



Task 5. Request for Proposals:

2027

Valorizing Strontium Recovered from Produced Water

Task proposed and developed by Chevron and NGL Water Solutions

Task Summary

You are tasked with developing a process to recover strontium (Sr) from Permian Basin Produced Water (PW). The objectives are twofold: (1) to further improve water quality and move the water one step closer to recycling PW for beneficial reuse, and (2) to convert the recovered strontium into a commercially valuable product, and 3) reduce the volume of PW constituents requiring disposal. Competitive solutions will demonstrate technical feasibility, economic viability, and the potential to increase beneficial reuse of produced water while reducing waste streams associated with oil and gas operations.

Proposed concepts may focus on the production of existing strontium compounds, the development of novel strontium-based materials, or the identification of emerging applications that support future market growth.

Problem Statement

Design an innovative process to recover strontium (Sr) from a 50,000 bbl/d Permian Basin PW treatment facility that operates at 50% recovery. From the resulting 25,000 bbl/d stream of brine concentrate, recover Sr and convert it into a useful, marketable product. The process must effectively separate Sr from competing constituents, particularly calcium (Ca), which is present at approximately four times the concentration of Sr and has similar ionic characteristics. Although Sr recovery is the primary objective, teams may also recover Ca and convert it into a secondary marketable product.

Your solution should be optimized to obtain the greatest market value from the recovered Sr while reducing the volume of reject brine and associated disposal costs. Teams shall consider Sr recovery, selectivity, product purity, and market value, as well as the capital, energy, chemical, operating, and maintenance costs required to produce the final product.

The innovative solution shall go beyond conventional approaches to constituent recovery and may include novel applications for the recovered products and/or the development of new markets. Solutions shall be logistically and economically feasible at full scale, provide a long-term offset to PW treatment and disposal costs, and include a plan for post-treatment and/or safe disposal of the remaining concentrate after Sr recovery, along with the disposal of solid waste streams generated during the process.

Background

Strontium and Produced Water

Produced water (PW) from the Permian Basin contains dissolved strontium (Sr), providing a potential source of a commercially valuable material. Strontium is used primarily in compounds such as strontium carbonate and strontium nitrate for ceramic ferrite magnets, pyrotechnics and signal flares, medical products, ceramics, and other specialty applications. The United States currently has no domestic strontium-mineral production, leaving the country dependent on imported material [1].

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Market analysts anticipate continued growth in Sr demand [2, 3]. Therefore, recovering Sr from Permian Basin PW could provide a domestic source of a valuable material while generating revenue to help offset the cost of treating PW for beneficial reuse.

Produced Water in the Permian Basin: An Untapped Water Source

The water itself represents another valuable resource. The western and southwestern United States are facing severe drought, while groundwater levels throughout the region have fallen to historic lows. With more than 60 million people depending on these limited water resources, identifying supplemental water sources is critical [4]. One abundant and largely underutilized source in this region is PW generated in the Permian Basin (Fig. 1).



Fig. 1. Permian basin (shaded in light grey). Within the Permian, lies the Delaware and Midland basins (both darker grey and outlined in brown). (Photo reproduced from IEEFA [5])

Produced water, a byproduct of oil and gas (O/G) production, is generated in large volumes throughout the Permian Basin. As oil and gas are pumped from deep underground, they are accompanied by *formation water*, which is naturally occurring saline water that has been trapped in rock formations for millions of years. After reaching the earth's surface, the oil, gas, and water are separated, and the hydrocarbons are sent for processing and sale. The remaining brine is called PW.

PW is approximately four times more saline than seawater and contains some residual oil. Depending on its basin of origin, it has its own signature of additional contaminants, including dissolved minerals, metals, naturally occurring radioactive materials (NORM), and other constituents that are drawn from the rock formations. Because of these contaminants, it has historically been treated as an industrial waste stream requiring disposal. However, that perspective has changed as the O/G industry explores opportunities for water reuse and resource recovery.

