OIL AND GAS RESEARCH PROGRAM PROJECT MANAGEMENT REPORT

Reice Haase, Deputy Executive Director, NDIC

December 8, 2022

NORTH Dakota

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Oil and Gas Research Program (247)			
Financial Statement - Cash Balance			
2021-2023			
November 14, 2022			
		Cash Balance	
July 1, 2021 Beginning Balance	$16,283,145.53		
Oil and Gas Tax Revenues through September 30, 2022		$14,500,000.00	
Transfer from the SIIF Fund		$9,500,000.00	
Interest/Other Income through September 30, 2022		$24,752.95	
Total Revenues		$24,024,752.95	
Expenditures through September 30, 2022			
Transfer to the Pipeline Authority Fund		$600,000.00	
Salt Cavern Study (Legislative Directed) (Contract 104)		$395,284.53	
Underground Storage (Legislative Directed) (Contract 92)		$616,800.00	
Legislative Directed Studies (Contracts 101 & 105)		$278,207.44	
Oil and Gas Research Projects		$3,393,552.18	
Oil and Gas Education Projects (Con. 91 & 102)		$417,077.93	
Oil and Gas Education College of Petroleum Engineering (Con.100)		$1,791,127.09	
Administrative Expenditures through September 30, 2022		$101,801.15	
Total Expenditures		$7,593,850.32	
Cash Balance as of September 30, 2022			$32,714,048.16
Outstanding Research Contract Commitments/Emerging Issues	-$10,282,992.84		
Outstanding contracted Legislative Directed Cavern Study	-$12,590,915.47		
Outstanding contracted Legislative Directed Studies	-$903,417.23		
Outstanding Education Contract Commitments	-$947,170.36		
Outstanding Petroleum Engineering Oil & Gas Research	-$3,976,872.91		
Outstanding Pipeline Authority Commitment	$0.00		
Estimated administrative expenses for 2021-2023 biennium	-$198,198.85		
		-$28,899,567.66	
Non-committed Cash Funding			**$3,814,480.50**
Estimated Revenues for 2021-2023 Biennium			
Oil and Gas Tax Revenues	$14,500,000.00		
SIIF Fund	$9,500,000.00		
Interest & Other Income	$25,000.00		
		$24,025,000.00	
2021-2023 Budget Allocation		Committed	Balance
Administration	$300,000.00	$300,000.00	$0.00
Pipeline Authority Transfer	$600,000.00	$600,000.00	$0.00
Legislative Directive Cavern Study	$9,500,000.00	$12,986,200.00	($3,486,200.00)
Legislative Directed Studies	$4,300,196.00	$1,798,425.00	$2,501,771.00
Petroleum Engineering Oil & Gas Research	$5,768,000.00	$5,768,000.00	$0.00
Oil and Gas Education Projects	$2,667,678.00	$1,364,248.29	$1,303,429.71
Oil and Gas Research Projects	$17,172,271.00	$13,676,545.02	$3,495,725.98
	$40,308,145.00	$36,493,418.31	$3,814,726.69
11/14/22			

ACTIVE PROJECTS

22

Active Projects

$12.7 Million

Paid To Date

$41.4 Million

Awarded Dollars

$28.7 Million

Outstanding Committed Dollars

G-045-087: SOLAR POWERED ELECTROKINETIC SOIL DESALINIZATION

- START DATE: SEPTEMBER 5, 2018
- USED DIRECT CURRENT TO REMEDIATE SOILS IMPACTED BY BRINE RELEASES
- SODIUM AND CHLORIDE ATTRACTED TO CATHODE AND ANODE, EXTRACTED
- REDUCED CHLORIDE CONCENTRATIONS TO 1/3 OF INITIAL CONCENTRATIONS OVER 3-YEAR PERIOD
- USING SOLAR VS. TRADITIONAL POWER SOURCE SAVED $440,000/YEAR

- OGRP: $149,960 OF $346,120 PROJECT

Contract No. G-045-087
"Solar Powered Electrokinetic Soil Desalinization"
Submitted by: Terran Corporation & Oasis Petroleum
Principal Investigator: Christopher Athmer

PARTICIPANTS

Sponsor	**Cost Share**
Terran & Oasis (cash & in-kind)	$196,160
North Dakota Industrial Commission/OGRC Funding	$149,960
Total Project Cost	$346,120

Project Schedule – 3 years
Contract Date – September 5, 2018
Start Date – September 5, 2018

