Keeler Community Services District DWSRF Draft Alternatives Assessment Engineering Report

Technical Assistance Work Plan No. 7046-A

California State Water Resources Control Board

30 April 2024

→ The Power of Commitment

Project name	Keeler Community Services District (CSD) AR 7046
Document title	Keeler Community Services District DWSRF Draft Alternatives Assessment Engineering Report | Technical Assistance Work Plan No. 7046-A
Project number	12571432
File name	

Status Code	Revision	Author	Reviewer		Approved for issue		
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[Compliance statement]

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The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

Contents

Table index

Figure index

Appendices

Abbreviations and Acronyms

ADD	Average Day Demand
CDPH	California Department of Public Health
CEQA	California Environmental Quality Act
CFA	Construction Financing Application
CRWA	California Rural Water Associates
CSD	Community Service District
DAC	Disadvantaged Community
DDW	Division of Drinking Water
DFA	Division of Financial Assistance
DWSRF	Drinking Water State Revolving Fund
eAR(s)	Electronic Annual Report(s)
gpd	Gallons per day
gph	Gallons per hour
gpm	Gallons per minute
GBUAPCD	Great Basin Unified Air Pollution Control District
IVWWD	Indian Valley Wells Water District
KCSD	Keeler Community Service District
LADWP	Los Angeles Department of Water and Power
P&P	Provost & Pritchard
MCL	Maximum Contaminant Level
SMCL	Secondary Maximum Contaminant Level

MDD	Maximum Day Demand
mg/L	Milligrams per liter
PHD	Peak Hourly Demand
POE	Point of Entry
POU	Point of Use
PUD	Public Utility District
PVC	Polyvinyl Chloride
SDWIS	Safe Drinking Water Information System
SWRCB	State Water Resources Control Board
TA	Technical Assistance
TAP	Technical Assistance Provider
µg/L	Micrograms per liter

Executive Summary

The Keeler Community Services District (KCSD) water system (”System,” CA1400036) serving the community of Keeler (“Community”) has been issued Compliance Orders (Citation No 05-44-21C-005, Compliance Order 05-44-19R-063, Citation No 05-44-20C-058, Compliance Order 05-44-20R-073, Citation 05-44-20C-069) by Inyo County to address water quality concerns in the Community’s supply well.

Provost & Pritchard (P&P) has been assigned as the System administrator and, at the time of this writing, is overseeing full-scope operations and management. P&P previously had focused on short-term solutions to the technical, financial, and managerial challenges of the System and is now looking toward long-term solutions. To avoid a funding conflict of interest, P&P has requested Technical Assistance (TA) on behalf of KCSD for the completion of this engineering report, recommending a long-term solution for the System’s water quality concerns and necessary infrastructure improvements. This work is funded under Technical Assistance Work Plan No. 7046-A, administered by GHD on behalf of the California State Water Resources Control Board (SWRCB), Division of Financial Assistance (DFA).

This Draft Preliminary Alternatives Analysis and Engineering Report is intended to provide the information and analyses required to satisfy the first five sections (Executive Summary, Background, Problem Description, Consolidation Analysis, and Alternatives Analysis) of the Engineering Report for the Construction Funding Application. This scope of work does not include the remaining sections regarding a selected alternative. This Draft is preliminary and will need to be updated as resolutions are found for the assumptions discussed herein.

The KCSD is classified as a community water system, with 84 connections serving a residential area with a population of 66 people. KCSD supplies water to the community of Keeler via one groundwater supply well (Well 01), one water storage tank, and a distribution network of water lines. The current source capacity of 150 gallons per minute (gpm) is restricted by the pump capacity and does not meet the highest estimated Maximum Day Demand (MDD) of 188 gpm. The storage capacity of 100,000 gallons does not meet the 271,000-gallon MDD. The System's electrical system is not currently outfitted to supply emergency backup power, which resulted in at least one power outage in June 2023.

In addition to the System capacities not meeting the current demands of the Community, the Water System poses water quality issues with concentrations of arsenic and manganese exceeding state Maximum Contaminant Level (MCL) and Secondary Maximum Contaminant Level (SMCL), respectively. Previous groundwater quality studies for KCSD have indicated consistently elevated levels of arsenic since 2004. Water quality samples are collected from Well 01 quarterly, during the second month of the quarter (February, May, August, November). All three quarterly samples collected during 2023 have arsenic concentrations (108, 69, and 83 µg/L, respectively) above the state MCL of 10 micrograms per liter (µg/L). All three quarterly samples collected during 2023 (79.1, 92, and 110 µg/L, respectively) have manganese concentrations above the state SMCL of 50 µg/L.

The purpose of this Engineering Report is to identify issues facing the System, propose options for meeting the Community's needs, and describe and recommend an alternative based on engineering feasibility, costs, and stakeholder input.

Due to physical distance from other water systems, physical consolidation has been identified as infeasible. The following alternatives analysis has been conducted to better understand available options for a long-term solution to ensure safe water supply for the System. The alternatives evaluated are Alternative 1, Installation of a new groundwater supply well; Alternative, 2 Pump upgrades to the existing groundwater supply well; Alternative 3, Centralized treatment using Greensand filtration; and Alternative 4, Centralized treatment using Dual media Filtration.

Significant issues have been identified regarding the water demand. First, the Community water demand is significantly higher than anticipated, which has greatly impacted cost estimates for the treatment alternatives. Without additional clarity on the water demand, it is not recommended that a treatment alternative be pursued at this time. Second, the existing water well is 41 years old and is estimated to be near the end of its useful life. Therefore, there are concerns regarding upgrading the pumps in the existing well and not having a backup water well. With the information currently available, it is recommended that water meters be installed to identify why the demand is so high and that Alternative 1, Installation of a new water well be pursued to potentially identify a new water source that would not require treatment.

Managerial consolidation is needed as a long-term operational solution for the System. Managerial consolidation outreach has been conducted with Inyo County Public Works Department, the Los Angeles Department of Water and Power Keeler Yard, and Indian Wells Valley Water District. At this time, managerial consolidation with Indian Wells Valley Water District has been identified as the most promising potential option. However, discussions are ongoing at the time of this writing.

The following information will be provided for the final report following Stakeholder feedback. Estimated construction costs for the proposed improvements total approximately **[**$**]**. Non-construction project costs, including permitting, fees, design finalization, and construction management will total approximately **[**$**]**. Together, the total project cost is estimated to require approximately **[**$**]**. The estimated future monthly water bill for the **[**applicant**]** is **[**$**]**.

1. Background Project Information

The Keeler Community Services District (KCSD) Water System (” System,” CA1400036) serving the community of Keeler (“Community”) has been issued Compliance Orders (Citation No 05-44-21C-005, Compliance Order 05-44-19R-063, Citation No 05-44-20C-058, Compliance Order 05-44-20R-073, Citation 05-44-20C-069) by Inyo County to address water quality concerns in the Community’s supply well. These are described in detail in Section 2. Provost & Pritchard (P&P) has been assigned as the System Administrator and, at the time of this writing, is overseeing full-scope operations and management. P&P previously had focused on short-term solutions to the technical, financial, and managerial challenges of the System and is now looking toward long-term solutions. To avoid a funding conflict of interest, P&P has requested Technical Assistance (TA) on behalf of KCSD for the completion of this engineering report addressing a long-term solution for the Community’s water quality concerns and necessary infrastructure improvements.

This Draft Preliminary Alternatives Analysis and Engineering Report is intended to provide the information and analyses required to satisfy the first five sections (Executive Summary, Background, Problem Description, Consolidation Analysis, and Alternatives Analysis) of the Engineering Report for the Construction Funding Application. This scope of work does not include the remaining sections regarding a selected alternative. This Draft is preliminary and will need to be updated as resolutions are found for the assumptions discussed herein. This work is funded under Technical Assistance Work Plan No. 7046-A, administered by GHD on behalf of the California State Water Resources Control Board (SWRCB) Division of Financial Assistance (DFA).

1.1 Project Location

The KCSD Water System is located in Keeler, California, in Inyo County. Keeler is approximately nine miles east of California State Highway 395 (Hwy 395) and is located on the west side of Owens Lake. The nearest community to Keeler is Lone Pine, which is located approximately 14 miles north. Keeler can be accessed from California Highway 136 (Hwy 136). Figure 1 presents a Vicinity Map and location of KCSD.

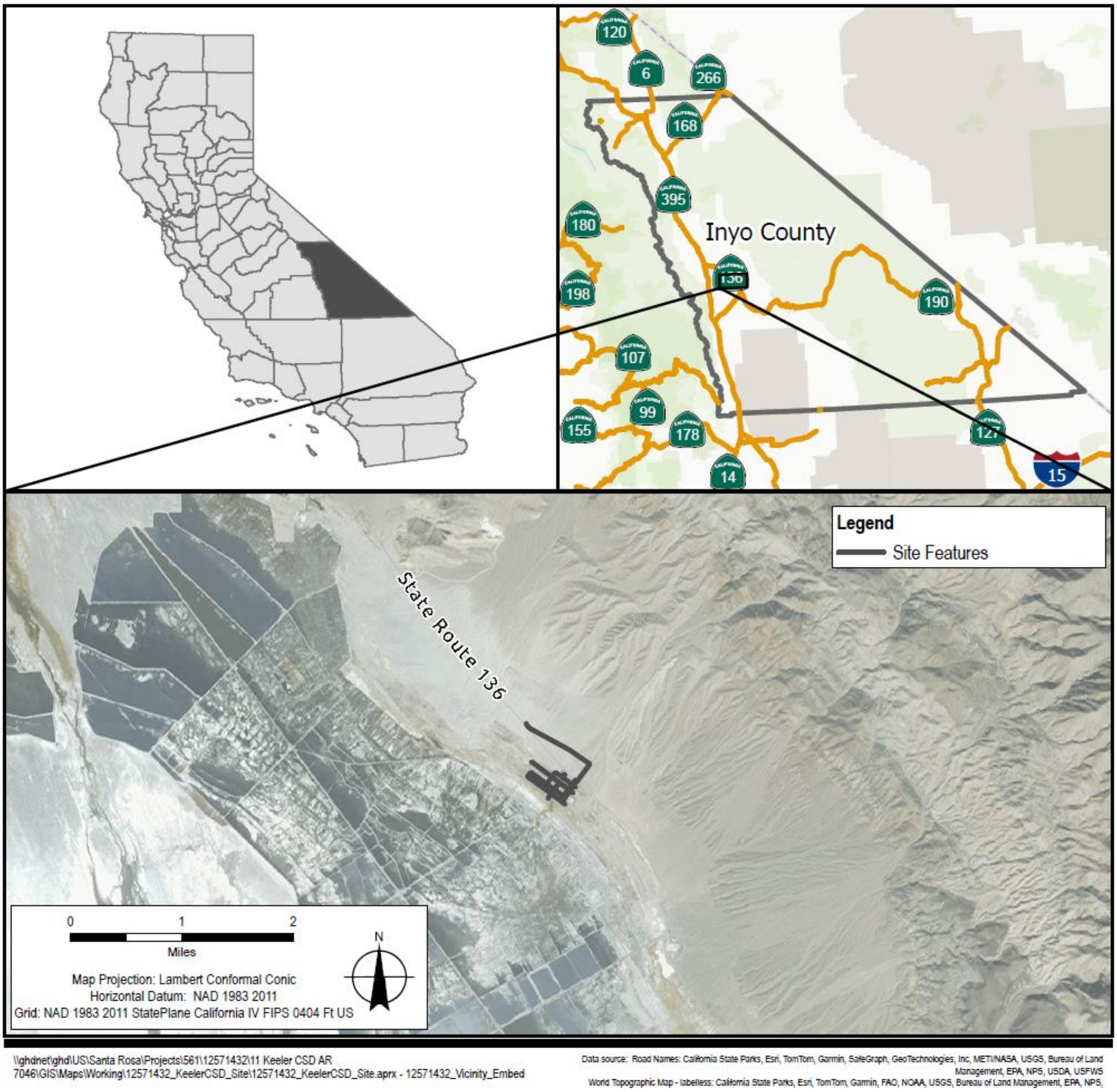


Figure 1 KCSD Vicinity Map.

1.2 Previous Water System Studies

In June 2021, the California Rural Water Association (CRWA) completed a feasibility study for KCSD, *Water System Improvements to Mitigate Arsenic and Manganese in Drinking Water* (CRWA 2021), to evaluate existing drinking water system infrastructure and to analyze the feasibility of potential solutions to support the System mitigation of arsenic and manganese. The 2021 report acknowledged the System had inadequate storage and production capacity to meet Community needs. The study was a feasibility assessment that included evaluation of several alternatives for water quality treatment and installation of a new well. The study included feasibility level cost estimates for each of the alternatives evaluated. The alternatives analyzed to meet drinking water standards included:

1. Drilling a new source well.
2. Water treatment using iron-based adsorption media for centralized, point-of-use (POU), and point-of-entry (POE) treatment.
3. Oxidation filtration using manganese-oxide media for centralized and POU treatment.
4. Reverse-osmosis (RO) filtration for POU and POE treatment.

The combination of treatment at different locations created the seven alternatives listed in Table 1 along with their advantages and disadvantages.

Table 1 Seven alternatives considered during CRWA's 2021 feasibility study and their respective advantages and disadvantages.

#	Alternative	Advantages	Disadvantages
1	New Water Supply Well	A new source could eliminate need for treatment if clean water was produced. New source well would satisfy drinking water system source and storage capacity needs.	Drilling a new well is costly and would potentially still require treatment if clean water was not produced.
2	Centralized Iron-Based Filtration Media	Treatment would effectively remove arsenic in compliance with the state MCL and would treat all water.	This system does not treat manganese.
3	Centralized Chemical Addition with Manganese-Oxide Filtration Media	Treatment would effectively remove arsenic and manganese in compliance with the state MCLs and would treat all water.	Increased costs, more automation, and additional equipment would be required.
4	POU Manganese-Oxide and Iron-Based Filtration Media	Only water used for drinking and cooking would be treated for arsenic and manganese, which would be more energy efficient.	Resistance is expected from residents as it would require installation at each home and regular testing and maintenance at the home.
5	POE Iron-Based Filtration Media	Treatment of arsenic and manganese would not require entering residential homes for installation or maintenance.	This system does not treat for manganese and would require coordination with residents to ensure sufficient spacing for installation.
6	POU Reverse-Osmosis Treatment	Only water used for drinking and cooking would be treated for arsenic and manganese which would be more energy efficient.	Resistance is expected from residents as it would require installation at each home and regular testing and maintenance at the home.
7	POE Reverse-Osmosis Treatment	Treatment of arsenic and manganese would not require	This system would require coordination with residents to ensure sufficient space for

#	Alternative	Advantages	Disadvantages
		entering residential homes for installation or maintenance.	installation, and RO treatment process is insufficient in water conservation.

The results of the Feasibility Study identified POU systems as the most feasible compared to centralized and POE alternatives, due to the POU systems achieving the required removal of arsenic and manganese at the lowest costs. It was also recommended that a pilot study be conducted to test the operations and maintenance required for the two POU alternatives considered to identify which POU system is more ideal for KCSD. Finally, it was recommended that KCSD pursue a new water supply well to meet drinking water system source and storage capacity requirements.

Another report developed for the System that is frequently cited in this Alternatives Analysis is a 2022 Initial Site Assessment Report authored by P&P following their assignment as System Administrator (P&P, 2022). The 2022 Initial Site Assessment Report provides additional detail regarding the System, including financial data and audits that are discussed in later sections of this report.

1.3 Water System Description

1.3.1 KCSD System Description

The KCSD water system (CA1400036) is classified as a community water system and has 84 connections serving a residential area with a population of 66 people.

KCSD supplies water to the community of Keeler via one groundwater supply well, one water storage tank, and a distribution network of water lines. Figure 2 presents a site map of the existing KCSD water system. The current source capacity of 150 gallons per minute (gpm) is restricted by the pump capacity and does not meet the highest estimated maximum daily demand (MDD) of 188 gpm. The storage capacity of 0.1 million gallons (MG) does not meet the 0.27 MG MDD. The System's electrical system is not currently outfitted to supply emergency backup power, which resulted in a power outage in June 2023.