PW in the Permian Basin

The Permian Basin is the largest oil-producing region in the United States. In this region, for every barrel (bbl) of oil pumped from the ground, an average of 3 to 6 bbl of water is also brought to the surface. This is expressed as the water-to-oil (WOR) ratio. The WOR in the Permian basin reaches up to 10:1 in the Delaware Basin. These large WOR ratios are not found in all O/G basins. For reference, another prolific basin in Appalachia yields PW at only 0.33 MMbbl/d.

In terms of water volume, the Permian Basin produces approximately 22–24 million barrels per day (MMbbl/d) of produced water (PW), with the upper volume equivalent to approximately 1.01 billion gallons per day (BGD), and volumes continue to rise [6]. Note that 1 bbl = 42 gallons.

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For comparison, manufacturing facilities across the entire state of Texas use approximately 1.08 BGD of water [7]. Thus, the volume of PW generated each day in the Permian Basin is roughly equivalent to the total daily water use of Texas's manufacturing sector.

Saltwater Disposal Wells

Historically, the most cost-effective means of disposing of these large volumes of PW has been through injection into geologic formations via EPA Class II Saltwater Disposal Wells (SWDs). The prevailing philosophy in the early days was that this ancient water, once deeply buried, was being returned to the subsurface where it originated. In addition, the cost of injection is relatively small (\$0.60 - \$1.25/bbl), compared with other options (such as transporting it to distant facilities, treating it for reuse, recovering marketable constituents, or concentrating and disposing of the residual brine and solids) that can climb up to \$7/bbl [8, 9].

Initially, SWD capacity appeared limitless. However, this deep saltwater injection has created widespread underground pressure problems. Although PW continues to be injected into SWDs, regulators have placed strict capacity limits on the wells. Once SWDs reach permitted capacity, they are decommissioned, and no further injection is allowed. These constraints create growing challenges for oil and gas operators tasked with safely managing increasing volumes of produced water.

The imbalance between the amount of PW produced every day and the limits on disposal is creating the beginning of an economic crisis in the O/G industry. It is estimated that PW disposal costs could increase by \$6/bbl - a steep rise compared with current pricing. This increase could result in profitable wells becoming uneconomical, especially in the Delaware basin that has the highest WOR and also the strictest limits on SWD disposal of all basins in the Permian [10].

With a need to manage these large volumes of water, combined with the strict limits on SWD disposal and an interest in conserving fresh water, PW operators have begun recycling a portion of their PW for use in fracking operations, when formerly they used freshwater. Although this recycling effort adds up to \$0.25 per barrel compared to using fresh water, it has significantly advanced water conservation in the industry. However, demand for fracturing water does not keep pace with the high volumes of PW generated in the Permian Basin.

Beneficial Reuse of PW

To fully utilize this potential source of water, the O/G industry is investing in research to treat PW for beneficial reuse. Research organizations, such as the New Mexico Produced Water Research Consortium (NMPWRC), have made significant advances in treatment technologies and await regulatory approval. Regulatory agencies, such as the New Mexico Environment Department (NMED), remain cautious about permitting PW reuse because of concerns about potential risks to human health and the environment. Similar research and regulatory efforts are underway in other oil- and gas-producing states.

Two broad categories are used to describe beneficial PW reuse. Refer to Appendix B for more details:

1. **Restricted beneficial reuse** limits treated PW to specific applications and operating conditions that limit human and environmental exposure. Examples include closed industrial processes, road construction, dust suppression, and other controlled uses.
2. **Unrestricted beneficial reuse** allows treated PW to be used without special restrictions related to its PW origin, provided the treated water meets all water-quality standards and regulatory requirements applicable to the intended use. Examples vary by state, but may include agricultural irrigation, landscape irrigation, livestock watering, or other uses for which the treated water meets all applicable regulatory and water-quality requirements.

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Initially, recycled PW will be used for non-edible agriculture, industry, habitats, or recreation. The degree of treatment will be determined by the intended purpose of the water. This is referred to as fit-for-purpose reuse. These recycling efforts will decrease the amount of PW slated for SWD disposal and preserve existing fresh water for drinking water and other higher-standard uses. Future plans that extend PW treatment for edible agricultural use and drinking water, will require more stringent treatment protocols and testing.

