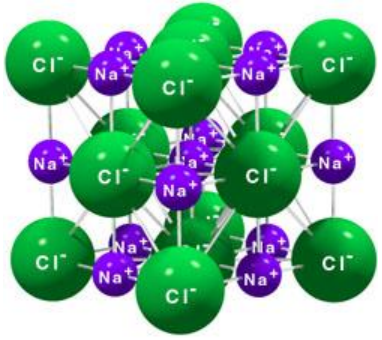
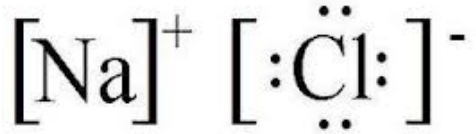
Advances in Impacts Recovery From Electrokinetics Soil Remediation





Presented by: Dustin Anderson and Shane Ewert

Grant Applicant: Stealth Energy Group

Grant Partners: Oasis Petroleum, EOG Resources, North Dakota State University

Presentation for North Dakota Industrial Commission – Oil and Gas Research Council
February 23, 2022

Presentation Overview

- How the EK research grant proposal supports North Dakota Oil and Gas Research Program’s goals and mission Statement
- Introduction to the Eletrokinetincs Technology
- Project Overview and Deliverables
- Project Budget
- Response to Technical Review
- Questions

Comments from Technical review

- Wide spread adoption, knowledge share – this technology has been around and used to remediate various containments including NaCl. An objective of this proposal is to develop publicly available resources that make it more digestible and user friendly

- Scientific/Technical contributions that address the North Dakota Industrial Commission and Oil and Gas Research Program Goals

- References to EK technology and use to remediate disturbed lands – refer to final slide of this presentation

- Milestones and communication plan – addressed on slide 10

North Dakota Oil and Gas Research Program (OGRP)

The Mission of the Oil and Gas Research Council is to promote the growth of the oil and gas industry through research and education:

- **Educate general public on the importance of the state oil and gas exploration and production industry,**
- **Encourage and promote the wise and efficient use of energy,**
- **Promote environmentally sound exploration and production methods and technologies,**
- Develop the state's oil and gas resources, and,
- **Support research and educational activities concerning the oil and natural gas exploration and production industry.**

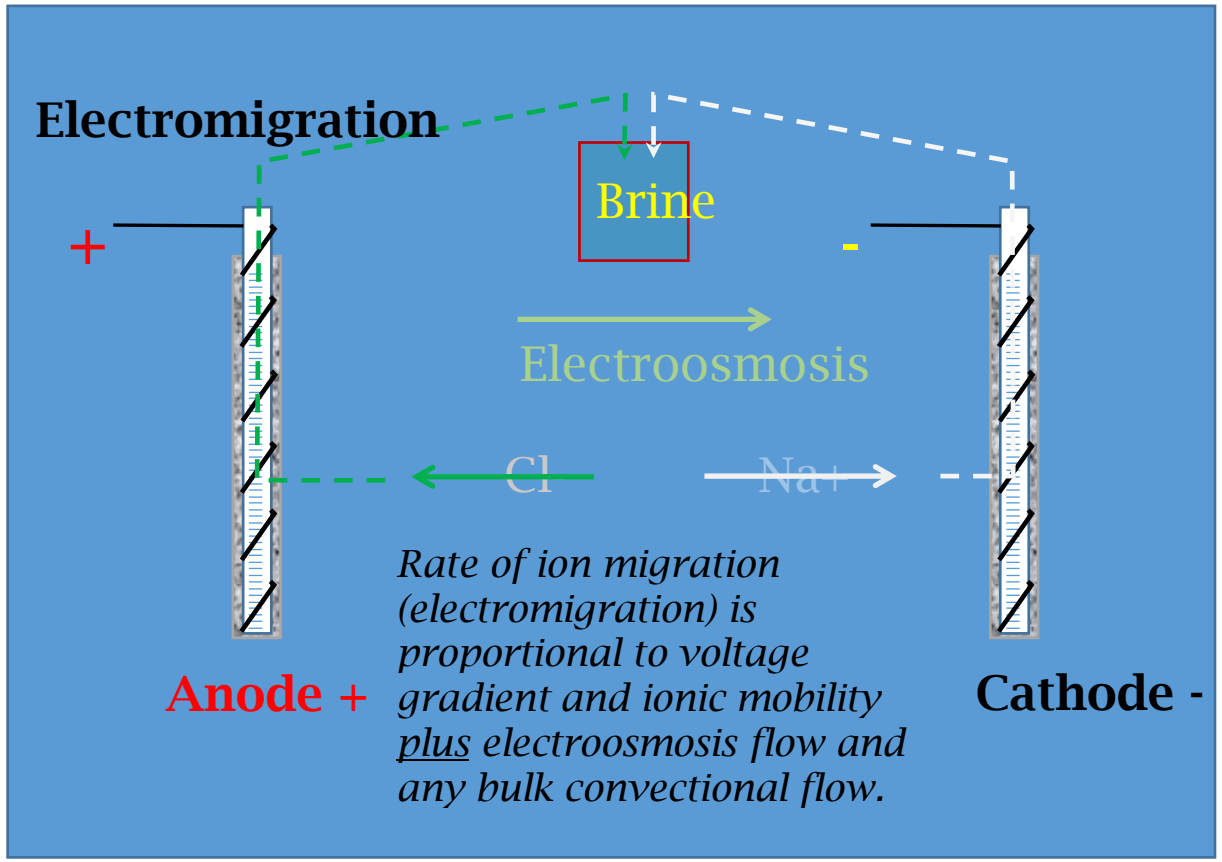
Why is this Project Important to Oil and Gas in North Dakota?

