

# **Oxidant Dispersal in Tight Clay Formations using EK-OX Technology**

**Ground Effects Environmental  
Services Inc.**

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# Presentation Overview



- **Recap (RemTech 2010)**
  - Technology Overview
- **2010 / 2011 Site**
  - Background
  - EK-OX Implementation
  - Current Status
- **Future Site(s)**
  - Fall 2011
  - Winter 2012

# Electrokinetic Phenomena

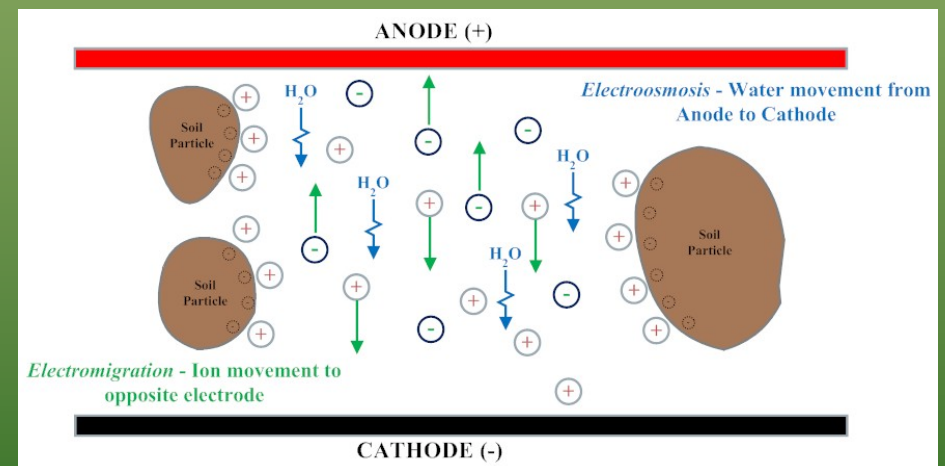


## •3 Key Principles (but not limited to...)

– Electrochemical redox

– Electromigration

– *Electroosmosis*



# Electroosmosis

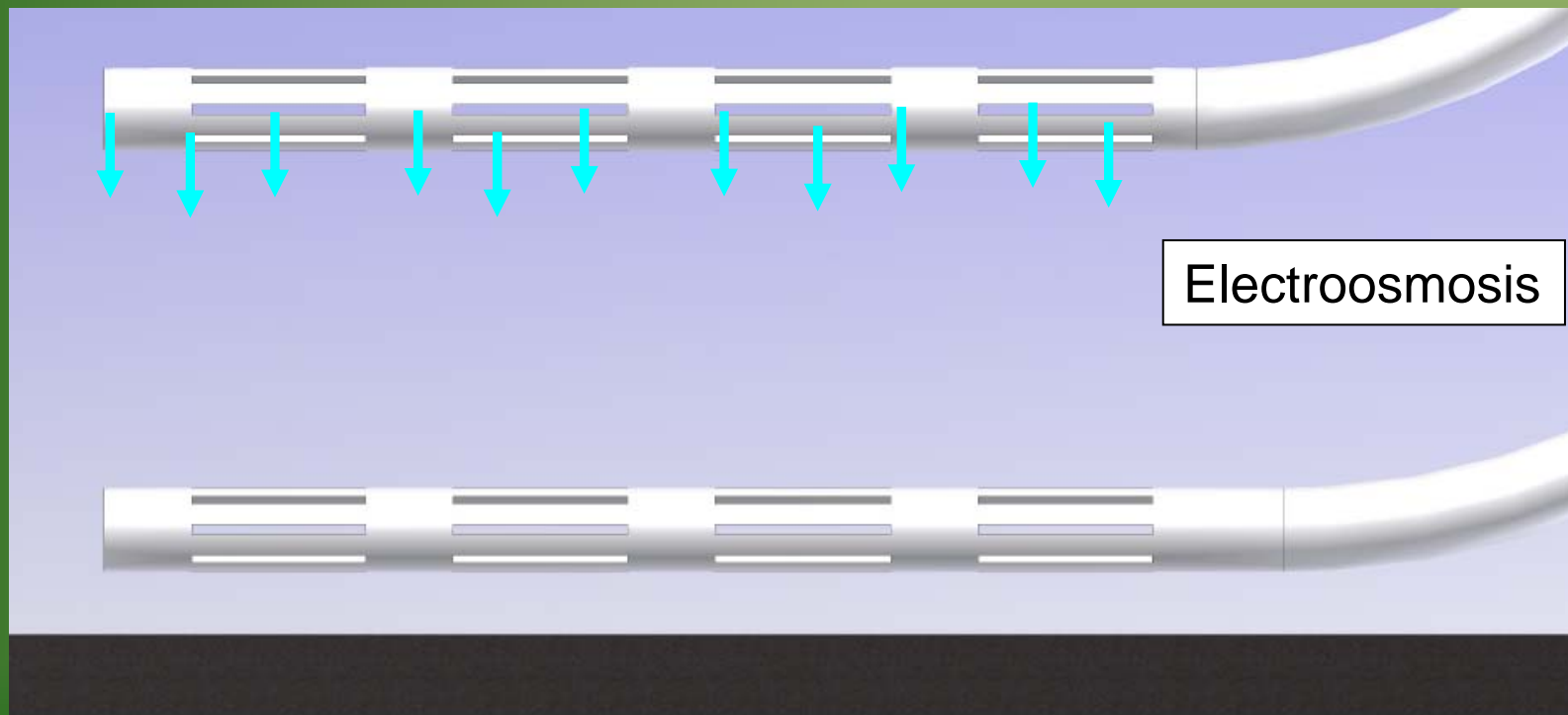


- **Uniform movement of water from anode to cathode.**
- **Clay typically has a negative surface charge.**
- **The extra cations, lined up along the pore walls and moving toward the cathode, drag the pore water along causing a net pore water flow to the cathode.**

# Electroosmosis Cont'd



- **Can be utilized to uniformly distribute chemical oxidants for oxidation of petroleum hydrocarbons.**



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# Current Technology



- **ISCO tough in low permeable sites.**
- **In situ injection techniques rely on physical contact with contaminants.**
- **Difficult to accomplish in fine grained soil, even with fracturing.**
- **Electroosmosis utilized to smear fluid evenly and quickly across the soil.**
- **Especially effective in tight packed soil.**

# EK-OX Technology



- **Even distribution of oxidants through fine grained soils.**
- **More efficient contact of oxidants with contaminants.**
- **Best suited for low permeability, low contaminant concentration sites.**
- **Rapid movement and dispersal of oxidants into contamination zone.**
- **Reduced remediation time frame.**

# EK-OX Pilot Project



## Objective

- **To accomplish a uniform and efficient dispersal of oxidants across a contaminated section of fine grained soil.**



# Site Background



- **Chlorinated hydrocarbon contamination (PCE/TCE)**
- **Impacts located in vadose zone**
- **Impacts located under supermarket and shopping center**
- **Tight clay soil characteristics (Regina Gumbo)**