After environmental approval, the limiting factor for treating PW for reuse will be cost. Removing salts, organics, and other constituents requires a complex, energy-intensive treatment train. Although recent technological developments are bringing down costs, treatment for non-potable beneficial reuse generally costs \$1.50–\$4.00/bbl; potable reuse requires substantially more treatment and is not included in this range.

This range is up to eight times the cost of treating surface waters for potable use (about \$0.48/bbl) [6]. However, this comparison reflects a substantial difference in source-water quality: surface water generally contains far lower concentrations of dissolved salts, organics, metals, and other contaminants than PW.

Table 1 compares the primary PW management approaches, including their costs, current share of PW management, and potential adverse consequences [9]. Enhanced evaporation is not considered a preferred long-term management option. However, it is included in the table because it is currently the only available alternative for some operators awaiting permits for treatment and beneficial reuse [11].

Table 1. Primary means of PW management, costs, percentage of market, and adverse effects [8, 9].

PW Management Method	Cost/bbl	Costs include	% of available PW	Effects
Inject into geologic formations via EPA Class II Saltwater Disposal Wells (SWDs)	\$0.60 - \$1.25/bbl. <i>(For this challenge, we will use \$0.70) [8]</i>	Transport & injection.	40-50%, and declining	1) SWDs have limited capacity. 2) PW becomes unavailable for any other use.
Recycling for Fracking Operations	\$0.25	Treatment & Delivery	50-60%, and increasing	Cannot keep pace with PW production.
Enhanced Evaporation [11]	\$0.22 - \$1.50	Transport, maintenance, & regulatory compliance.	2%	1) PW becomes unavailable for any other use. 2) Cannot keep pace with PW production.
Treating for non-drinking water beneficial reuse (such as agricultural reuse)	\$1.50 - \$4/bbl	Transport, treatment, & regulatory compliance.	<1%, emerging	PW would be available for reuse. Not currently approved by NMED
Treating for drinking water reuse	\$4 - \$7/bbl	Transport, treatment, & regulatory compliance.	<1%, emerging	PW would be available for reuse. Not currently approved by NMED
Compare to the cost of treating conventional surface waters for drinking water	\$0.48			

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Valorizing PW Constituents

One attractive option for offsetting PW treatment costs is to recover, process, and sell valuable materials from the water. Sometimes called brine mining or valorization, this active area of research may involve recovering elements directly or using them as feedstocks to produce marketable compounds [12].

Valorization can contribute to a circular economy by recovering useful resources rather than disposing of them through SWD injection. Recovery may also reduce reliance on conventional mining and its associated environmental impacts.

Task 3: Recovering Strontium from PW

Strontium commonly occurs in nature, averaging 0.034% of all igneous rock; only two minerals, celestite (strontium sulfate) and strontianite (strontium carbonate) are important strontium-bearing minerals, but it is also found in Permian Basin PW.

Table 2 reflects the typical constituents found in Permian Basin clean brine concentrate reported by Tarzona, et al [12]. Clean brine concentrate is the concentrated reject stream produced during PW desalination. Because pretreatment removes much of the suspended solids and organic matter, this stream generally has low TSS and organic content but high TDS—approximately 172,000 ppm in Table 2. Appendix A provides a simplified synthetic surrogate that teams may use for preliminary testing until the actual clean brine concentrate is provided.

Table 2. Typical constituents in Permian Basin Clean Brine Concentrate [13].

Constituent	Feed (ppm)	Constituent	Feed (ppm)
TDS	172,000	HCO ₃ ⁻	240
TPH*	<5	Li ⁺	25
Cl ⁻	72,100	SiO ₂	32
Na ⁺	47,600	Ba ⁺	2
Ca ²⁺	6,350	PO ₄ ³⁻	25
Sr ²⁺	3610	Fe	2
Mg ²⁺	1,270	Mn	0.72
K ⁺	350	Al ⁺	0.28
NH ₃	140	Zn ⁺	0.08
SO ₄ ²⁻	226	Pb ²⁺	1

*TPH: Total Petroleum Hydrocarbons

Successful solutions to this design challenge will help offset PW treatment costs by producing a marketable strontium-based product. Recovering strontium will also reduce the quantity of dissolved material requiring disposal in SWDs—both important goals for the O/G industry.

