Eastern New Mexico Rural Water System Water Treatment Plant Alternatives Analysis

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This technical memorandum (TM) outlines the water treatment plant (WTP) alternatives analysis for the Eastern New Mexico Rural Water System (ENMRWS).

Executive Summary

The Eastern New Mexico Water Utility Authority (ENMWUA) is planning to construct a 28-million-gallon-per-day (MGD) WTP that will treat water from Ute Reservoir and provide finished water to Cannon Air Force Base (Cannon AFB) and ENMWUA Members including Clovis (served by EPCOR), Portales, Elida, and Texico. A schematic design for this WTP was completed in 2009 assuming a process of conventional water treatment with enhanced coagulation. This design was based on preliminary water quality data collected in 2005. In 2022, an in-depth water quality sampling event was performed to confirm the 2005 data. Water quality data from this event showed a significant change in total dissolved solids (TDS), increasing from 774 milligrams per liter (mg/L) in 2005 to 1,120 mg/L in 2022. This can be an issue because TDS can impact water taste and quality. The TDS level observed in 2022 exceeds the World Health Organization limit for drinkable water. Because TDS cannot be removed with conventional water treatment methods, an assessment of treatment alternatives that can remove TDS was completed.

In December 2022, ENMWUA formed a WTP Working Group consisting of ENMWUA, Cannon AFB, EPCOR, and ENMWUA Members including Clovis, Portales, Elida, and Texico. The purpose of the WTP Working Group was to complete an alternatives analysis to determine the most desirable treatment method considering operational and customer impacts. The selected outcome based on this assessment is known as the best technical alternative (BTA). Each alternative was evaluated with and without renewable energy, which only factored into cost-scoring. The treatment alternatives considered were as follows:

1. Conventional treatment with enhanced coagulation
2. Reverse osmosis (RO) with deep well injection brine disposal
3. Conventional treatment with granular activated carbon (GAC) adsorption
4. RO with solar evaporation pond brine disposal

As part of this analysis, the WTP Working Group attended seven collaboration and informational workshops along with two site visits to facilities similar to the alternatives being evaluated between January and April 2023. The WTP Working Group assessed each alternative based on non-monetary criteria, then weighted each criterion by importance.

Non-monetary criteria were scored for each alternative using measurable metrics, then scores were normalized and evaluated in a cost-benefit analysis. Cost and non-monetary criteria were put into a decision model used to determine the treatment method with the highest benefit-to-cost ratio. Finally, a sensitivity analysis was used to verify criteria weighting.

Results of the alternative analysis showed that RO membrane treatment technology with deep well injection and renewables provided the highest benefit-cost score of 5.05 (refer to Table ES1). The next highest scores were RO membranes with solar evaporation ponds and renewables (4.73), RO membrane with deep well injection and with solar evaporation options without renewables, conventional treatment with GAC and renewables (3.83), conventional treatment with GAC without renewables (3.40), and lastly conventional treatment with enhanced coagulation and renewables (3.12) and without renewables (2.67).

Finally, a sensitivity analysis was performed to confirm the impact of criteria weighting on benefit-costs scores. Overall, the Working Group felt that Customer Acceptance was the most important criteria and that Alternative 2 – RO membranes with deep well injection and renewables was the BTA. On April 26, 2023, ENMWUA Board Members approved a motion to move forward with Alternative 2 including membrane filtration, RO, with deep well injection brine disposal, contingent upon the outcomes of pilot treatment process testing and injection well investigation.

Table ES1. Alternatives Summary

Alternative Name	Weighted Benefits Score (Non-Cost)	Non-Cost Score Rank	Total ENMWUA Wholesale Rate (Year 2023) ($/1,000 gallons	Cost Rank	Total Benefit Score (Cost and Non-Cost Combined)	Best Technical Alternative Rank
1. Enhanced Conventional (Renewables)	2.07	4	$3.21	1	3.12	4
2. Membrane / RO / Injection Well (Renewables)	**3.93**	**1**	**$3.77**	**2**	**5.05**	**1**
3. Conventional / GAC Adsorption (Renewables)	3.40	3	$4.30	4	3.83	3
4. Membrane / RO / Solar Evaporation Ponds (Renewables)	3.93	2	$4.03	3	4.73	2

Introduction

In 2022, a water quality sampling event was performed to confirm the basis for conventional water treatment design at the WTP. When the WTP schematic design was developed in 2009, an alternative analysis was performed based on available water quality data collected in 2005. Since 2005, significant changes in water quality, primarily increased levels of TDS and alkalinity, have resulted in a reassessment of the water treatment method selected for the WTP (Jacobs, 2023). To determine the best path forward, an alternatives analysis has been performed comparing various treatment methods. The alternative analysis involves a decision-making process that combines non-monetary benefits with costs to provide a holistic evaluation in determining the BTA. The alternatives analysis is based on the following objectives for the WTP:

- Provide communities with a safe, quality water that customers want to consume.
- Provide cost-effective water to communities.
- Equip ENMWUA with a robust treatment process capable of meeting drinking water regulations and desired water quality goals.
- Provide ENMWUA and each community with a system that is not complicated and is cost effective to operate.

This TM will define project alternatives and non-monetary decision criteria, detail the method of alternative scoring, document the force ranking of each decision criteria by importance based on the WTP Working Group's input, and provide a benefit-cost score for each alternative.

Background

Sampling events were performed at Ute Reservoir over several months in 2022 to confirm the water quality last assessed in 2005. The 2022 water quality analysis results showed that there was a significant increase in certain contaminants that could impact treatment processes compared to preliminary water quality data gathered in 2005. The specific contaminants that impact treatment for the surface water in Ute Reservoir are as follows:

- TDS
- Alkalinity
- Sulfate
- Chloride
- Hardness
- Sodium

The increased levels of these contaminants could be due to the lower reservoir levels increasing their concentration through infiltration of brackish groundwater into the reservoir or evaporation from the reservoir. Between 2005 and 2022, Ute Reservoir declined by about 23%of the reservoir's full capacity of 272,000 acres per foot. In 2013 the reservoir level dropped below the level observed in 2022, and then filled to the spillway level in 2017. In addition to contaminants that increased since 2005, several other contaminants were tested for the first time, including per- and polyfluoroalkyl substances (PFAS) and lithium. Both PFAS and lithium are listed as contaminants of concern under the U.S. Environmental Protection Agency (EPA) Unregulated Contaminant Monitoring Rules 5. In March 2023, EPA announced proposed regulations for six PFAS. The concentrations of the proposed PFAS found in Ute Reservoir were lower than the proposed regulation, but this could change in the future if contaminant concentrations in the water entering the reservoir increase, if regulatory limits are decreased, or additional contaminants are regulated. Table 1 summarizes the change in contaminant concentrations tested in Ute Reservoir for years 2005 and 2022. Detailed results of the water quality analysis can be found in the ENMRWS Source Water Quality Analysis (Jacobs, 2023).

Table 1. Source Water Quality Summary of Changes

Contaminant	Ute Reservoir 2005 Concentration	Ute Reservoir 2022 Concentration
Alkalinity (mg/L)	188 to 196	260 to 270
Chloride (mg/L)	52	110 to 120
TDS (mg/L)	756 to 774	1,000 to 1,100
TOC (mg/L)	6.03 to 6.11	5.04 to 5.29
PFOA (ng/L)	Not tested	2.8 to 3.0
PFOS (ng/L)	Not tested	1.9

ng/L = nanogram(s) per liter
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid
TOC = total organic carbon

Groundwater Blending

Groundwater blending was evaluated to determine if it would be a feasible means of reducing the TDS concentration in the source water. This evaluation was based on achieving a TDS concentration below the secondary maximum contaminant level (MCL) of 500 mg/L and consistent with what could be achieved using RO. The TDS concentration in groundwater supplies is approximately 300 mg/L. Table 2 shows several blending scenarios for three fundamental water qualities, including local groundwater, non-RO treated water from the WTP, and RO treated water from the WTP. The non-RO treated water represents the microfiltration (MF) or conventional water quality that would be produced from the WTP that would not pass through the RO treatment process.

Table 2. Summary of Blending Options to Reduce TDS

	Member Groundwater	Non-RO Treated Water	RO Treated Water	Customer Blended Water[a]
Scenario 1				
Percentage of Demand	25	75	0	100
TDS (mg/L)	300	1,200	72	**975**
TOC (mg/L)	0.1	4.5	0.4	**3.4**
Scenario 2				
Percentage of Demand	50	50	0	100
TDS (mg/L)	300	1,200	72	**750**
TOC (mg/L)	0.1	4.5	0.4	**2.3**
Scenario 3				
Percentage of Demand	80	20	0	100
TDS (mg/L)	300	1,200	72	**480**
TOC (mg/L)	0.1	4.5	0.4	**0.98**

Table 2. Summary of Blending Options to Reduce TDS

	Member Groundwater	Non-RO Treated Water	RO Treated Water	Customer Blended Water[a]
Scenario 4				
Percentage of Demand	25	30	45	100
TDS (mg/L)	300	1,200	72	**467.4**
TOC (mg/L)	0.1	4.5	0.4	**1.555**
Scenario 5				
Percentage of Demand	10	30	60	100
TDS (mg/L)	300	1,200	72	**433.2**
TOC (mg/L)	0.1	4.5	0.4	**1.6**

[a] Not all customers receive a perfect blend of water depending on community without significant improvements to the existing distribution system

Scenario 3 shows that 80% of the total water demand would need to be supplied by local groundwater if there was no RO treatment process, to meet the secondary MCL TDS concentration. With groundwater becoming more scare in the region, it is not safe to assume this much of the water demand could be supplied by groundwater. Significant modifications to the community systems would be required to collect and convey local groundwater resources to the ENMWUA entry point to ensure that all customers received a similar water quality. For these reasons, groundwater blending does not meet the project goals and is not a feasible means of reducing the TDS concentration.

Scenario 5 represents a feasible long-term scenario for achieving the secondary MCL for TDS concentrations. Under this scenario; 10%of the total demand would be supplied by local groundwater, 30% supplied by non-RO treated water from the WTP, and 60% supplied by RO treated water from the WTP.

Between January and April 2023, several workshops, site visits, and virtual meetings were conducted with the WTP Working Group. Those workshop and meetings included the following:

- Workshop 1 / Kick-off Meeting / Alternatives Development – On January 18, 2023, a kick-off meeting was held with the WTP Working Group to discuss and review changes in Ute Reservoir water quality since 2005 and alternative methods of treatment to address those changes.
- Site Visits
  - On February 16, 2023, the WTP Working Group toured the Canadian River Municipal Water Authority (CRMWA) deep well injection facility located just south of Logan, New Mexico. The purpose of this visit was to gain a better understanding of how brine produced from RO treatment could be disposed of and showed that deep well injection is feasible in this region of New Mexico.

  - On February 17, 2023, to gain a better understanding of conventional and membrane treatment methods, the WTP Working Group visited the City of Lubbock to tour their conventional and MF WTPs. This allowed the WTP Working Group to ask operators questions about their experiences and operational considerations with both conventional and MF treatment processes.

- Virtual Meeting 1 – On February 15, 2023, a virtual meeting was held to present membrane treatment options, different membrane configurations, and details on how RO would work for the WTP.
- Virtual Meeting 2 – On February 21, 2023, a virtual meeting was held to present information on how chloramine disinfection would impact facilities using chlorine disinfection currently. This meeting reviewed the chemistry of the chloramination process as well as the operational impacts including converting member systems to chloramine disinfection.
- Virtual Meeting 3 – On March 10, 2023, a virtual meeting was held to present information on injection wells. This meeting focused on the process of deep well injection, steps to getting necessary permitting including New Mexico Environment Department (NMED) review and approval, as well as design considerations for Eastern New Mexico.
- Workshop 2 – On March 16, 2023, a workshop was held to discuss and determine the non-monetary benefit criteria that would best represent the needs of the community. Once non-monetary benefit criteria were selected, the WTP Working Group ranked each criterion against each other in order of importance. Criteria that did not have a majority vote were flagged and used for the sensitivity analysis. The ranking from this workshop was used to develop a benefit score for each alternative.
- Workshop 3 – On March 28, 2023, a workshop was held to present the benefit scoring results and cost calculations for each alternative. Cost was combined with benefit scores to create a benefit-cost ratio. Each party in the Working Group had an opportunity to share their preferred treatment alternative based on the Alternative Analysis results.
- Board Meeting Update – On March 30, 2023, the ENMWUA Board was updated on the progress of the Alternative Analysis. The benefit scoring and costs for each of the alternatives were presented.
- Recommendation Meeting – A final alternative recommendation meeting was held on April 11, 2023, with the WTP Working Group to determine the BTA recommended for the ENMWUA Board approval.
- Board Approval – On April 26, 2023, the ENMWUA Board approved the recommended BTA for the WTP, which includes an MF and reverse on the findings of the pilot WTP and injection well investigations.

Alternative Descriptions

Alternatives evaluated as a part of this analysis will meet or exceed EPA primary drinking water regulations, providing water that is safe to drink. Each alternative will also be designed to operate smoothly, meaning they will not be operating on the edge of meeting

regulatory requirements. Three main treatment processes will be considered as a part of this analysis: (1) conventional treatment with enhanced coagulation, (2) MF with RO, and (3) conventional treatment with GAC adsorption. Each alternative was evaluated with and without renewable energy as a part of the cost analysis; however, the renewable energy component does not have an impact on the non-monetary benefits. The following sections provide a description of each alternative and their advantages and disadvantages.
A summary of alternatives included in this analysis is shown in Table 3.

Table 3. Alternatives Summary

#	Alternative Name	Description
1	Enhanced Conventional	Enhanced coagulation, ozone, biological activated carbon filtration, with chloramine disinfection
1A	Enhanced Conventional (Renewables)	Enhanced coagulation, ozone, biological activated carbon filtration, with chloramine disinfection; includes renewable energy
2	Membrane / RO / Injection Well	MF, RO, brine deep well injection, free chlorine disinfection
2A	Membrane / RO / Injection Well (Renewables)	MF, RO, brine deep well injection, free chlorine disinfection; includes renewable energy
3	Conventional / GAC Adsorption	Conventional coagulation, filtration, GAC adsorption, free chlorine disinfection
3A	Conventional / GAC Adsorption (Renewables)	Conventional coagulation, filtration, GAC adsorption, free chlorine disinfection; includes renewable energy
4	Membrane / RO / Solar Evaporation Ponds	MF, RO, solar evaporation ponds, free chlorine disinfection
4A	Membrane / RO / Solar Evaporation Ponds (Renewables)	MF, RO, solar evaporation ponds, free chlorine disinfection; includes renewable energy

Alternative 1 – Conventional Treatment with Enhanced Coagulation

Conventional treatment uses processes that have been around for decades and are proven and reliable methods of treating drinking water. Water chemistry and chemical additions are the primary methods used to remove contaminants. Conventional treatment consists of coagulation, flocculation, clarification, filtration, disinfection, and solids handling, as shown on Figure 1. Based on the source water quality alkalinity and total organic carbon (TOC) measured in 2022, a conventional treatment plant will be required by the EPA Stage 1 Disinfection Byproducts Rule to remove 25% of the TOC measured in the source water.
In this alternative, enhanced coagulation removes the required amount of TOC from the water by decreasing the pH of the water to optimize organics removal. Sulfuric acid is used to offset alkalinity in the source water and lower the pH. Ozonation provides additional removal of TOC and treatment for taste and odor compounds.

Several chemical additions are required for conventional treatment with enhanced coagulation, including sulfuric acid, ferric chloride, polymers, sodium hydroxide, ozone, liquid ammonium sulfate, sodium bisulfite, and sodium hypochlorite. Some of these chemicals are hazardous and require special monitoring, storage, and training for use at the WTP.

Conventional treatment is a robust process, but operation involves responding to changes in source water quality, requiring careful monitoring throughout the process. There are also limitations to conventional treatment including its inability to remove TDS from source water. Even with enhanced coagulation, this process would require the use of chloramines for secondary (residual) disinfection due to the levels of TOC that would remain in the finished water. TOCs alone are not harmful, but they can generate disinfection byproducts, especially with increased water age when water travels long distances, as is the case for the ENMWUA system. Using this process would require each user to convert their current groundwater supplies to chloramine disinfection, adding additional facilities, monitoring, and operation requirements.

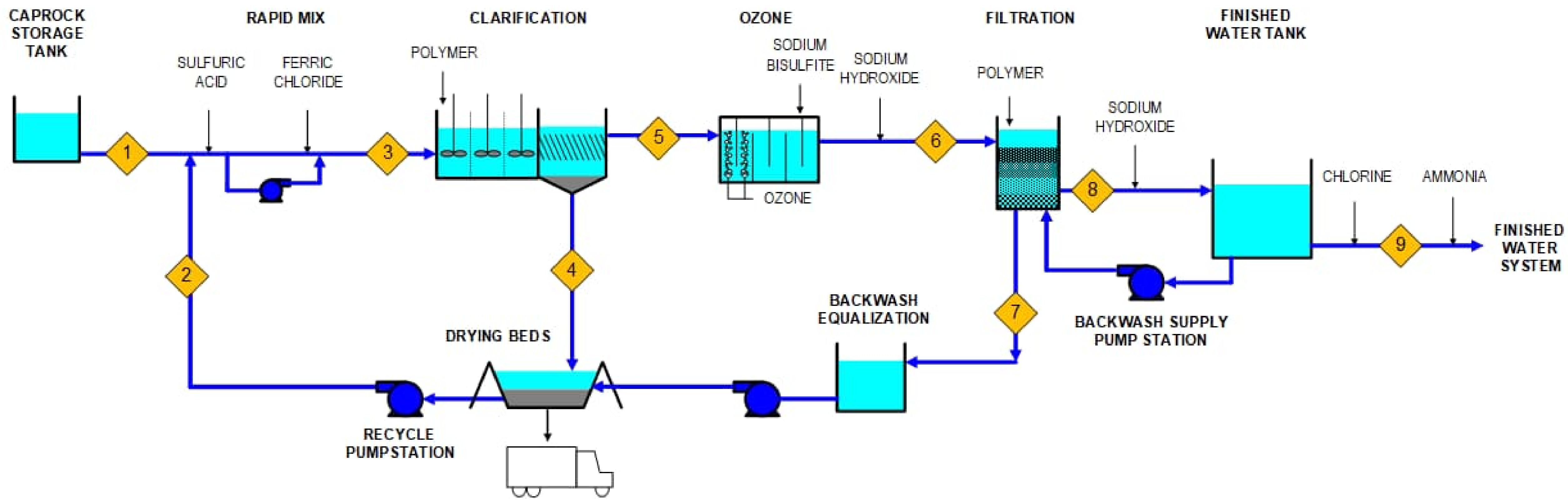
Conventional treatment with enhanced coagulation generates large amounts of solids that need to be disposed. Most of the solids generated comes from the chemical addition required. At the assumed full allocation of water being treated annually, the conventional process with enhanced coagulation would generate 4,260 tons of solids per year, which would require approximately 284 truck trips to remove and dispose of the solids in a nearby landfill.

Figure 1 shows the anticipated water quality throughout the conventional treatment with enhanced coagulation process based on previous treatability testing results and water chemistry calculations.

Advantages and disadvantages for conventional treatment with enhanced coagulation are summarized in Table 4.

Table 4. Advantage and Disadvantages of Enhanced Conventional Treatment

Advantages	Disadvantages
1. Robust and proven treatment process. 2. Does not generate a reject brine that requires disposal. 3. Minimizes the amount of water lost or wasted through the treatment process. 4. Reduces the initial and long-term permitting requirements. 5. Requires minimal electrical energy to operate the treatment process.	1. Cannot meet EPA drinking water secondary MCLs for TDS and sulfate. a. No health effects with TDS or sulfate b. Increased customer complaints regarding water taste 2. Does not remove enough TOC from the source water to prevent the need for chloramine secondary disinfection. 3. Requires each user to convert existing groundwater wells to chloramine disinfection. 4. Requires significantly more chemicals. a. One delivery per day at average flow conditions with hazardous chemicals such as sulfuric acid and sodium hydroxide 5. Produces more solids for disposal, not including the TDS from RO process. 6. Does not remove PFAS; less robust treatment process for removal of potential future contaminants. 7. Requires construction of more complicated concrete water-holding basins (increased construction schedule compared with RO).