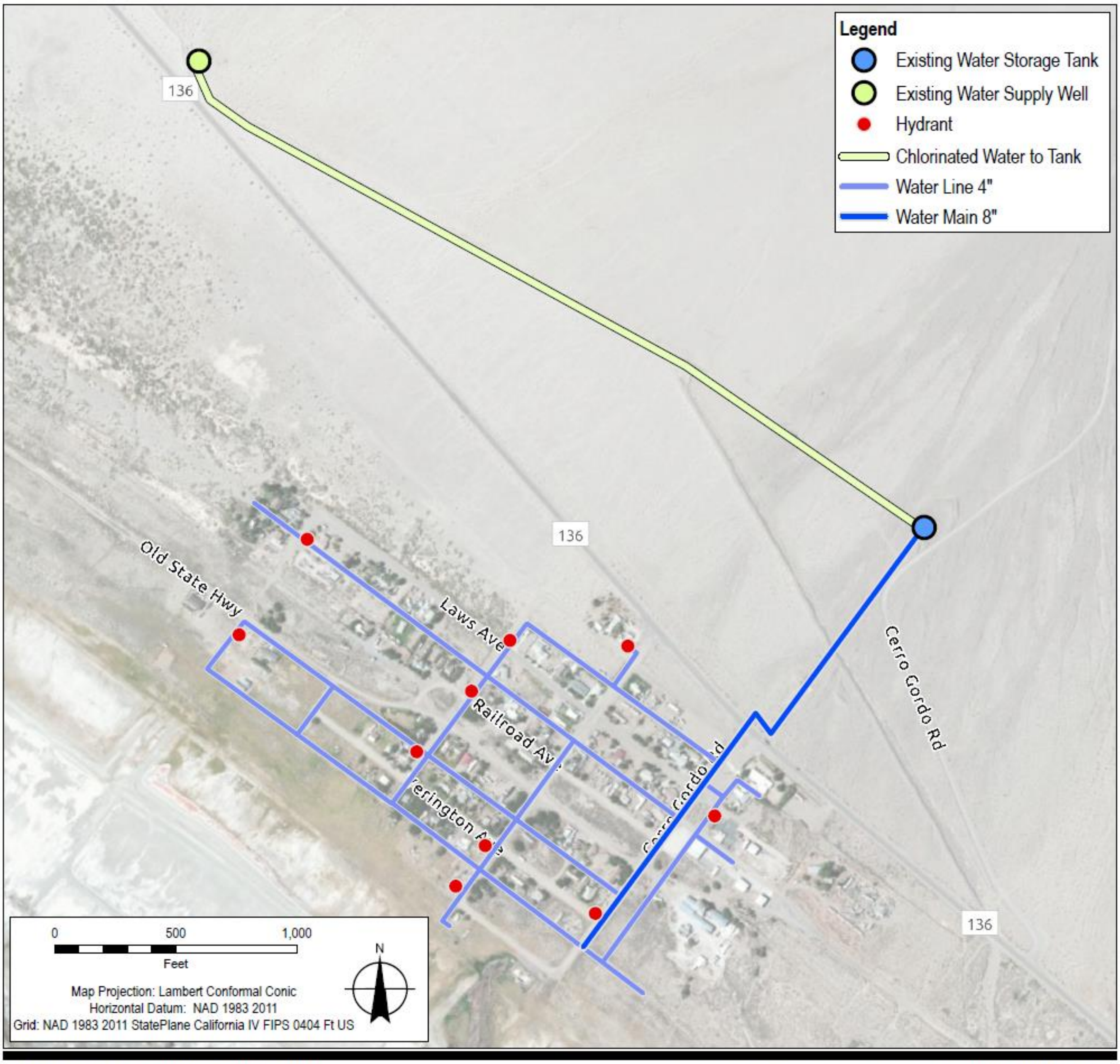
In addition to the System capacities not meeting the current demands of the System, the water system poses water quality issues with levels of arsenic and manganese exceeding State Maximum Contaminant Levels (MCL) and Secondary Maximum Contaminant Levels (SMCL). Previous groundwater quality studies for KCSD have indicated consistently elevated levels of arsenic since 2004. Water quality samples are collected from Well 01 quarterly, during the second month of the quarter (February, May, August, November). All three quarterly samples collected during 2023 have arsenic concentrations (108, 69, and 83 μg/L, respectively) above the state MCL of 10 micrograms per liter (μg/L). The water supply well also has manganese concentrations that exceed the SMCL of 50 μg/L. All three quarterly samples collected during 2023 (79.1, 92, and 110 μg/L, respectively) have manganese concentrations above the state SMCL of 50 μg/L.

1.3.2 KCSD Existing Facilities

The System operates one active groundwater well (Well 01) that is the only source of water for the System shown in Figure 3. Well 01 is 125 feet deep and was installed in 1984. The well is estimated to have a capacity of 312 gpm. However, the source capacity of the existing water supply well is limited by the existing well pump, which pumps 150 gpm. The existing pump capacity does not meet the maximum daily demand of 188 gpm. There is no backup water source.

Well 01 has a 5-horsepower (HP) and a 10-horsepower submersible pump, with the 5-horsepower pump acting as a backup pump. The 10 HP pump is positioned 100 feet below top of casing providing approximately 150 gpm and is considered the primary pump. The 5-HP pump is positioned 94 feet below top of casing and is rated at 75 gpm. The pumps and electrical system were installed in 2021. Power to the pumps is supplied from nearby solar equipment installed in 2013 and a connection to electricity supplied by Southern California Edison. Well 01 is shown in Figure 3, left.

A shed behind the well houses controls for disinfection through chlorination using liquid sodium hypochlorite before the water enters the distribution system. The chlorination system is shown in Figure 3, right. Prior to 2023, chlorination occurred only during the warmer months (May through November), but now the System is chlorinated continuously. Some residents have installed POU treatment systems within their homes (discussed in detail in Section 1.2); however, there is no System wide treatment aside from the chlorination treatment.



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Data source: World Imagery (Clarity): Esri, Maxar, Earthstar Geographics, CNES/Airbus DS, and the GIS User Community
Road Names: Esri Community Maps Contributors, California State Parks, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA, USFWS Created by:ethompson3

Figure 2 Keeler CSD existing infrastructure site map.

Figure 3 Image at left shows the groundwater well and the submersible pump connections for the KCSD Water System. Image at right shows the chlorination treatment of the groundwater at the well site prior to entering the distribution system.

A booster pump has been identified in site photographs. It is located at the well and it is assumed that the booster pump is used to move water from the well site to the 100,000-gallon storage tank via PVC pipe. Information regarding the booster pump has been requested but has not been received as of the time of this writing. At the well site, there is a blow-off sump, check-valve, and a meter that is not in service.

The storage tank is located approximately 70 feet higher than the well and 100 feet above the KCSD service area. The elevated storage tank provides a gravity feed for the KCSD distribution system providing a system pressure between 50 and 63 pounds per square inch (psi) (P&P, 2022).

Currently the KCSD well pump starts when the storage tank water level drops to 18 feet above the tank bottom and stops when the water level reaches 30 feet above the tank bottom (P&P, 2022).

The distribution system consists of primarily PVC schedule-80 pipes either 4-inch or 8-inch in diameter. The System is unmetered, but there are shutoff valves at each connection point. It is estimated that the distribution System was installed as early as the 1970s.

Figure 4 Image at left shows the 100,000-gallon storage tank. Image at right presents the solar equipment used to power the pump system at the groundwater well.

KCSD sells approximately 1-2 acre-feet per year of water to Great Basin Unified Air Pollution Control District (GBUAPCD) per an agreement signed in 2014. The water is used to irrigate land for dust control measures as part of the Keeler Dunes Dust Control Project.

Table 2 Inventory of existing system.

Asset	Size	Year Built	Condition
Groundwater Well 01	125 ft deep, 312 gpm source capacity	1984	Well 01 water levels are not monitored, and flow totals are not currently recorded. The well does not have a vent and does not meet maximum daily demands with the currently installed pumps.
5 HP Submersible Pump	94 ft BTOC, 75 gpm	2021	Pump is in good condition.
10 HP Submersible Pump	100 ft BTOC, 150 gpm	2021	Pump is in good condition.
Solar Equipment	50 Kilovolt-Amps	2013	Pump is in good condition.
Disinfection Treatment (Chlorine Injection)	N/A	Unknown	Chlorine feed is fed by chemical feed pump, not flow paced, Treatment system does not treat for arsenic or manganese.
Water Storage Tank	100,000 gallons	Unknown	Tank is in unknown condition due to lack of recent inspection records. Tank was determined to be in good condition according to an inspection last completed in 2000. The storage tank does not have

Asset	Size	Year Built	Condition
			an air gap and does not meet maximum daily water storage demands.
Distribution System	Provides for 0.1 square miles	As early as the 1970s	CRWA identified one major leak at the southern edge of the System in 2020 that was fixed prior to P&P becoming system Administrator. The distribution system has not been previously replaced.

1.3.3 Existing Land Easements

KCSD has an easement with the Bureau of Land Management (BLM) to have the well site and storage tank site on BLM land.

1.3.4 Estimated Water Demand

In the CRWA 2021 Feasibility Report, water demand for KCSD was quantified using the limited demand data provided by the County. Meter data was collected from 1995-1997 and 2001-2004, and partial data was collected by KCSD for 2016-2018 and 2020 (CRWA, 2021). The CRWA report indicates that KCSD began recording water usage again in 2020; however, P&P indicated that the most-recent water usage data available is the recorded 2020 data. Water use demand decreased from 1997 to 2001 but more-recent data suggests that water demand at KCSD has increased significantly compared to 1997 data. Additionally, the Great Basin Unified Air Pollution Control District (GBUAPCD) uses approximately 450,000 gallons per year from KCSD for dust control. No additional water demand data was identified in the P&P 2022 Initial Assessment of KCSD Report.

Water demand was estimated by CRWA in the 2021 Feasibility Report. Table 1 of the 2021 Feasibility Report presents available water demand data for the years with data between 1995 and 2020. It was found that the winter demand is significantly lower than the summer demand. It was also found that demand has increased significantly over time. The water demand estimate described below is based on the month with the highest recorded water use in 2020, which is shown in the table as August. The monthly demand in August of 2020 is shown at 4,780,733 gallons. It should be noted that the August 2018 monthly demand was similar, at 4,561,309 gallons. If the monthly August 2020 demand is divided by 31 days, then the average daily demand (ADD) for August of 2020 can be estimated as approximately 154,000 gallons per day (gpd) or 106 gpm.

Maximum Day Demand (MDD) and Peak Hourly Demand (PHD) were estimated consistent with CA Title 22 Section 64554(b)(2). August 2020 was identified as the maximum month for which data was available. A peaking factor of 1.5 was applied to the August 2020 monthly demand (4,780,733 gallons) and divided by 31 days. MDD is estimated at 231,325 gallons per day or 161 gpm. A second peaking factor of 1.5 was applied to the MDD to estimate PHD at 241 gpm.

The TA request provided to GHD at the start of this project lists the MDD as 188 gpm, however GHD has not been provided with the data for the estimate. This report assumes the MDD of 188 gpm is the correct demand estimate because as System Administrator it is assumed P&P

has access to the most recent data. If a peaking factor of 1.5 is applied to this estimate of MDD, PHD is estimated as 282 gpm. The water demand estimates calculated using the data presented in the 2021 CRWA report are presented in Table 3.

Table 3 KCSD water demand summary.

Data Source	Average Demand	Maximum Demands		
	Average Daily Demand (ADD)	Max Monthly Demand	Max Day Demand (MDD)	Peak Hourly Demand (PHD)
2021 CRWA Feasibility Report	Not stated	4,780,733 gallons[1]	231,325 gpd or 161 gpm[1,2]	241 gpm[1,2]
TA Request	Not stated	Not stated	271,000 gpd or 188 gpm	282 gpm[2]

[1] Based on measured data from a maximum month (August 2020).

[2] MDD and PHD were calculated using Peaking Factors of 1.5.

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CRWA describes the 2019 SWRCB standards for household water use in California as estimated at 86 gallons per capita per day (gpcd), which is the approximate use of a domestic household per day. The estimated MDD of 188 gpm is equivalent to 270,720 gpd. If divided by the 66 connections in Keeler, that implies a usage rate of 4,101 gallons per connection on the maximum day.

1.3.5 Storage Demand

Currently, for systems with fewer than 1,000 connections, Title 22, §64554(a)(2) requires that the System have a storage capacity equivalent to one MDD or have a backup emergency water source connection that can meet the MDD. Based on the estimate included in the TA request, the MDD is 271,000 gpd. Keeler currently has one storage tank with a 100,000-gallon storage capacity, leaving a remaining storage volume requirement of approximately 171,000 gallons. The storage tank is also required for fire flow; therefore, 60,000 gallons are reserved for fire emergencies in the service area. Due to KCSD's distance from other systems, an emergency intertie to another system is not feasible. Therefore, the options to meet this requirement include either installation of a backup water source (a new groundwater well) or installation of a new tank that can meet the storage requirement.

It is worth noting that Senate Bill 552 requires that no later than January 1, 2027, water systems with fewer than 1,000 connections must have at least one backup source of water supply or a water system intertie, that meets current water quality requirements and is sufficient to meet average daily demand. Therefore, a backup water supply is prudent for meeting future requirements.

Fire Safety and Fire Flow

A portion of the existing water storage tank capacity is reserved for fire flow (60,000 gallons) (P&P, 2022).

Industrial and Commercial Water Users

As previously described, (GBUAPCD) uses approximately 450,000 gallons per year from KCSD for dust control (P&P, 2022). GBUAPCD is the only other authorized user of the water produced by the KCSD System. It is not clear when GBUAPCD uses the purchased water, however based on its purpose for dust suppression it is assumed that it is primarily during the summer months. No data was found regarding the schedule of water distribution to GBUAPCD so it is unknown if this impacts KCSD’s ability to maintain fire storage volume in the storage tank or if it impacts potable uses.

Population Growth Demand

Keeler is not anticipated to have significant population growth. We therefore expect no growth-based increased in water demand.

1.3.6 Existing Operations and Maintenance (O&M) Practices

KCSD is operated by a five-member Board of Directors, who meet once per month (CRWA, 2021). Despite classifications as a D1 distribution system and T2 treatment plant, KCSD does not currently employ certified operators; all maintenance activities are performed by resident volunteers.

The 2022 P&P Initial Assessment Report provides details on KCSD’s financials. The report states that KCSD does not prepare a 5-year budget projection but that annual budgets are provided to the County at the beginning of each fiscal year. The report also describes that Keeler maintains a reserve fund, which contained $41,000 as of April 28, 2022. The standard residential rate for water is a flat fee of $35 per month. The light industrial rate is a flat $85 per month.

Included as an appendix in the 2022 P&P Initial Assessment Report is a Keeler Community Service District’s Statements of Revenues, Expenses, and Changes in Net Position for the Years Ended June 30, 2019, and 2018. This report was completed by Clifton Larson Allen LLP and is an Auditor’s Report detailing the financials of the water system.

According to this report, the 2019 total operating revenues for KCSD were $25,116. The Total operating expenses were $39, 445, representing a loss of operating income of $14,329. The year 2018 also had a loss of operating income.

The current rates and loss of operating income are potentially prohibitive for operation and maintenance of a potential future water treatment system.

2. Problem Description and Project Justification

KCSD has been issued several Compliance Orders and Citations by Inyo County for failing to address arsenic and manganese contaminants present in the Community's water supply well above the state MCL and SMCL. These citations and compliance orders are provided in Table 4. Note that they are listed in the order that is presented in the most recent compliance order. The most recent water sample from March 2022 indicated an arsenic concentration of 67 ug/L, with a running annual average of 76 µg/L since 2004, and a manganese concentration at 70 µg/L in March 2022. KCSD is also in non-compliance with source and storage capacity requirements. The current source capacity of 150 gpm does not meet the highest estimated MDD of 188 gpm, while the storage capacity of 100,000 gallons does not meet the 271,000 gallon MDD. The System's electrical system is not currently outfitted to supply emergency backup power, which resulted in a power outage in June 2023.

Table 4 Compliance orders and citations issued to KCSD.

Compliance Order or Citation Number	Date Issued	Date of Required Compliance	Issue Prompting Order or Citation	Understanding of Resolution
Citation No 05-44-21C-005	January 31, 2021	March 12, 2021	Non-compliance with Orders/Citations below and ongoing water quality issues with arsenic and manganese	Unresolved, prompted assignment of P&P as System Administrator
Compliance Order 05-44-19R-063	September 30, 2019	December 31, 2021	Development of a Corrective Action Plan (CAP) to address Arsenic MCL	Unresolved, did not submit an acceptable CAP
Citation No 05-44-20C-058	August 31, 2020	Quarterly, as per Order. Next quarterly compliance date of October 10, 2020.	Failure to distribute first and second quarter public notices regarding arsenic levels.	Unresolved, did not promptly distribute public notice during third quarter of 2020.
Compliance Order 05-44-20R-073	December 30, 2020	Quarterly, as per Order. Next quarterly compliance date of January 10, 2021.	Failure to distribute fourth quarter public notices regarding arsenic and manganese levels.	Unresolved, did not promptly distribute public notice during fourth quarter of 2020.
Citation 05-44-20C-069	December 17, 2020	January 4, 2021	Failure to submit a notification of receipt for citation issued for failure to collect lead and copper samples during the 2018-2020 compliance period.	Unresolved, did not submit notification of receipt for issued citation

Due to the presence of arsenic, most of KCSD's community members choose to get their drinking water from other sources, including buying water from local sellers or traveling to a nearby motor home park in Lone Pine to fill drinking water bottles.

Provost & Pritchard has been assigned as Administrator for the System and is currently overseeing full-scope operations and management. Provost & Pritchard has focused on short-term solutions to the technical, financial, and managerial challenges of the System and is now looking towards long-term solutions such as centralized treatment or consolidation. The Initial Assessment performed by Provost & Pritchard in 2022 found the following system deficiency and items to address:

- Arsenic and manganese concentrations above the primary and secondary drinking water MCLs, respectively.
- Wellhead piping deficiencies should be upgraded to address operational deficiencies (vent, air relief, blow off, etc.). The flow meter needs to be moved/upgraded to allow for easy measurement of total gallons pumped and also calibrated to improve accuracy.
- The chemical metering system should be upgraded to deliver proportional chlorine injection and continuous residual monitoring.
- The control wiring between the tank and wellhead should be replaced, preferably with a radio connection. SCADA is also recommended to monitor the well site operation and tank level to reduce operations costs and allow for remote monitoring by a certified water system operator.
- A second water tank should be installed to allow for the existing water tank to be relined and coated.
- Excessive water demand and the possibility of significant System leakage is acknowledged. An evaluation of the distribution system is needed since the distribution system may require significant maintenance. Besides the potential for leakage, many of the distribution system's isolation valves no longer function and fire hydrants have not been tested.
- Replacement of water meters at domestic and commercial connections is needed to help identify leaks, reduce Water System demands, charge customers based on water use, and reduce the overall cost of a potential water supply/treatment project.