# Site Background Cont'd



# Infrastructure

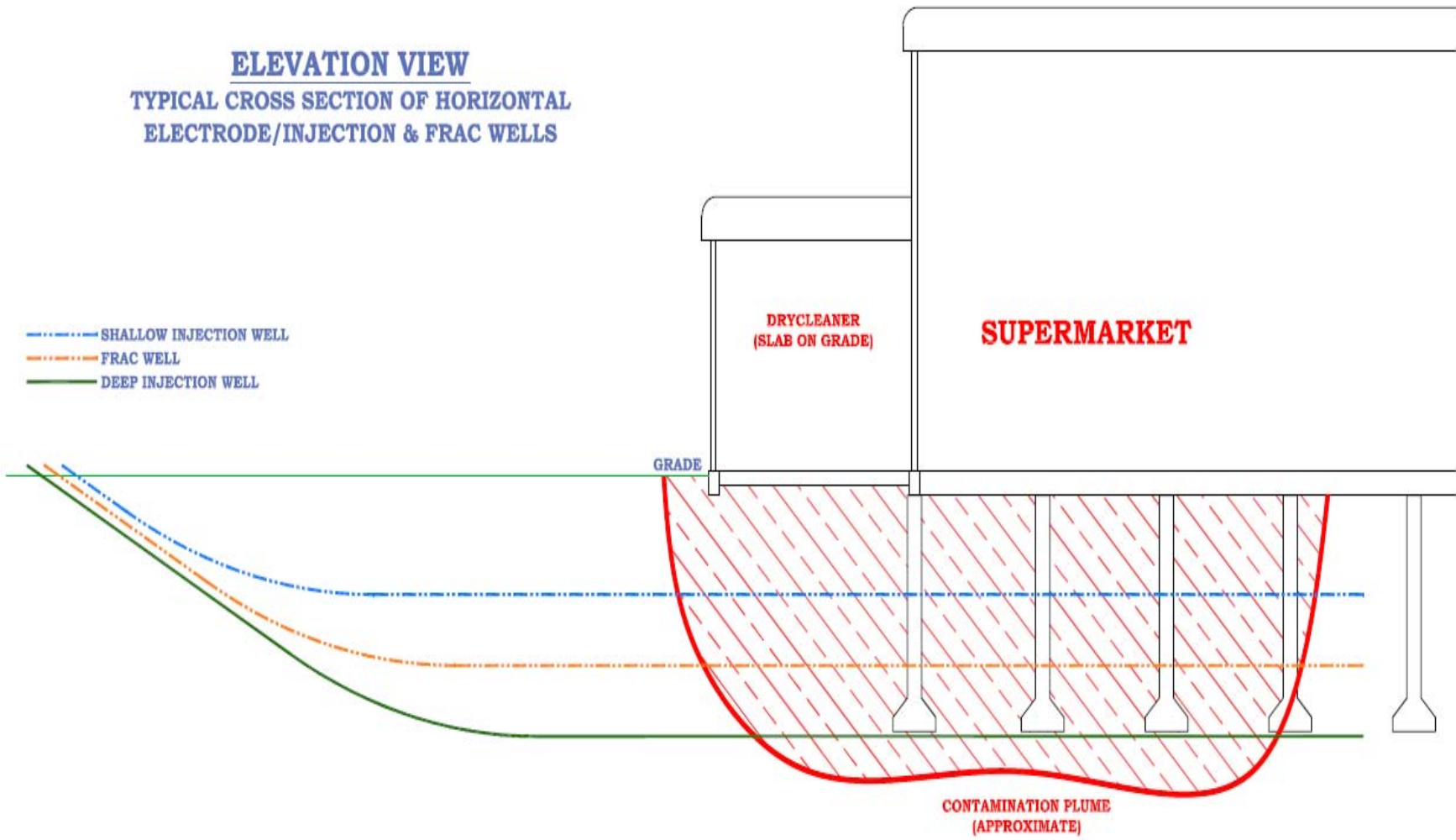


- **1.5” dia. carbon steel inj. well/electrodes (x8)**
- **1.5” dia. stainless steel inj. points (x3)**
- **15m effective well screen/electrode (33m total)**
- **Top inj. well/elec. @ 2.5m depth; bottom inj. well/elec. @ 6m depth**
- **5.5m separation between inj. well/elec. pairs**

