Final Technical Memorandum

To:	Scott Rogers, PE, Palmdale Water District	From:	Tama Snow, PE, Kyleen Marcella Stantec
Subject:	Recycled Water Alternatives Evaluation - Surface Water and Groundwater Augmentation Feasibility Study	Date:	April 30, 2021

1. Introduction

The following sections of this Technical Memorandum (TM) briefly presents the project background, scope of work, regulatory requirements, infrastructure requirements and initial costs to evaluate the feasibility of Palmdale Water District (PWD) utilizing recycled water for surface water augmentation and/or groundwater injection.

1.1. Project Background

PWD has been providing water service to its customers since 1918 when the Palmdale Irrigation District was formed. Due to extensive agricultural use, the groundwater basin has been in overdraft since the 1930's resulting in land subsidence. In 1973, Palmdale Irrigation District changed its name to Palmdale Water District.

PWD has conducted a number of studies that date back to as early as the 1990's to evaluate the water resources necessary to meet future water supply demands that have included using recycled water for landscape irrigation, discharging into Palmdale Lake, and discharging into existing sand and gravel pits to replenish the groundwater basin. In 2010 a Strategic Water Resources Study (RMC, 2010) was completed that projected water demands in the PWD service area would double by 2035. The study established the guiding objectives and necessary steps to meet future water needs. Those recommendations included the following:

- Acquire and or develop new imported water supplies
- Creating a combination of local surface spreading facilities to percolate untreated State Water Project (SWP) water and Aquifer Storage and Recovery (ASR) wells to inject potable water
- Add additional pumping capacity to meet up to 70 percent of water demands from the groundwater basin
- Pursue a recycled water exchange program with nearby agriculture in-lieu of groundwater pumping
- Expand water conservation programs
- Recover storage capacity in Littlerock Reservoir through sediment removal
- Implement a recycled water system for non-potable uses (primarily irrigation and possibly industrial)
- Conduct further research to use treated recycled water to replenish the groundwater basin through surface spreading.

In 2012 the Palmdale Recycled Water Authority (PRWA), comprised of members from the City of Palmdale and Palmdale Water District, was established to manage recycled water that is generated and used within the Palmdale area. PRWA manages the distribution of recycled water use, designing and constructing support facilities and financing the efforts. In 2015, a Recycled Water Facilities Master Plan (Carollo, 2015) was prepared that combined the City of Palmdale and Palmdale Water District's recycled water master plans. The recommended alternative included constructing a recycled water pump station and installing recycled water pipelines to the largest potential recycled water customers on the east side of PRWA's service area. Implementation in five manageable phases was suggested that would allow PRWA to identify and apply for grant funds for each phase.

In 2015, PWD prepared the Littlerock Creek Groundwater Replenishment and Recovery Project (LCGRRP) Feasibility Study (Kennedy Jenks, 2015), to investigate the feasibility of a groundwater banking, storage and extraction program. Two preferred alternatives were identified that would allow for groundwater recharge within the Lancaster sub-basin using both recycled water and water from the SWP and in 2016, PWD completed an Environmental Impact Report (EIR) for the Palmdale Regional Groundwater Recharge and Recovery Project (Helix, 2016). Since that time, PWD has been conducting a series of pilot studies to determine the infiltration rates. Less than favorable results from the pilot studies has led PWD to evaluate the feasibility of surface water augmentation and/or groundwater injection.

1.2 Project Scope

The scope of this project is to conduct a high-level evaluation of the feasibility of using recycled water from the Palmdale Water Reclamation Plant owned and operated by the County Sanitation District No. 20 of Los Angeles County (CSDLAC), for surface water augmentation at Palmdale Lake and/or groundwater injection. The scope of work included evaluating regulatory requirements, infrastructure needs and preparation of a planning level cost opinion.

1.3 Study Area

The PWD provides service to an area of approximately 40 square miles to the City of Palmdale and unincorporated areas in Los Angeles County. PWD serves a combination of residential, commercial, and industrial customers. The City's water needs are currently met through the following sources:

- Groundwater from 22 active production wells located in the Lancaster and Pearland sub-basins
- Surface water from Littlerock Dam Reservoir that is conveyed to Palmdale Lake via the Palmdale Ditch and treated at the Leslie O' Carter Water Treatment Plant (LOCWTP), and
- Imported water from the SWP via the East Branch of the California Aqueduct and treated at the LOCWTP.

The groundwater basin has been in a state of overdraft since the 1930's resulting in land subsidence, and in 2015, the Antelope Valley groundwater basin adjudication was finalized. The adjudication established respective water rights among groundwater producers and ordered a ramp down of production to the native basin safe yield.

Wastewater collection and treatment in the PWD service area and City of Palmdale is provided by CSDLAC District Nos. 14 and 20. The two districts serve a combined wastewater service area of approximately 76 square miles and more than 310,000 people. Collection is provided through a network of 104 miles of trunk sewers. The Antelope Valley is a closed basin without an outlet to the ocean and, therefore, wastewater either evaporates, is reused, or infiltrates into the Antelope Valley Groundwater Basin. For the purpose of this study, recycled water will be provided from the Palmdale WRP, which is a tertiary treatment plant with a design capacity of 12 million gallons of wastewater per day (mgd). A small amount of recycled water is used for landscape irrigation at the City of Los Angeles Department of Airports (LAWA) site and City of Palmdale. Most of the recycled water is currently used at agronomic rates on fodder crops. Historically, the WRP has discharged secondary effluent by land spreading, allowing it to percolate and evaporate, which has caused adverse impacts to the groundwater quality due to elevated nitrate levels.

1.4 Existing and Future Demands

Based on the Water System Master Plan (WSMP) prepared in 2016 (MWH, 2016) and updated in 2018 Table 1 shows the existing and projected water demands.

Table 1: Existing and Future Water Demands

	Water Demands		
	Average Annual		Maximum Day[1]
Year	**(acre-ft/yr)**	**(mgd)**	**(mgd)**
2020	25,900	23.1	42.6
2025	27,200	24.2	43.6
2030	28,500	25.4	45.7
2035	29,800	26.6	47.8
2040	31,100	27.7	49.9
Build-out	**44,600**	**39.8**	**71.6**

[1]Maximum Day Demand (MDD) = 1.8 x Average Day Demand

1.5 Existing and Future Supplies

PWD receives and/or has access to the following sources of water as described below and summarized in Table 2:

- 5,500 acre-feet of diversion rights with an average annual yield of approximately 4,000 acre-feet per year (afy) from Little Rock Creek surface water stored behind Little Rock Dam and delivered to Lake Palmdale via the Palmdale Ditch. Due to sediment build up behind the dam, the current capacity has been reduced to approximately 3,000 acre-feet. PWD has a sediment removal program proposed to restore the reservoir to its 1992 capacity of 3,500 acre-feet over the next 7-12 years. The agreement with Littlerock Creek Irrigation District governing the use of water from the reservoir expires in 2042 and will need to be renegotiated by PWD.
- 2,770 (2,769.63) afy of the Antelope Valley's native groundwater pursuant to the Antelope Valley Groundwater Basin adjudication (Judgment) in December 2015.
- Table A Entitlement of 21,300 afy of imported water from the State Water Project (SWP) via a turnout to Lake Palmdale from the East Branch of the California Aqueduct. The 2019 Delivery Capability

Reference: **Surface Water Augmentation Feasibility Study**

Report published by the California Department of Water Resources (DWR) estimates the long-term average reliability of the SWP at 58 percent. Based on this, PWD anticipates an average of 12,500 afy from the SWP.

Based on the most recent agreement between PWD and the CSDLAC, PWD is entitled to a maximum 4.75 mgd (5,325 afy) of tertiary recycled water from the Palmdale WRP. PWD also has an additional 1,500 afy available through the Palmdale Recycled Water Authority (PRWA) that could be utilized for augmentation. However, for the purpose of this report and cost estimating, the total recycled water flow is assumed to be 5,325 afy.

Table 2: Water Supply Summary

Description	Supply Allocation[1] (AFY)
Little Rock Creek Surface Water	3,000
Groundwater Rights (Adjudication Judgment 2015)	10,370
Imported Water	12,500
Return Flow Credits	4,900
Recycled Water	5,325
Total	**36,095**

[1] The most conservative availability of supplies were utilized

- Variable groundwater rights include approximately 1,370 afy of unused Federal Government native groundwater rights (total of 7,600 afy shared with other public water purveyors) pursuant to the Judgment.
- Variable groundwater rights also include approximately 4,900 to 6,000 afy of imported water return flow credits based on 39 percent of the running five-year average amount of imported water pursuant to the Judgment. For every 10 af of water imported into the valley, PWD receives 3.9 af of groundwater credit.

2. Regulatory Requirements

To ensure public health safety as well as antidegradation of the local groundwater basin, recycled water from municipal wastewater sources that is used as a water source for indirect potable reuse, must meet State and Regional Water Quality Control Board requirements and water basin standards. It must also receive approval from the State Water Resources Control Board Division of Drinking Water (SWRCB DDW). Presented below are the regulations pertaining to both surface water augmentation and groundwater injection.

2.1 Surface Water Augmentation

PWD is considering using recycled water from the Palmdale WRP for surface water augmentation in Palmdale Lake that currently provides drinking water to its customers. Water from Palmdale Lake is treated at the LOCWTP; and therefore, recycled water used for surface water augmentation must meet the California Code of Regulations Title 22 (Title 22) for indirect potable reuse via a surface water augmentation source, including meeting drinking water Maximum Contaminant Levels (MCLs).

Title 22 Regulations

Indirect potable reuse via surface water augmentation is addressed in Title 22 Section 60320.300. Table 3 summarizes the Title 22 requirements as specified in each subsection.

Table 3: Title 22 Requirements for Surface Water Augmentation

Title 22 Section	Requirements
60320.300 Application	The requirements of this section apply to Surface Water Source Augmentation Project Water Recycling Agencies (SWSAP WRA) where the placement of recycled municipal wastewater is planned into a surface water reservoir used as a source of domestic drinking water
60320.301 General Requirements	A plan must be submitted to the State and Regional Boards for review and written approval
60320.302 Advanced Treatment Criteria	Full advanced treatment using RO and AOP
60320.304 Lab Analyses	Analyses for primary and secondary MCLs must be performed using methods approved by State Board
60320.306 Wastewater Source Control	Municipal wastewater to be used for surface water augmentation should be from a comprehensive industrial pretreatment and pollutant source control program
60320.308 Pathogenic Microorganism Control	Treatment and underground retention must provide a minimum of 8-log enteric virus reduction, 7-log *Giardia* cyst reduction, and 8-log *Cryptosporidium* oocyst reduction
60320.312 Regulated Contaminants and Physical Characteristics Control	Extensive sampling, analyses, monitoring and reporting of water quality required for MCL, inorganics, organics, radionuclides, disinfection byproducts, and lead and copper

Title 22 Section	Requirements
60320.320 Additional Chemical and Contaminant Monitoring	Sampling and analysis of recycled water and groundwater must be performed for Priority Toxic Pollutants and other chemicals
60320.322 SWSAP Operation Plan	Requires submittal of a SWSAP Operation Plan
60320.326 Augmented Reservoir Monitoring	Monitoring locations in augmented reservoir should be identified and representative of the following characteristics: • differing water quality conditions across the horizontal extent of the surface water reservoir • each level in the surface water reservoir corresponding to the depths in which water may be withdrawn • surface water reservoir's epilimnion and hypolimnion
60320.328 Reporting	Water quality and compliance reporting to DDW, RWQCB, and SWSAP PWS affected by the SWSAP

The recycled water quality for surface water augmentation must meet the criteria for full advanced treatment as described in Section 60320.201 pathogen requirements, as well as meet drinking water MCLs. The basic requirements for full advanced treatment according to Title 22 are shown in **Table 4**.

