

2021 Request for Proposals

Research on the Treatment and Use of Treated Produced Water in New Mexico

New Mexico Water Resources Research Institute
and
New Mexico Produced Water Research Consortium

This Request for Proposals (RFP) is for 1) bench-scale, pilot-scale, and field-scale research, development, and demonstration projects of cost-effective treatment and use of produced water for different fit-for-purposes applications outside the oil and gas sector (these projects shall not result in any discharges to land, surface water bodies, or groundwater), and 2) associated research and analysis efforts on produced water availability, quantitative risk assessment, and socio-economic/environmental/ecological (SE3) cost benefit analysis.

Closing Date: 5:00 p.m. MST, February 8, 2021

SCHEDULE

Jan 4 , 2020	RFP release
January 15, 2021	Q&A session for NMPWRC members
February 8, 2021	Proposals due
February 26, 2021	Technical Review Committee (TRC) technical reviews due
March 9, 2021	TRC ranks proposals
March 16, 2021	TRC finalizes rankings and selects projects to be funded
March 18, 2021	NMPWRC and NMWRRI notify recipients
April 1, 2021	Begin Projects
March 31, 2022	Project Period End Date (No Later Than)

Table of Contents

Schedule	1
New Mexico Produced Water Background.....	3
Program Overview and RFP.....	4
Award Information	7
Eligibility.....	8
Intellectual Property.....	8
Independent Review, Selection, and Management Policy	8
Scoring Criteria.....	9
Proposal Content.....	10
Project Operation Review, Monitoring and Reporting Requirements.....	13
Proposal Submission Information.....	15
Contact Information.....	15
Attachment A: Budget Breakdown Template	16
Attachment B: Budget Justification Template	17
Attachment C: Request for Information of Produced Water Treatment and Reuse.....	18

NEW MEXICO PRODUCED WATER BACKGROUND

New Mexico is the third largest oil producer in the United States and is among the top natural gas-producing states [1]. Oil and natural gas wells generate large volumes of water known as produced water. As defined by the USEPA, “produced water is the fluid brought up from the hydrocarbon-bearing strata during the extraction of oil and natural gas, and includes, where present, formation water, injection water, and any chemicals added downhole or constituents released from the formation” [2]. For every barrel (42 gallons) of oil produced, four to seven barrels of produced water may be generated [3]. In 2019, industry in New Mexico generated 320 million barrels (13.4 billion gallons) of oil along with 1.246 billion barrels of produced water, of which 1.19 billion barrels (or 50.1 billion gallons) were in the southeast corner of the state (the Permian Basin), and 36.7 million barrels (or 1.54 billion gallons) in the northwest corner of the state (the San Juan Basin) [4]. As oil and gas production volumes continue to grow in New Mexico, so will the amount of produced water.

The majority of produced water is injected for enhanced oil recovery (EOR) or discharged through salt water disposal (SWD) wells. In 2019, 23.7 million barrels of produced water were injected in the northwest corner of the state.

Approximately 867 million barrels of produced water were injected in the southeast corner of the state, of which 541 million barrels of produced water were discharged in SWD wells (Figure 1) and 295 million barrels of produced water were injected into EOR wells.

New Mexico is an arid state, receiving an average of less than 15 inches of rainfall per year. While New Mexico has frequently experienced water scarcity throughout its history, New Mexico is

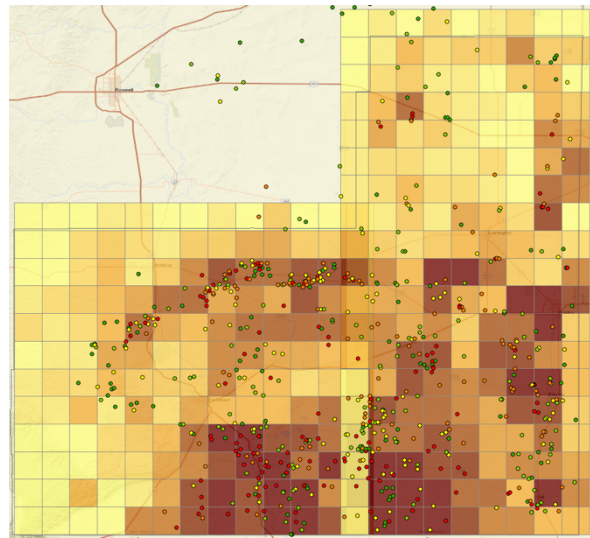


Figure 1. Spatial distribution of 644 active SWD wells in the Permian Basin – New Mexico