Stream Number	1	2	3	4	5	6	7	8	9	
	RW	RCY	CW	USL	SW	OZW	BWW	FE	FW	
Stream Name	Raw Water	Recycle	Coagulated Water	Unthickened Sludge	Settled Water	Ozonated Water	Backwash Waste	Filter Effluent	Finished Water	EPA Health Advisory Goal
Flow (mgd)	28.0	2.1	30.1	0.6	29.5	29.5	1.5	29.5	28.0	
Total Alkalinity (mg/L as $CaCO_3$)	280	226	156	156	156	251	251	251	262	
TDS (mg/L, calculated)	1200	1200	1200	1200	1200	1200	1200	1200	1200	500.0
TSS (mg/L)	7.0	1.0	38	1926	1.0	1.0	60.0	0.1	0.1	
TOC (mg/L)	7.0	7.0	7.0	97	5.3	5.3	10	4.7	4.7	2.0
pH	8.9	7.1	6.5	6.5	6.5	7.5	7.5	7.5	7.9	
Sulfate (mg/L)	440	539	539	539	539	539	539	539	539	250.0
Sodium (mg/L)	300	335	302	302	302	346	346	346	352	
Lithium (ug/L)	90	90	90	90	90	90	90	90	90	9.0
PFOS (ng/L)	2	2	2	2	2	2	2	2	2	4.0
PFOA (ng/L)	3	3	3	3	3	3	3	3	3	4.0

ENMRWS WTP PROCESS FLOW DIAGRAM
ENHANCED CONVENTIONAL

Figure 1. Enhanced Conventional WTP Process Flow Diagram

Alternative 2 – Microfiltration/Reverse Osmosis Treatment with Deep Well Injection

This alternative treatment process leverages several physical barriers to remove contaminants. The source water will pass through strainers to remove any large debris in the water. Chloramine and coagulant chemicals will then be added to the source water to reduce membrane fouling and increase TOC removal through the MF membranes. The MF membranes will consist of a pressurized hollow fiber membrane, used to remove turbidity and particles before the RO membranes. The MF membranes will provide the necessary *Giardia* and *Cryptosporidium* removal to meet the regulatory requirements. The RO consists of a three-stage process that removes high levels of TDS and TOC from the water. Only a percentage of the water treated through the MF process will be treated by RO. It is assumed that approximately 70% of the water would be treated through RO to achieve the desired TDS and TOC concentrations in the finished water. RO rejects contaminants based upon charge and size (molecular weight) and is well suited to remove potential future contaminants such as PFAS (high molecular weight) and lithium (charged ion). RO requires significant electrical power due to the relatively high pressures necessary to push water through the membranes and reverse the natural osmotic pressure associated with salinity. Pressures for the Eastern New Mexico RO system are expected to be around 200 psig. The RO process for the WTP would be able to recover about 93% of water sent through the process, which would result in a brine disposal of 1.5 MGD at peak flow conditions. The approach for RO blending would remove enough TOC that users would not need to change to a chloramine secondary disinfection approach.

The RO process produces a brine waste that contains high concentrations of salinity and other contaminants and requires disposal. There are two feasible options for brine disposal including deep well injection and solar evaporation ponds. Other options for brine disposal exist such as mechanical evaporation/crystallization; however, the additional capital and operating costs are not cost effective and were not considered in the analysis.

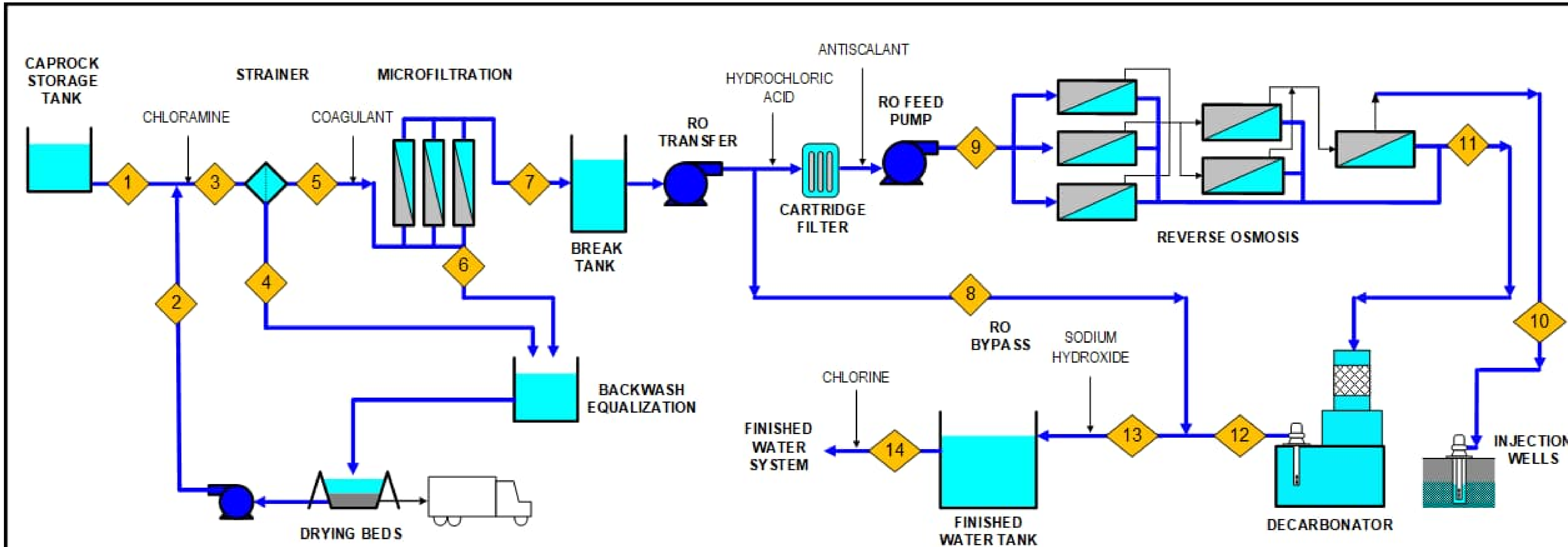
Deep well injection involves drilling a Class 1 well approximately 6,000 feet deep where brine is then pumped and disposed. Based on a similar injection well owned by CRMWA near Logan, New Mexico, initial projections show that an injection well could have a capacity of 250 to 300 gallons per minute, which would require four injection wells to accommodate the peak WTP brine concentrate flow. CRMWA's injection well water has a salinity of approximately 55,000 mg/L, compared to the estimated salinity of 15,000 mg/L for Eastern New Mexico's brine concentrate. Additional permitting requirements from NMED would also apply to the injection wells, including an exploratory test hole or well. The injection well option for brine disposal comes with increased risk of well capacities changing over time, where additional wells may be required in the future. A flow diagram showing the water treatment process for the MF/RO alternative with deep well injection for brine disposal is shown on Figure 2.

Figure 2 also shows the anticipated water quality throughout the MF/RO treatment process based on membrane manufacturer predictive analysis tools and water chemistry calculations. A pilot scale system would be constructed to refine the design criteria for both MF and RO membranes along with chemical dosing if this alternative were selected for the WTP.

A summary of advantages and disadvantages for the MF/RO process with deep well injection are shown in Table 5.

Table 5. Advantages and Disadvantages of MF/RO Membrane with Injection Well Alternative

Advantages	Disadvantages
1. Capable of meeting all EPA drinking water regulations for primary and secondary MCLs. 2. Removes enough TOC from the source water to allow for free chlorine secondary disinfection. a. Reduces the impact on each user by not changing the current disinfection approach. 3. Requires fewer chemical additions. 4. Produces less solids requiring disposal compared to conventional treatment, not including TDS. 5. Capable of treating potential new contaminants of concern including PFAS and PFOS. 6. More resilient treatment process for dealing with changes in water quality in the Ute Reservoir. 7. Simplified construction; requires less water-holding basins and time to construct.	1. Produces a reject brine that needs disposal. a. Multiple injection wells needed to accommodate flow. b. Injection well investigation required to confirm feasibility at the WTP site. c. Risk of injection wells' capacity reduction over time. 2. Permitting requirements will be more complicated due to brine disposal. 3. Approximately 7% of the source water treated is lost or wasted through the reject brine disposal. 4. Requires significantly more electrical energy to operate the treatment process. 5. Pilot testing recommended to confirm MF design parameters RO recovery rate and brine disposal flows.



Stream Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	RW	SRr	Sf	Sbw	MFf	MFbw	MFF	Bp	ROf	ROwc	ROp	DROp	Bp	Fp	
Stream Name	Raw Water	Solids Removal Recovery	Strainer Feed	Strainer Backwash Effluent	MF Feed	MF Backwash Effluent	MF Filtrate	RO Bypass	Feed to RO	RO Conc.	RO Perm. (w/FOS)	Decarb ROP	Blended Product	Finished Product	EPA Health Advisory Goal
Flow (mgd)	29.5	2.0	31.5	0.2	31.4	1.9	29.5	8.5	21.0	1.5	19.5	19.5	28.0	28.0	
Sodium (mg/L)	280	280	280	280	280	280	280	280	280	3801	23	23	100	100	
Bicarbonate (mg/L)	300	300	300	300	300	300	300	300	116	1473	14	14	101	101	
Sulfate (mg/L)	420	420	420	420	420	420	420	420	420	5920	9	9	133	133	250
Chloride (mg/L)	210	210	210	210	210	210	210	210	210	2814	21	21	78	78	
TDS (mg/L, calculated)	1209	1209	1209	1209	1209	1212	1212	1212	1098	15089	63	63	410	410	500
TSS (mg/L)	4.0	5.0	4.0	40.0	3.8	63.7	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.2	
TOC (mg/L)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.2	83.6	0.6	0.6	2.5	2.5	2.0
Lithium (ug/L)	85	85	85	85	85	85	85	85	85	1048	19	19	39	39	9
Perfluorooctanesulfonic acid (PFOS) (ng/L)	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	25.3	0.2	0.2	0.7	0.7	4.0
Perfluorooctanoic acid (PFOA) (ng/L)	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	38.7	0.3	0.3	1.1	1.1	4.0
pH	8.9	9.0	9.0	9.0	9.0	9.0	9.0	9.0	6.2	7.3	5.2	6.7	8.2	8.2	

ENMRWS WTP PROCESS FLOW DIAGRAM
REVERSE OSMOSIS (INJECTION WELLS)

Figure 2. Microfiltration, Reverse Osmosis, Injection Well WTP Process Flow Diagram

Alternative 3 – Conventional Treatment with Granular Activated Carbon

Similar to Alternative 1, this alternative is based on conventional treatment consisting of flocculation, clarification, filtration, and disinfection. Instead of enhanced coagulation and ozonation, GAC media is used for TOC removal. GAC media works by providing a high surface area where certain organic contaminants can be adsorbed. As the adsorption capacity of the GAC media is exhausted, the GAC media needs to be regenerated or replaced. The addition of GAC adsorption would replace the need for enhanced coagulation chemicals and ozone. Unlike Alternative 1, GAC can remove enough TOC from the source water that chloramines would not be required for secondary disinfection. As with Alternative 1, GAC is not capable of treating the TDS levels in the water.

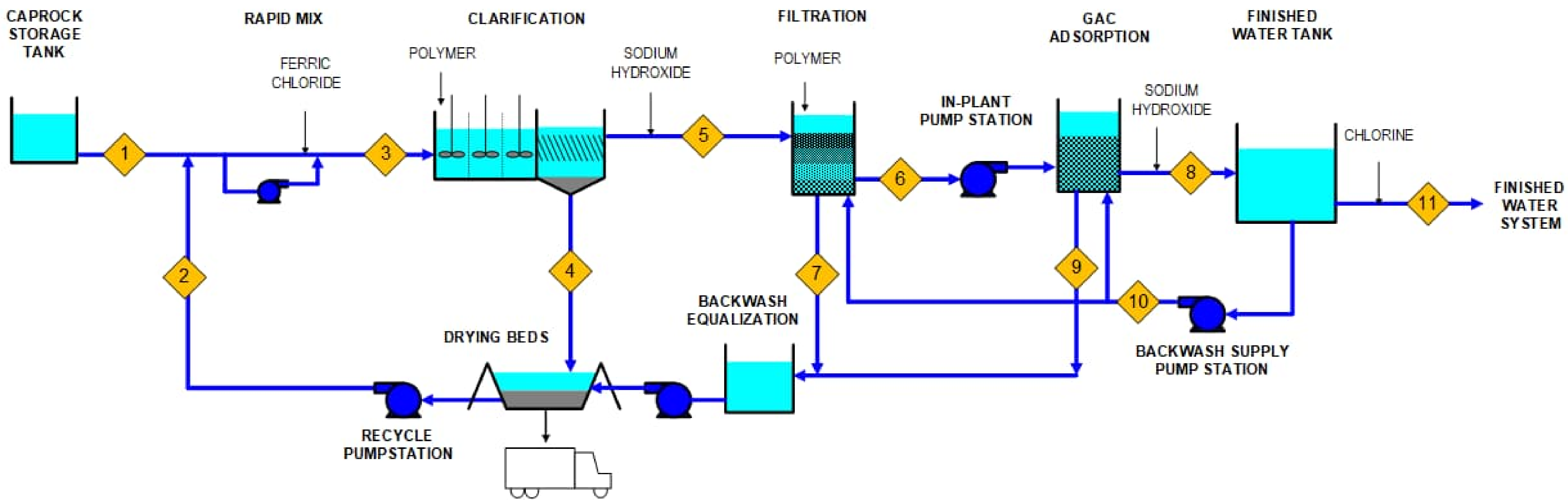
Some PFAS contaminants can be removed by GAC adsorption, but the removal efficiency is dependent on the frequency of media replacement. For this alternative, it was assumed that GAC would be replaced three times a year (GAC life of approximately 5,000 bed volumes), requiring significant coordination with vendors. Pilot testing or a Rapid Small-Scale Column Test of GAC media would be required to confirm exhaustion rates and TOC and PFAS removal capabilities. The GAC adsorption process would be located after filtration, as shown on Figure 3.

Figure 3 also shows the anticipated water quality throughout the conventional with GAC adsorption treatment process based on previous treatability testing results, water chemistry calculations, and industry guidance for TOC and PFAS removal through GAC adsorption.

A summary of advantages and disadvantages for the conventional treatment with GAC process is described in Table 6.

Table 6. Advantages and Disadvantages of Conventional Treatment with GAC

Advantages	Disadvantages
1. Does not generate a reject brine that needs disposal. 2. Minimizes the amount of water lost or wasted through the treatment process. 3. Reduces the initial and long-term permitting requirements. 4. Requires minimal electrical energy to operate the treatment process. 5. Removes enough TOC from the source water to allow for free chlorine disinfection. 6. Capable of partially treating potential new contaminants of concern including PFAS and PFOS but does not remove them completely.	1. Cannot meet EPA drinking water regulations for secondary MCLs for TDS and sulfate. a. No health effects with TDS or sulfate b. Increased customer complaints regarding water taste 2. Requires multiple replacements of GAC media per year, which is very costly. 3. Produces more solids for disposal not including TDS from RO process. 4. Requires more complicated construction of concrete water-holding basins and increased construction schedule. 5. Pilot testing to confirm GAC Exhaustion rates would be required to confirm design criteria.



Stream Number	1	2	3	4	5	6	7	8	9	10	11	
	RW	RCY	CW	USL	SW	FE	BWW	GAC	GWW	BWS	FW	
Stream Name	Raw Water	Recycle	Coagulated Water	Unthickened Sludge	Settled Water	Filter Effluent	Backwash Waste	GAC Adsorption	GAC Waste	Backwash Supply	Finished Water	EPA Health Advisory Goal
Flow (mgd)	28.0	2.7	30.7	0.6	30.1	30.1	1.5	28.5	0.5	2.0	28.0	
Total Alkalinity (mg/L as $CaCO_3$)	280	198	243	243	243	262	262	262	262	262	262	
TDS (mg/L, calculated)	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	500.0
TSS (mg/L)	7.0	1.0	38	1959	1.0	0.1	60.0	0.1	0.1	0.1	0.1	
TOC (mg/L)	7.0	7.0	7.0	62	6.0	6.0	74	2.4	126	2.4	2.4	2.0
pH	8.9	7.3	7.3	7.3	7.8	7.8	7.8	7.8	7.8	8.0	8.0	
Sulfate (mg/L)	440	440	440	440	440	440	440	440	440	440	440	250.0
Sodium (mg/L)	300	232	294	294	294	303	303	303	307	307	307	
Lithium (ug/L)	90	90	90	90	90	90	90	90	90	90	90	9.0
PFOS (ng/L)	2	2	2	2	2	2	2	1.2	1.2	1.2	1.2	4.0
PFOA (ng/L)	3	3	3	3	3	3	3	1.8	1.8	1.8	1.8	4.0

ENMRWS WTP PROCESS FLOW DIAGRAM
CONVENTIONAL & GAC

Figure 3. Conventional with GAC Adsorption WTP Process Flow Diagram

Alternative 4 – Microfiltration/Reverse Osmosis Treatment with Solar Evaporation Ponds

This alternative is identical to Alternative 2 except for the brine concentrate disposal method. This alternative involves the use of solar evaporation ponds in lieu of deep well injection.

RO brine concentrate would be stored in large solar evaporation ponds. Evaporation ponds for the WTP would require approximately 60 acres of space. The evaporation ponds would also need up to 55 mechanical misters to minimize the area required and to balance evaporation and precipitation rates. Solar evaporation ponds would require two layers of high-density polyethylene liners and a monitoring program to ensure leakage does not occur. Solids will accumulate over time, requiring solids removal disposal approximately every 10 years. At the assumed full allocation of water being treated annually, the RO process would generate 17,500 tons of solids per year, which would require approximately 11,500 truck trips to remove and dispose of the solids in a nearby landfill. The solar evaporation ponds have a useful life of approximately 30 years, similar to that of the injection wells. A flow diagram showing the water treatment process with RO including solar evaporation ponds is shown on Figure 4.

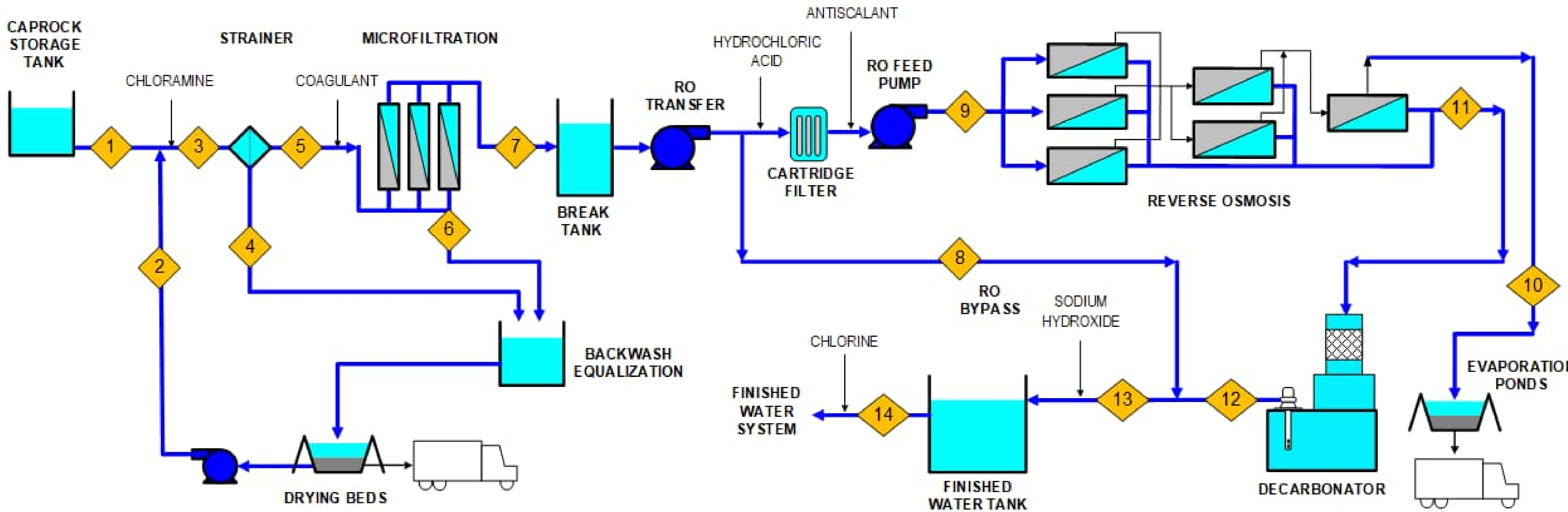
Figure 4 also shows the anticipated water quality throughout the MF/RO treatment process based on membrane manufacturer predictive analysis tools and water chemistry calculations. A pilot scale system would be constructed to refine the design criteria for both MF and RO membranes along with chemical dosing if this alternative were selected for the WTP.

A summary of advantages and disadvantages for the MF/RO process are shown in Table 7.

Table 7. Advantages and Disadvantages of MF/RO Membrane with Solar Evaporation Ponds Alternative

Advantages	Disadvantages

1. Capable of meeting all EPA drinking water regulations for primary and secondary MCLs.
2. Removes enough TOC from the source water to allow for free chlorine secondary disinfection.
   a. Reduces the impact on each user by not changing the current disinfection approach.
3. Requires fewer chemical additions.
4. Produces less solids requiring disposal compared to conventional treatment, not including TDS .
5. Capable of treating potential new contaminants of concern including PFAS and PFOS.
6. More resilient treatment process for dealing with changes in water quality in the Ute Reservoir.
7. Simplified construction, requires less water-holding basins and time to construct.
	1. Produces a reject brine that needs disposal.
	   a. Evaporation ponds generate a significant volume of solids that require hauling and disposal.
	   b. Mechanical misters require significant energy and maintenance, spray can travel large distances with high wind.
	2. Permitting requirements will be more complicated due to brine disposal.
	3. Approximately 7% of the source water treated is lost or wasted through the reject brine disposal.
	4. Requires significantly more electrical energy to operate the treatment process.
	5. Pilot testing recommended to confirm MF design parameters RO recovery rate and brine disposal flows.