Table 4: Title 22 Regulations for Full Advanced Treatment

Parameter	Requirements
Treatment Requirements	Full Advanced Treatment consisting of RO + oxidation
Reverse Osmosis	• NaCl rejection no less than 99% • NaCl average rejection of no less than 99.2% • Permeate recovery no less than 15%
Oxidation Requirement	Conduct challenge spiking tests for oxidation or testing to ensure 0.5-log reduction of 1,4-dioxane
Influent pH	6.5 to 8
Influent NaCl	less than or equal to 2,000 mg/L
Applied pressure	less than or equal to 225 psi

Recycled water entering the reservoir must meet pathogen reduction requirements. The limitations on the log reduction credits applied to each treatment process are as follows:

- Each treatment process in the recycled water treatment train can be credited with up to 6-log reduction,
- At least two processes are required,
- Each process must achieve at least 1-log reduction of the pathogen,
- If recycled water is greater than 10percent of the daily flow into the reservoir an additional log reduction in each category is required.

The pathogen reduction requirements for surface water augmentation are presented in **Table 5**.

Table 5: Title 22 Pathogen Reduction Requirements for Surface Water Augmentation

Pathogen	Log Reduction Requirements
Enteric Virus	8-log or 9-log[1]
Giardia cyst	7-log or 8-log[1]
Cryptosporidium oocyst	8-log or 9-log[1]
[1]If recycled water is greater than 10 percent of the daily flow into the reservoir an additional log reduction in each category is required.	

The recycled water must comply with primary and secondary MCLs and action levels (lead and copper). The list of current MCLs is provided in Appendix A. In addition to ensuring the recycled water meets drinking water MCLs, Title 22 requires monitoring of specific contaminants in the groundwater. This includes nitrogen as well as inorganic contaminants, radionuclides, organic chemicals, disinfection byproducts, and lead and copper, as listed in **Appendix A**. For the full list of organic chemicals, refer to Title 22 table 64444-A.

2.2 Groundwater Augmentation via Direct Injection

Groundwater augmentation can also be achieved through direct injection into the aquifer. Any water injected into a local aquifer must meet Title 22 regulations for subsurface application, including full advanced treatment and pathogen reduction requirements, drinking water MCLs, as well as comply with the Water Quality Control Plan for the Lahontan Region (Basin Plan) of the Regional Water Quality Control Board, Lahontan Region (RWQCB).

Title 22 Regulations

Indirect potable reuse for groundwater replenishment via subsurface application is addressed in Title 22 Section 60320.200. **Table 6** summarizes Title 22 requirements for direct injection.

Table 6: Title 22 Requirements for Subsurface Application (Direct Injection)

Title 22 Section	Requirements
60320.200 General Requirements	Primary buffer representing a zone of controlled drinking water well construction and a secondary buffer representing a zone of potentially controlled drinking water well construction
60320.201 Advanced Treatment Criteria	Full advanced treatment using RO and AOP
60320.202 Public Hearing	Project sponsor must hold public hearing prior to DDW submitting recommendations to RWQCB
60320.204 Lab Analyses	Analyses for primary and secondary MCLs must be performed using methods approved by State Board
60320.206 Wastewater Source Control	Municipal wastewater to be used for groundwater recharge should be from a comprehensive industrial pretreatment and pollutant source control program

Title 22 Section	Requirements
60320.208 Pathogenic Microorganism Control	Treatment and underground retention must provide a minimum of 12-log enteric virus reduction, 10-log *Giardia* cyst reduction, and 10-log *Cryptosporidium* oocyst reduction
60320.210 Nitrogen Compounds Control	Recycled water must be treated to less than 10 mg/L of total nitrogen concentration
60320.212 Regulated Contaminants and Physical Characteristics Control	Extensive sampling, analyses, monitoring and reporting of water quality required
60320.214 Diluent Water Requirements	Diluent water must meet primary and secondary MCLs as well as other requirements to be used for the RWC
60320.216 Recycled Municipal Wastewater Contribution (RWC) Requirements	DDW sets a maximum RWC up to 1.0 (100% recycled water) for projects that reliable achieve TOC concentrations less than 0.5 mg/L
60320.218 Total Organic Carbon Requirements	Maximum TOC limit of 0.5 mg/L is based on the 20-week running average of all TOC results
60320.220 Additional Chemical and Contaminant Monitoring	Sampling and analysis of recycled water and groundwater must be performed for Priority Toxic Pollutants and other chemicals
60320.222 Operation Optimization Plan	Requires submittal of an Operation Optimization Plan (OOP)
60320.225 Response Retention Time	Underground retention of the recycled water must allow for a sufficient response time to identify treatment failures and implement corrective actions
60320.226 Monitoring Well Requirements	At least two monitoring wells are required - -more than two weeks and less than six months downgradient from injection site -more than 30 days upgradient of nearest drinking water well
60320.228 Reporting	Water quality and compliance reporting to DDW, RWQCB, and downgradient drinking well owners is required
60320.230 Alternatives	Certain alternatives are allowed with DDW approval

Because direct injection of recycled water into the basin is considered indirect potable reuse, the recycled water quality must meet the criteria for full advanced treatment per Title 22 Section 60320.201. The basic requirements for full advanced treatment according to Title 22 are shown in Table 4 presented in Section 2.1. For direct injection, it is also a requirement to demonstrate the recycled water will be retained underground for at least two months. For each month the recycled water is retained underground, a 1-log virus reduction will be credited. The recycled water injected into the groundwater must meet pathogen reduction requirements. The limitations on the log reduction credits applied to each treatment process are as follows:

- Each treatment process in the recycled water treatment train can be credited with up to 6-log reduction,
- At least two treatment processes are required,
- Each process must achieve at least 1-log reduction of the pathogen,

The pathogen reduction requirements for subsurface application are presented in Table 7.

Table 7: Title 22 Pathogen Reduction Requirements for Subsurface Application (Direct Injection)

Pathogen	Log Reduction Requirements
Enteric Virus	12-log
Giardia cyst	10-log
Cryptosporidium oocyst	10-log

Recycled Water Contribution Requirements – Diluent Water. Recycled municipal wastewater can be combined with diluent water to meet less than 0.5 mg/L total organic carbon (TOC) in the recycled water. If the recycled water can reliably meet a TOC concentration of less than 0.5 mg/L no diluent water is needed.

Response Retention Time. For the protection of public health, recycled water must be retained in the groundwater basin for a minimum of two months. This means, there must be a two-month travel time from the point of groundwater injection to the closest extraction well. The response retention time can be demonstrated using a tracer study. Stantec recommends PWD perform a tracer study using an added tracer to determine the retention time in the groundwater basin to obtain the response time credit per month. As shown in **Table 8**, numerical and analytical modeling in a reservoir does not receive the full response time credit. For groundwater injection, Stantec estimates a groundwater basin travel time would require approximately 1,300 feet of distance between the injection location and the nearest drinking water well.

Table 8: Credit Allocation

Method used to estimate the retention time	Response time credit per month
Tracer study using an added tracer	1.0
Tracer study using an intrinsic tracer	0.67
Numerical modeling consisting of calibrated finite element or finite difference models using validated and verified computer codes used for simulating groundwater flow	0.50
Analytical modeling using existing academically acceptable equations such as Darcy's Law to estimate groundwater flow conditions based on simplifying aquifer assumptions	0.25
*Table adapted from Title 22 Table 60320.108	

Basin Plan Water Quality Objectives

In addition to the Title 22 requirements, recycled water injected into the groundwater basin must meet the Basin Plan water quality objectives. The water quality objectives are also found in the Salt & Nutrient Management Plan (SNMP) Los Angeles County Department of Public Works, Los Angeles County Sanitation Districts, Antelope Valley Salt and Nutrient Management Planning Stakeholders Group, 2014. Table 9 shows the SNMP Water Quality Management Goals alongside the assimilative capacity of the Lancaster Subbasin. The assimilative capacity is the difference between the SNMP water quality management goal and the existing water quality for select constituents. Other constituents not included have been shown in groundwater models (Antelope Valley SNMP, 2014) and not a concern at this time.

Table 9: Lancaster Subbasin SNMP Water Quality Management Goals and Assimilative Capacities

	unit	SNMP Water Quality Management Goal	Lancaster Subbasin Assimilative Capacity
Arsenic	µg/L	10[1]	1.1
Boron	mg/L	0.7[2]	0.56
		1[3]	0.86
Chloride	mg/L	238[2]	203
		250[4]	215
Fluoride	mg/L	1[2]	0.6
		2[3]	1.6
Nitrate	mg/L	10[1]	8.5
Total Chromium	µg/L	50[1]	44
Total Dissolved Solids	mg/L	450[25]	124.7[5]
		500[6]	175[6]
		1000[7]	675[7]
[1]SNMP Water Quality Mgmt Goal is based on the primary drinking water MCL			
[2]SNMP Water Quality Mgmt Goal is based on the AGR beneficial use threshold.			
[3]SNMP Water Quality Mgmt Goal is based on the CDPH Notification Level			
[4]SNMP Water Quality Mgmt Goal is based on the MCL			
[5]Recommended TDS capacity and goal			
[6]Upper TDS capacity and goal			
[7]Short term TDS capacity and goal			

3. Treatment and Infrastructure Requirements

To meet the regulatory requirements discussed in Section 2 for either surface water augmentation or groundwater injection, an advanced water purification facility (AWPF) will be required. The AWPF treatment train would include microfiltration/ultrafiltration membranes (MF/UF), 3-stage RO for high recovery (85 percent), and UV/AOP, before the water is stabilized and disinfected prior to either pumping to Palmdale Lake or injected. This treatment train is the primary option to meet all Title 22 requirements. The log reduction credits for each advanced water treatment process are presented on Figure 1. The following sections describe the AWPF processes along with specific infrastructure requirements to implement a surface water augmentation project or direct injection project.

