

#### Evaluation of the Propagation of Secondary Fractures in Low Permeability Fractured Clay Soils



### Outline

- Site information and the reason for investigating Secondary Fractures
- Hydraulic Fracturing
- Methods
- Results
- Application



## Site Information

- Chemical production plant in operation from the 1950s.
- Former pond which held waste water from an adjacent chlorinated organic production facility.
- Volatile Organics Compounds present in soil for 20 years .
- Fractured clay till.



### **Conceptual Site Model**



## VC concentrations from GoreSorbers<sup>™</sup>



Former Pond



### Site Layout





# Design of Remedial Strategy

- Wanted to reach target concentrations in 5 – 7 years
- Cost Effective Based on Volume of Soil
- Ability to treat Low permeability Soils
- Phased approach which would allow us to evaluate our design and optimize.



## Hydraulic Soil Fracturing and Injection







## **Primary Fracture Creation**



YX

SXX



YX

### **Injection Substrate**









Secondary Fractures



### **Remedial Design**





### Injectate volumes

- 2,300lbs Iron per fracture
- 168,000lbs Total iron injected
- Average of 234 gal of Injectate material (Guar, Water, Breaker and Glycol) per Fracture
- 16,457 gal Total treatment volume



## **Remedial Design**

- Fracture and Inject at 6 Locations
- Carry out Investigation
- Optimize The Process
- Implement on Larger Scale



### Methods

- Testpits
- Boreholes
- Iron Content
- Dye Tracing
- Fluorescence







## Downhole Digital Video Capture Method

THE GOPTER MA



### Results

- During hydraulic soil fracturing and injection the bulk of the treatment substrate is directed through the primary fracture.
- As this route generally follows existing native fracture networks and higher permeability conduits, fracturing and injection is able to effectively target contamination within and directly adjacent to these pathways.
- Based on this technique, fractures are placed so as to allow treatment substrates to migrate into within the established timeframe.
- Target concentrations







#### Primary Fractures CH2MHILL

### Soil Cores









## Iron Analysis and Fluoroscopic Analysis







#### Secondary Fractures



#### Primary Fractures

#### Secondary Fractures

#### Primary Fracture

#### Secondary Fractures

# Secondary Fracture Density/Relative Frequency

- Visual evidence from the down-hole video capture technique indicated the presence of secondary fractures when checked every 5 feet.
- Found to extend between 0.5' and 1'8" on either side of the primary fractures
- Relative Density Estimate adapted from Terry, R.D. *et al.* Journal of Sedimentary Petrography v. 25 n 3. pp 2290234 Sept. 1955



### VIDEO





 $\bigcirc$ 

### Immediate Successes

- Able to inject the necessary quantity of amendments
- Able to create and evaluate primary and secondary fractures
- Able to characterize the effective treatment zone
- Able to optimize the process
- Apply on a larger scale implementation.



## Long Term Applicability

- Have since used this method several other times across the site for these types of amendments as well as others.
- Have increased our understanding of the process allowing us to better design treatment regimes in the future.



### Acknowledgements









### Questions?