3. Existing Water Demand Concerns and Assumptions

Based on the exceptionally high water demands, assumptions were made in order to proceed with the alternatives analysis. The assumptions made regarding the input flow to the treatment systems could greatly impact cost because of the economy of scales. The Treatment system cost is impacted by the size of the equipment, volume of treatment media and chemicals needed, and the associated cost of the equipment and supplies. The cost of equipment and supplies varies by the size and volume and cost is not necessarily translatable between sizes. If treatment is pursued, the assumptions about flow input and treatment system size should be revised prior to selection of an alternative.

3.1 Concerns Regarding the Estimated Water Demand

Both the 2021 CWRA Feasibility Study and the 2022 P&P Initial Assessment Report state that there are concerns regarding the accuracy of the water demand data and subsequent demand estimates. The two reports describe that between 2001 and 2004 the average summer demand was 91,737 gpd. This is approximately 40% lower than the average monthly demand found for August of 2020, which is 154,000 gpd. Keeler has not seen a significant change in population or operations that can explain this increase in water demand. The 2021 CWRA Feasibility Study noted that a major leak on Maud Street was identified in May 2020. P&P informed GHD that this leak has been repaired. There has not been a more recent leak detection test completed for the System.

Due to the aging infrastructure and unreasonably high demand, there is potential that there are other significant leaks. However, it is unlikely leaks are entirely responsible for the exceptionally high demand because there are significant differences in summer versus winter demands. If leaks were the primary problem, then that would be observed year-round regardless of season. If the exceptionally high demand is not due to significant leaks, there is potential that unauthorized diversions are occurring for unauthorized uses.

An additional concern with the estimate is that the System is entirely unmetered and there is currently no way to separate the drinking water (indoor use) demand from the irrigation (outdoor use) demand. However, it is desired to separate the irrigation and the drinking water demands so that the capital expenditure and the long-term operation and maintenance expenditure of a potential water treatment system can be feasible for KCSD. The size of a water treatment system could be much smaller if only sized to meet the drinking water demand.

3.2 Estimated Eligible Design Capacity

It is difficult to define the appropriate design capacity due to the potential for significant System leaks or water theft that have led to exceptionally high existing water demand estimates (e.g., MDD of 188 gpm). An accurate estimate of design capacity would require quantifying domestic demand through metering using System meters to identify where losses are occurring. As mentioned previously, it is unlikely that the high demand is due entirely to system leaks because of the significant differences between seasonal demand. Prior to selection of a treatment alternative, it is critical to evaluate the System for unauthorized uses and revise the design capacity as appropriate.

For this analysis, it has been identified that the existing well had an original production estimate of 312 gpm, but the existing well pump is only able to produce 150 gpm. If the well is still capable of producing the original capacity, then the well is capable of exceeding the MDD of 188 gpm. Due to the well's age, it would need to be evaluated to determine if it is still capable of producing this volume. This would include pulling the pump, collecting TV data of the well casing, and performing a pump test. This is included in Alternative 2.

In order to receive vendor quotes for the cost of the treatment systems the flow input had to be defined as this impacts the size of the System components and the volumes of media and chemicals needed. When determining which flow input would be best to assign to a future treatment system the following was considered:

1. The MDD is estimated to be 188 gpm.

2. The wells capacity is estimated to be 312 gpm.
3. There is a desire to split the irrigation water from the drinking (potable) water, however this requires installation of a new distribution system, which raises the capital cost. This cost could be prohibitive for splitting the water uses.
4. Considerations of what the flow input would be if all of the water were treated.
5. Considerations of what the flow input would be if all of the water were treated and if there was a more reasonable water demand.

Historic water demand data presented in the 2021 CRWA Feasibility Study shows that the water demand is consistently lower in the winter months than the summer months, suggesting that a significant portion of the water is being used for irrigation. Using the MDD of 188 gpm it was estimated that on a peak day Keeler uses 4,100 gpcd. The SWRCB 2019 estimates that in California, an average household uses approximately 89 gpcd.

Without meters in the System, it is not possible to rigorously determine the percentage of water being utilized for drinking water versus irrigation water. However, for this analysis it was assumed that 70% of the water would be for an irrigation/outdoor use and 30% of the water used would be for drinking water/indoor use.

Based on the discussion above, it was assumed for this alternatives analysis that the potential future infrastructure (irrigation side and potable water side) would be capable of handling the well's assumed full capacity of 312 gpm.

Justification for this includes:

1. With a flow input of 312 gpm the 70%/30% split of irrigation/potable water equals 218 gpm to the irrigation side and 94 gallons per minute to the drinking water (treatment) side.
2. With this flow split, the treatment system would be sized to operate at a flow rate of 94 gpm. A treatment system producing 94 gpm would produce a daily total of 135,360 gallons. This divided by the 66 connections would allow for 2,050 gallons of potable water per connection, which far exceeds the average use per household reported by the SWRCB (89 gpcd).
3. Should the cost of splitting the irrigation water from the drinking water prove prohibitive, then a potable water production rate of 94 gallons per minute would provide adequate drinking water and a reserve for irrigation water. Therefore, sizing the System to this volume provides vendor quotes that estimate the approximate cost of a treatment system with a reasonable water demand as well as if all of the water needed to be potable (i.e., irrigation and drinking water were not separated).

Ultimately, the assumptions above could negatively impact the ability to compare the two treatment alternatives described in subsequent sections. This is due to the economy of scales. The Treatment system cost is impacted by the size of the equipment, volume of treatment media and chemicals needed, and the associated cost of the equipment and supplies. The cost of equipment and supplies varies by the size and volume and cost is not necessarily translatable between sizes. In addition, the equipment and media needed for the two treatment systems evaluated is not the same. Prior to the design of the project, the System should be evaluated for unauthorized uses and then the water demand estimates should be revised appropriately. Following revisions to the demand estimates either of the two proposed treatment alternatives could be resized to fit the updated demand estimate.

3.3 Irrigation and Outdoor Use Water Quality

As described above, it is desired to split the irrigation (outdoor use) and the potable drinking water (indoor use). Splitting the use could provide two primary benefits to the System.

The first benefit is that the treatment system size could be sized down, which could reduce capital and operation costs. The second benefit is that having a storage tank of irrigation water (raw well water) would provide the opportunity to discharge the treatment system backflush water into the irrigation tank for dilution, prior to the water being used for irrigation purposes. This is an important consideration because Keeler does not have a sanitary sewer system that the filter backflush water can be discharged to. Therefore, water quality standards for irrigation purposes were reviewed to evaluate if dilution of the filter backflush water is possible based on the contaminants present in the unpotable water.

The Lahontan Regional Water Quality Control Board's Basin Plan ("Basin Plan") was reviewed for Water Quality Objectives (WQOs) for agricultural uses (LRWQCB, 2023). Chapter 3 of the Basin Plan describes the WQOs for each type of beneficial use, including the agricultural (AGR) designation. Within Chapter 3, it is described that "in determining compliance with objectives including references to the AGR designated use, the Regional Board will refer to water quality goals and recommendations from sources such as (1) the Agricultural Organization of the United Nations, (2) the University of California Cooperative Extension Committee of Experts, and (3) McKee and Wolf's Water Quality Criteria (1963)".

GHD reviewed both the 1963 McKee and Wolf Water Quality Criteria (McKee and Wolf, 1963) and a report on Water Quality in Agriculture by the 2023 Food and Agriculture Organization of the United Nations and Integrated Water Management Institute (FAOUN, 2023). Both of the reports provide maximum contaminant levels for arsenic and manganese in an agricultural setting. The Basin Plan specifies that when two references are provided, the most stringent reference will be used. It is also the most recent source. Therefore, it is assumed that the FAOUN and IWNMI 2023 maximum contaminant levels would be used as the standard for comparison.

The most recent KCSD water sample from March 2022 indicated an arsenic concentration of 67 µg/L, with a running annual average of 76 µg/L (0.076 mg/L) since 2004, and a manganese concentration at 70 µg/L (0.07 mg/L) in March 2022. The provided maximum contaminant levels compared to KCSD sampling results are presented in Table 5 below.

Table 5 Maximum contaminant levels for manganese and arsenic in milligrams per liter (mg/L) presented by McKee and Wolf (1963) and FAOUN (2023).

Source	Manganese (mg/L)	Arsenic (mg/L)
McKee and Wolf, 1963	0.50	1
FAOUN and IWMI, 2023	0.20	0.10
KCSD Unpotable Water (mg/L)	0.07	0.076

The table above indicates that the unpotable water is potentially suitable for irrigation uses. To provide additional evidence for this, a mass balance is presented for each treatment alternative to show how the concentrations change with the proposed treatment processes. The mass balances are presented in Section 5.3.3 and Section 5.4.3.

4. Consolidation Analysis

Both physical and managerial consolidation were evaluated for KCSD. Physical consolidation is evaluated for potential of an intertie or connection to a larger system that could eliminate the supply and water quality issues. Managerial consolidation is evaluated for the potential of a long-term System manager. It is necessary that physical consolidation options be located physically near KCSD whereas managerial consolidation options could potentially be located at greater distance.

4.1 Physical Consolidation Options

Listed in Table 6 are water systems near KCSD that are within a 15-mile radius. This preliminary determination indicates that the nearby water systems are either too distant and/or too small to feasibly offer a physical consolidation solution. LADWP Keeler Yard and Inyo County PWD in Lone Pine are the two systems that could potentially offer a managerial consolidation solution. Figure 5 displays the location of KCSD in relation to the nearby water systems listed in Table 6. Water systems to the east of Hwy 395 were not considered due to the inherent distance limitations.

Table 6 Water systems nearest to KCSD.

System Name	System Type	System Number	Number of Connections	Straight Line Distance to System (miles)	Direction from KCSD to System
Keeler Yard LADWP	Non-Transient, Non-Community	CA1400527	3	1.45	Southeast
Inyo County PWD - Lone Pine	Community	CA1410009	503	12.5	Northwest
Mountain View Trailer Court	Community	CA1400099	24	11.5	Northwest
Quality Inn System	Transient, Non-Community	CA1400500	1	11.7	Northwest
Diaz Lake Campground	Transient, Non-Community	CA1400049	24	10.7	Northwest

System Name	System Type	System Number	Number of Connections	Straight Line Distance to System (miles)	Direction from KCSD to System
Foothill Mobile Home Park	Community	CA1400037	48	10.2	Northwest
Boulder Creek Trailer Park	Transient, Non-Community	CA1400504	20	10	Northwest
Cartago Mutual Water Company	Community	CA1400027	40	13.8	Southwest
Crystal Geyser Bottling Plant	Non-Transient, Non-Community	CA1400528	3	14.8	Southwest

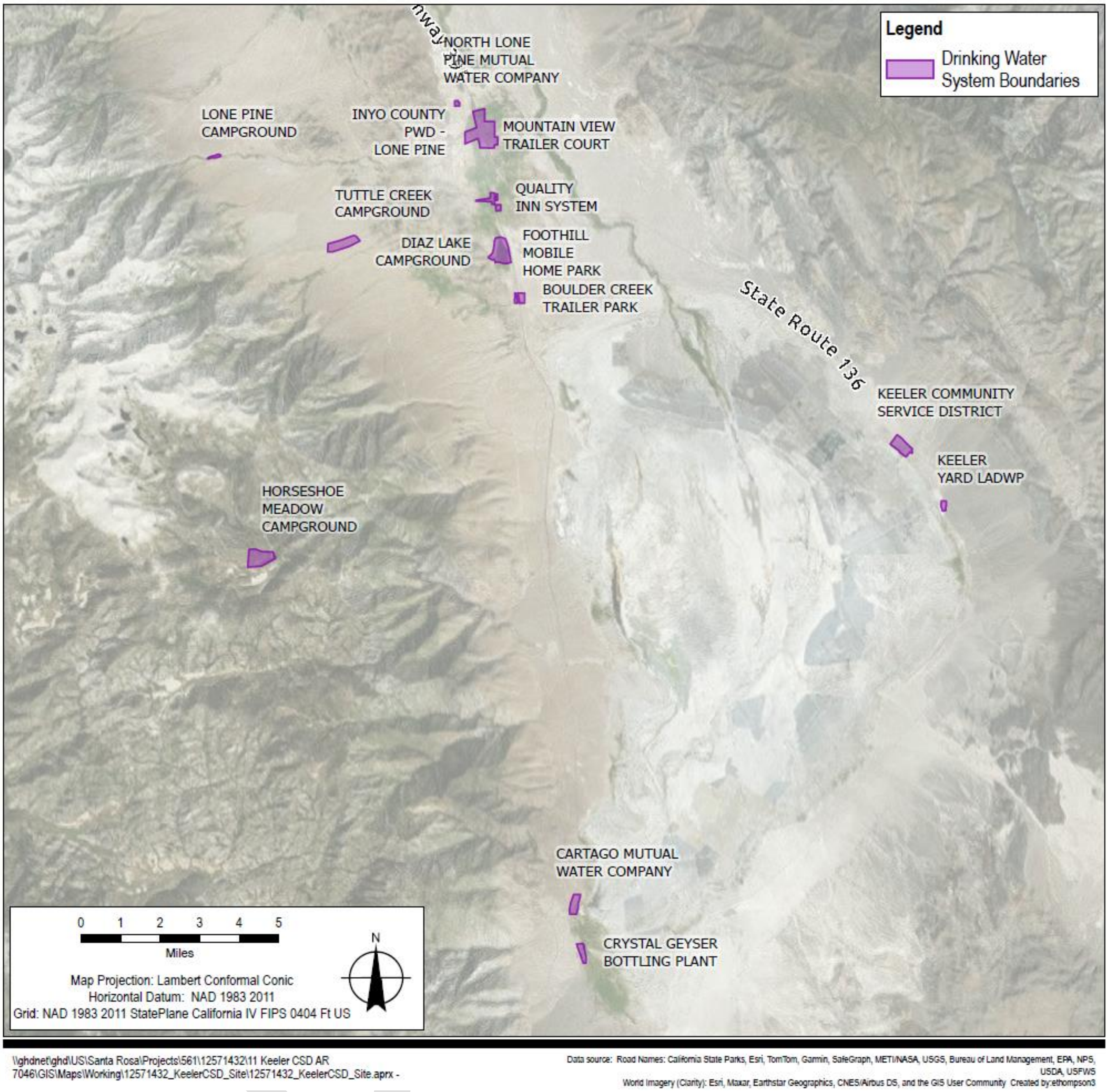


Figure 5 KCSD and nearby water systems.

4.2 Managerial Consolidation Options

As mentioned above, LADWP Keeler Yard and Inyo County PWD in Lone Pine are two systems that could potentially offer a managerial consolidation solution. In addition, Indian Wells Valley Water District, located approximately 90 miles south of KCSD has been identified as another potential managerial consolidation option. A summary of these systems and managerial consolidation challenges are provided in the sections below.

4.2.1 Inyo County PWD

4.2.1.1 System Description and Operations

The Inyo County Public Works Department Water System is located in Lone Pine, CA with two source wells supplying the water system. Both source wells are followed by treatment systems for the water prior to entering the distribution system. The water system is currently active year-round as a community water system about 12.5 miles away from KCSD. The system has a total of 503 connections; 404 connections residential and 99 commercial. In the 2022 Consumer Confidence Report for the Inyo County PWD Water System, water quality monitoring identified that there were no contaminants measuring above their respective allowed contaminant level per the SWRCB or EPA (Inyo County PWD, 2023).

4.2.1.2 Managerial Consolidation Potential

GHD began conducting outreach to Inyo County PWD in January 2024. GHD spoke with two Inyo County PWD representatives to discuss the potential for consolidation: Katie Patterson and John Pinckney. The Inyo County representatives understood the need for Keeler to have a long-term System Manager and why Inyo County would be an ideal fit. However, Inyo County is understaffed due to the limits of their pay scales and their remote location. For these reasons they struggle to attract and retain technical staff. They currently have one full-time staff member for their three water systems and that employee is already stretched thin. In addition, they struggle to pass rate increases and affording current staffing is difficult. Consolidation incentives were discussed; however, the consolidation incentives would not alleviate the need for additional operational staff.

In addition to the conversations summarized above, during the monthly meetings for this project DDW has noted that Inyo County PWD struggles with responsiveness. DDW has acknowledged that without additional technical staff it is unlikely that Inyo County PWD can manage operations of another water system.

4.2.2 LADWP Keeler Yard

4.2.2.1 System Description and Operations

The LADWP Keeler Yard Water System is located in Keeler, CA and operates as a surface water intake system with an abandoned fire well. The water system is located about 1.5 miles south of KCSD Water System and operates year-round as a nontransient noncommunity type system. The system serves three commercial service connections. The LADWP Keeler Yard Water System receives water from the Los Angeles Aqueduct System, Lubken Gate and Cartago Gate, and the Lower Owens River; water is then filtered and chlorinated prior to distribution. In the 2022 Keeler Yard Drinking Water Quality Report, it was reported that there were no violations of drinking water standards; however, there was an Unsafe Water Alert issued due to a water main break that was later repaired (LADWP, 2022).

4.2.2.2 Managerial Consolidation Potential

GHD began conducting outreach to LADWP Keeler Yard in January 2024. GHD has emailed and called three representatives, including Jason Crapson, Jonathan Leung, and Michael Mercado. GHD has not received return phone calls or emails from any of the representatives.

During discussions with Inyo County PWD it was noted that several of the local CSDs split from LADWP. It was noted that the relationship between the local CSDs and LADWP is contentious. It is likely for this reason that LADWP representatives have not responded to GHD consolidation outreach.