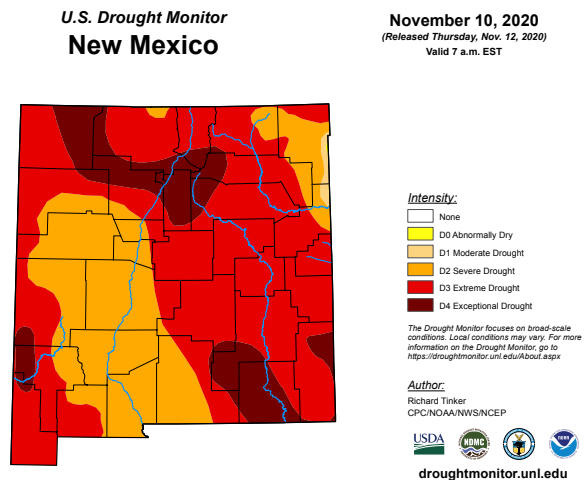


Figure 2. U.S. Drought Monitor – New Mexico

currently in a drought (Figure 2), and droughts are projected to become more intense in the future. Droughts not only challenge New Mexico's agricultural industry but also increase the frequency and severity of wildfires and dust storms [2].

Therefore, New Mexico is considering alternate pathways for produced water management and reuse that address:

- (1) Growing challenges of current produced water underground disposal practices that have been linked to environmental issues such as earthquakes and may not be sustainable in the long-term; and
- (2) Water scarcity and groundwater depletion, which are forecast to increase due to climate change.

Because of varying levels of oil residues, salts, suspended solids, and other chemicals and potential toxins, produced water must first be treated to be used outside the oil and gas sector. Advancements in water treatment technology are creating new and more cost-effective opportunities to treat and reuse produced water while protecting the environment and human health and safety.

PROGRAM OVERVIEW AND RFP

On July 1, 2019, New Mexico House Bill 546, known as the New Mexico Produced Water Act, went into effect. Through the Act, statutory and regulatory authority for the reuse of produced water was modified to include:

- Reuse within the oil and gas sector remains under the Oil Conservation Division (OCD) of the NM Energy, Minerals and Natural Resources Department.
- Treatment, use, discharge, handling, storage and transport for any purpose outside of the oil and gas sector is regulated by the NM Environment Department (NMED) through regulations to be adopted by the New Mexico Water Quality Control Commission (WQCC), as provided in the Water Quality Act (NMSA 1978, §§ 74-6-1 to -17).

In 2019, the NMED and the Regents of New Mexico State University (NMSU) entered into a Memorandum of Understanding (MOU 20 667 12200003, dated September 9, 2019) to create a produced water research consortium to support NMED's implementation of New Mexico House Bill 546. The New Mexico Produced Water Research Consortium (Consortium) was organized pursuant to that MOU to develop a research framework to fill scientific and technical knowledge gaps necessary to establish regulations and policies for the treatment and use of produced water for purposes outside the oil and gas sector. Any future regulations and policies for produced water management must be protective of public health and the environment, rooted in sound science, and consistent with all applicable laws.

The Consortium was also designed to facilitate the development of public-private partnerships to help build and grow future sustainable economic development opportunities through the treatment and use of produced water in the State.

The Consortium is organized as an association that includes: academia, consultants, government agencies, non-governmental organizations (NGOs), oil and gas companies, and technology companies. The objectives of the Consortium generally include:

- Establish a collaborative analysis, research, development, and demonstration program of technical experts from state and federal health and resource agencies, academia, industry, and NGOs,
- Utilize state, federal, academia, and industry capabilities to facilitate technology research, development, and demonstration projects,
- Collect technical data to support science-based, fit-for-purpose, treatment requirements for a range of applications such as industrial, construction, agriculture, rangeland, municipal, aquifer storage, and surface supplies,
- Fill science and technical gaps to better define treatment performance, cost, and health and safety, and economic, social, and environmental risks and benefits of the use of treated produced water, and
- Support NMED in public outreach and education of Consortium findings.

One of the goals of the Consortium is to research how to reduce the cost of treating produced water and to eliminate negative environmental impacts when utilizing the treated produced water for fit-for-purpose uses. However, costs escalate with the level and complexity of treatment required. There are many commercial produced water treatment processes available that include modular and scalable components to treat water volumes ranging from 1,000 to 250,000 barrels of water per day (bbls/d) [5]. However, treatment technologies often are not cost-competitive with the option of SWD well disposal or water reuse for hydraulic fracturing. Sourcing fresh water within the Permian Basin ranges from \$0.15-0.60/bbl on average, while disposal costs typically range from \$0.40-\$1.00/bbl [6].

