



2003 AFCEE Technology Transfer Workshop

San Antonio, Texas

Promoting Readiness through Environmental Stewardship

Bench & Pilot Scale Tests for Thermal Remediation

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Why do a Laboratory Test for Thermal Remediation?

- Unusual contaminant:
 - Chlorobenzene & DDT
 - Waste liquid mixture (Lowry waste pits)
- Possibility for the formation of undesirable byproducts
 - When using temperatures greater than 250 C



Types of Lab Tests

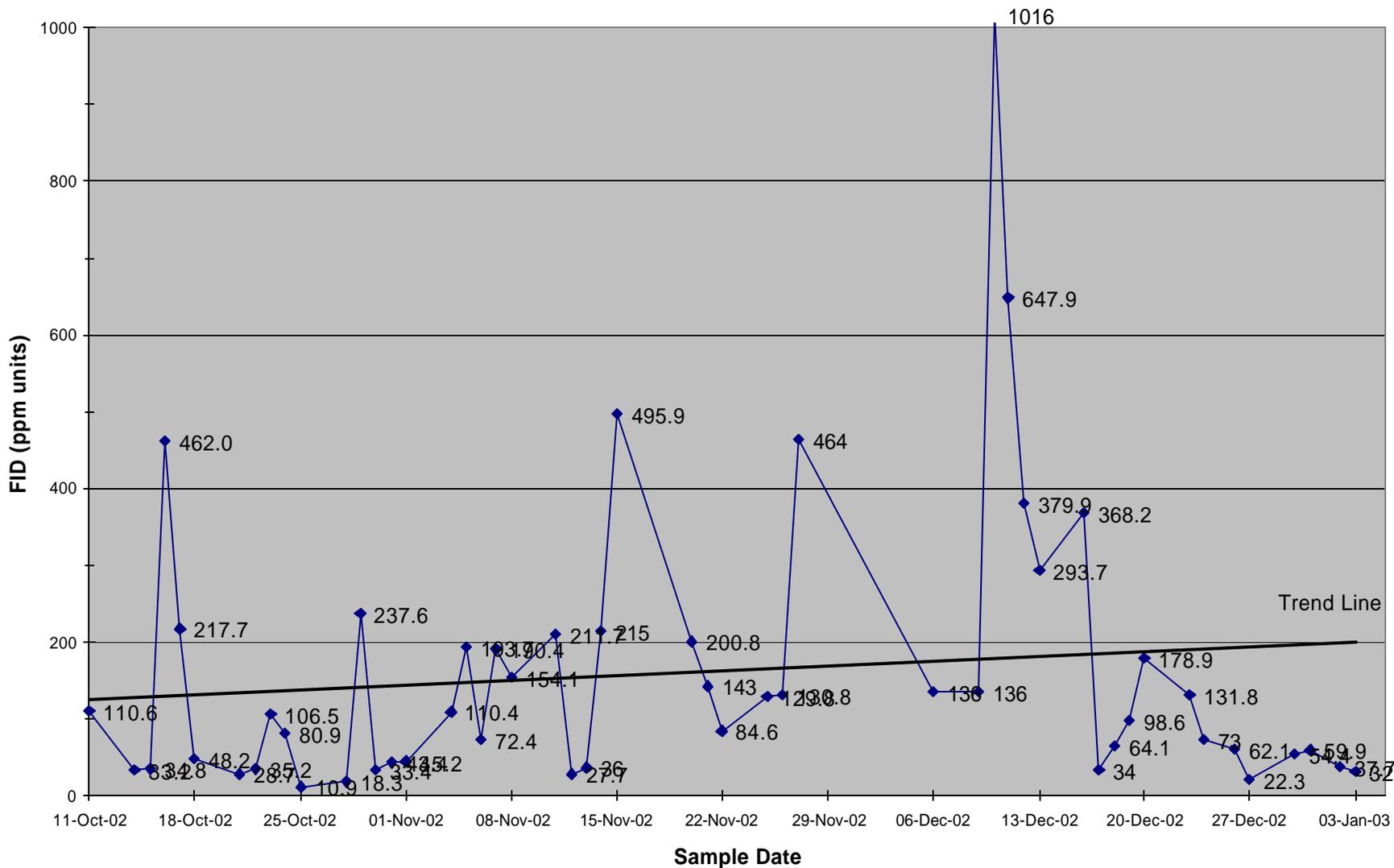
- Zero Dimensional: byproduct formation, endpoint using ERH, conductive heating
- One Dimensional: endpoint of steam injection
 - Caution! Creating a steam flood in a 1D column is difficult!
- Two Dimensional: liquid phase movement



What can you learn from a pilot test (or Phase 1)?

