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LCA Case Study – Options to Remediate a Groundwater Contaminant Plume

Green Remediation International Conference

June 16, 2010

Agenda

- Life cycle assessments (LCA)
- Site Description and Characterization
- Remedial Technology Evaluation
- LCA Results and Conclusions
- Questions/Discussion

Green Remediation

- Is the practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprint of cleanup actions

Life Cycle Assessment

- Considers Full Life Cycle of Remedy
  - *Raw Material Extraction*
  - *Material Production and Manufacturing and Transport*
  - *Remedy Construction and O&M*
  - *Final Disposal of Wastes*
- Goals
  - *Identify high impact LCA Stages Technologies*
  - *Minimize overall Environmental Burden of Life Cycle*

Source: Google images

Key Remediation Life Cycle Factors

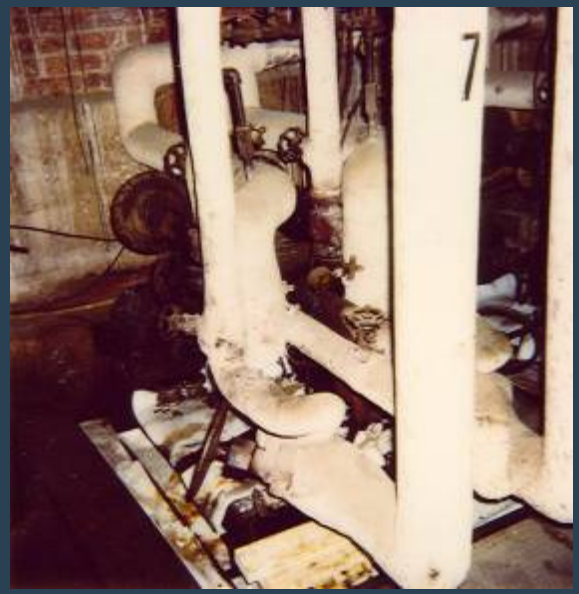
- Material consumption and waste generation
- Water use
- Energy consumption
- Length of operation period
- Overall emissions
- Costs