- The unintended release of oil and gas produced fluids can have lasting impacts on farm and rangelands
- There are few sustainable remediation options – even fewer available for sensitive areas
- Most remediation options remove soil or take decades to remediate
- There is limited communication between stakeholders – industry and landowners

What are the deliverables?

- Improved knowledge and use of the EK remediation technology
  - Improved contaminant recovery – **new well design and modified pumps**
  - Use in dry lands – **subsurface irrigation data**
  - Publicly available model to design, develop, and run EK treatment systems – **bench testing lab at NDSU**
  - Public outreach through **NDSU Extension** to improve education and communication with government, industry and landowners
  - Other applications for the EK technology – **cutting pit reclamation or containment, nutrient/salt accumulation of Ag lands and surface and ground water**

What is Electrokinetics (EK)?

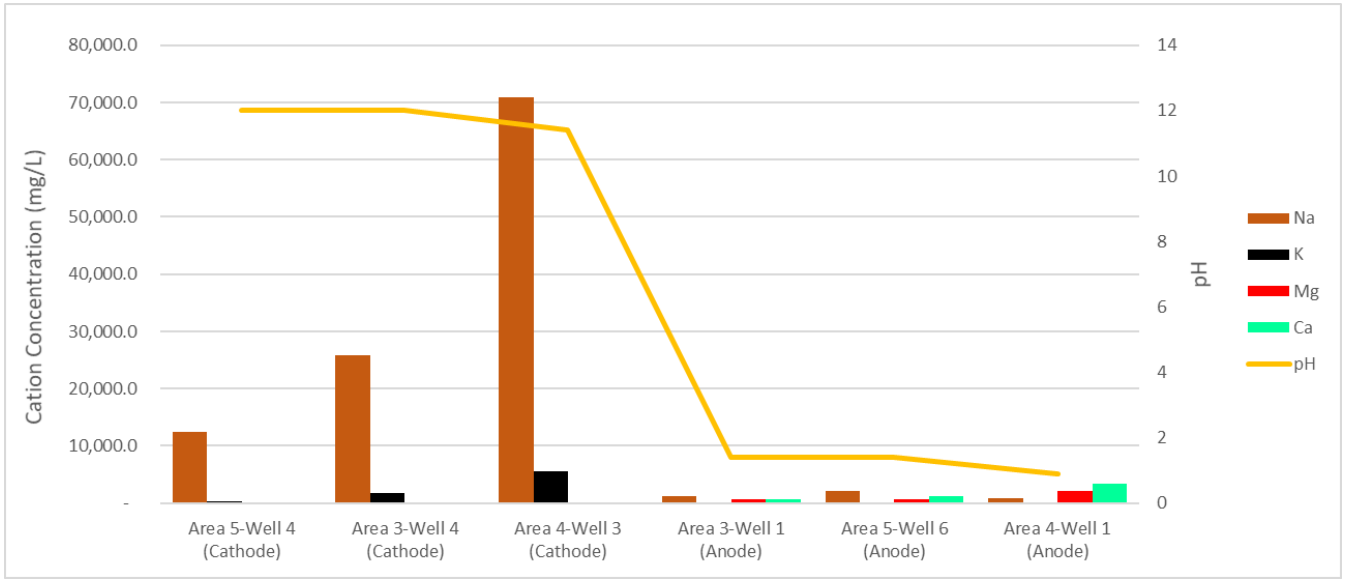


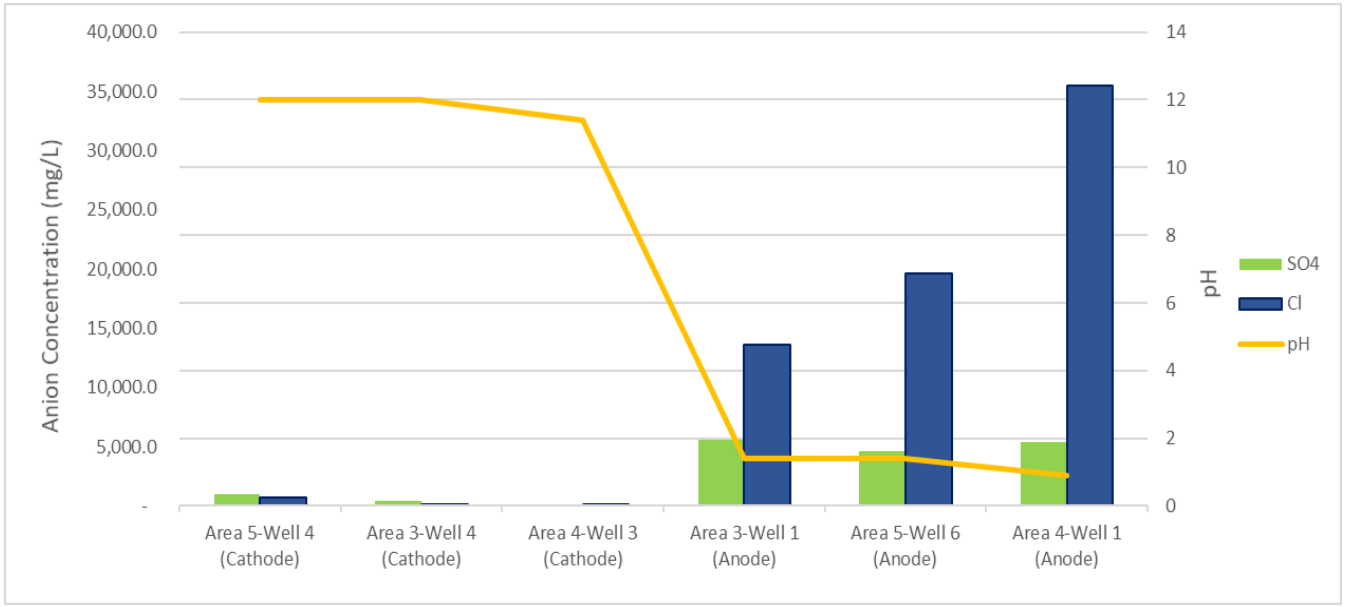
- Electroosmosis – movement of pore water and dissolved contaminants toward the cathode

- **Electromigration** – migration of ionic species toward respective electrodes (*anions toward anode, cations toward cathode)* by electrical attraction
  - EM ~ 10 x EO, depending on size and charge

Sodium comes out fast but chloride is much slower.

