 6 MGD Facility Construction Cost**	**1**	**LS**			**11,888,678**			**11,888,678.000**	**11,888,678**

Detail - With Taxes and Insurance

Estimator : K. Rosner

Group 1: Area
Group 2: Divisions

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Concentrate Discharge Pipeline									
General Requirements									
General Requirements	6	MO	197,439	35,724		139,452		62,102.400	372,614
**** Total General Requirements**	**1**	**LS**	**197,439**	**35,724**		**139,452**		**372,614.400**	**372,614**
Earthwork									
Excavate pipe trench w/backhoe	7,887	CUYD	197,756	17,501		26,180		30.610	241,437
Machine backfill pipe trench	10,252	CUYD	218,965	19,378		28,988		26.076	267,332
Excess pipe excavation soil	293	Cuyd	2,213	312		3,052		19.012	5,576
Brace pipe trench w/jacks	232,320	SQFT	1,807,872	215,613		537,793		11.025	2,561,278
Fault Line Crossing	400	LNFT			191,682			479.205	191,682
**** Total Earthwork**	**1**	**LS**	**2,226,806**	**252,804**	**191,682**	**596,014**		**3,267,306.103**	**3,267,306**
Site Construction									
Paving Overlay, 2" depth	12,402	TONS	632,854	1,159,048		194,561		160.179	1,986,462
* Asphalt pavement area *	38,720	SQYD							
Traffic Control - High	14,520	LNFT	1,360,639	19,297		61,616		99.280	1,441,552
Traffic Control - Special	4,000	LNFT	499,776	7,088		22,632		132.374	529,496
**** Total Site Construction**	**1**	**LS**	**2,493,269**	**1,185,433**		**278,808**		**3,957,509.936**	**3,957,510**
Utilities									
10" HDPE DR11 Pipe	14,520	LNFT	282,765	402,023		91,552		53.467	776,339
10" Cast Iron Knife Gate Valve	10	EACH	12,983	44,355		4,203		6,154.164	61,542
Combination Air Valves	10	EACH	19,474	5,814		6,305		3,159.377	31,594
Relocate/Adust Existing Utilities (Allow 2 crew days/location)	13	EACH	101,266	22,967		32,787		12,078.440	157,020
* Drainage pipe length *	14,520	LNFT							
**** Total Utilities**	**1**	**LS**	**416,488**	**475,159**		**134,848**		**1,026,494.363**	**1,026,494**
*** Total Concentrate Discharge Pipeline**	**14,520**	**LNFT**	**5,334,002**	**1,949,120**	**191,682**	**1,149,121**		**593.934**	**8,623,925**

Detail - With Taxes and Insurance

Group 1: Area
Group 2: Divisions

Estimator : K. Rosner

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Raw Feedwater									
General Requirements									
General Requirements	2	MO	65,813	11,908		46,484		62,102.400	124,205
**** Total General Requirements**	**1**	**LS**	**65,813**	**11,908**		**46,484**		**124,204.800**	**124,205**
Earthwork									
Excavate pipe trench w/backhoe	514	CUYD	12,877	1,140		1,705		30.610	15,721
Machine backfill pipe trench	657	CUYD	14,033	1,242		1,858		26.076	17,133
Excess pipe excavation soil	27	Cuyd	203	29		280		19.012	511
Brace pipe trench w/jacks	8,320	SQFT	64,745	7,722		19,260		11.025	91,726
**** Total Earthwork**	**1**	**LS**	**91,857**	**10,132**		**23,102**		**125,091.290**	**125,091**
Site Construction									
Patch Paving	123	TONS	6,296	11,530		1,935		160.179	19,761
* Asphalt pavement area *	578	SQYD							
**** Total Site Construction**	**1**	**LS**	**6,296**	**11,530**		**1,935**		**19,761.254**	**19,761**
Utilities									
16" HDPE DR 11 Pipe	520	LNFT	13,502	20,732		4,372		74.243	38,606
16" HDPE DR 11 Fitting - 90 Elbow	1	EACH	487	263		158		907.183	907
16" HDPE DR 11 Fitting - 45 Elbow	2	EACH	974	481		315		885.034	1,770
16" Cast Iron Butterfly Valve	1	EACH	1,298	13,400		420		15,118.490	15,118
16" Cast Iron Check Valve	1	EACH	1,947	16,777		631		19,355.235	19,355
* Drainage pipe length *	520	LNFT							
**** Total Utilities**	**1**	**LS**	**18,208**	**51,653**		**5,895**		**75,757.076**	**75,757**
*** Total Raw Feedwater**	**520**	**LNFT**	**182,174**	**85,223**		**77,417**		**663.105**	**344,814**

