ALTO LAKES WATER AND SANITATION DISTRICT

WATER SYSTEM IMPROVEMENTS

PRELIMINARY ENGINEERING REPORT (PER)

PREPARED FOR

Alto Lakes Water & Sanitation District

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EXECUTIVE SUMMARY

PURPOSE

The purpose of this preliminary engineering report (PER) is to provide an update to the previous PER developed by Parkhill in December of 2008. Since that time, several of the projects identified in that report have been completed including the Phase I Water Treatment Plant which provided iron and manganese removal from the well water. Two phases of the Distribution System Improvements have been completed providing more consistent pressures and fire flow capability to much of the system. This document updates the projected year for improvements out to 2045.

This document further develops the Phase II Water Treatment Plant through water quality testing and membrane system modeling. As noted in the original PER, brine disposal from the membrane treatment system is the most difficult part of the puzzle. This PER looks at new advancements in enhanced evaporation that look promising and will make membrane treatment a possibility for the Alto Lakes Water and Sanitation District (ALW&SD). This PER also prioritizes the remaining distribution system improvements based on pipe age and break history provided by the district.

TREATMENT ALTERNATIVES

The Phase I iron and manganese removal system is working well for the district but is projected that it will need to have added capacity to meet the 2045 demands. The existing oxidation/filtration system is proposed to be replaced with a larger system. The existing pressure vessels are starting to leak and are nearing the end of their useful life.

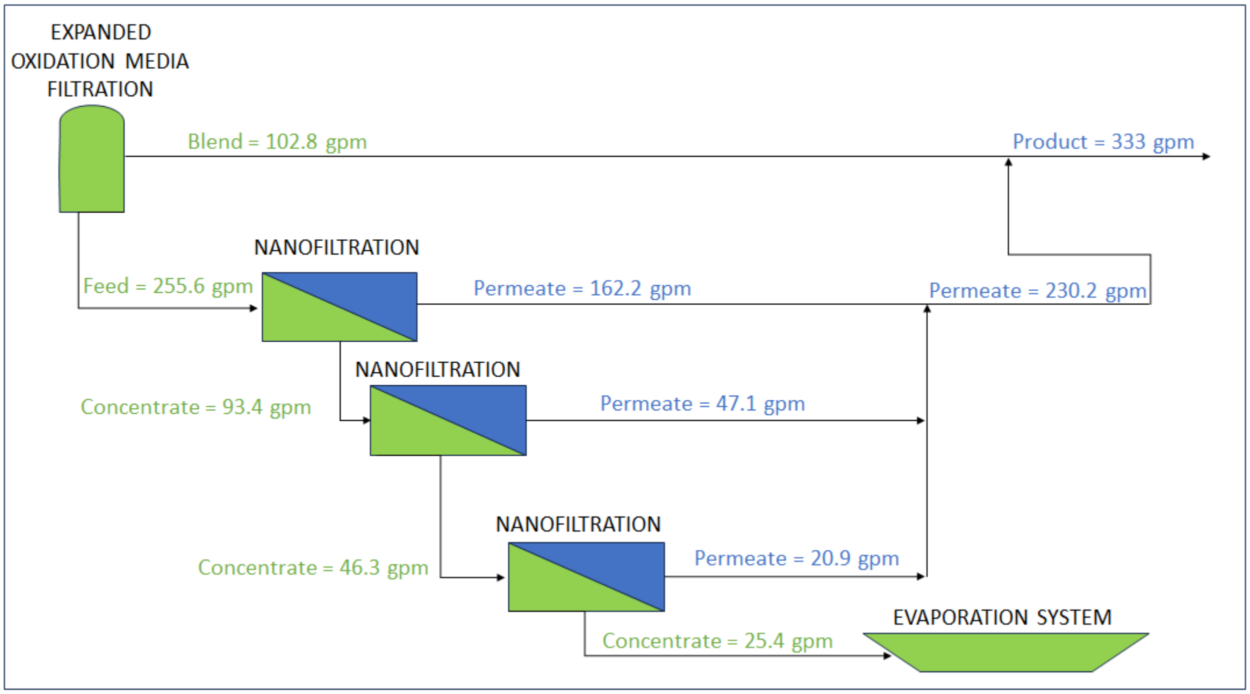
Phase II will reduce the hardness and total dissolved solids (TDS) in the finished water. The PER considers six different treatment alternatives for Phase II that use the best available treatment technologies to meet the district's treatment goals as shown in Table ES-1.

Constituent	Secondary Standard	Alto Lakes Well Water Concentration	ALW&SD Goal	Frequency Achieved*
TDS	500 mg/L	1,500 mg/L	<500 mg/L	98% +/-
Hardness	N/A	51.56 grains/gallon	<6 grains/gallon	96% +/-
System Recovery	N/A	N/A	90%	100%

*Frequency Achieved is at the design flow of 333 gpm. With lower peak day flows, frequency will be higher.

Tabe ES-1 – Treatment Goals

The technologies considered were: Ion Exchange, Nanofiltration, Reverse Osmosis and combinations of these technologies. The preferred alternative resulting from the analysis of the six alternatives was Flow Reversal Nanofiltration. The flow reversal process allows for higher recovery rates which means less brine to dispose of. By changing the direction of flow in the membrane tubes, the concentration of mineral is more evenly distributed throughout the membranes. This prevents high concentrations from building up and possibly precipitating in the treatment system causing fouling. ROTEC, the company who holds the patent on the Flow Reversal process has stated that their system will meet the 90% recovery goal at a minimum and expects that through piloting, they can improve this recovery rate. The proposed Phase II Treatment Schematic showing flow rates is pictured in Figure ES-1. A complete process schematic is included at the end of the executive summary showing all of the proposed treatment and disposal processes.



Note: Water quality at this flow condition will match that shown in Table ES-1

Figure ES-1 – Proposed Phase II Treatment Schematic

BRINE DISPOSAL ALTERNATIVES

The PER evaluates disposal alternatives that include evaporation ponds, and two enhanced evaporation technologies. Given the climatological data for the Alto area, the annual evaporation rate combined with the annual precipitation rate yields a net evaporation rate of 15.3 inches per year. These climate values are shown in Table ES-2.

Parameter	Alto Data 2024	Historical Value	Unit
Evaporation Rate	48.0	37.5	Inches/year
Precipitation Rate	8.0	22.2	Inches/year
Net Evaporation Rate	**40.0**	**15.3**	**Inches/year**

Table ES-2 – Average of Historical Climatological Data

The alternative employing ponds alone is hindered by the amount of rainfall received on the pond area. The advantage of the enhanced evaporation options is that they create a large surface area to evaporate water on by extending up from the ground and cover a relatively small surface area compared to the pond only system. The proposed alternative for brine disposal is the ECOVAP system which is made up of a collection of high-density polyethylene (HDPE) blocks with a maze of open channels in them that drastically increase the surface area. The benefit of this product over the other enhanced evaporation produce comes from ease of maintenance and the fact that there are less parts to replace and replacement parts are much less expensive. An example of an ECOVAP system is shown in Figure ES-2.

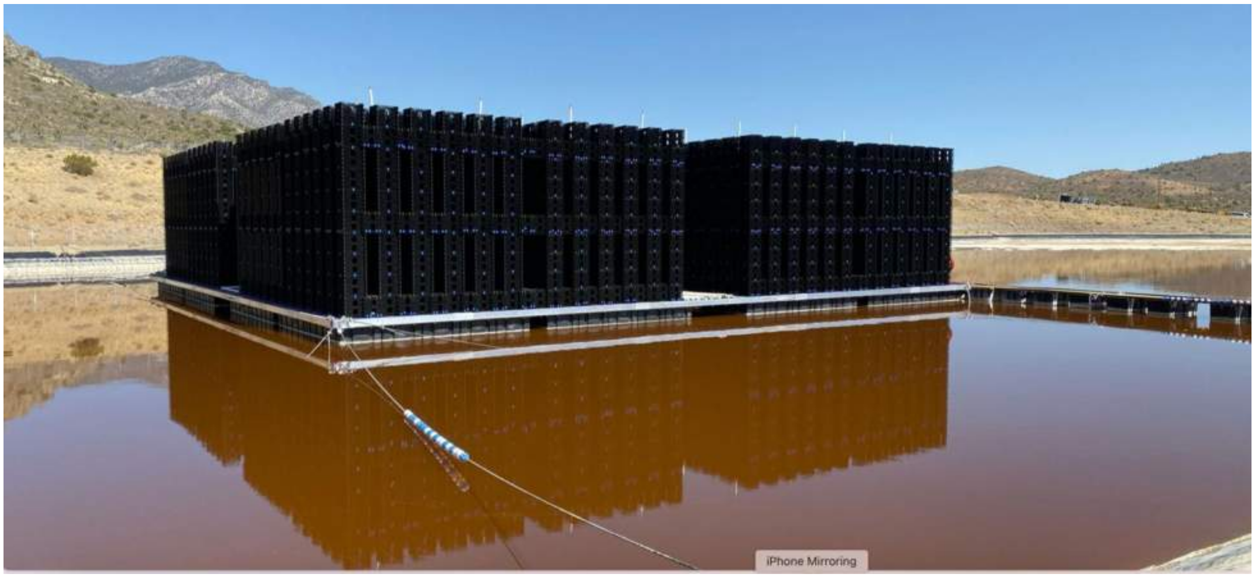


Figure ES-2 – ECOVAP system example

This system is expected to evaporate a minimum of 90 percent of the brine applied to the system resulting in a TDS concentration of 170,000 mg/L. This slurry would then be put on a drying bed to completely dry the solids and allow them to be hauled off to a landfill. At build-out, it is expected that a total of two acres of drying beds will be needed to completely dry out the solids. Based on the raw water quality, it is not expected that the solids would be considered hazardous. The proposed layout of the brine disposal system is shown in Figure ES-3. The equalization pond is needed to store brine during the winter months when the ECOVAP system may not be able to be used due to freezing temperatures.

COMPLETE SYSTEM MASS BALANCE

The proposed treatment system and brine disposal alternative mass balances have been combined in the diagram shown in Figure ES-4. This figure shows the build-out conditions for the system as expected for the peak day in 2045. When flows are lower, water quality can be improved and the brine needed to be disposed of will be less.

The total volume of dry solids to be hauled away each year based on the density of loose salt (70 lbs/cu-ft) at the build-out capacity is 638 cubic yards. Based on a 30 cubic yard hauler, this would be between 21 and 22 truckloads per year. At the current demands, the solids would be about 360 cubic yards per year or 56% of the build-out volume.

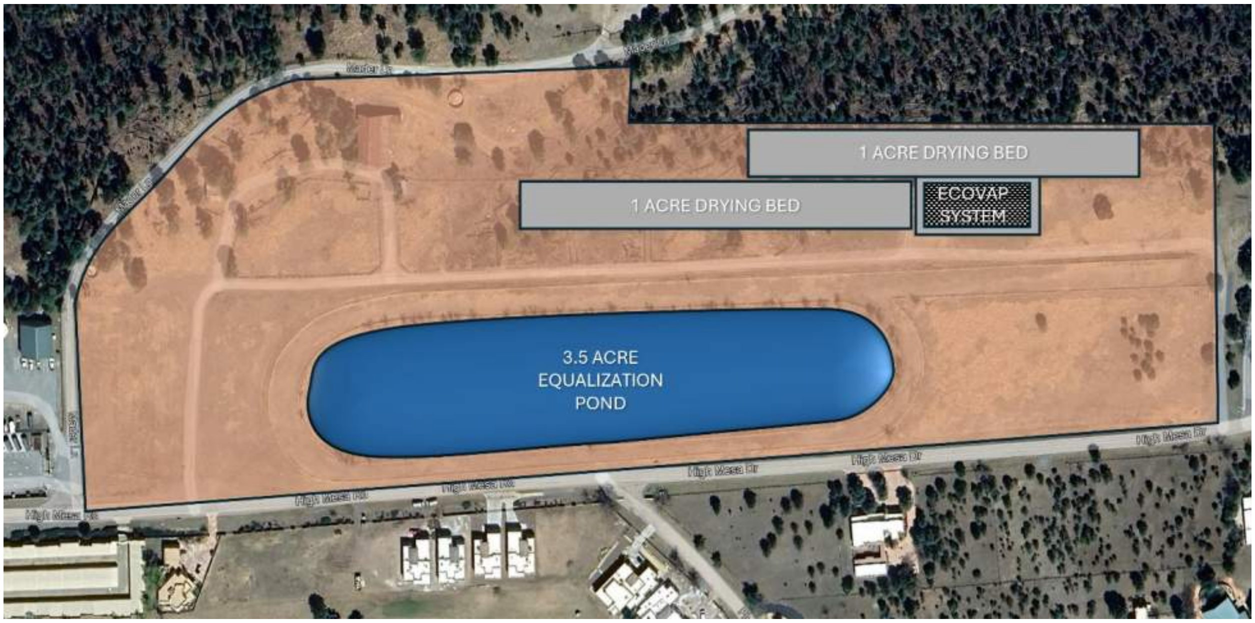


Figure ES-3 – Proposed Brine Disposal System Layout

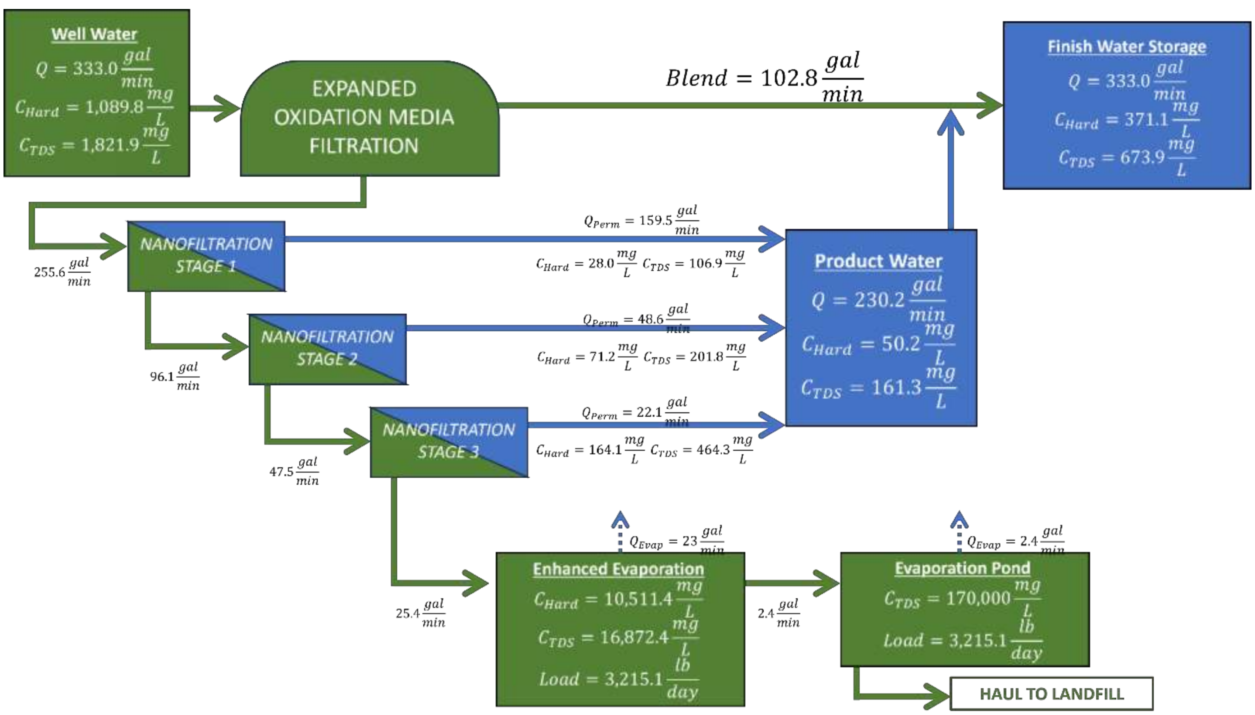


Figure ES-4 – System Mass Balance

TREATMENT SYSTEM AND BRINE DISPOSAL SYSTEM COSTS

The opinion of probable cost (OPC) for the proposed treatment and brine disposal system is expected to be just under $9.6M including engineering and administrative costs. About $1.3M of this contingency. This assumes a less expensive dual synthetic liner with a sand cushion is being used for the drying beds. This is about one third of the cost of concrete. The disadvantage of the synthetic liner is that it could be torn while using machinery to remove the dried solids from the top of the sand cushion.

DISTRIBUTION SYSTEM IMPROVEMENTS

The remaining distribution system improvements including pressure reducing stations and fire hydrants were grouped into projects that were projected to have costs between $4-5 million. Figure ES-5 shows the breakout of the projects. The phases were determined by pipe age, number of connections served and input by ALW&SD staff regarding repair history. This phasing was identified prior to the fires in 2024 that destroyed a large number of homes in the phase I area.

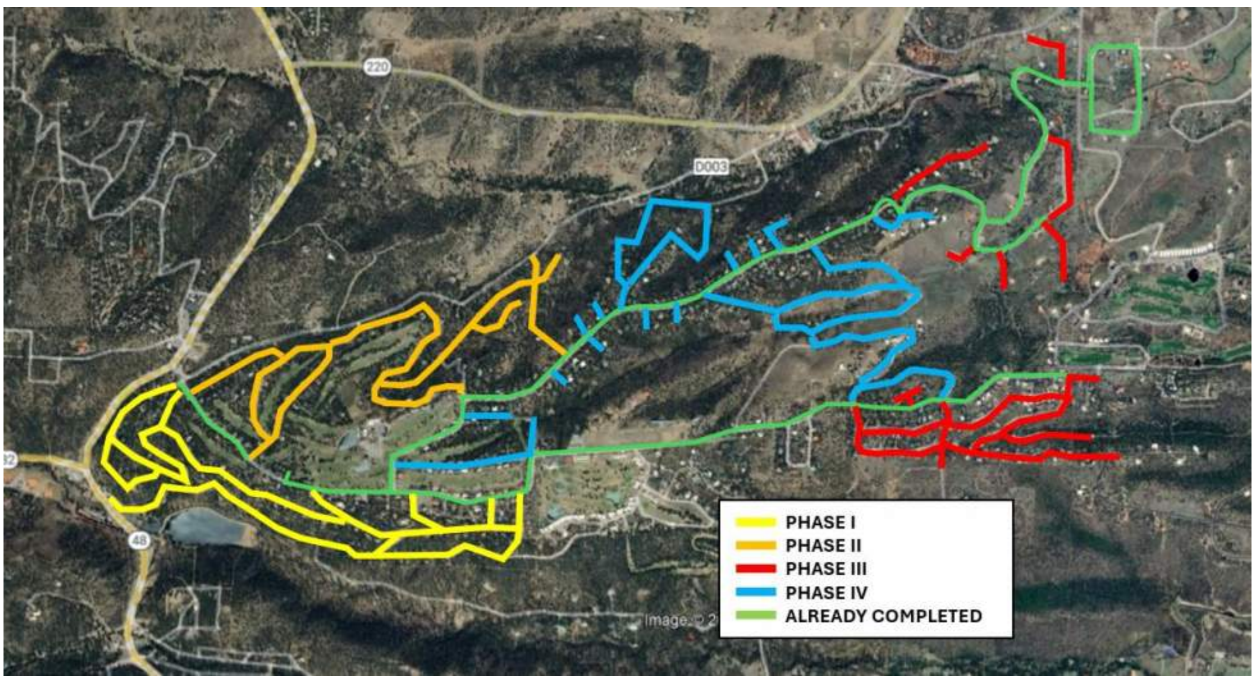


Figure ES-5 – Proposed Distribution System Phasing

The length of line to be replaced and projected costs are shown in Table ES-3.

Project Phase	Linear Feet of Pipe	Total Phase Cost
Phase I	25,500	$ 4,590,000
Phase II	18,800	$ 3,384,000
Phase III	23,320	$ 4,197,600
Phase IV	28,613	$ 5,150,340

Table ES-3 – Distribution System Phased Costs

ADVANCED METERING INFRASTRUCTURE (AMI)

Advanced Metering Infrastructure (AMI) is a system which automates water meter reading throughout the system without the need for a person to interact with the meters.

The CYCLOPS system by SPMR was found to provide the best value for the existing meter system. This system uses a digital camera which attaches to the existing meters and can take and send photos of the meter to a processing server to convert the photo into a meter reading. The photo is transmitted to servers via a cellular connection. This system sends one photo each day for recording purposes. A proposal to provide this system for all 1,245 meters in the district, including camera, cellular chip, antenna lock, server seat and one local computer license was $293,268. This does not include installation of the system but it does include training on how to install it via a webinar.

Ther are some annual recurring costs for the cellular connection and the photo recognition service. These two fees equate to $1.38 per meter per year or a total of $20,617.

1. GENERAL

The Alto Lakes Water & Sanitation District (ALW&SD) operates a water system that serves 1,245 residential connections. This document is an update to a previous Preliminary Engineering Report (PER) prepared by Parkhill in December of 2008. Since that time, several of the projects identified in the PER have been completed including the Phase I Water Treatment Plant, expansion of the treated water storage capacity and two projects that upgraded the distribution system. The Phase I Water Treatment Plant removes iron and manganese from the raw well water eliminating problems with taste and odor as well as staining of fixtures and clothing. The TDS and hardness remain high and as a result, most of the customers have in home water softening systems that waste water and introduce high levels of minerals into the ground through discharge of their septic systems.

Constituent	Secondary Standard MCL	Alto Lakes Well Water Concentration	ALW&SD Goal	Units	Frequency Achieved
Hardness, as $CaCO_3$	N/A	1,090.7 (63.7)	120.7 (6.0)	mg/L (grains/gal)	96% +/-
Total Dissolved Solids	500	1,500.0	500.0	mg/L	98% +/-
Note: MCL = Maximum Contaminant Level					

Table 1 – Existing Groundwater Quality and Drinking Water Goals for Alto, NM

The purpose of this project is to identify treatment system improvements necessary to adequately serve the ALW&SD service area and to make recommendations on steps needed to aid in preparing to meet these higher water quality goals when coupled with potential future population growth. The plan addresses water quality and quantity, distribution, and treatment. It also addresses financial and operational issues. The plan evaluates the water supply of the ALW&SD used for domestic demands, for the current need as well as future (to year 2045) conditions. Alternatives for water treatment methodologies are presented, as well as a discussion of their long-term effectiveness relative to the districts projected growth.

The current ALW&SD domestic water demands are approximately 61 MG per year and are expected to grow to just over 84 MG per year over the next twenty years.

The domestic demand currently serves 1,245 meters (2023 totals). The number of connections is expected to increase to 1,800 between the years 2075 and 2080.

2. PROJECT PLANNING AREA

a. Location Map

The unincorporated community of Alto, NM, situated in the Sacramento Mountains of Lincoln County and about five miles north of Ruidoso, covers an area of roughly 3.8 square miles (1,689 acres). It is served by the Alto Lakes Water and Sanitation District for a span extending 3.3 miles east to west and 2.3 miles north to south, at elevations between 6,915 and 7,550 feet above sea level. See Figure 1 which includes a map of the study area.

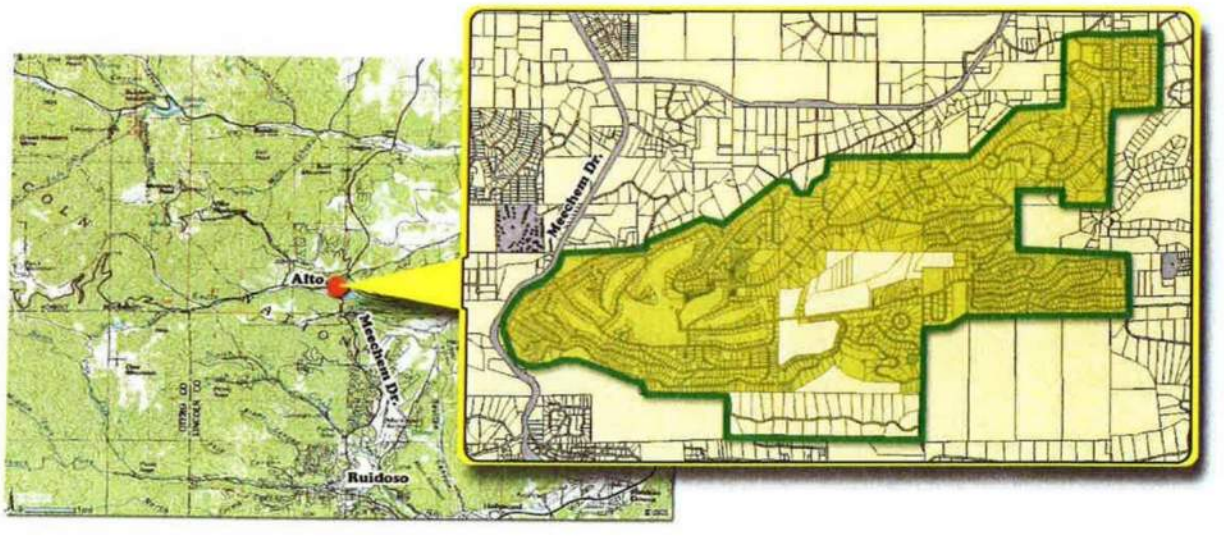


Figure 1 – Location – Study Area Map

b. Environmental Resources Present

The land occupied by the existing water treatment plant as well as the property purchased in preparation for Phase 2 of this project is characterized by forested regions interspersed with grassy meadows, predominantly featuring low-density subdivisions. No wetlands, streams, or flood plains are present within the area. Most of the project components are planned for previously disturbed locations such as roadways, their shoulders, and the pre-existing racetrack, qualifying the area as a categorical exclusion due to the additional low likelihood of significant environmental impacts. The water treatment plant site, which is partially forested, will require minimal to no work to prepare for the next phase of construction.
However, the area allocated for the brine disposal evaporation system will require some tree clearing. The surrounding forest will continue to provide suitable habitats for small animals and avian species potentially displaced by this development. There is minimal to no expectation of this project having a meaningful impact on endangered species or critical habitats. All of the components of this project will reside on previously disturbed land. A categorical exclusion checklist was completed for this project and the 2008 Preliminary Engineering Report found no cultural resources within the project area.

c. Growth Areas and Population Trends

In the District's service area, 56% of homes are occupied by full-time residents, with the remaining 43% used seasonally. Based on the findings of the District's 2015 Water Conservation Plan, this can alternatively be considered as a 29% vacancy rate when averaged over an entire year. However, this yearly average does not directly convey the variation in the District's population seen on a yearly cycle. It is estimated that nearly 41% of the District's homes are active for only half of the year or less. This means that while there may be historical records for overall demand within the district as well as the quantity of metered connections, it is difficult to approximate the population of the District with a high degree of confidence.