The key constituents that will play the largest role in your team's solution are strontium (Sr) and calcium (Ca). Separating these elements presents a particular challenge because both occur in the brine primarily as divalent cations (Sr²⁺ and Ca²⁺) and have similar ionic characteristics. Their identical charge and similar ionic size cause them to behave similarly in many separation processes, making it difficult for a treatment method to selectively capture Sr²⁺ while leaving Ca²⁺ in solution.

This challenge is compounded by the brine chemistry: Ca in the Permian is approximately two to four times the concentration of Sr, creating substantial competition for processes intended to selectively recover Sr. As such, your team may also consider recovering Ca in a saleable form, but this is secondary to Sr recovery.

Other key considerations and challenges are listed below.

Competing ions and ionic strength. At >170,000 ppm TDS, the brine is extremely saline, and coexisting ions can interfere with Sr recovery or alter equilibrium behavior. High concentrations of Ca^{2+} are especially problematic, but Mg^{2+} , Ba^{2+} , Na^+ , and other ions may also compete depending on the separation mechanism.

Selectivity versus recovery. Teams should recognize that recovering a high percentage of Sr and producing a high-purity Sr product are not the same thing: A process may remove substantial Sr but still co-recover too much Ca or other material to create a marketable product. Recent Sr-recovery studies explicitly use sequential impurity removal to improve product purity.

Scaling and unintended precipitation. Sulfate- and carbonate-based chemistries can precipitate Sr, but they may also precipitate Ca, Ba, or mixed solids. That creates challenges related to selectivity, fouling, solids handling, and downstream processing.

pH and reagent dosage. Precipitation and adsorption behavior can be highly sensitive to pH, alkalinity, and reagent concentration. Teams should consider not only whether a process works, but the operating window needed to make the process selective.

Product form and marketability. Teams should identify the intended Sr-containing product—Sr, SrCO_3 , SrSO_4 , another compound, etc., and establish purity specifications or a plausible end use that is economically viable.

Residuals and secondary waste. A process that recovers Sr but generates large quantities of Ca-rich sludge, spent adsorbent, or chemical waste may simply shift the disposal problem elsewhere.

Water recovery and compatibility with the larger treatment train. Because this is a desalination reject stream, students should consider whether Sr recovery improves or interferes with subsequent brine management or beneficial-reuse treatment.

Regeneration and reagent reuse. If applicable, media regeneration, loss of capacity over repeated cycles, and management of the regenerant should be evaluated.

Energy and chemical intensity. A technically successful separation may not be economically feasible if it requires excessive heating, pressure, reagents, or multiple treatment stages.

Scalability and throughput. Bench-scale selectivity is not enough. Teams should estimate residence time, flow rate, media quantity, reactor size, and solids-handling requirements at full scale.

Maximizing Value of the Treated PW Concentrate Stream

Consider the full economics of the problem by determining the best balance between three issues:

- 1) recovering high-purity Sr from the brine to make a useful product;
- 2) identifying an existing market or proposing a new market for the product that will generate reliable revenue;
- 3) transporting from the oilfield to the processing facility, and to distribution of the final product;
- 4) reducing the disposal volume of liquids and solids after you have recovered valuable constituents.

Teams should also factor into their analysis the possibility that their process may be more cost effective when scaled to higher production volumes than specified in this task. If this is the case, cost-recovery calculations for processing up to 150K bbl/day of concentrate may be included in the technical report.

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Treating and Disposing of Produced Water

For PW, “treatment” usually refers to desalination. Pre-treatment and post-treatment refer to removing oils, VOCs, suspended solids, etc. Every PW application has its own unique treatment train (pretreatment, treatment, and post-treatment) requirements. See Appendix B for additional PW-related terms (p. 11).

