PART 2 - ISCO
NEXT STEPS

• Develop Remedial Strategy (ISCO) in consideration of competing CSMs
• CSM 1 (Simplistic):
  – Residual NAPL: ‘Pancake’ Model
  – Bedrock as Equivalent Porous Medium (EPM)
• CSM2 (More Complex)
  • Residual NAPL: Vertical Equilibrium Model (VEM)
  • Bedrock: CSM considers Bedrock Complexity (GFM)
• Remedial Implementation
• Evaluate Monitoring Data wrt CSM 1 and 2
• Determine Next Steps
CSM Considerations

• Residual NAPL distribution
  – “Pancake Model”
  – Vertical Equilibrium Model

• Fracture System/GFM
  – Sub-horizontal “Sheeting Fractures”
  – West-Dipping Foliation Parallel Fractures

• GFM implications to CSM and ISCO effectiveness
Vertical LNAPL Distribution

**Pancake Model vs. Vertical Equilibrium Model**

- **No**
  - Pancake Model
  - Assumes LNAPL floats on water table
  - LNAPL penetrates below water table
  - Uniform LNAPL saturation

- **Yes**
  - Vertical Equilibrium
  - LNAPL and water coexist in pores

**Key Differences**
- Pancake Model
  - LNAPL floats on water table
  - Uniform LNAPL saturation
- Vertical Equilibrium Model
  - LNAPL penetrates below water table
  - LNAPL and water coexist in pores
“PANCAKE MODEL”
W-E Hydrogeologic Cross-Section
UST 13 Area
GFM - Observed Fracture System
True-Scale Cross Section of UST-13 Area Normal to Foliation, Illustrating Monitoring Gap
Conceptual Fracture Network
NAPL Pathway – Active Fractures
Vertical Equilibrium Model
Vertical Equilibrium Model
Conceptual Smear Zone – High Water Table

Figure 24
Time-scale Cross Section of UST 15 Area
Natural to Pollution Illustrating Monitoring Cap
Vertical Equilibrium Model
Conceptual Smear Zone – Low Water Table
2009 Persulfate Injection
2009 Persulfate Injection

• Focus on “hotspot” near 32M-01-18XBR
  – 50 X 50 X 25 ft (10 ft. Saturated thickness)
  – 3 shallow bedrock injection wells installed around 32M-01-18XBR

• Overburden injection well installed on Top-of-bedrock in former tank grave

• 1800 gallons of water/sodium persulfate solution injected February 2009 (5000 lbs)

• sodium hydroxide used as catalyst

• ~ $36,000 (Estimate)
2009 Persulfate Injection
Injection Pressure Response
Far Field

Data Corrupted
Injection Pressure Response
Near Field

Transducer Malfunction
Injection Conductivity Response
Near Field

**Discernable Conductivity Increase**
Long-Term Trends
1,2-Dichlorobenzene
Areas of Contamination 32 and 43A
Well 32M-01-18XBR

Cleanup goal = 600 ug/l

Multiple points for a date represent sample duplicate and QA lab data.

Injections began 2/18/03
Injections completed 2/20/08

May 2010
300 ug/l

Cleanup goal = 600 ug/l
May 2010
59 ug/l

Cleanup goal = 40 ug/l
Long-Term Trends
C9-C10 Aromatics
Area of Contamination 32 and 43A
Well 32M-01-18XBR

Cleanup goal = 200 ug/l

Injections began 2/18/08
Injections ended 2/20/09

May 2010
300 ug/l
True-Scale Cross Section of UST-13 Area Normal to Foliation, Injection Wells Installed
Questions for Ongoing LTM

• Is the apparent COC attenuation real?
• Or will the Oscillatory longer-term trends resume?
• Does the site behave as a typical “drowned smear zone”?
• Delivery: Will future remedial efforts need to more carefully consider the bedrock fracture system?
• Deliverance (Site Closure): How might one increase the oxidant contact with residual contaminants?
Next Steps

• Update CSM
  – Install Transducers to evaluate long-term water level trends
  – Improve Geologic-Fracture Model (GFM);
  – Evaluate COC trends wrt WLs and GFM

• Determine whether additional remedial measures are needed

• If necessary, Consider Injecting in down-dip directions ( Likely Location of Residual Contaminants)

• Monitor in down gradient areas in consideration of bedrock ground water gradients and bedrock fabric
2009 Persulfate Injection

INJECT HERE

MONITOR HERE
• THANKS

• Question ??