Additionally, the possibility of ALW&SD extending services to the adjacent Outlaw area is recognized in this report. However, due to difficulties with population approximations in this additional area for the same reasons as Alto, planning for this area is based on demand without considering the specific locations of that demand. Given the transient nature of the population, focusing on demand projections was more reasonable than estimating based on population which is itself assumed relative to the number of meters.

There are currently 1,245 meters in the ALW&SD service area. The projected build-out is estimated at 1,800 lots per meter due to lot considerations and challenging terrain associated with the District being situated in the middle of the Sacramento Mountains, limiting the District's potential expansion. The meter growth from 2015 to 2023 has averaged 0.73% per year. Demand per meter however, has grown at a rate of 3.62% which is markedly higher than the per-year growth in demand. This is likely due to a 16% increase in per-meter usage between 2019 and 2020. The surrounding context of the Coronavirus Pandemic is a more reasonable explanation of this behavior. This contrasts with the decreasing usage on a meter basis seen in the previous PER, which was attributed to water conservation efforts by the District.

Build out of the service area is expected to occur around 2075. Portions of data from this record is included in Table 2. Increased growth rate would allow the build out to happen sooner while a decrease would postpone the build out and the need for future facilities.

YEAR	DOMESTIC FLOW [GAL/YEAR]	METERS	USAGE [GAL/METER/DAY]
2015	55,215,135.00	1,265	119.50
2020	67,143,416.00	1,204	152.68
2021	65,084,650.00	1,217	146.42
2022	60,623,580.00	1,242	133.64
2023	58,928,222.00	1,245	129.59

Table 2 – Historical Domestic Water Usage

Flow meter and usage projections were generated using historical demand and meter data provided by the ALW&SD are summarized in Table 3, through the design period of this project.

YEAR	DOMESTIC FLOW [GAL/YEAR]	METERS	USAGE [GAL/METER/DAY]
2025	64,980,877.20	1,236	143.94
2027	66,823,503.60	1,239	147.69
2030	69,587,443.20	1,243	153.28
2035	74,194,009.20	1,250	162.51
2040	78,800,575.20	1,257	171.64
2045	83,407,141.20	1,264	180.67

Table 3 – Projected Domestic Water Usage

This flow is distributed throughout the year based on seasonal demands. Figure 2 shows the historical distribution of this flow with the peak day demand typically happening between June and July.

3. EXISTING FACILITIES

a. Facility Map

The existing water system consists of two ground storage tanks with a total storage capacity of 800,000 gallons. The 150,000 gallon ground storage tank was replaced in 2023 with a 500,000 gallon tank. The existing booster pump station provided pressure for the system and can convey 800 gpm at 60 psi. There are four wells that serve to supply the domestic demand and three wells used for non-potable uses like golf course irrigation. The two systems are completely separate. The District also operates a small wastewater treatment plant that serves approximately 80 domestic customers and one commercial customer. Figure 3 shows these existing facilities.

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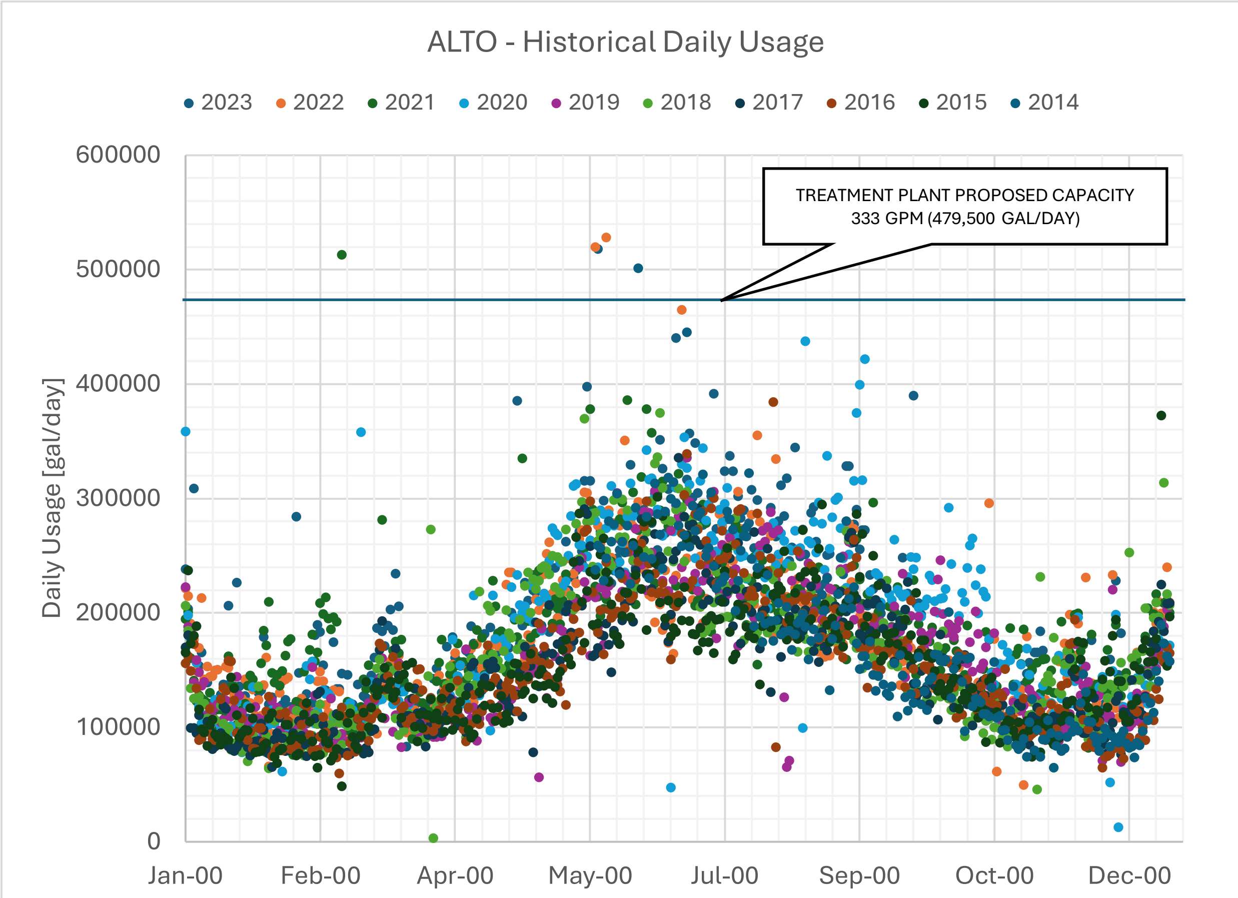


Figure 2 – Historical Demand Distribution

b. History

The water supply and distribution infrastructure of Alto Lakes was constructed by a developer beginning in the late 1960's. The distribution system was developed in small increments as indicated by the minimal backbone system and the various pipe sizes and piping materials extended to the outlying areas. In 1990, the system was acquired out of bankruptcy by the Alto Lakes Water Corporation, a private company which was regulated by the New Mexico Public Regulatory Commission. In April of 2008, the Alto Lakes Water & Sanitation District purchased the water and wastewater assets from the Water Corporation and

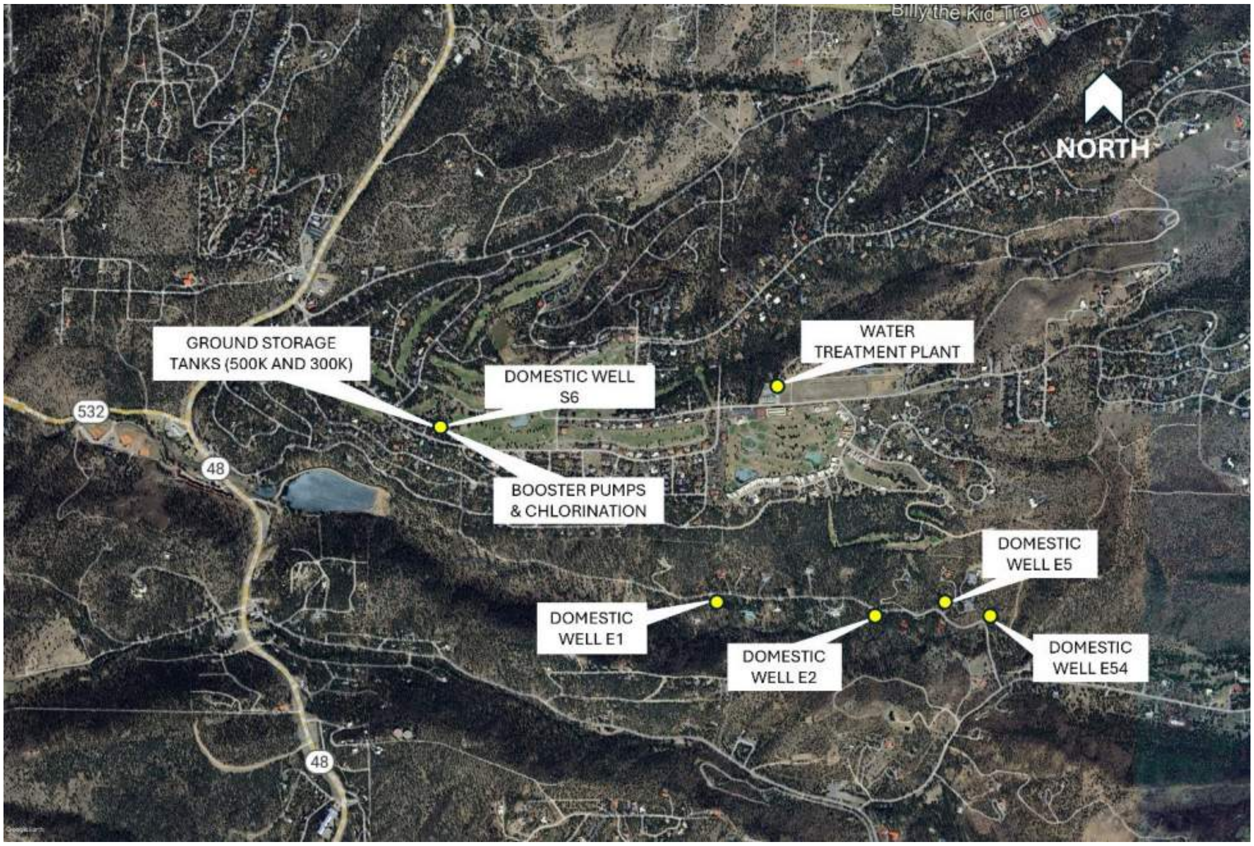


Figure 3 – Water System Facilities

now operates the system as a public entity with the intention of improving the water quality and the distribution system operation while taking advantage of public programs developed to help public water utilities meet State and Federal standards for drinking water supplies.

c. Condition of Facilities

The existing system has some components that are in need of rehabilitation including the 300,000 gallon water storage tank, pressure vessels for the iron and manganese treatment system and areas of the distribution system that have not been replaced as part of the phase 1 and phase 2 distribution system improvements.

Through a cursory inspection conducted by Parkhill in 2010 it was noted that the 300,000 gallon storage tank has lead paint on the exterior and needs to be brought up to current standards with respect to climb safety, access hatches, vents and railings. A full interior inspection is needed to determine if there are any structural concerns.

The iron and manganese removal system was installed in 2010 and has been performing as designed. There are times of the year when the transient population spikes for holiday and the existing treatment system is not large enough to keep up. During these events, the District has to bypass the treatment system with some raw water to blend with treated water to meet the demands. The pressure vessels are also showing signs of wear and are developing pinhole leaks in them. Two of the three vessels have already been replaced.

Two projects to replace distribution pipe and pressure reducing valves have been completed since the 2008 PER. There are still areas of the system that have pressures over 80 psi. These high pressures will be addressed with future distribution system improvements. Phasing recommendations for the remainder of the replacements identified in the 2008 PER will be part of this update.

4. NEED FOR PROJECT

a. Health and Safety

This Preliminary Engineering Report builds on the previous report's analysis. This report divides drinking water treatment infrastructure improvements between two phases. Phase 1 which has been constructed, addressed water quality issues related to iron and manganese concentrations and improvements to the distribution system downstream of the groundwater treatment plant. Phase 2 proposes introducing a membrane based treatment system to address issues relating to water hardness and Total Dissolved Solids concentrations that exceed EPA's secondary standards. Additionally, the Alto Lakes Water and Sanitary District is seeking to address concerns voiced by the District on the current water quality. The water system upgrades are prompted by health and safety considerations. While the existing conditions do not pose direct health risks, they fail to meet secondary standards set for aesthetic water quality. Issues with this include the operational costs and maintenance of commercial-scale ion-exchange water softeners in homes, which can harbor bacteria if not properly maintained. Moreover, the proposed Phase 2 enhancements will allow for the removal of TDS and hardness through nanofiltration (NF), aligning with EPA and New Mexico standards, and will eliminate the need for water softeners.

Recent water quality tests conducted in January 2024 showed minimal upcoming contaminants of concern, including PFAS (also known as "forever chemicals"), which were not detected. The enhancements will build upon the already effective iron-manganese oxidation system but further addressing calcium and magnesium content, which contributes to scale formation. This would improve taste and odor issues, although these have largely been addressed in Phase 1.

b. System O&M

The existing distribution system has experienced amounts of un-accounted for water due to leaks that have historically varied. These differences range from as low as near-zero percent for some months to as high as 45.5% in recent years. Notably, there was a significant difference of 38.7% in January 2024. Throughout the period of 2020 through 2024, this data suggests seasonal patterns with higher differences often occurring during colder months.

Operation and maintenance requirements of the existing groundwater treatment plant is relatively minimal. The system has a backwash requirement 1-3 times per week as well as replenishment of the supply of hypochlorite. This hypochlorite enhances the removal process, improves longevity of the media, and keeps the surface of the media oxidized to prevent buildup of solids. The media itself requires replacement on a 10-year schedule. This requires taking the unit out of service.

c. Growth

Water demand in the District, as recorded by ALW&SD from 2014 to 2023, has consistently grown, with a 16.6% increase in average daily demand over that period, but only a 9.6% increase in meter connections. This discrepancy suggests higher usage per existing meter rather than the more commonly expected increase in the number of meter connections. Factors such as the COVID-19 pandemic influenced this trend, with a notable rise in water usage as seasonal residents appear to have relocated to the District permanently. Throughout this period year-round residents spent more time within the district. This shift resulted in record-high demands during the pandemic years (2019 through 2021), peaking at nearly 194,000 gallons per day in 2020 – an increase of almost 25% from 2019. This trend has not been maintained, however. By 2022, the demand stabilized to within 15% of the 2019 average. The trend of increased demand per meter began in 2019, coinciding with the onset of the pandemic, and has shown signs of tapering off as we approach 2024. Long-term projections estimate the total number of meter will reach a full build-out at 1,800 meters between 2075 and 2080 based on the 9.6% growth rate in the last 10 years (0.96% per year).

5. ALTERNATIVES CONSIDERED

a. Design Criteria (Water Treatment and Brine Disposal)

The water quality criteria recommended as the ultimate goal for the ALW&SD water supply is shown in the following table along with the existing well water quality.

Constituent	Secondary Standard	Alto Lakes Well Water Concentration	ALW&SD Goal	Frequency Achieved*
TDS	500 mg/L	1,500 mg/L	<500 mg/L	98% +/-
Hardness	N/A	51.56 grains/gallon	<6 grains/gallon	96% +/-
System Recovery	N/A	N/A	90%	100%

Table 4 – Water Treatment Design Criteria

Due to the difficulties in disposing of the brine stream produced by TDS removal, the treatment has been phased. Phase 1 implemented a media technology to correct the previously excessive iron and manganese concentrations. The membrane system described in the following sections will be implemented as Phase 2. This membrane system will generate a highly concentrated brine flow which must be disposed of. As such, Phase 2 includes an evaporation system. The sizing of this evaporation system will directly be a function of the volume of brine produced by the treatment system. This necessitates a membrane system which minimizes the waste stream. This is accomplished by designing the system to operate at a recovery rate of at least 90%. The recovery rate is the ratio of the permeate (product water) flow to the feed (input water) flow. It represents the percentage of the incoming water that is converted into usable product water, with the remainder being discharged as concentrate, alternatively known as brine. Raising the recovery rate lowers the final volume of brine to be evaporated. With this context included, an overall recovery rate for the treatment system must be at least 90%. By comparison, typical nanofiltration and reverse osmosis systems with groundwater achieve recovery ranges of 85-90% and 80-85% respectively.

b. Description (Water Treatment and Brine Disposal)

Since the entire water supply for the ALW&SD service area comes from ground water sources, it contains constituents in concentrations that exceed the State of New Mexico Secondary Standard. These constituents are Iron, Manganese and TDS. The existing water treatment plant is capable of effectively treating the raw ground water to these secondary standards for iron and manganese. However, this system is not effective at removing TDS or the ions which comprise overall hardness. This is to be expected as there is no single treatment technology which is capable of reliably treating the source water, necessitating at least a two-step treatment process. The first stage of treatment will be an expansion of the existing media-based treatment system to provide removal of iron and manganese. This will support the second stage of treatment which will primarily remove TDS and hardness ions. This second stage treatment system will require facilities to dispose of a constant brine stream from the process. This brine will be highly concentrated with, among other constituents, high concentrations of magnesium, calcium, and TDS.

i. Hardness and TDS Removal Options

For this report, six membrane-based treatment systems were evaluated. They compare the operational efficacy of reverse osmosis (RO) membranes with their more porous counterparts, nanofiltration (NF) membranes.

1. Alternative 1 – Dual Stage Nanofiltration

Nanofiltration membranes, known for their "looser" membrane structure, effectively remove a wide variety of contaminants including magnesium, calcium, heavy metals, sulfates, nitrates, bacteria, viruses, and the composite constituents of the parameter Total Dissolved Solids (TDS). These membranes are particularly useful for water softening applications. They target removal of scale-forming divalent cations such as magnesium (Mg^{2+}) and calcium (Ca^{2+}), to the reduce total hardness. NF membranes generally achieve higher recovery rates compared to reverse osmosis systems, limiting the volume of brine produced by this alternative.

This system would be built such that treatment begins with the effluent from the existing iron-manganese removal system feeding the first-stage NF membranes. The concentrate (also known as the wasted brine) is processed through the second-stage of the NF system, with the final concentrate managed in the evaporation system included as a part of Phase 2 for this project. The permeate (also known as the product water) from both stages, when combined, reach a flow rate of 333 gallons per minute (gpm) as requested by the District.

From modeling work carried out between Parkhill and the equipment manufacturer for NF membrane systems, ROTEC, it was determined that this system effectively reduces hardness to a maximum concentration of 4.8 grains per gallon and lowers the TDS to about 145 mg/L. This aligns with the District's water quality objectives. However, this comes at the expense of a lower overall system recovery rate. The maximum recovery for this system is 86%, with a requirement of 387 gpm of feedwater to generate 333 gpm of potable water to be distributed to the District's clients. This reduction in performance is in large part due to excessive sulfate ion concentrations found within the District's groundwater supply. These sulfate ions reach their solubility limit and begin to precipitate, which has a dramatic effect on the membrane's efficiency and flow characteristics.

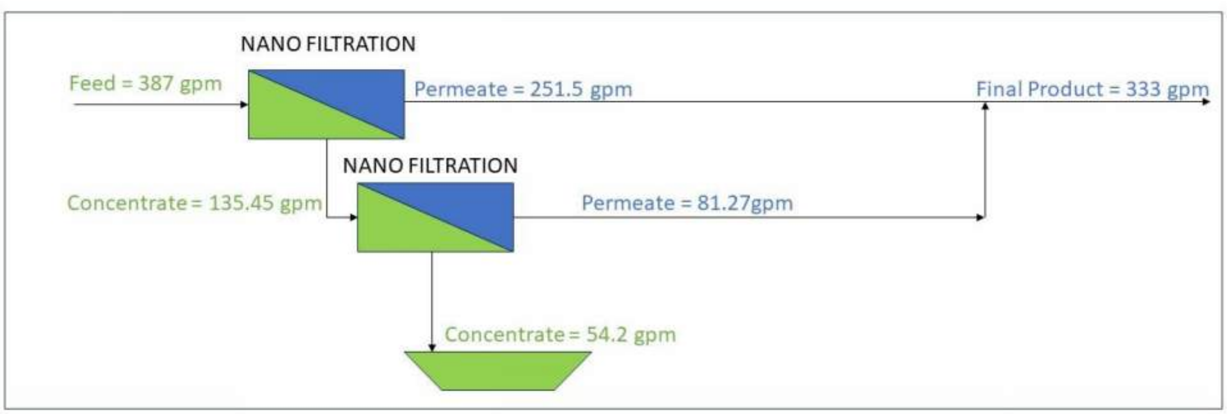


Figure 4 – Flow Diagram – Alternative 1

High ion concentrations in the first stage lead to increased osmotic pressure on the second stage, demanding more energy to force the flow through the NF membrane to enable treatment, and reducing the overall flux rate through the membrane. This results in a lower recovery rate in the second stage, necessitating a larger evaporation system to handle the increased volume of brine. Although this alternative achieves the desired water quality, it does not meet the District's goal of minimizing concentrate volume, prompting further exploration of other alternatives.

2. Alternative 2 – Dual Stage Nanofiltration and Single-Stage Reverse Osmosis

This alternative integrates dual-stage nanofiltration with single-stage reverse osmosis (RO) for groundwater treatment. Continuing from the previous alternatives analysis, it has been established that NF systems with their "looser" membranes, allow the removal of divalent and larger monovalent ions (like magnesium and calcium) while passing more Total Dissolved Solids. By comparison, RO membranes, with finer pores, restrict a broader range of ions and create a more highly concentrated reject stream, resulting in a larger osmotic pressure gradient. This osmotic pressure gradient is the differential pressure found across semipermeable membranes and is driven by the concentration differences in solutes when dissolved in differing concentrations between two fluid compartments. This gradient facilitates the movement of water from a lower to a higher solute concentration, until both concentrations are equal and the system reaches equilibrium. In reverse osmosis, the osmotic pressure gradient is countered by applying external pressure to the high solute concentration side, overcoming the natural osmotic pressure and driving water through the semipermeable membrane from a higher to a lower solute concentration. This process effectively purifies the water by removing dissolved salts, a majority of the components of TDS, and other impurities.

This alternative incorporates a third stage of RO to improve recovery rates, addressing concerns from Alternative 1. This setup would be arranged similar to before, with the concentrate from the second-stage NF membrane feeding the first-stage RO membranes. The higher efficiency of RO promises higher quality permeate with lower hardness and TDS levels, even better achieving the goals set by the District. However, this stage encounters operational challenges similar to those observed in the previous alternatives tail-end NF stages. By the time flow reaches the RO membranes, it has been highly concentrated due to prior filtration through the NF stages. This high concentration predominantly includes sulfate ions among other compounds, which approach their saturation points quickly within the RO process.

As sulfate and similar ions saturate, they precipitate and begin to clog the fine pores of the RO membrane, significantly impeding its ability to function efficiently. This phenomenon not only restricts the volume of flow that can pass through the membrane but also diminishes the overall recovery rate of the membrane. Essentially, the RO membranes face a higher osmotic pressure to already-elevated ion concentration in the feed stream, necessitating even greater operational pressures to maintain desired flow rates across the membrane. This results in increased energy costs, while potentially shortening the lifespan of the membranes due to the harsher operational conditions which lead to a higher likelihood of fouling. Additionally, despite the greater overall efficiency of RO membranes, the poorer quality concentrate from the NF stages reduces the overall system recovery rate to 85%. This results in a theoretical system that has marginally higher quality water, at the consequence of greater energy costs and a near-equivalently excessive volume of brine produced. When considered together, relative to the District's design constraints, this alternative is not feasible.

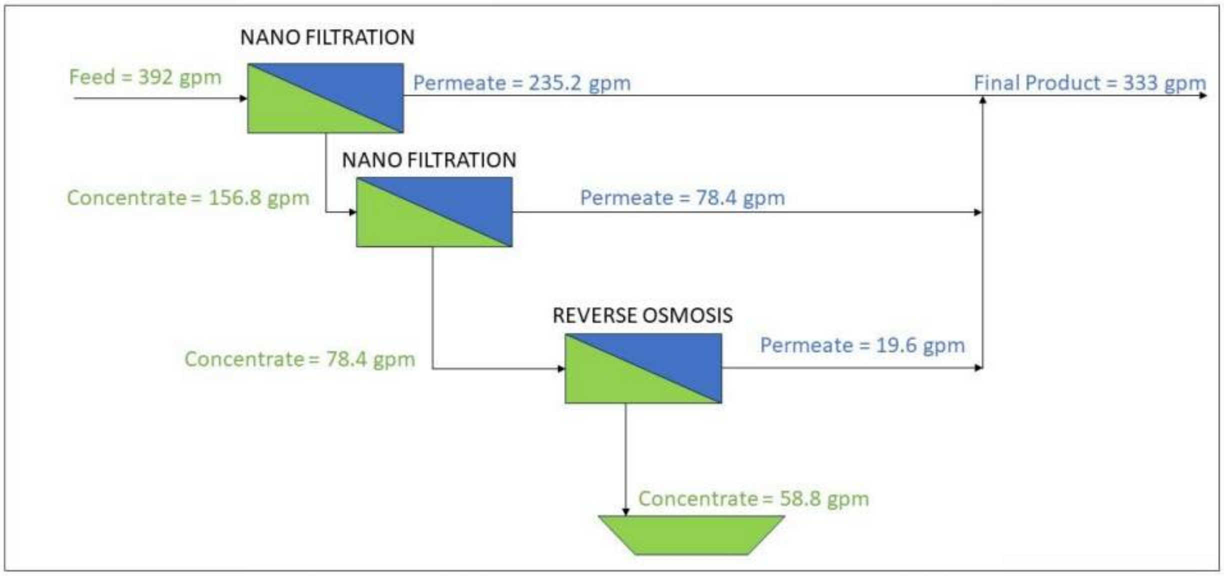


Figure 5 – Flow Diagram – Alternative 2

3. *Alternative 3 – Dual-Stage Nanofiltration and Single-Stage Reverse Osmosis with Ion Exchange*

To address the issue of detrimental ion accumulation observed in the tail-end membranes from Alternatives 1 and 2, this third alternative introduces an ion exchange system between the nanofiltration membranes and the reverse osmosis system, functioning similarly to the District's currently existing iron-manganese media filtration equipment. However, rather than utilizing a manganese dioxide media, this system uses a cationic exchange resin to swap undesirable ions with compounds that are less disruptive. This system would replace divalent cations that contribute to water hardness (magnesium and calcium) with a monovalent cation which does not contribute to overall hardness (sodium).