Project Deliverables:
Status Report: December 1, 2018 ✓
Status Report: June 1, 2019 ✓
Status Report: December 1, 2019 ✓
Status Report: June 1, 2020 ✓
Status Report: December 1, 2020 ✓
Status Report: June 1, 2021 ✓
Final Report: December 1, 2021 ✓

OBJECTIVE/STATEMENT OF WORK:
The objective of this project is to demonstrate the viability and cost effectiveness of using direct current (DC) power to reduce the sodium and chloride mass contamination in soil and groundwater from brine releases. Typical releases may be from leaking pipelines or storage pit. A secondary objective is to integrate an electrokinetic (EK) remediation system with solar power. Since the EK process relies on DC power to induce migration of chloride and sodium ions (as well as other soluble ions) to emplaced electrode wells, solar panel arrays that generally provide 24-48 volts, could prove to be the ideal power source at remote sites, or eventually any site. This project will include the design, installation and operation of solar powered EK soil desalinization system along with soil monitoring and reports showing the efficacy of the process and comparison to previous traditional remediation efforts. Soil near the Schmitz pad site near Williston, North Dakota became contaminated due to a leaky flange in a brine pipeline. Oasis Petroleum and Terran Corporation found the site to be suitable for the electrokinetic soil desalinization (EKSD) process to extract the salt contamination from the soil using a proprietary extraction system based on electromigration techniques.

The EKSD process is an effective and economical alternative to conventional excavation or pump and treat. The goal is to remove as much chloride and sodium mass as practical. This project will demonstrate the ability to operate the system using solar power at remote sites where line power is not available, and generators are not economically viable.

STATUS
The Contract has been executed.

December 2018
Due to the extended negotiations with the landowner at the test site, the project was delayed. Most of the equipment and materials was ordered and delivered to Oasis. The electrodes were assembled and

installed, but not connected to the solar panels. Also, the field site data acquisition system with remote communications was assembled and tested.

The design was also altered due to proximity to a vernal stream running through the site. For this pilot test, the treatment area will be reduced and limited to areas around the 3 most contaminated monitoring wells. If high chloride removals are seen, more electrodes may be added. The system is under construction and will begin operations April-May 2019.

A copy of the complete status report is available on the website.

June 2019

In mid-April, the solar panels were installed by Stealth Energy, OneCor and AET. Later in April, the electrical wiring was completed, as was the pump and tubing for the discharge collection system. The data system was installed and connected to allow remote monitoring. At startup in late April, a complete electrical current survey was done and matched the modeled output satisfactorily. A site visit in mid-May was made to optimize the system by adding 4 more panels for the MW-3 cluster because it was current limiting. Additional thermocouples and a water level transducer were also added to the data system.

The system is operating close to what was predicted by our model. The MW-3 cluster needed a few more panels to bump the voltage up to the other 2 clusters (MW-4 and MW-5). The MW-3 cluster appears to be more conductive than the other areas (MW-4, MW-5 areas), in agreement with the site data. Each of the 3 panel/EK clusters is yielding about 32-35 volts and 50 to 80 amps (1800 to 2700 watts) during a sunny day. On a cloudy day, the operational voltage may only be 10-20 volts.

A copy of the complete status report is available on the website.

December 2019

During the summer, the system was operated continuously with no interruption on the solar side. The electrode water extraction is accomplished using multi-head peristaltic pumps powered by constant speed gear motors at 20 RPM. The fluid is withdrawn from each electrode well by way of siphon tube, through the peristaltic pump head, and into a storage tote for future disposal. There were issues early on with tubing being chewed on by rodents and leaking pump tubing and connectors. Those issues were resolved over time this summer. By August, the system was operating smoothly.

The system operated a bit below what was predicted by our model. The primary reason was the weather in North Dakota this summer. The groundwater data collected prior to and after 2019 operations show little change in at the monitoring wells MW-3, MW-4 and MW-5. There was a minor increase of chloride at MW-3 and a minor decrease at MW-5 and no significant change of chloride concentration at MW-4. However, the fluid removed at the anode electrode wells indicates a much higher concentration of chloride (5,000 to 40,000 mg/l) than the monitoring wells (3000 – 10,000 mg/l). This indicates a substantial attraction of chloride to the anodes. A total of just under 500 gallons of brine-contaminated groundwater was removed. The volume was lower than anticipated but is a good starting data point. The pump rates next season will be increased. An increase in pump rates should help reduce the buildup of ions at the electrodes and help remove more ions.