The identification and verification of the cost and performance of advanced treatment technologies or processes that can either lower the cost or streamline the distribution of treated produced water would be of significant value in reducing the volume of produced water that is disposed of in SWDs, and increasing water availability for fit-for-purpose applications. In addition, these technologies could support extraction or recovery of specific minerals in produced water or treatment residuals as commodities. These may include lower-value, higher-concentration constituents such as Ca, Cl, K, Mg, Na, NH₃; and/or higher-value, lower-concentration trace constituents such as Br, Li, and platinum group metals.

The Consortium seeks proposed research, development, and demonstration projects of innovative solutions, processes, and technologies that will help address the technical issues of 1) cost-effectively treating produced water to create either water resources or mineral products that can be used safely by the public for fit-for-purpose use, or 2) new analysis or monitoring approaches to support fit-for-purpose reuse. The priority Areas of Interest (AOI) identified by the Consortium Technical Steering Committee are as follows:

AOI-1. Research and demonstration of cost-effective and energy-efficient mobile or fixed treatment technologies compatible with both medium and high salinity produced water and their associated constituents, including:

- Pretreatment and selective constituent or contaminant removal,
- Treatment and desalination for constituent and contaminant removal,
- Post-treatment for selective removal of constituents or water conditioning for fit-for-purpose use,
- Minimization and safe disposal of concentrate, byproducts or liquid and solid wastes produced during the treatment processes, or
- Recovery of minerals, chemicals, and other resources from produced water and its treatment residuals.

In this task, all treated water and residuals will need to be returned to the source water storage basin in accordance with all applicable produced water handling, storage and disposal requirements. Though very small volumes may be collected for AOI-2 or AOI-4.

AOI-2. Develop more robust - quicker, more efficient, more accurate, more sensitive, more cost effective - analytical methods for characterization of important produced water constituents for:

- Screening, treatment process monitoring, pre- and post-treatment quality assurance, application monitoring, and regulatory compliance,
- Produced water samples, processed produced waters and associated solid wastes, and residual constituent levels in soils, plants, and biota.

AOI-3. Support New Mexico Produced Water Data Portal development such as:

- Software development and geospatial analysis of produced water quality, quantity,
- Use options and data mining options, to make the data more valuable, accessible, and user friendly, and
- Address general public information access with some data confidentiality requirements.

AOI-4. Technical approaches to establish quantitative risk and toxicology testing and monitoring for produced water reuse applications that:

- Establish improved toxicology and quantitative risk assessment approaches for treated produced water and other waste waters
- Utilize new selected approaches (e.g., whole effluent toxicity (WET) tests and greenhouse studies) to measure and quantify the potential risks and toxicological impacts on plant, soil, species, and bioaccumulation of produced water and waste water reuse
- Establish treated produced water ‘relative risk’ evaluation approaches utilizing toxicity reduction evaluation (TRE) studies of produced and other waters

AOI-5. Develop tools for evaluating fit-for-purpose use scenarios including:

- Temporal and regional variation in produced water availability
- System cost benefit analyses
- Socio-economic, environmental, and ecological benefit cost analyses

A primary role of the Consortium in this RFP is to help proposers or proposal teams develop proposals to conduct bench scale, pilot and field demonstration research and development at sites having Cooperative Agreements with the Consortium to utilize test sites in the Permian Basin, the San Juan Basin, and at the Brackish Groundwater National Desalination Research Facility (BGNDRF) to facilitate testing of actual produced water under real-world operational conditions.

Additional considerations for research and demonstration projects include:

- Proposals are encouraged that have substantial funding outside of the Consortium award, and projects that include proposals for additional outside funding to augment the initial research.
- Inclusion of a strategy for the research to lead to technology commercialization, and/or the involvement of the private sector or a federal/state/county/community partner is strongly encouraged.
- Proposals in response to AOI-1 shall submit a Request for Information of Produced Water Treatment and Reuse Form (Attachment C) to assist in assessing the technical performance and cost-effectiveness of the proposed technology or solution to produced water treatment and reuse.

AWARD INFORMATION

During the Consortium’s solicitation of Expressions of Interest in Consortium meetings in January and July 2020, the Consortium already has more than 30 technology vendors that have requested to participate in this RFP. Many of these vendors have identified their own funding and partners. Others have identified their own funding but need support from the

Consortium in identifying appropriate produced water sources and/or testing locations.

Therefore, while the research and development awards selection is contingent on available funds through Consortium sponsorships, the Consortium plans to support 4-10 projects under this solicitation in 2021, several with minimal Consortium funding. The maximum project duration is one year, and projects that can be completed in 6-9 months are encouraged. The maximum funding for an award is expected to be between \$50,000-\$75,000 from the Consortium. The funding will be on a cost-reimbursement basis whereby recipients shall submit invoices not more often than monthly and not less frequently than quarterly for allowable costs incurred.

