



Produced Water Treatment Pilot Project Background Information

For Use in NMED Treatment Permit Discussions 2023

1. Applicant Summary Information:

Company: Devon Energy Production Company, L.P., 333 West Sheridan Avenue, Oklahoma City, Oklahoma 73102

Points of Contact	Company	Email	Phone
Paul Barbour	Devon Energy	Paul.barbour@dvn.com	(405)228-4308
Josh Bruening	Devon Energy	Josh.bruening@dvn.com	(405)552-7882
Joseph Olson	Devon Energy	Joseph.olson@dvn.com	(405)228-2444
Justin Maxwell	Devon Energy	Justin.maxwell@dvn.com	(575)988-1550

Company Description and Produced Water Treatment Experience:

Devon Energy is a leading independent energy company engaged in finding and producing oil and natural gas. With headquarters in Oklahoma City, Devon's operations are focused onshore in the United States. The company's portfolio of assets provides stable, environmentally responsible production and a platform for future growth. Devon has more than 2,000 employees who are dedicated to delivering results and improving the quality of life for people who live and work in the communities where the company operates.

As the first company to recycle flowback and produced water in natural gas wells in north Texas, Devon is an industry pioneer in recycling. We became one of the leading recyclers of treated produced water in New Mexico and led the effort to establish state rules to encourage the practice. Our recycling efforts are now concentrated in the New Mexico Delaware Basin, where we have our highest level of activity and water scarcity is an issue. Since 2015, Devon has reused over 250 million barrels of water from its water treatment facilities.

Application Date: January 22, 2024

Pilot Date: Estimated April 22, 2024

Type and scale of Project: Pilot scale of 75 barrels per day of clean effluent.

Project Funding: Funded by Devon Energy

Project Collaborators:

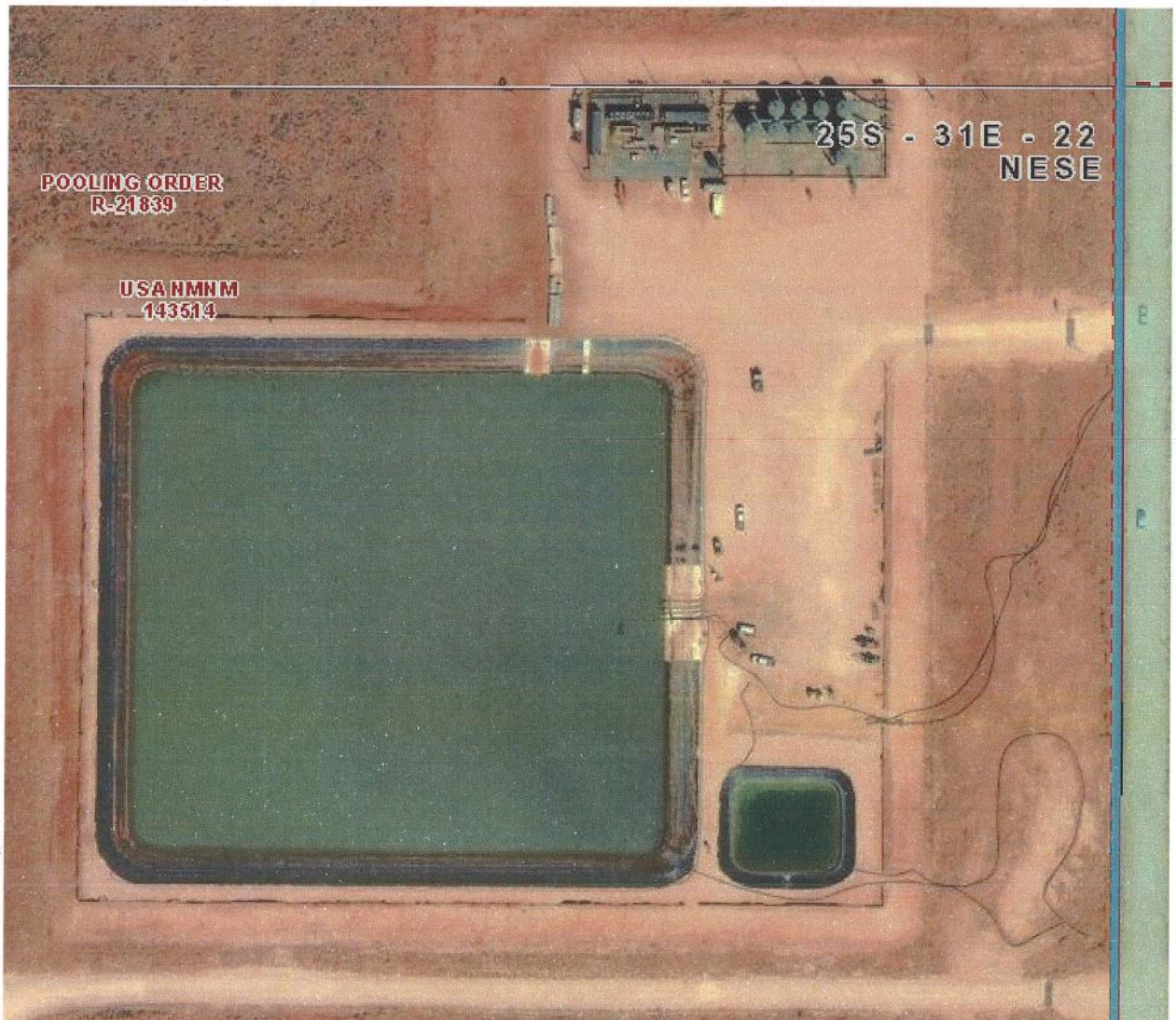
Group/Company	Role	Contact Info
Crystal Clearwater Resources	Technology Provider	Apoorva Sharma Chief Operating Officer, asharma@ccrh2o.com , (403)880-2421 Scott Carson , Chief Commercial Officer scarson@ccrh2o.com , (972) 345 3229
TBD – Devon is still evaluating post treatment options and if this will be done in a lab or in the field. Once a company is identified, DVN will inform the NMPWRC.	Post Treatment Ammonia Removal	

