Appendix C

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT PRELIMINARY DESIGN REPORT

Kennedy/Jenks Consultants

300 N. Lake Avenue, Suite 1020
Pasadena, CA 91101
626-568-4300
626-683-8938 (Fax)

Palmdale Regional Groundwater Recharge & Recovery Project Preliminary Design Report

9 November 2015

Volume 1

Prepared for

Palmdale Water District
2029 E. Ave Q
Palmdale, CA 93550

K/J Project No. 1344505*01

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List of Acronyms

ABM	Auger Boring Machine
AESI	Arrow Engineering Services, Inc.
AF	acre-feet
AF/yr	acre-feet/year
Aqueduct	California Aqueduct
AVEK	Antelope Valley-East Kern Water Agency
AWWA	American Water Works Association
bgs	below ground surface
CDPH	California Department of Health
CEQA	California Environmental Quality Act
cfs	cubic feet per second
Cla-Val	pump control valve
CML&C	cement mortar lined and coated
CMU	concrete masonry unit
CT	disinfectant concentration x time, mg/L-min
D.I.P.	ductile iron pipe
DDW	California Division of Drinking Water
DWR	California Department of Water Resources
EA	Environmental Assessment
EIR	Environmental Impact Report
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact

fps	feet per second
ft	feet or feet above mean sea level
gal	gallons
gpm	gallons per minute
HDD	horizontal directional drilling
HDPE	high density polyethylene
Helix	Helix Environmental Planning, Inc.
hf	head losses due to friction
HGL	hydraulic grade line
HP	horsepower
HVAC	heating, ventilating, and air conditioning
hypo	sodium hypochlorite
in	inches
kW	kilowatt
kWh/AF	kilowatt-hour/acre-foot
LACSD	Los Angeles County Sanitation District
LAWA	Los Angeles World Airports
lbs	pounds
LCGRRP	Littlerock Creek Groundwater Recharge and Recovery Project
LF	linear foot
LV	low voltage
MCC	motor control center
MG	million gallons

mg/L	milligrams per liter
MGD	million gallons per day
mi	miles
MTBM	micro-tunnel
MW	megawatt
MV	medium voltage
NAVD26	North American Vertical Datum 1926
NAVD88	North American Vertical Datum 1988
NEPA	National Environmental Protection Act
NHPA	National Historic Preservation Act
NPV	Net Present Value
OSHA	Occupational Safety and Health Administration
PDR	Preliminary Design Report
PLC	programmable logic controller
POC	point of connection
ppd	pounds per day
ppm	parts per million
PRGRRP	Palmdale Regional Groundwater Recharge & Recovery Project
Project	Palmdale Regional Groundwater Recharge & Recovery Project
PRV	pressure reducing valve
psi	pounds per square inch
PVC	polyvinyl chloride
PWD	Palmdale Water District

PWPS	Potable Water Pump Station
Q	design flows
Reclamation	U.S. Bureau of Reclamation
RIPS	LACSD Reservoir Influent Pump Station
RWPS	Return Water Pump Station
RWQCB	Regional Water Quality Control Board
SCADA	supervisory control and data acquisition system
SCE	Southern California Edison
SGIP	Self-Generation Incentive Program
SHPO	State Historic Preservation Officer
sq ft	square feet
SRF	State Revolving Fund
SWP	State Water Project
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TDH	total dynamic head
TDS	total dissolved solids
UPS	uninterruptable power supply
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VFD	variable frequency drive

Executive Summary

The Palmdale Regional Groundwater Recharge and Recovery Project (PRGRRP or Project) is a groundwater banking program with surface recharge of imported water and potentially recycled water, as well as recovery facilities to help meet future water demands and improve reliability. The Project will deliver raw water from the East Branch of the California Aqueduct (State Water Project [SWP] Water) and blend with recycled water from LACSD No. 20 to new recharge basins located in the City of Palmdale.

The purpose of this Preliminary Design Report (PDR) is to address the preliminary design for the PRGRRP facilities, which follows Alternative 10C as presented in the Littlerock Creek Groundwater Recharge and Recovery Project (LCGRRP) Feasibility Study Report, subsequently renamed Palmdale Regional Groundwater Recharge and Recovery Project (Kennedy/Jenks, 2015). In this Feasibility Study, 10 preliminary alternatives were developed for proposed recharge sites and evaluated (Alternatives 1 – 10). Based on the initial screening of the 10 alternatives, alternatives 9 and 10 were found to be more favorable than the other alternatives. In turn, these two alternatives were refined to generate four refined alternatives - Alternatives 9R, 10A, 10B, and 10C, with Alternative 10C selected for preliminary design.

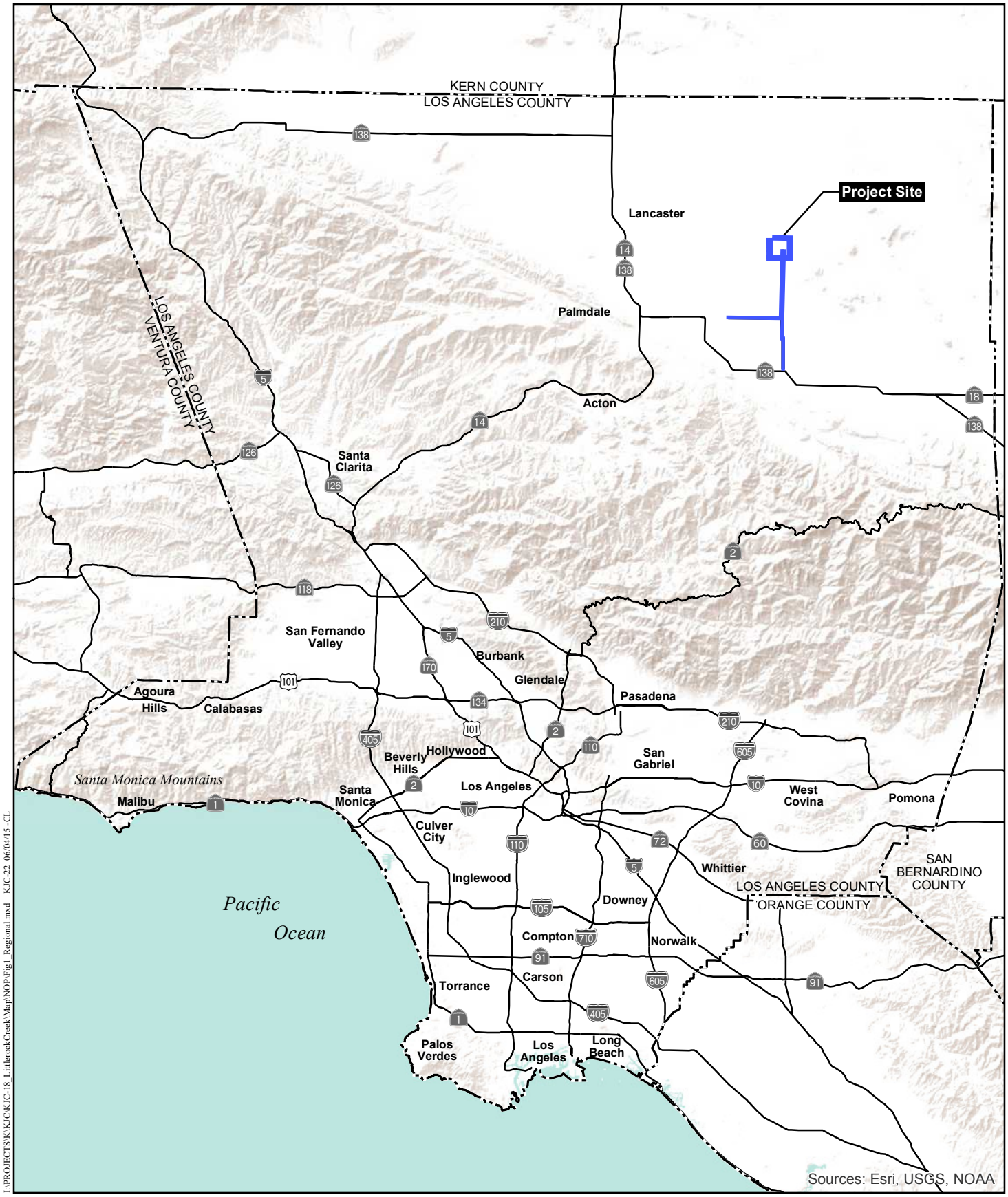
Site Location

The Project site is located generally in the northeastern undeveloped portion of the City of Palmdale in Los Angeles County, California and surrounding unincorporated Los Angeles County (Figure ES-1). More specifically, the Project site is situated north of State Route 138, east of State Route 14, south of Edwards Air Force Base, and west of the community of Lake Los Angeles. The Project site is located in portions of the Alpine Butte, Lancaster East, Littlerock, and Palmdale U.S. Geological Survey (USGS) 7.5-minute quadrangle maps (Figure ES-2). The Recharge Site is located south of East Avenue L, west of 105th Street East, north of Avenue L-8, and east of 100th Street.

Project Capacity and Phasing

Water for groundwater recharge is obtained from two sources: raw water from the East Branch of the California Aqueduct and recycled water from the Los Angeles County Sanitation District's (LACSD) Palmdale Water Reclamation Plant. The recharge capacity of the Project is estimated to be approximately 52,000 acre-feet per year (AF/yr). This recharge capacity is substantially greater than the maximum extraction capacity to allow high levels of recharge in wet years when SWP Water is readily available; thus, banking water for extraction in dry years when SWP Water is not available.

The Project will be developed in two phases. Phase 1 is intended to meet Palmdale Water District's water demands for the first 22 years of the Project's life, providing a water supply of 14,125 AF/yr. The second phase, Phase 2, is sized to meet PWD's water demand through 50 years (2067), as well as ultimate build-out, providing a water supply of up to 24,250 AF/yr.



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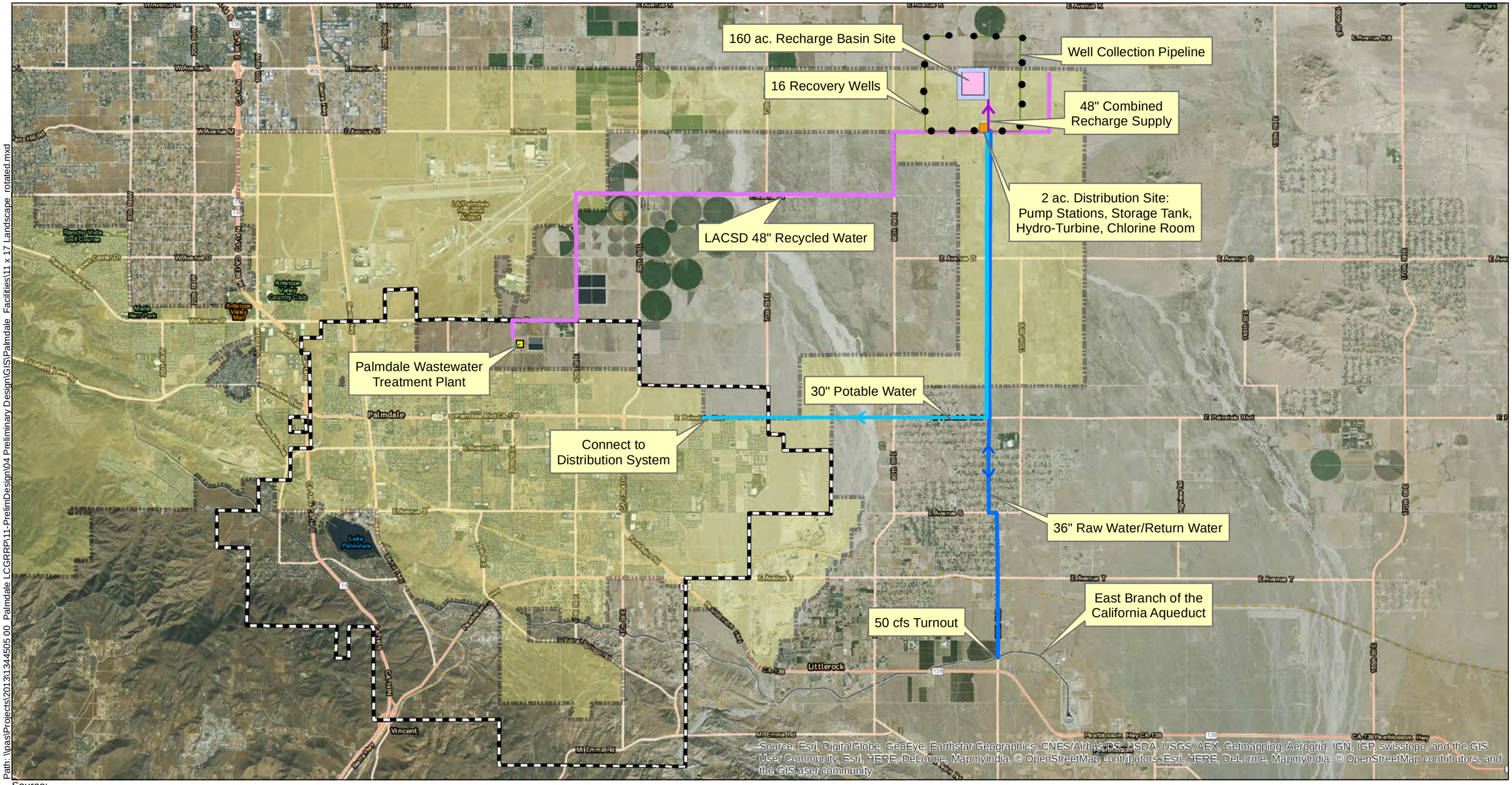
Regional Location Map

PALMDALE GROUNDWATER RECHARGE AND RECOVERY PROJECT

N 0 10 Miles

Figure ES-1: Regional Location Map



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Source:

Legend

- City of Palmdale Boundary
- Palmdale Water District (PWD) Service Area

N

0 3

Miles

Kennedy/Jenks Consultants

Palmdale Water District
Palmdale, CA

Palmdale Regional Groundwater Recharge & Recovery Project
Project Facility Map

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July 27, 2015

Figure ES-2: Project Facility Map

Phase 1 of the Project includes 8 of 16 Recovery Wells, 5 of 7 Potable Water Pump Station (PWPS) pumps, all conveyance pipelines, Recharge Site facilities, and Distribution Site facilities, with the exception of a short section of Well Collection Pipeline and the Return Water Pump Station (RWPS).

Phase 2 includes the additional 8 Recovery Wells, the remaining section of Well Collection Pipeline, the remaining 2 PWPS pumps, and the RWPS. Should sufficient interest exist among potential water bank partners, then the Phase 2 Recovery Wells, Well Collection Pipeline, and RWPS could be constructed earlier than the PWD water demand trigger for Phase 2.

Overall Project Description

The overall project is schematically described in Drawing G4 in Volume 2. Raw water enters the 36-inch diameter Raw Water/Return Water Pipeline through a 50 cfs turnout in the East Branch of the California Aqueduct (SWP Turnout). SWP Water passes through the sluice gate at the turnout entrance, into the transmission pipeline, and then passes through a magnetic flow meter and manual shut-off valve. The 36-inch diameter Raw Water/Return Water Pipeline continues 8.6 miles until reaching the Distribution Site, where the water enters the Hydro-turbine Room. Water flows between 10 and 40 cfs enter the hydro-turbine to convert excess pressure head to electricity, and water flows below 10 cfs and above 40 cfs are bypassed completely through two parallel pressure reducing valves. Discharge from the hydro-turbine and pressure reducing valves combines into a single 36-inch diameter pipeline and flows into a Distribution Box.

Recycled water is obtained through a new 30-inch diameter outlet in the existing 48-inch diameter LACSD recycled water pipeline. Water flow is measured with a magnetic flow meter, modulated by a control valve, and limited from back-flowing with a check valve. The water flows by gravity to the Distribution Box, where is it combined with SWP Water.

The combined recycled water and SWP Water exits the Distribution Box and flows by gravity 0.6 miles to the Splitter Box though a 48-inch diameter pipeline. The Splitter Box provides flow distribution to any or all of the four recharge basins. Four separate chambers are each equipped with 36-inch diameter sluice gates that deliver water through four independent 36-inch diameter pipelines to each basin inlet structure.

The four recharge basins are each designed with a recharge area of 20 acres and an operating water level of 3 feet. Each basin has approximately a 2.5-foot elevation drop, so Basin 4 is the lowest elevation while Basin 1 is the highest. If the water level in Basins 1, 2, or 3 reaches 3.5 feet, then the water will flow over an outlet weir to the adjacent down gradient basin.

To extract the groundwater, 8 Recovery Wells (for Phase 1) and 8 additional Recovery Wells (for Phase 2), total 16 wells, radially arranged, will discharge into the Well Collection Pipeline. The pipeline starts north of the recharge basins, with one side proceeding clockwise around the wells and the other counterclockwise, until combining at the Distribution Site (see Drawing C34 in Volume 2). The Well Collection Pipeline begins as a 12-inch diameter pipeline and expands to 16-, 20-, and 24-inch diameter pipeline to account for the increased water flow from each Recovery Well. The two pipeline segments combine as a 36-inch diameter pipeline on the Distribution Site.

Each Recovery Well has a small on-site blow-off pond for well startup. However, for operations that require longer blow-off periods, water can be routed through the Well Collection Pipeline to a secondary blow-off at the Distribution Site, and directed through the Distribution Box to the recharge basins.

When the extracted groundwater reaches the Distribution Site, potable water is chlorinated, directed through a 1.0-million gallon Storage Tank, and pumped by the PWPS through the 9.2-mile 30-inch diameter Potable Water Pipeline to the point of connection to the PWD 2800 Zone. Water entering the 2800 Zone has a hydraulic grade line of 2800 feet.

Return water to be pumped back to the East Branch of the California Aqueduct, by-passing the Storage Tank and disinfection, is pumped by the RWPS back through the same 8.6-mile 36-inch diameter Raw Water/Return Water Pipeline used to deliver SWP Water for recharge.

Preliminary Design Elements

Preliminary design elements of the Project are detailed in Sections 4 – 12 of this Preliminary Design Report (PDR) - Volume 1 and summarized herein. Volume 2 includes 59 preliminary drawings of the proposed facilities.

Pipelines

- **Raw Water/Return Water Pipeline (8.6 miles of 36-inch diameter pipeline):** The Raw Water/Return Water Pipeline is approximately 8.6 miles in length and will connect the Distribution Site with the East Branch of the California Aqueduct at the proposed SWP Turnout. The 36-inch diameter pipeline will travel north along 105th Street East from the SWP Turnout for approximately 2.3 miles. It will then traverse west along East Avenue S for approximately 0.1 mile, and then north along 105th Street East for approximately 1.5 miles to the terminus of 105th Street East at East Palmdale Boulevard. The Raw Water/Return Water Pipeline will continue north from the intersection of 105th Street East and East Palmdale Boulevard, along the future 105th Street East alignment through undeveloped land for approximately 4.7 miles to connect with the Distribution Site. At the Distribution Site, raw water will flow through the proposed hydro-turbine, and return water can be pumped back to the California Aqueduct through the RWPS. Raw water flowing through the hydro-turbine or by-passing the turbine, will flow by gravity from the Distribution Site through the Combined Recharge Supply Pipeline the last 0.6 mile to the Recharge Site.

- **Potable Water Pipeline (9.2 miles of 30-inch diameter pipeline):** The Potable Water Pipeline includes construction of a 30-inch diameter pipeline that originates at the PWPS and proceeds south along the same alignment as the Raw Water/Return Water Pipeline, and then traverses west along East Palmdale Boulevard, until 60th Street East.

- **Recycled Water Pipeline (0.1 mile of 30-inch diameter pipeline):** The Recycled Water Pipeline includes the construction of a 30-inch diameter pipeline that will connect to an existing LACSD 48-inch diameter recycled water pipeline at the intersection of 105th Street East and East Avenue M. The proposed 30-inch diameter Recycled Water Pipeline will traverse north and west for approximately 0.1 mile to a Distribution Box on

the Distribution Site where the recycled water will flow by gravity through the Combined Recharge Supply Pipeline the last 0.6 mile to the Recharge Site.

SWP Turnout

The new 50-cubic foot/second (cfs) SWP Turnout will be located at the intersection of the East Branch of the California Aqueduct and 106th Street East. The proposed turnout will connect to the side of the Aqueduct with a 36-inch diameter pipeline, and water will flow through the pipeline into an underground metering vault adjacent to the Aqueduct, before traveling north to the Recharge Site.

Hydro-turbine and Pressure Reducing Valves

A dual-nozzle Turgo turbine will be utilized for this Project. The proposed turbine accommodates flows as low as 10 cfs and as high as 40 cfs, with corresponding net heads as high as 371 feet and as low as 268 feet, respectively. The maximum expected system output at 40 cfs for the turbine is 770 kilowatts (kW).

The Hydro-turbine Room in the Pump Station Building is designed to house the Turgo turbine. The room is approximately 47 feet long and 35 feet wide, and houses the turbine, turbine by-pass with two pressure reducing valves, and generator electrical and turbine control panels.

In order to evaluate the potential of the hydropower project, turbine cost benefits were calculated. The current average energy cost of $0.14/kWh was used in the analysis. For the average range of flows, the Net Present Value (NPV) of Average Annual Net Savings is expected to be approximately $7.7 million to $16.0 million over the next 35 years, demonstrating that the hydropower project is financially beneficial even at the low-end average operating conditions, and becomes more beneficial as more water is delivered.

Recharge Site

The Recharge Site is 160 acres with four 20-acre cut-and-fill earth embankment recharge basins with shotcrete-lined interior slopes. The basins will occupy approximately 100 acres in the center of the 160-acre Recharge Site and provide 80 acres of basin floor for infiltration. With a perimeter access road around the toe of the recharge basin berms, approximately 110 acres will be fenced. The design infiltration rate based on limited field testing is 3 feet/day. Since the actual infiltration rate is critical for the proper sizing of the recharge basins, Kennedy/Jenks recommends that a field test basin on the order of 0.5 to 1.0 acres be operated for up to 30 days to confirm actual site full-scale recharge rates.

The Splitter Box, which has four chambers, will receive water from the Distribution Box and allow it to flow by gravity out the chamber(s) with opened sluice gates to each of four respective recharge basins.

Recovery Wells

The project will include 16 Recovery Wells occurring in two phases as previously described, with all wells having a target capacity of 1,200 gallons per minute (gpm). Recovery Wells will be configured in a radial pattern surrounding the Recharge Site, located on a 1.5-mile by 1.5- mile

square, centered around the Recharge Site. The Recovery Wells are set back 0.5 miles on each side of the Recharge Site to provide greater than six months of travel time, as required by the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW), for recycled water traveling from the recharge basins to the Recovery Wells. A Well Collection Pipeline will connect the Recovery Wells to the Distribution Site. The piping for Phase 1 is sized for ultimate capacity and is located either in existing or future street alignments. The Phase 1 Well Collection Pipeline will include approximately 5.7 miles of 12-, 16-, 20-, 24- and 36-inch diameter pipelines, with the remaining 0.3 miles of 12-inch diameter pipeline to be constructed at the same time as the Phase 2 Recovery Wells.

Distribution Site and Chlorination System

The 1-million-gallon Storage Tank and Pump Station Building (with chlorination facilities) will be located on a 2-acre parcel approximately 0.5 mile south of the recharge basins, at the northwest corner of the intersection of Avenue M and 105th Street East. The chlorination system is located in the Chlorine Room at the southeast corner of the pump station. This system's primary purpose is to generate, store, and deliver the chlorine used for disinfection of the potable water produced by the Recovery Wells.

Storage Tank

Groundwater that is to meet potable water requirements is pumped into the Storage Tank. The purpose of the Storage Tank is threefold:

1) **Disinfection:** Chlorine, which is generated on-site in the form of sodium hypochlorite, is injected into the 30-inch diameter tank inlet. The Storage Tank is sized, and the inlet and outlet pipes are designed to meet the required chlorine contact time for disinfection.

2) **Pump Can Pressurization:** The water level of the Storage Tank provides static head, and therefore pressurization, of the pump cans for the PWPS vertical turbine pumps in the Pump Station Building.

3) **Return Water Air Gap:** The water level of the Storage Tank provides sufficient head for the operation of the return water air gap piping, control valves, and structure that serve the RWPS wet well in the Pump Station Building.

Potable Water Pump Station

The Potable Water Pump Station will pump potable water from the Storage Tank to the PWD distribution pipeline's point of connection to the 2800 Zone. The PWPS consists of 7 vertical turbine pumps, 2 of which are for future expansion.

Return Water Pump Station

The optional Return Water Pump Station is designed to accommodate water banking partners and will consist of a 6-pump system to pump un-disinfected potable water from the Well Collection Pipeline to the East Branch of the California Aqueduct. This RWPS will be located adjacent to the 1-million-gallon Storage Tank and discharge back into the 36-inch diameter Raw

Water/Return Water Pipeline. It is not required for this pump station to be implemented until a water banking partnership is achieved.

Electrical

A pad mounted transformer will be required to provide electrical service for each Recovery Well, including a metering switchboard at 480V. The RWPS and PWPS will utilize a single electrical room located at the eastern center of the Pump Station Building. The electrical room is designed to house 13 variable frequency drives (2 future), 2 transformers, 2 programmable logic controller (PLC) cabinets, a lighting panel, a power panel, a switchgear, and a motor control center.

Opinion of Probable Construction Cost

The preliminary (10%) design level Opinion of Probable Construction Cost for the Project is $78.4 million without a contingency and in current dollars. With a 15% contingency, the Opinion of Probable Construction Cost increases to $90.2 million. For capital planning, 15% should be added for Engineering Design and Construction Management; thus, the total funding requirement is $103.7 million. This total is broken down into two phases: $85.3 million and $18.4 million. A summary of the Opinion of Probable Construction Cost is presented in Table ES-1.

Table ES-1: Opinion of Probable Construction Costs by Phase

Infrastructure	Phase 1	Phase 2*	Total
Well Drilling	$5,470,000	$5,470,000	$10,940,000
Well Equipping, Site Work, and Buildings	$6,060,000	$6,050,000	$12,110,000
Recharge Site	$9,170,000	$0	$9,170,000
Pipelines	$39,430,00	$170,000	$39,600,000
Distribution Site	$14,080,000	$4,300,000	$18,380,000
Subtotal	*$74,250,000*	*$15,950,000*	*$90,200,000*
Design and Construction Management	$11,140,000	$2,390,000	$13,530,000
Total**	**$85,390,000**	**$18,340,000**	**$103,730,000**

* Phase 2 or work to be initiated for water banking partners.
** Includes $2,750,000 in Phase 1 for the hydro-turbine, which could be considered optional.

Permitting

Permitting for the Project will be significant due to the indirect potable reuse of the recycled water and the multiple jurisdictions the transmission pipelines pass through.

Construction Permits

The following Construction permits are anticipated to be required by local agencies:

- Los Angeles County Well Drilling Permit for well drilling
- Los Angeles County Well Operating Permit for well operation

- Los Angeles County Encroachment Permit for pipeline construction in right-of-ways
- Palmdale City Traffic Control Permit for traffic control during pipeline construction
- Union Pacific Encroachment Permit for pipeline crossing

The following permits are anticipated to be required for construction by State agencies:

- Site specific Storm Water Pollution Prevention Plan (SWPPP) prepared by the various construction contractors.
- DWR Encroachment Permit for turnout construction
- Occupational Safety and Health Administration (OSHA) Underground Classification Permit for jack and bore

State Permitting for Groundwater Replenishment Using Recycled Water

The permit for the indirect potable reuse of recycled water will be managed by the Lahonton Regional Water Quality Control Board (Lahonton RWQCB), which requires the submission of a Report of Waste Discharge for discharging recycled water for groundwater recharge via surface spreading. The Title 22 Engineering Report will support the Report of Waste Discharge by demonstrating how the Project complies with the Title 22 Groundwater Replenishment Using Recycled Water Regulations adopted on June 18, 2014. Approval of the Title 22 Engineering Report must be obtained from both the DDW and RWQCB, with the RWQCB the permitting agency.

Kennedy/Jenks will prepare the Title 22 Engineering Report for submission first to the SWRCB DDW for preliminary approval, and then to the RWQCB. The report will describe the existing LACSD Palmdale Regional Reclamation Plant treatment process, the SWP Water supply as the blending source, groundwater spreading facilities, groundwater residence time, distance to Recovery Wells, distance to existing potable wells, and related information.

California Environmental Quality Act

The California Environmental Quality Act (CEQA) requires every project proposed in the state of California to be examined for potential effects on the environment. An Environmental Impact Report (EIR) is currently being prepared for the Project, including CEQA-Plus requirements. These activities are described in more detail in Section 14.3.

Federal National Environmental Protection Act

Because PWD is seeking federal funding through the U.S. Department of Interior Bureau of Reclamation (Reclamation) for the Project, the Project must comply with the National Environmental Policy Act (NEPA). Therefore, two separate documents will be prepared: one EIR under CEQA and one Environmental Assessment (EA)/Finding of No Significant Impact (FONSI) under NEPA. In addition, to comply with federal requirements, the Project will require a National Historic Preservation Act (NHPA) Section 106 Consultation with the State Historic Preservation Officer (SHPO).

Next Steps and Implementation

The next step in implementation of the Project is to utilize the PDR to develop contract documents for the proposed facilities.

Additional Studies

Several studies are recommended to inform the design development in the next phase, including:

- Geotechnical Investigation – to incorporate site-specific sub-surface considerations for all Project facilities.
- Surge Analysis – to develop design of the surge tank that will be located at the Distribution Site for protection of the Raw Water/Return Water Pipeline.
- Corrosion Evaluation – to develop cathodic protection design for all pipelines.
- Potholing – to further develop design of all pipelines by identifying potential utility conflicts.

In addition, it is recommended to install several monitoring wells around the Recharge Site and institute a quarterly groundwater sampling program to collect at least two years of background water quality data in the Lancaster Sub-basin. This data will be required to obtain permitting approval from the Lahontan RWQCB.

Design and Construction Packaging

It is anticipated that the Project facilities will be divided into six design/construction packages that can be bid individually. This division will allow multiple facilities to be constructed in parallel, which will reduce the overall construction schedule. It will also foster a more competitive bidding environment by allowing more firms to compete on smaller individual packages, which will potentially reduce overall construction cost. The design/construction packages are as follows:

- Well Drilling
- Well Equipping
- Large Pipelines, including:
    - Raw Water/Return Water Pipeline
    - Potable Water Pipeline
    - Recycled Water Turnout and Recycled Water Pipeline
    - SWP Turnout

- Small Pipelines, consisting of the well collection pipelines
- Recharge Basins
- Distribution Site, consisting of all of the facilities located at the Distribution Site, including:
    - Potable Water Pump Station
    - Return Water Pump Station
    - Pump Station Building
    - Storage Tank
    - Hydro-turbine

The focus following submittal of this PDR will be to complete the Blue Ribbon Panel assessment and Title 22 Engineering Report. Environmental compliance and public outreach work will continue to be developed with an anticipated complete date of May 2016. The permitting work can begin after the completion of the Title 22 Engineering Report and just prior to the completion of the environmental compliance work. It is assumed that development of the contract documents will begin after the environmental compliance task is completed. All of the facilities are anticipated to be constructed by February 2019. A preliminary implementation schedule is included in Section 15.3.

Section 1: Introduction and Background

This section provides an introduction and background to the Preliminary Design Report (PDR) for the Palmdale Regional Groundwater Recharge and Recovery Project (PRGRRP and/or Project) for the Palmdale Water District (PWD). In addition, this section provides background information, including a summary of the Littlerock Creek Groundwater Replenishment and Recovery Project (LCGRRP) Feasibility Study, an overview of the PDR's organization, and the Project team. While the LCGRRP initially focused on recharge in or adjacent to Littlerock Creek, refinement of the final alternatives shifted the preferred Recharge Sites to the east and away from Littlerock Creek. The preferred alternative (Alternative 10C) is approximately 3.5 miles east of the creek. Therefore, the name of the project was revised to reflect "Palmdale Regional" as the PRGRRP.

1.1 Introduction

The PRGRRP is a groundwater banking program with surface recharge of a blend of imported water and recycled water, as well as recovery facilities to help meet future water demands and improve reliability. The Project will deliver raw water from the East Branch of the California Aqueduct (State Water Project [SWP] Water) to new recharge basins located in the City of Palmdale. For the magnitude of recharge proposed under the Project, SWP Water, in years when available, will need to be recharged nearly year round. Recycled water produced locally also will be included in the recharge (compliant with applicable regulations); this source is anticipated to be available at an approximately constant rate year-round. The recharge capacity of the Project is estimated to be approximately 52,000 acre-feet per year (AF/yr). This recharge capacity is substantially greater than the maximum extraction capacity to allow high levels of recharge in wet years when SWP Water is readily available; thus, banking water for extraction in dry years when SWP Water is not available.

The Project will be developed in two phases. Phase 1 is intended to meet PWD's water demands for the first 22 years of the Project's life, providing a water supply of 14,125 AF/yr. The second phase, Phase 2, is sized to meet PWD's water demand through 50 years (2067), as well as ultimate build-out, providing a water supply of up to 24,250 AF/yr. The components of the Project that can easily be phased include the Recovery Wells, a short section of Well Collection Pipeline, the Potable Water Pump Station (PWPS), and the Return Water Pump Station (RWPS); the remaining transmission pipelines are all proposed to be constructed in a single phase. To meet PWD's potable water supply needs, Phase 1 is proposed to construct 8 of 16 Recovery Wells, with the remaining 8 Recovery Wells constructed in Phase 2. Once the radial extraction pattern is established with the first 8 recovery wells that captures the majority of recharge, the additional wells can be added incrementally or all at once at PWD's discretion. For potable water delivery to meet PWD's needs, the PWPS could be constructed with just 4 pumps (3 duty plus 1 standby), with an additional 3 pumps added in Phase 2. However, PWD is actively seeking partners to form a water bank to recharge and recover additional water beyond the needs of PWD. The recharge conveyance and recharge facilities sized for ultimate can store in excess of 25,000 AF/yr for PWD's partners beyond the needs of PWD alone, although the recovery and pump-back facilities are limited in PWD's base Phase 1 Project. The addition of a 5th pump in the Phase 1 PWPS (4 duty plus 1 standby) will allow PWD to deliver up to 5,000 AF/yr through its existing distribution system using interties with neighboring water agencies. In

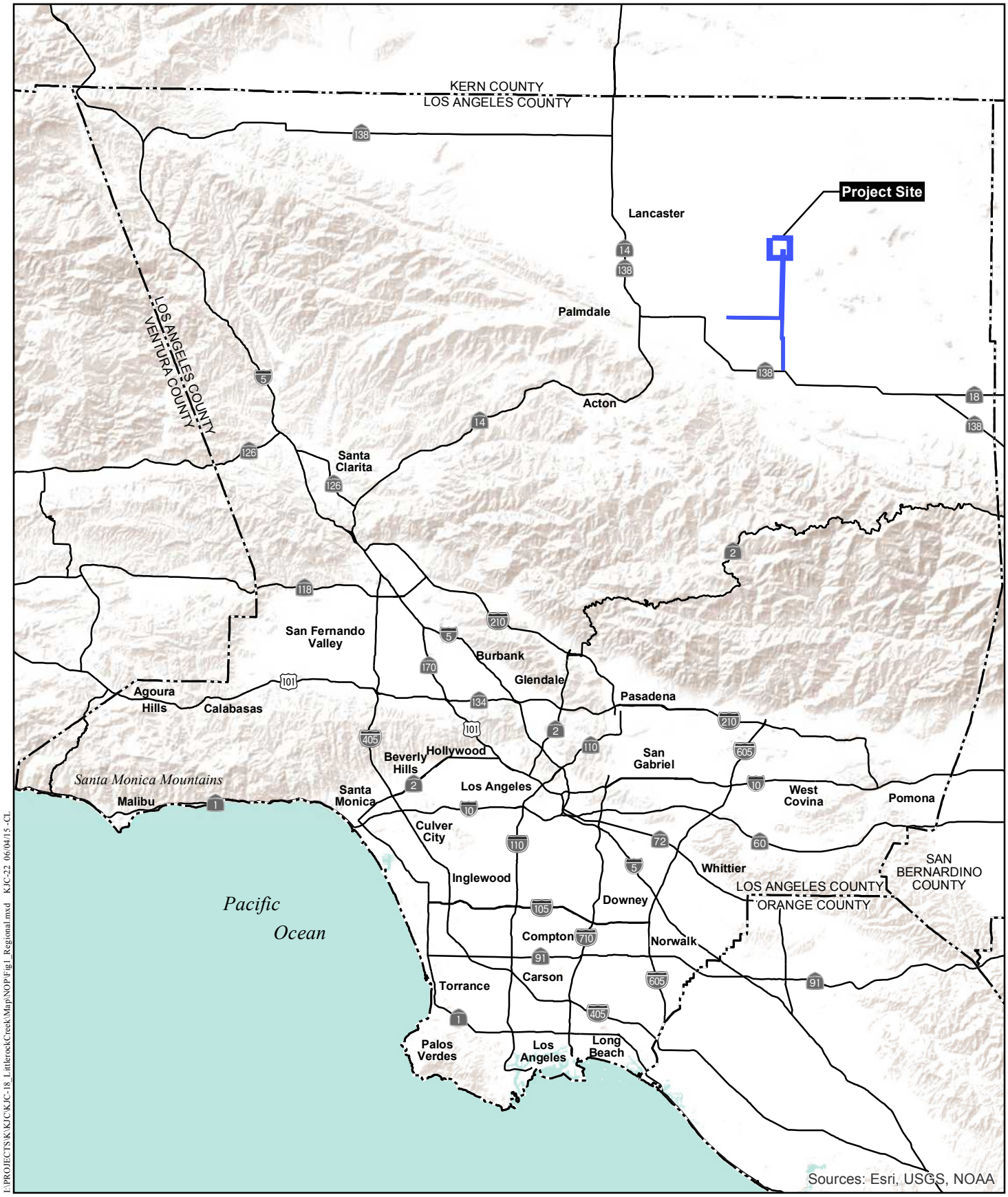
order to recover and pump back up to 100,000 AF in four consecutive dry years, all 16 Recovery Wells are required, as well as construction of the RWPS with all 6 pumps (5 duty plus 1 standby).

The 770 kW hydro-turbine at the Distribution Site (the end of the Raw Water/Return Water Pipeline) is an optional, but beneficial, component of the Project. An analysis, which is included in this PDR, indicates a substantial net present value of the average net savings over a range of operating conditions. The turbine qualifies for an incentive from Southern California Edison (SCE) equal to approximately 30 percent of the capital costs, and other grant funding programs may also be available. For this reason, the hydro-turbine is included in the Opinion of Probable Construction Costs in Section 13.

To clarify, the Phase 1 Project includes 8 of 16 Recovery Wells, 5 of 7 PWPS pumps, all conveyance pipelines, Recharge Site facilities, and Distribution Site facilities, with the exception of a short section of Well Collection Pipeline and the RWPS. Phase 2 includes the additional 8 Recovery Wells, the remaining section of Well Collection Pipeline, the remaining 2 PWPS pumps, and the RWPS. Should sufficient interest exist among potential water bank partners, then the Phase 2 Recovery Wells, Well Collection Pipeline, and RWPS could be constructed earlier than the PWD water demand trigger for Phase 2.

1.1.1 Site Location

The Project site is located generally in the northeastern undeveloped portion of the City of Palmdale in Los Angeles County, California and surrounding unincorporated Los Angeles County (Figure 1-1). More specifically, the Project site is situated north of State Route 138, east of State Route 14, south of Edwards Air Force Base, and west of the community of Lake Los Angeles. The Project site is located in portions of the Alpine Butte, Lancaster East, Littlerock, and Palmdale U.S. Geological Survey (USGS) 7.5-minute quadrangle maps (Figure 1-2). The Recharge Site is located south of East Avenue L, west of 105th Street East, north of Avenue L-8, and east of 100th Street.



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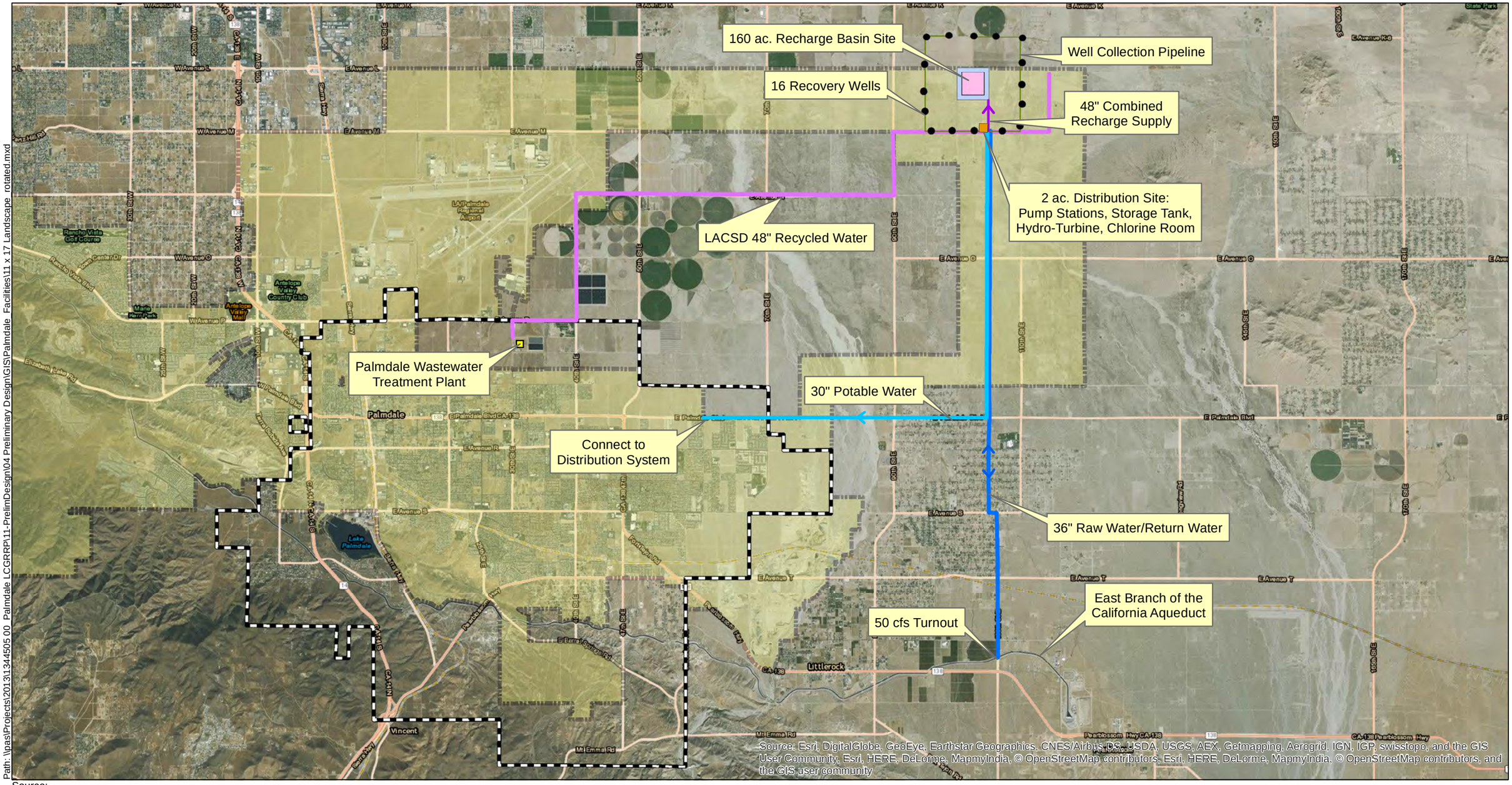
Regional Location Map

PALMDALE GROUNDWATER RECHARGE AND RECOVERY PROJECT

N 0 10 Miles

Figure 1-1: Regional Location Map



Path: \\pas\Projects\2013\1344505 00_Palmdale LCGRRP\11-PrelimDesign\04 Preliminary Design\GIS\Palmdale_Facilities\11 x 17 Landscape_rotated.mxd

Source:

Legend

- City of Palmdale Boundary
- Palmdale Water District (PWD) Service Area

N

0 3

Miles

Kennedy/Jenks Consultants

Palmdale Water District
Palmdale, CA

Palmdale Regional Groundwater Recharge & Recovery Project
Project Facility Map

1344505*01
July 27, 2015

Figure 1-2: Project Facility Map

1.1.2 Purpose and Scope

The purpose of the PDR is to address the preliminary design for the PRGRRP facilities, following Alternative 10C as presented in the LCGRRP Feasibility Study Report (Kennedy/Jenks, 2015), described in Section 1.2. Preliminary design includes the following elements:

- **SWP Turnout (50 cfs):** The new 50-cubic foot/second (cfs) SWP Turnout will be located at the intersection of the East Branch of the California Aqueduct (Aqueduct) and 106th Street East. (A turnout at the East Branch of the California Aqueduct is a connection/gate that allows water to discharge from the Aqueduct). The proposed turnout will connect to the side of the Aqueduct with a 36-inch diameter pipeline, and water will flow through the pipeline into an underground metering vault adjacent to the Aqueduct, before traveling north to the Recharge Site.

- **Raw Water/Return Water Pipeline (8.6 miles of 36-inch diameter pipeline):** The Raw Water/Return Water Pipeline is approximately 8.6 miles in length and will connect the Distribution Site with the East Branch of the California Aqueduct at the proposed SWP Turnout. The 36-inch diameter pipeline will travel north along 105th Street East from the SWP Turnout for approximately 2.3 miles. It will then traverse west along East Avenue S for approximately 0.1 mile, and then north along 105th Street East for approximately 1.5 miles to the terminus of 105th Street East at East Palmdale Boulevard. The Raw Water/Return Water Pipeline will continue north from the intersection of 105th Street East and East Palmdale Boulevard, along the future 105th Street East alignment through undeveloped land for approximately 4.7 miles to connect with the Distribution Site. At the Distribution Site, raw water will flow through the proposed hydro-turbine, and return water can be pumped back to the California Aqueduct through the RWPS. Raw water flowing through the hydro-turbine or by-passing the turbine, will flow by gravity from the Distribution Site through the Combined Recharge Supply Pipeline the last 0.6 mile to the Recharge Site.

- **Recycled Water Pipeline (0.1 mile of 30-inch diameter pipeline):** The Recycled Water Pipeline includes the construction of a 30-inch diameter pipeline that will connect to an existing Los Angeles County Sanitation District (LACSD) 48-inch diameter recycled water pipeline at the intersection of 105th Street East and East Avenue M. The proposed 30-inch diameter Recycled Water Pipeline will traverse north and west for approximately 0.1 mile to a Distribution Box on the Distribution Site where the recycled water will flow by gravity through the Combined Recharge Supply Pipeline the last 0.6 mile to the Recharge Site.

- **Recharge Site (160-acre site w/Splitter Box and four 20-acre recharge basins):** The Recharge Site is 160 acres with four 20-acre cut-and-fill earth embankment recharge basins with shotcrete-lined interior slopes. The basins will occupy approximately 100 acres in the center of the 160-acre Recharge Site and provide 80 acres of basin floor for infiltration. With perimeter access around the toe of the recharge basin berms, approximately 110 acres will be fenced.

- **Recovery Wells (16 wells):** The project will include 16 Recovery Wells occurring in two phases as previously described, with all wells having a target capacity of 1,200 gallons per minute (gpm). Recovery Wells will be configured in a radial pattern surrounding the Recharge Site, located on a 1.5-mile by 1.5- mile square, centered around the Recharge Site. The Recovery Wells are set back 0.5 miles on each side of the Recharge Site to provide greater than six months of travel time, as required by the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW), for recycled water traveling from the recharge basins to the Recovery Wells. A Well Collection Pipeline will connect the Recovery Wells to the Distribution Site. The piping for Phase 1 is sized for ultimate capacity and is located either in existing or future street alignments. The Phase 1 Well Collection Pipeline will include approximately 5.7 miles of 12-, 16-, 20-, 24- and 36-inch diameter pipelines, with the remaining 0.3 miles of 12-inch diameter pipeline to be constructed at the same time as the Phase 2 Recovery Wells.

- **Distribution Site:** The 1-million-gallon Storage Tank and Pump Station Building (with chlorination facilities) will be located on a 2-acre parcel approximately 0.5 mile south of the recharge basins, at the northwest corner of the intersection of Avenue M and 105th Street East. An artist rendering of the Distribution Site is shown in Figure 1-3.

Figure 1-3: Artist Rendering of Distribution Site

- **Potable Water Pump Station and Potable Water Pipeline:** The Potable Water Pump Station will pump potable water from the Storage Tank through the Potable Water Pipeline to the point of connection to PWD's 2800 Zone. The PWPS consists of 7 vertical turbine pumps, 2 of which are for future expansion. The 30-inch diameter Potable Water Pipeline will originate at the PWPS and proceed south along the same

alignment as the Raw Water/Return Water Pipeline, and then traverse west along East Palmdale Boulevard, until 60th Street East.

- **Return Water Pump Station:** The optional Return Water Pump Station is designed to accommodate a water banking partner or partners and will consist of a 6-pump system to pump un-disinfected potable water from the Well Collection Pipeline to the East Branch of the California Aqueduct. This RWPS will be located adjacent to the 1-million-gallon Storage Tank and discharge back into the 36-inch diameter Raw Water/Return Water Pipeline. It is not required for this pump station to be implemented until a water banking partnership is achieved.

1.2 Previous Reports

The overarching goal of the LCGRRP Feasibility Study was to investigate the feasibility of a groundwater banking, storage, and extraction program on behalf of PWD to help meet future water demands and improve water supply reliability. Furthermore, the overarching goal was to construct new facilities to recharge and recover SWP Water as well as locally-available recycled water. The recycled water would be recharged continuously, with surplus SWP Water stored during normal and wet years in quantities to meet the regulations for recycled water content; with the ratio tracked over a trailing 120-month period. Recovery of potable water supply for PWD would be continuous, although banked water would be available for recovery during dry years, providing reliable water supply stabilization.

Ten preliminary alternatives were developed for proposed recharge sites and subsequently evaluated (Alternatives 1 – 10). Based on the initial screening of the 10 alternatives, alternatives 9 and 10 were found to be more favorable than the other alternatives. In turn, these two alternatives were refined to generate four refined alternatives - Alternatives 9R, 10A, 10B, and 10C. Ultimately, Alternative 10C was selected for preliminary design. The evaluation and selection of Alternative 10C is detailed in the LCGRRP Feasibility Study Report (Kennedy/Jenks, 2015) and was based on several factors, including:

- Biological and cultural resources constraints
- Environmental impacts
- Cost and economics
- Recharge and recovery capacity
- Water quality
- Risk and uncertainties
- Public acceptance
- Institutional and private entity issues
- Ability to recharge recycled water

- Regulatory and permitting constraints

These factors favored the current location, which is located several miles east of Littlerock Creek. In addition, the selected location is several miles from the LACSD nitrate and total dissolved solids (TDS) contaminant plume, a distance greater than 5 miles from the U.S. Air Force Plant 42 runway, situated outside of the Los Angeles World Airports (LAWA) property, and located adjacent to the LACSD 48-inch diameter recycled water pipeline.

1.3 Report Organization

This PDR is organized into two volumes, wherein Volume I contains the report itself and Volume 2 includes 59 drawings. Volume I for the PRGRRP is organized into the following sections:

- **Section 1 – Introduction and Background:** Introduction to the PDR for the Project, and it also includes background information, a summary of the LCGRRP Feasibility Study, an overview of the PDR's organization, and the Project team.

- **Section 2 - Overall Project Description:** Overall Project description, Distribution Site plan, as well as information regarding the hydraulic profile, operational strategy, and construction impacts.

- **Section 3 - Field Investigations:** Field investigations, including the topographic survey, utility research, and infiltration testing.

- **Section 4 - Pipelines:** Project's pipelines, including design criteria, alignment, existing utilities, hydraulics, and easements, as well as supporting information on sensitive receptors, soils, and construction methods.

- **Section 5 – Hydro-turbine and Pressure Reducing Valves:** Hydro-turbine and by-pass pressure-reducing valves, including projected power generation and an economic analysis defining the average annual savings over a wide range of operating conditions.

- **Section 6 - Recharge Basins:** Recharge basins located at the Recharge Site, including design criteria and infiltration testing.

- **Section 7 – Recovery Wells:** Design, layout, drilling, and equipping of the Recovery Wells.

- **Section 8 – Chlorination System:** Chlorination system, including its design parameters and facility sizing, of which its primary purpose is to generate, store, and deliver the chlorine used for disinfection of the potable water produced by the Recovery Wells.

- **Section 9 – Storage Tank:** Storage Tank, including the design criteria and chlorine contact time.

- **Section 10 – Potable Water Pump Station:** Design of the PWPS.

- **Section 11 – Return Water Pump Station:** Design of the RWPS.

- **Section 12 – Electrical:** Electrical considerations and design for the Project.
- **Section 13 – Opinion of Probable Construction Cost:** Opinion of probable construction cost of the Project.
- **Section 14 – Permitting:** Permitting required for the Project.
- **Section 15 – Next Steps and Implementation Schedule:** Description of the next steps required for implementation of the proposed Project facilities, including a summary of recommended additional studies, design and construction packaging, and implementation schedule.

1.4 Project Team

The Project team includes staff from PWD, Kennedy/Jenks, and its subconsultants. Palmdale Water District's team members and roles are shown on Table 1-1.

Table 1-1: Palmdale Water District Project Team

Person	Role
Dennis D. LaMoreaux, P.E.	General Manager
Matthew Knudson, P.E.	Assistant General Manager/Project Manager
James A. Riley, P.E.	Engineering/Grant Manager
Jon M. Pernula	Water and Energy Resources Manager
Peter Thompson	Deputy Water and Energy Resources Manager
Mike McNutt	Public Relations

Kennedy/Jenks is responsible for preparation of this PDR, with project management, technical design, and other technical support provided by a variety of people as shown on Table 1-2. In addition, a suite of subconsultants provided support in specific technical areas.

Table 1-2: Kennedy/Jenks Project Team

Person/Subconsultant	Role
David Ferguson, Ph.D., P.E.	Project Manager
Harold Glaser, P.E.	Principal-In-Charge
Paul Tinhpheng, P.E.	Project Engineer
Brandon Hale, P.E.	Assistant Project Engineer
John Coffman, P.E.	Pipeline Lead
Greg Behnke	Recharge Site Lead
Timothy Waters, E.I.T.	Well and Well Recovery Pipeline Lead
Alexandra McMath, E.I.T.	Distribution Site Lead
Melanie Rivera Ray Lyons, P.E.	Technical Support
Zixuan Chen, P.E.	Cost Estimating
Mike Maley, P.E., PG, CHG	Groundwater Modeling

Person/Subconsultant	Role
Jeff Morris, P.E.	Electrical Design
Bryant Behnke Robert Briggs David McClung Harry Sugg III	Computer Aided Design (CAD)
Arrow Engineering Services, Inc.	Survey and Utilities Research
Helix Environmental Planning, Inc.	Environmental
Katz & Associates, Inc.	Public Outreach
The Terrazas Group	3D Renderings
M2 Resource Consulting, Inc.	Technical Writing/Editing

Section 2: Overall Project Description

This section provides an overall Project description and Distribution Site plan. In addition, information regarding the hydraulic profile, operational strategy, and construction impacts is presented.

2.1 Process Flow Diagram

Water for groundwater recharge is obtained from two sources: raw water from the East Branch of the California Aqueduct and recycled water from the LACSD No. 20 Palmdale Water Reclamation Plant. The two water sources travel through the proposed system as described below and displayed schematically in Drawing G4 in Volume 2.

Raw water enters the 36-inch diameter transmission pipeline through a 50 cfs turnout in the East Branch of the California Aqueduct (SWP Turnout). Raw water passes through the sluice gate at the turnout entrance, into the transmission pipeline, and then passes through a magnetic flow meter and manual shut-off valve. The 36-inch diameter Raw Water/Return Water Pipeline continues 8.6 miles until reaching the Pump Station site, where the water enters the Hydro-turbine Room. Water flows between 10 and 40 cfs enter the hydro-turbine to convert excess pressure head to electricity, and water flows below 10 cfs and above 40 cfs are bypassed completely through two parallel pressure reducing valves. Discharge from the hydro-turbine and pressure reducing valves combines into a single 36-inch diameter pipeline and flows into the Distribution Box.

Flow control for the raw water delivery is accomplished downstream in the Hydro-turbine Room using the two nozzles at the hydro-turbine when the hydro-turbine is in service, and using the two 16-inch diameter pressure-reducing valves (PRVs) with electronic actuated rate of flow control when the turbine is being by-passed.

Recycled water is obtained through a new 30-inch diameter outlet in the existing 48-inch diameter LACSD recycled water pipeline. Water flow is measured with a magnetic flow meter, modulated by a control valve, and limited from back-flowing with a check valve. The water flows by gravity to the Distribution Box, where is it combined with SWP Water, and potentially with blow-off water from the Recovery Wells and overflow water from the Storage Tank.

The combined recycled water and SWP Water exits the Distribution Box and flows by gravity 0.6 miles to the Splitter Box though a 48-inch diameter pipeline. The Splitter Box provides flow distribution to any or all of the four recharge basins. Four separate chambers are each equipped with 36-inch diameter sluice gates that deliver water through four independent 36-inch diameter pipelines to each basin inlet structure. Overflow weirs in the Splitter Box to each chamber provide equal flow distribution to all chambers with an open sluice gate. The sluice gates to Basins 1, 2, and 3 will be manually operated, while the sluice gate for Basin 4 will have a motor operator. Since Basin 4 cannot overflow to a successively lower basin, rather it overflows to the ground, the basin is equipped with a float switch that will signal the motor-operated sluice gate to close. If the water level in the Splitter Box exceeds normal operating levels, then it will flow into an overflow chamber and then into the first pipeline and to Basin 1.

The recharge basins are each designed with a recharge area of 20 acres and an operating water level of 3 feet. Basin 1 is nearest to the Splitter Box, while Basin 4 is the farthest, with Basin 2 and Basin 3 in between. Each basin has approximately a 2.5-foot elevation drop, so Basin 4 is the lowest elevation while Basin 1 is the highest. If the water level in Basins 1, 2, or 3 reaches 3.5 feet, then the water will begin flowing over an outlet weir to an outlet pipeline that joins the inlet pipeline for the adjacent down gradient basin.

To extract the groundwater, 8 Recovery Wells (for Phase 1) and 8 additional Recovery Wells, total 16 wells (for Phase 2), radially arranged, will discharge into the Well Collection Pipeline. The pipeline starts to the north of the recharge basins, with one side proceeding clockwise around the wells and the other counterclockwise, until combining at the Distribution Site; see drawing C34 in Volume 2. The Well Collection Pipeline begins as a 12-inch diameter pipeline and expands to 16-, 20-, and 24-inch diameter pipeline to account for the increased water flow from each Recovery Well. The two pipeline segments combine as a 36-inch diameter pipeline on the Distribution Site, where well RC-1 discharges directly into the 36-inch diameter pipeline.

Each Recovery Well has a small on-site blow-off pond for well startup. However, for operations that require longer blow-off periods, water can be routed through the Well Collection Pipeline until reaching the Distribution Site where it branches off the Well Collection Pipeline and enters the blow-off pipeline. The branches are located upstream of the convergence point between the east and west portions of the Well Collection Pipeline. This allows for either the east or west branch to be blown-off while the other branch remains in service. Wells located along the branch that is being blown-off will be temporarily shut off. Water in the blow-off pipeline is routed to the Distribution Box so that it can be recharged again.

When the extracted groundwater reaches the Distribution Site, potable water is chlorinated and pumped to the point of connection to the PWD 2800 Zone. Return water can also be pumped back to the East Branch of the California Aqueduct. A tee at the end of the Well Collection Pipeline routes the groundwater to the Storage Tank through the 30-inch diameter tank inlet, with the option to direct a portion of the supply to the RWPS. Chlorine is normally added to the tank inlet for disinfection. If the Storage Tank is out of service, then a 36-inch diameter pipeline by-passes the tank and has a back-up chlorine injection point for disinfection. The Storage Tank outlet pipe connects to the PWPS, where 4-duty plus 1-spare pumps in Phase 1, expandable to 6-duty plus 1-spare pumps in Phase 2, pump the water 9.2 miles in the 30-inch diameter Potable Water Pipeline to the PWD point of connection.

The RWPS conveys non-disinfected potable water to the East Branch of the California Aqueduct for use by potential partner agencies. Since the RWPS delivers water back through the same 8.6-mile 36-inch diameter Raw Water/Return Water Pipeline used to deliver SWP Water for recharge, the pipeline can only be used in one direction at a time. It is envisioned that recharge will occur roughly 6 normal and wet years out of 10 years, and that return pumping will occur roughly 4 dry years out of 10 years. When the non-disinfected potable water is pumped back through the RWPS, an air gap is necessary to provide cross-connection control to separate the Raw Water/Return Water Pipeline from the potable system. The air gap requires wet well storage for the RWPS pumps, which is provided by a rectangular cast-in-place concrete wet well sized to store a minimum of 75,000 gallons. This sizing provides approximately 10 minutes of operational storage for a single return water pump or 2 minutes for the maximum 5-pump flow.

The RWPS discharge header connection to the 36-inch diameter Raw Water/Return Water Pipeline connects the RWPS to the Hydro-turbine Room, discussed in Section 5. Housed within the Hydro-turbine Room are two pressure relief valves and associated pipelines, which serve the dual purpose of providing by-pass capability to the hydro-turbine during recharge operations as well as pressure relief to the RWPS during pump back, negating the need for a pressure relief pipeline within the pump room for the RWPS.

2.2 Distribution Site Plan

The Distribution Site, located on a 2.1-acre parcel northwest of the intersection of East Avenue M and the future 105th Street East, contains the following structures:

- Pump Station Building
- 1 million gallon (MG) Storage Tank
- Distribution Box
- Electrical Substation
- Recovery Well 1

With the exception of the Distribution Box, the Distribution Site is graded to an elevation of 2,551-feet to raise the site out of the flood plain. This is approximately 4 to 5 feet higher than the existing ground elevation. The elevated area of the Distribution Site is paved with asphalt-concrete. Driveway access to the Distribution Site is located on East Avenue M and the future 105th Street East. The perimeter of the Distribution Site is lined with a 7-foot chain link fence with three strands of barb wire.

The Pump Station Building houses:

- Return Water Wet Well
- Return Water Pump Station
- Potable Water Pump Station
- Chlorine Room
- Electrical Room
- Control Room with unisex restroom
- Hydro-turbine and PRV by-pass

The Electrical Substation contains the following SCE equipment:

- Transformers

- Metering switchgear
- Primary disconnects
- Power factor correction capacitors

2.3 Hydraulic Profile

Raw water and recycled water are delivered to the recharge basins by gravity flow. The head loss of the raw water travelling from the East Branch of the California Aqueduct to the Distribution Site is less than the drop in elevation, resulting in excess head at the Distribution Site; therefore, a hydro-turbine is located in the Pump Station Building to convert the excess head to electricity. After passing through the hydro-turbine (or the PRVs if the flow by-passes the hydro-turbine), the water flows by gravity into the Distribution Box. The recycled water travel distance to the Distribution Box is much shorter than the raw water, but the beginning pressure is only slightly higher than atmospheric.

The depth of the Distribution Box is dependent on the entrance elevation of the recycled water, which is the deepest pipe entering the box, and the water level of the Splitter Box downstream at the Recharge Site. Since the Recycled Water Pipeline enters the Distribution Box with an invert 5 feet below the ground surface, the outlet pipeline that takes the combined water to the Splitter Box is 10.5 feet below the ground surface. The 5 feet of separation allows for sufficient head space between the Recycled Water Pipeline invert and the Combined Water Pipeline invert, which requires 4 feet of headwater above the pipeline invert to flow the maximum design flow of 72.2 cfs. A 48-inch diameter pipeline delivers the supply from the Distribution Box to the Splitter Box by gravity.

The Splitter Box elevation is set to allow both gravity flow from the Distribution Box and gravity flow to each of the four recharge basins. The Splitter Box and 36-inch diameter delivery pipelines can deliver up to 36.1 cfs or 50% of the maximum design flow of 72.2 cfs; although Basin 1 can deliver up to the full 72.2 cfs when the Splitter Box is in emergency overflow.

After water is recharged to the groundwater basin, it is extracted by groundwater wells. Recovery Wells vary between 200-horsepower (HP) and 250-HP. The wells pump the groundwater up and discharge it into the Well Collection Pipeline, which leads to the 1 MG Storage Tank. Each Recovery Well is equipped with a variable frequency drive to account for variations in groundwater levels, drawdown, flow set point variations, and flow-dependent head losses.

Extracted groundwater can be chlorinated and pumped to PWD's distribution system or pumped back to the East Branch of the California Aqueduct through the RWPS as un-disinfected potable water. Operating the PWPS at maximum capacity requires five 700-HP pumps to provide approximately 520 feet of total dynamic head. Pumping to the PWD system requires four 400-HP pumps to provide up to 369 feet of total dynamic head in Phase 1, and six 400-HP pumps to provide up to 445 feet of total dynamic head in Phase 2.

2.4 Operational Strategy

The project's control system will be able to monitor and control the multiple components for the following: 1) SWP Water delivery, 2) recycled water delivery, 3) recharge basins, 4) Recovery Well production, 5) chlorine treatment, 6) potable water delivery to PWD's distribution system, and 7) return water delivery to the East Branch of the California Aqueduct.

1) **SWP Water:** For seasonal changes in SWP Water delivery, a sluice gate at the East Branch of the California Aqueduct canal can be manually opened and closed. In order to monitor this delivery, the California Department of Water Resources (DWR) meter status at the turnout is communicated via SCADA (supervisory control and data acquisition system). Flow control for delivery of SWP Water is provided at the hydro-turbine through adjustment of the two hydro-turbine nozzles. The predesigned hydro-turbine has an operating range of 10 to 40 cfs. The full flow above or below the operating range of the hydro-turbine is by-passed through one or both 16-inch diameter PRVs in the Hydro-turbine Room. As such, the PRVs will be specified as electronic actuated rate of flow control valves.

2) **Recycled Water:** Delivery of recycled water to the Distribution Box by gravity flow to the Recharge Site is controlled through the recycled water turnout meter vault structure with a motor-operated control valve.

3) **Recharge Basins:** Delivery of water to the recharge basins is through a Splitter Box with manually operated sluice gates to Basins 1, 2, and 3, and a motor-operated sluice gate to Basin 4. Each manually operated sluice gate will be equipped with an open/close limit switch, and the delivery of water is monitored with alarms by level sensors equipped in each basin.

4) **Recovery Wells:** The Recovery Well layout is designed to recover the majority of the recharge water. The number of wells can be adjusted to match the target flow rate to meet potable and raw water/ return water demands; however, a near radial pattern of operating wells is ideal. With Variable Frequency Drives (VFDs), the wells can operate from approximately 50 to 100% of their design capacity, with the most efficient energy use (kilowatt-hours/AF [kWh/AF]) anticipated in the range of 70 to 90% capacity. Thus, the number of wells can be selected accordingly. Recovery Well start-up can be initiated in remote auto or manual. The operator should confirm the oil lube status prior to pump operation, under routine maintenance, in order to protect the well shaft bearings.

   A pump control valve (Cla-Val) will be utilized to first discharge water through the 8-inch diameter blow-off line, then after a pre-determined period of time (typically 10 minutes) a second pump control valve will discharge to the Well Collection Pipeline through the 10-inch diameter discharge header. The discharge line will incorporate two air vacuum release valves, pressure gauge, sample tap, mag meter, and gate valve. A flow switch to indicate no flow status, and a pressure switch to indicate high pressure, will be also be installed in the well discharge line with alarm and shut-down settings.

5) **Chlorination System:** Potable water entering the 1 MG Storage Tank is normally chlorinated through the inlet of the tank using a two-pump (with alternating duty) chemical metering pump skid located in the Chlorine Room. The chlorine residual

analyzer on the tank outlet will monitor the chlorine dose, in order to maintain the disinfection target of 4-log Virus inactivation.

6) **PWD Distribution System:** The Storage Tank provides suction to the PWPS that is equipped with 4 duty plus 1 standby 400 HP pumps with VFDs. The number of pumps used is established by the operator to match potable water demand. The pump speed is controlled by the target water level in the tank.

7) **Pump Back to East Branch:** Flow from the Storage Tank through the Air Gap Structure leading to the Return Water Wet Well is controlled through two motor-operated 18-inch diameter modulating plug valves; a single plug valve is operated for low flow conditions. The plug valve operation is tied to the wet well water level. The number of return water pumps is based on the target flow, and the pump speed is controlled by the on-site magnetic flow meter. To prevent overflow of the wet well in the event of a power failure, a 480v uninterruptable power supply (UPS) is proposed to drive the plug valves closed.

A personal computer with a hot redundant spare will reside in the control room of the pump station and will operate using Wonderware software. The system will link remotely with the existing SCADA system via radio. As such, PWD's operators can monitor and control the Project remotely.

2.5 Construction Impacts

For the Project to be operational in early 2018, construction should commence in May 2017, and continue in phases over a period of approximately 21 months. Construction activities are planned into five phases, as shown in Table 2-1, with different contracts awarded for each phase.

Table 2-1: Project Construction Phases

Phase	Project Component	Construction Period	Total Phase Duration
1	Well Drilling	May 2017 – March 2018	10 months
2	Well Equipping	February 2018 – February 2019	12 months
3	Pipelines and SWP Turnout	July 2017 – June 2018	11 months
4	Recharge Basins	July 2017 – July 2018	12 months
5	Distribution Site	October 2017 – February 2019	16 months

Construction generally occurs in non-residential areas, with the exception of the transmission pipeline construction along East Palmdale Boulevard between 60th Street East and 105th Street East, and 105th Street East between East Avenue S and East Palmdale Boulevard.

2.5.1 Operations During Construction

The PWD distribution system will remain in operation during construction, except for a 48-hour period when the transmission pipeline connects to the system at 60th Street East and East Palmdale Boulevard. Only the section of the PWD system nearest to the point of connection will

be taken offline for the tie-in. Other utilities that are crossed by the transmission pipelines will remain in operation, with the exception of minor gas or water lateral relocations that impact select residents.

The East Branch of the California Aqueduct, operated by the DWR, will remain in operation during the construction of the SWP Turnout. A cofferdam will provide a dewatered section of the Aqueduct for the contractor. Water passing the cofferdam will have a slight increase in velocity due to the cross-sectional area restriction; however, this velocity increase should not impact the Aqueduct since the bottom and side slopes are lined with 4 inches of concrete. Once construction is complete, the cofferdam will be removed and water flow in the Aqueduct will return to normal.

Section 3: Field Investigations

This section describes field investigations, including the topographic survey, utility research, and infiltration testing.

3.1 Topographic Survey

Arrow Engineering Services, Inc. (AESI), a licensed surveyor contracted with Kennedy/Jenks, performed the topographic survey of the transmission pipelines, Distribution Site facilities, recharge basins, and Well Collection Pipelines. Aerial mapping consists of 1-ft contours of the following areas:

- 150-foot swaths in non-residential areas and 250-foot in residential areas for the 30-inch diameter Potable Water Pipeline alignment along East Palmdale Boulevard between 60th Street East and 105th Street East.

- 150-foot swaths in non-residential areas and 250-foot in residential areas for the 36-inch diameter Potable Water Pipeline alignment along 106th Street East between the East Branch of the California Aqueduct and East Avenue S, East Avenue S between 105th Street East and 106th Street East, and 105th Street East between East Avenue S and East Avenue L-8.

- 160-acre parcel for the recharge basins defined as the area between 100th Street East on the west, East Avenue L-8 on the south, the future 105th Street East on the east, and East Avenue L on the north.

- 1,000-foot swaths for the Well Collection Pipeline centered along 95th Street East from East Avenue K-8 to East Avenue M, East Avenue K-8 from 95th Street East to 110th Street East, 110th Street East from East Avenue K-8 to East Avenue M, and East Avenue M from 95th Street East to 110th Street East.

Field surveying supplemented the areal mapping in order to tie-in control points, cover areas that obstructed in the aerial imaging, and confirm utility locations. Street right-of-way limits and parcel lines are drawn based on the Los Angeles County Assessor's Parcel Maps.

3.2 Utility Research

Existing utility records were collected by AESI and confirmed through the supplemental field survey. Records for utilities are provided by the utility owner. The following utilities have services within the Project area:

- AT&T

- Antelope Valley-East Kern Water Agency (AVEK)

- City of Palmdale

- Los Angeles County Waterworks District
- Level3 Communications (telephone)
- Littlerock Creek Irrigation District
- Southern California Gas Company
- Southern California Electric
- Time Warner
- Verizon

Utilities are more congested in the locations defined as:

- East Avenue S between 105th Street East and 106th Street East
- East Palmdale Boulevard between 60th Street East and 70th Street East
- East Palmdale Boulevard between 88th Street East and 105th Street East
- 105th Street East between East Avenue S and East Palmdale Boulevard

Non-residential areas typically have fewer utilities. Detailed descriptions of utilities and their impacts to the transmission pipelines are discussed in Section 4.3.

3.3 Infiltration Testing

Infiltration testing to determine groundwater infiltration rates is discussed in Section 6.

Section 4: Pipelines

This section discusses the Project's pipelines, including design criteria, alignment, existing utilities, hydraulics, and easements. In addition, supporting information, sensitive receptors, soils, construction methods, and more is provided.

4.1 Design Criteria

Water to the recharge basins comes from two sources: raw water from the East Branch of the California Aqueduct and recycled water from the LACSD Palmdale Water Reclamation Plant. The Raw Water/Return Water Pipeline is designed to convey up to 50 cfs (36,100 AF/yr) and the Recycled Water Pipeline is designed for an ultimate capacity of up to 22.2 cfs (16,100 AF/yr). Both water sources are combined in a Distribution Box at the Distribution Site, and water flows by gravity to the Recharge Site. The Distribution Box, Combined Recharge Supply Pipeline, and Splitter Box, are all sized to convey up to 52,200 AF/yr.

Groundwater is extracted by the Recovery Wells and delivered to a 1 MG Storage Tank at the Distribution Site. Potable water is pumped to PWD's distribution system with a point of connection to the 2800 Zone at the intersection of 60th Street East and East Palmdale Boulevard. The Potable Water Pipeline is sized for an ultimate capacity of 33.5 cfs (24,250 AF/yr). Alternatively, the groundwater can be pumped back to the East Branch of the California Aqueduct through the Raw Water/Return Water Pipeline at up to 41.5 cfs (30,000 AF/yr). Table 4-1 shows the pipeline design criteria.

Table 4-1: Pipeline Design Criteria

Pipeline	Path	Pipe Size (in)	Length (mi)	Capacity (AF/yr)	Max Full Pipe Velocity (fps)
Raw Water/Return Water	Aqueduct to Pump Station	36	8.6	36,100	7.1
Recycled Water	POC to Distribution Box	30	0.1	16,100	4.5
Combined Recharge Supply	Distribution Box to Splitter Box	48	0.6	52,200	5.7
Potable Water	Pump Station to PWD POC	30	9.2	24,250	6.8

Notes: POC = point of connection; in = inches; mi = miles; fps = feet per second

For each of the pipelines, the maximum design velocity is lower than the industry accepted upper limit of 8.0 fps in order to minimize head loss.

4.2 Alignment

This section presents the alignment for the Project's pipelines.

4.2.1 Raw Water/Return Water

The Raw Water/Return Water Pipeline, conveying water from the East Branch of the California Aqueduct and return flow from the Distribution Site, begins with a 50 cfs turnout at the northeast corner of the intersection of the East Branch of the California Aqueduct and 106th Street East in Pearblossom, CA; an unincorporated area of Los Angeles County. The pipeline continues north along 106th Street East on the east side of the roadway, outside of the edge of pavement until reaching the Union Pacific Railroad crossing. This crossing, approximately 1.15 miles north of the East Branch of the California Aqueduct (south of East Avenue T) will be performed by a jack-and-bore method, as discussed in 4.11.2. After crossing the railroad, the Raw Water/Return Water Pipeline continues north outside the edge of pavement on the east side of the roadway until reaching East Avenue S, at which point the pipeline turns west.

On East Avenue S, the Raw Water/Return Water Pipeline travels west on the south side of the street, crossing two high pressure gas lines and jogging between two power poles. At 105th Street East, the Raw Water/Return Water Pipeline turns north in the center of the roadway, and continues six feet east off the center of 105th Street East until reaching East Avenue R. This portion of the pipeline alignment was chosen to be near the center of the roadway due to the alternating gas and water pipelines running on the east and west edge of roadway on 105th Street East. These utility conflicts do not allow for a new large diameter Raw Water/Return Water Pipeline to be installed between the existing utilities and edge of right-of-way.

At Avenue R, the paved portion of the roadway jogs to the east and remains in the east half of the total right-of-way. Subsequently, the Raw Water/Return Water Pipeline jogs to the west and continues travelling north in the unpaved portion of the roadway. This alignment was selected to reduce pipeline installation in the paved roadway.

At East Palmdale Boulevard, the Raw Water/Return Water Pipeline crosses the roadway at a slight angle. This will allow for a jack-and-bore installation if the County of Los Angeles does not permit open trench, cut and cover, installation across this major arterial roadway. After crossing East Palmdale Boulevard, the Raw Water/Return Water Pipeline travels in largely undeveloped land along the future alignment of 105th Street East, currently an intermittent and unmaintained dirt road. As such, only sporadic right-of-way paths are available for use. The pipeline continues along the west side of the future 105th Street East and switches to the east side of the roadway all the way to East Avenue M. The pipeline switches to the west side of the section line in East Avenue M and proceeds to enter the Pump Station Building located northwest of the intersection of East Avenue M and East 105th Street East.

Where right-of-way is absent along the future alignment of 105th Street East between East Palmdale Boulevard and East Avenue M, it is proposed that PWD secure easements for initial construction as well as on-going operations and maintenance.

4.2.2 Recycled Water

Recycled water for recharge is obtained from a turnout in an existing 48-inch diameter LACSD recycled water pipeline travelling from the LACSD pump station to the LACSD seasonal storage ponds. A turnout to send water to the recharge basins will be at the intersection of East Avenue M and 105th Street East. The pipeline will immediately jog north to the west side of the section

line in 105th Street East and travel north until turning west and terminating at the Distribution Box.

The Distribution Box collects raw water from the East Branch of the California Aqueduct (after passing through the hydro-turbine or the PRVs), recycled water from the LACSD turnout, groundwater from the well blow off, and potable water from the Storage Tank overflow. The Combined Recharge Supply Pipeline exiting the Distribution Box is designated as recycled water since the recycled water from LACSD is the controlling water quality of the blended water. This pipeline exits the box, turns east until reaching the west side of the section line in 105th Street East, at which point it travels north until turning west and entering the Splitter Box at the recharge basins.

4.2.3 Potable Water

The Potable Water Pipeline departs the Pump Station Building at 105th Street East and East Avenue M. It travels south along 105th Street East, paralleling the Raw Water/Return Water Pipeline, until reaching East Palmdale Boulevard and turning west. The alignment continues west along East Palmdale Boulevard on the north between the edge of pavement and the power poles until passing 100th Street East, at which point the pipeline moves in between the power poles and the edge of right-of-way. This alignment continues until reaching 88th Street East, when the pipeline again moves to between the power poles and the edge of pavement.

Continuing along East Palmdale Boulevard, the Potable Water Pipeline approaches the Littlerock Wash. Water crosses this dry creek from the south and travels to the north when flowing, so the pipeline alignment shifts to the south side of the road between the edge of pavement and the edge of right-of-way. Placing the pipeline on the upstream side of the water passing over the roadway reduces the potential of water scour from damaging the pipeline. The switch to the south side of the roadway is outside the U.S. Federal Emergency Management Agency (FEMA) delineated limit of the 100-year flood event.

After passing the Littlerock Wash, the pipeline alignment switches back to the north side of East Palmdale Boulevard, located between the edge of pavement and the power poles. The Potable Water Pipeline continues west until reaching 65th Street East, where it jogs between an existing potable water pipeline and the edge of pavement on the north side of the road. Upon reaching the point of connection to the PWD distribution system at 60th Street East, located on the north portion of East Palmdale Boulevard, the Potable Water Pipeline connects to an existing cross. To the west of the cross is an abandoned water pipeline that conflicts with the new Potable Water Pipeline, requiring removal of approximately 150 linear feet of the abandoned pipeline.

4.2.4 Pipeline Separation Requirements

When a potable water pipeline is in close proximity to a raw or sewer water pipeline, there is a risk of contamination if the raw or sewer water pipelines were to leak and infiltrate into the potable water pipeline. Along 105th Street East, from East Palmdale Boulevard to the Distribution Site near East Avenue M, the Potable Water Pipeline parallels the Raw Water/Return Water Pipeline for approximately 4.5 miles. Additionally, the Potable Water Pipeline parallels a sanitary sewer pipeline between 60th Street East and 65th Street east, for approximately 0.65 miles.

Section 64572 of the California Code of Regulations requires that new water mains must maintain a minimum horizontal separation of four feet and vertical separation of one foot above a raw water pipeline, and a minimum horizontal separation of 10 feet and vertical separation above of one foot from a sewer water pipeline. However, the code states that the vertical separation is not required when the horizontal distance between the pipelines is over 10 feet.

In order to avoid increased trenching costs due to the vertical separation requirement, the Potable Water Pipeline is a horizontal distance of 10 feet from the paralleling Raw Water/Return Water Pipeline along 105th Street East. The Potable Water Pipeline is also located greater than 10 feet horizontally from the existing sanity sewer on East Palmdale Boulevard.

4.3 Existing Utilities

Arrow Engineering Services, Inc. (AESI) performed research of existing utilities. Utilities that are in close proximity to the alignment include: fiber optic, communication, irrigation, gas, overhead power, and storm drains. The pipeline alignment is designed to minimize utility crossings and excess excavation depths, while providing the pipeline separation requirements for potable water pipelines adjacent to raw water, recycled water, and sewer pipelines per DDW standards.

The following four tables (Table 4-2 through Table 4-5) list the existing utilities that are in close proximity to the alignment.

Table 4-2: Existing Water Utilities Near the Alignment

Utility Owner	Type	Size/Material	Proximity to 36-inch Raw Water/Return Water Pipeline	Proximity to 30-inch Potable Water Pipeline
LA County Waterworks District	Potable Water	12” Ductile Iron	30’ - 70’ from 76+00 to 130+75 Crosses at 76+00 Crosses at 130+75	
	Potable Water	6” Asbestos Cement	5’ - 60’ from 76+00 to 217+50 Crosses at 197+40 Crosses at 204+10 Crosses at 210+75	Crosses at 178+50
	Potable Water	Unknown		40’ from 158+00 to 171+00
	Potable Water	12” Asbestos Cement		Crosses at 172+00
	Potable Water	12” Steel	Crosses at 75+75	40’ – 60’ from 171+00 to 251+00 Crosses at 174+75 Crosses at 176+50 Crosses at 185+10 Crosses at 191+75 Crosses at 198+40 Crosses at 211+65 Crosses at 242+80 Crosses at 247+90 Crosses at 249+50 Crosses at 250+40
Littlerock Creek Irrigation District	Potable Water	12” PVC	45’ from 49+50 to 62+50	6’ from 50+25 to 63+00
LACSD	Recycled Water	48” HDPE	Crosses at 458+50	Crosses at 492+40
Palmdale Water District	Potable Water	20” Steel, breaks off into 6” D.I.P and 16” D.I.P		Crosses at 10+60 Crosses at 10+90 3.5’ – 7’ from 11+00 to 37+00 (where it crosses) Crosses at 24+50
Palmdale (City Public Works Department)	Sewer Water	15” Vitrified Clay		30’ – 40’ from 10+00 to 51+00

Notes: PVC = polyvinyl chloride; HDPE = high density polyethylene; D.I.P. = ductile iron pipe.