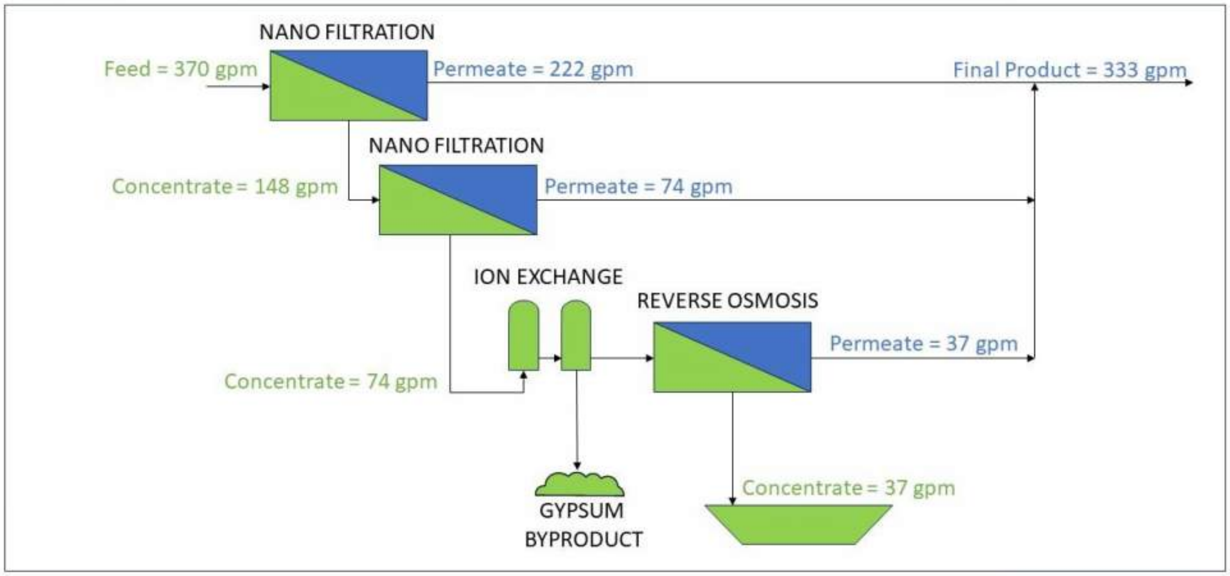


Figure 6 – Flow Diagram – Alternative 3

Analysis of Alto's existing groundwater chemistry relative to the removal capacity of a theoretical ion exchange system showed that this unit would effectively remove sulfate ions from the stage two nanofiltration concentrate, effectively doubling the recovery rate of the RO process alone, leading to an overall recovery rate of 89.1%. This rate aligns well with the system's design goals, offering an option with an expected water quality of 4 grains per gallon hardness and 130 mg/L TDS. However, this system demands significantly more operational oversight compared to the other alternatives, mainly in replenishing the collection of chemicals required to recharge the ion exchange unit. Considering the heightened operator intervention along with this system being below the requested recovery rate of 90%, builds a strong argument that this alternative is not feasible.

4. *Alternative 4 - Dual-Stage Reverse Osmosis with Ion Exchange and Softened Blend*

From modeling the proposed systems for Alternatives 2, 3, and 4, it was determined that the District's existing groundwater is favorable for reverse osmosis to treat to a very high quality. This is because RO membranes are typically used for seawater desalination which has a much higher TDS. The groundwater supplied to the District via its well system has a TDS of approximately 1,500 mg/L. Comparing to average seawater concentrations which vary around 35,000 mg/L. This means a system utilizing RO rather than NF can achieve noticeably higher removal rates, resulting in a permeate with as low as 0.5 grains per gallon of hardness and an equivalently low concentration of TDS. Additionally, when arranged in a multistage setup such as this for groundwater, the removal of carbonate ions can be nearly 100%. This is a key design consideration, as these carbonate ions are crucial for buffering pH levels in the District's water distribution system.

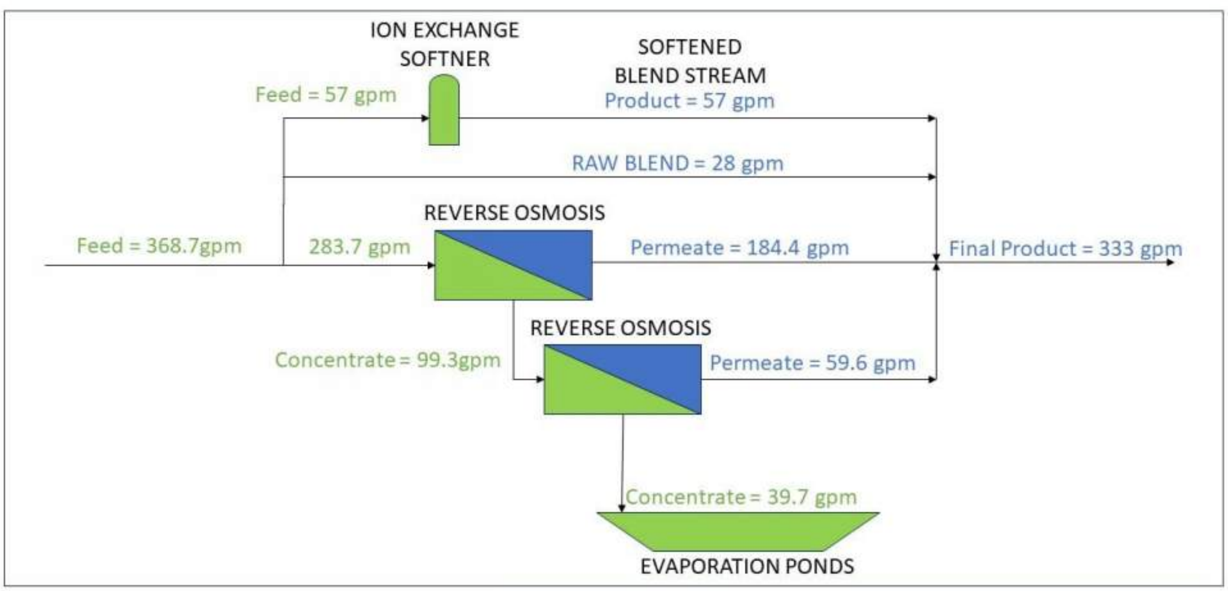


Figure 7 – Flow Diagram – Alternative 4

Carbonate ions help neutralize acids by forming bicarbonate, which precipitates out of the solution when reacting with an acid, stabilizing the pH. However, with the RO membranes removing most of the available bicarbonate, the final product water to the District is likely to be more acidic. This increased acidity could accelerate corrosion in the District's distribution system, raising maintenance costs and introducing the potential for heavy metal leaching (such as iron, copper, and lead) from pipes, which could affect water taste and the overall health of the community. To address these challenges, when investigating this alternative, which utilizes RO membranes rather than NF for softening, this alternative considers blending the ion exchange product with some raw effluent from the iron-manganese system to blend with the two permeate streams from the reverse osmosis membranes. This contributes necessary carbonate ions, raising the pH towards a more neutral range. The iron-manganese plus ion exchange flows are blended to generate a final product water with 5.95 grains per gallon of hardness and 494 mg/L TDS.

This alternative is attractive compared to the prior alternatives in this report, as it is optimizes the system to include RO membranes only, rather than a combination of RO and NF. This simplifies maintenance for operating staff for the membranes in this theoretical system.

However, the use of ion exchange in conjunction with a raw blend introduces significant operational requirements. As mentioned in Alternative 3, additional maintenance is required to replenish salt within the ion exchange unit. It is estimated that for this proposed system, when operating at 333 gallons per minute, will require approximately 1,110 pounds daily of salt for effective operation. Considering the relatively remote nature of Alto, NM, this is impractical on a large scale. Furthermore, the system's reduced recovery rate due to blending is 88.5% and the need for continuous monitoring of the effluent quality to ensure blend ratios are adequate pose additional concerns for maintaining consistent water quality.

5. Alternative 5 – Three-Stage Flow Reversal Reverse Osmosis

This alternative employs a three-stage flow-reversal reverse-osmosis (FR-RO) treatment setup, pioneered by ROTEC, which incorporates more complex piping and valve systems to interconnect each stage. This design addresses membrane fouling – an inevitable issue mentioned earlier in this report, where particulate and dissolved substances accumulate on or within the membrane, reducing performance. This fouling necessitates increased pressure over time to maintain permeate quality and volume, with the rate of fouling influenced by the types of contaminants, their concentrations, and the overall membrane's age.

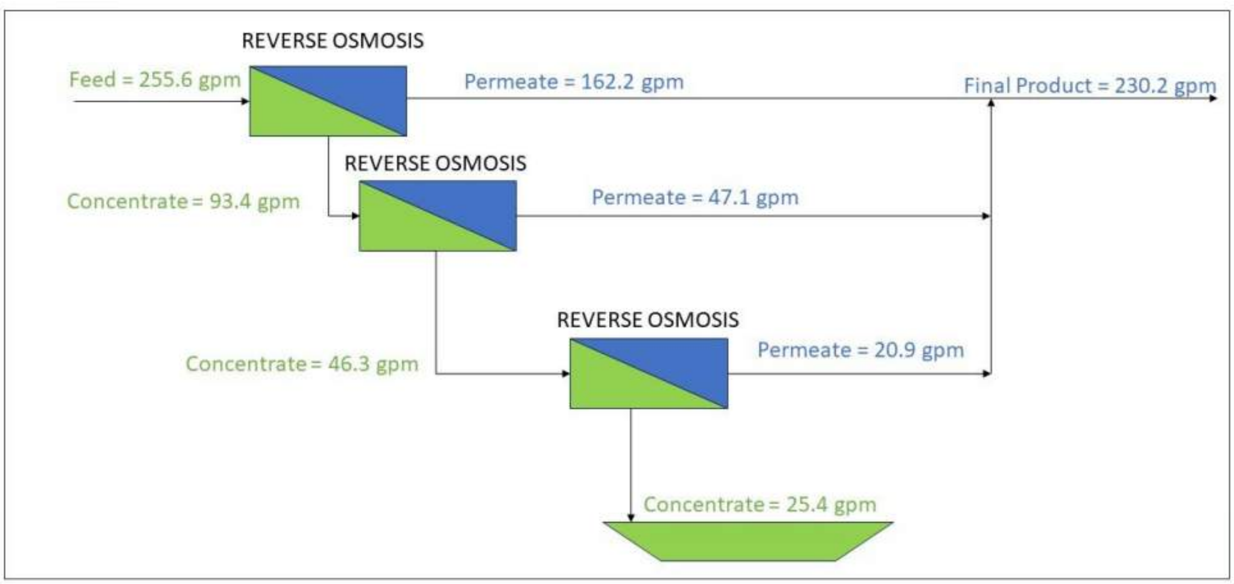


Figure 8 – Flow Diagram – Alternative 5

The flow-reversal system mitigates fouling by allowing the rotation of reverse osmosis stages. In typical setups, the first stage receives the highest quality feedwater, and progressively worsens through the

following stages. This was problematic for the first alternative, as the brine feeding the final stage of NF treatment approached the peak available saturation for sulfates, leading to undue excessive fouling of the membrane at a point sooner than typically anticipated. By automating the operation of valves to swap the first and third stages, fouling is more evenly distributed, enhancing membrane longevity.
Another significant design feature takes advantage of the arrangement of the RO membranes which are spiral-wound around a central pipe within the units pressure vessels. In standard systems, feedwater enters one end of the vessel, leading to uneven fouling throughout the entire surface area of the membrane. The flow-reversal design alternates the feed at both ends on a scheduled basis, further reducing uneven wear.

This setup, automated by a PLC (Programmable Logic Controller), monitors pressure changes indicative of fouling. Upon detecting a specified pressure gradient, the system adjusts the flow and stage configuration to minimize fouling and by extension reducing the frequency of membrane replacement. This optimizes maintenance expenditures and aligns this design with project design goals in terms of minimizing long-term costs while achieving drinking water well within water quality goals. The system achieves a 90% recovery rate with minimal hardness and TDS. However, the permeate produced is too aggressive for direct distribution and requires blending with water from the existing iron-manganese removal system to adjust the pH and prevent leaching of built-up scale in the distribution piping. This blending, capped at 10% of the RO system's permeate to avoid excessive hardness, demands operating staff devote additional time to managing the blend ratio. This is unfavorable relative to the District's requested design, leading to alternative 6 in the following section.

6. Alternative 6 - Three-Stage Flow Reversal Nanofiltration

Alternative 6 employs a three-stage flow-reversal nanofiltration (FR-NF) system, initially developed for reverse osmosis systems such as the theoretical system in the prior section. This system includes similar valves and additional piping to divert flow on an alternating schedule between the first and third stages with the same intent of reducing the rate of membrane fouling. Similarly, the point where flow enters the pressure vessel is alternated as well to allow for an even distribution of precipitation of contaminants along the membrane surface. However, this design differs by utilizing "looser" nanofiltration membranes, which have a lower efficiency for some of the constituents of TDS. These looser membranes selectively removed the contaminants of concern to the District (hardness and TDS) while maintaining an adequate level of carbonates to ensure the pH is more stable and the water is less aggressive.

From discussions with the District concerning the five previous alternatives included in this report, there was an additional design consideration that warranted a modification to the treatment systems design. Based on input from membrane manufacturers, it was determined that the allowable turndown is crucial to the efficient operation of both NF and RO membranes. In this context, turndown is the ability to operate the membrane system at reduced flow rates relative to its maximum designed capacity. This term describes the operational flexibility of the system, which allows it to handle varying feed water quality and quantities while maintaining a cost-effective efficiency.

Previously, the design intent was to size the groundwater treatment system to meet 99.7% of historical demands. However, operating a unit with a total capacity of 333 gallons per minute across a 24 hours per day, 7 days per week schedule, results in approximately 175 million gallons per year of potable water. This is slightly more than twice the projected demands for 2045. Operationally, this indicates that the unit would only be operated at approximately half of its designed flowrate. From discussions with designers at ROTEC as well as membrane manufacturers such as TORAY, and DOW, it has been indicated that operating the membranes on this schedule is not ideal. This could potentially cause damage the membrane if left unpressurized for longer than a few weeks at a time. To address this, a reduced flowrate was selected with the option of blending iron-manganese treated water to make up to 333 gallons per minute for future sustained peak demand events. This brought the system to an operational range of 150 gallons per minute to 230 gallons per minute, with a maximum flowrate of 333 gallons per minute when blended. The water quality anticipated while operating from 150 gallons per minute to 230 gallons per minute are included in Table 5.

Flowrate [gal/min]	Ambient Temperature [°F]	Hardness [grain/gal]	Total Dissolved Solids [mg/L]
150	52.0	4.156	202.33
150	73.0	5.913	280.35
230	52.0	2.935	145.43
230	73.0	4.356	211.11

Table 5 – Anticipated Permeate Water Quality for FR-NF System

The predicted water quality while blending up to 333 gallons per minute is included in Table 6 for comparison. Also, these blend concentrations will likely be marginally lower than these approximations after further blending with whatever volume is within the existing ground storage tank prior to final distribution.

Temperature	Parameter	Iron-Manganese Effluent	FR-NF Permeate Water	Blend Water
52.0°F	Hardness mg/L (grains)	1,090.71 (63.8)	50.25 (2.9)	372.07 (21.8)
	TDS mg/L	1,500.00	145.43	564.41
73.0°F	Hardness mg/L (grains)	1,090.71 (63.8)	74.56 (4.4)	388.86 (22.7)
	TDS mg/L	1,500.00	211.11	609.77
Note: 6 grains/gallon is equivalent to 102.708 mg/L.				

Table 6 – Anticipated Water quality for FR-NF + Iron-Manganese Effluent Blend

When taken as a whole, this approach is largely achieving the goals set by the District. This system can provide product water for use by the District with higher quality than that set by the EPA’s secondary standards for the vast majority of future projected demands. For the minority of periods in the future comprised of consecutive peak day demands, the District will still be able to supply water but at a minor consequence to water quality. It is anticipated that the max blended concentration seen by the District’s clients is 22.7 grain/gal which, while higher than 6 grain/gal, is still a 64% improvement from the water quality current supplied to the District. This would occur for the scenario associated with the flow diagram displayed in Figure 8 below.

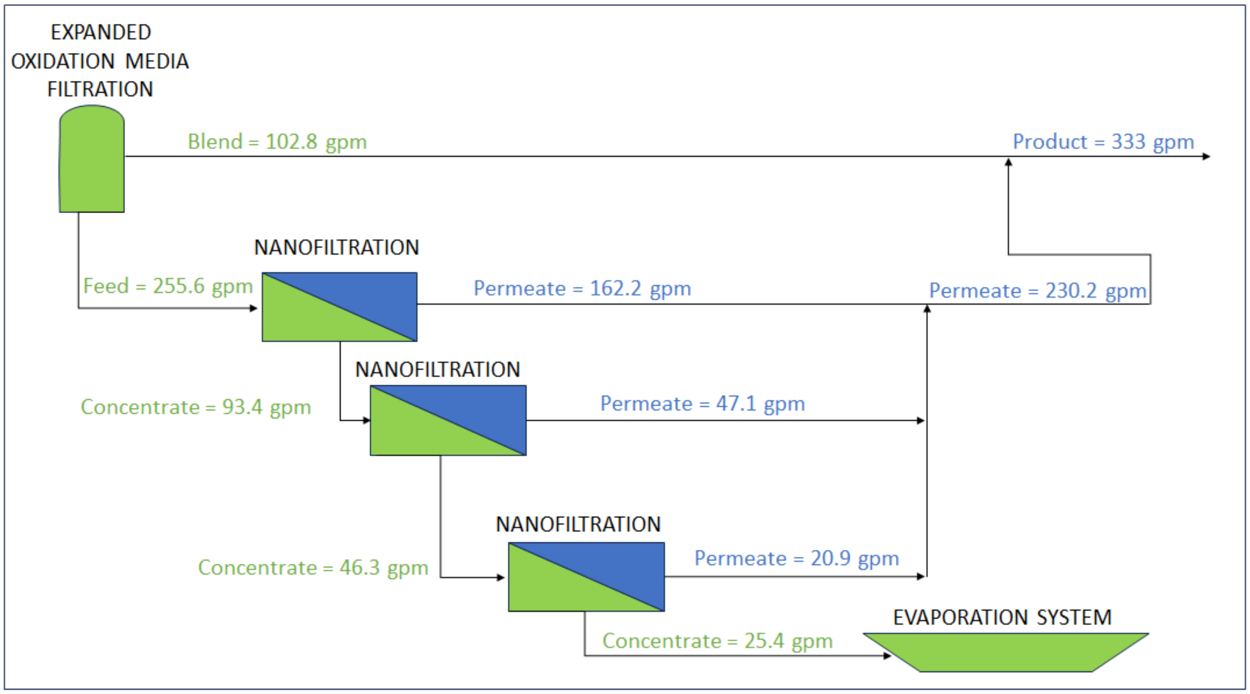


Figure 9 – Flow Diagram – Alternative 6

7. *Alternative Analysis*

The six alternatives for groundwater treatment are analyzed in the following decision matrix using nonmonetary criteria. The alternative with the lowest score is ranked as the preferred alternative. As shown in the table, the preferred alternative for treatment expansion to the existing Alto groundwater treatment plant is a three-stage flow-reversal nanofiltration membrane system.

Criteria	2-Stage NF	2-Stage NF+1-Stage RO	2-Stage NF + IX/RO	2-Stage RO+ IX/Raw Blend	3-Stage FR-RO	3-Stage FR-NF
Alternative	**One**	**Two**	**Three**	**Four**	**Five**	**Six**
Ease of Operation	1	2	3	3	1	1
Power Consumption	1	3	3	4	4	2
Waste Stream	4	4	3	4	1	1
Water Quality	1	1	1	2	1	1
Post Stabilization	3	3	3	2	4	3
Total	**13**	**15**	**16**	**15**	**11**	**8**
Note: Lowest number is best option. NF = Nanofiltration RO = Reverse Osmosis FR = Flow Reversal IX = Ion Exchange						

Table 7 – Groundwater Treatment Alternative Analysis

ii. Brine Disposal Options

1. Evaporation Ponds

The first alternative considered in this report for disposal of the brine generated by the nanofiltration water treatment system is a network of evaporation ponds. This system would comprised of five ponds which, when exposed to the natural climate of Alto, can evaporate the water associated with the brine. This would generate a dewatered salt which could be hauled away to be disposed of at the Otero/Lincoln landfill just south of Alamogordo. For the potential requirement of evaporation ponds for this stage of enhancement to the District's treatment system, two plots adjacent to the existing water treatment plant were purchased by the District. These plots cumulatively occupy approximately 40 acres of land.

The assumptions going into this design primarily revolve around the yearly precipitation and evaporation associated with the climate of Alto, NM. By investigating historical data from the United States Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), and the Community Collaborative Rain, Hail & Snow Network (CoCoRaHS), the following yearly rates were chosen.

Parameter	Alto Data 2024	Historical Value	Unit
Evaporation Rate	48.0	37.5	Inches/year
Precipitation Rate	8.0	22.2	Inches/year
Net Evaporation Rate	**40.0**	**15.3**	**Inches/year**

Table 8 – Alto Climate from Historical Weather Data

With a net-positive evaporation rate, the conditions for Alto are favorable for the utilization of evaporation ponds for brine disposal. The design for these ponds is then constrained relative to the following relationship:

Net Volume in Pond = Brine Volume + Precipitated Volume – Evaporated Volume

To ensure that this proposed pond system is sufficient throughout the design period, brine volumes associated with demand growth through 2045 were used, with the nanofiltration treatment system operating with a recovery rate of at least 90%. For this, a minimum pond surface area of 20 acres is required to allow for sufficient capacity to evaporate the composite brine and precipitation flows. These ponds would be split into the following arrangement.

Pond Number	Depth	Freeboard	Surface Area	Volume	
	[feet]	[feet]	[acres]	[cubic feet]	[gallons]
One	1.00	2.00	4.125	179,685	1,344,043.8
Two	1.00	2.00	4.125	179,685	1,344,043.8
Three	1.00	2.00	4.125	179,685	1,344,043.8
Four	1.00	2.00	4.125	179,685	1,344,043.8
Five A	1.00	2.00	1.75	76,230	570,200.4
Five B	1.00	2.00	1.75	76,230	570,200.4
Cumulative			20.00	871,200	6,516,576

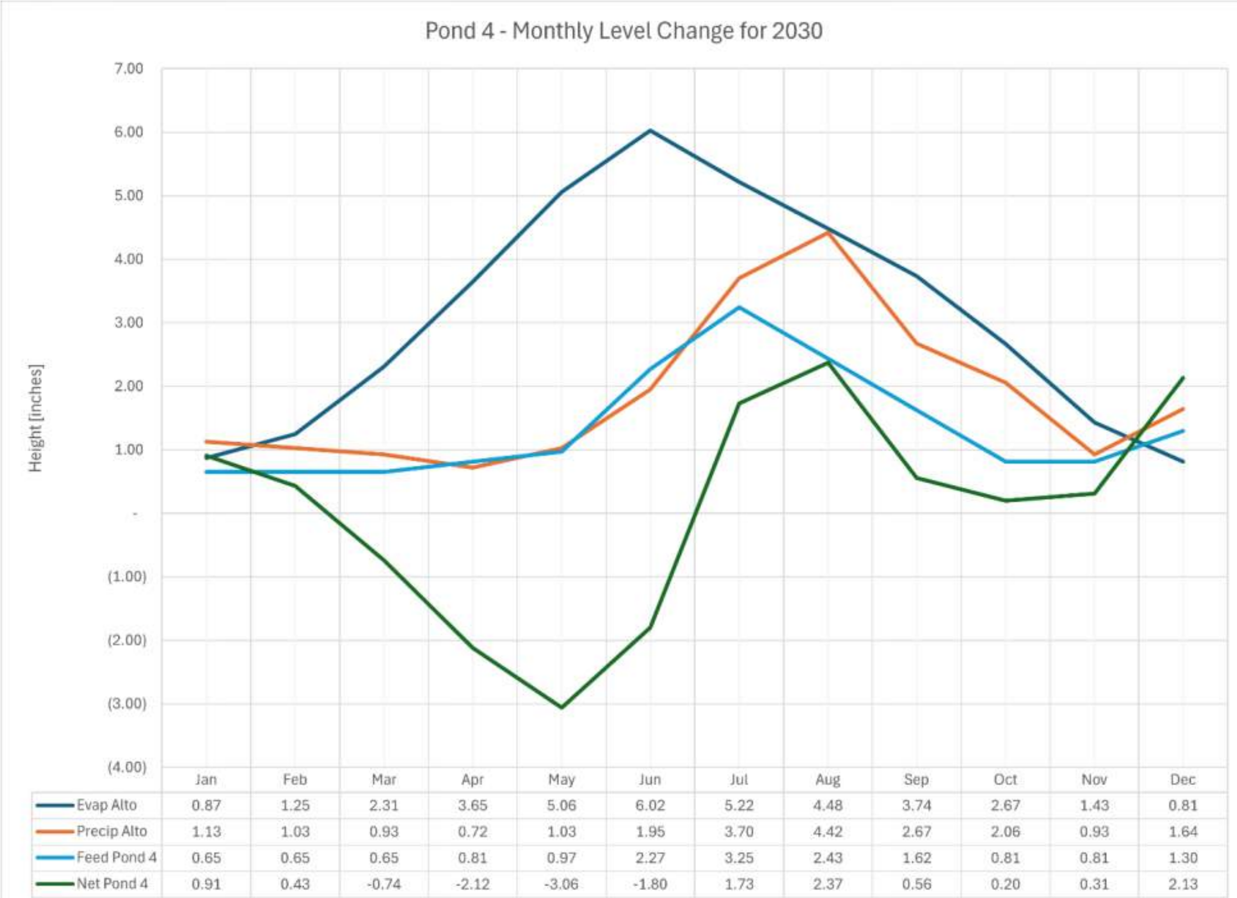
Table 9 – Design Data for Five Pond Evaporation System

A plan view of this alternative is shown in Figure 10.

Figure 10 – 20 Acre Evaporation Pond Layout

Utilizing an adjustable weir would allow one pond to flow to the next in the sequence. In the event of a 25 year rainstorm, which could contribute as much as 12 inches of precipitation in addition to the anticipated 22.2 inches per year, the weirs could be raised to take advantage of the additional volume associated with the 2 feet of freeboard included with each pond. This system would have sufficient space to store the volume associated with brine flows in 2045, when the demand has reached its peak projected for the design period, along with the occurrence of a 25-year storm, without overflowing into the surrounding land.