# Infrastructure Cont'd

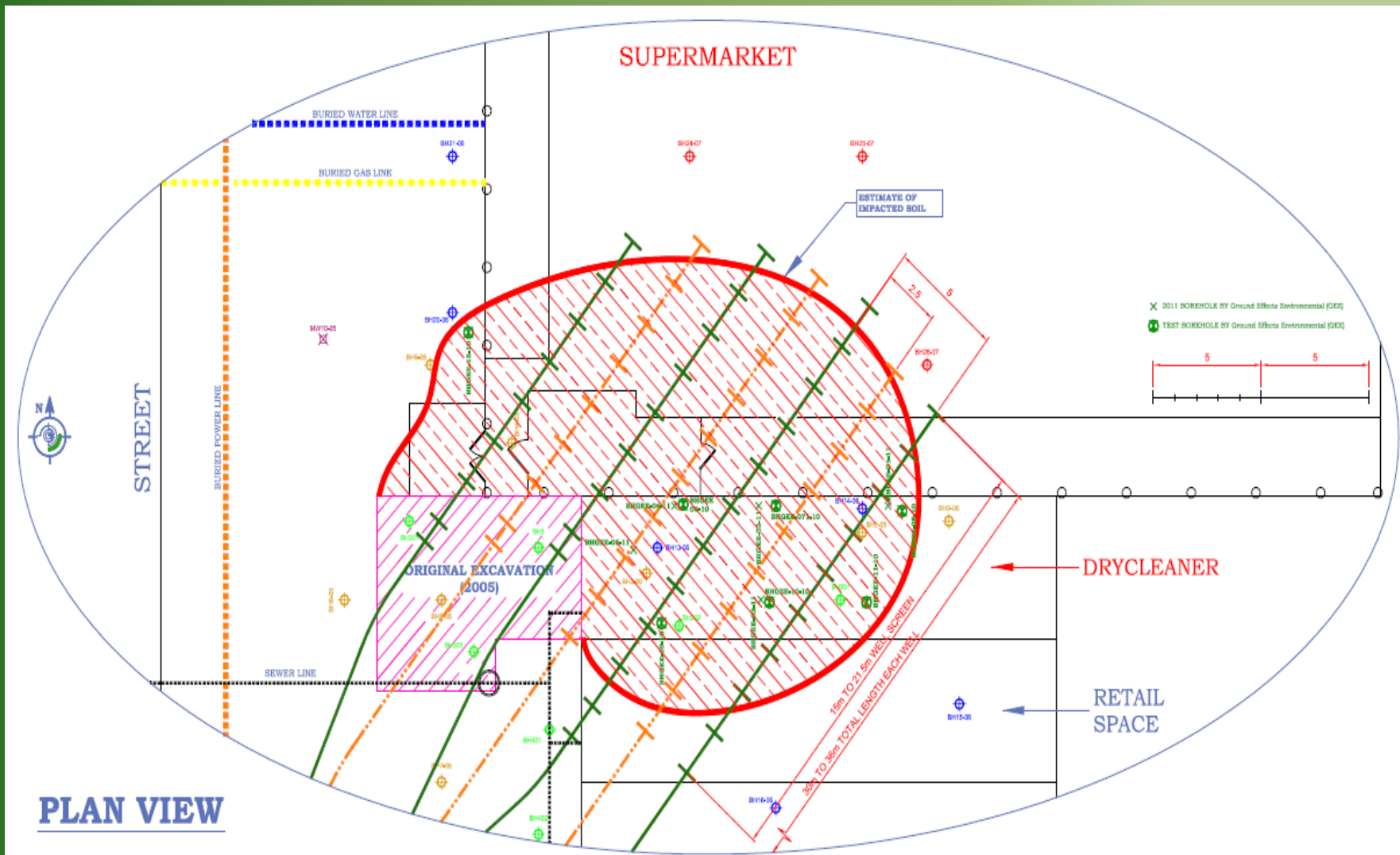


## ELEVATION VIEW TYPICAL CROSS SECTION OF HORIZONTAL ELECTRODE/INJECTION & FRAC WELLS



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# Infrastructure Cont'd



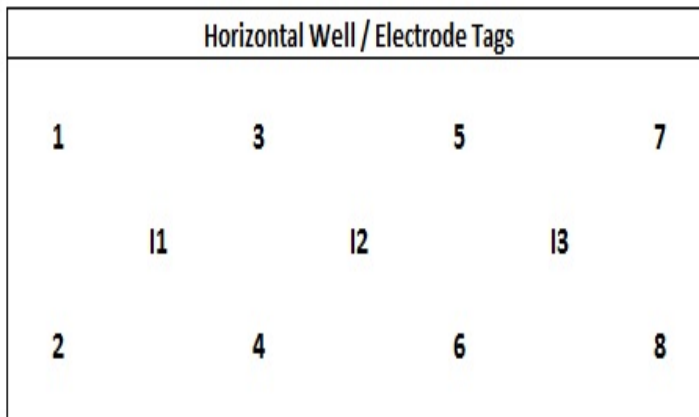
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# Injection Program