Permian Basin Treatment Rates

Based on the salinities in the Permian Basin, current treatments operate at approximately at 50% recovery. Thus, a facility that treats 50,000 bbl/d of Permian Basin PW will generate 25,000 bbl/d of highly treated effluent and 25,000 bbl/d of concentrated brine as the residual stream. Your team will be removing constituents from this residual stream, but will not be expected to treat produced water for reuse.

Residual Stream

After removing the constituents needed to produce your product, your team will be left with your own residual stream that, in your full-scale operation, you should plan to inject into an SWD. These residuals should be in liquid form because the disposal of solid waste from PW is difficult and expensive. Further, to minimize down-hole pressures, regulations limit TDS to 250,000 ppm for SWD injection. Teams are cautioned to ensure that any chemicals they may add while producing their valuable product will not elevate the TDS levels of their residual effluent.

Consider the cost of SWD injection to be \$0.70/bbl. Therefore, each barrel of produced water diverted from disposal will avoid \$0.70 in injection costs. Assume the processing facility will be sufficiently close to an SWD site that there will be no transportation costs related to delivering remaining brine to an SWD.

Design Considerations

Your proposed design should provide specific details and outcomes as follows.

- **Base your analysis on a 50,000 bbl/day** treatment facility having a 25,000 bbl/day reject concentrate stream.
- **Produce a usable and marketable product from Sr recovered** from the provided concentrated brine. Prioritize a product that will optimize a long-term, stable income from the sale of the product while minimizing the costs associated with disposal of the remaining concentrate.
- **Include a Process Flow Diagram (PFD)** for the selected treatment process. The PFD must include mass and energy balances (input and output streams, reactants, reaction rates, etc.). Take extra care to ensure that all processes and waste streams are included. This is a major element of judging (see Team Manual for PFD examples).
- **Propose a plan for waste-stream management after product generation.** If post-treatment prior to injection into an SWD is needed to ensure safety and/or regulatory compliance, include this in your PFD and process analyses as theoretical considerations. A bench-scale demonstration of waste stream post-treatment is not required.
- **Ensure that the TDS** of your residual (waste) stream will be no higher than 250,000 ppm to comply with SWD injection regulations.
- **Assume that constituent recovery and disposal** of any remaining brine will be accomplished within the PW treatment facility, thus eliminating the need for considering transportation logistics or costs on either end of your process.
- **Present a Techno-Economic Assessment and Analysis (TEA)** to construct a full-scale process to produce a usable product that will scale with an influent rate of 25,000 bbl/day of brine concentrate. This will include your estimate of costs for a full-scale solution. Include appropriate graphical representation of your cost data.
 - All costs must be demonstrated, including the cost of managing and disposing of the residual streams, staffing, and any post-treatment needed after product generation.

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- CAPEX (Capital costs) typically include, but are not limited to, equipment, pipes, pumps, etc. Do not include costs of buildings and appurtenances to the treatment process.
- OPEX (Operating costs) should be calculated as cost to produce your product on an annual basis, based on a rate of 25,000 bbl/day of influent brine concentrate. Include these costs:
 - Materials needed, including consumables (chemicals, sacrificial components, etc.)
 - Professional labor rate (\$150/hr); Staff labor rate (\$70/hour); solids disposal costs (\$50/ton); energy requirements (cost/bbl and Kwh/bbl): use an electricity rate of \$0.15/kWh and research an industrial natural gas rate and state in \$/MM BTU.
 - Additional operating costs that your team identifies.
 - If higher production rates (up to 150,000 bbl/day) would improve earnings from constituent recovery, include this analysis in your TEA, along with 25,000 bbl/day estimates.
- Determine how revenue from the recovered constituent will offset PW treatment costs. Assume the following values: Cost of treatment \$2.75/bbl (this is the midpoint from reported range of \$1.50-\$4.00/bbl for PW treatment) and the SWD injection cost of \$0.70/bbl.
- Visualization tools: Sensitivity analyses, etc.
- Teams are advised to create a multi-disciplinary team by inviting a business major to help draw up economic plans for full-scale implementation of your designs.
- **Include a public involvement plan** that addresses public perception and potential public contributions in utilizing PW in your chosen product and its application (see Team Manual).
- **Address any intangible or indirect benefits** of the selected treatment process, such as improving the environmental impact of mining and/or producing your selected product.
- **Address safety aspects of handling** the raw clean brine concentrate, residual streams, and final products. Safety issues for the full-scale design should be addressed in the written report. Safety issues for the bench-scale demonstration should be addressed in both the written report and the Experimental Safety Plan (ESP).
- **Report any use of AI, machine learning, predictive modeling, automation, or other decision-support tools**, and describe how the tools were used. These resources may be used only to support the team's independent engineering research, analysis, calculations, assumptions, and conclusions. Teams remain fully responsible for verifying all information, performing the underlying engineering analysis, and defending their design decisions based on their own work.