Table 4-3: Existing Communication Lines Near the Alignment

Name of Owner	Type	Proximity to 36-inch Raw Water/Return Water Pipeline	Proximity to 30-inch Potable Water Pipeline
AT&T	Communication	6' – 50' from 10+00 to 57+50; 55' from 69+50 to 71+25; Crosses at 24+25 Crosses at 144+25 Crosses at 157+50 Crosses at 164+50 Crosses at 171+10 Crosses at 190+65 Crosses at 217+40	Crosses at 36+90 Crosses at 90+50 Crosses at 159+00 Crosses at 172+50 Crosses at 198+75 Crosses at 205+25 60' – 80' from 198+75 to 214+15 5' from 237+50 to 239+40 (where it crosses) 45' from 239+40 to 250+40 Crosses at 245+25 Crosses at 248+75
Unknown	Communication	Crosses at 102+25 Crosses at 137+40 60' – 75' from 130+50 to 138+ 00 (where it crosses) Crosses at 190+50	
Time Warner Cable	Communication	Crosses at 191+25	
IXN Communications, Inc.	Fiber Optic Cable		20' – 75' from 10+00 to 251+75 Crosses at 244+10

Table 4-4: Existing Gas Lines Near the Alignment

Name of Owner	Size	Proximity to 36-inch Raw Water/Return Water Pipeline	Proximity to 30-inch Potable Water Pipeline	Notes
Southern California Gas	<4" Polyethylene	Crosses at 102+65 14' from 102+65 to 103+50 60' – 80' from 130+50 to138+00 Crosses at 138+00 Crosses at 144+75 9' – 20' from 144+75 to 165+25 Crosses at 151+35 Crosses at 157+60 Crosses at 164+40 Crosses at 171+00 Crosses at 177+60 Crosses at 184+20 17' from 184+20 to 191+10 (where it crosses)	19' from 165+00 to 172+25 (where it crosses) 35' – 65' from 213+90 to 244+60 Crosses at 224+10 Crosses at 224+40	There are approx. 0.85 – 1.5 ma running through gas lines on Ave. O and Ave. S Anodes located 600' west of 105th St. E and north of Ave. S at 106th St. E
Southern California Gas	30" High Pressure - 2	15' – 50' from 130+50 to137+50 Crosses at 130+25 Crosses at 137+90		
Southern California Gas	12" High Pressure	Crosses at 352+90		

Table 4-5: Existing SCE Overhead Power Lines Near the Alignment

Proximity to 36-inch Raw Water/Return Water Pipeline	Proximity to 30-inch Potable Water Pipeline
Crosses at 13+10	
40 – 80’ from 13+00 to79+75	
Crosses at 39+10	
Crosses at 62+60	
Crosses at 76+00	
Crosses at 82+75	6’ – 65’ from 10+00 to 251+90
Crosses at 89+00	Crosses at 92+05
Crosses at 96+10	Crosses at 164+90
36’ from 100+75 to 103+10	Crosses at 171+50
Crosses at 103+00	Crosses at 171+80
Crosses at 123+50	Crosses at 173+00
Crosses at 131+50	Crosses at 179+00
7’ – 30’ from 130+50 to 138+25 (where it crosses)	Crosses at 198+00
Crosses at 144+25	Crosses at 222+00
Crosses at 150+75	Crosses at 225+75
Crosses at 157+30	Crosses at 228+50
Crosses at 157+45	Crosses at 230+40
Crosses at 164+00	Crosses at 232+00
Crosses at 164+75	Crosses at 233+60
Crosses at 170+60	Crosses at 240+50
Crosses at 177+25	Crosses at 245+45
Crosses at 184+30	Crosses at 251+90
Crosses at 191+05	
8’ – 14’ from 203+70 to 204+50	
Crosses at 217+90	

4.4 Hydraulics

This section discusses hydraulics, including transmission pipelines and recharge basins.

4.4.1 Transmission Pipelines

Sizes for the proposed transmission pipelines are dependent on the design criteria presented in Section 4.1 and the head loss determined by the hydraulic analysis. The Hazen-Williams equation is used to calculate the head loss due to friction between the water and the pipeline since the volume of water travelling through the transmission pipelines constitutes full flow. Additionally, the minor head loss due to elbows, contractions, and other fittings are included, where appropriate. A summary of the hydraulic calculations to determine head loss is presented in Table 4-6.

The Raw Water/Return Water Pipeline from the East Branch of the California Aqueduct to the Pump Station Building is sized as a 36-inch diameter pipeline because a 30-inch diameter pipeline would have a hydraulic grade line (HGL) below the invert elevation of the pipeline at the

pump station at 50 cfs. This would have resulted in a negative pressure at the Pump Station Building, and the water would have been unable to flow by gravity. Upsizing the pipeline to 36-inch diameter provides less head loss over the flow range analyzed, 10 cfs to 50 cfs, which makes more head available for the hydro-turbine to convert to electricity. Due to the high head at the Pump Station Building under static and low flow (10 cfs) conditions, the pressure exceeding 160 pounds per square inch (psi) requires that the lower reach of the pipeline and associated appurtenances are rated for 250 psi working pressure. When retrun water is pumped back to the East Branch of the California Aqueduct at the maximum design capacity, the operating head at the Pump Station Building discharge will be approximately 500 feet or 216 psi. This falls within the 250 psi working pressure of the pipeline and appurtenances. As the pipeline moves uphill, away from the Pump Station Building, the static head and friction losses begin to reduce the operating pressure. Once the internal pressure drops below 135 psi (90% of 150 psi), the pipeline and appurtenances pressure rating also decrease to 150 psi. This transition point occurs approximately half way through the 8.6-mile pipeline. A surge analysis should be performed during final design to determine the level of surge allowance and the recommended control strategies. Due to the pipeline profile and head conditions, a 6,000 gallon surge tank has been assumed as the appropriate surge protection to be located at the Distribution Site.

Similar to the Raw Water/Return Water Pipeline, the Potable Water Pipeline is sized to minimize head loss since the water must be boosted to reach the 2800 Zone at the point of connection with the PWD's system. A 30-inch diameter pipeline allows for an acceptable head loss over the relatively long 9.2-mile transmission pipeline. Since the booster pumps have variable frequency drives, the motors can be slowed to reduce the pump output while maintaining sufficient head to meet the 2800 Zone requirement when lower flows are being pumped. Similar to the Raw Water/Return Water Pipeline, roughly half of the pipeline length will require Class 250 psi pipeline and appurtenances with the other half conventional Class 150 psi pipeline and appurtenances. A surge analysis should be performed during final design to determine the level of surge allowance and the recommended control strategies. Due to the pipeline profile and head conditions, no surge control beyond air/vacuum relief valves and PRV by-pass piping on the PWPS header have been included in this PDR.

The recycled water turnout in East Avenue M receives water from the LACSD Palmdale Water Reclamation Plant. Through the Palmdale Effluent Management System, recycled water is pumped to agricultural land via the Agricultural Pump Station operated by LACSD. When more water is produced than consumed by agriculture, the excess water is pumped through a 48-inch diameter pipeline to two 450-MG storage ponds by the Reservoir Influent Pump Station. When the agriculture demand exceeds the supply from the Agricultural Pump Station, the water supply is supplemented by the storage ponds via the Reservoir Effluent Pump Station (also operated by LACSD). The recycled water turnout at East Avenue M and 105th Street East has an anticipated net head of 44 feet when water is being pumped to the storage ponds and 18 feet when water is being pumped away from the storage ponds. The low head when the recycled water is being pumped from the storage ponds back to the agriculture land necessitates a larger diameter pipe to limit the head loss. A 30-inch diameter pipeline allows for only 2 feet of head loss during the pipeline's short run from the turnout to the Distribution Box.

The pipeline connecting the Distribution Box to the Splitter Box collects water from four potential sources:

1) 36-inch diameter Raw Water/Return Water Pipeline, after passing through the hydro-turbine or the pressure reducing valves.

2) 30-inch diameter Recycled Water Pipeline from the LACSD turnout.

3) 24-inch diameter Potable Water Pipeline from the Storage Tank overflow.

4) 16-inch diameter groundwater blow-off piping from the Recovery Wells.

The depth of the Distribution Box is dependent on the invert of the pipelines entering the box and the water level of the Splitter Box downstream. With an anticipated maximum flow of 72.2 cfs and a minimal slope of 0.2%, the pipeline is sized with a 48-inch diameter to limit head loss to six feet. This sizing allows the maximum flow without submerging the Recycled Water Pipeline or Raw Water/Return Water Pipeline entering the Distribution Box.

Table 4-6: Transmission Piping Hydraulic Calculations (Using Hazen-Williams)

Pipeline	Description	Length (ft)	Maximum Flow (cfs)	Begin Elevation (ft)	End Elevation (ft)	Pump Head (ft)	Recommended Pipe Size (in)	Velocity (fps)	Friction Head Loss (ft)	Minor Head Loss (ft)	End HGL (ft)
Raw Water/Return Water	Aqueduct to Pump Station	45,200	50	2939	2554	0	36	7.1	165	18	2756
	Pump Station to Aqueduct	45,200	41.4	2550	2943	526	36	5.8	119	14	2943
Potable Water	Pump Station to PWD POC (Phase 1)	48,600	26.2	2567	2624	369	30	5.3	130	6	2800
	Pump Station to PWD POC (Phase 2)	48,600	33.4	2567	2624	445	30	6.8	204	8	2800
Recycled Water	POC to Distribution Box (RIPs to Ponds)	530	22.2	2586	2541	0	30	4.5	1	1	2584
	POC to Distribution Box (Ponds to RIPs)	530	22.2	2560	2541	0	30	4.5	1	1	2558
Combined Recharge Supply	Distribution Box to Splitter Box	3,000	72	2541	2535	0	48	5.8	5	1	2535

Notes: RIPS = LACSD Reservoir Influent Pump Station; ft = feet or feet above mean sea level

4.4.2 Recharge Basins

The Splitter Box has four chambers that receive water and allow it to flow by gravity to each of four respective recharge basins. There are weirs 4 feet off the floor at the entrance to each chamber to control the split of flow delivered to each basin. From the Distribution Box, water flows into the Splitter Box, over the weirs, out the chamber(s) with opened sluice gates, and into the recharge basins. The weirs are 11 feet in length, which require a water depth of 1.0 feet over the weir in order to deliver 36.1 cfs into one chamber. This configuration provides sufficient hydraulic capacity to allow only two basins to be recharging simultaneously during the total peak flow of 72.2 cfs; although more than two basins can also be used simultaneously.

When water enters the Splitter Box, the number of open sluice gates dictates how the flow will split: one, two, three, or four open sluice gates allow delivery of 100, 50, 33, or 25 percent of the flow. Normal operation will deliver water to one or two basins. The chambers connected to out-of-service basins will remain flooded so the sluice gates must remain closed. The design is for in-service or out-of-service; not for throttling flow. Once the water enters any of the 36-inch diameter pipelines to flow into the corresponding recharge basin, the pipelines will flow partially full; therefore, Manning's Equation is used in the analysis. Table 4-7 details the hydraulic calculations for three flow scenarios: low, medium, and high. The low flow scenario assumes only recycled water from LACSD is being recharged, with no diluent supply since the recycled water content requirement can be met over a 120-month running average. The high flow scenario assumes both recycled water from LACSD and raw water from the East Branch of the California Aqueduct are being recharged. The ending water surface level is assumed to be 3 feet above the pipeline invert, since at 3.5 feet in Basins 1, 2, and 3 the water will begin overflowing to the downstream recharge basin. Basin 1 shows an ending hydraulic grade line lower than the ending water surface level, implying the water is be unable to reach the desired ending water surface level; however, in this circumstance the water level will increase in the splitter box which allows the desired water level in Basin 1 to be reached. Basin 4 has only an Emergency Spillway leading to the ground at 4.0 feet of depth, so the sluice gate for Basin 4 (only) will be equipped with a motor operator tied to a float switch in Basin 4; such that flow to Basin 4 will be shut off at a pre-determined depth (such as 3.0 feet). Although alarms will be sent by SCADA, once the sluice gate to Basin 4 is closed, all flow will be directed to any other open sluice gates. If all other chambers have closed sluice gates, then the Splitter Box emergency weir will discharge all flow (up to 72.2 cfs) to Basin 1.

Table 4-7: Recharge Basin Piping Hydraulic Calculations (Using Manning's)

Basin	Length (ft)	Slope (ft/ft)	Flow (cfs)	Begin WSL (ft)	End WSL (ft)	Velocity (fps)	Ratio Full (-)	End HGL (ft)
Basin 1	240	0.0143	4	2530.3	2529.42	5.9	0.10	2529.2
			20	2532.1	2529.42	9.4	0.30	2529.0
			36.1	2533.3	2529.42	11.0	0.46	2528.7
Basin 2	740	0.0074	4	2530.3	2527.47	4.7	0.12	2529.6
			20	2532.1	2527.47	7.4	0.38	2529.7
			36.1	2533.3	2527.47	8.6	0.60	2528.8
Basin 3	1230	0.0060	4	2530.3	2525.52	4.3	0.13	2529.7
			20	2532.1	2525.52	6.9	0.41	2529.5

Basin	Length (ft)	Slope (ft/ft)	Flow (cfs)	Begin WSL (ft)	End WSL (ft)	Velocity (fps)	Ratio Full (-)	End HGL (ft)
			36.1	2533.3	2525.52	7.9	0.65	2527.7
Basin 4	1730	0.0054	4	2530.3	2523.54	4.2	0.14	2529.7
			20	2532.1	2523.54	6.6	0.43	2529.1
			36.1	2533.3	2523.54	7.6	0.67	2526.4

4.5 Easements

While the Raw Water/Return Water and Potable Water Pipelines are designed to be within County of Los Angeles and City of Palmdale right-of-ways, some portions of the alignment do not have right-of-way obtained by these agencies. Temporary and permanent easements are required where construction or construction-related activities cannot be conducted in the public right-of-way. Table 4-8 lists the easements PWD is required to obtain for the alignment of the transmission pipelines.

Ten of the forty easements are on existing roadways that have right-of-way granted around the property. Six of these properties are on 106th Street East, three are on 105th Street East, and one is on East Palmdale Boulevard. It appears that the County of Los Angeles should have obtained the right-of-way when the road was originally constructed, but that did not occur. Palmdale Water District should notify the County of Los Angeles of the ten parcels that do not have a dedicated right-of-way.

The remaining thirty easements along the future 105th Street East will need to be acquired by PWD. Assuming a right-of-way width of 40 feet, the calculated easement areas are presented in Table 4-8. When excluding the ten properties that the County of Los Angeles may obtain for right-of-way dedication, the total area that PWD needs to obtain for transmission pipeline easements is 905,860 square feet.

Table 4-8: Transmission Pipeline Easements Required

Number	Assessor Parcel Number	Owner	Area (sq ft)
1*	3046-029-016*	Mariamma G. Thomas*	33,008*
2*	3044-019-011*	Peter Darmanian*	36,492*
3*	3044-032-004*	Hee T. & Sunha S. Chae*	9,068*
4*	3044-032-003*	Carol A. Byrne & Pauline Elders*	8,937*
5*	3044-032-002*	Romeo Bundalian*	9,318*
6*	3044-032-001*	Irene Jones*	7,908*
7*	3027-025-032*	Douglas F. Crawford*	11,849*
8*	3027-026-056*	Daniel Martinez*	9,111*
9*	3027-026-041*	Napoleon & Marion Avery*	10,007*
10	3027-001-032	Marilouise J. Huff	5,331
11	3028-016-008	Chamroeun Theam & Tola Kim	53,449
12	3028-016-007	Grand Palm LLC & Hypericum Land Company LLC	53,455
13	3028-015-031	IRA Services Cstdn Mihn V. Nguyen IRA Services Cstdn A. Stouffer	26,731
14	3028-015-030	P&Q Properties	26,728
15	3028-015-012	Filemon M. & Byeongran S. Reyes	51,905
16	3028-008-002	Stephen M. Davis	106,228
17	3028-008-017	Sustainable Property Holdings	53,434
18	3028-008-015	Sustainable Property Holdings	51,495
19	3077-009-044	Sharol Sperling	44,785
20	3077-009-043	Sharol Sperling	6,599
21	3077-009-042	Walter A. & Janius N Stempien & Velur Land Investments Inc.	13,365
22	3077-009-033	Kiroko Hubota & Hiroko Kubota	26,743
23	3077-009-025	Hiroshi & Nobuko Urata	13,363
24	3077-008-018	Olegario & Eulinia F. Remarata & Napoleon & Rizalina F. Felix	26,726
25	3077-008-028	Mark W. & Kristie R. Wakefield & Velur Land Investments Inc.	13,364
26	3077-008-029	Patricia B. Paige Trust	13,359
27	3077-008-004	Elizabeth M. Bartolomea, Et Al.	26,720
28	3077-008-003	Andy H. Tran	25,520
29	3380-013-001	Lan Yu Hui C Y Lan Wu Mike Wu Family Trust	105,210
30	3380-012-015	Thomas R. & Bennet R. Angrews	13,588
31	3380-012-014	Shemarya Family Trust	13,448

Number	Assessor Parcel Number	Owner	Area (sq ft)
32	3380-012-005	Bonnie Peterson	13,449
33	3380-012-004	Belta P. Kalajian	13,422
34	3380-011-031	Dolores M. Fuller & Mary A. Inga	13,479
35	3380-011-030	5316 Maywood LLC	13,479
36	3380-011-021	Jones Korn Properties LLC	13,488
37	3380-011-020	Hak N. & Mee T. Wong	11,464
38	3378-015-022	Joseph & Susan Guarrera	28,041
39	3378-015-021	An Cao	27,492
40*	3027-010-030*	Nasser & Hellen Charchian, Et. Al.*	2,063*
		Total	**1,043,621**
		Total, excluding right-of-way that should be obtained by the County of Los Angeles	**905,860**

(a) * Denotes easements that should be obtained by County of Los Angeles for right-of-way in existing roadways; sq ft = square feet

4.6 Sensitive Receptors

The proposed pipelines are located in a substantially sparse area, allowing construction activities to have minimal impact on adjacent sensitive receptors. Sensitive receptors include, but are not limited to, hospitals, schools, daycare facilities, elderly housing and convalescent facilities[1]. These are areas where the occupants are more susceptible to the adverse effects of exposure to air pollutants, such as dust. Noise sensitive receptors are subject to stress and/or the interference of excessive noise including those areas listed for sensitive receptors, as well as residential areas.

Table 4-9 lists sensitive receptors that may be affected by the construction of the pipelines. The sensitive receptors will be notified of the construction timeframe, working hours, road closures, and any other information regarding the construction. Traffic control plans will be submitted by the contractor to the agency with jurisdiction (City of Palmdale or Los Angeles County) for review and acceptance. The most susceptible sensitive receptor will be Daisy Gibson Elementary school, as it is within 100 feet of the Potable Water Pipeline. Hence, extra safety measures will be taken while construction activities are near the school.

Table 4-9: List of Sensitive Receptors

Sensitive Receptor	Type	Distance to Pipeline (ft)
Daisy Gibson Elementary School	School	100
Jehovah's Witnesses of Littlerock	Church	160
Westport Home (Assisted Living Facility)	Assisted Living	840
Carroll Manor Residential Care	Assisted Living	920
Littlerock High School	School	1,850
Livingstone Cathedral of Worship	Church	2,900
Antelope Elementary School	School	2,960
Golden Poppy Elementary School	School	3,590
Los Amigos School	School	5,390
William J Pete Knight High School	School	5,650
Keppel Academy	School	6,920
Living in Christ Faith Ministry	Church	7,130
Quail Valley Elementary School	School	7,710
Pear Blossom Pumping Plant	Pumping Plant	7,970
Dimel Palace Board-Care Facility	Assisted Living	8,030
Buena Vista Elementary School	School	9,980
South Valley Primary Care	Hospital	10,300
Kaiser Permanente Medical Care	Hospital	11,250

In addition to the sensitive receptors listed in Table 4-9, noise sensitive receptors include residential areas. Both the Raw Water/Return Water Pipeline and Potable Water Pipeline run south from East Avenue M to East Palmdale Boulevard, where they then split. The 30-inch diameter Potable Water Pipeline then runs west until reaching 60th Street, while the 36-inch

[1] http://www.epa.gov/region1/eco/uep/sensitivereceptors.html

diameter Raw Water/Return Water Pipeline continues south until reaching the East Branch of the California Aqueduct. While the two pipelines run adjacent to each other, there is a small residential area located approximately 950 feet west of the alignment along E Avenue M-8. After splitting, there are residential areas as close as 30 feet to the edge of roadway.

4.7 Materials

Pipe materials, including steel pipe and ductile iron pipe, were initially considered because of the availability, durability, and ease of construction. Both materials can meet the system pressure requirements, and both can be cathodically protected. The main differences in the two pipe options are the pipe joints and cost. Ductile iron is put together with gaskets at each joint. Steel pipe can be either fully welded or have gaskets at the joints.

Gasket joints may eventually leak over time due to pipe movement caused by earthquakes, material impurities, age, and poor installation (rolled gaskets); however, gasket joints are faster and cheaper to install. Welded joints require more installation time and larger excavation quantities if the pipe joint is welded externally, but pipes with welded joints offer thrust restraint and are less susceptible to leakage.

Generally, in pipe sizes above approximately 24-inch diameter, steel pipe is typically lower in cost. Since the 30-inch diameter Potable Water Pipeline is 9.24 miles long and the 36-inch diameter Raw Water/Return Water Pipeline is 8.6 miles long, the cost difference between steel pipe and ductile iron will be significant. Steel pipe conforming to American Water Works Association (AWWA) C200 requirements is recommended. In order to reduce overall pipe cost, straight long runs can be installed with gasket joints, while angles can be installed as welded pipe.

The steel pipe should also be cement mortar lined and coated to protect the pipeline from corrosion. Soil conditions are anticipated to be mildly corrosive. More information regarding the corrosion of the transmission pipelines is in Section 4.9.

4.8 Existing Soil Conditions

Existing soil conditions are important to understand during the design of pipelines for two reasons: 1) to determine the soil corrosivity and 2) to determine if existing soils are suitable for pipeline support and backfill. Soil investigations were not performed as a part of the preliminary design phase, but will be performed in the final design phase.

The County of Los Angeles and City of Palmdale were contacted during a search for existing soils reports. This search, known colloquially as a desktop investigation, did not result in the identification of any reports near the pipeline alignment. Both the County and City were unable to locate geotechnical investigations along the pipeline alignments.

Previous experience with soils near the 36-inch diameter Raw Water/Return Water Pipeline alignment has shown the soils to be moderately corrosive. As such, this report assumes the soils will be moderately corrosive. Soils are also assumed to be sandy, but suitable for backfill. Once soil investigations for the pipeline alignments are completed, the corrosivity and pipeline bedding/backfilling recommendations can be finalized.

4.9 Corrosion

Cathodic protection is dependent on soil in contact with a pipeline. As described previously, geotechnical investigations were not performed as part of the scope services, but will be performed as part of the final design. To determine soil corrosivity, soil samples will be tested for:

- pH
- Resistivity
- Chlorides

However, three previous geotechnical investigations were performed for the AVEK Water Agency – Eastside Groundwater Banking and Extraction Project. For the AVEK Eastside Project, soil samples were taken from various locations including a section of pipe that crosses the Raw Water/Return Water Pipeline. Investigations have shown a pH range of 7.4 – 8.1, a soluble sulfate range of 4.6 – 307 parts per million (ppm) (considered "negligible"), a soluble chloride range of 1.2 – 33 ppm, and a saturated resistivity range of 1,400 – 4,400 Ohm-cm. The investigation results indicate "Moderately Corrosive" soils.

The pipelines will be protected against moderately corrosive soils through the cement mortar coating, bonding rubber ring joints for electrical conductivity, and installation of test leads (test stations) at set intervals, typically every 1,500 feet. Additional protection may be required if stray current are present, such as from active Cathodic protection systems (i.e., for the gas pipelines described below). If corrosive soils are found within the area, then a recommended 10 feet of separation between the project pipeline and any cathodically protected lines will be implemented. However, a minimum of 5 feet of separation will be implemented at isolated close points to avoid stray currents from protected lines, given the resistivity of the anticipated silty-sand soil conditions.

A Cathodic Protection Survey should be performed during detailed design to evaluate stray currents and soil conditions. If corrosive soils or stray currents are found during investigation, then appropriate cathodic protection can be implemented. Typical corrosion protection includes installing galvanic anodes or impressed current.

Southern California Gas has two 30-inch diameter high pressure distribution lines that are parallel to the alignment (east-west) along East Avenue S between 105th Street East and 106th Street East. There are approximately 0.85 to 1.5 milliamps of current running on both lines. Discussions with Southern California Gas indicate that these pipelines are protected by galvanic anodes, and that the anodes are located on the North side of East Avenue S, approximately 600 feet west of 105th Street East. One possibility to protect the project pipelines is to install galvanic anodes to each end of the portion that runs parallel to the gas line, where a test station is to be set up.

In addition, Southern California Gas has a 12-inch diameter high pressure distribution line that crosses the Potable Water Pipeline and Raw Water/Return Water Pipeline alignments at the

intersection of East Avenue O and 105th Street East. There is also approximately 0.85 to 1.50 milliamps running on this line.

If cathodic protection of the Potable Water Pipeline and Raw Water/Return Water Pipeline is required in the vicinity of the high pressure distribution lines, then further cathodic protection options will be analyzed by a corrosion engineer.

4.10 Appurtenances

Appurtenances are necessary for pipeline protection and maintenance. The following pipeline appurtenances are recommended:

- Cathodic test stations will be incorporated into the design if the geotechnical investigation indicates soils are moderately corrosive to corrosive.

- Butterfly line valves will be installed at approximately every 10,000 feet in accordance with PWD standards. The valves will be rated for 150 psi where pressures are less than150 psi near the Aqueduct, and 250 psi where pressure is greater than 150 psi near the Distribution Site. Valve boxes and covers will be included.

- Air and vacuum release valves, a minimum of 4-inches in diameter, will be located at high points in the pipeline and at line valve locations. PWD standard air and vacuum valves are not applicable to this size of pipeline; therefore, site-specific air and vacuum release valves will be provided in final design.

- Blow offs will be located at low points of the pipeline and at line valve locations. Minimum size of blow offs are 8-inches. Site-specific air and vacuum release valves will be provided in final design.

- Flexible couplings with harness assemblies will be provided at jack and bore locations (i.e. railroad crossing) to allow for potential pipe movement. They may also be required at fault locations, if they are determined to exist as shown in the final geotechnical investigation.

- Manways will be placed adjacent to Butterfly Line Valves at approximately 10,000 foot maximum spacing to provide PWD staff access to the pipeline for inspection and maintenance.

- Pipe bedding, testing, and water line identification will be in accordance with PWD standards.

- Metering of flow will be at the Aqueduct turnout and the discharge of the Return Water Pump Station.

- A sluice gate with stop logs to allow for maintenance of the sluice gate will be provided at the SWP Turnout.

4.11 Construction Methods

This section describes the construction methods to be used during pipeline construction.

4.11.1 Open Cut Construction

Trenching, also known as cut and cover construction, is the most common method of pipeline installation due to its inexpensive cost and lack of sophisticated equipment required. Open trench construction is specified along the majority of the pipeline alignment, while trenchless construction, such as jack and bore, is required at certain crossings, such as the railroad. Trenchless installation may be required at other locations depending on pothole information obtained during final design.

4.11.2 Jack and Bore Construction

In areas where inadequate cover between the ground surface and a utility exists, traffic interruption is required to be minimized, or cut and cover construction cannot be utilized without extensive permitting and restrictions, jack and bore construction procedures, also known as horizontal auger boring will be utilized. This trenchless construction method is commonly used for crossing railroad, roadways, road embankments, flood control channels, storm sewers, and sanitary sewers, and it is an economical method that can be used under various soil conditions. Jack and bore construction is recommended for the railroad crossing. All construction procedures will abide by the most stringent requirements noted within Los Angeles County, Union Pacific Railroad, and PWD standards.

Jacking and boring is accomplished with an Auger Boring Machine (ABM). The ABM jacks a steel casing pipe through the earth and simultaneously removes earth spoils by means of a rotating auger armed with helical flights within the casing. The basic components of a horizontal auger boring system include the base unit, casing pusher, power pack, auger sections, track, and track extensions. In addition, various cutting drill bits are available for different soil conditions.

The typical jack and bore installation begins with the excavation of jacking and receiving pits at the beginning and end of the proposed trenchless section. Typical jacking pit dimensions for pipelines such as this are roughly 12 feet in width by 40 feet in length. Receiving pit dimensions are smaller at roughly 10 feet in width by 10 feet in length. Jacking pits are significantly larger to account for the ABM, which must brace itself against the back wall of the shaft. The bottom of the bore shaft is usually over-excavated and backfilled with crushed stone in order to provide adequate support for the equipment.

Welded steel pipe is used for the casing in order to prevent potential damage caused by the rotating augers and any corrosive soils. After successful installation of the casing pipe, the carrier pipe can be installed. Carrier pipe is installed by attaching casing spacers to the outer diameter of the pipe prior to insertion, which will keep the carrier pipe centered within the casing.

Permalok, an alternative steel casing pipe material, should be considered by PWD as an alternative during the bid phase. This steel pipe has a machine press-fit connection that locks

the joint. This type of pipe/joint is typically more expensive. However, welding costs are eliminated and construction duration is reduced. Allowing Permalok will let bidders determine the least costly material and construction method to use.

A casing size of 48 inches is anticipated to be sufficient to carry the 36-inch diameter Raw Water/Return Water Pipeline through the railroad under crossing. A jack and bore may also be required where the Raw Water/Return Water Pipeline crosses East Palmdale Boulevard at 105th Street East, should Los Angeles County not allow the closure of East Palmdale Boulevard for open cut installation.

4.11.3 Justification for Jack and Bore Technique

Micro-tunnel (MTBM) and horizontal directional drilling (HDD) techniques are potential alternatives to jack and bore, but are best utilized in applications where the required bores are longer and more cost efficient for large trenchless projects. MTBM is typically used for installing pipes where a high accuracy in line and grade is required. One of the common problems with the HDD technique is the slurry (drilling fluid) seepage into the surrounding formation that can potentially cause a frac-out (a fracture between the horizontal bore and the earth's surface). These techniques are significantly more expensive than jack and bore construction and are not conducive to the installation required in this project.

In addition to costs, MTBM and HDD require considerably more space for equipment staging areas. Each of these construction methods can require up to 2 acres, possibly much more for HDD, for equipment and pipe layout. Additional temporary or construction easements would be required to accommodate these needs.

4.12 Construction Staging

Construction staging, or the temporary storage of equipment and materials, is anticipated to be adjacent to the pipeline alignment. Materials will be delivered to the Distribution Site, and the pipeline contractor will move the materials to the installation area when needed. Materials must be stored in accordance to the requirements outlined in the Environmental Impact Report (EIR). Overnight storage of equipment adjacent to the pipeline installation work may occur if permitted by the County of Los Angeles or the City of Palmdale.

Staging and laydown for work at the turnout will be at the turnout construction area, as described in Section 4.14. This laydown area must be approved by the DWR as the area is within the DWR right-of-way.

4.13 Traffic Control

Traffic control plans are required to be submitted to the County of Los Angeles and the City of Palmdale for work related to the pipeline installation. While some portions of the alignment are in lightly-travelled areas, other portions of the alignment are in heavily-travelled corridors. Vehicle trip counts were not performed as a part of this conceptual design. Estimates as to what constitutes a lightly versus heavily-travelled corridor are based on site visits.

The 36-inch diameter Raw Water/Return Water Pipeline spans a sparsely-travelled area outside the edge of pavement from the SWP Turnout to East Avenue S. This construction will have minimal impacts to the traffic. The 36-inch diameter Raw Water/Return Water Pipeline and 30-inch diameter Potable Water Pipeline are not in traffic areas along 105th Street East, north of East Palmdale Boulevard, because 105th Street East has not been constructed for this section. Therefore, traffic impacts will be zero for this stretch of the alignment.

However, traffic in East Palmdale Boulevard appears to be high in volume and high in speed. This stretch of the road passes through both City and County jurisdiction, so traffic control plans need to be submitted for approval from the appropriate agency. While the 30-inch diameter Potable Water Pipeline alignment is outside the edge of pavement for the majority of the distance, there are numerous street crossings at intersections. Additionally, the 30-inch diameter Potable Water Pipeline crosses East Palmdale Boulevard two times and the 36-inch diameter Raw Water/Return Water Pipeline crosses the road one time. While it is more cost effective to install the pipeline at night with a cut and cover method, this requires approval from the City or County, along with approved traffic control plans. Even with submittal of traffic control plans, the City or County may not permit this construction, which would necessitate a trenchless installation method.

4.14 SWP Turnout

A new turnout on the East Branch of the California Aqueduct is needed to deliver raw water from or back into the canal (SWP Turnout). Typically turnout siphons are used for low delivery volumes under 20 cfs. Since the Project requires a 50 cfs turnout, the structure will be cut into the side wall of the Aqueduct. The turnout is modelled after another 50 cfs turnout proposed in the City of Palmdale. The layout of the SWP Turnout is detailed in Drawing C41 in Volume 2.

Once the conceptual design of the SWP Turnout is complete, this must be submitted to DWR as a component of the Turnout Authorization and Acceptance Procedures. DWR will review the documents for four to six weeks, which may require additional submittals to address DWR comments. DWR must also approve the final drawings and specifications before the Project enters construction. While in construction, all submittals, construction schedules, environmental reviews, and other related items must be submitted to DWR. The DWR “Overview of Turnout Authorization and Acceptance Procedures” is included in Appendix A.

4.14.1 Aqueduct Operating Levels

The depth of the SWP Turnout structure is dependent on the design water levels. In a conversation with Scott Hunt with DWR on 30 June 2015, water levels at the Pearblossom Pump Station and a control point upstream of the Project’s turnout were provided. This information is listed in Table 4-10. DWR provided the approximate Mile Post for the Project turnout and stated the elevations at the Pearblossom Pump Station can be linearly interpolated back to the Project turnout.

Table 4-10: Aqueduct Elevations

	Pearblossom Pump Station (NAVD26)	Control Point (NAVD26)	Project Turnout (NAVD26 / NAVD88)

	Pearblossom Pump Station (NAVD26)	Control Point (NAVD26)	Project Turnout (NAVD26 / NAVD88)
Mile Post	360.6	356.9	358.75
Top of Liner (ft)	2941.0	2942.3	2941.65[a] / 2944.75[b]
Normal Maximum (ft)	2939.0	-	2939.65[a] / 2942.75[b]
Normal Minimum (ft)	2936.4	-	2937.05[a] / 2940.15[b]
Absolute Minimum (ft)	2935.0	-	2935.65[a] / 2938.75[b]

(a) Value linearly interpolated
(b) NAVD26 to NAVD88 correction factor of +3.1 ft

The elevations provided by DWR are in the North American Vertical Datum 1926 (NAVD26), while the current vertical datum is the North American Vertical Datum 1988 (NAVD88). To convert the elevation from NAVD26 to NAVD88, the USGS has a website named "VERTCON." After entering the latitude and longitude for the project site, the suggested vertical shift is +2.8 feet. However, AESI compared two monuments near the turnout, surveyed on both datums, and determined the appropriate shift is +3.1 feet. Therefore, the NAVD88 elevations in the table reflect a +3.1 foot correction factor.

4.14.2 SWP Turnout Components

The SWP Turnout is a cutout from the Aqueduct slopped side. The clear width of the turnout is 7 feet and the depth from the top of the liner is approximately 12 feet. Since the overall depth of the Aqueduct is 15.67 feet, the turnout structure is nearly at the bottom of the Aqueduct.

Water enters the turnout as it travels along the Aqueduct, passing first through a trash rack before passing through the motor operated sluice gate. The motorized sluice gate is anticipated to remain fully open during operations, not partially open to modulate flow. If the sluice gate requires maintenance, then stop log guides are provided to allow PWD to stop the water flow temporarily.

The 36-inch diameter Raw Water/Return Water Pipeline slightly protrudes from the wall of the turnout into the Aqueduct. The invert of the pipeline is set at 3924.00-feet to allow for 4.75-feet of headwater on top from the invert of the pipe when measured from the absolute minimum water level. Only 4-feet of headwater depth is required for 50 cfs to enter the pipe when the pipeline is hydraulically under inlet control. While it is unlikely the Project will be withdrawing 50 cfs of flow when the Aqueduct is operating at its absolute minimum water elevation, this depth provides PWD with operational flexibility should PWD elect to withdraw more than 50 cfs, which would require a larger headwater depth.

After entering the pipeline, the water travels to the meter vault. The meter vault is located on DWR right-of-way, as required by DWR. The vault will house a bi-directional magnetic meter since water will be withdrawn from the Aqueduct in years of surplus and pumped back in years of deficit. For isolation of the meter, a motorized shut-off valve will also be housed within the meter vault. Power for the meter, valve, and other vault appurtenances will be provided from existing power poles along the west side of 106th Street East.

Flow control for the raw water delivery is accomplished downstream in the Turbine Room using the two nozzles at the turbine when the turbine is in service, and using the two 16-inch diameter PRVs with electronic actuated rate of flow control when the turbine is being by-passed.

4.14.3 Construction Method

Construction of the SWP Turnout will require installation of a cofferdam. This structure allows the Aqueduct to remain in service while dewatering a section for construction of the new turnout. Water must be pumped out from inside the cofferdam, with the water preferably deposited back into the Aqueduct. If DWR does not allow the water to be put back into the Aqueduct, then the contractor will have to arrange for disposal of the water.

Existing portions of the 4-inch concrete liner must be removed during excavation of the turnout. The concrete will be replaced once the turnout is complete. A representative from DWR will likely be onsite during construction activities for observation. Construction is anticipated to block access to the primary access road on the north side of the Aqueduct. The secondary access road to the south of the Aqueduct will remain open and unobstructed throughout the construction. If DWR requires the primary access road to remain in service, then the contractor will work with DWR to ensure the road remains accessible to DWR's satisfaction.

The contractor's laydown area is planned to be on the north side of the primary access road, between the edge of roadway and the fence line. It is anticipated the laydown area will be 200-feet long by 50-feet wide and will not impinge into the primary access roadway path. The contractor will clear and grub the laydown area. Minor grading may be required to level out the pad; however, this grading will occur at least 30-feet from the edge of the Aqueduct.

4.15 60th Street East Point of Connection

The 30-inch diameter Potable Water Pipeline will connect to an existing steel pipeline owned by PWD in the intersection of 60th Street East and East Palmdale Boulevard. The pressure zone at the point of connection is the 2800-foot zone. The point of connection is at an existing cross fitting, with a 20-inch diameter to the east and west and a 16-inch diameter to the north and south. Existing pipelines are connected to the west, south, and east of the cross. The pipeline to the east is abandoned and heavily corroded. The north side of the cross is blind flanged.

The new 30-inch diameter Potable Water Pipeline will connect to the east of the cross fitting. In order to accomplish this, 150 linear feet of abandoned steel pipe will be removed. The 30-inch diameter Potable Water Pipeline will be reduced down to 20-inch by two reducers in series, a 30-inch by 24-inch and a 24-inch by 20-inch, separated by 10 linear feet. At the point of connection on the east side of the existing cross, an insulating flange kit will be installed to prevent electrical current exchange between the new and existing pipelines.

4.16 Railroad Crossing

In order to cross the Union Pacific Railroad in accordance with their non-flammable pipeline crossing requirements, a jack and bore will be required. This will allow the railroad to remain in service during the pipeline installation. Additionally, a casing is required to carry the proposed water pipeline.

Following the requirements in the non-flammable pipeline crossing, a 48-inch diameter steel casing will contain the 36-inch diameter pipeline. A minimum of 4.5-feet of soil cover over the top of the casing is required below the railroad tracks and a minimum of 3-feet of cover over the top of the casing below the ground surface west of the railroad. The casing will extend 35-feet (2D + 20-feet) from the centerline of the railroad in each direction, where D is considered the distance between the subgrade and the bottom of the casing. The value for D is assumed to be 7.5-feet. In addition, the casing will extend 5-feet beyond the slope of the roadbed, measured from the bottom of the casing.

Implementing the pipeline and casing under the railroad will require a jack and bore process with a 10-foot by 10-foot receiving pit to the west of the railroad and a 40-foot by 12-foot jacking pit to the east of the railroad. Further description of the jack and bore process is described in Section 4.11.

4.17 Littlerock Wash Crossing

Littlerock Wash is an ephemeral creek that is susceptible to flooding, especially during the months of February and March. When the wash floods, water flows from the south to the north and overtops East Palmdale Boulevard. The road is then closed to traffic and reopened once the floodwaters recede. Several decades ago, stormwater would cause this section of roadway to frequently wash out. To remedy the situation, the County of Los Angeles Road Maintenance Division installed rip-rap on north of the road to avoid scour. The Road Maintenance Division also believes that due to the frequency of washout, the existing roadway was likely reconstructed with a concrete base. However, there are no design or record drawings of the road reconstruction or the rip-rap installation.

The 30-inch diameter Potable Water Pipeline crosses the wash along Palmdale Boulevard. To avoid placing the pipeline in the area of scour, the pipeline alignment moves to the south side of the road. This move places the pipeline upstream of the scour. The Potable Water Pipeline may be concrete encased, either completely or just the top half of the pipeline, to protect it from water scour damage should the roadway wash out again. This decision will be determined during final design.

The FEMA Flood Plain map for the area was consulted to ensure that the pipeline along the south side of East Palmdale Boulevard is outside the extents of the 100-year storm event flood limits. The Potable Water Pipeline alignment runs on the south side of the roadway for approximately 7,000 linear feet, which requires two additional crossings of East Palmdale Boulevard. A cut and cover construction method is preferred at these two crossing, but the County of Los Angeles will determine roadway crossing requirements.

Section 5: Hydro-turbine & Pressure Reducing Valves

This section describes the hydro-turbine and PRVs, including project power generation and an economic analysis defining the average annual savings over a wide range of operating conditions.

5.1 Design Criteria

Hydropower is widely used across the United States and constitutes approximately 7% of all electricity generated power[2]. Within the United States, California is one of the largest producers of hydropower, boasting 16,468 gigawatt-hours of electricity generated in 2014[3].

In order to determine and maximize electricity output at a hydropower facility, as well as classify the facility as large (>30 megawatt [MW]), small (<30 MW), mini (<1 MW), or micro (<100 kilowatt [kW]), the expected flow and net head available for the system must be considered. Table 5-1 outlines the average flow and net head conditions for the 36-inch diameter Raw Water/Return Water Pipeline, running approximately 8.6 miles, which will be used for approximately 6 years out of 10 when SWP Water is delivered from the East Branch of the California Aqueduct to the Recharge Site. The Hazen-Williams equation is used to calculate head losses due to friction (hf) using a C-value of 135, design flows (Q) ranging from 10 to 50 cfs, and a hydraulic pipe diameter of 36 inches. The brake horsepower equation is used to calculate the potential power output (kW), with design flows from 10 to 50 cfs and an estimated efficiency of 85%.

As can be seen in Table 5-1, the range in electricity production is 268 to 780 kW with the maximum production occurring at 44 cfs. Electricity production drops off at flows higher than 44 cfs due to greater head loss, with the potential production of 758 kW at 50 cfs. Given the wide range in flow, a 2-nozzle turgo impulse turbine was selected preliminarily with an operating range of 10 to 40 cfs. Any flows under 10 cfs or over 40 cfs will be bypassed through either one or two 16-inch diameter pressure reducing valves with the turbine in standby. Hence, the estimated maximum production is 770 kW of electricity. Given that the maximum electricity production is less than 1 MW, the application is referred to as a “mini hydropower” facility.

Table 5-1: Average Flow and Net Head Ranges Available for the PRGRRP and the Percentage of Time that Each will Occur

Q (gpm)	Q (cfs)	Hf (ft)	Net Head (ft)	HP	kW	% Time
4,500	10.0	8.6	371.4	358.7	268	2
4,900	10.9	10.1	369.9	389.1	290	
>4,900	>10.9					8
5,400	12.1	12.1	367.9	426.4	318	
>5,400	>12.2					10
6,600	14.7	17.5	362.5	513.5	383	
>6,600	>14.7					20
8,900	19.9	30.5	349.5	667.7	498	

[2] http://water.usgs.gov/edu/wuhy.html
[3] http://www.energyalmanac.ca.gov/renewables/hydro/

Q (gpm)	Q (cfs)	Hf (ft)	Net Head (ft)	HP	kW	% Time
>8,900	>19.9					15
11,000	24.6	45.2	334.8	790.6	590	
>11,000	>24.6					10
13,400	29.9	65.1	314.9	905.8	676	
>13,400	>29.9					10
15,600	34.8	86.2	293.8	983.7	734	
>15,600	>34.8					10
16,800	37.5	98.9	281.1	1013.6	756	
>16,800	>37.5					10
17,900	40.0	111.3	268.7	1032.6	770	
>17,900	>40.0					5
19,700	44.0	132.9	247.1	1045.1	780	
22,400	50.0	168.5	211.5	1016.8	758	

In addition to bypassing low and high flows, the pressure reducing valves are used when the turbine is offline for repairs or maintenance. Based on the Cla-Val product data, two 16-inch diameter pressure reducing valves can combine to meet the maximum flow condition of 50 cfs.

5.2 Turbine Description

There are two main types of turbines, reaction turbines and impulse turbines, and each is operated based on the amount of flow and head in the system. High, medium, and low head are considered to be 100 meters and above, 30 to 100 meters, and 2 to 30 meters, respectively. Reaction turbines are generally used for low head and high flow conditions, whereas impulse turbines are often used for high head and low flow conditions.

Impulse and reaction turbines are further categorized into variations based on the specific amount of head and flow available. A popular type of reaction turbine is the Francis turbine, which has a runner with fixed buckets and is immersed in water. Water is introduced just above the runner then falls through, causing it to spin, which allows the reactive forces to be converted into electricity. Figure 5-1 shows a typical Francis turbine.

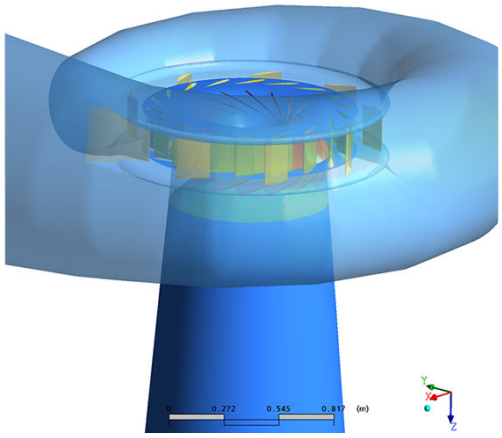


Figure 5-1: Typical Francis Turbine[4]

However, a reaction turbine will not be used for this Project because the maximum head available of 369 feet is considered high, and an impulse turbine is more appropriate. A common type of impulse turbine is the Pelton turbine, which has one or more free jets that discharge water through a nozzle into an aerated space and then impinge on the buckets of a runner. In doing so, the jet forces the wheel to spin, allowing rotational energy to be transmitted to a generator to produce electricity. Figure 5-2 shows a typical layout of a single-nozzle Pelton turbine. The nozzle can be adjusted in order to increase or decrease the flow that reaches the buckets of the turbine, which controls the amount of electricity produced.

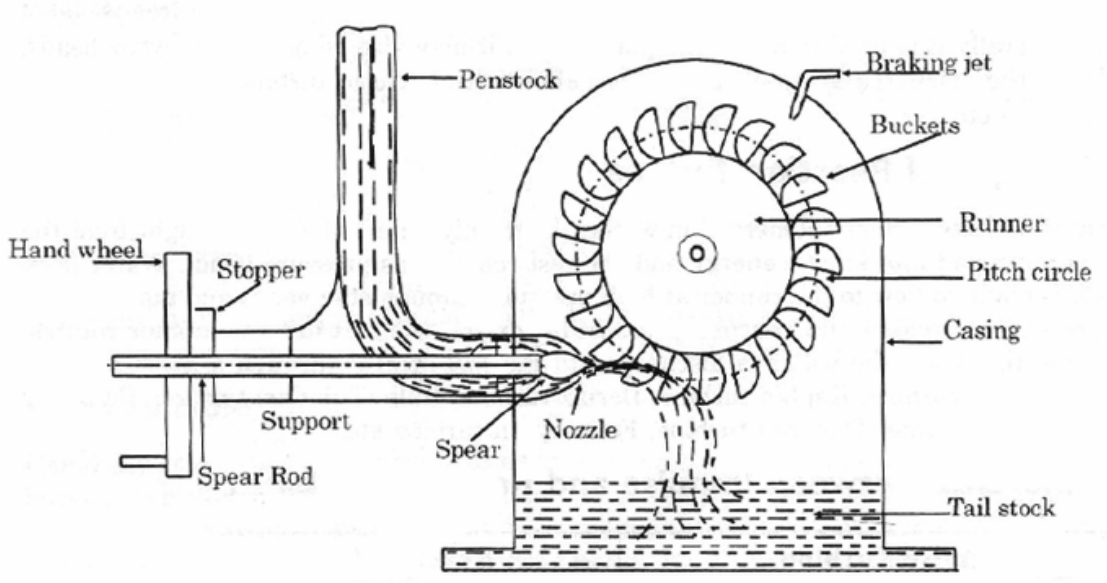


Figure 5-2: Layout of a Typical Single-Nozzle Pelton Turbine[5]

[4] http://www.hfm.tugraz.at/fileadmin/_migrated/pics/Stuetz-Leitschaufeln-Laufrad.jpg
[5] http://2.bp.blogspot.com/-bfXeZTChjjs/U4x7iOT07dI/AAAAAAAANCQ/TwDgw_gOcrA/s1600/Pelton-Wheel-Impulse-Turbine.png

A Turgo turbine, also an impulse turbine, operates in the same manner as a Pelton, but with slight variations. Instead of a wheel comprised of a runner with bucket-shaped blades, it has a cast wheel whose shape generally resembles a fan blade that is closed on the outer edges. Figure 5-3 shows the runner and blades of a typical Pelton turbine on the left, and the runner and blades of a typical Turgo turbine on the right.

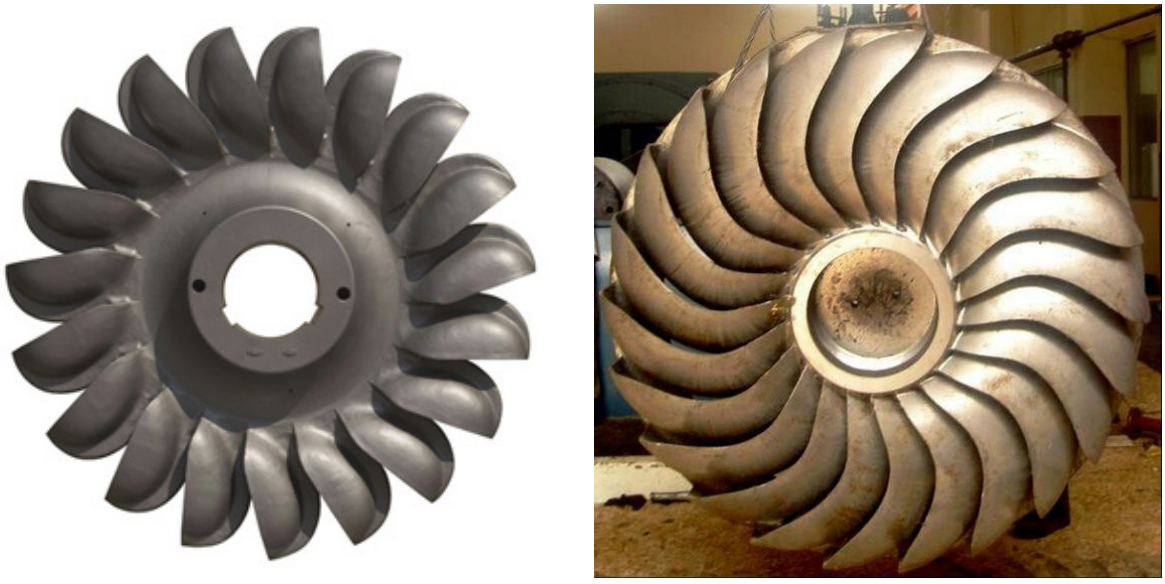


Figure 5-3: Runners and Blades of Both the Pelton[6] (left) and Turgo[7] (right) Turbines

Also unlike the Pelton, the Turgo has a nozzle that is able to force a jet of water to strike the plane of the runner at an angle of approximately 20 degrees, shown in Figure 5-4. This configuration allows the Turgo to have a smaller diameter runner than the Pelton, while maintaining equivalent electricity production, and allowing for a greater range in flow.

[6] http://www.cerecengineering.com/example/img/galerie/image4.jpg
[7] http://i01.i.aliimg.com/img/pb/844/082/379/379082844_198.jpg

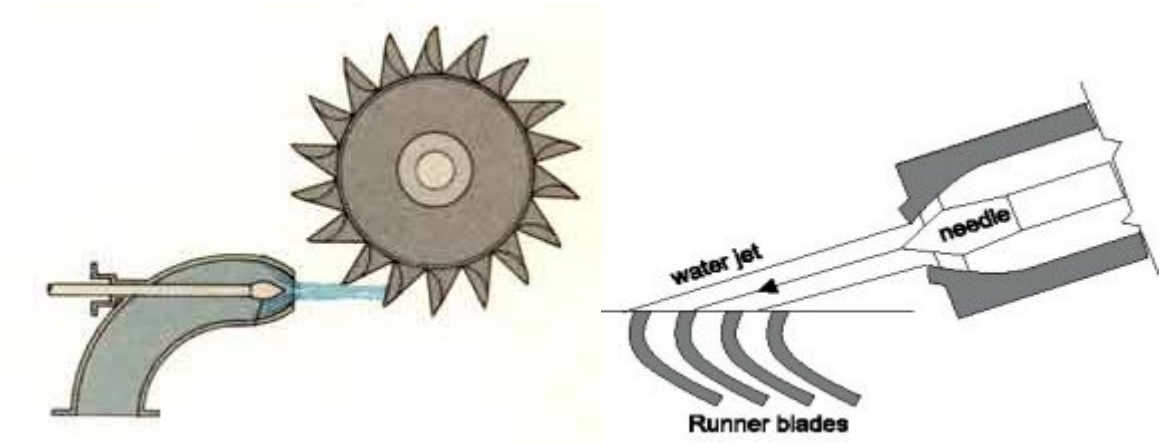


Figure 5-4: Schematic of Both Pelton[8] (left) and Turgo[9] (right) Water Jets Hitting the Respective Runner Blades

The specific flow and head ranges determine whether the Pelton or the Turgo is best suited. Figure 5-5 shows flow/net head relationships and the corresponding turbine that best suits each, and Table 5-2 shows specific head ranges that each type of turbine best accommodates (note that 1 meter = 3.28 feet, and 1 cubic meter = 35.31 cubic feet). Based on the figure and table, a Turgo turbine best fits the project requirements, which are highlighted in yellow.

[8] http://www.waterwheelfactory.com/turbine/wwwpelton.jpg
[9] http://www.microhydropower.net/basics/turbines.php#Turgo

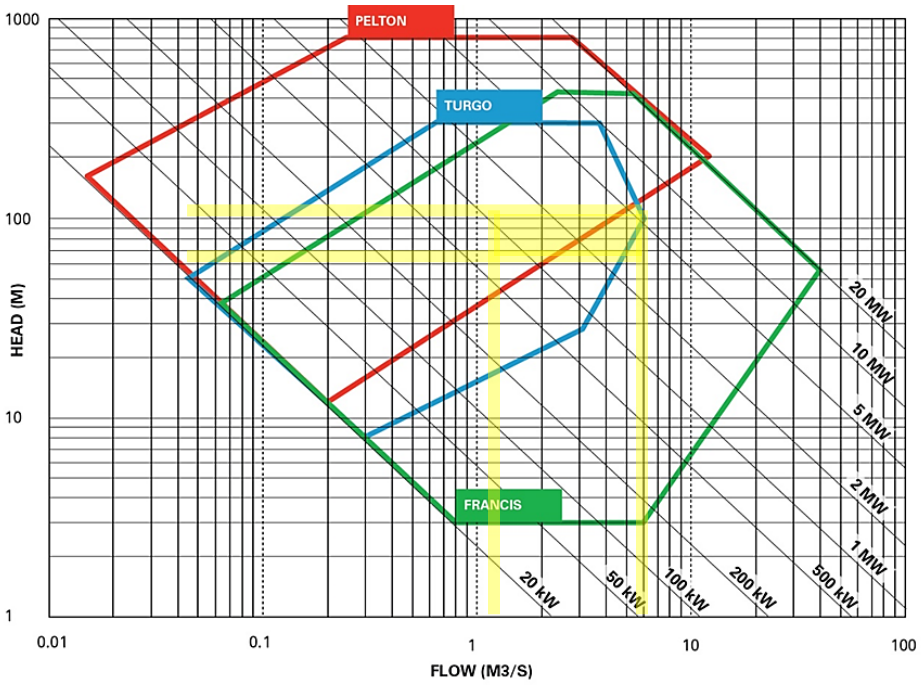


Figure 5-5: Flow/Net Head Relationships and the Turbines that Best Accommodate Each Range (in SI Units) [10]

Table 5-2: Turbine Types and Their Corresponding Range of Net Head (in SI Units) [11]

Turbine type	Head range in metres
Kaplan and Propeller	$2 < H_n < 40$
Francis	$25 < H_n < 350$
Pelton	$50 < H_n < 1'300$
Crossflow	$5 < H_n < 200$
Turgo	$50 < H_n < 250$

Turbines are custom-built to ensure maximum power output for the required conditions. The Turgo turbine, more specifically, can maximize power output by adding multiple nozzles in order to accommodate a wide range of flows. Figure 5-6 shows a single nozzle Turgo on the left, as well as a dual nozzle Turgo on the right. The dual-nozzle Turgo better accommodates a wide range of flows, as it has the capability to shut off one nozzle during lower flow conditions, and open both nozzles during higher flow conditions.

[10] http://www.gilkes.com/user_uploads/range_chart.jpg
[11] http://www.esha.be/fileadmin/esha_files/documents/publications/GUIDES/GUIDE_SHP/GUIDE_SHP_EN.pdf

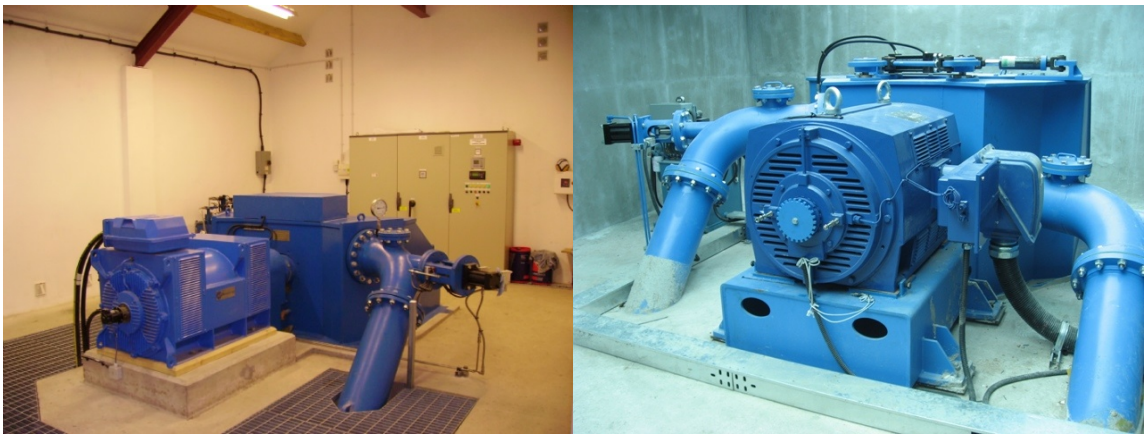


Figure 5-6: Typical Single Nozzle Turgo (left) and Dual-Nozzle Turgo (right)

Canyon Industries, based in Deming, Washington, manufactures a variety of turbines and recommends a dual-nozzle Turgo turbine similar to the Turgo turbines shown in Figure 5-6 for this Project. The proposed turbine accommodates the design conditions shown in Table 5-3, in addition to flows as low as 10 cfs and as high as 40 cfs, with corresponding net heads as high as 371.4 feet and as low as 268.7 feet, respectively. Given the aforementioned design conditions, the expected system output at 40 cfs for the turbine is 770 kW. Figure 5-7 shows a preliminary drawing of the proposed turbine from Canyon Industries.

Table 5-3: Design Conditions for Turgo Turbine

Criteria	Value	Units
Equipment Life	35	Years
Number of Units	1	Turbine
Maximum Flow	40	cfs
Minimum Flow	10	cfs
Maximum Available Head	371	Feet
Minimum Available Head	268	Feet
Maximum Energy Production	770	kW
Minimum Energy Production	268	kW
Capacity Factor	60	Percent
Turbine Size	770	kW

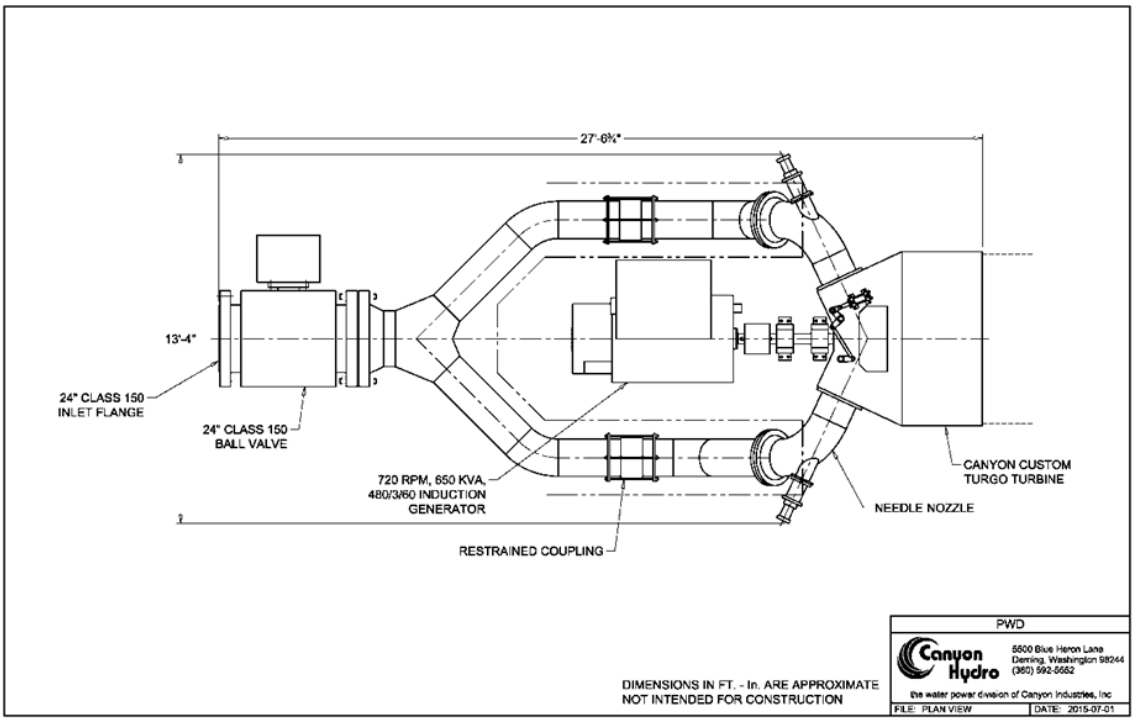


Figure 5-7: Proposed Dual-Nozzle Turgo Turbine Drawing

The supplier's cost for the recommended dual-nozzle Turgo is approximately $800,000, and includes the following primary equipment:

- Canyon dual-nozzle Turgo with hydraulic actuation
- Induction generator 480/3/60
- Switchgear and control panels for automated grid parallel operation
- Hydraulic power unit skid
- Turbine inlet valve
- Bifurcation piping with dismantling joints and structural steel equipment mounting frames

The full opinion of probable construction cost of $2,760,000 is presented in the next section (Section 5.3).

The Hydro-turbine Room in the Pump Station Building is designed to house the Turgo turbine suggested by Canyon Industries (Drawing M3 in Volume 2). The room is approximately 47 feet long and 35 feet wide, and houses the turbine, turbine by-pass with two pressure reducing valves, as well as generator electrical and turbine control panels.

5.3 Projected Power Generation

A 35-year analysis is provided based on estimated annual SWP Table A Amount allocations and recharge water deliveries from the East Branch of the California Aqueduct. Four average operating conditions are shown in Table 5-4, with their corresponding flow, net head, and average deliveries. It is assumed that in a period of 10 years, 6 years are normal to wet, and 4 years are dry, which is reflected in the average SWP delivery column of the table.

Table 5-4: Range of Average Flow, Delivery, and Net Head Conditions Available for Turbine

Average Annual Delivery when Available (AF/yr)	Average Flow when Operating (cfs)	Average SWP Deliveries (Assuming 6 years out of 10) (AF/yr)	Net Head Available at Turbine (feet)
10,000	13.8	6,000	364
15,000	20.8	9,000	347
20,000	27.7	12,000	324
25,000	34.6	15,000	295

In order to evaluate the potential of the hydropower project, turbine cost benefits are provided in Table 5-5 based on the average conditions in Table 5-4. The current average energy cost of $0.14/kWh was used in the analysis. For the average range of flows, the Net Present Value (NPV) of Average Annual Net Savings is expected to be approximately $7.7 million to $16.0 million over the next 35 years. The annual average of the net savings is portrayed graphically in Figure 5-8. As can be seen, the hydropower project is financially beneficial even at the low-end average operating conditions, and becomes more beneficial as more water is delivered.

Table 5-5: Range of Turbine Cost Benefits Based on Average Conditions

Average Annual Delivery when Available (AF/yr)	Energy Production at 85% Efficiency (kW)	Average Annual Energy Production (kWh/Year)	NPV of Average Net Savings over 35 Years	Average Annual Net Savings	Average Unit Cost Savings per AF
10,000	362	1,902,672	$7,714,402	$392,340	$65
15,000	517	2,717,352	$11,206,648	$569,107	$63
20,000	643	3,379,608	$14,045,507	$712,801	$59
25,000	732	3,847,392	$16,042,105	$814,057	$54

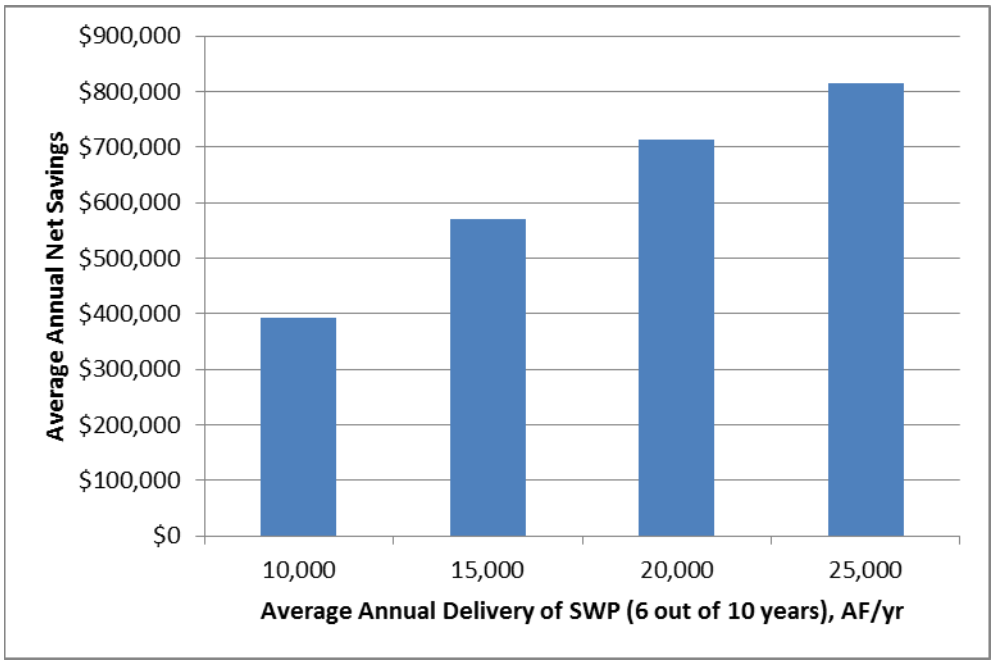


Figure 5-8: NPV of Average Annual Savings for a Range of Average Operating Conditions

Another benefit of the hydropower project is that is qualifies for the California Public Utilities Commission's Self-Generation Incentive Program (SGIP). The hydropower turbine falls under the "Pressure Reduction Turbines" category; therefore, the incentive received is either: a) 30% of the Capital Cost (shown in Table 5-6) or b) $1.07 x 1000 x the size of the Project in kW, whichever is less. The total SGIP incentive for this hydropower project could be as high as $824,000 ($1.07 x 1000 x 770 kW), which is less than 30% of the Capital Cost of $828,000. However, only 50% of the total incentive is received up front, and the remaining 50% is received in increments of 10% per year based on annual production over the first 5 years. For each of the average annual delivery conditions described above (10,000, 15,000, 20,000, or 25,000 AF/yr) PWD would receive only 47, 67, 83, or 95 percent of the maximum annualized payments of $412,000 based on less than full production, as shown in Table 5-7. Currently, the SGIP allows incentives to be available through January 1, 2016. However, because Governor Brown recently increased the Renewables Portfolio Standard percentage goal for the state, renewal of this program is very likely in the short-term.

Table 5-6: Capital Cost Breakdown for Hydropower Turbine

Cost Element	Cost
Turbine Vendor Package	$800,000
Building (1700 sf at $250/sf)	$425,000
Piping and By-pass	$250,000
Mechanical Install (30% of turbine price)	$240,000
Electrical/Instrumentation (20% of turbine price)	$160,000
Construction Subtotal	$1,875,000
Contractor Mark-up, Taxes, Bonds (12% of Installed Cost)	$225,000
Contingency - included in estimates	$0

Cost Element	Cost
Escalation to Midpoint of Construction (6%)	$125,000
Construction Total	$2,225,000
Design Engineering (8% of Construction Cost)	$178,000
Regulatory/Permitting (6% of Construction Cost)	$134,000
Construction Management (8% of Construction Cost)	$178,000
Agency Administration (2% of Construction Cost)	$45,000
TOTAL	**$2,760,000**

Table 5-7: Total SGIP Incentive for Range of Average SWP Deliveries

Average Annual Delivery when Available (AF/yr)	Estimated Incentive Based on kW Produced in Years 1 through 5	SGIP Total Incentive	Percent of Maximum SGIP Incentive
10,000	$412,000 + $194,000	$606,000	73%
15,000	$412,000 + $277,000	$689,000	84%
20,000	$412,000 + $344,000	$756,000	92%
25,000	$412,000 + $392,000	$804,000	98%

Section 6: Recharge Basins

This section describes the Project's recharge basins, including design criteria and infiltration testing.

6.1 Design Criteria

The Project has four 20-acre recharge basins, which are centered on a 160-acre property to be purchased by PWD. Approximately 35 percent of the property is already owned by the Los Angeles County Sanitations District for potential use as a future Effluent Management Area. The Recharge Site lies between East Avenue L to the north and East Avenue L-8 to the south, and between 100th Street East to the west and 105th Street East to the east. Figure 6-1 shows the layout of the recharge basins as well as the associated structures.

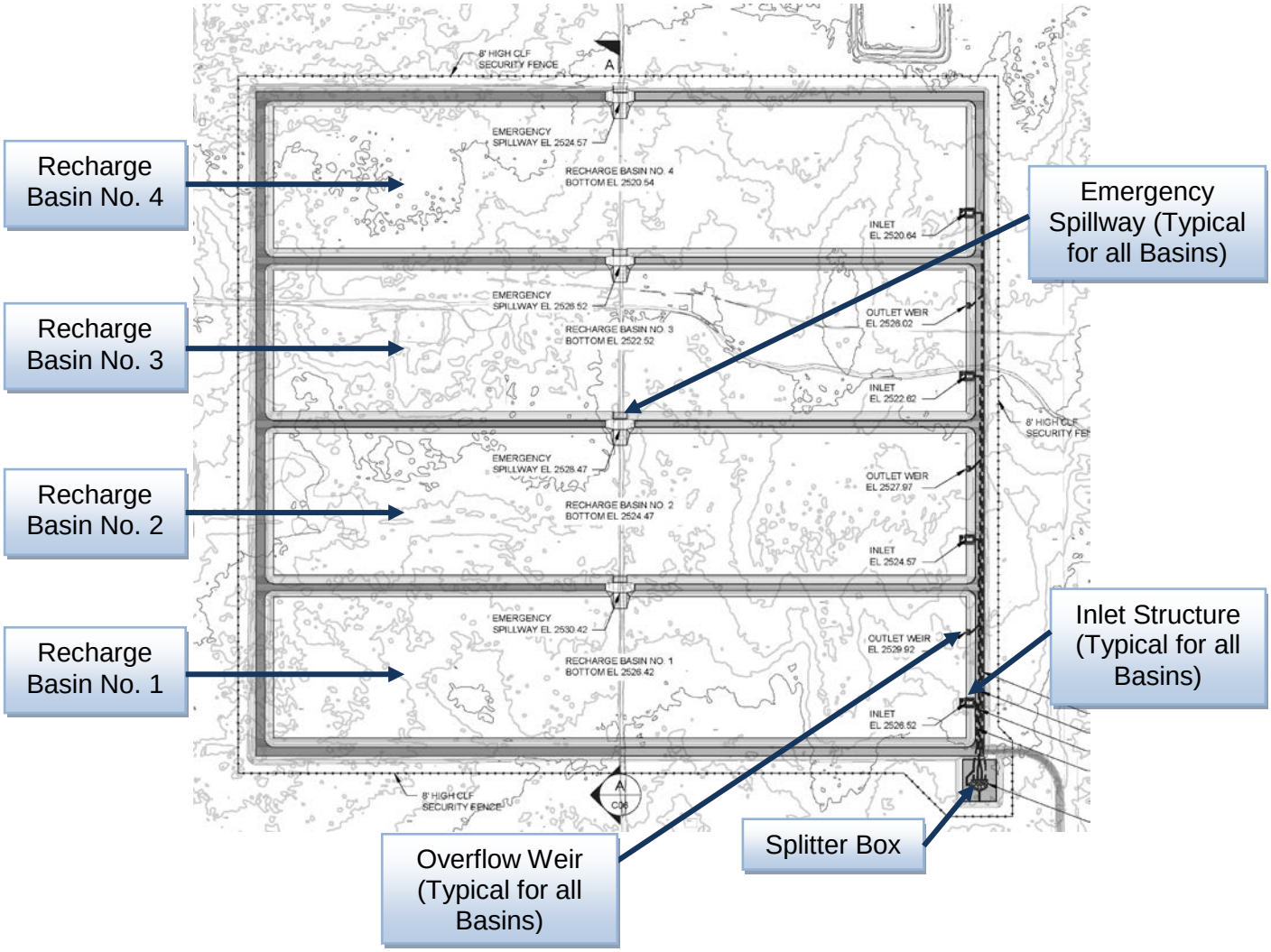


Figure 6-1: Site Layout of the Four 20-Acre Recharge Basins

Each of the four recharge basins is 2,080-feet long and 425-feet wide (measured on the basin floor, from side to side). The basins are designed for ultimate capacity reached in Phase 2. Each basin is approximately 2.5 feet lower than the preceding basin, following the slope of the land (with Basin 1 at the highest elevation). Each basin is separated from one another by a 20-foot wide interior access road with a depressed 40-foot long concrete emergency overflow spillway. All of the emergency overflow spillways have a ramp to the south for periodic maintenance. The outer perimeter berm is designed with a wider 26-foot access road.

The design elements for the recharge basins and Splitter Box are listed in Table 6-1.

Table 6-1: Design Elements for Recharge Basins

Design Element	Value	Unit
Site Area	160	Acres
Maximum Recharge Area	80	Acres
Maximum Annual Recharge	52,200	AF/yr
Number of Basins	4	-
Basin Area	20	Acres
Design Infiltration Rate	3	Feet/Day
Water Surface Level to Overflow:		
Basins 1 - 3	3.5	Feet
Basin 4	N/A	
Water Surface Level to Emergency Spillway:		
Basins 1 - 4	4.00	Feet
Emergency Spillway Elevations:		
Basin 1	2,530.42	Feet
Basin 2	2,528.47	Feet
Basin 3	2,526.52	Feet
Basin 4	2,524.57	Feet
Basin Floor Elevations:		
Basin 1	2,526.42	Feet
Basin 2	2,524.47	Feet
Basin 3	2,522.52	Feet
Basin 4	2,520.54	Feet
Access Road Width – Interior Berms	20	Feet
Access Road Width – Exterior Berms	26	Feet
Basin Interior Side Slopes	3:1	Horizontal:Vertical
Basin Interior Side Slopes with Access Ramp	8	Percent
Basin Exterior Side Slopes	3:1	Horizontal:Vertical

6.2 Description

Provided herein is a description of the recharge basins.

6.2.1 Splitter Box and Pipelines

The raw water and recycled water combined flow enters a trapezoidal-shaped, cast-in-place concrete Splitter Box via a 48-inch diameter transmission pipeline. The Splitter Box is covered with a metal grating on the roof deck and is equipped with handrails around the perimeter to ensure accessibility of the roof deck. In addition to accessibility, the metal grating allows periodic visual inspection of a level sensor attached inside the Splitter Box.

The Splitter Box slopes downward toward four chambers. Each chamber is equipped with an overflow weir at a water depth of 4 feet and weir length of 11 feet, as well as a 36-inch diameter sluice gate. Each chamber is connected to a 36-inch diameter steel pipeline, which changes to HDPE pipe approximately 10 feet after leaving the chamber. The four pipelines leaving the Splitter Box are designed to carry 36 cfs of water to each of the four basins.

The Splitter Box is designed to deliver flow to one, two, or three of the basins at any given time depending on the rate of flow. At flow rates less than 60 cfs, only two basins need to be in service, assuming the design infiltration rate of 3.0 feet/day (see Section 6.3). At the maximum recharge rate of 52,200 AF/yr (72 cfs), three basins are needed if the infiltration rate is 3.0 feet/day or less, as greater than 3.6 feet/day is required for two basins to recharge 72 cfs. The sluice gate on each Splitter Box chamber will be operated to rotate the basins in and out of service. When an out-of-service recharge basin has become dry and cracked, it can be returned to service, allowing for maximum infiltration.

In case inflow exceeds outflow for the number of open sluice gates, the Splitter Box has an emergency overflow weir attached to the west wall. The water level must reach 5 feet and 3 inches in order to exit the overflow weir, where the water proceeds to a 48-inch diameter pipeline that reduces to a 36-inch diameter pipeline, which then connects to the pipeline leading to Basin 1. The emergency overflow pipe slopes downward from the emergency overflow weir to the Basin 1 pipeline in order to prevent water from backing up to the Splitter Box.

6.2.2 Inlet Structure

From the Splitter Box, water flows through a separate 36-inch diameter pipeline for each basin, where the flow enters the basin through an inlet structure. The water spreads across a 15-foot wide by 21.5-foot long concrete cast-in-place inlet structure to reduce velocity when entering the basin, converting pipe flow to sheet flow. Following the concrete inlet floor, the water passes over 20 feet of rip-rap to dissipate energy and minimize erosion of the bed of the recharge basin. The end of the rip-rap extends to a depth of 4 feet at the pond interface bottom in order to further minimize erosion.

Each inlet structure is equipped with a level sensor located in the corner of the structure and inside a stilling well to minimize the effect of turbulence from the inlet flow. These sensors report to the Project SCADA system. Basin 4 is also equipped with a hard-wired float switch to prevent high water conditions as described in Section 6.2.4.

6.2.3 Outlet Weir Structure

When the water level in Basin 1, 2, or 3 reaches 3.5 feet, it flows over a weir and into a concrete cast-in-place overflow structure. The overflow structure has the capacity to carry the full 36 cfs of water through a 36-inch diameter pipeline that flows partially-full to the next down gradient recharge basin inlet pipe. The weir serves to minimize the increase in depth required for the water to exit, and prevent water from the downstream inlet pipe backing up into the adjacent upstream basin when out of service. The operation of Basin 4 with no such outlet weir is discussed in the following section.

6.2.4 Emergency Spillway and Berms

In an emergency case when the water level reaches 4.03 feet in Basins 1, 2, or 3, there is an emergency overflow spillway that leads to the adjacent down gradient recharge basin (Basins 2, 3, and 4). For Basin 4, the emergency overflow spillway is set at an elevation of 4.0 feet and spills to the ground north of Basin 4. As a result, Basin 4 is equipped with a float switch that will signal the motor operator on the sluice gate for Basin 4 to close at a pre-determined water depth. The remaining three sluice gates for Basins 1, 2, and 3 are manually operated.

Each spillway is 40-feet wide and extends as a ramp into the up gradient basin to allow vehicles to enter for maintenance activities. All of the emergency overflow spillways have an 8 percent downward slope on the south to serve as access ramps for periodic maintenance, each with a 3:1 horizontal to vertical slope on the north to match the adjacent slopes. The outer perimeter berm is designed with a wider 26-foot access road.

The Recharge Site is designed for balanced cut-and-fill construction. After clearing and grubbing, all excavated dirt is used to construct the berms around each basin. Each of the interior berms is also constructed with shotcrete for added stability.

6.2.5 Access and Maintenance

Access to the 160-acre Recharge Site is prevented by an 8-foot high chain link security fence along the perimeter, just beyond the berm toe of slope. A new 16-foot wide access road leading to the site entrance is located along the west edge of the future alignment 105th Street East and is constructed of Class 2 Aggregate Base. After entering the Recharge Site, a 26-foot access road continues north paralleling 105th Street East, then follows the perimeter berm of the recharge basins, eventually leading back to the entrance. The emergency overflow spillways can be reached via the 20-foot access roads between each of the four basins. These spillways act as access routes to the inside of each basin.

6.2.6 Hydraulics

The average water depth maintained in each basin is 0 to 2 feet with 0.5 feet of freeboard. The maximum water depth possible for Basins 1, 2, and 3 is 4 feet, and for Basin 4 the maximum water depth is 4.00 feet, which is the water level when the individual basin emergency overflow spillways are reached. Before reaching the emergency overflow spillway, the water level reaches an outlet weir at a depth of 3.5 feet for Basins 1, 2, and 3. The weir depth at the maximum influent flow of 36 cfs is 0.6 feet, or a water depth of 3.1 feet. It is only if the outlet

structure or outlet pipeline is blocked or clogged that the water level would ever reach the emergency overflow for Basins 1, 2, or 3. Basin 4 does not have an outlet structure as there is no down gradient basin. Instead, Basin 4 is equipped with a float switch and motor-operated sluice gate to prevent overflow as described in Section 6.2.4.

In order to monitor and record the water level inside the basins, each basin is equipped with a level indicator that is tied into the Project control SCADA system. A typical cross section of all four basins is presented on drawing C06 in Volume 2.

The elevation placement of the Splitter Box is engineered to maximize the net head in the piping leading to the recharge basins. Section 4.4.2 details the hydraulics of the recharge basin pipelines. Water is able to reach each recharge basin even with flows ranging between 4 and 36 cfs. With the Splitter Box overflow weir flowing, Basin 1 can receive up to 72 cfs.

6.3 Infiltration Testing

The recharge rate can be estimated through standard infiltration tests, and both the recharge rate and recovery capacity were estimated in the groundwater model. Converse Consultants prepared a *Percolation Test Results Report* (Converse Consultants, 2014) that presents subsurface conditions and recommended design infiltration rates for five locations of which three sets of data are within or near the proposed recharge site. The report is provided in Appendix F of the LCGRRP Feasibility Study Report (Kennedy/Jenks, 2015).

Converse Consultants performed a document review of published and unpublished geologic/geotechnical reports pertaining to the Project area for appropriate seismic and faulting information, depth to groundwater, and site geology. Field exploration of the Project area included site reconnaissance and a subsurface exploration program in order to obtain subsurface information and perform percolation tests. The field exploration included drilling one exploratory boring at each test location to at least 10 feet below the expected bottom of the recharge basins and a maximum depth of 21.5 feet below ground surface (bgs). An additional 3 percolation test borings surrounding each of the exploratory borings were drilled to 5 feet bgs in order to perform percolation testing.