Estimate Detail - ACWD Task 9 Pipeline Estimate

Detail - With Taxes and Insurance

Estimator : K. Rosner

Group 1: Area
Group 2: Divisions

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Permeate (Recycled Water)									
General Requirements									
General Requirements	2	MO	65,813	11,908		46,484		62,102.400	124,205
**** Total General Requirements**	**1**	**LS**	**65,813**	**11,908**		**46,484**		**124,204.800**	**124,205**
Earthwork									
Excavate pipe trench w/backhoe	612	CUYD	15,353	1,359		2,033		30.610	18,744
Machine backfill pipe trench	783	CUYD	16,732	1,481		2,215		26.076	20,428
Excess pipe excavation soil	32	Cuyd	242	34		334		19.012	610
Brace pipe trench w/jacks	9,920	SQFT	77,196	9,207		22,964		11.025	109,366
**** Total Earthwork**	**1**	**LS**	**109,522**	**12,080**		**27,545**		**149,147.307**	**149,147**
Site Construction									
Patch Paving	147	TONS	7,506	13,748		2,308		160.179	23,561
* Asphalt pavement area *	689	SQYD							
**** Total Site Construction**	**1**	**LS**	**7,506**	**13,748**		**2,308**		**23,561.495**	**23,561**
Utilities									
16" HDPE DR 11 Pipe	620	LNFT	16,099	24,719		5,212		74.243	46,030
16" HDPE DR 11 Fitting - 90 Elbow	1	EACH	487	263		158		907.183	907
16" HDPE DR 11 Fitting - 45 Elbow	2	EACH	974	481		315		885.034	1,770
16" HDPE DR 11 Fitting - Tee	1	EACH	649	664		210		1,523.813	1,524
16" Cast Iron Butterfly Valve	1	EACH	1,298	13,400		420		15,118.490	15,118
16" Cast Iron Check Valve	2	EACH	3,895	33,555		1,261		19,355.235	38,710
* Drainage pipe length *	620	LNFT							
**** Total Utilities**	**1**	**LS**	**23,401**	**73,082**		**7,577**		**104,060.374**	**104,060**
*** Total Permeate (Recycled Water)**	**620**	**LNFT**	**206,243**	**110,818**		**83,913**		**646.732**	**400,974**

Detail - With Taxes and Insurance

Estimator : K. Rosner

Group 1: Area
Group 2: Divisions

Description	Quantity	UM	Lab.Total	Mat.Total	Sub.Total	Eqp.Total	Process Equip.	Tot.UnitCost	TotalCost
Permeate Overflow									
General Requirements									
General Requirements	1	MO	32,907	5,954		23,242		62,102.400	62,102
**** Total General Requirements**	**1**	**LS**	**32,907**	**5,954**		**23,242**		**62,102.400**	**62,102**
Earthwork									
Excavate pipe trench w/backhoe	277	CUYD	6,934	614		918		30.610	8,465
Machine backfill pipe trench	354	CUYD	7,556	669		1,000		26.076	9,225
Excess pipe excavation soil	14	Cuyd	109	15		151		19.012	275
Brace pipe trench w/jacks	4,480	SQFT	34,863	4,158		10,371		11.025	49,391
**** Total Earthwork**	**1**	**LS**	**49,462**	**5,456**		**12,440**		**67,356.848**	**67,357**
Site Construction									
Patch Paving	66	TONS	3,390	6,209		1,042		160.179	10,641
* Asphalt pavement area *	311	SQYD							
**** Total Site Construction**	**1**	**LS**	**3,390**	**6,209**		**1,042**		**10,640.675**	**10,641**
Utilities									
16" HDPE DR 11 Pipe	280	LNFT	7,270	11,164		2,354		74.243	20,788
16" HDPE DR 11 Fitting - 90 Elbow	1	EACH	487	263		158		907.183	907
16" HDPE DR 11 Fitting - 45 Elbow	1	EACH	487	241		158		885.034	885
16" Cast Iron Butterfly Valve	1	EACH	1,298	13,400		420		15,118.490	15,118
16" Cast Iron Check Valve	1	EACH	1,947	16,777		631		19,355.235	19,355
* Drainage pipe length *	280	LNFT							
**** Total Utilities**	**1**	**LS**	**11,490**	**41,844**		**3,720**		**57,053.842**	**57,054**
*** Total Permeate Overflow**	**280**	**LNFT**	**97,248**	**59,462**		**40,444**		**704.121**	**197,154**
Total Gross Cost			**5,819,667**	**2,204,622**	**11,410,682**	**1,350,895**			**20,785,867**