Stream Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	RW	SRr	Sf	Sbw	MFf	MFbw	MFF	Bp	ROf	ROwc	ROp	DROp	Bp	Fp	
Stream Name	Raw Water	Solids Removal Recovery	Strainer Feed	Strainer Backwash Effluent	MF Feed	MF Backwash Effluent	MF Filtrate	RO Bypass	Feed to RO	RO Conc.	RO Perm. (w/FOS)	Decarb ROP	Blended Product	Finished Product	EPA Health Advisory Goal
Flow (mgd)	29.5	2.0	31.5	0.2	31.4	1.9	29.5	8.5	21.0	1.5	19.5	19.5	28.0	28.0	
Sodium (mg/L)	280	280	280	280	280	280	280	280	280	3801	23	23	100	100	
Bicarbonate (mg/L)	300	300	300	300	300	300	300	300	116	1473	14	14	101	101	
Sulfate (mg/L)	420	420	420	420	420	420	420	420	420	5920	9	9	133	133	250
Chloride (mg/L)	210	210	210	210	210	210	210	210	210	2814	21	21	78	78	
TDS (mg/L, calculated)	1209	1209	1209	1209	1209	1212	1212	1212	1098	15089	63	63	410	410	500
TSS (mg/L)	4.0	5.0	4.0	40.0	3.8	63.7	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.2	
TOC (mg/L)	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.2	83.6	0.6	0.6	2.5	2.5	2.0
Lithium (ug/L)	85	85	85	85	85	85	85	85	85	1048	19	19	39	39	9
Perfluorooctanesulfonic acid (PFOS) (ng/L)	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	25.3	0.2	0.2	0.7	0.7	4.0
Perfluorooctanoic acid (PFOA) (ng/L)	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	38.7	0.3	0.3	1.1	1.1	4.0
pH	8.9	9.0	9.0	9.0	9.0	9.0	9.0	9.0	6.2	7.3	5.2	6.7	8.2	8.2	

ENMRWS WTP PROCESS FLOW DIAGRAM
REVERSE OSMOSIS
(EVAPORATION PONDS)

Figure 4. Microfiltration, Reverse Osmosis, Solar Evaporation Pond WTP Process Flow Diagram

Decision Criteria

Decision criteria provide a means of comparison for the options being considered. Because cost is always included in the selection process, the goal of developing non-monetary criteria is to reflect on key issues impacting the project. Non-monetary criteria provide a framework for identifying the most advantageous process, increase collaboration among the Working Group, and identify trade-offs between alternatives. Each non-monetary criterion developed for this process is discussed in this section. The following guidelines are applied for decision criteria:

- Decision criteria must be mutually exclusive to prevent double counting benefits or lack thereof.
- Decision criteria must offer differentiation among alternatives to avoid diluting the areas where differentiation is present.
- Decision criteria must be measurable to avoid subjectivity and to maximize defensibility.

On March 16, 2023, the Working Group met to identify, discuss, and rank non-monetary criteria. A summary of the criteria selected by the Working Group is provided in Table 8. Please refer to Appendix B for detailed meeting summaries of the workshop held as part of this alternatives analysis.

Table 8. Summary of Benefit Scoring Criteria

ID	Criteria Name	Criteria Description	Scoring Methodology
A	Customer Acceptance of ENMWUA Water / Water Quality	• Alternative's ability to meet all NMED drinking water regulations for primary and secondary MCLs. • Alternative's impact on customer complaints and satisfaction with the taste of their water. • Scale and hardness buildup impacts to existing customers' valves, hot water heaters, staining, etc.	Finished Water TDS Concentration (mg/L) (LOW SCORE WINS)
B	Member Complexity	• Alternative's impacts on user system operations and the need for a chloramine disinfection approach. • With chloramines there will likely be added costs to the user operations that is not reflected in the cost estimates.	Chloramine Disinfection Required or Not (0=Not Required, 1=Required) (LOW SCORE WINS)
C	Water Loss / Efficiency	• Alternative's ability to minimize water loss and waste. • Water will be lost through brine disposal. • Water will also be lost intermittently through distribution system flushing to prevent nitrification events for chloramine disinfection.	Treatment Process Water Efficiency Percentage (HIGH SCORE WINS)
D	Permitting Complexity	• Alternative's impact on permitting the brine disposal injection wells. Potential for permitting requirements to change over time. • This criterion also accounts for the inherent risk of the brine disposal injection wells.	Brine Disposal Injection Wells Required or Not (0=Not Required, 1=Required) (LOW SCORE WINS)
E	Emerging Contaminants / Future Regulations	• Alternative's ability to treat future contaminants of concern (such as PFAS, lithium). • Stakeholders must weigh planning for the future versus attempting to forecast regulations?	Treatment Process Removal Percentage of PFAS (HIGH SCORE WINS)

Decision Criteria Weighting

The Working Group force-ranked each criterion on the relative importance of criterion against each other during the March 16 workshop, which established the weighted percentage for each non-cost criteria. The final criteria weighting is shown in Table 9. Each criterion automatically receives one vote.

Table 9. Weighted Criteria Results

ID	Criteria	A Customer Acceptance of ENMWUA Water / Water Quality	B Member Complexity	C Water Loss / Efficiency	D Permitting Complexity	E Emerging Contaminants / Future Regulations	Number of Responses	Weighting Percentage
A	Customer Acceptance of ENMWUA Water / Water Quality	A	A	A	A	A	5	33.3
B	Member Complexity		B	B	B	E	3	20.0
C	Water Loss / Efficiency			C	C	C	3	20.0
D	Permitting Complexity				D	E	1	6.7
E	Emerging Contaminants / Future Regulations					E	3	20.0

Based on the criteria weighting, Customer Acceptance was chosen to have the greatest impact on benefit score, while Permitting Complexity was chosen to have the smallest impact. Permitting Complexity was not voted to be more important than any other criteria by the Working Group. The other criteria had an equal weight based on the ranking. Some of the criteria forced ranking was not unanimous, which is described in more detail in the Sensitivity Analysis section of this TM.

Decision Criteria Scoring

Each criteria listed earlier was scored based on measurable data. This method allows scoring to be based on data and not subjective. Each criterion scoring method is described in the subsequent sections. A summary of criteria scores is provided in Table 10.

Customer Acceptance of Water/Water Quality. The main contaminant of concern for this criterion is TDS. All alternative methods can treat the other contaminants identified in Ute Reservoir to the primary MCL. Because TDS is the main differentiator, the TDS concentration that the alternative can achieve was used to score water quality, where the lowest level of TDS is the most desirable. Table 10 shows the RO alternatives as being the most desirable, based on achieving a TDS concentration less than the Secondary MCL of 500 mg / L. Both conventional alternatives are the least desirable because they do not achieve the Secondary MCL of 500 mg/L.

Member Complexity. Member complexity scoring was based on the need to include chloramine facilities for secondary disinfection at existing user sites. The more chloramine disinfection facilities needed, the more coordination and effort on behalf of users to convert their systems. Table 10 shows the conventional water treatment with enhanced coagulation alternative is the least desirable because chloramination is required for disinfection due to TOC levels and long water travel time to users. The RO alternatives and conventional treatment with GAC alternative are the most desirable because chloramination is not required.

Water Loss/Efficiency. The percentage of water recovered from the alternative treatment process was used for scoring the water loss and efficiency criterion. Table 10 shows the RO alternatives are the least desirable because of the brine waste stream, the disposal of which will result in significant water loss. Both conventional treatment alternatives are the most desirable because virtually 100% of the water diverted from Ute Reservoir will eventually be delivered to customers.

Permitting Complexity. Scoring for the permitting complexity criterion was based on the number of additional permits required for a given process. Because RO will require additional monitoring for brine disposal regardless if deep injection wells or solar evaporation ponds are used, it has a higher score for permitting requirements, where lower scores are more desirable.

Emerging Contaminants/Future Regulations. There are several contaminants that EPA may enforce treatment for in the future. Preliminary regulations for PFAS were released in March 2023, and this criterion is scored based on the percentage removal of PFAS provided by the alternative treatment process. Higher removal is reflected in a higher score, indicating greater non-monetary benefits. Conventional treatment with enhanced coagulation is the least desirable alternative because its ability to treat emerging contaminants, including PFAS, is limited. Conventional treatment with GAC provides more flexibility in treating PFAS and other emerging or future contaminants. The RO alternatives provide even greater treatment for PFAS and other emerging contaminants and are therefore the most desirable alternatives.

After scoring was complete, each score was normalized on a scale of 1 to 5 using the spread of values where a score of 1 is least desirable, and a score of 5 is the most desirable alternative. Normalizing the values across the range of scores reduces the complexity of comparing the non-monetary scores against each other. The normalized scores for each alternative are also shown in Table 10.

Table 10. Benefit Score Summary

		Benefit Scores					Normalized Scores				
	Criteria:	Customer Acceptance / Water Quality	Member Complexity	Water Loss / Efficiency	Permitting Complexity	Emerging Contaminants / Future Regulations					
	Scoring Method:	TDS Concentration (mg/L) (LOW SCORE WINS)	Chloramine Disinfection Required or Not (0=Not Required, 1=Required) (LOW SCORE WINS)	Water Efficiency Percentage (HIGH SCORE WINS)	Brine Disposal Injection Wells Required or Not (0=Not Required, 1=Required) (LOW SCORE WINS)	Removal Percentage of PFAS (HIGH SCORE WINS)					
ID	Alternative						Customer Acceptance of ENMWUA Water / Water Quality	Member Complexity	Water Loss / Efficiency	Permitting Complexity	Emerging Contaminants / Future Regulations
1	Enhanced Conventional	1,100	1	99.5	0	0	1.0	1.0	5.0	5.0	1.0
2	Membrane / RO / Injection Well	450	0	93	1	90	5.0	5.0	1.0	1.0	5.0
3	Conventional / GAC Adsorption	1,100	0	99.5	0	60	1.0	5.0	5.0	5.0	3.7
4	Membrane / RO / Solar Evaporation Ponds	450	0	93	1	90	5.0	5.0	1.0	1.0	5.0
Minimum		450	0	93	0	0					
Maximum		1,100	1	99.5	1	90					
Spread		650	1	6.5	1	90					
Scale		5	5	5	5	5					

Benefit Scoring Results

The non-monetary criteria weighting was applied to each of the normalized scores in Table 10 to calculate the total benefit score for each alternative. The results of benefit scoring are shown in Table 11 and on Figure 5. Results show that both RO membrane options provide the greatest non-monetary benefits, then conventional with GAC, with conventional with enhanced coagulation scoring the worst. Based on the criteria weighting, the RO alternatives provide nearly twice the non-monetary benefits than the conventional with enhanced coagulation alternative. The RO alternative scores are identical because the associated risk with evaporation ponds and deep well injection will be about the same.

Table 11. Benefit Scores for Each Alternative

			Alternatives			
			1	2	3	4
ID	Criteria	Weighting	Enhanced Conventional	Membrane / RO / Injection Well	Conventional / GAC Adsorption	Membrane / RO / Solar Evaporation Ponds
A	Customer Acceptance of ENMWUA Water / Water Quality	33.3%	0.33	1.67	0.33	1.67
B	Member Complexity	20.0%	0.20	1.00	1.00	1.00
C	Water Loss / Efficiency	20.0%	1.00	0.20	1.00	0.20
D	Permitting Complexity	6.7%	0.33	0.07	0.33	0.07
E	Emerging Contaminants / Future Regulations	20.0%	0.20	1.00	0.73	1.00
Total			**2.07**	**3.93**	**3.40**	**3.93**

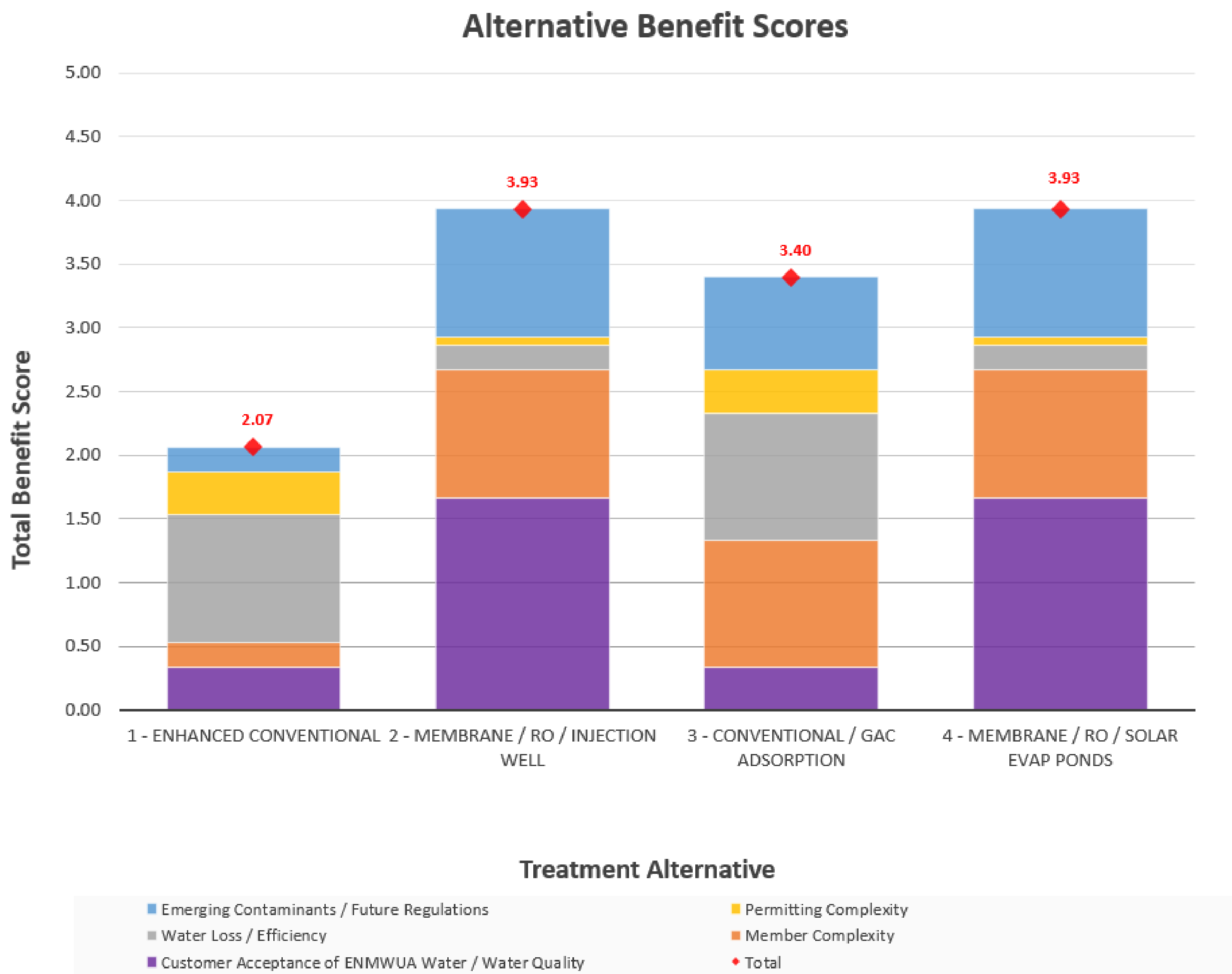


Figure 5. Benefit Scores for Each Alternative

Alternative Cost Estimates

Cost estimates were generated using Jacobs' Replica Parametric Design tool (Replica). These are Class 4 cost estimates defined by the Association for the Advancement of Cost Engineering (AACE). Class 4 estimates are typically within −30% to +50% accuracy. The Class 4 estimate definition is described in the following (AACE, 2022):

> *Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Typically, engineering is from 1% to 15% complete, and would comprise at a minimum the following: plant capacity, block schematics, indicated layout, process flow diagrams (PFDs) for main process systems, and preliminary engineered process and utility equipment lists.*

Cost assumptions for this analysis were reviewed by Jacobs design-build cost estimating teams and the Jacobs operations and maintenance (O&M) group, who are responsible for providing hard bid costs for design-build construction projects and annual O&M contracts. The following sections will describe capital expenditure (CAPEX) and operation and maintenance expenditure (OPEX) in more detail. The costs developed are for the purposes of comparing alternatives, and more detailed costs will be developed as the project design commences.

Capital Costs

CAPEX unit cost assumptions were updated with current market conditions provided by cost estimators and are based on a January 2023 Engineering News Record Construction Cost Index (ENR CCI) of 13175. The ENR CCI measures the changes in cost for production factors in construction, including materials, equipment, salaries, transportation, etc. for a 20-city average. Site allowances for construction were assumed to be a percentage of the total unit process facility costs; the percentage used varies by alternative depending on complexity. The CAPEX costs also include contractor markups and profit, land acquisitions, project management, engineering, permitting, services during construction, and startup and commissioning. Capital costs for all options include a 30% contingency for facility costs, which is recommended by AACE for a Class 4 level estimate. Detailed CAPEX costs and assumptions for each alternative are provided in Appendix A. CAPEX costs also include conveyance and facilities needed to complete the project, which remain the same for each alternative.

Annual OPEX Costs

Jacobs' Replica model was used to determine sizing and annual usage of equipment, chemicals, and other annual O&M costs. OPEX cost estimates included the following for each alternative:

- Labor and Staffing
- Maintenance
- Chemicals
- Energy
- Solids Handling and Disposal
- Laboratory
- Other Operating and Employee Expenses

For this alternatives analysis, the project costs do not include a facility replacement fund. The plan for determining the final ENMWUA water rates will be developed under a separate project task.

A preliminary estimation of staffing needs was developed for the OPEX costs. It was assumed that some staff would have multiple responsibilities or roles and that the plant would not need to be staffed at night. The level of staffing required for each alternative is assumed to be the same, where alternatives requiring increased maintenance and replacement activities would be contracted as outside services. A list of assumed staffing needs is provided in Table 12.

Table 12. Preliminary Staffing List

Position	Number of Full-Time Employees
Director	1
Finance Manager	1
Administration Assistant	1
Procurement Supervisor	1
Project Superintendent	1
O&M Manager	1
Admin Asst / Data Mgt	1
Operator IV	2
Operator III	2
Operator II	2
Mechanic I	2
Electrician I	1
I&C Tech I	1
Utility worker	2
Total Positions	**19**

Cost assumptions for the OPEX costs are summarized in Table 13. These costs are not a complete list but represent the more significant consumable costs that provide differentiation between the alternatives.

Table 13. Operating Cost Assumptions for Each Treatment Method

Consumable	Conventional Treatment with Enhanced Coagulation	Membrane RO	Conventional with GAC
Energy	Energy consumption based on average flow for the full allocation and Farmer's Electric rate structure. Each alternative evaluated with and without renewable energy facilities.		
Chemicals	Chemical usage is based on average flow for the full allocation and max dose. Cost includes chemical delivery to the site.		
Membranes	N/A	Micro/Ultra Filtration membranes replaced every 7 years RO membranes replaced every 5 years	N/A
GAC Replacement	N/A	N/A	GAC media is replaced three times per year
Disposals	Solids removed and disposed of once per year	Solids removed and disposed of once per year (does not include brine concentrate salt disposal)	Solids removed and disposed of once per year
Salt Disposal	N/A	For solar evaporation ponds, salt is removed every 10 years For deep well injection, brine is disposed of 24/7	N/A

Maintenance costs include both preventive and corrective maintenance that is based on applicable CAPEX costs for process equipment and, where applicable, the sitewide allowances. It was assumed that outside services would be used for items such as specialized equipment maintenance, equipment rentals, fire protection system testing, HVAC (heating, ventilating, and air conditioning) service, high service electrical maintenance, renewable energy facility maintenance, landscape maintenance, herbicide application, and painting (refer to Appendix A for alternative cost assumptions).
A summary of maintenance costs and their percentage of equipment capital cost is shown in Table 14.

Table 14. Maintenance Cost Assumptions

Maintenance Discipline	Percentage of Capital Cost
Process Equipment	3.5
Mechanical	3.5
Electrical	1.5
Instrumentation and Control	3.5

Alternative Analysis Cost Summary

CAPEX and OPEX costs were used to determine the relative Wholesale Customer Rate for comparison purposes. Water rates for this analysis assume the full allocation of water rights are being used. Reduced flows will increase customer rates due to fixed costs. The following assumptions were used to develop the Wholesale Customer Rates:

- ENMWUA Share of CAPEX Cost = 10%
- CAPEX Debt Financing
  - Interest Rate = 1%
  - Administrative Fee = 0.25%
  - Loan Term = 30 years
- Annual Inflation Rate = 3%
- Ute Water Annual Fee = $25 per acre-feet
- ISC Ute Reservoir Annual O&M = $92,120

A summary of costs for each alternative showing CAPEX (for the WTP alternative and the remaining ENMRWS project), OPEX, and Wholesale Rate is provided in Table 15. The Wholesale Rate is provided in year 2023 and 2031 dollars using the annual inflation rate of 3%.

Overall, conventional treatment with enhanced coagulation has the lowest wholesale rate compared to other alternatives, which was expected due to lower CAPEX costs and electrical costs compared with other options and because salt disposal is not required. Conventional with GAC was the most expensive option, primarily due to frequent replacement and cost of the GAC media. Overall, renewable energy sources reduce the wholesale costs of each alternative despite higher capital costs.