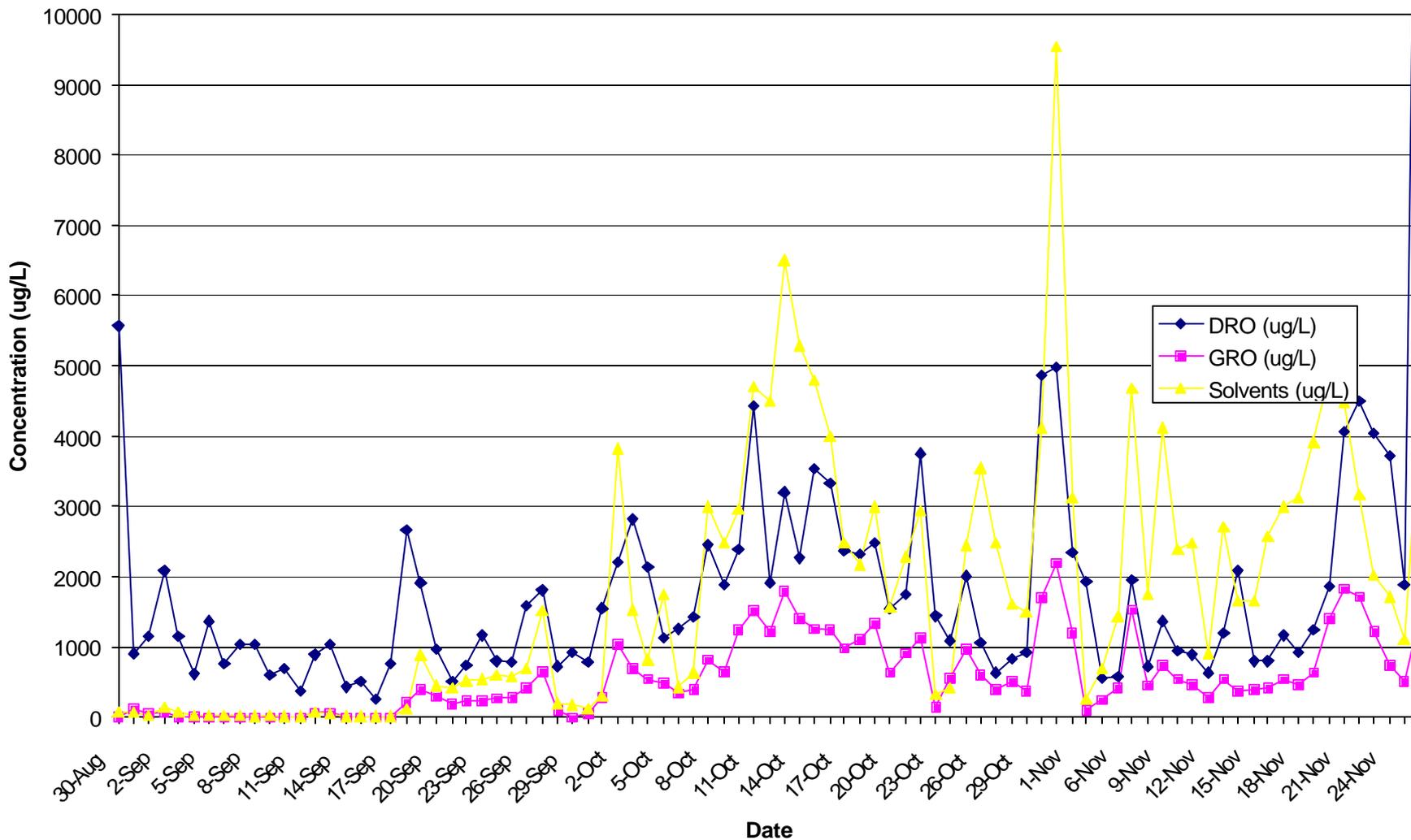
- Demonstrate mass recovery
- Engineering design parameters
 - Injection/extraction well spacing
 - Electrode spacing/design
 - Treatment of recovered contaminants
- Design for remediation in unusual environments
 - Use of ERH where metal exists on the ground surface
 - Use of ERH where buried metal exists
 - Fractured rock sites

Silresim ERH Influent Vapors





Loring Aqueous Concentrations



Promoting Readiness through Environmental Stewardship







Not all questions can be addressed with the same pilot

- Mass removal
- Remaining mass
- Possible spreading of contaminants
- Mass flux changes
- Groundwater concentrations
- Time to reach cleanup goals



Can a pilot tell you what the final concentrations will be?