3.1 AWPF Facility

The anticipated design flows and recovery for each process in the AWPF treatment train are summarized in Table 10. These flows are based on 4.75 mgd (5,325 afy) of influent water, the maximum allotment of recycled water PWD is entitled to from the CSDLAC. The resulting effluent water quality is provided in Table 11. Reverse osmosis (RO) should achieve higher than 95 percent reduction of TDS, 80 precent reduction of nitrogen species, and 95 percent reduction of TOC. The proposed AWPF treatment train will also meet all drinking water MCLs . Detailed process modelling should be completed during conceptual design to confirm these assumptions.

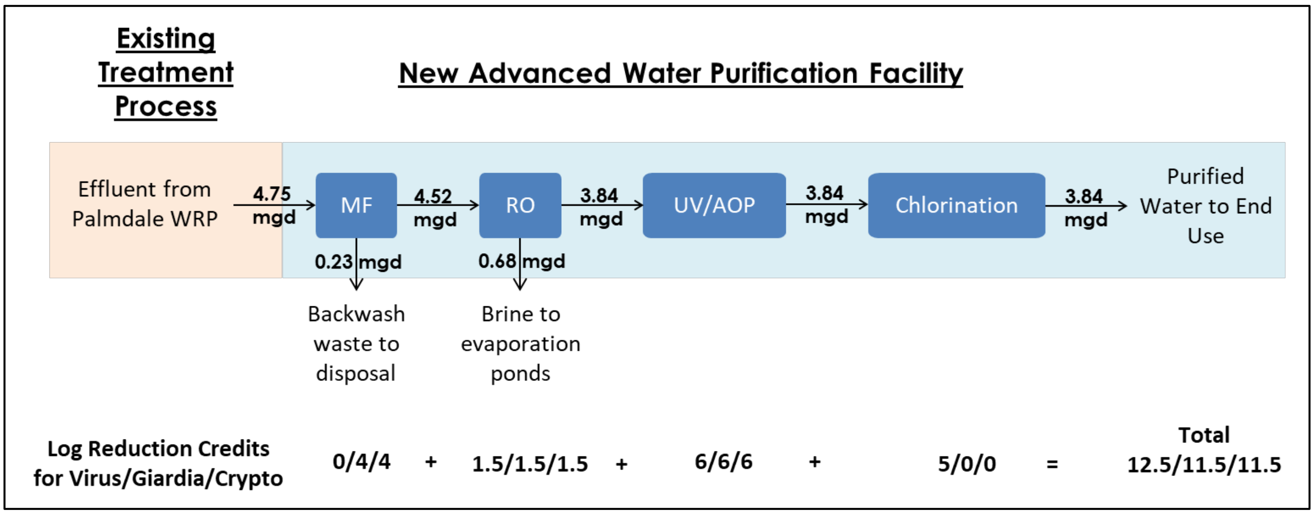

Figure 1: Proposed Advanced Water Purification Treatment Process

Table 10: Process Flow and Recovery Table

Process	Unit	Influent Design Flow (mgd)
AWPF Influent Flow	mgd	4.75
MF		
Feed	mgd	4.75
Recovery	%	95
MF Filtrate	mgd	4.52
RO		
Feed	mgd	4.52
Recovery	%	85
Permeate	mgd	3.84
Brine Flow	mgd	0.68
UV/AOP	mgd	3.84

Table 11: Anticipated AWPF Effluent Water Quality

Parameter	Unit	SNMP Requirement	Palmdale WRP 2019 Tertiary Effluent	Projected AWPF Effluent Concentration
Arsenic	µg/L	●	0.3	<0.03
Boron	mg/L	●	NS	--
Chloride	mg/L	●	156	15.6
Fluoride	mg/L	●	NS	--
Nitrate as nitrogen	mg/L	●	3.2	0.6
Total chromium	µg/L	●	0.9	<0.05
Total dissolved solids	mg/L	●	462	23.1
Total organic carbon	mg/L		5.4	0.27
NS = Not sampled				

Membrane Filtration

The MF system will use microfiltration/ultrafiltration membranes to remove particulate matter from the feed water that would otherwise foul the RO membranes. MF is also anticipated to achieve a 4-log reduction of *Cryptosporidium* and *Giardia*. While various membrane technologies and module configurations exist, the pressurized hollow-fiber membrane system is assumed for this application.

Reverse Osmosis

The RO system will remove a significant portion of the dissolved solids, organics, and pathogens that remain after the MF system. RO membranes also reject ammonia, nitrate, and organic nitrogen to varying degrees but typically higher than 80 percent. The RO system is expected to receive pathogen credits of 1.5-log for *Cryptosporidium*, *Giardia*, and enteric viruses, each. A single-pass configuration was considered for reduction of total dissolved solids and total nitrogen by RO. For this analysis, a 3-stage RO system with 85 percent recovery was considered. Other configurations and proprietary RO systems are available and should be evaluated further.

If PWD identifies goals for additional resource recovery through either brine minimization or production water efficiency, other technologies could be considered. Closed-Circuit Desalination (CCD) was evaluated for its ability to increase overall RO permeate and reduce brine production (from 0.68 mgd to 0.23 mgd) and consequently the amount of land needed for evaporation ponds. CCD would also ensure less permeate is lost to evaporation. The difference between the overall cost of reducing the evaporation pond size versus the high equipment capital cost is negligible due to low land costs in the Palmdale region. Additionally, the permeate from CCD is not eligible for pathogen log reduction credits and cannot be used for any potable reuse applications. For these reasons, Stantec does not recommend pursuing the use of CCD in the treatment train. Should land costs increase significantly, PWD may consider CCD and use the permeate on-site.

UV/AOP

The UV/AOP consists of dosing with an oxidizing agent, after which the water is exposed to UV light in a reactor. Membrane treatment increases the UV transmittance of the water making the UV process more efficient and therefore, UV/AOP is typically located downstream of the RO process. The combined effect of the oxidant (hydrogen peroxide or free chlorine) and ultraviolet light creates hydroxyl radicals, which attack any trace organic constituents or pathogens in the water. The UV/AOP system is expected to achieve both destruction of trace organics, targeting 0.5-log reduction of 1,4-dioxane as a surrogate constituent; and disinfection, targeting 6.0-log reduction each of enteric viruses, *Cryptosporidium*, and *Giardia*.

Post-stabilization and disinfection

Post-stabilization is an important element of any potable reuse system that includes RO. Because RO permeate is very low in total dissolved solids (TDS), hardness, and alkalinity, it is aggressive and chemically unstable. In surface water augmentation applications, this can lead to pipe corrosion in the conveyance system for the product water and can affect the water quality in the receiving surface water.

Most facilities producing RO product water practice pH and/or alkalinity adjustment for corrosion control. Lime and CO_2 addition is recommended to reach target goals for hardness, alkalinity, and pH. Lime addition increases alkalinity, pH, and hardness. CO_2 addition lowers the pH without affecting the alkalinity and helps target the treated water quality pH goal.

Disinfection of the final effluent is achieved through chlorination using sodium hypochlorite. This addition of hypochlorite maintains a free chlorine residual in the distribution system. Chlorine treatment also provides a 5-log reduction of enteric viruses.

3.3 Surface Water Augmentation

Palmdale Lake

Palmdale Lake is located in the southwestern corner of Palmdale and is owned by PWD. The lake is currently filled with two water sources imported water from the State Water Project (SWP), and Little Rock Reservoir where water is transferred via the Palmdale Ditch. The volume of Palmdale Lake is approximately 4,189 AF. The theoretical retention time is determined by dividing the reservoir volume by the maximum outflow on a monthly basis. Thus, the maximum monthly outflow from Palmdale Lake under the proposed SWSAP regulations (no less than 2 months of retention time) would be 11.2 mgd, on average. The current maximum capacity of the Leslie O. Carter WTP is 35 mgd, so there would be limitations on the volume of water that could be extracted from Palmdale Lake making it difficult for PWD to meet future potable water demands.

The regulations provide for lower pathogen reduction requirements if 1 percent dilution in the reservoir can be demonstrated. To be conservative, obtaining a 10 percent dilution in Palmdale Lake was assumed. A key component of the draft surface water augmentation regulations is the need for dilution of the advanced purified water from the AWPF as it enters Palmdale Lake to ensure complete mixing and prevent short circuiting. For there to be complete mixing in the horizontal direction, the water should enter the lake through a diffuser to spread the water evenly over an extended distance perpendicular to the direction of travel. If PWD decides to move forward with this alternative, a computational fluid dynamics (CFD) model is recommended to predict how mixing will occur in the lake during different times of the year and the best location for the addition of advanced purified water.

Reference: **Surface Water Augmentation Feasibility Study**

AWPF Location and Conveyance

The entire AWPF footprint is estimated to be approximately 1.5 acres and includes all processes, chemicals, parking and access roads. Two sites recommended by PWD were assessed for locating the AWPF, as shown on Figures 2 and 3 Neither site is owned by PWD and would require land acquisition along with additional environmental, community, ownership, and utility research. PWD owns a number of properties across Palmdale, as shown in Appendix B that could be investigated if neither of the below sites are available for acquisition.

- **AWPF Site #1** is located at the intersection of 30th St E and E Ave Q and would require approximately 0.5 miles (2,700 LF) of 20-inch pipeline to convey Palmdale WRP effluent to the AWPF. Once the recycled water has been advanced treated at the AWPF, it would be conveyed to Palmdale Lake. This will require final effluent pumps at the AWPF and a new 16-inch diameter pipe that could discharge either directly into Palmdale Lake on the opposite bank from the existing WTP intake, or into Palmdale Ditch which conveys flows from Little Rock Reservoir through the unlined Palmdale Ditch to Palmdale Lake. PWD is currently considering lining the ditch or converting it to a pipeline which would help reduce water loss due to percolation and evaporation and retain all flows into the Lake. There are multiple alternatives for AWPF effluent piping alignments that should be further studied. For this report, two alignments were considered as shown on Figure 2.
    - **Alignment A:** The first alignment option takes effluent from the AWPF site and heads west on E Ave Q before turning south on 25th St E before discharging into Palmdale Ditch. This alignment is approximately 21,000 LF with an approximate 290 feet in elevation gain.
    - **Alignment B:** The second alignment follows E Ave Q, turns south on Sierra Hwy and eventually discharges directly into Lake Palmdale, near the discharge from Palmdale Ditch. This alignment is approximately 28,400 LF with an approximate 240 feet in elevation gain.
- **AWPF Site #2** is located at the intersection of Pearblossom Highway and Barrel Springs Road, near the Palmdale Ditch and would require approximately 4.6 miles of 20-inch pipeline to convey Palmdale WRP effluent to the AWPF. There is an existing 24-inch recycled water pipeline along 30th St. E that runs from the Palmdale WRP to Avenue R, as shown on Figure 2, that could be used to convey the recycled water partway to Site #2 and could save on new pipeline construction costs. However, additional hydraulic studies would be required to determine if the existing pipeline has the capacity and if additional pumping is required to reach Site #2. For this study, additional pumping is assumed to be required. Since Site #2 is located adjacent to the Palmdale Ditch, it is recommended that the Palmdale Ditch be used convey the advanced treated water directly to Palmdale Lake. This alternative minimizes the amount of effluent piping needed. AWPF Site #2 is shown on Figure 3.