Table 15. Summary of Capital, O&M, and Wholesale Rate Costs for Each Alternative

Cost Basis	Alternatives							
	1	1A	2	2A	3	3A	4	4A
	Conventional with Enhanced Coagulation	Conventional with Enhanced Coagulation (Renewables)	Membrane / RO / Injection Well	Membrane / RO / Injection Well (Renewables)	Conventional / GAC Adsorption	Conventional / GAC Adsorption (Renewables)	Membrane / RO / Solar Evaporation Ponds	Membrane / RO / Solar Evaporation Ponds (Renewables)
Water Treatment Plant Cost ($ Million)	$277.0	$282.7	$396.0	$407.5	$337.0	$342.8	$445.4	$456.9
Project Capital Cost (Year 2023) ($ Million)	$817.4	$844.4	$936.4	$969.2	$877.4	$904.5	$985.8	$1,018.6
Annual O&M Cost (based on 14.5-MGD AADF) (Year 2023) ($ Million)	$16.40	$13.40	$19.40	$15.90	$22.00	$19.00	$20.60	$17.10
Total Member Wholesale Rate (Year 2023) ($/1,000 gallons)	$3.75	$3.21	$4.40	$3.77	$4.84	$4.30	$4.66	$4.03
Total Member Wholesale Rate (Year 2031) ($/1,000 gallons)	$4.76	$4.07	$5.57	$4.78	$6.14	$5.45	$5.90	$5.11

Note:

AADF = Average Annual Day Flow

Decision Modeling Results

Non-monetary scoring shown in Table 11 determined that the Membrane/RO alternatives provide the highest benefit score. Non-monetary scoring is combined with 2023 Member Wholesale Rates from Table 15 to determine the option that has the highest benefit-to-cost ratio. For each alternative, the Wholesale Customer Rate was normalized against the highest rate, which was the Conventional with GAC alternative. The benefit score was divided by the normalized wholesale rate number to generate the benefit-cost ratio. A summary of normalized cost ratios and the resulting benefit-cost score for each alternative is shown in Table 16 and on Figure 6, where the BTA has the highest benefit score.

Results of the benefit-cost analysis show that the alternative with the best benefit-to-cost ratio is RO with Well Injection and renewables. Overall, the RO alternatives scored highest, followed by conventional with GAC, then conventional with enhanced coagulation. The conventional with enhanced coagulation alternative had the lowest costs overall. Regardless of the brine disposal option, the RO treatment process is the BTA for the WTP (injection wells and solar evaporation ponds for the RO brine are nondifferentiable in terms of benefit and cost).

Table 16. Summary of Cost, Benefit Score, and Benefit-Cost Ratio Results

Cost Basis	Alternative							
	1	1A	2	2A	3	3A	4	4A
	Conventional with Enhanced Coagulation	Conventional with Enhanced Coagulation (Renewables)	Membrane / RO / Injection Well	Membrane / RO / Injection Well (Renewables)	Conventional / GAC Adsorption	Conventional / GAC Adsorption (Renewables)	Membrane / RO / Solar Evaporation Ponds	Membrane / RO / Solar Evaporation Ponds (Renewables)
Project Capital Cost ($ Million)	$817.40	$844.40	$936.40	$969.20	$877.40	$904.50	$985.80	$1,018.60
Annual O&M Cost (Based on 14.5 MGD AADF) ($ Million)	$16.40	$13.40	$19.40	$15.90	$22.00	$19.00	$20.60	$17.10
Total Customer Wholesale Rate (Year 2023) ($/1,000 gallons)	$3.75	$3.21	$4.40	$3.77	$4.84	$4.30	$4.66	$4.03
Normalized Total Customer Wholesale Rate to Highest Rate	0.77	0.66	0.91	0.78	1.00	0.89	0.96	0.83
Benefit Score	2.07	2.07	3.93	3.93	3.40	3.40	3.93	3.93
Benefit-Cost Ratio	**2.67**	**3.12**	**4.33**	**5.05**	**3.40**	**3.83**	**4.09**	**4.73**

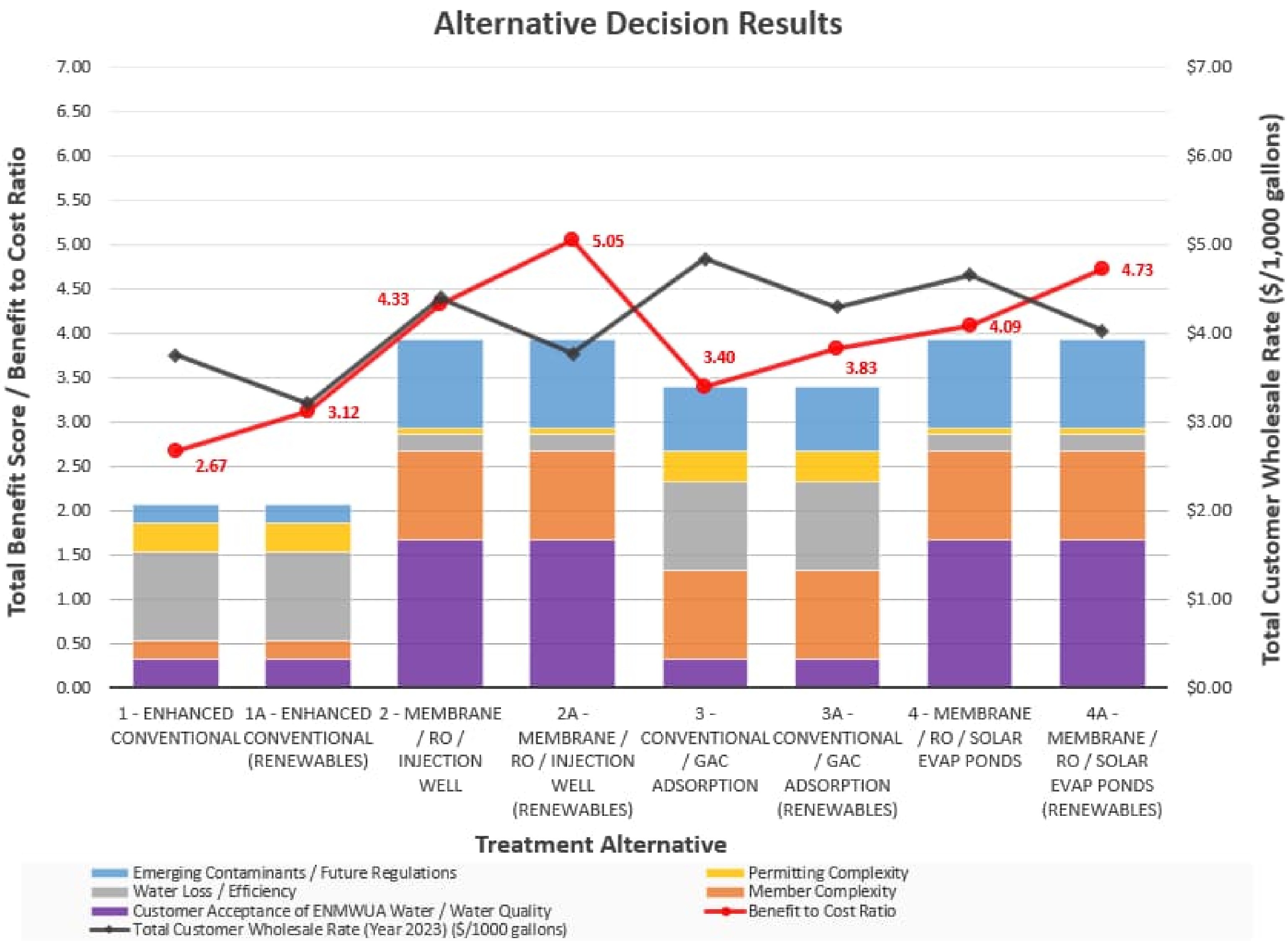


Figure 6. Benefit-Cost Ratios Shown in Red Compared to Wholesale Rate and Criteria Weighting

Sensitivity Analysis

A sensitivity analysis was performed to observe how the weighting of decision criteria impacted the benefit-to-cost ratio results. The first sensitivity analysis involved adjusting the criteria weighting where the voting results did not have a clear majority. For this scenario, the Water Loss / Efficiency and Member Complexity criteria weighting increased to 26.7%. The Customer Acceptance and Emerging Contaminants weighting decreased to 26.7% and 13.3%, respectively. This scenario still showed that the Membrane / RO alternatives provided the greatest benefit-to-cost ratios as shown on Figure 7.

To change the results of the alternative with the highest benefit-to-cost ratio, the Permitting Complexity and Water Loss / Efficiency criteria would have to be the two most important categories, both weighted at 25%, followed by Member Complexity and Emerging Contaminants with a 20% weight, and Customer Acceptance with a 10% weight.
This scenario would result in GAC with renewables having the highest benefit-to-cost ratio, shown on Figure 8.

This would contradict the Working Group opinions expressed at each workshop by making Customer Acceptance the least important criterion instead of the most important. This scenario seems unlikely due to the strong consensus on the importance of Customer Acceptance, Emerging Contaminants, and Member Complexity expressed by the Working Group at the workshops.

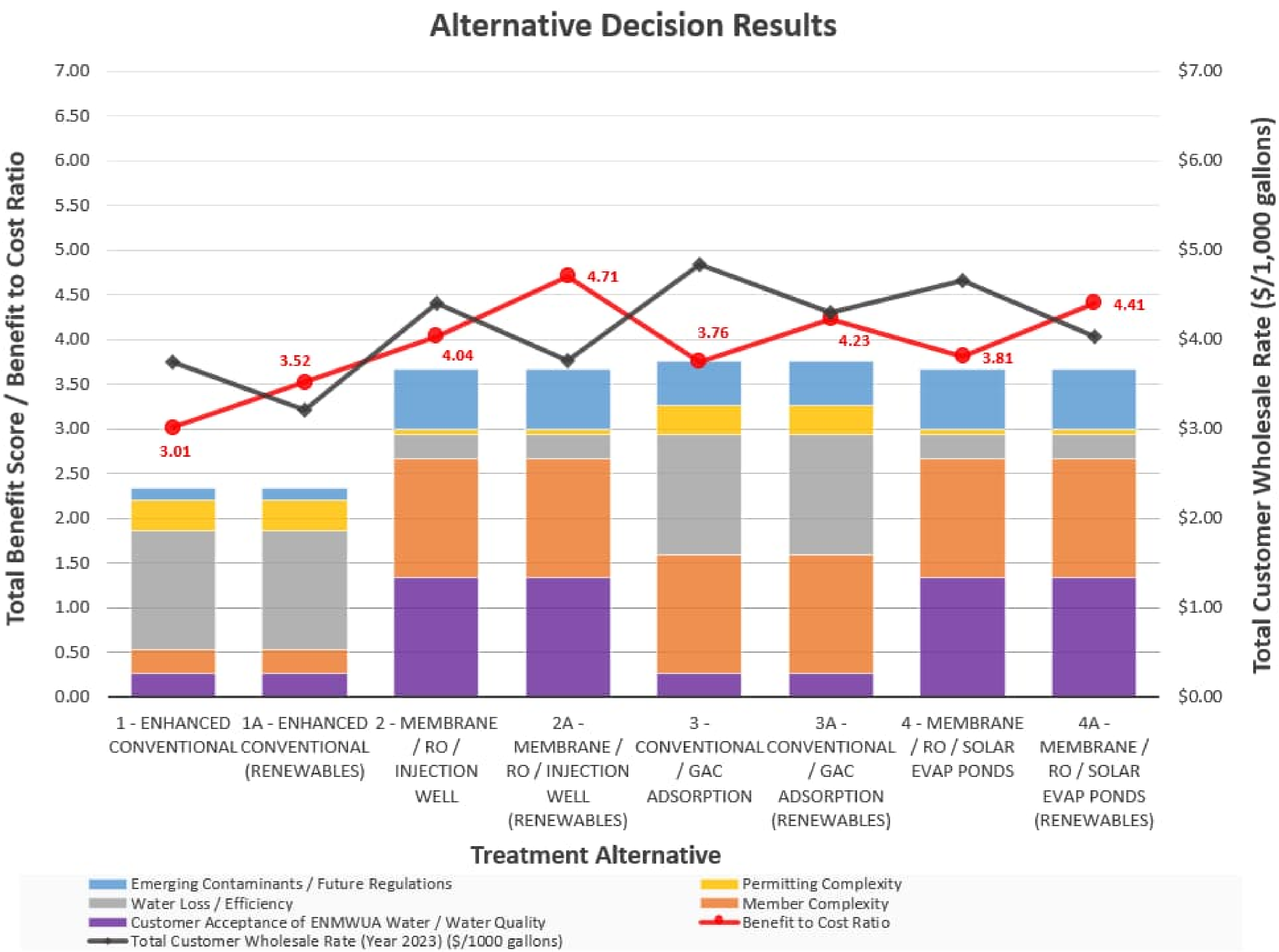


Figure 7. Sensitivity Analysis – Split Votes during Forced Ranking Process

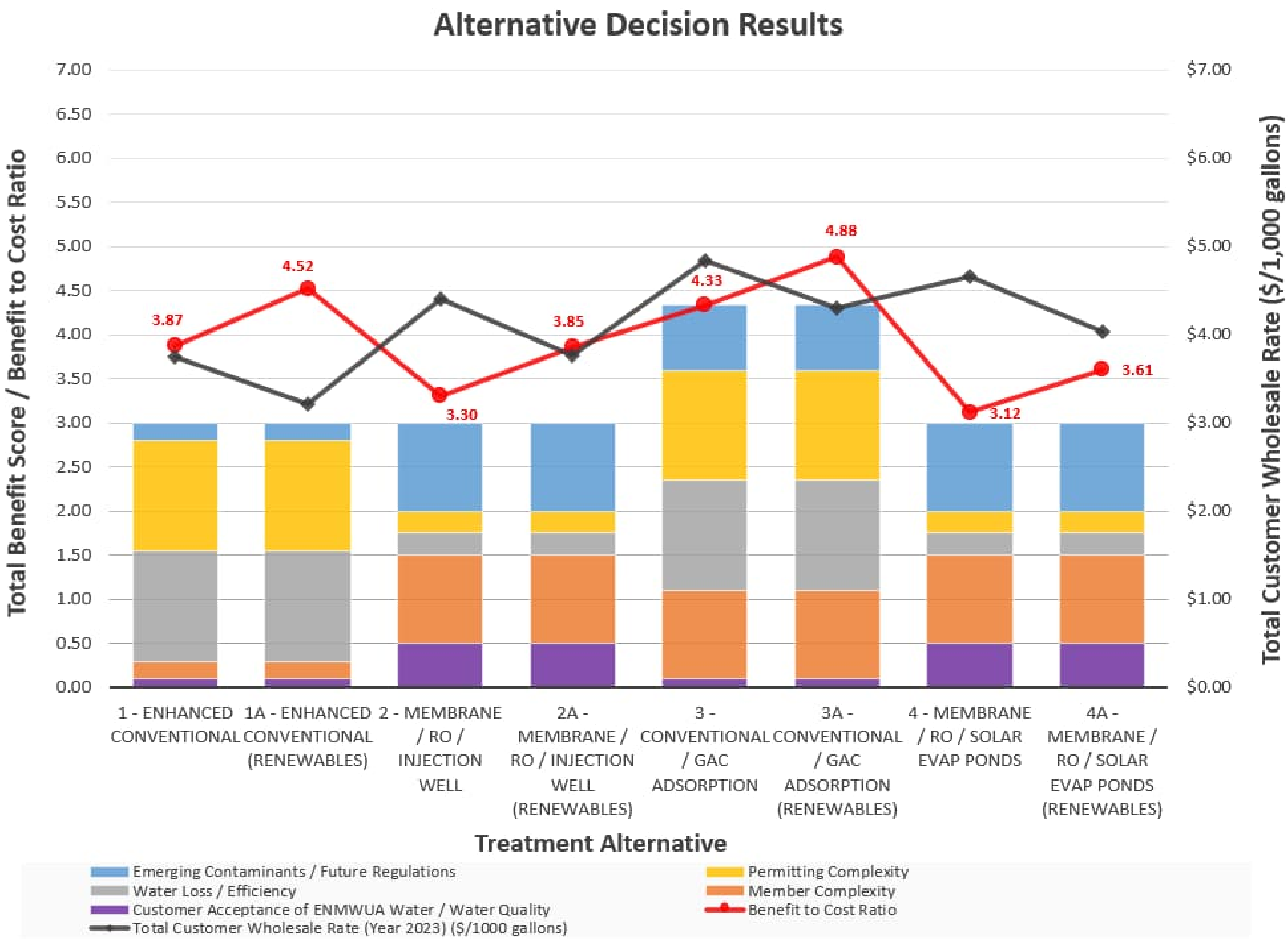


Figure 8. Sensitivity Results Showing Weighting Needed to Change the Results for the Highest Benefit-Cost Ratio

Conclusion and Recommendations

Based on the criteria weighting selected by the Working Group, the BTA is the RO membrane treatment with deep well brine injection and renewable energy. The next best alternative is RO membrane treatment with solar evaporation ponds. The Working Group's discussion about which alternative should be selected to move forward as the preferred treatment process resulted in a unanimous recommendation. On April 26, 2023, ENMWUA Board Members approved a motion to move forward with the treatment process including membrane filtration and RO with deep well injection for brine disposal, contingent upon the outcomes of the pilot treatment process testing and injection well investigation.

References

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Jacobs. 2023. Eastern New Mexico Rural Water System Source Water Quality Analysis.

U.S. Environmental Protection Agency (EPA). 2023. Proposed PFAS National Primary Drinking Water Regulation. https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas.

Appendix A
Detailed Alternative Cost Estimates

ENMRWS Project Cost Estimates for Treatment Alternatives Analysis

Alternative 1 - Conventional WTP with chloramine disinfection

Project Component Description	Construction Cost	Annual O&M Cost
Treatment Process Facilities		
Pressure Reducing Station	$1,930,000	$64,000
Rapid Mix	$1,168,000	$35,000
Flocculation	$4,087,000	$58,000
Sedimentation	$7,529,000	$207,000
Ozone Contactor and Generation	$9,066,000	$409,000
Filtration	$17,822,000	$474,000
Finished Water Tanks	$14,267,000	$66,000
Backwash Supply Pump Station	$3,211,000	$131,000
Sulfuric Acid Chemical	$2,047,000	$1,426,000
Ferric Chloride Chemical	$2,151,000	$1,129,000
Flocculant Aid Polymer Chemical	$380,000	$60,000
Filter Aid Polymer Chemical	$702,000	$24,000
Sodium Hydroxide Chemical	$2,309,000	$2,767,000
Sodium Hypochlorite Chemical	$966,000	$397,000
Sodium Bisulfite Chemical	$663,000	$33,000
Liquid Ammonium Sulfate Chemical - WTP	$647,000	$11,000
Liquid Ammonium Sulfate Chemical - Member Large	$928,000	$31,000
Liquid Ammonium Sulfate Chemical - Member Small	$2,143,000	$83,000
Backwash Waste Equalization Basin and Pump Station	$3,011,000	$34,000
Solids Drying Beds	$6,227,000	$488,000
Solids Recycle Pump Station	$1,178,000	$48,000
Operations and Maintenance Building	$2,397,000	$17,000
Subtotal Facility Construction / Annual O&M Costs	***$84,829,000***	***$7,992,000***
Additional Project Construction / Annual O&M Costs		
Overall Sitework (10%)	$8,483,000	
Plant SCADA and Control System (10%)	$8,483,000	$417,000
Overall Yard Electrical (10%)	$8,483,000	$417,000
Overall Yard Piping (10%)	$8,483,000	$417,000
Constructability Factor (1%)	$849,000	
Outside Services	-	$315,000
Laboratory Testing	-	$75,000
Operating and Employee Expenses	-	$100,000
Contractor Markups and Contingency		
Contingency (30%)	$35,883,000	-
Overhead (15%)	$23,324,000	-
Profit (7%)	$12,518,000	-
Mobilization, Bonds, and Insurance (3%)	$5,741,000	-
Total Construction / Annual O&M Costs	***$197,100,000***	***$9,800,000***
Variable Costs		
Permitting (2%)	$3,942,000	-
Engineering (12%)	$23,652,000	-
Services During Construction (12%)	$23,652,000	-
Commissioning and Startup (4%)	$7,884,000	-
Land Acquisition	$140,000	-
Total Variable Costs	***$59,300,000***	
New Mexico Gross Receipts Tax		
Taxes (8%)	$20,512,000	-
Total Capital and Annual O&M Costs	***$277,000,000***	***$9,800,000***

ENMRWS Project Cost Estimates for Treatment Alternatives Analysis

Alternative 1A - Conventional WTP with chloramine disinfection includes Renewable Energy

Project Component Description	Construction Cost	Annual O&M Cost
Treatment Process Facilities		
Pressure Reducing Station	$1,930,000	$64,000
Rapid Mix	$1,168,000	$35,000
Flocculation	$4,087,000	$58,000
Sedimentation	$7,529,000	$207,000
Ozone Contactor and Generation	$9,066,000	$409,000
Filtration	$17,822,000	$474,000
Finished Water Tanks	$14,267,000	$66,000
Backwash Supply Pump Station	$3,211,000	$131,000
Sulfuric Acid Chemical	$2,047,000	$1,426,000
Ferric Chloride Chemical	$2,151,000	$1,129,000
Flocculant Aid Polymer Chemical	$380,000	$60,000
Filter Aid Polymer Chemical	$702,000	$24,000
Sodium Hydroxide Chemical	$2,309,000	$2,767,000
Sodium Hypochlorite Chemical	$966,000	$397,000
Sodium Bisulfite Chemical	$663,000	$33,000
Liquid Ammonium Sulfate Chemical - WTP	$647,000	$11,000
Liquid Ammonium Sulfate Chemical - Member Large	$928,000	$31,000
Liquid Ammonium Sulfate Chemical - Member Small	$2,143,000	$83,000
Backwash Waste Equalization Basin and Pump Station	$3,011,000	$34,000
Solids Drying Beds	$6,227,000	$488,000
Solids Recycle Pump Station	$1,178,000	$48,000
Operations and Maintenance Building	$2,397,000	$17,000
Subtotal Facility Construction / Annual O&M Costs	***$84,829,000***	***$7,992,000***
Additional Project Construction / Annual O&M Costs		
Overall Sitework (10%)	$8,483,000	
Plant SCADA and Control System (10%)	$8,483,000	$417,000
Overall Yard Electrical (10%)	$8,483,000	$417,000
Overall Yard Piping (10%)	$8,483,000	$417,000
Constructability Factor (1%)	$849,000	
Outside Services	-	$315,000
Laboratory Testing	-	$75,000
Operating and Employee Expenses	-	$100,000
Contractor Markups and Contingency		
Contingency (30%)	$35,883,000	-
Overhead (15%)	$23,324,000	-
Profit (7%)	$12,518,000	-
Mobilization, Bonds, and Insurance (3%)	$5,741,000	-
Total Construction / Annual O&M Costs	***$197,100,000***	***$9,800,000***
Variable Costs		
Permitting (2%)	$3,942,000	-
Engineering (12%)	$23,652,000	-
Services During Construction (12%)	$23,652,000	-
Commissioning and Startup (4%)	$7,884,000	-
Land Acquisition	$140,000	-
Total Variable Costs	***$59,300,000***	
Renewable Energy Facilities		
Wind Turbine	$5,320,000	-$820,000
New Mexico Gross Receipts Tax		
Taxes (8%)	$20,938,000	-
Total Capital and Annual O&M Costs	***$282,700,000***	***$9,000,000***