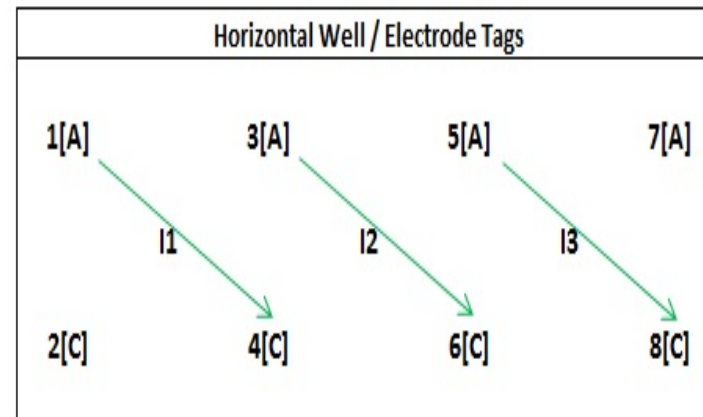


- **A predetermined volume of chemical oxidant (persulfate) was injected into the impacted clay soil formation.**
- **EK3 was then used to smear the chemical oxidant throughout the vadose zone using the electrokinetic phenomenon of electroosmosis.**

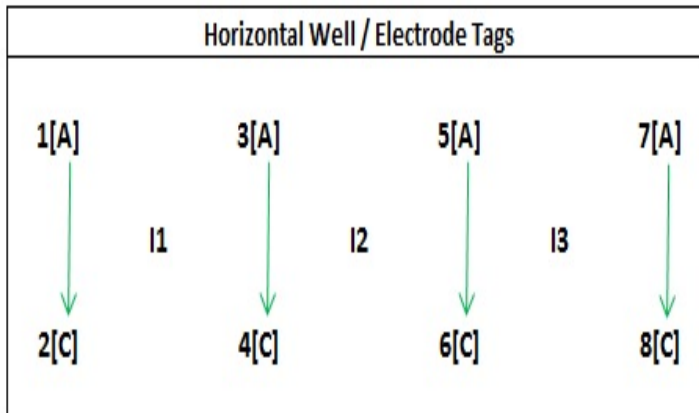
# Injection Program Cont'd



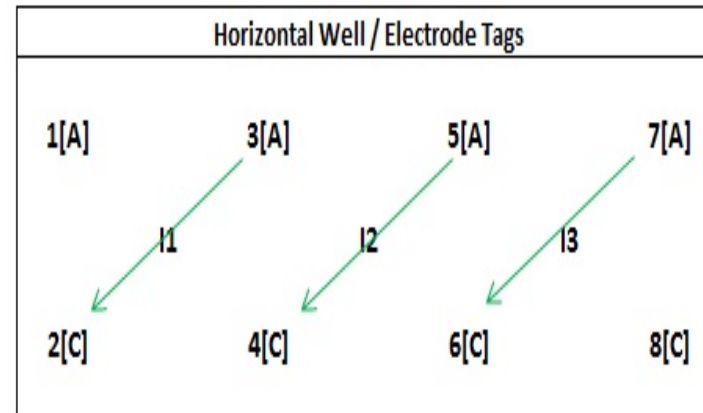
[A] - Anode  
[C] - Cathode



Phase 2



Phase 1



Phase 3

→ Chem-ox movement through EK Enhancement (Electroosmosis)

# Injection Program Cont'd



- **EK3 enhances the injection process in tight clay soils where typically the direction and/or radius of influence are considered unknown or tough to control.**
- **The anode/cathode configuration is adjusted in order to manipulate the flow direction of chemical oxidant.**