- You might get some indication of final concentrations – if you:
 - Run it for sufficient time
 - Do not have recontamination from surrounding contaminated areas
 - Cover the range of heterogeneity present
- Economics drives turning off thermal remediation system



What should be the scale of the pilot?

- Depends on the question to be answered
- Large enough to encompass the scale of heterogeneity at the site
- Some pilots have been full scale



How do you interpret the data?

- To answer the question that the pilot was designed to ask
- Resist the temptation to interpret data in terms of questions that the pilot was not meant to address

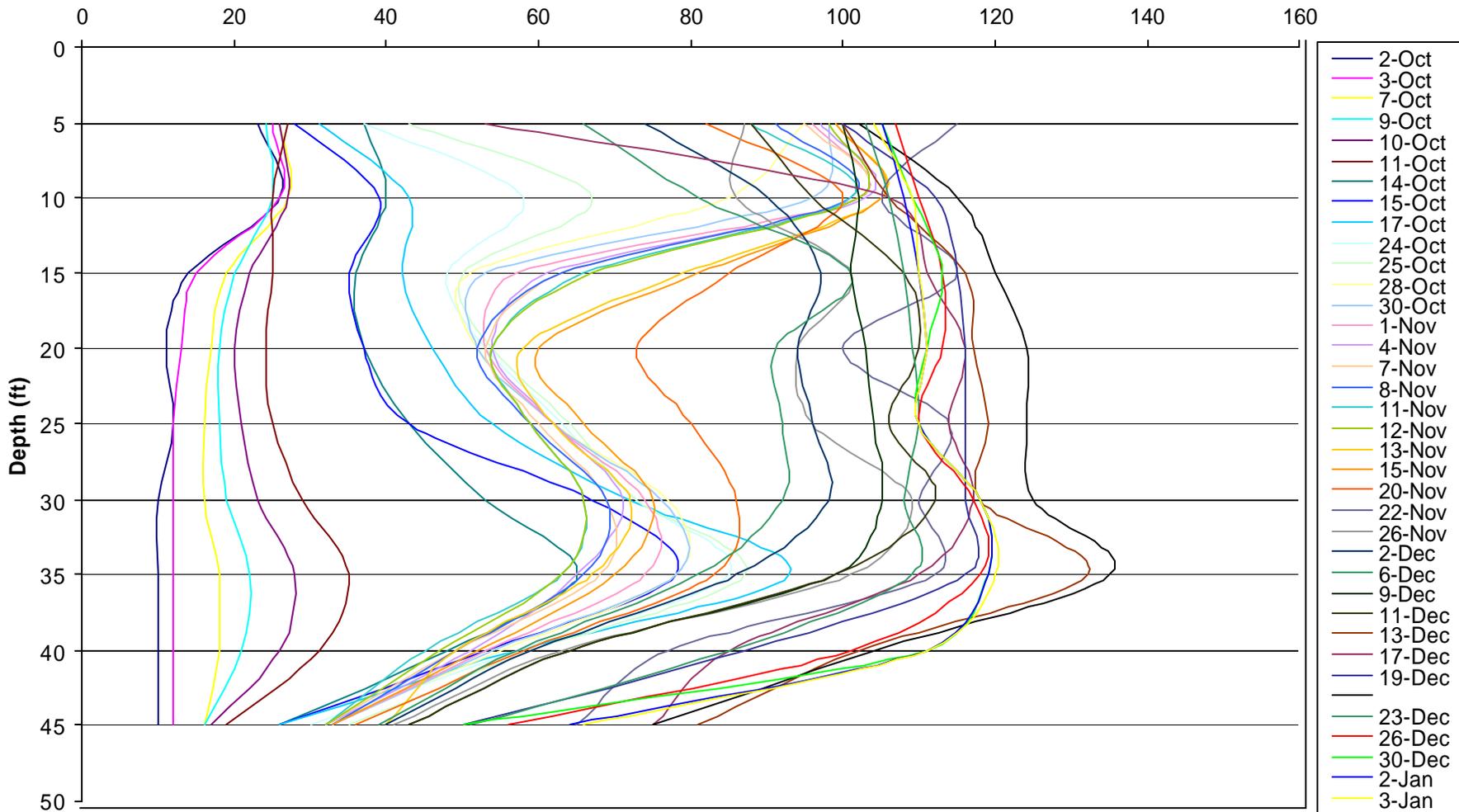


What should be monitored during a pilot scale?

- Depends on questions to be answered
- Include:
 - Capture of mobilized contaminants
 - Measuring hydraulic gradients & vapor pressures in & around target zone
 - Uniformity of heating of the target area
 - Thermocouples
 - Electrical Resistance Tomography
 - Effectiveness of above ground treatment system
 - Recovery of contaminants
 - Final soil/rock and groundwater concentrations

Silresim ERH Pilot Study: Subsurface Temperature (Temp 4)

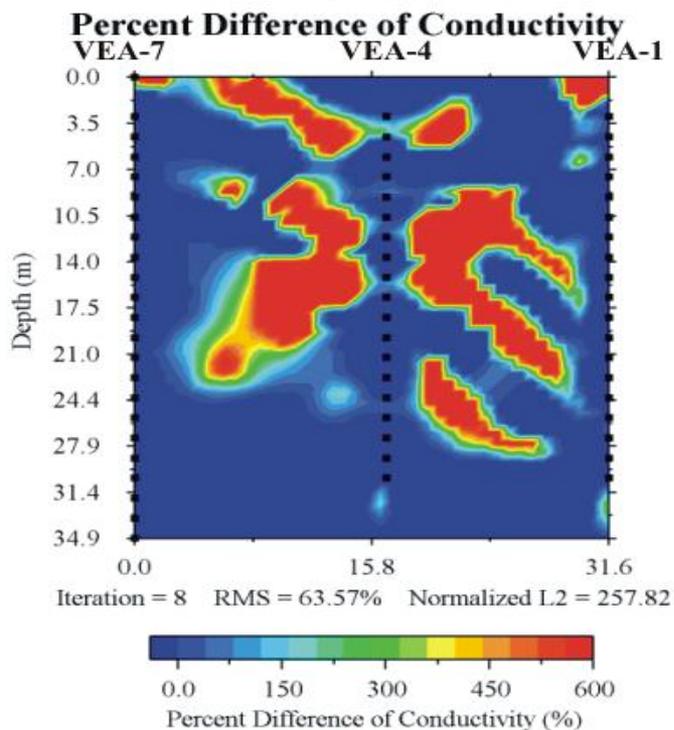
Temperature (C)