ENMRWS Project Cost Estimates for Treatment Alternatives Analysis

Alternative 2 - Micro Filtration, Reverse Osmosis, Deep Well Injection

Project Component Description	Construction Cost	Annual O&M Cost
Treatment Process Facilities		
Membrane Filtration	$29,834,000	$2,114,000
Membrane Break Tank	$211,000	$1,000
Reverse Osmosis Pump Station	$5,145,000	$270,000
Reverse Osmosis Filtration	$26,560,000	$3,177,000
Air Stripper	$7,290,000	$393,000
Finished Water Tanks	$14,267,000	$66,000
Sodium Hypochlorite Chemical	$1,668,000	$921,000
Liquid Ammonium Sulfate Chemical	$594,000	$83,000
Ferric Chloride Chemical	$510,000	$48,000
Hydrochloric Acid Chemical	$6,863,000	$1,137,000
Sodium Hydroxide Chemical	$506,000	$34,000
Backwash Waste Equalization Basin	$1,230,000	$6,000
Deep Well Injection	$49,322,000	$2,366,000
Solids Drying Beds	$2,384,000	$85,000
Solids Recycle Pump Station	$1,299,000	$60,000
Operations and Maintenance Building	$2,397,000	$17,000
Subtotal Facility Construction / Annual O&M Costs	***$150,080,000***	***$10,778,000***
Additional Project Construction / Annual O&M Costs		
Overall Sitework (2.5%)	$3,752,000	
Plant SCADA and Control System (6%)	$9,005,000	$443,000
Overall Yard Electrical (8%)	$12,007,000	$590,000
Overall Yard Piping (6%)	$9,005,000	$443,000
Outside Services	-	$315,000
Laboratory Testing	-	$75,000
Operating and Employee Expenses	-	$100,000
Contractor Markups and Contingency		
Contingency (30%)	$55,155,000	-
Overhead (15%)	$35,851,000	-
Profit (7%)	$19,240,000	-
Mobilization, Bonds, and Insurance (3%)	$8,823,000	-
Total Construction / Annual O&M Costs	***$303,000,000***	***$12,800,000***
Variable Costs		
Permitting (2.5%)	$7,575,000	-
Engineering (8%)	$24,240,000	-
Services During Construction (6%)	$18,180,000	-
Commissioning and Startup (3%)	$9,090,000	-
Land Acquisition	$420,000	-
Pilot and Injection Well Testing	$4,000,000	-
Total Variable Costs	***$63,600,000***	
New Mexico Gross Receipts Tax		
Taxes (8%)	$29,328,000	-
Total Capital and Annual O&M Costs	***$396,000,000***	***$12,800,000***

ENMRWS Project Cost Estimates for Treatment Alternatives Analysis

Alternative 2A - Micro Filtration, Reverse Osmosis, Deep Well Injection with Renewable Energy

Project Component Description	Construction Cost	Annual O&M Cost
Treatment Process Facilities		
Membrane Filtration	$29,834,000	$2,114,000
Membrane Break Tank	$211,000	$1,000
Reverse Osmosis Pump Station	$5,145,000	$270,000
Reverse Osmosis Filtration	$26,560,000	$3,177,000
Air Stripper	$7,290,000	$393,000
Finished Water Tanks	$14,267,000	$66,000
Sodium Hypochlorite Chemical	$1,668,000	$921,000
Liquid Ammonium Sulfate Chemical	$594,000	$83,000
Ferric Chloride Chemical	$510,000	$48,000
Hydrochloric Acid Chemical	$6,863,000	$1,137,000
Sodium Hydroxide Chemical	$506,000	$34,000
Backwash Waste Equalization Basin	$1,230,000	$6,000
Deep Well Injection	$49,322,000	$2,366,000
Solids Drying Beds	$2,384,000	$85,000
Solids Recycle Pump Station	$1,299,000	$60,000
Operations and Maintenance Building	$2,397,000	$17,000
Subtotal Facility Construction / Annual O&M Costs	***$150,080,000***	***$10,778,000***
Additional Project Construction / Annual O&M Costs		
Overall Sitework (2.5%)	$3,752,000	
Plant SCADA and Control System (6%)	$9,005,000	$443,000
Overall Yard Electrical (8%)	$12,007,000	$590,000
Overall Yard Piping (6%)	$9,005,000	$443,000
Outside Services	-	$315,000
Laboratory Testing	-	$75,000
Operating and Employee Expenses	-	$100,000
Contractor Markups and Contingency		
Contingency (30%)	$55,155,000	-
Overhead (15%)	$35,851,000	-
Profit (7%)	$19,240,000	-
Mobilization, Bonds, and Insurance (3%)	$8,823,000	-
Total Construction / Annual O&M Costs	***$303,000,000***	***$12,800,000***
Variable Costs		
Permitting (2.5%)	$7,575,000	-
Engineering (8%)	$24,240,000	-
Services During Construction (6%)	$18,180,000	-
Commissioning and Startup (3%)	$9,090,000	-
Land Acquisition	$420,000	-
Pilot and Injection Well Testing	$4,000,000	-
Total Variable Costs	***$63,600,000***	
Renewable Energy Facilities		
Wind Turbine	$10,640,000	-$1,327,201
New Mexico Gross Receipts Tax		
Taxes (8%)	$30,180,000	-
Total Capital and Annual O&M Costs	***$407,500,000***	***$11,500,000***

ENMRWS Project Cost Estimates for Treatment Alternatives Analysis

Alternative 3 - Conventional WTP with GAC Adsorption

Project Component Description	Construction Cost	Annual O&M Cost
Treatment Process Facilities		
Pressure Reducing Station	$1,930,000	$64,000
Rapid Mix	$1,168,000	$35,000
Flocculation	$4,087,000	$58,000
Sedimentation	$7,529,000	$207,000
Filtration	$17,822,000	$474,000
Finished Water Tanks	$14,267,000	$66,000
Backwash Supply Pump Station	$3,211,000	$131,000
In-Plant Lift Station	$7,260,000	$287,000
Granular Activated Carbon Adsorption	$31,176,000	$9,241,000
Ferric Chloride Chemical	$2,151,000	$1,129,000
Flocculant Aid Polymer Chemical	$380,000	$60,000
Filter Aid Polymer Chemical	$702,000	$24,000
Sodium Hydroxide Chemical	$1,029,000	$508,000
Sodium Hypochlorite Chemical	$966,000	$397,000
Backwash Waste Equalization Basin and Pump Station	$3,011,000	$34,000
Solids Drying Beds	$6,227,000	$488,000
Solids Recycle Pump Station	$1,178,000	$48,000
Operations and Maintenance Building	$2,397,000	$17,000
Subtotal Facility Construction / Annual O&M Costs	***$106,491,000***	***$13,268,000***
Additional Project Construction / Annual O&M Costs		
Overall Sitework (10%)	$10,650,000	
Plant SCADA and Control System (10%)	$10,650,000	$523,000
Overall Yard Electrical (10%)	$10,650,000	$523,000
Overall Yard Piping (10%)	$10,650,000	$523,000
Constructability Factor (1%)	$1,065,000	
Outside Services	-	$315,000
Laboratory Testing	-	$75,000
Operating and Employee Expenses	-	$100,000
Contractor Markups and Contingency		
Contingency (30%)	$45,047,000	-
Overhead (15%)	$29,281,000	-
Profit (7%)	$15,714,000	-
Mobilization, Bonds, and Insurance (3%)	$7,206,000	-
Total Construction / Annual O&M Costs	***$247,500,000***	***$15,400,000***
Variable Costs		
Permitting (2%)	$4,950,000	-
Engineering (10%)	$24,750,000	-
Services During Construction (10%)	$24,750,000	-
Commissioning and Startup (4%)	$9,900,000	-
Land Acquisition	$140,000	-
Total Variable Costs	***$64,500,000***	
New Mexico Gross Receipts Tax		
Taxes (8%)	$24,960,000	-
Total Capital and Annual O&M Costs	***$337,000,000***	***$15,400,000***

ENMRWS Project Cost Estimates for Treatment Alternatives Analysis

Alternative 3A - Conventional WTP with GAC Adsorption with Renewable Energy

Project Component Description	Construction Cost	Annual O&M Cost
Treatment Process Facilities		
Pressure Reducing Station	$1,930,000	$64,000
Rapid Mix	$1,168,000	$35,000
Flocculation	$4,087,000	$58,000
Sedimentation	$7,529,000	$207,000
Filtration	$17,822,000	$474,000
Finished Water Tanks	$14,267,000	$66,000
Backwash Supply Pump Station	$3,211,000	$131,000
In-Plant Lift Station	$7,260,000	$287,000
Granular Activated Carbon Adsorption	$31,176,000	$9,241,000
Ferric Chloride Chemical	$2,151,000	$1,129,000
Flocculant Aid Polymer Chemical	$380,000	$60,000
Filter Aid Polymer Chemical	$702,000	$24,000
Sodium Hydroxide Chemical	$1,029,000	$508,000
Sodium Hypochlorite Chemical	$966,000	$397,000
Backwash Waste Equalization Basin and Pump Station	$3,011,000	$34,000
Solids Drying Beds	$6,227,000	$488,000
Solids Recycle Pump Station	$1,178,000	$48,000
Operations and Maintenance Building	$2,397,000	$17,000
Subtotal Facility Construction / Annual O&M Costs	***$106,491,000***	***$13,268,000***
Additional Project Construction / Annual O&M Costs		
Overall Sitework (10%)	$10,650,000	
Plant SCADA and Control System (10%)	$10,650,000	$523,000
Overall Yard Electrical (10%)	$10,650,000	$523,000
Overall Yard Piping (10%)	$10,650,000	$523,000
Constructability Factor (1%)	$1,065,000	
Outside Services	-	$315,000
Laboratory Testing	-	$75,000
Operating and Employee Expenses	-	$100,000
Contractor Markups and Contingency		
Contingency (30%)	$45,047,000	-
Overhead (15%)	$29,281,000	-
Profit (7%)	$15,714,000	-
Mobilization, Bonds, and Insurance (3%)	$7,206,000	-
Total Construction / Annual O&M Costs	***$247,500,000***	***$15,400,000***
Variable Costs		
Permitting (2%)	$4,950,000	-
Engineering (10%)	$24,750,000	-
Services During Construction (10%)	$24,750,000	-
Commissioning and Startup (4%)	$9,900,000	-
Land Acquisition	$140,000	-
Total Variable Costs	***$64,500,000***	
Renewable Energy Facilities		
Wind Turbine	$5,320,000	-$820,000
New Mexico Gross Receipts Tax		
Taxes (8%)	$25,386,000	-
Total Capital and Annual O&M Costs	***$342,800,000***	***$14,600,000***

ENMRWS Project Cost Estimates for Treatment Alternatives Analysis

Alternative 4 - Micro Filtration, Reverse Osmosis, Solar Evaporation Ponds

Project Component Description	Construction Cost	Annual O&M Cost
Treatment Process Facilities		
Membrane Filtration	$29,834,000	$2,114,000
Membrane Break Tank	$211,000	$1,000
Reverse Osmosis Pump Station	$5,145,000	$270,000
Reverse Osmosis Filtration	$26,560,000	$3,177,000
Air Stripper	$7,290,000	$393,000
Finished Water Tanks	$14,267,000	$66,000
Sodium Hypochlorite Chemical	$1,668,000	$921,000
Liquid Ammonium Sulfate Chemical	$594,000	$83,000
Ferric Chloride Chemical	$510,000	$48,000
Hydrochloric Acid Chemical	$6,863,000	$1,137,000
Sodium Hydroxide Chemical	$506,000	$34,000
Backwash Waste Equalization Basin	$1,230,000	$6,000
Solar Evaporation Ponds	$69,134,000	$3,360,000
Solids Drying Beds	$2,384,000	$85,000
Solids Recycle Pump Station	$1,299,000	$60,000
Operations and Maintenance Building	$2,397,000	$17,000
Subtotal Facility Construction / Annual O&M Costs	***$169,892,000***	***$11,772,000***
Additional Project Construction / Annual O&M Costs		
Overall Sitework (2.5%)	$4,248,000	
Plant SCADA and Control System (6%)	$10,194,000	$501,000
Overall Yard Electrical (8%)	$13,592,000	$668,000
Overall Yard Piping (6%)	$10,194,000	$501,000
Outside Services	-	$315,000
Laboratory Testing	-	$75,000
Operating and Employee Expenses	-	$100,000
Contractor Markups and Contingency		
Contingency (30%)	$62,436,000	-
Overhead (15%)	$40,584,000	-
Profit (7%)	$21,780,000	-
Mobilization, Bonds, and Insurance (3%)	$9,988,000	-
Total Construction / Annual O&M Costs	***$343,000,000***	***$14,000,000***
Variable Costs		
Permitting (2.5%)	$8,575,000	-
Engineering (8%)	$27,440,000	-
Services During Construction (6%)	$20,580,000	-
Commissioning and Startup (3%)	$10,290,000	-
Land Acquisition	$420,000	-
Pilot Testing	$2,000,000	-
Total Variable Costs	***$69,400,000***	
New Mexico Gross Receipts Tax		
Taxes (8%)	$32,992,000	-
Total Capital and Annual O&M Costs	***$445,400,000***	***$14,000,000***

ENMRWS Project Cost Estimates for Treatment Alternatives Analysis

Alternative 4A - Micro Filtration, Reverse Osmosis, Solar Evaporation Ponds with Renewable Energy

Project Component Description	Construction Cost	Annual O&M Cost
Treatment Process Facilities		
Membrane Filtration	$29,834,000	$2,114,000
Membrane Break Tank	$211,000	$1,000
Reverse Osmosis Pump Station	$5,145,000	$270,000
Reverse Osmosis Filtration	$26,560,000	$3,177,000
Air Stripper	$7,290,000	$393,000
Finished Water Tanks	$14,267,000	$66,000
Sodium Hypochlorite Chemical	$1,668,000	$921,000
Liquid Ammonium Sulfate Chemical	$594,000	$83,000
Ferric Chloride Chemical	$510,000	$48,000
Hydrochloric Acid Chemical	$6,863,000	$1,137,000
Sodium Hydroxide Chemical	$506,000	$34,000
Backwash Waste Equalization Basin	$1,230,000	$6,000
Solar Evaporation Ponds	$69,134,000	$3,360,000
Solids Drying Beds	$2,384,000	$85,000
Solids Recycle Pump Station	$1,299,000	$60,000
Operations and Maintenance Building	$2,397,000	$17,000
Subtotal Facility Construction / Annual O&M Costs	***$169,892,000***	***$11,772,000***
Additional Project Construction / Annual O&M Costs		
Overall Sitework (2.5%)	$4,248,000	
Plant SCADA and Control System (6%)	$10,194,000	$501,000
Overall Yard Electrical (8%)	$13,592,000	$668,000
Overall Yard Piping (6%)	$10,194,000	$501,000
Outside Services	-	$315,000
Laboratory Testing	-	$75,000
Operating and Employee Expenses	-	$100,000
Contractor Markups and Contingency		
Contingency (30%)	$62,436,000	-
Overhead (15%)	$40,584,000	-
Profit (7%)	$21,780,000	-
Mobilization, Bonds, and Insurance (3%)	$9,988,000	-
Total Construction / Annual O&M Costs	***$343,000,000***	***$14,000,000***
Variable Costs		
Permitting (2.5%)	$8,575,000	-
Engineering (8%)	$27,440,000	-
Services During Construction (6%)	$20,580,000	-
Commissioning and Startup (3%)	$10,290,000	-
Land Acquisition	$420,000	-
Pilot Testing	$2,000,000	-
Total Variable Costs	***$69,400,000***	
Renewable Energy Facilities		
Wind Turbine	$10,640,000	-$1,349,904
New Mexico Gross Receipts Tax		
Taxes (8%)	$33,844,000	-
Total Capital and Annual O&M Costs	***$456,900,000***	***$12,700,000***

Appendix B
Workshop Summaries

Alternative Analysis for the Eastern New Mexico Water Treatment Plant

Date:	January 18, 2023	Jacobs Engineering Group Inc.
Project name:	Eastern New Mexico Rural Water System	3721 Rutledge Road NE
Project no:	D3299319	Suite B-1
Prepared by:	Bryor Price	Albuquerque, NM 87109
Location:	Clovis, NM	United States
		www.jacobs.com

Participants:
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Mike Kasem (EPCOR)
Chad Talbot (EPCOR)
Tom Torres (EPCOR)
Durward Dixon (Town of Elida)
JT Walla (Cannon AFB)

The objective of this meeting was to discuss the purpose and process of the alternative analysis for the Eastern New Mexico Water Treatment Plant (ENMWTP). The meeting summarized different treatment methods and their impacts. The following summarizes discussion items as a result of the meeting held on January 18th, 2023, between Jacobs, Eastern New Mexico Water Utility Authority (ENMWUA), and member communities.

Item #	Item Description
1.	Project Overview a. Orlando Ortega provided and introduction and overview of the project highlighting that IIJA has allowed a large amount of funding to go towards infrastructure projects. b. Summary of each project segment was provided. c. Summary of projects that are funded for 2022/2023. Items are either being designed or constructed for each item.
2.	Alternative Analysis Objectives a. The goal of Alternative analysis is to provide ENMWUA Board with a decision process that considers non-monetary benefits and cost impacts and avoids the “gut” feel decision approach, focusing on data. b. Ensure that ENMWUA provides communities with a safe, quality water that customers want to consume. c. Ensure that ENMWUA provides a cost-effective water to communities. d. Ensure that ENMWUA is provided with a robust WTP process capable of meeting drinking water regulations and desired water quality goals e. Ensure that the WTP process provides ENMWUA and the Members with a system that is not complicated and cost effective to operate
3.	Alternative Analysis Decision Approach a. Define Project Alternatives b. Perform site visits of Facilities like the alternatives

Item #	Item Description

c. Define non-monetary decision evaluation criteria. For example, water quality, environmental, etc.
d. Determine method for scoring alternatives
e. Force rank evaluation criteria by importance
f. Develop capital and annual O&M costs for each alternative
g. Compare non-monetary benefits and costs for each alternative
h. Perform a sensitivity analysis on the non-monetary benefits
i. Select an alternative to proceed with on the Project
j. Orlando added that the purpose of this group is to make a recommendation to the ENMWUA Board. This presentation describes the initial layout. The people attending the meeting are important for making this decision.
   - Costs will still be evaluated as part of this analysis, but the goal is to avoid skewing the decision with cost alone. The analysis will also look at sensitivity to see how much of an impact each category has.

4. Background - Water Quality
   a. Water was not sampled between 2022 and 2005, and the water quality has changed since 2005.
      a. Sampling 5 times over the last year has been done to capture water quality events.
   b. TDS has increased beyond the EPA secondary limits. These limits don't have to be met and are more about aesthetics.
   c. Alkalinity and Total Organic Carbon will require a lot of chemicals to remove organics, which will add a large amount of cost.
   d. Sulfate & Chloride levels are higher, which contributes to a TDS increase
      a. Question: What is the cause of increases?
         i. Response: TDS concentrated in the lake. It should be noted there is a known brine aquifer downstream. Ute Reservoir has an outlet but is not required to release water downstream.
         ii. The lake level fills and drains through precipitation and evaporation, currently the lake level is much lower than when tested in 2005. TDS will not be removed from the water unless a treatment process is implemented. When water evaporates, the TDS concentrates.
         iii. Brine aquifers may be contributing to salinity, and it is something observed downstream.
      b. Orlando clarified that the Canadian River Compact allows Ute to store up to 200,000 acre-ft of water.
      c. Question: Would the ENMWUA project pulling water reduce the TDS?
         i. Response: Over time as TDS is pulled out of the reservoir, TDS would go down assuming that the reservoir fills with rainwater. The Canadian River has a salinity control project and they have been researching this since the 50s and 60s. Brine aquifers sit at the base of the dam, which contributes to salinity downstream. There may be some brine aquifers in the same area that contribute to TDS in Ute, but that is unconfirmed.
      d. Question: Where was sampling performed? Does it matter? Could it be concentrated lower in the reservoir?
         i. Response: Sampling happened at the surface since we can't get too far down into the lake. After talking to some experts, it seems unlikely that there is a "settled" portion of TDS in the lower regions of the lake. We should consider our current readings for TDS when designing and think about the likelihood of them changing.
      e. Question: Are there other customers?
         i. Response: No. 24,000 ac-ft is the agreement. Quay county has water rights included in that agreement, but they currently are not part of this project.