EK Challenge(s)





Key Takeaways:

- **Ions (NaCl) can be moved in weeks to months**
- Strong alkaline Front at the cathode
- Strong acid front at the anode
- **Small footprint**
- Recovered contaminant can be disposed by deep well injection
- **Easy to operate**

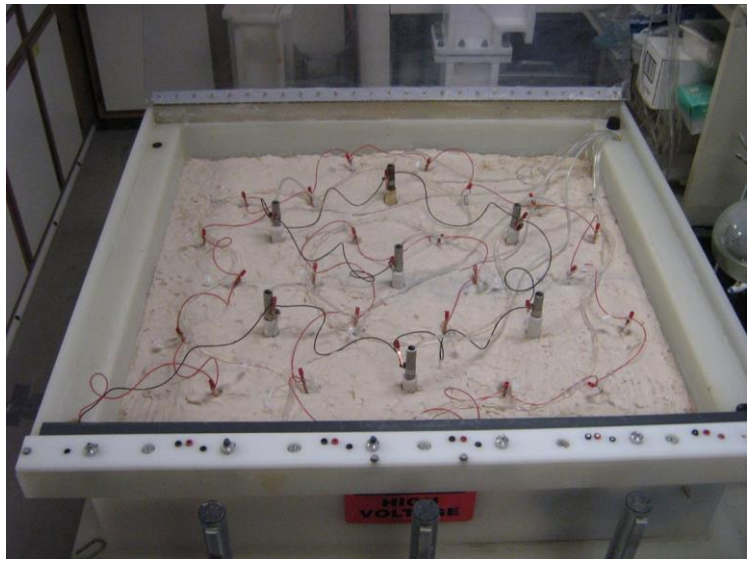
Challenges:

- **Chloride mounding at the anode**
- Clay dispersion at the cathode
- **Currently only used in saturated soil**
- **Not easy to design**
- **Few people understand the technology**

Project Scope of EK Remediation Grant

Oasis Project – install 2” sand packed wells and work with different pumps and pump rates to overcome ion mounding at the electrode. Three cells (27 wells) will be installed and operated for two seasons. Groundwater and soil data will be collected and reported to demonstrate success

EOG Project – install subsurface irrigation system to supply enough soil pore water to carry the electrical current and to remove the salts. Two EK treatment cells and a subsurface drip irrigation system will be installed and operated for at least 2 field seasons. Soil and recovered water data will be collected and reported to demonstrate success.



NDSU – prepare a bench scale treatment cell where industry can send impacted soil samples. The samples can be tested and modeled to develop a treatment design.

NDSU Extension will be utilized to bridge communication and knowledge gaps between all stakeholders.