Case Study Site Description

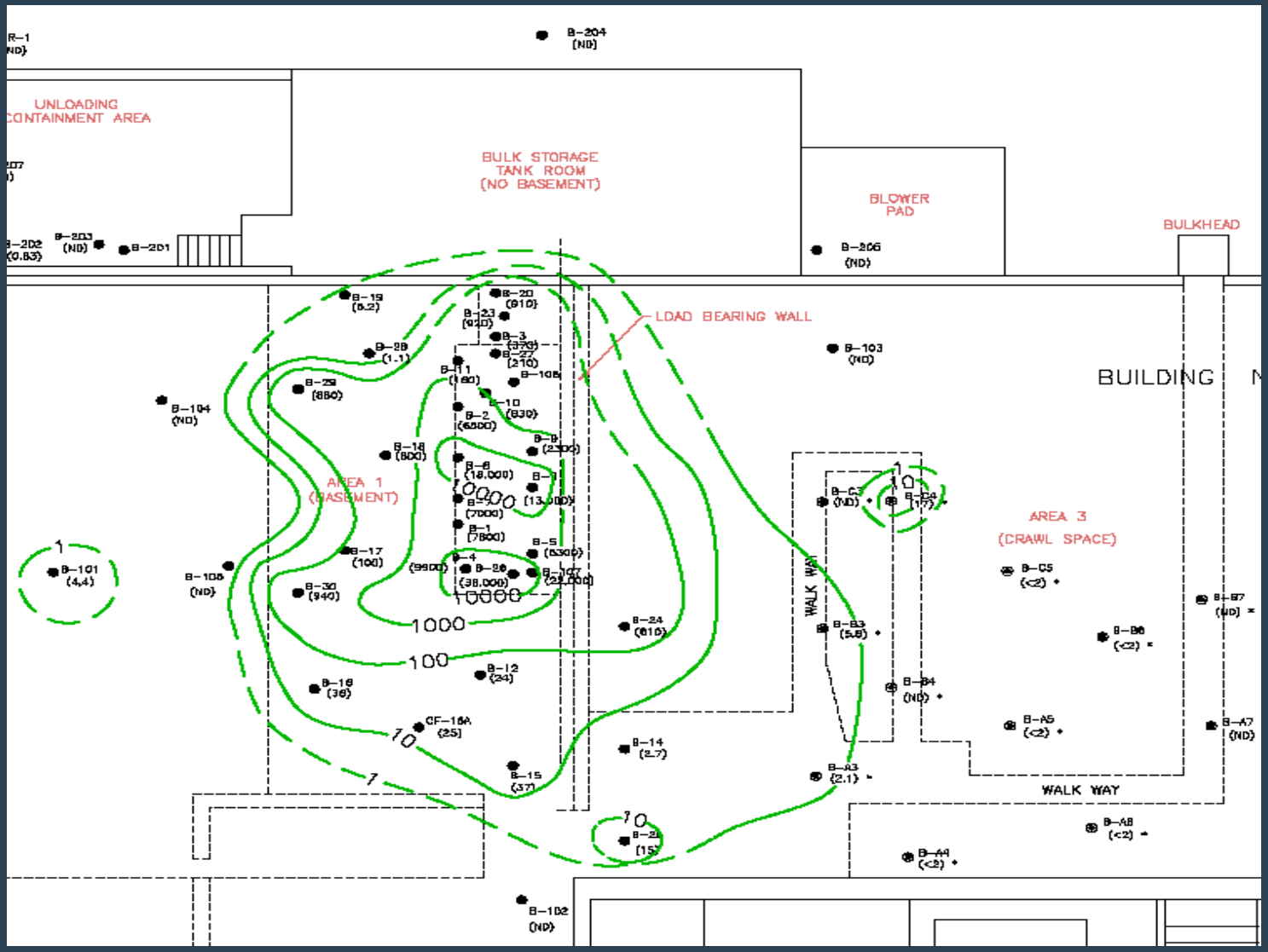
- 23 Acres + ~165,000 s.f. building
- Site purchased in 1967
- Rural setting – No public water
- Manufacturing of foam products

PCB Release CSM

- PCB heat transfer oil used 1968 to 1972
- Oil leaked from pump seals in basement
- Seeped into cracks through floor
- Impacted unconsolidated materials and shallow bedrock



Pre-Remediation PCB Concentrations in Soil (mg/Kg)