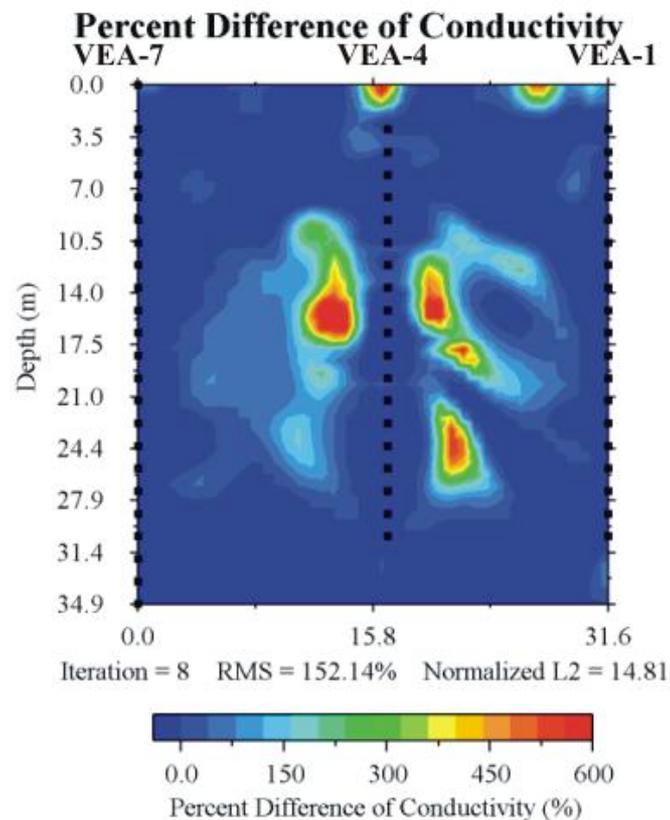


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Obtaining Hot Soil Samples

- Use PTFE (Teflon), stainless steel or brass liners
- Longer sleeve is better
- Immediately cap ends
- Cool with ice for approximately 30 minutes
- Monitor temperature with meat thermometer
- Battelle Monterey Paper, 2002





Obtaining Hot Groundwater Samples

- Caution! Using a bailer may allow superheated water to flash to steam!
- Cool groundwater in ice bath before filling sample container
- Expect concentrations to increase when the ground is hot, decreases when contaminants are essentially depleted
- Composition may change – acetone may remain



What about Rebound?

- Not in a thermal remediation system
 - Heating/mixing will increase groundwater concentrations during treatment
 - Order of magnitude increase during steam injection
 - Two fold increase during ERH
 - Recontamination from surrounding contaminated areas can occur



Recommendations for lab or pilot scale

- Define question to be answered
 - Limit questions to most important
- Design system to answer that question
- Carefully interpret all monitoring data
- Allow flexibility
 - If first design does not work, redesign and implemented the changes