Reference: Surface Water Augmentation Feasibility Study

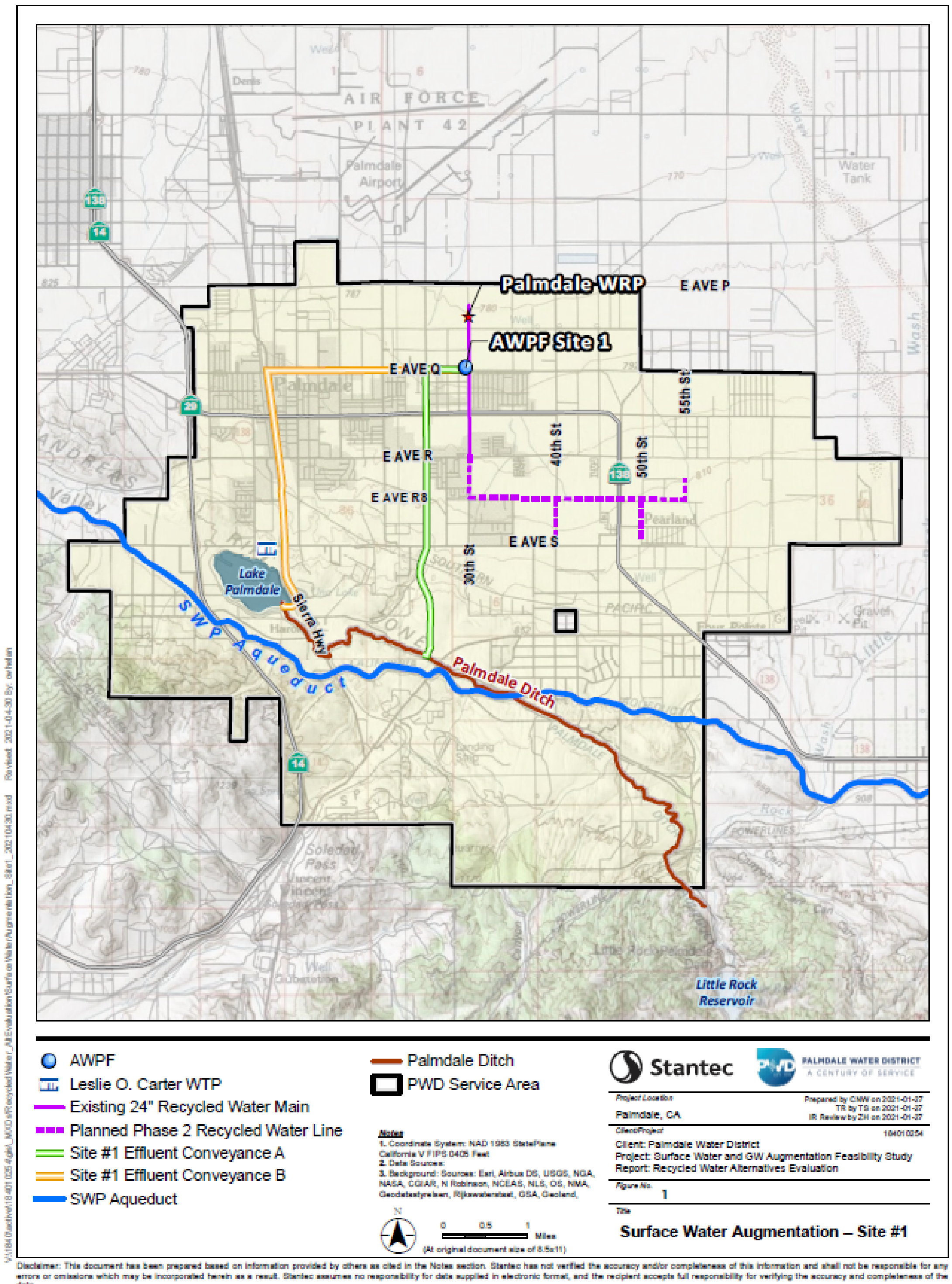

Figure 2: Surface Water Augmentation - Site #1

April 30, 2021

Scott Rogers, PE, Palmdale Water District

Reference: **Surface Water Augmentation Feasibility Study**

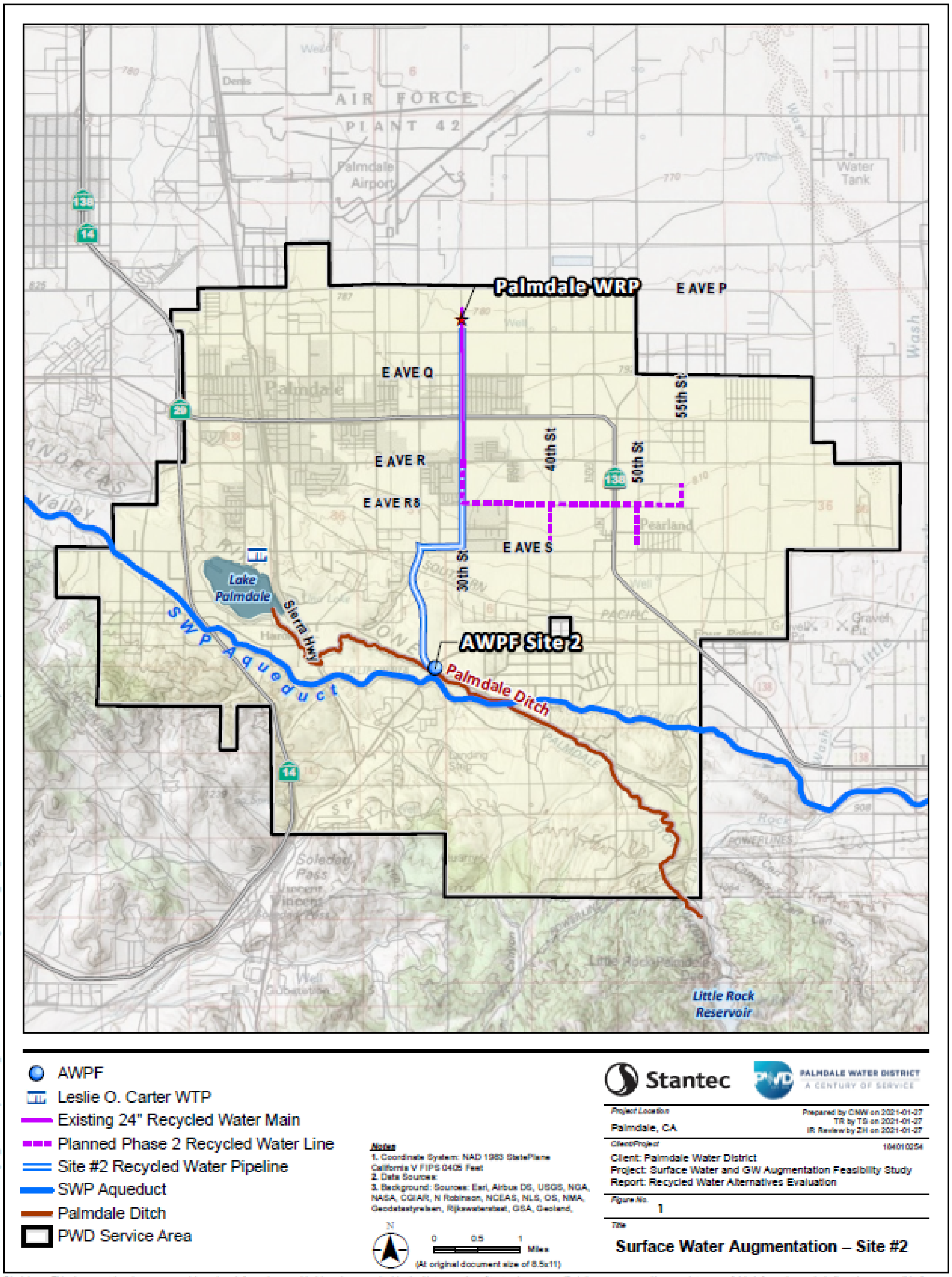

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Figure 3: Surface Water Augmentation - Site #2

3.4 Groundwater Augmentation

For groundwater augmentation, the advanced treated water would be pumped from the AWPF to one or more groundwater injection wells. The location of the injection well(s) is dependent on the estimated travel times needed to provide the minimum underground response retention time between the injection well(s) and the closest downgradient drinking water well. Using the Antelope Valley Watermaster (AVWM) Spring 2020 groundwater elevation contour map and the groundwater travel time parameters presented in Table 12, a 2-month travel distance was calculated to be approximately 1,050 feet. To be conservative until tracer studies are conducted, this study assumes a half mile distance (2,640 ft) is required from new groundwater injection wells to existing active production wells to meet the required minimum 2-month travel time.

Table 12: Groundwater Travel Time Parameters

Parameter	Value
Horizontal hydraulic conductivity (Kh, well sorted sand)	0.1 cm/sec
Hydraulic gradient	0.0185
Effective porosity (for medium sand)	0.25

In 2015, a groundwater recharge study entitled, “Littlerock Creek Groundwater Recharge and Recovery Feasibility Study”, was performed by Kennedy/Jenks Consultants on behalf of PWD (Kennedy/Jenks Consultants, 2015). This feasibility study evaluated locating groundwater recharge basins and recovery wells at up to seven locations east and northeast of the PWRP bounding Littlerock Creek. Owing to the minimum 2.5-mile distance between the PWRP and the closest proposed recharge and recovery site alternative, PWD indicated they would prefer to locate an injection well in close proximity to the PWRP. Locating one or more injection wells at AWPF Site #1, as described in Section 3.3, would minimize the conveyance requirements.

PWD operates five production wells in Township 6 North Range 11 West Section 19 (T6NR11W-19) immediately west of the PWRP as shown on Figure 4. These wells include Wells 2A, 3A, 7A, 8A and 23A, and are located in the western half of T6NR11W-19. Based on a review of the available State Well Completion Reports, Water Well Drillers Reports and well drilling and construction data (see “Technical Memorandum Well Rehabilitation Prioritization Program”, Kyle Groundwater, 2020), the geologic materials present below depths of about 500 feet below ground surface (ft bgs) to 1,054 ft bgs consist predominantly of interbedded sand and clay with occasional gravel. Well depths range between 840 ft bgs at Well 23A and 960 ft bgs at Well 8A. Current depth to groundwater at these wells varies between approximately 520 and 550 ft bgs. Current pumping rates at these wells varies between about 850 gallons per minute (gpm) at Well 23A and 1,900 gpm at Well 8A (Kyle Groundwater, 2020).