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Source Area Remediation

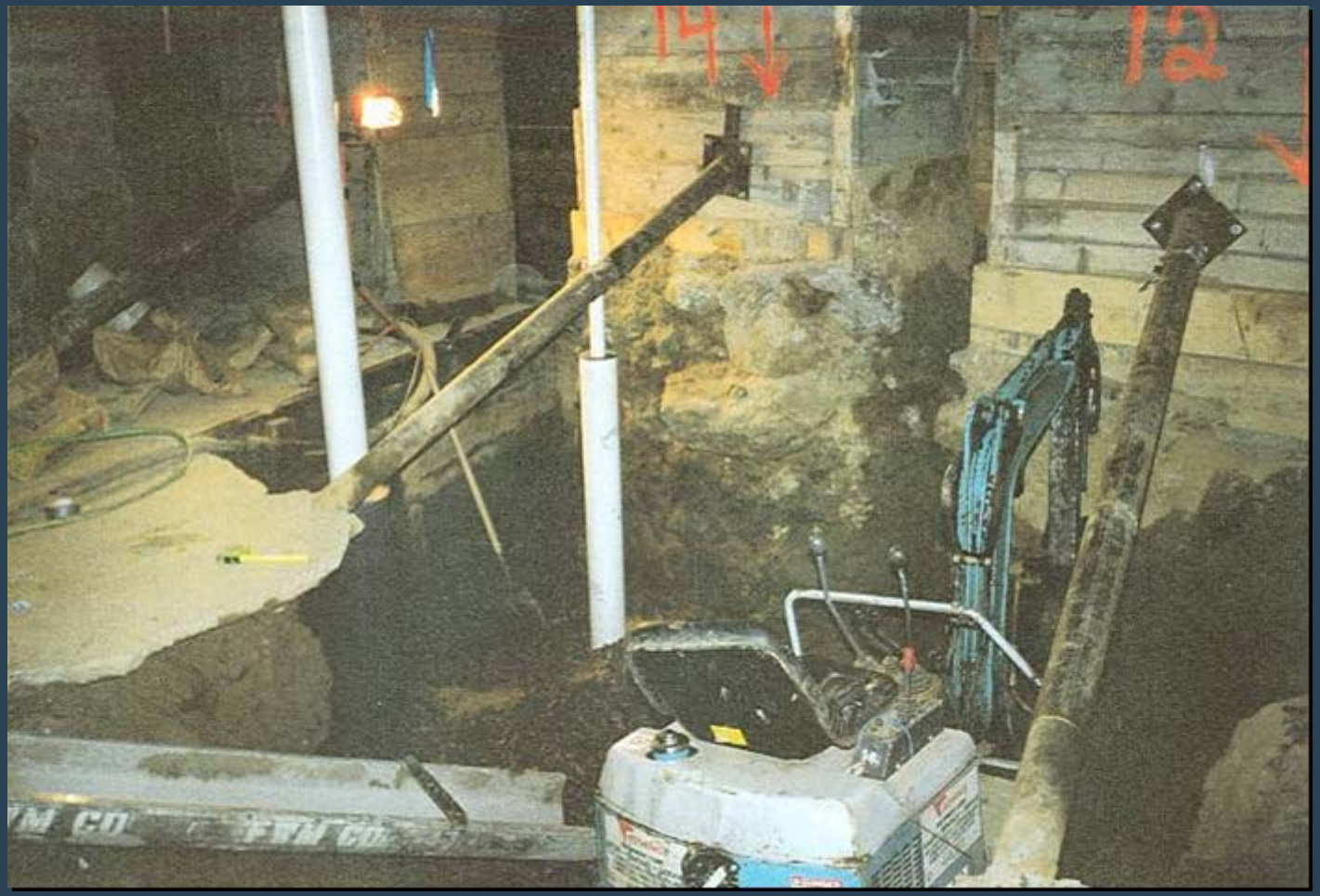
- Self implementing option – 40 CFR 761.61(a)
- Structurally reinforced building
- Removed concrete, soil and weathered rock
- Dewatering below groundwater
- Backfilled and restored basement floor

Summary of Source Remediation

- 1,000 tons of PCB impacted soil, and weathered bedrock removed
- >95 percent of PCBs removed
- Soil meets Clean-up Criteria
- Some PCBs in competent bedrock (10 to 260 mg/Kg)

Soil Removal Using Minihoe

Area 1 Excavation



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Bedrock Removal using Pneumatic Hammer