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2. Project Site Location and Description:

- **Basin:** Permian Basin
- **Location:** Section 22, Township 25 South, Range 31 East, N.M.P.M. Eddy County, State of New Mexico
- **Coordinates:** **Lat:** 32.115076° N **Lon:** 103.758510° W
- **General Directions:** From HW128, turn south on to Orla RD. Drive ~6 miles South on Orla Road and turn West. These are lease roads. Then proceed to the site.
- **Site Description:** Cotton Draw 22 Water Treatment Facility (CD 22)
- **Land Status:** State
- **Arial view of site:**



- **Produced Water Source and Quality:** (produced water source and general quality in ppm TDS). The produced water source is from the Wolfcamp, Bone Spring and Avalon formations around the treatment facilities. The TDS of the water is generally between 115,000ppm and 130,000ppm.



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3. Executive Summary:

Devon Energy desires to perform a 30-day produced water desalination trial to test the effectiveness of Crystal Clearwater Resources (CCR) proprietary Spontaneous Evaporation and Condensation Technology (SPEC). The trial will test two types of water; one that has been pre-treated with a dissolved air flotation unit to remove solids and iron, and another that has only had settling time to allow for the water and oil to separate. The goal of the trial is to produce water that has a total dissolved solids (TDS) level of less than 500 parts per million (ppm) and remove BTEX, ammonia, and other potential contaminants.

The data collected from the trial will be shared with the New Mexico Produced Water Consortium, NMED, OCD, and other interested parties to provide information to help develop regulations for safe surface discharge.

The trial is an important step in Devon Energy's commitment to finding innovative solutions to reduce the environmental impact of its operations. By partnering with Crystal Clearwater Resources, Devon Energy is exploring new ways to treat and recycle produced water that can be a valuable resource in the drought-stricken area of Southeast New Mexico.

The results of the trial will provide valuable data to regulators and the industry, helping to ensure that produced water can be safely treated and discharged into the environment.

4. Proposed Reuse Application of Treated Water: (following statement required)

For the purposes of this test, there will be no discharge of the produced water. The distillate will be collected in a holding tank for sampling before being blended back with the concentrated brine for discharge into the CD 22 produced water pit to be used in Devon's drilling and completion operations.

5. Similar or related permits/notification needed with other agencies, or nearby properties:

Attached Form C-147 from The State of New Mexico Energy Minerals and Natural Resources Department.

6. Pilot-System Process and Design:

Pretreatment

1. Raw produced water enters a newly installed above ground storage tank (AST) or is processed through a gun barrel to remove oil and solids.
2. Raw produced water is then moved from the AST or gun barrel to the treatment plant where it is treated with chemicals such as hydrogen peroxide, a coagulant, and a flocculant.
3. The water is agitated via a serpentine system of pipes.
4. Water is then put into a dissolved air flotation (DAF) unit for removal of the solids.



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5. The discharge of the DAF units has the same TDS as the water going in, but the solids and iron has been removed. Water is then stored in the pond for use in drilling and completions operations.

Desalination

The desalination process will be tested with water that has gone through the pretreatment step above and raw water directly from the AST tank.