Owing to the generally good depth to groundwater in T6NR11W-19, one or more injection wells could be installed directly adjacent to AWPF Site #1 (Groundwater Injection Site #1, as shown in Figure 4) or in the southeast corner of T6NR11W-19 (Groundwater Injection Site #2, as shown in Figure 4), a distance of at least 2,600 feet from the closest operating PWD production well and within 500 feet of AWPF Site #1. PWD also owns a 100 foot by 100 ft easement at the northwest corner of 27th Street East and Avenue Q that offers another location for the injection well(s) and would not require additional land cost. This location, as shown in Appendix C, is approximately 1,000 feet from AWPF Site #1 and still maintains at least 2,600 feet from nearby operating PWD production wells. Preliminary design for injection wells in this area would consist of a 16-inch diameter stainless steel louvered casing extending from depths of 600 to 850 ft bgs, to ensure complete saturation of the perforated casing and maximize injection flow rates. The estimated design injection flow rate may range between 800 and 1,000 gpm but could be higher depending on hydrogeologic conditions.

April 30, 2021

Scott Rogers, PE, Palmdale Water District

Reference: Surface Water Augmentation Feasibility Study

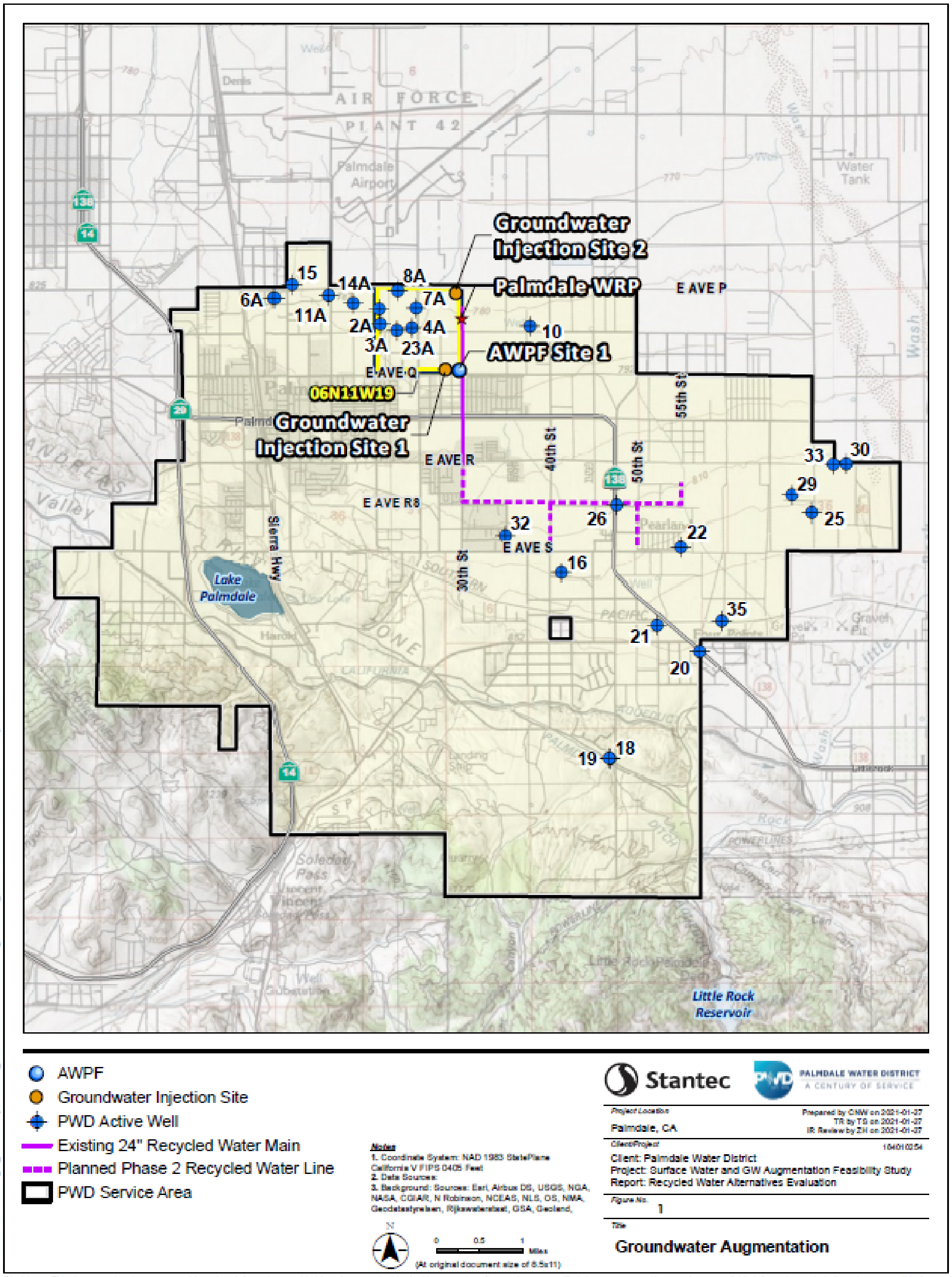

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Figure 4: Groundwater Injection Sites 1 & 2

To obtain maximum regulatory verification of injectate travel time/retention time to the closest PWD operating well(s), Stantec recommends a tracer study be performed using a nearby, non-operating well as the tracer injection location. A tracer study would involve using a conservative, non-reactive tracer which passively moves through the groundwater system via advection (natural or induced groundwater flow, the latter, caused by a pumping well) and undergoes dilution and dispersion during migration from the source location. Because the tracer is non-reactive, the tracer can be detected in groundwater samples collected at periodic intervals once the tracer is injected in the source well. The elapsed time between injection of the tracer in a non-pumping well and the first detection of the tracer in a pumping well is the travel time or retention time. For the northern wellfield in T6N/R11-19, non-operational Well 10 may be used as a tracer well. This well is located about 1,500 ft east of the PWRP and 7,060 east of the closest PWD operating Well 7A. Well 7A or 4A, could be used to verify travel times because the groundwater flow direction in this area is generally to the west-northwest or west toward a pumping depression created by the northern PWD wellfield.

While installing wells near the PWRP would be cost effective due to the limited conveyance pipelines required, wells could also be installed in the easternmost portion of the PWD service area to take advantage of different geologic conditions. PWD currently operates four production wells in T6NR11W-35 and 36 in the including Wells 25, 29, 30 and 33 (Figure 4). Based on a review of available data (Kyle Groundwater, 2020), the geologic materials present below depths of about 200 to 607 ft bgs consist predominantly of interbedded sand and clay and sand and gravel. Well depths range between 370 ft bgs at Well 29 and 600 ft bgs at Well 25. Decomposed granite was encountered in the four wells at depths ranging between 349 ft bgs at Well 29 and 505 ft bgs at Well 25. Current depth to groundwater (March 2020) at these four wells varies between approximately 128 ft bgs at Well 29 and 201 ft bgs at Well 33, with the depth to water at Well 29 measured in December 2018. Current pumping rates at these wells varies between an average of approximately 161 gpm at Well 29 and 508 gpm at Well 25 (Kyle Groundwater, 2020) and must be carefully managed due to mutual interference effects caused by pumping.

Well depths in the eastern portion of the PWD service are relatively shallow compared to the northern wellfield due to the relatively shallow depth to granitic bedrock. In addition, groundwater levels, albeit relatively shallow, are declining. In order to reduce the impacts of pumping in this area, one or more injection wells could be installed in the southeast quarter of T6NR11W-36 (northwest corner of East Avenue R and 75th Street East), a distance of 2,800 feet from the closest operating PWD production well (Well 25). This location is approximately 4.75 miles from AWPF Site #1. A preliminary design for one or more injection wells in this area would consist of a 16-inch diameter stainless steel louvered casing extending from depths of 250 to 400 ft bgs to ensure complete saturation of the perforated casing and maximize injection flow rates. The estimated design injection flow rate may range between 300 and 500 gpm and could be higher depending on hydrogeologic conditions.

For the eastern wellfield, non-operational Well 25 may be used as a tracer well. This well is located about 1,600 ft southeast and upgradient of closest operating Well 29 and 3,230 and 3,630 ft, respectively, south-southwest of Wells 30 and 33. Well 25 was drilled to a depth of 607 ft bgs and completed to a depth of 600 ft bgs in 1989. Geologic materials below a depth of 200 ft bgs consist mostly of interbedded clay and sand, gravel and clay and some sand and gravel. Decomposed granite was reported at depths below 505 ft bgs. A tracer study using Well 25 as the tracer injection well would allow for the monitoring of Wells 29, 30 and 33 because pumping from the three wells reportedly causes mutual interference (Kyle Groundwater, 2020) thus modifying the regional northwesterly groundwater flow direction. This study recommends locating the new injection wells in the northern wellfield to take advantage of the proximity to PRWP and consequently reduce conveyance costs. However, groundwater modeling will be required to confirm final well locations and hydrogeologic conditions.

3.5 Brine Treatment Alternatives

One of the challenges in using RO system is brine disposal. For either potable reuse alternative, the AWT facility will produce up to 0.68 mgd of RO brine, which requires proper disposal. Multiple alternatives for disposal could be considered, including deep well injection, brine lines, or evaporation ponds.

Deep Well Injection

Deep well injection of the brine would require a Class I Injection Well as classified by the U.S. Environmental Protection Agency (EPA). Class I wells are designed to inject the brine thousands of feet below the lowermost underground source of drinking water. Injection wells are regulated under the EPA's Underground Injection Control (UIC) program. In California, the Department of Conservations Division of Oil, Gas & Geothermal Resources (DOGGR) regulates injection wells under the EPA's oversight and in collaboration with the State Water Resources Control Board (SWRCB).

These agencies must adhere to multiple state and federal water quality laws, including the California Water Code, the Federal Clean Water Act, and the Safe Drinking Water Act (SDWA). The SDWA has strict requirements for injection well construction, operation, testing, and monitoring. This would require detailed geologic studies to prove that deep injection is feasible and an analysis of the surrounding area to identify other wells that may allow fluid to move out of the injection zone. Injection wells require multiple casings and continuous monitoring and recording devices. Given the rigorous and expensive permitting requirements, uncertainty in successful permitting, and current public concerns over hydraulic fracking, this option is not recommended.

Brine Lines

Palmdale is not within close proximity to a regional brine line; the nearest existing brine line is located in the Inland Empire, over 60 miles away. Due to the extensive pipeline and pumping required for conveyance to this brine line, this option is not recommended.

Evaporation Ponds

Another option for brine disposal is hauling to nearby evaporation ponds with the resulting salts disposed at the Chiquita Canyon Landfill or other suitable location. Using estimated monthly average evaporation and precipitation rates for Palmdale, this would require 35 acres of land for adequate drying (assuming a depth of 0.5 inches maximum in the evaporation ponds). Implementing brine minimization technologies such as CCD could help reduce brine production (from 0.68 mgd to 0.23 mgd) and consequently the amount of land needed for the evaporation ponds to less than 15 acres but is not recommended due to the limitations of reusing the CCD permeate and the cost to implement CCD is substantial compared to the cost of land. LACSD owns property just north of the intersection of 40^{th} St E and E Avenue P that was formerly used for oxidation ponds and are a recommended option for brine evaporation as either Pond 4 or 5 (as shown in Figure 5) are approximately 34 acres each so one pond would be sufficient for the brine disposal requirements of the AWPF.