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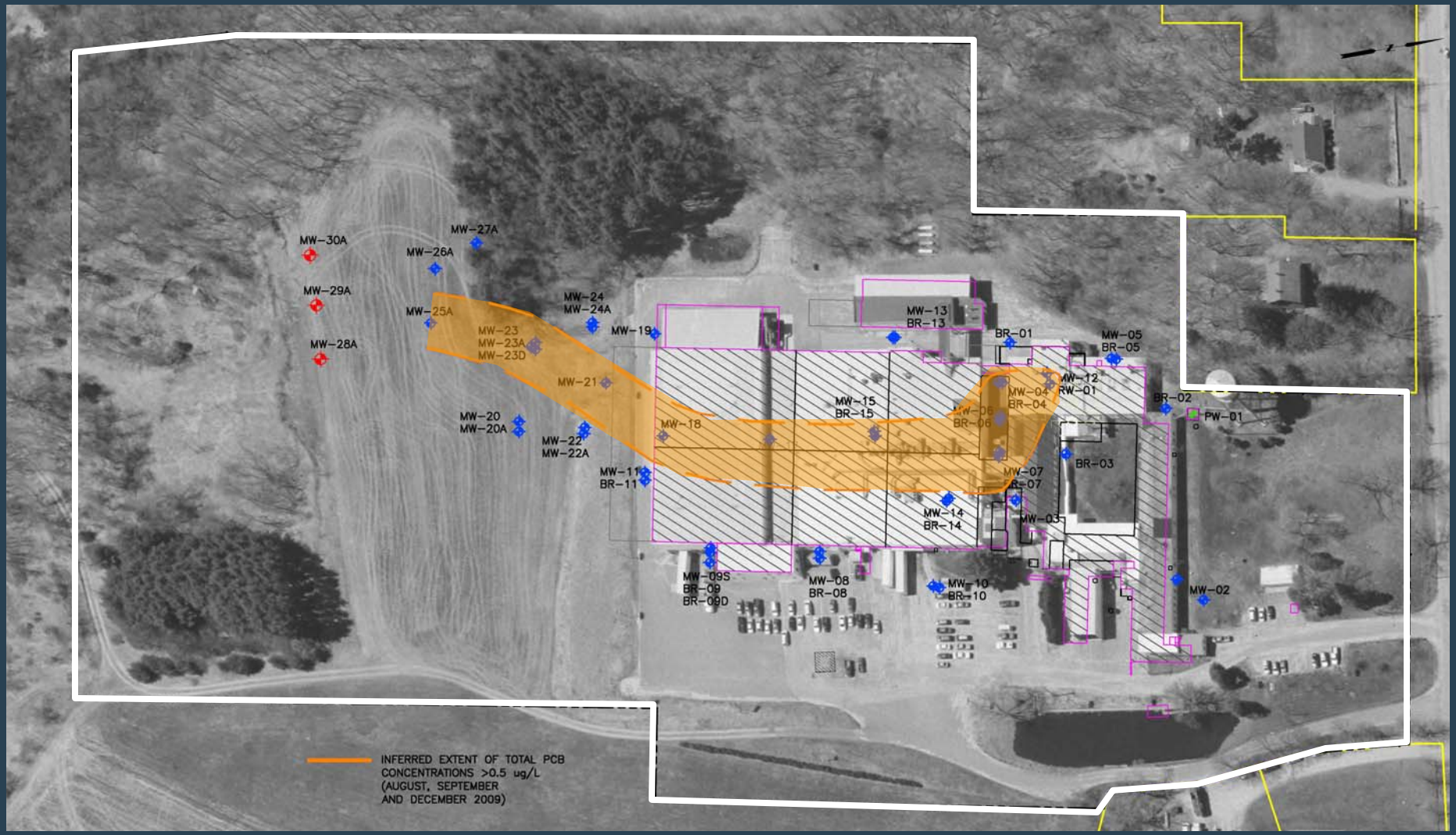
Portion of Restored Floor and Wall

PCBs in Groundwater

- Extensive MW network in place – 45 wells
- PCB Concentrations in plume (0.30 to 20 ug/L)
- Long narrow plume (100 ft wide by ~800 ft long)
- Colloidal transport primary mechanism
- Plume dependant on mass flux of PCBs
- ~ 1/2 tablespoon of PCBs in plume (Aroclor 1248)