Boring Set 1 is approximately 1 mile west of the Project site, Boring Set 2 is along the northern boundary of the Project site, and Boring Set 3 is approximately 0.5 miles south of the Project site. Therefore, Boring Set 2 is the most applicable to the Project.

The subsurface soils encountered in the exploratory borings consist primarily of loose- to medium-dense silt and sand mixtures. Lenses of caliche were observed in some boring locations. The presence of caliche along with dry moisture conditions resulted in some soil layers being slightly cemented. Groundwater was not encountered in any of the borings. The document review indicated that historical groundwater depths of 175 to 350 feet bgs have been measured at multiple wells located near the Project area. As a result, groundwater is not expected to be encountered during construction.

Percolation rates describe the movement of water horizontally and downward into soil. Infiltration rates describe the downward movement of water through a horizontal surface. Percolation rates are related to infiltration rates, but are generally higher and require conversion

before use in design. The results of the percolation tests, conversion factors, and a factor of safety were used to estimate the infiltration rates for the project area. The recommended design infiltration rates for the Project area are presented in Table 6-2. However, Kennedy/Jenks recommends a design infiltration rate of 3 feet/day to account for the borehole test short duration, horizontal as well as vertical infiltration, and an expected long-term drop in percolation rates over time.

Table 6-2: Design Infiltration Rates

Boring Set	Test Location Description	Recommended Design Infiltration Rate (ft/day)
No. 1	South Side of Avenue L	9.4
No. 2	South Side of Avenue L	9.4
No. 3	North Side of Avenue M	12.0

Two basins together can recharge up to 43,800 AF/yr (60 cfs) of water given the design infiltration rate of 3 feet/day. However, during years with readily available SWP Water or during years when several partners are banking water, the basins must be able to accommodate 52,200 AF/yr of water (72.1 cfs). If the long-term infiltration rate for the Project is at least 3.6 feet/day, two basins will store up to 52,500 AF/yr of water. At less than 3.6 feet/day, the use of three basins is necessary to recharge the maximum design flow.

Since the actual infiltration rate is critical for the proper sizing of the recharge basins, Kennedy/Jenks recommends that a field test basin on the order of 0.5 to 1.0 acres be operated for up to 30 days to confirm actual site full-scale recharge rates.

The slopes of the recharge basins are expected to have a 3:1 (horizontal to vertical) gradient. Based on the subsurface conditions, caving of dry cohesionless granular soils may occur during excavation. Unsuitable conditions for a cut slope may include low-density soils, running sands, severe soil fractures, or other conditions. A flatter slope ratio of 4:1 was recommended for slope stability purposes in such dry and cohesionless sandy soils. However, the Project uses a 3:1 (horizontal to vertical) slope, but is constructed using shotcrete on the interior slopes. The shotcrete slopes will also provide erosion protection from wave action caused by wind.

Section 7: Recovery Wells

This section describes the design, layout, drilling, and equipping of the Recovery Wells.

7.1 Description

This Project includes 16 Recovery Wells that are located in the Lancaster Sub-basin, and each has a target design capacity of 1,200 gpm. The Recovery Wells are configured in a radial pattern surrounding the center of the recharge basins that locates the Recovery Wells on an approximately 1.5 mile by 1.5 mile square. Each of the Recovery Wells is setback from the closest border of the recharge basins a distance that is greater than 0.5 miles, which allows for a minimum travel time, based on groundwater modeling, of at least one year as required by the California DDW for recycled water traveling from the recharge basins to the Recovery Wells.

Each of the Recovery Wells has been designated with a number from 1 to 16, which is preceded by "RC-" to identify the recovery wells individually. RC-1 is located on the Distribution Site at the intersection of East Avenue M and 105th Street East. From there, the wells are numbered in ascending order in a clockwise direction. The 16 Recovery Wells are located on the 1.5 mile by 1.5 mile square in the following manner:

- Four Recovery Wells (RC-1, RC-2, RC-3, and RC-16) are located along the northern side of East Avenue M. All four of these Recovery Wells are located to the south of the recharge basins.

- Three Recovery Wells (RC-4, RC-5, and RC-6) are located along the western side of 95th Street East, and one Recovery Well (RC-7) is located along the eastern side of 95th Street East. All four of these Recovery Wells are located to the west of the recharge basins.

- Three Recovery Wells (RC-8, RC-9, and RC-10) are located along the northern side of East Avenue K-8. All three of these Recovery Wells are located to the north of the recharge basins.

- Five Recovery Wells (RC-11, RC-12, RC-13, RC-14, and RC-15) are located along the western side of 110th Street East. All five of these Recovery Wells are located to the east of the recharge basins.

The Recovery Wells are proposed to be constructed in two equal phases. Phase 1 will include construction of 8 of the Recovery Wells, and Phase 2 will include construction of the remaining 8 Recovery Wells. Alternating Recovery Wells will be constructed during the two phases (even numbered wells in Phase 1, and odd numbered wells in Phase 2), which will allow for the recharge basins to be surrounded by Recovery Wells after Phase 1. It is important that RC-8, which is north/northwest of Basin 4, be constructed first as it is down gradient of the recharge basins and will be critical for the Tracer Study required to be initiated before the end of the third month of Project operation.

Of the 16 Recovery Well sites, 5 sites are located on property that is owned by LACSD, and can be easily transferred to PWD. The remaining 11 sites will need to be acquired. Seven of the Recovery Well sites (RC-4, RC-6, RC-8, RC-10, RC-12, RC-14, and RC-16) will need to be acquired for Phase 1, and four of the Recovery Well sites (RC-3, RC-7, RC-9, and RC-11) will need to be acquired for Phase 2. More information about acquisition of these 11 Recovery Well sites is discussed in Section 7.5.

The Well Collection Pipeline is proposed to convey extracted water along two different routes. There is a break between RC-8 and RC-9 that creates these two different routes. Extracted water from RC-2 through RC-8 will be conveyed in a counter clockwise direction along East Avenue K-8, 95th Street East, and East Avenue M. Extracted water from RC-9 through RC-16 will be conveyed in a clockwise direction along East Avenue K-8, 110th Street East, and East Avenue M. These two pipelines will connect into a single 36-inch diameter pipeline on the Distribution Site. Since RC-1 is located adjacent to the Distribution Site, extracted water from RC-1 is discharged directly into the 36-inch diameter Well Collection Pipeline; thus, combining all of the Recovery Well production. The extracted groundwater is delivered to the Storage Tank through the 30-inch diameter tank inlet and receives chlorination. The portion of the extracted groundwater to be pumped back to the East Branch of the California Aqueduct by-passes the tank and remains un-chlorinated; hence “un-disinfected potable” or “return water”.

All of the backbone Well Collection Pipelines will be installed during Phase 1, with the exception of the 12-inch diameter pipeline from RC-9 to RC-10 since RC-9 is a Phase 2 Recovery Well. All of the backbone Well Collection Pipeline will be sized to convey the ultimate production capacity from the Recovery Wells in both phases.

The Well Collection Pipelines are proposed to be located so as to maximize the amount of pipeline that can be placed in City of Palmdale right-of-way or LACSD property, minimizing the amount of easements that need to be acquired. More information about acquisition of easements for the Well Collection Pipeline is discussed in Section 7.5. The Well Collection Pipelines will be located:

- North of East Avenue M
- West of 95th Street East
- North of East Avenue K-8 (for piping that is located to the west of 100th Street East)
- South of East Avenue K-8 (for piping that is located to the east of 100th Street East)
- West of 110th Street East

7.2 Design Criteria

A hydraulic analysis was conducted to analyze the Recovery Wells both on an individual basis as well as a collective system. System hydraulics for each Recovery Well are based on the target capacity, the anticipated groundwater levels, pipeline velocities, and the operating HGL of the Storage Tank that the Well Collection Pipeline connects to. The following list summarizes the system hydraulics for the Recovery Wells:

- Operating Storage Tank Elevation — 2,567.0 feet
- Well Depth (target for all wells) — 600 feet below ground surface (bgs)
- Depth to Groundwater — 200 – 300 feet (bgs)
- Well Specific Capacity — 15 – 50 gpm/ft
- Design Capacity per well (all wells) — 1,200 gpm
- Design Total Dynamic Head (TDH) — 420 feet (RC-1) to 540 feet (RC-8)
- Recovery Well Casing — 18-inch outer diameter
- Recovery Well Column — 10-inch diameter (v=4.90 fps @ 1,200 gpm)
- Main Discharge Pipeline — 10-inch diameter (v=4.9 fps @ 1,200 gpm)
  12-inch diameter (v=3.4 fps @ 1,200 gpm)
- Blow-off Pipeline — 8-inch diameter (v=7.7 fps @ 1,200 gpm)
- Well Collection Pipeline — See Table 7-1

Each Recovery Well will pump extracted water through a 10-inch diameter discharge header that is upsized to a 12-inch diameter pipeline underground leaving the well building. The individual 12-inch diameter pipeline for each Recovery Well connects into the common Well Collection Pipeline system that conveys all of the extracted water to the Storage Tank. Table 7-1 provides the sizing for the Well Collection Pipeline based on the number of Recovery Wells connected to a particular pipeline. Table 7-2 provides the approximate total length of Well Collection Piping required.

Table 7-1: Well Collection Pipeline Sizing

Number of Recovery Wells Connected	Total Flow (gpm)	Well Collection Pipeline Size (in)	Velocity (fps)
1	1,200	12	3.40
2	2,400	16	3.83
3	3,600	16	5.74
4	4,800	20	4.90
5	6,000	20	6.13
6	7,200	24	5.11
7	8,400	24	5.96
8	9,600	24	6.81
15	18,000	36	5.67
16	19,200	36	6.05

Table 7-2: Well Collection Pipeline Length

Well Collection Pipeline Size (in)	Total Length (ft)
12	4,250
16	8,500
20	7,850
24	9,350
36	200

Note: Total length does not include Recovery Well column piping, piping on the individual recovery well sites, or piping from the Recovery Well sites to the Well Collection Pipeline

Each Recovery Well will be housed in a building that has two components: a metal pull-apart building to house the Recovery Well, and a concrete masonry unit (CMU) building to house the discharge pipeline, blow-off pipeline, and electrical panels and controls. The metal pull-apart building will attach to one side of the CMU building with an opening that will create a single larger building. The metal pull-apart building is proposed to be 10 feet by 10 feet, and the CMU building is proposed to be 22.67 feet by 16.67 feet for an overall dimension of 32.67 feet by 16.67 feet. The metal pull-apart building has a sloped roof from 12 feet to 14.5 feet in height, and the CMU building has a sloped roof that ranges in height from 16 feet to 18.5 feet.

Each Recovery Well site has a local blow-off basin described in Section 7.4.3.

In addition to the local blow-off basins for each Recovery Well, PWD will have the ability to flush either route of the Well Collection Pipeline. Each route of the Well Collection Pipeline has a tee immediately prior to where the two connect into a single 36-inch diameter pipeline on the Distribution Site. From these tees, two short segments of 16-inch diameter pipelines connect into one 16-inch diameter pipeline that is used to discharge the flushed water through an air-gap to the Distribution Box that, in turn, flows to the Recharge Site. This flushing ability can be used to maintain the Well Collection Pipeline and water quality within it, but can also be used if a Recovery Well requires prolonged sampling such as a 24-hour discharge prior to being put into the potable water system. During Phase 1 with four Recovery Wells on each route of the Well Collection Pipeline, one well on each route could be flushed for 24 hours or longer while the other three remain off.

7.3 Drilling

All 16 Recovery Wells are proposed to have a standard design based on previous geophysical tests and modeling of the aquifer, although final screen placement will vary as described herein. Table 7-3 provides the design parameters for the Recovery Wells. Figure 7-1 depicts a typical design for the Recovery Wells.

Table 7-3: Recovery Well Design

Parameter	Design
Recovery Well Depth	600 feet bgs
Top of Perforated Screen	300 feet bgs

Parameter	Design
Bottom of Perforated Screen	600 feet bgs
Total Amount of Perforated Screen	200 feet in multiple sections
Recovery Well Pump Depth	480 feet bgs
Well Casing/Screen Outside Diameter	18-inches

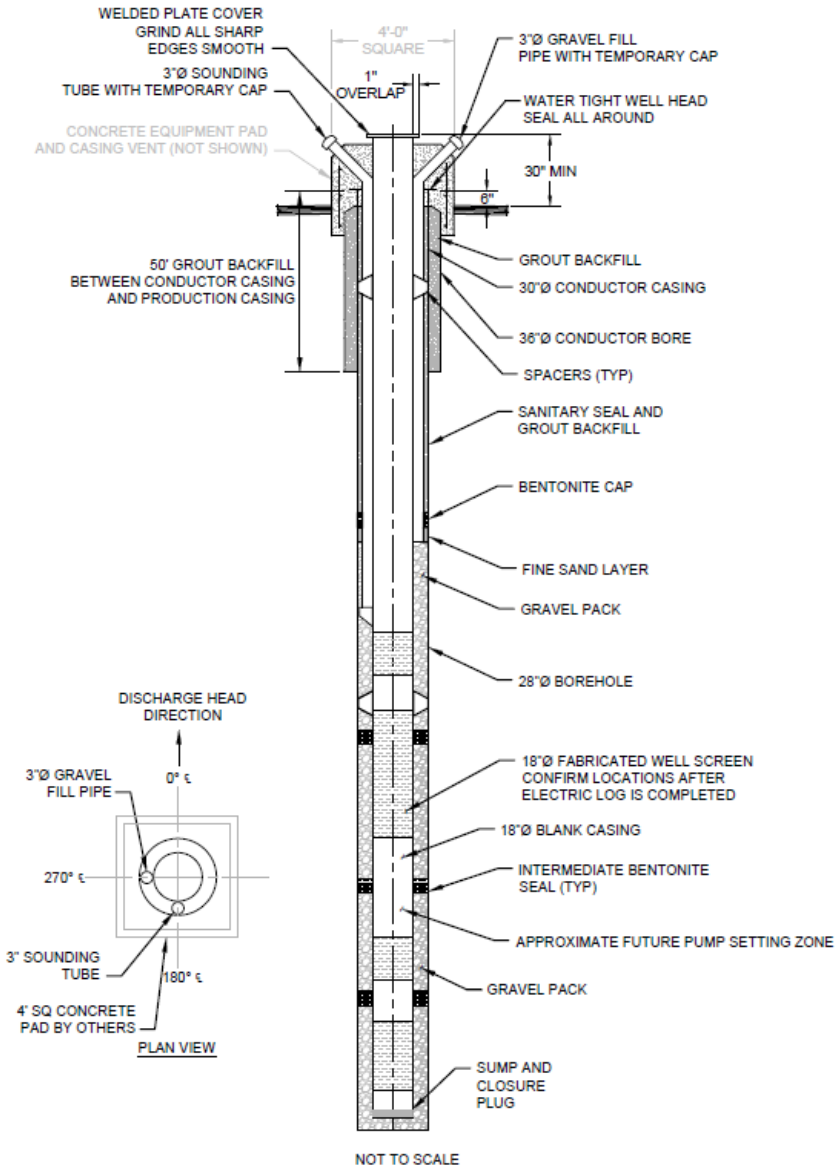


Figure 7-1: Typical Recovery Well Design

It should be noted that Figure 7-1 shows a typical Recovery Well design and does not reflect actual final design of the Recovery Wells. Final Recovery Well design will occur following the

completion of the well bore hole drilling, geophysical logging, formation geotechnical sample analysis, and water quality sampling.

7.4 Recovery Well Equipping

The Recovery Well equipping phase will include the installation of pumps and motors, oil lube, blow-off pipeline, main discharge pipeline, buildings, as well as electrical panels and controls.

7.4.1 Pumps

The Recovery Wells will be equipped with variable speed vertical turbine pumps. The target design capacity for each Recovery Well (RC-1 through RC-16) is 1,200 gpm, but an adjustment in design capacity may be appropriate after pump testing is performed by the well drilling contractor. The well column piping will be 10-inch diameter, the main discharge piping will be 10-inch diameter before being upsized to 12-inch diameter, and the Well Collection Pipeline will range from 12-inch to 36-inch diameter. The motor horsepower for the recovery wells is expected to range from 200-HP to 250-HP. The difference in motor horsepower is related to the difference in elevation of each Recovery Well site and the difference in distance that a Recovery Well has to pump the extracted water to the Storage Tank. Recovery Wells that are located at a greater elevation and closer to the Storage Tank have lower motor horsepower requirements. Table 7-4 provides the expected motor horsepower for each Recovery Well.

Table 7-4: Expected Recovery Well Motor Horsepower

Recovery Well	Motor Horsepower (HP)
RC-1	200
RC-2	200
RC-3	200
RC-4	250
RC-5	250
RC-6	250
RC-7	250
RC-8	250
RC-9	250
RC-10	250
RC-11	250
RC-12	250
RC-13	250
RC-14	200
RC-15	200
RC-16	200

Water levels are projected to vary substantially over the range of wet, normal, and dry years under which maximum spreading, normal spreading, and reduced spreading, respectively, may occur, along with normal extraction pumping and maximum extraction pumping. Variations in the discharge pressure will also result from changes in friction and minor losses associated with

the actual quantity of water extracted from the recovery wells. Due to fluctuations in groundwater levels, changes in friction losses and minor losses, variations in specific capacity of the recovery wells, and difference in operating levels of the storage tank, VFDs will be required to meet the range of flow and head conditions during operation and to ensure that submergence over the well pump is maintained.

7.4.2 Oil Lube

The Recovery Wells are required to be lubricated in order to prevent seizing, wear, tear, and failure of the pump shafts, pumps, or motors. The two methods that can be used for lubricating the Recovery Wells are “oil lube” and “water lube.” Water lube systems require a small diameter water supply pipeline (typically 1-inch diameter), water supply source, and sufficient pressure in order to water lube prior to starting up the operation of a Recovery Well. Due to the overall distance between the Recovery Wells, the range in elevation of the Recovery Well sites, and the PWD’s preference, the water lube method will not be used, and the oil lube method has been selected for lubricating the Recovery Wells.

Oil lube works by dripping oil through the bearings along the shaft in an enclosed tube, which is isolated from the rest of the Recovery Well to prevent the oil from getting into the potable water being extracted by the Recovery Well. Keeping the Recovery Well sufficiently lubed prevents accelerated wearing of the bearings that could lead to seizing of the shaft and failure of the pump or motor. Oil lube is a constant process that occurs prior to starting up a Recovery Well and continues during operation of the Recovery Well. The oil is supplied through an oil reservoir that will be located next to the Recovery Well. The level of oil in the oil reservoir must be checked by an operator on a routine basis to ensure that there is a sufficient amount of oil to provide lubrication to the Recovery Well.

7.4.3 Blow-off System

Each Recovery Well is equipped with its own blow-off system that allows any extracted water to be diverted from the main discharge piping if required. An example of when the blow-off system will be used is during the startup of a Recovery Well in which fine sand and silt may be present in the extracted water. Since the water is intended for potable use, water containing the fine sand and silt will be diverted through the blow-off system so it will not reach the Well Collection Pipeline.

Each Recovery Well will be equipped with an 8-inch diameter blow-off pipeline that discharges at a right angle from a tee in the main discharge header upstream of the flow meter. Each Recovery Well site has a blow-off basin where the blow-off pipeline will discharge. This blow-off system will not divert water back to the recharge basins due to the distance between the different Recovery Well sites and the recharge basins, and the fact that fines in this water would settle in the recharge basin and clog the infiltration bed surface over time.

Each on-site blow-off basin has an overall length of 95 feet, an overall width of 25 feet, an overall depth of 2.33 feet, and side slopes of 1:1. An 8-foot wide access ramp with a slope of 5 percent is provided to allow for access of maintenance vehicles and workers. This blow-off basin configuration provides roughly 28,500 gallons of storage capacity, which is equivalent to the amount of water extracted by a Recovery Well at the design capacity of 1,200 gpm for

approximately 24 minutes. Typical blow-off times for Recovery Well start-up are on the order of 10 minutes; thus, the blow-off pond storage volume will allow multiple well starts as the water in the pond percolates and/or evaporates.

Over time, depending on the amount of fines produced by any given Recovery Well and how often the blow-off system is used, the blow-off basin may need to be cleaned by scraping any accumulated fines from the surface of the blow-off basin.

Each blow-off basin has an emergency spillway that prevents the pond from overflowing on the Recovery Well site. The flow line of the spillway is located 2 feet above the bottom of the blow-off basin, which results in 4 inches of freeboard. The spillway diverts water from the blow-off basin to outside the boundary of the Recovery Well site where it will percolate back into the ground.

A backflow prevention device is required near the point of discharge of the blow-off pipeline into the blow-off basin. The most economical backflow preventer is an air-gap, which is provided by constructing the blow-off piping at least two times the pipe diameter above the maximum water surface. A concrete wall with concrete and shotcrete pads will be designed at the outlet for erosion control.

7.4.4 Discharge and Metering

Each Recovery Well will be equipped with an above grade 10-inch diameter discharge pipeline that incorporates a deep well air vacuum and release valve, pressure gauge and pressure switch, blow-off tee, Cla-Val deep well pump control valve, Cla-Val booster pump control valve, sample tap, magnetic flow meter, main line isolation valve (butterfly valve), drain valve, and two 90-degree elbows. The Cla-Val deep well pump control valve is located on the 8-inch diameter blow-off pipeline. The Cla-Val booster pump control valve is located on the main discharge pipeline and has a built-in check valve that prevents the direction of flow from reversing.

The pipe material for the main discharge pipeline and blow-off pipeline is cement mortar lined and epoxy coated steel pipe above ground, and cement mortar lined and coated (CML&C) steel pipe below ground. The two 90-degree elbows are used to transition the main discharge pipeline from above grade to below grade. After the second 90-degree elbow, which is below grade, the main discharge pipeline will be increased in size to 12-inch diameter CML&C steel pipe. The below grade 12-inch diameter discharge pipeline will have a minimum of 4 feet of cover, and the below grade 8-inch diameter blow-off pipeline will have a minimum of 3 feet of cover.

7.4.5 Noise Enclosures

Helix Environmental Planning, Inc. (Helix) prepared an Acoustical Analysis Report in July 2015 for the PRGRRP. As part of the Acoustical Analysis Report, the anticipated noise impacts from any of the recovery wells were analyzed. It was determined that the noise impacts from any of the Recovery Well pumps within either the City of Lancaster or Los Angeles County will be less than significant.

As discussed in Section 7.2, each Recovery Well will be housed in a CMU and metal pull-apart building. Having each Recovery Well located in a building will provide substantial noise reduction.

7.4.6 Site Work

An overall site measuring 100 feet by 100 feet is proposed for each Recovery Well. Each site will be constructed at an elevation that is roughly two feet above the maximum existing grade on the site. Table 7-5 provides the site elevations for each of the Recovery Well sites. A chain link fence will be installed and offset a distance of 0.5 feet inside the perimeter of the site. This chain link fence will enclose all the components of each Recovery Well site, including the Recovery Well building and blow-off basin.

Table 7-5: Recovery Well Site Elevations

Recovery Well	Existing Grade (ft)	Final Site Elevation (ft)
RC-1	2547.3	2549.3
RC-2	2547.0	2549.0
RC-3	2539.0	2541.0
RC-4	2527.7	2529.7
RC-5	2519.5	2521.5
RC-6	2508.5	2510.5
RC-7	2496.0	2498.0
RC-8	2498.5	2500.5
RC-9	2503.0	2505.0
RC-10	2505.6	2507.6
RC-11	2505.8	2507.8
RC-12	2516.0	2518.0
RC-13	2528.7	2530.7
RC-14	2538.5	2540.5
RC-15	2551.5	2553.5
RC-16	2550.0	2552.0

The main discharge pipeline will be above grade initially within the Recovery Well building, but will transition to below grade prior to exiting the extents of the Recovery Well building. The main discharge piping will then remain below grade as it leaves the site and connects to the Well Collection Pipeline.

The blow-off pipeline will be above grade initially within the Recovery Well building, but will transition to below grade prior to exiting the Recovery Well building. The blow-off pipeline will then remain below grade until just before the blow-off basin. The blow-off pipeline will have a vertical transition to above grade just prior to the air-gap where it discharges into the blow-off basin.

All 16 of the Recovery Well sites will have an identical overall site layout. Class 2 aggregate base surfacing will be placed at each Recovery Well site pad and along the access roads.

7.5 Easements

When possible, the Recovery Well and well piping will be placed on LACSD property or City of Palmdale right-of-way. However, temporary or permanent easements are required for portions of the Recovery Well sites and Well Collection Pipeline not located on LACSD or public property. Table 7-6 lists the easements required for the Well Collection Pipeline, and Table 7-7 lists the easements required for the Recovery Well sites.

The easements required for the Well Collection Pipeline lie along 95th Street East, East Avenue K-8, and East Avenue M. These easements are assumed to require 40-foot, 30-foot, and 50-foot right-of-way widths, respectively, which follow the right-of-way widths for similar roads in the area. The Well Collection Pipeline along 110th Street East and the majority of East Avenue M are within City of Palmdale right-of-way, and therefore do not require easements.

The Recovery Well sites require 150 by 150 foot easements in order to contain all well drilling and equipping. Recovery Wells not listed in Table 7-7 lie within LACSD property, and therefore do not require easements. Hence, the total area for which easements are required is 776,048 square feet. For the Recovery Well sites, PWD may prefer outright ownership.

Table 7-6: Easements Required for Well Collection Pipeline

Number	Assessor Parcel Number	Owner	Area Needed (sq. ft)
1	3378-004-001	Kiyoshi Hiramatsu	13,200
2	3378-004-005	Raphale Cohen, et al.	13,800
3	3378-004-034	Daniel P. Doboszenski	26,400
4	3378-004-008	Bolthouse Properties LLC	52,200
5	3378-021-001	Estelita A. Briones	11,376
6	3378-021-016	John R. & Gloria B. Miller	13,375
7	3378-021-017	Rosa R. Daynolo	13,375
8	3378-021-032	Nimia P. Ong & Teodora R. Santiago	13,375
9	3378-022-024	Roy J. & Frances C. Chang	13,375
10	3378-022-023	Mario & Jocelyn De Guzman, et al.	13,375
11	3378-022-022	Isidro C. Baquiran Jr. & Sandra Baquiran	13,375
12	3378-022-021	Ernesto P. & Segundina L. Beronilla	13,375
13	3378-023-001	Benedicto B. & L. G. Torres	8,800
14	3378-023-014	Ernesto & Erlinda Medel, et al.	8,800
15	3378-023-013	Burton H. Sander	8,800
16	3378-023-012	M. A. & Marian A. Ganoe	8,800
17	3378-023-005	Bolthouse Properties LLC	19,800
18	3378-024-006	Randy & Esther D. Dalugdugan	52,800
19	3378-005-006	Bolthouse Properties LLC	38,100
20	3378-005-005	Bolthouse Properties LLC	38,100
21	3378-005-004	Bolthouse Properties LLC	22,110
22	3378-003-012	Ronald Levey & Julie Fiorda	19,800
23	3378-003-010	B&R Land Developers Inc	9,900
24	3378-003-009	Southland Service Inc	9,900
25	3378-003-007	David Mednick & Lisa M. Owen	19,800
26	3378-005-004	Vacant Land	22,200
27	3378-003-008	Liu Huafen Li Delin Liu Hongwe	19,800
28	3378-020-033	Dennis & Geri Waer	10,436
		Total	528,548

Table 7-7: Easements Required for Recovery Well Sites

Well Number	Assessor Parcel Number	Owner	Area Needed (sq. ft)
RC-3	3378-020-026	Walter C. Mosauer & Eleanor C. Kravitz	22,500
RC-4	3378-023-005	Bolthouse Properties LLC	22,500
RC-6	3378-004-008	Bolthouse Properties LLC	22,500
RC-7	3378-004-032	IRA Services CSTDN ACEH Capital LLC	22,500
RC-8	3378-003-012	Ronald Levey & Julie Fiorda	22,500
RC-9	3378-005-001	Bolthouse Properties LLC	22,500
RC-10	3378-005-002	Bolthouse Properties LLC	22,500
RC-11	3378-005-006	Bolthouse Properties LLC	22,500
RC-12	3378-005-006	Bolthouse Properties LLC	22,500
RC-14	3378-010-009	Bienvenido S. Perez	22,500
RC-16	3378-012-001	Leo & June M. Hayashi	22,500
		Total	247,500

Section 8: Chlorination System

The chlorination system is located in the Chlorine Room at the southeast corner of the pump station. Layout of the Pump Station Building is shown on Figure 8-1. This system's primary purpose is to generate, store, and deliver the chlorine used for disinfection of the potable water produced by the Recovery Wells. The following section outlines the design parameters as well as the facility sizing details.

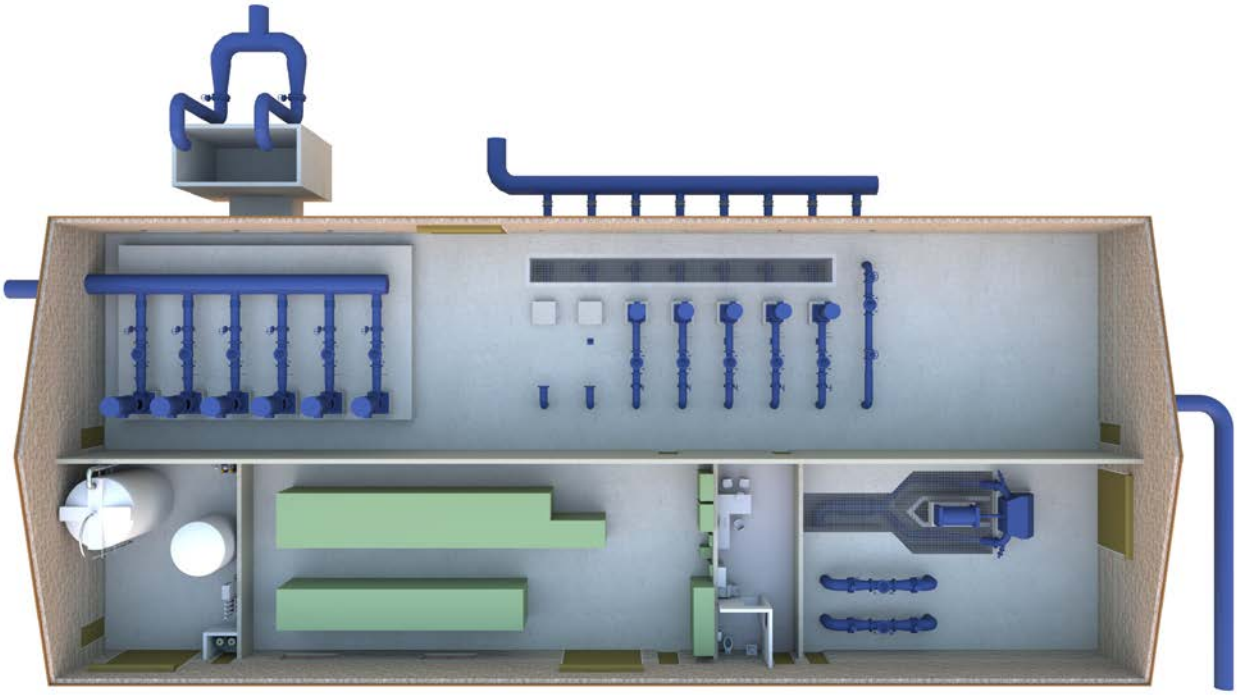


Figure 8-1: Layout of Pump Station Building

8.1 Design Criteria

The proposed Chlorine Room is designed to house an on-site sodium hypochlorite (hypo) generator and its appurtenances primarily to inject chlorine into the 30-inch diameter tank inlet pipeline, with chlorination of the 36-inch diameter tank by-pass pipeline in the event the tank is out of service. For the Phase 1 flow of up to 12,000 gpm and a maximum dose of 1.0 milligrams per liter (mg/L), 144 pounds per day (ppd) of chlorine equivalent is required. For the future ultimate (Phase 2) condition, the maximum potable water delivery increase to 15,000 gpm and 180 ppd of chlorine will be required. Using generator duty times of approximately 70 percent, or a maximum generator operation of roughly 17 hours per day, the proposed generator capacity for Phase 1 is 200 ppd, and for Phase 2 (year 2040) is 260 ppd. With a generator life of 20 years, the initial hypo generator can be replaced when the PWPS capacity is increased in Phase 2 of the Project. Design criteria are provided in Table 8-1.

Table 8-1: On-Site Hypo Generation Design Criteria

Parameter	Phase 1 Criteria	Ultimate Criteria
Maximum Flow (gpm)	12,000	15,000
Maximum Flow (MGD)	17.3	21.6
Maximum Chlorine Dose (ppm)	1.00	1.00
Maximum Chlorine Demand (ppd)	144	180
Proposed Generator Size (ppd)	200	260
Generator Duty Time (%)	72%	69%

Notes: MGD = million gallons per day

8.2 Facility Sizing

The chlorine generation system consists of a salt truck delivery/fill station, salt/brine storage tank, water softening system, skid-mounted hypo generation unit, hypo storage tank, hydrogen blower and vent system, chemical metering pumps, piping, and chemical injectors at the points of chlorine application. The facility sizing accommodates both Phase 1 and ultimate flows, although replacement equipment and tanks will be required over the life of the Project. The following paragraphs provide the placement and sizing of the primary components of the system.

The hypo system requires approximately 3 pounds of salt per pound of chlorine equivalent, meaning the site requires up to 432 pounds of salt to provide the maximum daily chlorine demand for Phase 1 flows. Since a full truck delivery of salt is 25 tons, a 35-ton brine saturation tank (10 feet in diameter and 13 feet tall) will provide approximately 4 months of storage between truck deliveries at the maximum Phase 1 use rate. Due to the freezing temperatures the site may encounter, the brine saturation tank is housed inside the Chlorine Room and is sized to incorporate saturation as well as storage, with a roll-up door large enough to replace the tank during the Project life. The truck delivery/fill station utilizes a 4-inch diameter stainless steel fill line stubbed through the exterior of the building to the top of the tank, and an 8-inch diameter PVC vent pipe extended to the exterior of the building, with a filter sack to minimize salt dust during filling operations.

From the saturation tank, the brine is fed along the wall through a 2-inch diameter pipeline to the hypo generation unit. The hypo generation unit pulls brine from the brine saturation tank as well as water from the feed water softening system, located in a separate closet. The closet lies at the northeast corner of the Chlorine Room and houses a 2-cylinder water softening system. This location permits access only from the exterior of the building, providing vendor access for the cylinders while maintaining security for the Chlorine Room.

The hypo generation unit pumps the brine and softened water through electrodes to produce the required hypo. At 0.8% hypo, double-wall containment is not required and the dilute hypo (bleach) is much less corrosive to pumps and piping than the alternative of bulk delivery of 12.5% hypo. The hypo generator skid will have a built-in programmable logic controller (PLC) control system, and most vendor systems operate with a constant current and variable brine feed to compensate for any scaling of the electrodes over time. Depending on the quality of salt used and soft water provided, as well as the usage rate, the generator electrodes typically need to be acid cleaned about once every six months. The daily material consumption of the hypo generation unit is provided in Table 8-2.

Table 8-2: Hypo Generation Daily Material Consumption at Maximum Capacity

Material	Phase 1 Consumption	Ultimate Consumption
Salt (lbs)	432	540
Power (kWh)	288	360
Water (gal)	2,160	2,700

Notes: gal = gallons; lbs = pounds

The generated hypo is stored in a 3,000-gallon capacity polyethylene tank (8 feet in diameter and 9 feet tall). At the maximum Phase 1 use rate of 2,160 gallons of hypo per day for 12,000 gpm at a dose of 1.0 mg/L, the 3,000-gallon tank has a storage capacity of 1.4 days. For future Phase 2 conditions, a slightly larger tank can be installed. The hypo tank is a single-walled tank, as double containment is not required for hypo at concentrations less than 1.0 percent. The hypo tank feeds a chemical metering pump skid with 1 duty plus 1 spare (1+1) metering pumps. The metering pump discharge is delivered to one of two injection points as described earlier.

A facility sizing summary is provided in Table 8-3.

Table 8-3: Facility Sizing Summary

Facility	Value
Salt Brine Saturator (tons)	35
Hypo Generation Unit (ppd)	200
Water Softening System (cylinders)	2
Hypo Storage Tank (gal)	3,000
Metering Pump Skid (pumps)	2

Section 9: Storage Tank

This section describes the Storage Tank, including the design criteria and chlorine contact time.

9.1 Design Criteria

Groundwater that is to meet potable water requirements is pumped into the Storage Tank. The design criteria for the Storage Tank are detailed in Table 9-1.

Table 9-1: Storage Tank Design Criteria

Parameter	Value
Storage Volume (MG)	1
Diameter (ft)	88
Maximum Water Height (ft)	22
Bottom Elevation (ft)	2552
Overflow Elevation (ft)	2574
Top of Tank Shell Elevation (ft)	2576
Top of Knuckle Plate Elevation (ft)	2579
Overflow Cone Weir Diameter (in)	54
Overflow Pipe Diameter (in)	24
Inlet Pipe Diameter (in)	30
Outlet Pipe Diameter (in)	30
Tank Bypass Pipe Diameter (in)	36

9.2 Description

The purpose of the Storage Tank is threefold:

1) **Disinfection:** Chlorine, which is generated on-site in the form of sodium hypochlorite, is injected into the 30-inch diameter tank inlet. The Storage Tank is sized, and the inlet and outlet pipes are designed to meet the required chlorine contact time for disinfection (see Section 9.3).

2) **Pump Can Pressurization:** The water level of the Storage Tank provides static head, and therefore pressurization, of the pump cans for the PWPS vertical turbine pumps in the Pump Station Building.

3) **Return Water Air Gap:** The water level of the Storage Tank provides sufficient head for the operation of the return water air gap piping, control valves, and structure that serve the RWPS wet well in the Pump Station Building.

Designing the Storage Tank to provide disinfection and supply the pump stations with a supply buffer to account for operational fluctuations yields a tank that is 88 feet in diameter and 22 feet in water height. The Storage Tank will be constructed of welded steel that is epoxy coated for corrosion and solar protection. The inlet and outlet pipe connections will be above grade and

contain a double ball valve expansion joint to allow for seismic motion. A stairwell is provided on the side of the Storage Tank for access to the roof hatch. A 54-inch diameter overflow cone inside the reservoir is set at the maximum water height so that when the water level reaches that height, water overflows with minimal additional height into the 54-inch diameter cone and out the 24-inch diameter standpipe and pipeline, which carries the water through an air gap into the Distribution Box.

9.3 Chlorine Contact Time

The two important factors for disinfection are the concentration of the disinfectant residual and the contact time. Assuming a water depth of 8 feet in the tank for chlorine contact time, the available volume of water is 360,000 gallons. Operating the lower portion of the Storage Tank for chlorine contact time credit allows the remaining 14 feet of water height to be available for operational variability.

Using the U.S. Environmental Protection Agency's (USEPA) Guidance Manual for disinfection, the 4 log virus inactivation value with free chlorine at 15°C yields a required chlorine contact value of 4 mg/L-min. The 15°C temperature of the water is anticipated to be the coldest water entering the Storage Tank throughout the year. Additionally, the 4 log value is the most conservative removal/inactivation value.

A baffling factor of 0.25 is assumed based upon the orientation of the tank inlet and outlet, where the inlet enters the tank and has a 90 degree bend west and the outlet is located 270 degrees radially away from the inlet. A factor of 0.10 assumes a straight path of travel though the tank, and 0.6 assumes baffles are installed to increase mixing. The assumed value of 0.25 falls within these two extremes.

Finally, two flow rates are considered in this analysis: 12,000 gpm and 15,030 gpm. The first flow rate of 12,000 gpm is the maximum that is pumped back to PWD's distribution system in Phase 1. Using this value and the parameters discussed above, Table 9-2 details the required chlorine dosage rate and the actual chlorine CT provided. A tank outlet residual of 0.65 mg/L yields an actual CT of 4.8 mg/L-min, which is 1.2 times higher than the required CT of 4 mg/L-min. The additional 20% is a factor of safety.

The chlorination system is sized to provide a maximum chlorine dose of 1.0 mg/L, but an average dose of 0.80 mg/L is anticipated, and should yield a tank outlet on the order of 0.70 mg/L.

Table 9-2: Chlorine Contact Time Calculations for 12,000 gpm

Variable	Value	Unit
CT Value, 4 log Virus Inactivation @ 15°C	4	mg/L-min
Volume of Water @ 8 ft	360,000	gal
Chlorine Contact Time @ 12,000 gpm	30	min
Baffling Factor	0.25	-
T_{10}/T	7.5	min
Chlorine Residual	0.65	mg/L
Actual CT Value	4.8	mg/L-min

Variable	Value	Unit
Factor of Safety	1.2	-

Notes: CT = disinfectant concentration x time, mg/L-min

At the ultimate potable water delivery through the PWPS of 15,030 gpm, PWD can still meet the 4-log CT by either increasing the chlorine residual or operating the tank at a slightly higher minimum water level (greater volume). As detailed in Table 9-3 the higher flow requires a higher chlorine residual of 0.80 mg/L to obtain the same 4.8 mg/L-min CT value. As detailed in Table 9-4, the higher flow requires a greater reservoir volume (minimum water level of 9.8 feet) with a residual of 0.65 mg/L to obtain the same 4.8 mg/L-min CT value. Both options continue to provide a 20% factor of safety for the 4-log CT value.

Table 9-3 Chlorine Contact Time Calculations for 15,030 gpm w/ Higher Chlorine Residual

Variable	Value	Unit
Ct Value, 4 log Virus Inactivation @ 15°C	4	mg/L-min
Volume of Water @ 8 ft	360,000	gal
Chlorine Contact Time @ 15,030 gpm	24	min
Baffling Factor	0.25	-
T_{10}/T	6.0	min
Chlorine Dosage	0.80	mg/L
Actual CT Value	4.8	mg/L-min
Factor of Safety	1.2	-

Table 9-4 : Chlorine Contact Time Calculations for 15,030 gpm w/ Greater Reservoir Volume

Variable	Value	Unit
Ct Value, 4 log Virus Inactivation @ 15°C	4	mg/L-min
Volume of Water @ 9.8 ft	445,000	gal
Chlorine Contact Time @ 15,030 gpm	29.6	min
Baffling Factor	0.25	-
T_{10}/T	7.4	min
Chlorine Dosage	0.65	mg/L
Actual CT Value	4.8	mg/L-min
Factor of Safety	1.2	-

Section 10: Potable Water Pump Station

The Potable Water Pump Station is a seven pump system used to convey the potable water from the Storage Tank to the PWD distribution pipeline's point of connection to the 2800 Zone. This section outlines the design of the PWPS.

10.1 Hydraulic Analysis

The design parameters for the proposed PWPS are shown in Table 10-1. This station offers a unique conversion from Phase 1 to ultimate conditions, taking into consideration the required future increased total dynamic head due to the higher head loss through the relatively long (9.2 mile) 30-inch diameter transmission pipeline. Initially, the pumps are sized for 3,000 gpm at 369 feet TDH with 400-HP motors, and in the future, the same pump cans and 400-HP motors will serve pumps sized for 2,500 gpm at 445 feet TDH. This transition can be accomplished using the same pumps, but with a different trim or number of stages to maintain the optimum pump efficiency.

Table 10-1: Potable Water Pump Station Design Criteria

	Distribution System	Distribution System (Ultimate)
Demand (AF/yr)	19,125 [a]	24,250
Flow (gpm)	11,856	15,030
Potable Water Pipeline Diameter (in)	30	30
Full Flow Velocity (fps)	5.4	6.8
Discharge Piping Length (mi)	9.2	9.2
Pump Station Suction Elevation (ft)	2,567[b]	2,567[b]
Static HGL (ft)	2,800	2,800
Static Head (ft)	233	233
Frictional Head Loss[c] (ft)	130	204
Minor Head Loss (ft)	6	8
TDH (ft)	369	445
Pump Capacity (gpm)	3,000	2,500
Required HP	349	351
Motor Size (HP)	400	400
Number of Pumps	4+1	6+1

Notes:
(a) The Phase 1 potable water demand of 14,125 AF/yr is increased to 19,125 AF/yr to enable PWD to deliver up to 5,000 AF/yr to neighboring water agencies through its potable water system; thus, the 4+1 pump configuration could be considered as a 3+2 configuration with regard to PWD's system reliability.
(b) The target operating water level of the Storage Tank (PWPS suction) is 15 feet or 2,567 feet.
(c) Hazen-Williams roughness coefficient assumed to be 135.

10.2 Facility Sizing

The PWPS lies at the center of the pump room within the Pump Station Building, with additional space provided directly north to be used as determined by PWD. The PWPS consists of 7

vertical turbine pumps, 2 of which are for future expansion. For the future pumps, the pump cans, underground piping, and valves will be installed initially, but not the pumps, motors, or VFDs. The following sections denote the design process and sizing for the PWPS. An artist rendering of the initial phase of the PWPS is presented in Figure 10-1.

Figure 10-1: Artist Rendering of Return Water Pump Station

10.2.1 Pump Design

Prior to this report, Kennedy/Jenks conducted a Pump Station Alternatives Analysis in order to assist in the selection process between vertical turbine pumps and horizontal centrifugal pumps. This analysis resulted in the recommendation of vertical turbine pumps, which has been selected by PWD to be used within this PDR. The full technical memorandum documenting this analysis is located in Appendix B.

Vertical turbine pumps are advantageous in their use of pump bowls, which enables them to successively place multiple impellers in series. This aspect of the pumps allows their design to be adaptable to whatever head/flow combination they may experience while maintaining a slight efficiency advantage over comparable centrifugal pumps in this size range. For the PWPS, the pumps will provide further adaptability through the use of VFDs. The pumps are sized for 400-HP motors at a voltage of 4160v. Other electrical aspects of the pump station are discussed in Section 12.

In order to accommodate the pump column, a vertical turbine pump is required to be housed either in a wet well or a pump can. Whereas a wet well provides water storage, a pump can is able to be pressurized. The pressurized pump can is advantageous for ground-level pumps in

order to take advantage of the additional suction head available from the tank water level. As such, the PWPS utilizes pump cans, allowing pressurized water to flow from the tank into the pump cans.

10.2.2 Conveyance

Potable water is transferred from the Storage Tank to the PWPS through a 30-inch diameter tank outlet to a 36-inch diameter suction header. The header splits into seven 16-inch diameter suction pipelines, which run through the valve sump. The valve sump houses a single isolation butterfly valve for each suction pipeline, which continues to the PWPS pump cans.

Each pump discharges water through a 14-inch diameter discharge pipeline, past an air/vacuum valve, through a check valve, through a butterfly valve, which then bends 90 degrees down into a 30-inch diameter below grade discharge header. The discharge header then proceeds north out of the building, then east leaving the Distribution Site, then south on 105th Street East.

Included within the PWPS is a single pressure relief pipeline. In a high pressure event, water will be able to run back upstream from the discharge header through this 12-inch diameter pipeline. The bypass pipeline includes two gate valves on either side of a single pressure relief valve, which is mechanically self-actuated only as a safety measure in a high pressure event.

The pipeline sizing and accompanying velocities are provided in Table 10-2.

Table 10-2: Potable Water Pump Station Pipeline Design

Pipeline	Size (in)	Phase 1 Velocity (fps)	Ultimate Velocity (fps)
Suction Header	36	3.7	4.7
Suction Pipeline	16	4.8	4.0
Discharge Pipeline	14	6.3	5.2
Discharge Header	30	5.4	6.8

Section 11: Return Water Pump Station

The Return Water Pump Station is a six pump system used to pump un-disinfected potable water from the Well Collection Pipeline to the East Branch of the California Aqueduct. This section outlines the design of the RWPS.

As described in Section 1.1, the RWPS is optional and not required to be implemented until a water banking partnership is established that requires conveying extracted groundwater back to the East Branch of the California Aqueduct; thus, the name "Return Water Pump Station".

11.1 Hydraulic Analysis

The design parameters for the proposed RWPS are shown in Table 11-1.

Table 11-1: Return Water Pump Station Design Criteria

	Return Water System
Demand (AF/yr)	30,000
Flow (gpm)	18,597
Diameter (in)	36
Full Flow Velocity (fps)	5.9
Discharge Piping Length (mi)	8.6
Pump Station Suction Elevation (ft)	2,550[a]
Static HGL (ft)	2,943
Static Head (ft)	393
Frictional Head Loss[b] (ft)	119
Minor Head Loss (ft)	14
TDH (ft)	520+/-
Pump Capacity (gpm)	3,720
Required HP	617
Motor Size (HP)	700
Number of Pumps	5+1

Note:
(a) The target operating water level of the wet well (RWPS suction) is estimated to be just below grade or approximately 2,550 feet.
(b) Hazen-Williams roughness coefficient assumed to be 135.

11.2 Facility Sizing

The RWPS lies at the southern end of the pump room within the Pump Station Building. The station consists of 6 vertical turbine pumps, which are expected to be installed with the assistance of partner agencies that require the return of banked water to the East Branch of the California Aqueduct. The following sections denote the design process and sizing for the RWPS. An artist rendering of the RWPS is presented in Figure 11-1.

Figure 11-1: Artist Rendering of Return Water Pump Station

11.2.1 Pump Design

The RWPS conveys non-disinfected potable water to the East Branch of the California Aqueduct for use by potential partner agencies. Since the RWPS delivers water back through the 8.6-mile 36-inch diameter Raw Water/Return Water Pipeline, an air gap is used to provide cross-connection control to separate the return water system from the potable system. The air gap requires storage for the RWPS pumps and is supplemented by a rectangular cast-in-place concrete wet well sized to store a minimum of 75,000 gallons. This sizing provides approximately 10 minutes of operational storage for a single return water pump or 2 minutes for the maximum 5-pump flow.

Unlike pump cans, the wet well is not pressurized. In order to minimize the head loss between the operating Storage Tank level through the air gap to the wet well operating water surface, the roof of the wet well is elevated approximately 2 feet above the finished pump room floor elevation, which enables the water level to lie close to grade elevation. Furthermore, placing the wet well slightly above grade enables its overflow to be designed to discharge outside of the pump station at grade. The drainage location of the overflow will be determined in final design.

The RWPS discharge header connection to the 36-inch diameter Raw Water/Return Water Pipeline connects the RWPS to the Hydro-turbine Room, discussed in Section 5. Housed within the Hydro-turbine Room are two pressure relief pipelines, which serve the dual purpose of providing by-pass capability to the turbine during recharge operations as well as pressure relief to the RWPS during pump back, negating the need for a pressure relief pipeline within the pump room for the RWPS.

Similarly to the PWPS, the RWPS pumps will provide further adaptability through the use of VFDs. The pumps are sized to operate with 700-HP motors at a voltage of 4160v. Other electrical aspects of the pump station are discussed in Section 12.

11.2.2 Conveyance

Non-disinfected potable water is transferred from the Recovery Wells to the air gap through a 36-inch diameter pipeline that by-passes the Storage Tank. The pipeline splits and reduces into two 24-inch diameter pipes. Each 24-inch diameter pipe then reduces to 18-inch diameter to house 18-inch diameter modulating plug valves, designed to throttle the water flowing to the Return Water Wet Well. Downstream of the plug valves, the pipelines enlarge to two 24-inch diameter pipes, which elbow vertically for connection to two 90-degree elbows to form an air gap over an Air Gap Structure. The air gap is required to be 48 inches (two diameters) above the highest possible water elevation of the structure to provide cross-connection control.

The Air Gap Structure is an 18-foot by 8-foot box designed to capture the discharge from the dual 24-inch diameter air gap pipes. The structure extends below grade, where it runs east through a 12-foot by 4-foot wet well channel. The channel is designed to operate submerged while providing less than 1 fps velocity to the pumps at full flow. The low velocity was chosen based on Hydraulic Institute Standards for pump sump design and mitigates the chance of vortexing within the wet well. The channel terminates at the wet well, where the water flows through the pumps to the discharge system.

Each of the six pumps discharge through a 16-inch diameter discharge pipeline, past an air/vacuum valve, through a check valve, through a butterfly valve, and into an above grade 36-inch diameter discharge header. The discharge header proceeds south through the wall, beyond which it elbows below grade, elbows east around the pump station building, connecting to the 36-inch diameter Raw Water/Return Water Pipeline for conveyance to the East Branch of the California Aqueduct.

The pipeline sizing and accompanying velocities are provided in Table 11-2.

Table 11-2: Raw Water Pump Station Conveyance Design

Pipeline	Size (in)	Velocity (fps)
Non-Disinfected Potable	36	5.8
Wet Well Channel	144x48	0.9
Discharge Pipeline	16	5.9
Discharge Header	36	5.8

Section 12: Electrical

This section denotes the electrical considerations and design for the Project.

12.1 Recovery Wells

A pad mounted transformer will be required to provide electrical service for each Recovery Well, including a metering switchboard at 480V. Southern California Edison (SCE) will be coordinated with during detailed design to confirm availability of service, transformer sizing, and location(s). The well pump motor horsepower will range from 200- to 250-HP per well, with a VFD and solenoid-actuated pump control valves controlling the pumps. The Variable Frequency Drive (VFD) assists the pump in remaining at an optimal point on the system head curve by increasing or decreasing the rotational speed of the motor, as well as enabling automation of the production flow rate to maintain a steady level in either the RWPS wet well or PWPS Storage Tank. The solenoid-actuated pump control valves are used for both the blow off and discharge pipelines in order to automate the startup/blow off sequence.

12.2 Pump Station

The RWPS and PWPS utilize a single electrical room located at the eastern center of the Pump Station Building. The electrical room is designed to house 13 VFDs (2 future), 2 transformers, 2 Programmable Logic Controller (PLC) cabinets, a lighting panel, a power panel, a switchgear, and a motor control center (MCC).

The layout of the Electrical Room is shown on Drawing M2 (Volume 2), and an Electrical Legend and Electrical Single Line Diagram are shown on Drawings E1 and E2 in Volume 2, respectively.

Due to the high power demand of the pump stations, the local utility will require it to be fed at medium voltage (MV). The use of MV necessitates the use of a 4160V system due to the availability of MV switchgear, MV drives, and MV motors for this operating voltage. Utility service will consist of two transformers with associated primary fusing and switching, power factor correction capacitors, and MV metering cabinets, all of which will be located outdoors in a fenced substation enclosure.

The two utility feeds will terminate at opposing ends of a double-ended, metal clad MV switchgear lineup, sized for 4160V and 1200A.The switchgear will be located indoors, in a NEMA 1 enclosure using a “main-tie-main” configuration, which improves reliability and maintainability by allowing half of the gear to be isolated while still running part of the facility. The switchgear will contain MV circuit breakers to feed each of the 11 MV VFDs, plus two circuit breakers for future MV VFDs and two circuit breakers to feed step-down transformers.

The two 4160-480V step-down transformers located within the Electrical Room will be sized to supply the 480V electrical needs of the facility through a 480V, double ended “main-tie-main” MCC. The control center will facilitate the motor operated valves, chlorine system, as well as heating, ventilating, and air conditioning (HVAC). The MCC will also control the two transformers for instrumentation, lighting, receptacle, and miscellaneous small loads; the single

well site located directly southwest of the Distribution Site; and serve as the connection point for the turbine-generator.

Utilizing MV can be advantageous in multiple ways. The higher voltage keeps operating (and hence, fault) currents much lower. Lower currents result in much smaller cabling and conduit requirements, which eliminates the need for parallel cabling runs to each motor and making installation easier. Furthermore, MV drives typically have harmonic mitigation measures built-in, which is advantageous over low voltage (LV) drives that often require additional equipment to counter harmful harmonic currents.

Section 13: Opinion of Probable Construction Cost

This section describes the Opinion of Probable Construction Cost for the Project, presenting estimates for several groups of infrastructure as well as the two Project phases of work (Phase 1 and Phase 2).

13.1 Engineer's Estimate

The preliminary (10%) design level Opinion of Probable Construction Cost for the Project is $78.4 million without a contingency and in current dollars. With a 15% contingency, the Opinion of Probable Construction Cost increases to $90.2 million. For capital planning, 15% should be added for Engineering Design and Construction Management; thus, the total funding requirement is $103.7 million. This total is broken down into two phases: $85.4 million and $18.3 million as described below.

The detailed costs are presented in Appendix C and broken out for each of 17 specification divisions. The Division 1 cost for mobilization/demobilization is assumed to be 7% of the total cost before markups are applied. The following markups are assumed for the Opinion of Probable Construction Cost:

- Contractor's Markup on Subs: 10%
- Taxes (Los Angeles County): 9.00%
- Contractor's Overhead and Profit: 12%
- Contingency: 15%
- Escalation: 2% per year

The Opinion of Probable Construction Cost, which is based on the preliminary design, is a Class 4 in accordance with American Association of Cost Engineers. A Class 4 contains an assumed accuracy of +30% to -15% of the actual cost of the Project.

The Project phasing for each of the major infrastructure categories is summarized in Table 13-1. The cost estimate for the two phases of well drilling and installation, with 8 Recovery Wells in each phase, includes the construction of five temporary percolation ponds and use of temporary piping for step testing and constant rate testing of each well. If all 16 Recovery Wells are constructed in a single phase, then the temporary facilities would only be required once, and a savings of approximately $200,000 would be realized.

Table 13-1: Construction Phasing by Category of Infrastructure

Infrastructure	Phase 1	Phase 2*
Well Drilling	8 Recovery Wells	8 Recovery Wells
Well Equipping, Site Work, and Buildings	8 Recovery Wells	8 Recovery Wells

Infrastructure	Phase 1	Phase 2*
Recharge Site	All	
Pipelines	All, except 1,680 linear feet (LF) of 12-inch diameter Well Collection Pipeline	1,680 LF of 12-inch diameter Well Collection Pipeline from RW-9 to RW-10
Distribution Site	All, except RWPS mechanical and electrical. Air Gap Structure and Return Water Wet Well included in Phase 1	RWPS air gap piping, modulating plug valves, pumps, motors, discharge piping and appurtenances, discharge header, VFD panels, electrical cables, and control wiring

* Phase 2 or work to be initiated for water banking partners.

A summary of the Opinion of Probable Construction Cost is presented below in Table 13-2.

Table 13-2: Opinion of Probable Construction Costs by Phase

Infrastructure	Phase 1	Phase 2*	Total
Well Drilling	$5,470,000	$5,470,000	$10,940,000
Well Equipping, Site Work, and Buildings	$6,060,000	$6,050,000	$12,110,000
Recharge Site	$9,170,000	$0	$9,170,000
Pipelines	$39,430,00	$170,000	$39,600,000
Distribution Site	$14,080,000	$4,300,000	$18,380,000
Subtotal	*$74,250,000*	*$15,950,000*	*$90,200,000*
Design and Construction Management	$11,140,000	$2,390,000	$13,530,000
Total**	**$85,390,000**	**$18,340,000**	**$103,730,000**

* Phase 2 or work to be initiated for water banking partners.
** Includes $2,750,000 in Phase 1 for the hydro-turbine, which could be considered optional.

Section 14: Permitting

Permitting for the Project will be significant due to the indirect potable reuse of the recycled water and the multiple jurisdictions the transmission pipelines pass through.

14.1 Construction Permits - Local and State

The following permits are anticipated to be required by local agencies:

- Los Angeles County Well Drilling Permit for well drilling
- Los Angeles County Well Operating Permit for well operation
- Los Angeles County Encroachment Permit for pipeline construction in right-of-ways
- Palmdale City Traffic Control Permit for traffic control during pipeline construction
- Union Pacific Encroachment Permit for pipeline crossing

The following permits are anticipated to be required for construction by State agencies:

- Site specific Storm Water Pollution Prevention Plan (SWPPP) prepared by the various construction contractors
- DWR Encroachment Permit for turnout construction
- Occupational Safety and Health Administration (OSHA) Underground Classification Permit for jack and bore

14.2 State Permitting for Groundwater Replenishment Using Recycled Water

In 2009, the State of California adopted Resolution No. 2009-0011 with the goal of increasing the use of recycled water in the state. Within the revised Water Code, Section 13521 requires the California Department of Public Health (CDPH) to develop uniform recycled water criteria as it relates to public health protection. This task was reassigned to the SWRCB DDW. The permit for the indirect potable reuse of recycled water will be managed by the Lahonton Regional Water Quality Control Board (Lahonton RWQCB), which requires the submission of a Report of Waste Discharge for discharging recycled water for ground water recharge via surface spreading. The Title 22 Engineering Report will support the Report of Waste Discharge by demonstrating how the project complies with the Title 22 Groundwater Replenishment Using Recycled Water Regulations adopted on June 18, 2014. Approval of the Title 22 Engineering Report must be obtained from both DDW and RWQCB, with the RWQCB the permitting agency.

Kennedy/Jenks will prepare the Title 22 Engineering Report for submission first to the SWRCB DDW for preliminary approval, and then to the RWQCB. The report will describe the existing

LACSD Palmdale Regional Reclamation Plant treatment process, the SWP Water supply as the blending source, groundwater spreading facilities, groundwater residence time, distance to the Recovery Wells, distance to existing potable wells, and related information. The current Title 22 report for the LACSD Palmdale Water Reclamation Plant will be referenced or included as an appendix, at the discretion of the DDW and RWQCB. Kennedy/Jenks will summarize information from the Antelope Valley Integrated Water Management Plan, Salt and Nutrient Management Plan, and Lahonton RWQCB Basin Plan. Kennedy/Jenks will prepare an anti-degradation analysis to demonstrate that the proposed Project complies with the basin plan objectives.

In this effort, Kennedy/Jenks will demonstrate to DDW and the RWQCB that the proposed groundwater recharge Project, system redundancy, groundwater monitoring and contingency plans meet Title 22 and all DDW permitting requirements, with the anticipation that the Project can be successfully permitted during the design phase.

The Title 22 Engineering Report will include the following elements:

- Project Overview
    - Background
    - Project location
    - Project history
    - Project description
    - Responsible parties
    - Purpose of this report
- Sources of water
    - State Water Project supply
        - Water quality
        - Water quantity and supply reliability
    - LACSD Palmdale Water Reclamation Plant
        - Recycled water quantity and quality
- Water quality standards and treatment requirements
- Water reclamation facility description
    - Wastewater characteristics
- Groundwater basin description
    - Hydrogeology
    - Existing groundwater quality
    - Basin plan objectives
- Groundwater recharge facilities
    - Water supply source blending
    - Groundwater modeling
    - Recharge water retention time
- Groundwater wells
    - Existing wells and proximity to recharge basin(s)
    - New wells
- Groundwater recharge and reuse system monitoring and reporting program
    - Monitoring provisions
    - Groundwater monitoring
    - Extraction well water quality monitoring

    - Reporting
- Contingency plan

Once the project is approved by the DDW and RWQCB, and a permit is issued by RWQCB, PWD will submit an application for a Domestic Water Supply Permit Amendment to add the new Recovery Wells, Distribution Site (including chlorination), and Potable Water Pipeline to its water system facilities and Operations Plan.

14.3 California Environmental Quality Act

The California Environmental Quality Act (CEQA) requires every project proposed in the state of California to be examined for potential effects on the environment. An EIR is currently being prepared for the Project by Helix, as a sub-consultant to Kennedy/Jenks. For each topic to be evaluated in detail in the EIR, the discussion will include a description of baseline conditions, significance criteria, impact analysis, and measures (as applicable) to avoid, minimize, or mitigate impacts on the environment to less than significant levels. Topics that will be analyzed in detail are as follows:

- Air quality
- Biological resources
- Cultural resources
- Geology and soils
- Greenhouse gas emissions and climate change
- Groundwater and Surface water hydrology, and water quality
- Noise

The report will be provided under separate cover. The findings and mitigation measures will be incorporated in the final design phase of the Project.

Since PWD may be seeking SWRCB Clean Water State Revolving Fund (SRF) program funds for the Project, and because the SRF Program is partially funded by the USEPA, the Project requires compliance not only with CEQA, but also with federal regulations such as the Clean Air Act, Endangered Species Act, and National Historic Preservation Act Section 106 as part of the SWRCB's CEQA-Plus requirements. Based on Helix's existing scope for the Project that includes the Federal process described below, the technical studies currently being prepared for the Project will address the applicable Federal components required for analysis as part of the CEQA Plus scope. PWD will submit the required documents to the SWRCB, who in turn, will distribute the submittal package to the appropriate federal agencies for a 30-day review as required by the CEQA-Plus process. This distribution is in addition to the standard State Clearinghouse public review requirements under CEQA.

14.4 Federal National Environmental Protection Act

Because PWD is seeking federal funding through the U.S. Department of Interior Bureau of Reclamation (Reclamation) for the Project, the Project must comply with the National Environmental Policy Act (NEPA). Therefore, Helix will also be preparing two separate documents: one EIR under CEQA and one Environmental Assessment (EA)/Finding of No Significant Impact (FONSI) under NEPA. The preparation of two stand-alone documents will allow PWD to review, finalize, and approve the EIR (in which PWD will be the lead agency) at a more accelerated rate than if a joint NEPA/CEQA document (in which both PWD and Reclamation will be lead agencies) is prepared. Under this scenario, the CEQA document's approval will not be held up by Reclamation if it is reviewing and processing a joint NEPA/CEQA document.

In addition, to comply with federal requirements, the project will require a National Historic Preservation Act (NHPA) Section 106 Consultation with the State Historic Preservation Officer (SHPO).

Section 15: Next Steps & Implementation Schedule

This section describes the next steps required for implementation of the proposed Project facilities, including a summary of recommended additional studies, design and construction packaging, and implementation schedule.

15.1 Additional Studies

The next step in implementation of the Project is to utilize the PDR to develop contract documents for the proposed facilities. Several studies are recommended to inform the design development in the next phase, including:

- Full-scale infiltration test – to confirm design recharge rate.
- Geotechnical Investigation – to incorporate site-specific sub-surface considerations for all Project facilities.
- Surge Analysis – to develop design of the surge tank that will be located at the Distribution Site for protection of the Raw Water/Return Water Pipeline.
- Corrosion Evaluation – to develop cathodic protection design for all pipelines.
- Potholing – to further develop design of all pipelines by identifying potential utility conflicts.

In addition, it is recommended to install several monitoring wells in or around the Recharge Site and institute a quarterly groundwater sampling program to collect at least two years of background water quality data in the Lancaster Sub-basin. This data will be required to obtain permitting approval from the Lahontan RWQCB.

15.2 Design & Construction Packaging

It is anticipated that the Project facilities will be divided into six design/construction packages that can be bid individually. This division will allow multiple facilities to be constructed in parallel, which will reduce the overall construction schedule. It will also foster a more competitive bidding environment by allowing more firms to compete on smaller individual packages, which will potentially reduce overall construction cost. The design/construction packages are as follows:

- Well Drilling
- Well Equipping
- Large Pipelines, including:
    - Raw Water/Return Water Pipeline

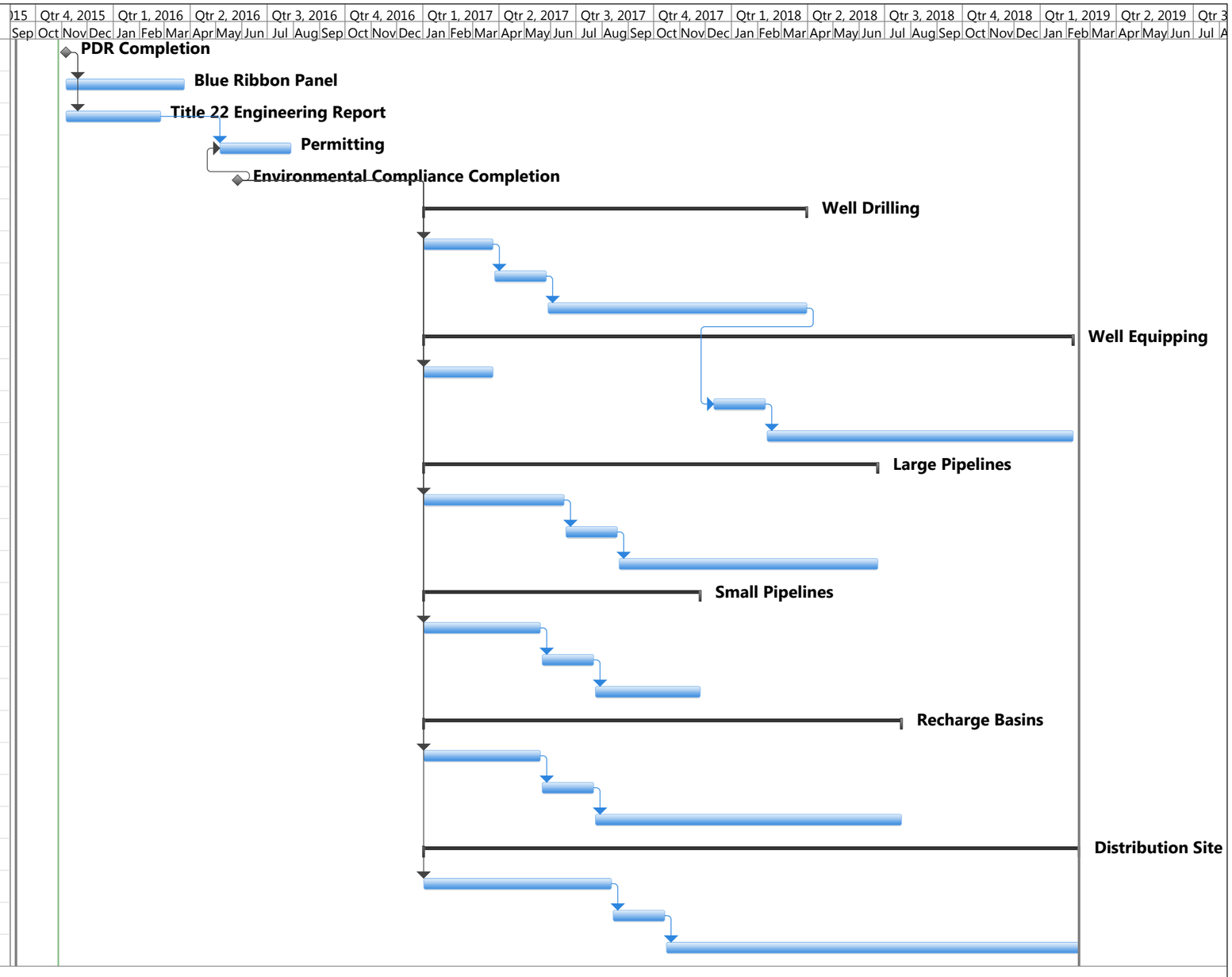
    - Potable Water Pipeline
    - Recycled Water Turnout and Recycled Water Pipeline
    - SWP Turnout
- Small Pipelines, consisting of the well collection pipelines
- Recharge Basins
- Distribution Site, consisting of all of the facilities located at the Distribution Site, including:
    - Potable Water Pump Station
    - Return Water Pump Station
    - Pump Station Building
    - Storage Tank
    - Hydro-turbine

15.3 Implementation Schedule

A proposed facility design & construction schedule is provided as Figure 15-1. It is anticipated that after the completion of this report, the focus will be to complete the Blue Ribbon Panel assessment and Title 22 Engineering Report. Environmental compliance and public outreach work will continue to be developed with an anticipated completion date of May 2016. The permitting work can begin after the completion of the Title 22 Engineering Report and just prior to the completion of the environmental compliance work.

It is assumed that development of the contract documents will begin after the environmental compliance task is completed. PWD has the option to start the design development earlier in order to expedite implementation of the Project. Most of the facility packages will be designed, bid, and constructed in parallel. The only exception is the well equipping, which will need to follow the completion of the well drilling. All of the facilities are anticipated to be constructed by February 2019.

ID	Task Name	Duration	Start	Finish
1	PDR Completion	0 days	Fri 11/6/15	Fri 11/6/15
2	Blue Ribbon Panel	100 days	Fri 11/6/15	Thu 3/24/16
3	Title 22 Engineering Report	80 days	Fri 11/6/15	Thu 2/25/16
4	Permitting	60 days	Fri 5/6/16	Thu 7/28/16
5	Environmental Compliance Completion	0 days	Fri 5/27/16	Fri 5/27/16
6	**Well Drilling**	**325 days**	**Mon 1/2/17**	**Fri 3/30/18**
7	Design	60 days	Mon 1/2/17	Fri 3/24/17
8	Bid	45 days	Mon 3/27/17	Fri 5/26/17
9	Construction	220 days	Mon 5/29/17	Fri 3/30/18
10	**Well Equipping**	**550 days**	**Mon 1/2/17**	**Fri 2/8/19**
11	Design	60 days	Mon 1/2/17	Fri 3/24/17
12	Bid	45 days	Mon 12/11/17	Fri 2/9/18
13	Construction	260 days	Mon 2/12/18	Fri 2/8/19
14	**Large Pipelines**	**385 days**	**Mon 1/2/17**	**Fri 6/22/18**
15	Design	120 days	Mon 1/2/17	Fri 6/16/17
16	Bid	45 days	Mon 6/19/17	Fri 8/18/17
17	Construction	220 days	Mon 8/21/17	Fri 6/22/18
18	**Small Pipelines**	**235 days**	**Mon 1/2/17**	**Fri 11/24/17**
19	Design	100 days	Mon 1/2/17	Fri 5/19/17
20	Bid	45 days	Mon 5/22/17	Fri 7/21/17
21	Construction	90 days	Mon 7/24/17	Fri 11/24/17
22	**Recharge Basins**	**405 days**	**Mon 1/2/17**	**Fri 7/20/18**
23	Design	100 days	Mon 1/2/17	Fri 5/19/17
24	Bid	45 days	Mon 5/22/17	Fri 7/21/17
25	Construction	260 days	Mon 7/24/17	Fri 7/20/18
26	**Distribution Site**	**555 days**	**Mon 1/2/17**	**Fri 2/15/19**
27	Design	160 days	Mon 1/2/17	Fri 8/11/17
28	Bid	45 days	Mon 8/14/17	Fri 10/13/17
29	Construction	350 days	Mon 10/16/17	Fri 2/15/19



Project: 16_Schedule_v1
Date: Wed 10/28/15

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone

Figure 15-1: Implementation Schedule

Appendix A

Overview of Turnout Authorization and Acceptance Procedures

Overview of Turnout Authorization and Acceptance Procedures

The list below describes the general steps required for the Department of Water Resources (DWR) to authorize and administer construction of a new permanent turnout on the State Water Project (SWP) by a SWP contractor:

1. The contractor submits a written request to DWR providing a description of the proposed turnout project including the following information:
   - Conceptual plan and profile of the turnout facilities;
   - Anticipated maximum and minimum flow rates in cubic-feet-per-second;
   - Anticipated maximum monthly water delivery in acre-feet;
   - Estimated start date for water delivery through the permanent turnout; and
   - Authorization for DWR to bill the contractor for review costs incurred by DWR.

     Initially, DWR requests authorization of $60,000 to complete the project. Recently completed projects, over the past several years, have varied between $40,000 to in excess of $400,000. Depending on the complexity of the project, changes or additions to project plans may result in additional review time and costs. DWR will inform the SWP contractor if charges are approaching the estimated amount so that additional costs may be authorized by the SWP contractor, if necessary.

2. Upon receipt of the written authorization, DWR will set up a chargeable account to track all work performed and will assign staff reviewers. Staff review of the initial request will generally include consideration of the following:
   - Feasibility of the turnout location;
   - All features and structures of the turnout connection;
   - Anticipated construction activities within the SWP right of way;
   - Access roads required during construction, operation and maintenance phases;
   - Access to an electric power source;
   - Hydraulic devices and their appurtenances; and
   - Operational and hydraulic analyses related to the effects on the integrity of the California Aqueduct.

3. DWR requires approximately four to six weeks to review the conceptual plans and specifications. DWR will provide comments to the contractor regarding the proposed turnout upon completion of review of the conceptual plans and specifications. If subsequent submittals are required, additional review time will be required for each submittal. DWR staff will provide written comments upon completion of each review. Subsequent submittals, depending on the extent of additional work involved, may require an increase in the funding authorization.

Overview of Turnout Authorization and Acceptance Procedures

4. The contractor, upon approval of the initial and any subsequent submittals, will incorporate DWR's comments into final plans and specifications and submit copies to DWR, together with all required environmental documents, encroachment permits, a construction schedule, and a proposed aqueduct outage schedule for DWR approval. The proposed outage schedule should be coordinated with the appropriate DWR Field Division.

5. The final plans and specifications must be approved by DWR prior to the SWP contractor's award of a construction contract.

6. Prior to construction, DWR will prepare an Agreement between DWR and the contractor for the construction, operation and maintenance of the proposed turnout and will send copies to the contractor for signature. The contractor will return all signed copies and, if required, a Board of Director's Resolution of Authorization. After final execution by DWR, a copy of the Agreement will be returned to the SWP contractor. Typically, the process takes approximately four months from the date of receipt of the environmental documents through obtaining an executed Agreement.

7. Prior to the start of construction, the SWP contractor will provide DWR with the following:
   - Proof of insurance coverage;
   - Date the construction contract was awarded; and
   - Date of entry onto the SWP right of way.

8. DWR will inspect the turnout construction to ensure compliance with approved plans and specifications within the SWP right of way, resolve any technical issues, and perform meter calibration.

9. When construction of the turnout has been satisfactorily completed, the SWP contractor shall furnish a set of reproducible as-built drawings for DWR's review. After the as-built drawings have been reviewed and approved, DWR will prepare a formal Statement of Acceptance of the turnout that will be sent to the SWP contractor.

10. DWR may send an invoice to the SWP contractor, at any time, for all work completed to date, including design and environmental reviews, preparation of correspondence regarding procedures and submittals, preparation of the Agreement, and the resolution of technical issues. An invoice may also be sent, in advance, for any anticipated future costs. DWR will send a final invoice to the SWP contractor after the project has been completed. Payment will be due thirty days after the date of each invoice.

California Department of Water Resources

CONTRACT INFORMATION FORM

FOR OFFICE USE ONLY
Tracking Number:
SWPAO Number:
Date:

1.0 Title: _____

2.0 SWP Contractor or Lead Agency. Please list name, phone number, and email address for the following staff below:

Engineering/Contract: _____

Environmental: _____

Legal: _____

3.0 Date of Request to DWR: _____

4.0 Project Description (Brief):

_____

_____

_____

5.0 Name(s) of Local Public Agency(s) Participating in Project

_____

_____

6.0 Construction

Is this a modification or expansion of an existing facility? ☐ Yes ☐ No

6.1 For new or modification projects, please provide: legible and reproducible site plan, to scale, with north arrow, coordinates (or mile posts), dimensions, footprint, DWR right of way, and adjacent land use.

7.0 Environmental Documents (NEPA/CEQA or functionally equivalent)

(Title) _____

State Clearing House Number # _____

Federal # _____; Other control numbers _____

Notice of Determination date _____

Notice of Exemption: date and posting place _____

DFG or USFWS Consultation, if required _____

Provide four (4) hard copies to address below [*or electronic*]

Chief, Water Delivery Analysis & Documentation Branch
State Water Project Analysis Office
Department of Water Resources
1416 9th Street, Room 1620
Sacramento, CA 95814 (916.653.6250)

- *Electronic files may be included on a CD or sent electronically. Please provide electronic files in Word, pdf,or Excel file formats.*

Appendix B

Pump Station Design Alternatives Technical Memorandum

Kennedy/Jenks Consultants

300 N. Lake Avenue, Suite 1020
Pasadena, CA 91101
626-568-4300
FAX: 626-683-8938

Pump Station Design Alternatives Technical Memorandum

18 August 2015

Prepared for

Palmdale Water District
2029 East Avenue Q
Palmdale, CA 93550

K/J Project No. 1344505*01

Memorandum

Palmdale Water District
18 August 2015

Introduction

Kennedy/Jenks is preparing a preliminary design report (PDR) to address each of the project elements of the Palmdale Regional Groundwater Recharge and Recovery Project (PRGRRP). The PDR documents the preliminary design criteria, including the preliminary design layouts of equipment, piping, and appurtenances, along with estimates of probable construction costs. Prior to completion of the PDR, an evaluation of the alternatives and selection of the preferred alternative by Palmdale Water District (PWD) for the Storage Tank and adjoining Pump Station Building (collectively known as the Distribution Site) is required. The purpose of this technical memorandum (TM) is to provide an analysis of two alternative pump station designs and document PWD's preference for inclusion in the PDR.

The Pump Station Building houses both a Return Water Pump Station (RWPS) and Potable Water Pump Station (PWPS). The RWPS conveys non-disinfected potable water to the East Branch of the California Aqueduct for use by potential partner agencies, and the PWPS conveys disinfected potable water to the PWD distribution system. Since the RWPS delivers water back through the 8.5-mile 36-inch diameter raw water/return water pipeline, an air gap structure is used to provide cross-connection control to separate the return water system from the potable water system.

The two alternatives under consideration include two types of pumps: (1) vertical turbine pumps (VTPs) and (2) horizontal centrifugal pumps. For both alternatives, the Storage Tank, Pump Station Building, site piping, Air Gap Structure and Return Water Wet Well, and RWPS are all sized for the ultimate project capacity; with the PWPS designed in phases. The RWPS has 5 duty and 1 standby pumps (5+1), and the PWPS has 4+1 pumps initially and 6+1 pumps to meet the ultimate project capacity.

General design criteria for the Distribution Site are presented in the following section. The pump station and individual pump parameters are presented in separate tables for each alternative. While the demand, flow, transmission pipelines, site ground elevation, number of pumps and motor horsepower are the same for both alternatives, the Storage Tank, Air Gap Structure, and Return Water Wet Well configurations are different for each alternative; thus, the total dynamic head (TDH) varies slightly for each alternative.

General Design

The following design aspects are applicable to both types of pump station:

- A 1.0 million gallon above ground steel tank serves as the termination of the Well Collection Pipelines from all 16 recovery wells; provides buffer storage between the wells and the pump stations; serves as a direct pumping forebay for the PWPS; and

serves as intermediate storage between the Storage Tank and the Return Water Wet Well.

- The Pump Station Building will house a Hydro-Turbine room, Chlorine room, Electrical Substation, and Control room, which will be the same size regardless of the type of pump chosen.

- The Hydro-Turbine room will contain both a hydro-turbine as well as two pressure relieving by-pass valves and pipelines.

- The RWPS utilizes a cast-in-place rectangular wet well sized to store a minimum of 75,000 gallons; providing approximately 10 minutes of operational storage for a single return water pump or 2 minutes for the maximum 5-pump flow.

Vertical Turbine Pump Station

The VTPs consist of a vertically-oriented motor, which extends by a shaft through a column to the impeller, housed in a pump bowl. The number of bowls can be varied in the future to accommodate higher head pumping requirements as long as the future horsepower requirements are taken into consideration with the original pumps. Maintenance can be performed directly on the motors, while the pump column must be extracted in order to maintain the pump impellers.

In order to accommodate the pump column, a vertical turbine pump is required to be housed either in a wet well or a pump can. Whereas a wet well provides water storage, a pump can is able to be pressurized. The pressurized pump can is advantageous for ground-level pumps in order to take advantage of the additional suction head available from the Storage Tank water level. However, a wet well allows for an air gap structure between the Storage Tank and the return water system, and provides additional operational storage. The proposed Vertical Turbine Pump Station (VTPS) utilizes both a wet well design and pump cans in order to provide the required discharge for the RWPS and PWPS, respectively.

Design Parameters

The VTPS design parameters for each pump station are presented in Table 1.The table highlights the difference in suction water elevation for the PWPS pump cans compared to the RWPS wet well.