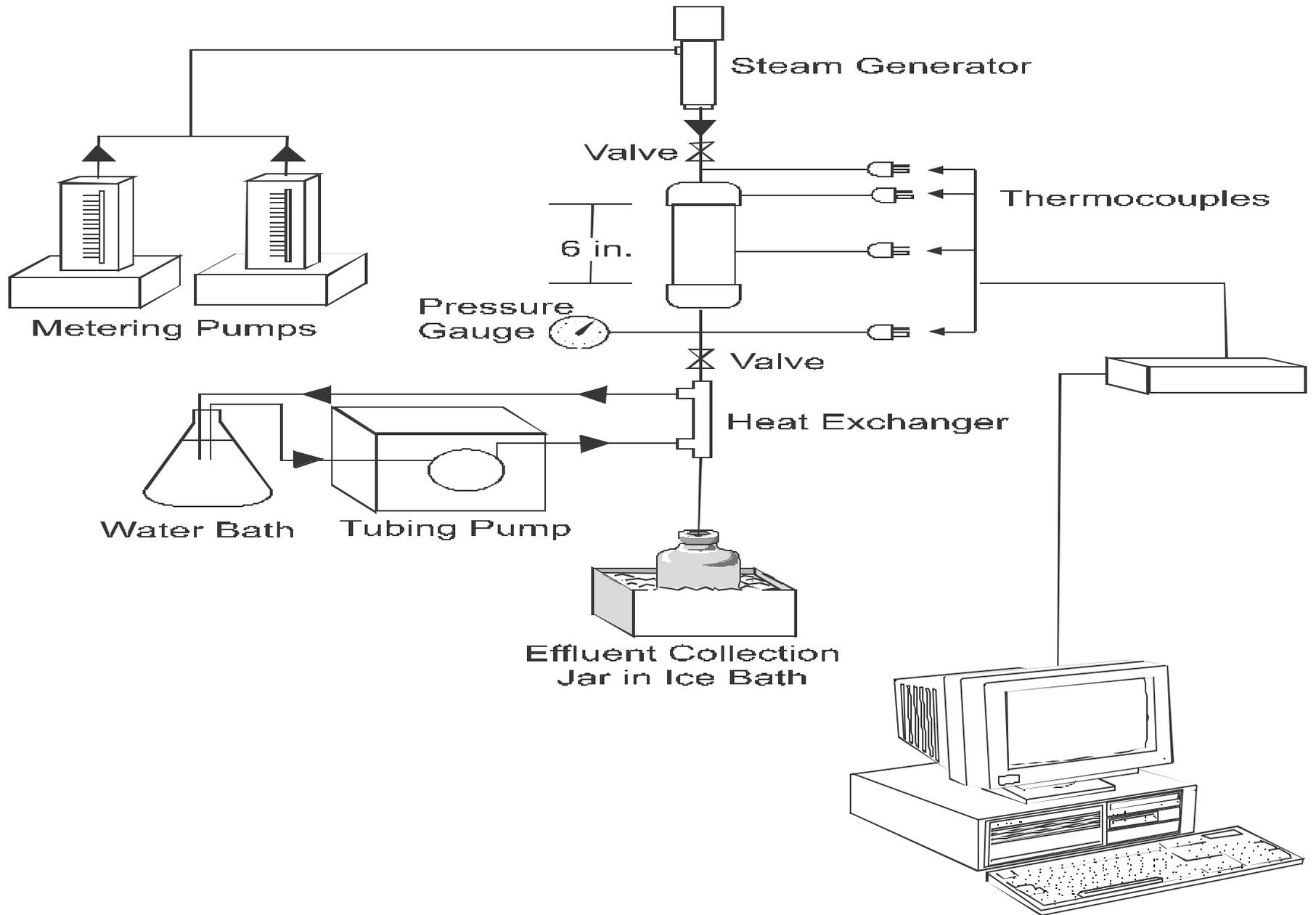