ELIGIBILITY

While the RFP is open to any organization, company, or entity, any organization of company selected under this RFP will be required to participate with the Consortium as a member in good standing with the Consortium before proposal awards and project work is started. The 2021 New Mexico Produced Water Research Consortium Membership Agreement is available on the Consortium website at <https://NMPWRC.nmsu.edu>.

Additionally, all projects must be designed and managed such that there is no planned or accidental discharge or release of produced water outside of a permitted OCD oil and gas industry facility.

INTELLECTUAL PROPERTY

Except the intellectual properties (IP) developed by NMSU researchers or jointly developed with NMSU, the Consortium does not intend nor should it be construed to convey, vest, assign or transfer any license of the IP or the Developed IP in the proposed projects to NMSU or to any other entity or third party, including, but not limited to, any affiliates or other entity related in any manner to NMSU. The Consortium does not claim conflict of interest with the IP of technology developers.

INDEPENDENT REVIEW, SELECTION, AND MANAGEMENT POLICY

All proposals will be reviewed by an independent Technical Review Committee (TRC). To help the Consortium review, select, and manage research projects, the Consortium has entered into an agreement with the New Mexico Water Resources Research Institute (NM WRRI) to conduct reviews and project selection, scheduling, funding and management of projects, and coordinate final project data collection, evaluation, and publication. NM WRRI has over 50-years of experience in selecting and managing water modeling,

treatment, and application research, development, and demonstration projects with state and federal agency partners.

The TRC will be created to review proposals and make project selections based on scoring of evaluation criteria in Table 1. The TRC will be comprised of Consortium management, invited and volunteer Technical Steering Committee members, Government Advisory Board (GAB) representatives, and NM WRII invited reviewers. TRC members will be knowledgeable in the field, and will be subject to NM WRII proposal non-Conflict of Interest requirements, and will be subject to NM WRII proposal information confidentiality requirements.

After receiving TRC review recommendations, the awards will be finalized. Upon selection, NM WRII will coordinate the issuance of contracts. For post-award, NM WRII will track each projects' spending, reporting, and deliverables in cooperation with the Consortium and the Project Evaluation Team (PET). NM WRII will verify final deliverables and final project reports in cooperation with the Consortium PET. As with the TRC, the PET will be comprised of 3-5 independent technical experts who are knowledgeable in the field, have no conflict of interest, and will be subject to confidentiality requirements.

SCORING CRITERIA

For proposal selection, the TRC will follow the scoring review rubric identified in Table 1.

Table 1. Proposal Scoring Criteria

Criteria	Points
1. Does the proposal address one or more of the five 2021 AOIs? How?	5
2. Are the proposed 1) research objectives, 2) methodology, and 3) approach of the project clearly described?	10
3. Will the research and development approach and methodology lead to satisfying the research objectives and provide a 1) cost-effective, 2) deployable, 3) environmentally sound solution to produced water reuse?	15
4. Are the project 1) scope, 2) effort, 3) schedule, and 4) costs reasonable in relation to the approach and stated objectives?	10
5. Does the proposal reflect 1) new ideas and/or 2) new approaches to solving/addressing the stated problem?	10
6. Is there adequate availability of 1) equipment, 2) instruments, 3) manpower, and 4) test facilities to complete the proposed work?	10
7. Is the identified team qualified to undertake the proposed work as demonstrated through past 1) training, 2) experience, 3) applications and 4) publication in this or closely related research and/or projects?	15

8. Does the proposal on AOI-1 provide a 1) efficient, 2) cost-effective, and 3) available technology for produced water treatment and reuse based on the submitted Request for Information form (Attachment C)?	10
9. Does the proposal indicate how successful completion of the research or testing will provide a 1) technical or 2) policy solution to the problem or a significant component of the problem?	8
10. Does the proposed project have outside 1) funding, or 2) demonstrate potential to attract substantial outside funding to augment the initial research? Is there 1) an opportunity or 2) process for commercialization?	7
Maximum Total Points: 100 for AOI-1 proposals and 90 for other AOI proposals	

PROPOSAL CONTENT

The technical proposal shall be no more than 10 (ten) consecutively numbered pages. The page limit does not include the cover letter, Principal Investigator (PI) Qualifications, budget and budget justification, and Request for Information form (Attachment C) for AOI-1. Proposals should be created with 12 pt Times Roman font using one-inch margins and single-spaced text. All graphics must be embedded in the text.

Proposals will consist of the following:

1. Cover letter

The cover letter should indicate whether the entire proposal or any segment of it has been supported by outside funding or will be submitted to organizations other than the Consortium for the purposes of obtaining outside funds. The Consortium strongly encourages the leverage of funds and pursuit of outside funding. Submission to other agencies does not preclude consideration of the proposal by the Consortium. The letter must also contain signatures of the PI, co-PI(s), and other administrative and financial contacts.