4.2.3 Indian Wells Valley Water District

4.2.3.1 System Description and Operations

The Indian Wells Valley Water District (IWVWD) is a water supplier located in Ridgecrest, Kern County, California. IWVWD is located approximately 90 miles south of KCSD. The water system serves 31,024 people, including 11,722 residential connections and 655 commercial connections. The water system is supplied through eleven groundwater wells.

4.2.3.2 Managerial Consolidation Potential

As KCSD Administrator, P&P has been in discussions with IWVWD regarding managerial consolidation of KCSD. GHD was notified by P&P that IWVWD is open to managerial consolidation with KCSD and some of the small water systems that are currently managed by Inyo County PWD. There is a meeting with Inyo County PWD, P&P, and GHD that is scheduled on 4/30/24 to discuss potential managerial consolidation with IWVWD of some of the small water systems that Inyo County PWD oversees.

4.3 Consolidation Summary

Due to distance from other systems, it does not appear feasible for KCSD to physically consolidate with another system. Given the communication challenges with LADWP it is anticipated that managerial consolidation with LADWP is not feasible. The same is anticipated with Inyo County PWD due to the difficulties with staffing and due to the number of water systems currently being managed. Indian Valley Wells Water District has expressed interest in managerial consolidation with KCSD and other small systems in the area. The system is also larger and likely to have the staffing resources needed to take on another system. Therefore, Indian Valley Wells Water District has the highest potential for managerial consolidation with KCSD.

5. Alternatives Analysis

KCSD currently faces numerous challenges as outlined in Section 2. This alternatives analysis has been conducted to better understand available options for a long-term solution to ensure safe water supply for the System. The four alternatives evaluated were chosen as alternatives based on Stakeholder feedback and the previous studies that were done (discussed in Section 1.2).

The alternatives were chosen base on Stakeholder feedback and the previous studies completed. Table 7 presents a matrix of the alternatives and potential solutions.

The alternatives considered include:

1. **Installation of a New Groundwater Supply Well**
2. **Pump Upgrades for the Existing Groundwater Supply Well (Well 01)**
3. **Centralized Treatment Using Greensand Filtration**
4. **Centralized Treatment Using Dual Media Filtration**

Table 7 Matrix presenting the alternatives evaluated and the potential combinations of alternatives for KCSD. Alternatives evaluated are shown in black cells and the potential combinations are presented in white cells.

	Alt 1 - Installation of a New Groundwater Supply Well	**Alt 2 - Pump Upgrades for the Existing Groundwater Supply Well (Well 01)**	**Combination of Installation of a New Groundwater Supply Well + Pump Upgrades for the Existing Groundwater Supply Well (Well 01)**
Alt 3 - Centralized Greensand Filtration Treatment	Installation of a new groundwater supply well with centralized Greensand filtration treatment system	Pump upgrades for the existing groundwater supply well (Well 01) with centralized Greensand filtration treatment system	Both a new supply well and pump upgrades for the existing supply well with centralized Greensand filtration treatment system
Alt 4 - Centralized Dual Media Filtration Treatment	Installation of a new groundwater supply well with centralized dual media filtration treatment system	Pump upgrades for the existing groundwater supply well (Well 01) with centralized dual media filtration treatment system	Both a new supply well and pump upgrades for the existing supply well with centralized dual media filtration treatment system

Along with the primary alternatives shown above, additional design components are also considered as follows:

Additional design components considered for Alternative 1 (New Well Installation) and Alternative 2 (Pump Upgrades to Existing Well) include:

– Backup generator, which satisfies Senate Bill 552 requirements that state that by no later than January 1, 2024, communities must ensure continuous operations during power failures by providing adequate backup electrical supply.
– Well Redevelopment (Alternative 2 Upgrades to Existing Well only)
– Upgrades to the electrical service (Alternative 2 Upgrades to Existing Well only)

– Well Siting Study (Alternative 1 New Well only)
– New electrical service (Alternative 1 New Well only)
– Disinfection/Chlorination setup (Alternative 1 New Well only)

Additional design components considered for Alternative 3 (Greensand Treatment) and Alternative 4 (Dual media Filtration Treatment) include:

– New electrical service at the storage tank location to power the treatment facility
– Installation of a new distribution system that would deliver the potable drinking water. The existing distribution system would become the delivery system for irrigation (outdoor use) water. The new distribution system would be installed parallel to the existing system.
– Water meter installation throughout the System.

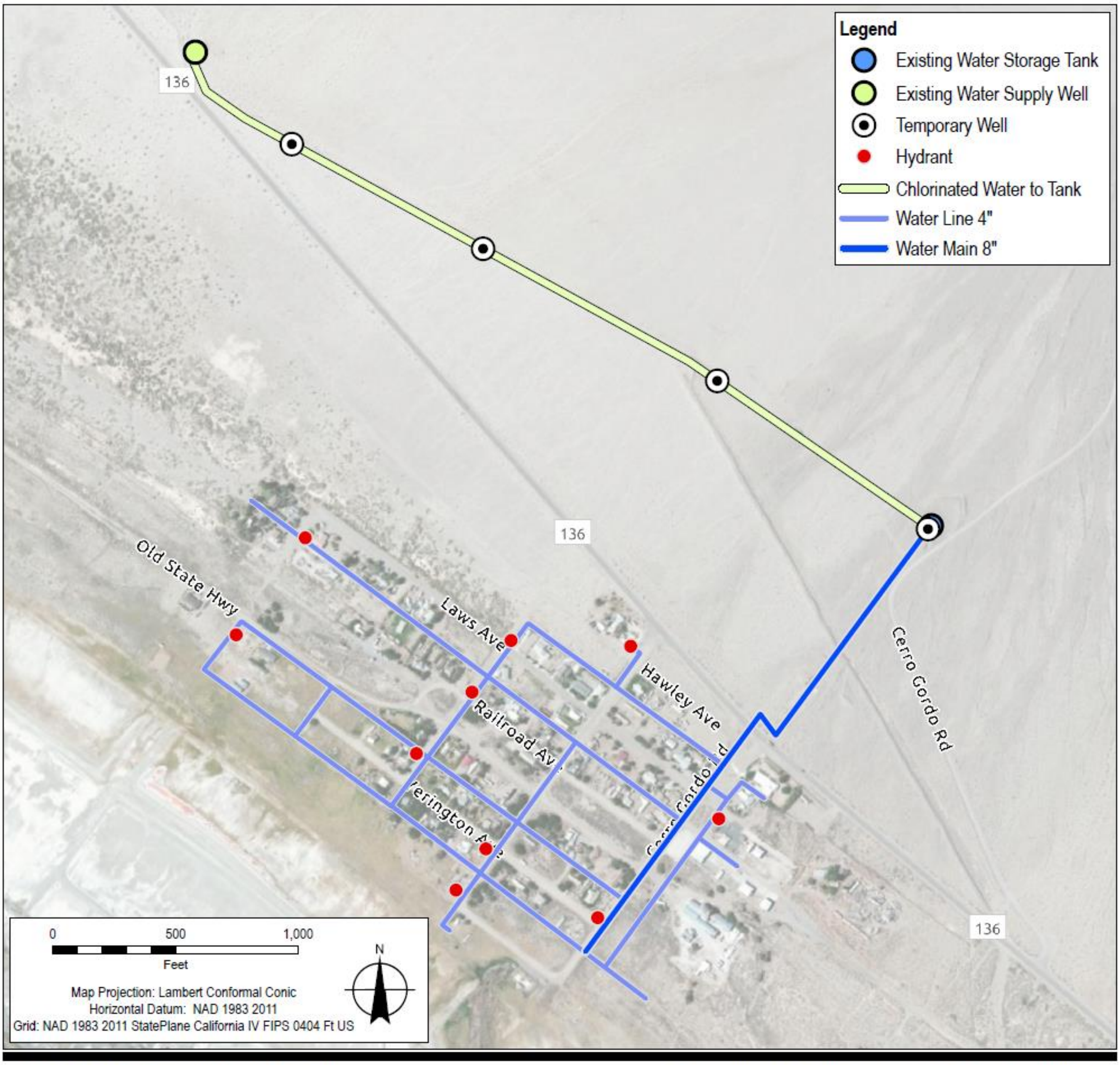
5.1 Alternative 1: Installation of A New Groundwater Supply Well

5.1.1 Description

The existing well has recorded levels of arsenic and manganese above the State MCLs for drinking water and with the current operational use doesn't meet the MDD of the Community served. Additionally, it is relatively old (41 years) and is reaching the end of its design life (40 to 50 years). The installation of an additional groundwater well would provide a new primary drinking water source and could potentially improve water quality, reducing or eliminating the cost of treatment.

In addition, as discussed in Section 1.3.5, if a water system has fewer than 1,000 connections the water system must either have a backup water supply that meets the MDD or a storage volume of one MDD. The existing water tank stores 100,000 gallons does not meet the MDD of approximately 271,000 gallons. Installation of a new well would provide a second supply, which would satisfy these requirements without needing to increase the Water System's storage capacity. In addition, installation of a new well would meet the future requirement of Senate Bill 552, which states that no later than January 1, 2027, water systems with fewer than 1,000 connections have a least one backup source of water supply, or a water system intertie, that meets current water quality requirements and is sufficient to meet average daily demand.

For this alternative, a hydrogeologic and well-siting study would be performed to gather aquifer quality and quantity information, via a series of hydrogeologic boings and/or temporary wells located along the existing raw water line alignment, as shown in Figure 6. The information gathered would be used to develop an understanding of feasibility, estimated production capacity, long-term reliability, preferred location, and design criteria for a new well.



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Data source: World Imagery (Clarity): Esri, Maxar, Earthstar Geographics, CNES/Airbus DS, and the GIS User Community Road Names: Esri Community Maps Contributors, California State Parks, © OpenStreetMap, Microsoft, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA, USFWS Created by:ethompson3

Figure 6 Locations of potential temporary test wells or borings for a hydrogeologic and well siting study.

5.1.2 Design Criteria

Alternative 1 includes the following primary design components:

- Well-Siting Study
- Well Construction
- New electrical service to the well
- Backup generator (at either Well 1 or the New Well, depending on which is determined to be the primary well)

Well-Siting Study

A hydrogeologic and well-siting study would be required to determine the location and design criteria for a new well. The hydrogeologic and well siting study would include drilling four (4) temporary test wells that would be used to evaluate water quantity via an abbreviated pump test during test well development and obtaining water quality tests to evaluate the concentrations of arsenic and manganese. Water from test well development would be discharged onsite.

Well Construction

Following the well siting-study and selection of a preferred location, a new permanent well would be installed. Well design would follow current Waterworks and Department of Water Resources guidelines. The well would be enclosed by a tamper-resistant structure. Intertie piping and related distribution system components would meet current Waterworks Standards. The location of the well is assumed to be near the existing raw water line from the existing well to the existing tank site and would require minimal piping to connect and would not require a geotechnical investigation.

New Electrical Service to the Well

A new well installed along the water transmission pipeline between the existing well and the existing storage tank (as shown in Figure 6) would require a new electrical service. There is currently no electrical service at the storage tank location, however there are nearby powerlines that run approximately parallel to the water transmission line between the storage tank and existing well location. If a new well were installed, a new electrical service could potentially be installed and connected to the nearby power lines.

One significant data gap for estimating the new electrical service to a well is the well location, which cannot be identified prior to conducting the hydrogeologic investigation. There are many factors that will influence the cost of a new service, including the distance from the utility poles that will connect the new service, the estimated electrical load needed, and the level of difficulty for site access and installation, among other factors.

It has been assumed that if a treatment system were installed, it would be installed at the existing storage tank site. This is because this site offers the ability to gravity feed the System following treatment. As part of the treatment system costing exercise, the cost of a new electrical service connection at the existing tank site was estimated. Without knowing the location of a new well and the estimated electrical load, it has been assumed that the cost of a new electrical service along the water transmission line would be comparable to the cost of a new service at the existing tank site. However, this cost could change significantly depending on the placement of the new well.

Backup Generator

A backup generator would be installed at one of the two well locations, whichever becomes the primary supply well. However, for cost-estimating purposes, the existing well was assumed for the generator connection. This cost could change significantly should the generator be installed at a new well location with a different electrical service connection. Note that the backup generator has not been sized to power a treatment system should one of the treatment alternatives be selected.

This estimate assumes that a 50 kW Diesel engine generator with a Level 2 sound enclosure on a concrete pad and a 100-Amp 3 pole automatic transfer switch would be installed to provide emergency power to a well pump and booster pump site. The estimated electrical loads are shown in Table 8. This also assumes that an electrical service upgrade to a 200-Amp, 480-volt would be installed for the existing electrical service. A new switchboard and necessary conduits and cables to intercept the new electrical service would be installed.

Table 8 Estimated electrical load at the existing well site.

Load Description	Kilowatt (kW)
Lighting	2
Well pump	30
Booster pump	2
Misc Controls and Receptacles	10
Total	44

5.1.3 Environmental Impacts

The new well would be constructed in areas identified to minimize environmental impacts or on already-developed sites. The existing well experiences relatively little drawdown (less than eight feet) when both pumps are operating (combined 225 gpm). There have also been no identified wells on nearby properties, so no significant well interference is anticipated on nearby wells from the construction of a new well operating at 300 gpm. No significant environmental impacts are expected.

A CEQA Categorical Exemption (information gathering) will need to be prepared for the hydrogeologic and well siting temporary wells. It is anticipated that a CEQA Categorical Exemption or Initial Study and Mitigated Negative Declaration will be required for the construction of the new production well.

5.1.4 Land Requirements

The existing well and water storage tank are on easements from BLM land. A new well would either be located on the existing easement that contains the water tank or on the easement along the existing water line between Well 01 and the storage tank. In addition, if the new well did not solve the water quality issues, then one of the two treatment alternatives should be considered, which would include additional land requirements and coordination with BLM.

5.1.5 Construction and Site Considerations

The proposed locations for the temporary test wells for the hydrogeologic study are located within BLM owned parcels and would need an access agreement to perform the initial study followed by a lease agreement at the proposed new well location, assuming it is not located within the existing lease areas. The site is covered by relatively loose sands and test wells would need to be drilled by equipment that won’t get easily stuck in the sand or that requires a significant amount of support equipment as they will either need to be brought in by track mounted equipment or by hand.

5.1.6 Additional Considerations

5.1.6.1 Operations and Maintenance

Preventative and routine maintenance of the new well and the associated pump would be required. The anticipated lifespan of the replacement well ranges between 30 and 50 years and the lifespan of the new well pump is estimated to be 20 years.

5.1.7 Cost Estimate

Construction and Non-Construction Implementation Costs

Based on prior experience with well siting and drilling in the project area, wells are expected to extend a minimum of 100 feet below the ground surface to access the primary aquifer and meet minimum surface seal requirements. Drought conditions in the region are increasing demand for drilling services, which have significantly increased costs and extended project timelines. A detailed breakdown of the estimated cost of a new well is provided in Appendix A. Note that the costs presented are estimated as Association for the Advancement of Cost Estimation (AACE) Level 4 estimates, appropriate for estimating feasibility with some semi-detailed unit costs with assembly level line items. The site work, mobilization/demobilization, and non-construction implementation costs are estimated based on a percentage of the construction costs. This is seen in detail in the provided appendix.

A new well would require a high-level well siting study, design and installation of a well pump, electrical and control systems, intertie installation and design, and initial water quality testing. In addition, this alternative includes the cost of a new electrical connection to the well location, a backup generator, and a prefabricated pump house.

Additional treatment may be required to meet water quality standards following the guidelines presented in Alternatives 3 and 4. However, the cost of treatment is not included in this estimate.

Table 9 Estimated construction and non-construction implementation costs for new groundwater well alternative.

Item	Estimated Cost[1]
Construction Costs	
Drilling Subcontractor (Permanent Well Installation)	$52,500
Well Pump and Equipping	$20,000
New Electrical Connection	$60,000
Backup Generator	$108,100
Prefabricated Pump House	$35,000
Site Work	$41,340

Item	Estimated Cost[1]
Mobilization/Demobilization	$55,120
Well Siting Study	$100,000
Total Construction Costs (without contingency)	**$472,060**
Non-Construction Implementation Costs	
Administration	$23,603
Land/ROW Acquisition	$4,721
Engineering	$70,809
CEQA - Exempt	$9,441
General Permitting	$4,721
Bid Period Services	$14,162
Construction Administration	$47,206
Labor Compliance	$4,721
Project Close Out	$14,162
Contingency	$94,412
Non-Construction Implementation Soft Costs (including 20% contingency)	**$287,957**
Total (Construction costs and Non-Construction Implementation Costs)	**$760,017**

Annual Operations and Maintenance Cost

Estimated operations and maintenance costs (O&M) for this alternative can be seen in Table 10. The operating expenses are based on the financial audit supplied in the 2022 P&P Initial Assessment Report (P&P, 2022). A 5% increase each year (2020-2024) has been added because the most recent data is from 2019. A detailed breakdown of the operational cost of a new well is provided in Appendix A.

Table 10 Estimated annual operations and maintenance cost.

Source	Item	Estimated Annual Cost
Initial cost from the 2019 audit within the 2022 P&P Report, with 5% added for years 2020 through 2024. Costs shown are the calculated costs for 2024.	Services and supplies	$ 15,947
	Repairs and maintenance	$ 24,175
	Insurance	$ 2,283
	Utilities	$ 6,312
	Miscellaneous	$ 836
	Depreciation	$ 789
	Estimated existing annual operation and maintenance costs	$ 50,343
Calculated for this alternatives analysis	**Operational cost of new well (1.5% CAPEX)**	**$11,400**
Total Expenses per year		$61,742

Cost Effective Present Worth Analysis and Life-Cycle Cost Analysis

The exceptionally high water demand estimates have significantly impacted the costs presented in the alternatives analysis. The effective present worth analysis and life-cycle cost analysis should be revisited following revisions to the demand estimates.