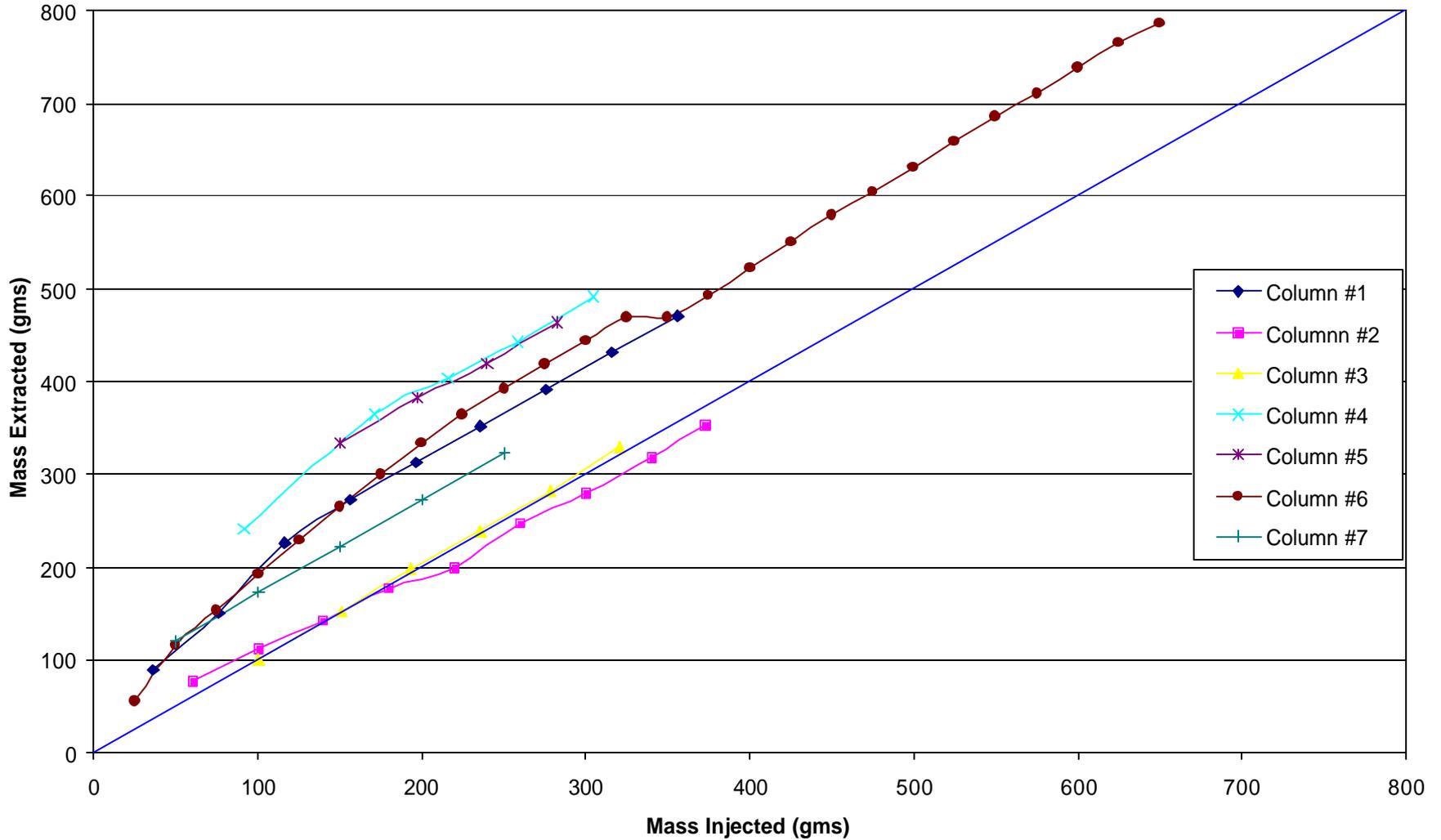