Table 1: Vertical Turbine Pump Station Design Parameters

	Distribution System	Distribution System (Ultimate)	Return Water System
Demand (AF/yr)	19,125 [a]	24,250	30,000
Flow (gpm)	11,856	15,035	18,597
Diameter (in)	30	30	36
Full Flow Velocity, (fps)	5.4	6.8	5.9
Discharge Piping Length (mi)	9.2	9.2	8.5
Pump Station Suction Elevation (ft)	2,567[b]	2,567[b]	2,550[c]
Static HGL (ft)	2,800	2,800	2943
Static Head (ft)	233	233	393
Head Loss[d] (ft)	132	206	116
TDH (ft)	365	439	509
Pump Capacity (gpm)	3,000	2,500	3,720
Required HP	345	346	600
Motor Size (HP)	400	400	600
Number of Pumps	4+1	6+1	5+1

Note:
(a) The Phase 1 potable water demand of 14,125 AF/yr is increased to 19,125 AF/yr to enable PWD to deliver up to 5,000 AF/yr to neighboring water agencies through its distribution system; thus, the 4+1 pump configuration could be considered as a 3+2 configuration with regard to PWD's system reliability.
(b) The target operating water level of the Storage Tank (PWPS suction) is 15 feet or approximately 2,567 feet.
(c) The target operating water level of the Wet Well (RWPS suction) is estimated to be just below grade or approximately 2,550 feet.
(d) Hazen-Williams roughness coefficient assumed to be 135.
(e) AF/yr = acre-feet per year; gpm = gallons per minute; in = inches; fps = feet per second; mi = miles; ft = feet; HP = horsepower.

Layout

A visual representation of the layout as well as the footprint of the pump station is shown on Figure 1. A three-dimensional rendering of the pump room interior is presented in Figure 2. The raised area around the RWPS represents the top of the Return Water Wet Well, which resides approximately 2 feet above the finished floor. The separation of the Return Water Wet Well from the building floor is a structural feature designed to allow for slight differential settlement. The elevated wet well slab provides additional elevation to minimize the additional static head that the RWPS must overcome from the Return Water Wet Well being placed below grade.

The orientation of the VTP motors grants them a minimal footprint. Each pump is placed 7 feet center-to-center, permitting a clearance of 3.5 feet between base plates, which are approximated to also be 3.5 feet square. This spacing provides enough room between the pumps for maintenance, while placing the pump columns close enough within the wet well to reduce vortexing. In order to optimize the RWPS wet well roof slab, the discharge piping has been placed on the roof of the wet well. The RWPS discharge header extends beyond the wet well through the wall, where it turns to proceed below grade.

The PWPS pump cans require a different design than the RWPS. The suction header for the PWPS is below grade outside the building and the suction laterals extend below grade through a valve sump and into the pump cans. Flow runs through the valve sump, into the pump cans, and through the pumps to the discharge laterals, which turn down 90-degrees through the floor to the below-grade discharge header. The discharge header runs under the floor and exits the building to the north just beyond the center wall separating the pump stations and the hydro-turbine room.

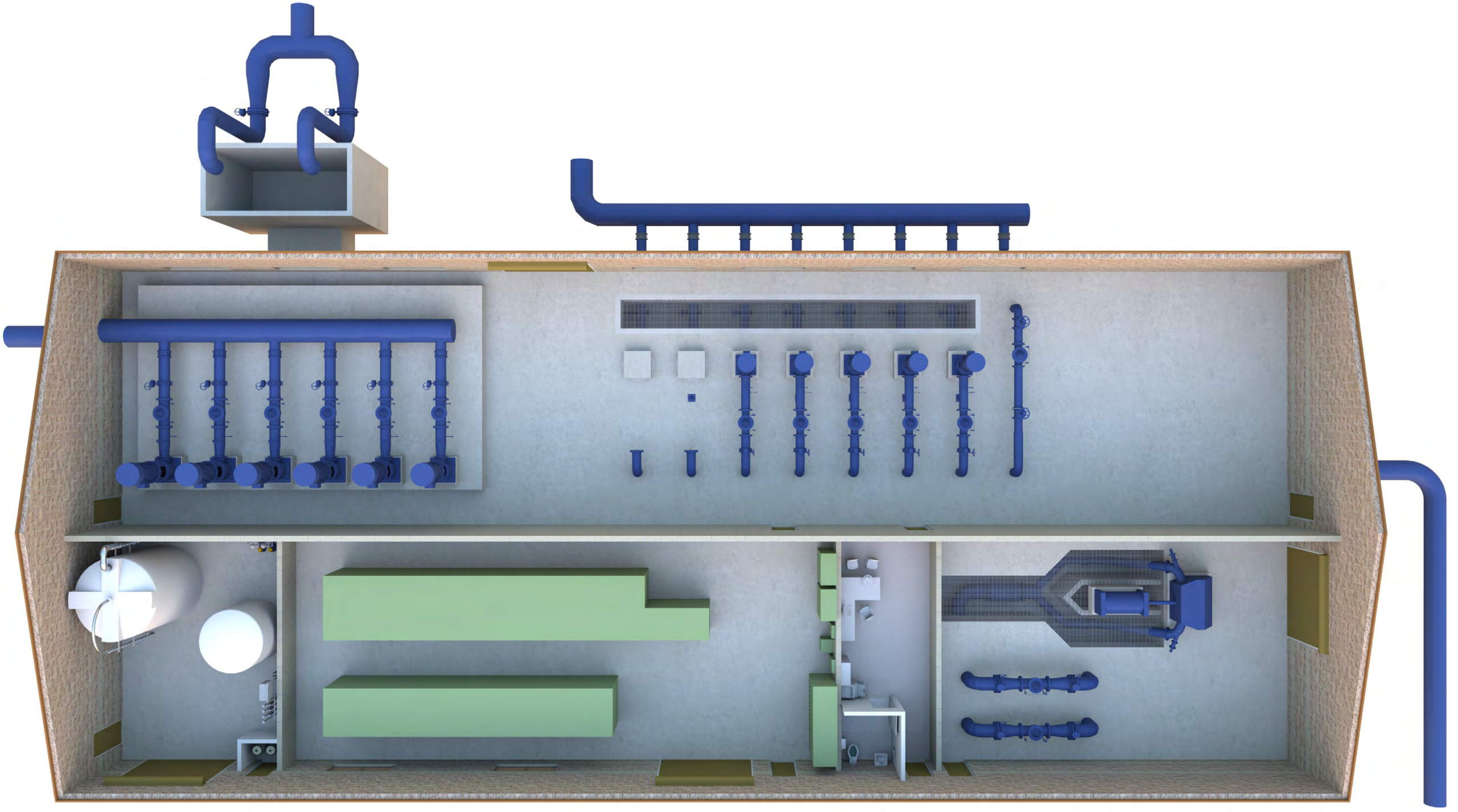


Figure 1: Vertical Turbine Pump Station Plan View

Figure 2: Vertical Turbine Pump Station Rendering

Cost Estimate

The division summary of the opinion of probable construction cost for the VTPS alternative is presented in Table 2. The full estimate has been placed in Attachment A. This cost estimate is a Class 4 in accordance with the American Association of Cost Engineers for the purpose of this TM and may not represent the final cost of the project.

Table 2: Opinion of Probable Construction Cost **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE WATER DISTRICT PRGRRP **Prepared By:** ZC

Date Prepared: 22-Jul-15

Building: Tank-Pump Station Site: VERTICAL TURBINE ALTERNATIVE **K/J Proj. No.:** 1344505*00

Estimate Type:

- ☐ **Conceptual**
- ☐ **Construction**
- ☐ **Preliminary (w/o plans)**
- ☐ **Change Order**
- ☒ **Design Development @ 10% Complete**

Current at ENR

Escalated to ENR

Mos. to Midpoint 24

SUMMARY BY DIVISION

DIV. No.	ITEM DESCRIPTION	MATERIALS	INSTALLATION	SUB-CONTRACTOR	TOTAL
1	General Requirements[1]				
2	Site Work	194,773.60	328,765.54		523,539.14
3	Concrete	421,969.16	405,825.81		827,794.97
4	Masonry	145,396.88	145,396.88		290,793.75
5	Metals	391,280.00	49,320.00		440,600.00
6	Wood & Plastics				
7	Thermal & Moisture Protect.	116,356.78	78,466.51		194,823.29
8	Doors & Windows	59,100.00	19,750.00		78,850.00
9	Finishes	24,360.00	21,222.50		45,582.50
10	Specialties	5,225.00	1,075.00		6,300.00
11	Equipment	2,356,000.00	579,050.00		2,935,050.00
12	Furnishings	3,000.00	500.00		3,500.00
13	Special Construction	33,000.00	5,000.00	650,000.00	688,000.00
14	Conveying Systems				
15	Mechanical	1,313,510.00	416,768.00	5,000.00	1,735,278.00
16	Electrical	4,122,900.00		335,000.00	4,457,900.00
17	Instrumentation	157,000.00		113,000.00	270,000.00
	Subtotals	9,343,871.42	2,051,140.23	1,103,000.00	12,498,011.65
	Division 1 Costs (Inc Mob. Demob) @ 7%	654,071.00	143,579.82	77,210.00	874,860.82
	Subtotals	9,997,942.42	2,194,720.05	1,180,210.00	13,372,872.47
	Taxes - Materials @ 8.75%	874,819.96			874,819.96
	Subtotals	10,872,762.38	2,194,720.05	1,180,210.00	14,247,692.43
	Taxes - Labor @				
	Subtotals	10,872,762.38	2,194,720.05	1,180,210.00	14,247,692.43
	Contractor MU on Sub @ 8%			94,416.80	94,416.80
	Subtotals	10,872,762.38	2,194,720.05	1,274,626.80	14,342,109.23
	Contractor OH&P @ 12%	1,304,731.49	263,366.41		1,568,097.89
	Subtotals	12,177,493.86	2,458,086.45	1,274,626.80	15,910,207.12
	Estimate Contingency @ 15%				2,386,531.07
	Subtotal				18,296,738.19
	Escalate to Midpt of Const. @ 5%	608,874.69	122,904.32	63,731.34	795,510.36
	Estimated Bid Price	12,786,368.56	2,580,990.78	1,338,358.14	19,092,248.54
	Total Estimate				19,093,000.00

Notes

1) Mobilization/demobilization, SWPPP, and Insurance cost is included in Division 1 Costs

Estimate Accuracy	
+15%	-5%

Estimated Range of Probable Cost		
+15%	Total Est.	-5%
$21,956,950	**$19,093,000**	**$18,138,350**

Advantages

The design of the VTPS allows for a unique amount of adaptability. In essence, adding additional pump bowls is similar to running multiple pumps in series, allowing a single pump to produce a similar capacity to what would otherwise be multiple pumps. The ability of the pump to more easily adapt to the design parameters provides a more readily available pump for a greater variety of requirements while maintaining a favorable level of efficiency, such as 80 to 85 percent. The greater efficiency of the pump enables it to run at a lower horsepower.

Although and centrifugal pumps promote similar costs, other aspects of the design influence the additional costs between the alternatives. With their small footprint, VTPs can be housed within a smaller pump station building than horizontal centrifugal pumps, 2,275 square feet in this comparison. Furthermore, the lower required horsepower of the VTP for the RWPS will allow for a slightly smaller motor size. These features reduce the cost of this alternative such that it offers the lower capital cost of the two alternatives.

Disadvantages

Although the orientation of the VTP can be an advantage, it can also cause some challenges with regard to maintenance. Because the pump column and shaft extend below the motor, and the pump bowls are beneath the building floor, the entire pump assembly must be extracted from the pump can or wet well in order to perform maintenance on the bearings or impellers. Due to the length of the pump assembly, a bridge crane is not practical for extraction, thereby requiring an exterior crane and sky lights for maintenance or replacement. Furthermore, routine maintenance of the motors requires using a ladder or mobile platform in order to reach the components.

In regard to functionality, the flow of water through a VTP enters from a suction bell at the end of the pump column. The water then flows up the column to a 90° bend and through the discharge. Although there are no inherent issues with this design, it should be noted that the design of the system makes it susceptible to potential damage in the event the pump encounters thrust due to surge, such as that caused by instantaneous power failure. Surge protection (i.e. surge tanks and pressure relief valves), along with features such as anti-ratchet motor housings, should be evaluated during detailed design.

Horizontal Centrifugal Pump Station

Horizontal centrifugal pumps consist of a horizontally-oriented motor, which extends through the casing (volute) to the impeller. The intake guides the water through the volute, which is shaped in such a way as to allow the water to flow through the sides of the impeller. As the impeller spins, it discharges the water through open ends and forces it through the decreasing diameter of the volute. This design accelerates and pressurizes the water in order to overcome the head at the desired capacity. Located on grade, both the motor and impeller can be accessed for maintenance without removing the pump.

The proposed Horizontal Centrifugal Pump Station (HCPS) utilizes both a wet well design and direct suction piping from the tank in order to provide the required design for the RWPS and PWPS, respectively.

Design Parameters

Centrifugal pumps are completely housed within the volute, with the additional footprint being determined by the motor and pump-motor frame or skid. The design parameters for the horizontal centrifugal pumps are presented in Table 3.

Table 3: Horizontal Centrifugal Pump Station Design Parameters

	Distribution System	Distribution System (Ultimate)	Return Water System
Demand (AF/yr)	19,125[a]	24,250	30,000
Flow (gpm)	11,856	15,035	18,597
Diameter (in)	30	30	36
Full Flow Velocity, (fps)	5.4	6.8	5.9
Length (mi)	9.2	9.2	8.5
Pump Station Suction Elevation (ft)	2574[b]	2574[b]	2559[c]
Static HGL (ft)	2,800	2,800	2943
Static Head (ft)	226	226	384
Head Loss[d] (ft)	132	206	116
TDH (ft)	358	432	500
Pump Capacity (gpm)	3,000	2,500	3,720
Required HP	339	340	587
Motor Size (HP)	400	400	600
Number of Pumps	4+1	6+1	5+1

Note:
(a) The Phase 1 potable water demand of 14,125 AF/yr is increased to 19,125 AF/yr to enable PWD to deliver up to 5,000 AF/yr to neighboring water agencies through its distribution system; thus, the 4+1 pump configuration could be considered as a 3+2 configuration with regard to PWD's system reliability.
(b) The target operating water level of the Storage Tank (PWPS suction) is 22 feet or approximately 2,574 feet.
(c) The target operating water level of the Return Water Wet Well (RWPS suction) is estimated to be 7 feet above grade or approximately 2,559 feet.
(d) Hazen-Williams roughness coefficient assumed to be 135.
(e) AF/yr = acre-feet per year; gpm = gallons per minute; in = inches; fps = feet per second; mi = miles; ft = feet; HP = horsepower.

Layout

A visual representation of the layout as well as the footprint of the pump station is shown on Figure 3. A three-dimensional rendering of the Pump Station Building interior is presented in Figure 4. The yellow bridge crane shown in the figure is for use during installation or removal of any of the pumps or associated equipment.

Similarly to the VTPS, the centrifugal pumps are placed side by side with a minimum of 3.5 feet of clearance between each pump pad. The approximate length of the pump skid for the PWPS is 7 feet, 8 inches, and the RWPS is somewhat larger. Therefore, the total length required for

side-by-side pumps increases the rectangular Pump Station Building footprint by 2,275 square feet.

The proposed Return Water Wet Well is a stand-alone above-grade cast-in-place rectangular concrete structure approximately 6 feet clear from the exterior wall of the Pump Station Building. This design differs from the VTPS in two principle features: (1) the stand-alone wet well takes advantage of the head in the tank to provide a slightly higher suction water level to the ground-level pumps than the VTPS wet well design, whereby the pumps are located on top of the wet well roof, and (2) the wet well structure is completely separate from the building in order to minimize issues associated with differential settlement. The RWPS suction laterals pass directly from the wall of the wet well to the pumps through the wall of the building, with the discharge oriented similar to the VTPS. The PWPS suction laterals extend from the buried suction header out of the ground at a 45° angle, where they extend through the wall to the pumps, with the discharge oriented similar to the VTPS.

Due to the increased footprint of the horizontal motors, the Pump Station Building is considerably larger. While maintaining a rectangular building with the chlorine and turbine rooms on opposite ends, the additional building length provides space for an additional maintenance/storage room.

Cost Estimate

The division summary of the opinion of probable construction cost for the horizontal centrifugal pump alternative is presented in Table 4. The full estimate has been placed in Attachment B. The cost estimate is a Class 4 in accordance with the American Association of Cost Engineers for the purpose of this TM and may not represent the final cost of the project.

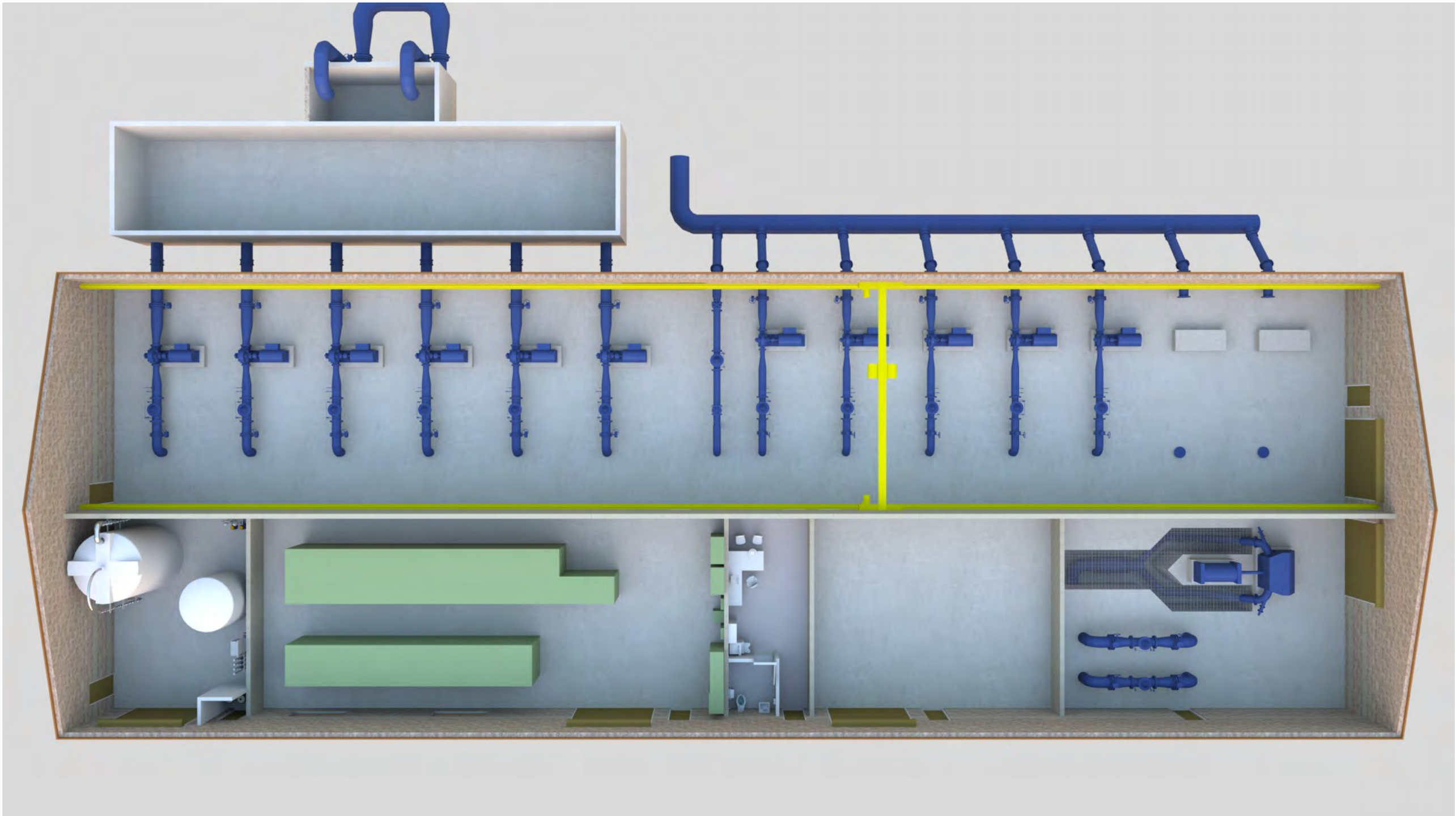


Figure 3: Horizontal Centrifugal Pump Station Plan View

Figure 4: Horizontal Centrifugal Pump Station Rendering

Table 4: Opinion of Probable Construction Cost **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE PRGRRP **Prepared By:** ZC

Date Prepared: 22-Jul-15

Building: Tank-Pump Station Site: CENTRIFUGAL PUMP ALTERNATIVE **K/J Proj. No.:** 1344505*00

Estimate Type:
- ☐ **Conceptual**
- ☐ **Construction**
- ☐ **Preliminary (w/o plans)**
- ☐ **Change Order**
- ☒ **Design Development @ 10% Complete**

Current at ENR

Escalated to ENR

Mos. to Midpoint 24

SUMMARY BY DIVISION

DIV. No.	ITEM DESCRIPTION	MATERIALS	INSTALLATION	SUB-CONTRACTOR	TOTAL
1	General Requirements[1]				
2	Site Work	215,790.60	369,024.47		584,815.07
3	Concrete	420,875.62	395,264.10		816,139.72
4	Masonry	176,716.88	176,716.88		353,433.75
5	Metals	491,280.00	49,320.00		540,600.00
6	Wood & Plastics				
7	Thermal & Moisture Protect.	143,746.21	96,904.64		240,650.85
8	Doors & Windows	33,100.00	14,550.00		47,650.00
9	Finishes	55,080.00	18,510.00		73,590.00
10	Specialties	5,225.00	1,075.00		6,300.00
11	Equipment	2,351,000.00	577,800.00		2,928,800.00
12	Furnishings	3,000.00	500.00		3,500.00
13	Special Construction	33,000.00	5,000.00	600,000.00	638,000.00
14	Conveying Systems	66,000.00	28,200.00		94,200.00
15	Mechanical	1,381,055.00	455,888.00	5,000.00	1,841,943.00
16	Electrical	4,122,900.00		335,000.00	4,457,900.00
17	Instrumentation	157,000.00		113,000.00	270,000.00
	Subtotals	9,655,769.30	2,188,753.08	1,053,000.00	12,897,522.39
	Division 1 Costs (Inc Mob. Demob) @ 7%	675,903.85	153,212.72	73,710.00	902,826.57
	Subtotals	10,331,673.15	2,341,965.80	1,126,710.00	13,800,348.95
	Taxes - Materials @ 8.75%	904,021.40			904,021.40
	Subtotals	11,235,694.56	2,341,965.80	1,126,710.00	14,704,370.36
	Taxes - Labor @				
	Subtotals	11,235,694.56	2,341,965.80	1,126,710.00	14,704,370.36
	Contractor MU on Sub @ 8%			90,136.80	90,136.80
	Subtotals	11,235,694.56	2,341,965.80	1,216,846.80	14,794,507.16
	Contractor OH&P @ 12%	1,348,283.35	281,035.90		1,629,319.24
	Subtotals	12,583,977.90	2,623,001.70	1,216,846.80	16,423,826.40
	Estimate Contingency @ 15%				2,463,573.96
	Subtotal				18,887,400.36
	Escalate to Midpt of Const. @ 5%	629,198.90	131,150.08	60,842.34	821,191.32
	Estimated Bid Price	13,213,176.80	2,754,151.78	1,277,689.14	19,708,591.68
	Total Estimate				19,709,000.00

Notes

[1] Mobilization/demobilization, SWPPP, and Insurance cost is included in Division 1 Costs

Estimate Accuracy	
+15%	-5%

Estimated Range of Probable Cost		
+15%	Total Est.	-5%
$22,665,350	**$19,709,000**	**$18,723,550**

Advantages

Ease of maintenance is one of their greatest advantages of horizontal centrifugal pumps. With the motor and impeller located on grade, staff members easily can maintain the motor through the access panel(s) or remove the pump casing to reach the impeller. Additionally, the use of a bridge crane compared to sky lights promotes ease of maintenance.

In regard to susceptibility to thrust, the centrifugal pumps can allow reverse flow without damaging the pump. However, similar considerations are necessary regarding surge protection, to be addressed during detailed design.

Disadvantages

Unlike VTPs, the horizontal centrifugal pumps only house a single impeller. This limits the design's ability to adapt beyond the readily available pump sizes. In order to provide the flow for a high-head application such as this pump station, the available efficiency may ebb as low as 74 to 76 percent. In order to overcome this lower efficiency, the RWPS pumps require a higher horsepower to provide the required pressure and capacity.

Although the larger pump building for the HCPS allows the building to accommodate a separate maintenance/storage room, the increased size also necessitates higher costs. Although there are certain alternatives to assist with the footprint, such as vertically orienting the motor, this option would require additional support for the motor as well as special maintenance equipment and is not practical for the large motor sizes on this project. Of the two alternatives, the HCPS is higher in initial capital cost by approximately $600,000 compared to the VTPS.

Conclusion and Recommendation

Both pump stations are similar in design and functionality. Due to this level of similarity, the criteria by which to compare them is primarily ease of maintenance and construction cost, with construction cost given more weight. Although the horizontal centrifugal pump station has a greater ease of maintenance, the VTPS has a lower capital cost by approximately $600,000 making it the more favorable alternative. With feedback from PWD staff, the VTPS is recommended for inclusion in the PDR.

Attachment A: VTPS Opinion of Probable Cost

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE WATER DISTRICT PRGRRP

Prepared By: ZC
Date Prepared: 22-Jul-15
K/J Proj. No. 1344505*00

Building, Area: Tank-Pump Station Site: VERTICAL TURBINE ALTERNATIVE

Estimate Type:
- [ ] **Conceptual**
- [ ] **Preliminary (w/o plans)**
- [X] **Design Development @** **10** **% Complete**
- [ ] **Construction**
- [ ] **Change Order**

Current at ENR
Escalated to ENR
Months to Midpoint of Construct

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 1 - GENERAL REQUIREMENTS (SEE DIVISION SUMMARY)											
Div 1	1	Mobilization, Bonds, Permits, Construction Survey, Cleanup, and Demobilization	1	LS							
Div 1	2	Disinfection and hydrostatic testing of tanks, piping, and appurtenances	1	LS							
Div 1	3	Erosion Control Measures	1	LS							
Div 1	4	Startup / Commissioning	1	LS							
SUBTOTAL - DIVISION 1			1	LS							
DIVISION 2 - SITE WORK											
2200	1	Site Preparation (stripping/grubbing)	1	LS			3,000.00	3,000			3,000
2301	2	RW Wet Well Excavation	1,218	CY			10.00	12,183			12,183
2301	3	Distribution Box Excavation	278	CY			10.00	2,777			2,777
2301	4	Pump Station Excavation	3,119	CY			10.00	31,191			31,191
2301	5	Tank Excavation	1,665	CY			10.00	16,652			16,652
	6	Meter Vault Excavation	459	CY			11.00	5,052			5,052
2301	7	Trenching for Pipelines	1,067	CY			15.00	16,000			16,000
2301	8	Bedding for Pipelines	89	CY	10.00	889	15.00	1,333			2,222
2301	9	Imported Backfill for Pipe Zone	891	CY	10.00	8,906	15.00	13,359			22,265
2301	10	Imported Site Fill (From 1.0 Mile Away)	13,200	CY			10.00	132,000			132,000
	11	Tank Ringwall Subgrade Scarification and Recompaction	175	CY			10.00	1,745			1,745
	12	Tank Backfill	1,912	CY	25.00	47,810	15.00	28,686			76,497
	13	Building Backfill	2,442	CY	25.00	61,050	15.00	36,630			97,680
2705	14	Aggregate Base Paving	31,103	SF	1.00	31,103	0.40	12,441			43,544
2705	15	Crushed Rock for Tank	14	CY	20.00	274	1.00	14			287
2705	16	Crushed Rock for Building	482	CY	20.00	9,636	1.00	482			10,118
2706	17	Crushed Rock for Metering Boxes	8	CY	20.00	166	1.00	8			174
2705	18	Crushed Rock for Distribution Box	12	CY	20.00	240	1.00	12			252
2820	19	7' Chain Link Fence	1,200	LF	25.00	30,000	10.00	12,000			42,000
2820	20	4' Access Gate	1	EA	1,200.00	1,200	200.00	200			1,400
2820	21	20' Electric Rolling Gate	1	EA	3,500.00	3,500	3,000.00	3,000			6,500
SUBTOTAL - DIVISION 2						194,774		328,766			523,539
DIVISION 3 -CONCRETE											
	1	Building Footings	236	CY	325.00	76,824	300.00	70,914			147,738
	2	Tank Footings	123	CY	325.00	39,933	300.00	36,861			76,794
	3	Building Pad	366	CY	325.00	118,926	300.00	109,778			228,704

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE WATER DISTRICT PRGRRP

Prepared By: ZC
Date Prepared: 22-Jul-15
K/J Proj. No. 1344505*00

Building, Area: Tank-Pump Station Site: VERTICAL TURBINE ALTERNATIVE

Estimate Type: ☐ Conceptual ☐ Construction
☐ Preliminary (w/o plans) ☐ Change Order
☒ Design Development @ 10 % Complete

Current at ENR
Escalated to ENR
Months to Midpoint of Construct

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
	4	Pump Pad and Pump Cans	47	CY	325.00	15,131	300.00	13,967			29,097
	5	Wet Well - Footing & Floor	83	CY	325.00	26,975	300.00	24,900			51,875
	6	Wet Well - Walls & Roof	112	CY	350.00	39,200	650.00	72,800			112,000
	7	Air Gap Structure - Footing & Floor	29	CY	325.00	9,425	300.00	8,700			18,125
	8	Air Gap Structure - Walls	27	CY	350.00	9,450	650.00	17,550			27,000
	9	Distribution Box - Footing & Floor	22	CY	325.00	7,150	300.00	6,600			13,750
	10	Distribution Box - Walls	36	CY	350.00	12,600	650.00	23,400			36,000
	11	Precast - Meter Box	2	EA	25,000.00	50,000	2,000.00	4,000			54,000
	12	Concrete Backfill inside Building	164	CY	100.00	16,356	100.00	16,356			32,711
SUBTOTAL - DIVISION 3						421,969		405,826			827,795
DIVISION 4 -MASONRY											
4220	1	CMU Walls (Operations/Control Building)	9,693	SF	15.00	145,397	15.00	145,397			290,794
SUBTOTAL - DIVISION 4						145,397		145,397			290,794
DIVISION 5 -METALS											
5100	1	Building Roof Framing	1	LS	350,000.00	350,000	25,000.00	25,000			375,000
5500	2	Steel Pipe Supports	1	LS	20,000.00	20,000	12,000.00	12,000			32,000
5500	3	Misc Metals	1	LS	10,000.00	10,000	10,000.00	10,000			20,000
5500	4	Aluminum Riveted Bar Grating	1	LS	10,000.00	10,000	2,000.00	2,000			12,000
5501	5	Handrails (Distribution Box)	64	LF	20.00	1,280	5.00	320			1,600
SUBTOTAL - DIVISION 5						391,280		49,320			440,600
DIVISION 6 -WOOD & PLASTICS											
6150											
SUBTOTAL - DIVISION 6											
DIVISION 7 -THERMAL & MOISTURE PROTECTION											
7200	1	Roof Insulation	10,184	SF	1.00	10,184	1.25	12,730			22,914
7200	2	Wall Insulation	1,200	SF	0.75	900	1.00	1,200			2,100
7320	3	Metal Roof	10,184	SF	10.00	101,841	6.00	61,104			162,945
7600	4	Misc Flashing	1	LS	1,000.00	1,000	1,000.00	1,000			2,000
7600	5	Gutters	304	LF	8.00	2,432	8.00	2,432			4,864
SUBTOTAL - DIVISION 7						116,357		78,467			194,823
DIVISION 8 -DOORS & WINDOWS											
8110	1	Metal Work	1	LS	5,000.00	5,000	1,000.00	1,000			6,000

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE WATER DISTRICT PRGRRP

Prepared By: ZC
Date Prepared: 22-Jul-15
K/J Proj. No. 1344505*00

Building, Area: Tank-Pump Station Site: VERTICAL TURBINE ALTERNATIVE

Estimate Type:
☐ **Conceptual** ☐ **Construction**
☐ **Preliminary (w/o plans)** ☐ **Change Order**
☒ **Design Development @** **10** **% Complete**

Current at ENR
Escalated to ENR
Months to Midpoint of Construct

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
8305	2	Access Doors	10	EA	350.00	3,500	150.00	1,500			5,000
8330	3	Roll-Up Doors	6	EA	3,000.00	18,000	1,500.00	9,000			27,000
8520	4	Aluminum Windows	1	EA	1,000.00	1,000	250.00	250			1,250
8700	5	Skylights/Roof Access Hatches	13	EA	2,000.00	26,000	400.00	5,200			31,200
8900	6	Louvers	14	EA	400.00	5,600	200.00	2,800			8,400
SUBTOTAL - DIVISION 8						59,100		19,750			78,850
DIVISION 9 -FINISHES											
9250		Gypsum Wallboard									
9250	1	Walls	1,485	SF	1.00	1,485	1.00	1,485			2,970
9250	2	Ceiling	2,550	LF	1.00	2,550	1.25	3,188			5,738
9500	3	Acoustic Tile Ceiling	390	SF	2.00	780	1.50	585			1,365
9650		Resilient Flooring									
9650	4	VCT Flooring	390	SF	2.50	975	2.00	780			1,755
9650	5	Resilient Base	100	LF	2.00	200	1.50	150			350
9900		Painting									
9900	6	Gypsum Board	4,035	SF	2.00	8,070	1.00	4,035			12,105
9900	7	Doors and Frames	10	EA	30.00	300	100.00	1,000			1,300
9960	8	Mechanical Coatings	1	LS	10,000.00	10,000	10,000.00	10,000			20,000
SUBTOTAL - DIVISION 9						24,360		21,223			45,583
DIVISION 10 -SPECIALTIES											
10050		Building Specialties									
10050	1	Fire Extinguishers	3	EA	75.00	225	25	75			300
10050	2	Switchboard Mats	1	LS	1,500.00	1,500	200	200			1,700
10400	3	Identifying Devices	1	LS	2,500.00	2,500	500	500			3,000
10800	4	Toilet Room Accessories	1	SETS	1,000.00	1,000	300.00	300			1,300
SUBTOTAL - DIVISION 10						5,225		1,075			6,300
DIVISION 11 - EQUIPMENT											
11003	1	Onsite Hypo Generation System (inlcude metering pump, hypo storage tank, PLC control, softener)	1	LS	200,000.00	200,000	40,000.00	40,000			240,000
11215	2	PW Vertical Turbine Pumps	5	EA	97,000.00	485,000	24,250.00	121,250			606,250
11215	3	RW Vertical Turbine Pumps	6	EA	145,000.00	870,000	36,250.00	217,500			1,087,500
11240	4	Chlorine Injectors SAF-T-LOCK	1	EA	1,000.00	1,000	300.00	300			1,300
	5	Turbine Generator (Vendor Quote)	1	LS	800,000.00	800,000	200,000.00	200,000			1,000,000
SUBTOTAL - DIVISION 11						2,356,000		579,050			2,935,050

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE WATER DISTRICT PRGRRP

Prepared By: ZC
Date Prepared: 22-Jul-15
K/J Proj. No. 1344505*00

Building, Area: Tank-Pump Station Site: VERTICAL TURBINE ALTERNATIVE

Current at ENR
Escalated to ENR
Months to Midpoint of Construct

Estimate Type:
- ☐ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☒ **Design Development @** **10** **% Complete**
- ☐ **Construction**
- ☐ **Change Order**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 12 - FURNISHINGS											
		Control Room	1	LS	3,000.00	3,000	500.00	500			3,500
						3,000		500			3,500
DIVISION 13 - SPECIAL CONSTRUCTION											
13211	1	Welded Steel Tank	1.00	EA					650,000	650,000	650,000
13416	2	Brine Tank	1.00	EA	33,000.00	33,000	5,000.00	5,000			38,000
	3	Bridge Crane (Not Used)	1.00	EA							
SUBTOTAL - DIVISION 13						33,000		5,000		650,000	688,000
DIVISION 15 - MECHANICAL											
15050	1	36" Steel Pipe 250 psi	320	LF	130.00	41,600	209.00	66,880			108,480
15050	2	30" Steel Pipe 250 psi	320	LF	110.50	35,360	176.00	56,320			91,680
15050	3	24" Steel Pipe 250 psi	80	LF	91.00	7,280	148.50	11,880			19,160
15050	4	36" Steel Pipe 150 psi	410	LF	100.00	41,000	190.00	77,900			118,900
15050	5	30" Steel Pipe 150 psi	100	LF	85.00	8,500	160.00	16,000			24,500
15050	6	24" Steel Pipe 150 psi	130	LF	70.00	9,100	135.00	17,550			26,650
15050	7	16" Steel Pipe 250 psi	182	LF	60.00	10,920	115.00	20,930			31,850
15050	8	14" Steel Pipe 250 psi	100	LF	40.00	4,000	78.00	7,800			11,800
15050	9	12" Steel Pipe 250 psi	30	LF	35.00	1,050	68.00	2,040			3,090
15050	10	14" Victaulic Coupling	11	EA	500.00	5,500	150.00	1,650			7,150
15050	11	16" Flex Coupling	13	EA	1,500.00	19,500	350.00	4,550			24,050
15050	12	30" Flex Tend	1	EA	55,000.00	55,000	5,000.00	5,000			60,000
15050	13	36" Butterfly Valve (250 psi)	1	EA	37,000.00	37,000	3,700.00	3,700			40,700
15050	14	30" Butterfly Valve (150 psi)	2	EA	17,900.00	35,800	1,790.00	3,580			39,380
15050	15	30" Butterfly Valve (250 psi)	1	EA	26,000.00	26,000	2,600.00	2,600			28,600
15050	16	20" Butterfly Valve (250 psi)	4	EA	10,300.00	41,200	1,030.00	4,120			45,320
15050	17	16" Butterfly Valve (250 psi)	13	EA	6,500.00	84,500	650.00	8,450			92,950
15050	18	14" Butterfly Valve (250 psi)	5	EA	6,200.00	31,000	620.00	3,100			34,100
15050	19	12" Gate Valve	2	EA	4,700.00	9,400	470.00	940			10,340
15050	20	16" Cla-Val	8	EA	48,000.00	384,000	4,800.00	38,400			422,400
15050	21	14" Cla-Val	5	EA	39,000.00	195,000	3,900.00	19,500			214,500
15050	22	12" Cla-Val	1	EA	20,000.00	20,000	2,000.00	2,000			22,000
15050	23	18" Plug Valve w/electric motor operator	2	EA	9,200.00	18,400	920.00	1,840			20,240
15050	24	2" Air Valve	13	EA	2,000.00	26,000	500.00	6,500			32,500
15050	25	24" Flowmeter	2	EA	25,000.00	50,000	5,000.00	10,000			60,000
15050	26	30" Flowmeter	1	EA	35,000.00	35,000	7,000.00	7,000			42,000
		Building - HVAC									
	27	Pump Room - Exhaust Ventilation	1	LS	40,000.00	40,000	4,080.00	4,080			44,080
	28	Electrical Room - HAVC	1	LS	36,500.00	36,500	10,330.00	10,330			46,830

OPINION OF PROBABLE CONSTRUCTION COST | **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE WATER DISTRICT PRGRRP

Prepared By: ZC
Date Prepared: 22-Jul-15
K/J Proj. No. 1344505*00

Building, Area: Tank-Pump Station Site: VERTICAL TURBINE ALTERNATIVE

Current at ENR
Escalated to ENR
Months to Midpoint of Construct

Estimate Type:
- ☐ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☒ **Design Development @** **10** **% Complete**
- ☐ **Construction**
- ☐ **Change Order**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
	29	Hypochlorite Room - Wall Propeller Exhaust Fan	1	EA	1,500.00	1,500	128.00	2,000			3,500
	30	Garage/Workshop - HAVC	1	EA	3,400.00	3,400	128.00	128			3,528
	31	Testing and Balancing @ 5% of HVAC total	1	LS					5,000	5,000	5,000
SUBTOTAL - DIVISION 15						1,313,510		416,768		5,000	1,735,278
DIVISION 16 - ELECTRICAL											
	1	Service Entrance Equipment/Raceways/Utility Fees	1	LS	138,000	138,000			25,000	25,000	163,000
	2	Medium Voltage Switchgear	1	LS	1,400,000	1,400,000			70,000	70,000	1,470,000
	3	Medium Voltage Variable Frequency Drives	11	EA	200,000	2,200,000			10,000	110,000	2,310,000
	4	Medium Voltage Transformers	2	EA	33,000	66,000			3,500	7,000	73,000
	5	480V Switchboard	1	EA	113,000	113,000			15,000	15,000	128,000
	6	480V Transformers	2	EA	4,200	8,400			1,000	2,000	10,400
	7	Lighting	1	LS	85,000	85,000			15,000	15,000	100,000
	8	Medium Voltage Raceways & Cable	1	LS	48,000	48,000			36,000	36,000	84,000
	9	Low Voltage/Control/Signal Raceways & Cable	1	LS	56,000	56,000			46,000	46,000	102,000
	10	Grounding	1	LS	8,500	8,500			9,000	9,000	17,500
SUBTOTAL - DIVISION 16						4,122,900				335,000	4,457,900
DIVISION 17 - INSTRUMENTATION											
	1	PLC Cabinets	2	EA	50,000	100,000			10,000	20,000	120,000
	2	Miscellaenous Instrumentation	1	LS	25,000	32,000			8,000	8,000	40,000
	3	SCADA Equipment	1	LS	25,000	25,000			5,000	5,000	30,000
	4	Programming	2	EA					40,000	80,000	80,000
SUBTOTAL - DIVISION 17						157,000				113,000	270,000

Attachment B: HCPS Opinion of Probable Cost

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE PRGRRP

Prepared By: ZC
Date Prepared: 22-Jul-15
K/J Proj. No. 1344505*00

Building, Area: Tank-Pump Station Site: CENTRIFUGAL PUMP ALTERNATIVE

Estimate Type:
- ☐ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☒ **Design Development @** 10 **% Complete**
- ☐ **Construction**
- ☐ **Change Order**

Current at ENR
Escalated to ENR
Months to Midpoint of Construct

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 1 - GENERAL REQUIREMENTS (SEE DIVISION SUMMARY)											
Div 1	1	Mobilization, Bonds, Permits, Construction Survey, Cleanup, and Demobilization	1	LS							
Div 1	2	Disinfection and hydrostatic testing of tanks, piping, and appurtenances	1	LS							
Div 1	3	Erosion Control Measures	1	LS							
Div 1	4	Startup / Commissioning	1	LS							
SUBTOTAL - DIVISION 1			1	LS							
DIVISION 2 - SITE WORK											
	1	Site Preparation (stripping/grubbing)	1	LS			4,000.00	4,000			4,000
	2	RW Wet Well Excavation	864	CY			10.00	8,640			8,640
	3	Distribution Box Excavation	278	CY			10.00	2,777			2,777
	4	Pump Station Excavation	3,802	CY			10.00	38,016			38,016
	5	Tank Excavation	1,313	CY			10.00	13,126			13,126
	6	Trenching for Pipelines	1,067	CY			15.00	16,000			16,000
	7	Bedding for Pipelines	89	CY	10.00	889	15.00	1,333			2,222
	8	Backfill for Pipelines	891	CY	10.00	8,906	15.00	13,359			22,265
	9	Imported Fill (From 0.5 Mile Away)	16,800	CY			10.00	168,000			168,000
	10	Tank Ringwall Subgrade Scarification and Recompaction	135	CY			10.00	1,352			1,352
	11	Tank Back Fill	1,608	CY	25.00	40,207	15.00	24,124			64,332
	12	Building Back Fill	2,986	CY	25.00	74,651	15.00	44,791			119,442
	13	Aggregate Base Paving	41,744	SF	1.00	41,744	0.40	16,697			58,441
	14	Crushed Rock for Tank	12	CY	20.00	236	1.00	12			248
	15	Crushed Rock for Building	578	CY	20.00	11,552	1.00	578			12,129
	16	Crushed Rock for Metering Boxes	8	CY	20.00	166	1.00	8			174
	17	Crushed Rock for Distribution Box	12	CY	20.00	240	1.00	12			252
	18	6' Chain Link Fence	1,300	LF	25.00	32,500	10.00	13,000			45,500
	19	4' Access Gate	1	EA	1,200.00	1,200	200.00	200			1,400
	20	20' Electric Rolling Gate	1	EA	3,500.00	3,500	3,000.00	3,000			6,500
SUBTOTAL - DIVISION 2						215,791		369,024			584,815
DIVISION 3 -CONCRETE											
3200/3300	1	Building Footings	283	CY	325.00	91,981	300.00	84,905			176,886
3200/3300	2	Tank Footings	106	CY	325.00	34,488	300.00	31,835			66,323
3200/3300	3	Building Pad	453	CY	325.00	147,093	300.00	135,778			282,870
3200/3300	4	Pump Pad	12	CY	325.00	3,805	300.00	3,512			7,317
3200/3300	5	Wet Well - Footing & Floor	88	CY	325.00	28,686	300.00	26,479			55,165
3200/3300	6	Wet Well - Walls & Roof	87	CY	350.00	30,333	650.00	56,333			86,667

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE PRGRRP

Prepared By: ZC
Date Prepared: 22-Jul-15
K/J Proj. No. 1344505*00

Building, Area: Tank-Pump Station Site: CENTRIFUGAL PUMP ALTERNATIVE

Estimate Type: ☐ Conceptual ☐ Construction
☐ Preliminary (w/o plans) ☐ Change Order
☒ Design Development @ 10 % Complete

Current at ENR
Escalated to ENR
Months to Midpoint of Construct

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
3200/3300	7	Air Gap Structure - Footing & Floor	16	CY	325.00	5,304	300.00	4,896			10,200
3200/3300	8	Air Gap Structure - Walls	27	CY	350.00	9,437	650.00	17,526			26,963
3200/3300	9	Distribution Box - Footing & Floor	22	CY	325.00	7,150	300.00	6,600			13,750
3200/3300	10	Distribution Box - Walls	36	CY	350.00	12,600	650.00	23,400			36,000
3200/3301	11	Precast - Meter Box	2	EA	25,000.00	50,000	2,000.00	4,000			54,000
SUBTOTAL - DIVISION 3						420,876		395,264			816,140
DIVISION 4 -MASONRY											
4220	1	CMU Walls (Operations/Control Building)	11,781	SF	15.00	176,717	15.00	176,717			353,434
SUBTOTAL - DIVISION 4						176,717		176,717			353,434
DIVISION 5 -METALS											
5100	1	Control Building Roof Framing	1	LS	450,000.00	450,000	25,000.00	25,000			475,000
5500	2	Steel Pipe Supports	1	LS	20,000.00	20,000	12,000.00	12,000			32,000
5500	3	Misc Metals	1	LS	10,000.00	10,000	10,000.00	10,000			20,000
5500	4	Aluminum Riveted Bar Grating	1	LS	10,000.00	10,000	2,000.00	2,000			12,000
5501	5	Handrails (Distribution Box)	64	LF	20.00	1,280	5.00	320			1,600
SUBTOTAL - DIVISION 5						491,280		49,320			540,600
DIVISION 6 -WOOD & PLASTICS											
SUBTOTAL - DIVISION 6											
DIVISION 7 -THERMAL & MOISTURE PROTECTION											
7200	1	Roof Insulation	12,596	SF	1.00	12,596	1.25	15,745			28,341
7200	2	Wall Insulation	1,575	SF	0.75	1,181	1.00	1,575			2,756
7320	3	Metal Roof	12,596	SF	10.00	125,961	6.00	75,577			201,537
7600	4	Misc Flashing	1	LS	1,000.00	1,000	1,000.00	1,000			2,000
7600	5	Gutters	376	LF	8.00	3,008	8.00	3,008			6,016
SUBTOTAL - DIVISION 7						143,746		96,905			240,651
DIVISION 8 -DOORS & WINDOWS											
8110	1	Metal Work	1	LS	5,000.00	5,000	1,000.00	1,000			6,000
8305	2	Access Doors	10	EA	350.00	3,500	150.00	1,500			5,000
8330	3	Roll-Up Doors	6	EA	3,000.00	18,000	1,500.00	9,000			27,000
8520	4	Aluminum Windows	1	EA	1,000.00	1,000	250.00	250			1,250
8700	5	Skylights/Roof Access Hatches Noy Used)									
8900	6	Louvers	14	EA	400.00	5,600	200.00	2,800			8,400
SUBTOTAL - DIVISION 8						33,100		14,550			47,650

OPINION OF PROBABLE CONSTRUCTION COST | **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE PRGRRP

Prepared By: ZC
Date Prepared: 22-Jul-15
K/J Proj. No. 1344505*00

Building, Area: Tank-Pump Station Site: CENTRIFUGAL PUMP ALTERNATIVE

Estimate Type: ☐ Conceptual ☐ Construction
☐ Preliminary (w/o plans) ☐ Change Order
☒ Design Development @ 10 % Complete

Current at ENR
Escalated to ENR
Months to Midpoint of Construct

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 9 -FINISHES											
9250		Gypsum Wallboard									
9250	1	Walls	2,100	SF	1.00	2,100	1.00	2,100			4,200
9250	2	Ceiling	3,600	SF	1.00	3,600	1.25	4,500			8,100
9500	3	Acoustic Tile Ceiling	1,200	SF	2.00	2,400	1.50	1,800			4,200
9650		Resilient Flooring									
9650	4	VCT Flooring	1,200	SF	2.50	3,000	2.00	2,400			5,400
9650	5	Resilient Base	140	LF	2.00	280	1.50	210			490
9900		Painting									
9900	6	Gypsum Board	5,700	SF	2.00	11,400	1.00	5,700			17,100
9900	7	Doors and Frames	10	EA	30.00	300	100.00	1,000			1,300
9960	8	Pipeline Coating	400	LF	80.00	32,000	2.00	800			32,800
SUBTOTAL - DIVISION 9						55,080		18,510			73,590
DIVISION 10 -SPECIALTIES											
10050		Building Specialties									
10050	1	Fire Extinguishers	3	EA	75.00	225	25	75			300
10050	2	Switchboard Mats	1	LS	1,500.00	1,500	200	200			1,700
10400	3	Identifying Devices	1	LS	2,500.00	2,500	500	500			3,000
10800	4	Toilet Room Accessories	1	SETS	1,000.00	1,000	300.00	300			1,300
SUBTOTAL - DIVISION 10						5,225		1,075			6,300
DIVISION 11 - EQUIPMENT											
11003	1	Onsite Hypo Generation System (inlcude metering pump, hypo storage tank, PLC control, softener)	1	LS	200,000.00	200,000	40,000.00	40,000			240,000
11215	2	PW Centrifugal Pumps	5	EA	90,000.00	450,000	22,500.00	112,500			562,500
11215	3	RW Centrifugal Pumps	6	EA	150,000.00	900,000	37,500.00	225,000			1,125,000
11240	4	Chlorine Injectors SAF-T-LOCK	1	EA	1,000.00	1,000	300.00	300			1,300
	5	Turbine Generator Power House	1	LS	800,000.00	800,000	200,000.00	200,000			1,000,000
SUBTOTAL - DIVISION 11						2,351,000		577,800			2,928,800
DIVISION 12 - FURNISHINGS											
		Control Room	1	LS	3,000.00	3,000	500.00	500			3,500
						3,000		500			3,500
DIVISION 13 - SPECIAL CONSTRUCTION											
13211	1	Welded Steel Tank	1.00	EA					600,000	600,000	600,000
13416	2	Brine Tank	1.00	EA	33,000.00	33,000	5,000.00	5,000			38,000

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PALMDALE PRGRRP

Prepared By: ZC
Date Prepared: 22-Jul-15
K/J Proj. No. 1344505*00

Building, Area: Tank-Pump Station Site: CENTRIFUGAL PUMP ALTERNATIVE

Estimate Type: ☐ Conceptual ☐ Construction
☐ Preliminary (w/o plans) ☐ Change Order
☒ Design Development @ 10 % Complete

Current at ENR
Escalated to ENR
Months to Midpoint of Construct

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
SUBTOTAL - DIVISION 13						33,000		5,000		600,000	638,000
DIVISION 14 - CONVERYING SYSTEMS											
14630	1	Bridge Crane	1.00	EA	66,000.00	66,000	28,200.00	28,200			94,200
SUBTOTAL - DIVISION 13						66,000		28,200			94,200
DIVISION 15 - MECHANICAL											
15050	1	36" Steel Pipe 250 psi	350	LF	130.00	45,500	209.00	73,150			118,650
15050	2	30" Steel Pipe 250 psi	350	LF	110.50	38,675	176.00	61,600			100,275
15050	3	24" Steel Pipe 250 psi	80	LF	91.00	7,280	148.50	11,880			19,160
15050	4	36" Steel Pipe 150 psi	410	LF	100.00	41,000	190.00	77,900			118,900
15050	5	30" Steel Pipe 150 psi	100	LF	85.00	8,500	160.00	16,000			24,500
15050	6	24" Steel Pipe 150 psi	130	LF	70.00	9,100	135.00	17,550			26,650
15050	7	16" Steel Pipe 250 psi	260	LF	60.00	15,600	115.00	29,900			45,500
15050	8	14" Steel Pipe 250 psi	100	LF	40.00	4,000	78.00	7,800			11,800
15050	9	12" Steel Pipe 250 psi	60	LF	35.00	2,100	68.00	4,080			6,180
15050	10	20" Steel Pipe	80	LF	70.00	5,600	135.00	10,800			16,400
15050	11	16" Victaulic Coupling	7	EA	800.00	5,600	150.00	1,050			6,650
15050	12	30" Flex Tend	1	EA	55,000.00	55,000	5,000.00	5,000			60,000
15050	13	16" Flex Coupling	8	EA	1,500.00	12,000	350.00	2,800			14,800
15050	14	20" Flex Coupling	6	EA	2,300.00	13,800	350.00	2,100			15,900
15050	15	36" Butterfly Valve (250 psi)	1	EA	37,000.00	37,000	3,700.00	3,700			40,700
15050	16	30" Butterfly Valve (150 psi)	2	EA	17,900.00	35,800	1,790.00	3,580			39,380
15050	17	30" Butterfly Valve (250 psi)	1	EA	26,000.00	26,000	2,600.00	2,600			28,600
15050	18	20" Butterfly Valve (250 psi)	4	EA	10,300.00	41,200	1,030.00	4,120			45,320
15050	19	20" Butterfly Valve (150 psi)	6	EA	7,100.00	42,600	710.00	4,260			46,860
15050	21	16" Butterfly Valve (250 psi)	13	EA	6,500.00	84,500	650.00	8,450			92,950
15050	22	14" Butterfly Valve (250 psi)	5	EA	6,200.00	31,000	620.00	3,100			34,100
15050	23	12" Gate Valve	2	EA	4,700.00	9,400	470.00	940			10,340
15050	24	16" Cla-Val	8	EA	48,000.00	384,000	4,800.00	38,400			422,400
15050	25	14" Cla-Val	5	EA	39,000.00	195,000	3,900.00	19,500			214,500
15050	26	12" Cla-Val	1	EA	20,000.00	20,000	2,000.00	2,000			22,000
15050	27	18" Plug Valve	2	EA	9,200.00	18,400	920.00	1,840			20,240
15050	28	2" Air Valve	13	EA	2,000.00	26,000	500.00	6,500			32,500
15050	29	24" Flowmeter	2	EA	25,000.00	50,000	5,000.00	10,000			60,000
15050	30	30" Flowmeter	1	EA	35,000.00	35,000	8,750.00	8,750			43,750
		Building - HVAC									
		Pump Room - Exhaust Ventilation	1	LS	40,000.00	40,000	4,080.00	4,080			44,080
		Electrical Room - HAVC	1	LS	36,500.00	36,500	10,330.00	10,330			46,830
		Hypochlorite Room - Wall Propeller Exhaust Fan	1	EA	1,500.00	1,500	128.00	2,000			3,500

OPINION OF PROBABLE CONSTRUCTION COST

KENNEDY/JENKS CONSULTANTS

Project: PALMDALE PRGRRP

Prepared By: ZC
Date Prepared: 22-Jul-15
K/J Proj. No. 1344505*00

Building, Area: Tank-Pump Station Site: CENTRIFUGAL PUMP ALTERNATIVE

Current at ENR
Escalated to ENR
Months to Midpoint of Construct

Estimate Type:
- ☐ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☒ **Design Development @** **10** **% Complete**
- ☐ **Construction**
- ☐ **Change Order**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
		Garage/Workshop - HAVC	1	EA	3,400.00	3,400	128.00	128			3,528
		Testing and Balancing @ 5% of HVAC total	1	LS					5,000	5,000	5,000
SUBTOTAL - DIVISION 15						1,381,055		455,888		5,000	1,841,943
DIVISION 16 - ELECTRICAL											
	1	Service Entrance Equipment/Raceways/Utility Fees	1	LS	138,000	138,000			25,000	25,000	163,000
	2	Medium Voltage Switchgear	1	LS	1,400,000	1,400,000			70,000	70,000	1,470,000
	3	Medium Voltage Variable Frequency Drives	11	EA	200,000	2,200,000			10,000	110,000	2,310,000
	4	Medium Voltage Transformers	2	EA	33,000	66,000			3,500	7,000	73,000
	5	480V Switchboard	1	EA	113,000	113,000			15,000	15,000	128,000
	6	480V Transformers	2	EA	4,200	8,400			1,000	2,000	10,400
	7	Lighting	1	LS	85,000	85,000			15,000	15,000	100,000
	8	Medium Voltage Raceways & Cable	1	LS	48,000	48,000			36,000	36,000	84,000
	9	Low Voltage/Control/Signal Raceways & Cable	1	LS	56,000	56,000			46,000	46,000	102,000
	10	Grounding	1	LS	8,500	8,500			9,000	9,000	17,500
SUBTOTAL - DIVISION 16						4,122,900				335,000	4,457,900
DIVISION 17 - INSTRUMENTATION											
	1	PLC Cabinets	2	EA	50,000	100,000			10,000	20,000	120,000
	2	Miscellaenous Instrumentation	1	LS	25,000	32,000			8,000	8,000	40,000
	3	SCADA Equipment	1	LS	25,000	25,000			5,000	5,000	30,000
	4	Programming	2	EA					40,000	80,000	80,000
SUBTOTAL - DIVISION 17						157,000				113,000	270,000

Appendix C

Opinion of Probable Construction Cost Details

Table 2: Opinion of Probable Construction Cost **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 09-Sep-15

Building: Summary **K/J Proj. No.:** 1344505*01

Estimate Type:

- [ ] **Conceptual**
- [ ] **Construction**
- [ ] **Preliminary (w/o plans)**
- [ ] **Change Order**
- [x] **Design Development @ 10% Complete**

Current at ENR

Escalated to ENR

Mos. to Midpoint

ITEM DESCRIPTION			MATERIALS	INSTALLATION	SUB-CONTRACTOR	TOTAL
Subtotals			31,731,385.79	27,894,820.01	3,019,050.00	62,645,255.80
Division 1 Costs	@	7%	2,221,197.01	1,952,637.40	211,333.50	4,385,167.91
Subtotals			33,952,582.80	29,847,457.41	3,230,383.50	67,030,423.71
Taxes - Materials	@	9.00%	3,055,732.45			3,055,732.45
Subtotals			37,008,315.25	29,847,457.41	3,230,383.50	70,086,156.16
Taxes - Labor	@	0.00%		0.00		0.00
Subtotals			37,008,315.25	29,847,457.41	3,230,383.50	70,086,156.16
Contractor MU on Sub	@	10%			323,038.35	323,038.35
Subtotals			37,008,315.25	29,847,457.41	3,553,421.85	70,409,194.51
Contractor OH&P	@	12%	4,440,997.83	3,581,694.89		8,022,692.72
Subtotals			41,449,313.08	33,429,152.30	3,553,421.85	78,431,887.23
Estimate Contingency	@	15%				11,764,783.08
Subtotal						90,196,670.32
Escalate to Midpt of Const.	@					0.00
Estimated Bid Price			41,449,313.08	33,429,152.30	3,553,421.85	90,196,670.32
Total Estimate						90,197,000.00

Notes

[1] Mobilization/demobilization, SWPPP, and Insurance cost is included in Division 1 Costs

Estimate Accuracy	
+30%	-15%

Estimated Range of Probable Cos		
+30%	Total Est.	-15%
$117,256,10	**$90,197,00**	**$76,667,45**

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 07-Sep-15

Building: Well Drilling **K/J Proj. No.:** 1344505*01

Estimate Type:
- [ ] **Conceptual**
- [ ] **Construction**
- [ ] **Preliminary (w/o plans)**
- [ ] **Change Order**
- [x] **Design Development @ 10% Complete**

Current at ENR

Escalated to ENR

Mos. to Midpoint

SUMMARY BY DIVISION

DIV. No.	ITEM DESCRIPTION			MATERIALS	INSTALLATION	SUB-CONTRACTOR	TOTAL
1	General Requirements						
2	Site Work			671,440.00	6,710,560.00	504,000.00	7,886,000.00
3	Concrete						
4	Masonry						
5	Metals						
6	Wood & Plastics						
7	Thermal & Moisture Protect.						
8	Doors & Windows						
9	Finishes						
10	Specialties						
11	Equipment						
12	Furnishings						
13	Special Construction						
14	Conveying Systems						
15	Mechanical						
16	Electrical						
17	Instrumentation (see DIV 13)						
	Subtotals			671,440.00	6,710,560.00	504,000.00	7,886,000.00
	Division 1 Costs	@	7%	47,000.80	469,739.20	35,280.00	552,020.00
	Subtotals			718,440.80	7,180,299.20	539,280.00	8,438,020.00
	Taxes - Materials	@	9.00%	64,659.67			64,659.67
	Subtotals			783,100.47	7,180,299.20	539,280.00	8,502,679.67
	Taxes - Labor	@					
	Subtotals			783,100.47	7,180,299.20	539,280.00	8,502,679.67
	Contractor MU on Sub	@	10%			53,928.00	53,928.00
	Subtotals			783,100.47	7,180,299.20	593,208.00	8,556,607.67
	Contractor OH&P	@	12%	93,972.06	861,635.90		955,607.96
	Subtotals			877,072.53	8,041,935.10	593,208.00	9,512,215.63
	Estimate Contingency	@	15%				1,426,832.34
	Subtotal						10,939,047.98
	Escalate to Midpt of Const.	@					
	Estimated Bid Price						10,939,047.98
	Total Estimate						10,940,000.00

Estimate Accuracy	
+30%	-15%

Estimated Range of Probable Cost		
+30%	Total Est.	-15%
$14,222,000	**$10,940,000**	**$9,299,000**

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 7-Sep-15

Building, Area: Well Drilling **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** 10 **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 2 -Site Work											
	1	Site Prep	16	EA			10,000.00	160,000			160,000
	2	Install 30" Conductor Casing, 50 feet	16	EA					30,000	480,000	480,000
	3	Drill, Sample, Log Pilot Borehole	9,760	FT			150.00	1,464,000			1,464,000
	4	Geophysical Log (E-Log) Pilot Borehole	16	EA			7,500.00	120,000			120,000
	5	Aquifer Zone Testing for Yield and Water Quality (3 zones per well at 580, 500, 420, 340 ft bgs)	4	EA	7,500.00	30,000	67,500.00	270,000			300,000
	6	Ream to 28-Inches	8,960	FT			125.00	1,120,000			1,120,000
	7	Install 18" Louvered Well Screen	3,200	FT	40.00	128,000	160.00	512,000			640,000
	8	Gravel Pack	6,400	FT	24.00	153,600	96.00	614,400			768,000
	9	Bentonite Cap/Seal	16	EA	300.00	4,800	1,200.00	19,200			24,000
	10	Install 18" Blank Casing	6,480	FT	23.00	149,040	92.00	596,160			745,200
	11	Install 3" Gavel Tube	3,360	FT	5.00	16,800	10.00	33,600			50,400
	12	Install 3" Sounding Tube	7,120	FT	5.00	35,600	20.00	142,400			178,000
	13	Install Sanitary Seal	3,200	FT	48.00	153,600	12.00	38,400			192,000
	14	Airlift and Swab	960	HRS			500.00	480,000			480,000
	15	Well Development by Surging and Pumping	768	HRS			550.00	422,400			422,400
	16	Formation Pump Test - Step Rate Test	256	HRS			400.00	102,400			102,400
	17	Formation Pump Test - Constant Rate Test	384	HRS			400.00	153,600			153,600
	18	Title 22 Water Quality Analysis	16	EA			1,000.00	16,000			16,000
	19	Well Disinfection and Bacteriological Sampling	16	LS			6,000.00	96,000			96,000
	20	Well Video	16	EA					1,500	24,000	24,000
	21	Temporary Percolation Pond & Pip	5	EA			35,000.00	175,000			175,000
	22	Temporary Percolation Pond & Pip	5	EA			35,000.00	175,000			175,000
SUBTOTAL - DIVISION 2						671,440		6,710,560		504,000	7,886,000

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 7-Sep-15

Building, Area: Well Drilling **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** 10 **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 3 - Concrete											
NOT USED											
SUBTOTAL - DIVISION 3											
DIVISION 4 - Masonry											
NOT USED											
SUBTOTAL - DIVISION 4											
DIVISION 5 - Metals											
NOT USED											
SUBTOTAL - DIVISION 5											
DIVISION 6 - Wood and Plastic											
NOT USED											
SUBTOTAL - DIVISION 6											
DIVISION 7 - Thermal and Moisture Protection											
NOT USED											
SUBTOTAL - DIVISION 7											
DIVISION 8 - Doors and Windows											
NOT USED											

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 7-Sep-15

Building, Area: Well Drilling **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** 10 **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
SUBTOTAL - DIVISION 8											
DIVISION 9 - Finishes											
NOT USED											
SUBTOTAL - DIVISION 9											
DIVISION 10 - Specialties											
NOT USED											
SUBTOTAL - DIVISION 10											
DIVISION 11 - Equipment											
NOT USED											
SUBTOTAL - DIVISION 11											
DIVISION 12 - Furnishings											
NOT USED											
SUBTOTAL - DIVISION 12											
DIVISION 13 - Special Construction											
NOT USED											
SUBTOTAL - DIVISION 13											
DIVISION 14 - Conveying Systems											

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 7-Sep-15

Building, Area: Well Drilling **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** 10 **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
NOT USED											
SUBTOTAL - DIVISION 14											
DIVISION 15 - Mechanical											
NOT USED											
SUBTOTAL - DIVISION 15											
DIVISION 16 - Electrical											
NOT USED											
SUBTOTAL - DIVISION 16											
DIVISION 17 - Instrumentation											
NOT USED											
SUBTOTAL - DIVISION 17											

OPINION OF PROBABLE CONSTRUCTION COST | **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP | **Prepared By:** ZC

Date Prepared: 09-Sep-15

Building: Well Equipping, Site Work, and Buildings | **K/J Proj. No.:** 1344505*01

Estimate Type:

- ☐ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☒ **Design Development @ 10% Complete**
- ☐ **Construction**
- ☐ **Change Order**

Current at ENR

Escalated to ENR

Mos. to Midpoint

SUMMARY BY DIVISION

DIV. No.	ITEM DESCRIPTION			MATERIALS	INSTALLATION	SUB-CONTRACTOR	TOTAL
1	General Requirements			0.00	0.00	0.00	0.00
2	Site Work			294,236.44	294,969.42	0.00	589,205.86
3	Concrete			381,261.90	323,053.26	0.00	704,315.16
4	Masonry			260,064.00	216,720.00	0.00	476,784.00
5	Metals			414,580.00	264,420.00	0.00	679,000.00
6	Wood & Plastics			64,000.00	48,000.00	0.00	112,000.00
7	Thermal & Moisture Protect.			36,800.00	20,800.00	0.00	57,600.00
8	Doors & Windows			83,200.00	44,800.00	0.00	128,000.00
9	Finishes			19,840.00	17,600.00	0.00	37,440.00
10	Specialties			17,600.00	5,120.00	0.00	22,720.00
11	Equipment			2,700,800.00	440,000.00	0.00	3,140,800.00
12	Furnishings			0.00	0.00	0.00	0.00
13	Special Construction			0.00	0.00	0.00	0.00
14	Conveying Systems			0.00	0.00	0.00	0.00
15	Mechanical			525,360.00	152,576.00	0.00	677,936.00
16	Electrical			0.00	0.00	1,120,000.00	1,120,000.00
17	Instrumentation			432,000.00	30,400.00	128,000.00	590,400.00
	Subtotals			5,229,742.35	1,858,458.68	1,248,000.00	8,336,201.02
	Division 1 Costs	@	7%	366,081.96	130,092.11	87,360.00	583,534.07
	Subtotals			5,595,824.31	1,988,550.78	1,335,360.00	8,919,735.10
	Taxes - Materials	@	9.00%	503,624.19			503,624.19
	Subtotals			6,099,448.50	1,988,550.78	1,335,360.00	9,423,359.28
	Taxes - Labor	@	0.00%		0.00		0.00
	Subtotals			6,099,448.50	1,988,550.78	1,335,360.00	9,423,359.28
	Contractor MU on Sub	@	10%			133,536.00	133,536.00
	Subtotals			6,099,448.50	1,988,550.78	1,468,896.00	9,556,895.28
	Contractor OH&P	@	12%	731,933.82	238,626.09		970,559.91
	Subtotals			6,831,382.32	2,227,176.88	1,468,896.00	10,527,455.20
	Estimate Contingency	@	15%				1,579,118.28
	Subtotal						12,106,573.48
	Escalate to Midpt of Const.	@	0%				0.00
	Estimated Bid Price						12,106,573.48
	Total Estimate						12,110,000.00

Estimate Accuracy	
+30%	-15%

Estimated Range of Probable Cost		
+30%	Total Est.	-15%
$15,743,000	**$12,110,000**	**$10,293,500**

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 7-Sep-15

Building, Area: Well Equipping, Site Work, and Buildings **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** 10 **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 2 -Site Work											
	1	Site Grading; over-excavation; backfill	16	EA	0.00	0	7,500.00	120,000		0	120,000
	2	Building Excavation	2,070	CY	0.00	0	10.00	20,696		0	20,696
	3	Building Backfill and Compaction (Native)	1,231	CY	0.00	0	5.00	6,156		0	6,156
	4	Clearing and Grubbing	16	EA	0.00	0	500.00	8,000		0	8,000
	5	3/4" Crushed Rock - 6" depth, Site	967	SY	7.00	6,770	1.50	1,451		0	8,220
	6	Bollards	128	EA	250.00	32,000	50.00	6,400		0	38,400
	7	Blow-off Pond - Sand Layer	533	CY	8.00	4,267	8.00	4,267		0	8,533
	8	Fencing	6,080	LF	25.00	152,000	10.00	60,800		0	212,800
	9	Electric Rolling Gates	16	EA	5,000.00	80,000	4,000.00	64,000		0	144,000
	10	Pedestrian Gate	16	EA	1,200.00	19,200	200.00	3,200		0	22,400
SUBTOTAL - DIVISION 2						294,236		294,969		0	589,206
DIVISION 3 - Concrete											
	1	Building Footings and Slab	821	CY	325.00	266,683	300.00	246,169		0	512,852
	2	Spillway Shotcrete (4" thick)	370	SF	4.00	1,481	1.00	370		0	1,851
	3	Basin Shotcrete (4" thick)	13,574	SF	4.00	54,298	1.00	13,574		0	67,872
	4	Fence Footings	225	CY	175.00	39,407	200.00	45,037		0	84,444
	5	Air Gap Outfall Retaining wall	36	CY	325.00	11,556	300.00	10,667		0	22,222
	6	Air Gap Outfall Reinforced Pad	5	CY	325.00	1,643	300.00	1,517		0	3,160
	7	Pump Base	19.00	CY	326.00	6,194	301.00	5,719		0	11,913
SUBTOTAL - DIVISION 3						381,262		323,053		0	704,315
DIVISION 4 - Masonry											
	1	CMU Wall	14,448	SF	18.00	260,064	15.00	216,720		0	476,784
SUBTOTAL - DIVISION 4						260,064		216,720		0	476,784
DIVISION 5 - Metals											
	1	Channels at Roll-up Door	224	LF	20.00	4,480	30.00	6,720		0	11,200
	2	Pipe Supports	1	LS	100,000.00	100,000	50,000.00	50,000		0	150,000

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 7-Sep-15

Building, Area: Well Equipping, Site Work, and Buildings **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** 10 **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
	3	Anchor Bolts	1	LS	500.00	500	500.00	500		0	1,000
	4	Channels for Movable Building	320.00	LF	30.00	9,600	45.00	14,400		0	24,000
	5	Metal Pull Apart Building	16.00	EA	12,000.00	192,000	8,000.00	128,000		0	320,000
	6	Metal Roof	10,800.00	SF	10.00	108,000	6.00	64,800		0	172,800
SUBTOTAL - DIVISION 5						414,580		264,420		0	679,000
DIVISION 6 - Wood and Plastic											
	1	Roof Framing, trim, and misc wood	16	EA	4,000.00	64,000	3,000.00	48,000		0	112,000
SUBTOTAL - DIVISION 6						64,000		48,000		0	112,000
DIVISION 7 - Thermal and Moisture Protection											
	1	Sealants, roof insulation, etc	16	EA	1,500.00	24,000	800.00	12,800		0	36,800
	2	Flashing, gutters & downspouts	16	EA	800.00	12,800	500.00	8,000		0	20,800
SUBTOTAL - DIVISION 7						36,800		20,800		0	57,600
DIVISION 8 - Doors and Windows											
	1	Double door & frame	16	EA	800.00	12,800	500.00	8,000		0	20,800
	2	Roll-up door	16	EA	3,000.00	48,000	1,500.00	24,000		0	72,000
	3	Double door hardware	16	EA	400.00	6,400	200.00	3,200		0	9,600
	4	Louvers	32	EA	500.00	16,000	300.00	9,600		0	25,600
SUBTOTAL - DIVISION 8						83,200		44,800		0	128,000
DIVISION 9 - Finishes											
	1	Painting - Doors and Trim	16	EA	40.00	640	300.00	4,800		0	5,440
	2	Painting-CMU Anti-Grafitti Coating	16	EA	1,200.00	19,200	800.00	12,800		0	32,000
SUBTOTAL - DIVISION 9						19,840		17,600		0	37,440

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 7-Sep-15

Building, Area: Well Equipping, Site Work, and Buildings **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** 10 **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 10 - Specialties											
	1	Fire extingushers	16	EA	100.00	1,600	20.00	320		0	1,920
	2	Identifying Devices	16	EA	1,000.00	16,000	300.00	4,800		0	20,800
SUBTOTAL - DIVISION 10						17,600		5,120		0	22,720
DIVISION 11 - Equipment											
	1	Vertical Turbine Deep Well Pump	16	EA	113,800.00	1,820,800	17,500.00	280,000		0	2,100,800
	2	VFD for Well Pump w/Panel AC Unit	16	EA	55,000.00	880,000	10,000.00	160,000		0	1,040,000
SUBTOTAL - DIVISION 11						2,700,800		440,000		0	3,140,800
DIVISION 12 - Furnishings											
NOT USED											
SUBTOTAL - DIVISION 12											
DIVISION 13 - Special Construction											
NOT USED											
SUBTOTAL - DIVISION 13											
DIVISION 14 - Conveying Systems											
NOT USED											
SUBTOTAL - DIVISION 14											
DIVISION 15 - Mechanical											

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 7-Sep-15

Building, Area: Well Equipping, Site Work, and Buildings **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** 10 **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
	1	2" Deep Well Air and Vacuum Valve	16	EA	2,500.00	40,000	500.00	8,000		0	48,000
	2	2" Combination Air and Vacuum Valve	16	EA	2,500.00	40,000	500.00	8,000		0	48,000
	3	2" Water Service Tap	16	EA	1,250.00	20,000	286.00	4,576		0	24,576
	4	Oil Lube System	16	EA	1,000.00	16,000	300.00	4,800		0	20,800
	5	10" Butterfly Valve	16	EA	1,500.00	24,000	300.00	4,800		0	28,800
	6	Sidewall Exhaust Fan	32	EA	400.00	12,800	200.00	6,400		0	19,200
	7	10" Pump Control Valve	16	EA	12,000.00	192,000	2,400.00	38,400		0	230,400
	8	8" Deep Well Pump Control Valve	16	EA	9,000.00	144,000	1,800.00	28,800		0	172,800
	9	10" CML&C Pipe	352	LF	30.00	10,560	50.00	17,600		0	28,160
	10	8" CML&C Pipe	1,040	LF	25.00	26,000	30.00	31,200		0	57,200
SUBTOTAL - DIVISION 15						525,360		152,576		0	677,936
DIVISION 16 - Electrical											
	1	Site Electrical, Lighting, Grounding	16	EA		0		0	30,000	480,000	480,000
	2	MCC Panel and Electrical Service	16	EA		0		0	40,000	640,000	640,000
SUBTOTAL - DIVISION 16						0		0		1,120,000	1,120,000
DIVISION 17 - Instrumentation											
	1	Well Level Press. Transmitter	16	EA	900.00	14,400	200.00	3,200		0	17,600
	2	Pressure Transmitter	16	EA	2,500.00	40,000	500.00	8,000		0	48,000
	3	Press. Switch	16	EA	300.00	4,800	100.00	1,600		0	6,400
	4	Flow Switch	16	EA	300.00	4,800	100.00	1,600		0	6,400
	5	10" Discharge Flow Meter	16	EA	6,000.00	96,000	1,000.00	16,000		0	112,000
	6	RTU w/SCADA Radio and Anntenna	16	EA	17,000.00	272,000		0	8,000	128,000	400,000
SUBTOTAL - DIVISION 17						432,000		30,400		128,000	590,400

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 09-Sep-15

Building: Pipelines **K/J Proj. No.:** 1544231*01

Estimate Type:
- ☐ **Conceptual**
- ☐ **Construction**
- ☐ **Preliminary (w/o plans)**
- ☐ **Change Order**
- ☒ **Design Development @ 10% Complete**

Current at ENR

Escalated to ENR

Mos. to Midpoint

SUMMARY BY DIVISION

DIV. No.	ITEM DESCRIPTION			MATERIALS	INSTALLATION	SUB-CONTRACTOR	TOTAL
1	General Requirements[1]			0.00	0.00	0.00	0.00
2	Site Work			100,460.88	197,960.88	0.00	298,421.76
3	Concrete			33,200.00	10,000.00	0.00	43,200.00
4	Masonry			0.00	0.00	0.00	0.00
5	Metals			0.00	0.00	0.00	0.00
6	Wood & Plastics			0.00	0.00	0.00	0.00
7	Thermal & Moisture Protect.			0.00	0.00	0.00	0.00
8	Doors & Windows			0.00	0.00	0.00	0.00
9	Finishes			0.00	0.00	0.00	0.00
10	Specialties			0.00	0.00	0.00	0.00
11	Equipment			0.00	0.00	0.00	0.00
12	Furnishings			0.00	0.00	0.00	0.00
13	Special Construction			175,000.00	375,000.00	90,000.00	640,000.00
15	Mechanical			13,197,898.00	13,341,516.00	0.00	26,539,414.00
16	Electrical			0.00	0.00	0.00	0.00
17	Instrumentation			0.00	0.00	0.00	0.00
	Subtotals			13,506,558.88	13,924,476.88	90,000.00	27,521,035.76
	Division 1 Costs	@	7%	945,459.12	974,713.38	6,300.00	1,926,472.50
	Subtotals			14,452,018.00	14,899,190.26	96,300.00	29,447,508.26
	Taxes - Materials	@	9.00%	1,300,681.62			1,300,681.62
	Subtotals			15,752,699.62	14,899,190.26	96,300.00	30,748,189.88
	Taxes - Labor	@	0.00%		0.00		0.00
	Subtotals			15,752,699.62	14,899,190.26	96,300.00	30,748,189.88
	Contractor MU on Sub	@	10%			9,630.00	9,630.00
	Subtotals			15,752,699.62	14,899,190.26	105,930.00	30,757,819.88
	Contractor OH&P	@	12%	1,890,323.95	1,787,902.83		3,678,226.79
	Subtotals			17,643,023.58	16,687,093.09	105,930.00	34,436,046.67
	Estimate Contingency	@	15%				5,165,407.00
	Subtotal						39,601,453.67
	Escalate to Midpt of Const.	@	0%				0.00
	Estimated Bid Price			17,643,023.58	16,687,093.09	105,930.00	39,601,453.67
	Total Estimate						39,602,000.00

Notes

[1] Mobilization/demobilization, SWPPP, and Insurance cost is included in Division 1 Costs

Estimate Accuracy	
+30%	-15%

Estimated Range of Probable Cost		
+30%	Total Est.	-15%
$51,482,600	**$39,602,000**	**$33,661,700**

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Pipelines **K/J Proj. No.** 1544231*01

Current at ENR

Escalated to ENR

Months to Midpoint of Construct

Estimate Type: **Conceptual** **Construction**

Preliminary (w/o plans) **Change Order**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 2 -Site Work											
	1	Meter Vault Excavation	520	CY		5,000	15.00	2,500		0	7,500
	2	Meter Vault Backfill	446	CY	10.00	4,461	10.00	4,461		0	8,922
	3	Traffic Control for 36" Pipe Installation	1	LS		0	28,000.00	28,000	7,000	7,000	35,000
	4	Traffic Control for 30" Pipe Installation	1	LS		0	72,000.00	72,000	18,000	18,000	90,000
	5	Pavement for 36" Pipe	1	LS	46,000.00	46,000	46,000.00	46,000			92,000
	6	Pavement for 30" Pipe	1	LS	45,000.00	45,000	45,000.00	45,000			90,000
SUBTOTAL - DIVISION 2						100,461		197,961		0	323,422
DIVISION 3 - Concrete											
	1	10'X10'x10' Meter Vault with Traffic Rated Hatch	2	EA	16,600.00	33,200	5,000.00	10,000		0	43,200
SUBTOTAL - DIVISION 3						33,200		10,000		0	43,200
DIVISION 4 - Masonry											
NOT USED											
SUBTOTAL - DIVISION 4											
DIVISION 5 - Metals											
NOT USED											
SUBTOTAL - DIVISION 5											
DIVISION 6 - Wood and Plastic											
NOT USED											
SUBTOTAL - DIVISION 6											

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Pipelines **K/J Proj. No.** 1544231*01

Current at ENR

Escalated to ENR

Months to Midpoint of Construct

Estimate Type: **Conceptual** **Construction**

Preliminary (w/o plans) **Change Order**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 7 - Thermal and Moisture Protection											
NOT USED											
SUBTOTAL - DIVISION 7											
DIVISION 8 - Doors and Windows											
NOT USED											
SUBTOTAL - DIVISION 8											
DIVISION 9 - Finishes											
NOT USED											
SUBTOTAL - DIVISION 9											
DIVISION 10 - Specialties											
NOT USED											
SUBTOTAL - DIVISION 10											
DIVISION 11 - Equipment											
NOT USED											
SUBTOTAL - DIVISION 11											
DIVISION 12 - Furnishings											
NOT USED											

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Pipelines **K/J Proj. No.** 1544231*01