Site Map Showing PCB Plume



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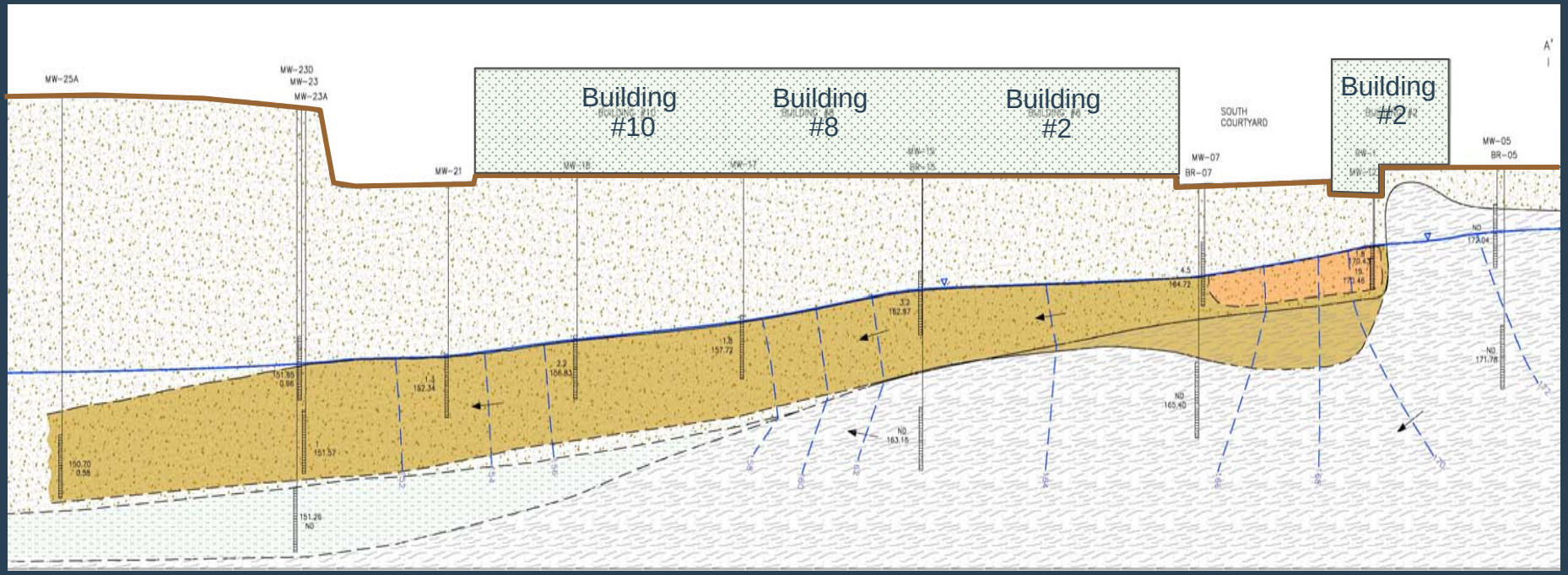
Site Map Showing Cross Section



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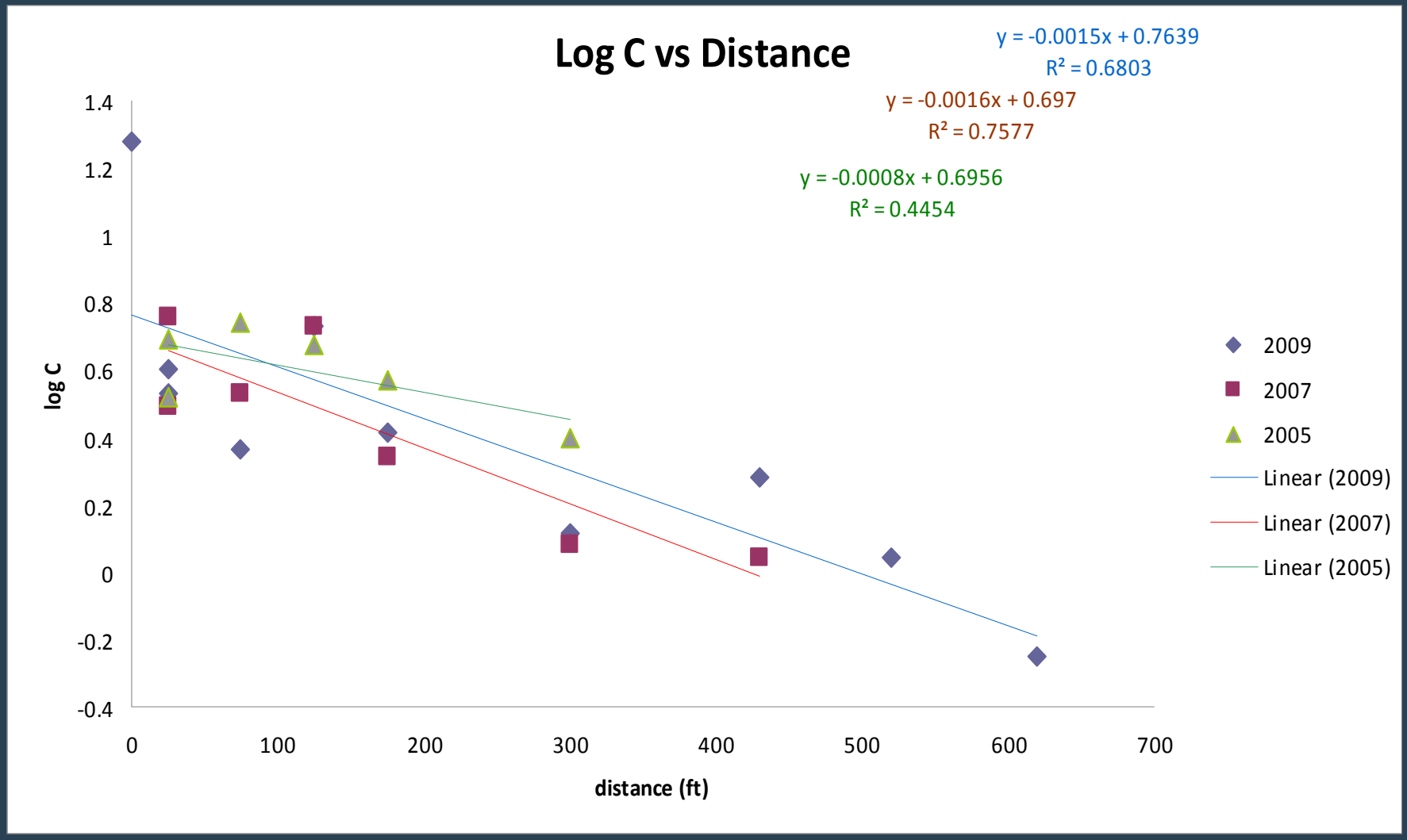
Mass Flux Analysis