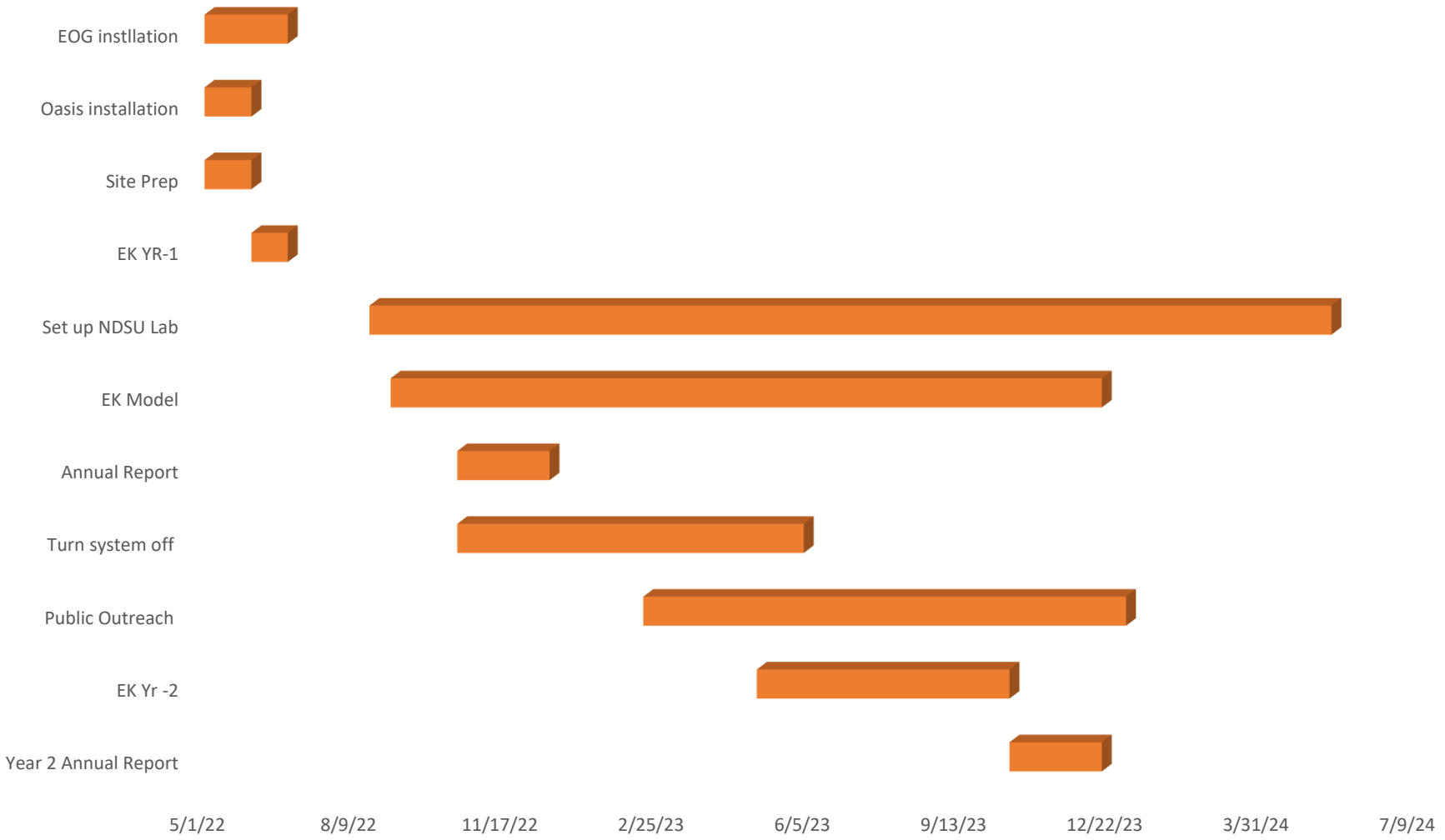
NDSU NORTH DAKOTA STATE UNIVERSITY

Project Budget

Project Associated Expense	NDIC's Share	Applicant's Share (Cash)	Applicant's Share (In-Kind)	Other Project Sponsor's Share
Site Prep - Direct	$0	$0	$22,000	Stealth
Site Prep - Investigation	$0	$0	$14,500	Stealth
System Design - Labor	$124,040	$0	$25,000	EOG
Equipment/Materials	$125,960	$0	$45,000	Oasis
Installation - Direct	$0	$0	$48,000	EOG/Oasis
Installation - Labor	$0	$0	$38,160	EOG/Oasis
Operations - Direct	$0	$0	$30,000	EOG/Oasis
Operations - Labor	$0	$0	$30,000	EOG/Oasis
Monitoring - Direct	$0	$0	$40,000	EOG/Oasis
Monitoring - Labor	$15,000	$0	$0	
Demobilization - Direct	$0	$0	$20,000	EOG/Oasis
Demobilization - Labor	$0	$0	$0	
Totals	**$265,000**		**$312,660**	

- NDIC Share will be put towards bench scale lab and model development ($137,982) and purchase irrigation system and pumps ($127,018)
- Stealth will go towards labor of field efforts for both EOG and Oasis projects ($36,500)
- Oasis Share will go towards field testing at the Schmitz – development of pumps and wells ($148,080)
- EOG Shares will go towards field testing and development of subsurface irrigation strategies ($128,080)

Project Milestones and Communication Plan



Scientific References

I. Hassan et al., 2015. *Solar powered electrokinetic remediation of Cu polluted soil using a novel anode configuration.* Electrochimica Acta 181. pg 58-67.

K. Do-Hung et al., 2012. *Hexagonal two dimensional electrokinetic system for restoration of saline agriculture land: A pilot study*. Chemical Engineering Journal 198-199. pg 110-121.

J. Virkutyte et al., 2002. *Electorkinetic soil remediation – critical overview*. The Science of the Total Environment 289 pg 97-121.

Local use:

Oasis Connie remediation – used EK to remediate brine impacted prairie-pot hole in Northwester, ND. Not published but data is available upon request or publicly available from the ND DEQ.

C. Athmer et al,. 2019. *Development of a Solar Powered Electrokinetic Desalinization system*. IPEC Conference talk – not published but available upon request.