Current at ENR

Escalated to ENR

Months to Midpoint of Construct

Estimate Type: **Conceptual** **Construction**

Preliminary (w/o plans) **Change Order**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
SUBTOTAL - DIVISION 12											
DIVISION 13 - Special Construction											
	1	Turnout Facility	1.00	LS	125,000.00	125,000	375,000.00	375,000		0	500,000
	2	Jack and Bore RR Crossing	1.00	LS	50,000.00	50,000		0	90,000	90,000	140,000
SUBTOTAL - DIVISION 13						175,000		375,000		90,000	640,000
DIVISION 14 - Conveying Systems											
NOT USED											
SUBTOTAL - DIVISION 14											
DIVISION 15 - Mechanical											
						0		0		0	0
						0		0		0	0
SUBTOTAL - DIVISION 14						0		0		0	0
DIVISION 15 - MECHANICAL						0		0		0	0
	1	48" CML&C Pipe (150 psi)	2,890	LF	128.00	369,920	155.00	447,950		0	817,870
	2	36" CML&C Pipe (150 psi)	19,800	LF	97.00	1,920,600	115.00	2,277,000		0	4,197,600
	3	30" CML&C Pipe (150 psi)	17,480	LF	80.00	1,398,400	96.00	1,678,080		0	3,076,480
	4	24" CML&C Pipe (150 psi)	9,350	LF	64.00	598,400	76.80	718,080		0	1,316,480
	5	20" CML&C Pipe (150 psi)	7,850	LF	53.00	416,050	64.00	502,400		0	918,450
	6	16" CML&C Pipe (150 psi)	8,500	LF	43.00	365,500	51.00	433,500		0	799,000
	7	12" CML&C Pipe (150 psi)	6,000	LF	32.00	192,000	38.00	228,000		0	420,000
	8	10" CML&C Pipe (150 psi)	528	LF	26.00	13,728	32.00	16,896		0	30,624
	9	36" CML&C Pipe (250 psi)	25,400	LF	145.00	3,683,000	135.00	3,429,000		0	7,112,000
	10	30" CML&C Pipe (250 psi)	31,680	LF	120.00	3,801,600	112.00	3,548,160		0	7,349,760
	11	36" Butterfly Valve (150 psi)	4	EA	36,000.00	144,000	3,600.00	14,400		0	158,400
	12	36" Butterfly Valve (250 psi)	2	EA	21,000.00	42,000	2,100.00	4,200		0	46,200
	13	30" Butterfly Valve (150 psi)	1	EA	17,900.00	17,900	1,790.00	1,790		0	19,690
	14	30" Butterfly Valve (250 psi)	2	EA	26,300.00	52,600	2,630.00	5,260		0	57,860
	15	24" Butterfly Valve (150 psi)	2	EA	14,000.00	28,000	1,500.00	3,000		0	31,000

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Pipelines **K/J Proj. No.** 1544231*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
	16	20" Butterfly Valve (150 psi)	1	EA	7,000.00	7,000	800.00	800		0	7,800
	17	16" Butterfly Valve (150 psi)	2	EA	3,600.00	7,200	500.00	1,000		0	8,200
	18	24" Butterfly Valve (MOV)	1	EA	25,000.00	25,000	5,000.00	5,000		0	30,000
	19	2" Air Valve	10	EA	2,000.00	20,000	500.00	5,000		0	25,000
	20	24" Flowmeter (for 30")	1	EA	25,000.00	25,000	5,000.00	5,000		0	30,000
	21	30" Flowmeter (for 36")	1	EA	35,000.00	35,000	7,000.00	7,000		0	42,000
	22	Blowoff Valve	10	EA	3,500.00	35,000	1,000.00	10,000		0	45,000
SUBTOTAL - DIVISION 15						13,197,898		13,341,516		0	26,539,414
DIVISION 16 - Electrical											
NOT USED											
SUBTOTAL - DIVISION 16											
DIVISION 17 - Instrumentation											
NOT USED											
SUBTOTAL - DIVISION 17											

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 09-Sep-15

Building: Recharge Basin **K/J Proj. No.:** 1344505*01

Estimate Type:
- ☐ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☒ **Design Development @ 10% Complete**
- ☐ **Construction**
- ☐ **Change Order**

Current at ENR

Escalated to ENR

Mos. to Midpoint

SUMMARY BY DIVISION

DIV. No.	ITEM DESCRIPTION			MATERIALS	INSTALLATION	SUB-CONTRACTOR	TOTAL
1	General Requirements[1]			0.00	0.00	0.00	0.00
2	Site Work			2,029,428.52	2,631,922.93	0.00	4,661,351.44
3	Concrete			273,304.63	219,771.30	0.00	493,075.93
4	Masonry			0.00	0.00	0.00	0.00
5	Metals			62,060.00	17,940.00	0.00	80,000.00
6	Wood & Plastics			0.00	0.00	0.00	0.00
7	Thermal & Moisture Protect.			0.00	0.00	0.00	0.00
8	Doors & Windows			0.00	0.00	0.00	0.00
9	Finishes			0.00	0.00	0.00	0.00
10	Specialties			0.00	0.00	0.00	0.00
11	Equipment			0.00	0.00	0.00	0.00
12	Furnishings			0.00	0.00	0.00	0.00
13	Special Construction			125,000.00	65,000.00	0.00	190,000.00
14	Conveying Systems			0.00	0.00	0.00	0.00
15	Mechanical			471,800.00	367,300.00	0.00	839,100.00
16	Electrical			20,000.00	20,000.00	20,000.00	60,000.00
17	Instrumentation			4,800.00	2,700.00	54,050.00	61,550.00
	Subtotals			2,986,393.15	3,324,634.22	74,050.00	6,385,077.37
	Division 1 Costs	@	7%	209,047.52	232,724.40	5,183.50	446,955.42
	Subtotals			3,195,440.67	3,557,358.62	79,233.50	6,832,032.79
	Taxes - Materials	@	9.00%	287,589.66			287,589.66
	Subtotals			3,483,030.33	3,557,358.62	79,233.50	7,119,622.45
	Taxes - Labor	@	0.00%		0.00		0.00
	Subtotals			3,483,030.33	3,557,358.62	79,233.50	7,119,622.45
	Contractor MU on Sub	@	10%			7,923.35	7,923.35
	Subtotals			3,483,030.33	3,557,358.62	87,156.85	7,127,545.80
	Contractor OH&P	@	12%	417,963.64	426,883.03		844,846.67
	Subtotals			3,900,993.97	3,984,241.65	87,156.85	7,972,392.47
	Estimate Contingency	@	15%				1,195,858.87
	Subtotal						9,168,251.34
	Escalate to Midpt of Const.	@	0%				0.00
	Estimated Bid Price			3,900,993.97	3,984,241.65	87,156.85	9,168,251.34
	Total Estimate						9,169,000.00

Notes

[1] Mobilization/demobilization, SWPPP, and Insurance cost is included in Division 1 Costs

Estimate Accuracy	
+30%	-15%

Estimated Range of Probable Cost		
+30%	Total Est.	-15%
$11,919,700	**$9,169,000**	**$7,793,650**

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Recharge Basin **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 2 -Site Work											
	1	Site Preparation (stripping/grubbing)	110	AC		0	1,000.00	110,000		0	110,000
	2	Site Excavation	225,000	CY		0	8.00	1,800,000		0	1,800,000
	5	Stockpile Surplus	25,000	CY		0	5.00	125,000		0	125,000
	6	Splitter Box Back Fill	2,000	CY		0	8.00	16,000		0	16,000
	7	Shotcrete (4" Thick)	373,190	SF	4.00	1,492,760	1.00	373,190		0	1,865,950
	8	Aggregate Base Paving (6" Thick)	232,770	SF	1.00	232,770	0.40	93,108		0	325,878
	9	Crushed Rock for Basin Inlet and Outlet	170	CY	20.00	3,400	1.00	170		0	3,570
	10	Crushed Rock for Splitter Box	55	CY	20.00	1,099	1.00	55		0	1,153
	11	Grouted Riprap	400	CY	100.00	40,000	50.00	20,000		0	60,000
	12	8' Chain Link Fence	9,000	LF	28.00	252,000	10.00	90,000		0	342,000
	13	4' Access Gate	2	EA	1,200.00	2,400	200.00	400		0	2,800
	14	20' Electric Rolling Gate	1	EA	3,500.00	5,000	3,000.00	4,000		0	9,000
SUBTOTAL - DIVISION 2						2,029,429		2,631,923		0	4,661,351
DIVISION 3 - Concrete											
	1	Concrete Fill (Basin Inlet)	74	CY	300.00	22,200	50.00	3,700		0	25,900
	2	Inlet Concrete	128	CY	325.00	41,600	300.00	38,400		0	80,000
	3	Overflow Access Ramp Concrete	385	CY	325.00	125,185	175.00	67,407		0	192,593
	4	Splitter Box	192	CY	325.00	62,400	425.00	81,600		0	144,000
	5	Outlet Concrete	67	CY	325.00	21,919	425.00	28,664		0	50,583
SUBTOTAL - DIVISION 3						273,305		219,771		0	493,076
DIVISION 4 - Masonry											
NOT USED											
SUBTOTAL - DIVISION 4											
DIVISION 5 - Metals											
	1	Unistrut Pipe Support system	1	LS	1,000.00	1,000	500.00	500		0	1,500

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Recharge Basin **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
	2	Handrails (Basin Inlet)	276	LS	20.00	5,520	5.00	1,380		0	6,900
	3	Misc Metals	1	LS	5,000.00	5,000	10,000.00	10,000		0	15,000
	4	Galv Stl Grating (Basin Inlet)	1,290	SF	18.00	23,220	2.00	2,580		0	25,800
	5	Galv Stl Grating (Splitter Box)	1,240	SF	18.00	22,320	2.00	2,480		0	24,800
	6	Ladder with Hatch	1	LS	5,000.00	5,000	1,000.00	1,000		0	6,000
SUBTOTAL - DIVISION 5						62,060		17,940		0	80,000
DIVISION 6 - Wood and Plastic											
NOT USED											
SUBTOTAL - DIVISION 6											
DIVISION 7 - Thermal and Moisture Protection											
NOT USED											
SUBTOTAL - DIVISION 7											
DIVISION 8 - Doors and Windows											
NOT USED											
SUBTOTAL - DIVISION 8											
DIVISION 9 - Finishes											
NOT USED											
SUBTOTAL - DIVISION 9											
DIVISION 10 - Specialties											
NOT USED											

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Recharge Basin **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
SUBTOTAL - DIVISION 10											
DIVISION 11 - Equipment											
NOT USED											
SUBTOTAL - DIVISION 11											
DIVISION 12 - Furnishings											
NOT USED											
SUBTOTAL - DIVISION 12											
DIVISION 13 - Special Construction											
	1	Surge Tank	1	EA	125,000.00	125,000	65,000.00	65,000		0	190,000
SUBTOTAL - DIVISION 13						125,000		65,000		0	190,000
DIVISION 14 - Conveying Systems											
NOT USED											
SUBTOTAL - DIVISION 14											
DIVISION 15 - Mechanical											
	1	36" Slide Gates for Splitter Box	4	EA	6,337.50	25,350	3,075.00	12,300		0	37,650
	2	MOV for 36" Slide Gate	1	EA	5,000.00	5,000	1,500.00	1,500		0	6,500
	3	12" Slide Gates for Splitter Box	2	EA	3,225.00	6,450	750.00	1,500		0	7,950
	4	36" HDPE Pipelines	4,150	LF	100.00	415,000	80.00	332,000		0	747,000

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Recharge Basin **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
	5	36" Steel Pipe Stub; & 48" to 36" Steel Transition	1	LS	20,000.00	20,000	20,000.00	20,000		0	40,000
SUBTOTAL - DIVISION 15						471,800		367,300		0	839,100
DIVISION 16 - Electrical											
	1	Site Lighting; MOV Slide Gate No. 4; I&C w/radio	1	LS	45,000.00	20,000	20,000.00	20,000	20,000	20,000	60,000
SUBTOTAL - DIVISION 16						20,000		20,000		20,000	60,000
DIVISION 17 - Instrumentation											
	1	Level Transimitter	5	EA	900.00	4,500	500.00	2,500		0	7,000
	2	Subcontractor (OH&P)	1	LS	0.00	0	0.00	0	34,050	34,050	34,050
	3	Float Switch in Basin No. 4	1	EA	300.00	300	200.00	200		0	500
	4	RTU, radio; antenna	1	LS	0.00	0	0.00	0	20,000	20,000	20,000
SUBTOTAL - DIVISION 17						4,800		2,700		54,050	61,550

Table 2: Opinion of Probable Construction Cost

KENNEDY/JENKS CONSULTANTS

Project: PWD PRGRRP

Prepared By: ZC

Date Prepared: 09-Sep-15

Building: Distribution Site

K/J Proj. No.: 1344505*01

Estimate Type:

- ☐ **Conceptual**
- ☐ **Preliminary (w/o plans)**
- ☒ **Design Development @ 10% Complete**
- ☐ **Construction**
- ☐ **Change Order**

Current at ENR

Escalated to ENR

Mos. to Midpoint

SUMMARY BY DIVISION

DIV. No.	ITEM DESCRIPTION			MATERIALS	INSTALLATION	SUB-CONTRACTOR	TOTAL
1	General Requirements[1]			0.00	0.00	0.00	0.00
2	Site Work			194,773.60	328,765.54	0.00	523,539.14
3	Concrete			421,969.16	405,825.81	0.00	827,794.97
4	Masonry			145,396.88	145,396.88	0.00	290,793.75
5	Metals			391,280.00	49,320.00	0.00	440,600.00
6	Wood & Plastics			0.00	0.00	0.00	0.00
7	Thermal & Moisture Protect.			116,356.78	78,466.51	0.00	194,823.29
8	Doors & Windows			59,100.00	19,750.00	0.00	78,850.00
9	Finishes			24,360.00	21,222.50	0.00	45,582.50
10	Specialties			5,225.00	1,075.00	0.00	6,300.00
11	Equipment			2,356,000.00	579,050.00	0.00	2,935,050.00
12	Furnishings			3,000.00	500.00	0.00	3,500.00
13	Special Construction			33,000.00	5,000.00	650,000.00	688,000.00
15	Mechanical			1,306,890.00	442,318.00	5,000.00	1,754,208.00
16	Electrical			4,122,900.00	0.00	335,000.00	4,457,900.00
17	Instrumentation			157,000.00	0.00	113,000.00	270,000.00
	Subtotals			9,337,251.42	2,076,690.23	1,103,000.00	12,516,941.65
	Division 1 Costs	@	7%	653,607.60	145,368.32	77,210.00	876,185.92
	Subtotals			9,990,859.02	2,222,058.55	1,180,210.00	13,393,127.57
	Taxes - Materials	@	9.00%	899,177.31			899,177.31
	Subtotals			10,890,036.33	2,222,058.55	1,180,210.00	14,292,304.88
	Taxes - Labor	@	0.00%		0.00		0.00
	Subtotals			10,890,036.33	2,222,058.55	1,180,210.00	14,292,304.88
	Contractor MU on Sub	@	10%			118,021.00	118,021.00
	Subtotals			10,890,036.33	2,222,058.55	1,298,231.00	14,410,325.88
	Contractor OH&P	@	12%	1,306,804.36	266,647.03		1,573,451.39
	Subtotals			12,196,840.69	2,488,705.57	1,298,231.00	15,983,777.26
	Estimate Contingency	@	15%				2,397,566.59
	Subtotal						18,381,343.85
	Escalate to Midpt of Const.	@					0.00
	Estimated Bid Price			12,196,840.69	2,488,705.57	1,298,231.00	18,381,343.85
	Total Estimate						18,382,000.00

Notes

[1] Mobilization/demobilization, SWPPP, and Insurance cost is included in Division 1 Costs

Estimate Accuracy	
+30%	-15%

Estimated Range of Probable Cost		
+30%	Total Est.	-15%
$23,896,600	**$18,382,000**	**$15,624,700**

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Distribution Site **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 2 -Site Work											
2200	1	Site Preparation (stripping/grubbing)	1	LS	0.00	0	3,000.00	3,000		0	3,000
2301	2	RW Wet Well Excavation	1,218	CY	0.00	0	10.00	12,183		0	12,183
2301	3	Distribution Box Excavation	278	CY	0.00	0	10.00	2,777		0	2,777
2301	4	Pump Station Excavation	3,119	CY	0.00	0	10.00	31,191		0	31,191
2301	5	Tank Excavation	1,665	CY	0.00	0	10.00	16,652		0	16,652
	6	Meter Vault Excavation	459	CY	0.00	0	11.00	5,052		0	5,052
2301	7	Trenching for Pipelines	1,067	CY	0.00	0	15.00	16,000		0	16,000
2301	8	Bedding for Pipelines	89	CY	10.00	889	15.00	1,333		0	2,222
2301	9	Imported Backfill for Pipe Zone	891	CY	10.00	8,906	15.00	13,359		0	22,265
2301	10	Imported Site Fill (From 1.0 Mile Away)	13,200	CY	0.00	0	10.00	132,000		0	132,000
	11	Tank Ringwall Subgrade Scarification and Recompaction	175	CY	0.00	0	10.00	1,745		0	1,745
	12	Tank Backfill	1,912	CY	25.00	47,810	15.00	28,686		0	76,497
	13	Building Backfill	2,442	CY	25.00	61,050	15.00	36,630		0	97,680
2705	14	Aggregate Base Paving	31,103	SF	1.00	31,103	0.40	12,441		0	43,544
2705	15	Crushed Rock for Tank	14	CY	20.00	274	1.00	14		0	287
2705	16	Crushed Rock for Building	482	CY	20.00	9,636	1.00	482		0	10,118
2706	17	Crushed Rock for Metering Boxes	8	CY	20.00	166	1.00	8		0	174
2705	18	Crushed Rock for Distribution Box	12	CY	20.00	240	1.00	12		0	252
2820	19	7' Chain Link Fence	1,200	LF	25.00	30,000	10.00	12,000		0	42,000
2820	20	4' Access Gate	1	EA	1,200.00	1,200	200.00	200		0	1,400
2820	21	20' Electric Rolling Gate	1	EA	3,500.00	3,500	3,000.00	3,000		0	6,500
SUBTOTAL - DIVISION 2						194,774		328,766		0	523,539
DIVISION 3 - Concrete											
	1	Building Footings	236	CY	325.00	76,824	300.00	70,914		0	147,738
	2	Tank Footings	123	CY	325.00	39,933	300.00	36,861		0	76,794
	3	Building Pad	366	CY	325.00	118,926	300.00	109,778		0	228,704
	4	Pump Pad and Pump Cans	47	CY	325.00	15,131	300.00	13,967		0	29,097

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Distribution Site **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
	5	Wet Well - Footing & Floor	83	CY	325.00	26,975	300.00	24,900		0	51,875
	6	Wet Well - Walls & Roof	112	CY	350.00	39,200	650.00	72,800		0	112,000
	7	Air Gap Structure - Footing & Floor	29	CY	325.00	9,425	300.00	8,700		0	18,125
	8	Air Gap Structure - Walls	27	CY	350.00	9,450	650.00	17,550		0	27,000
	9	Distribution Box - Footing & Floor	22	CY	325.00	7,150	300.00	6,600		0	13,750
	10	Distribution Box - Walls	36	CY	350.00	12,600	650.00	23,400		0	36,000
	11	Precast - Meter Box	2	EA	25,000.00	50,000	2,000.00	4,000		0	54,000
	12	Concrete Backfill inside Building	164	CY	100.00	16,356	100.00	16,356		0	32,711
SUBTOTAL - DIVISION 3						421,969		405,826		0	827,795
DIVISION 4 - Masonry											
4220	1	CMU Walls (Operations/Control Building)	9,693	SF	15.00	145,397	15.00	145,397		0	290,794
SUBTOTAL - DIVISION 4						145,397		145,397		0	290,794
DIVISION 5 - Metals											
5100	1	Building Roof Framing	1	LS	350,000.00	350,000	25,000.00	25,000		0	375,000
5500	2	Steel Pipe Supports	1	LS	20,000.00	20,000	12,000.00	12,000		0	32,000
5500	3	Misc Metals	1	LS	10,000.00	10,000	10,000.00	10,000		0	20,000
5500	4	Aluminum Riveted Bar Grating	1	LS	10,000.00	10,000	2,000.00	2,000		0	12,000
5501	5	Handrails (Distribution Box)	64	LF	20.00	1,280	5.00	320		0	1,600
SUBTOTAL - DIVISION 5						391,280		49,320		0	440,600
DIVISION 6 - Wood and Plastic											
NOT USED											
SUBTOTAL - DIVISION 6											
DIVISION 7 - Thermal and Moisture Protection											

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Distribution Site **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
7200	1	Roof Insulation	10,184	SF	1.00	10,184	1.25	12,730		0	22,914
7200	2	Wall Insulation	1,200	SF	0.75	900	1.00	1,200		0	2,100
7320	3	Metal Roof	10,184	SF	10.00	101,841	6.00	61,104		0	162,945
7600	4	Misc Flashing	1	LS	1,000.00	1,000	1,000.00	1,000		0	2,000
7600	5	Gutters	304	LF	8.00	2,432	8.00	2,432		0	4,864
SUBTOTAL - DIVISION 7						116,357		78,467		0	194,823
DIVISION 8 - Doors and Windows											
8110	1	Metal Work	1	LS	5,000.00	5,000	1,000.00	1,000		0	6,000
8305	2	Access Doors	10	EA	350.00	3,500	150.00	1,500		0	5,000
8330	3	Roll-Up Doors	6	EA	3,000.00	18,000	1,500.00	9,000		0	27,000
8520	4	Aluminum Windows	1	EA	1,000.00	1,000	250.00	250		0	1,250
8700	5	Skylights/Roof Access Hatches	13	EA	2,000.00	26,000	400.00	5,200		0	31,200
8900	6	Louvers	14	EA	400.00	5,600	200.00	2,800		0	8,400
SUBTOTAL - DIVISION 8						59,100		19,750		0	78,850
DIVISION 9 - Finishes											
9250	1	Walls	1,485	SF	1.00	1,485	1.00	1,485		0	2,970
9250	2	Ceiling	2,550	LF	1.00	2,550	1.25	3,188		0	5,738
9500	3	Acoustic Tile Ceiling	390	SF	2.00	780	1.50	585		0	1,365
9650	4	VCT Flooring	390	SF	2.50	975	2.00	780		0	1,755
9650	5	Resilient Base	100	LF	2.00	200	1.50	150		0	350
9900	6	Gypsum Board	4,035	SF	2.00	8,070	1.00	4,035		0	12,105
9900	7	Doors and Frames	10	EA	30.00	300	100.00	1,000		0	1,300
9960	8	Mechanical Coatings	1	LS	10,000.00	10,000	10,000.00	10,000		0	20,000
SUBTOTAL - DIVISION 9						24,360		21,223		0	45,583
DIVISION 10 - Specialties											
10050	1	Fire Extinguishers	3	EA	75.00	225	25.00	75		0	300
10050	2	Switchboard Mats	1	LS	1,500.00	1,500	200.00	200		0	1,700
10400	3	Identifying Devices	1	LS	2,500.00	2,500	500.00	500		0	3,000
10800	4	Toilet Room Accessories	1	SETS	1,000.00	1,000	300.00	300		0	1,300
SUBTOTAL - DIVISION 10						5,225		1,075		0	6,300

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

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Date Prepared: 9-Sep-15

Building, Area: Distribution Site **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
DIVISION 11 - Equipment											
11003	1	Onsite Hypo Generation System (inlcude metering pump, hypo storage tank, PLC control, softener)	1	LS	200,000.00	200,000	40,000.00	40,000		0	240,000
11215	2	PW Vertical Turbine Pumps	5	EA	97,000.00	485,000	24,250.00	121,250		0	606,250
11215	3	RW Vertical Turbine Pumps	6	EA	145,000.00	870,000	36,250.00	217,500		0	1,087,500
11240	4	Chlorine Injectors SAF-T-LOCK	1	EA	1,000.00	1,000	300.00	300		0	1,300
	5	Turbine Generator (Vendor Quote)	1	LS	800,000.00	800,000	200,000.00	200,000		0	1,000,000
SUBTOTAL - DIVISION 11						2,356,000		579,050		0	2,935,050
DIVISION 12 - Furnishings											
	1	Control Room	1	LS	3,000.00	3,000	500.00	500		0	3,500
SUBTOTAL - DIVISION 12						3,000		500			3,500
DIVISION 13 - Special Construction											
13211	1	Welded Steel Tank	1	EA		0		0	650,000	650,000	650,000
13416	2	Brine Tank	1	EA	33,000.00	33,000	5,000.00	5,000		0	38,000
SUBTOTAL - DIVISION 13						33,000		5,000		650,000	688,000
DIVISION 14 - Conveying Systems											
NOT USED											
SUBTOTAL - DIVISION 14											
DIVISION 15 - Mechanical											
15050	1	36" Steel Pipe 250 psi	320	LF	130.00	41,600	209.00	66,880		0	108,480

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

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X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
15050	2	30" Steel Pipe 250 psi	320	LF	110.50	35,360	176.00	56,320		0	91,680
15050	3	24" Steel Pipe 250 psi	80	LF	91.00	7,280	148.50	11,880		0	19,160
15050	4	36" Steel Pipe 150 psi	410	LF	100.00	41,000	190.00	77,900		0	118,900
15050	5	30" Steel Pipe 150 psi	100	LF	85.00	8,500	160.00	16,000		0	24,500
15050	6	24" Steel Pipe 150 psi	130	LF	70.00	9,100	135.00	17,550		0	26,650
15050	7	16" Steel Pipe 150 psi	380	LF	36.00	13,680	70.00	26,600		0	40,280
15050	8	16" Steel Pipe 250 psi	182	LF	60.00	10,920	115.00	20,930		0	31,850
15050	9	14" Steel Pipe 250 psi	100	LF	40.00	4,000	78.00	7,800		0	11,800
15050	10	12" Steel Pipe 250 psi	30	LF	35.00	1,050	68.00	2,040		0	3,090
15050	11	14" Victaulic Coupling	11	EA	500.00	5,500	150.00	1,650		0	7,150
15050	12	16" Flex Coupling	13	EA	1,500.00	19,500	350.00	4,550		0	24,050
15050	13	30" Flex Tend	1	EA	55,000.00	55,000	5,000.00	5,000		0	60,000
15050	14	36" Butterfly Valve (250 psi)	1	EA	37,000.00	37,000	3,700.00	3,700		0	40,700
15050	15	30" Butterfly Valve (150 psi)	2	EA	17,900.00	35,800	1,790.00	3,580		0	39,380
15050	16	30" Butterfly Valve (250 psi)	1	EA	26,000.00	26,000	2,600.00	2,600		0	28,600
15050	17	20" Butterfly Valve (250 psi)	4	EA	10,300.00	41,200	1,030.00	4,120		0	45,320
15050	18	16" Butterfly Valve (250 psi)	6	EA	6,500.00	39,000	650.00	3,900		0	42,900
15051	19	16" Butterfly Valve (150 psi)	7	EA	3,600.00	25,200	500.00	3,500		0	28,700
15050	20	14" Butterfly Valve (250 psi)	5	EA	6,200.00	31,000	620.00	3,100		0	34,100
15050	21	12" Gate Valve	2	EA	4,700.00	9,400	470.00	940		0	10,340
15050	22	16" Cla-Val	8	EA	48,000.00	384,000	4,800.00	38,400		0	422,400
15050	23	14" Cla-Val	5	EA	39,000.00	195,000	3,900.00	19,500		0	214,500
15050	24	12" Cla-Val	1	EA	20,000.00	20,000	2,000.00	2,000		0	22,000
15050	25	18" Plug Valve w/electric motor operator	2	EA	9,200.00	18,400	920.00	1,840		0	20,240
15050	26	2" Air Valve	13	EA	2,000.00	26,000	500.00	6,500		0	32,500
15050	27	24" Flowmeter	2	EA	25,000.00	50,000	5,000.00	10,000		0	60,000
15050	28	30" Flowmeter	1	EA	35,000.00	35,000	7,000.00	7,000		0	42,000
	29	Pump Room - Exhaust Ventilation	1	LS	40,000.00	40,000	4,080.00	4,080		0	44,080
	30	Electrical Room - HAVC	1	LS	36,500.00	36,500	10,330.00	10,330		0	46,830
	31	Hypochlorite Room - Wall Propeller Exhaust Fan	1	EA	1,500.00	1,500	128.00	2,000		0	3,500
	32	Garage/Workshop - HAVC	1	EA	3,400.00	3,400	128.00	128		0	3,528

OPINION OF PROBABLE CONSTRUCTION COST **KENNEDY/JENKS CONSULTANTS**

Project: PWD PRGRRP **Prepared By:** ZC

Date Prepared: 9-Sep-15

Building, Area: Distribution Site **K/J Proj. No.** 1344505*01

Current at ENR

Estimate Type: **Conceptual** **Construction** **Escalated to ENR**

Preliminary (w/o plans) **Change Order** **Months to Midpoint of Construct**

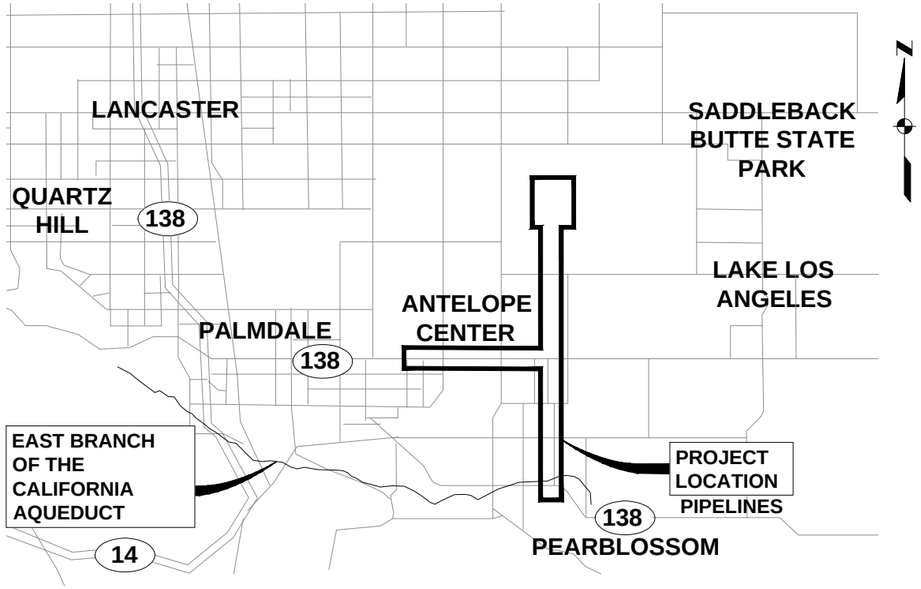
X **Design Development @** **10** **% Complete**

Spec. Section	Item No.	Description	Qty	Units	Materials $/Unit	Materials Total	Installation $/Unit	Installation Total	Sub-contractor $/Unit	Sub-contractor Total	Total
	33	Testing and Balancing @ 5% of HVAC total	1	LS					5,000	5,000	5,000
SUBTOTAL - DIVISION 15						1,306,890		442,318		5,000	1,754,208
DIVISION 16 - Electrical											
	1	Service Entrance Equipment/Raceways/Utility Fees	1	LS	138,000	138,000		0	25,000	25,000	163,000
	2	Medium Voltage Switchgear	1	LS	1,400,000	1,400,000		0	70,000	70,000	1,470,000
	3	Medium Voltage Variable Frequency Drives	11	EA	200,000	2,200,000		0	10,000	110,000	2,310,000
	4	Medium Voltage Transformers	2	EA	33,000	66,000		0	3,500	7,000	73,000
	5	480V Switchboard	1	EA	113,000	113,000		0	15,000	15,000	128,000
	6	480V Transformers	2	EA	4,200	8,400		0	1,000	2,000	10,400
	7	Lighting	1	LS	85,000	85,000		0	15,000	15,000	100,000
	8	Medium Voltage Raceways & Cable	1	LS	48,000	48,000		0	36,000	36,000	84,000
	9	Low Voltage/Control/Signal Raceways & Cable	1	LS	56,000	56,000		0	46,000	46,000	102,000
	10	Grounding	1	LS	8,500	8,500		0	9,000	9,000	17,500
16010	11	Subcontractor OH&P (15%)		LS		0		0	25,479	0	0
SUBTOTAL - DIVISION 16						4,122,900		0		335,000	4,457,900
DIVISION 17 - Instrumentation											
	1	PLC Cabinets	2	EA	50,000	100,000		0	10,000	20,000	120,000
	2	Miscellaenous Instrumentation	1	LS	25,000	32,000		0	8,000	8,000	40,000
	3	SCADA Equipment	1	LS	25,000	25,000		0	5,000	5,000	30,000
	4	Programming	2	EA		0		0	40,000	80,000	80,000
SUBTOTAL - DIVISION 17						157,000		0		113,000	270,000

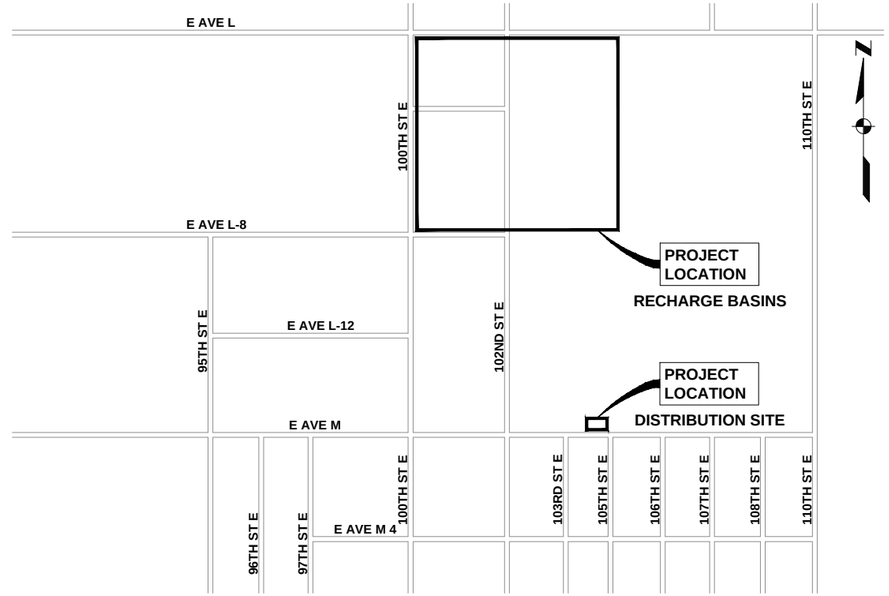
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

CITY OF PALMDALE AND UNINCORPORATED LOS ANGELES COUNTY, CA

NOVEMBER 2015



VICINITY MAP
SCALE: 1" = 2.5 MILES
0 5 MILES
1"= 2.5 MILES



LOCATION MAP
SCALE: 1" = 1000'
0 1000 2000
1"=1000'

VOLUME 2

PRELIMINARY - NOT FOR CONSTRUCTION

USE OF DOCUMENTS

THIS DOCUMENT, INCLUDING THE INCORPORATED DESIGNS, IS AN INSTRUMENT OF SERVICE FOR THIS PROJECT AND SHALL NOT BE USED FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF KENNEDY/JENKS CONSULTANTS.

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	PST

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

TITLE SHEET, VICINITY AND LOCATION MAPS

FILE NAME	1344505g01
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	G1
OF	-

11/6/2015 12:04 PM BRYANT BEHNKE
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505g01.dwg

DRAWING INDEX

SHEET NO	DRAWING NO	DRAWING TITLE
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2	G2	SHEET INDEX AND GENERAL NOTES
3	G3	SYMBOLS, SURVEY CONTROL, AND ABBREVIATIONS
4	G4	PROCESS FLOW DIAGRAM
5	G5	HYDRAULIC GRADE PROFILE SWP TURNOUT TO SPLITTER BOX
6	G6	HYDRAULIC GRADE PROFILE SPLITTER BOX TO RECHARGE BASINS
7	G7	HYDRAULIC GRADE PROFILE POTABLE WATER PUMP STATION TO PWD POINT OF DISTRIBUTION SYSTEM CONNECTION
CIVIL		
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26	C19	RAW WATER/ RETURN WATER AND POTABLE WATER PIPELINE PLAN 3
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GENERAL NOTES

1. THIS PROJECT IS WITHIN CITY OF PALMDALE AND LOS ANGELES COUNTY UNINCORPORATED TERRITORY RIGHT OF WAY. CONTRACTOR SHALL CONFORM WITH BOTH PALMDALE AND LOS ANGELES COUNTY UNINCORPORATED TERRITORY ENCROACHMENT PERMIT AND REQUIREMENTS.
2. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO APPLY FOR ANY NECESSARY ENCROACHMENT PERMIT FROM ANY GOVERNING AGENCY.
3. THE CONTRACTOR SHALL CONTACT UNDERGROUND SERVICES ALERT (USA) (800) 227-2600 PRIOR TO ANY EXCAVATION. THE KNOWN EXISTING BURIED UTILITIES AND PIPELINES ARE SHOWN ON THE DRAWINGS IN THEIR APPROXIMATE LOCATION. THERE IS NO GUARANTEE THAT ALL EXISTING PIPELINES AND OBSTRUCTIONS ARE SHOWN OR THAT LOCATIONS INDICATED ARE ACCURATE. THE CONTRACTOR SHALL "POTHOLE" TO DETERMINE THE ACTUAL LOCATION AND ELEVATION OF ALL EXISTING UTILITIES CROSSING NEW PIPELINES.
4. ALL WORK SHALL CONFORM TO THE PALMDALE WATER DISTRICT (PWD) DESIGN AND CONSTRUCTION STANDARDS.
5. CONSTRUCTION MATERIALS TESTING AND INSPECTION SHALL COMPLY WITH THESE CONSTRUCTION DOCUMENTS AND SPECIFICATIONS AND SHALL MEET OR EXCEED THE REQUIREMENTS OF THE GOVERNING AGENCY, THE STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION ("GREEN BOOK") AND THE AMERICAN SOCIETY FOR TESTING AND MATERIALS (A.S.T.M.) STANDARDS. FAILURE TO MEET ANY OF THE ABOVE REQUIREMENTS SHALL BE CAUSE FOR REJECTION.
6. ALL CONSTRUCTION AND OPERATIONS BY THE CONTRACTOR SHALL BE IN ACCORDANCE WITH CAL-OSHA REQUIREMENTS.
7. CONTRACTOR SHALL KEEP ONE ACCURATE, LEGIBLE SET OF AS-BUILT DRAWINGS AT THE SITE AND AVAILABLE FOR REVIEW BY THE ENGINEER IN CONTRACTOR'S FIELD OFFICE THROUGHOUT THE PROJECT IN ACCORDANCE WITH SPECIFICATION. THE AS-BUILT DRAWINGS SHALL BE SUBMITTED TO (PWD) FOR APPROVAL PRIOR TO FINAL ACCEPTANCE OF THE WORK.
8. ALL SOILS COMPACTION REPORTS MUST BE GIVEN TO INSPECTOR PRIOR TO PRESSURE TESTING ANY PIPELINE.
9. OPEN TRENCH AT ANY ONE TIME SHALL BE LIMITED TO 600 FEET ALONG ROAD RIGHT-OF-WAY UNLESS OTHERWISE APPROVED IN WRITING BY PWD. TRENCH SHALL BE BACKFILLED AND COMPACTED OR COVERED WITH STEEL PLATES AT THE CONCLUSION OF EACH DAY.
10. SURFACE IMPROVEMENTS DAMAGED OR REMOVED AS A RESULT OF THE CONTRACTOR'S OPERATIONS SHALL BE RECONSTRUCTED BY THE CONTRACTOR TO THE LOCAL GOVERNING AGENCY'S STANDARDS.
11. IT IS THE CONTRACTOR'S RESPONSIBILITY TO PROTECT ANY STREET MONUMENTATION IN PLACE. IF ANY MONUMENT IS DISTURBED OR DESTROYED, THE CONTRACTOR WILL BE REQUIRED TO CONTRACT WITH A REGISTERED LAND SURVEYOR FOR THE RE-ESTABLISHMENT AND MAPPING OF THE DESTROYED MONUMENT.

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER — DAVID W. FERGUSON — No. CE 34626 Exp. 09/30/17 — STATE OF CALIFORNIA

DESIGNED BCH

DRAWN HCS

CHECKED PST

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

SHEET INDEX AND GENERAL NOTES

FILE NAME: FILE NAME

JOB NO.: 1344505.01

DATE: NOVEMBER 2015

SHEET G2 OF -

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CIVIL/GENERAL SYMBOLS

GENERAL CIVIL	NEW	EXISTING
WIRE BOX		
GUY WIRE		
SPOT ELEVATION	18.00	x 35.5
INTERMEDIATE CONTOUR		
INDEX CONTOUR	120	120
BURIED CABLE MARKER		
TRAFFIC BOLLARD		
SIGN		
TREE/SHRUB		
BUILDING		
PIPELINE		
FENCE	X X	X X
BURIED ELECTRICAL	E E	E E
OVERHEAD UTILITY LINE		OH OH
GAS		GAS GAS
FIBER OPTICS	FO FO	FO FO
STORM DRAIN	SD SD SD	SD SD
WATER	W W	W W
TELEPHONE	T T T	T T T
RIGHT-OF-WAY		
PROPERTY LINE		
PERMANENT EASEMENT	PE	PE
PETROLEUM		P P P
TEMPORARY CONSTRUCTION EASEMENT	TCE	TCE
WORK AREA BOUNDARY	WAB	
POWER POLE		
LIGHT		
FLOW LINE DIRECTION		
CENTERLINE		
POTHOLE LOCATION		
SURVEY MONUMENT		
APPROXIMATE GEOTECHNICAL BORING LOCATION		
TEMPORARY BENCHMARK (TBM)		
CURB		
EDGE OF PAVEMENT (IN PLAN)		
TO BE DEMOLISHED		
TREE TO BE REMOVED		CO
CLEAN OUT		
FIRE HYDRANT		
AIR RELEASE VALVE, COMBINATION		
DRAIN ASSEMBLY		
NEW CATHODIC TEST STATIONS		
WATER SYSTEM VALVE		
CATCH BASIN		
MANHOLE		
BASE REPAIR		
CONCRETE		(E) CONC
ASPHALTIC CONCRETE PAVEMENT (IN PLAN)		
ASPHALTIC CONCRETE PAVEMENT (IN SECTION)		(E) AC
AGGREGATE BASE (IN SECTION)		(E) AB
UNDISTURBED EARTH (IN SECTION)		
SLOPING GRADE (IN PLAN)	HIGH LOW	HIGH LOW

PIPING SYMBOLS

JOINTS	SINGLE LINE PLAN	DOUBLE LINE PLAN
FLANGED OR GROOVED PIPE COUPLING		
BELL AND SPIGOT OR MECHANICAL		

FITTINGS	
ELBOW-REDUCING	
CROSS OR TEE	
REDUCER	
UNION	
FLEXIBLE COUPLING	
FLANGED COUPLING ADAPTER	
PLUG OR BLIND FLANGE	

VALVE SYMBOLS

VALVES	SINGLE LINE PLAN	SINGLE LINE ELEVATION
GATE		
BUTTERFLY		
BALL		
CHECK		
CONTROL VALVE	CV	CV
SOLENOID VALVE		
REDUCER		
AIR GAP		
WATER METER	M	M
SLUICE GATE		

REFERENCE SYMBOLS

DETAIL DESIGNATION: 1 / C8 — SHEET DRAWN ON

DETAIL

A

DETAIL DESIGNATION: A / C3 — SHEET DRAWN ON

SECTION

ABBREVIATIONS

&	AND
L	ANGLE
@	AT
"	INCH SUPERSCRIPT
'	FOOT SUPERSCRIPT
Ø	PHASE, DIAMETER
AB	ANCHOR BOLT, AGGREGATE BASE
AC	ASBESTOS CEMENT
ACP	ASBESTOS CEMENT PIPE
ALUM	ALUMINUM
APPROX	APPROXIMATE (-LY)
APN	ASSESORS PARCEL NUMBER
ATS	ANODE TEST STATION
AVE	AVENUE
AVG	AVERAGE
BF	BLIND FLANGE
BFP	BACKFLOW PREVENTER
BFV	BUTTERFLY VALVE
BM	BENCH MARK
BLDG	BUILDING
BO	BLOW OFF
CATS	CASING ANODE TEST STATION
CAV	COMBINATION AIR VALVE
CB	CATCH BASIN
CDF	CONTROLLED DENSITY FILL
CIP	CAST IRON PIPE
CMP	CORRUGATED METAL PIPE
℄	CENTERLINE
CY	CUBIC YARD
CL	CLASS, CENTERLINE
CLR	CLEAR (-ANCE)
COL	COLUMN
CONC	CONCRETE
CONN	CONNECT (-S, -TION)
CONST	CONSTRUCT (-TION)
CONT	CONTINU (-ED, -OUS)
CRS	COMBINED RECHARGE SUPPLY
(D)	DEMOLISH
DEFL	DEFLECTION
DI	DUCTILE IRON
DIA	DIAMETER
DIP	DUCTILE IRON PIPE
DIM	DIMENSION
DR	DIMENSION RATIO
DWG	DRAWING
(E), EXIST	EXISTING
E	EAST
EA	EACH
ECC	ECCENTRIC
EL	ELEVATION
ELEC	ELECTRIC (-AL)
ELL	ELBOW
ENCL	ENCLOSURE
ENGR	ENGINEER
EP, EOP	EDGE OF PAVEMENT
EQUIP	EQUIPMENT
E&T	ELECTRICAL AND TELEPHONE
ETC	ET CETERA
(F)	FUTURE
FO, F/O	FIBER OPTIC
FT	FEET (FOOT)
FCA	FLANGED COUPLING ADAPTER
FG	FINISH GRADE
FH	FIRE HYDRANT
FM	FLOW METER, FINISHED GRADE
FLEX	FLEXIBLE
FLGD	FLANGED
FPTS	FOREIGN PIPELINE TEST STATION
FPVC	FUSIBLE POLYVINYL CHLORIDE
GB	GRADE BREAK
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
GS	GALVANIZED STEEL
GV	GATE VALVE
GALV	GALVANIZE
GND	GROUND
HB	HOSE BIBB
HDPE	HIGH DENSITY POLYETHYLENE
HVAC	HEATING, VENTILATING & AIR CONDITIONING
HT	HEIGHT
HORZ	HORIZONTAL
HP	HORSEPOWER
HWY	HIGHWAY
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IJTS	INSULATING JOINT TEST STATION
INV	INVERT
LF	LINEAR FEET
MGD	MILLION GALLONS PER DAY
(M)	MODIFIED
MH	MANHOLE
MJ	MECHANICAL JOINT
MATL, MTL	MATERIAL
MAX	MAXIMUM
MIN	MINIMUM
MISC	MISCELLANEOUS
MPT	MALE PIPE THREAD
(N)	NEW
N	NORTH
NC	NORMALLY CLOSED
NFC	NOT FOR CONSTRUCTION
NO	NORMALLY OPEN, NUMBER
NTS	NOT TO SCALE
N/A	NOT APPLICABLE
NOM	NOMINAL
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OVERFLOW
(OH E&T)	OVERHEAD ELEC AND TEL
OH	OVERHEAD
P	PIPE
PE	PERMANENT EASEMENT
PL	PROPERTY LINE
POC	POINT OF CONNECTION
PP	POWER POLE
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH-GAUGE
PUE	PUBLIC UTILITY EASEMENT
PVC	POLYVINYL CHLORIDE
PW	POTABLE WATER
R	RADIUS
RCP	REINFORCED CONCRETE PIPE
RD	ROAD
RR	RAILROAD
RT	RIGHT
R/W	RIGHT-OF-WAY
RED	REDUCE
REF	REFERENCE
REINF	REINFORCING (-MENT)
REW	RECYCLED WATER
RW	RAW WATER / RETURN WATER
REQ'D	REQUIRED
S	SOUTH
SA	SAMPLE
SCHED	SCHEDULE
SD	STORM DRAIN
SECT	SECTION
SHT, SH	SHEET
SIM	SIMILAR
SPEC	SPECIFICATION
SQ	SQUARE
IN2	SQUARE INCHES
SS	SANITARY SEWER, STAINLESS STEEL
SSMH	SANITARY SEWER MANHOLE
ST	STREET
STA	STATION
STD	STANDARD
SURF	SURFACE
T	THICKNESS
T	TYPE, TELEPHONE
TB	THRUST BLOCK
TBD	TO BE DETERMINED
TBM	TEMPORARY BENCH MARK
TCE	TEMPORARY CONSTRUCTION EASEMENT
TEL	TELEPHONE
THK	THICK
TM	TRANSMISSION MAIN (WATER)
TOP	TOP OF PAVEMENT
TOS	TOP OF SLAB
TS	TRAFFIC SIGNAL
TV	TELEVISION
TYP	TYPICAL
(UG), UG	UNDERGROUND
UPRR	UNION PACIFIC RAILROAD
V	VENT
VAR	VARIES
VERT	VERTICAL
W	WEST, WIDE, WIDTH, WATER
WAB	WORK AREA BOUNDARY
WSP	WELDED STEEL PIPE
W/	WITH
W/O	WITHOUT
XING	CROSSING
YOLO COM	YOLO COUNTY COMMUNICATIONS

SURVEY CONTROL INFORMATION

BASIS OF BEARINGS

THE COORDINATES SHOWN BELOW ARE BASED ON THE CALIFORNIA COORDINATE SYSTEM OF 1983, ZONE 5, EPOCH 2010. THE FOLLOWING CONTROL POINTS WERE LOCATED BASED UPON THIS DATUM AND THE GRID COORDINATES ARE SHOWN BELOW:

DATUM STATEMENT

THE BEARINGS AND DISTANCES SHOWN HEREON ARE AT GROUND AND WERE CALCULATED BY USING A COMBINED SCALE FACTOR OF 1.00019939 FROM CONTROL POINT 2 NOTED ABOVE.

BENCH MARK:

NUMBER L 5876

DPW BM TAG IN CTR CONC HDWL @ SW COR

105TH ST E & PALMDALE BLVD 11M S & 7.6M

W/O C/L INT

ELEVATION: 2678.495 (NAVD 88)

LLANO QUAD 2004 ADJUSTMENT

POINT	DESCRIPTION	NORTHING	EASTING
CP–1	CONTROL POINT 1 - FOUND COUNTY ENGINEER'S MONUMENT IN WELL AT THE INTERSECTION OF 106TH STREET EAST & PEARBLOSSOM HWY.	2012021.25	6579596.41
CP–2	CONTROL POINT 2 - FOUND COUNTY ENGINEER'S MONUMENT AT THE INTERSECTION OF 105TH STREET STREET EAST & PEARBLOSSOM HWY.	2033421.82	6578845.55
CP–3	CONTROL POINT 3 - FOUND COUNTY SURVEYOR'S MONUMENT AT THE INTERSECTION OF 105TH STREET EAST & AVENUE M.	2057501.00	6578768.23
CP–4	CONTROL POINT 4 - FOUND COUNTY SURVEYOR'S MONUMENT AT THE INTERSECTION OF 60TH STREET EAST & PALMDALE BLVD.	2033391.79	6554781.22

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SCALES

0 1/2"

0 12.5mm

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REGISTERED PROFESSIONAL ENGINEER — DAVID W. FERGUSON — No. CE 34626 Exp. 09/30/17 — STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	PST

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

SYMBOLS, SURVEY CONTROL AND ABBREVIATIONS

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	G3
OF	-

L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505010g03.dwg 11/6/2015 12:04 PM BRYANT BEHNKE

CV = CONTROL VALVE
M = METER
NC = NORMALLY CLOSED
PRV = PRESSURE REDUCING VALVE
SG = SLUICE GATE
SWP = STATE WATER PROJECT

RECOVERY WELLS

M (TYP.)

16" 12" 16" 12" 16" 16" 20" 20" 20" 20" 24" 24" 24" 24"

NC NC 12" 8" 16" 16"

16"
WELL BLOW OFF

RECHARGE BASINS

OVERFLOW TO GROUND

BASIN 4
BASIN 3
BASIN 2
BASIN 1

OVERFLOW 36"
OVERFLOW 36"
OVERFLOW 36"

36" 36" 36" 36"

48" x 36" 48" CV

SPLITTER BOX

36" 36" NC 36" x 30" 30" CHLORINE

AIR GAP

1 MG STORAGE TANK

54"

36" BYPASS

24"
TANK OVERFLOW

AIR GAP

DISTRIBUTION BOX

48"
COMBINED RECHARGE SUPPLY

36" x 24" 24" 36" x 24" 24" x 18" 18" 18" 24" x 18" CV CV 24" x 18" 24" x 18" 24" 24"

AIR GAPS (TYP. OF 2)

30" 30" x 36"

NC
CHLORINE

36"

36" SWP WATER

RECYCLED WATER 30"

CV M

LACSD RECYCLED WATER 48"

OVERFLOW TO GROUND

POTABLE WATER PUMP STATION

WET WELL

PUMP STATION BUILDING

16" (TYP.)

36"

12" 12" PRV 12" 16" (TYP.) 14" (TYP.)

36" 20" 20" 16" x 20" 16" x 20" 16" 16" 16" PRV (TYP. OF 2) 20" x 16" 20" x 16" 24" 36" x 24" 20" BYPASS 20" BYPASS

HYDRO-TURBINE

36"
RAW WATER

SG M
TWO DIRECTIONAL

SWP WATER

EAST BRANCH

RETURN WATER PUMP STATION

M 36"
RAW WATER

30"
POTABLE WATER

PWD DISTRIBUTION SYSTEM (2800 ZONE)

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SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER — DAVID W. FERGUSON — No. CE 34626 Exp. 09/30/17 — STATE OF CALIFORNIA

DESIGNED BCH
DRAWN HCS
CHECKED PST

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

PROCESS FLOW DIAGRAM

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: G4 OF -

11/6/2015 12:05 PM BRYANT BEHNKE
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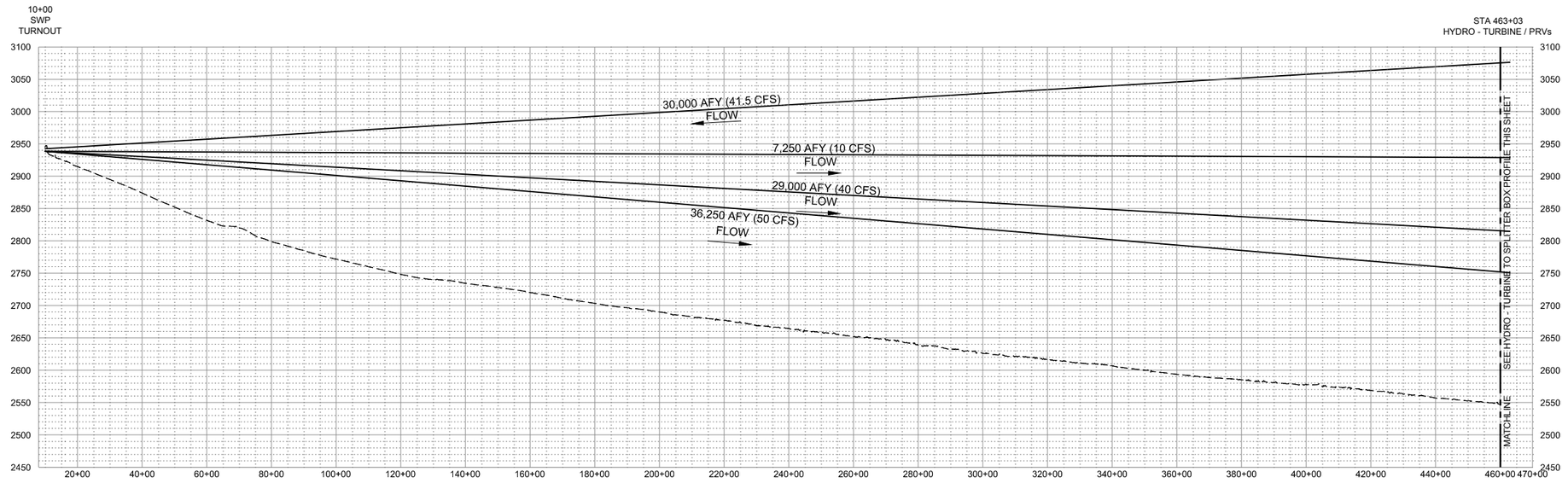
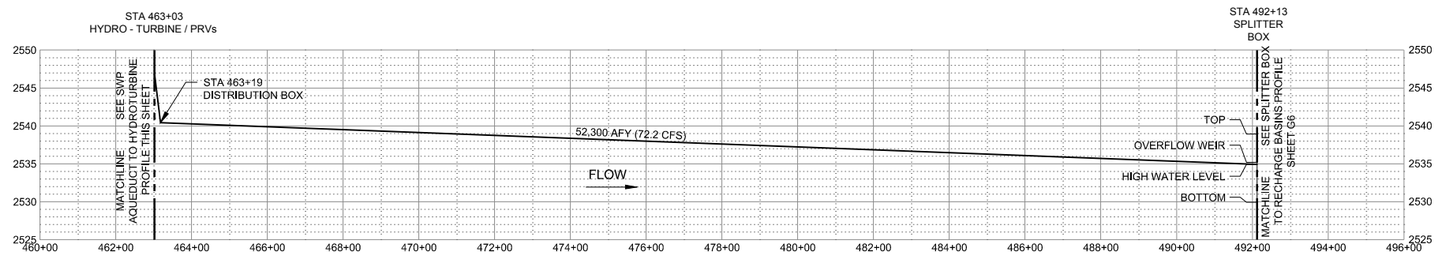


0 2000 3000
1"=2000'

HYDRAULIC GRADE PROFILE - SWP TURNOUT TO HYDRO - TURBINE

SCALE: HORZ 1" = 2000'
VERT 1" = 50'

0 50 100
1"=50'



0 100 200 300
1"=200'

HYDRO - TURBINE TO SPLITTER BOX

SCALE: HORZ 1" = 200'
VERT 1" = 10'

0 10 20
1"=10'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
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No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

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PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
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HYDRAULIC GRADE PROFILE SWP TURNOUT TO SPLITTER BOX

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: G5 OF -

BRYANT BEHNKE 11/6/2015 1:21 PM
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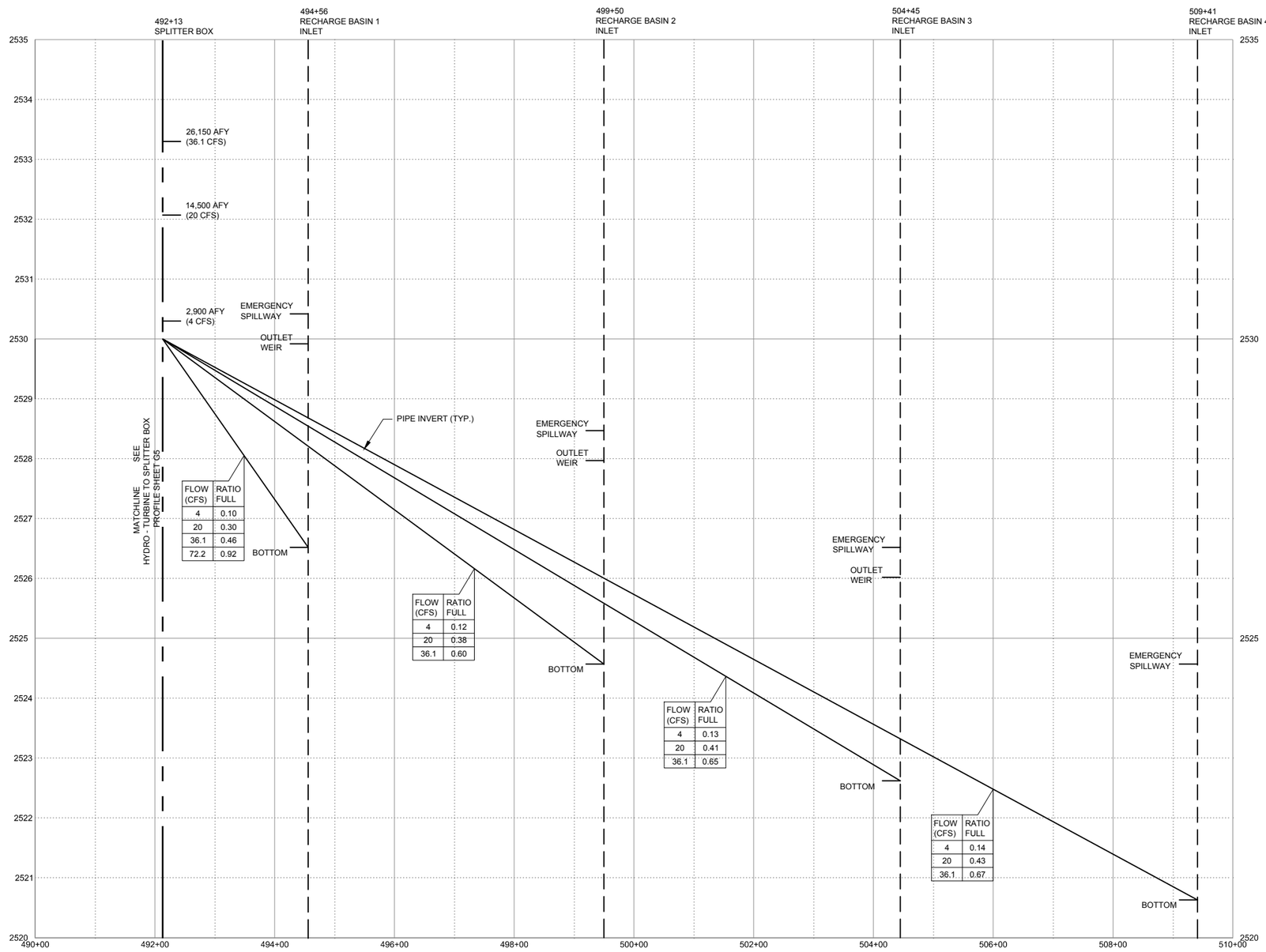

HYDRAULIC GRADE PROFILE - SPLITTER BOX TO RECHARGE BASINS

SCALE: HORZ 1" = 100'
VERT 1" = 5'

0 2.5 5
1" = 5'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES

0 1/2"
0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

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DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED BCH
DRAWN HCS
CHECKED PST

PALMDALE WATER DISTRICT
PALMDALE, CA

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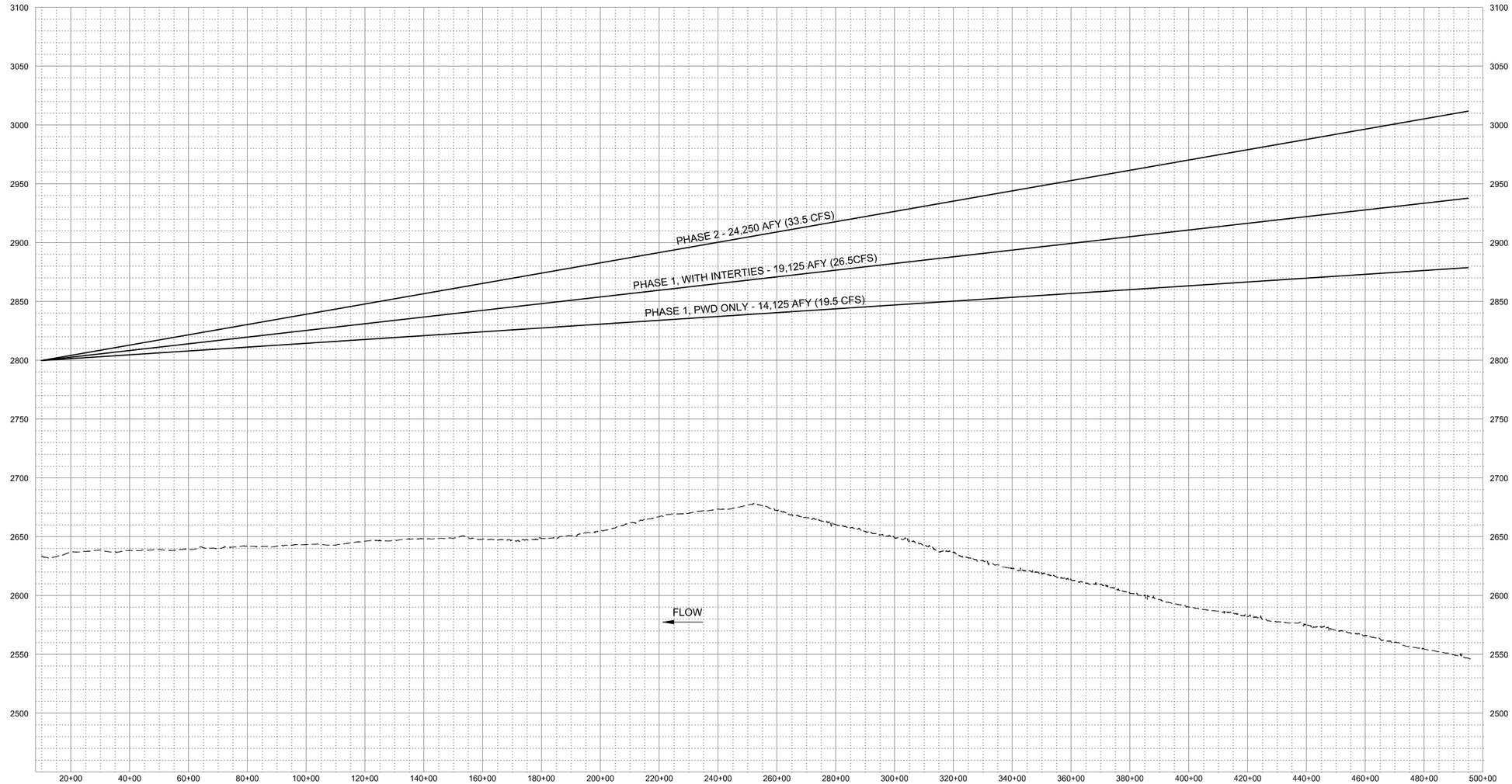
HYDRAULIC GRADE PROFILE SPLITTER BOX TO RECHARGE BASINS

FILE NAME 134450501g06.dwg
JOB NO. 1344505.01
DATE NOVEMBER 2015
SHEET G6 OF -



0 2000 3000
1"=2000'

0 50 100
1"=50'

HYDRAULIC GRADE PROFILE - POTABLE WATER PUMP STATION TO PWD POINT OF DISTRIBUTION SYSTEM CONNECTION

SCALE: HORZ 1" = 2000'
VERT 1" = 50'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED BCH
DRAWN HCS
CHECKED PST

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

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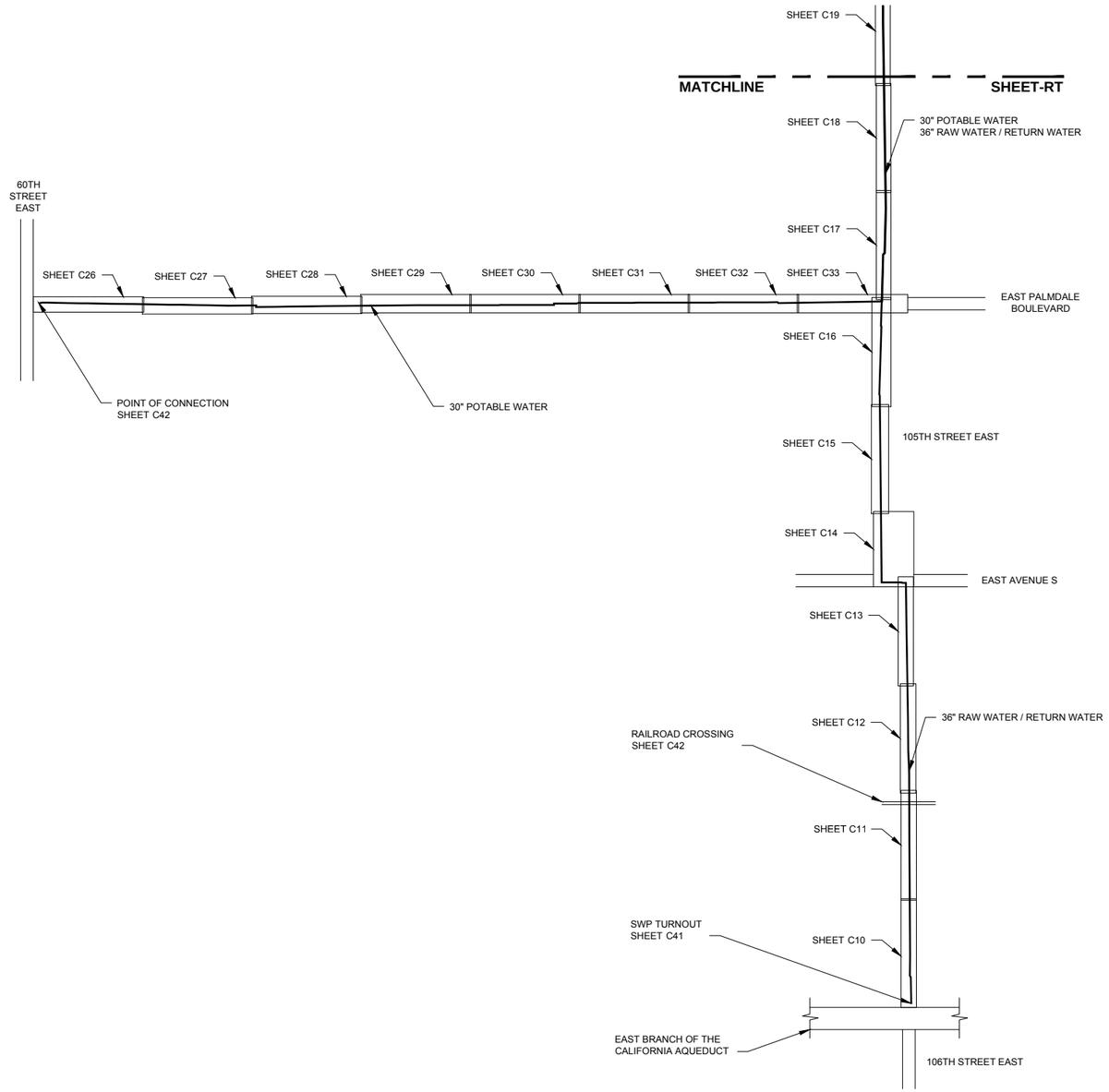
HYDRAULIC GRADE PROFILE
POTABLE WATER PUMP STATION TO PWD POINT OF DISTRIBUTION SYSTEM CONNECTION

FILE NAME 134450501g07.dwg
JOB NO. 1344505.01
DATE NOVEMBER 2015
SHEET G7 OF -

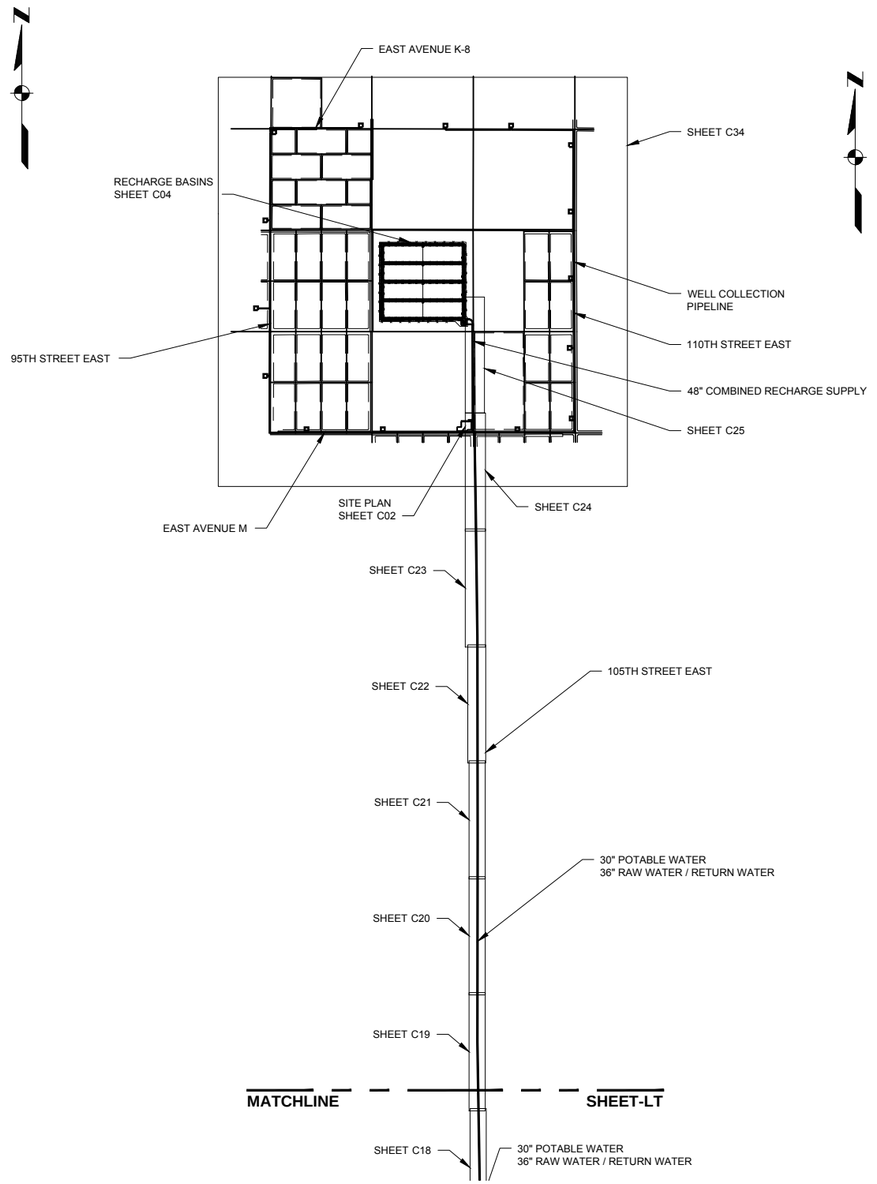


OVERALL PLAN

SCALE: 1" = 2000'

0 2000 4000

1"=2000'



OVERALL PLAN

SCALE: 1" = 2000'

0 2000 4000

1"=2000'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED BCH

DRAWN HCS

CHECKED JFC

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
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OVERALL PROJECT PLAN

FILE NAME: FILE NAME

JOB NO.: 1344505.01

DATE: NOVEMBER 2015

SHEET: C01 OF -

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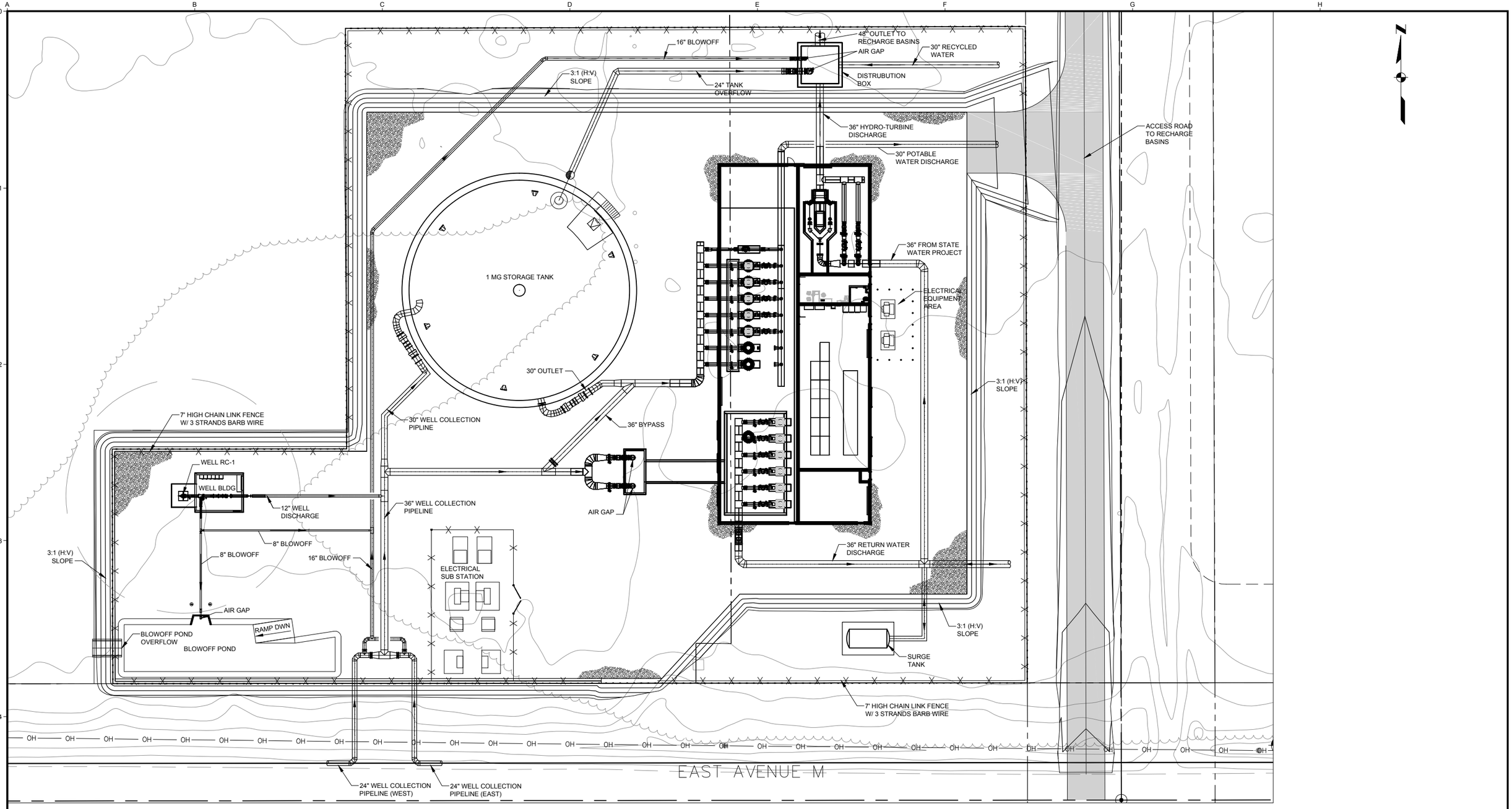

0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

PRELIMINARY - NOT FOR CONSTRUCTION

L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505001c02.dwg
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REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	GBB
DRAWN	GBB
CHECKED	PST

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
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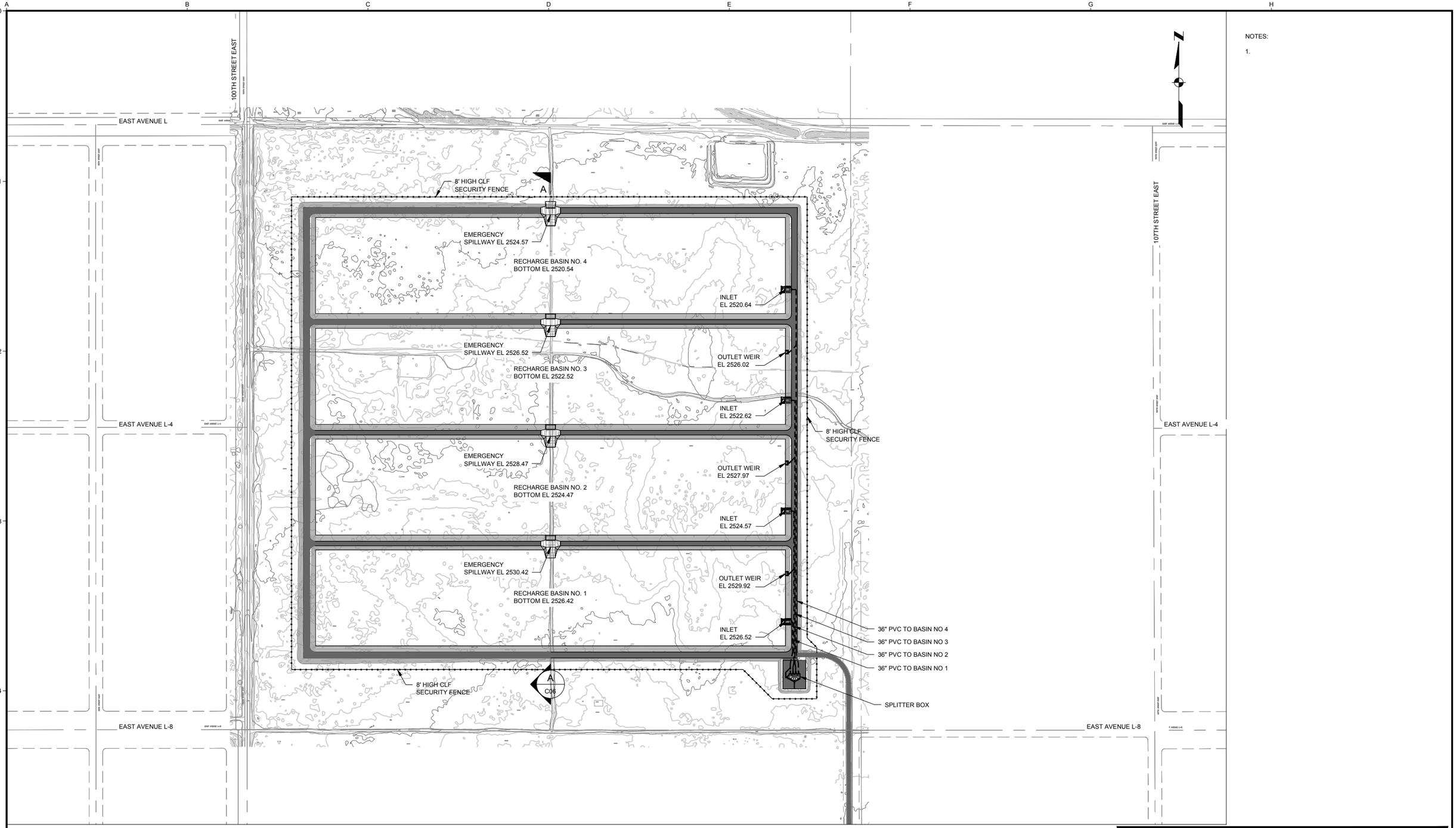
DISTRIBUTION SITE PLAN

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C02 OF -

NOTES:

1.



0 100 200 300
1"=200'

PLAN
SCALE: 1" = 200'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED GBB
DRAWN GBB
CHECKED PST

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

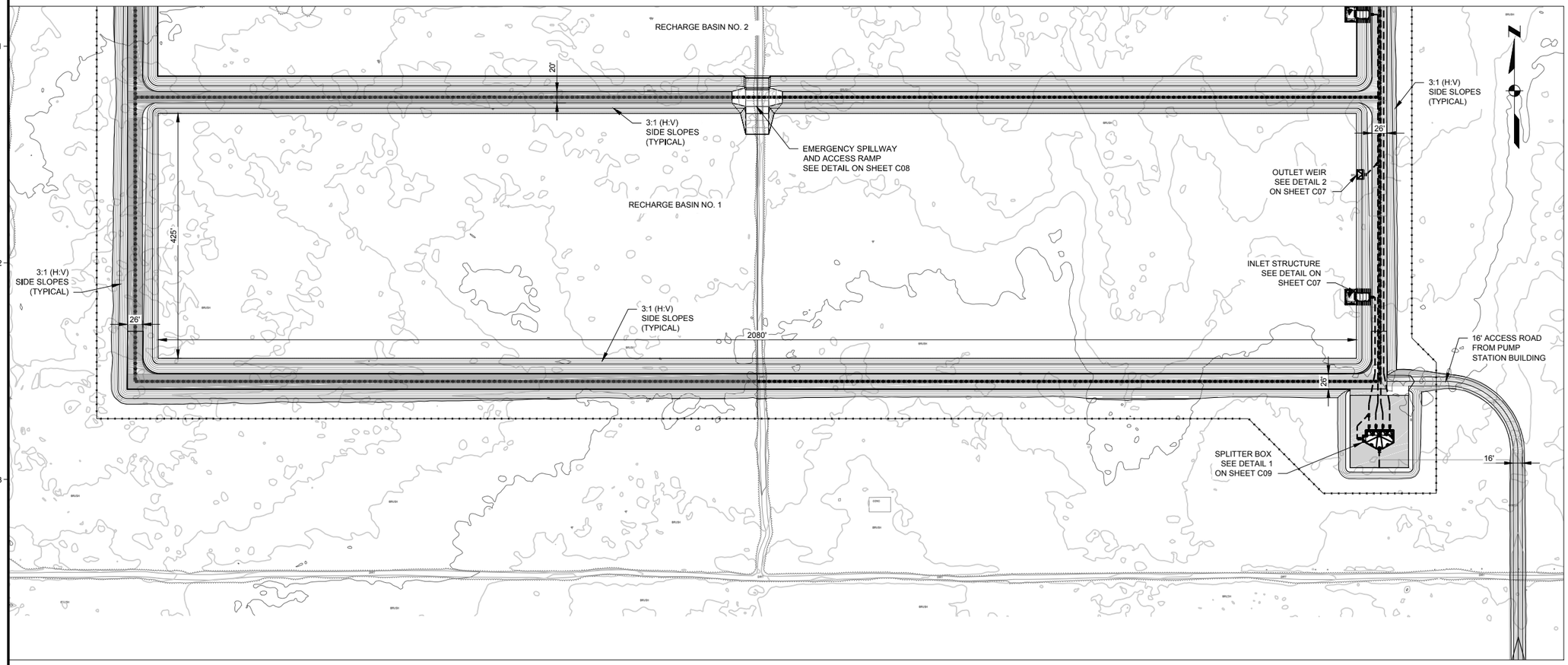
RECHARGE BASIN OVERALL SITE PLAN

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: C04 OF -

L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\134450501c04.dwg 11/6/2015 1:27 PM BRYANT BEHNKE

NOTES:

1.