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	f. Question: How does that compare with GW? i. Response: TDS is on average 300 to 350 mg/L for ENM members. A couple wells have higher concentrations but on average is in the 300 mg/L range.
5.	Background: Water Quality and Treatment Discussion a. Convention treatment is a process/technology that has existed for decades. Conventional treatment is unable to remove salts like those found in TDS. b. Desalination is the only way to remove TDS. Reverse Osmosis the most likely treatment method for this option. a. Question: Isn't there a lot of waste with RO? What do you do with waste? **i.** Response: This will be discussed later in the presentation. This is a special challenge for inland waters.
6.	CRMWA a. CRMWA is a wholesaler of water to Lubbock & Amarillo among other communities, similar to the ENMWUA. b. They experience the same issue with Lake Meredith - High TDS, above 1000 mg/L. c. They have installed ground water wells to remove brine and use deep well injection to dispose.
7.	City of Amarillo a. Blend groundwater and surface water. Conventional treatment processes are very common in the west. a. Question: Is the Canadian River being fed by groundwater? i. Response: Yes, groundwater, rain, and likely some leakage from the dam. There are heavy storm events that feed these reservoirs. b. Texas has raised their secondary TDS standards, possibly due to these high TDS conditions.
8.	Lubbock a. Question: Where are they blending? Continue to rely on GW? a. Response: Blending depends on location and where entry points are. There are parts of the community that get different water quality than others. This is a challenge ENM members will also face. b. Question: What is the long-term plan in terms of sustainability? a. Response: It's unknown how long the groundwater will last. b. Orlando Ortega added that there should be caution about relying on blending to reduce TDS because of sustainability. c. There has been discussion about long term reliability on groundwater with Lubbock and CMRWA since they use the same aquifer. d. Note that 28 million gallons per day (MGD) is the peak demand. Looking at water data for the past 5-10 years, the annual average day flow rate is 9.8 MGD. Currently communities are not using what is available in the allotment.
9.	Alternatives - Conventional Process a. High TOC levels lead to concerns with requiring chloramine disinfection and ammonia facilities to support it. b. A typical ammonia facility would include a 55-gallon drum storage, piping, small metering pumping into the distribution system, electricity, tied into SCADA system c. Question: Where would sampling in system occur? a. Answer: Currently there are 6 to 12 monitor points or dead ends, in the EPCOR system d. Question: For the well sites would they continue gas? What is the balance? a. Answer: It is up to members if they want to get away from Chlorine gas, which is cheap. Shelf life is not an issue unless wells are off 2 years. e. EPCOR noted there would need to be additional structures to store equipment.

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	a. This structure would require containment and would be designed with secondary containment. f. Cost of Ammonia is slightly more expensive but will require small dosages. g. There are concerns about unintended consequences of changing the chemical makeup of the water. h. Nitrification is the big issue that needs to be considered. Flushing events are costly for EPCOR. i. EPCOR experienced this in the City of Portland. They didn't have to do a boil but did conduct a flushing event. j. EPCOR also noted older pipe and consequences for change of direction of flow of pipe. Will happen regardless of treatment. k. Overall, there may need to be increased monitoring or on-line monitoring

10.	Alternatives - Conventional Process
	a. Question: How often does filter media need to be replaced?
	    a. Response: GAC - 15 to 20 years.
	    b. GAC gets broken down over time and has to be replaced
	b. GAC can remove some TOC but not TDS
	    a. TOC is high considering other waters in the area.
	    b. Enhanced coagulation is needed to remove total organic carbon. This requires pH to be lowered, which requires use of hazardous acids.
	    c. Ozone is a disinfectant but helps with taste and color. It is a gas that is bubbled through the water.

11.	Chloramine Discussion
	a. Chloramine is an important factor in treatment since it will interact with existing disinfection. It maintains longer residuals. If the chloramine and chlorine are mixed it can impact taste and require flushing. It will require more maintenance and monitoring to keep chemicals in balance.
	    a. EPCOR noted that this is EPCOR's concern because there's up to 10 points of entry into EPCOR's system, which means they will be responsible for monitoring and maintaining. This will impact any place where chlorination occurs.
	    b. Some wells may require a small detention tank.
	    c. Currently EPCOR has 10 wells that go into the system
	    d. For Portales, the contact time will be at the tank. Chlorination is at the tank sites, so there are only two locations for Portales.
	    e. This method is more work for members.
	b. Question: What is the alternative to chloramine?
	    a. Response: Alternatives are discussed later on but in order to avoid chloramines additional TOC removal is required which would increase treatment costs.
	    b. 1.5 ratio of chlorine to ammonia. It's not too hard to mix but does require monitoring and maintenance.
	    c. Ammonia is a fairly expensive chemical, but members would not be using a lot of it. It will mean more monitoring to avoid nitrification.
	    d. Assume 6-12 monitors in EPCOR’s system at key locations where water blends.
	c. Question: Once surface water comes in can wells be turned off to accommodate that water?
	    a. Response: Ultimately that is up to the members to decide.
	d. Question: Do the extra chemicals require containment?
	    a. Answer: All chemical is in a tote or a drum.
	    b. Likely secondary containment with a pallet or similar for a leak.
	e. Question: If there isn't space, we would likely need to have a building to accommodate this?
	    a. Response: Yes

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- f. Question: is the cost of liquid ammonia sulfate is similar to chlorine?
  - a. Response: It's a bit higher, but you use a bit less.
- g. Question: Will changing the chemical makeup cause issues?
  - a. Response: The main concern is really nitrification.
  - b. Cannot afford to flush with the drought if this occurs.
  - c. There is not a risk of nitrification unless a demand comes into the system that pulls the chlorine out.
  - d. EPCOR mentioned that ammonia never dissipates, but chlorine does. Nitrifying bacteria wipe out chlorine. In Portland experience they had to do mass flushing.
  - e. If there is no chlorine residual in the water, there is risk of having bacteria.
  - f. Question: How does monitoring work?
    1. Answer: If ammonia levels are up and not maintaining chlorine residual- you may be required to flush.
    2. Ideally you see that chlorine residuals are maintained by monitoring them.
    3. Online monitoring would allow this to be watched, but this also comes with capital and maintenance costs.
- h. Question: Is this chlorine method mandatory?
  - a. Response: This is just one method of treatment, but there are other methods that will be discussed.
  - b. Goal is to be clear about everything that is involved in this.
  - c. The long detention time of the water plus the high organics level have been the reason that this process was selected.

12. Flow Diagram

- a. Most organic carbon is dissolved, so this won't be removed through filtration. Because particles are so small, coagulation can combine particles to remove.
- b. Drying beds – some utilities replace every year; some utilities wait up to 10 years
  - a. Drying beds are 4 acres each
  - b. Annually means there is not a massive lump payment you're not prepared for every 10 years.
  - c. Do not expect solids to be hazardous due to low radio nuclides
  - d. Question: Are there alternatives to solids treatment?
    - i. Response: These solids do not have many organics. There is iron, it's inert. There likely is not an alternate for iron-based coagulant.
- c. 900-1000 mg/L TDS is considered undrinkable as an industry standard.
- d. Question: Is there anything that can be added to the conventional facility that can treat TDS?
  - a. Response: RO can be added. Not all of it would be treated by RO, it would just be enough to meet the blending requirement.
- e. The water treatment plant will have to remove 25% of total organic carbon to meet drinking water limits, which is why coagulation is critical, and coagulation is impacted by alkalinity.
- f. Question: What manpower does it take to run the plant?
  - a. Response: If you man 24/7 you need a bare minimum of 5 operators. You would also need at least 6 managers, mechanics, engineers, electrical and instrumentation and control. Overall, 10 to 15 people.
  - b. Question: How is this different for RO?
    - i. Response: RO would not be much different with 10 to 15 people
  - c. There has been discussion on how to set up the facility to reduce the number of staff needed to run.

13. Pros and Cons of Conventional Treatment

- a. Question: Has a process been considered for using an air stripper instead of chloramine? Allowing DBPs to form and using air stripping at each delivery site to remove?

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	a. Response: Air striping works for TTHM but not Haloacetic Acids. b. One possible option is for the pipeline to be leveraged as a contactor. Keep chlorine at the plant low and use the pipeline for contact time b. Question: How many chemicals are needed on site? a. Response: Roughly 10 different chemicals on site. Some are used more, some less. b. Question: How are the larger chemicals stored? i. Response: Typically, there is a fill station outside of the building and staff will make sure they are hooked up correctly. There would need to be a person there to help with deliveries. c. Question: Lubbock has membrane facilities- is there an alternative? Is it just conventional vs RO or are there other options? a. Response: A micro filtration membrane plant can do a lot of what conventional can, but it cannot remove TOC or TDS. d. Question: Is there anything that could be added to the conventional to help with TDS? ○ Response: RO is really the only option to remove TDS. • Question: Is there talk about using excess water for recharge? ○ Response: This has not been a part of the project. ○ Member communities can do what they wish with their water.
14.	Alternatives - RO Process a. Question: There's talk of significant electrical power- can you do solar power? a. Response: Wind is an option and the best based on analysis. Wind has a 7-10 year payback where solar has 28 year payback depending on the electrical demand charges. b. Question: Which plant was looked at when considering the renewables? Who operates? i. Response: Renewables were based on the conventional plant. The operation could be contracted out. b. Microfiltration will not remove organics. Lubbock is using this because of different chemical makeup in lake water. c. Note that pH is not lowered for the RO process. d. The amount of water sent through RO is based on the level of TDS decided. RO removes everything, which means that alkalinity still needs to be added back in when re-blended. e. TOC should be considered when you are looking at blending. f. Question: What is the TDS leaving RO? a. Response: Essentially 0, so blending is what brings up TDS b. To reach 500 TDS, this would equate to roughly half of the water needing to be treated by RO. c. Question: Is the blending adjustable? i. Response: Yes d. You can reduce TOC with RO blending, this can lower TOC down to not needing Chloramine g. Question: Can adjustments be made to operation over time? a. Response: Yes h. The water treatment plant can start with fewer RO modules and build out as needed by adding modules. i. Waste is approximately 5% going through the whole plant. j. Question: Is the brackish water feeding the Canadian River? a. Response: Yes, studies have shown yes. This research has been happening since the 60s. k. EPCOR noted that the safety aspect for operators is a pro for RO. l. EPCOR noted that taste complaints are currently low.

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	a. Some people will taste it, some will not. With the conventional plant, all TDS will move through.
	m. Current water in ENM tastes good, when anything different is introduced, it will be noticed.
	n. Aesthetics are a concern- if RO can address this, it is a win.
	o. Drinking water regulations will be more stringent in the future.
	p. Conventional will be less costs to the Authority and more to distributers. There is payment one way or another. Complaint of water quality versus complaint on cost.
	q. One goal should be to educate the community so that they can be aware of what to do to deal with water quality.
	r. For the CRWA facility there is about 300 gallons per minute (GPM) into well with continuous flow.
	    a. Deep injection well will be about 4,000 ft deep.
	        i. These wells have risk because they are so deep.
	s. Evaporation ponds require a lot of space. This would be 15,000 tons of salt solids that would need to be disposed of.
	t. Question: Are there records of deep well injection in the area other than the CRWA?
	    a. Response: Will find out after conversations with the state.
	u. Question: Is Zero Liquid Discharge an option?
	    a. Response: This would just add more cost and energy.

15.	Groundwater Blending
	a. Question: Should there be a model without blending with GW?
	    a. Response: Seems like a good idea to consider this.
	b. Orlando Ortega said groundwater will blend with surface water.
	    a. GW will not be abandoned; it will continue to be used as long as it is available. There will be a balance of both, eventually surface water will be dominant.
	    b. Question: What does hardness do to the existing wastewater plant?
	        i. Response: No issues. TDS at the plant is already over 1000 mg/L
	        ii. There are also no issues with reuse.

16.	Site Visits
	a. The goal of site visits is to understand the difference between membrane and conventional plants.
	b. Lubbock has both membrane and conventional and can be a day visit
	c. Jacobs can design conventional and RO treatment plants
	    a. Consider how the constituents will receive the water, will they be pleased with how money has been spent? The goal is to have an A+ rating the year after water is being delivered.
	    b. Surface water is more expensive and that is the reality. That is why we want to focus on non-cost factors before adding cost back in.
	d. Lubbock uses Chloramine, which may make it more appealing for a site visit.
	e. Looking for a date that can accommodate as many people as possible.

ENMWUA Treatment Process Decision Criteria & Cost Assumptions Workshop

Date:	March 16, 2023
Project name:	Eastern New Mexico Rural Water System
Project no:	D3299319
Prepared by:	Bryor Price
Location:	Clovis-Carver Public Library, Clovis NM
Participants:	Orlando Ortega (ENMWUA) Bryor Price (Jacobs) Wendy Christofferson (Jacobs) Jim Honea (Jacobs) Steve Alt (Jacobs) Dave Grigsby (Jacobs) Allie Arning (Jacobs) Chris Bryant (City of Clovis) Justin Howalt (City of Clovis) Jim Lucero (City of Portales) John Desha (City of Portales) Chris Cordova (City of Portales) Mark Huerta (EPCOR) Mike Kasem (EPCOR) Chad Talbot (EPCOR) Tom Torres (EPCOR) Tawnya Toft (EPCOR) Jon T. Walla (Cannon AFB) Brian Carr (Cannon AFB) Sara Newton (Cannon AFB) Loea Morgan (Cannon AFB) Brian Daly (Cannon AFB) Max Carter (City of Texico) Jerry Johnson (City of Texico)

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This workshop has two major objectives; 1) establish and weight the decision criteria to be used for evaluating non-financial benefits of each alternative, 2) Discuss the assumptions used to generate the CAPEX and OPEX costs for each of the alternatives.

Item #	Item Description and Notes
1.	**Introductions and Review of Treatment Process Decision Objective** A. A total dissolved solids (TDS) change from 720 mg/L in 2005 to 1100 mg/L in 2022 triggered a review of water treatment process. B. This alternative analysis will be data driven. C. The goal is to have safe, quality and cost-effective water for the communities. D. Ensure that the treatment process is robust and reliable. E. Question: is the water quality data available to folks in the room? a. Response: yes, a tech memo should be complete by the end of the month that summarizes results. F. The goal of this workshop is to define the non-monetary decision criteria and weight the importance of the selected criteria. G. Review of water quality a. Currently the reservoir has PFOS and PFOA below the advisory limits. b. Question: Was this a one-time sample event? Are these averaged results? i. Response: These show the range of results over 4 sampling events.

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	c. Due to the concentrations of organic carbon present in the source water, a chloramine disinfection approach would be required with conventional treatment. d. Mr. Ortega added that the conventional treatment method has not been ruled out, but we need to look at TDS levels. e. A third treatment option of conventional with granular activated carbon (GAC) adsorption was considered to mitigate the need to go to a chloramine system. i. This would be needed if the group chooses to not go forward with removing TDS and if chloramine disinfection was not desirable.
2.	**Review of Treatment Alternatives**

A. RO Pros and Cons

a. If the RO process is chosen, the injection well would require a "test hole" to meet permitting requirements.

b. Discussions with the state indicate that they do not feel a pilot plant is required with membranes, but piloting would still have benefits to optimize design criteria.

B. Background on Conventional Treatment originally looked at in 2006

a. RO treatment was originally ruled out due to cost in 2006.

b. Enhanced coagulation was selected for treatment process in the 2006.

c. Conventional treatment generates a large amount of solids.

d. Alkalinity has increased significantly, which means that more chemicals would be needed to reduce the water pH for the enhanced conventional process.

e. Question: What is the anticipated flow?

i. Response: 28 million gallons per day (MGD).

ii. The price of chemicals has increased greatly since 2006.

f. To achieve a finished water goal of 2 mg/L of total organic carbon (TOC), it would be difficult with a conventional process without adding a lot of chemicals to remove the necessary amount of TOC, which may not even be achievable based on previous bench scale testing.

g. Question: Where does the waste go?

i. Response: TOC goes to a solids drying bed, it gets settled out in the process.

h. Mr. Ortega mentioned the tour of the City of Lubbock conventional water plant and a new membrane water plant.

i. The membrane plant is 15 MGD, and the conventional plant has a capacity of 70 MGD.

ii. Currently they blend ground water and surface water to reduce TDS concentrations.

i. Question: What has contributed to the change in the water quality?

i. Response: Water testing was last performed in 2005. The reservoir is at a lower level, this may be why there is a higher concentration. Right now, Ute Lake may be a worst-case scenario with the low levels.

1. There is no discharge requirement out of Ute Lake. The rise and fall of levels are due to rain and evaporation.

ii. Question: Could modeling be performed to predict quality such as TDS?

1. Response: The reservoir is mostly supplied by rainwater. However, it would be time consuming to gather the data necessary to model the reservoir water quality with any confidence.

2. When researching why this might have increased, we found the salinity control project by the Canadian River Municipal Water Authority (CRMWA), which has been studied since the 1960s. There are brine aquifers downstream of Ute Reservoir, so this may be a contributing factor to TDS in the lake.

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iii. The plan now is to continually sample the source water annualy to see how the water quality changes over time.

j. EPCOR mentioned that they would want to plan for the worst-case scenario.

k. Question: With a conventional plant- what happens if water quality gets worse?
   i. Response: Conventional will not do anything for removing TDS. TDS is not a health concern, but it is a quality/taste concern for customers.

l. Question: How flexible can the plant be designed?
   i. Response: The conventional process will never treat the TDS, but it will meet safe drinking water quality standards as long as chloramines are used to prevent Disinfection By-products (DBPs). However, PFOS and PFOAS may be an issue in the future, and these cannot be removed through a conventional treatment process.

m. Overall, RO is much more flexible. It can prevent the need to use chloramines.

n. Steve Alt added that RO is flexible on the Lithium side also. The RO plant could be adapted in the future. There would potentially be a need to tighten the membrane, but that is a flexible option.

o. Question: Is the 70% RO split based on 28 MGD?
   i. Response: Yes, this is with blending a 70% split to get TDS down regardless of flow. If TDS improves, we still need RO to remove TOC.

p. If RO were the chosen process, a pilot study could help determine the ideal levels for bypass and chemical addition. Look at feeding Powder Activated Carbon (PAC) upstream of the WTP and using the raw water pipeline as a contactor to remove TOC. The crux of the RO is brine disposal. Anti-scalant is used to prevent scaling of the membranes. The vendor has been doing bench testing, the pilot testing would take us beyond bench testing.

q. Question: Have you spoken to the state about brine injection? Are they receptive?
   i. Response- Yes, this could be acomplished. Now that NMED has primacy, NMED has not permitted one of these Class I injection wells on their own, so this would be their first. We are assuming we would follow EPA guidelines which would require a test hole. CRMWA has a Class I injection well, it can inject 250-300 gpm, which would be the kind of flow our process would need. This shows it is capable nearby.

r. Note that there would need to be more than one well if one needs to get shut down for repair or other reasons. Currently the analysis is assuming 4 injections wells.

s. When construction was done on the injection well for CRMWA Salinity Control Project they had issues with a collar and think they poured concrete down to the bottom of the injection well where they hit the granite wash formation, when the drilling rig hit the granite wash, the drilling rate increased, which would imply that formation would have greater porosity and could potentially accept larger volumes of brine for disposal. Maybe a horizontal lateral would be better than a traditional vertical well. A test hole would be required to confirm this data.
   i. Question: Are there any abandoned fracking wells?
      1. Response: They may not be constructed in the way that would allow EPA to dispose, but there are not any in the area based on available data.
   ii. Question: When you say the state is receptive, who are you talking about specifically?
      1. Response: Speaking with Melanie Sandoval- she would be responsible.
   iii. Question: Has Melanie spoken with the chief?
      1. Response: Yes, likely based on our conversations. This will still require permitting but it is feasible.
      2. One if not all of the wells would probably be on the treatment plant site.

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t. CRWMA injection well probably has a brine worse than that anticipated for the ENMRWS. The concentrate that we would be injecting would have less TDS. CRWMA is the in 50,000 mg/L range and we are in the 15-20,000 mg/L range.

   i. CRMWA put steel casing in their well and are having corrosion issues. These concerns could be mitigated from a construction standpoint.

u. If this group were to recommend the RO method, it would be contingent on deep well injection working. We would not move forward with a system selected if it was not shown to work.

C. Conventional with GAC process and no enhanced coagulation

a. For this process this addition of sulfuric acid would not be required and ferric chloride would only be fed as a coagulant. Sodium hydroxide would be added, but much less than with an enhanced conventional plant. The most notable difference is that GAC adsorption would be used to remove TOC.

   i. Assuming GAC is replaced 3 times a year to get 70% TOC removal. This would require pilot testing to confirm GAC exhaustion rates.

b. Question: What is the waste associated with GAC Adsorption?

   i. Response: There is virtually no water waste with this alternative. However, the GAC media will require replacement, maybe every week to a month rotating through each of the contactors. GAC can be regenerated, but eventually there will be a waste product of GAC media.

c. Question: How does this media replacement compare to RO?

   i. Response: RO membranes require replacement every 5 years. MF/UF membranes require replacement every 5 to 7 years.

   ii. Lubbock MF/UF membranes manufactured originally by Memcor have never been on the Jacobs short list due to the issues that they have had. The two top membranes on our short list are made in Japan. We would avoid manufacturers who have had known failure issues. The design membrane systems use to be very proprietary, with proper design flexible racks can be built such that alternatives manufacturers can be accommodated.

d. Clarification alone would provide about 15% TOC removal in a conventional process, which is why GAC would need to be changed so much to remove the remaining TOC. GAC adsorption would be applied post filtration.

e. Question: What are the disadvantages of GAC Adsorption?

   i. Response: The main disadvantage to GAC Adsorption is the continual replacement of the media.

f. Question: For RO, 70% of the total flow is treated? Why is this not the same division for GAC?

   i. Response: 100% water goes through GAC. Over time the media adsorption capacity degrades, so there would be a staggered replacement where new ones are 100% effective and others are less, so it would be combined total removal.

g. Question: Is it cheaper to replace carbon than membranes?

   i. Response: Probably not. But costs are still being developed. This would require a significant amount of GAC media. This route would also require pilot testing to confirm GAC exhaustion rates. This alternative would also need an in-plant pump station, the plant flow must be lifted to allow for gravity flow through the GAC contactors.

h. Question: What would be needed for upgrading and maintaining the plant? Which one would we want to deal with 30 years from now?