5.1.8 Advantages and Disadvantages

This alternative would provide a new primary water source for KCSD while keeping the existing well that is reaching the end of its design life as an emergency backup water source. The hydrogeologic study (or well siting study) would identify the areas with the best water quality available which could reduce the size of the treatment system and corresponding long-term O&M costs. In addition, having a secondary source of water would eliminate the need to increase the storage volume to meet the MDD of approximately 271,000 gpd.

The advantages of Alternative 1 installation of a new well include:

– The existing well is approximately 41 years old and estimated to be near the end of its useful life (e.g., wells are estimated to have a useful life of 30-50 years). This alternative provides a replacement well and the opportunity to have the existing well become a backup well.

– Having a backup supply source meets the future requirement of Senate Bill 552, which requires that water systems either have an intertie or backup supply that meets current water quality requirements and the ADD by January 1, 2027.
– This alternative provides a backup supply well, which would eliminate the need to increase the Water System storage capacity to 271,000 gallons.
– The well-siting study would investigate finding a new water supply with reduced water quality issues.
– The capital cost of the alternative is small, relative to the cost of a new treatment system.
– The long-term operation and maintenance cost of the alternative is small, relative to the cost of maintaining a new treatments system. This assumes that the new well would be installed in an area identified in the well siting study as having reduced water quality issues.
– The alternative provides a backup power supply so that the water supply is not impacted by power outages. This also satisfies Senate Bill 552 requirements that state that by no later than January 1, 2024 communities must ensure continuous operations during power failures by providing adequate backup electrical supply.

The disadvantages of Alternative 1 installation of a new well include:

– Without nearby water quality data, it is difficult to properly assess the likelihood of finding a new water source with reduced water quality issues within the nearby vicinity of KCSD's existing infrastructure.
– If a new water supply with reduced water quality concerns cannot be identified, then a treatment system will still be needed.
– There are many potential costs associated with the construction of a new well that are difficult to estimate without having existing data, such as the needed depth and diameter of a new well, site preparation, and trucking and material costs for the rural location, among others.

5.1.9 Alternative Evaluation and Recommendations

As mentioned in previous sections, there are concerns regarding the accuracy of the water demand estimates. The high demand estimate (188 gpm) has greatly influenced the cost of the treatment alternatives (e.g., the higher the demand, the larger the treatment system and the higher the capital and operational costs). Without additional demand data, Alternative 1 provides the opportunity to search for a water supply that has fewer water quality issues that may not require treatment.

The cost of Alternative 1 is relatively low compared to the cost of installing and maintaining a treatment system. In addition, a new well would eliminate the need to increase the storage volume from 100,000 gallons to 271,000 gallons because there would be a backup supply well. If the need to increase storage can be removed, then the tank cost for that increased storage can be removed. The cost of a new storage tank (water product tank) is captured in Alternatives 3 and 4 treatment system installations. In addition, this alternative can be pursued while water meters are installed in the System, which would provide clarity regarding the high water demand.

Under the assumption that there will not be any additional water demand or quality data available, Alternative 1 is recommended alternative. However, it is assumed that for this alternative to be a fruitful alternative it needs to include the well-siting study and investigation and refinement of the water demand estimates.

5.2 Alternative 2: Pump Upgrades to Existing Well

5.2.1 Description

This alternative includes installation of a new pump and redevelopment of the existing well (if required). If production could be raised to the wells initial capacity of 312 gpm, this could provide an increase to the well's yield and meet the required 188 gpm MDD while operating for 14.5 hours and allowing for 9.5 hours of recovery. This alternative was developed to address water quantity concerns and does not address water quality issues. Therefore, this alternative would need to be paired with one of the treatment alternatives (Alternatives 3 or 4).

The existing well is operated with a 10-horsepower stainless steel submersible pump and a backup 5-horsepower stainless steel pump that can provide up to 150 and 75 gpm of water respectively. This is less than the yield of 312 gpm reported on the Well Completion Report during its initial construction.

The well is 41 years old and well yields tend to decline over their expected service life, typically between 40 and 50 years. However, it is constructed with a PVC casing which tends to last longer than other casing materials and may still have a yield similar to when it was initially constructed. To maximize yield, rehabilitation of the well may be required. In most cases, the contractor responsible for redeveloping a well will not know whether redevelopment is required or possible until the well pump is removed to allow for closed circuit television (CCTV) inspection.

If the well is in poor condition, the contractor would suggest drilling a new well, and the project would need to revert to the first alternative as the relative cost of attempting to repair the well is on par with the cost of drilling a new well.

If the well is in good condition and the well has maintained or can be redeveloped to its original yield, this alternative would consist of removing the existing pumps and down-column piping, performing an initial inspection of the well's condition with CCTV, redeveloping the well (if required), performing a pump test to size the pump for the well, and installation of the new pump.

5.2.2 Design Criteria

Alternative 2 includes the following primary design components:

- Well redevelopment (if needed and dependent on capacity)
- New well pumps
- Upgrades to electrical system and backup generator

Well Inspection and Redevelopment

Initial inspection for the well would include removing the pumps and down-column pipe, followed by CCTV inspection to determine the available well depth and condition of the PVC casing and perforated sections. If the well is recommended for redevelopment, the steps may include chemical treatment, surging & pumping, swabbing of perforated casing intervals, and (relining) of the casing breaks.

New Well Pumps

Following the initial inspection and redevelopment, a pump test would be performed (8 hours) to evaluate the aquifer capacity and size the new pump. The pump test would consist of a step drawdown test using a minimum of three flow rates (50%, 100%, and 150% of the design flow rate) to determine the well's specific capacity and size a new pump. The expected volume of water from the pump test is on the order of 171,000 gallons and will need to be stored or discharged onsite at time of the test.

The existing well pumps are likely in good condition having been replaced by KCSD in 2021 and may have resell value.

Upgrades to Electrical System and Backup Generator

A backup generator would be installed at the existing well location. Note that the backup generator has not been sized to power a treatment system should one of the treatment alternatives be selected.

This estimate assumes that a 50 kW Diesel engine generator with a Level 2 sound enclosure on a concrete pad and a 100-Amp 3 pole automatic transfer switch would be installed to provide emergency power to a well pump and booster pump site. The estimated electrical loads are shown in Table 8. This also assumes that an electrical service upgrade to a 200-Amp, 480-volt would be installed for the existing electrical service. A new switchboard and necessary conduits and cables to intercept the new electrical service would be installed.

Additional Design Considerations

In order to address water quality concerns and meet the storage requirement of MDD, a treatment system with a product water tank would be required following Alternatives 3 or 4.

5.2.3 Environmental Impacts

No significant environmental impacts are expected. It is anticipated that a CEQA categorical exemption would be pursued for this alternative.

5.2.4 Land Requirements

There are no additional land requirements for pump upgrades to the existing well. However, this alternative alone does not solve the water quality issues. Therefore, if this alternative is selected as the solution to the supply issue, then a treatment alternatives should be considered as a solution to the water quality issues. The treatment alternatives require additional land requirements and coordination with BLM. In addition, this alternative does not meet the requirement of having either a second water source or a storage capacity of one MDD. Therefore, the treatment systems product water tank would need to be sized to accommodate the additional needed storage. This is included in the treatment system alternatives.

5.2.5 Construction and Site Considerations

The area around the well is not paved and contains loose sand. Temporary site access gravel roads or tire modifications may be required for large vehicles that are required to access the well for any onsite activities.

If the well is redeveloped, KCSD would need a temporary source of potable water.

If the well cannot yield volumes similar to its original construction, a new well would need to be constructed and follow the same access guidelines as discussed in the previous alternative.

5.2.6 Cost Estimate

Construction and Non-Construction Implementation Costs

Well redevelopment costs (if required) will vary depending on existing well condition, depth, and cleaning requirements. These would be further defined after the contractor pulls the well pump and performs a CCTV inspection. This cost estimate assumes that redeveloping the well is both reasonable and an efficient use of funds. A detailed breakdown of the estimated cost of pump upgrades to the existing well is provided in Appendix B. Note that the costs presented are estimated as Association for the Advancement of Cost Estimation (AACE) Level 4 estimates, appropriate for estimating feasibility with some semi-detailed unit costs with assembly level line items. The site work, mobilization/demobilization, and non-construction implementation costs are estimated based on a percentage of the construction costs. This is seen in detail in the provided appendix.

In addition, this cost estimate includes electrical upgrades at the existing well site and installation of a backup generator.

Note that this alternative does not solve for the water quality issues and would need to be paired with a treatment alternative. The costs below do not include the cost of pairing this alternative with one of the treatment alternatives. Therefore, to get a total project cost the total cost from Alternative 2 would need to be added with one of the treatment alternative costs.

Table 11 Estimated construction cost for pump upgrades to the existing well.

Item	Estimated Cost[1]
Construction Cost	
Well Condition Assessment	$10,000
Well Rehab and Pump Test	$20,000
New Pump	$7,500
Electrical Upgrades and Backup Generator	$108,100
Site Work	$7,280
Mobilization/ Demobilization	$29,120
Total Construction Costs (without contingency)	**$182,000**

Item	Estimated Cost[1]
Non-Construction Implementation Costs	
Administration	$9,100
Engineering	$27,300
Bid Period Services	$9,100
Construction Administration	$18,200
Project Close Out	$5,460
Contingency	$36,400
Non-Construction Implementation Soft Costs (including 20% contingency)	**$105,560**
Total (Construction costs and Non-Construction Implementation Costs)	**$287,560**

Annual Operations and Maintenance Cost

Estimated operations and maintenance costs (O&M) for this alternative can be seen in Table 12. The operating expenses are based on the financial audit supplied in the 2022 P&P Initial Assessment Report (P&P, 2022). A 5% increase each year (2020-2024) has been added because the most recent data is from 2019. A detailed breakdown of the operational cost of pump upgrades to the existing well is provided in Appendix B.

Table 12 Estimated annual operations and maintenance cost.

Source	Item	Estimated Annual Cost
Initial cost from the 2019 audit within the 2022 P&P report, with 5% added for years 2020 through 2024. Costs shown are the calculated costs for 2024.	Services and supplies	$ 15,947
	Repairs and maintenance	$ 24,175
	Insurance	$ 2,283
	Utilities	$ 6,312
	Miscellaneous	$ 836
	Depreciation	$ 789
	Estimated existing annual operation and maintenance costs	$ 50,343
Calculated for this alternatives analysis	**Operational cost of pump upgrades to existing well**	$4,313

Total Expenses per year		$54,655

Cost Effective Present Worth Analysis and Life-Cycle Cost Analysis

The exceptionally high water demand estimates have significantly impacted the costs presented in the alternatives analysis. The effective present worth analysis and life-cycle cost analysis should be revisited following revisions to the demand estimates.

5.2.7 Advantages and Disadvantages

This alternative would provide more water quantity for relatively little capital and O&M cost.

This alternative does not address water quality issues and would need to be paired with either alternative 3 or 4 to address arsenic and manganese levels. Additionally, this alternative does not improve the service life of the well (likely to last 10-20 years depending on the condition of the well casing) and it is uncertain if the well's yield has degraded since its construction.

The advantages of Alternative 2 pump upgrades to the existing well include:

– The alternative provides a backup power supply so that the water supply is not impacted by power outages. This also satisfies Senate Bill 552 requirements that state that by no later than January 1, 2024 communities must ensure continuous operations during power failures by providing adequate backup electrical supply.

The disadvantages of Alternative 2 pump upgrades to the existing well include:

– Upgrading the existing well is needed to meet the demand of 188 gpm, however this does not solve the water quality issues. Therefore, this alternative must be paired with a treatment alternative. This means that this alternative has a much higher capital cost than just the well upgrades alone.
– The existing well is approximately 41-years old and therefore is estimated to be near the end of the well's useful life (wells are estimated to have a useful life of 30-50 years).
– Given that the well is old, there may be unforeseen future maintenance costs.
– This alternative does not include a new backup water source and therefore the water storage must be increased to meet one MDD, which means storage must increase from 100,000 gallons to 271,000 gallons. The cost of a new storage tank greatly impacts the cost of this alternative.
– Without a backup water supply, this alternative does not meet upcoming Senate Bill 552 requirements, which states that no later than January 1, 2027 water systems with fewer than 1,000 connections have a least one backup source of water supply, or a water system intertie, that meets current water quality requirements and is sufficient to meet average daily demand.

5.2.8 Alternative Evaluation and Selection

As mentioned in previous sections, there are concerns regarding the accuracy of the water demand estimates. The high demand estimate (188 gpm) greatly influences the water storage needed. Alternative 2 does not include installation of a backup supply, therefore the alternative must meet the required storage volume of one MDD (271,000 gallons). This means increasing storage from 100,000 gallons to 271,000 gallons. This alternative also does not solve the water quality issues; therefore, it must be paired with one of the treatment alternatives. The cost of the new storage tank (referred to as product water tank) is captured in Alternatives 3 and 4 in the treatment alternatives costs.

In summary, this alternative does not alone solve the water quality issues and does not alone solve the backup water supply or storage issues. This alternative is also more costly because it must be paired with a treatment alternative.

For these reasons, Alternative 2 pump upgrades to the existing well is not recommended.

5.3 Alternative 3: Greensand Filtration Treatment

Under this alternative, a greensand filter water treatment facility would be constructed adjacent to the existing water tank. As discussed in previous sections, it is desired to split the irrigation water (outdoor use/unpotable water) and the drinking water (indoor use/potable water). If the outdoor use and indoor use water is separated, the treatment facility can be sized down and the operation and maintenance efforts and costs will be reduced.

It is assumed that the treatment facility would be constructed at the existing water storage tank site. This allows for both the potable water and the unpotable water to be gravity fed into the distribution system. The existing storage tank and distribution network would be used for the unpotable water. The potable water would be processed and then stored in a product water tank, which would provide the additional storage required (~171,000 gallons) to meet the MDD requirement for small communities that do not have a backup water supply. If a new well were installed, then the product water tank could be smaller, as the community would then have a backup supply.

The irrigation and drinking water split would occur at the water tank and treatment system site. Therefore, a new transmission line from the well to the treatment site would not be needed. The irrigation water would be stored in the existing storage tank and gravity fed into Keeler through the existing distribution network. The potable water would be stored in a new product water tank and then gravity fed into Keeler through a new distribution network, installed parallel to the existing network.

As part of this alternative, water meters would be installed through the System. No additional fire hydrants are planned. Under this alternative fire hydrants would utilize irrigation water.

5.3.1 Design Criteria

The primary design components for Alternative 3 are as follows:

- Construction of the Greensand Treatment System.
- New electrical service at the storage tank location to power the treatment facility.
- Installation of a new distribution system that would deliver the potable drinking water. The existing distribution system would become the delivery system for irrigation (outdoor use) water. The new distribution system would be installed parallel to the existing system.
- Water meter installation throughout the System.

5.3.2 Treatment Description

Alternative 3 is shown in Figure 7. The water from the well initially is chlorinated using flow-paced sodium hypochlorite dosing to disinfect, inhibit biological growth, and oxidize manganese in the raw well water. Following this, the process will split between the irrigation water system and the drinking water system.

The drinking water system starts with a filter vessel which will contain granular ferric hydroxide (GFH) adsorption media to remove most arsenic in the water. From this process, the water is sent through a greensand filters where oxidation and removal of manganese will occur. The greensand media in the filter allows the dissolved manganese in the water to adsorb onto the media and the chlorine added previously rapidly oxidizes the manganese. From the filters, the water will flow to the product water tank for storage. Then the water will be dosed with sodium hypochlorite to inhibit biological growth and will be driven by gravity to the new drinking water distribution system. The system will include an opposite flow connection from the product water tank to the greensand filters to periodically clean the dual-media filters by reversing flow in a sequence called back washing. Spent backwash water will be sent to the irrigation water tank.

This spent backwash water blends with the chlorinated well water in the irrigation water tank. This water then flows through the existing distribution water mains as non-potable water for landscaping.

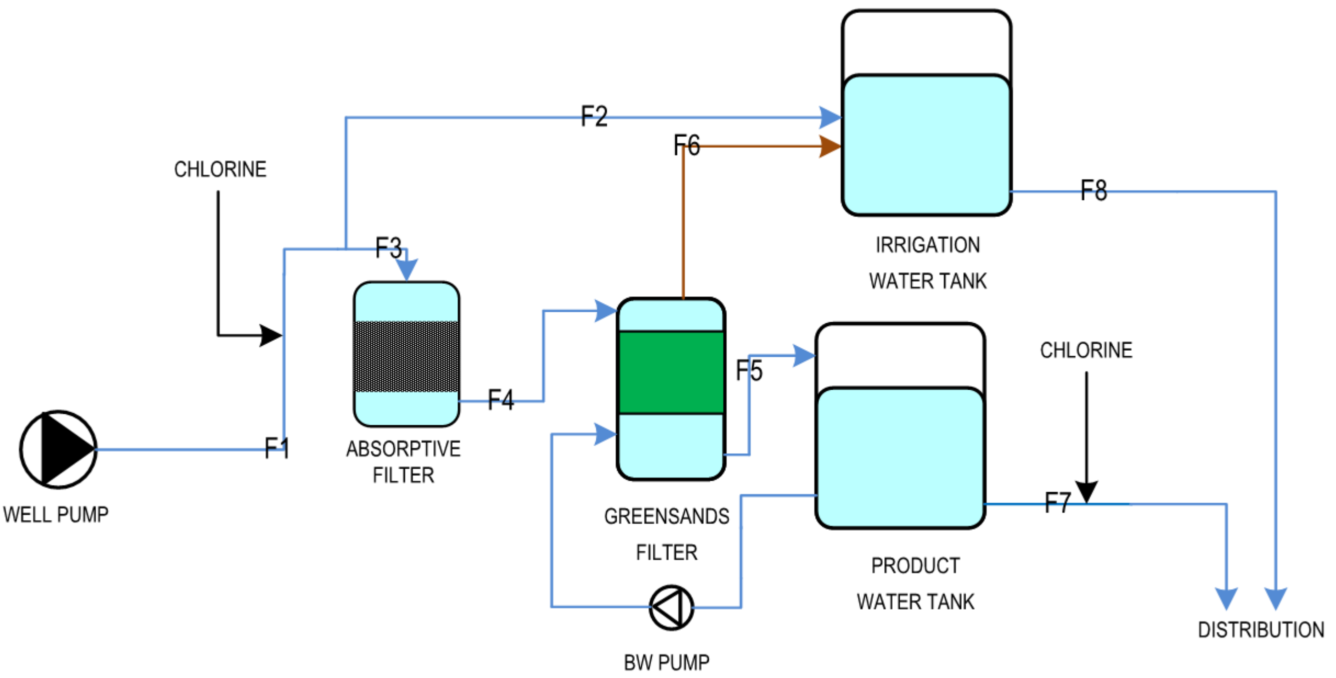

Figure 7   Greensand Treatment process flow diagram. Note that steps F1 through F7 are discussed in detail in the following section.