0 100 200
1"=100'

PLAN
SCALE: 1" = 100'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	GBB
DRAWN	GBB
CHECKED	PST

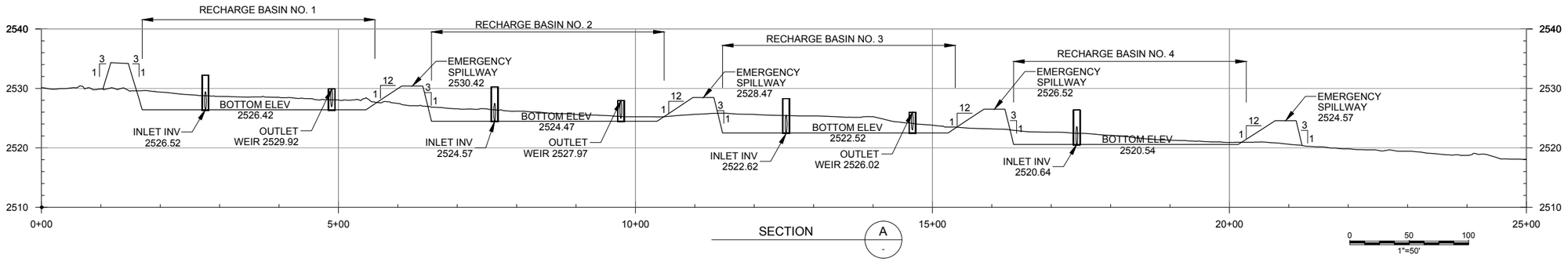
PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RECHARGE BASIN TYPICAL PLAN

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C05
OF	-

BRYANT BEHNKE 11/6/2015 1:29 PM
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505001c05.dwg



SECTION A

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
PAUL T. W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED GBB

DRAWN GBB

CHECKED PST

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RECHARGE BASIN TYPICAL SECTION

FILE NAME: FILE NAME

JOB NO.: 1344505.01

DATE: NOVEMBER 2015

SHEET C06 OF -

BRYANT BEHNKE 11/6/2015 11:30 PM

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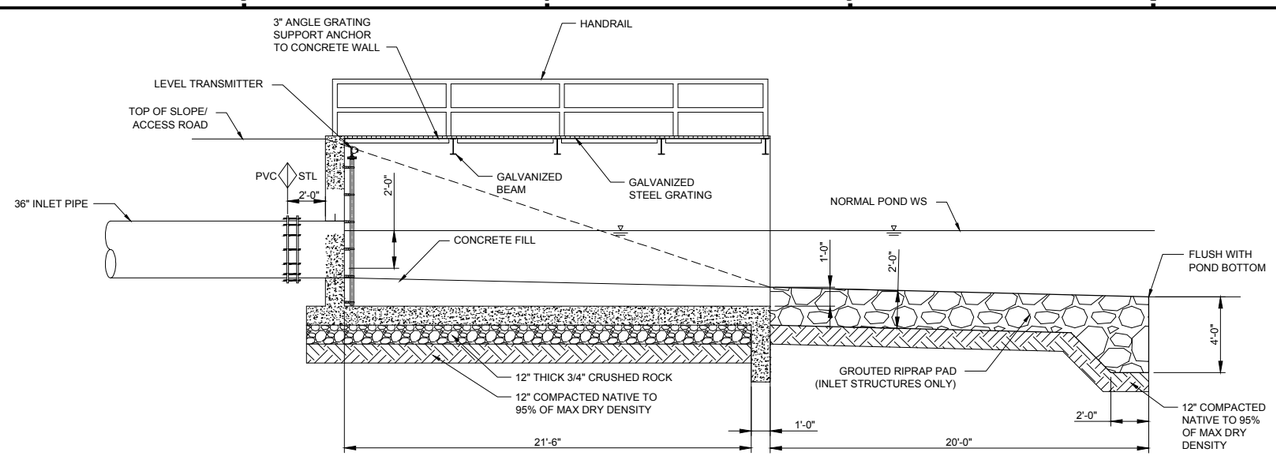
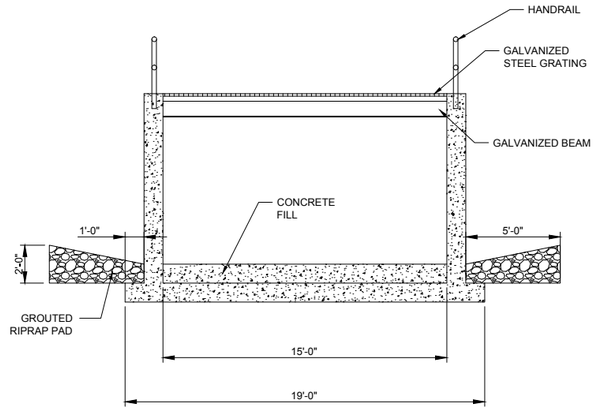
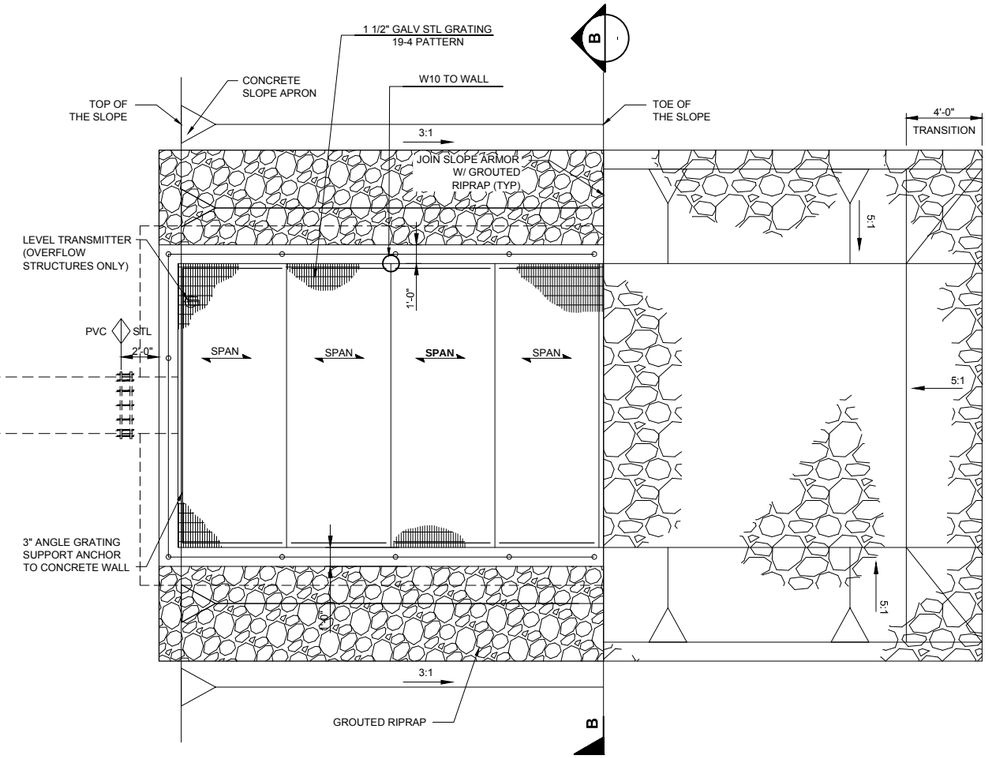


SECTION A
0 4' 8'
1" = 4'-0"

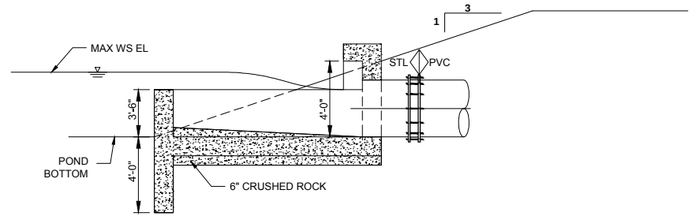


SECTION B
0 4' 8'
1" = 4'-0"

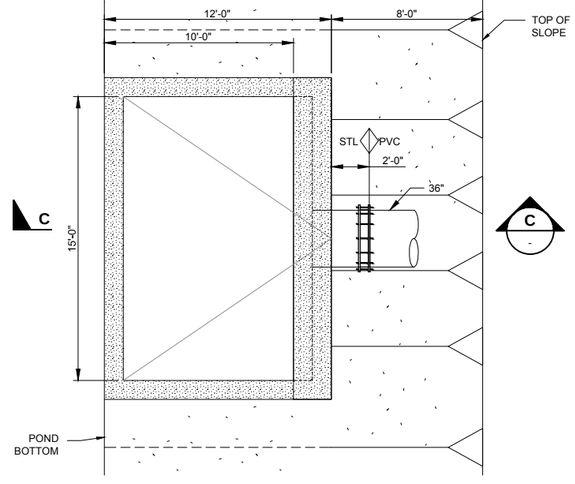


RECHARGE BASIN INLET 1
0 4' 8'
1" = 4'-0"

A



SECTION C



PLAN

RECHARGE BASIN OVERFLOW DETAIL 2
0 4' 8'
1" = 4'-0"

PRELIMINARY - NOT FOR CONSTRUCTION

USE OF DOCUMENTS

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER — BRAD W. FERGUSON — No. CE 34626 Exp. 09/30/17 — STATE OF CALIFORNIA

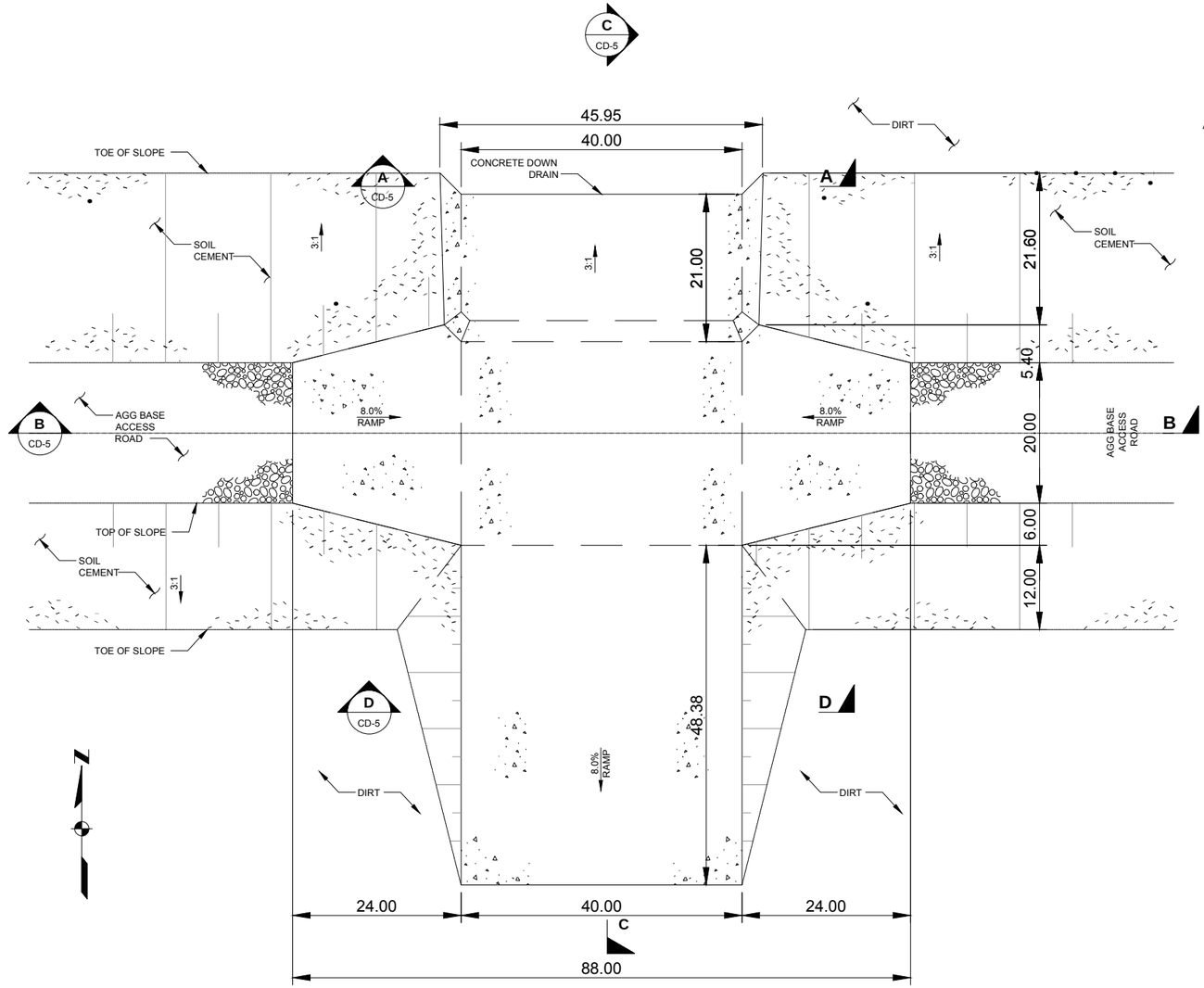
DESIGNED	GBB
DRAWN	GBB
CHECKED	PST

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT
Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

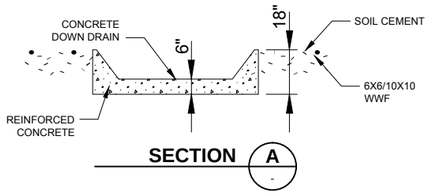
RECHARGE BASIN INLET AND OUTLET DETAILS

FILE NAME	134450501c07.dwg
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C07 OF -

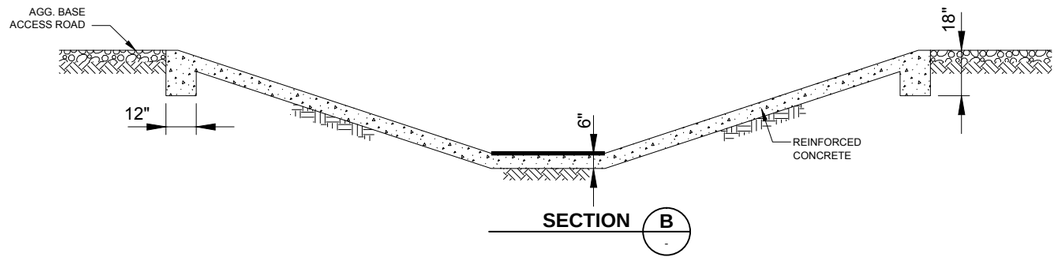
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\134450501c07.dwg 11/6/2015 11:30 PM BRYANT BEHNKE



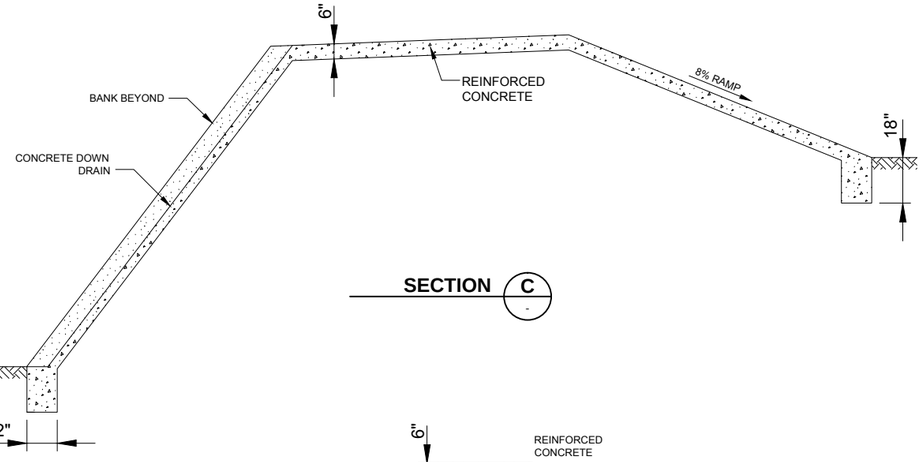
EMERGENCY SPILLWAY AND ACCESS RAMP (1)



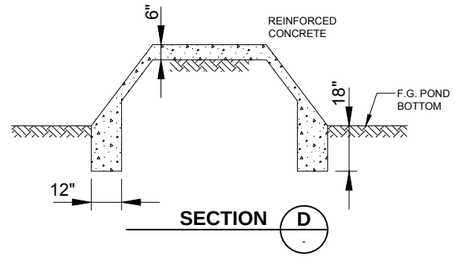
SECTION A



SECTION B



SECTION C



SECTION D

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NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER — DAVID W. FERGUSON — No. CE 34626 Exp. 09/30/17 — STATE OF CALIFORNIA

DESIGNED	GBB
DRAWN	BMB
CHECKED	PST

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

EMERGENCY SPILLWAY AND ACCESS RAMP

FILE NAME	134450501c08.dwg
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C08
OF	-

BRYANT BEHNKE 11/6/2015 1:30 PM

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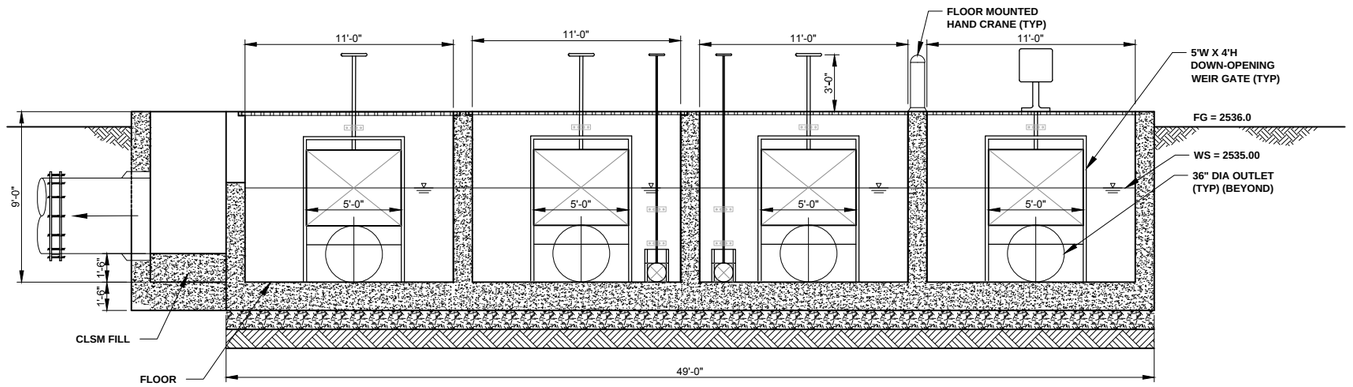
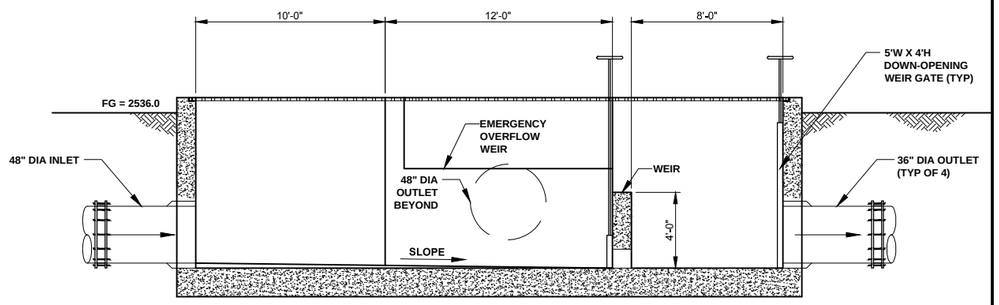


SECTION A

0 4' 8'

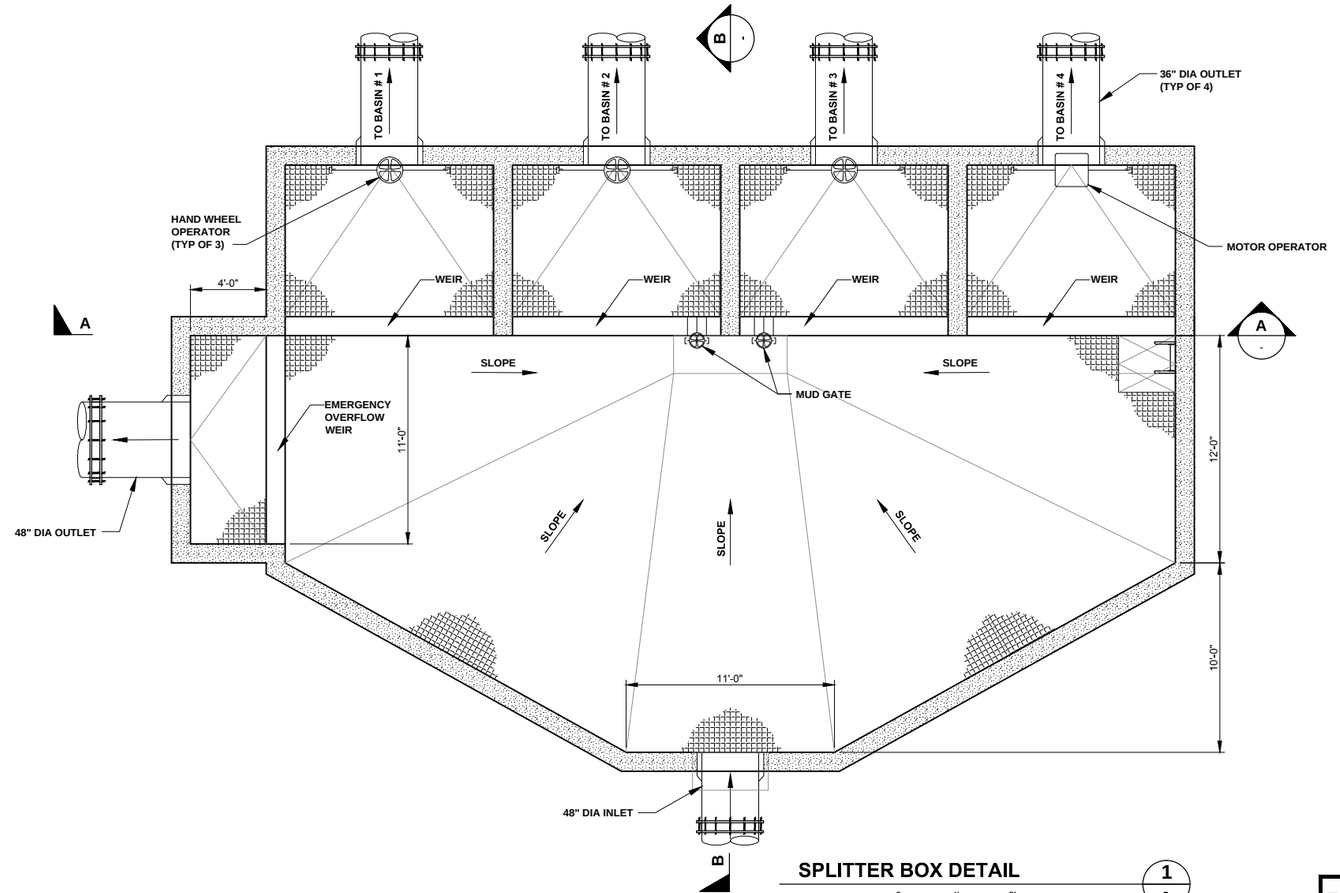
1"=4'-0"



SECTION B

0 4' 8'

1"=4'-0"



SPLITTER BOX DETAIL

0 4' 8'

1"=4'-0"

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	GBB
DRAWN	GBB
CHECKED	PST

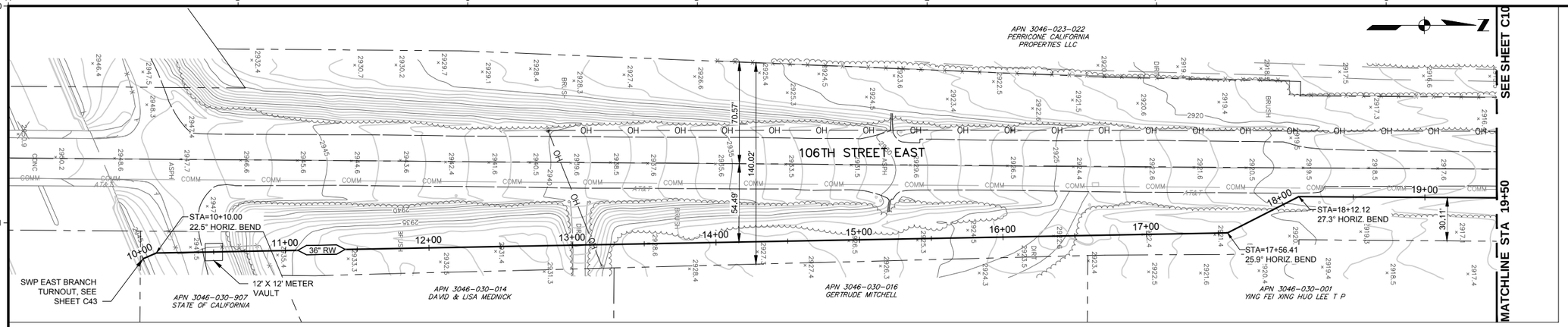
PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

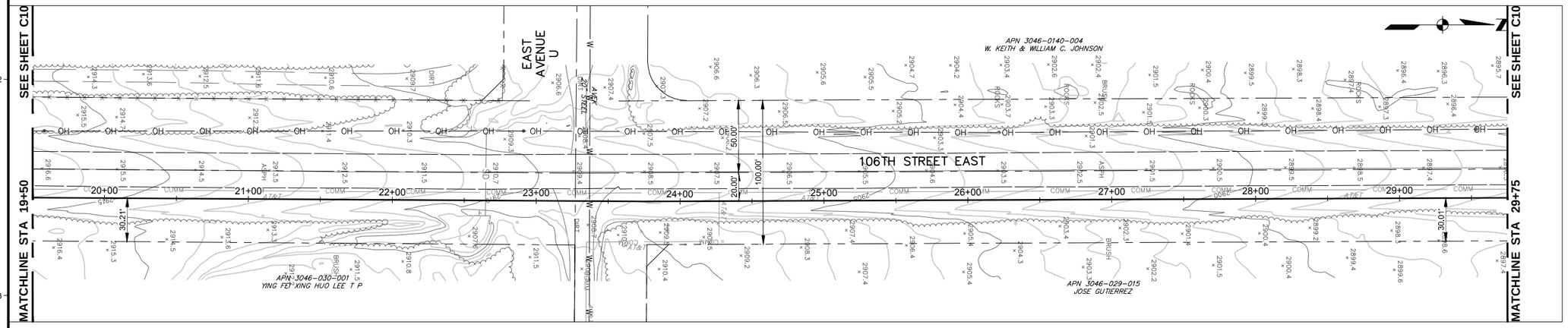
SPLITTER BOX DETAILS

FILE NAME	134450501c09.dwg
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C09
OF	-



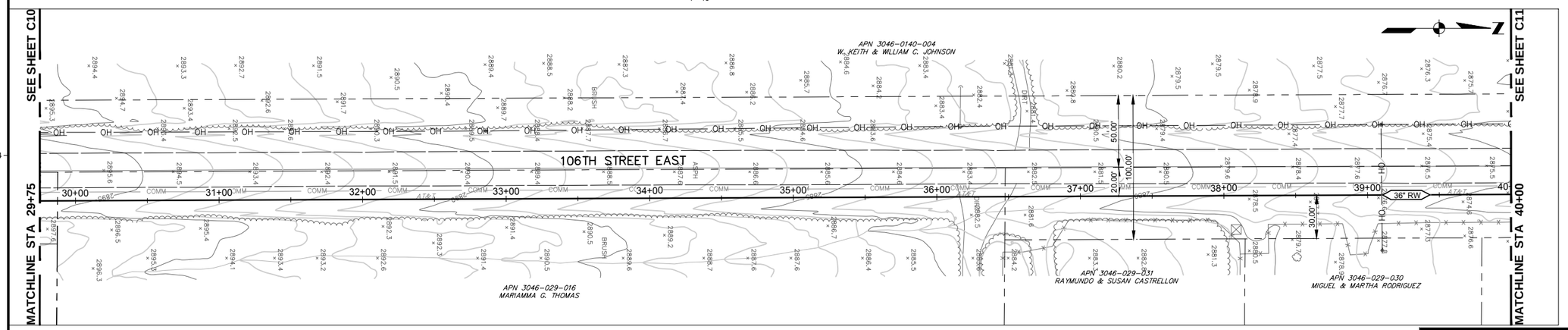
0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

NOTES:

1.

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

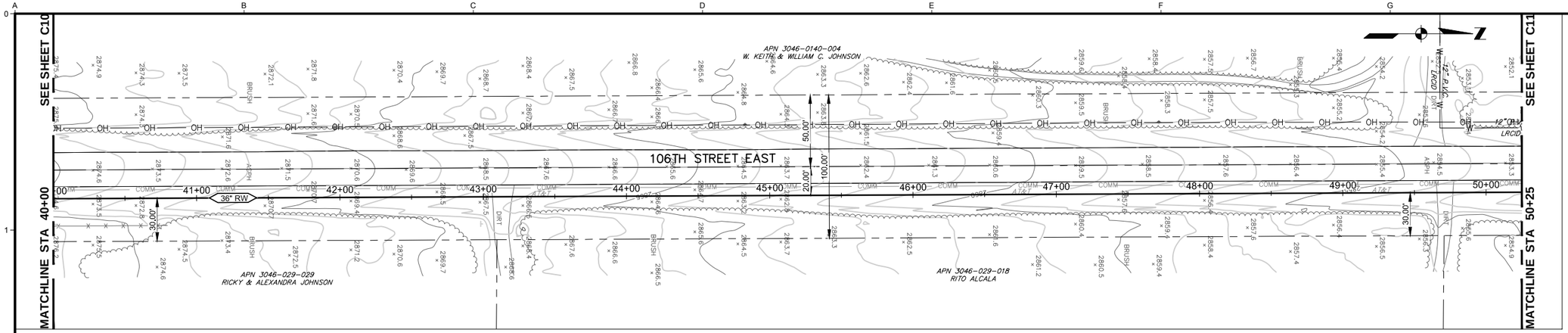
DESIGNED BCH
DRAWN HCS
CHECKED JFC

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT
Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RAW WATER/RETURN WATER PIPELINE PLAN 1

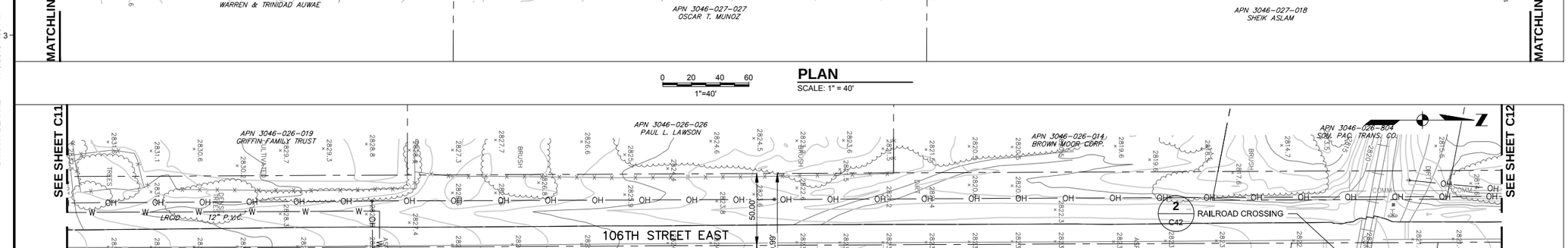
FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: C10 OF -

11/6/2015 11:32 PM BRYANT BEHNKE
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505001c10.dwg



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

NOTES:

1.

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

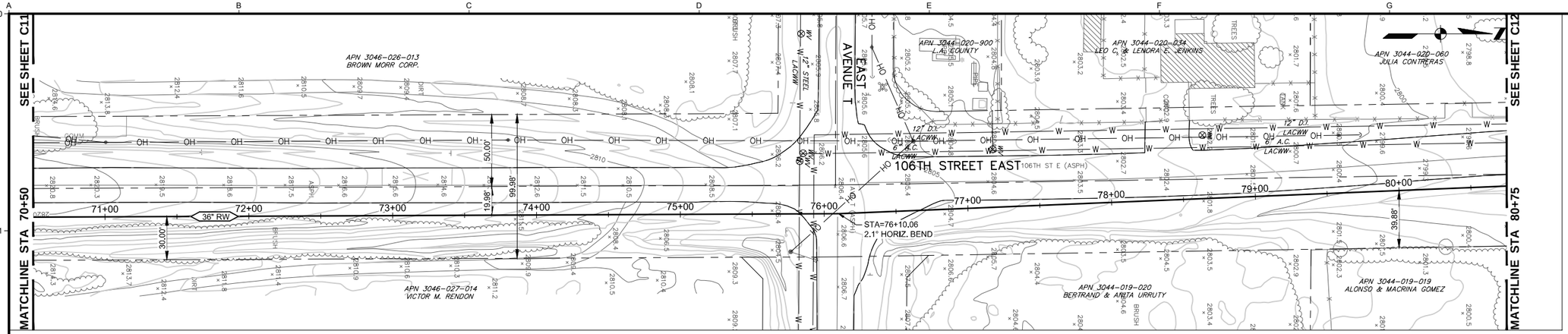
PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RAW WATER/RETURN WATER PIPELINE PLAN 2

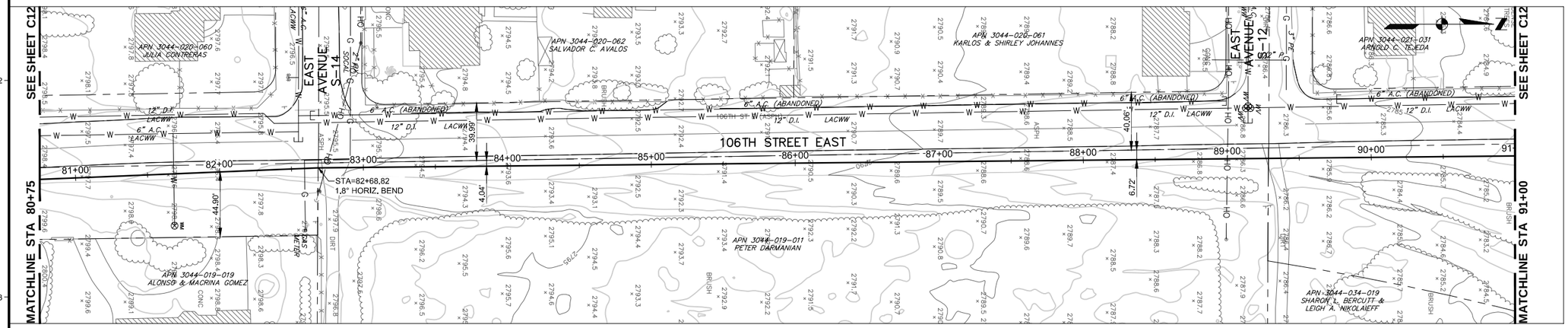
FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C11
OF	-

11/6/2015 1:35 PM BRYANT BEHNKE L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505011c11.dwg



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



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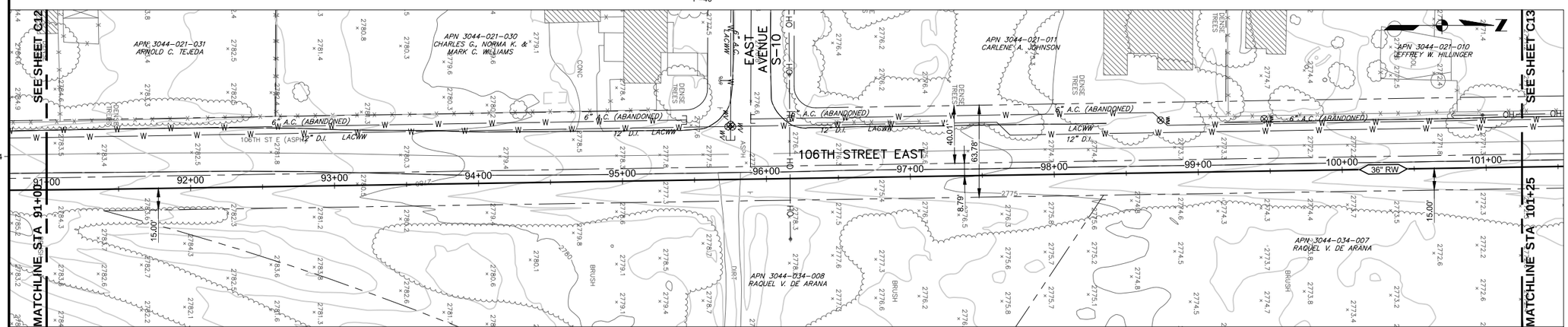
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

NOTES:

1.

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

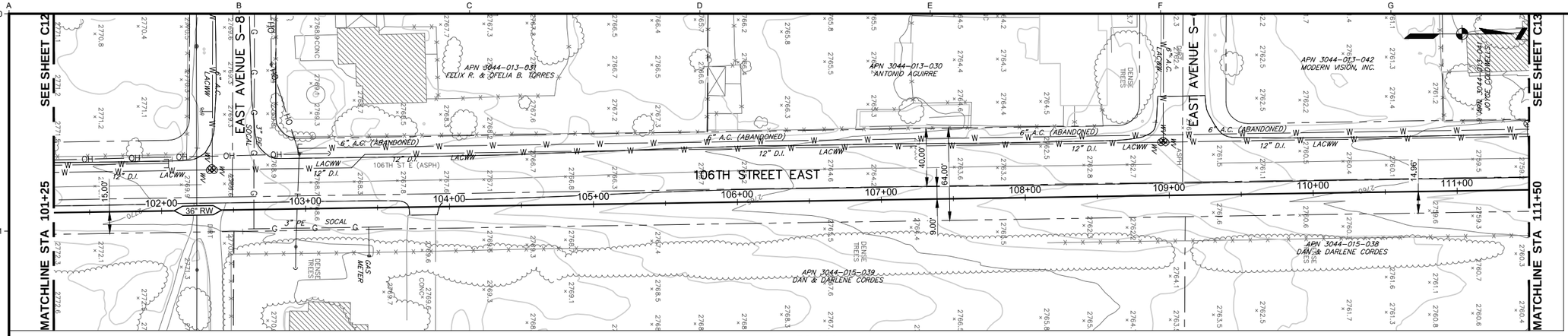
RAW WATER/RETURN WATER PIPELINE PLAN 3

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C12
OF	-

L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\134450501c12.dwg 11/6/2015 1:37 PM BRYANT BEHNKE

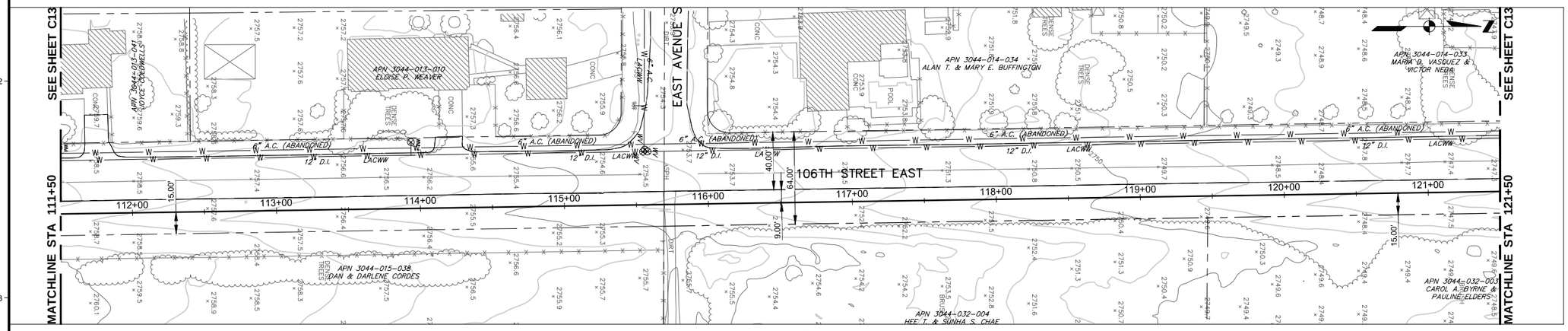
NOTES:

1.



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



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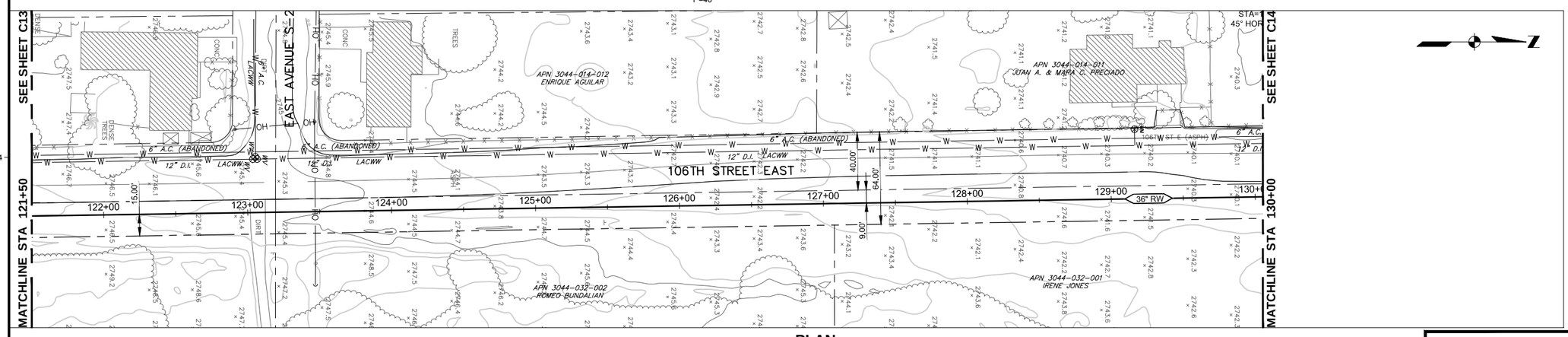
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

PALMDALE WATER DISTRICT
PALMDALE, CA

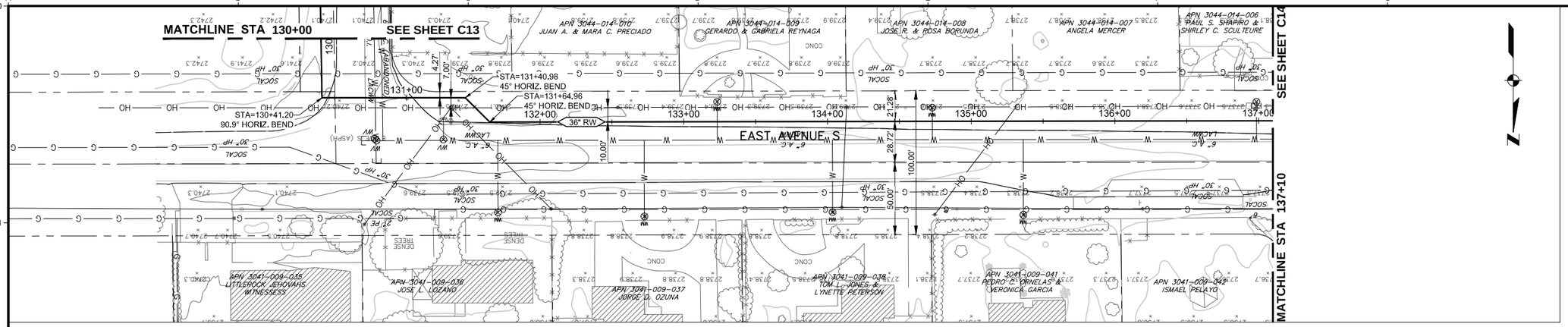
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RAW WATER/RETURN WATER PIPELINE PLAN 4

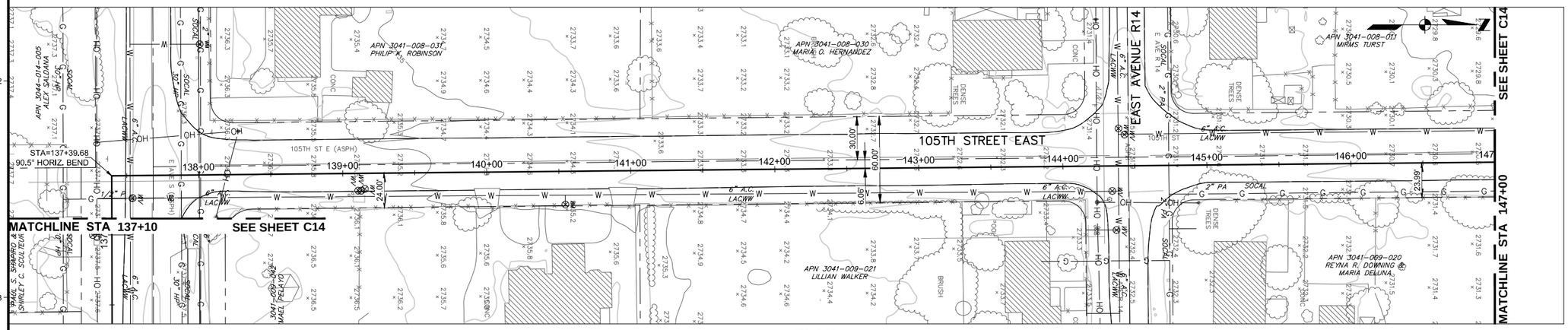
FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C13
OF	-

11/6/2015 1:39 PM BRYANT BEHNKE L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\134450501c13.dwg



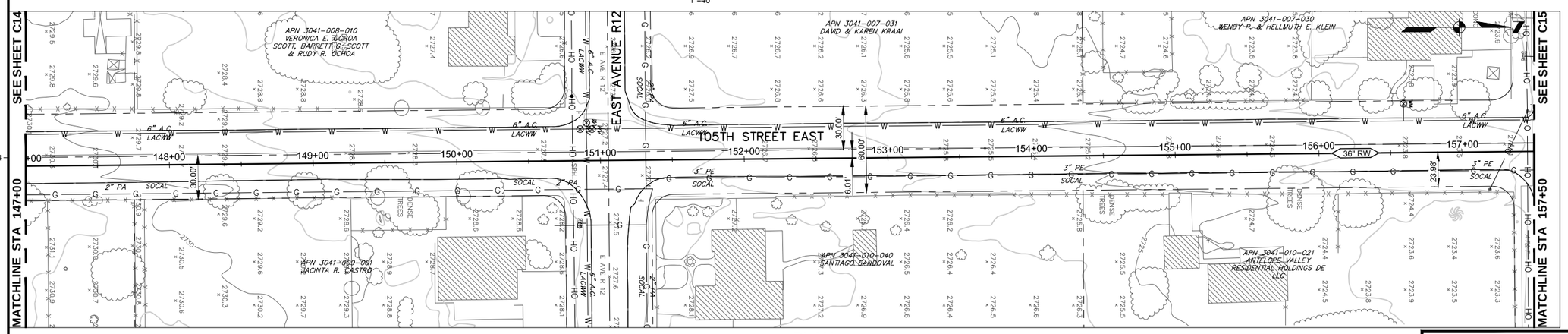
0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

NOTES:

1.

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RAW WATER/RETURN WATER PIPELINE PLAN 5

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C14
OF	-

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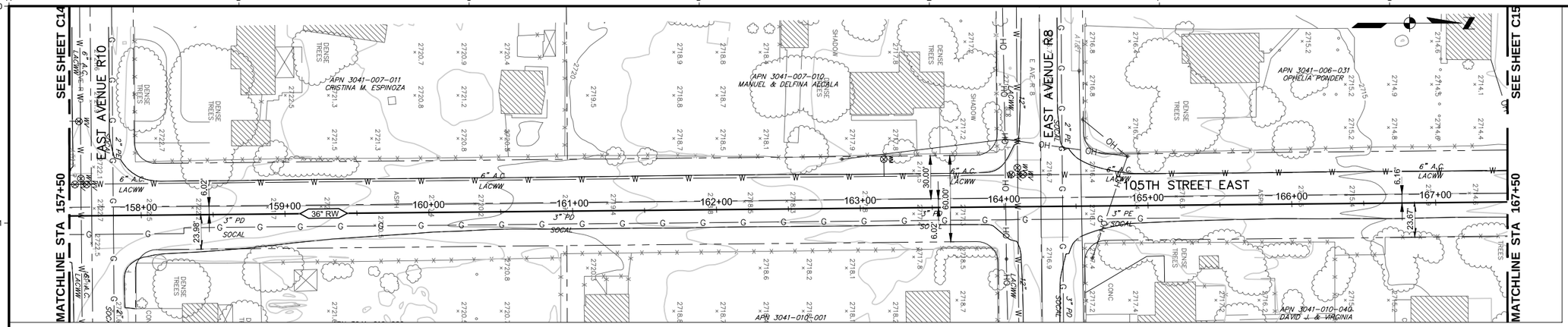

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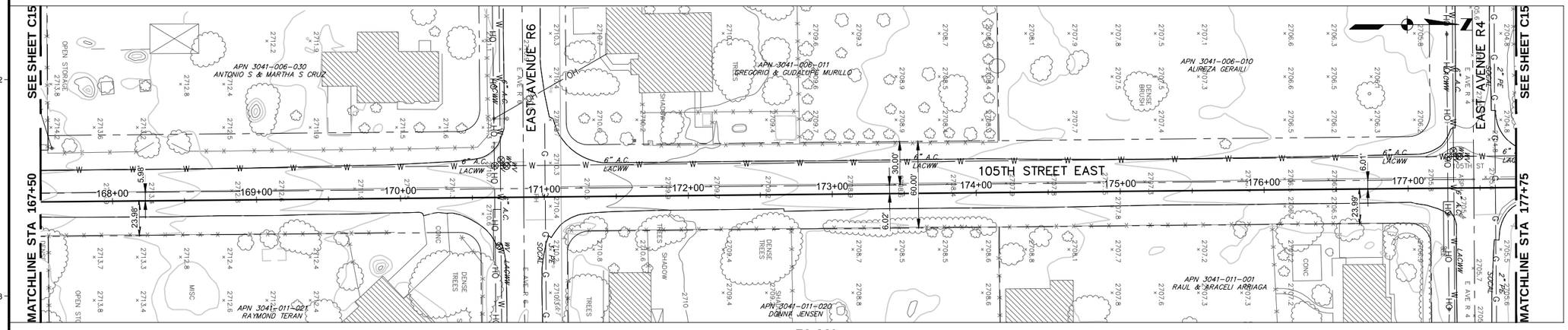
PLAN
SCALE: 1" = 40'



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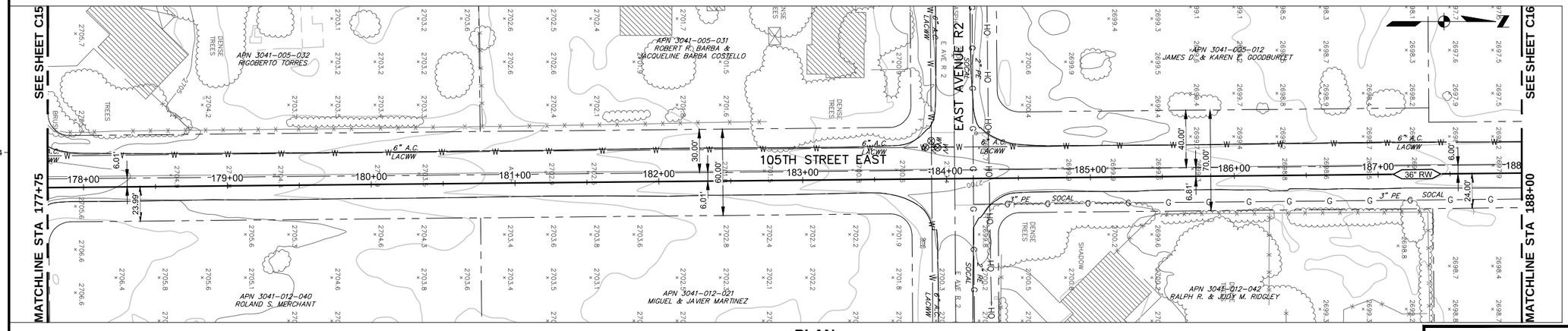
PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

NOTES:

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SCALES
0 1/2"
0 12.5mm
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DESIGNED BCH
DRAWN HCS
CHECKED JFC

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RAW WATER/RETURN WATER PIPELINE PLAN 6

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: C15 OF -

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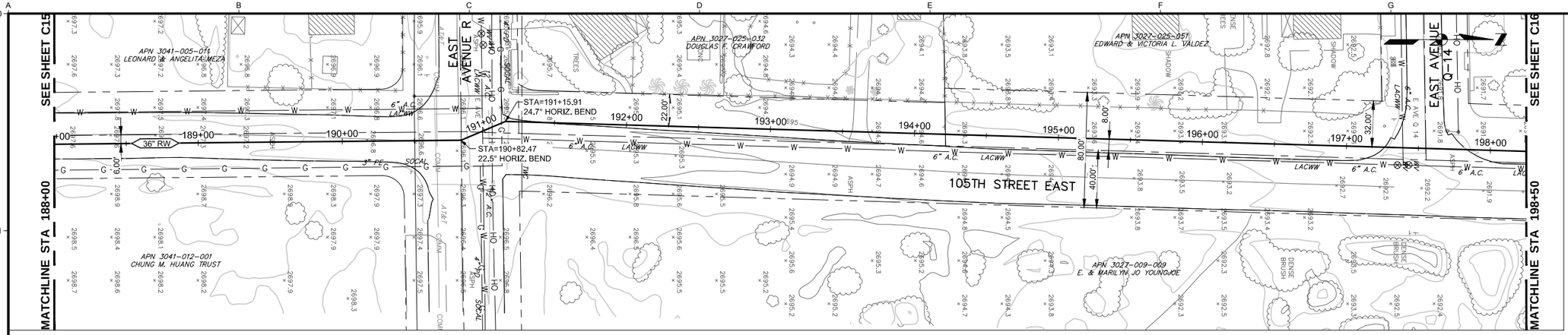

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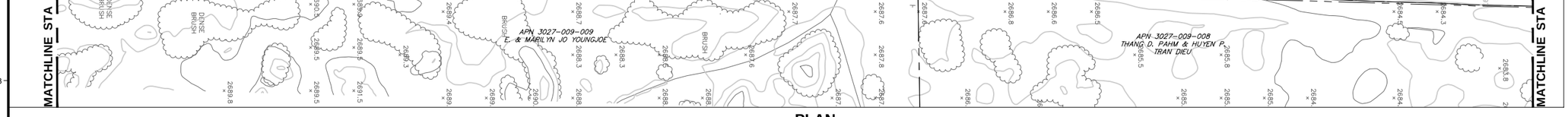

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PLAN
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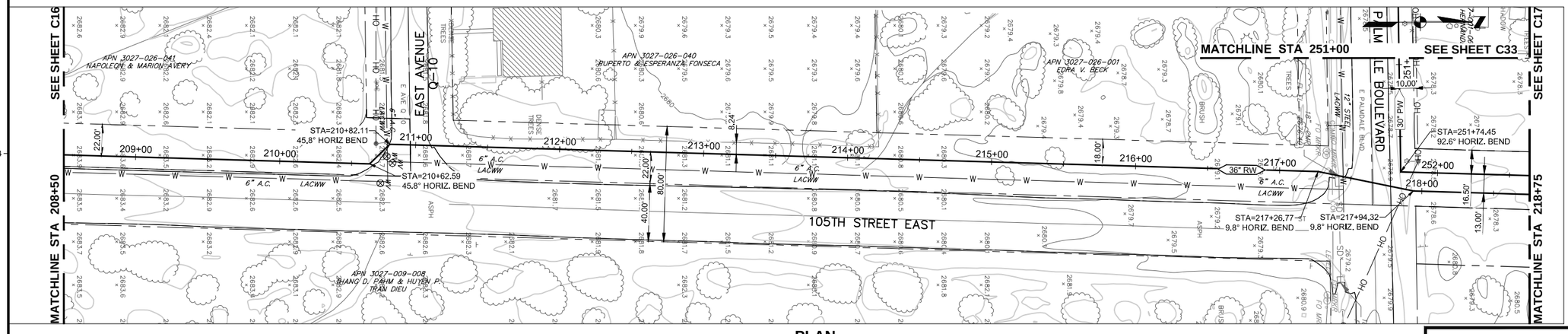

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1"=40'

PLAN
SCALE: 1" = 40'

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PALMDALE WATER DISTRICT
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PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

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RAW WATER/RETURN WATER PIPELINE PLAN 7

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C16 OF -

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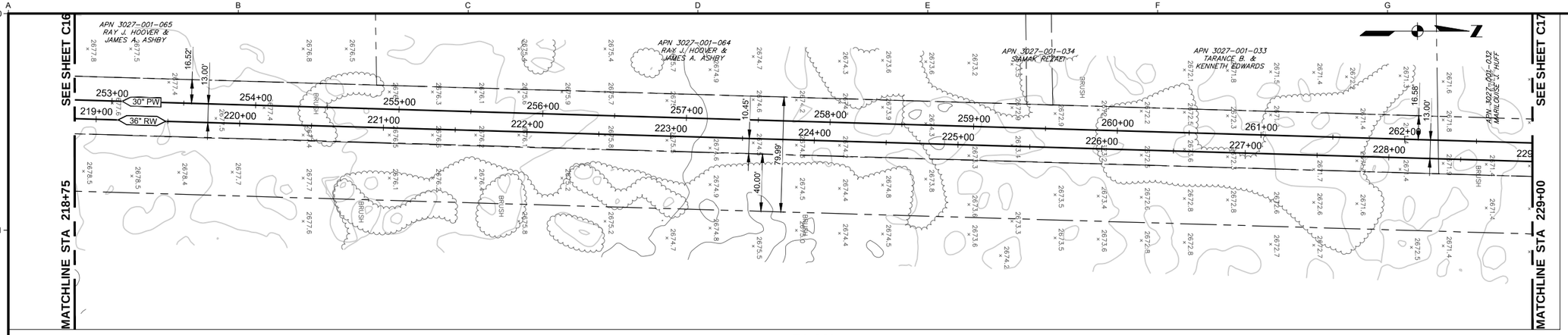

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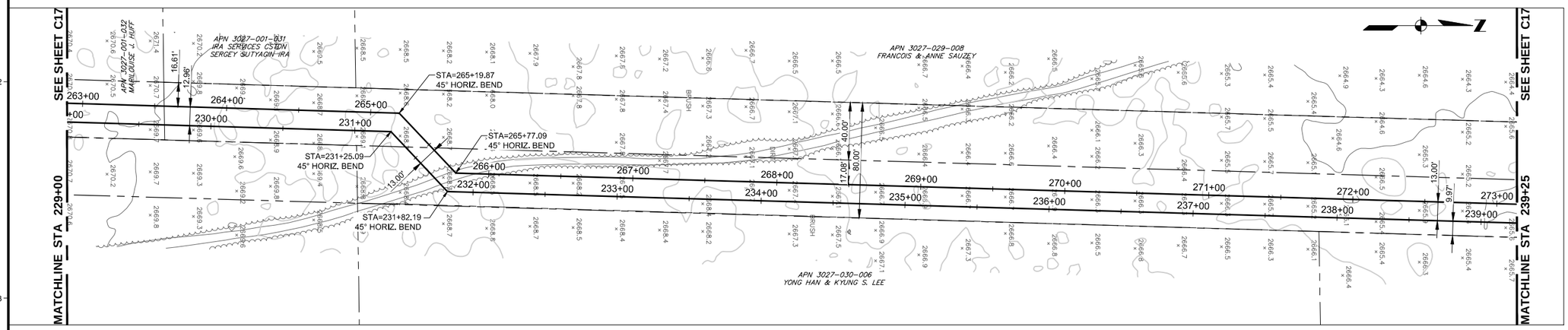

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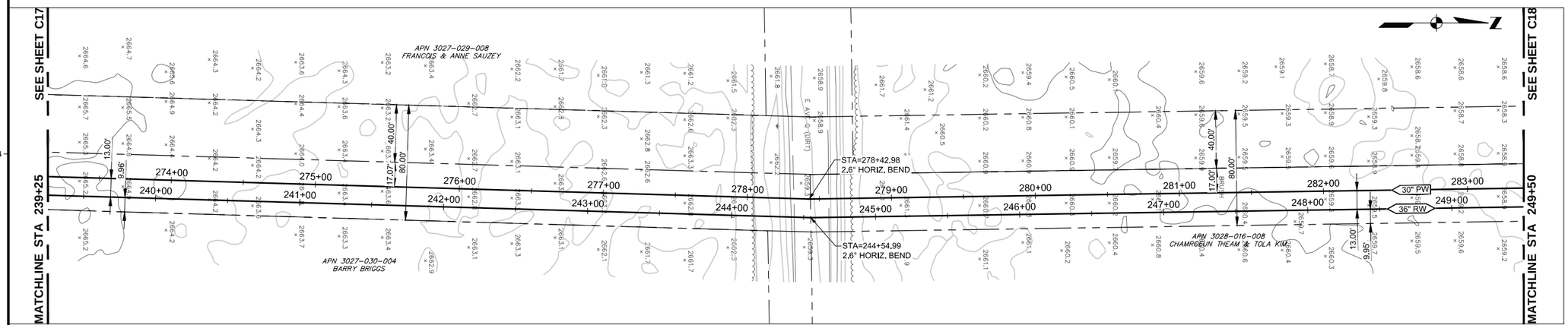

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1"=40'

PLAN
SCALE: 1" = 40'

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PALMDALE WATER DISTRICT
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RAW WATER/RETURN WATER PIPELINE AND POTABLE WATER PIPELINE PLAN 1

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C17 OF -

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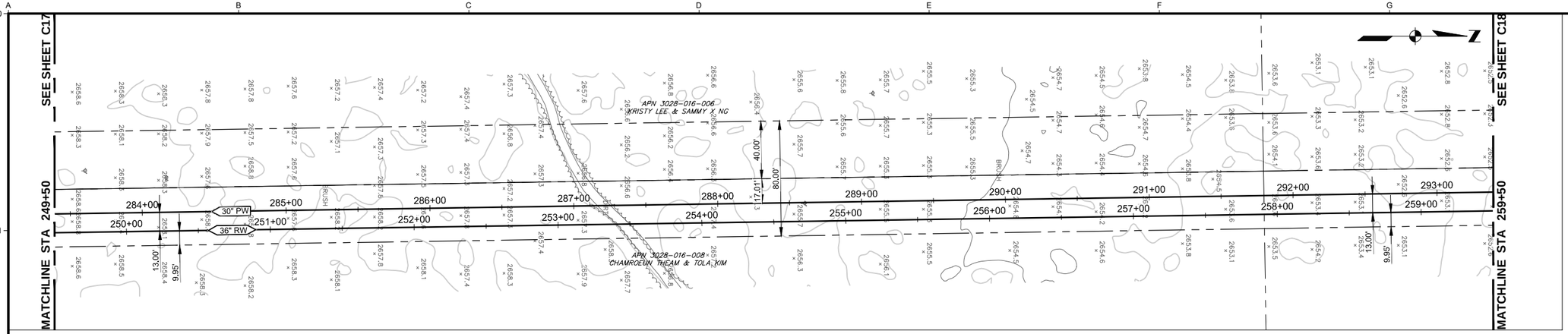

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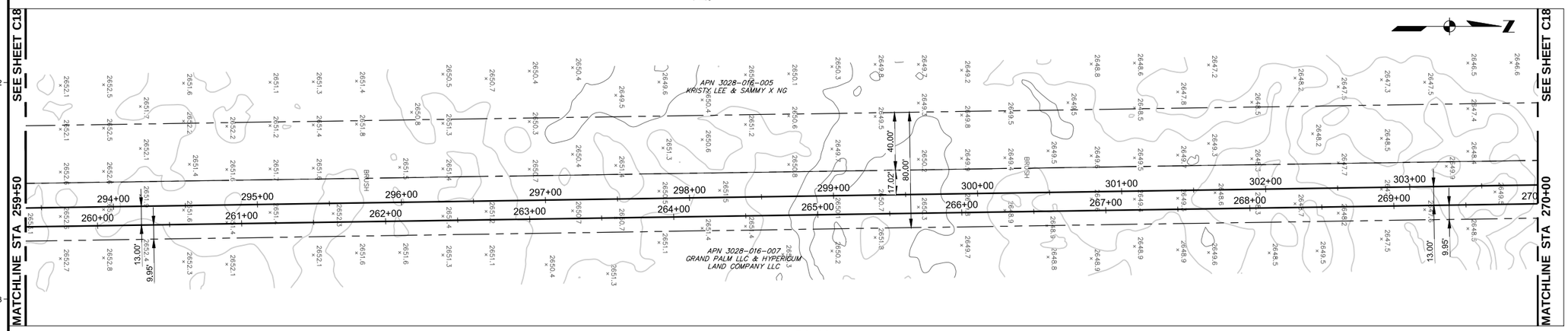
PLAN
SCALE: 1" = 40'



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PLAN
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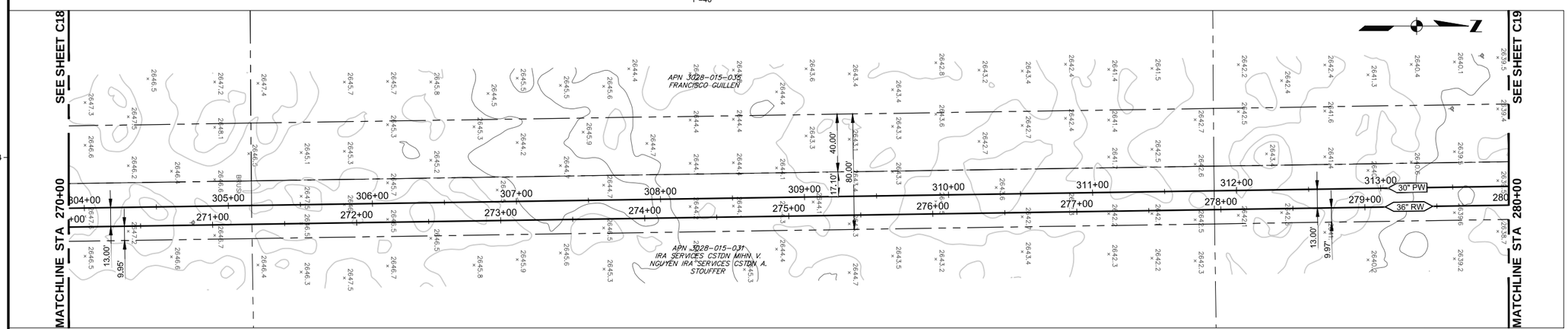

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1"=40'

PLAN
SCALE: 1" = 40'

NOTES:

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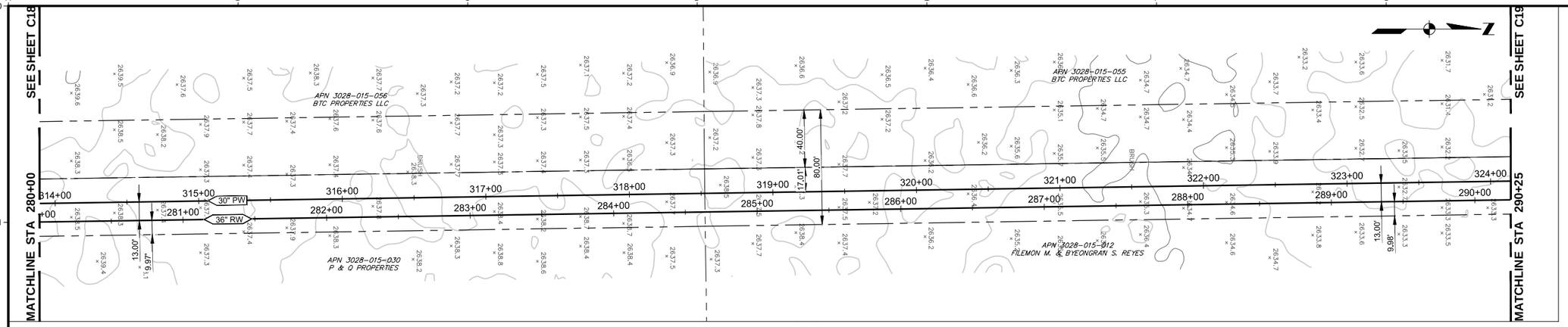
RAW WATER/RETURN WATER PIPELINE AND POTABLE WATER PIPELINE PLAN 2

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C18
OF	-



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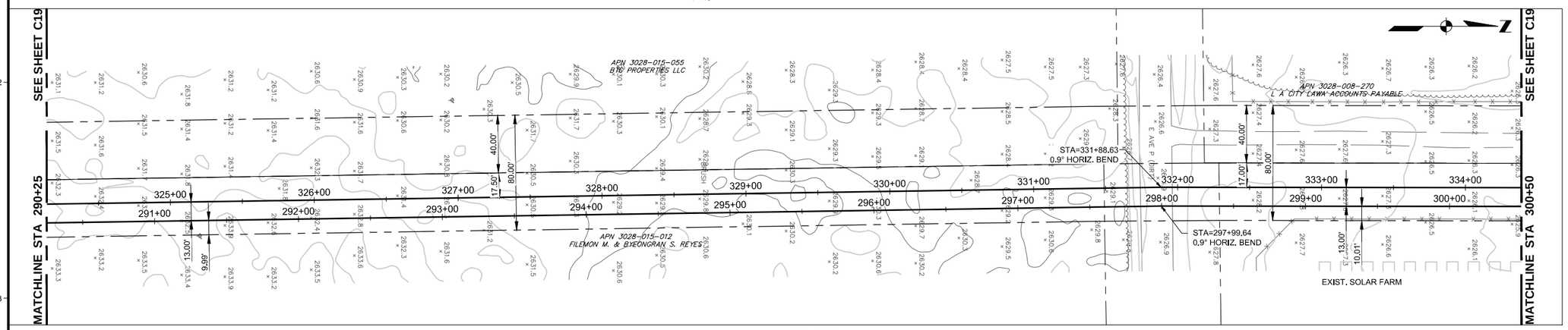
PLAN
SCALE: 1" = 40'



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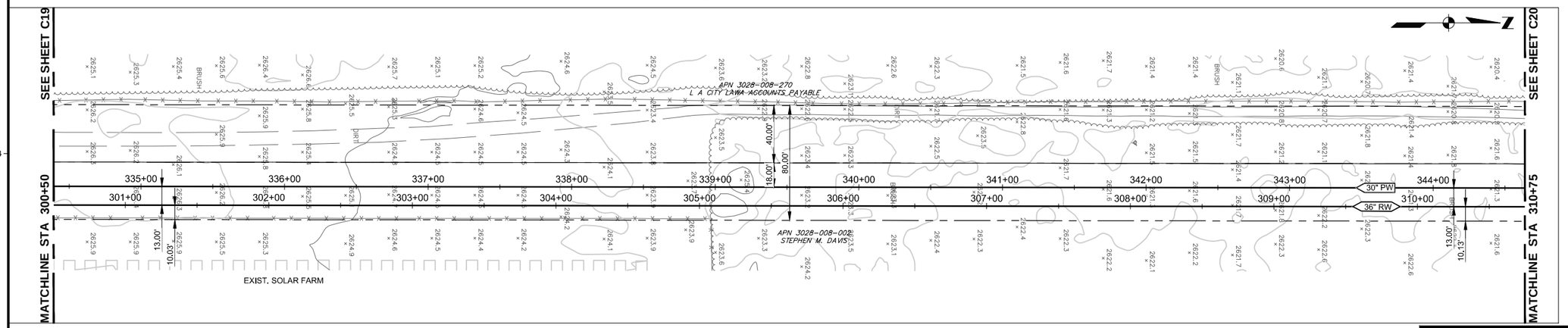
PLAN
SCALE: 1" = 40'



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1"=40'

PLAN
SCALE: 1" = 40'

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PALMDALE WATER DISTRICT
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Kennedy/Jenks Consultants
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RAW WATER/RETURN WATER PIPELINE AND POTABLE WATER PIPELINE PLAN 3

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C19
OF	-

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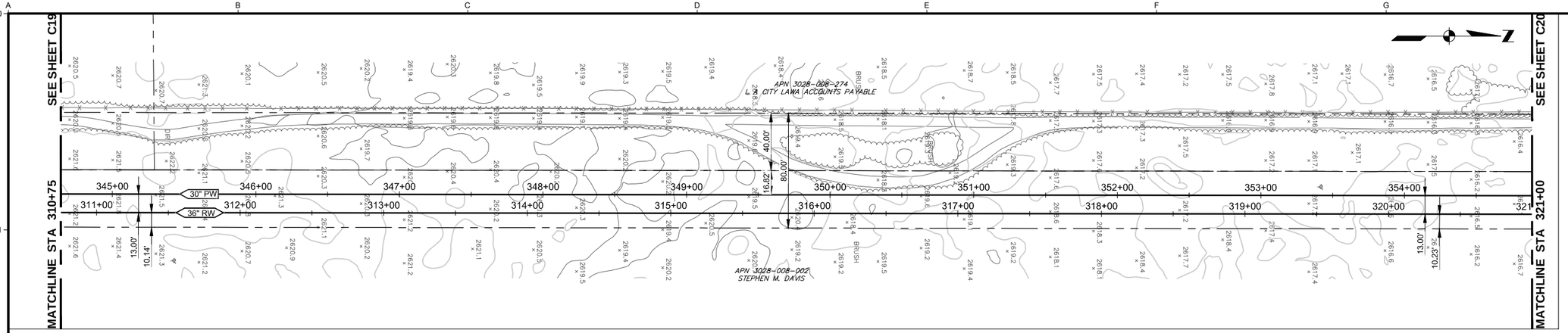

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PLAN
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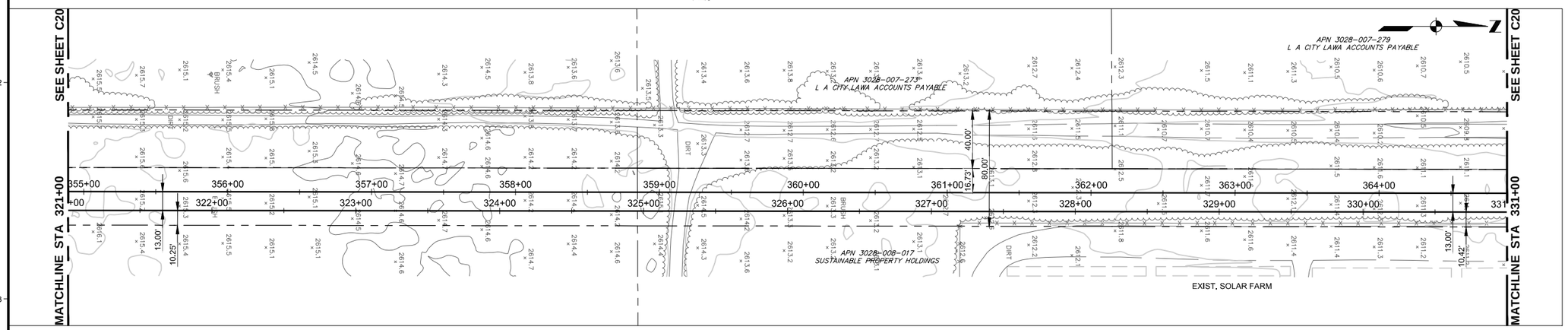

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PLAN
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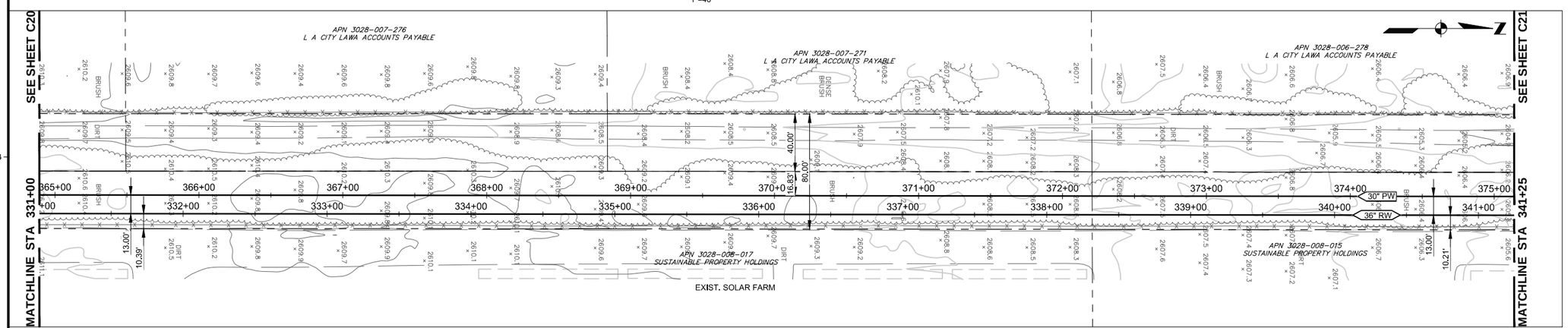

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1"=40'

PLAN
SCALE: 1" = 40'

NOTES:

1.