Bench Scale Demonstration

The bench-scale unit should demonstrate a process that produces a useful, marketable Sr-based product from pre-treated brine concentrate obtained from the Permian Basin. The bench-scale design should be scalable to a plant that produces 25,000 bbl/day of concentrated brine.

The chemistry of the brine will be similar to that shown in Table 2. In January 2027, the NMPWRC will report constituent values for the brine to be used at the contest. Teams should consider the corrosive nature of the clean brine concentrate and ensure that materials used in the bench-scale apparatus will maintain their integrity when exposed to fluids of chemistry shown in Table 2.

WERC's intent is to supply teams with real Clean Brine Concentrate (CBC) from a midstream operator. However, due to operators potentially going offline near the contest dates, WERC will use the synthetic solution outlined in Appendix A as a backup for Clean Brine Concentrate.

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At the contest, each team will be provided with up to 18 liters (5-gallon container) of clean brine concentrate (or the synthetic solution) to work with during the bench-scale demonstration. You are not required to use the entire amount of the solution during the demonstration. In your ESP, indicate how much clean brine concentrate you will need at the contest (by March 1, 2027).

After treatment, your team shall submit 125-mL samples for analysis: one sample of influent (brine concentrate), two samples of your waste stream, and additional samples of your final product, as warranted by your ESP. Collection of samples will be witnessed by a WERC staff member.

PW EHS Protocols

Untreated PW is considered a hazardous material, but it is not a hazardous waste. It can be toxic and/or corrosive. Teams should consult their institution's Environmental Health and Safety (EHS) protocols for handling and disposing of the brine concentrate. At the contest, teams will follow all handling and disposal protocols outlined by the NMPWRC and the New Mexico Environment Department (NMED).

Teams will bring to the contest

Teams will bring a functioning apparatus that will fulfill the requirements of the task, with all piping properly tethered. All experimental conditions and equipment must be documented in the ESP for review.

WERC will provide at the contest

At the contest, each team will be provided with:

- 1) a kiddie wading pool and/or tarps as secondary containment in case of spills,
- 2) Up to 18 liters of concentrated clean brine (or a comparable synthetic solution) to work with during the bench-scale demonstration, and
- 3) 125-mL sample bottles for influent, waste stream, and product collection.

Contest Analytical Testing Techniques

At the contest, each team's bench-scale demonstration will be analyzed by:

- Composition and/or functionality of the product produced, as determined by the team's ESP.
- Waste stream reduction (volume)
- TDS of the team's reject brine (to be less than 250,000 ppm)
- Additional analyses may be warranted by the team's ESP and may include pH, turbidity, TSS, etc.

Deliverables (See Team Manual)

Each team must submit (*see Dates and Deadlines, next page*):

- 30% Project Review
- ESP and required short course
- Technical Report—System design, data analysis, bench-scale results, full-scale plans, and 3 independent audits.
- Equipment Transport Form (if shipping equipment to Las Cruces)
- Flash Pitch—The audience for the Task 2 Pitch is El Paso Electric Company as potential investors. (Other Tasks may be assigned to pitch to community leaders or funding agencies.)
- Oral Presentation—Slides and presentation summarizing the design and key findings
- Poster Presentation—Visual summary of the design and results; presentation at the poster.
- Bench-Scale Demonstration—Working model, tested onsite; presentation benchside.