6 MGD PT Groundwater Treatment Facility - O&M Cost Estimate

ITEM	QTY	UNIT	UNIT PRICE	TOTAL COST ($ 2022)	NOTES
Consumables				**$ 452,000**	
Membrane Replacement	268	EA	$ 1,246	$ 334,000	Replacement cost for 3 trains spread over 4 years; unit cost escalated to Feb. 2022 dollars
Decarbonation Tower Media	300	CF	$ 65	$ 20,000	Replacement cost spread over 10 years; unit cost escalated to Feb. 2022 dollars
Equipment Consumables	1	LS	$ 57,000	$ 57,000	2% of Div 11; cost escalated to Feb. 2022 dollars
Electrical Consumables	1	LS	$ 33,000	$ 33,000	2% of Div 16; cost escalated to Feb. 2022 dollars
Instrumentation Consumables	1	LS	$ 8,000	$ 8,000	2% of Div 17; cost escalated to Feb. 2022 dollars
Power Costs				**$ 928,000**	
Power	4,635,286	kWH	$ 0.20	$ 928,000	Scaled by influent flows and online factor
Chemical Costs				**$ 490,000**	
Chemicals	1	LS	$490,000	$ 490,000	CIP chemicals for 3 trains; scaled by influent flows and online factor; escalated unit price to Feb. 2022 dollars
Other Costs				**$ 189,000**	
Contract Services	1	LS	$ 18,000	$ 18,000	Escalated unit price to Feb. 2022 dollars
Laboratory Services	1	LS	$ 21,000	$ 21,000	Scaled by influent flows and online factor; escalated unit price to Feb. 2022 dollars
Concentrate Disposal (1.5 MGD)	1	LS	$ 150,000	$ 150,000	Scaled for 1.5 MGD concentrate disposal and online factor; escalated unit price to Feb. 2022 dollars
			TOTAL ANNUAL O&M COSTS	**$ 2,059,000**	

APPENDIX J: USBR SWRCB CROSSWALK

CROSSWALK BETWEEN USBR & SWRCB REQUIREMENTS AND THE PWFS REPORT

Per Reclamation's Directives and Standards, a crosswalk is required that identifies where each of the mandatory Title XVI Feasibility Study items are addressed in the PWFS. Table 1 identifies where the required information is located in the 2023 Purified Water Feasibility Study (incorporated here by reference). Both the crosswalk and additional information that is provided in Chapter 11 are organized by the required content as outlined in Reclamation's Directives and Standards:

1. Introductory Information
2. Statement of Problems and Needs
3. Water Reclamation and Reuse Opportunities
4. Description of Alternatives
5. Economic Analysis
6. Selection of the Proposed Title XVI Project
7. Environmental Consideration and Potential Effects
8. Legal and Institutional Requirements
9. Financial Capability of Sponsor
10. Research Needs