# Observations



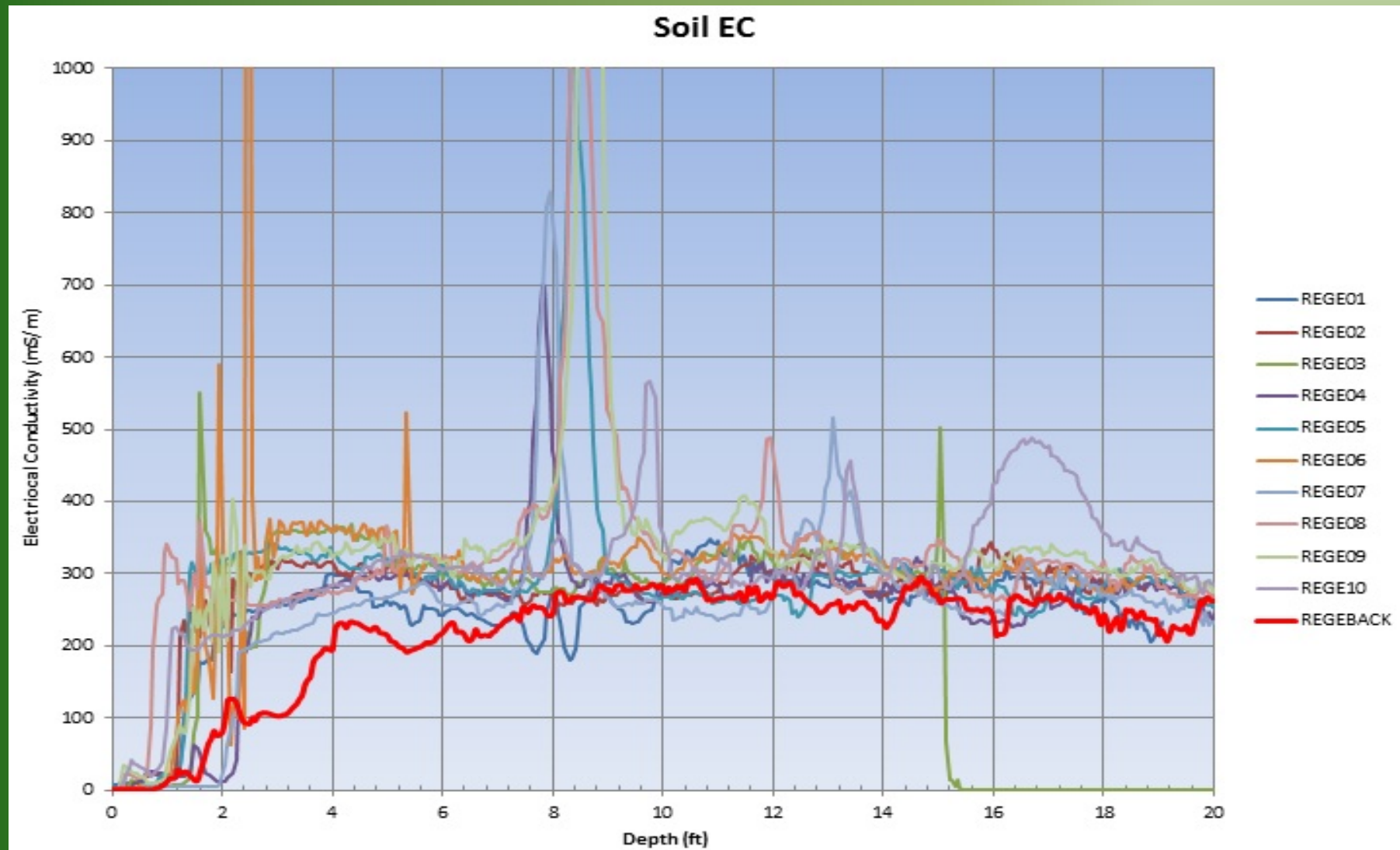
- **Liquid buildup at cathode wells within hours/days of initial DC power application.**
- **pH and conductivity spikes in liquid at cathode wells (Cond. spikes 50,000 – 220,000  $\mu\text{S}/\text{cm}$  & pH spikes  $>13$ ).**
- **Increased sulfate readings in the liquid effluent extracted from the cathodes.**

# Observations Cont'd



- **The three previous observations suggest communication through the tight clay formation via electroosmosis.**
- **The graph to follow shows the electrical conductivity of the impacted zone within days of the final injection.**
- **Compared to the background EC (red), one can see a general overall increase in EC.**