Figure 5: LACSD Former Oxidation Ponds

Due to the presence of nitrate-impacted groundwater in the area of the former oxidation ponds, it is recommended to utilize a liner to minimize the potential flux of nitrogen and salts which may be present in the soils. For this evaluation, the evaporation pond liner considered was a heavy duty Hypalon liner, which can be driven on by heavy machinery. Once the liquid in the brine is evaporated, the resulting salts are minimal and can be hauled to a landfill within Los Angeles County approximately every five years, or per PWD's preference. Due to the availability and low cost of land, this evaluation recommends solar evaporation ponds as the viable brine disposal solution. Mechanical evaporation processes were not considered due to the added capital and O&M expenses, upkeep of additional mechanical equipment and the minimal depth (0.5 inches) required for evaporation not requiring a mixing process. However, should PWD decide to move forward with this project, an in-depth analysis can be prepared as part of a 10 percent design analysis that evaluates the cost and benefits of CCD to reduce brine concentrate and include an evaluation of using a renewable energy driven mechanical process to increase evaporation in the evaporation pond. As part of this evaluation, varying technologies for brine concentrate and mixing systems should be considered.

4. Engineer's Estimate of Probable Construction Costs

The same treatment process and flow rates are anticipated for both surface water augmentation at Palmdale Lake and groundwater injection. The primary difference in costs is largely dependent on conveyance requirements from the AWPF to Palmdale Lake and the groundwater injection site(s).

The following sections discuss the capital costs, operation and maintenance (O&M) costs, and the net present value for each alternative evaluated herein.

4.1 Capital Costs

The capital costs in this analysis are classified as a Class 5 engineer's opinion of probable construction costs (OPCC) as defined by the American Association of Cost Engineers (AACE). Class 5 estimates are used for conceptual studies where the project has only been defined up to approximately 2 percent. The cost estimates also include a low range of -50% and a high range of +50%. The equipment identified in Section 3 is incorporated into the Class 5 OPCC as well as other components of each alternative, including conveyance, pumps, the injection well for the direct injection alternative, a canopy over the equipment, evaporation pond liners, and the cost of land.

To estimate the cost of the process and conveyance equipment, Stantec applied reference equipment costs including vendor quotes and bid results from recent projects. These reference costs are provided in Table 13.

Table 13: Equipment and Conveyance Reference Costs

Equipment	Unit	Cost per Unit
Process Equipment		
Microfiltration	$/mgd	$ 1,207,000
Reverse Osmosis	$/mgd	$ 642,000
UV/AOP	$/mgd	$ 639,000
Chlorination System	$/mgd	$ 77,000
Post-Stabilization	$/mgd	$ 227,000
Other Equipment		
Conveyance Pipeline – 20-in	$/LF	$ 500
Conveyance Pipeline – 16-in	$/LF	$ 400
Conveyance Pumps	$/mgd	$ 460,000
Injection Well Pump	$/well	$ 600,000
Well Drilling	$/well	$ 622,000
Canopy	ea	$ 500,000
Evaporation Pond Liner	$/ac	$ 175,000
Land Unit Cost	$/ac	$ 30,000

To account for the installation, site work, yard piping, electrical and instrumentation needed for a fully functional project, markups as a percentage of the cost have been applied to the capital costs as outlined in

Table 14 below. A contingency of 35 percent has been applied to the total capital costs which is typical for an estimate at this level of a project where there are many unknowns. In addition, a contingency of 20 percent has been applied to account for engineering, legal, administrative, and project management fees. Table 14 lists the markups applied and whether they are applied to the process equipment costs, the equipment cost (process equipment and other equipment identified in Table 13), or the total construction cost.

Table 14: Markups applied to the Capital Costs

Capital Cost Markup	Amount (percent)	Applied to
Installation	20	Equipment Cost
Site Work	10	Equipment Cost
Yard Piping	10	Process Equipment Cost
Electrical and Instrumentation	40	Process Equipment Cost
Contingency	35	Construction Cost
Engineering/Legal/Admin/PM	20	Construction Cost

The capital cost estimates for each end use alternative are shown in Table 15.

Table 15: Capital Cost Estimate for the Recycled Water Alternatives

	Surface Water Augmentation			Groundwater Augmentation via Direct Injection
	AWPF Site 1, Conveyance Option A	AWPF Site 1, Conveyance Option B	AWPF Site 2	
Total Capital Cost ($M)	**$83.9**	**$89.5**	**$85.5**	**$74.0**
Low Range: -50% ($M)	$42.0	$44.8	$42.7	$37.0
High Range: +50% ($M)	$125.9	$134.3	$128.2	$111.0
$/gpd (effluent flow)	$21.9	$23.3	$22.3	$19.3
$/acre-ft (effluent flow)[1]	$976	$1,042	$995	$861

The total capital cost for surface water augmentation in Palmdale Lake is higher than direct injection due to the of the costs for conveyance required from the AWPF to Palmdale Lake. For this feasibility study, it was assumed that two injection wells could be co-located within a one-mile radius of the facility. If this is not possible following further hydrogeological evaluations, the cost for direct injection would increase due to the need to possibly purchase property for a second well and the pipeline to convey recycled water to a second well site.

4.2 Operations & Maintenance Costs

The preliminary operations & maintenance (O&M) costs considered in this evaluation include power, chemical, replacement parts, labor, maintenance, and the cost to operate and maintain the evaporation ponds. Stantec used estimates from previous vendor quotes and typical process requirements. Stantec assumed four operators would be required to operate and maintain the new AWPF, conveyance facilities, and evaporation ponds. The evaporation pond O&M costs include hauling the brine to the evaporation ponds, hauling the dried salts to a disposal facility, and the landfill dumping fee. If a site adjacent to the proposed AWPF is available for evaporation pond use, a brine line could be implemented. At this time, it is unknown if this is feasible, thus it is assumed the brine will be hauled. The costs applied for the O&M cost evaluation are provided in Table 16.

Table 16: O&M Cost Assumptions

Parameter	Assumption
Annual Labor ($/operator)	$200,000
Number of Operators	4
Maintenance (of equipment cost)	2 percent
Contingency	15 percent
Power ($/kWh)	$0.15
Hauling cost ($/60 miles)	$350
Landfill Dumping Fee ($/ton)	$68

The annual O&M costs for each alternative are presented in Table 17.

Table 17: Annual O&M Cost Estimate for the Recycled Water Alternatives

	Surface Augmentation			Direct Injection
	AWPF Site 1, Conveyance Option A	AWPF Site 1, Conveyance Option B	AWPF Site 2	
Annual O&M Cost ($M)	**$5.0**	**$5.1**	**$5.0**	**$4.9**
Low Range: -50% ($M)	$2.5	$2.5	$2.5	$2.4
High Range: +50% ($M)	$7.5	$7.6	$7.6	$7.3
$/gpd (effluent flow)	$1.3	$1.3	$1.3	$1.3
$/acre-ft (effluent flow)	$58.4	$59.2	$58.6	$56.8

The yearly O&M costs do not vary significantly between the alternatives due to the same process equipment requirements for each alternative. The conveyance O&M requirements are significantly less than the process equipment operating costs, particularly the power and chemicals needed for MF and RO.

4.3 Net Present Value

The Net Present Value (NPV) presents the combined capital and O&M costs to evaluate the alternatives in a more equal comparison in present-day dollars. For this evaluation, the inflation rate was assumed at 3 percent over a 20 year period. The NPV costs for each alternative are presented in Table 18.

Table 18: Net Present Value for the Recycled Water Alternatives

	Surface Augmentation			Direct Injection
	AWPF Site 1, Conveyance Option A	AWPF Site 1, Conveyance Option B	AWPF Site 2	
Net Present Value ($M)	**$158.6**	**$165.2**	**$160.4**	**$146.6**
Low Range: - 50% ($M)	$116.6	$120.4	$117.7	$109.6
High Range: +50% ($M)	$200.5	$209.9	$203.1	$183.6
$/gpd (effluent flow)	$41.3	$43.1	$41.8	$38.2
$/acre-ft (effluent flow)[1]	$1,850	$1,930	$1,870	$1,710

[1]These costs per af are capital costs only and do not include the purchase price of the recycled water from LA County San No. 20 which is generally $200-$250/af.

The NPV for Direct Injection is estimated to be approximately 7.5 percent less than the least expensive surface water augmentation alternative, AWPF Site 1 with Conveyance Option A. The AWPF Site 1 alternative with Conveyance Option A uses a smaller diameter pipeline (16-inch vs. 20-inch) for a greater portion of the length, thereby reducing the overall cost of Option A.

5. Conclusions and Recommendations

At this high planning level of evaluation, Stantec recommends the use of MF, RO, UV/AOP, and chlorination for both surface water augmentation and groundwater injection to achieve the required level of pathogen log reduction. Both alternatives will require further evaluation, monitoring, reporting and approvals as required by Title 22, from regulatory agencies before and after implementation. In comparing surface water augmentation to direct injection, the direct injection alternative is more cost effective and provides a feasible means of implementation.

There are similar direct injection projects that have been successfully implemented and have been in operation for years such as West Basin Municipal Water District's barrier wells and Orange County Water District's Talbert Barrier Project. Surface water augmentation using recycled water is a newer concept and, while the regulations allow it, there are no surface water augmentation projects currently operating in California. Hence, the approval process will be more onerous. The first surface water augmentation project utilizing recycled water will be the City of San Diego Pure Water Program scheduled for Phase I completion in 2024.

In addition, due to the introduction of recycled water into Palmdale Lake and the retention time requirement of two months, the water treatment plant will be limited to approximately 11.2 mgd capacity. This may prevent PWD from being able to meet future potable water demands. We recommend conducting a detailed seasonal water demand and supply analysis taking into consideration SWP supplies, recycled water supplies and supplies from Little Rock Dam to determine the future implications and limitations of implementing a surface water augmentation project utilizing Palmdale Lake. In addition, this analysis could include evaluating a combination project of surface water augmentation, groundwater injection and/or spreading to make the best use of PWD's existing water supplies and set PWD up for meeting future water demands.

It is important to note that the costs prepared for this analysis are Class 5 costs and include significant contingencies. As more decisions are made and preliminary design is advanced, the costs can be refined.

6. Next Steps

A preliminary schedule for PWD to implement a groundwater injection program is presented in Figure 6, illustrating the various tasks and sequence required for implementation. No start or end dates have been defined but the schedule does provide indication of the minimum time required to implement the final project, assuming no delays beyond the PWD's control. The schedule also does not account for securing funding sources or regulatory deadlines.