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Evaluation Criteria

Each year, the WERC Environmental Design Contest and its sponsors award more than \$35,000 in cash prizes. Awards include task-specific prizes and overall contest awards.

Read the *2027 Team Manual*, as a team, for a comprehensive understanding of the contest evaluation criteria: <https://werc.nmsu.edu/team-info/guidelines.html>

Judges' evaluation of your entry will include consideration of the following points specific to this task.

- Quality and completeness of the process flow diagram.
- Quantitative confirmation of strontium recovery, including recovery efficiency, selectivity, and purity of the recovered product.
- Quality, marketability, and demonstrated value of the strontium-based product and, if applicable, a secondary calcium-based product.
- Bench-scale demonstration that effectively demonstrates the proposed recovery and separation technology.
- Potential for full-scale implementation, including process effectiveness, reliability, scalability, operational complexity, and integration with PW treatment.
- Efficient use of energy, chemicals, water, and other consumable materials.
- Effective management of the remaining brine, residuals, and other waste streams.
- Cost effectiveness of the proposed solution, including its potential to offset PW treatment and disposal costs through product recovery and reduced waste volume.

Dates, Deadlines, FAQs (*dates subject to change—watch website FAQs*)

Today	Email us to reserve a spot for your team and join the email list for this task. Registration is limited to the first 34 teams.
Weekly	Check FAQs weekly for updates: Task-specific FAQs: 2027 Tasks/Task FAQs General FAQs: WERC General FAQs
Nov. 1 – Dec. 31, 2026	Early Bird Registration (discount applies)
Dec. 31, 2026	30% Project Review Due
Dec. 1, 2026 – March 1, 2027	Mandatory on-demand Course: <i>Preparing the Experimental Safety Plan</i> . See WERC's website and Team Manual for information.
February 15, 2027	Final date to register a team.
March 1 – 5, 2027	Email ESP to Juanita Miller (miljgh@nmsu.edu). Include requests for chemicals, materials, etc.
March 22, 2027	Submit Equipment Transport form (if shipping items to Las Cruces)
March 26, 2027	Technical Report due
March 29, 2027	Submit Flash Pitch Slides and Summary
April 4 – 7, 2027	Contest in Las Cruces

Contacts:

Safety Officer: Juanita Miller, miljgh@nmsu.edu (for ESP and Safe Bench-scale operation questions)

Program Manager: Ginger Scarbrough, gscarbro@nmsu.edu (for all non-ESP questions)

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Appendix A. Preparing the Synthetic Solution

The following synthetic solution will allow your team to prepare samples for preliminary testing at your campus, prior to receiving the actual clean brine. This will also be used at the April contest, should there be an issue obtaining clean brine from our industry partner.

Table A. Synthetic solution for testing the bench-scale apparatus (*Recipe subject to change*).

Water phase	Amount per liter of synthetic solution
DI water	Begin with 750 mL of DI water and dissolve the sea salt. After adding the remaining constituents, add DI water to bring the final solution volume to 1 L.
Sea Salt ¹	105 g
Calcium chloride dihydrate, CaCl ₂ ·2H ₂ O	23.3 g
Strontium chloride hexahydrate, SrCl ₂ ·6H ₂ O	11 g
Magnesium chloride hexahydrate (MgCl ₂ ·6H ₂ O)	10.6
Potassium chloride (KCl)	0.67 g
Sodium sulfate ⁴ (Na ₂ SO ₄)	0.33 g
Sodium bicarbonate (NaHCO ₃)	0.33 g
Oil phase	Amount per liter of synthetic solution
TrueSyn 200 I ^{2,3}	92 mg
Solid phase	Amount per liter of synthetic solution
Fine-grade Arizona Test Dust (Medium Grade) ^{3, 4}	50 mg
Sodium Bentonite Drilling Clay (AquaGel by Baroid Industrial Drilling) ⁴	50 mg

¹ Mass chosen to balance Na⁺ and Cl⁻ targets, since matching one exactly overshoots the other (±13%). At the contest, if needed, WERC will source the sea salt from the local Sprouts (store brand), as it dissolves fairly easily.