Table 1: Crosswalk with Title XVI Feasibility Study Directives and Standards

Reclamation Chapter / Subchapter	Corresponding Reference
Chapter 1. Introductory Information	
1a. Identification of the non-Federal project sponsor	• PWFS Report: Section 1.3; Section 3.3.3
1b. A description of the study area and an area/project map	• PWFS Report: Section 1.3; Figure 1-2
1c. A definition of the study area in terms of both the site-specific project area where the reclaimed water supply will be needed and developed, and any reclaimed water distribution systems.	• PWFS Report: Section 1.3, Figure 1-2
Chapter 2. Statement of Problems and Needs	
2a. Description of the problem and needs for a water reclamation and reuse project	• PWFS Report: Section 1.3.1
2b. Description of current and projected water supplies, include water rights, and potential sources of additional water, other than the proposed Title XVI project, and plans for new facilities.	• PWFS Report: Section 1.3; Section 3.3.2
2c. Description of current and projected water demands and current and projected water supply and demand imbalances	• PWFS Report: Section 1.3
2d. Description of any water quality concerns for the current and projected water supply.	• PWFS Report: Section 3.2.1; Section 3.2.7
Chapter 3. Water Reclamation and Reuse Opportunities	
3a. Description of all uses for reclaimed water, or categories of potential uses (including but not limited to, environmental restoration, fish and wildlife, groundwater recharge, municipal, domestic, industrial, agricultural, power generation, and recreation). Identify any associated water quality, and associated treatment requirements.	• PWFS Report: Section 2
3b. Description of the water market available to utilize reclaimed water to be produced, including: (i) Identification of: 1. Potential and existing users,	• Not applicable
2. Expected use, peak use	• Not applicable
3. On-site conversion costs,	• Not applicable
4. Desire to use recycled water, including letters of intent if available.	• PWFS Report: Section 3
(ii) Description of any consultation with potential recycled water customers. Letters of intent must be included, if applicable.	• Not applicable

(iii) Description of the market assessment procedures used.	• Not applicable
3c. Discussion of considerations which may prevent implementing a water reuse project. Identify methods or community incentives to stimulate recycled water demand, and methods to eliminate obstacles which may inhibit the use of reclaimed water, including pricing.	• PWFS Report: Section 3.2; Table 3-17
3d. Identification of all the water and wastewater agencies that have jurisdiction in the potential service area or over the sources of reclaimed water.	• PWFS Report: Section 1.3
3e. Description of potential sources of water to be reclaimed, including impaired surface and ground waters.	• PWFS Report: Section 1.3.4; Section 3.2.2; Section 5.2.1
3f. Description and location of the source water facilities, including: 1. Capacities,	• PWFS Report: PWFS Report: Section 1.3.4; Section 3.2.2
2. Treatment processes,	• PWFS Report: Section 1.3.4
3. Design criteria, plans for future facilities,	• PWFS Report: Section 1.3.4
4. Existing flows, quantities of impaired water available to meet new reclaimed and reused water demands	• PWFS Report: Section 1.3.4; Section 3.2.2
3g. Description of the current water reuse taking place in the study area, including a list of reclaimed water uses, type and amount of reuse, and a map of existing pipelines and use sites.	• PWFS Report: Section 1.3.2
3h. Description of current and projected wastewaters and disposal options other than the proposed Title XVI project, and plans for new wastewater facilities, including projected costs, if any	• PWFS Report: Section 1.3.4
3i. Summary of water reclamation and reuse technology currently in use, and opportunities for development of improved technologies.	• Not applicable.
Chapter 4. Description of Alternatives	
4a. Description of non-Federal funding condition. The reasonably foreseeable future actions that the non-Federal project sponsor would take if Federal funding were not provided for the proposed water reclamation and reuse project, including estimated costs.	• PWFS Report: Section 11.1
4b. Statement of the specific objectives all alternatives, including the Title XVI Project, are designed to address.	• PWFS Report: Section 5.2.1
4c. Description of the proposed Title XVI project including detailed project cost estimate; annual operation, maintenance, and replacement cost estimate;	*For the following references, Alternative A (Phases I&II, prorated Pit #2) is the recommended Title XVI project*