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Remedial Options Evaluation

- Resources utilized in evaluation
  - *On line database research (e.g. CLU-IN)*
  - *Consultation with experts, including remedial system vendors*

- Screened Remedial Options
  - *Initial screening*
  - *Secondary screening*

Remedial Technology Evaluation

- Technologies retained after screening
  - *Monitored Natural Attenuation*
  - *In-situ chemical oxidation (ISCO)*
  - *Permeable reactive barrier (PRB)*
  - *Groundwater pump and treat (P&T)*
- Each evaluated in detail

Remedial Technology Evaluation

- ISCO
  - *Could find very limited success with PCBs*
  - *Method requires low pH – risk of mobilizing metals*
  - *Surfactant-enhanced approach risks PCB mobilization*
  - *Uncertainties associated with fractured rock*

- PRB
  - *Tested for PCBs at the research level*
  - *Potential risks associated with use of nano zerovalent Fe*
  - *Permit could be difficult to obtain*
  - *Site limitations (shallow rock and building)*
  - *PRB life key to LCA*

Remedial Technology Evaluation - MNA

- Biodegration not a significant factor
- Attenuation relies on adsorption, dispersion/diffusion and colloid filtering
- Rate of attenuation = rate of replenishment of PCBs
- Plume would persist for >100 years
- Life cycle impacts low

Remedial Technology Evaluation – P&T

- Extraction well already exists in source area
- Prior test demonstrated an extensive area of influence
- Treatment via activated carbon simple and effective
- Will cut off the PCB source from the aquifer
- Can be expanded further downgradient in future
- Containment rather than clean-up
- Very long life cycle

Selected Option

- P&T 4 gpm in source area
- Monitor downgradient plume and domestic wells
- Estimated recovery 8 - 24g PCBs year
- Co_2 emissions of ~ 50 MT/year
- Co_2 emissions of ~1,400 MT/ lb of PCBs recovered
- Is this right option?

Smart Pump and Treat

- Optimize GW extraction rate
- Right size pumps
- Select ideal GW monitoring frequency
- Supplemental solar power?
- Periodically evaluate system performance
  - *(e.g. Remedial System Evaluations (RSE) and alternative technologies*

Conclusions

- A LCA is useful tool during groundwater remedy selection
- Collateral environmental damage from groundwater clean-up can be significant
- Further education is needed on how to weigh competing environmental effects

Questions

Robert M. Danielson, CPG, LEP

Senior Associate

Fuss & O'Neill, Inc.

146 Hartford Road

Manchester, CT 06040

Phone: 860-646-2469

email: rdanielson@fando.com