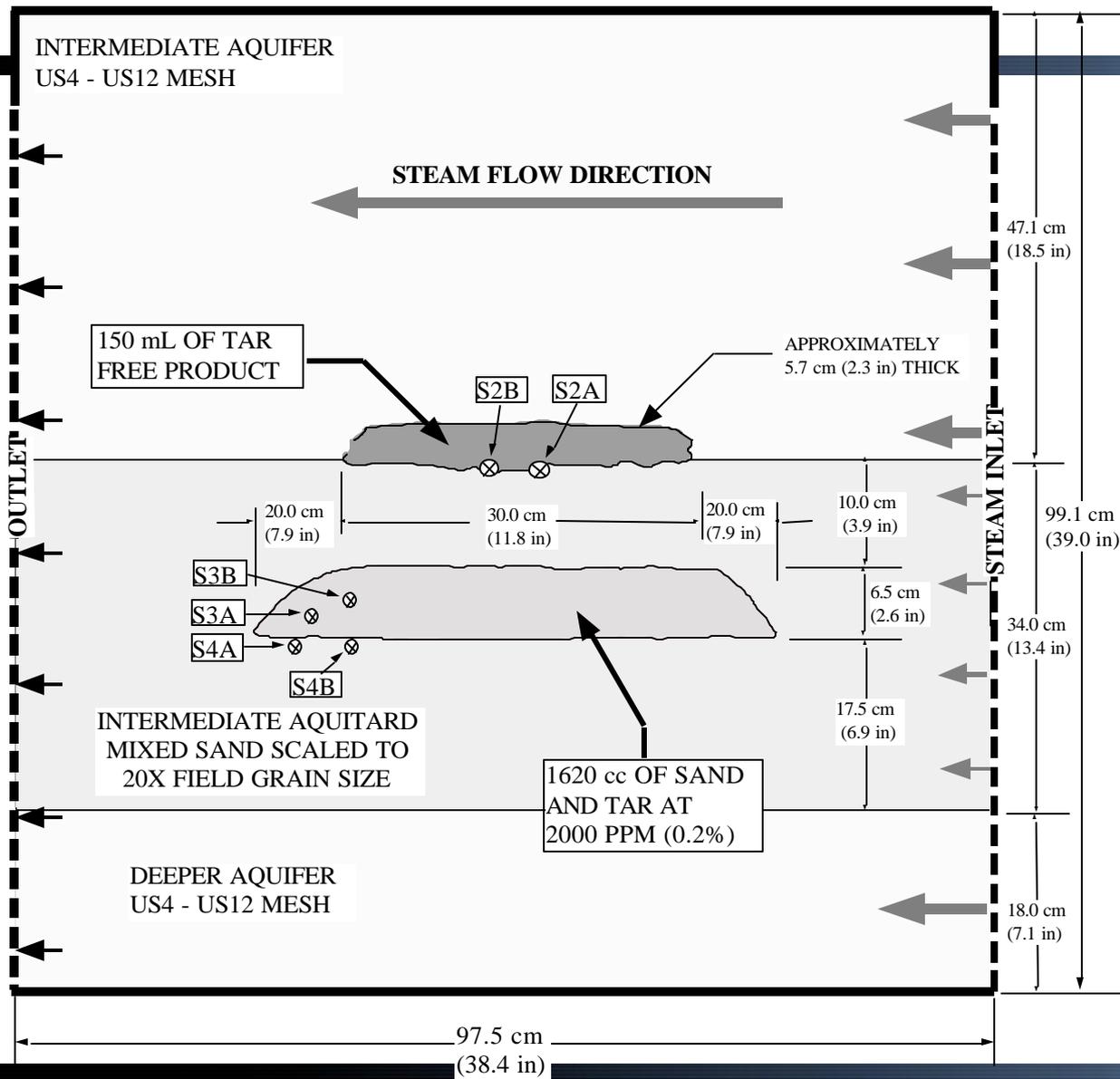