and life cycle costs shall be provided with sufficient detail to permit a more in-depth evaluation of the project, including non-construction costs. Cost estimates shall clearly identify expenditures for major structures and facilities, as well as other types of construction and non-construction expenses, and shall be based on calculated quantities and unit prices	PWFS Report: Section 6.5; Section 6.6; Section 7.4; Section 7.4; Section 8.4; Section 8.5; Section 9.1.1
4d. Estimated costs shall be presented in terms of dollars per million gallons (MG), and/or dollars per acre-foot of capacity, to facilitate comparison of alternatives. References, design data, and assumptions must be identified. The level of detail shall be as required for feasibility studies in RM D&S, Cost Estimating (FAC 09-01).	PWFS Report: Section 6.5; Section 6.6; Section 7.4; Section 7.4; Section 8.4; Section 8.5; Section 9.1.1
4e. Description of waste-stream discharge treatment and disposal water quality requirements for the proposed Title XVI project.	• PWFS Report: Section 5.3.1; Section 6.3
4f. Description of at least two alternative measures, or technologies available for water reclamation, distribution, and reuse for the project under consideration. These alternatives must be approvable by the state(s) or tribal authorities in which the project will be located.	• PWFS Report: Section 5.2.1
Chapter 5. Economic Analysis	
5a. The economic analysis included in the feasibility study report shall describe the conditions that exist in the area and provide projections of the future with, and without, the project. Emphasis in the analysis must be given to the contributions that the plan could make toward alleviation of economic problems and the meeting of future demand.	• PWFS Report: Section 11.3
5b. A cost comparison of alternatives that would satisfy the same demand as the proposed Title XVI project. Alternatives used for comparison must be likely and realistic, and developed with the same standards with respect to interest rates and period of analysis.	PWFS Report: Section 11.3
5c. Description of the other water supply alternatives considered to accomplish the objectives to be addressed by the proposed Title XVI project, including benefits to be gained by each alternative, total project cost, life cycle cost, and corresponding cost of the project water produced expressed in dollars per million gallons (MG), and/or dollars per acre-foot. An appraisal	• PWFS Report: Section 11.2; Section 11.3

level cost estimates, or better, is acceptable for these alternatives.	
5d. When a Title XVI project provides water supplies for municipal and industrial use, the benefits of the Title XVI project can be measured in terms of the cost of the alternatives most likely to be implemented in the absence of the project. This is assuming that the two alternatives would provide comparable levels of service. This comparison must be provided, if applicable.	Not Applicable.
5e. Some Title XVI project benefits may be difficult to quantify; for example, a drought tolerant water supply, reduced water importation, and other social or environmental benefits. These benefits shall be documented and described qualitatively as completely as possible. These qualitative benefits can be considered as part of the justification for a Title XVI project in conjunction with the comparison of project costs.	• PWFS Report: Section 3.1.1, 3.1.2, 3.1.3
Chapter 6. Selection of the Proposed Title XVI Project	
6a. Provide a justification of why the proposed Title XVI project is the selected alternative in terms of meeting objectives, demands, needs, cost effectiveness, and other criteria important to the decision.	• PWFS Report: Section 5.2.2
6b. Provide an analysis, and if applicable, an affirmative statement of whether the proposed Title XVI project would address the following: (i) Reduction, postponement, or elimination of development of new or expanded water supplies; (ii) Reduction or elimination of the use of existing diversions from natural watercourses, or withdrawals from aquifers; (iii) Reduction of demand on existing Federal water supply facilities; and (iv) Reduction, postponement, or elimination of new or expanded wastewater facilities.	• PWFS Report: Section 1.1; Section 11.4 and 11.5