SPEC employs the process of evaporation/condensation which has two main advantages. First, it allows the replacement of large, complex equipment made from exotic metallurgy. Second, the tendency for fouling/mineral scaling is drastically reduced, along with associated downtime/maintenance costs required by most thermal technologies. An overview of the treatment process is as follows:

6. Pretreated or untreated influent is transferred enters the evaporator loop from the feed tank.
7. The brine stream is heated using heat recovered from the condensate loop through a heat exchanger. Most of the thermal energy required for this process is recovered through this operation.
8. The heated brine stream is heated to the desired process temperature through a second heat exchanger which pulls new heat from any heat source (e.g., boiler, waste heat recovery, solar thermal) through a liquid media (e.g., Ethylene glycol).
9. The fully heated brine stream cascades through the entire series of evaporators.
10. The brine temperature drops in each stage as water evaporates.
11. The concentrated brine stream at the bottom of the evaporator loop is recirculated until the salinity reaches the desired level. It is possible to concentrate the evaporator loop up to the point of saturation.
12. Similarly, the temperature of the distillate increases as water cascades through each stage.
13. The heat accumulated in the condenser stream is recovered internally by the heat exchanger to drive further evaporation.
14. The concentrated effluent that is produced from this process will be ~240,000 TDS and will be blended into Devon's produced water pond to be used in drilling and completions operations. The clean effluent will be blended into the produced water pond as well or may go through a post treatment process for further polishing.

Post Treatment – Devon is still evaluating which post treatment will be used.

15. The clean effluent will be polished through activated carbon to remove co-distilled compounds and Devon is still evaluating technologies to address ammonia removal. These technologies could be:
 - Electrolysis and oxidation
 - Moving bed biofilm reactor (MBBR)
 - Others
16. Post treated clean effluent will be discharged into the produced water pit to be used in drilling and completion operations.

7. Project Goals and Objectives: (Summary of objectives and KPI's similar to below)



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The pilot project is expected to operate for 30 days producing up to 75bbls/day of clean effluent compatible with reuse for agricultural irrigation or industrial uses such as green hydrogen or cooling water for data centers. It is expected the concentrate and distillate will have the following beginning and final qualities.

Parameter	Influent Water	Concentrated Effluent	Clean Effluent
TDS, mg/L	123,000	240,000	<500
pH	6.4	6.4	6.4
Water Volume (bbls/d)	150	~ 75	~ 75
Ammonia, mg/L*	x	Y	<10

*Devon does not test for ammonia in its standard testing protocols.

Additionally, the concentrated brine will be tested for lithium, iodine, and other valuable minerals that could be extracted economically once they are concentrated. The following Key Performance Indicators (KPI's) will be evaluated to assess system and process cost effectiveness and overall performance:

Operational throughput – ~75 bbls/day of clean effluent water

Operational uptime – 23 average hours/day

Non-productive time - 1 hours/day

Meet water quality target - 95% of time.

Max. water quality variation - x average % above target level

Estimated Energy use/cost per bbl treated - ~ 1.3 kwh/bbl, ~ 0.15 mmbtu/bbl, and \$x/bbl

Clean effluent and concentrate effluent recovery – 50% average bbls/bbls treated

The data collected will be utilized to help develop larger-scale treatment systems to support enhanced operations efficiencies and reduce full-scale treatment costs.

8. Summary of Risk and Toxicology Sampling, Testing, and Analysis: (Following Statement Required)

The KPI's noted above will be measured daily on-site with simple field-testing systems and monitors. Daily samples of the influent and both effluent streams will be captured by CCR or Devon to be sent to a lab for analysis.

Risk and Toxicology testing and analysis of the treated produced water will be coordinated and managed through the NMPWRC. Samples will be taken and tested using the Consortium's sampling protocol, and their Risk and Toxicology testing protocol. CCR will coordinate with the NMPWRC so they can collect and prepare Risk and Toxicology analysis samples to ensure proper care, custody, and control. The Consortium will collect up to two set of samples once routine operations have been established to provide information on process efficacy and reliability relative to potential future treated water safety.

9. Equipment Vendor and Associated Suppliers: (Identify as appropriate)

Equipment or Vendor Name/Description	Role
Crystal Clearwater Resources	Technology supplier



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Frac Tank rental	Frac Tank provider
Post Treatment provider – TBD	Post Treatment

10. Expected Produced Water Users: (Required Statement)

The effluent streams from the pilot operations will be discharged into the CD 22 produced water pit to be used in drilling and completions operations.

11. Disposal and Decommissioning: (Required information)

Equipment: None - Reuse for testing at other sites

Material: Secondary containment and expendables for the treatment system will be 60 mil HDPE liner with 10oz geo.

Water: All water will be disposed by discharge into Devon’s Cotton Draw 22 produced water pond (OCD permit number 2RF-141, 10/02/2023).

Soil: Any contaminated soil will be disposed at R360 Environmental Solutions at 4507 W. Carlsbad HWY, Hobbs, NM, 88241.

12. Expected Operational Testing, Reporting, and Proposed Review Schedule

Pilot mobilization, set up, and shakedown: estimated 4/22/2024

Pilot Operations: 4/22/2024 through 5/22/2024

Draft Report: 7/1/2024

1/17/2024

Company POC - Joseph Olson

Date