2. Page One: Topic and Problem Statement

Title: Use a **concise** descriptive title that clearly reflects a specific relationship to each produced water AOI research topic.

Keywords: Select three to five “keywords” suitable for indexing and retrieval. These may be included in the title or may be different than title words.

Priority Topic: Choose one or more of the AOIs:

AOI-1. Treatment technologies

- AOI-2. Characterization methods
- AOI-3. Support data portal development
- AOI-4. Risk assessment
- AOI-5. Evaluation of produced water reuse scenarios

Name of PI and co-PI(s): Include name, address, e-mail, and telephone number.

Project Period: State the project period.

Statement of Problem: State briefly the priority problem to be addressed by the project. This section should not exceed two paragraphs.

Statement of the Results and Benefits Expected: Indicate the results, benefits, or information expected to be gained from the project and how they could be used. Describe in detail any long-term, large-scale plans that might be explored as a result of this proposal, including possible external funding sources. This section should not exceed two paragraphs.

3. Pages Two through Ten: Main Body

Problem and Objectives: This section should contain two major sections. The first section should be a description of the specific produced water problem for each AOI to be addressed, in greater detail than the brief summary on the first page. It should describe the relevance of the proposed project to the problem. The second section should describe the specific project objectives.

Methods, Procedures, and Facilities: Provide sufficient information to permit evaluation of the technical adequacy of approach to satisfy objectives. If the proposed budget includes the purchase of a major item of equipment, a description of the equipment with justification for the need must be included in this section. Or if software development will be part of the project approach, identify the computer software to be purchased.

Current Status of the Technology: Demonstrate the importance of the proposed research based on completed or ongoing activities on the same or related topics.

Other Research Support: Include a brief summary of the proposed project support, pending proposals to other funding agencies, amount of grant or proposal, preceding case studies and/or current status of any of these elements. Show the relationship, if any, of your proposed project to your present involvement in other projects.

4. Financial Plan Summary

Submit a Budget Breakdown (Attachment A) and Budget Justification (Attachment B) using the following line items. All categories should identify specific needs for the Consortium outside funding and provide adequate detail as to use of any funds that may be received from the Consortium.

1. Salaries: For each project member, identify estimated percentage of time in month/hours and the rate of compensation proposed. The use of the Consortium project funds to supplement research salaries resulting in compensation above the regular salary rate is not allowed. .
2. Supplies: Indicate separately the amounts estimated for laboratory, field and/or computer supplies. Provide detail on any specific item that represents a significant portion of the proposed amount. If fabrication of equipment is proposed, list parts and costs separately from other items.
3. Nonexpendable Equipment: Identify individually any item having a useful life of more than one year and an acquisition cost of more than \$5,000 per unit. Each item must be described and justified as to specific need for the project.
4. Mobilization/Demobilization: All estimated costs should be itemized showing the number of trips required and type of trip (field, scientific meeting, conference).
5. Other Direct Costs: Energy, operational and equipment maintenance, sampling, or other costs as appropriate.
6. Total Direct Costs: Sum of all direct costs in items 1-5
7. Indirect Costs will not be allowed.

5. PI Qualifications

PI and co-PI(s) Qualifications: Limit to one page per individual. Include the biographical sketch for the PI and any co-PI(s) using the National Science Foundation format as described below.

(a) Professional Preparation

(b) Appointments

A list, in reverse chronological order, of all the individual's academic/professional appointments beginning with the current appointment.

(c) Synergistic Activities

A list of up to ten examples that are most closely related to the proposed project, demonstrate the broader impact of the individual's professional and scholarly

activities.

6. References

7. Letter/s of Acknowledgement

If the applicant is leveraging funding (in-kind or cost share) in its proposal, it must furnish Letter/s of Acknowledgement from any entity that is contributing additional leveraged resources to the proposed project. Any leveraged resources noted in proposals that are not accompanied by a Letter of Acknowledgement and/or Commitment of in-kind resources, will not be considered for the final score.

PROJECT OPERATION REVIEW, MONITORING AND REPORTING REQUIREMENTS

The award letter will include project operation review, project monitoring schedule, and reporting requirements and a template for progress reviews, progress reports, and the final report. Anticipated content for these reports is described below.

1. Quarterly Reports

Recipients shall submit quarterly project reports by the last day of each quarter to the NM WRRRI Program Manager. The quarterly reports should contain a sufficient amount of information to allow for the reviewers to understand the experimental plan, methods, rationale, project reviews and monitoring by the Consortium, and analysis of data collected. PIs are encouraged to include meeting minutes, project operation information such as graphs, photos, and water quality data in the quarterly report. The quarterly report due dates will be June 30, September 30, December 31, and March 31.