These ponds are sized such that operating staff can haul dewatered solids from the evaporation ponds on a variable schedule. This schedule will change throughout the design period in response to the growth in demand anticipated for the District. This results in Pond 4 acting as the final pond from which solids are hauled for the period from initial pond construction through 2035. Following 2035, flow would begin overflowing the weir associated with Pond 4, allowing Pond 5 to transition into the final evaporation pond. For example, for the year of 2030, after the evaporation system has been under operation for a few years and brine demand has grown by approximately 4.1% from 6.6 million gallons per year to 6.9 million gallons per year, Pond 4 sees occasional periods for solids removal. This is shown in Figure 11 which displays the height contributed to Pond 4 by evaporation, precipitation, brine (alternatively known as the feed water), and the resulting net level change within the pond.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evap Alto	0.87	1.25	2.31	3.65	5.06	6.02	5.22	4.48	3.74	2.67	1.43	0.81
Precip Alto	1.13	1.03	0.93	0.72	1.03	1.95	3.70	4.42	2.67	2.06	0.93	1.64
Feed Pond 4	0.65	0.65	0.65	0.81	0.97	2.27	3.25	2.43	1.62	0.81	0.81	1.30
Net Pond 4	0.91	0.43	-0.74	-2.12	-3.06	-1.80	1.73	2.37	0.56	0.20	0.31	2.13

Figure 11 – Pond 4 Change in Level per Month

Each of the three variables contributing to the net level change is on its own yearly cycle. Evaporation peaks in June while precipitation is building up to a maximum that is reached by August. As well, demands fluctuate depending on the ambient temperature, variation in the District's population, and other factors. Examining Figure 11 in more detail shows this more clearly. This variation allows for solids removal for a portion of the year.

Continuing with 2030 operation as an example, Pond 4 has a net-positive accumulation for January and February which is due in part to the volume overflowing from Pond 3. This volume begins evaporating until the end of April and the beginning of May, when Pond 4 will be empty of all water. This will continue until the beginning of July, wherein Pond 4 begins once again to accumulate water. This gives operating staff one to three months per year, depending on the District's rainfall, from which to remove solids from Pond 4. This would be allowable until 2035. After this year, Pond 4 will consistently overflow into Ponds 5A and 5B. Ponds 5A and 5B are split such that operating staff, at their discretion could terminate flow to Pond 5A, allowing it to fully evaporate its volume, and utilize Pond 5B for brine storage in the interim. Alternatively, these two ponds could be allowed to float together, with their composite surface area enabling solids removal on a yearly basis during the period of April through late June.

While this technology is appropriate for the Alto Lakes brine based on the volume requiring disposal, there are other design considerations which make this option less favorable. Primarily, the surface area required will occupy approximately 74% of the total space available in the land purchased directly adjacent to the existing water treatment plant. This restricts the District from utilizing this land for public recreational facilities or other amenities as a majority of the total surface area is occupied by the evaporation pond system. While the topography is favorable in the land previously occupied by the racetrack, this is not the case for the property for ponds situated North of this landmark. While the freeboard is sufficient to hydraulically retain a 25-year storm, this would severely limit operating staff from hauling solids for the years immediately following the anticipated 12 inch rain event. While these considerations don't rule out this Alternative, this overall design is unfavorable relative to the District's requested system.

2. WAIV and Equalization Pond System

Other technologies exist to enable higher rates of evaporation with a footprint smaller than the previously discussed evaporation ponds. One such technology is the WAIV (Wind-Aided Intensified eVaporation) Evaporation System supplied by Clear Creek Environmental Solutions. Figure 12 shows a photo of a WAIV unit.

Figure 12 – WAIV Unit Installation

This product utilizes an array of vertically oriented sails. These sails are designed to have a hydrophilic (with a tendency to be wetted by water) surface which distributes the brine across a surface area equal to 1.4 acres. As wind blows between the sails, the water within the sails evaporates and is carried away, enabling further evaporation to occur. This is achieved in a unit with a footprint of only 1,600 square feet. Additionally, the unit can be modified to include a solar-powered fan which would enable the unit to evaporate brine regardless of ambient weather conditions.

From pilot studies carried out by Clear Creek Environmental Solutions, an evaporation rate for the unit in Alto is estimated to be approximately 1.51 million gallons per year. If this rate is confirmed through piloting in Alto, at least five WAIV units would be needed to meet anticipated demand through 2035. For the following decade, an additional unit would be required though its operation is only required for half of the year or less through 2045. This option gives the District the capacity to evaporate up to 658,500 additional gallons of brine flow if needed.

This alternative is not without its drawbacks. Due to the colder climate associated with Alto during its winter season, it is anticipated that the units will be effectively inoperable for the period of November through February. This requires an equalization pond to act as storage during high-flow and low evaporation periods of the year. From examining the anticipated precipitation shown by the orange line in Figure 10, a pond with the following dimensions will be sufficient for this requirement. Variation in the level of the pond will not exceed the 2 feet of height available with a maximum of 1.9 feet by the end of February. After starting up the WAIV units during March, the level in the pond will vary between 6 to 15 inches.

Parameter	Value	Unit
Surface Area	3.50	Acres
Depth	2.00	Feet
Freeboard	2.00	Feet
Volume	261,360.00	Cubic Feet
	1,954,972.80	Gallons

Table 10 – Design Values for Equalization Pond

Figure 13 shows the site layout with six (6) WAIV units and 3.5 acre equalization pond.

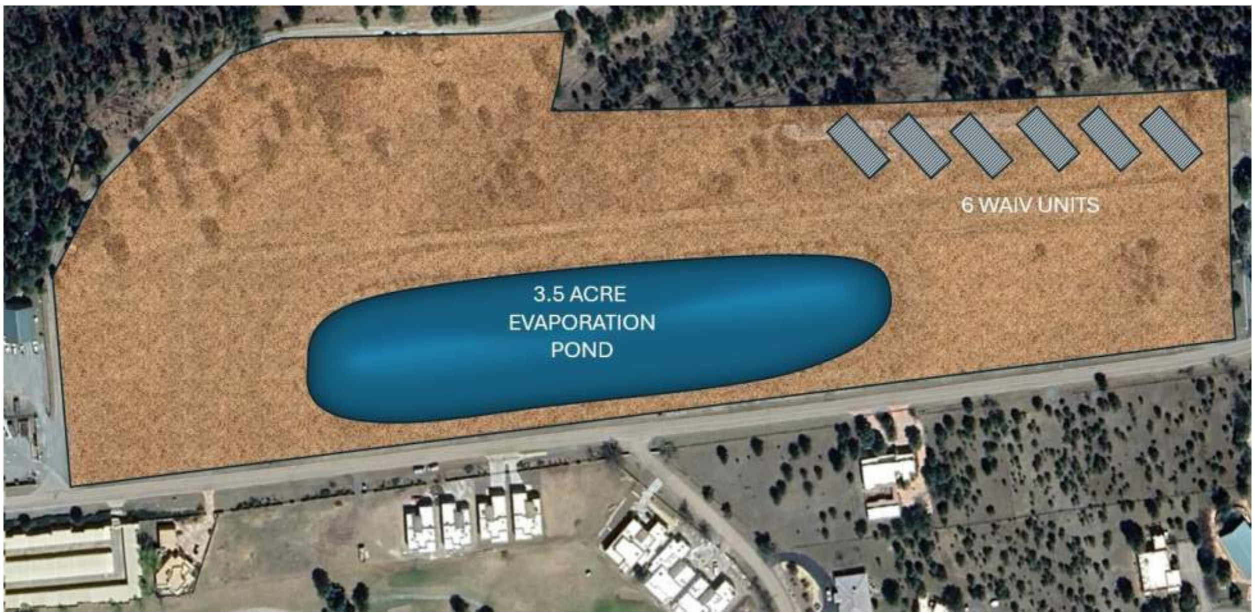


Figure 13 – Equalization Pond and WAIV Unit Layout

Utilizing the relatively flat grade found in the vicinity of the old racetrack, the equalization pond could be built such that the max hydraulic grade line, including the 25 year storm is equivalent to the level with the surrounding grade. The pond would have a gentle, one foot tall berm around the perimeter to prevent any surface runoff from entering the pond. This pond would accommodate brine produced by the water treatment system until a pump would convey the flow to a height of 15 feet. The WAIV units would then be arranged in parallel. The concentrated blowdown from the units would periodically be pumped to small disposal beds where it could be dried and hauled away.

Overall, this system is favorable allowing other uses of the surrounding land by the District. When compared to a system comprised entirely of evaporation ponds, the WAIV allows for a significantly reduced footprint. Additionally, the unit requires minimal operator intervention and has an overall low energy cost. While these traits overall make it suitable for the District, there is a degree of uncertainty associated with this unit similar to that of the proposed nanofiltration groundwater treatment system. While the model results indicate that conditions are favorable for this design, a pilot study is highly recommended to allow for the verification of the evaporation rate advertised by the WAIV unit prior to construction.

3. ECOVAP and Equalization Pond System

Competing enhanced brine evaporation systems were considered as part of this analysis, specifically the ECOVAP Evaporative Matrix. This unit is pictured below in Figure 14. This equipment is comprised of HDPE interlocking panels which provide a surface for brine to trickle down, operating on a similar design principle to the WAIV unit. The modular construction of this unit allows for the evaporation capacity of the unit to be expanded if future demands create excess brine volumes. This technology has been constructed to handle brine produced as a byproduct of oilfield drilling, mining, and power generation.

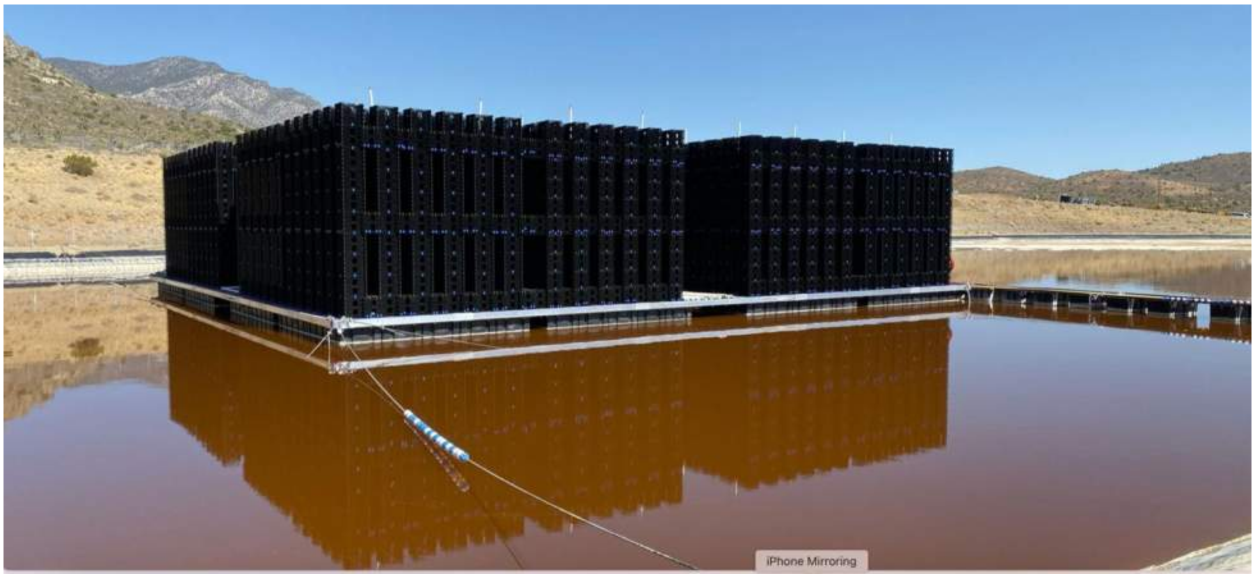


Figure 14 – ECOVAP Unit Installation

Brine flows by gravity to the storage and evaporation ponds before being pumped to the top of the HDPE matrix. This is achieved by a low-pressure recirculation pump, which is also the only mechanical component of this system. Brine flows across the surface of the panels with the design of the ECOVAP unit enabling complete saturation within minutes of operation starting. When compared to the equivalent volume of flow within a pond, the exposed surface area of the brine is significantly increased, allowing ambient heat to induce evaporation at a higher rate. With the water spread over a larger surface, more of the water is also directly exposed to solar radiation, allowing a larger volume of the water to heat up when compared to deeper bodies of water with typical evaporation ponds. This promotes a higher rate of phase change from liquid to vapor for the nanofiltration brine.

Crucial to the operation of systems such as the ECOVAP and WAIV units is wind-driven convection, which allows for water vapor to be removed. If high humidity air were allowed to remain stagnant in the vicinity of these units, evaporation rates would be dampened. Wind-driven convection also facilitates convective heat transfer. Together, these functions to have a synergistic effect which drastically reduces the ground surface area requirements for a unit to achieve equivalent evaporation rates to the ponds considered as the first alternative in this report. From previous installations and pilot studies carried out by the manufacturers of the ECOVAP unit, it has been estimated that a unit requiring 0.54 acres of space is required to evaporate the equivalent of 27 acres of ponds – exceeding the 20 acres estimates for Alto. This should provide the district with flexibility in operation, should unusually cold or wet weather events be seen by the district. The dimensions for this unit are outlined in Table 11.

Unit Dimensions [feet]			Footprint [acres]
Length	Width	Height	
80	300	22	0.54

Table 11 – Dimensions of ECOVAP Unit and Minimum Required Footprint

Pilot testing and full scale operations of the ECOVAP system has yielded 90 percent reduction in the water applied while maintaining the ability to flush the slurry from the system by gravity. In the case of this project, that would yield a solids concentration of 17%, a TDS concentration of 170,000 mg/L at the bottom of the unit. At the design year, this would be 850,000 gallons per year that would have to be dried in the drying beds. With a net evaporation of 15 inches per year, it would require just under two acres of drying beds.

Similar to the WAIV unit described in the previous section, brine from the proposed nanofiltration groundwater treatment system flows by gravity to 3.5-acre equalization storage pond as a buffer to hold water during the time when application to the ECOVAP system is not possible. At initial operation, four 10 HP pumps would supply the pressure required for flow to trickle down the proposed units. For final flows of 8.5 million gallons per year, an additional two 10 HP pumps would be required. This assumes that the unit would operate during months with favorable ambient conditions, which was considered to be from March to November.

This alternative is advantageous to the WAIV unit because it does not require replacement of the utilized matrix. The sails used by the previously considered alternative accumulate solids and other particulate matter, creating an ongoing cost for their replacement through constant operation. This also requires that these units be taken down quarterly for a minimum of eight hours for required maintenance.

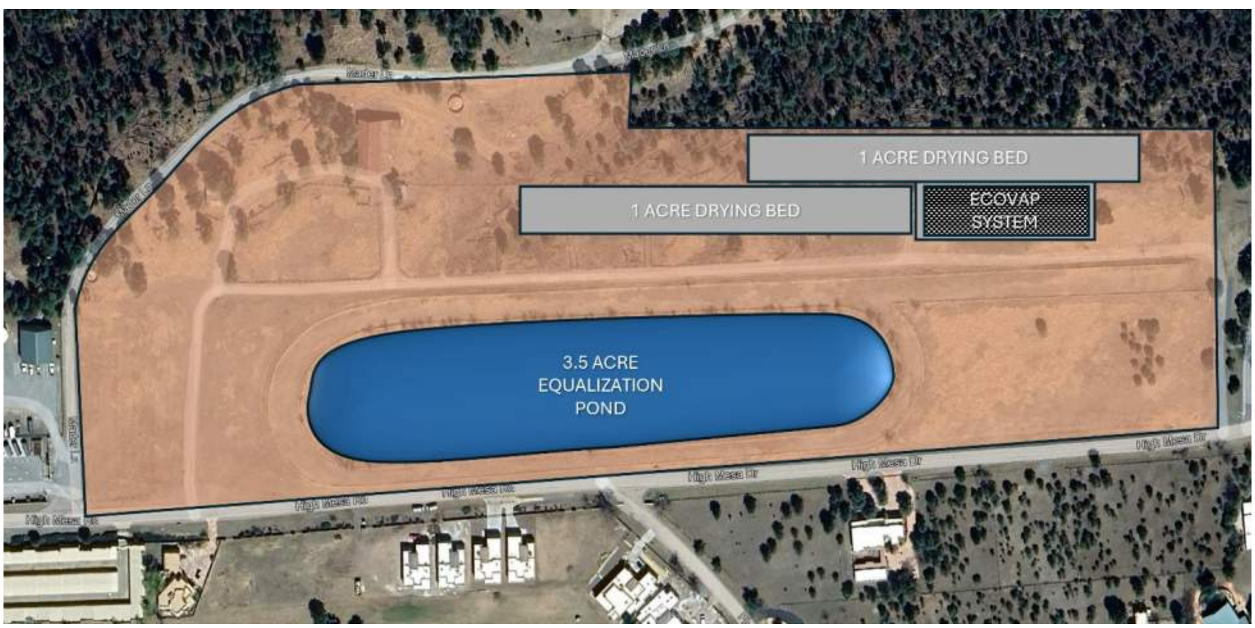


Figure 15 – Equalization Pond and ECOVAP Unit Layout with Drying Beds

For replacement sails on the WAIV system, costs are approximated to be $90,000 per year based on conversations with the manufacturer. By comparison, the HDPE construction of the ECOVAP unit negates this requirement. This reduces the operational and maintenance requirements of this alternative. O&M requirements entail monthly examinations of the pumps for proper operation and adjustment of timers as needed. Piping and spray heads additionally need to be inspected on a yearly basis, but otherwise, the unit operates with no additional maintenance requirements by plant staff.

Similar to the WAIV unit, this alternative is also favorable to evaporation ponds as it requires a minimal footprint to achieve the evaporation rates required of the groundwater treatment system. This enables a greater degree of the land purchased by the landowner in the vicinity of the treatment plant to be utilized for other purposes. Additionally, the minimized footprint of the unit also enables the system to be kept out of sight to a greater degree. This alternative is even more advantageous as operational costs are at a minimum and operator intervention is infrequent. This comes with a lower power consumption and a design that enables construction of additional panels should excess capacity be required due to future growth in Alto past the time frame considered within this report.

4. Alternative Analysis

The three alternatives for brine disposal are analyzed in the following decision matrix using non-monetary criteria. The alternative with the lowest score is ranked as the preferred alternative. As shown in Table 12, the preferred alternative for brine disposal is a system comprised of ECOVAP units and an additional equalization pond.

Criteria	Evaporation Pond Only (Alternative 1)	WAIV Units + Equalization Ponds (Alternative 2)	ECOVAP Units + Equalization Ponds (Alternative 3)
Ease of Operation	1	3	3
Power Consumption	1	4	2
Effect on Surroundings	5	1	1
Impact to Public	4	1	1
Land Requirements	5	1	1
Maintenance Requirements	1	3	2
Total	**17**	**13**	**10**
Note: Lowest number is the best option.			

Table 12 – Brine Disposal Alternative Analysis

While the above matrix did not compare these alternatives on the basis of cost, cost estimates for the two enhanced brine disposal alternatives are included below in Tables 13 and 14 for the reference and future budgetary preparations.

a. Location Map (Water Treatment and Brine Disposal)

The proposed expansion will take place at the existing water treatment plant, located at 103 Mader Lane, Alto, NM 88312. The site is shown in Figure 15.

b. Environmental Impacts (Water Treatment and Brine Disposal)

The environmental implications of the Phase 2 treatment expansion of the existing water treatment plant, under Alternative 6, primarily relate to the management and disposal of waste streams generated by the nanofiltration process. By contrast, Phase 1 of this project, which involved the construction of the now existing treatment plant and targeted removal of iron and manganese, was completed with minimal waste production and by extension, limited environmental impact.

DESCRIPTION	QTY	UNITS	$/UNIT	TOTAL
Mobilization	1	LS	$176,424.32	$196,861.07
Clear and Grub	3.5	AC	$4,800.00	$16,800.00
Excavation/Grading for Ponds	23,100	CY	$6.50	$150,149.27
Dual Lined Drying Beds	90,000	SF	$4.50	$405,000.00
Pond Dual Liner System w/ Leak Detection	167,706	SF	$4.50	$754,677.00
Concrete Pad/Drying Beds	443	CY	$1,000.00	$443,000.00
Roadway Around Ponds	80,000	SF	$1.50	$120,000.00
WAIV Equipment and Installation	6	EA	$408,735.00	$2,452,410.00
			Subtotal	$4,538,897.34
			Contingency (20%)	$907,779.47
			Construction Total	$5,446,676.81
			Engineering Design (10%)	$544,667.68
			Construction Management (5%)	$27,233.38
			Total Project	$6,018,577.87

Table 13 – Opinion of Probable Cost for WAIV Enhanced Evaporation System

DESCRIPTION	QTY	UNITS	$/UNIT	TOTAL
Mobilization	1	LS	$176,424.32	$196,861.07
Clear and Grub	3.5	AC	$4,800.00	$16,800.00
Excavation/Grading for Ponds	23,100	CY	$6.50	$150,149.27
Dual Lined Drying Beds	90,000	SF	$4.50	$405,000.00
Pond Dual Liner System w/ Leak Detection	167,706	SF	$4.50	$754,677.00
Concrete Pad	443	CY	$1,000.00	$443,000.00
Roadway Around Ponds	80,000	SF	$1.50	$120,000.00
Installation of ECOVAP Equipment	1	LS	$750,000.00	$750,000.00
ECOVAP Equipment	1	EA	$2,500,000.00	$2,500,000.00
			Subtotal	$5,336,487.34
			Contingency (20%)	$1,067,297.47
			Construction Total	$6,403,784.81
			Engineering Design (10%)	$640,378.48
			Construction Management (5%)	$320,189.24
			Total Project	$7,364,352.53

Table 14 – Opinion of Probable Cost for ECOVAP Evaporation Equipment

With the progression into Phase 2 underway, an analysis of potential environmental impacts is essential, especially concerning brine disposal. This is addressed with the utilization of the WAIV units mentioned earlier in this report. This unit is designed to evaporate brine while ensuring no release of spray, mist, or aerosols, which indicates that there is little cause for concern related to air quality in the vicinity of the unit. This will be verified during the piloting phase of this project. Additionally, utilization of these units allows the size of the associated pond, used for equalization of the hydraulic system, to be reduced from 20 acres to 3 acres. Due to this, impacts on the surrounding woodlands, small animal, and avian populations displaced by this development will be minimal. The areas impacted by this project have all been previously disturbed. A Categorical Exclusion Checklist has been completed for this project and it is not anticipated that there will be any impact to protected or endangered species.

c. Land Requirements (Water Treatment and Brine Disposal)

The existing water treatment plant is housed within a building that covers 2,000 square feet of the site. The treatment plant site, as well as the two properties to the East of the plant, are currently owned by the District and are adequate for the needs of Phase 2.

With the recent purchase by the District of additional property in the vicinity of the existing treatment plant, there is sufficiently adequate space for expansion as needed for this project. Within one of the two properties purchased by the District, there is 26.9 acres of available surface area for this project. It is anticipated that the evaporation pond system will comprise approximately 3.8 acres between the equalization pond and the projected six units which are required. This would leave more than 80% of the available land open for a cart barn, pickleball courts, or a walking path.

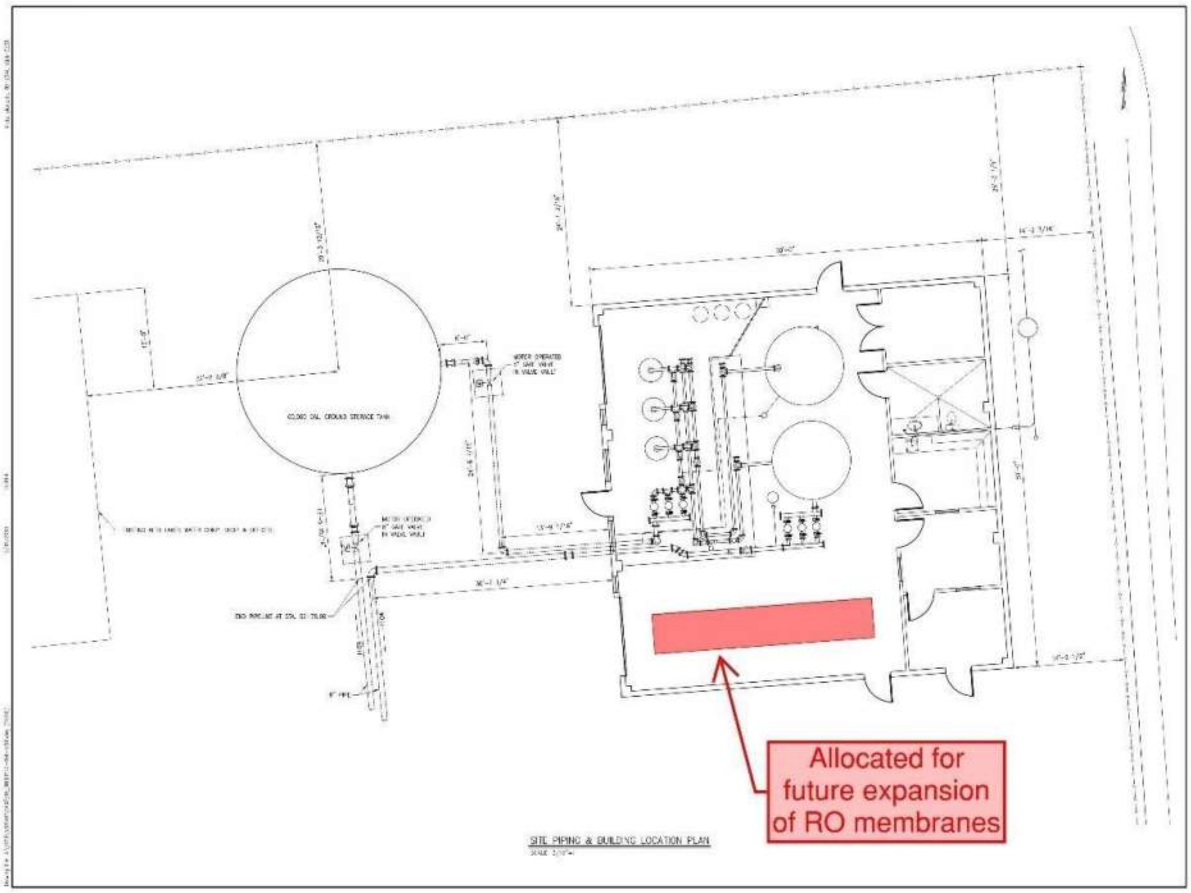


Figure 16 – Existing Treatment Plant Site

d. Construction Problems (Water Treatment and Brine Disposal)

The proposed water treatment plant expansion is located within the existing building and, as such, should have minimal problems preparing for and carrying out construction. Similarly, the equalization pond and WAIV units are planned to be constructed along a portion of the existing property that was previously utilized as a racetrack. This means that the area is relatively flat.