Figure 9. Steam injected (condensed) versus effluent collected for the steam injection experiments.

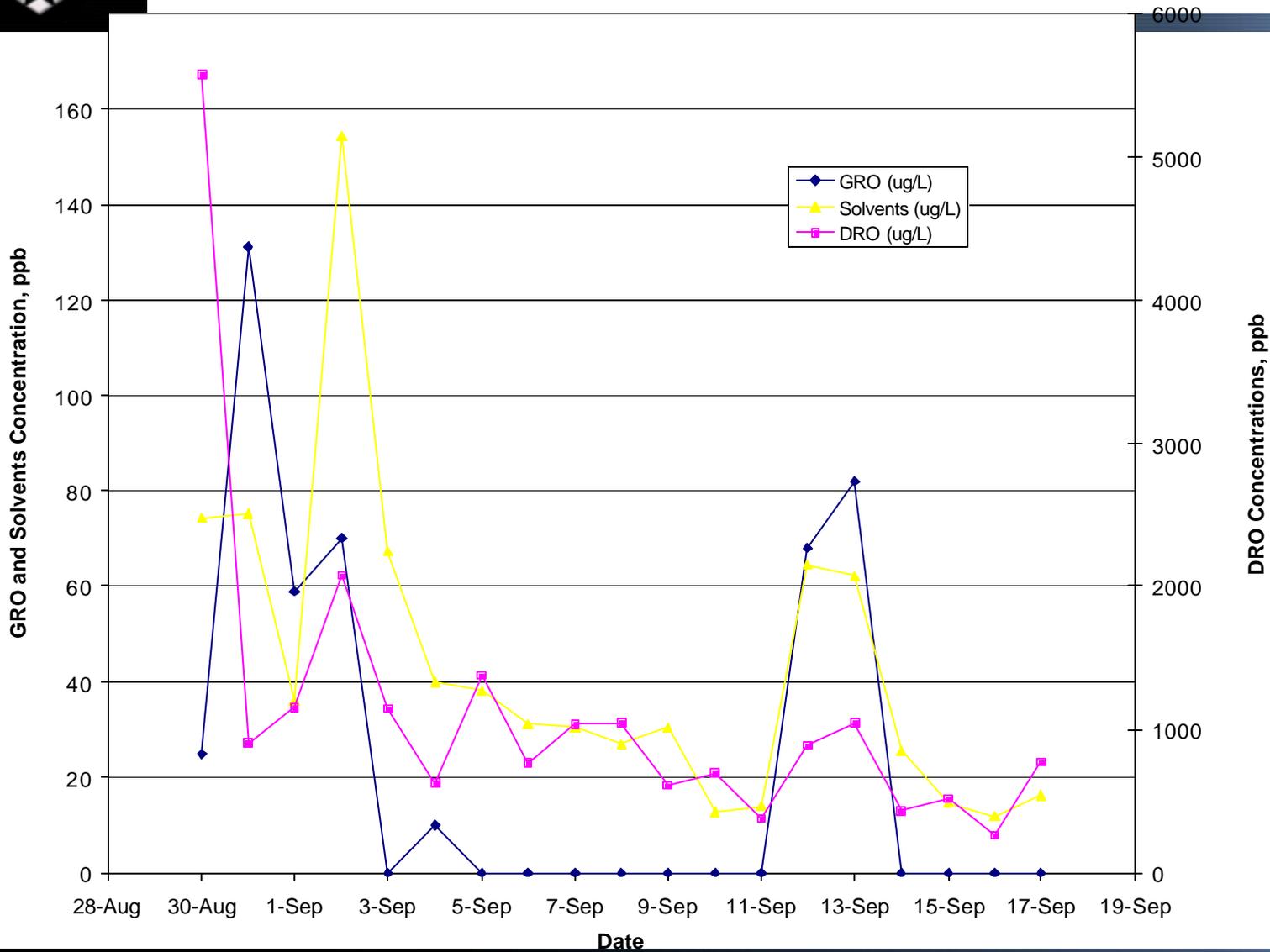




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