5.3.3 Mass Balance Water Quality Evaluation

A mass balance analysis was completed to evaluate if the backflush water produced from the greensand filter could be recycled into the irrigation water tank and with mixing of unpotable water input, meet water quality standards for irrigation purposes. A discussion of water quality regulatory guidelines for agricultural designation was provided in Section 3.3. In summary, we applied maximum contaminant guidelines of 0.20 mg/L for manganese and 0.10 mg/L for arsenic.

To evalaute water quality and water recycling options, assumptions were made about the flow rates and the volume of water being used for irrigation versus drinking water. The mass balance analysis looked at a well production rate of 312 gpm (assumed to be the wells full capacity) and also 200 gpm (a smaller volume that meets the estimated MDD requirements). It has been assumed that 70% would go to the irrigation side and 30% would go to the drinking water side. Even with the lower total flow input of 200 gpm, that would be 60 gpm to the drinking water side, or 1,309 gpd of potable water available per connection. This should far exceed the use for a residence.

The mass balance results for the two flow rates are shown below as Figure 8 and Figure 9.

Note that the ratio of unpotable water to backflush water is what drives the output of concentrations, and not the total flow input. Results indicate that at this ratio the arsenic and manganese concentrations could meet the regulatory guidelines discussed above. Note that this ratio is conservative. If water demand invesitgation reveal a lower potable use and the treatement system were decreased in size, then these concentrations could be decreased based on a lower backflush volume into the storage tank.

Flow # :		F1	F2	F3	F4		F5	F6	F7	F8			
		Well Pump	Irrigation Bypass	Absorptive Filter Feed	Greensand Filter Feed	Recovery	Greensand Filter Filtrate	Greensand Filter Waste	Drinking Water	Irrigation Water	Estimated MDD and Required Storage Volume	Total produced each day	Available Treated Water per day per Connection
Configuration #1	(gpm)	200	139	61	61	98%	60	1	60	140	188	200	
	(gpd)	288,035	199,872	88,163	88,163	98%	86,400	1,728	86,400	201,600	270,720	288,000	1,309
	As (mg/l)	0.076	0.076	0.076	0.008	-	0.008	0.008	0.008	0.075			
	Mn (mg/l)	0.070	0.070	0.070	0.070	-	0.0036	3.3250	0.004	0.098			

Figure 8 Mass balance for a flow input of 200 gpm and a 70/30 split of irrigation to potable water. Note that the ratio is the driving factor for the output concentrations. F8 indicates that at this ratio the arsenic and manganese concentrations could meet the regulatory guidelines discussed above.

Flow # :		F1	F2	F3	F4		F5	F6	F7	F8			
		Well Pump	Irrigation Bypass	Absorptive Filter Feed	Greensand Filter Feed	Recovery	Greensand Filter Filtrate	Greensand Filter Waste	Drinking Water	Irrigation Water	Estimated MDD and Required Storage Volume	Total produced each day	Available Treated Water per day per Connection
Configuration #1	(gpm)	312	217	96	96	98%	94	2	94	218	188	312	
	(gpd)	449,335	311,801	137,535	137,535	98%	134,784	2,696	134,784	314,496	270,720	449,280	2,042
	As (mg/l)	0.076	0.076	0.076	0.008	-	0.008	0.008	0.008	0.075			
	Mn (mg/l)	0.070	0.070	0.070	0.070	-	0.0036	3.3250	0.004	0.098			

Figure 9 Mass balance for a flow input of 312 gpm and a 70/30 split of irrigation to potable water. Note that the ratio is the driving factor for the output concentrations. F8

indicates that at this ratio the arsenic and manganese concentrations could meet the regulatory guidelines discussed above.

5.3.4 Environmental Impacts

One concern regarding impacts of the treatment systems are the water quality concentrations of the irrigation water. Although they are anticipated to meet water quality for irrigation uses, there would need to be an understanding with residents and signage for visitors that the water is not potable.

5.3.5 Land Requirements

KCSD would need to coordinate an extension of the land easement at the storage tank site with BLM. The new easement would need to be large enough for the existing storage tank to remain (which would house irrigation/outdoor use water) and the treatment facility components (including the new water product tank which would house the drinking water supply).

5.3.6 Construction and Site Considerations

It has been assumed that a good location for a new treatment system would be at the existing storage tank site. This would allow for the distribution system to remain gravity fed. The site and access roads are covered by relatively loose sands and gravel. This could require additional site preparations including compaction and potentially paving, in order to construct the treatment facility and to allow access for trucks delivering operational supplies.

5.3.7 Cost Estimate

Construction and Non-Construction Implementation Costs

Capital and operational costs have been estimated for each alternative that outline the primary System components and estimated primary operational costs. These costs are also anticipated to change, potentially significantly, as the design progresses. However, these costs provide the opportunity to do a cost comparison between the treatment alternatives evaluated. Note that the high water demand estimates significantly impact the size of the treatment system components and the associated capital and operational costs. A detailed breakdown of the estimated cost of this treatment alternative is provided in Appendix C. Note that the costs presented are estimated as Association for the Advancement of Cost Estimation (AACE) Level 4 estimates, appropriate for estimating feasibility with some semi-detailed unit costs with assembly level line items.

The cost of this alternative includes the cost of the Greensand Filtration Treatment System, a new electrical service for the treatment system, a new distribution system for the drinking water, and the cost of water meters.

To secure vendor quotes, assumptions about the production rate and the amount of water being processed by the treatment plant were necessary for treatment system sizing. The costs have been developed using the following assumptions:

– The well will be pumping at 312 gpm.
– The product water tank will be sized to hold 171,000 gallons. This provides the additional storage required to meet the storage MDD. The existing tank holds 100,000 gallons,

therefore combined with the product water tank, storage of one MDD of 271,000 gallons would be met.

- The split of irrigation to drinking water is 70% of the 312-gpm going to the irrigation side and 30% of the 312-gpm going to the treatment/drinking water side. This results in a flow rate of 94 gpm going to the treatment side and 218 gpm going to the irrigation side.
- The cost of energy will be $0.20 $/kilowatt hour ($/kWh).
- Chemical costs were based on estimates provided by vendors in March and April 2024.
- Filter backwash water will be recycled into the existing water tank, which would become the irrigation water tank.
- KCSD will hold the certifications necessary to operate the treatment process.
- The costs provided are based partly on quotes provided by vendors, which may significantly change with market fluctuations. Quotes from vendors are typically guaranteed for 30 days following receipt of the quote.
- The existing water meter boxes are in good condition and would be utilized for installation of the water meters.
- The site work, mobilization/demobilization, and non-construction implementation costs are estimated based on a percentage of the construction costs. This is seen in detail in the provided appendix.

Table 13 Alternative 3 Greensand treatment system cost estimate.

Item	Estimated Cost
Construction Costs	
Greensand Filtration Treatment System	$ 3,212,185
New Electrical Service	$ 60,000
Distribution System Replacement	$ 2,347,675
Water Meters	$ 250,800
Site Work (calculated based on a percentage of the items above, see appendix)	$ 587,066
Mobilization/Demobilization (calculated based on a percentage of the items above, see appendix)	$ 1,174,132
Total Construction Costs (without contingency)	**$ 7,631,858**
Non-Construction Implementation Costs	
Administration	$ 381,593
Land/ROW Acquisition	$ 76,319
Engineering	$ 1,144,779

Item	Estimated Cost
CEQA - MND	$ 381,593
General Permitting	$ 76,319
Bid Period Services	$ 228,956
Construction Administration	$ 763,186
Labor Compliance	$ 76,319
Project Close Out	$ 228,956
Contingency	$ 1,526,372
Non-Construction Implementation Soft Costs (including 20% contingency)	**$ 4,884,389**
Total (Construction costs and Non-Construction Implementation Costs)	**$ 12,516,247**
[1] *Based on*	

Annual Operations and Maintenance Cost

Estimated operations and maintenance costs (O&M) for this alternative can be seen in

Table 14. The operating expenses are based on the financial audit supplied in the 2022 P&P Initial Assessment Report (P&P, 2022). A 5% increase each year (2020-2024) has been added because the most recent data is from 2019. A detailed breakdown of the operational cost of this treatment alternative is provided in Appendix C.

Estimating the operational expenses of the treatment system is challenging at this stage due to the limited design. The estimated operational expenses include both variable costs (costs that can change with market value and that are dependent on how often the System is in operation) and fixed costs (costs that are estimated based on known future equipment replacement and equipment maintenance). The total estimated operational expense is the sum of these two cost categories.

The annualized media replacement cost represents the dollar amount that should be saved yearly for future replacement. This cost is estimated based on the media capital cost and the estimated life of the media.

The O&M Cost is a standardized cost (1.5% of the Capital Cost) which is the estimated dollar amount that it would take for both the manual labor requirements as well as preventative maintenance. A standardized cost of 1.5% is used for guidance, however depending on the System this will vary.

Table 14 Estimated annual operations and maintenance cost

Source	Item	Estimated Annual Cost
Existing Estimated Operation and Maintenance Costs		
Initial cost from the 2019 audit within the 2022 P&P report, with 5% added for years 2020 through 2024. Costs shown are the calculated costs for 2024.	Services and supplies	$ 15,947
	Repairs and maintenance	$ 24,175
	Insurance	$ 2,283
	Utilities	$ 6,312
	Miscellaneous	$ 836
	Depreciation	$ 789
	Estimated existing annual operation and maintenance costs	**$ 50,343**
Treatment System Estimated Operation and Maintenance Costs		
Operational costs of the Greensand Filtration Treatment System Calculated for this alternatives analysis	Power	$ 19,272.00
	Chemical	$ 7,400
	Total Variable Costs	$ 26,672
	Annualized Media Replacement	$ 417,802.11
	Operation and Maintenance (1.5% of CAPEX)	$ 48,183
	Total Fixed Costs	$ 465,985
	Operational Cost of Greensand Filtration Treatment	**$ 492,657**
Total Expenses per year		**$ 542,999**

Cost Effective Present Worth Analysis and Life-Cycle Cost Analysis

The exceptionally high water demand estimates have significantly impacted the costs presented in the alternatives analysis. The effective present worth analysis and life-cycle cost analysis should be revisited following revisions to the demand estimates.

5.3.8 Advantages and Disadvantages

The advantages of Alternative 3 Greensand Treatment include:

- The opportunity to install a new distribution system for the drinking water supply, reducing the consumer reliance on the aged distribution system for drinking water supply.
- The opportunity to separate the drinking water and irrigation water and use the existing distribution system for irrigation water. This reduces the size of the treatment system needed, therein reducing the capital and operational cost of the treatment system.
- A simplified treatment approach in comparison to Alternative 4 Dual Media Filtration because treatment chemicals are not needed (beyond sodium hypochlorite).
- A treatment approach that removes arsenic prior to filter backflushing, reducing the arsenic concentration in the irrigation water.
- A treatment approach that potentially allows for recycling of the backflush water into the existing storage tank to be used for irrigation water. This assumes that the RWQCB agrees with the contamination concentrations described herein for irrigation uses.

The disadvantages of Alternative 3 Greensand Treatment include:

- The size and production rate of the treatment system is based on assumptions regarding questionable water demand data. The unreasonably high MDD of 188 gpm greatly impacts the size of the System and therefore the estimated capital and operational costs.
- A significantly higher yearly operational cost than the Dual Media Treatment Alternative due to the arsenic media consumption, replacement, and disposal.
- Requires that an operator with a treatment license be assigned to maintain the treatment system.
- Relies on BLM granting additional land in the easement to KCSD for construction of the treatment facility.
- The operation and maintenance of any treatment system requires staff available to perform operation and maintenance activities that can be time intensive. Keeler currently does not have available staff to perform operation and maintenance activities.
- The current water system income and consumer rates do not support the long-term operation and maintenance costs of a new treatment system.
- Without a backup water supply, this alternative does not meet upcoming Senate Bill 552 requirements, which states that no later than January 1, 2027 water systems with fewer than 1,000 connections have a least one backup source of water supply, or a water system intertie, that meets current water quality requirements and is sufficient to meet average daily demand.

5.3.9 Alternative Evaluation and Selection

As mentioned in previous sections, there are concerns regarding the accuracy of the water demand estimates. The high demand estimate (188 gpm) has greatly influenced the cost of the treatment alternatives (e.g., the higher the demand, the larger the treatment system and the higher the capital and operational costs).

In addition, KCSD currently does not have the finances or staff available for operation and maintenance of a treatment system. A rate study could help identify if increases in rates can alleviate this shortfall. However, with so few connections/customers it is not clear that the community can support the long-term costs of a treatment system operating at this scale.

Without a higher confidence in the demand data and without better understanding how the community can financially support or staff a treatment system, installation of a treatment system is not recommended.

5.4 Alternative 4: Dual Media Filtration Treatment

Under this alternative, a dual media filtration water treatment facility would be constructed adjacent to the existing water tank. As discussed in previous sections, it is desired to split the irrigation water (outdoor use/unpotable water) and the drinking water (indoor use/potable water). If the outdoor use and indoor use water is separated the treatment facility can be sized down and the operation and maintenance efforts and costs will be reduced.

It is assumed that the treatment facility would be constructed at the existing water storage tank site. This allows for both the potable water and the unpotable water to be gravity fed into the distribution system. The existing storage tank and distribution network would be used for the unpotable water. The potable water would be processed and then stored in a product water tank, which would provide the additional storage required (~171,000 gallons) to meet the MDD requirement for small communities that do not have a backup water supply. If a new well were installed, then the product water tank could be sized down since the community would then have a backup supply.

The irrigation and drinking water split would occur at the water tank and treatment system site. Therefore, a new transmission line from the well to the treatment site would not be needed. The irrigation water would be stored in the existing storage tank and gravity fed into Keeler through the existing distribution network. The potable water would be stored in the product water tank and then gravity fed into Keeler through a new distribution network, installed parallel to the existing network.

As part of this alternative, water meters would be installed through the System. No additional fire hydrants are planned.

5.4.1 Design Criteria

The primary design components for Alternative 3 are as follows:

- Construction of the Greensand Treatment System.
- New electrical service at the storage tank location to power the treatment facility.

– Installation of a new distribution system that would deliver the potable drinking water. The existing distribution system would become the delivery system for irrigation (outdoor use) water. The new distribution system would be installed parallel to the existing system.
– Water meter installation throughout the System.

5.4.2 Treatment Description

Alternative 4 is shown in Figure 10. Similar to the previous alternative, the water from the well initially is chlorinated using flow-paced sodium hypochlorite dosing to disinfect and inhibit biological growth in the raw well water. Following this, the process will split between the irrigation water system and the drinking water system.

The drinking water system is first dosed with sodium permanganate and ferric chloride. Sodium permanganate is a fast-acting oxidizer of manganese and arsenic. Ferric chloride acts as a coagulant and precipitates the oxidized arsenic and manganese. The water will then flow into dual-media filters to remove the oxidized and coagulated contaminants. This dual media consists of anthracite and sand. From the filters, the water will flow to the product water tank for storage. Then the water will be dosed with sodium hypochlorite to inhibit biological growth and will be driven by gravity to the new drinking water distribution system. The system will include an opposite flow connection from the product water tank to the dual-media filters to periodically clean the dual-media filters by reversing flow in a sequence called back washing. Spent backwash water will be sent to the irrigation water tank.

This spent backwash water blends with the chlorinated well water in the irrigation water tank. This water then flows through the existing distribution water mains as non-potable water for landscaping.