Chapter 7. Environmental Consideration and Potential Effects	
7a. The Title XVI feasibility study report must include sufficient information on the proposed Title XVI project to allow Reclamation to assess the potential measures and costs that may be necessary to comply with NEPA, and any other applicable Federal law. Accordingly, the following information is required:	
(i) Discussion whether, and to what extent, the proposed Title XVI project will have potentially significant impacts on endangered or threatened species, public health or safety, natural resources, regulated waters of the United States, or cultural resources.	• PWFS Report: Section 10
(ii) Discussion whether, and to what extent, the project will have potentially significant environmental effects, or will involve unique or undefined environmental risks.	• PWFS Report: Section 10
(iii) Description of the status of required Federal, state, tribal, and/or local environmental compliance measures for the proposed Title XVI project including copies of any documents that have been prepared, or results of any relevant studies.	• PWFS Report: Section 10
(iv) Any other information available to the study lead that would assist with assessing the measures that may be necessary to comply with NEPA, and other applicable Federal, state or local environmental laws such as the Endangered Species Act or the Clean Water Act.	• PWFS Report: Section 10
(v) Discussion of how the proposed Title XVI project will affect water supply and water quality from the perspective of a regional, watershed, aquifer or river basin condition.	PWFS Report: Section 10.5
(vi) Discussion of the extent to which the public was involved in the feasibility study, and a summary of comments received, if any.	• PWFS Report: Section 3.3.1; Section 4.3.1; Section 10.6
(vii) Description of the potential effects the project may have on historic properties. Discussion must include potential mitigation measures, the potential for adaptive reuse of facilities, an analysis of historic preservation costs, and the potential for heritage education, if necessary.	• PWFS Report: Section 10.7

Chapter 8. Legal and Institutional Requirements	
8a. Analysis of any water rights issues potentially resulting from implementation of the proposed water reclamation and reuse project. All proposed Title XVI projects must comply with state water law.	• PWFS Report Section 11.6.1
8b. Discussion of legal and institutional requirements, state, and/or local requirements with the potential to affect implementation of the project. Title XVI projects using Reclamation project water must address contractual requirements as described in RM Policy, *Reuse of Bureau of Reclamation Project Water* (PEC 05-09).	• PWFS Report Section 11.6.2
8c. Discussion of the need for multi-jurisdictional or interagency agreements, any coordination undertaken, and any planned coordination activities.	• PWFS Report: Section 3.3.3; Section 4.3.3; Section 4.3.4; Section 11.6.3
8d. Discussion of permitting procedures required for the implementation of water reclamation projects in the study area, and any measures that the non-Federal project sponsor can implement that could speed the permitting process.	• PWFS Report: Section 4.3.2; Section 11.6.4
8e. Discussion of any unresolved issues associated with implementing the proposed water reclamation and reuse project, how and when such issues will be resolved, and how the project would be affected if such issues are not resolved.	• Not Applicable
8f. Identification of current and projected wastewater discharge requirements resulting from the proposed Title XVI project.	• PWFS Report: Section
8g. Description of rights to wastewater discharges resulting from implementation of the proposed Title XVI project.	• PWFS Report: Section 3.2.2
Chapter 9. Financial Capability of Sponsor	
9a. Proposed schedule for project implementation.	• PWFS Report: Section 11.7.1
9b. Discussion of the willingness of the non-Federal project sponsor to pay for its share of capital costs and the full operation, maintenance, and replacement costs.	• PWFS Report: Section 11.7.2; Section 4.3.4
9c. A plan for funding the proposed water reclamation and reuse project's construction, operation, maintenance, and replacement costs, including an analysis of how the non-Federal project sponsor will pay construction and annual operation, maintenance, and replacement costs.	• PWFS Report: Section 11.7.3; Section 4.3.4

9d. Description of all Federal and non-Federal sources of funding and any restrictions on such sources, for example, minimum or maximum cost-share limitations. Generally, for Title XVI authorized projects, the Federal cost share is limited to 25 percent, of $30,000,000, whichever is less.	• PWFS Report: Section 11.7.3; Section 4.3.4
Chapter 10. Research Needs	
At a minimum the report must include a statement on whether the proposed water reclamation and reuse project includes basic research needs, and the extent that the proposed Title XVI project will use proven technologies and conventional system components.	• PWFS Report: Section 11.8
If further research is necessary to implement the proposed Title XVI Project, the following is required:	
10a. Description of research needs associated with proposed water reclamation and reuse project, including the objectives to be accomplished through research.	• Not Applicable
10b. Description of the basis for Reclamation participation in the identified research.	• Not Applicable
10c. Identification of the parties who will administer and conduct necessary research.	• Not Applicable
10d. Identification of the timeframe necessary for completion of necessary research.	• Not Applicable

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