# Observations Cont'd



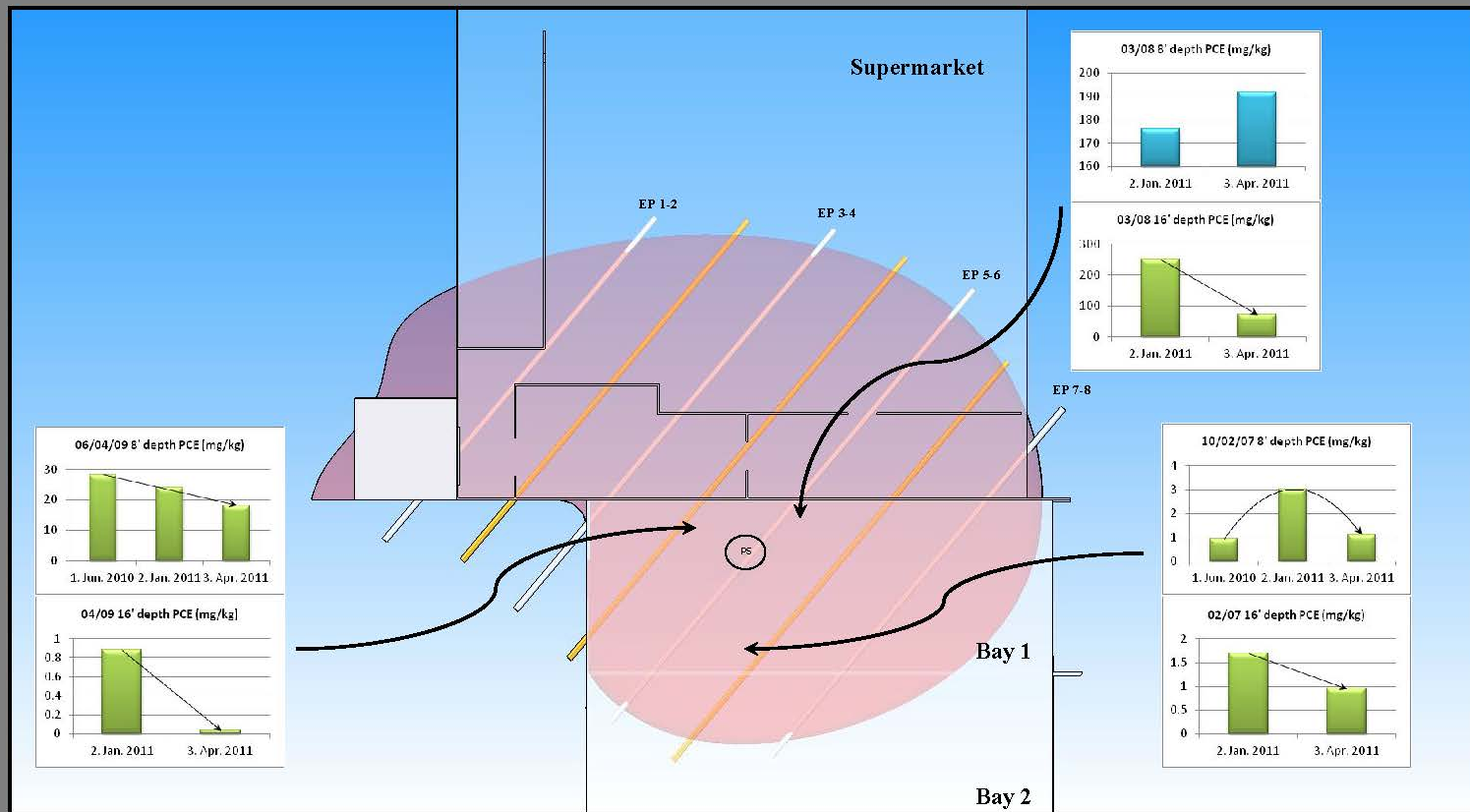
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# Observations Cont'd



- **The increased EC and spikes throughout indicate that there is a smearing effect taking place.**
- **The chosen chem-ox (Persulfate) for this application takes time to complete reactions and in the weeks to follow GEE will conduct another EC test within the impacted formation to observe progress.**

# Results (PCE/TCE)



# Results Cont'd



06/04/09 8' depth PCE (mg/kg)



# Next Steps Current Site



# Future Site(s)



- **Mechanix Shop**
  - **Fall 2011**
  - **Vertical application**
  - **5, 10, 15m grid spacing's, etc.**
  - **?Site Photo?**
  
- **Winter Projects**
  - **United States / Milder climatic conditions**
  - **Tight soil stratigraphy's**



# Future Site(s) Cont'd





# Questions?

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