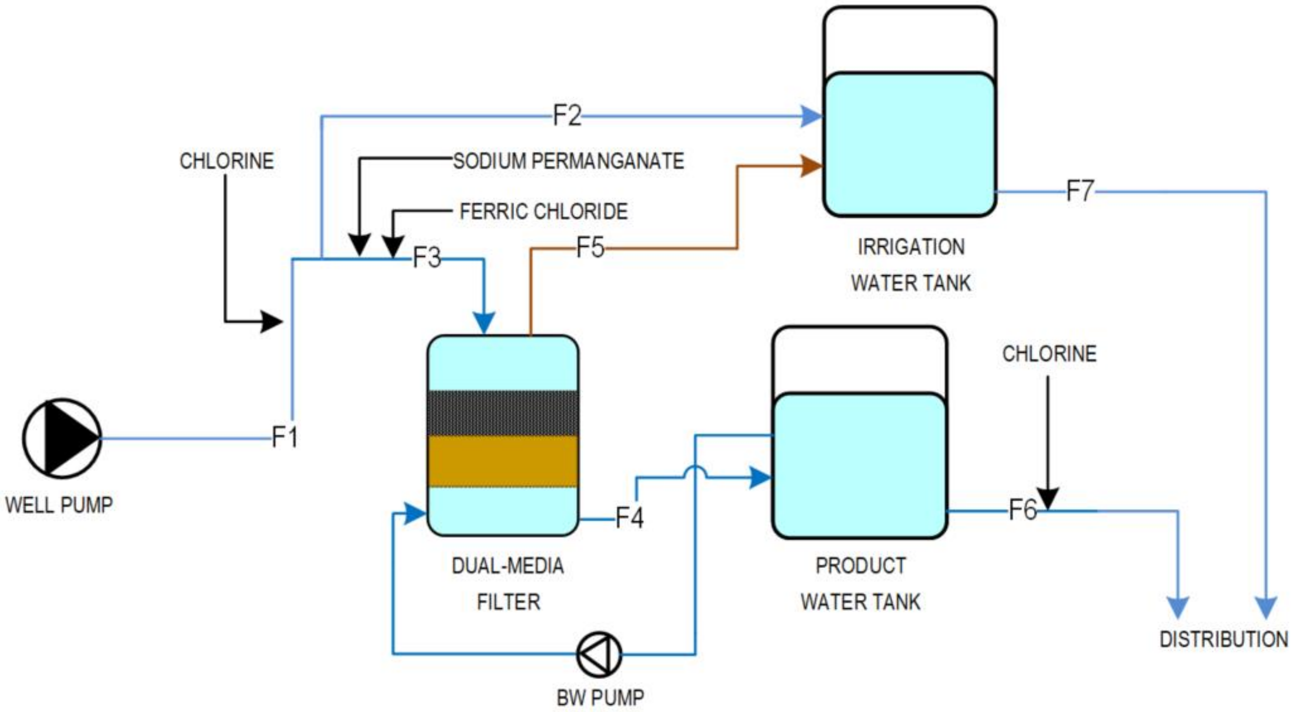

Figure 10 Dual Media Treatment process flow diagram. Note that steps F1 through F7 are discussed in detail in the following section.

5.4.3 Mass Balance Water Quality Evaluation

A mass balance analysis was completed to evaluate if the backflush water produced from the greensand filter could be recycled into the irrigation water tank and with mixing of unpotable water input, meet water quality standards for irrigation purposes. A discussion of water quality regulatory guidelines for agricultural designation was provided in Section 3.3 In summary, we applied contaminant guidelines of 0.20 mg/L for manganese and 0.10 mg/L for arsenic.

The concerns regarding the accuracy of the water demand estimates has been discussed in detail in previous sections. To evalaute water quality and water recycling options assumptions were made about the flow rates and the volume of water being used for irrigation versus drinking water.

The mass balance analysis looked at a well production rate of 312 gpm (assumed to be the wells full capacity) and also 200 gpm (which is a smaller volume that meets the estimated MDD requirements). There is no data currently on how much water is being used for irrigation (outdoor use) and drinking water (indoor use). It has been assumed that 70% would go to the irrigation side and 30% would go to the drinking water side. Even with the lower total flow input of 200 gpm, that would be 60 gpm to the drinking water side, or 1,309 gpd of potable water available per connection. This should far exceed the use for a residence.

The mass balance results for the two flow rates are shown below as Figure 11 and Figure 12.

Note that the ratio of unpotable water to backflush water is what drives the output of concentrations, and not the total flow input. Results indicate that at this ratio the arsenic and manganese concentrations could meet the regulatory guidelines discussed above. Note that this ratio is conservative. If water demand invesitgation reveal a lower potable use and the treatement system were decreased in size, then these concentrations could be decreased based on a lower backflush volume into the storage tank.

Flow # :		F1	F2		F3		F4	F5	F6	F7			
		Well Pump	Irrigation Bypass	Sodium Permanganate [0.5 mg/l]	Dual Media Filter Feed	Recovery	Dual Media Filter Filtrate	Dual Media Filter Waste	Drinking Water	Irrigation Water	Estimated MDD and Required Storage Volume	Total produced each day	Available Treated Water per day per Connection
Configuration #1	(gpm)	200	138		62	97%	60	2	60	140	188	200	
	(gpd)	288,080	199,008		89,072	97%	86,400	2,592	86,400	201,600	270,720	288,000	1,309
	As (mg/l)	0.076	0.076		0.076	-	0.008	2.3	0.008	0.10			
	Mn (mg/l)	0.070	0.070		0.260	-	0.026	0.2	0.026	0.07			

Figure 11 Mass balance for a flow input of 200 gpm and a 70/30 split of irrigation to potable water. Note that the ratio is the driving factor for the output concentrations. F8 indicates that at this ratio the arsenic and manganese concentrations could meet the regulatory guidelines discussed above.

Flow # :		F1	F2		F3		F4	F5	F6	F7			
		Well Pump	Irrigation Bypass	Sodium Permanganate [0.5 mg/l]	Dual Media Filter Feed	Recovery	Dual Media Filter Filtrate	Dual Media Filter Waste	Drinking Water	Irrigation Water	Estimated MDD and Required Storage Volume	Total produced each day	Available Treated Water per day per Connection
Configuration #1	(gpm)	312	216		96	97%	94	3	94	218	188	312	
	(gpd)	449,405	310,453		138,953	97%	134,784	4,044	134,784	314,496	270,720	449,280	2,042
	As (mg/l)	0.076	0.076		0.076	-	0.008	2.3	0.008	0.10			
	Mn (mg/l)	0.070	0.070		0.260	-	0.026	0.2	0.026	0.07			

Figure 12 Mass balance for a flow input of 312 gpm and a 70/30 split of irrigation to potable water. Note that the ratio is the driving factor for the output concentrations. F8 indicates that at this ratio the arsenic and manganese concentrations could meet the regulatory guidelines discussed above.

5.4.4 Environmental Impacts

One concern regarding impacts of the treatment systems are the water quality concentrations of the irrigation water. Although they are anticipated to meet water quality for irrigation uses, there would need to be an understanding with residents and signage for visitors that the water is not potable.

5.4.5 Land Requirements

KCSD would need to coordinate an extension of the land easement at the storage tank site with BLM. The new easement would need to be large enough for the existing storage tank to remain (which would house irrigation/outdoor use water) and the treatment facility components (including the new water product tank which would house the drinking water supply).

5.4.6 Construction and Site Considerations

It has been assumed that a good location for a new treatment system would be at the existing storage tank site. This would allow for the distribution system to remain gravity fed. The site and access roads are covered by relatively loose sands and gravel. This could require additional site preparations including compaction and potentially paving, in order to construct the treatment facility and to allow access for trucks delivering operational supplies.

5.4.7 Cost Estimate

Construction and Non-Construction Implementation Costs

Capital and operational costs have been estimated for each alternative that outline the primary system components and estimated primary operational costs. These costs are also anticipated to change, potentially significantly, as the design progresses. However, these costs provide the opportunity to do a cost comparison between the treatment alternatives evaluated. Note that the high-water demand estimates significantly impact the size of the treatment system components and the associated capital and operational costs. A detailed breakdown of the estimated cost of this treatment alternative is provided in Appendix D. Note that the costs presented are estimated as Association for the Advancement of Cost Estimation (AACE) Level 4 estimates, appropriate for estimating feasibility with some semi-detailed unit costs with assembly level line items.

The cost of this alternative includes the cost of the Dual Media Filtration Treatment System, a new electrical service for the treatment system, a new distribution system for the drinking water, and the cost of water meters.

To secure vendor quotes, assumptions about the production rate and the amount of water being processed by the treatment plant were necessary for treatment system sizing. The costs have been developed using the following assumptions:

– The well will be pumping at 312 gpm.
– The product water tank will be sized to hold 171,000 gallons. This provides the additional storage required to meet the storage MDD. The existing tank holds 100,000 gallons, therefore combined with the product water tank, storage of one MDD of 271,000 gallons would be met.
– The split of irrigation to drinking water is 70% of the 312-gpm going to the irrigation side and 30% of the 312-gpm going to the treatment/drinking water side. This results in a flow rate of 94 gpm going to the treatment side and 218 gpm going to the irrigation side.
– The cost of energy will be $0.20 $/kilowatt hour ($/kWh).
– Chemical costs were based on estimates provided by vendors in March and April 2024.
– Filter backwash water will be recycled into the existing water tank, which would become the irrigation water tank.
– KCSD will hold the certifications necessary to operate the treatment process.
– The costs provided are based partly on quotes provided by vendors, which may significantly change with market fluctuations. Quotes from vendors are typically guaranteed for 30 days following receipt of the quote.

– The existing water meter boxes are in good condition and would be utilized for installation of the water meters.
– The site work, mobilization/demobilization, and non-construction implementation costs are estimated based on a percentage of the construction costs. This is seen in detail in the provided appendix.

Table 15 Alternative 4 Dual Media treatment system cost estimate.

Item	Estimated Cost
Construction Costs	
Greensand Filtration Treatment System	$3,465,386
New Electrical Service	$60,000
Distribution System Replacement	$2,347,675
Water Meters	$250,800
Site Work (calculated based on a percentage of the items above, see appendix)	$612,386
Mobilization/Demobilization (calculated based on a percentage of the items above, see appendix)	$1,224,772
Total Construction Costs (without contingency)	**$7,961,019**
Non-Construction Implementation Costs	
Administration	$398,051
Land/ROW Acquisition	$79,610
Engineering	$1,194,153
CEQA - MND	$398,051
General Permitting	$79,610
Bid Period Services	$238,831
Construction Administration	$796,102
Labor Compliance	$79,610
Project Close Out	$238,831
Contingency	$1,592,204
Non-Construction Implementation Soft Costs (including 20% contingency)	**$5,095,052**

Item	Estimated Cost
Total (Construction costs and Non-Construction Implementation Costs)	**$13,056,072**
[1] Based on	

Annual Operations and Maintenance Cost

Estimated operations and maintenance costs (O&M) for this alternative can be seen in Table 16. The operating expenses are based on the financial audit supplied in the 2022 P&P Initial Assessment Report (P&P, 2022). A 5% increase each year (2020-2024) has been added because the most recent data is from 2019. A detailed breakdown of the operational cost of this treatment alternative is provided in Appendix D.

Table 16 Estimated annual operations and maintenance cost.

Source	Item	Estimated Annual Cost
Existing Estimated Operation and Maintenance Costs		
Initial cost from the 2019 audit within the 2022 P&P report, with 5% added for years 2020 through 2024. Costs shown are the calculated costs for 2024.	Services and supplies	$ 15,947
	Repairs and maintenance	$ 24,175
	Insurance	$ 2,283
	Utilities	$ 6,312
	Miscellaneous	$ 836
	Depreciation	$ 789
	Estimated existing annual operation and maintenance costs	**$ 50,343**
Treatment System Estimated Operation and Maintenance Costs		
Operational costs of the Dual Media Filtration Treatment System Calculated for this alternatives analysis	Power	$ 23,126
	Chemical	$ 34,200
	Total Variable Costs	$ 57,326
	Annualized Media Replacement	$ 315.00
	Operation and Maintenance (1.5% of CAPEX)	$ 51,980
	Total Fixed Costs	$ 52,296
	Operational Cost of Greensand Filtration Treatment	**$ 109,622**

Total Expenses per year		**$ 159,964**

Cost Effective Present Worth Analysis and Life-Cycle Cost Analysis

The exceptionally high water demand estimates have significantly impacted the costs presented in the alternatives analysis. The effective present worth analysis and life-cycle cost analysis should be revisited following revisions to the demand estimates.

5.4.8 Advantages and Disadvantages

The advantages of Alternative 4 Dual Media Treatment include:

- The opportunity to install a new distribution system for the drinking water supply, reducing the consumer reliance on the aged distribution system for drinking water supply.
- The opportunity to separate the drinking water and irrigation water and use the existing distribution system for irrigation water. This reduces the size of the treatment system needed, therein reducing the capital and operational cost of the treatment system.
- A treatment approach that potentially allows for recycling of the backflush water into the existing storage tank to be used for irrigation water. This assumes that the RWQCB agrees with the contamination concentrations described herein for irrigation uses.
- A lower yearly operational cost than the Greensand Treatment Alternative.

The disadvantages of Alternative 4 Dual Media Treatment include:

- The size and production rate of the treatment system is based on assumptions regarding questionable water demand data. The unreasonably high MDD of 188 gpm greatly impacts the size of the System and therefore the estimated capital and operational costs.
- Does not remove arsenic prior to filter backflushing and results in higher concentrations of arsenic in the irrigation water.
- Requires storage of oxidation chemicals and proper chemical dosing, which is not required in the Greensand Treatment Alternative.
- Requires that an operator with a treatment license be assigned to maintain the treatment system.
- Relies on BLM granting additional land in the easement to KCSD for construction of the treatment facility.
- The operation and maintenance of any treatment system requires staff available to perform operation and maintenance activities that can be time intensive. Keeler currently does not have available staff to perform operation and maintenance activities.
- The current Water System income and consumer rates do not support the long-term operation and maintenance costs of a new treatment system.
- Without a backup water supply, this alternative does not meet upcoming Senate Bill 552 requirements, which states that no later than January 1, 2027 water systems with fewer than 1,000 connections have a least one backup source of water supply, or a water system

intertie, that meets current water quality requirements and is sufficient to meet average daily demand.

5.4.9 Alternative Evaluation and Selection

As mentioned in previous sections, there are concerns regarding the accuracy of the water demand estimates. The high demand estimate (188 gpm) has greatly influenced the cost of the treatment alternatives (e.g., the higher the demand, the larger the treatment system and the higher the capital and operational costs).

In addition, KCSD currently does not have the finances or staff available for operation and maintenance of a treatment system at this scale. A rate study could help identify if increases in rates can alleviate this shortfall. However, with so few connections/customers it is not clear that the community can support the long-term costs of a treatment system.

Without a higher confidence in the demand data and without better understanding how the community can financially support or staff a treatment system, installation of a treatment system is not recommended.

6. Considerations and Recommendations

There are many unknowns and issues regarding the water demand estimates. The water demand is unreasonable for the size and number of connections (MDD is 188gpm or approximately 4,100 gpd per connection assuming all connections are used equally). Due to the exceptionally high demand, the storage requirement of one MDD is estimated as 271,000 gallons, which greatly influences the cost of the alternatives evaluated. Specifically, the size of the treatment system components.

In addition, not knowing the split between irrigation (outdoor use) and drinking water (indoor use) impacts the many factors of the analysis, including the input flow values for the treatment systems, the mass balance for contaminant concentrations, and the treatment system component sizes (i.e., filter, media volume, and tank sizes).

Major data gaps that significantly impact this evaluation include:

- The exceptionally high-water demand and lack of meter data throughout the system.
- Unknowns regarding the appropriate storage volume, which has been driven by the water demand estimate.
- Lack of additional nearby water quality data.

The primary recommendations based on this evaluation that should be addressed first, include:

1. Conduct a meter study: The meter study should include installation of meters at selected locations within the community that could help isolate areas of the greatest use. This would help evaluate unauthorized and illegal uses as well as potential system leaks. The meters used in this study could be installed for temporary or permanent use.
2. Leak detection testing: The last leak detection testing was completed in 2010. There could potentially be additional unidentified leaks driving up the estimated demand.

3. Following the meter and leak detection studies, calculate the true water demand and appropriate water storage volume.
4. Conduct a Hydrogeologic investigation/Well Siting Study, as described in Alternative 1. This would help evaluate the potential for finding a new water source with reduced water quality issues.

The preferred alternative is Alternative 1 Installation of a new water supply well. The design of this alternative would be informed by the hydrogeologic investigation. A new well would replace the aging well that is estimated to be near the end of its useful life. A new well also provides the opportunity for the existing well to become a backup emergency source reducing the need to increase the storage volume from 100,000 gallons to 271,000 gallons. The existing well would become a backup well. Although the backup well would not provide a potable source of water it would provide water for emergency fire flow and irrigation uses.

7. References

California Rural Water Association (CRWA). 2021. *Keeler Community Services District Feasibility Study: Water System Improvements to Mitigate Arsenic and Manganese in Drinking Water*, Inyo-Mono Integrated Regional Water Management Program, California.

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The Food and Agriculture Organization of the United Nations (FAOUN) and International Water Management Institute (IWMI). 2023. Water Quality in Agriculture: Risks and Risk Mitigation.