Additional details available in the full report.

June 2020

The system was shut down for the winter in early October 2019 and restarted at the end of April 2020. The winter shut down is due to the impracticality of keeping everything from freezing during the cold North Dakota winters and the lack of solar incidence.

During the winter, we left one of the solar banks, MW-3, connected in order to follow the solar output during the winter months. The daily (24-hr) average voltage profile showed that during the winter months, the output is less than half of the output during the summer months. This was expected and confirms the lack of progress that can be made during the winter months the system is shut down.

Since the spring 2020 startup, we have experienced some issues with the data system. Two of the well groups (MW-3, MW-4) began recording irregular voltage and current readings. They are presently being repaired. The troubleshooting process can be slow due to lack of direct cell phone reception in the valley and the impracticality of site travel for Terran personnel during the Covid-19 crisis. This basically requires remote troubleshooting over phone to field support agents who need to drive a short distance from the site to communicate with cell phones.

For this summer, we have increased the pump speed and fluid withdrawal. The pump motors were upgraded to 50 RPM, or higher, up from the current 20 RPM which should increase the flow by 2.5 times or more.

December 2020

The EK system operated well for most of the summer other than some a period with intermittent data recovery due to rodents and varmints chewing on instrument lines. The rodent issues started during the spring 2020 startup when we experienced some issues with the data system. Two of the well groups (MW-3, MW-4) began recording irregular voltage and current readings. They were repaired. However, the issues returned mid-summer. From early July to August 1, the data was again erratic and unreliable due to chewed wires. The system was operating and removing sodium and chloride during that time. However, we do not have reliable voltage and current data recordings during that time.

For this summer, we increased the pump speed and fluid withdrawal. The pump motors were upgraded to 50 RPM, up from the current 20 RPM which should increase the flow by 2.5 times. A total of 1,135 gallons chloride and sodium rich water was removed at the electrodes by the pumps.

Another issue this year was the lower water table than last. For an extended period through July and August, MW-4 cluster was shut down due to low water in that area. Running the anodes with limited water could cause drying and overheating of the anodes and permanent damage. After some August rain events, the MW-4 cluster was turned back on.

June 2021

The EK system was shut down for the winter months. Due to the well pad being de-energized for well pump removal this winter, the data system was also shut down for an extended period with no additional solar data collected.

In March, groundwater samples were collected from the monitoring wells along with soil samples at selected distances between anodes and cathodes. The soil samples (saturated paste method) showed a general trend of chloride concentrations increasing near the anodes, even after 5 months of the system shut down.

The groundwater samples from MW-3, MW-4 and MW-5 all continue to show a reduced chloride concentration since the start of the project in 2018. All 3 monitoring well chloride concentration are approximately 1/3 of the 2018 concentrations.

In November 2020, soon after shut-down, the EK wells were sampled and showed very high concentrations of chloride in the anode wells (average 22,900 mg/l) and very high sodium concentrations at the cathodes (average 36,400 mg/l). This data, along with the soil paste data indicate electromigration due to the EK system is working well. However, the extraction at the electrodes must be increased to remove more of the ions. The ions are accumulating at the electrodes at a faster rate

than they are being removed. There was originally a concern for an overall lack of groundwater, but the rate of extraction must be increased. For this summer, the pump head size and speed are being increased to significantly increase water withdrawal at the electrodes.

March 2022

Final report received. Final report includes figures showing sodium and chloride concentration declines during the project period. Discussed cost-effectiveness and comparison of using DC power vs. other remediation techniques with Dustin Anderson on a 7/29/2022 phone call. Per the phone call with Dustin Anderson, the solar project resulted in a cost savings of over $440,000 vs. traditional power.

The report concludes that the project was a moderate success. Primary challenges were a loss of line power for the pumps, rodent damage to power lines, and reliability of micro pumps for field applications and corrosive fluids. The report suggested that increased water pumping from electrode wells was needed to effectively remove chlorides from anode wells. Overall, operating an electrokinetic remediation system on solar power with 12-volt peristaltic pumps was found to increase reliability and reduce maintenance.

Updated 9/1/2022

CONTACT INFORMATION

- **Reice Haase, NDIC Deputy Executive Director**
  - **701-651-7350**
  - **rhaase@nd.gov**