#### Brine spills: Causes, Consequences, and Remediation

Kerry Sublette Sublette Consulting, Inc.



#### UNDERSTANDING RISKS OF MANAGING OIL AND GAS WASTEWATER



### Produced water spills are all too common

- Huge volumes of produced fluids (oil + brine) generated and moved by pipeline to tank batteries
- Costly management and disposal; brine moved by pipeline and truck to injection wells
- Highly corrosive and damaging to infrastructure
- Produced water management cost money, it does not make money!

## Spills of produced water or brine on soil result in two types of damage:



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Excess salinity

- Creates an osmotic imbalance that reduces water uptake by plant roots. Plants can go into drought stress even though there is plenty of water in the soil.



## Spills of produced water or brine on soil result in two types of damage:



- Excess sodicity (an excess of sodium)
  - Destroys soil structure by dispersing clays
  - Produces a hardpan that will not transmit water
  - Erosion

Both salinity and sodicity must be addressed in any successful remediation of a brine impacted site

# *In situ* vs. *ex situ* remediation of brine spills

- Ex situ (dig and haul)
  - Sometimes required for immediate protection of an environmental receptor
  - Excavation destroys thousands of years of soil development
  - Replacement soil may be or poor quality and different chemical and physical properties and/or contain invasive species
  - Plant communities on replacement soil will be totally different from the original
  - Ex situ sites are typically more subject to erosion and soil compaction, struggling plant communities, diminished productivity, shallow root penetration, etc.

# *In situ* vs. *ex situ* remediation of brine spills

- In situ
  - Minimally disrupts soil integrity, generally results in more productive plant communities comparable to pre-spill conditions
  - In situ treatment generally not suitable with shallow water tables due to high probability for groundwater contaminations
  - In situ treatment is much less costly that ex situ treatment but requires more time

### Remediation of a Brine Spill In Brief

- First response
  - Flushing and containment
- Reducing salinity
  - Breaking open the soil
  - Bulking agents
  - Fresh water
  - Drainage
- Reducing sodicity
  - Soluble calcium ion to reverse sodic reaction with clays
- Revegetation
  - Taking advantage of plant root systems

### Remediation of a Brine Spill: What Goes Wrong?

- The number 1 reason for failure of *in situ* remediation of a brine spill on soil is a lack of understanding of the basic processes of
  - flushing the salinity,
  - drainage and handling of leachate, and
  - reversing sodicity.
- There is no magic bullet! It's science and engineering.

#### Total Disolved Solids from the Produced Waters Database in the United States



















### What you will hear this afternoon

- The basics of *in situ* remediation and what we learn from what goes wrong
- Advanced site characterization
- Advances in electrokinetics
- Site reclamation and restoration meeting regulatory and landowner standards
- Case studies from ND