Appendices

Appendix A

Alternative 1 Detailed Costs

Keeler CSD
Alternative #1- Installation of a New Groundwater Supply Well

Major Equipment and Construction Items				
Unit Items	**Quantity**	**Unit**	**Unit Cost**	**Total**
Drilling Subcontractor (Permanent Well Installation)	150	ft	$ 350.00	$52,500
Well Pump and Equipping	1	LS	$ 20,000.00	$20,000
New Electrical Connection	1	ea	$ 60,000.00	$60,000
Backup Generator	1	ea	$ 108,100.00	$108,100
Prefabricated Pump House	1	ea	$ 35,000.00	$35,000
Subtotal 1				**$275,600**
Other Construction Items		**Cost Estimate**		**Total**
Site Work		15%	of subtotal 1	$41,340
Mobilization/ Demobilization		20%	of subtotal 1	$55,120
Subtotal 2		35%	of subtotal 1	**$96,460**
Studies Needed				
Well Siting Study	1	LS	$ 100,000.00	$100,000
Subtotal 3				**$100,000**
Non Construction Implementation Costs (Soft Costs)				
Administration		5%	of (subtotal 1 + 2 + 3)	$23,603
Land/ROW Acquisition		1%	of (subtotal 1 + 2 + 3)	$4,721
Engineering		15%	of (subtotal 1 + 2 + 3)	$70,809
CEQA - Exempt		2%	of (subtotal 1 + 2 + 3)	$9,441
General Permitting		1%	of (subtotal 1 + 2 + 3)	$4,721
Bid Period Services		3.0%	of (subtotal 1 + 2 + 3)	$14,162
Construction Administration		10%	of (subtotal 1 + 2 + 3)	$47,206
Labor Compliance		1%	of (subtotal 1 + 2 + 3)	$4,721
Project Close Out		3%	of (subtotal 1 + 2 + 3)	$14,162
Contingency		20%	of (subtotal 1 + 2 + 3)	$94,412
Subtotal 3		61%	of (subtotal 1 + 2)	**$287,957**
Cost Summary				
Total Construction Estimate (w/o Contingency)		100%	of (subtotal 1 + 2 + 3)	**$472,060**
Total Estimated Project Costs				**$760,017**

Keeler CSD
Alternative #1- Installation of a New Groundwater Supply Well

Annual Variable Operational Expenditure

Unit Items	Quantity	Unit	Unit Cost ($/unit)	Total
Utilities	1	total	$ 6,312.00	$ 6,312
Subtotal 1				**$ 6,312**

Annual Fixed Operational Expenditure

	Quantity	Unit	Unit Cost ($/unit)	Total
Services and supplies	1	total	$ 15,947.00	$ 15,947
Repairs and Maintenance	1	total	$ 24,175.00	$ 24,175
Insurance	1	total	$ 2,283.00	$ 2,283
Miscellaneous	1	total	$ 836.00	$ 836
Depreciation	1	total	$ 789.00	$ 789
Operational Cost of New Well (1.5% of CAPEX)	1	total	$11,400	$ 11,400
Subtotal 2			0	**$ 55,430**

Cost Summary

Total Annual Operating Expenditure	**$ 61,742**

Keeler Backup Generator for Well and Booster Pump Cost Estimate				
Line Item No.	Item	Quantity	Unit Price	Cost
1	50 kW Diesel Engine w/ Level 2 Sound Enclosure and 24 hour sub base fuel tank	1	$ 55,000.00	$ 55,000
2	Concrete Pad for Generator	1	$ 10,000.00	$ 10,000
3	100-Amp 3-Pole Automatic Transfer Switch	1	$ 6,600.00	$ 6,600
4	Misc. Conduit and Wiring	1	$ 10,000.00	$ 10,000
5	VFD for 30 Horsepower Motor	2	$ 10,750.00	$ 21,500
6	Panel Replacement	1	$ 5,000.00	$ 5,000
			Total	**$ 108,100**

Keeler Treatment System Location - New Electrical Service Cost Esitmate*				
Line Item No.	Item	Quantity	Unit Price	Cost
1	200-Amp 208Y/120-Volt Electrical Service Pedestal	1	$ 10,000.00	$ 10,000
2	Utility Service Pole	1	$ 10,000.00	$ 10,000
3	Misc Conduit, Wire and Trenching	1	$ 25,000.00	$ 25,000
4	200-Amp Panelboard	1	$ 5,000.00	$ 5,000
5	Utility Coordination	1	$ 10,000.00	$ 10,000
			Total	**$ 60,000**
	Note:			
	*electrical cost estimate does not include any process equipment or pumps			

Appendix B

Alternative 2 Detailed Costs

Keeler CSD
Alternative #2 - Pump Upgrades to Existing Water Supply Well

Major Equipment and Construction Items				
Unit Items	**Quantity**	**Unit**	**Unit Cost**	**Total**
Well Condition Assessment	1	ea	$ 10,000.00	$10,000
Well Rehab and Pump Test	1	ea	$ 20,000.00	$20,000
New Pump	1	ea	$ 7,500.00	$7,500
Electrical Upgrades and Backup Generator	1	ea	$ 108,100.00	$108,100
Subtotal 1				**$145,600**
Other Construction Items		**Cost Estimate**		**Total**
Site Work		5%	of subtotal 1	$7,280
Mobilization/ Demobilization		20%	of subtotal 1	$29,120
Subtotal 2		25%	of subtotal 1	**$36,400**
Non Construction Implementation Costs (Soft Costs)				
Administration		5%	of (subtotal 1 + 2)	$9,100
Engineering		15%	of (subtotal 1 + 2)	$27,300
Bid Period Services		5.0%	of (subtotal 1 + 2)	$9,100
Construction Administration		10%	of (subtotal 1 + 2)	$18,200
Project Close Out		3%	of (subtotal 1 + 2)	$5,460
Contingency		20%	of (subtotal 1 + 2)	$36,400
Subtotal 3		58%	of (subtotal 1 + 2)	**$105,560**
Cost Summary				
Total Construction Estimate (w/o Contingency)		100%	of (subtotal 1 + 2)	**$182,000**
Total Estimated Project Costs				**$287,560**

Keeler CSD
Alternative #2- Pump Upgrades to Existing Water Supply Well

Annual Variable Operational Expenditure				
Unit Items	**Quantity**	**Unit**	**Unit Cost ($/unit)**	**Total**
Utilities	1	total	$ 6,312.00	$ 6,312
Subtotal 1				**$ 6,312**
Annual Fixed Operational Expenditure				
	Quantity	**Unit**	**Unit Cost ($/unit)**	**Total**
Services and supplies	1	total	$ 15,947.00	$ 15,947
Repairs and Maintenance	1	total	$ 24,175.00	$ 24,175
Insurance	1	total	$ 2,283.00	$ 2,283
Miscellaneous	1	total	$ 836.00	$ 836
Depreciation	1	total	$ 789.00	$ 789
Operational cost of the new pumps (1.5% of CAPEX)	1	total	$4,313	$ 4,313
Subtotal 2			0	**$ 48,343**
Cost Summary				
Total Annual Operating Expenditure				**$ 54,655**

Keeler Backup Generator for Well and Booster Pump Cost Estimate				
Line Item No.	Item	Quantity	Unit Price	Cost
1	50 kW Diesel Engine w/ Level 2 Sound Enclosure and 24 hour sub base fuel tank	1	$ 55,000.00	$ 55,000
2	Concrete Pad for Generator	1	$ 10,000.00	$ 10,000
3	100-Amp 3-Pole Automatic Transfer Switch	1	$ 6,600.00	$ 6,600
4	Misc. Conduit and Wiring	1	$ 10,000.00	$ 10,000
5	VFD for 30 Horsepower Motor	2	$ 10,750.00	$ 21,500
6	Panel Replacement	1	$ 5,000.00	$ 5,000
			Total	**$ 108,100**

Appendix C

Alternative 3 Detailed Costs

Keeler CSD
Alternative #3- Centralized Greensand Filtration Treatment

Major Equipment and Construction Items				
Unit Items	**Quantity**	**Unit**	**Unit Cost**	**Total**
Greensand Filtration Treatment System	1	ea	$ 3,212,185	$3,212,185
New Electrical Service	1	ea	$ 60,000	$60,000
Distribution System Replacement	1	ea	$ 2,347,675	$2,347,675
Water Meters	66	EA	$ 3,800	$250,800
			$ -	$0
Subtotal 1				**$5,870,660**
Other Construction Items		**Cost Estimate**		**Total**
Site Work		10%	of subtotal 1	$587,066
Mobilization/ Demobilization		20%	of subtotal 1	$1,174,132
Subtotal 2		30%	of subtotal 1	**$1,761,198**
Non Construction Implementation Costs (Soft Costs)				
Administration		5%	of (subtotal 1 + 2)	$381,593
Land/ROW Acquisition		1%	of (subtotal 1 + 2)	$76,319
Engineering		15%	of (subtotal 1 + 2)	$1,144,779
CEQA - MND		5%	of (subtotal 1 + 2)	$381,593
General Permitting		1%	of (subtotal 1 + 2)	$76,319
Bid Period Services		3%	of (subtotal 1 + 2)	$228,956
Construction Administration		10%	of (subtotal 1 + 2)	$763,186
Labor Compliance		1%	of (subtotal 1 + 2)	$76,319
Project Close Out		3%	of (subtotal 1 + 2)	$228,956
Contingency		20%	of (subtotal 1 + 2)	$1,526,372
Subtotal 3		64%	of (subtotal 1 + 2)	**$4,884,389**
Cost Summary				
Total Construction Estimate (w/o Contingency)		100%	of (subtotal 1 + 2)	**$7,631,858**
Total Estimated Project Costs				**$12,516,247**

Keeler CSD
Alternative #3 - Centralized Greensand Filtration Treatment

Annual Variable Operational Expenditure				
Unit Items	**Quantity**	**Unit**	**Unit Cost ($/unit)**	**Total**
Power	1	total	$ 19,272.00	$ 19,272
Chemical	1	total	$ 7,400.00	$ 7,400
Utilities	1	total	$ 6,312.00	$ 6,312
Subtotal 1				**$ 32,984**
Annual Fixed Operational Expenditure				
	Quantity	**Unit**	**Unit Cost ($/unit)**	**Total**
Services and supplies	1	total	$ 15,947.00	$ 15,947
Repairs and Maintenance	1	total	$ 24,175.00	$ 24,175
Insurance	1	total	$ 2,283.00	$ 2,283
Miscellaneous	1	total	$ 836.00	$ 836
Depreciation	1	total	$ 789.00	$ 789
Annualized Media Replacement	1	total	$ 417,802.11	$ 417,802
Operation and Maintenance (1.5% of CAPEX)	1	total	$ 48,182.78	$ 48,183
Subtotal 2				**$ 510,015**
Cost Summary				
Total Annual Operating Expenditure				**$ 542,999**

Treatment System Capital Costs		
Treatment Options	**Greensand**	**Dual Media**
Treatment Equipment		
Media Filter(s)	$ 1,886,280.00	$ 1,992,640.00
Process pump	$ 96,600.00	$ 96,600.00
Controls	$ 167,835.00	$ 167,835.00
Product tank	$ 637,500.00	$ 637,500.00
Chemical Handling	$ 41,970.00	$ 188,811.00
Site Work & Additional Structure		
Chemical & Storage Building	$ 300,000.00	$ 300,000.00
General site work (electrical, soil compaction,etc)	$ 82,000.00	$ 82,000.00
Total	**$ 3,212,185.00**	**$ 3,465,386.00**

Treatment OPEX		
	Cost	
Item	**Greensand**	**Dual Media**
Power	$ 19,272.00	$ 23,126.40
Chemical	$7,400	$34,200
Total Variable Costs	**$26,672**	**$57,326**
Annualized Media Replacement	$ 417,802.11	$ 315.00
Operation and Maintenance (1.5% of CAPEX)	$48,183	$ 51,980.79
Total Fixed Costs	**$465,985**	**$52,296**
Total Annual Operating Costs In First Year	**$492,657**	**$109,622**

Distribution System						
No.	**Description**	**Quantity**	**Unit**	**Unit Price**	**Subtotal**	**Assumptions**
1	Asphalt Pavement Removal and Disposal	400	TON	$ 50.00	$ 20,000	Assumed 6-in asphalt thickness, and trench zones include 6-in on each side plus additional foot on each side
2	8-Inch C900 PVC Water Main and Fittings	2429	LF	$ 175.00	$ 425,075	Pricing for pipe include fittings, trenching costs, and pipe bedding/ trenching materials
3	4-Inch C900 PVC Water Main and Fittings	11920	LF	$ 115.00	$ 1,370,800	Pricing for pipe include fittings, trenching costs, and pipe bedding/ trenching materials
4	8-inch Isolation Valve	3	EA	$ 3,000.00	$ 9,000	** excluding valves from well to tank and from tank to rest of distribution system
5	4-Inch Isolation Valve	66	EA	$ 1,000.00	$ 66,000	
6	3/4" Water Service Lines	66	EA	$ 4,800.00	$ 316,800	copper tubing or plastic tubing
7	Asphalt Concrete Pavement Restoration	400	TON	$ 350.00	$ 140,000	Assumed 6-in asphalt thickness, and trench zones include 6-in on each side plus additional foot on each side
				Total	$ 2,347,675	

Water Meters						
No.	**Description**	**Quantity**	**Unit**	**Unit Price**	**Subtotal**	**Assumptions**
1	3/4" Water Meters	66	EA	$ 3,800.00	$ 250,800	Assumes the existing meter boxes are in good condition and can be used

Keeler Treatment System Location - New Electrical Service Cost Esitmate*				
Line Item No.	Item	Quantity	Unit Price	Cost
1	200-Amp 208Y/120-Volt Electrical Service Pedestal	1	$ 10,000.00	$ 10,000
2	Utility Service Pole	1	$ 10,000.00	$ 10,000
3	Misc Conduit, Wire and Trenching	1	$ 25,000.00	$ 25,000
4	200-Amp Panelboard	1	$ 5,000.00	$ 5,000
5	Utility Coordination	1	$ 10,000.00	$ 10,000
			Total	**$ 60,000**
	Note:			
	*electrical cost estimate does not include any process equipment or pumps			

Appendix D

Alternative 4 Detailed Costs

Keeler CSD Alternative #4 - Centralized Dual Media Filtration Treatment				
Major Equipment and Construction Items				
Unit Items	**Quantity**	**Unit**	**Unit Cost**	**Total**
Dual Media Filtration Treatment System	1	ea	$ 3,465,386	$3,465,386
New Electrical Service	1	ea	$ 60,000	$60,000
Distribution System Replacement	1	ea	$ 2,347,675	$2,347,675
Water Meters	66	EA	$ 3,800	$250,800
Subtotal 1				**$6,123,861**
Other Construction Items		**Cost Estimate**		**Total**
Site Work	10%	of subtotal 1		$612,386
Mobilization/ Demobilization	20%	of subtotal 1		$1,224,772
Subtotal 2	30%	of subtotal 1		**$1,837,158**
Non Construction Implementation Costs (Soft Costs)				
Administration	5%	of (subtotal 1 + 2)		$398,051
Land/ROW Acquisition	1%	of (subtotal 1 + 2)		$79,610
Engineering	15%	of (subtotal 1 + 2)		$1,194,153
CEQA - MND	5%	of (subtotal 1 + 2)		$398,051
General Permitting	1%	of (subtotal 1 + 2)		$79,610
Bid Period Services	3.0%	of (subtotal 1 + 2)		$238,831
Construction Administration	10%	of (subtotal 1 + 2)		$796,102
Labor Compliance	1%	of (subtotal 1 + 2)		$79,610
Project Close Out	3%	of (subtotal 1 + 2)		$238,831
Contingency	20%	of (subtotal 1 + 2)		$1,592,204
Subtotal 3	64%	of (subtotal 1 + 2)		**$5,095,052**
Cost Summary				
Total Construction Estimate (w/o Contingency)	100%	of (subtotal 1 + 2)		**$7,961,019**
Total Estimated Project Costs				**$13,056,072**

Keeler CSD
Alternative #4- Centralized Dual Media Filtration Treatment

Annual Variable Operational Expenditure				
Unit Items	**Quantity**	**Unit**	**Unit Cost ($/unit)**	**Total**
Power	1	total	$ 23,126.40	$ 23,126
Chemical	1	total	$ 34,200.00	$ 34,200
Utilities	1	total	$ 6,312.00	$ 6,312
Subtotal 1				**$ 63,638**
Annual Fixed Operational Expenditure				
	Quantity	**Unit**	**Unit Cost ($/unit)**	**Total**
Services and supplies	1	total	$ 15,947.00	$ 15,947
Repairs and Maintenance	1	total	$ 24,175.00	$ 24,175
Insurance	1	total	$ 2,283.00	$ 2,283
Miscellaneous	1	total	$ 836.00	$ 836
Depreciation	1	total	$ 789.00	$ 789
Annualized Media Replacement	1	total	$ 315.00	$ 315
Operation and Maintenance (1.5% of CAPEX)	1	total	$ 51,980.79	$ 51,981
Subtotal 2				**$ 96,326**
Cost Summary				
Total Annual Operating Expenditure				**$ 159,964**

Treatment System Capital Costs		
Treatment Options	**Greensand**	**Dual Media**
Treatment Equipment		
Media Filter(s)	$ 1,886,280.00	$ 1,992,640.00
Process pump	$ 96,600.00	$ 96,600.00
Controls	$ 167,835.00	$ 167,835.00
Product tank	$ 637,500.00	$ 637,500.00
Chemical Handling	$ 41,970.00	$ 188,811.00
Site Work & Additional Structure		
Chemical & Storage Building	$ 300,000.00	$ 300,000.00
General site work (electrical, soil compaction,etc)	$ 82,000.00	$ 82,000.00
Total	**$ 3,212,185.00**	**$ 3,465,386.00**

Treatment OPEX		
	Cost	
Item	**Greensand**	**Dual Media**
Power	$ 19,272.00	$ 23,126.40
Chemical	$7,400	$34,200
Total Variable Costs	**$26,672**	**$57,326**
Annualized Media Replacement	$ 417,802.11	$ 315.00
Operation and Maintenance (1.5% of CAPEX)	$48,183	$ 51,980.79
Total Fixed Costs	**$465,985**	**$52,296**
Total Annual Operating Costs In First Year	**$492,657**	**$109,622**

Distribution System						
No.	Description	Quantity	Unit	Unit Price	Subtotal	Assumptions
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4	200-Amp Panelboard	1	$ 5,000.00	$ 5,000
5	Utility Coordination	1	$ 10,000.00	$ 10,000
			Total	**$ 60,000**
	Note:			
	*electrical cost estimate does not include any process equipment or pumps			