6. PROPOSED PROJECT (RECOMMENDED ALTERNATIVE)

a. Project Design

The proposed water treatment plant project consists of three separate components. They are:

- Expansion of the existing iron-manganese oxidation media filter to a net production capacity of 333 gallons per minute. This equipment will operate as before by utilizing its oxidizing filtration (AD-26) media prior to membrane treatment. This equipment is supplied by AdEdge.
- Three-Stage Flow-Reversal Nanofiltration which will act as a softener to achieve lower hardness concentration and reduced TDS. This equipment will be installed downstream of the iron-manganese oxidation media filter which will act as pretreatment for the membrane system. It will include the appurtenances associated with a flow-reversal membrane system. This equipment is supplied by ROTEC who holds the patent on the flow-reversal technology.
- Finally, to handle the brine produced by the nanofiltration membrane system, a configuration of ECOVAP enhanced evaporation units. These will fully evaporate the volume of brine produced as a byproduct of softening the District's groundwater and removing TDS. Associated with these units will be a 3.5-acre equalization pond/catchment basin as well as two 1-acre drying beds. Based on source water quality, it is not anticipated that the brine would be considered hazardous. Pilot test results will be able to confirm how the brine will ultimately be disposed of.

b. Cost Opinion

i. Water Treatment and Brine Disposal

The following is the anticipated project cost for the recommended treatment and disposal alternatives.

PROJECT	OPINION OF COST
Iron and Manganese Equipment (AdEdge)	$420,000.00
Nanofiltration Equipment (ROTEC)	$480,000.00
Brine Disposal Evaporation System (ECOVAP)	$3,250,000.00
3.4 Acre Equalization Pond/Drying Beds	$2,077,487.00
Iron and Manganese Installation	$340,000.00
Nanofiltration Installation	$375,000.00
Subtotal	$6,942,487.00
Contingency (20%)	$1,388,497.40
Engineering & Admin (15%)	$1,249,647.66
Total Project Cost	**$9,580,632.06**

Table 16 – Treatment and Disposal Costs

7. CONCLUSIONS AND RECOMMENDATIONS

a. Water Treatment and Brine Disposal

Since the last Preliminary Engineering Report, the ALW&SD has made significant improvements to the District's infrastructure, particularly concerning iron and manganese concentrations. Phase 1, including this water treatment system, has noticeably improved aesthetic issues such as staining of fixtures and clothing, as well as odor problems. Additionally, there is the projected increase in current water demands for domestic use and golf course irrigation, which currently stand at 51 million gallons per year. Projections indicate an increase to 84 million gallons by the year 2045, which is the design period for this project.

Despite these improvements, the District's water supply continues to experience high levels of total dissolved solids and overall hardness. The proposed project aims to address these ongoing challenges by implementing the following improvements:

- Expanding the capacity of the existing iron-manganese removal unit not only enhances the gains made in Phase 1 but also prepares the system for the additional volume expected to supply the new nanofiltration process before transmission to the District's customers.
- The introduction of a flow-reversal nanofiltration membrane system, which is aimed at reducing TDS and hardness to below the state's secondary standards. This system is expected to remove the need for household water softeners, thereby reducing the environmental impact of residential brine discharge into the community's septic system.
- Implementing the ECOVAP enhanced evaporation unit represents a unique approach to managing the concentrated brine byproduct from the new treatment process, which is crucial for preventing potential groundwater contamination. This achieves the District's goal of effectively disposing of the brine produced by the expanded and enhanced groundwater treatment plant. The lower O&M costs as well as reduced maintenance requirements of this unit compared to the comparable WAIV system make the ECOVAP the preferred alternative for this portion of the treatment plant. Based on the water quality data available, it is expected that the dried solids will be non-hazardous and would be disposed of at the Otero/Lincoln Landfill currently used by the District for solid waste disposal. The dried solids will be tested during the piloting project to verify this.

The design considers not only current needs but also anticipated future challenges, preparing the District to effectively manage its water resources sustainably. By following these recommendations, the District will enhance its capability to provide high-quality water to its residents, adapt to future demands, and maintain compliance with evolving environmental standards.

b. Water Distribution Phasing

The water distribution system alternatives were not revisited since the first two phases of the distribution system improvements have been working as expected. In order to complete the remainder of the improvements identified in the 2008 PER, four additional phases have been identified. This phasing continues to work outward from the booster pumps station towards the edges of the system. The phases are shown in Figure 17. The opinion of cost for each of the phases is between \$3.4 and \$5.1 million. The OPC's for each phase are shown in Table 16.

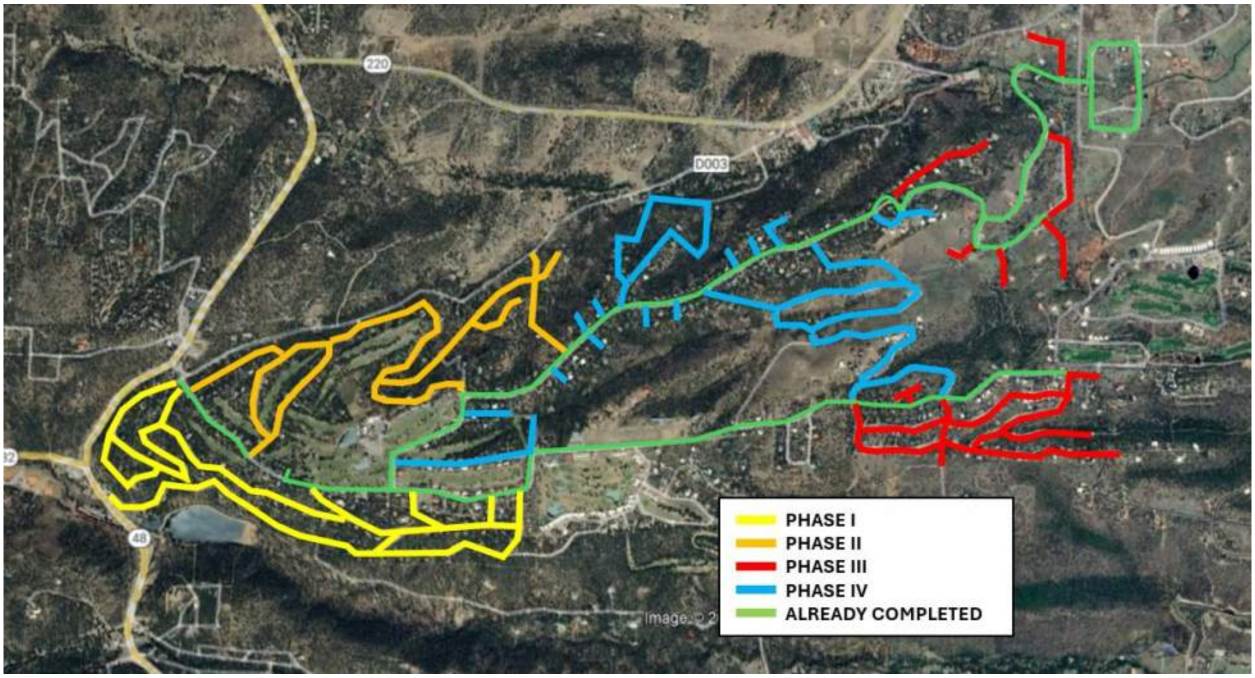


Figure 17 – Proposed Distribution System Phasing

Project Phase	Linear Feet of Pipe	Total Phase Cost
Phase I	25,500	$ 4,590,000
Phase II	18,800	$ 3,384,000
Phase III	23,320	$ 4,197,600
Phase IV	28,613	$ 5,150,340

Table 16 – Distribution System Phased Costs

c. Advanced Metering Infrastructure (AMI)

Advanced Metering Infrastructure (AMI) is a system which automates water meter reading throughout the system without the need for a person to interact with the meters. Communication is accomplished with either radio transmission or cellular connections.

The AMI systems have replaced Automated Meter Reading (AMR) systems over the past decade. AMR systems typically used vehicle mounted equipment or handheld devices that would automatically read electronic meters as Meter Reader Staff drove or walked by the meters. This technology used low power radio transmitters on each of the meters.

With the robust cellular network throughout the country, industry has gone away from owner-operated radio networks in favor of using established cellular networks for meter communications. For the ALW&SD system, this is particularly attractive since ordinances preclude the use of radio towers in the area. In order to cover the extents of the system with radio towers, if allowed, would require dozens of towers to relay signals through the trees and up and down the hills. Cellular systems would be able to provide coverage of the entire ALW&SD system through existing infrastructure.

There are several vendors that sell electronically encoded meters that can be connected to cellular endpoints and then connected to a proprietary processing system. We had reached out to vendors of this type of system but they were not responsive in providing a quote for their systems. We were able to get a replacement meter and cellular endpoint price which was quoted at $500.00 each. For the 1,245 meters in the system, this would result in a cost of $622,500. This does not include meter and endpoint installation, cellular service, software or any processing.

Another option which uses existing analog meters is the CYCLOPS system by SPMR. This system uses a digital camera which attaches to the existing meters and can take and send photos of the meter to a processing server to convert the photo into a meter reading. Figure 18 shows the CYCLOPS camera installed on a meter. This system sends one photo each day via a cellular endpoint. A proposal for providing a CYCLOPS system for all 1,245 meters in the ALW&SD system including camera, cellular chip, antenna lock, server seat and one local computer license was $293,268. This does not include installation of the system but it does include training on how to install it via a webinar.

The camera sits over the meter in such a way that the meter is still visible for manual reading if necessary.

If the cost of the CYCLOPS system is agreeable, it would be the recommended path to an AMI system due to the lower cost and the ability to attached it to meters already used in the system.

Ther are some annual recurring costs for the cellular connection and the photo recognition service. These two fees equate to $1.38 per meter per year or a total of $20,617.

An AMI system would benefit the district by freeing up staff who typically read meters every month to do other tasks that are sidelined while meters are being read. It also eliminates the human factor in recording meter readings which can result in errors and provides photographic record of the meter reading in the event of disputes.

Figure 18 – CYCLOPS Camera installation

APPENDIX A
ROTEC FR-NF MODEL RESULTS AND QUOTE

Budgetary Proposal

Flow Reversal Reverse Osmosis (FR-RO)

R240201 Alto Lakes
Parkhill
May 16th, 2024
Version 1.1

1. Project Overview

The Town of Alto Lakes is improving their water treatment plant with a focus on hardness and TDS reduction by adding a reverse osmosis treatment system to their existing iron/manganese in an effort to improve the quality of their drinking water. The client is prioritizing high-recovery in an effort to reduce the size of the evaporation ponds that require construction to treat the reject. A pilot project will be required and ROTEC has generated a separate proposal for that project.

2. Value Proposition

ROTEC has determined that the best design approach would be a 3-stage Flow Reversal-enabled system with a recovery rate of 90%. This is approximately 10% higher than what a conventional RO system would achieve, resulting in 50% of the brine discharge and half of the total required size for the evaporation ponds. Compared to a conventional system, the ROTEC system will save in excess of 15,000,000 gallons of brine each year.

15+ MILLION GALLONS PER YEAR OF BRINE SAVED

Given the extremely high cost of building evaporation ponds, it's likely that the premium for the ROTEC system over conventional RO would be paid back in less than 1 year due to savings on land, civil works and operational requirements.

It should be noted that ROTEC is also providing one system that can operate with two drastically different flow rates, from 150 gpm of product up to 230 gpm of product. This versatility is not easily achieved with conventional RO systems.

In addition to higher recover and versatility, utilizing a Flow Reversal RO system will lead to the following benefits:

- **Decreased cleaning (CIP) frequency**
- **Longer membrane life**
- **Complete fallback and redundancy to operate as a conventional RO system**

3. Basis of Design

ROTEC has been asked to an RO treatment train targeting a 90% recovery rate. The plant has to be capable of treating enough water to produce 230 gpm of permeate on days where maximum production capacity is required. The minimum capacity of the plant requires only 150 gpm of permeate to be produced. The temperature range for the plant was indicated to be between 52-73° F.

The client has supplied flow distribution data, and feedwater quality data entering and exiting the existing iron/manganese pretreatment system.

The following feedwater quality has been used as the basis for the design of the system.[1]

Parameter	Unit	Raw Water	Adjusted Feed	Estimated Permeate	Estimated Concentrate
Hardness	ppm as CaCO3	1089.75	1089.75	74.568	10303.8
Ca	ppm	290.00	290.00	19.844	2742.0
Mg	ppm	89.00	89.00	6.090	841.5
Na	ppm	123.57	123.57	38.028	900.2
K	ppm	3.90	3.90	1.748	23.4
NH4	ppm	0.00	0.00	0.000	0.0
Ba	ppm	0.015	0.015	0.001	0.1
Sr	ppm	0.000	0.000	0.000	0.0
H	ppm	0.00	0.00	0.000	0.0
CO3	ppm	1.10	0.15	0.004	18.2
HCO3	ppm	183.00	159.12	29.453	1285.4
SO4	ppm	970.00	970.00	57.851	9248.8
Cl	ppm	140.00	155.01	52.037	1090.0
F	ppm	0.59	0.59	0.442	1.9
NO3	ppm	1.00	1.00	0.362	6.8
PO4	ppm	1.00	1.00	0.060	9.5
OH	ppm	0.01	0.00	0.000	0.0
SiO2	ppm	18.00	18.00	5.132	134.8
B	ppm	0.00	0.00	0.000	0.0
CO2	ppm	3.99	21.91	21.91	21.91
NH3	ppm	0.00	0.00	0.00	0.00
Br-1	ppm	0.140	0.140	0.058	0.9
TDS	ppm	1821.31	1811.50	211.11	16303.58
pH		7.80	7.00	6.32	7.82

1. *Expected water quality based on Nitto Hydranautics projection at 73F and 3 years membrane life.*
2. *Iron (Fe) levels are assumed to be less than 0.1 ppm.*

4. Proposed Solution

ROTEC has designed a 3-stage Flow Reversal-enabled system in a 6:2:1 PV configuration with 7 elements per vessel and including booster pumps after the 1st and 2nd stages. The recommended membrane type is ESNA1-LF-LD Hydranautics.

Scope of the provided systems will include:

- Membranes
- Pressure Vessels
- Pumps
- VFDs
- Power & Control Cabinets
- Skid-frame
- All appurtenances incl. valves, piping, instrumentation

A continuous acid injection is required to adjust the pH for 7.0 to optimize the Flow Reversal effect between the stages.

The estimated OPEX to run this system for power, chemicals and membrane replacement is as follows:

- Power ($0.1/kwh) = $20,780/year considering 24 hour/day operation
- Chemicals (antiscalant, sulfuric acid) = $138,907/year
- Membrane Replacement (every 5 years) = $6,300/year

Totaling approximately $165,897 per year in operating costs.

The system layout will be approximately as follows:

- Length: 31' 6"
- Width: 9' 6"
- Height: 11' 7"

Snapshots from the following membrane projections can be seen in the Appendix:

- 230 gpm at 73 F
- 230 gpm at 52 F
- 150 gpm at 73 F
- 150 gpm at 52 F

5. Commercial Proposal

The ±20% budgetary price for the system is listed in the table below. Should the system require being built in the U.S., a rough estimate of a 15% price increase should be considered.

Item	Qty	Unit Price (USD)
Flow Reversal 150-230 gpm RO Skid	1	$390,000
Calcite Post-Treatment Filter + Feed Pump	1	$143,000 (optional)

6. About ROTEC

ROTEC offers high-recovery Reverse Osmosis (RO) systems based on our proprietary Flow Reversal Reverse Osmosis (FR-RO) technology. Our systems *challenge the flow* in traditional RO, maximizing recovery rates to generate more clean water, utilize less raw water, and reduce brine volumes dramatically. Our system improvements minimize OPEX, chemical use and clean-in-place (CIP) events, leading to a substantially more sustainable and eco-friendly water treatment approach. ROTEC provides turnkey water treatment solutions including new RO plants, brine concentrators, and pre- and post-treatment systems. Unique in the water industry, we are also active in retrofitting RO treatment plants by applying FR-RO in existing configurations.

ROTEC is now a well-known brand in the water treatment sector and is setting the standard for increasing recovery rates in reverse osmosis systems. Operating in 15 countries and expanding rapidly, ROTEC was voted "Most Valuable Technology Company" in 2018 at Singapore's International Water Week and received an award for "Breakthrough Technology Company of the year – Distinction" at the 2022 Global Water Awards. There are now nearly 60 installations of Flow Reversal worldwide and the technology has been deployed and validated by leading industrial and municipal groups including Mekorot, Vitens, SUEZ, PUB, Coca-Cola, Pepsi, Sinopec, Henkel, Jacobs and Kurita.

On behalf of ROTEC, we look forward to executing this project with you and are fully committed to providing you with world-class service and support.

Best Regards,

Max Finder
Head of U.S. Sales
Mobile + 1-610-220-0621
Email: maxf@rotec-water.com, Website: www.rotec-water.com

Permeate Throttling (Variable), Booster Pump

Project name	R240201		Page : 1/4
Calculated by	T.O	Permeate flow/train	150.00 gpm
HP Pump flow	166.67 gpm	Raw water flow/train	166.67 gpm
Feed pressure	83.4 psi	Permeate recovery	90.00 %
Feed temperature	11.1 °C(52.0°F)	Element age	3.0 years
Feed water pH	7.00	Flux decline %, per year	7.0
Chem dose, mg/l, 32 %	56.3 HCl	Fouling factor	0.80
Specific energy	1.08 kwh/kgal	SP increase, per year	7.0 %
Pass NDP	56.1 psi	Inter-stage pipe loss	3.000 psi
Average flux rate	8.57 gfd		
		Feed type	Brackish Well Non-Fouling

Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Flow / Vessel Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Stagewise Pressure Boost psi	Stagewise Pressure Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	95.8	27.8	11.8	8.2	6.7	9.7	1.15	14.5	0	76.7	132.9	ESNA1-LF-LD	42	6 x 7M
1-2	36.3	35.4	17.3	9.3	10	11.4	1.1	14.5	35	98.7	242.9	ESNA1-LF-LD	14	2 x 7M
1-3	18	34.6	16.6	9.3	9.3	12.7	1.1	14.5	45	131.4	488.4	ESNA1-LF-LD	7	1 x 7M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1	Concentrate 2	Concentrate 3
Hardness, as CaCO3	1089.75	1089.75	71.157	2502.3	5039.2	10323.6
Ca	290.00	290.00	18.936	665.9	1341.0	2747.3
Mg	89.00	89.00	5.811	204.4	411.6	843.1
Na	123.57	123.57	36.745	257.0	480.7	910.9
K	3.90	3.90	1.702	7.5	13.3	23.8
NH4	0.00	0.00	0.000	0.0	0.0	0.0
Ba	0.015	0.015	0.001	0.0	0.1	0.1
Sr	0.000	0.000	0.000	0.0	0.0	0.0
H	0.00	0.00	0.000	0.0	0.0	0.0
CO3	1.70	0.11	0.002	0.6	2.9	13.7
HCO3	183.00	154.29	27.314	334.9	647.5	1269.0
SO4	970.00	970.00	54.963	2234.5	4510.9	9265.0
Cl	140.00	157.54	51.008	323.4	599.1	1123.5
F	0.59	0.59	0.440	0.8	1.3	2.0
NO3	1.00	1.00	0.350	2.0	3.7	6.9
PO4	1.00	1.00	0.057	2.3	4.7	9.6
OH	0.07	0.00	0.000	0.0	0.0	0.0
SiO2	18.00	18.00	4.945	37.8	71.4	136.4
B	0.00	0.00	0.000	0.0	0.0	0.0
CO2	3.37	26.15	26.15	26.15	26.15	26.15
NH3	0.00	0.00	0.00	0.00	0.00	0.00
Br-1	0.140	0.140	0.056	0.3	0.5	0.9
TDS	**1821.92**	**1809.15**	**202.33**	**4071.46**	**8088.66**	**16352.18**
pH	**7.80**	**7.00**	**6.30**	**7.31**	**7.57**	**7.83**

Saturations	**Raw Water**	**Feed Water**	**Concentrate**	**Limits**
CaSO4 / ksp * 100, %	45	45	761	400
SrSO4 / ksp * 100, %	0	0	0	1200
BaSO4 / ksp * 100, %	213	213	2784	10000
SiO2 saturation, %	17	19	129	140
CaF2 / ksp * 100, %	9	9	435	50000
Ca3(PO4)2 saturation index	0.9	-0.2	2.0	2.4
CCPP, mg/l	36.89	3.48	830.21	850
Langelier saturation index	0.55	-0.32	2.30	2.8
Ionic strength	0.05	0.05	0.45	
Osmotic pressure, psi	9.9	9.8	84.7	

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Permeate Throttling (Variable), Booster Pump

Project name	R240201		Page : 1/4
Calculated by	T.O	Permeate flow/train	150.00 gpm
HP Pump flow	166.67 gpm	Raw water flow/train	166.67 gpm
Feed pressure	63.1 psi	Permeate recovery	90.00 %
Feed temperature	22.8 °C(73.0°F)	Element age	3.0 years
Feed water pH	7.00	Flux decline %, per year	7.0
Chem dose, mg/l, 32 %	48.2 HCl	Fouling factor	0.80
Specific energy	0.89 kwh/kgal	SP increase, per year	7.0 %
Pass NDP	37.1 psi	Inter-stage pipe loss	3.000 psi
Average flux rate	8.57 gfd		
		Feed type	Brackish Well Non-Fouling

Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Flow / Vessel Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Stagewise Pressure Boost psi	Stagewise Pressure Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	92.4	27.8	12.4	7.9	6.7	10.3	1.13	14.5	0	56.4	194.8	ESNA1-LF-LD	42	6 x 7M
1-2	38.7	37.1	17.8	10	10.4	13.2	1.1	14.5	35	77.9	308.7	ESNA1-LF-LD	14	2 x 7M
1-3	19	35.5	16.5	9.8	9.2	15.4	1.12	14.5	45	110.7	636.6	ESNA1-LF-LD	7	1 x 7M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1	Concentrate 2	Concentrate 3
Hardness, as CaCO3	1089.75	1089.75	101.220	2364.5	4817.9	10073.7
Ca	290.00	290.00	26.936	629.2	1282.1	2680.8
Mg	89.00	89.00	8.267	193.1	393.5	822.7
Na	123.57	123.57	49.483	232.7	427.5	797.2
K	3.90	3.90	2.210	6.6	11.2	19.3
NH4	0.00	0.00	0.000	0.0	0.0	0.0
Ba	0.015	0.015	0.002	0.0	0.1	0.1
Sr	0.000	0.000	0.000	0.0	0.0	0.0
H	0.00	0.00	0.000	0.0	0.0	0.0
CO3	1.86	0.15	0.007	0.7	3.3	15.8
HCO3	183.00	159.13	39.285	320.2	618.2	1204.6
SO4	970.00	970.00	78.827	2114.1	4321.8	9069.0
Cl	140.00	155.01	67.472	286.2	518.2	951.1
F	0.59	0.59	0.523	0.6	0.9	1.2
NO3	1.00	1.00	0.467	1.8	3.2	5.8
PO4	1.00	1.00	0.081	2.2	4.5	9.3
OH	0.20	0.00	0.000	0.0	0.0	0.0
SiO2	18.00	18.00	6.717	34.4	63.9	120.6
B	0.00	0.00	0.000	0.0	0.0	0.0
CO2	3.77	21.91	21.91	21.91	21.91	21.91
NH3	0.00	0.00	0.00	0.00	0.00	0.00
Br-1	0.140	0.140	0.074	0.2	0.4	0.7
TDS	**1822.07**	**1811.50**	**280.35**	**3822.20**	**7648.66**	**15698.38**
pH	**7.80**	**7.00**	**6.44**	**7.28**	**7.53**	**7.79**

Saturations	**Raw Water**	**Feed Water**	**Concentrate**	**Limits**
CaSO4 / ksp * 100, %	40	40	668	400
SrSO4 / ksp * 100, %	0	0	0	1200
BaSO4 / ksp * 100, %	213	213	2708	10000
SiO2 saturation, %	14	15	93	140
CaF2 / ksp * 100, %	9	9	162	50000
Ca3(PO4)2 saturation index	1.1	0.1	2.2	2.4
CCPP, mg/l	36.89	4.49	786.93	850
Langelier saturation index	0.78	-0.08	2.46	2.8
Ionic strength	0.05	0.05	0.43	
Osmotic pressure, psi	10.3	10.2	83.2	

Permeate Throttling (Variable), Booster Pump

Project name	R240201		Page : 1/4
Calculated by	T.O	Permeate flow/train	230.00 gpm
HP Pump flow	255.56 gpm	Raw water flow/train	255.56 gpm
Feed pressure	122.6 psi	Permeate recovery	90.00 %
Feed temperature	11.1 °C(52.0°F)	Element age	3.0 years
Feed water pH	7.00	Flux decline %, per year	7.0
Chem dose, mg/l, 32 %	56.3 HCl	Fouling factor	0.80
Specific energy	1.43 kwh/kgal	SP increase, per year	7.0 %
Pass NDP	85.3 psi	Inter-stage pipe loss	3.000 psi
Average flux rate	13.1 gfd		
		Feed type	Brackish Well Non-Fouling

Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Flow / Vessel Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Stagewise Pressure Boost psi	Stagewise Pressure Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	159.5	42.6	16	13.7	11.8	15.6	1.18	14.5	0	110.9	84.8	ESNA1-LF-LD	42	6 x 7M
1-2	48.6	48	23.7	12.5	15.3	15.2	1.1	14.5	30	122.6	210.5	ESNA1-LF-LD	14	2 x 7M
1-3	22.1	47.5	25.4	11.3	15.3	15.1	1.1	14.5	45	149.3	439.1	ESNA1-LF-LD	7	1 x 7M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1	Concentrate 2	Concentrate 3
Hardness, as CaCO3	1089.75	1089.75	50.250	2852.0	5697.2	10511.4
Ca	290.00	290.00	13.372	759.0	1516.1	2797.3
Mg	89.00	89.00	4.104	232.9	465.3	858.5
Na	123.57	123.57	26.834	302.3	572.0	1000.5
K	3.90	3.90	1.273	9.1	16.5	27.7
NH4	0.00	0.00	0.000	0.0	0.0	0.0
Ba	0.015	0.015	0.001	0.0	0.1	0.1
Sr	0.000	0.000	0.000	0.0	0.0	0.0
H	0.00	0.00	0.001	0.0	0.0	0.0
CO3	1.70	0.11	0.001	0.9	4.1	15.5
HCO3	183.00	154.29	19.547	387.0	757.9	1344.7
SO4	970.00	970.00	38.684	2544.4	5091.7	9411.1
Cl	140.00	157.54	37.335	382.0	718.0	1247.2
F	0.59	0.59	0.349	1.1	1.8	2.8
NO3	1.00	1.00	0.257	2.4	4.5	7.7
PO4	1.00	1.00	0.040	2.6	5.2	9.7
OH	0.07	0.00	0.000	0.0	0.0	0.0
SiO2	18.00	18.00	3.593	44.4	84.5	148.6
B	0.00	0.00	0.000	0.0	0.0	0.0
CO2	3.37	26.15	26.15	26.15	26.15	26.15
NH3	0.00	0.00	0.00	0.00	0.00	0.00
Br-1	0.140	0.140	0.041	0.3	0.6	1.0
TDS	**1821.92**	**1809.15**	**145.43**	**4668.33**	**9238.31**	**16872.41**
pH	**7.80**	**7.00**	**6.16**	**7.36**	**7.63**	**7.85**