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No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

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DRAWN	HCS
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PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RAW WATER/RETURN WATER PIPELINE AND POTABLE WATER PIPELINE PLAN 4

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C20
OF	-

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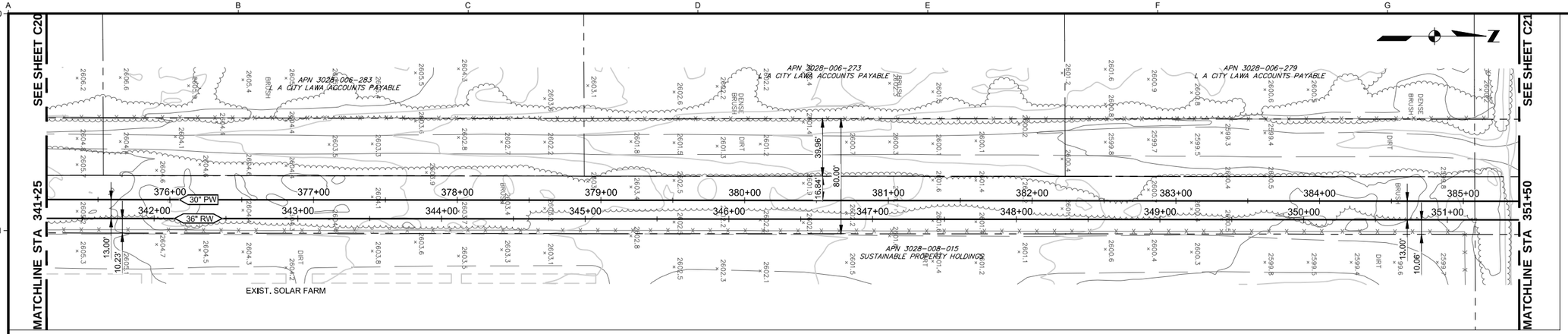

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PLAN
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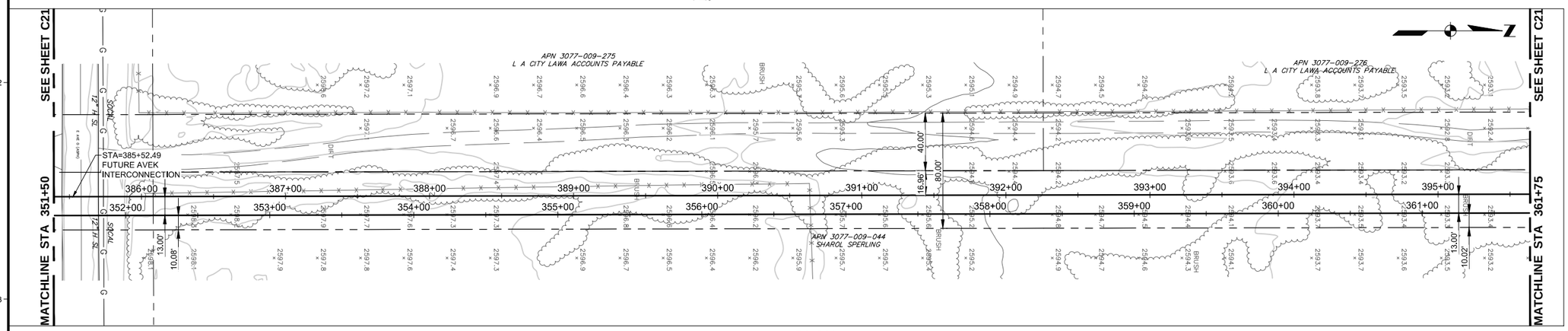

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PLAN
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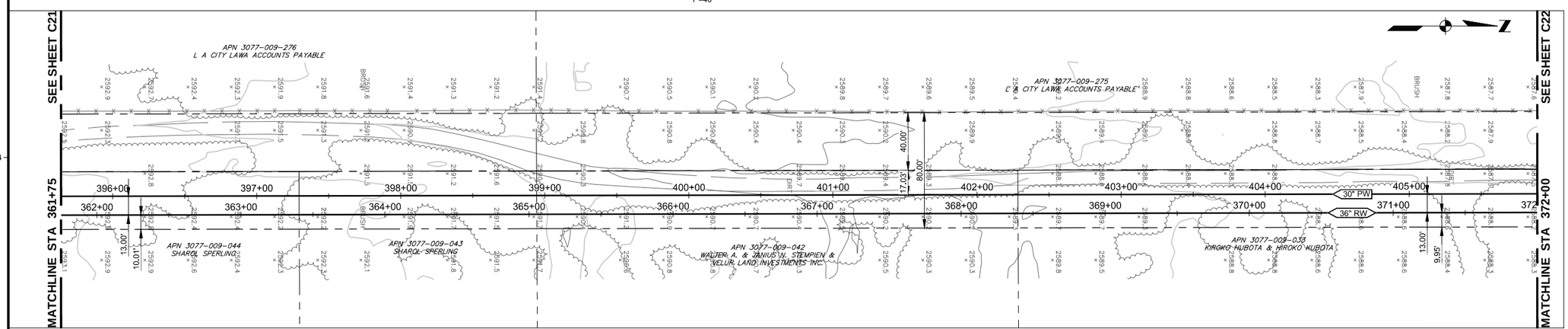

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PLAN
SCALE: 1" = 40'

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PALMDALE WATER DISTRICT
PALMDALE, CA
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Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RAW WATER/RETURN WATER PIPELINE AND POTABLE WATER PIPELINE PLAN 5

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C21
OF	-

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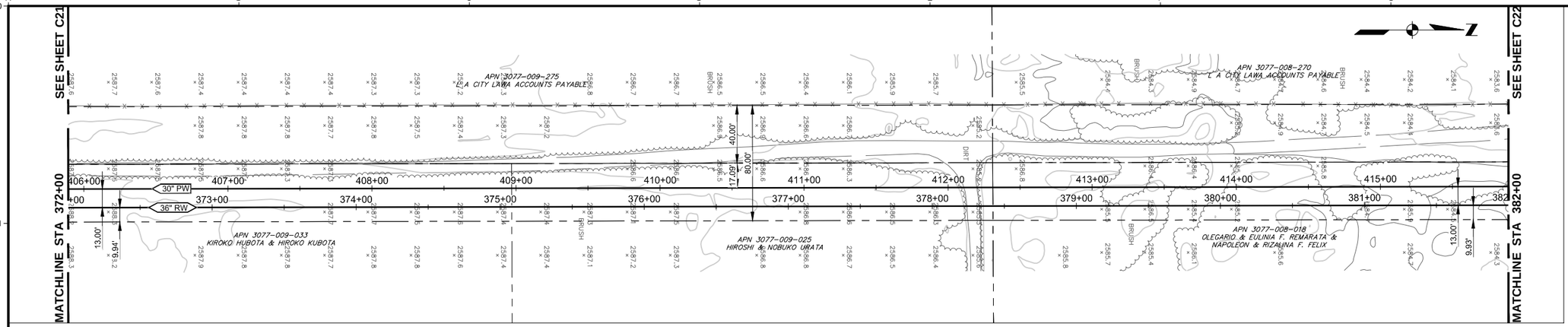

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PLAN
SCALE: 1" = 40'

0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

NOTES:

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DRAWN	HCS
CHECKED	JFC

PALMDALE WATER DISTRICT
PALMDALE, CA
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RAW WATER/RETURN WATER PIPELINE AND POTABLE WATER PIPELINE PLAN 6

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C22
OF	-

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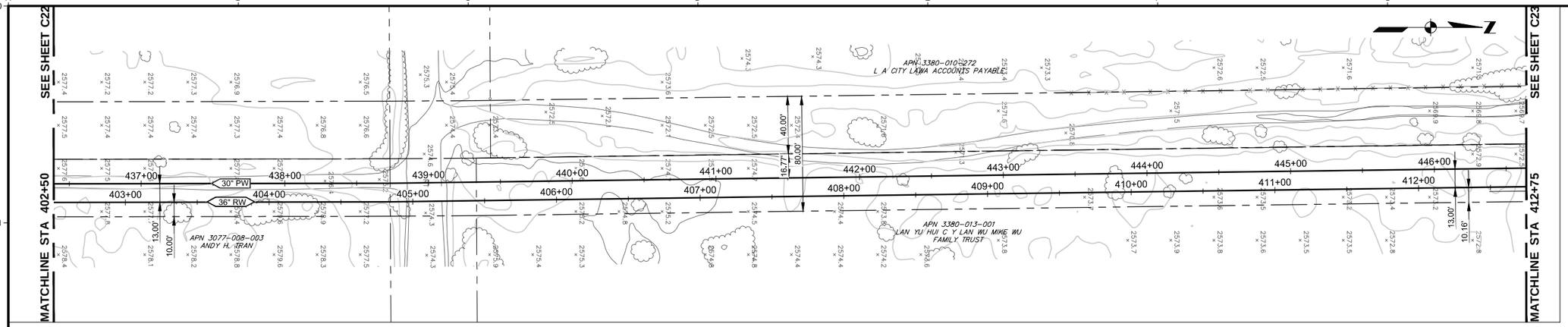

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PLAN
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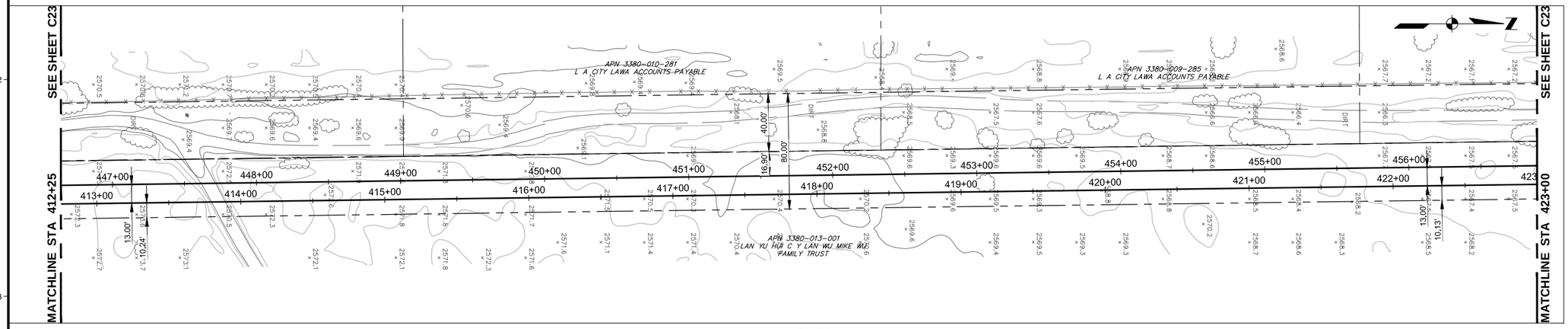

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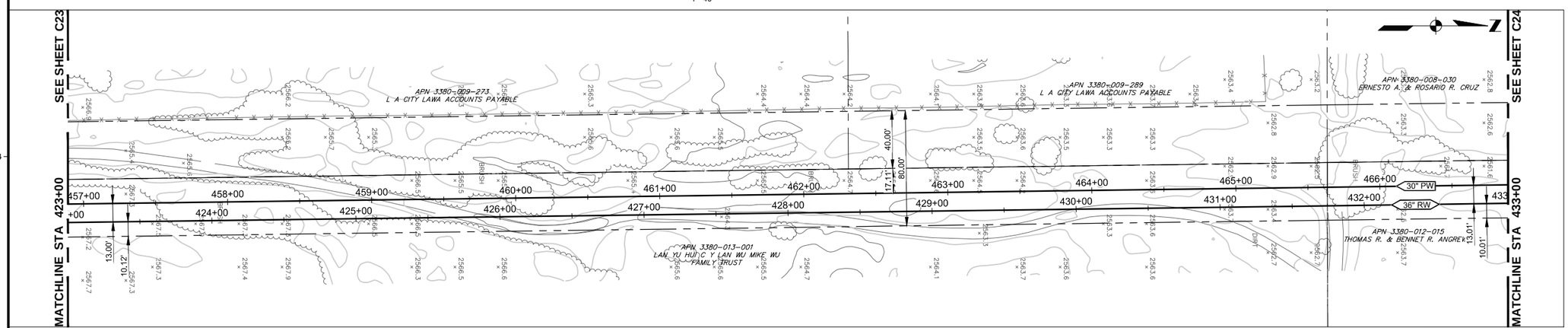
PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

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PALMDALE WATER DISTRICT
PALMDALE, CA

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RAW WATER/RETURN WATER PIPELINE AND POTABLE WATER PIPELINE PLAN 7

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C23
OF	-

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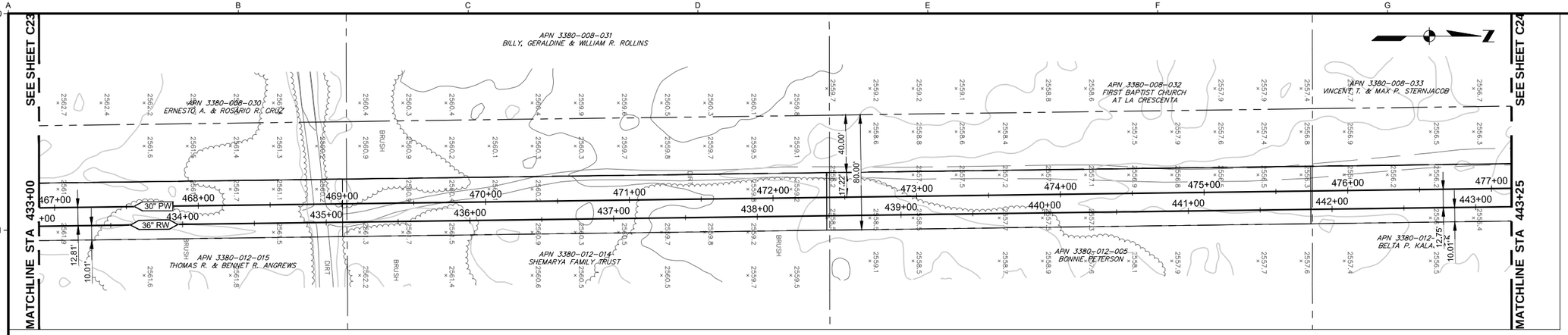

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PLAN
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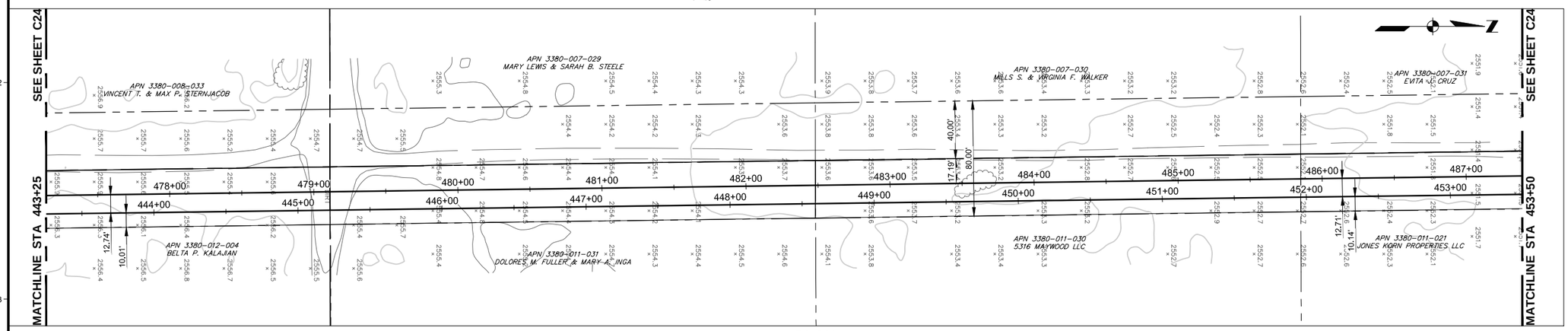

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PLAN
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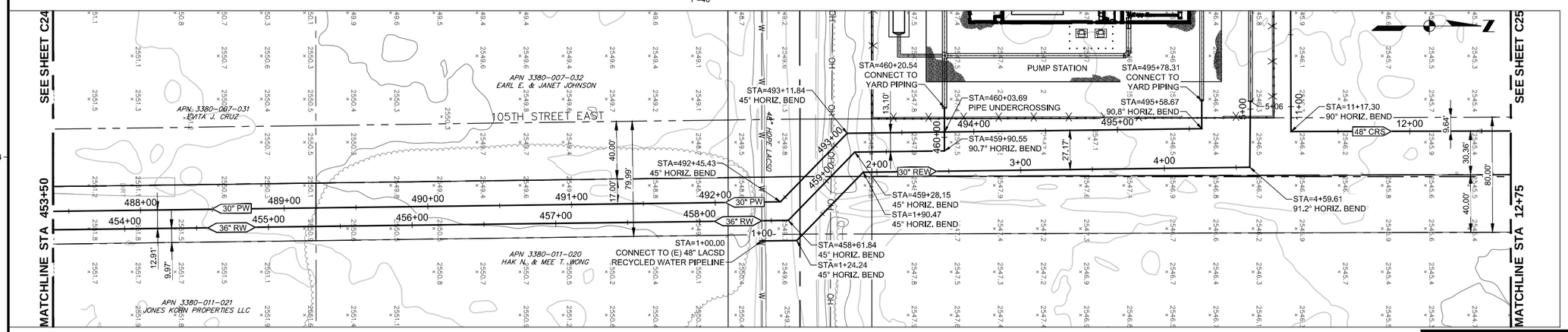

0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

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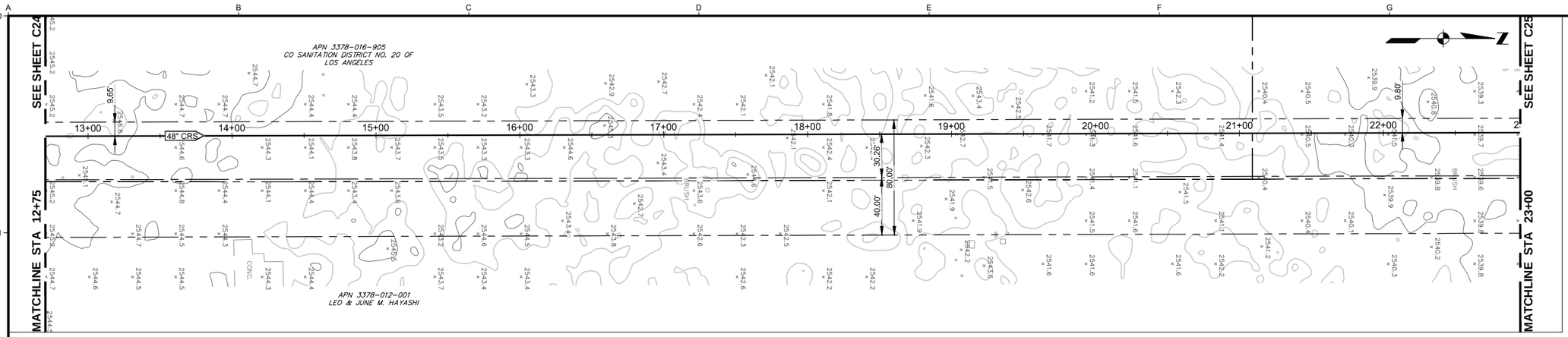
RAW WATER / RETURN WATER PIPELINE AND POTABLE WATER PIPELINE PLAN 8

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C24
OF	-

11/6/2015 2:09 PM BRYANT BEHNKE
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505001c24.dwg

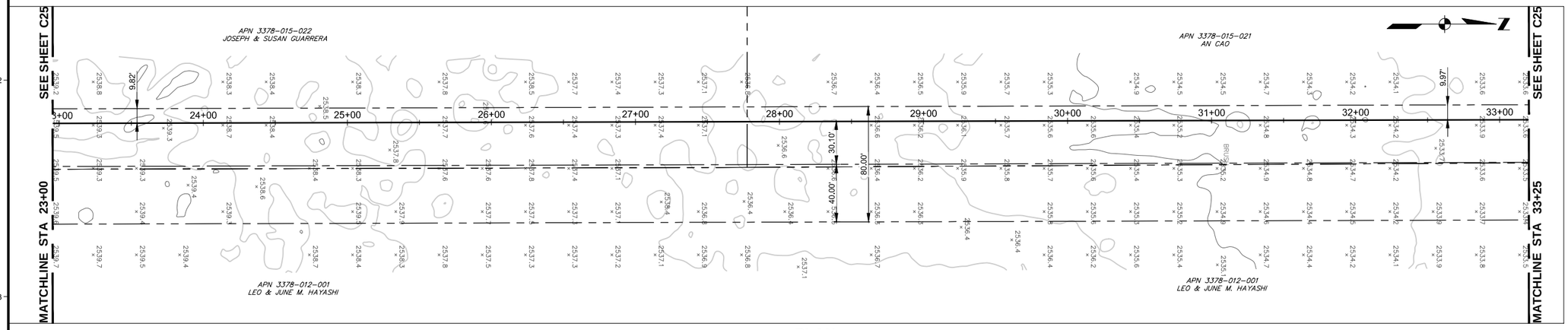


NOTES:

1.

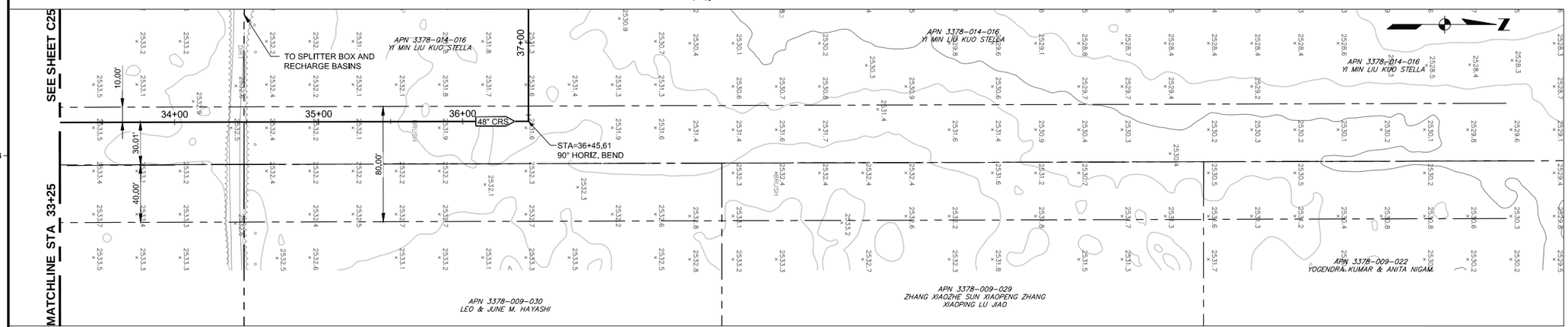
0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER DAVID W. FERGUSON No. CE 34626 Exp. 09/30/17 STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

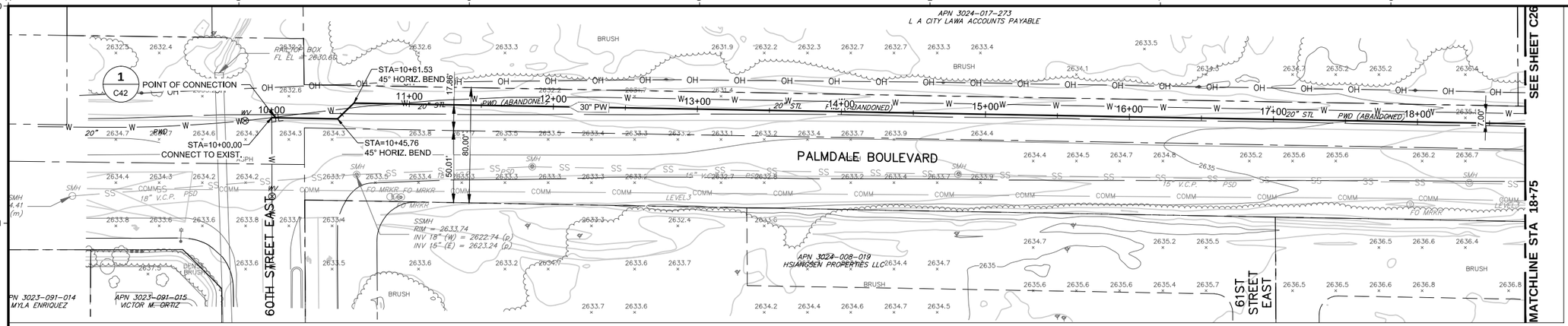
PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

COMBINED RECHARGE SUPPLY PIPE PLAN

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C25
OF	-

L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505 01c25.dwg
BRYANT BEHNKE
11/6/2015 2:17 PM



PLAN
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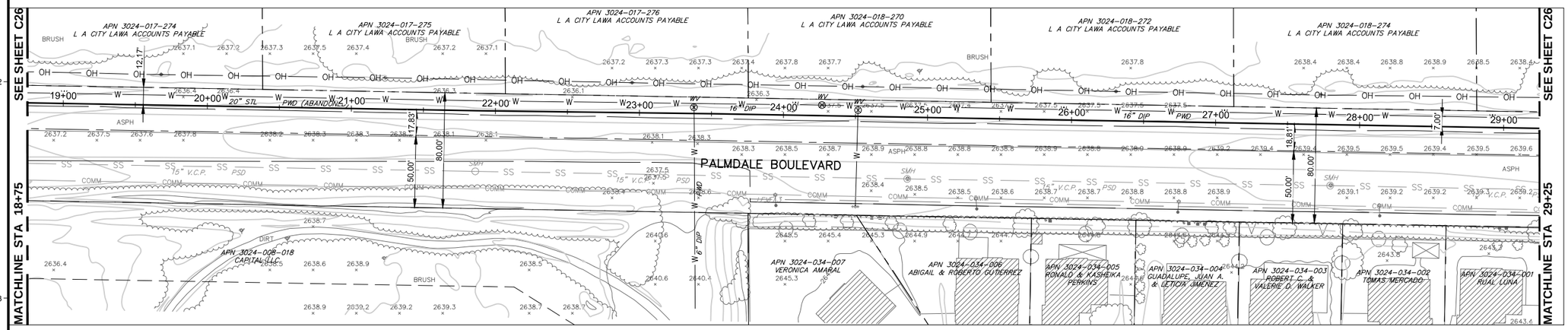
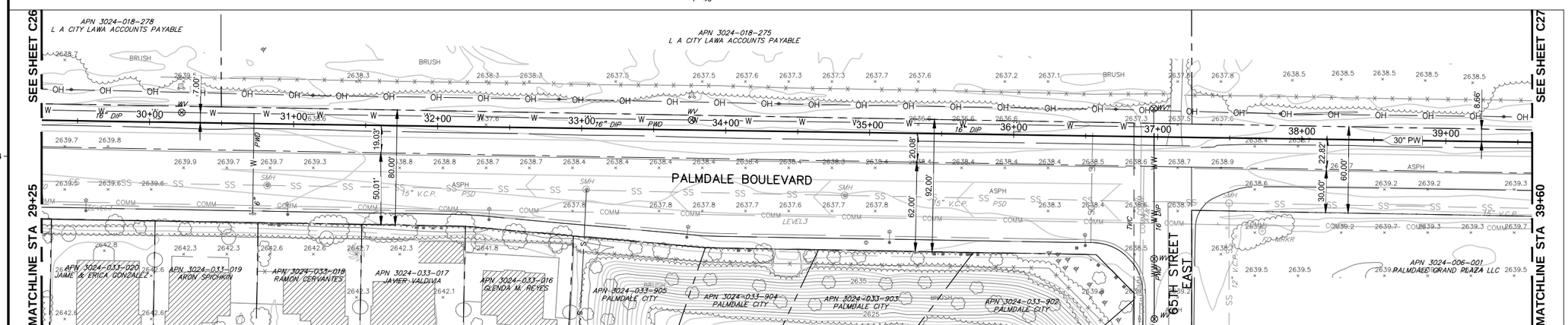


PLAN
SCALE: 1" = 40'



PLAN
SCALE: 1" = 40'

NOTES:
1.

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

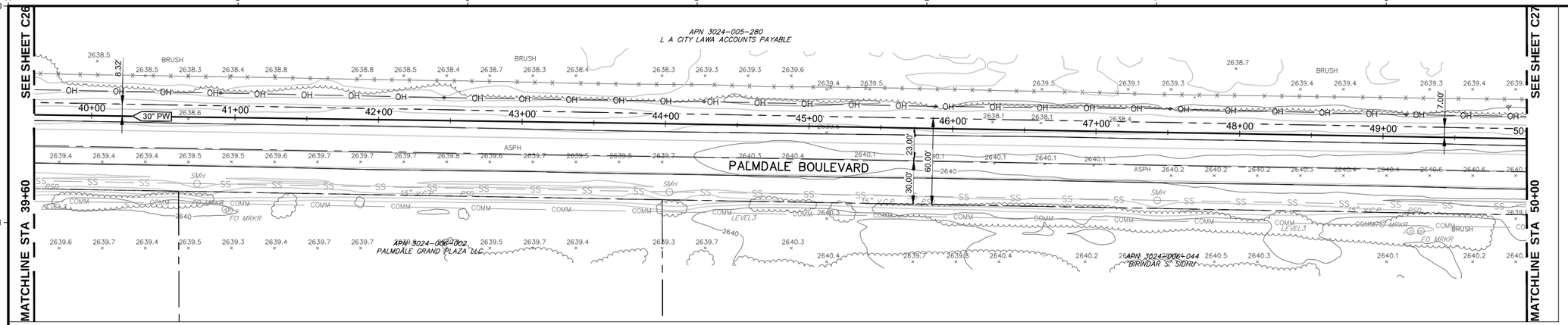
PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

POTABLE WATER PIPELINE PLAN 1

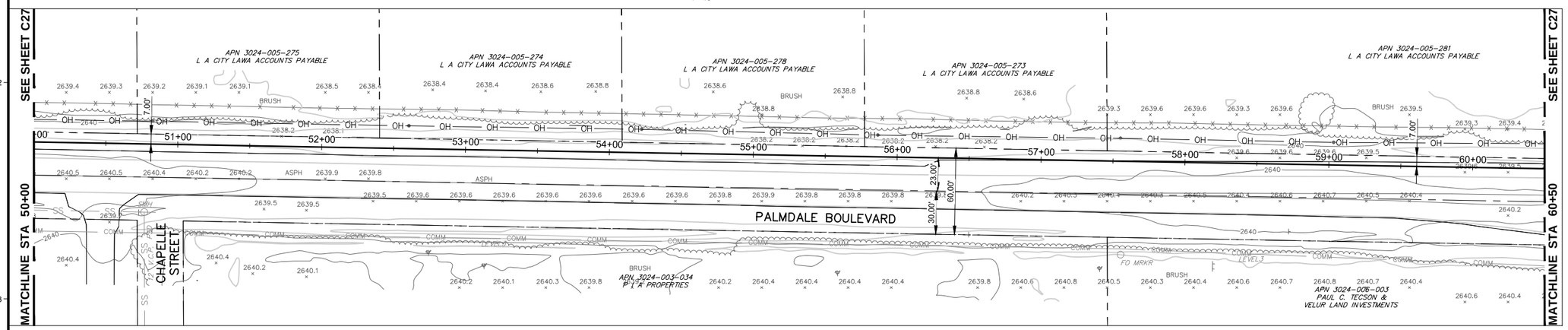
FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C26
OF	-

11/6/2015 2:19 PM BRYANT BEHNKE
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505001c26.dwg



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



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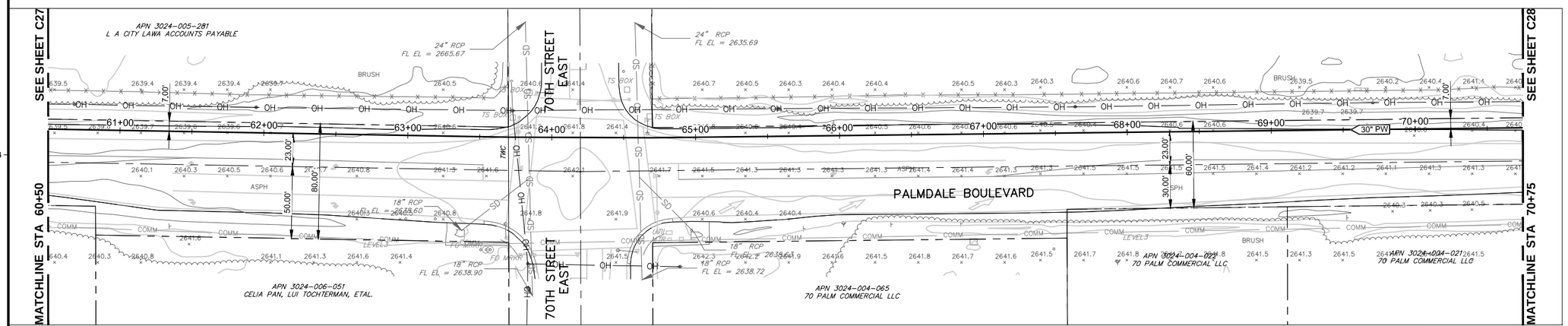
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

NOTES:
1.

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

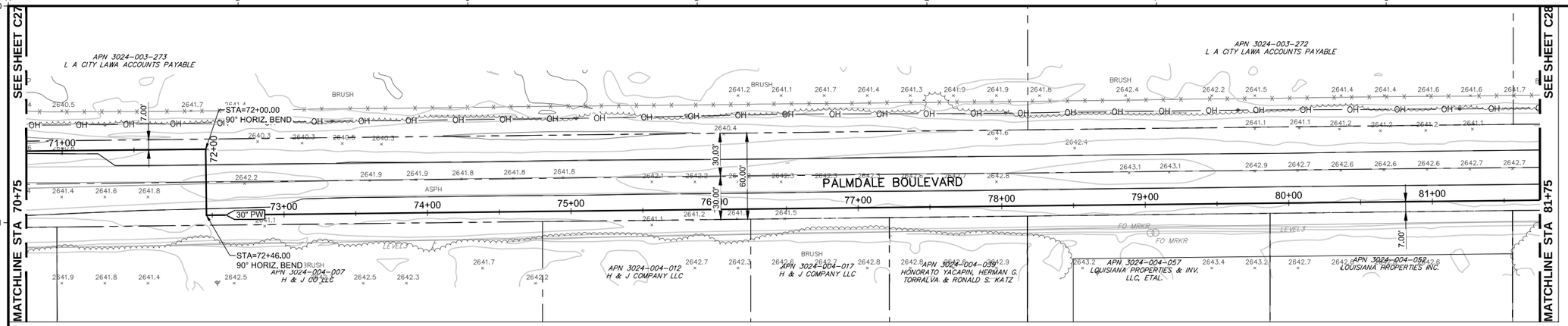
DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT
Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

POTABLE WATER PIPELINE PLAN 2

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C27
OF	-

11/6/2015 2:21 PM BRYANT BEHNKE L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505011c27.dwg



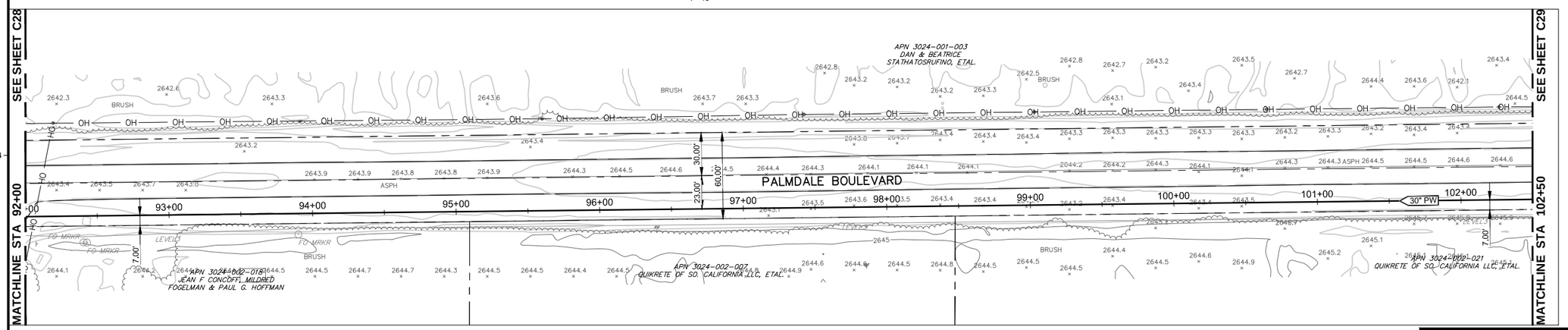
0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

NOTES:
1.

0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
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REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

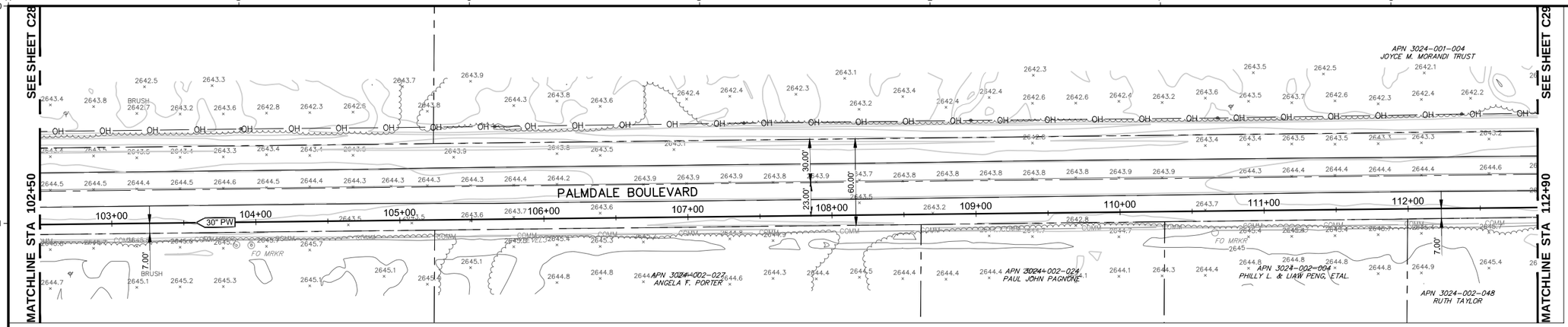
POTABLE WATER PIPELINE PLAN 3

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C28
OF	-

L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505001c28.dwg
BRYANT BEHNKE
11/6/2015 2:24 PM

NOTES:

1.



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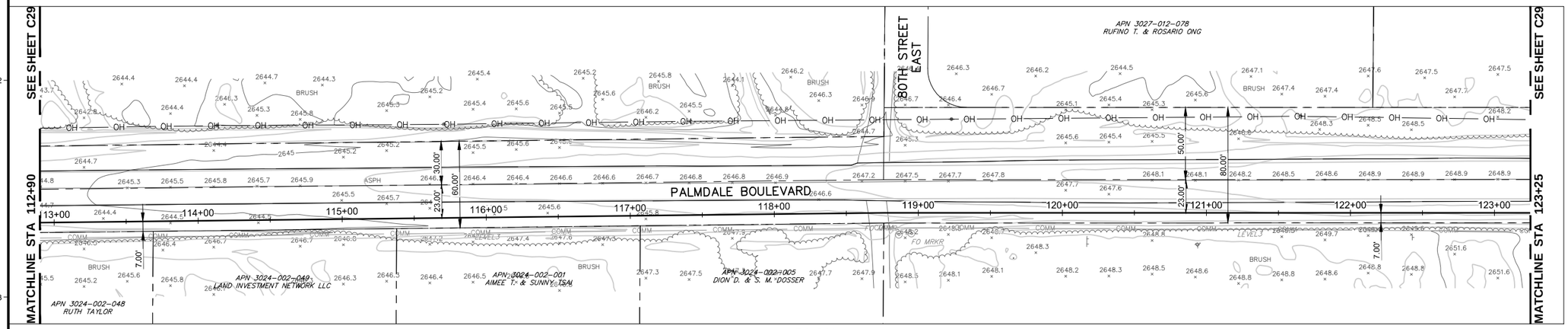
1"=40'

PLAN
SCALE: 1" = 40'



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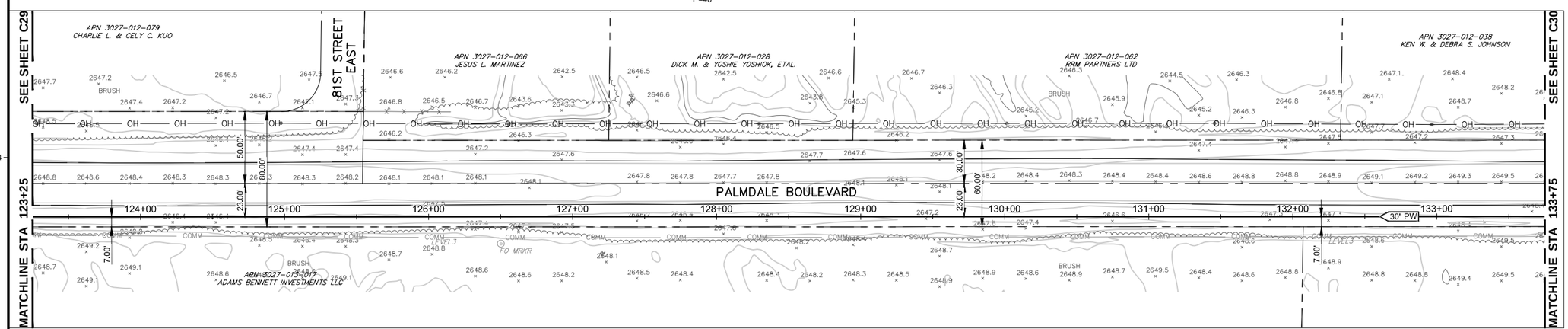
PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

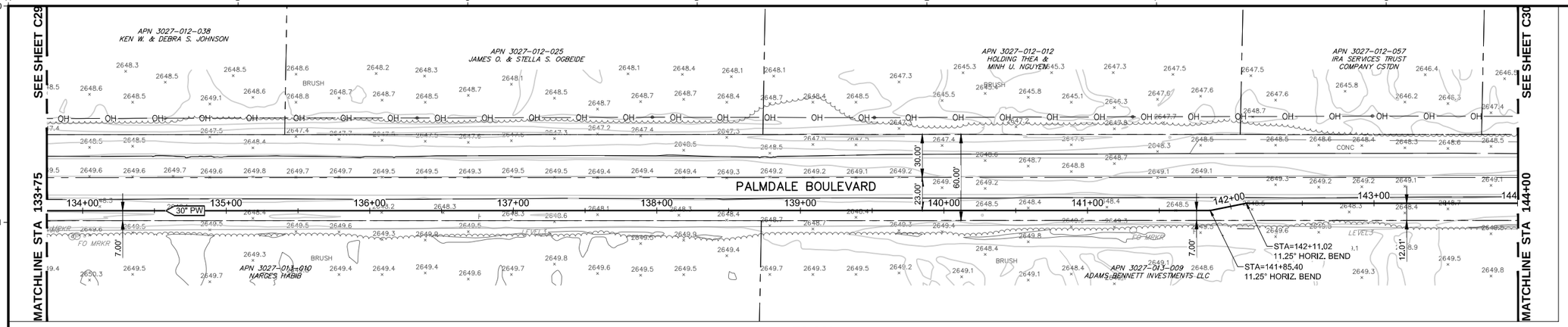
PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

POTABLE WATER PIPELINE
PLAN 4

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C29
OF	-

L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505001c29.dwg 11/6/2015 2:26 PM BRYANT BEHNKE



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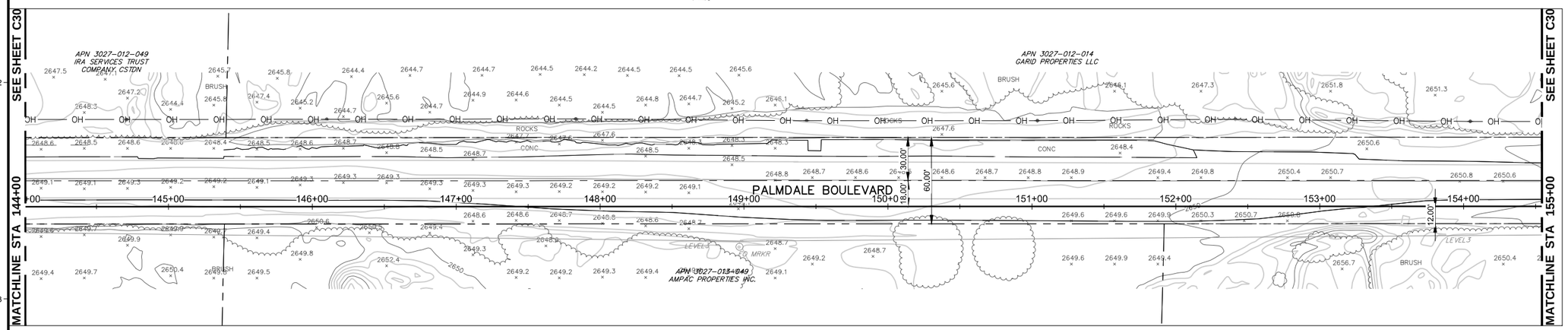
1"=40'

PLAN
SCALE: 1" = 40'



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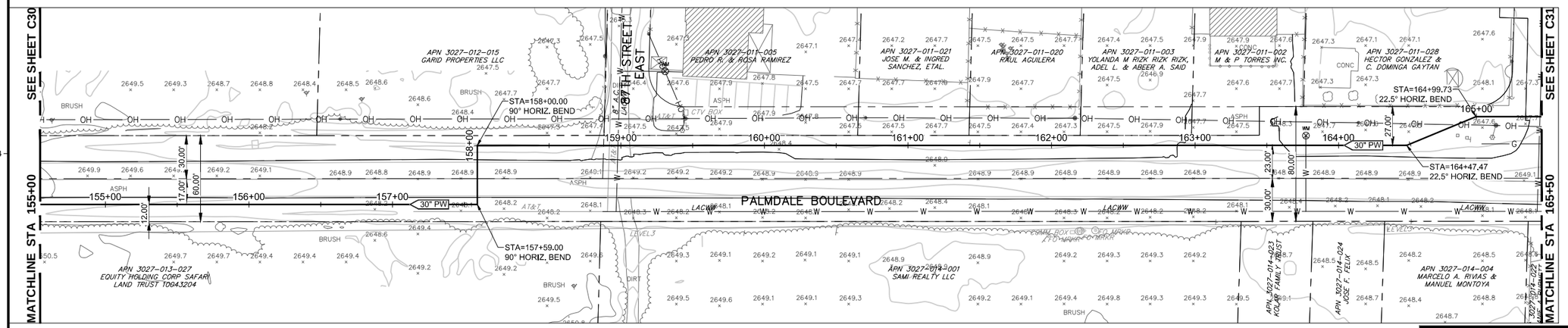
PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

PRELIMINARY - NOT FOR CONSTRUCTION

NOTES:
1.

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

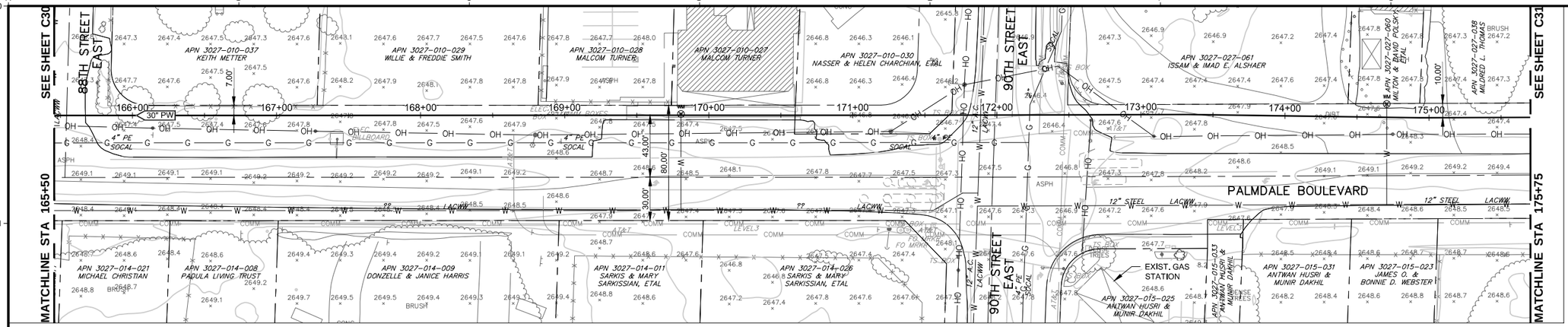
DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT
Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

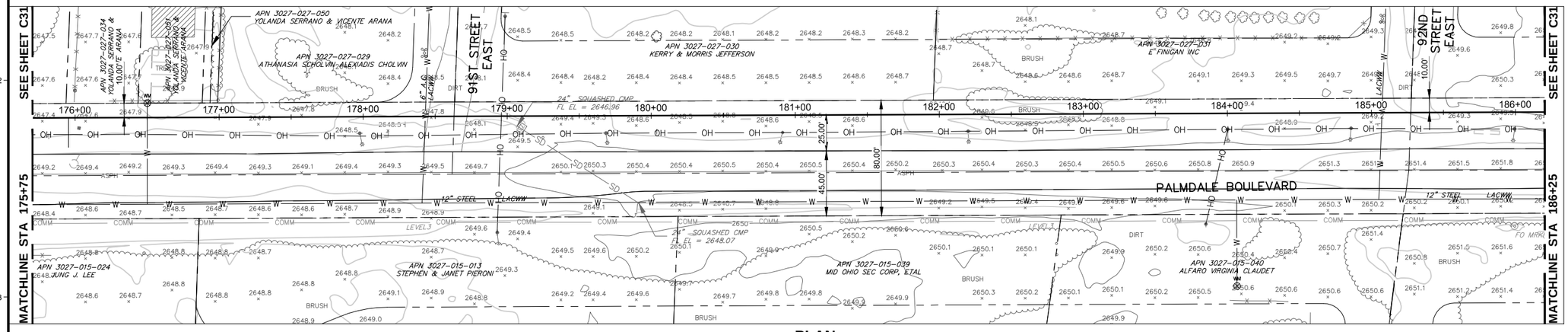
POTABLE WATER PIPELINE
PLAN 5

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C30
OF	-

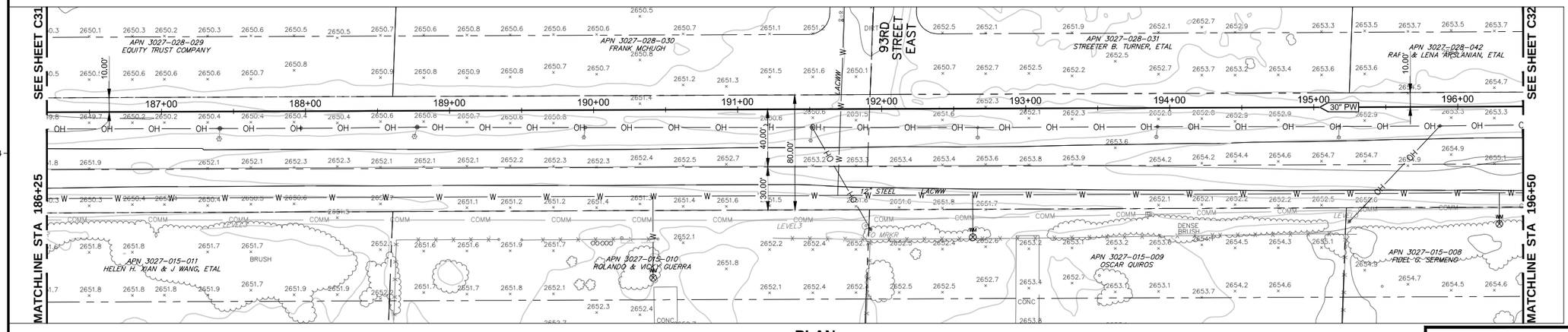
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\134450501c30.dwg BRYANT BEHNKE 11/6/2015 2:28 PM



PLAN
SCALE: 1" = 40'



PLAN
SCALE: 1" = 40'



PLAN
SCALE: 1" = 40'

NOTES:

1.

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER DAVID W. FERGUSON No. CE 34626 Exp. 09/30/17 STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT
Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

POTABLE WATER PIPELINE PLAN 6

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C31 OF -

11/6/2015 2:31 PM BRYANT BEHNKE
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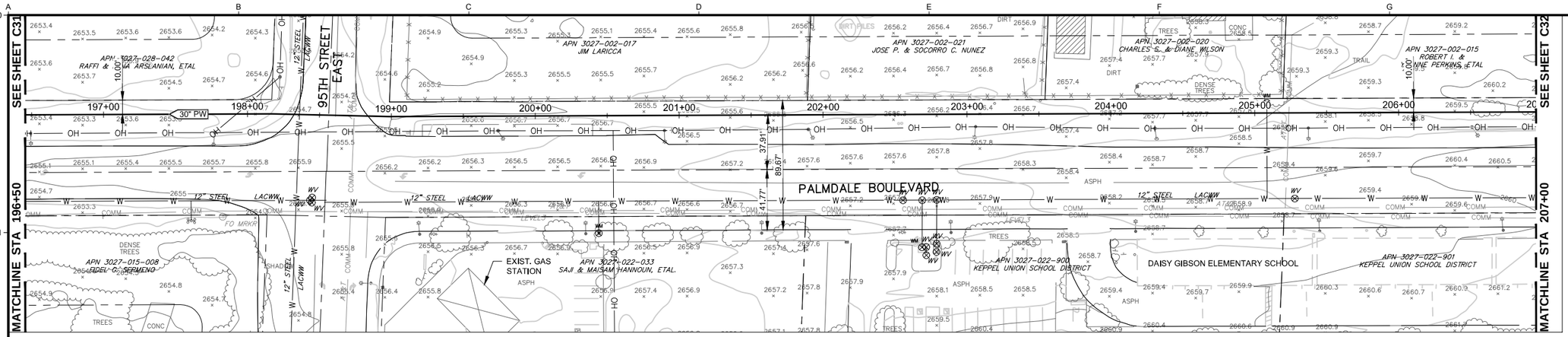

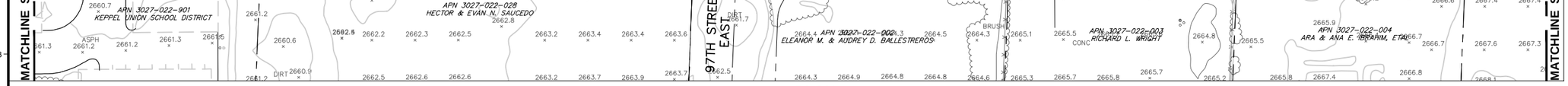

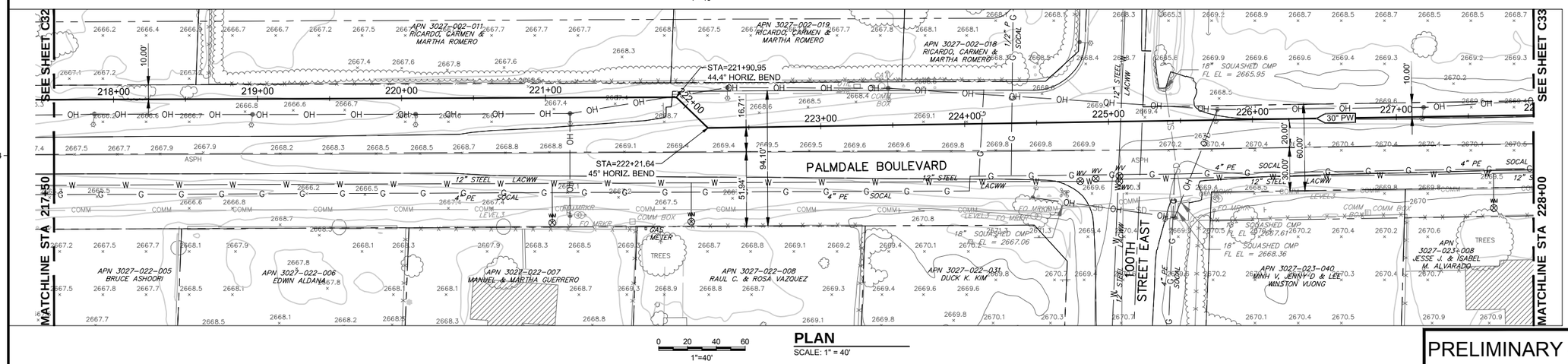

NOTES:

1.

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NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER DAVID W. FERGUSON No. CE 34626 Exp. 09/30/17 STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

POTABLE WATER PIPELINE PLAN 7

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C32
OF	-

11/6/2015 2:33 PM BRYANT BEHNKE

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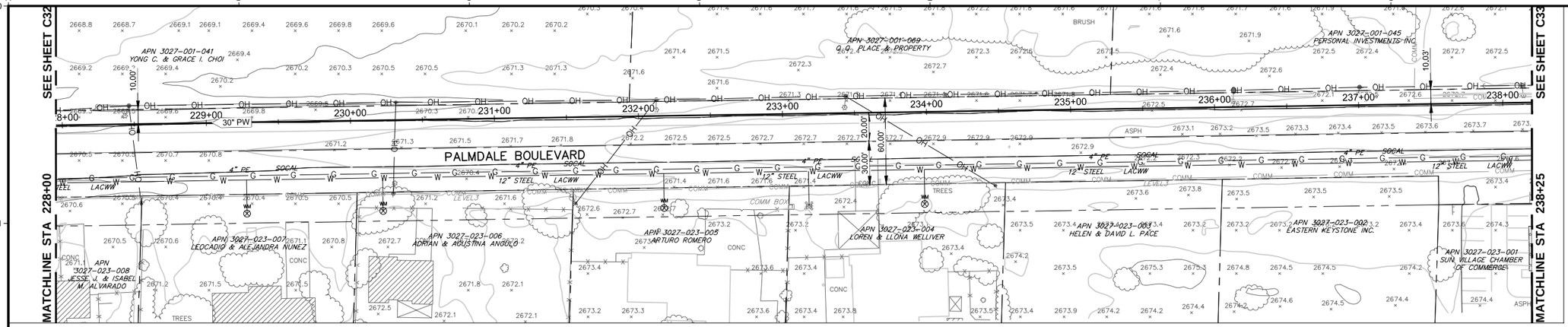
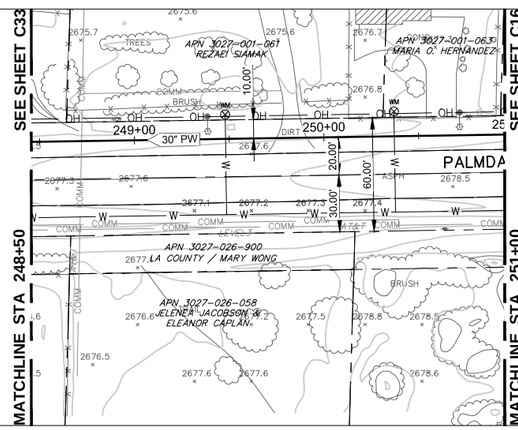


0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'



0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

NOTES:
1.

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER DAVID W. FERGUSON No. CE 34626 Exp. 09/30/17 STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

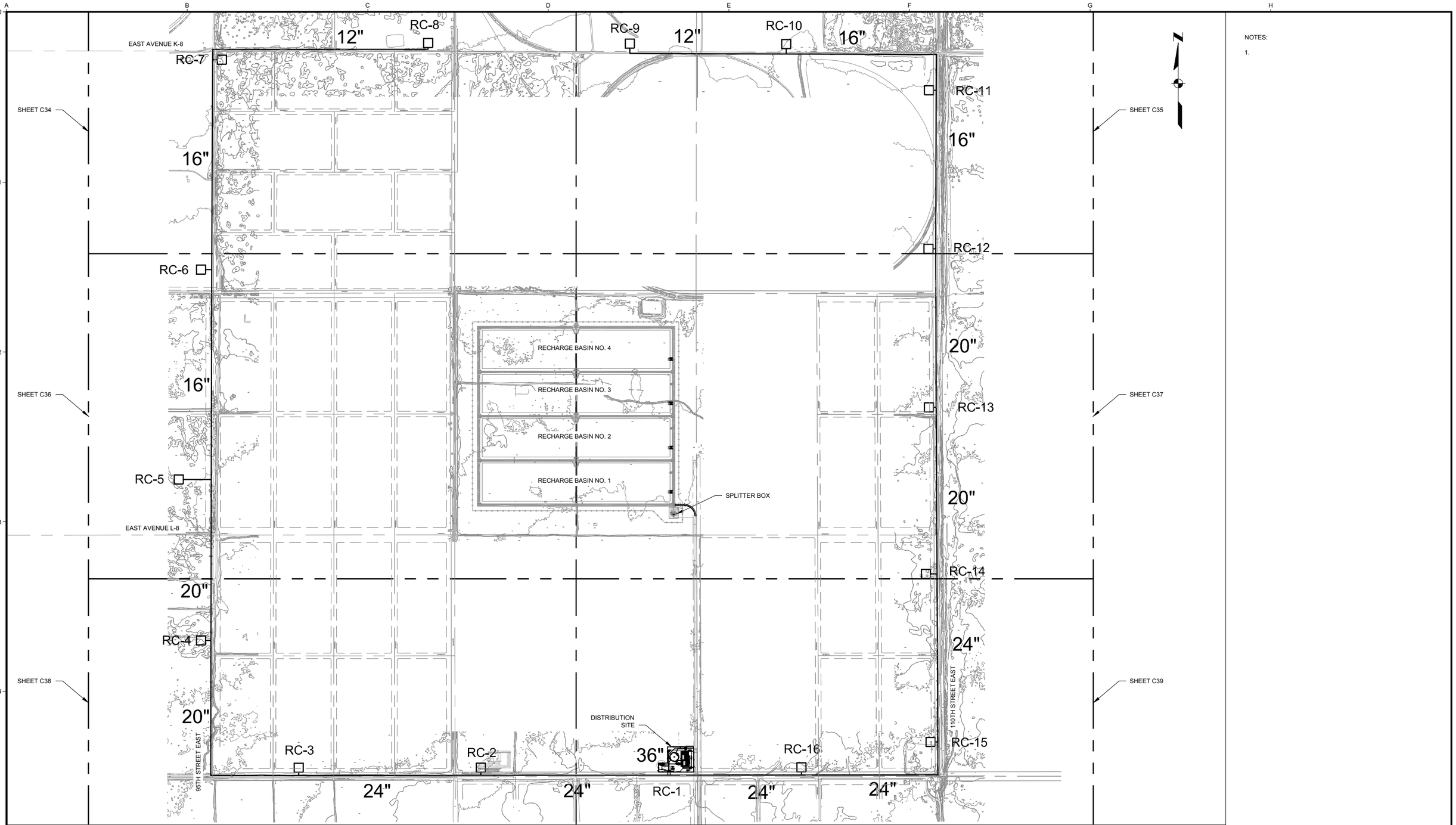
PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

POTABLE WATER PIPELINE PLAN 8

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C33
OF	-

11/6/2015 2:35 PM BRYANT BEHNKE
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505001c33.dwg



NOTES:

1.

0 500 1000
1"=500'

PLAN
SCALE: 1" = 500'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	BCH
DRAWN	HCS
CHECKED	JFC

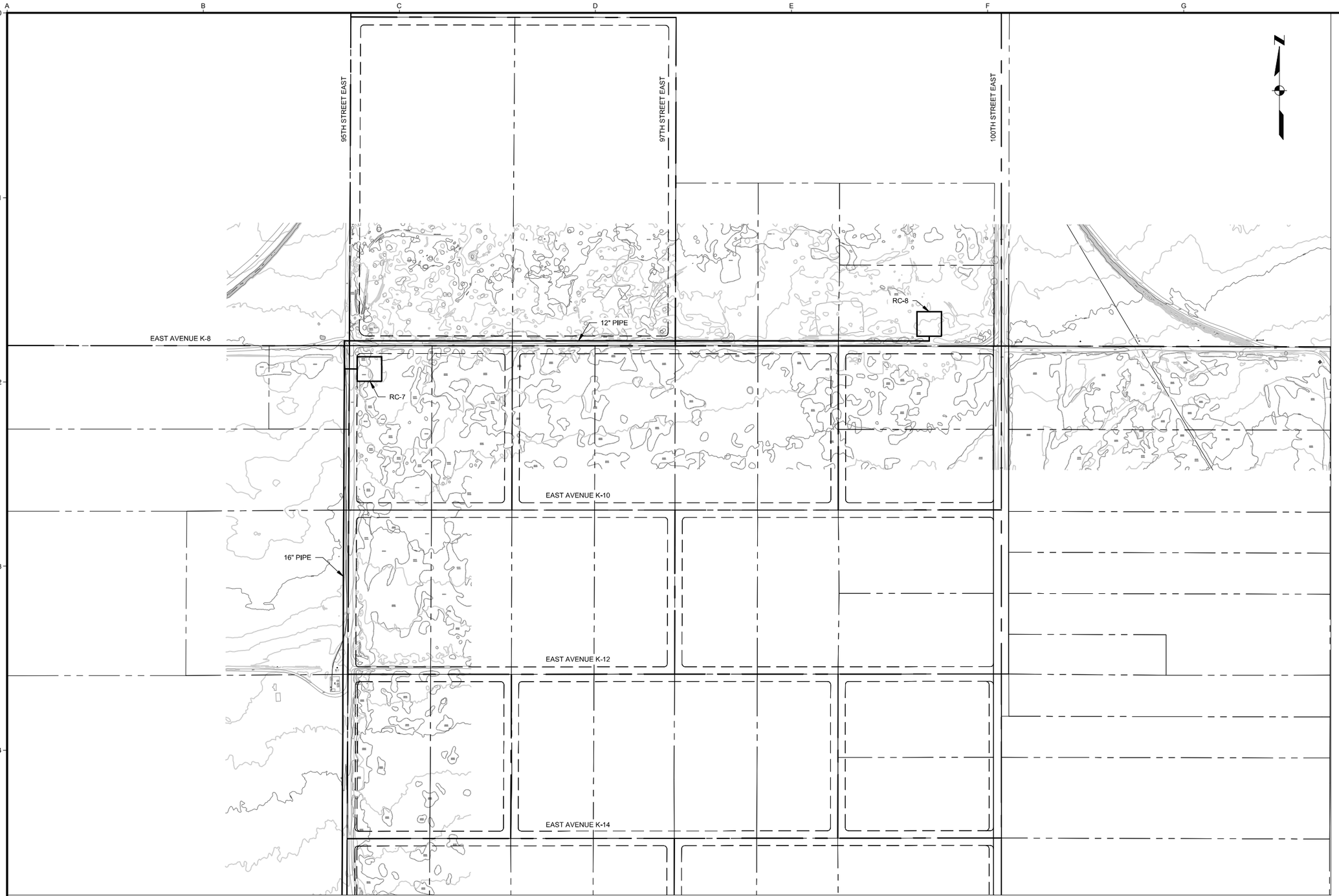
PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RECOVERY WELL LOCATIONS AND WELL COLLECTION PIPELINE

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C34
OF	-

BRYANT BEHNKE 11/6/2015 2:39 PM
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\134450501c34.dwg



NOTES:

1.

0 100 200 300

1"=200'

PLAN

SCALE: 1" = 200'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER — PAUL T. W. FERGUSON — No. CE 34626 Exp. 09/30/17 — STATE OF CALIFORNIA

DESIGNED	TMW
DRAWN	GBB
CHECKED	PST

PALMDALE WATER DISTRICT

PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants

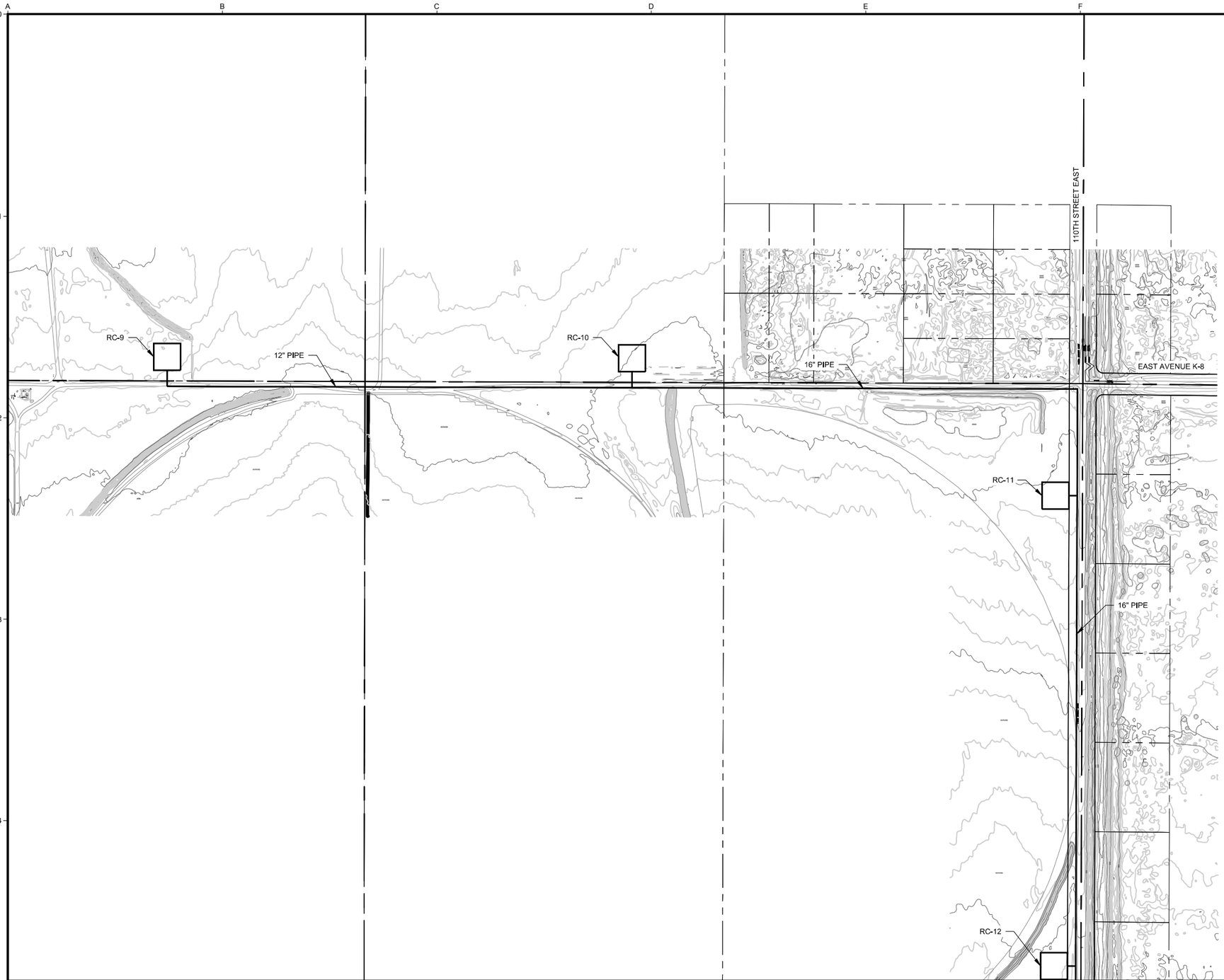
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

WELL COLLECTION PIPELINE
PLAN 1

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C35
OF	-

L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505001c35.dwg

BRYANT BEHNKE 11/6/2015 2:42 PM



NOTES:

1.

0 100 200 300
1"=200'

PLAN
SCALE: 1" = 200'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

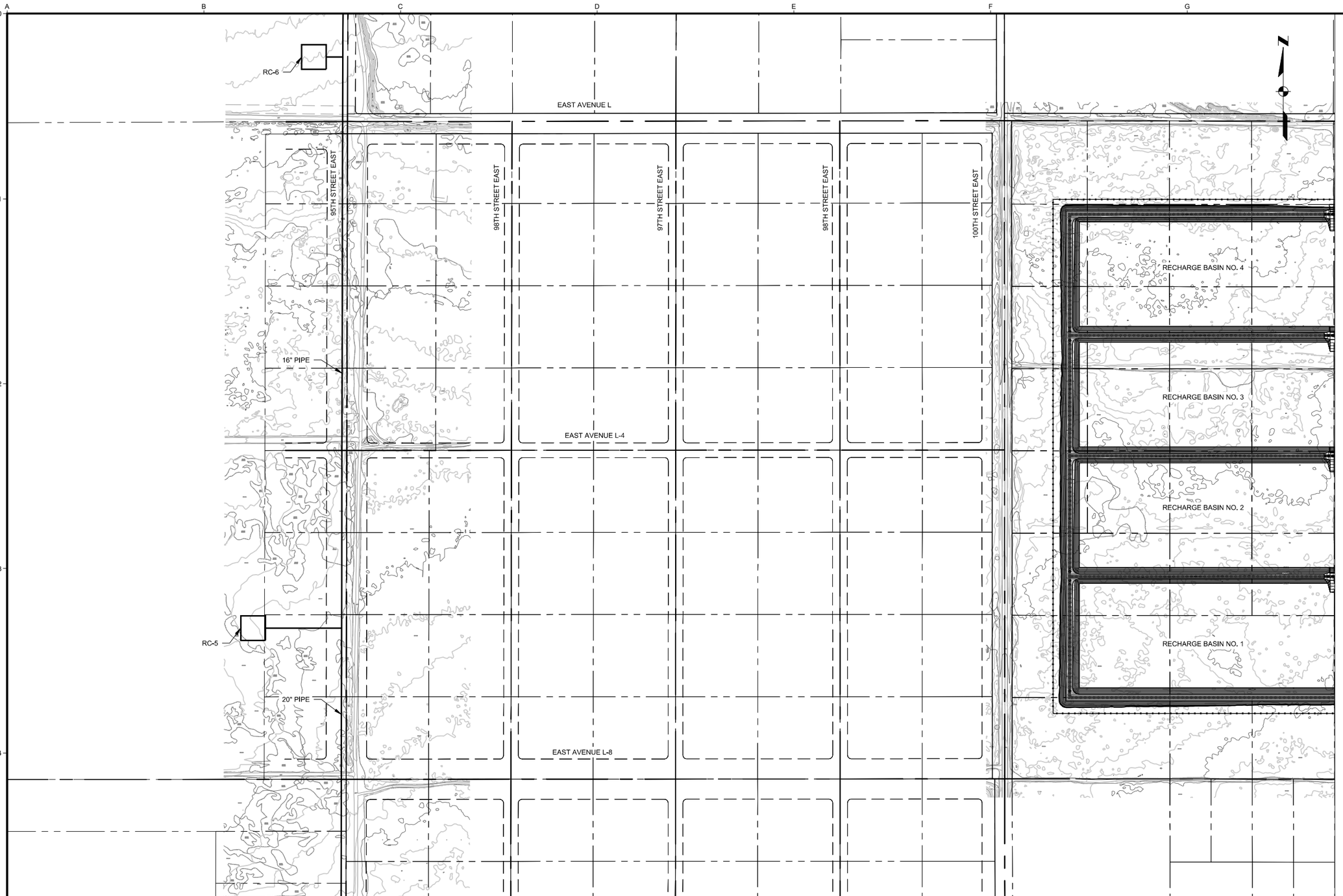
DESIGNED TMW
DRAWN GBB
CHECKED PST

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

WELL COLLECTION PIPELINE
PLAN 2

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: C36 OF -



NOTES:

1.

0 100 200 300
1"=200'

PLAN
SCALE: 1" = 200'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

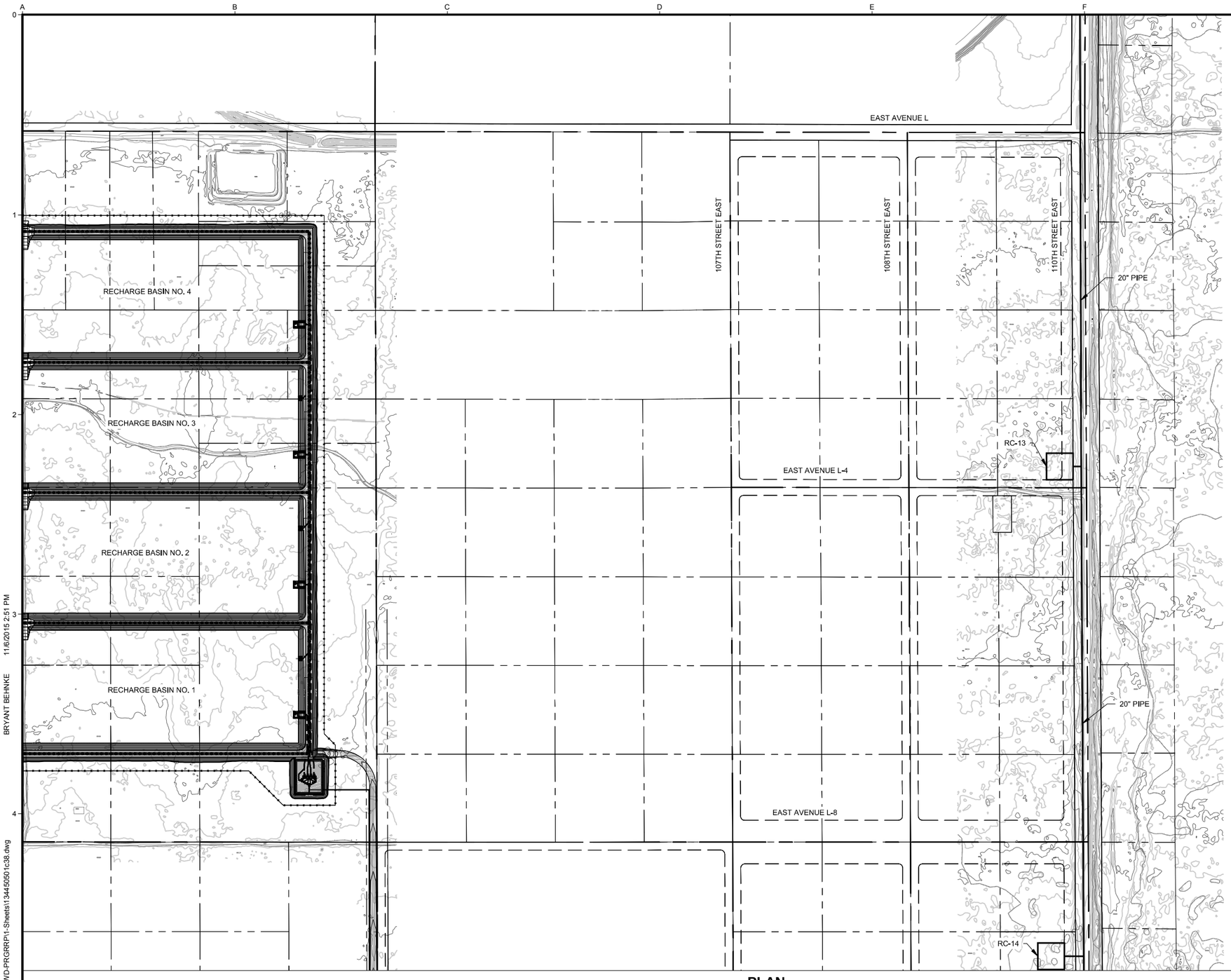
DESIGNED	TMW
DRAWN	GBB
CHECKED	PST

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

WELL COLLECTION PIPELINE
PLAN 3

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C37 OF -



NOTES:

1.

0 100 200 300
1"=200'

PLAN
SCALE: 1" = 200'

PRELIMINARY - NOT FOR CONSTRUCTION

USE OF DOCUMENTS

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
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REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	TMW
DRAWN	GBB
CHECKED	PST

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

WELL COLLECTION PIPELINE PLAN 4

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C38 OF -

BRYANT BEHNKE 11/6/2015 2:51 PM
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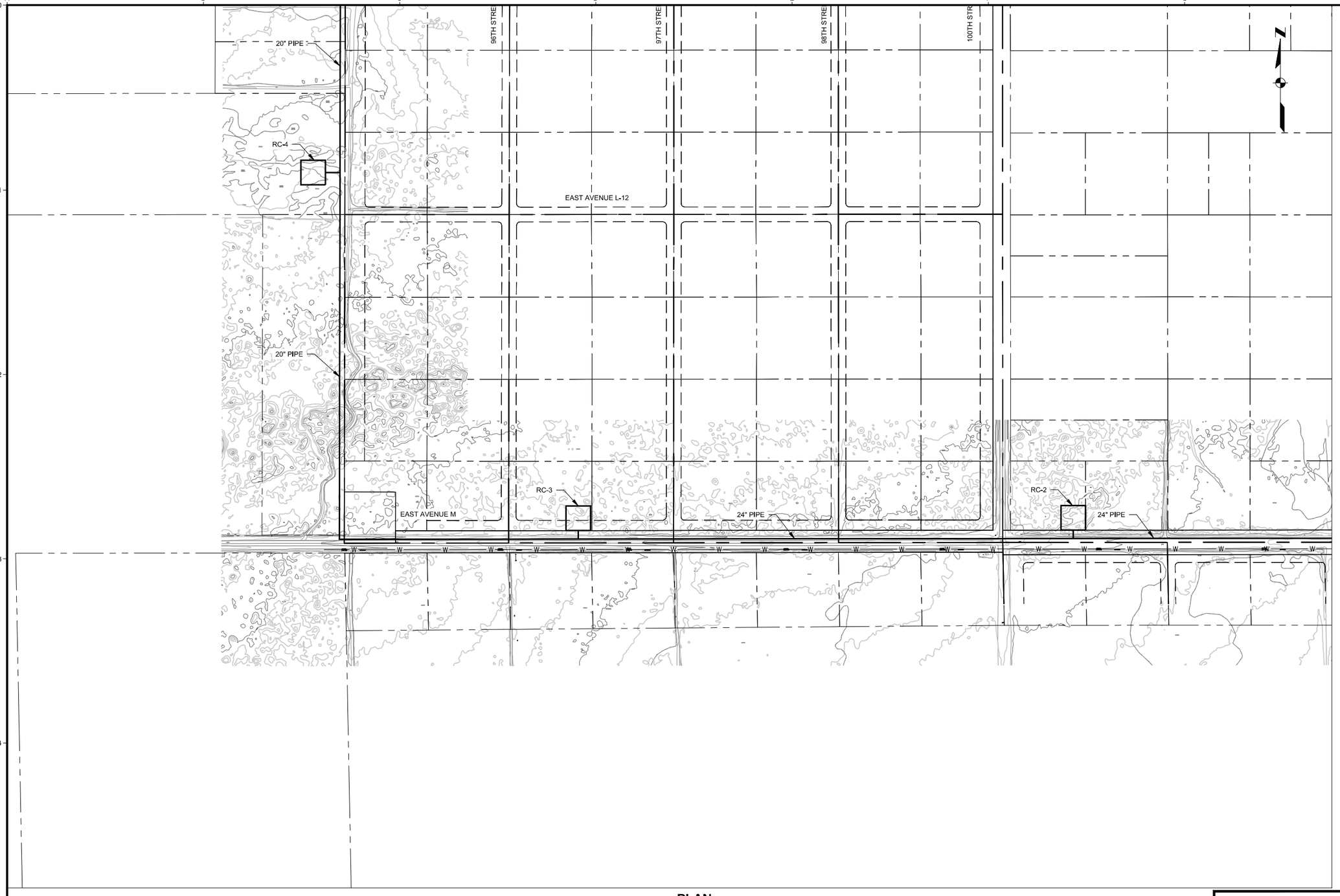

NOTES:

1.

0 100 200 300
1"=200'

PLAN
SCALE: 1" = 200'

PRELIMINARY - NOT FOR CONSTRUCTION

USE OF DOCUMENTS

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
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REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED TMW
DRAWN GBB
CHECKED PST

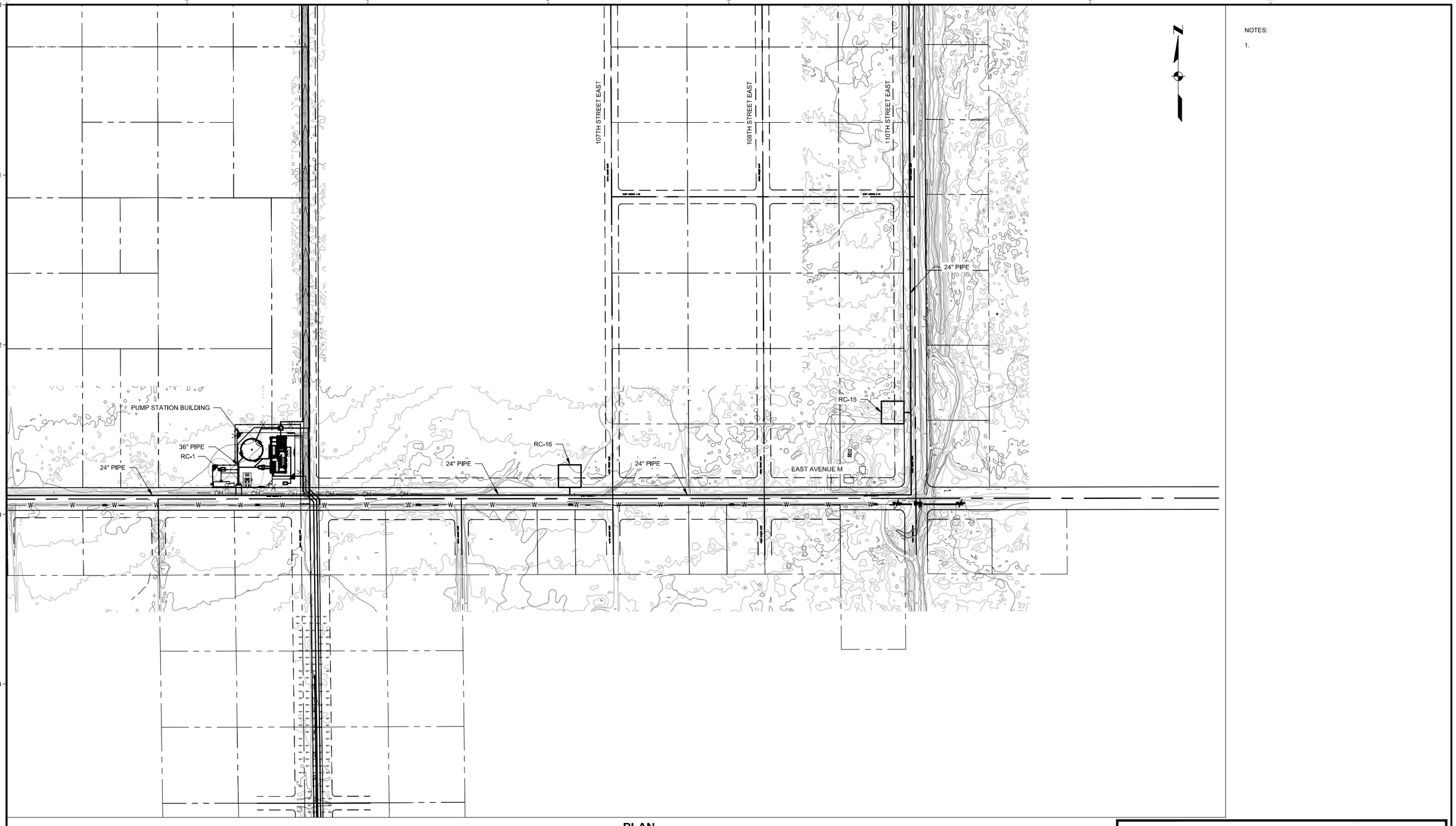
PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

WELL COLLECTION PIPELINE
PLAN 5

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: C39 OF -

11/6/2015 2:54 PM BRYANT BEHNKE
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\134450501c39.dwg



NOTES:

1.