- Groundwater Modeling to include flow and solute transport modeling – 8 months
- Basis of Design Report – 9 months
- Outreach – life of project
- Environmental/EIR – 16 months
- Permitting – 24 months
- Land Acquisition – 12 months
- Title 22 Engineering Report – 16 months
- Design – 16 months
- Bidding – 3 months
- Construction – 24 months
- Startup – 4 months

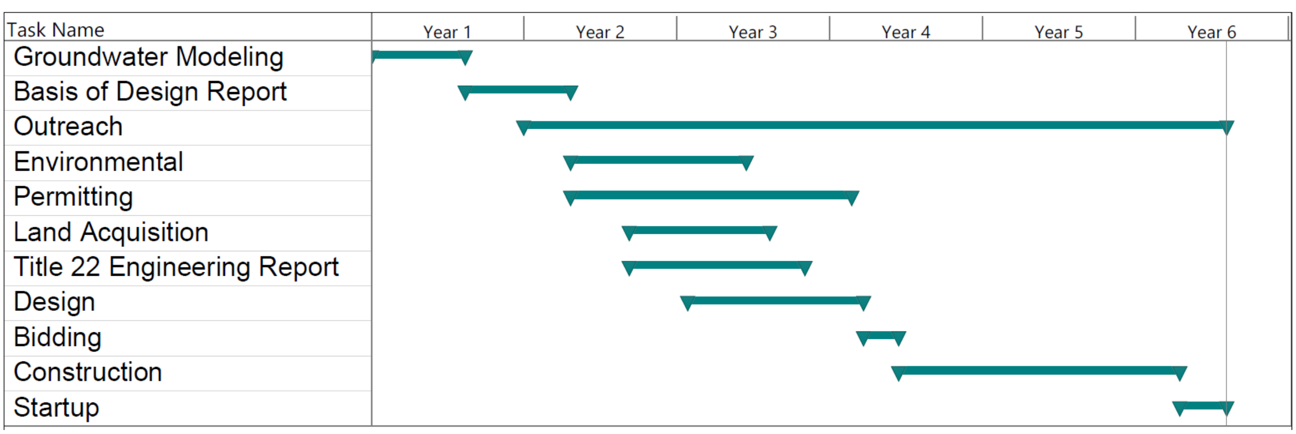


Figure 6: Project Next Steps

PWD could implement additional measures to expedite the schedule, such as the consideration of utilizing a progressive design-build delivery method. As the above schedule is conservative for planning purposes, it should be continuously updated and refined as the project progresses.

APPENDIX A – MAXIMUM CONTAMINANT LEVELS

Table 19: Primary and Secondary MCLs from Title 22 Drinking Water Standards

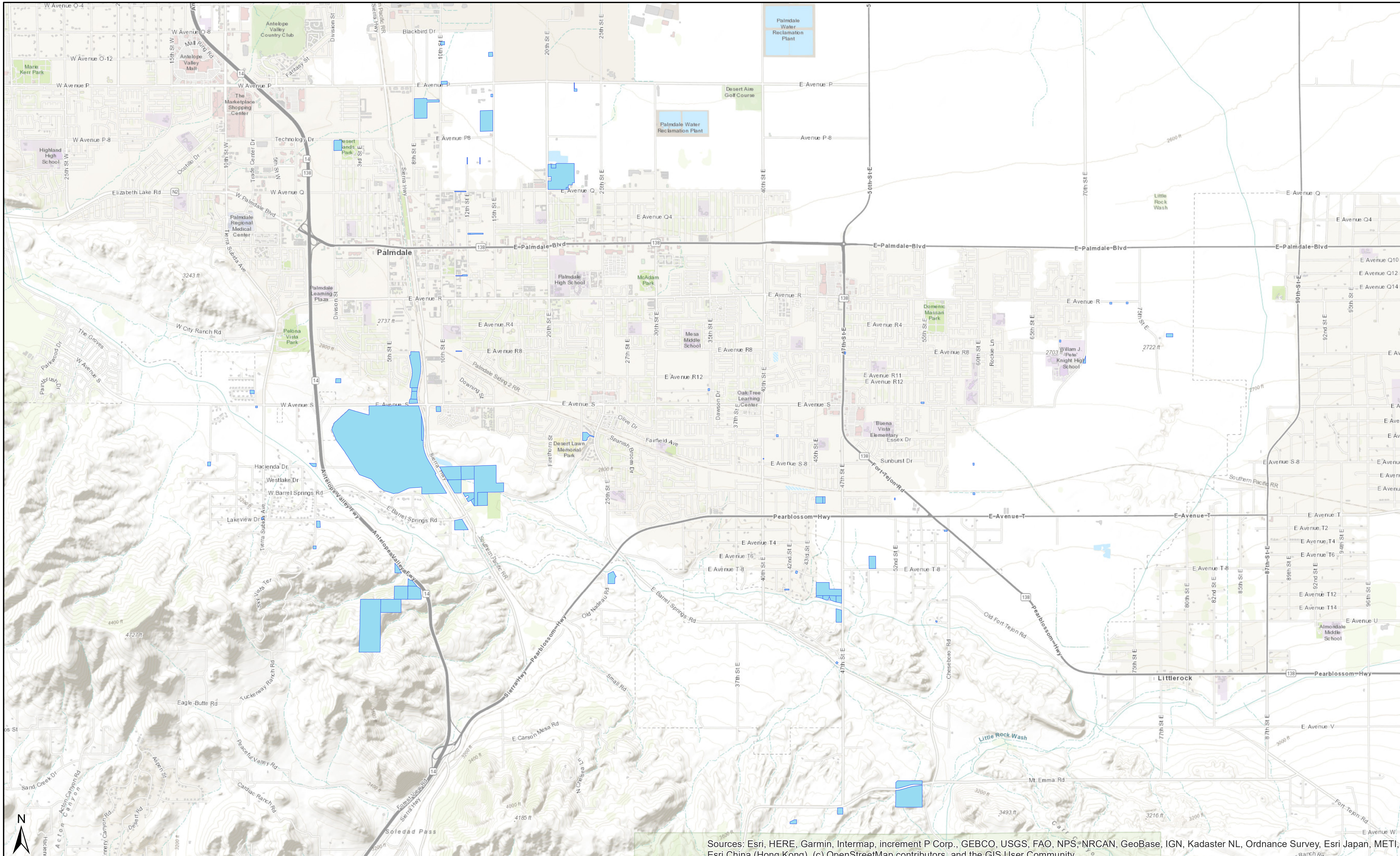
Category	Contaminant	Unit	Level	MCL	Palmdale WRP 2019 Tertiary Effluent Average Monthly Monitoring Results
Radionuclides	Radium-226	pCi/L	Primary	5 (combined radium-226 & -228)	NS
Radionuclides	Radium-228	pCi/L	Primary		NS
Radionuclides	Gross Alpha particle activity (excluding radon and uranium)	pCi/L	Primary	15	
Radionuclides	Uranium	pCi/L	Primary	20	NS
Radionuclides	Beta/photon emitters	mrem/yr	Primary	4	
Radionuclides	Strontium-90	pCi/L	Primary	8	NS
Radionuclides	Tritium	pCi/L	Primary	20,000	NS
Inorganics	Aluminum	mg/L	Primary	1	NS
Inorganics	Antimony	mg/L	Primary	0.006	DNQ Est. Conc. 0.46
Inorganics	Arsenic	mg/L	Primary	0.01	DNQ Est. Conc. 0.26
Inorganics	Asbestos	MFL	Primary	7	NS
Inorganics	Barium	mg/L	Primary	1	NS
Inorganics	Beryllium	mg/L	Primary	0.004	ND
Inorganics	Cadmium	mg/L	Primary	0.005	ND
Inorganics	Chromium	mg/L	Primary	0.05	0.55
Inorganics	Cyanide	mg/L	Primary	0.15	NS
Inorganics	Fluoride	mg/L	Primary	2	NS
Inorganics	Mercury	mg/L	Primary	0.002	0.001
Inorganics	Nickel	mg/L	Primary	0.1	1.1
Inorganics	Nitrate (as nitrogen)	mg/L	Primary	10	1.25
Inorganics	Nitrate+Nitrite (sum as Nitrogen)	mg/L	Primary	10	
Inorganics	Nitrite (as nitrogen)	mg/L	Primary	1	0.031
Inorganics	Perchlorate	mg/L	Primary	0.006	NS
Inorganics	Selenium	mg/L	Primary	0.05	DNQ Est. Conc. 0.13
Inorganics	Thallium	mg/L	Primary	0.002	ND
Inorganics	Lead	ug/L	Primary	15	DNQ Est. Conc. 0.04
Inorganics	Copper	ug/L	Primary	1300	1.14

Category	Contaminant	Unit	Level	MCL	Palmdale WRP 2019 Tertiary Effluent Average Monthly Monitoring Results
Disinfection Byproducts	Total Trihalomethanes (TTHMs)	mg/L	Primary	0.08	5.4
Disinfection Byproducts	Haloacetic acids (HAA5)	mg/L	Primary	0.06	NS
Disinfection Byproducts	Bromate	mg/L	Primary	0.01	NS
Disinfection Byproducts	Chlorite	mg/L	Primary	1	NS
Inorganics	Aluminum	mg/L	Secondary	0.2	NS
Inorganics	Color	units	Secondary	15	NS
Inorganics	Copper	mg/L	Secondary	1	1.14
Other	Foaming Agents (MBAs)	mg/L	Secondary	0.5	ND
Inorganics	Iron	mg/L	Secondary	0.3	NS
Inorganics	Manganese	mg/L	Secondary	0.05	NS
Other	Methyl-tert-butyl-ether (MTBE)	mg/L	Secondary	0.005	ND
Other	Odor	units	Secondary	3	NS
Inorganics	Silver	mg/L	Secondary	0.1	ND
Other	Thiobencarb	mg/L	Secondary	0.001	NS
Other	Turbidity	NTU	Secondary	5	NS
Inorganics	Zinc	mg/L	Secondary	5	88.5
DNQ = Detected, not quantifiable ND = Not detected NS = Not sampled					

Table 20: Consumer Acceptance Contaminant Level Ranges

Constituent	unit	Recommended	Upper	Short Term
TDS	mg/L	500	1,000	1,500
Specific Conductance	uS/cm	900	1,600	2,200
Chloride	mg/L	250	500	600
Sulfate	mg/L	250	500	600

APPENDIX B – PWD OWNED PARCELS



PALMDALE WATER DISTRICT OWNED PROPERTY

APPENDIX C – PWD 100’X100’ EASEMENT

HYDRANTS, FIRE FLOW AND ACCESS GENERAL REQUIREMENTS

1. ALL HYDRANTS SHALL MEASURE 6"x4"x2 1/2", BRASS OR BRONZE, CONFORMING TO CURRENT AWWA STANDARD C503, OR APPROVED EQUAL. HYDRANDS SHALL BE INSTALLLED PER SPECIFICATIONS OF THE LOS ANGELES COUNTY WATER ORDINANCE NO. 7834 (TITLE 20) UTILITY MANUAL, SECTION 4.0 TO 4.6.