Quarterly reports shall follow the NM WRRRI report template and include the following information:

- a. Brief description of project, research objectives, and methodology as reflected in the proposal
- b. Progress and findings to date including project activities, project reviews, project monitoring, presentations, and new discoveries
- c. Narrative description and relevant explanatory data to illustrate significant accomplishments during the reporting period
- d. Description of unanticipated delays or problems (if any) that may impede performance
- e. An outline of the anticipated activities and adjustments to the project during the next reporting period
- f. Work remaining

- g. Progress of spending in the task showing budget spent and budget remaining with comparison to planned spending
- h. Appendix-water quality data in a specific format as defined by the consortium

Each quarterly report shall include at least two slides (in ppt format) that provide summary information on the project appropriate for viewing by interested parties.

2. Final Technical Completion Report

A final technical completion report shall be submitted by the project period end date to the NM WRI Program Manager. It shall document and summarize the results of the project and will be prepared using NM WRI technical completion report format as follows:

- a. Title page
- b. Disclaimer
- c. Acknowledgements
- d. Informative abstract of 200 words or less
- e. Table of contents (including list of figures and/or tables)
- f. Justification of work performed
- g. Clearly stated project objectives that should reflect those included in the project proposal
- h. Detailed statements indicating the degree to which project objectives were achieved
- i. Review of materials and methods used
- j. Discussion of results and their significance
- k. Principal findings and conclusions
- l. Recommendations for additional research or application
- m. Summary
- n. References
- o. Appendix-water quality data in a specific format as defined by the consortium

Each Consortium PET will provide a data presentation format consistent with the Federal Remediation Technology Roundtable guidelines for each project. PIs must provide the NM WRI Program Manager with an electronic file containing the final technical completion report. After PET review, the report will be published as part of the Consortium technical completion report publication series.

3. Additional reporting guidelines

Investigators are encouraged to pursue publication of the findings of their project in other media especially professional scientific journals, and to make presentations at professional meetings and conferences. Investigators are asked to notify the Consortium of any subsequent publications that may result from the project. All published and presented work

supported through this funding must bear an acknowledgment of support.

Intellectual property is an important aspect of some projects and should be identified so that confidentiality procedures can be followed. NMSU's Arrowhead Center is available for PI support.

Presentations in ppt format are required to be given at Consortium project workshops. PIs must also agree to provide additional project status updates and additional information as required by the Consortium for various reports.

PROPOSAL SUBMISSION INFORMATION

Proposals shall be submitted electronically in PDF format as an attachment to an email message addressed to nmwrrri@nmsu.edu. On the "Subject" line of the email message, include "2021 NM-PWRC Research for the Development and Use of Produced Water." Completed proposals, as described below, must be emailed to nmwrrri@nmsu.edu no later than **5:00 p.m. MST on February 8, 2021**. Successful PIs will be notified by March 18, 2021. The planned project start date is April 1, 2021.

CONTACT INFORMATION

Please contact NM-PWRC and NM WRRI if you have any questions.

Mike Hightower, NM-PWRC Program Director; mmhightower@q.com

Sam Fernald, NM WRRI Director; afernald@nmsu.edu; 575-646-4337

Carolina Mijares, NM WRRI Program Manager; mijares@nmsu.edu; 575-646-7991

REFERENCES

1. EIA. U.S. Energy Information Administration. New Mexico State Profile and Energy Estimate. February 20, 2020. Available at: <<https://www.eia.gov/state/?sid=NM>>. **2020**.
2. USEPA. Oil and Natural Gas Produced Water Governance in the State of New Mexico - Draft White Paper. Prepared by the State of New Mexico and the U.S. Environmental Protection Agency. Agency, E.P., Ed. US EPA and The State of New Mexico: 2018.
3. NMED. New Mexico Environment Department. Produced Water Fact Sheet. Available at: <https://www.env.nm.gov/wp-content/uploads/sites/16/2019/10/Produced-Water-Factsheet_ENGLISH_-FINAL-191010.pdf>. **2019**.
4. OCD. State of New Mexico Oil Conservation Division. OCD Data and Statistics. Available at: <<ftp://164.64.106.6/Public/OCD/>>. **2020**.
5. USDOE. U.S. Department of Energy Request for Information (RFI). Potential Prize Competition titled "Water Security Grand Challenge Beneficial Use of Produced and Flowback Water from Oil & Natural Gas Resource Extraction in the Permian Basin. Issue Date: 10/30/2020. **2020**.
6. Capper, L. Determining the True Cost of Water, Hart Energy, March 1, 2019. Available at: <<https://www.hartenergy.com/exclusives/determining-true-cost-water-177877>>. **2019**