² Sourcing Option: RB Products will ship to you and charge for shipping only. Contact micah@rbproductsinc.com

³ Sourcing Option: Powder Technologies Inc. offers 4 kg for \$80. Contact: levi@powdertechologyinc.com

⁴ Contact WERC—we will gladly ship these items to you. They ordinarily come in industrial quantities.

Constituents that are listed in Table 1 that are intentionally omitted from Table A (subject to change):

- TPH: Represented by oil phase.
- NH₃: Volatile and presents inhalation and handling concerns.
- Pb²⁺, Ba²⁺: Unnecessary toxicity.
- SiO₂: Not a simple soluble salt; usable silica sources (e.g., sodium silicate) are corrosive
- Lithium and silica: Not central to strontium recovery and add sourcing or preparation complications.
- Fe, Mn, Al, Zn: Present only at trace concentrations and likely to complicate preparation without meaningfully affecting the challenge.

See the following page for Sample Preparation instructions

Task 5. Valorizing Strontium Recovered from Produced Water

Sample Preparation

To prepare samples for preliminary testing at your campus, follow the steps on the next page to make 1 L of synthetic produced water using the chemistry in Table A.

- Use a wide-mouth, semi-transparent polyethylene or polypropylene container.
- Mix water phase: add 750 mL DI water, then dissolve the sea salt and remaining water-phase constituents, in the order listed, until fully dissolved.
- Mix oil phase, then add solids to it.
- Add oil phase to water phase and gently mix.
- Add DI water to bring to 1.0 L.
- Just before use, homogenize* to generate small oil-phase droplets.

* If a homogenizer is not available, use a high-speed drill connected to a paint-mixing paddle and blend on highest speed for 5 minutes.

Note: Although disinfection is usually an essential pre-treatment step, it will be disregarded for the contest.

Appendix B: Additional Produced Water Terms

Clean Brine Concentrate used at the contest - Pretreated produced water concentrate resulting from a desalination treatment process. It will have low TSS, low organics, and high TDS (>200,000 ppm). If the clean brine concentrate is not available, WERC will provide a synthetic solution, as outlined in Appendix A.

Brine – any solution with a concentration of over 35,000 ppm TDS (USGS definition).
PW and PW concentrates are usually brines.

Clean Brine – A clean brine is a high-salt concentration PW with oils, greases, suspended solids, iron, and bacteria removed. It has been pH adjusted. It has NOT been desalinated. The term “clean brine” must be associated with produced water. (Produced Water Society definition)

Distillate - desalinated water or desalinated brine, using a thermal process.

Permeate - desalinated water from an RO process

Desalination concentrate - the highly saline reject concentrate that comes out of a desalination (RO or distillation) process.

PW Reuse Terminology, as defined by the NM Environment Department (<https://www.env.nm.gov/water-reuse>)

Reuse water: Treated wastewater from domestic, industrial, or produced-water sources that has received treatment appropriate for its intended application and is protective of human health and the environment. This is a defined term in 20.6.8 NMAC. [cloud.env.nm.gov](https://www.env.nm.gov)

Produced water reuse: Use of produced water for activities outside and unrelated to oil and gas exploration, production, treatment, or refining.

Limited reuse of treated produced water: NMED’s description of the current regulatory program. “Limited reuse” is not separately defined in 20.6.8 NMAC; it describes the limited scope of reuse presently allowed. [env.nm.gov](https://www.env.nm.gov)

Authorized pilot project: Under the current rule, off-field produced-water reuse is limited to permitted pilot projects designed to study treatment performance, treated-water quality, treatment volumes, toxicity, and potential reuse applications. These projects must prevent releases that could affect groundwater or surface water.