Saturations	**Raw Water**	**Feed Water**	**Concentrate**	**Limits**
CaSO4 / ksp * 100, %	45	45	772	400
SrSO4 / ksp * 100, %	0	0	0	1200
BaSO4 / ksp * 100, %	213	213	2839	10000
SiO2 saturation, %	17	19	140	140
CaF2 / ksp * 100, %	9	9	892	50000
Ca3(PO4)2 saturation index	0.9	-0.2	2.1	2.4
CCPP, mg/l	36.89	3.48	880.55	850
Langelier saturation index	0.55	-0.32	2.35	2.8
Ionic strength	0.05	0.05	0.46	
Osmotic pressure, psi	9.9	9.8	88.6	

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Nitto HYDRANAUTICS Nitto Group Company

Permeate Throttling (Variable), Booster Pump

Project name	R240201		Page : 1/4
Calculated by	T.O	Permeate flow/train	230.00 gpm
HP Pump flow	255.56 gpm	Raw water flow/train	255.56 gpm
Feed pressure	92.7 psi	Permeate recovery	90.00 %
Feed temperature	22.8 °C(73.0°F)	Element age	3.0 years
Feed water pH	7.00	Flux decline %, per year	7.0
Chem dose, mg/l, 32 %	48.2 HCl	Fouling factor	0.80
Specific energy	1.12 kwh/kgal	SP increase, per year	7.0 %
Pass NDP	55.6 psi	Inter-stage pipe loss	3.000 psi
Average flux rate	13.1 gfd		
		Feed type	Brackish Well Non-Fouling

Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Flow / Vessel Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Stagewise Pressure Boost psi	Stagewise Pressure Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	162.2	42.6	15.6	13.9	11.4	17.2	1.18	14.5	0	81.2	122.4	ESNA1-LF-LD	42	6 x 7M
1-2	47.1	46.7	23.1	12.1	14.4	16.3	1.1	14.5	30	93.9	317.5	ESNA1-LF-LD	14	2 x 7M
1-3	20.9	46.2	25.4	10.7	14.4	16.5	1.1	14.5	45	121.4	658.7	ESNA1-LF-LD	7	1 x 7M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1	Concentrate 2	Concentrate 3
Hardness, as CaCO3	1089.75	1089.75	74.568	2911.8	5761.7	10303.8
Ca	290.00	290.00	19.844	774.9	1533.3	2742.0
Mg	89.00	89.00	6.090	237.8	470.6	841.5
Na	123.57	123.57	38.028	298.9	545.2	900.2
K	3.90	3.90	1.748	8.8	15.1	23.4
NH4	0.00	0.00	0.000	0.0	0.0	0.0
Ba	0.015	0.015	0.001	0.0	0.1	0.1
Sr	0.000	0.000	0.000	0.0	0.0	0.0
H	0.00	0.00	0.000	0.0	0.0	0.0
CO3	1.10	0.15	0.004	1.2	5.2	18.2
HCO3	183.00	159.12	29.453	400.4	753.6	1285.4
SO4	970.00	970.00	57.851	2600.2	5158.6	9248.8
Cl	140.00	155.01	52.037	369.9	667.4	1090.0
F	0.59	0.59	0.442	1.0	1.4	1.9
NO3	1.00	1.00	0.362	2.4	4.2	6.8
PO4	1.00	1.00	0.060	2.7	5.3	9.5
OH	0.01	0.00	0.000	0.0	0.0	0.0
SiO2	18.00	18.00	5.132	44.0	81.0	134.8
B	0.00	0.00	0.000	0.0	0.0	0.0
CO2	3.99	21.91	21.91	21.91	21.91	21.91
NH3	0.00	0.00	0.00	0.00	0.00	0.00
Br-1	0.140	0.140	0.058	0.3	0.6	0.9
TDS	**1821.31**	**1811.50**	**211.11**	**4742.51**	**9241.50**	**16303.58**
pH	**7.80**	**7.00**	**6.32**	**7.37**	**7.61**	**7.82**

Saturations	**Raw Water**	**Feed Water**	**Concentrate**	**Limits**
CaSO4 / ksp * 100, %	40	40	681	400
SrSO4 / ksp * 100, %	0	0	0	1200
BaSO4 / ksp * 100, %	213	213	2777	10000
SiO2 saturation, %	14	15	103	140
CaF2 / ksp * 100, %	9	9	425	50000
Ca3(PO4)2 saturation index	1.1	0.1	2.3	2.4
CCPP, mg/l	36.89	4.49	840.65	850
Langelier saturation index	0.78	-0.08	2.53	2.8
Ionic strength	0.05	0.05	0.45	
Osmotic pressure, psi	10.3	10.2	87.8	

APPENDIX B
ADEDGE IRON & MANGANESE TREATMENT QUOTE

AdEdge Water Technologies - Scope of Supply

Alto Lakes, NM

340 GPM AdEdge Filtration System for Iron and Manganese Removal

Doug Craver, Technical Sales Manager - Southwest
480-243-1824
Doug.Craver@chartindustries.com

3/19/2024

Model
APU26-8460CS-2-AVH

Item	Detail	Design	Supply	Install
	APU26-8460CS-2-AVH, Skid Mounted Carbon Steel Vessel System, Automatic Operation	AdEdge	AdEdge	Others
	Pre-packaged Skid Mounted System with Vessels, Interconnecting Piping, and Valve Harness designed to run in parallel. System is shipped Factory Assembled, Skid Mounted, Pre-piped and Wired, Pressure and Flow Tested, and Ready for Installation.			
A	**Carbon Steel Pressure Vessels**	AdEdge	AdEdge	Others
	Skid Mounted Carbon Steel Vessels Operating in parallel with Media and Underbedding			
	100 psi ASME-Code Vessels			
	Vessels are lined with internal NSF61 Epoxy Liner			
	One (1) Drain Valve per Vessel			
	One (1) Manway for Media Loading			
	Sch80 PVC Internal Inlet Distributor and Hub and Lateral Underdrain			
	One (1) Combination Air/Vacuum Release Valve per Vessel			
B	**Process Valves and Piping**	AdEdge	AdEdge	Others
	Sch80 PVC Inlet, Treated Outlet, and Backwash Headers with Flanged Tie Points			
	Sch80 PVC Harness Piping on Each Vessel			
	Valve Harness with Five (5) Lug-Style Bray Butterfly Control Valves with 120VAC RCEL Electric Actuators			
	Manual Isolation Valve at the Inlet of Each Vessel			
	Manual Flow Control Valve on System Backwash Outlet			
	Manual Flow Control Valve on System Treated Outlet			
	Treated Water Backwash Supply: Auxiliary Inlet Connection w/ (2) Check Valves and (1) Lug-Style Butterfly Control Valve			
C	**PLC and Controls Detail**	AdEdge	AdEdge	Others
	Automatic System Operation (Service, Backwash, and Rinse Modes)			
	Allen Bradley CompactLogix PLC Installed Inside Control Panel for Automatic Operation			
	C-More 10" Color Touch Screen HMI Mounted on Control Panel			
	Operator "Touch" Graphics Screens for Automatic and Manual Operation			
	304SS NEMA 4X Skid-mounted Control Panel to House Electrical and System Controls			
	Terminal Locations on Control Panel for Ancillary Controls and Device Inputs/Outputs (factory installed and labeled)			
D	**Instrumentation / Monitoring**	AdEdge	AdEdge	Others
	304SS Hydraulic Panel with System Inlet/Outlet Pressure Gauges and Sample Ports, One (1) per system			
	Pressure Gauges and Sample Ports on Each Vessel's Inlet and Outlet			
	E+H Electromagnetic Promag W 400 Flow Meter on Each Vessel's Inlet			
	Pressure Sensors on System Inlet/Outlet for System DP measurement			
E	**Oxidation Filtration Media and Underbedding**	AdEdge	AdEdge	Others
	ADGS+ Oxidation Filtration Media with Anthracite Cap			
	Anthracite: 50 cuft per vessel (100 cuft total)			
	GS+: 100 cuft per vessel (200 cuft total)			
	Gravel Underbedding			
	71 cuft per vessel (142 cuft total)			
F	**Included Field Services and Miscellaneous**	AdEdge	AdEdge	NA
	Electronic O&M Manual including Engineering Drawings, Design Report, and Control Description			
	System Commissioning Plan and Coordination of Installation with Installer (Pre-Startup)			
	System Startup and Comissioning On-Site Including Media Loading Supervision and Initial Media Flush			
	Five (5) x 8 hour Days Included for Start-Up and Training. Additional Work Billed on Time and Materials Basis			
	Operator Training During System Startup			
G	**Factory Testing**	AdEdge	AdEdge	NA
	Factory Acceptance Testing in accordance with AdEdge QC procedures and SOPs			
	Hydraulic and Mechanical Testing to Ensure System Meets Requirements			
	Pressure Testing per AdEdge Standard Procedures to Test for Leaks			
H	**Warranty and Maintenance**	NA	AdEdge	NA
	Standard 1-year Equipment Warranty			
I	**Freight for Media, Sub-Fill, and System**		Not Included	
J	**Taxes (end use, sales or duty taxes as applicable)**		Not Included	

Estimated Fabrication and Delivery Schedule

***Note: The following schedule is based on receiving signed contract within 10 business days of proposal issue date to secure vessels.**
Schedule does not start until Chart credit approval process has been passed, and the order has been accepted by Chart.

1	Produce Shop Drawings / Submittals from Award / PO	*6 weeks*
2	Fabrication of System upon approval of Shop Drawings (based on shop availability and project timing)	*24-26 weeks*
3	Shipping to the site	*TBD*
4	Installation of the System	*TBD by others*
5	Startup, Commissioning, Training following Mechanical/Electrical Completion	*2-3 days*
6	AdEdge's manufacturing schedule is only a best estimate at the time of proposal and will be adjusted, if necessary, at time of submittal approval and release to manufacturing. Where the delivery of materials is delayed due to supply chain volatility, and/or, through no fault of the customer or AdEdge, AdEdge shall not be liable for any additional costs or damages associated with such delay(s).	

Pricing Schedule

Scope of Supply Total:	Included
Subtotal:	**$420,000**
Freight:	Not Included
Taxes:	Not Included
Total:	***$420,000***

Pricing in this proposal is valid for 10 business days from date issued.

Payment Schedule and Terms and Conditions

AdEdge Water Technologies - Scope of Supply

Alto Lakes, NM

340 GPM AdEdge Filtration System for Iron and Manganese Removal

Doug Craver, Technical Sales Manager - Southwest
480-243-1824
Doug.Craver@chartindustries.com

3/19/2024

Model
APU26-8460CS-2-AVH

- *Progress Invoice #1: 10% on contract*
- *Progress Invoice #2: 30% upon design release to manufacturing / fabrication; due on approved shop drawings & initiation of fabrication*
- *Progress Invoice #3: 55% upon shipment*
- *Progress Invoice #4: 5% upon successful startup or 45 days after shipment, whichever is first*
- *All invoices due net 30 days*
- *Project schedule is subject to timely receipt of progress payments. T his is not a pay when paid contract, therefore delayed payments will result in a temporary hold on the project until received.*
- *Late payments subject to 18% per annum interest .*
- *Alternative payment terms may result in an interest charge being added to the price to cover interest associated with financing.*

Notes, Clarifications and Exceptions

1 Freight for media and equipment supplied, IF included in the pricing accounts for one joint shipment. Customer requested split shipments will be at customer's expense for the additional shipment(s).
2 AdEdge will coordinate closely with Installer and the Engineer on all equipment and design related items.
3 No state and local permits or building, use or environmental permits will be secured by AdEdge.
4 No site engineering is included; primary interface with regulators will be completed by engineer with support from AdEdge. Work by AdEdge includes shop drawings and submittals for attaining Regulatory approval.
5 System will be shipped for offloading by personnel other than AdEdge personnel with appropriate equipment and trained operator.
6 Media will be shipped in pallets or supersacks for offloading by forklift. - By Others
7 No system foundations, offloading, placement, piping, pipe supports, insulation or tie-ins will be completed by AdEdge.
8 Owner or others will be responsible for furnishing chemicals, unless otherwise specified in Scope.
9 Wiring and tie in of any external devices not part of the AdEdge scope e.g., SCADA shall be by the Owner or Others.
10 Unless otherwise specified in scope of supply, no seismic engineering or seismic related design or equipment modifications are considered in the pricing; can be incorporated as appropriate for the project.
11 If, during the performance of this contract, from the date of the contract signing until the release to manufacturing milestone only, the price of materials significantly increases through no fault of AdEdge, a change order will be issued to equitably adjust the contract value by an amount reasonably necessary to cover any such significant price increase. AdEdge shall provide documentation from the impacted manufacturer that substantiates any such increase. As used herein, a significant price increase shall mean any increase in price exceeding 5%, as compared to prices used at the date of contract signing.
12 AdEdge Standard Purchase Agreement applies unless otherwise noted.
13 AdEdge will request a 48-hour delivery window for treatment equipment delivery. AdEdge will closely coordinate with the customer/contractor during system shipment.
14 Unless otherwise specified in scope of supply, treatment System does not meet American Iron & Steel (AIS) requirements. AIS requirements can be met upon request at an additional cost.
15 Delays / Schedule: AdEdge has presented its offer and firm pricing in this proposal for a system that will be fabricated within provided project specific schedule. If after execution of the contract, Purchaser delays the equipment fabrication for whatever reason beyond four (4) months (including that from late payments) AdEdge reserves the right to assess reasonable escalation charges in the form of a change order to the project at the rate of 1% of the contract value per month for each month the project is delayed after four (4) months and/or adjust prices to pass on materials cost increases which exceed 5% incurred due to customer fabrication delays over four (4) months
16 Start Up Services Delays / Schedule: AdEdge has presented its offer and firm pricing in this proposal for a system that will be started up within provided project specific schedule. If after execution of the contract, Purchaser delays the startup for whatever reason beyond two (2) months (including that from late payments) AdEdge reserves the right to assess travel related escalation charges, if 5% or more, in the form of a change order to the project for increased travel expenses which may result from this delay.

Items Supplied By Others / Contractor

A *Interconnecting pipe to the system, appropriate electrical connections to AdEdge Equipment*
B *Pressurized water supply for use during start-up*
C *Non-AdEdge system related site, civil, or structural engineering or support costs from Owner*
D *Safety equipment as required for media loading, startup/commissioning*
E *Offloading, storage and placement of all equipment and media*
F *Site work and any building structure / facility or shade structure to be provided; HVAC*
G *Construction of structural concrete pad as necessary for treatment equipment provided by AdEdge*
H *Anchoring Equipment, tanks and other equipment to the building's foundation/structural pads*
I *Dedicated power supply to AdEdge equipment; Interconnecting control and instrumentation wiring to control panel*
J *Multiple Laborers for Media loading with AdEdge Supervision*
K *Interface with Regulators / Permitting and all permits for successful completion of the project*

Confidentiality Notice

Acceptance

The parties hereto acknowledge that the signatory below is authorized to represent the respective party and bind that party to the terms and conditions contained herein.

Acceptance by Purchaser:

By: ______________________________
Signature

Name (print): ______________________________

Title: ______________________________

Date of Acceptance: ______________________________

Purchase Order # ______________________________

AdEdge Water Technologies, LLC
2055 Boggs Road
Duluth, Georgia 30096
678-835-0052 Fax: 678-835-0057

By: ______________________________
Signature

Name (print): ______________________________

Title: ______________________________

Date of Acceptance: ______________________________

APPENDIX C
WAIV PRODUCT LITERATURE AND QUOTE

PROPOSAL

WIND-AIDED INTENSIFIED EVAPORATION (WAIV®) FOR WASTEWATER DISPOSAL

ALTO LAKES WATER & SANITATION DISTRICT
CONFIDENTIAL

PREPARED FOR:
PARKILL ENGINEERING

APRIL 29, 2024

Prepared By:

Clear Creek Environmental Solutions, LLC
also d.b.a. Leachate Management Specialists, LLC
10940 S. Parker Road, Suite 776
Parker, CO 80134

Brad Granley, P.E.
President and Founder

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1.0 INTRODUCTION

Clear Creek Environmental Solutions, LLC (Clear Creek) has prepared this Proposal for Parkhill Engineering (Parkhill) for a Wind-Aided Intensified Evaporation (WAIV®) wastewater disposal system at the Alto Lakes Water and Sanitation District (Client) groundwater treatment system (Site) located at 1221 High Mesa Road, Alto, New Mexico. Parkhill contacted Clear Creek recently seeking information about WAIV® as a potential solution for the Site. As a result of subsequent conference calls and correspondence, Clear Creek has developed this proposal which consists of a technology background, anticipated evaporative capacity for WAIV® at the Site, and estimated costs.

2.0 BACKGROUND

The Site is a groundwater treatment plant with a planned expansion consisting of a nanofiltration membrane system to reduce hardness and evaporation ponds for brine disposal. Parkhill anticipates brine flow will be between 12.7 and 15.9 gallons per minute (GPM), or 6.68 to 8.36 million gallons a year (MGY). Parkhill and the Client are seeking a low-energy evaporation technology that will help enhance evaporation and reduce the land required for the evaporation ponds.

3.0 FIRM CAPABILITIES AND ORGANIZATION

Clear Creek is a limited liability company established in 2013 by a group of experienced environmental professionals who wanted to find a better way to manage leachate and industrial wastewater by providing cutting edge, innovative, and environmentally sound treatment and disposal solutions. Over the years, Clear Creek has earned a reputation in the solid waste industry for operating with the highest of integrity, trustworthy at all times, placing our client's interests above our own, and working to make our client's day easier in any way we can. Clear Creek is known in industry as technical experts (as subject matter experts) and are sought out for our expertise and knowledge. We are able to provide a range of consulting and engineering services for public and private clients at each stage of a project, including site assessment, permitting, design, facilitating fabrication, installation, and operation and maintenance (O&M). We focus on what we do best, always providing the highest value added throughout every project. In general, tasks outside of our internal expertise (e.g., site construction of systems, civil works, utility drops, etc.) are completed by partnering with vetted, highly qualified contractors.

Our specialties include providing sustainable disposal and treatment systems including the WAIV® technology, plant-based Phyto-Utilization™, constructed wetlands, enhanced brine evaporation using halophilic microbes, and a foam fractionation system for PFAS removal from untreated wastewaters.

4.0 EXPERIENCE SUMMARY

Clear Creek has operated WAIV® systems at a variety of locations in the US and has multiple full-scale WAIV® projects in installation or final contract phases, including with one of the largest solid waste companies in the country. Clear Creek holds the patent rights to the technology and continues to advance the system for use with complex wastewater streams in close collaboration with the inventor, Dr. Jack Gilron, from Ben Gurion University in Israel.

Clear Creek has led numerous, exceptionally successful, on-site wastewater disposal projects across North America, with over 130 million gallons of leachate disposed, nearly $8.5 million of avoided off-site disposal costs, 16,300 tanker trips avoided, 1.2 million miles not driven, 2,200 tons of CO_2 not emitted, and nearly 4,200 tons of CO_2 sequestered by the plants (Phyto-Utilization™ systems). Our staff's projects have won multiple national engineering excellence awards in Washington D.C., and an international award from the King of Thailand for our use of vetiver grass in Phyto-Utilizations™ systems.

Additionally, we designed a unique constructed wetland treatment system at a landfill in the Bahamas that repurposed approximately 500,000 waste tires for an elevated berm structure to withstand hurricane flooding, as well as a hydrogen sulfide treatment system for a US landfill that needed a quick solution to prevent being cut off by a WWTP. Both of those systems are still in operation and treating the leachate to below discharge limits.

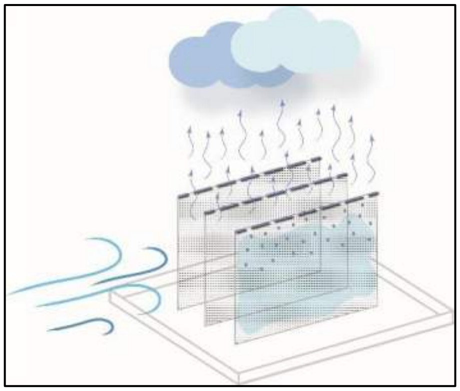
In 2022, Clear Creek partnered with The Water and Carbon Group (WCG) to offer its LEEF System® as a low-energy PFAS extraction and volume reduction system. Based in Australia, WCG developed the LEEF System® to treat highly contaminated wastewater such as landfill leachate, wastewater, or brine streams from industrial activities using foam fractionation technology. A key feature is that pre-treatment is typically not required for direct PFAS removal. To show capability in the US, WCG constructed pilot and demonstration systems, and since Summer 2022, WCG and Clear Creek have been successfully removing PFAS from highly contaminated landfill leachates and wastewater, including reverse osmosis concentrate (RO reject), during demonstration trials throughout the country. To date, we have operated the system with twenty leachates and RO rejects from twelve different landfills and a mining site impacted by AFFF, and have obtained extraordinary results removing PFAS down to very low ppt concentrations or laboratory limits of detection.

5.0 SCOPE

With this submittal, Clear Creek proposes to design and provide equipment for a full-scale WAIV® system specific for the Site that can evaporate the volume desired in a way that is fully protective of the environment. The WAIV® system works via an 'attached evaporative process' where no wastewater is sprayed into the air, thereby virtually eliminating the possibility of drift of wastewater. Further, the system is placed into a containment area to provide additional protection. Additional system and technology information is provided below. Clear Creek will work with Parkhill and Site personnel throughout the process, provide regulatory support and permitting assistance if needed, provide installation oversight and training, and assist with testing and start-up. Clear Creek understands this scope is considered draft and can be modified and refined as the potential project develops.

6.0 WIND-AIDED INTENSIFIED EVAPORATION (WAIV®) TECHNOLOGY

WAIV® fits into a newer class of liquid disposal technologies called "Natural Systems" where natural processes are strategically leveraged to sustainably solve practical problems on landfills and other facilities. It is different from other evaporative technologies because no droplets, mists, or aerosols are



sprayed into the air, and it is not a thermal-based approach, so no supplemental fuel (either via landfill gas or purchased LP) is required. Instead, the fundamental principle of this straight-forward technology is to create a large amount of wetted evaporative surface area within a small footprint where wind-driven, intensified evaporation occurs. This is accomplished by installing a horizontal array of vertically mounted 'sails,' which are specially fabricated to possess hydrophilic properties, on a rigid frame. Wastewater is distributed across the top of each sail and then natural processes take over: gravity draws the liquid downward, special properties of the sail fabric spread the liquid laterally, and then wind naturally passing through the large area of wetted sails causes evaporation to occur due to differences in relative humidity. Procedures are in place to minimize and mitigate scaling.

One modular WAIV® unit is approximately 80 feet long, 20 feet wide, and 16 feet in height. Containment for a one-unit system is approximately 0.15 acres, with additional units requiring another 0.10 acres each. While the footprint of a unit is only 0.15 acres, its evaporative surface area is more than 1.4 acres per unit, which basically makes this a vertical evaporation pond while minimizing footprint to reduce civil works and saving facilities valuable land for other uses.

6.1 WAIV® Benefits

Nature is effectively leveraged in this green approach for on-site wastewater disposal. The modular system has few moving parts and is uncomplicated to operate. Once a system is in place, only locally available parts would be expected for regular O&M. Additionally, WAIV® can easily be integrated with potential future treatment systems including PFAS or other contaminant removal, should that become necessary.

The WAIV® technology does not create sprays, mists, or aerosols, so off-footprint migration does not occur. Droplet drift has been studied and due to the 'attached evaporative process' (i.e., evaporation occurs directly from the surface of the 'sails') if any drop is lost from the sails, they have been shown to be limited to within the system's lined containment area. The containment is designed to incorporate potential drift distance, and safety factors can be added based on client preference and site conditions.

The use of a Natural System like WAIV® provides many other potential benefits, including:

- Using a green and sustainable method to manage wastewater.
- Removing diesel-burning tanker trucks from the road will:
  - Reduce greenhouse gas emissions and the facility's carbon footprint.
  - Reduce liability of hauling wastewater and truck traffic on and off site.
  - Reduce dependence on transportation costs due to fuel surcharges.
- Providing positive public relations opportunities.
- Reducing costs typically associated with off-site disposal.
- Reducing or eliminating reliance on WWTPs.

WAIV® can operate in a variety of climates, including humid and cool areas. Its performance is directly correlated with the pan evaporation rate, which is determined by numerous parameters such as humidity, temperature, wind, solar radiation, and precipitation. The technology has been proven through previous project efforts in Israel, Mexico, Australia, and the US, showing typical evaporation at least ten times (10x) the volume of evaporation ponds based on footprint area. Specifically, a full-scale WAIV® system has been evaporating leachate at a landfill in Australia since 2013, and the technology has been used for reverse osmosis (RO) brine at a coal seam gas facility in Australia; RO brine generated at an automobile manufacturing facility in Mexico; brackish water at a desalination plant in Israel; and brackish water at a winery in Australia.

6.2 WAIV® in the United States

As summarized below, Clear Creek has operated WAIV® in different climates of the US with results showing actual evaporation closely meeting or exceeding the modeled rates.

<u>Hot-Dry Spring and Summer in Semi-Arid Climate in New Mexico</u>

WAIV® was used to evaporate brackish water at the Bureau of Reclamation Brackish Groundwater National Desalination Research Facility (BGNDRF) in Alamogordo, New Mexico, in 2020. The actual evaporation closely correlated to the hourly wind speed and relative humidity, which are the key indicators used in our modeling. For evaporation results, the actual rate was 99.4% of the modeled rate.