Attachment A. BUDGET BREAKDOWN*

Project Number: (Number will be provided by the application system)

Project Title:

Cost Category	Consortium	Outside Fund	Total
1. Salaries and Wages	\$	\$	\$
- <u>Principal Investigator(s)</u>			
- <u>Others</u>			
Total Salaries and Wages			
2. Supplies			
3. Equipment			
4. Services or Consultants			
5. Other direct costs			
6. Total direct costs			
7. Total estimated costs	\$	\$	\$

* This form is provided as a worksheet only

Attachment B BUDGET JUSTIFICATION (TEMPLATE)

Project Number: (Number will be provided by the application system)

Project Title:

<p>Salaries and Wages for PIs. Provide personnel, title/position, estimated hours and the rate of compensation proposed for each individual.</p>
<p>Salaries and Wages for Others. Provide personnel, title/position, estimated hours and the rate of compensation proposed for each individual.</p>
<p>Supplies. Indicate separately the amounts proposed for office, laboratory, computing, and field supplies. Provide a breakdown of the supplies in each category.</p>
<p>Equipment. Identify non-expendable personal property having a useful life of more than one (1) year and an acquisition cost of more than \$5,000 per unit. If fabrication of equipment is proposed, list parts and materials required for each, and show costs separately from the other items. A detailed breakdown is required.</p>
<p>Services or Consultants. Identify the specific tasks for which these services, consultants, or subcontracts would be used. Provide a detailed breakdown of the services or consultants to include personnel, time, salary, supplies, travel, etc.</p>
<p>Other Direct Costs. Itemize costs not included elsewhere. Costs for services and consultants should be included and justified under “Services or Consultants (above). Please provide a breakdown for costs listed under this category.</p>

Attachment C REQUEST FOR INFORMATION
PRODUCED WATER TREATMENT AND REUSE

Assessment Scenarios / Cost Models Submitted

Please select which of the following usage scenarios you plan to submit a proposal. You may choose to only address high TDS stream (A) , or medium TDS stream (B), or low TDS streams (C), or you may respond to all scenarios (D) if your technology is expected to be effective in all TDS ranges. Also, while the Base case is required for at least one scenario (e.g., irrigation, surface water discharge, etc), the Effluent Reuse Case (e.g., clean brine for hydraulic fracturing) is optional. Please confirm which scenarios you believe your technologies are suited to address and for which you plan to submit a proposal:

A. High TDS (>100,000 mg/L) unconventional produced water

- Base Case
- Effluent Reuse Case

B. Medium TDS (40,000 – 100,000 mg/L) conventional produced water

- Base Case
- Effluent Reuse Case

C. Low TDS (<40,000 mg/L) brackish water, seawater, and some conventional produced water

- Base Case
- Effluent Reuse Case

D. All TDS

- Base Case
- Effluent Reuse Case

Influent Water Specifications

Influent Specifications: as shown in Table 2.

Table 2. General Water Quality of Different Produced Waters Expected to Be Treated*

Parameters	Unit	Low TDS	Medium TDS	High TDS
pH		6.8	6.8	6.8
Temperature	°C	35-40	35-40	35-40
Total suspended solids	g/L	15	15	15
Turbidity	NTU	50-55	50-55	50-55
Total dissolved solids (TDS)	mg/L	~25,000	~100,000	~150,000
Total organic carbon	mg/L	150	150	150
Dissolved organic carbon	mg/L	120	120	120
Diesel Range Organics (C10-C20)	mg/L	30	30	30
Gasoline Range Organics (C6 - C10)	mg/L	25-30	25-30	25-30
Motor oil/lube range organics (C20-C34)	mg/L	20	20	20
Benzene	mg/L	170	170	170
Toluene	mg/L	2.0	2.0	2.0
p-Xylene	mg/L	0.2	0.2	0.2
Ethylbenzene	mg/L	100	100	100
Alkyl Naphthalene	mg/L	2.0	2.0	2.0
Chloride	mg/L	12,000	60,000	90,000
Bromide	mg/L	120	650	950
Iodide	mg/L	10	20	430
Sulfate	mg/L	150	800	1,200
Total Alkalinity as HCO ₃ ⁻	mg/L	180	900	1,300
Aluminum	mg/L	1	3	4
Ammonium (NH ₄ ⁺)	mg/L	300	600	600
Barium	mg/L	1	3	4
Boron	mg/L	5	20	30
Calcium	mg/L	500	2,500	3,800
Iron	mg/L	10	40	60
Lithium	mg/L	1	6	10
Magnesium	mg/L	100	400	600
Manganese	mg/L	0.1	1	1
Phosphorous	mg/L	<1	<1	<1
Potassium	mg/L	100	600	800
Silicon	mg/L	2	10	15
Sodium	mg/L	7,00	35,000	50,000

Strontium	mg/L	50	300	400
Sulfur as H ₂ S	mg/L	60	300	500
Uranium	mg/L	0.2	0.5	0.5
Zinc	mg/L	0.6	1	1

* Based on general New Mexico produced water quality data

Effluent Specifications

In the Effluent Specification, the following should be specified:

- Volumes effluent available (e.g., water recovery per scenario and case)
- Characterization of effluent (what constituents will be removed or reduced? Which constituents will remain? At what concentrations?)