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	i. Response: Some plants can last for 50 years, at least structurally. From a robustness standpoint, RO is the best bet to meet future regulations. Conventional treatment can't meet newer contaminants of concern. i. Question: Why not put only 70% of water through GAC? i. Response: GAC does not have a 100% removal efficiency like RO, so blending is not feasible. As water passes through the new GAC media the effectiveness of the media will degrade as particles are binding to the media. A pilot study would help determine how long GAC would last. j. Question: How do you make sure you get preferred suppliers? Is this limited to the Buy America Build America (BABA) act? k. Response: Many of these companies have suppliers in America. i. Or equal is stricter on Bureau projects, but if they are just providing funding, they are more flexible. This may just be a waiver process. l. Question: How was Buy America Build America handled in the past? i. Response: Shortlist who we want, BABA can cause an issue where we would need early procurement. 1. This could be a discussion on piloting different kinds of RO membranes. m. It was noted that concrete and facilities in Lubbock still looked good- some tight piping design would be avoided. n. The membrane plant had one operator in Lubbock but it was likely designed for more. o. Question: Are there GAC systems available to tour? i. Response: There are GAC facilities in New Mexico that could be toured. Rio Rancho has pressure GAC filters. Not much different than a typical gravity filter, but there is not sand. You can use pressure vessels but looking at the calcs there would need to be 34 so it might not make sense. a. Staffing would be similar between conventional and RO plants. Potentially different staff but similar numbers. There would likely be the same number of operators. Staffing for the GAC alternative would likely need to be increased. b. Question: Why was Lubbock trying to figure out their plant? i. Response: This was because membranes were failing, likely because of the manufacturer. When talking to them about the plant prior to the failures, they were happy with the plant. c. Question: What did Lubbock do with their MF backwash? i. Response: It goes to an equalization pond and gets recycled to the head of the treatment plant. d. Question: Was the MF plant used to treat all contaminants? i. Response: No, it could not treat TDS and PFAs. Only RO can remove TDS. e. Question: Is Lubbock blending for flavor? i. Response: They blend surface and ground water as needed. ii. If they didn't blend they may have a TDS problem. iii. CRMWA uses most of their groundwater to blend down TDS in Lake Meredith. What they can do with groundwater is different than ENM, they have access to more groundwater. iv. CRMWA continues to purchase water rights, they have a 100-200 year water supply. f. Question: Consider using submerged membranes?

Item #	Item Description and Notes
	i. Response: submerged membranes are much more difficult to clean. When encased, the volume around the membranes is controlled and reduces chemical needs. It used to be favored but is not now. g. There are not a lot of issues with turbidity, mostly organics for Ute water.
3.	**Discuss and Establish Decision Criteria and Scoring Methodology** A. Note that the ideal number is 5-6 criteria that are meaningful and capture benefits that cost will not account for. B. Water Quality Criteria a. For TDS we are looking at taste factor. Customers will need replace water heaters and valves. This is more than just how it tastes. What is being saved up front is being passed down to customers one way or another. b. Going to chloramines is a difficult sell to customers. Currently they already have problems with water heaters and water stains. Chloramine disinfection will require public education. c. There would be equipment sitting for years before use. The quality of water is important for operators. We don't want people to water their yards and salty water. d. Question: Can treatment match what is already existing? How will it be blended with existing water quality? WQ is becoming an issue in some areas i. Response: Yes, RO treatment can closely replicate the groundwater quality with a few exceptions. e. Can we agree that having water quality is a critical criterion to include? i. Yes ii. Yes, but this criterion should extend beyond TDS, like PFAs. 1. Note that TOC has an impact of member complexity. Water quality can be reflected in different criteria. iii. Yes, water quality is important and will impact local community water reports. iv. Scale and buildup will increase and impact the system f. After weighting, each criterion will be scored. There needs to be a meaningful/quantifiable way to score criteria. TDS concentration can achieve this. g. Question: Is the concentration of TDS a meaningful way to score this criterion? i. Response: Yes, the group agreed with this scoring methodology. C. Member complexity and the impacts to existing Member community operations by changing to a chloramine disinfection approach. a. Public perception is an important part of this whole process- switching to Lake water will cause issues regardless of what is selected due to the change. b. Question: Cost is related to all of this; how do we separate? i. Response: When we look at changing to chloramine disinfection, we don't know how exactly this will impact the system. This is monetary, but we don't know what the actual cost to each community is, that is not a part of the ENMWUA scope. ii. The Water Authority will pay for the chloramine system, but the operations and maintenance of the chloramine facilities will be the responsibility of the Member communities in addition to increased monitoring and staffing, and potential infrastructure to support this change. c. RO removes alkalinity, but even with a 70% split , blended water will add back enough to have robust alkalinity. d. Question: Has anyone looked at the risk of making the switch with alkalinity?

Item #	Item Description and Notes
	i. Response: At the alkalinity levels we are anticipating it would likely not be an issue. 1. Looking to treat to -0.3 Langelier index, but this can be adjusted. 2. Groundwater currently is +0.2 index for Portales. e. Question: If we stick to conventional, alkalinity will be very similar to what is currently in the system? i. Response: Yes, the alkalinity will be similar to current groundwater conditions. f. Question: Is it fair to say we want a member complexity component? i. Response: Yes, absolutely. ii. Scoring is essentially a pass/fail for whether or not chloramine disinfection is required , but the complexity varies by member. 1. Response: The criteria generally reflects the impacts on the communities. This impact will come out in criteria weighting. If the criteria is weighted higher, it will have a bigger impact on the scoring. iii. Adding these facilities and paying for operation over time will be felt by rate payers. 1. There may be even more small things like adding instrumentation for monitoring or fixing dead ends. These would be one-time costs. 2. All members pay based on allocations. Clovis pays more because they have more customers. It should balance out based on the number of rate payers. It will be on members to pay for additional chemical and labor costs. 3. Internally members would need to model to see where these disinfection additions would be needed. iv. Question: How are we ranking? 1. Response: It depends on if high score or low score wins. It's assumed that systems without chloramine would score better. v. Installing these improvements might not make customers happy. vi. Confidence in the water from the community. Water will be the most expensive utility we deliver; we need to get it right the first time. 1. Response: A new water is being brought into the system, so there will be impacts. For instance, moving water another direction for first time might have issues. This specific criterion focuses on chloramine. vii. It's not apples to apples on population, for instance Texico is way more impacted because they need more facilities per capita. viii. Overall Chloramines can be used to capture member complexity based on a pass/fail scoring method. D. Water loss and Efficiency- water lost through the treatment process. With chloramines there may need to be flushing to prevent a nitrification event which would also waste water, but this is hard to quantify. GAC would have the least amount of water loss. a. Question: What is the water loss for RO? i. Response: The water loss for RO is 7% of what is treated through the RO process. b. Question: What is the loss of the 28 MGD? i. Response: 1.5 MGD lost- this is for peak flow. For a conventional plant, the only loss is from solids which is essentially zero. c. This criterion is also a big deal for public perception. d. There will be waste no matter what.

Item #	Item Description and Notes
	e. Question: What is the loss for a conventional plant? i. Response: It's minimal. The solids drying bed/filters would lose water through evaporation. f. Question: How often do you need to change out sand in the solids drying bed/filters? i. Response: Can be replaced every 5 years depending on solids removal. It does need to be replaced over time. g. Question: Does everyone agree that water loss is a criterion that should be on the list? i. Response: Yes. ii. EPCOR: Flushing is going to be needed for conventional without GAC if chloramine is used. This perception would be worse compared to injection, because the public will witness the flushing. h. How does this group want to quantify this criterion considering flushing? i. Consider a pass/fail? Focus on the plant only. ii. Flushing due to nitrification has a direct relation to the treatment process. iii. Question: How much water is wasted in a softening unit? 1. Response: Water softeners are a customer choice. iv. There will be flushing that needs to occur regardless of chloramines. v. Question: With conventional vs. RO, is there one that is a bigger impact to customers, and one is bigger impact to the Authority. Is there consideration for flushing? 1. Response: No, because it is difficult to quantify. 2. EPCOR: Chloramine is an operational challenge. vi. Question: How often do facilities need to flush relative to what would be wasting? 1. Response: It's important to keep water moving. In the winter when they are not moving a lot of water, which is when they need to flush. It's hard to quantify because it is so system dependent. vii. Question: Where do they flush to? 1. Response: the ground surface and storm sewer systems. viii. Looking at worst case scenario if they had to flush, it would be a public perception issue. ix. Question: Water will be provided to Portales for 30 miles will it stagnate? 1. Response: Water will be moving through the transmission line constantly. At low flows it doesn't have as much detention time, approximately 1.5 days. 2. The Langelier Saturation index can be adjusted. x. This criteria scoring will be based only on water loss through the treatment process and will not reflect water loss as a result of flushing. E. Public Perception and Permitting a. This should be two separate issues. Permitting is on the Authority. b. Question: Who on the Authority is responsible? i. Response: Orlando Ortega. c. These permits must be maintained constantly, when each permit is issued it could be different from the previous, which is a risk. d. Permitting will be an issue if going with the RO alternative, which would open things up to the public. e. Question: Is permitting complexity and brine disposal risk part of the same criteria?

Item #	Item Description and Notes
	i. Response: The surface water permitting is the same, the scoring method is based on additional permits required. f. Question: Are permit cycles similar for injection wells and plant? i. Response: The injection wells will require additional permitting. The plant will only require additional permitting if the process is changed. g. Question: How long are injection well permits good for? i. Response: Typically 5 years. h. Permitting has changed significantly for CAFB. i. They may be stricter due to their situation. The state is monitoring ground water quality, but not a well that is 6,000 ft into the ground. i. Based on information on Caprock, formations get deeper as you go south. It's about 6,000 ft to get to the granite wash formation. j. Injection wells create a significant risk if that is the preferred alternative. k. Regardless of treatment decision, public education is a critical component of this process. It will change customer water, so public needs to understand. Make sure the public understands this will not be injecting into the aquifer, and it will not have an impact to their drinking water. l. Public perceptions crossing a lot of different topics, so keeping that in mind, public perception should be considered when weighting because it covers so many criteria. There needs to be differentiation in scoring, to keep the criteria mutually exclusive and prevent double counting the benefits of an alternative. m. Question: How is scoring done for this criteria? i. Response: Based on discussions a pass/fail approach if injection wells are required or not. n. The great thing is that there is a well just like the one that this would be operating to the north of the plant for CRMWA. o. Question: Is it fair to have permitting and brine disposal risk as its own category? i. Response: Yes ii. RO will get the same score twice, so that's why it should be combined. iii. We are trying to not double-count things or stack against one option or another. Therefore we avoid having too many criteria. p. Permitting complexity and brine disposal risk should be lumped together - reword risk of performing injection. q. The Group agrees to remove Option E because it has been accounted for elsewhere. r. The permitting complexity criteria will be scored by a pass or fail if brine disposal injection wells are required or not. F. Future Regulations a. When PFAs testing technology gets better the regulatory limit could change and be reduced to initial advisory levels. i. Backlash of cost and impact to all communities may prevent this decrease in limits from changing too much, but it's difficult to know what the EPA will do in the future. ii. Adapt to emerging contaminants in the future is important. b. RO is likely the best option for this approach due to its flexibility. Conventional can't treat these emerging contaminants. c. General consideration for the group: How much capital investment due you put in now for something that may or may not happen in the future? d. Could this category be changed to adaptability?

Item #	Item Description and Notes
	i. Response: For any of these plants, RO could be added on the back end. So, they are technically adaptable. e. Right now, there is funding- 75% is funded. This is the one shot these communities have to implement a treatment process that can guarantee for future regulations. f. Question: Would it be fair to use the removal percentage of PFAs to score for this criterion? i. Response: Yes, this is what we know of now. G. Operational complexity- This category could likely go away a. This would be on the Authority's side of the meter. All we need to look at is operational cost. This could go away. b. Question: Move to remove this category? c. Response: Yes, this is captured in the monetary part of project. i. Robustness of the treatment facility could impact water quality if members needed to suddenly rely on wells. Example, in Arizona TSS increases suddenly. 1. Response: These plants would be robust; they will not be designed on the ragged edge and will have redundancy. They are also pulling off a lake and not a river where water quality changes are buffered by volume. ii. Question: Is there enough distance for whatever settling to happen in the lake? 1. Response: turbidity will tick up with increases in flow, the plant can handle this. It will need chemical adjustments. The RO and membranes may be more robust because it doesn't require a chemical adjustment. iii. Question: Is reliability and robustness worth considering for conventional? 1. From a WQ standpoint yes, but solids would increase with increased source water turbidity. There would likely not be a turbidity increase that would require a shut down. iv. There is likely not enough differentiation between the alternative to have this as an option- this will be removed. H. Safety a. There will be exposure to dangerous chemicals with all alternatives, the quantities of the chemicals will be different, but they will still exist. Safety will be designed into the systems. b. The plants visited are well designed and maintained. c. There are more injuries from mechanical issues than there are with chemical in one person's experience. d. Question: Which treatment plant can provide the greatest amount of flow? What's the turn-down ability. i. Response: The treatment plant and conveyance system will be capable of turning down to 5 MGD. e. The ENMWUA has a contract for 16,415 acre-feet of water reserved in Ute Reservoir. Just because we have a certain amount allocated doesn't mean it will be available during drought years. f. Question: What is the demand today from members? g. Response: It averages to about 9.8 MGD for everyone. The allocation average annual day flow is 14.65 MGD. i. Communities have been doing a great job with conservation. ii. Community was aware there would potentially be drought.

Item #	Item Description and Notes
	iii. There will be a blending of groundwater and surface water as long as groundwater is available. h. Group agreed to delete safety and operational complexity criteria. I. Other Discussion a. RO is likely the future for communities that experience high TDS. b. RO is often not considered due to power costs, but ENM is in a great location for renewables. c. Renewables will be included in the cost for all alternatives. d. Project Schedule i. RO would delay the ultimate design, but it may not have an impact on the actual project schedule. ii. Not worth worrying about +/- a year for the design of the treatment plant. e. Community confidence is being rolled into customer acceptance.
4.	**Force rank to Establish Decision Criteria Weighting for Importance** A. Is Criteria A (Customer Acceptance / Water Quality) - is more important than Criteria B (Member Complexity). **a. Group agreed that Criteria A was more important that Criteria B.** B. Is Criteria A more important than Criteria C (Water Loss / Efficiency)? a. **Group agreed that Criteria A is more important than Criteria C. However, this is a criteria the needs to be included in the sensitivity analysis if the vote was in favor of Criteria C.** C. Is Criteria A more important than Criteria D (Permitting Complexity)? **a. Group agreed that Criteria A is more important than Criteria D.** D. Is Criteria A more important than Criteria E (Emerging Contaminants / Future Regulations)? **a. Group agreed that Criteria A is more important than Criteria E.** E. Question: Can we explain the member complexity criteria? a. Response: Chloramine issue. There will be water loss no matter what happens. Member complexity is EPCOR's second most important criteria over water quality. F. Is Criteria B more important than Criteria C? **a. Group agreed that Criteria B is more important than Criteria C. However, this should be factored into the sensitivity analysis.** b. Chloramine monitoring and metering is all a part of non-monetary benefits. c. Will need to make sure members understand chloramine disinfection and may not understand why flushing occurs. d. Question: What is the industry standard for treating similar water? i. Response: For water systems with similar water and quality it is often blending as seen in Texas, but that may not always be viable for ENM. ii. It doesn't matter if water meets the standard or not, it needs to be palatable. e. Members will have to respond to the state about water rates. f. An example is Amarillo, which does not treat their high TDS. This all comes down to cost. The cost component is not seen as much due to funding from the feds and the state. Renewable energy also helps with the energy cost. i. Generally, RO loses due to costs, but because of benefits and ability to fund the project, it is viable. g. This is member water that will be provided to communities so there needs to be a defensible approach. The point of these workshops is to instill confidence in the selected treatment process.

Item #	Item Description and Notes

	G. Is Criteria B more important than Criteria D?
	  a. **Group agreed that Criteria B is more important than Criteria D.**
	H. Permitting is a hurdle that can be overcome.
	I. It all comes back to if customers will accept the water.
	J. Most voted that member complexity is more important than permitting complexity.
	K. Initial vote for member complexity vs. future contaminates was close to even
	  a. Since these are both going to go for RO, future regulations were selected as more important.
	L. Is Criteria B more important than Criteria E?
	  a. **Group agreed that Criteria E is more important than Criteria B. However, this should be included in the sensitivity analysis**
	M. Is Criteria C more important than Criteria D?
	  a. **Group agreed that Criteria C is more important than Criteria D.**
	N. Is Criteria C more important than Criteria E?
	  a. **Group agreed that Criteria C is more important than Criteria E. However, this should be included in the sensitivity analysis.**
	O. Is Criteria D more important than Criteria E?
	  a. **Group agreed that Criteria E is more important than Criteria D.**
	P. It should be noted that permitting complexity is not impacting, most feel permitting is inevitable so it's not as important. It happens one way or another.
	  a. Group agreed that each criteria should get at least one vote in determining the weighting percentage.
	A. Member complexity is going to be an issue no matter the treatment process selected.
	B. Consider renaming future regulations as emerging contaminants.
	C. CAFB believes that water loss should be higher.
	  a. Water loss will not impact reservoir.
	  b. The reservoir loss is cyclical and fills and empties regularly.
	  c. Trying to save water and use it best.
	  d. CAFB has changed the story for the Ute pipeline as a way to add to their water portfolio, but not banking on it supplying their complete water needs.
	    i. The pipeline will have water, but it was never expected to provide all the water to all the communities, it's always been a supplemental supply of water.
	  e. EPCOR made the point that at some point in the future, wastewater effluent will likely need to be treated and used for potable supply. At some point we are going to need to treat this water, so it makes sense to remove as much of the contaminants as possible up front.

5.	Wrap Up A. These alternatives will be looked at over 25 years operational period. B. A follow up workshop will be held on March 28th, to review the scoring of the decision criteria, cost estimates, and decision results including a sensitivity analysis. C. The goal is to come to a consensus on the path forward to the treatment plant and bring that decision to the board in the same week, on March 30th. D. CAFB mentioned that they don't allow contractors to add the "what-if" factor regarding potential changes in the future. a. Portales responded that we don't know what will happen, but we need to have the ability to adapt and treat regulations that are occurring right now, for example PFAs.

Item #	Item Description and Notes
	i. The point of this criteria is about if the conventional treatment plant is selected and criteria changes. It's a "what-if" but also a real reality that is being discussed. E. The goal of this process is to look at finding the best system for everyone, and bottom line is being efficient with funding and cost will benefit the members. If the water isn't being treating at the front end, then the members will have to deal with it. F. Question: When is the treatment plant supposed to be built? a. Funding would be available in 2026. G. The ISSC feels confident the ENMWUA could pull 24,000 acre-ft/year and keep it healthy. It's not as low as it has been before. ENM can hold 200,000 acre-ft in the reservoir. a. This study was updated 3-4 years ago. There will be drought years where the water taken will be limited. H. Funding has been going well over the last few years. Three grant agreements have been signed with the USBR. The money will be distributed over a 5-year period. $160 million dollars of funding plus $17.4 million was added, then the state of NM added $30 million. Keeping costs down will prevent from borrowing a lot more money, the members have borrowed $47 million. I. Second year of allocation received $94.6 million, and now working towards 3rd year. The aim is to provide water by 2031.