0 20 40 60
1"=40'

PLAN
SCALE: 1" = 40'

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NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED TMW
DRAWN GBB
CHECKED PST

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

WELL COLLECTION PIPELINE
PLAN 6

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: C40 OF -

11/6/2015 2:57 PM BRYANT BEHNKE
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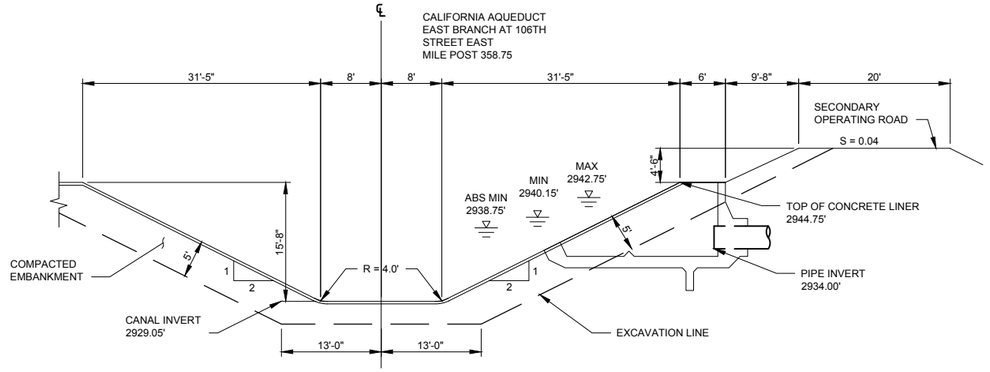
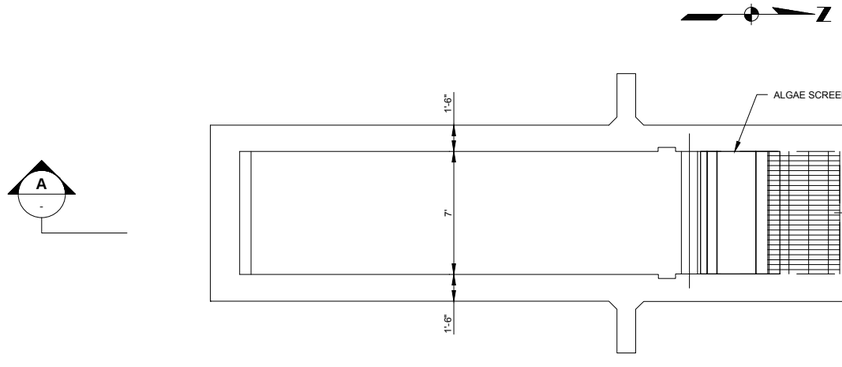


0 10 20
1"=10'

TYPICAL PARTIAL AQUEDUCT SECTION

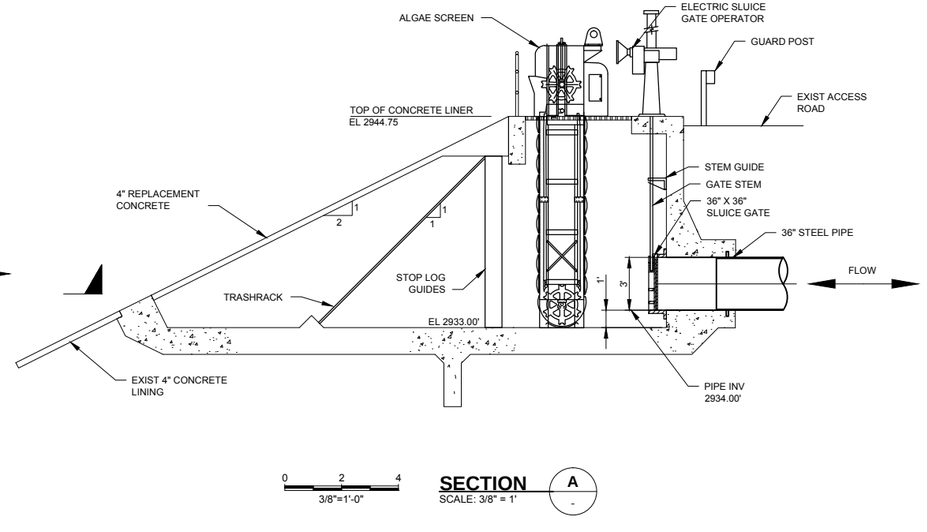
SCALE: 1" = 10'



0 2 4
3/8"=1'-0"

PLAN

SCALE: 3/8" = 1'



0 2 4
3/8"=1'-0"

SECTION A

SCALE: 3/8" = 1'

SWP TURNOUT PLAN AND SECTION

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
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REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED BCH
DRAWN HCS
CHECKED JFC

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

SWP TURNOUT SECTIONS & DETAILS

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: C41 OF -

BRYANT BEHNKE 11/6/2015 2:57 PM
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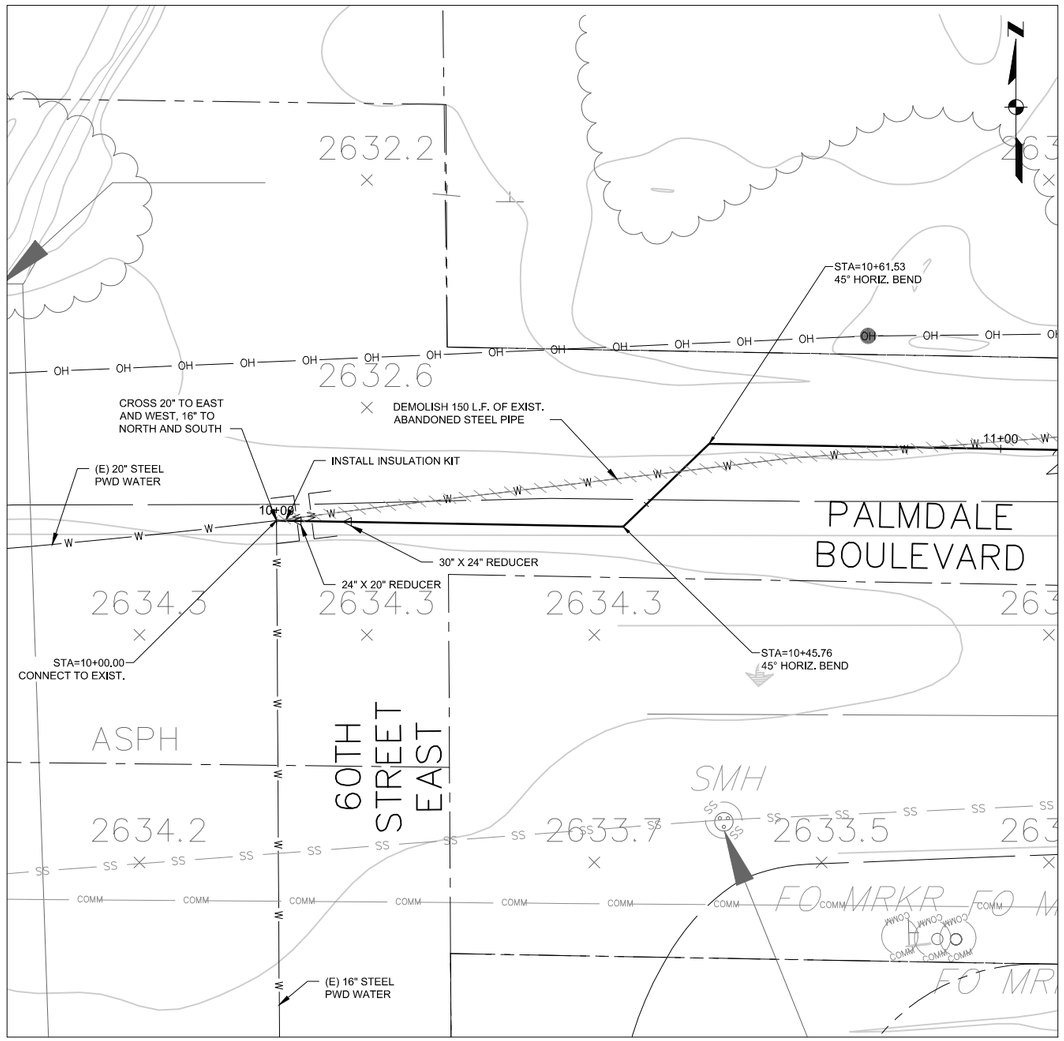
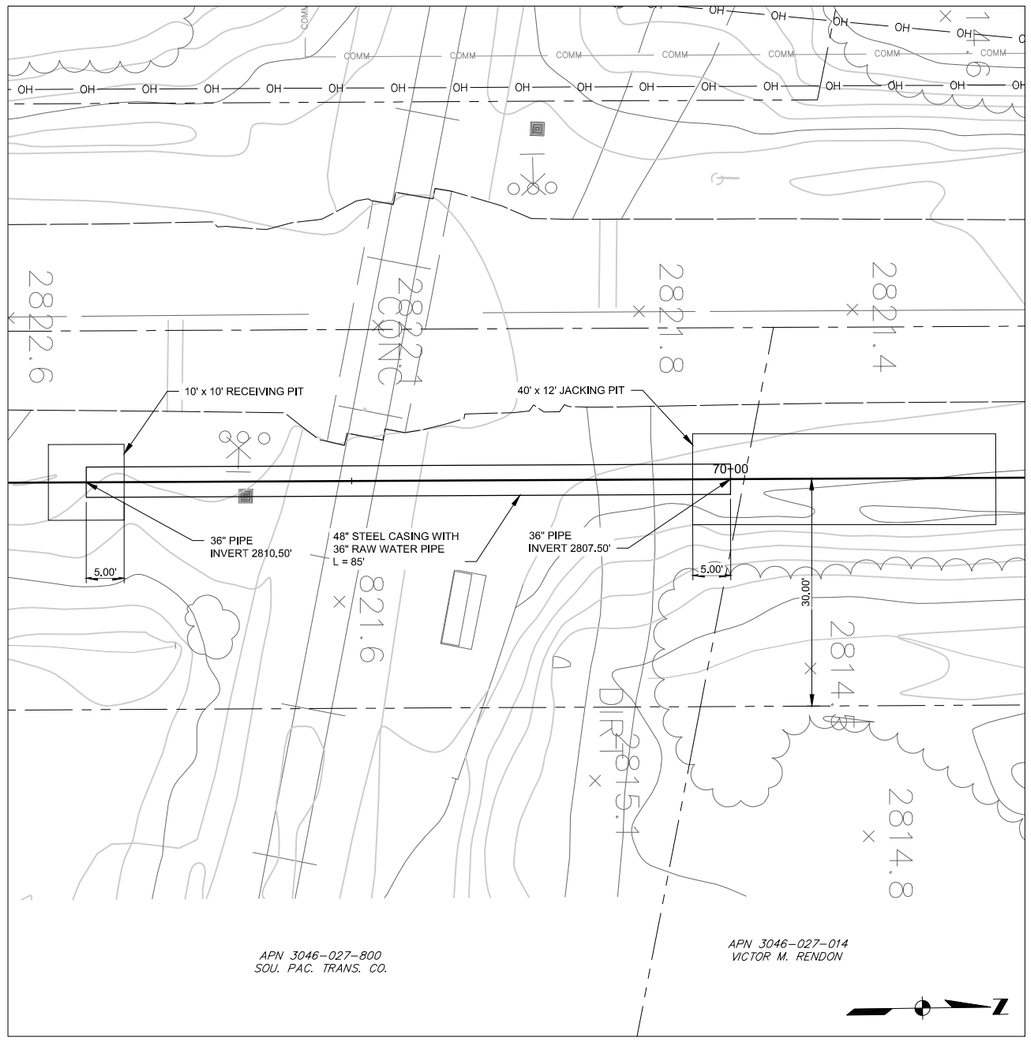
NOTES:

1.





0 10 20
1"=10'

PWD POINT OF DISTRIBUTION SYSTEM CONNECTION — 1

SCALE: 1" = 10'

0 10 20
1"=10'

RAILROAD CROSSING PLAN — 2

SCALE: 1" = 10'

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NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

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REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED BCH

DRAWN HCS

CHECKED JFC

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

PIPELINE ENLARGED PLANS

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: C42 OF -

BRYANT BEHNKE 11/6/2015 2:59 PM

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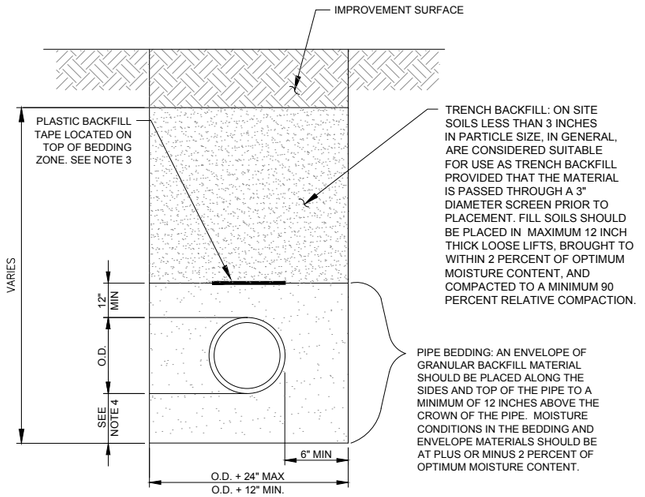


SAFETY RESPONSIBILITIES

1) THE CONTRACTOR SHALL SELECT, INSTALL AND MAINTAIN SHEETING, SHORING, BRACING, AND SLOPING AS NECESSARY TO MAINTAIN SAFE EXCAVATIONS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ENSURING ALL SAFETY MEASURES ARE HEEDED INCLUDING BUT NOT LIMITED TO THE FOLLOWING:

2) COMPLY FULLY WITH 29 CFR PART 1926 OSHA SUBPART P FOR EXCAVATION AND TRENCHING REQUIREMENTS.

3) PROVIDE SAFE ACCESS FOR THE AGENCY/ENGINEER SAMPLING AND TESTING WITHIN THE EXCAVATION.

4) PROVIDE SAFE ACCESS FOR BACKFILL, COMPACTION, AND COMPACTION TESTING.

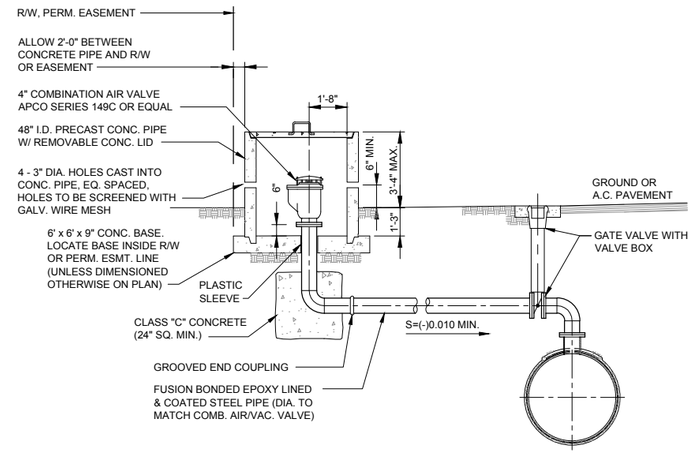
5) MAINTAIN EXCAVATIONS IN A SAFE MANNER THAT SHALL NOT ENDANGER PROPERTY, LIFE, OR HEALTH. ALL EARTH WORK SHALL BE PERFORMED IN STRICT ACCORDANCE WITH APPLICABLE LAW, INCLUDING LOCAL ORDINANCES, APPLICABLE OSHA, CAL/OSHA, CALIFORNIA CIVIL CODE, AND CALIFORNIA DEPARTMENT OF INDUSTRIAL SAFETY REQUIREMENTS.

NOTES:

1. BACKFILL SHALL BE MECHANICALLY CONSOLIDATED AND SHOVEL SLICED UNDER THE HAUNCHES OF THE PIPE.
2. IN ROCKY OR UNYIELDING SOIL, THE TRENCH SHALL BE EXCAVATED A MINIMUM OF 12" BELOW THE PIPE AND THE TRENCH WIDTH SHALL BE INCREASED BY 12".
3. ONE 12" STRIP OF BACKFILL TAPE SHALL BE USED FOR ALL PIPES.
4. FOR 12" DIAMETER AND SMALLER PIPE, USE 6" DEPTH. FOR LARGER DIAMETER PIPE, USE 10" DEPTH.

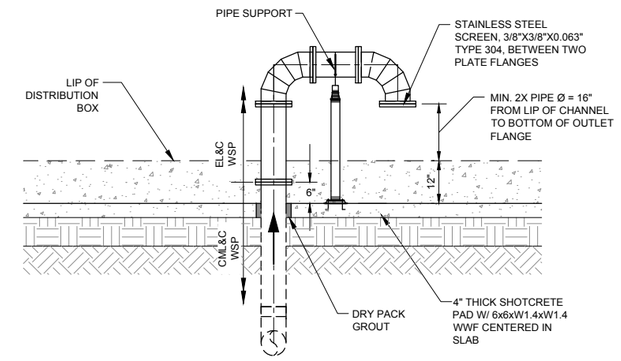
PIPE TRENCH DETAIL — 1

NOT TO SCALE



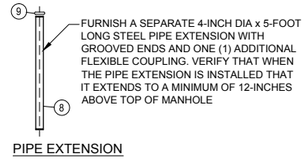
4" AIR VACUUM/AIR RELEASE VALVE — 2

NOT TO SCALE

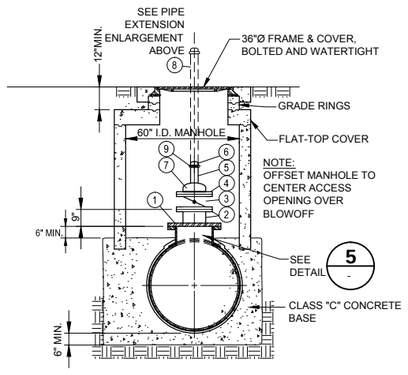


AIR GAP DETAIL — 3

NOT TO SCALE



PIPE EXTENSION



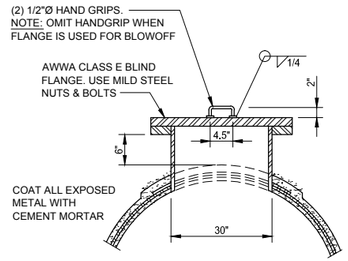
MATERIALS LIST

1. 30-INCH FLANGE WITH 12" FLANGED OUTLET
2. 12-INCH STEEL PIPE WITH FLANGE
3. 12-INCH FLANGED BUTTERFLY VALVE, HANDWHEEL OPERATED
4. 12-INCH SLIP ON FLANGE
5. 4-INCH STEEL PIPE NIPPLE WITH GROOVED END
6. 4-INCH GROOVED COUPLING & CAP
7. 12-INCH CAP W/ 4" OUTLET
8. 4-INCH DIA STEEL PIPE WITH GROOVED ENDS (DELIVER TO AGENCY)
9. GROOVED COUPLING, SIZE TO MATCH PIPE (DELIVER TO AGENCY)

NOTE:
ITEMS 1 THRU 9 SHALL BE FUSION BONDED EPOXY LINED AND COATED

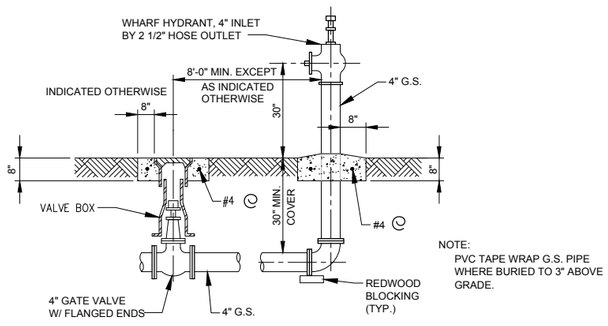
ACCESS MANHOLE W/ BLOW-OFF ASSEMBLY DETAIL — 4

NOT TO SCALE



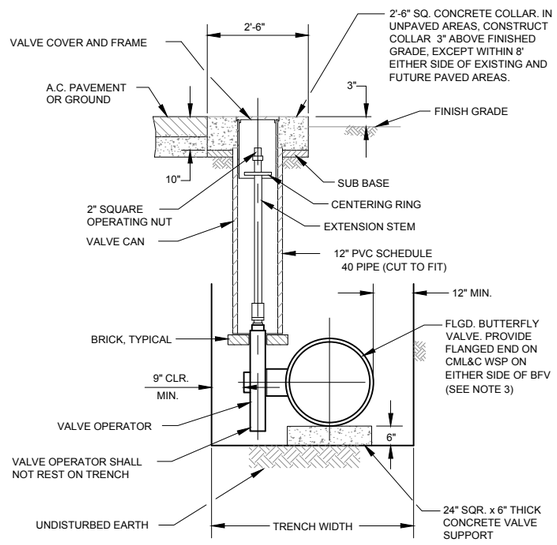
30" ACCESS MANHOLE — 5

NOT TO SCALE



WHARF TYPE FIRE HYDRANT DETAIL — 6

NOT TO SCALE



NOTE:
1. INSTALL VALVE BOX AND RISER.
2. WRAP BURIED VALVES AND FITTINGS WITH POLYETHYLENE SHEET ENCASEMENT.

BURIED BUTTERFLY VALVE OPERATOR DETAIL — 7

NOT TO SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
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REGISTERED PROFESSIONAL ENGINEER — DAVID W. FERGUSON — No. CE 34626 Exp. 09/30/17 — STATE OF CALIFORNIA

DESIGNED BCH
DRAWN HCS
CHECKED JFC

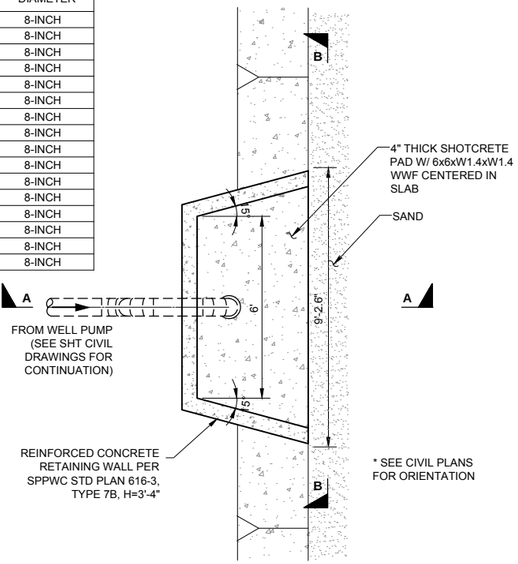
PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT
Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

PIPELINE DETAILS

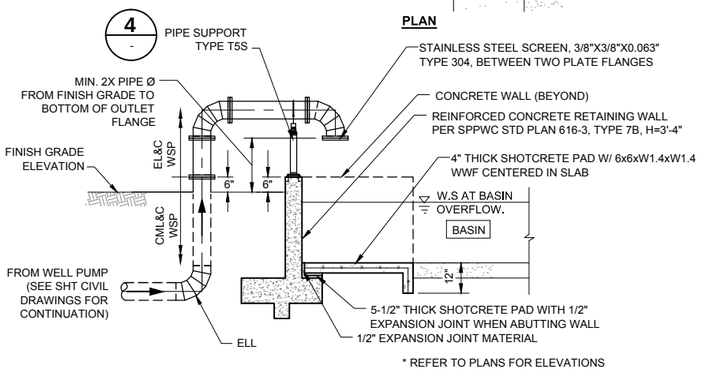
FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET C43 OF -

L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\1344505001c43.dwg
BRYANT BEHNKE 11/6/2015 2:59 PM

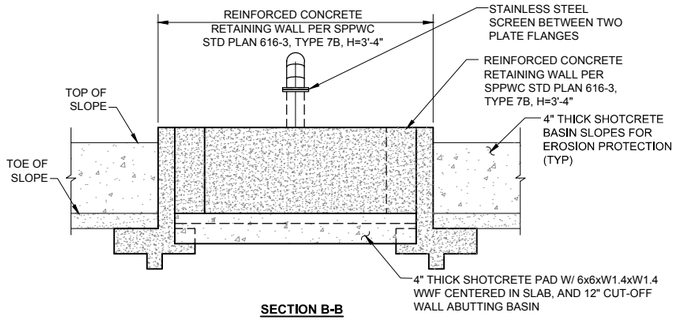
EXTRACTION WELL NO.	CIVIL SITE PLAN SHEET	PIPE TO WASTE DIAMETER
RC-1	C39	8-INCH
RC-2	C38	8-INCH
RC-3	C38	8-INCH
RC-4	C38	8-INCH
RC-5	C36	8-INCH
RC-6	C36	8-INCH
RC-7	C34	8-INCH
RC-8	C34	8-INCH
RC-9	C35	8-INCH
RC-10	C35	8-INCH
RC-11	C35	8-INCH
RC-12	C35	8-INCH
RC-13	C37	8-INCH
RC-14	C37	8-INCH
RC-15	C39	8-INCH
RC-16	C39	8-INCH



PLAN



SECTION A-A

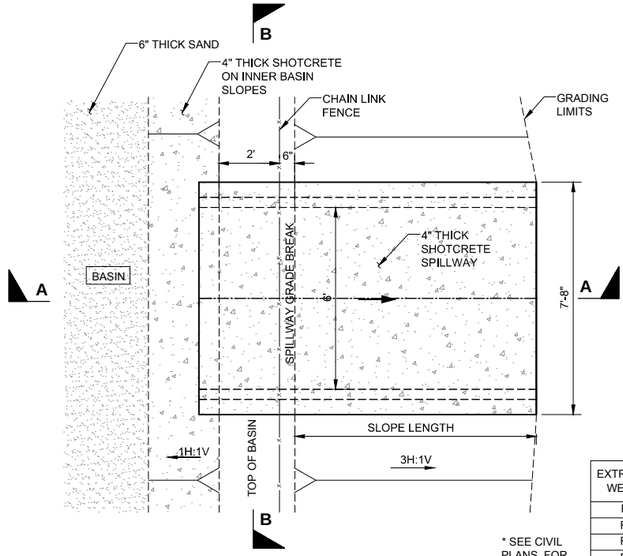


SECTION B-B

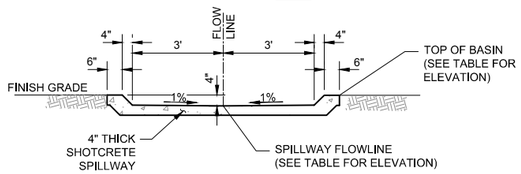
TYPICAL AIR-GAP OUTFALL DETAIL 1

0 1

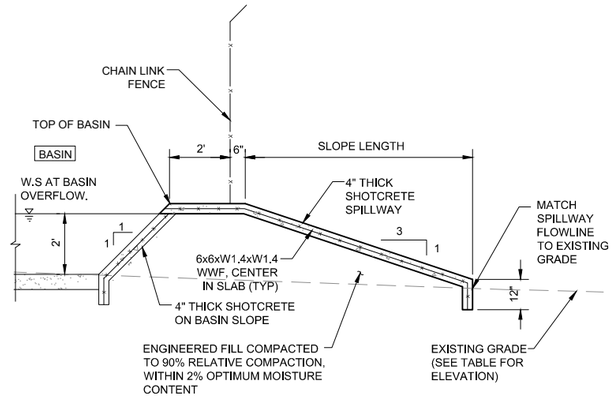
3/8"=1'-0"



PLAN



SECTION B-B



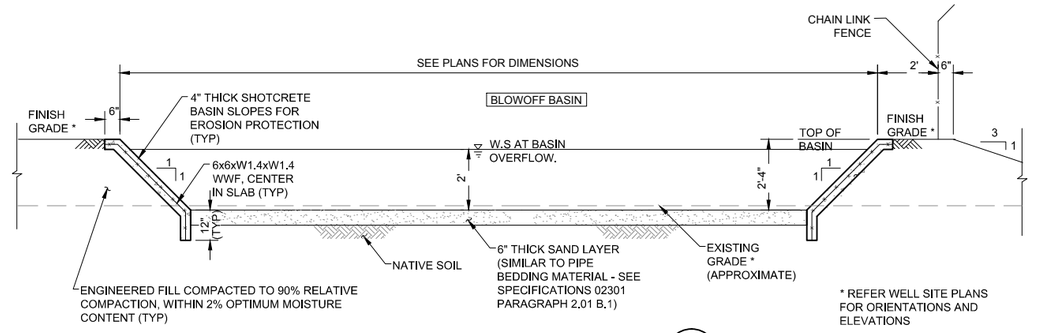
SECTION A-A

EXTRACTION WELL NO.	CIVIL SITE PLAN SHEET	TOP OF BASIN ELEVATION	SPILLWAY FLOWLINE ELEVATION	EXISTING GRADE ELEVATION	SLOPE LENGTH
RC-1	C39	2551.00	2550.67		
RC-2	C38	2549.00	2548.67		
RC-3	C38	2541.00	2540.67		
RC-4	C38	2529.70	2529.37		
RC-5	C36	2521.50	2521.17		
RC-6	C36	2510.50	2510.17		
RC-7	C34	2498.00	2497.67		
RC-8	C34	2500.50	2500.17		
RC-9	C35	2505.00	2504.67		
RC-10	C35	2507.60	2507.27		
RC-11	C35	2507.80	2507.47		
RC-12	C35	2518.00	2517.67		
RC-13	C37	2530.70	2530.37		
RC-14	C37	2540.50	2540.17		
RC-15	C39	2553.50	2553.17		
RC-16	C39	2552.00	2551.67		

TYPICAL SPILLWAY DETAIL 2

0 1

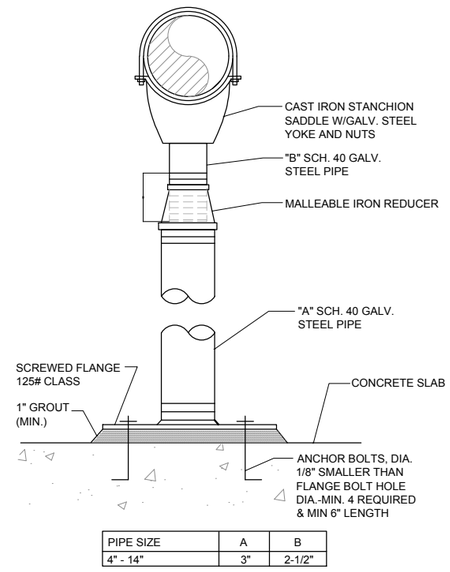
3/8"=1'-0"



TYPICAL BASIN SECTION DETAIL 3

0 1

3/8"=1'-0"



PIPE SIZE	A	B
4" - 14"	3"	2-1/2"

TYPE 5 ADJUSTABLE SUPPORT (T5S) 4

N.T.S.

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NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER — DAVID W. FERGUSON — No. CE 34626 Exp. 09/30/17 — STATE OF CALIFORNIA

DESIGNED	TMW
DRAWN	GBB
CHECKED	PST

PALMDALE WATER DISTRICT
PALMDALE, CA

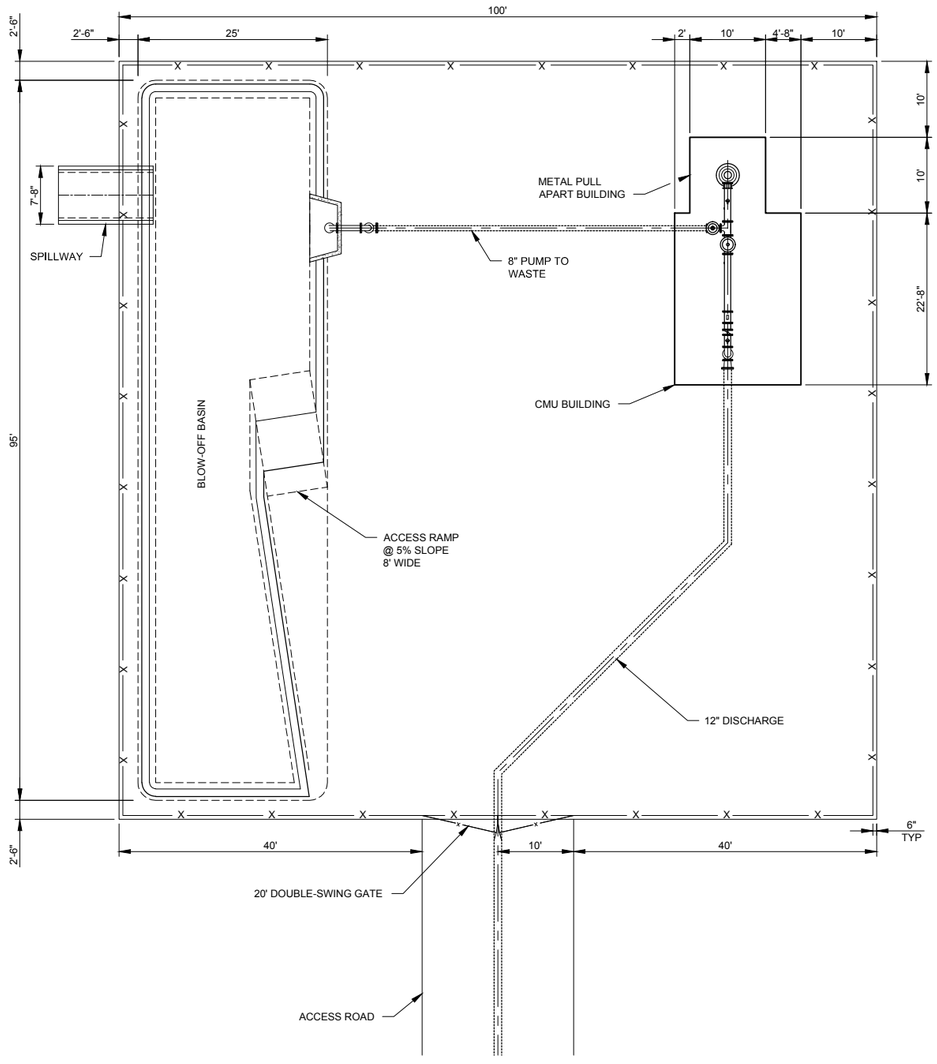
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

RECOVERY WELL DETAILS

FILE NAME	134450501c44.dwg
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	C44
OF	-

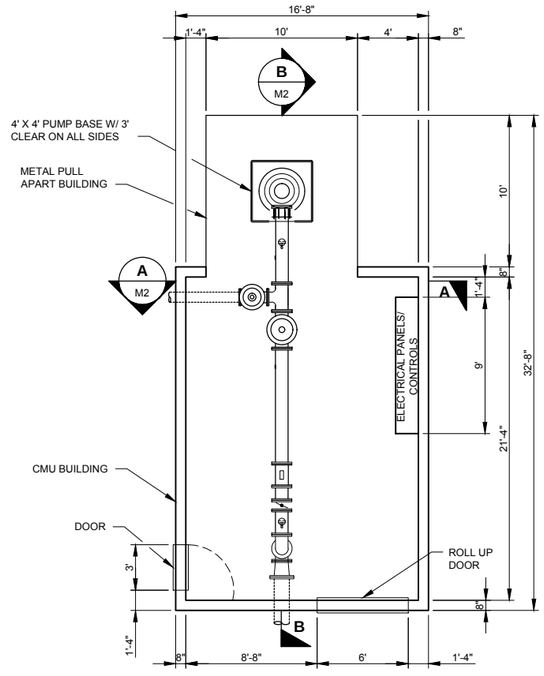
L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\134450501c44.dwg 11/6/2015 2:59 PM BRYANT BEHNKE



0 10 20
1"=10'

RECOVERY WELL SITE PLAN (TYP.)

SCALE: 1" = 10'



0 5 10
1"=5'

RECOVERY WELL BUILDING PLAN (TYP.)

SCALE: 1" = 5'

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

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DESIGNED TMW

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PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

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RECOVERY WELL PLAN, TYPICAL

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: M1 OF -

BRYANT BEHNKE 11/6/2015 2:59 PM

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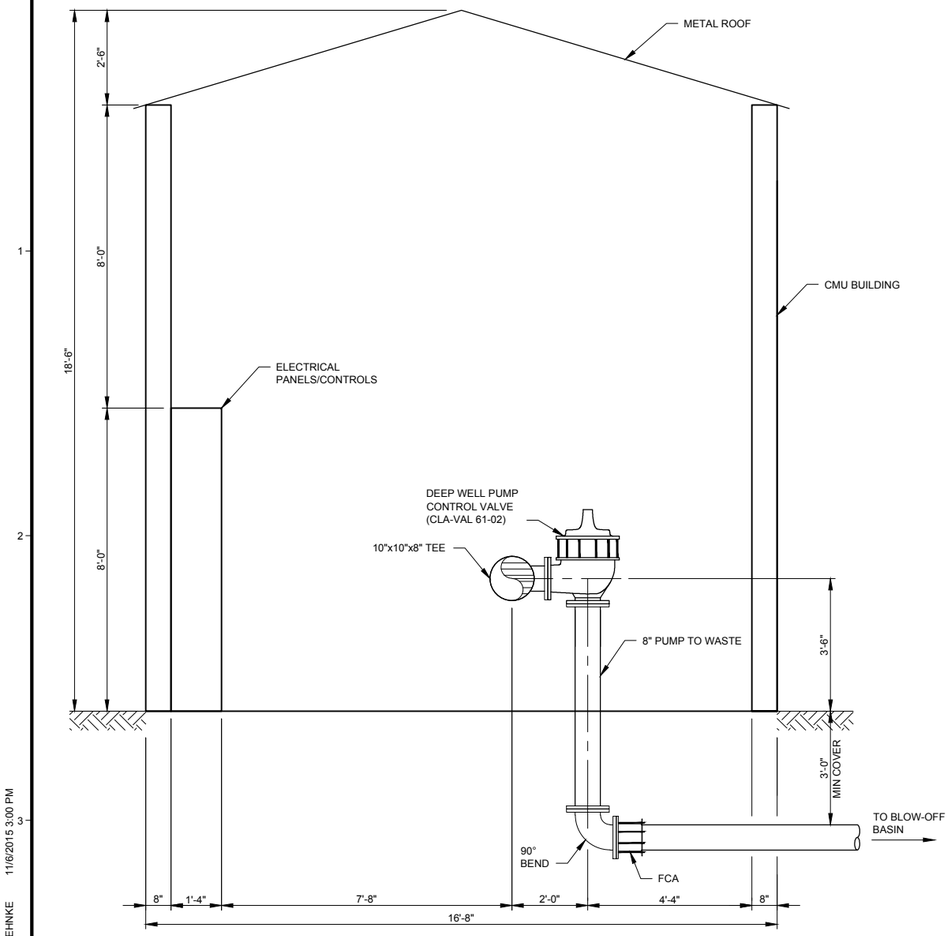


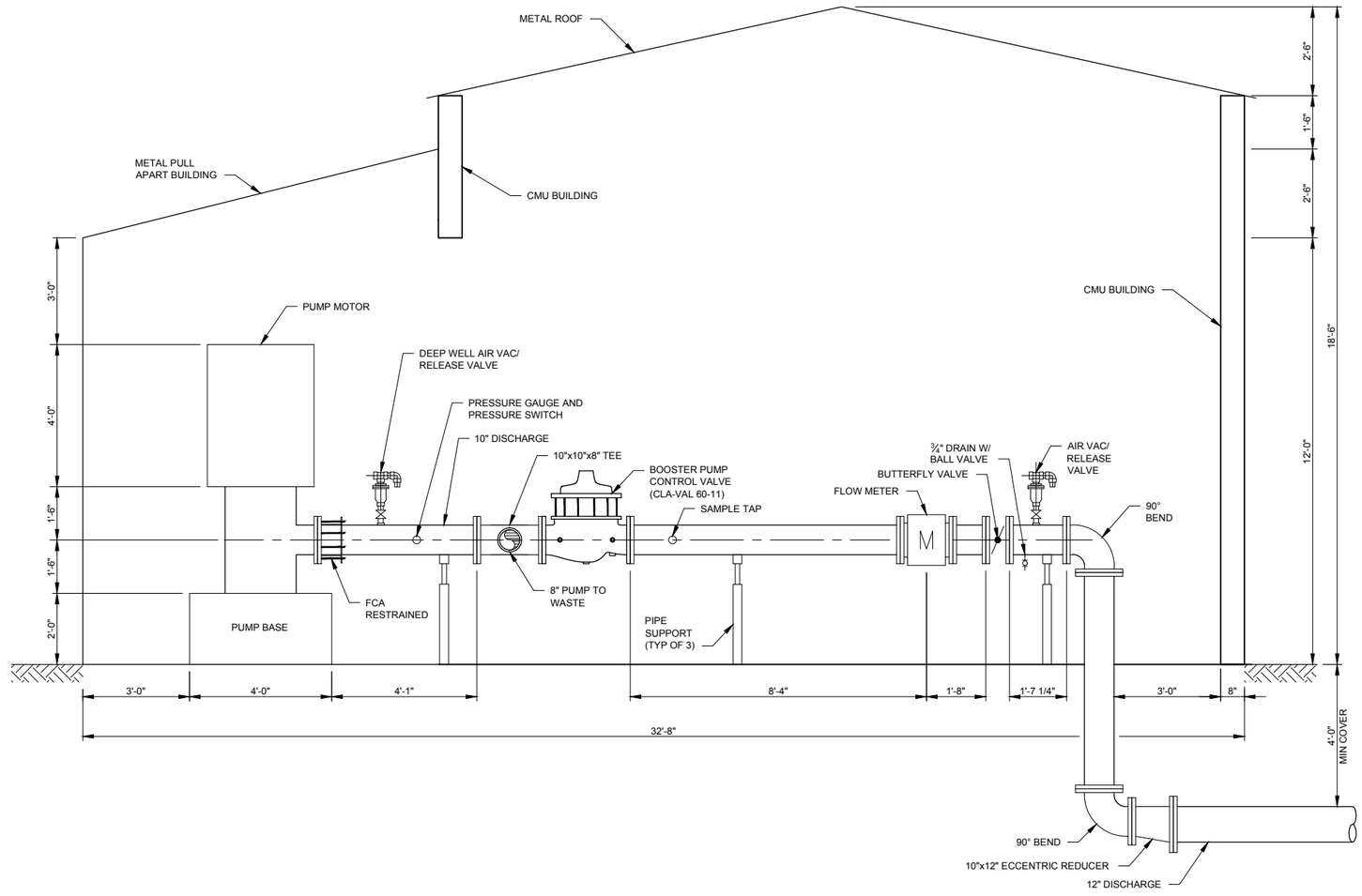
RECOVERY WELL BUILDING SECTION A

SCALE: 1/2" = 1'

M1

0 1 2 3

1/2"=1'-0"



RECOVERY WELL BUILDING SECTION B

SCALE: 1/2" = 1'

M1

0 1 2 3

1/2"=1'-0"

NOTE:

1. THE 10'x12' SECTION BETWEEN THE METAL PULL APART BUILDING AND CMU BUILDING IS OPEN TO CREATE ONE ROOM.

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

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DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED	TMW
DRAWN	BMB
CHECKED	PST

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RECOVERY WELL SECTION, TYPICAL

FILE NAME	FILE NAME
JOB NO.	1344505.01
DATE	NOVEMBER 2015
SHEET	M2
OF	-

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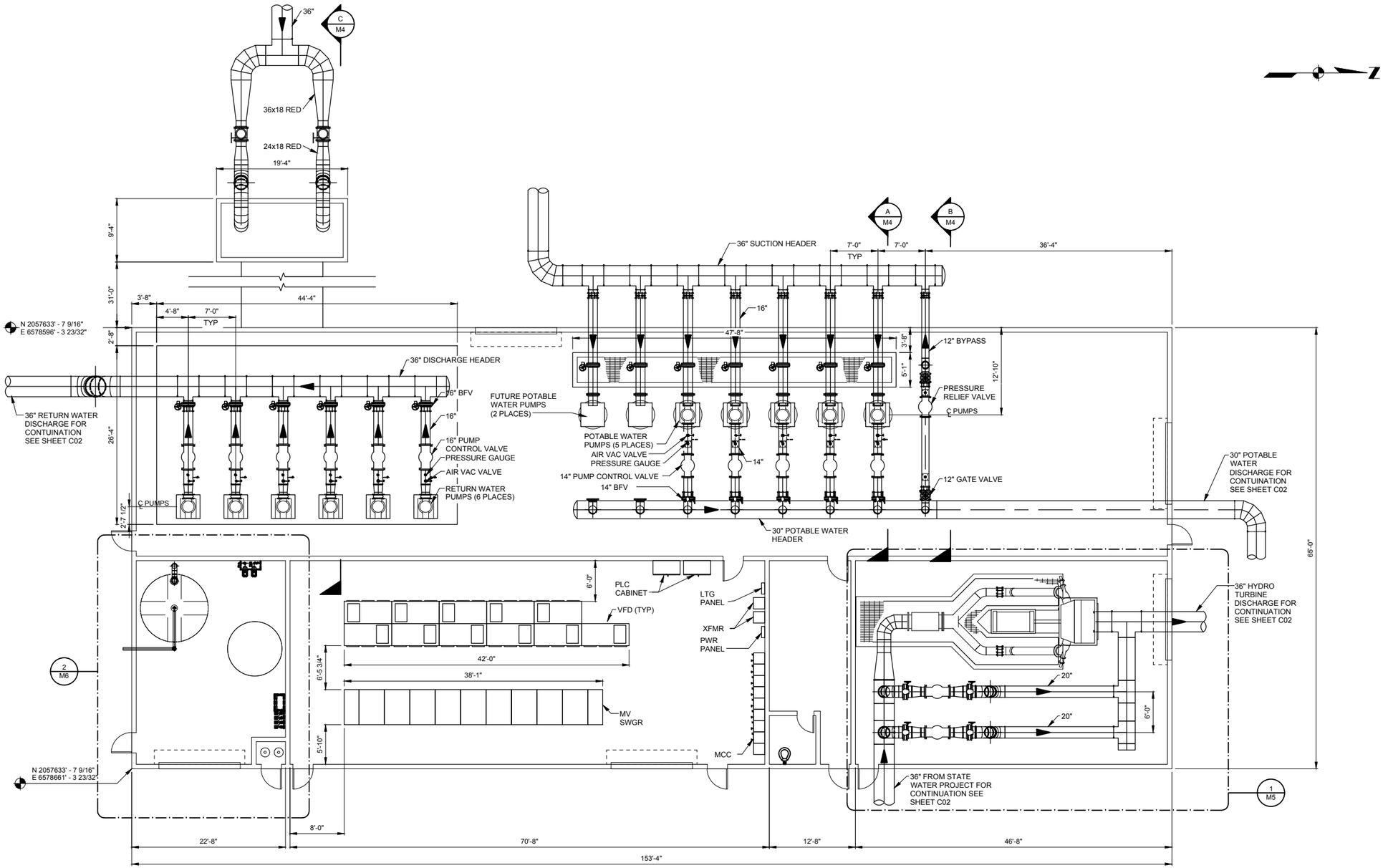

PUMP STATION PLAN

SCALE: 1/8" = 1'-0"

1 / M4

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES

0 —— 1"

0 —— 25mm

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DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED ALM

DRAWN D.McCLUNG

CHECKED DWF

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PALMDALE, CA

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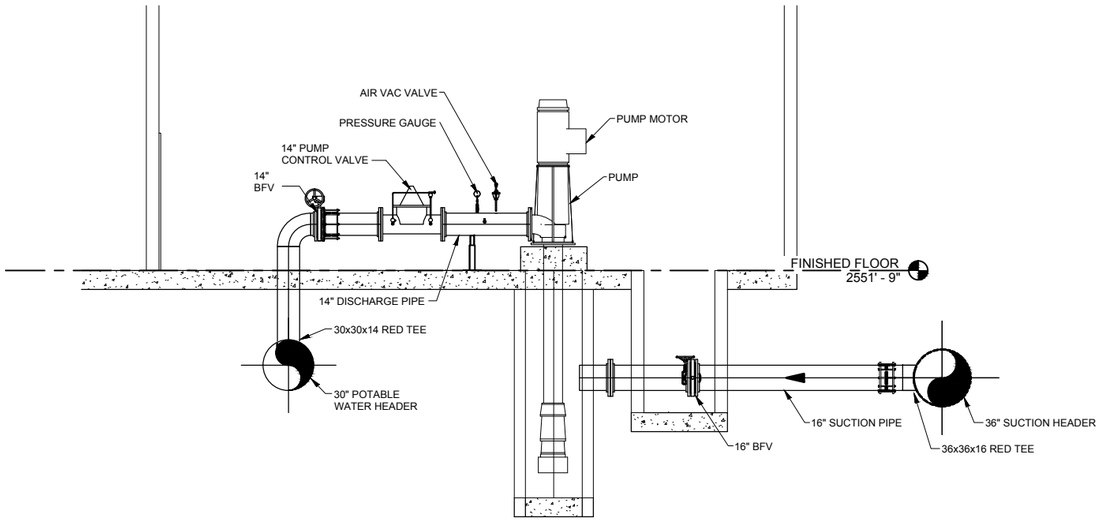
PUMP STATION PLAN

FILE NAME

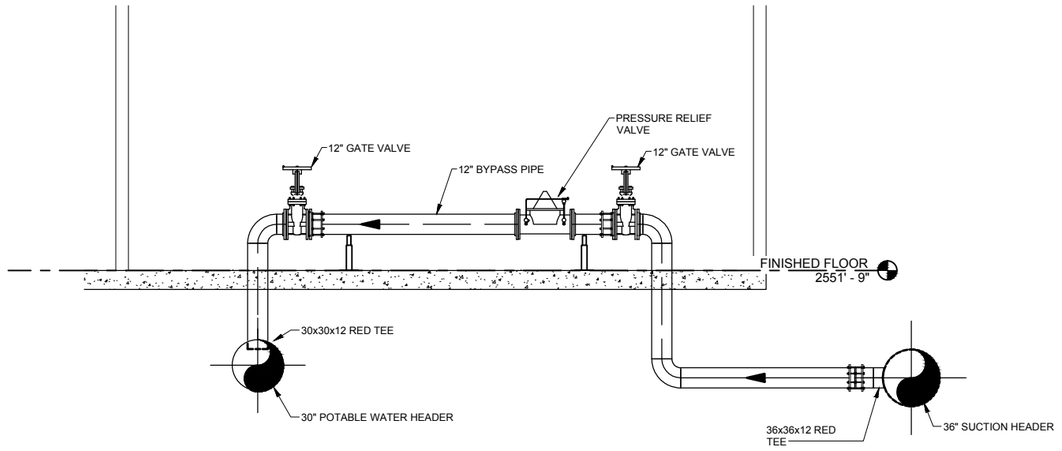
JOB NO. 13445051*01

DATE SEPTEMBER 2015

SHEET M3 OF



POTABLE WATER PUMP SECTION (A, M3)
SCALE: 1/4" = 1'-0"



POTABLE WATER BYPASS SECTION (B, M3)
SCALE: 1/4" = 1'-0"

RETURN WATER PUMP STATION (C, M3)
SCALE: 1/4" = 1'-0"

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NO.	REVISION	DATE	BY

SCALES
0 ——— 1"
0 ——— 25mm
IF THIS BAR IS NOT DIMENSIONS SHOWN, ADJUST SCALES ACCORDINGLY

REGISTERED PROFESSIONAL ENGINEER DAVID W. FERGUSON No. CE 34626 Exp. 09/30/17 STATE OF CALIFORNIA

DESIGNED	ALM
DRAWN	D.McCLUNG
CHECKED	DWF

PALMDALE WATER DISTRICT
PALMDALE, CA
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT
Kennedy/Jenks Consultants
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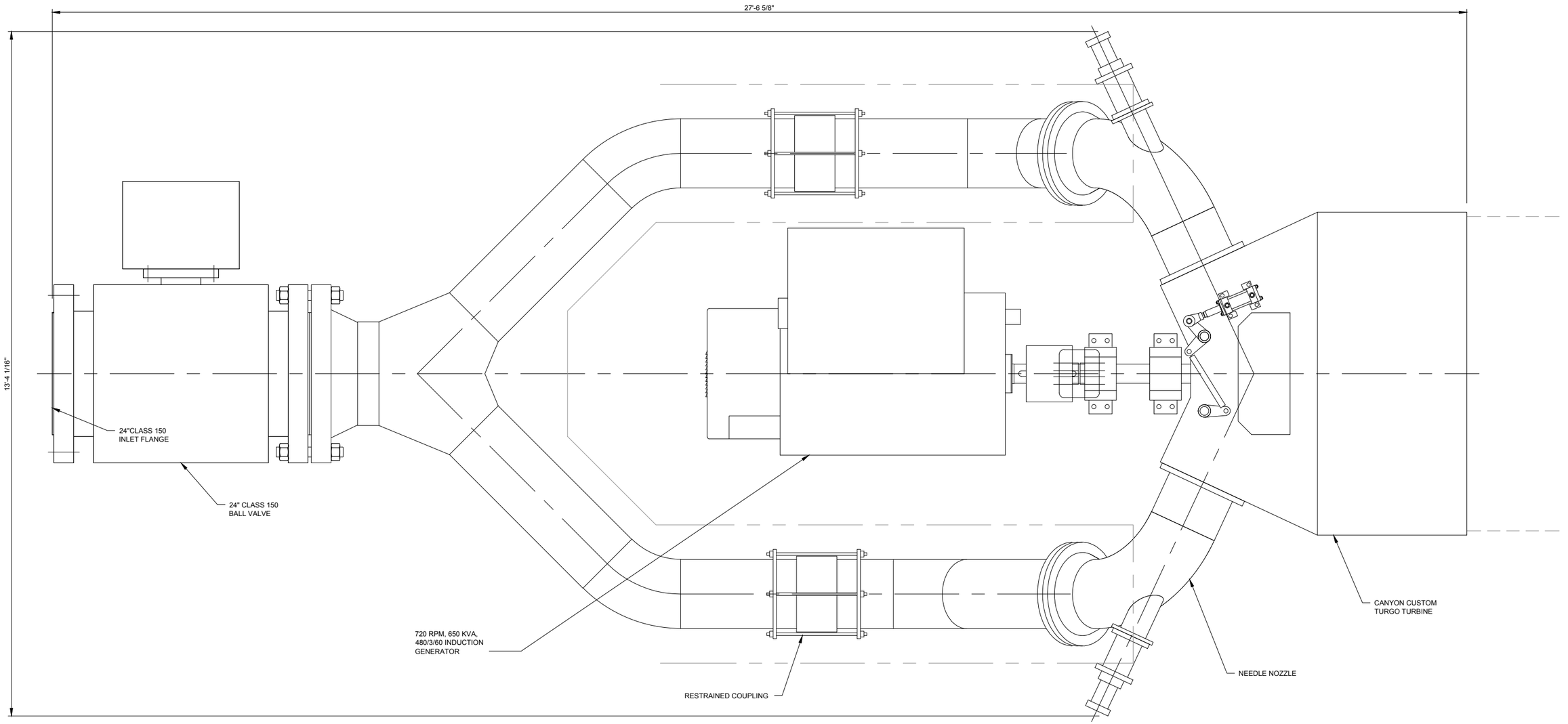
PUMP STATION SECTION

FILE NAME	
JOB NO.	13445051*01
DATE	SEPTEMBER 2015
SHEET	OF
	M4



0 20 40 60
1"=40'

HYDRO-TURBINE PLAN
SCALE: 1" = 1'

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SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
DAVID W. FERGUSON
No. CE 34626
Exp. 09/30/17
STATE OF CALIFORNIA

DESIGNED MJR
DRAWN BMB
CHECKED PST

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PALMDALE, CA
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HYDRO-TURBINE PLAN

FILE NAME: FILE NAME
JOB NO.: 1344505.01
DATE: NOVEMBER 2015
SHEET: **M5** OF -

BRYANT BEHNKE 11/6/2015 3:00 PM
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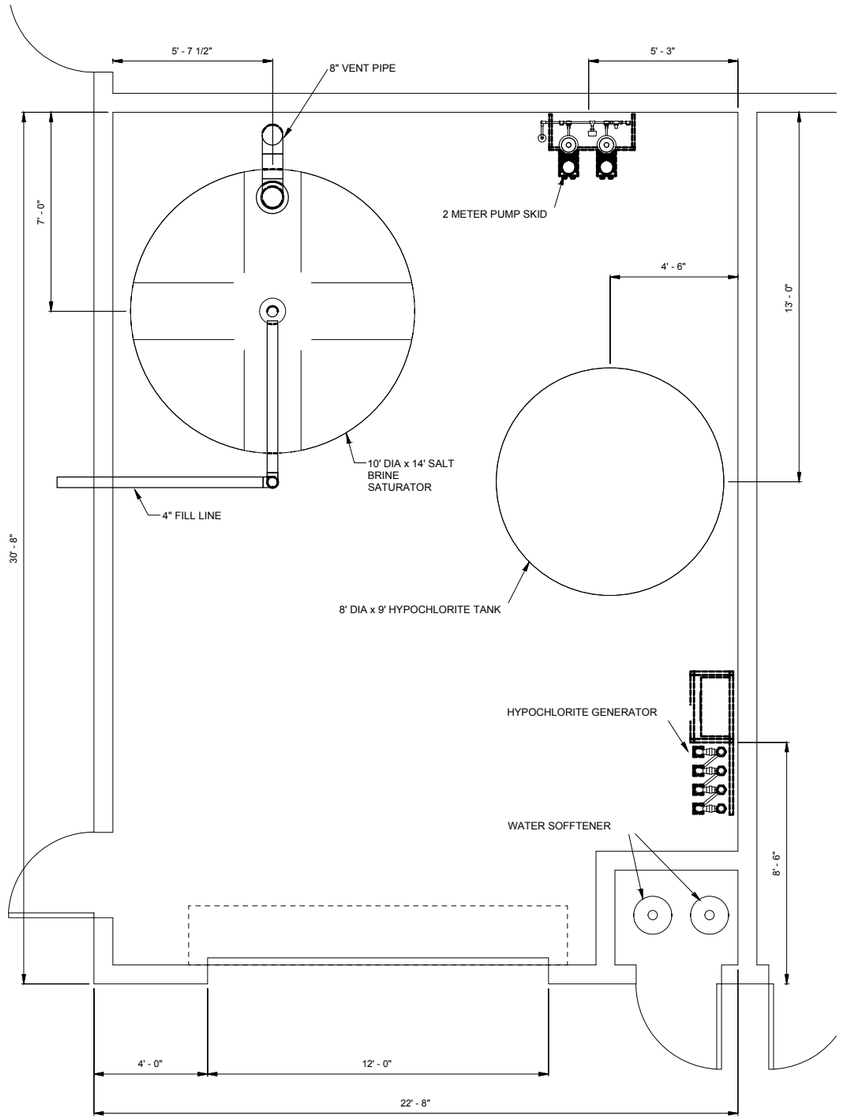

CHLORINATION ROOM PLAN (2 / M3)
SCALE: 3/8" = 1'-0"

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NO.	REVISION	DATE	BY

SCALES
0 1"
0 25mm
IF THIS BAR IS NOT DIMENSIONS SHOWN, ADJUST SCALES ACCORDINGLY

REGISTERED PROFESSIONAL ENGINEER DAVID W. FERGUSON No. CE 34626 Exp. 09/30/17 STATE OF CALIFORNIA

DESIGNED ALM
DRAWN DWM
CHECKED DWF

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PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

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CLORINATION ROOM PLAN

FILE NAME
JOB NO. 13445051*01
DATE SEPTEMBER 2015
SHEET M6 OF

ABBREVIATIONS

a	CIRCUIT BREAKER AUX. CONTACT, CLOSED WHEN BREAKER IS CLOSED
A	AMMETER, AMPERES
AC	ALTERNATING CURRENT
A/D	ANALOG TO DIGITAL
ADJ	ADJUSTABLE
AF	AMPERE FRAME
AFD	ADJUSTABLE FREQUENCY DRIVE
AFF	ABOVE FINISHED FLOOR
AIC	AMPERES INTERRUPTING CAPACITY
AL	ALUMINUM
ALT	ALTERNATOR
A/M	AUTO/MANUAL CONTROLLER
ANN	ANNUNCIATOR
APPROX	APPROXIMATE
AS	AMMETER SWITCH
AT	AMMETER TRIP
ATS	AUTOMATIC TRANSFER SWITCH
AUTO	AUTOMATIC
AUX	AUXILIARY
AWG	AMERICAN WIRE GAGE
b	CIRCUIT BREAKER AUX. CONTACT, CLOSED WHEN BREAKER IS OPEN
BCG	BARE COPPER GROUND
BLDG	BUILDING
C	CONDUIT, CONTACTOR
CAB	CABINET
CAP	CAPACITOR
CB	CIRCUIT BREAKER
CC	CONTROL CABLE, CLOSING COIL
CHH	COMMUNICATION HANDHOLE
CL	CHLORINE
CKT	CIRCUIT
CMH	COMMUNICATION MANHOLE
CO	CONDUIT ONLY
COMM	COMMUNICATION
COND	CONDUCTOR
CONT	CONTINUED, CONTINUATION
CPT	CONTROL POWER TRANSFORMER
CP	CONTROL PANEL
CR	CONTROL RELAY
CS	CONTROL SWITCH
CT	CURRENT TRANSFORMER
CWP	COLD WATER PIPE
DC	DIRECT CURRENT
DIA	DIAMETER
DIAG	DIAGRAM
DISC	DISCONNECT
DISTR	DISTRIBUTION
DN	DOWN
DP	DISTRIBUTION PANEL
DPDT	DOUBLE POLE, DOUBLE THROW
DPST	DOUBLE POLE, SINGLE THROW
DWG	DRAWING
(E)	EXISTING
EA	EACH
EF	EXHAUST FAN
EHH	ELECTRICAL HANDHOLE
EL, ELEV	ELEVATION
ELEC	ELECTRIC, ELECTRICAL
ELEM	ELEMENTARY
EMERG	EMERGENCY
ENCL	ENCLOSURE
EFFL	EFFLUENT
EQ	EQUAL
EQPT	EQUIPMENT
ETM	ELAPSED TIME METER
FACP	FIRE ALARM CONTROL PANEL
FDR	FEEDER
FF	FINISHED FLOOR
FLEX	FLEXIBLE
FLUOR	FLUORESCENT
FO	FIBER OPTIC
FREQ	FREQUENCY
FT	FEET, FOOT
FU	FUSE
(F)	FUTURE
FVNR	FULL VOLTAGE, NON REVERSING
FVR	FULL VOLTAGE, REVERSING
FWD	FORWARD
GA	GAUGE
GALV	GALVANIZED
GEN	GENERATOR
GFI	GROUND FAULT INTERRUPTER
GND	GROUND
GRS	GALVANIZED RIGID STEEL
H_2O_2	HYDROGEN PEROXIDE
HH	HANDHOLE
HMI	HUMAN MACHINE INTERFACE
HOA	HAND-OFF-AUTOMATIC
HOR	HAND-OFF-REMOTE
HORIZ	HORIZONTAL
HP	HORSEPOWER
HPS	HIGH PRESSURE SODIUM
HTR	HEATER
HV	HIGH VOLTAGE
HZ	HERTZ (CYCLES PER SECOND)
IND LT	INDICATING LIGHT
INCAND	INCANDESCENT
INSTR	INSTRUMENT, INSTRUMENTATION
I/O	INPUT/OUTPUT
JB	JUNCTION BOX
KA	KILOAMPERES
KCMIL	THOUSANDS OF CIRCULAR MILS
KV	KILOVOLTS
KVA	KILOVOLT AMPERES
KVAR	KILOVOLT AMPERES REACTIVE
KVARH	KILOVOLT AMPERES REACTIVE HOURS
KW	KILOWATTS
KWH	KILOWATT HOURS
LCP	LIGHTING CONTROL PANEL
LP	LIGHTING PANEL
LPS	LOW PRESSURE SODIUM
LTG	LIGHTING
LT(S)	LIGHT(S)
(M)	MODIFIED
mA	MILLIAMPERES
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MCP	MOTOR CIRCUIT PROTECTOR
MFR	MANUFACTURER
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
MOV	MOTOR OPERATED VALVE
MS	MOTOR STARTER
MTD	MOUNTED
MTG	MOUNTING
MV	MEDIUM VOLTAGE
(N)	NEW
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURER'S ASSOC.
NEUT	NEUTRAL
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN, NUMBER
NTS	NOT TO SCALE
OH	OVERHEAD
OT	OVER TEMPERATURE
OL	THERMAL OVERLOAD RELAY
PB	PULLBOX, PUSHBUTTON
PD	POSITIVE DISPLACEMENT
PE	PHOTOELECTRIC
PEC	PHOTOELECTRIC CELL
PF	POWER FACTOR
pH	MEASURE OF ACIDITY OR ALKALINITY
PH	PHASE
PLC	PROGRAMMABLE LOGIC CONTROLLER
PNL	PANEL
PNLBD	PANELBOARD
PRI	PRIMARY
PS	PRESSURE SWITCH
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
PWR	POWER
(RL)	RELOCATE
(RLD)	RELOCATED
RCPT	RECEPTACLE
RCT	REPEAT CYCLE TIMER
REQD	REQUIRED
RM	ROOM
RPM	REVOLUTIONS PER MINUTE
SCE	SOUTHERN CALIFORNIA EDISON
SCR	SILICON CONTROLLED RECTIFIER
SD	SMOKE DETECTOR
SEC	SECONDS, SECONDARY
SECT	SECTION
SF	SUPPLY FAN
SHH	SIGNAL HANDHOLE
SHT	SHEET
SIG	SIGNAL
SN	SOLID NEUTRAL
SPECS	SPECIFICATIONS
SPDT	SINGLE POLE, DOUBLE THROW
SS	STAINLESS STEEL, SOLID STATE
SW	SWITCH
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SYNC	SYNCHRONIZING
TB	TERMINAL BOX, TERMINAL BOARD
TC	TELEPHONE CABINET
TEL	TELEPHONE
TEMP	TEMPERATURE
TSP	TWISTED SHIELDED PAIR
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
TYP	TYPICAL
UG	UNDERGROUND
UH	UNIT HEATER
UV	ULTRA VIOLET
V	VOLTS
VA	VOLT-AMPERES
VCP	VENDOR CONTROL PANEL
VFD	VARIABLE FREQUENCY DRIVE
VAR	VOLT AMPERES REACTIVE
VERT	VERTICAL
VH	VAR-HOUR
VS	VOLTMETER SWITCH
W	WIRE, WATTS
WHM	WATTHOUR METER
WHDM	WATTHOUR DEMAND METER
WR	WEATHER RESISTANT
WT	WATERTIGHT
WTP	WATER TREATMENT PLANT
XFMR	TRANSFORMER

GENERAL NOTES:

G1. THESE DRAWINGS ARE DIAGRAMMATIC ONLY; EXACT LOCATIONS OF ELECTRICAL EQUIPMENT SHALL BE DETERMINED IN THE FIELD BY THE ENGINEER. THE INSTALLATION OF ALL EQUIPMENT SHOWN ON THESE DRAWINGS OR DESCRIBED IN THE SPECIFICATIONS SHALL CONFORM TO THE REQUIREMENTS SET FORTH IN THE LATEST EDITIONS OF ALL APPLICABLE CODES AND UTILITY COMPANY STANDARDS. CONTACT THE UTILITY COMPANY REPRESENTATIVES AND VERIFY THEIR REQUIREMENTS.

G2. THIS IS A GENERALIZED LEGEND SHEET. THIS CONTRACT MAY NOT USE ALL INFORMATION SHOWN.

G3. NOTIFY THE ENGINEER IMMEDIATELY IF CONFLICTS IN EQUIPMENT LOCATIONS ARE DISCOVERED OR IF PROBLEMS ARISE DUE TO FIELD CONDITIONS, LACK OF INFORMATION OR ANY OTHER REASON. NO PAYMENT WILL BE MADE FOR CHANGES WHICH HAVE NOT BEEN FAVORABLY REVIEWED BY THE ENGINEER.

G4. INFORMATION SHOWN MAY NOT BE ALL INCLUSIVE. SEE ALSO ANSI C37.2, Y1.1, Y32.2, AND Y32.9.

G5. VERIFY ALL COLOR REQUIREMENTS BEFORE ORDERING MATERIALS.

G6. REFER TO THE MECHANICAL DRAWINGS FOR CERTAIN CONTROL DIAGRAMS AND EXACT LOCATIONS OF MECHANICAL EQUIPMENT AND FOR CERTAIN CONNECTIONS TO BE MADE TO ELECTRICAL CIRCUITS.

PLAN NOTES:

P1. CONDUIT SIZE AND FILL SHALL BE AS INDICATED. WHERE NO SIZE IS SHOWN, THE CONDUIT SHALL BE SIZED IN ACCORDANCE WITH THE EDITION OF THE NATIONAL ELECTRICAL CODE ADOPTED BY THE AUTHORITY HAVING CODE ENFORCEMENT JURISDICTION. WHERE NO FILL IS INDICATED, THE FILL SHALL BE 2#12. PROVIDE 3/16 INCH NYLON PULL ROPE IN EACH EMPTY CONDUIT.

P2. LOWER CASE LETTERS ADJACENT TO A SWITCH OR LIGHT FIXTURE INDICATE A SWITCHED CIRCUIT. FOR FOUR LAMP FLUORESCENT FIXTURES WIRED IN PAIRS WITHIN EACH FIXTURE, THE "a" SWITCH CONTROLS THE OUTER LAMPS AND THE "b" SWITCH CONTROLS THE INNER LAMPS; WIRE 3 LAMP FIXTURES SIMILARLY.

P3. CONDUIT AND WIRE LAYOUT FOR LIGHTING AND RECEPTACLES NOT SHOWN. PROVIDE PER NEC.

P4. NUMBER OF CIRCLES DOES NOT REPRESENT THE NUMBER OF CONDUITS IN THE ENCASEMENT.

PLAN SYMBOLS

- OVERHEAD POWER LINE (OH)
- UNDERGROUND CONDUIT
- UNDERGROUND DUCT LINE (CONCRETE ENCASEMENT) NOTE P4
- UNDERGROUND DIRECT BURIAL CONDUITS NOTE P4
- MULTIPLE CONDUIT RUN
- CONDUIT CONCEALED IN FLOOR
- CONDUIT CONCEALED IN WALL OR CEILING
- CONDUIT EXPOSED
- CALLOUT INDICATING CONDUIT SIZE, NUMBER OF WIRES AND WIRE SIZE (3/4"C-3#12)
- CALLOUT INDICATING CONDUIT PER SCHEDULE (1)
- CONDUIT RUN, HATCH MARKS INDICATE NO. OF #12 CONDUCTORS NO HATCH MARKS IS 2#12 UNLESS OTHERWISE NOTED
- HOME RUN TO PANELBOARD OR AS INDICATED
- FLEXIBLE CONDUIT
- CONDUIT RUN, BROKEN AND CONTINUED ON SAME SHEET OR AS NOTED
- CONDUIT WITH SEAL FITTING
- CAP ON CONDUIT STUB
- OPEN CIRCLE DENOTES UPWARD CONDUIT RISER
- SEMI CIRCLE DENOTES DOWNWARD CONDUIT RISER
- INDICATES REMOVAL
- FA — FIRE ALARM CONDUIT
- T — TELEPHONE CONDUIT
- S — SECURITY SYSTEM CONDUIT
- 120V SURFACE MOUNTED PANELBOARD
- 120V FLUSH MOUNTED PANELBOARD
- 480V SURFACE MOUNTED PANELBOARD
- 480V FLUSH MOUNTED PANELBOARD
- M — MOTOR
- DISCONNECT SAFETY SWITCH
- COMBINATION MOTOR STARTER
- S_{MS} — MANUAL MOTOR STARTER
- CONTROL STATION
- EQUIPMENT MOUNTING STAND
- GROUND ROD AND BOX
- INSTRUMENT
- EMH EHH SHH — ELECTRIC MANHOLE / POWER HANDHOLE / SIGNAL HANDHOLE
- K — INTRUSION REMOTE KEY PAD
- D — INTRUSION DOOR SWITCH
- SAP — SECURITY ALARM PANEL
- EQUIPMENT CONNECTION

- S_* — SINGLE POLE SWITCH
  2 = 2 POLE, 3 = 3 WAY, 4 = 4 WAY,
  K = KEY OPERATED
  WR = WEATHER RESISTANT
  D = DIMMER
  P = SWITCH WITH PILOT LIGHT
- S^{ab} — SINGLE POLE SWITCH (NOTE P2)
- FLUORESCENT FIXTURE (NOTE P2)
- FLUORESCENT FIXTURE WITH NIGHT LIGHTING (UNSWITCHED) OR FLUORESCENT FIXTURE WITH SELF-CONTAINED EMERGENCY BALLAST/BATTERY
- WALL/CEILING MOUNTED FIXTURE
- WALL/CEILING MOUNTED FIXTURE NIGHT LIGHTING (UNSWITCHED)
- POLE MOUNTED FIXTURE
- WALL/CEILING MOUNTED EXIT LIGHT - DIRECTIONAL ARROW WHERE INDICATED, SHADED AREA INDICATES ILLUMINATED FACE
- EMERGENCY LIGHT WITH SELF CONTAINED BATTERY
- (A) — LIGHT FIXTURE IDENTIFICATION
- SINGLE RECEPTACLE, 120V
- SINGLE RECEPTACLE, 240V
- DUPLEX WALL RECEPTACLE, 120V
  WR = WEATHER RESISTANT
  G = GROUNDED
  IG = ISOLATED GROUND
  GF = GROUND FAULT INTERRUPTER
  DOUBLE DUPLEX WALL RECEPTACLE, 120V
- DUPLEX FLOOR RECEPTACLE, 120V
- MULTI-OUTLET ASSEMBLY WITH SINGLE RECEPTACLE, 120V SPACING (X INCHES) AS NOTED, MOUNTING HEIGHT AS NOTED (H, X")
- RECEPTACLE, 480V
- WALL/CEILING MOUNTED JUNCTION BOX
- FLOOR RECESS MOUNTED JUNCTION BOX
- THERMOSTAT, WALL MOUNTED
- WALL TELEPHONE OUTLET (+12")
- DATA WALL OUTLET
- TELE-DATA WALL OUTLET
- FLOOR OUTLETS
- F — FIRE ALARM PULL STATION
- F — FIRE ALARM FLASHING LIGHT
- F — FIRE ALARM HORN
- B — BELL
- BUZZER
- H — HEAT DETECTOR
- S — SMOKE DETECTOR
- FACP — FIRE ALARM CONTROL PANEL
- PROXIMITY SENSOR
- WALL SENSOR

SINGLE LINE SYMBOLS

- GROUND CONNECTION
- SWITCH, 3 POLE EXCEPT WHERE NOTED. RATING IN AMPERES AS NOTED
- AUTOMATIC TRANSFER SWITCH 3 POLE, RATING AS NOTED
- ST — SHUNT TRIP
- TB-# / #A / 1 — FUSE
- FUSE CUTOUT
- MCP 100AT / 100AT 100AF — CIRCUIT BREAKER, 3 POLE EXCEPT WHERE NOTED. RATING IN AMPERES AS NOTED. IF TWO RATINGS APPEAR (EG. 100/625) THEN DEVICE IS MCP; NUMERATOR IS CONTINUOUS CURRENT RATING & DENOMINATOR IS INSTANTANEOUS TRIP SETTING.
- POWER CIRCUIT BREAKER DRAWOUT ABOVE 1500V RATING AS NOTED
- CURRENT TRANSFORMER
- VOLTAGE TRANSFORMER
- POWER OR DISTRIBUTION TRANSFORMER RATING AS NOTED
- 100 — MOTOR. NUMBER INDICATES HORSEPOWER
- GEN — GENERATOR, SIZE INDICATED
- CONTROL PACKAGE PROVIDED WITH THE DRIVEN EQUIPMENT
- BUS STAB ON MCC OR SWITCHGEAR, CORD & PLUG CONNECTION FOR MOTORS
- OL — THERMAL OVERLOAD
- * A - AMMETER
  V - VOLTMETER
  WH - WATTHOUR METER
  GS - GROUND FAULT SENSOR
- MOV — MOTOR OPERATED VALVE
- K — KIRK KEY INTERLOCK
- POWER RECEPTACLE FOR PORTABLE EQUIPMENT
- # — RELAY DEVICE FUNCTION, # PER ANSI NUMBER C37.2
- TERMINATOR / POTHEAD
- SPLICE, TERMINATION
- 1 — MOTOR STARTER NUMBER INDICATES NEMA SIZE
- CAPACITOR
- VFD — VFD - VARIABLE FREQUENCY DRIVE
  SS - SOLID STATE STARTER
- AFD 5 / 5 — AFD WITH BYPASS CONTACTOR, CONTACTOR NEMA SIZE AS INDICATED
- SS — SS STARTER WITH BUILT-IN FULL SPEED CONTACTOR
- SPD — SURGE PROTECTIVE DEVICE

ELEMENTARY DIAGRAM SYMBOLS

- FUSE. RATING IN AMPERES
- M — MOTOR; ETM — ELAPSED TIME METER
- ** — CONTROL DEVICE COIL. PREFIX NUMBER, WHEN USED, DISTINGUISHES BETWEEN DEVICES OF THE SAME TYPE.
  ALT - ALTERNATOR; CR - CONTROL RELAY; GR - GENERAL RELAY; ISR - INTRINSICALLY SAFE RELAY
  LR - LATCH RELAY; PR - PROBE RELAY; SV - SOLENOID VALVE; TD - TIME DELAY RELAY; TR - TIMING RELAY
- (?) — INDICATING LIGHT
- PUSH-TO-TEST INDICATING LIGHT
  * COLORS:
  A - AMBER; B - BLUE; C - CLEAR; G - GREEN; R - RED; N - NEON; W - WHITE; Y - YELLOW
- ON OFF — SINGLE POLE SWITCH NORMALLY OPEN / CLOSED
- START / STOP — EMERGENCY PUSHBUTTON NORMALLY OPEN / CLOSED
- START / STOP — PUSHBUTTON NORMALLY OPEN / CLOSED
- SWITCH 1-POLE / 3-POLE
- MULTI-POSITION SELECTOR SWITCH
- H O A — HAND-OFF-AUTOMATIC SWITCH X-INDICATES CONTACTS CLOSED
- H O R — HAND-OFF-REMOTE SWITCH X-INDICATES CONTACTS CLOSED
- TERMINAL
- H1 H3 H2 H4 / X1 X2 — CONTROL POWER TRANSFORMER
- MOTOR HEATER — MOTOR HEATER
- AMP/FRAME — AMPS / POLES — CIRCUIT BREAKER, MCP 1-POLE / 3-POLE
- GROUND CONNECTION
- INSTRUMENT
- NO CR NC CR — CONTACT NORMALLY OPEN / CLOSED
- BUS STAB ON MCC; CORD & PLUG CONNECTION FOR MOTORS
- OL — THERMAL OVERLOAD
- BUZZER; BELL; HORN
- 1 CR / 2-2, 3, 0, 0 — CROSS REFERENCE TO ANOTHER DIAGRAM
- NORMALLY OPEN CONTACT ON THE OTHER DIAGRAM
- SPARE CONTACTS ON RELAY. IF OMITTED, THEN THE SPEC. REQUIREMENTS REGARDING SPARE CONTACTS APPLY.
- NORMALLY CLOSED CONTACT ON THIS DIAGRAM

SENSING SWITCHES		
CLOSE ON		SENSED VARIABLE
RISING	FALLING	
FS	FS	FLOW
LS	LS	LEVEL
PS	PS	PRESSURE
TS	TS	TEMPERATURE

LIMIT SWITCHES	
ZS	CLOSE ON REACHING LIMIT
ZS	CLOSE ON LEAVING LIMIT

TIMED CONTACTS			
SYMBOL	NORMAL	OPEN TO CLOSED	CLOSED TO OPEN
TR	OPEN	DELAYED	INSTANTANEOUS
TR	CLOSED	INSTANTANEOUS	DELAYED
TR	OPEN	INSTANTANEOUS	DELAYED
TR	CLOSED	DELAYED	INSTANTANEOUS

ELEMENTARY DIAGRAMS

E1 UNDERLINED WORDS SHOWN AT A PUSHBUTTON, LIGHT, SELECTOR SWITCH, ETC. INDICATE THE LEGEND PLATE REQUIREMENT FOR THAT PARTICULAR DEVICE. ANY ADDITIONAL NAMEPLATES ARE INDICATED ON ELEVATIONS WITH THE REQUIRED NAMEPLATE INSCRIPTIONS.

E2 "NORMAL" STATUS OF SWITCHES OR CONTACTS IS THE SHELF POSITION.

E3 NUMBERS AND LETTERS IDENTIFY DEVICE.

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES
0 1/2"
0 12.5mm
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER — JEFFREY M. MORRIS — No. E20409 Exp. 09/30/2017 — ELECTRICAL — STATE OF CALIFORNIA

DESIGNED JMM
DRAWN RJ
CHECKED PAR

PALMDALE WATER DISTRICT
PALMDALE, CA

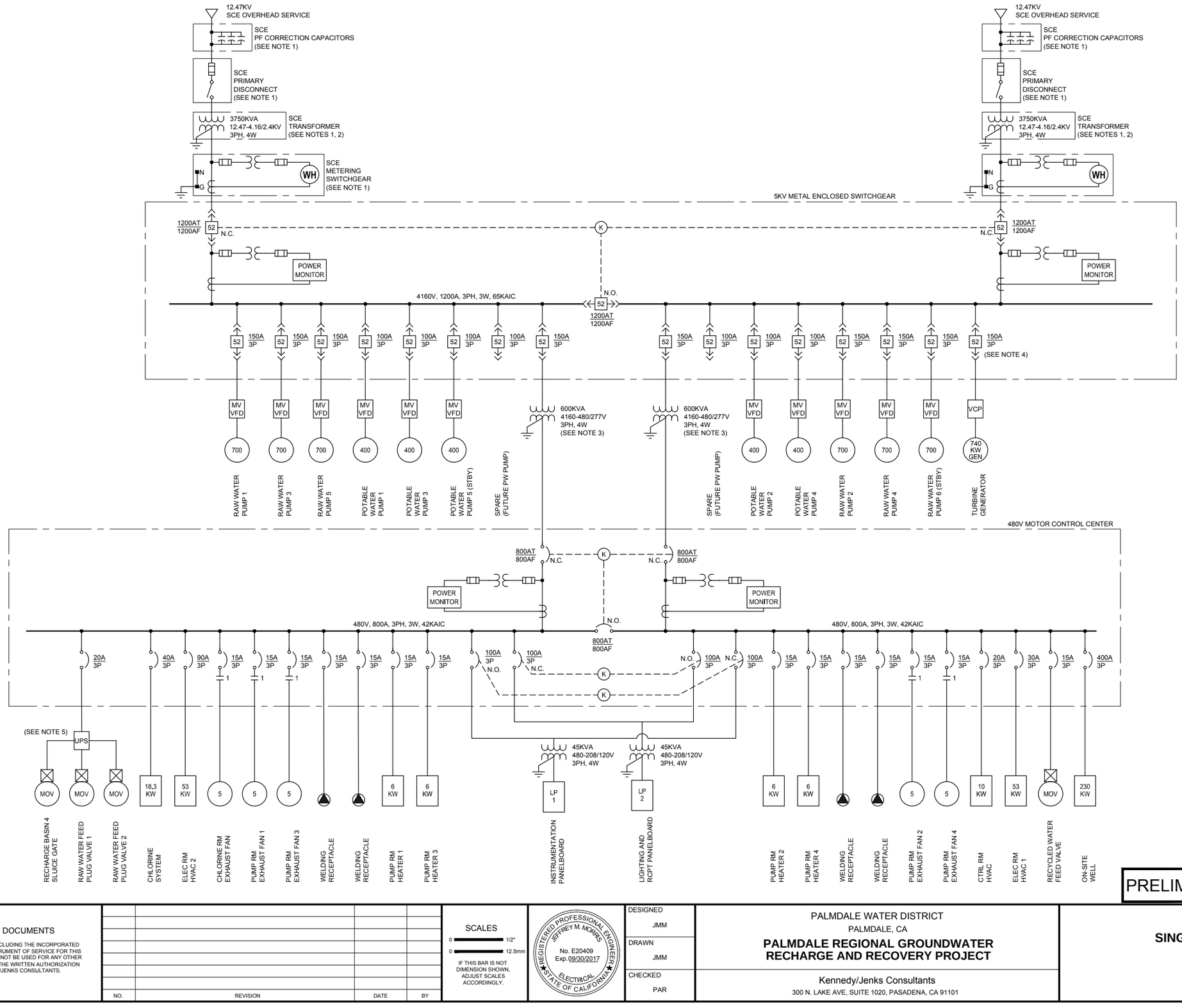
PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

ELECTRICAL LEGEND AND ABBREVIATIONS

FILE NAME 134450501e01.dwg
JOB NO. 1344505.01
DATE NOVEMBER 2015
SHEET E1 OF -

L:\Palmdale_Water_District\1344505.01_PWD-PRGRRP\1-Sheets\134450501e01.dwg 11/6/2015 3:00 PM BRYANT BEHNKE



NOTES:

1. FINAL DESIGN OF SERVICE ENTRANCE EQUIPMENT TO BE PERFORMED BY SCE.
2. SCE UTILITY TRANSFORMERS ARE SHOWN SIZED FOR HALF OF THE OVERALL FACILITY LOAD.
3. STEP-DOWN TRANSFORMERS FEEDING THE MOTOR CONTROL CENTER ARE EACH SIZED FOR THE FULL 480V LOAD, TO ALLOW FOR MORE FLEXIBILITY DURING MAINTENANCE SHUTDOWNS.
4. ADDITIONAL PROTECTIVE RELAYING FOR PHASE SYNCHRONIZATION AND OTHER FUNCTIONS WILL BE PROVIDED ON THE FEEDER FROM THE TURBINE GENERATOR. THESE ARE REQUIRED FOR COMPLIANCE WITH SCE RULE 21 FOR GENERATING FACILITY INTERCONNECTIONS.
5. UPS PROVIDED FOR VALVES THAT MAY NEED TO BE CLOSED IN THE EVENT OF A POWER OUTAGE, TO PREVENT OVERFLOWING THE RAW WATER PUMP STATION WET WELL OR SPILLING RECYCLED WATER OUT OF RECHARGE BASIN 4. ACTUATORS SHALL BE CONFIGURED TO CLOSE THE VALVE OR GATE BASED UPON LOSS OF UTILITY POWER SIGNAL FROM UPS.

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	REVISION	DATE	BY

SCALES

0 1/2"

0 12.5mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

REGISTERED PROFESSIONAL ENGINEER
JEFFREY M. MORRIS
No. E20409
Exp.09/30/2017
ELECTRICAL
STATE OF CALIFORNIA

DESIGNED JMM

DRAWN JMM

CHECKED PAR

PALMDALE WATER DISTRICT
PALMDALE, CA

PALMDALE REGIONAL GROUNDWATER RECHARGE AND RECOVERY PROJECT

Kennedy/Jenks Consultants
300 N. LAKE AVE, SUITE 1020, PASADENA, CA 91101

ELECTRICAL SINGLE LINE DIAGRAM

FILE NAME 134450501e02.dwg

JOB NO. 1344505.01

DATE NOVEMBER 2015

SHEET OF **E2** -

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BRYANT BEHNKE 11/6/2015 3:00 PM