Base Case: Below is a list of general fit-for-purpose water quality levels based on a current understanding of various applications, industry trends, and different state guidance reviewed.

Wholesale water index: 3000-4000 mg/L

Groundwater recharge - drinking water: < 500 mg/L and EPA primary drinking water standards

Brackish aquifer recharge: <2500 mg/L and EPA secondary drinking water standards

Agriculture/Dairy: 1000-2000 mg/L, Boron <1 mg/L, Sodium adsorption ratio (SAR)<12

Rangeland: 2000-5000 mg/L, Boron <2 mg/l, SAR <15

Industrial: 100-1000 mg/L

Thermoelectric cooling water: 500-15,000 mg/L

Road grading/maintenance/construction : 10,000 – 30,000 mg/L

Treated Produced Water Re-Use Case or Produced Water Pre-treatment:

As noted in the RFP, all treated produced water associated with a project under AOI-1 must be disposed of within permitted oil and gas facilities. Proposals contemplating pre-treatment of produced water should meet the following emerging industry standards as proposed by the Produced Water Society including:

- pH 6-8
- Turbidity < 25 NTU
- Oxidation Reduction Potential (ORP) - 250-350 mV
- Oil < 30 mg/L – no sheen
- H₂S non-detectable
- Particle size filter < 25 micron

Expected System Operational Performance Summary

Onsite or offsite treatment system: _____

Selected reuse application: _____

Expected project treatment cost target: _____ \$/bbl

Expected project total treatment throughput target: _____ gallons or bbls

Avg. process throughput: _____ gal/hr or bbl/hr

Expected project duration: _____ weeks

Daily operation: _____ hrs/per day

Expected system operational availability (maintenance) : _____ %

Technology Readiness Level (Table 3): _____

Water recovery : _____ % by initial water influent volume

Treated Water Quality _____ comparison to initial water quality

Waste Recovery: _____ % by initial water influent volume

Wastewater quality: _____ comparison to initial water quality

Energy requirement: _____ kWh/day or MMBTU/day and type

Chemicals/consumables used _____ by weight or volume per bbl treated

Mobilization period from time of approval: _____ weeks

Setup and Shakedown testing on site: _____ weeks

Demobilization period following project completion: _____ weeks

Rental equipment needs and costs: _____ Type and \$/week

Operator/personnel hours: _____ person hrs/week of operation, by job category

Total System Footprint: _____ square feet (for mobile and field test systems)

Process Monitoring Schedule: _____ Type and Locations, times/day, constituents

Sampling Schedule: _____ Type and Locations, times/week, constituents

Sampling/monitoring total Costs: _____ \$/week

Table 3. Technology Readiness Levels Definitions and Descriptions

Technology Readiness Level, or “TRL” is a widely used industry indicator of maturity of development of a technology toward commercialization using a scale of 1-9, with 9 being fully deployment and commercialization ready.

TRL 1 - Basic Research: Initial scientific research has been conducted. Principles are qualitatively postulated and observed. Focus is on new discovery rather than applications.

TRL 2 - Applied Research: Initial practical applications are identified. Potential of material or process to solve a problem, satisfy a need, or find application is

TRL 3 - Critical Function or Proof of Concept Established: Applied research advances and early stage development begins. Studies and laboratory measurements validate analytical predictions of separate elements of the technology.

TRL 4 - Lab Testing/Validation of Alpha Prototype Component/Process: Design, development and lab testing of components/processes. Results provide evidence that performance targets may be attainable based on projected or modeled systems.

TRL 5 - Laboratory Testing of Integrated/Semi-Integrated System: System Component and/or process validation is achieved in a relevant environment.

TRL 6 - Prototype System Verified: System/process prototype demonstration in an operational environment (beta prototype system level).

TRL 7 - Integrated Pilot System Demonstrated: System/process prototype demonstration in an operational environment (integrated pilot system level).

TRL 8 - System Incorporated in Commercial Design: Actual system/process completed and qualified through test and demonstration (pre-commercial demonstration).

TRL 9 - System Proven and Ready for Full Commercial Deployment: Actual system proven through successful operations in operating environment, and ready for full commercial deployment