Cool Winter in Central Sierra, Mediterranean Climate in California

Clear Creek's system evaporated RO reject wastewater at a closed mining facility near Carson Hill, California for one of the largest mining companies in the world. The system operated well, and results showed consistent trends between actual and modeled evaporation rates (within 93% of modeled rate) during the more difficult to predict winter months. The system's performance and volume reduction capability were tested with various electrical conductivity ranges, starting with 6,000 uS/cm and reaching nearly 40,000 uS/cm. Despite the winter weather, WAIV achieved a volume reduction of approximately 6.5x during the test. There was no observed scaling and only minimal clogging, which shows its robustness. Clogging and scaling are addressed as part of routine site-specific design components and simple O&M activities.

Warm-Dry Summer in the Bay Area of California

At a WM landfill in the Bay Area of California, WAIV® again validated the modeling in 2022 with actual evaporation rates very consistent with the predictions (within 95% of the modeled rate), resulting in significant volume reduction. Site operational personnel were **pleased with the ease of operation** and stated that **little effort was needed to run the system**. The system's performance with high-salinity wastewater was also tested, including extreme conditions with conductivity as high as 127,000 uS/cm. The system experienced very little to no fouling at those concentrations and it was able to operate continuously with only minimal maintenance required.

Hot-Humid Spring and Summer in Gulf Coast Climate in Louisiana

The technology was used at a Waste Connection's landfill in Louisiana, with results showing that actual evaporation rates were often almost identical to the modeled predictions on a day-to-day basis. Over the long term, cumulative actual evaporation exceeded the modeled rate by greater than 20%. A second test at this site conducted in late July and August (the hottest and most humid time of the year) resulted in actual evaporation at 95% of modeled. At that site, the system was in the direct path of a hurricane in 2020, but only sustained very minor damage because the high winds were able to pass through the structure unobstructed, although operation was delayed for a while until the region's power was restored.

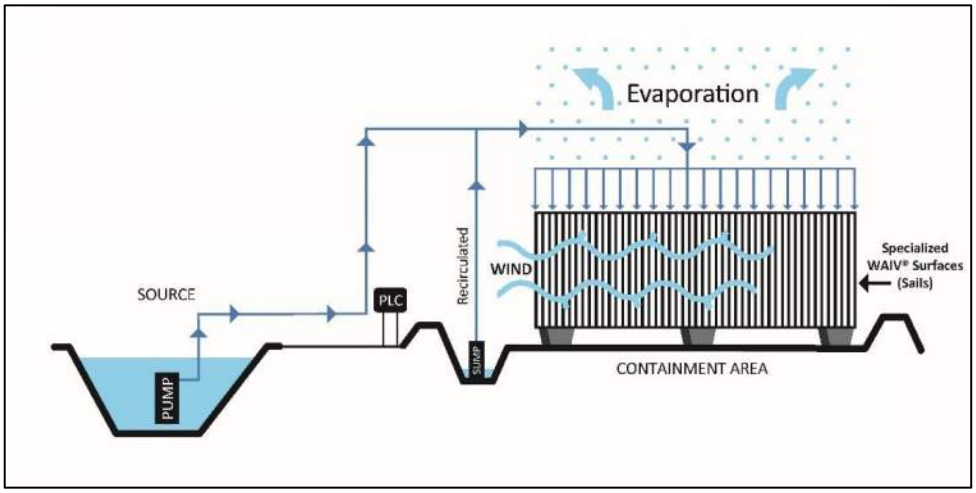
7.0 PROCESS FLOW

A WAIV® system's main components are a process pump, filter, flow and conductivity sensors, and the WAIV® structure and sails. Flow from the pump and to the system would be controlled with a programmable logic controller (PLC) and human machine interface (HMI) located in a control panel included with the system. The PLC will monitor and display pond level, conductivity readings, pre-filter pressure, post-filter pressure, number of backwash cycles, flow through the system (instantaneous and total), valve operation, pump operation, and alarm conditions. The control system components, process pump, and filter will be installed in a prefabricated enclosure (if needed) with HVAC.

The HMI can be accessible through the internet for monitoring and operation via a cellular modem connection. Remote access to the system can be obtained through a computer with a web browser or through a smart phone. In addition to remote access, the connection allows the system to send an email to desired personnel with flow total, tank level, and other desired information on a nightly basis. If a remote connection is lost, that is not critical to operation and no immediate response is required. Also, alarms are emailed and not via phone to minimize disruption to site personnel's daily routines.

The system monitors pressure, flow, fluid level in the pond, and other sensors to verify proper operation. If these sensors detect a malfunction (e.g., high pressure due to an unopened valve, low flow due to pump failure, etc.), the operation is stopped or suspended, and an email notification is sent to the appropriate personnel. In addition, quick stop buttons will be included to allow personnel to stop operation.

From the control system, wastewater would be distributed to the WAIV® units for evaporation as illustrated in the figure below (the process tank shown may not be necessary for this project). Excess liquid not evaporated drips down into a containment area and is either recirculated back into the process through a sump pump installed with a level switch or back to the storage pond. An automated freshwater flush should be performed as needed (after a shutdown) to prevent scaling and precipitation buildup. The amount of non-potable water required is minimal. The Site can use whatever size freshwater tank is preferrable, which would need to be refilled periodically.



The system will also be installed with a weather station to monitor various real-time meteorological conditions. The information from the station will be collected through a datalogger, which is also accessible remotely (if desired) through a cellular modem. When the outdoor temperature reaches a low setpoint, the system shuts down and is automatically drained. Additional temperature control options can also be installed as a part of the system infrastructure to match local needs, including heat trace, insulation, etc., for exposed exterior piping and equipment.

Electrical usage will be minimal with the largest load being an expected 5-hp pump for each WAIV® unit. Alternative power sources such as solar could be included if desired.

8.0 PRELIMINARY MODELING

Clear Creek has completed a preliminary review and found that characteristics at the Site are favorable for a WAIV® system to accomplish its objectives. The desired volume of liquid to be evaporated annually can be effectively managed by a WAIV® system due to its modular design, and chemistry provided poses no concerns. The system can be easily aligned with prevailing winds at the Site to maximize evaporative capacity. Additionally, the presence of evaporation ponds is ideal for WAIV® and provides a significant advantage, allowing a complete water balance that minimizes impacts to the environment (using less energy) while effectively managing wastewater on an annual basis and meeting the low water mark in the pond each fall. The annual cost of maintenance to keep the system running is also very low, and highly skilled labor is not required.

As shown in **Table 1** below, it is anticipated that one WAIV® unit installed at the Site will evaporate approximately 1.88 MGY and four units will evaporate 7.61 MGY. The WAIV® system may not be able to fully operate in the winter months between November and March due to freezing temperatures, so actual evaporation capacities may be lower than listed during those months. Based on available weather data for the location, it appears the average temperatures during the winter range from 58 to 22 °F. If the system is turned off completely between November and March, it is anticipated that one WAIV® unit will evaporate approximately 1.51 MGY and four units will evaporate 6.12 MGY. If additional evaporation add-ons are included in the WAIV® system such as fans, as well as a cold-weather package to help maximize operation throughout the year, those capacities will be higher.

Table 1 - Anticipated Evaporation Capacity of WAIV® at the Site (gallons)

Month	1 Unit		2 Units		3 Units		4 Units	
	gal/month	gal/day	gal/month	gal/day	gal/month	gal/day	gal/month	gal/day
Jan	36,984	1,193	75,461	2,434	113,938	3,675	152,415	4,917
Feb	57,716	2,061	116,925	3,772	176,134	5,682	235,344	7,592
Mar	162,598	5,245	326,282	10,525	489,967	15,805	653,651	21,086
Apr	225,202	7,507	451,354	14,560	677,506	21,855	903,658	29,150
May	243,897	7,868	489,424	15,788	734,950	23,708	980,477	31,628
Jun	281,696	9,390	566,242	18,266	850,789	27,445	1,135,336	36,624
Jul	254,447	8,208	513,917	16,578	773,387	24,948	1,032,857	33,318
Aug	208,909	6,739	424,200	13,684	639,490	20,629	854,781	27,574
Sep	175,999	5,867	355,527	11,469	535,056	17,260	714,585	23,051
Oct	138,608	4,471	279,388	9,013	420,167	13,554	560,947	18,095
Nov	59,345	1,978	119,641	3,859	179,936	5,804	240,231	7,749
Dec	34,947	1,127	72,067	2,325	109,186	3,522	146,306	4,720
Total	**1,880,347**		**3,790,427**		**5,700,507**		**7,610,587**	

9.0 PROPOSED COSTS

A summary of proposed costs for one through four WAIV® units is provided in **Table 2** below. The costs include the WAIV® equipment system with pumps, actuated valves, transducers, filters, sensors, PLC/HMI, prefabricated building, and all Clear Creek services from design to Site visits, permitting assistance, and oversight of key portions of the work. The cost estimates do not include civil work to prepare area, the containment, electrical field connections, piping to the system, a catwalk (dock) around the WAIV® structure for access (or gravel in a sunken containment for accessibility), procurement and placement of concrete blocks for the frame to sit on (ballasts to hold in place), a cold-weather package (heat trace, insulation, etc.), optional solar power equipment, optional enhancements like fans, or assembly of the easy-to-build units. A one-unit system would cost $630,073 and four units $1,634,941. If the equipment and control system can be installed within an existing building so that a separate prefabricated building is unnecessary, the costs would be reduced by approximately $55,000.

Table 2 - Summary of Costs for WAIV® Units

Number of WAIV Units	Expected Evaporative Capacity (gal)	Cost / Unit	Total CCES Cost	Ballpark CCES O&M Costs	Containment Footprint (ac)
1	1,880,347	$630,073	$630,073	$40,000	0.15
2	3,790,427	$468,264	$936,528	$50,000	0.25
3	5,700,507	$428,083	$1,284,250	$60,000	0.35
4	7,610,587	$408,735	$1,634,941	$70,000	0.45

Because Clear Creek holds the patent to WAIV®, has developed modeling and design specifications, and has operated the technology throughout the country, we have unique, specialized expertise and knowledge that is beneficial for the Site. As part of Clear Creek's post-installation O&M services, Clear Creek can provide technical support and troubleshooting, remote monitoring and operation through the system's telemetry, on-Site inspections with quarterly visits to assess operation, recommend actions when necessary, manage and evaluate data, assist in any required reporting, and any other services requested by the Site. The cost for Clear Creek's annual O&M service would be approximately $40,000 for a 1-unit system.

Local or Site personnel O&M requirements are minimal compared to other evaporation technologies and there are very low consumables required (i.e., low amount of electricity, freshwater for flushing). It is anticipated that approximately two hours per week for regular inspections and minor adjustments, and a quarterly, eight-hour maintenance event may be required by site personnel. The actual hours per week and frequency of the eight-hour events will be based on actual conditions observed by site personnel once the system is in steady-state operation. Electric charges will be minimal with the largest load being an expected 5-hp pump per WAIV® unit. Brine buildup in the WAIV® containment berm may need to be occasionally routed back into the ponds, removed off-Site, or otherwise disposed. A pump setup option could be installed to automatically direct the brine back to the ponds when a conductivity setpoint is triggered, minimizing labor and expenses.

10.0 SUMMARY

Clear Creek has prepared this proposal for Parkhill for a WAIV® wastewater evaporation system at the Site located in Alto, New Mexico. Clear Creek proposes to design and procure a full-scale WAIV® system specific for the Site that is capable of evaporating the volume desired in a way that is protective of the environment. Clear Creek will work with Parkhill and Site personnel throughout the process, provide installation oversight and training, and assist with testing and start-up.

Based on preliminary modeling, one WAIV® unit could evaporate approximately 1,880,347 gallons of wastewater and cost $630,073. Capacities may be reduced during the winter months if system operation would need to be suspended, but optional cold-winter packages and/or fans would help maximize operation throughout the year.

APPENDIX D
ECOVAP PRODUCT LITERATURE AND QUOTE

ecoVAP™

High Level Design
Parkhill – Alto Lakes, NM
August 5, 2024


VISION
OUR LEGACY.
THEIR FUTURE.
REPAIRING THE WORLD’S WATER CRISIS


COMPANY MISSION
INNOVATIVE SOLUTIONS.
UNMATCHED PERFORMANCE.
REIMAGINING WATER MANAGEMENT
FOR GLOBAL ACCESS TO FRESHWATER

ECOVAP TECHNOLOGY

BIOMIMICRY
MEETS AEROSPACE ENGINEERING

HARNESSING THE POWER OF MOTHER NATURE
FOR INNOVATIVE WATER SOLUTIONS

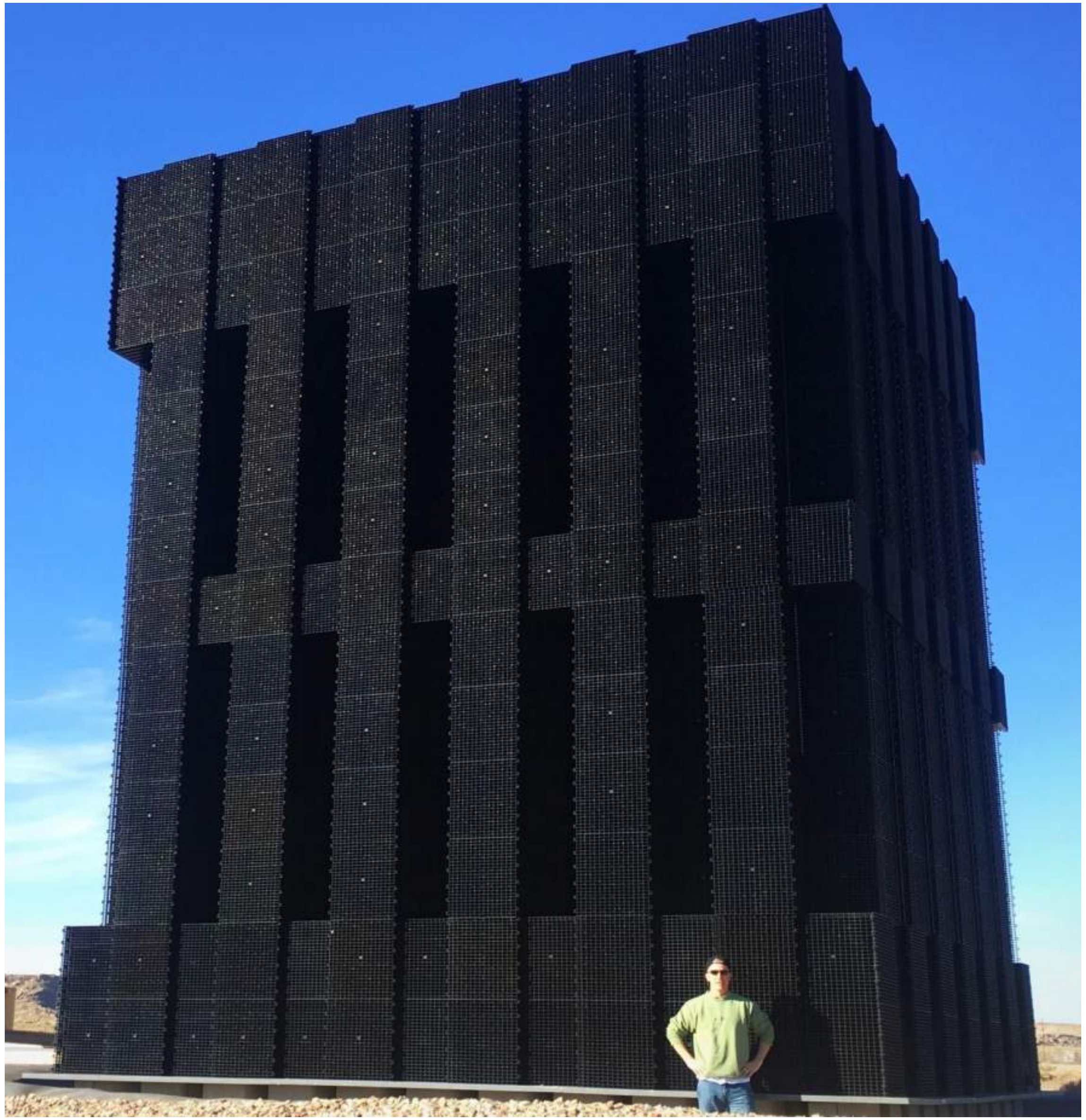
HIGHLY EFFECTIVE WASTE EVAPORATION TECHNOLOGY

TOP 10 WASTEWATER MANAGEMENT SOLUTION PROVIDERS - 2019

ECOVAP Inc. is a diversified water technology company that uses biomimicry to solve the dilemma of water evaporation, recovery and cooling in industrial applications:

- Patented low-energy technology that evaporates water > 59 times faster than pond surfaces
- Modular Evaporative Matrix™ easily installed, relocated, or removed that significantly reduces capital and operating costs compered to other disposal options.
- **Applicable to any industry with wastewater disposal challenges in need of rapid water evaporation:**
  - Oil & Gas produced water
  - Brine concentration for mineral recovery
  - Mine tailing ponds
  - Remediation

Significantly reduces land requirements, transport infrastructure, and environmental impact of traditional water disposal, improving operational sustainability and social license to operate



COMPANY EVOLUTION

2016

Develop Solution
- Acquire Test Facility
- Research Solutions
- Patent Solutions

2017

Test Solution
- Develop Manufacturing
- Secure Supply Chain
- 3rd Party Validation

2018

Validate Solution
- 1st Production Deployment
- Multi-Season Validation
- Gen2 Product Developed

2019

Deploy Production Solution
- Oil and Gas Site
- Mining Facility
- Utility Generation
- Water Disposal Facility

2020 | 2021

Evolve Solution
- Expand Existing Customers
- R&D New Solutions
- Gen3 Developed

2022

MARKET LAUNCH

APPLICATIONS

Oil & Gas Produced Water

On-Site Mobile Oilfield Evaporators

- Up to 90% reduction of water-trucks on the road
- Reduces fixed asset investments
- Simple relocation of mobile units to new locations

Pond Facility Evaporators

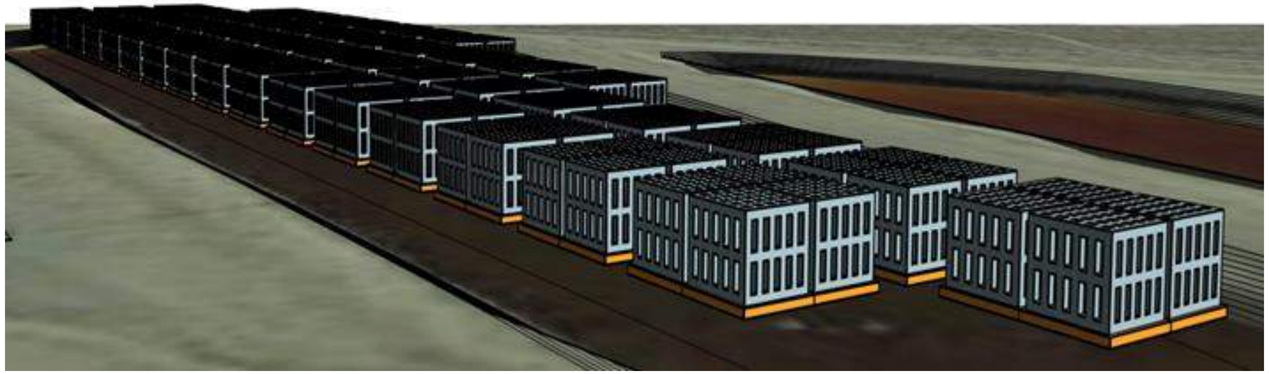
- Configurable as Towers, Walls, or Floating Barges
- 30x reduction in land use
- 35-40% less Capital Expense & Operating Expense

Mining

- Capacity increase in existing tailing ponds
- Cost effective zero discharge drain-down
- Concentrator with minimal to no solid loss

Power Generation

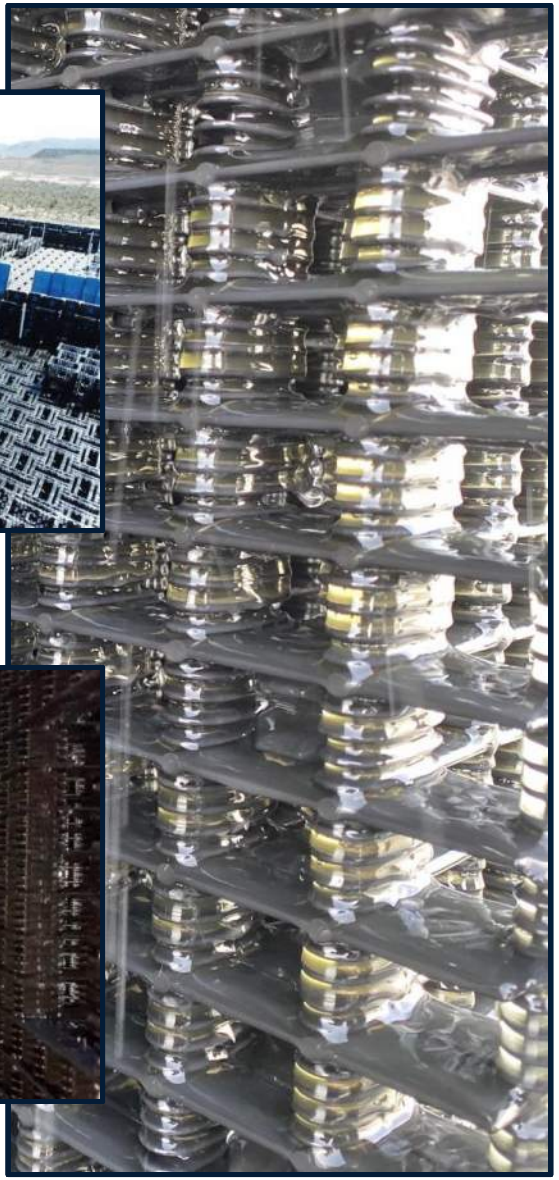
- Capacity increase of cooling blowdown ponds
- Energy and Environmentally better alternative to high maintenance evaporators
- Accelerate post-shut down groundwater remediation



A 100% RECYCLABLE SOLUTION THAT RETURNS BILLIONS OF GALLONS CLEAN WATER TO THE HYDROLOGIC CYCLE

ECOVAP EVAPORATION MATRICES

TOP 10
WASTEWATER MANAGEMENT
SOLUTION PROVIDERS - 2019



HOW IT WORKS:

- HDPE panels with patented airfoil design create hundreds of saturated vertical water columns that hold water in suspension
- Complete tower saturation reached in minutes using a low-pressure recirculating pump
- Higher available surface area enhances solar- and wind-driven evaporation via convection, i.e. no fan or other power source

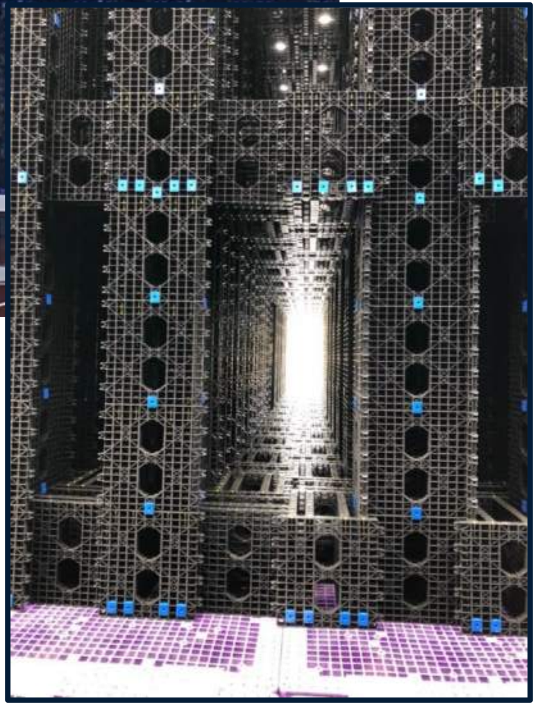
INDEPENDENT ENGINEERING REVIEW:

- *Potential results*: "ECOVAP's technology may be **over 60 times higher** than the rate provided by the conventional surface water evaporation approach."
- *Actual field test results*: "For the entire test duration, daily water meter data indicate that the Evaporation Tower is **59 times more efficient** in evaporating water than the approach relying on the surface water evaporation only."