Selected Decision Criteria and Scoring Methodology

ID	Criteria Name	Criteria Description	Scoring Methodology
A	Customer Acceptance of ENMWUA Water / Water Quality	- Alternative's ability to meet all of the NMED drinking water regulations for Primary and Secondary MCLs. - Customer complaints and satisfaction with the taste of their water. - Scale and hardness buildup impacts to existing customers valves, hot water heaters, staining, etc.	Finished Water TDS Concentration (mg/L) (LOW SCORE WINS)
B	Member Complexity	- Alternatives impacts on ENMWUA Member system operations and the need for a chloramine disinfection approach. - With Chloramines there will likely be added costs to the member community operations that is not reflected in the cost estimates.	Chloramine Disinfection Required or Not (0=Not Required, 1=Required) (LOW SCORE WINS)
C	Water Loss / Efficiency	- Alternative's ability to minimize water loss and waste. - Water will be lost through brine disposal. - Water will also be lost intermittently through distribution system flushing to prevent nitrification events for chloramine disinfection.	Treatment Process Water Efficiency Percentage (HIGH SCORE WINS)
D	Permitting Complexity	- Alternatives impact on permitting the brine disposal injection wells. Potential for permitting requirements to change over time. - This criteria also accounts for inherent risk of the brine disposal injection wells.	Brine Disposal Injection Wells Required or Not (0=Not Required, 1=Required) (LOW SCORE WINS)
E	Emerging Contaminants / Future Regulations	- Alternatives ability to treat future contaminants of concern (PFAs, Lithium, ????). - Note: How much does the ENMWUA want to plan for the future and try to forecast these regulations.	Treatment Process Removal Percentage of PFAs (HIGH SCORE WINS)

Decision Criteria Ranking and Weighting

		A	B	C	D	E		
	Criteria	Customer Acceptance of ENMWUA Water / Water Quality	Member Complexity	Water Loss / Efficiency	Permitting Complexity	Emerging Contaminants / Future Regulations	Number of Responses	Weighting Percentage
A	Customer Acceptance of ENMWUA Water / Water Quality	A	A	A	A	A	5	33.3%
B	Member Complexity		B	B	B	E	3	20.0%
C	Water Loss / Efficiency			C	C	C	3	20.0%
D	Permitting Complexity				D	E	1	6.7%
E	Emerging Contaminants / Future Regulations					E	3	20.0%
							15	100.0%

ENMWUA
EASTERN NEW MEXICO WATER UTILITY AUTHORITY

Selection Committee Decision Criteria and Alternative Cost Estimate Assumption Workshop

Clovis Carver Library, Ingram Room
701 N. Main Street, Clovis NM, 88101
Thursday, March 16, 2023 – 8:30 am

Sign In Sheet

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Sign In Sheet

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Selection Committee Decision Criteria and Alternative Cost Estimate Assumption Workshop

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Thursday, March 16, 2023 – 8:30 am

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ENMWUA
EASTERN NEW MEXICO WATER UTILITY AUTHORITY

ENMWUA Treatment Process Decision Criteria & Cost Assumptions Workshop

Date:	March 28, 2023
Project name:	Eastern New Mexico Rural Water System
Project no:	D3299319
Prepared by:	Bryor Price
Location:	Clovis-Carver Public Library, Clovis NM
Participants:	Orlando Ortega (ENMWUA) Bryor Price (Jacobs) Wendy Christofferson (Jacobs) Jim Honea (Jacobs) Steve Alt (Jacobs) Dave Grigsby (Jacobs) Allie Arning (Jacobs) Chris Bryant (City of Clovis) Justin Howalt (City of Clovis) John Desha (City of Portales) Chris Cordova (City of Portales) Mark Huerta (EPCOR) Mike Kasem (EPCOR) Chad Talbot (EPCOR) Tom Torres (EPCOR) Tawnya Toft (EPCOR) Jon T. Walla (Cannon AFB) Jeff Davis (Cannon AFB) Durward Dixon (Elida) Sara Newton (Cannon AFB) Chris Castillo (Cannon AFB)

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This workshop has three major objectives; 1) Review the results of the non-monetary benefit scoring from the previous workshop, 2) Review the CAPEX and OPEX costs for each of the alternatives, 3) Discuss the preferred best technical alternative based on the decision modeling results.

Item #	Item Description and Notes
1.	**Alternative Analysis Objective and Approach**

A. A Summary of analysis objectives was provided.

B. Orlando noted that the board will not be making a decision about the treatment process this week but will discuss the current standing of the Alternative Analysis.

C. Ute Reservoir will be a different source water, which will cause changes no matter what is selected. This analysis will focus on the alternatives and criteria related specifically to treatment.

D. Question: There is a great deal of brine disposal with Reverse Osmosis (RO)- will that get put back into the ground?

   a. Yes, deep well injection is one option and evaporation ponds are the other option.

   b. Question: where does the salt go if solar evaporation ponds were used?

      i. The salt is not hazardous, so it would be trucked to a landfill if evaporation ponds were used.

   c. Question: How much brine/rejection water would be disposed?

      i. At the peak flow of 28 million gallons per day (MGD) 1.5 MGD of brine would be disposed. On an average annual day basis, the brine disposal flow would be 0.75 MGD.

      ii. Injection wells would be drilled to about 6,000 feet to avoid any aquifers. These would likely be located on site with the water treatment facility. The CRWMA is currently doing this nearby, so this option is feasible.

E. Alternative Decision Evaluation Guidelines

Item #	Item Description and Notes

a. A summary of criteria and ranking was provided.
b. Scoring is pass/fail for chloramine disinfection based on if it is needed or not for a given treatment method.
c. Question: What loss is associated with the conventional treatment process? Would water needed for chemical feed involve loss? What about water in the solids process?
    i. Response: In a conventional plant water loss occurs at the solids drying beds. An underdrain system would be used with the solids system to recover as much water as possible.
d. Emerging contaminates may occur sooner rather than later. This water treatment plant is the one-shot Eastern NM communities have to build a reliable surface water treatment system. It’s important to consider what can impact the process in the future.
    i. Question: For the solar evaporation ponds- are they covered? Is PFOS/PFOA removed from that water?
        1. The solar evaporation ponds are not covered.
        2. If brine is injected via deep well, then it won’t be seen again. If you remove PFOS where does it go?
            a. If injected, all contaminates in the water will remain underground. For salt generated via evaporation ponds, landfills will contain the salt with any contaminates.
        3. The PFOS/PFOA levels are not too high in Ute Reservoir water. The Environmental Protection Agency (EPA) issued a 4 ng/L limit and Ute was in 1.9-3 ng/L range, which is below the threshold but still close to the limit.
    ii. Question: Has CRWMA had any pushback on the contaminates going in the injection well?
        1. Response: No. The water is also not being treated for consumption, just to remove salinity from the groundwater influencing the Canadian River downstream of Ute Reservoir.
        2. Using a deep injection well is encapsulating the water forever.
        3. Is the dried salt considered hazardous waste?
            a. Response: Generally, it is only considered hazardous if radio nuclides are in the water. There are projects where salts must go to special landfills. For this project, the salt would not be considered hazardous.
            b. Contaminates from the water are contained either way via landfill or deep well injection.

F. Criteria Weighting
    a. Initial weighting will be reviewed as decided in the last workshop where the criteria were force ranked against each other by the Selection Committee, then we will look at changing the analysis to see how it changes the results. Note that permitting did not receive a vote, it was considered the least important criterion.
    b. Jacobs does not have a preference on the treatment plant. This is the decision of the community; Jacobs can design any preferred plant.

G. Scoring
    a. Scores for each criterion were normalized from 1-5 with 1 as the worst and 5 as the best.
    b. All individual benefit scores are multiplied by the weight of the criteria.
        i. Overall, looking at benefits only, RO has the highest benefit score.
    c. Questions: It seems like the injection wells should be a higher risk- is that reflected?

Item #	Item Description and Notes
	i. Response: This was captured in the permitting criteria, which was not voted for. Right now, it only carriers a 6.7% weighting importance, which is why it does not have a high impact. d. Question: We discussed piloting of the well, and if shown that RO is not viable, will we not do it? i. Response: If any of these options are shown to not work, then that process will not be selected. RO and deep well injection are very likely feasible, but a pilot will tell us if it is feasible at the site. There is a lot we can learn from piloting, and it can help us optimize the treatment process.
2.	**Cost Analysis**

A. Cost estimates are rated as Class IV. The cost analysis includes a 30% contingency.
   a. A 90% design level is what it takes to get to a Class I estimate.
   b. Updated quotes were received for major process equipment.
   c. These numbers are for comparing alternatives and may not match the detail shown in the recent cost estimate updates, these costs will change in the future as the design criteria is finalized.
   d. The analysis is shown in 2023 dollars.

B. Detailed annual Operation Expenditures (OPEX) costs include all operations and maintenance and employee expenses.
   a. All costs shown assume the full allocation of water is being used.
   b. Question: Does this include sustaining costs and capital replacement costs? VFD replacements? Pump replacements?
      i. Response: We are not including larger replacement fund costs. You can start saving this money now, but ultimately rate payers today are benefiting someone tomorrow. This approach still needs to be confirmed with the ENMWUA and the Members as the approach to water rates are finalized.
      ii. Normally equipment has an end of life. In good planning, you plan to replace the plant and borrow money to pay for it. The Water Authority does have a replacement fund, but it’s not big enough to pay for those large replacements.
         1. Note it’s important to consider this replacement cost for moderate replacement projects to avoid funding.
         2. Brine injection wells are carrying a replacement contingency due to the risk associated with them. If the committee wants to look more into these we can, but it is hard to predict. This evaluation will happen before a rate is established.
         3. The cycle of replacements does not end, everyone is paying for the next replacement.
         4. The Water Authority does have an asset management fund. How this fund is established will be determined when the approach to rate development is established.
      iii. Question: Was GAC replacement factored in for this analysis?
         1. Response: Yes, three replacements per year were assumed.
         2. Was Ion Exchange Resin (IER) evaluated as an option?
            a. That option was not looked at, but costs would be like GAC.
            b. The IER process produces a brine that requires disposal, but much less than the reverse osmosis process.
   c. Question: Are some of these employees assumed wearing multiple hats?

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i. Response: The assumption is that there may be some people on contract for specific work. For membrane replacement, that work could be contracted, and some could be done in house. This is just a rough estimate of staff, additional staff could be required depending on the operational plans.

ii. How many facilities need to be weeded? How many remote sites need to be maintained?

1. The current count of staff is assuming unmanned operation at night with remote monitoring. An additional operator could be added for contingency. Mechanics and I&C could pick up shifts. The total number will change, but this was just a bare minimum assumption.

iii. Question: Is a Level 3 operator going to be needed?

1. It's assumed there would be a Level 4 operator. It will need to be factored in on what it takes to bring in a operator and what the rate needs to be. The issue is getting people to stay long enough to be a Level 4 operator.
2. There will probably need to be more operators to make the size of this system work.
3. It is difficult to keep people working on a 24-hour operation. The longer people stay with you the better they get.

iv. What may require additional people is the addition of GAC. For now, the staffing is not creating much differentiation between the different treatment alternatives.

v. Some roles were combined where it made sense if someone is only doing a specific job, for example, only 30% of the time.

d. This list of employees covers the entire system.

e. Solids handling assumes hauling once a year.

f. Question: This means the wind turbines are about $5 Million?

i. Yes, roughly. We looked at US made turbines assuming $1.4 million per Mega-Watt of generation.

ii. Will these be tied into the grid? Do we pay the cost to tie into the grid? Understanding this is a substantial cost.

1. Yes, the renewables will be tied into the grid and the Water Authority pays for the costs to get power to the sites, and yes this has been factored in.
2. There will need to be additional investigation on not interfering with military with wind turbine and communications.

g. One of the downsides to the GAC system is that it is volatile in pricing. It could go up and down, especially since it easier to implement as a treatment option for PFOS/PFOA compared to RO. GAC does not have brine disposal, only disposal of GAC that has reached full adsorption.

i. Brine disposal is included in the annual O&M costs, injection well operation, repair, and maintenance.

ii. A detailed breakdown of cost assumptions will be provided with the Alternative Analysis Report.

iii. Question: How is the $8 Million GAC factored and $3 Million for disposal?

1. Both of these costs are factored into the Annual O&M costs, they are based on GAC usage and the operations of the injection well.

iv. Question: Does GAC require much more labor than RO? Who does the labor, is the media replacement contracted out?

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1. Response: It depends on the approach. It may make sense to contract based on the amount that will need to be replaced. You can regenerate, but it doesn't come back as good as new. There are options, but the assumption is replacement with new GAC each time.
2. Someone will be cycling through a GAC contactor every couple of weeks to a month.
3. There would likely be a regeneration contract with the supplier that would have a change out process.

h. Question: What is the long-term sustainability of GAC?
    i. Response: Not sure. GAC is effective treatment, so there will be a demand for it.

i. Membranes are not reusable and are typically disposed of in a landfill, but they last much longer than GAC would. Contaminates do not stay on a membrane, but they do adsorb to GAC. GAC must be replaced so that there is more space for contaminants to be removed.

j. The area required for solar evaporation is 50-60 acres. This area would require 50-60 misters. This would be about the same amount of area for the injection wells, and HDPE liners are expensive.
    i. Question: If you must run continuously, how do you turn off the misters?
        1. Response: For high winds, turn off the misters. There would be capacity to turn off misters and allow plant to keep flowing.
    ii. Concern for birds hanging out near the ponds. There are bird repelling systems and a wind detection system to turn off misters automatically.
    iii. Misters produce a lot of horsepower, like the injection wells.
    iv. How deep do the ponds need to be?
        1. About 6-ft deep, this results in about 17,000 tons of salt a year at the full allocation flow. This is why O&M costs are higher for this option.
        2. HDPE can hold up with UV. Overtime they will eventually fail but can last up to 35 years.

k. A pilot plant could explore GAC to confirm assumptions on GAC usage.
    i. Would the test hole for the injection well be drilled at the WTP location?
        1. Response: The test hole would not allow injection. The test hole just confirms the formation, which is a much easier permitting process versus a test well.
        2. We could go further and apply for a test well to see exactly what could be injected, but the formation data will be necessary regardless. Details on how best to approach the injection well permitting process will be explored if that option is selected.

l. Question: Can you use the test hole to inject?
    i. Yes, it depends on how you set it up. It depends on the permitting process. We will be required to do a test hole to confirm formations.
    ii. The test well would be a smaller diameter than what is needed. The actual casing would be 8-10 inches in diameter.

m. It's important to know how much the formation would accept to see if it's a viable option.

n. The permeate would be combined with the brine and put back in the lake for pilot testing. This would need to be further investigated as a possibility.
    i. Piloting disposal would be a challenge. Could possibly work with CRMWA.
    ii. The pilot testing brine flow would be about 3 gallons per minute (GPM).

o. CRMWA has been operating their well for 20 years- but it must cycle. It is likely on a 20-25 year well life cycle. Capacity starts to decrease over time. CRMWA made comments about

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	materials for construction, and the construction process has likely improved since the well was installed. p. Question: Do these numbers call for one injection well? i. Response: These numbers assume 4 injection wells, each about 300 GPM capacity. ii. El Paso uses injection wells, they have 3 injection wells about 1 mile apart. The separation can depend on the type/orientation of the well for distance apart. q. What is the cost share? i. Members are paying 100-percent of the OPEX costs. All of the cost is built into OPEX costs. Replacement cost is carried for the wells that is factored in at 3-percent annually for the cost of a new well.
3.	**Cost-Benefit Results** A. Question: Assuming everyone is taking full allocation. If groundwater is being blended for TDS, would this increase allocation cost? a. Response: The more ENMWUA water used, the less expensive the water rate will be. Blending with groundwater has not been considered as a long-term viable option without some form of reverse osmosis if the TDS concentration is to meet the Secondary MCL. B. Comment: Chloramines are something members need to consider. Consumer confidence needs to be the most important criteria. Keeping the costs down is important but we cannot sacrifice quality. a. High total dissolved solids (TDS) will start messing up water heaters. It will impact customers. This transition needs to be seamless. i. Response: When water was first tested and TDS levels were high, this is what triggered this analysis for treatment options. An RO unit for your house is an option, but these units require replacement to be effective. Brine generated is sent to the wastewater treatment facilities, where it needs to be dealt with. It is difficult to put a monetary value to this. b. Portales does not want RO brine to come into plant. If it is on the customers to deal with TDS, it is much more of a challenge and unpredictable. c. It seems like PFOS is a concern to the Water Authority. Members do not want to put in a system that cannot treat the water. C. It doesn't make sense to make permitting complexity a highly weighted criteria because it will be possible to get necessary permitting. The community is not concerned with permitting. a. Permitting really describes the risk of dealing with brine through disposal wells. This material must be disposed of in some way. b. This all goes back to the confidence of the customers. c. It does not make sense to say customer acceptance is the lowest weighted criteria based on previous conversations. d. One person noted that bill increases are representative of a cell phone bill. e. If you flush a hydrant, it's noticeable to everyone, and that water was meant to be used. When water is injected to a deep well, that water is not drinkable, and it is not visible. f. Water bills are going to increase with this project no matter what. If you increase someone's rates and bill and they don't like the taste, what does that say? g. What it comes down to is what customers are going to accept. It's a given that potential and future contaminants will be taken care of. The best option at this point is what they don't see as far as water disposal. h. CRMWA is watching ENMWUA to see what choices are made in this process. They are experiencing the same issues, but at a more extreme level.

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- i. Question: Can we partner with CRMWA for brine disposal?
    - i. Response: The hauling would be an issue. The water will be very corrosive. It would likely be more cost effective if done locally.
    - ii. If CRMWA did RO on their lake water, they are hundreds of miles away, so they would likely need to inject brine locally.

D. Does the group feel that there is a best technical alternative?

- a. Portales: Membrane/RO is the way to go. The main question is how to handle the brine afterwards.
- b. RO is the most effective process
- c. Sara: Has anyone done research on treating brine water?
    - i. Response: Portales says research they investigated showed it would be significant effort.
    - ii. Jacobs noted that the cost of Zero Liquid Discharge (ZLD) would be very high. Not aware of a treatment that would generate the brine as an effluent.
        1. An option was not investigated that was economical or possible to use the brine water.
    - iii. Wastewater that needs to be injected versus water that can be treated
    - iv. There is not a method of using 30,000 mg/l stream of TDS that could be used for other reasonable purposes.
    - v. It is essentially sea water, so there are not as many uses for this.
    - vi. Orlando mentioned that there is a limit to cost.
- d. If TDS subsides over time as the lake fills, organics still need to be removed. Piloting will help look at what options are available to remove total organic carbon (TOC). There are opportunities to look at reducing the RO waste stream.
    - i. Piloting allows finetuning of design. It will allow opportunities to reduce the cost.
    - ii. Brine incineration is a ZLD option.
- e. Question: What is the cause of the contaminates in the lake?
    - i. The lake is slowly concentrating over time, but also there are brine aquifers that feed Lake Meredith. It's possible that this could contribute to Ute Lake.
- f. The 1.5 MGD of brine concentrate flow is when the system is running at peak design flow. This happens in the middle of the summer but is not sustained over time.
- g. Source water is taken to where a salt is reaching saturation without precipitation. We are working with an anti-scalant vendor to make sure salts stay in solution. We could not run through another RO because the salt concentration is so high.
- h. Question: EPA says average waste stream for RO is 20%, why is our waste stream so low?
    - i. EPA does not care what the recovery is, only the water quality. EPA may be including seawater desalination in their number. The chemistry of Ute Reservoir water allows a much higher recovery than an average RO system.
    - ii. Question: What in the water chemistry allows such a high recovery?
        1. Response: The limiting factor is Barium Sulfate. If this salt goes up, recovery goes down.
    - iii. Question: What happens if the recovery is not what was expected for piloting? Or if we cannot get permits?
        1. Response: If the recovery is lower than 93%, then we will have to look at economics to see what is feasible.
    - iv. What happens if we are not getting expected results with pilot study?

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	1. If this group decides that RO is the way to go, it will be contingent on pilot testing. If we engage in pilot testing and numbers are bad, then yes, we will come back to the drawing board. 2. We are not deciding on a method and going with it no matter what. In this situation another alternative would be reviewed. v. The concern is more than taste, it's PFAs and other future contaminates. The difficulty is designing something that will exist in 10-years, planning for the unknowns. Reverse osmosis is the best option for removing most all contaminants. vi. Keep in mind that not all water is going through the RO. vii. The 1.5 MGD number is based on the 20 MGD that would go through RO. viii. PFOS and PFOA have been on the radar for a long time. 1. Advisory limits were significantly less than previous values. 2. At those low levels, GAC is not going to get you to those low advisory levels but can meet the currently proposed regulations. ix. Question: Water loss has different definitions- if we inject the water is gone forever. If evaporation is done, it helps the water cycle it is not technically being wasted. 1. Would a landfill be beyond the scope for something considered for this project? a. Probably. It may be an option it has not been investigated. Incineration of the brine is expensive. x.
4.	**Discussion: What is the best technical alternative?** **a. Portales and EPCOR- Do you feel that RO is the best technical alternative?** i. Yes, we believe so. **ii.** In the beginning, Portales like conventional because it was what they knew. They don't want to have to add additional treatment in the future. **b. Mayor Dixon, what are your thoughts?** **i.** Elida water is already low quality. Preferred the taste of lake water to Clovis water, probably because of chlorine. **c.** Portales does not see a way around RO. **d.** RO is safer because it requires less operator interaction with chemicals. **i.** Conventional plants may be easier to operate but the system needs to work for folks in the future. It is difficult to find qualified Operators locally. **ii.** It is difficult to keep people long enough to allow for routine maintenance. **e. JT Walla -** Cannon wants to look deeper to see what the best alternative is and come forward in April. **f.** Best case scenario is to meet one more time and hear Cannon's conclusion. Mr. Ortega would like to have everyone's input from the board. Currently the board meeting is April 27th, the plan would be to meet the week before the meeting. **g.** All of this needs to be moved through state regulations, which they will. The priority is health and safety issues. **h.** Will EPCOR and Portales use a fixed amount of water from the reservoir? **i.** It will be dynamic because in the summer more water will be pulled from the Water Authority. One of the reasons Portales wants to leverage their full allocation and explore Aquifer Storage and Recovery (ASR).

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	i. There will be a minimum requirement for members to take to allow operation of the Water Authority. Eventually more and more water will be provided. The Authority membership has fronted the cost of this project thus far. The costs will rise over the initial years, and then plateau once water is being delivered. **j.** Water resources are diminishing, so this water resource is necessary. The water portfolio is important as a whole. **k.** Water will be blended at first, depending on groundwater availability. **l.** Likely two 3.8 MW wind turbines would be required for the RO alternative.
5.	Wrap Up A. Meeting is scheduled for April 11th. Come up with a decision point in April.