2. ALL REQUIRED PUBLIC FIRE HYDRANTS SHALL BE INSTALLED, TESTED AND ACCEPTED PRIOR TO CONSTRUCTION.

3. VEHICULAR ACCESS MUST BE PROVIDED AND MAINTAINED SERVICEABLE THROUGHOUT CONSTRUCTION.

~~4. PROVIDE AN APPROVED FIRE SPRINKLER SYSTEM. SUBMIT PLANS FOR APPROVAL PRIOR TO INSTALLATION. FIRE CODE #2.101. REASON SEC. 3802 U.B.C.~~

5. THE REQUIRED FIRE FLOW FOR PUPLIC FIRE HYDRANTS AT THIS LOCATION IS 2500 GALLONS PER MINUTE AT 20 PSI FOR A DURATION OF TWO HOURS, OVER AND ABOVE MAXIMUM DAILY DOMESTIC DEMAND.

FIRE AND LIFE SAFETY BUILDING REQUIREMENTS

1. PROVIDE AN APPROVED ONE - HOUR, FIRE - RESISTIVE CORRIDOR. TITLE 24, 3305. (INDICATE ON FLOOR PLAN).

2. ALL CORRIDOR OPENINGS SHALL MEET THE REQUIREMENT OF BUILDING CODE 3305 - H, INCLUDING STEEL FRAMES, 20 - MINUTE LABELED DOORS, HINGES, LATCHING DEVICES, AND CLOSURES. TITLE 24, 3305 - H. (INDICATE IN DOOR SCHEDULE).

3. EXITS SHALL BE ILLUMINATED AT ANY TIME THE BUILDING IS OCCUPIED, WITH LIGHT HAVING AN INTENSITY OF NOT LESS THAN ONE FOOT - CANDLE AT FLOOR LEVEL. TITLE 24, 3313.

4. PROVIDE EXIT SIGNS PER TITLE 24, 3314.

~~5. POST " NO PARKING - FIRE LANE " SIGNS ALONG VEHICULAR ACCESS ROADS. FIRE CODE 10.207 - K, 1.~~

5. PAINT SIGNS ON PAVED FIRE LANES THAT READ "NO PARKING - FIRE LANE" AT INTERVALS NOT TO EXCEED 50'-0" IN WHITE LETTERS, 12" IN HEIGHT AND 2" IN STROKE. FIRE LANES ARE THE FOUR VEHICLE PATHS AROUND THE BUILDING

6. WALLS AND SOFFITS OF ENCLOSED USABLE SPACE UNDER INTERIOR STAIRWAYS THAT ARE NOT REQUIRED TO BE ENCLOSED BY BUILDING CODE SEC. 3309(f), SHALL BE PROTECTED ON THE ENCLOSED SIDE AS REQUIRED FOR ONE-HOUR FIRE-RESISTIVE CONSTRUCTION. BUILDING CODE SEC. 3306(m) OR TITLE 24, SEC. 3305(m).

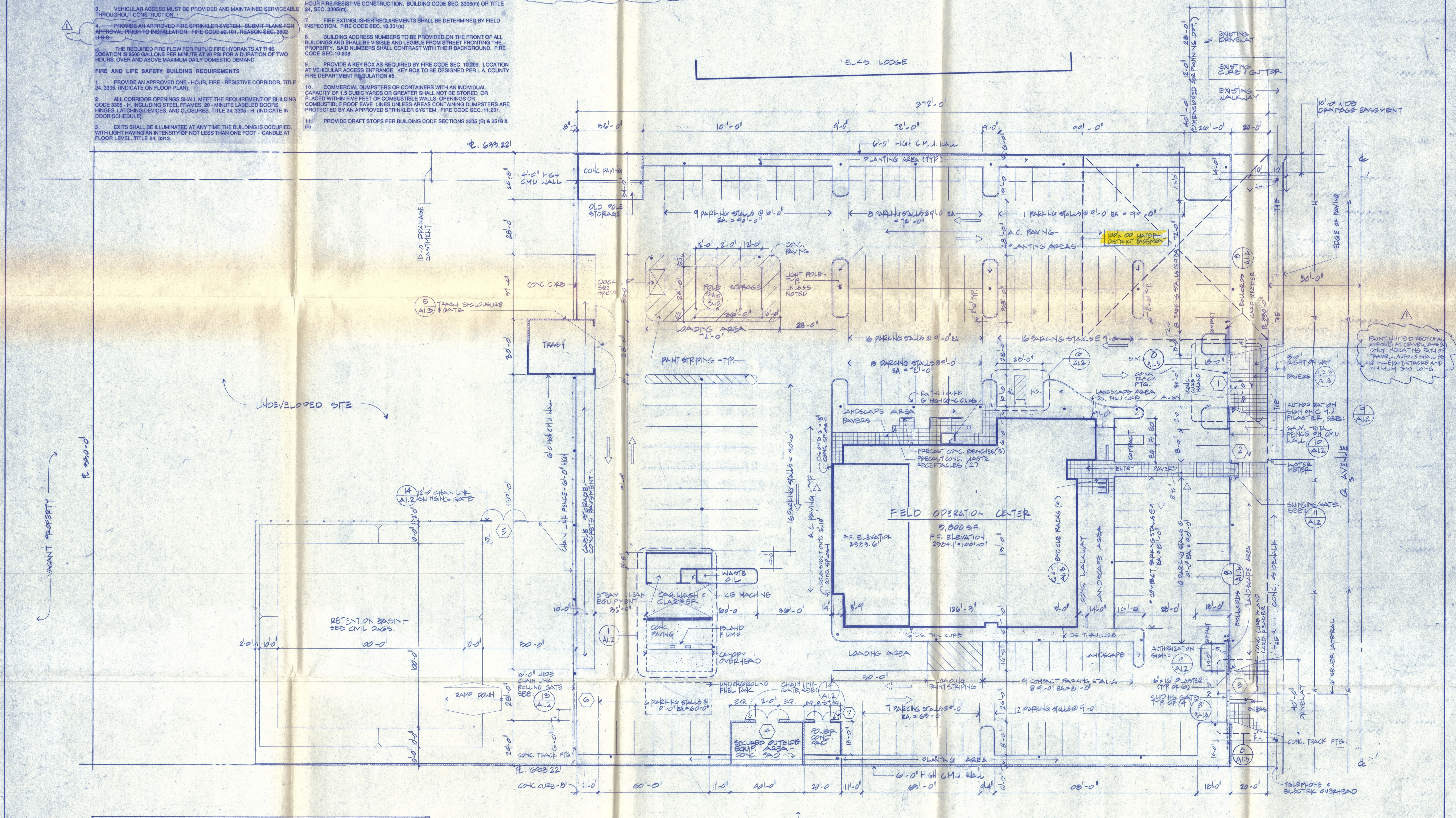
7. FIRE EXTINGUISHER REQUIREMENTS SHALL BE DETERMINED BY FIELD INSPECTION. FIRE CODE SEC. 10.301(a).

8. BUILDING ADDRESS NUMBERS TO BE PROVIDED ON THE FRONT OF ALL BUILDINGS AND SHALL BE VISIBLE AND LEGIBLE FROM STREET FRONTING THE PROPERTY. SAID NUMBERS SHALL CONTRAST WITH THEIR BACKGROUND. FIRE CODE SEC.10.208.

9. PROVIDE A KEY BOX AS REQUIRED BY FIRE CODE SEC. 10.209. LOCATION AT VEHICULAR ACCESS ENTRANCE. KEY BOX TO BE DESIGNED PER L.A. COUNTY FIRE DEPARTMENT REGULATION #5.

10. COMMERCIAL DUMPSTERS OR CONTAINERS WITH AN INDIVIDUAL CAPACITY OF 1.5 CUBIC YARDS OR GREATER SHALL NOT BE STORED OR PLACED WITHIN FIVE FEET OF COMBUSTIBLE WALLS, OPENINGS OR COMBUSTIBLE ROOF EAVE LINES UNLESS AREAS CONTAINING DUMPSTERS ARE PROTECTED BY AN APPROVED SPRINKLER SYSTEM. FIRE CODE SEC. 11.201.

11. PROVIDE DRAFT STOPS PER BUILDING CODE SECTIONS 3205 (B) & 2516 & (iii)



SITE PLAN

SCALE: 1" = 20'-0"

PROJECT DATA

ADDRESS: 2655 EAST AVENUE Q, PALMDALE, CALIFORNIA			
LEGAL DESCRIPTION			
ACCESSOR PARCEL NUMBER:	3022-011-012		
A PORTION OF LOT 15, PALMDALE COLONY LANDS T.G.N., R.11W.			
ZONING:	M-A		
PROJECT DESCRIPTION:	UTILITY SERVICE YARD		
LOT SIZE:	208,962 SQ.FT. (4.8 ACRES)		
DEVELOPED SITE AREA:	124,905 SQ.FT. (59.7% OF DEVELOPED SITE)		
BUILDING AREA:	13,920 SQ.FT. (11% OF DEVELOPED SITE)		
LANDSCAPE AREA:	12,751 SQ.FT. (10.2% OF DEVELOPED SITE)		
IMPERVIOUS PAVED AREAS	98,234 SQ.FT. (78.8% OF DEVELOPED SITE)		
PARKING REQUIREMENTS			
ASSEMBLY, STORAGE & MAINTENANCE:	7,700 S.F. @ 3 PER1,000 SQ.FT. =		24 STALLS REQ.
OFFICE AREA:	4,000 S.F. @ 1 PER 250 SQ.FT. =		16 STALLS REQ.
TOTAL PARKING STALLS REQUIRED:			40
TOTAL PARKING STALLS PROVIDED:	21 COMPACT,123 REGULAR, 17 OVERSIZED (TRUCKS) & 2 H.C.		
BUILDING TYPE:	V-N	NON SPRINKLERED	
BUILDING OCCUPANCY & AREAS:	OCCUPANCY	AREA	AREA ALLOWED PER UBC
MAINTENANCE AREA:	B1	2,685 SQ.FT.	
OFFICE & STORAGE:	B2	11,230 SQ.FT.	(8,000 SQ.FT x 2) = 16,000 SQ.FT. 100% INCREASE FOR SEPARATION AT ALL SIDES.

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LICENSED ARCHITECT
R. H. McDONALD, JR.
SIGNATURE
Jan 93
EXP. DATE
LIC. NO. C-4404
STATE OF CALIFORNIA

PACIFIC BELL

SITE PLAN

LOS ANGELES SECTOR
UTILITY SERVICE YARD
AVENUE Q
PALMDALE, CALIFORNIA

ASSOCIATE MANAGER
MANAGER
EST. NO. KC1078E
W.O. NO. 7055
R.O. NO.
DRAWN BY
DATE 8/15/91
DRAWING 243W1
A1.1
OF SHEETS