GOLDER

MINING OPERATIONS - PHASE 1 (CA):
1% SURFACE AREA USE, 25% INCREASE IN EVAP CAPACITY

TOP 10
WASTEWATER MANAGEMENT
SOLUTION PROVIDERS - 2019



TOWER ECOVAP-EM™ (TX) : 95% DECREASE IN TRUCK TRANSPORT
35% COST REDUCTION

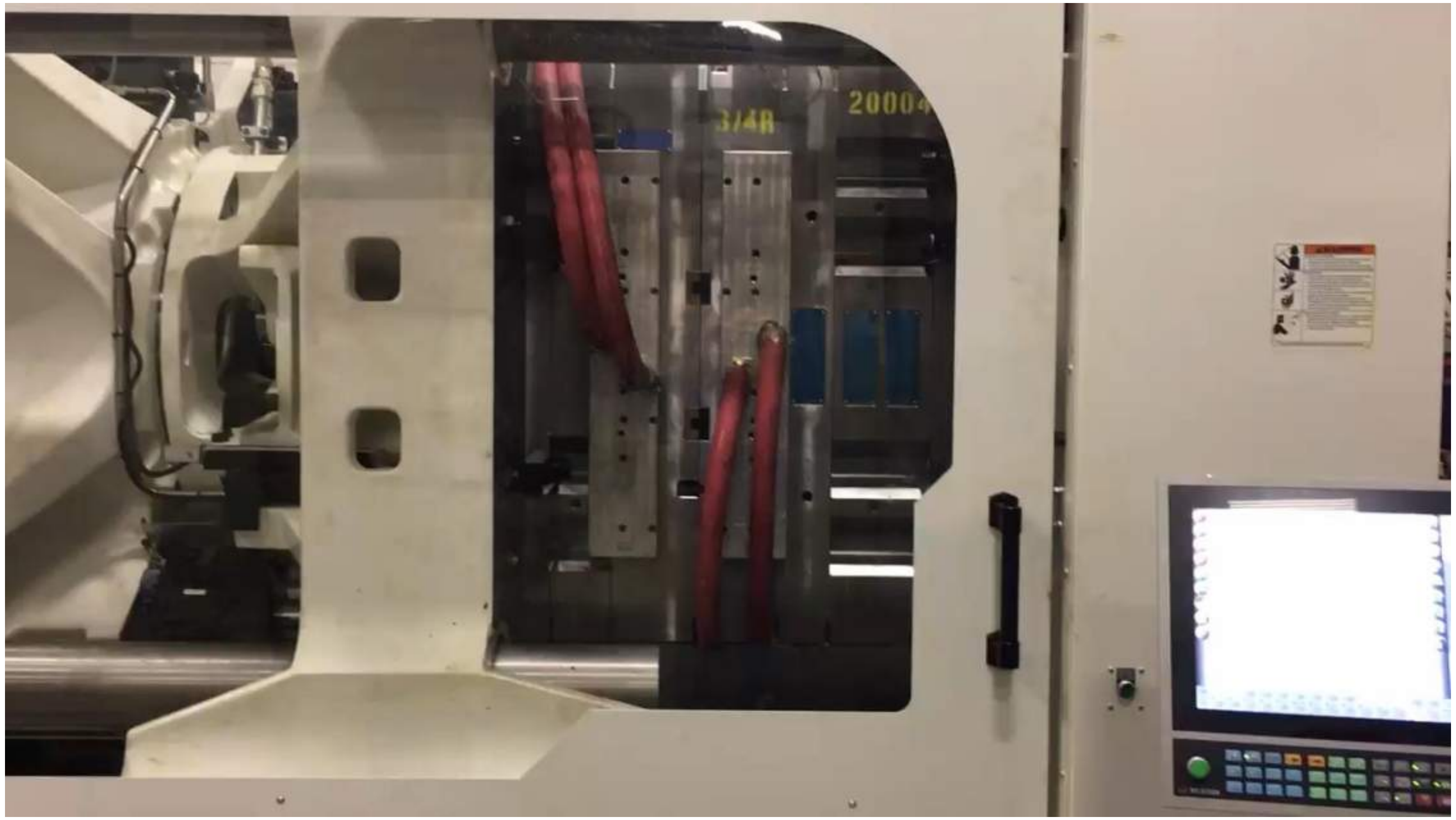
HIGH HUMIDITY DEPLOYMENT (FL): EXCEEDED EXPECTED RESULTS BY 21% IMPROVED SURFACE EVAPORATION BY 2,500%

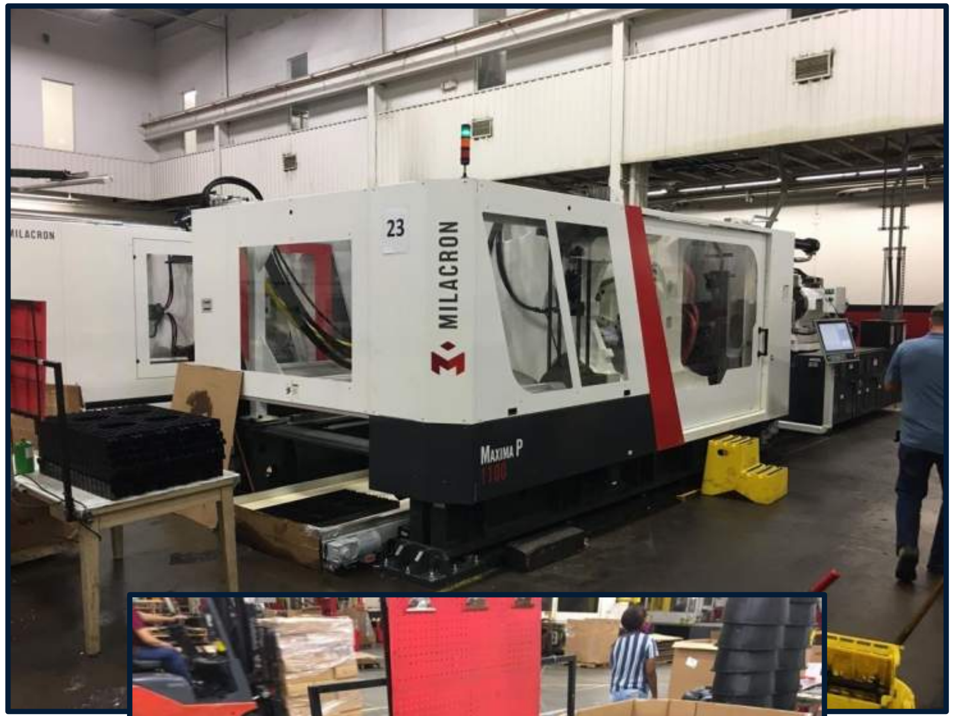
DIKE ECOVAP-EM™ (UT): 96% REDUCTION IN LAND USE; 50% CAPEX REDUCTION

"Wall" installation surrounding conventional ponds

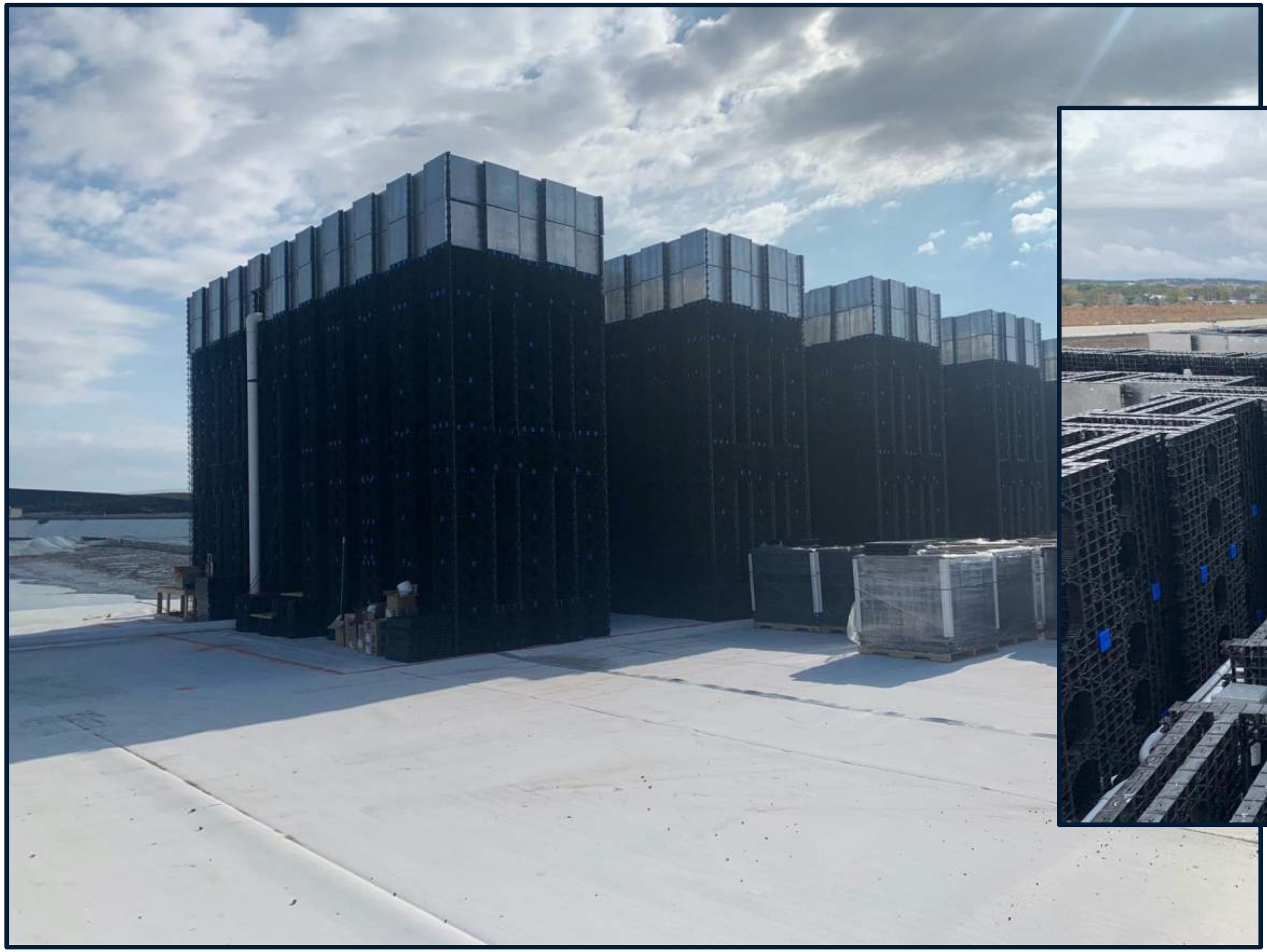
MANUFACTURING PROCESS

1,100 – Ton Injection Mold Press

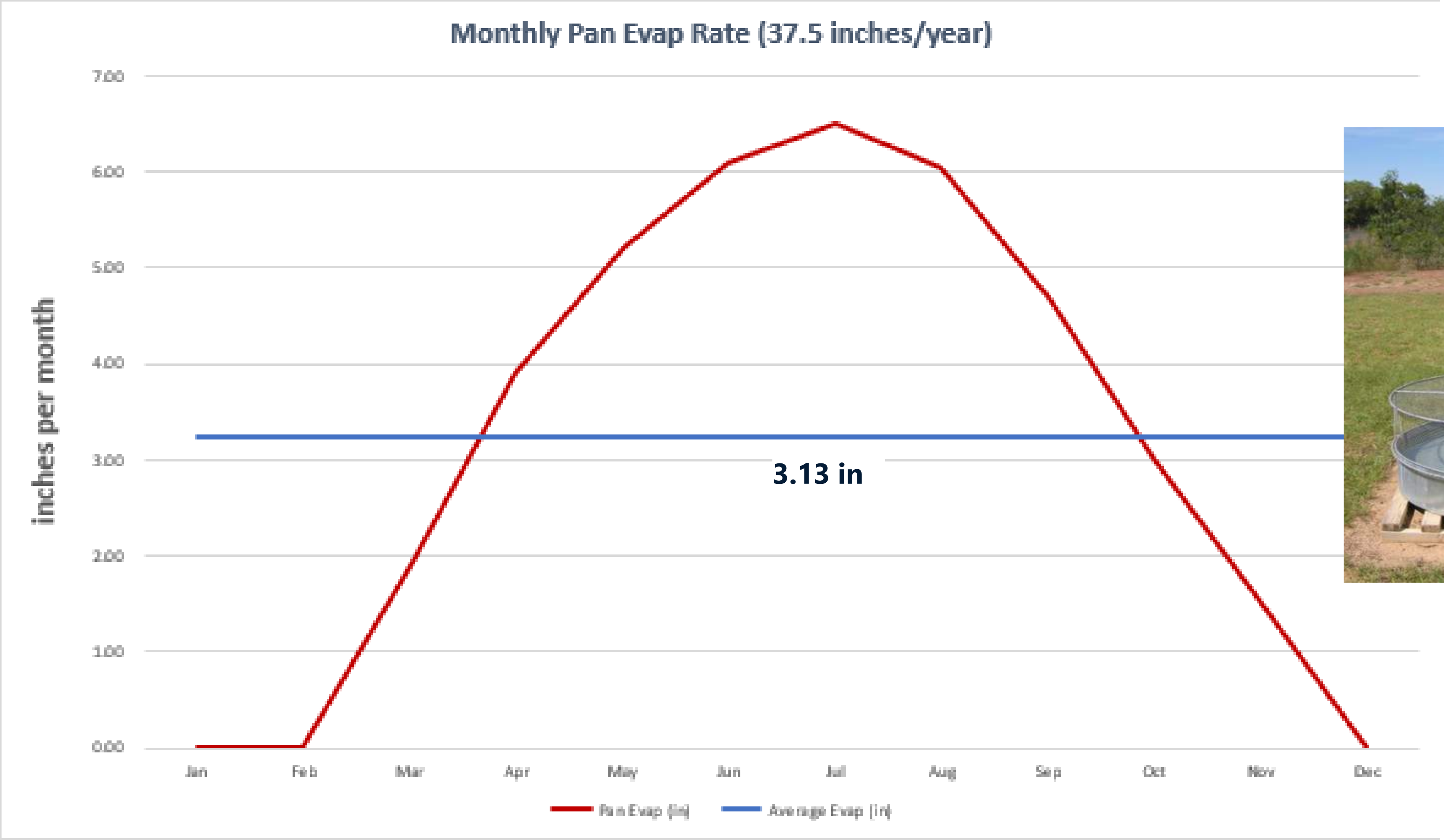




DEPLOYMENT

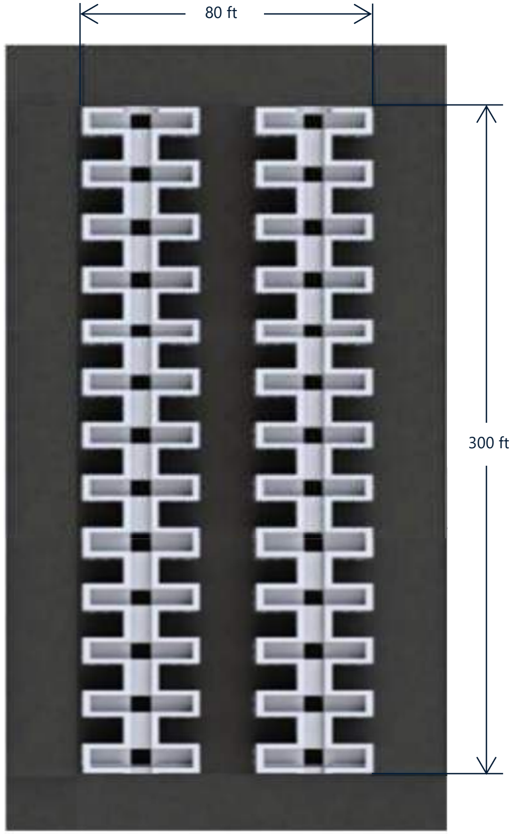


EVAPORATION PROFILE – ALTO LAKES, NM



INDICATIVE SOLUTION: ALTO LAKES, NM

Average Annualized Evaporation: 22 GPM (8.5 million gallons/year – Mar to Nov)
Pan Evaporation Rate of 37.5 inches/year



Illustrative example (configuration can vary)

DESCRIPTION:

Matrix dimensions: 80′ x 300′ x 22′ (lwh)

Footprint - 0.54 acres of space
- Equivalent to 27 acres of pond evaporation
- Pond cost $10 per sq ft = $445,000 / acre

Installed on the side of the existing pond

SPECIFICATIONS:

Pump Requirements vary based upon approach: 4-6 10 HP Pumps

Customer responsible to provide electrical requirements

Customer responsible for ground prepared to EcoVAP specifications

GROUND PREP

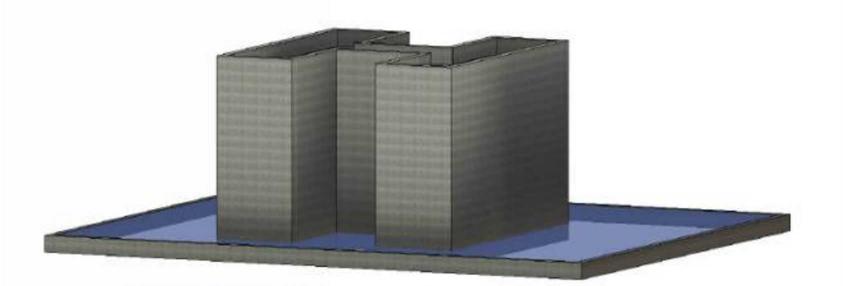
ECOVAP MATRIX GROUND PREP

GROUND PREP: Minimum Ground Prep Required.
- Subgrade/native soil should be compacted 90-95% at a depth of up to 12” depending on soil test results to achieve a standard 90 proctor.
- 6-12” Type 2 road base infill material compacted to achieve a standard 90 proctor .
- Vapor barrier as needed to be determined by moisture levels in the region. (To be determined by onsite native soil testing and completed by site owners.)
- Level surface - zero slope

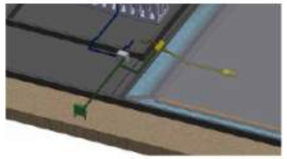
CONCRETE PAD - EcoVAP preffered perminent method
- #4 1/2" rebar set 12" on center - 1" to 1.5" above bottom of concrete
- Concrete should be 1/2" to 1" rock at 3000 PSI with a 4" slump +/- 1"
- Concrete pad should be 4" thick

NOTE: Once all site compaction is complete no machinery allowed to be on compacted area.

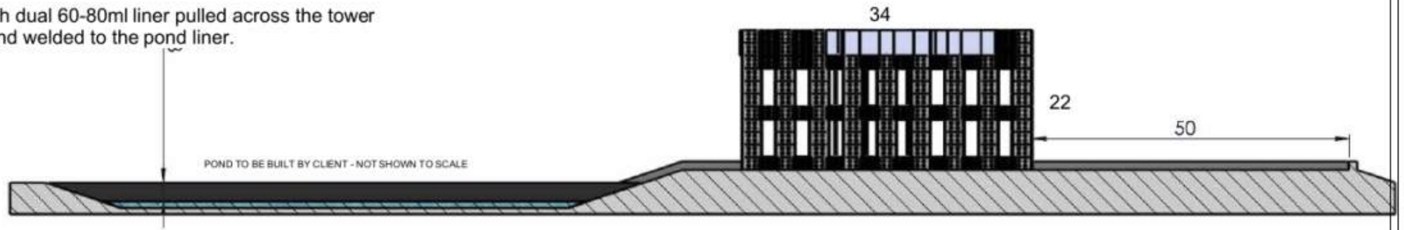
HDPE LINER
- Ground covered with dual 60-80ml liner pulled across the tower construction area and welded to the pond liner.



Zoomed view of the EcoVAP Matrix



PIPING
- Yellow - intake line from source water for temporary water evaporation test.
- Blue - Main pipe to lift water from temorary pond up to top of Matrix for water distribution
- Green - Power source and control panel



DUAL HDPE LINED COMPACTED BASE -Minimum Required

DUAL HDPE LINED CONCRETE BASE (EcoVap Prefferred Perminent Method)

SOME IMAGES ARE FOR VISUALIZATION PURPOSES ONLY AND MAY OR MAY NOT BE SHOWN TO SCALE

www.ecovap.com
3214 N University Ave Ste 133
Provo, UT 84604
801.960.3238

Site Ground Prep

Project number	Project Number
Date	May 10, 2023
Drawn by	KLR
Checked by	Checker

0.1GP 1

Scale

OPERATIONAL OVERVIEW: ALTO LAKES, NM

Weekly:

- Panels requires no maintenance

Monthly:

- Examine pumps for function
- Examine for loss of pressure
- Examine for hose puncture or break
- Check matrices for “constant wet” status
- Adjust timers, as needed

Yearly:

- Examine piping or spray heads, as needed

Next Steps:

- This Indicative Solution is an estimate
- A formal proposal will require a site visit and an engineering design with electrical and construction parameters
- Finalize Contract

SOLUTION OVERVIEW: ALTO LAKES, NM

COST ESTIMATE:

- Commercial terms to be finalized
- Includes:
  - All necessary matrix parts
  - Level 1 pumps and control system
  - Shipping and Installation

ASSUMPTIONS:

- 37.5-inch Annual Pan Evaporation Rate
- Customer responsible for electrical requirements
- Customer responsible for ground prepared to EcoVAP specifications
- Installation and shipping costs estimated and could change with site specific details

Location	Annual Pan Evaporation	Matrix Size	Volume Evaporated	Up-front Investment	Installation (estimated)	OpEx /Mo	Amortized 10 years
Alto Lakes	37.5	.54 acres	8.5 million per year	$2,500,000	$750,000	$750	$0.04/gal

SMALL PILOT OPTION FOR OPERATIONAL AND CHEMISTRY ANALYSIS

EXCELLENT FOR :

- Operational comfortableness
- Chemistry test
- Resiliency test
- Low risk build out system observation

6-MONTH TRIAL LICENSE

Does not include:

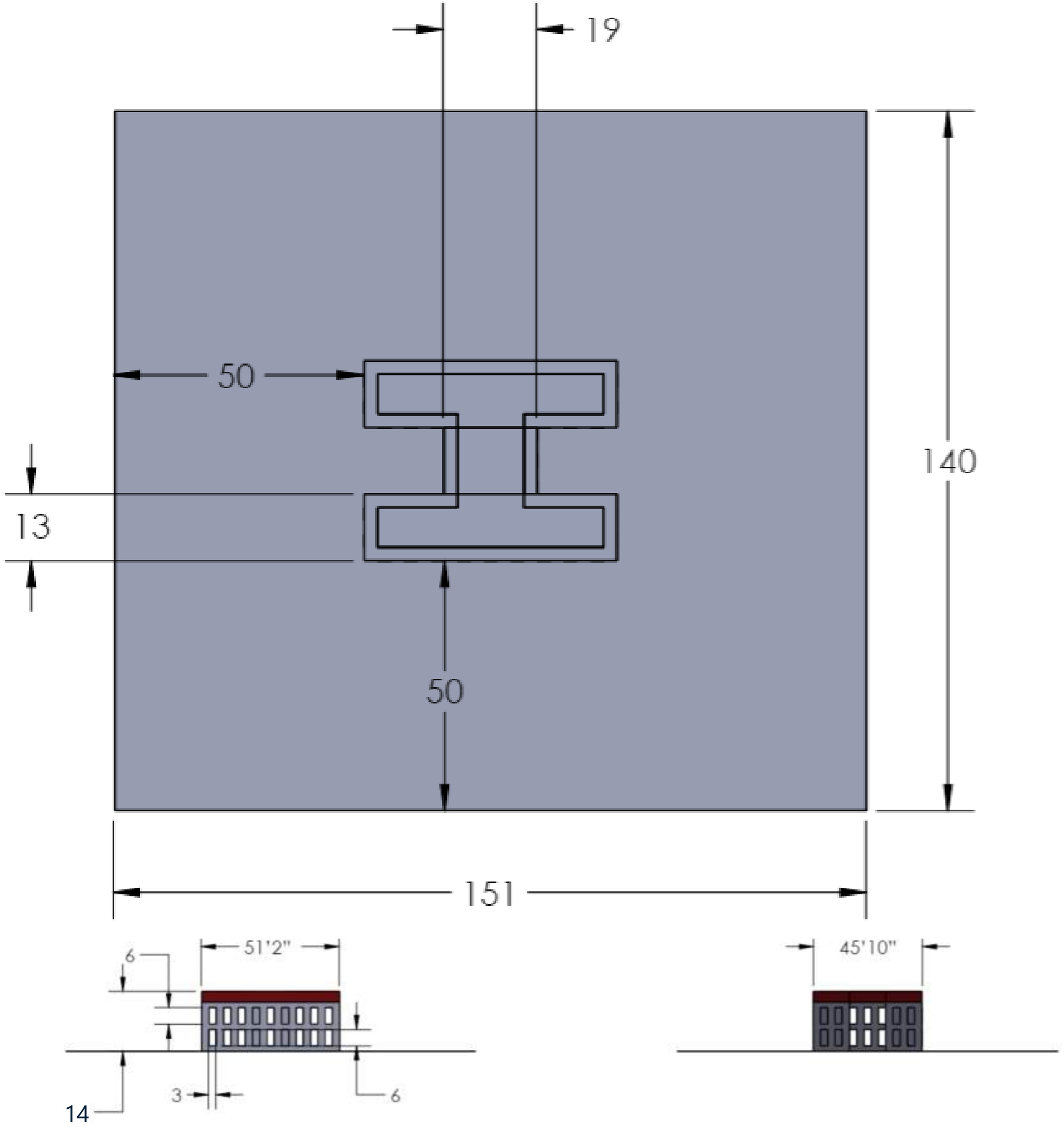
  - Power to Matrix
  - Ground Preparation
  - HDPE Liner
  - Testing equipment

DELIVERY:

- Price includes basic level 1 pump (additional charges for special pumps)
- Operational in 3-4 days of equipment arrival

4.2m x 4.9m x 4.2m (lwh)
14′ x 16′ x 14′

ECOVAP EVAPORATIVE MATRIX MODULE LOW PROFILE EXPANDABLE OPTION



Illustrative example (configuration can vary)

46′ x 46′ x 14′ (lwh)

EXPANDABLE PILOT OPTION

EXCELLENT FOR :

- Evaluating Evaporation Rate against Pond Evaporation
- Chemistry testing
- Expandability

System Includes:

- EcoVAP Matrix
- Matrix Water Distribution System
- Basic Control System
- 1 – 10 HP Pump

System does not include:

- Power to Matrix
- Pond and Ground Preparation
- HDPE Liner
- Testing equipment

Illustrative example (configuration can vary)

46′ x 46′ x 22′ (lwh)
14m x 14m x 6.7m

INDICATIVE PRICE OVERVIEW - PILOTS
(Pan evaporation rate – 37.5 in/year

COST ESTIMATES:
- Included: All necessary matrix parts, Level 1 pump and control systems
- Excluded: Land prep, Electrical delivery

NEXT STEPS:
- Prepare and present Formal MOU
- Finalize site preparation parameters
- Finalize Contract

Size	Volume (m3/hr)	Matrix Size (LWH)	Up-front Investment	Installation (Est)	Shipping (Est)
Mini-Pilot Trial (6 months)	~60 gal/hr	14 x 16 x 14 ft	$75,000	$25,000	$10,000
Low Profile Pilot (6 months)	~150 gal/hr	46 x 46 x 14 ft	$135,500	$30,000	$20,000
Expandable Pilot (6 months)	~300 gal/hr	46 x 46 x 22 ft	$198,000	$55,000	$25,000

ENVIRONMENTAL BENEFITS

	Injection Disposal	Evaporation Pond	Evaporation Pond w/ Atomizing Sprayer	ECOVAP
Earthquake Risk	**Can be High, depending on location**	None	None	**None**
Transport Energy Consumption / Air Pollution to Disposal Site	**Moderate-to-High, depending on distance**	Lower than injection disposal as can be closer to wells	Lower than injection disposal as can be closer to wells	**Low: ECOVAP can be located on site**
Land Use Footprint	Low	**High**	Moderate	**Usually less than 5% of conventional pond**
Energy Consumption at Disposal Location	**Moderate - but depends on geology and required PSI**	Low	**Moderate**	**Usually less than 10% of SWD / enhanced evap**
Water Supply Diminishment	**High - water permanently buried very deep**	Very low - clean water returns to atmosphere	Very low - clean water returns to atmosphere	**Very low - clean water returns to atmosphere**
Potential for Aquifer Contamination	Med - depending on location, but has been documented and risk increases with time	Very low; safeguards in place	Very low; safeguards in place	**Less than 5% of conventional because only need 1/20th the sites**
Air Pollution	Negligible compared to overall E+P, refining and distribution infrastructure	Very low compared to overall E+P, refining and distribution infrastructure	**High vs. other methods, but still relatively low vs. overall E+P, refining, distribution**	**Negligible compared to overall E+P, refining and distribution infrastructure**
Residual Oil Capture	Low	High	High	**High**
Other "Water Mining" Captures (i.e., fertilizer, salts, lithium, waxes/parafins, etc.)	None	High	High	**High**

QUESTIONS?

Bill Flecky
Senior Vice President
Business Development

bflecky@ecovap.com

TOP 10
WASTEWATER MANAGEMENT
SOLUTION PROVIDERS - 2019

FURTHER IMAGES