

DENSITY-DRIVEN VAPOR FLOW OF CHLORINATED SOLVENTS

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RESEARCH BACKGROUND

- **density-driven vapor advection has been suggested to be an important transport mechanism**

Falta et al., 1989

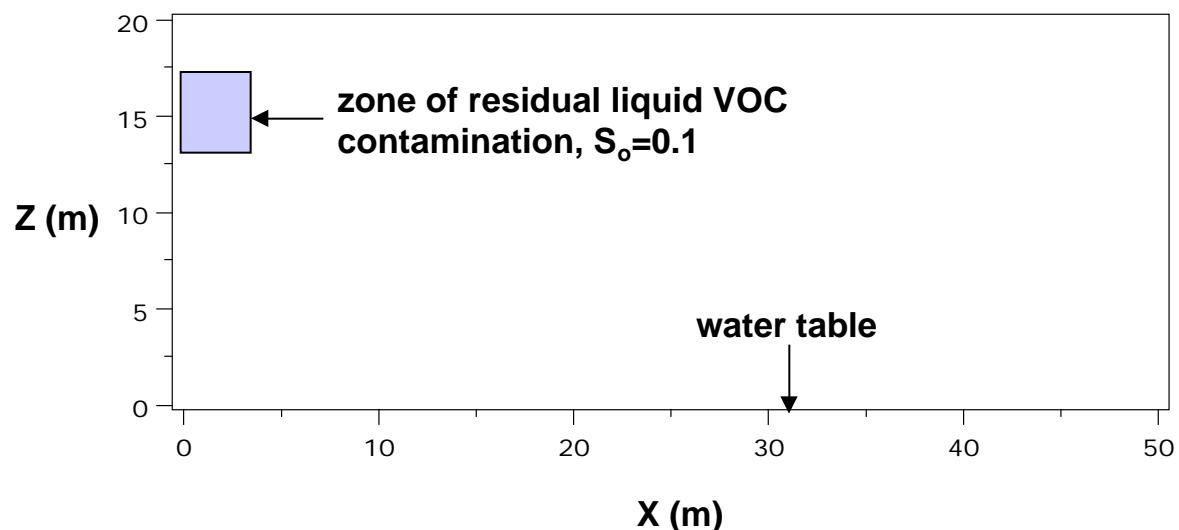
Sleep and Sykes, 1989

Mendoza and Frind, 1990

- **many DOE sites possess the conditions in which density-driven vapor flow may be important**

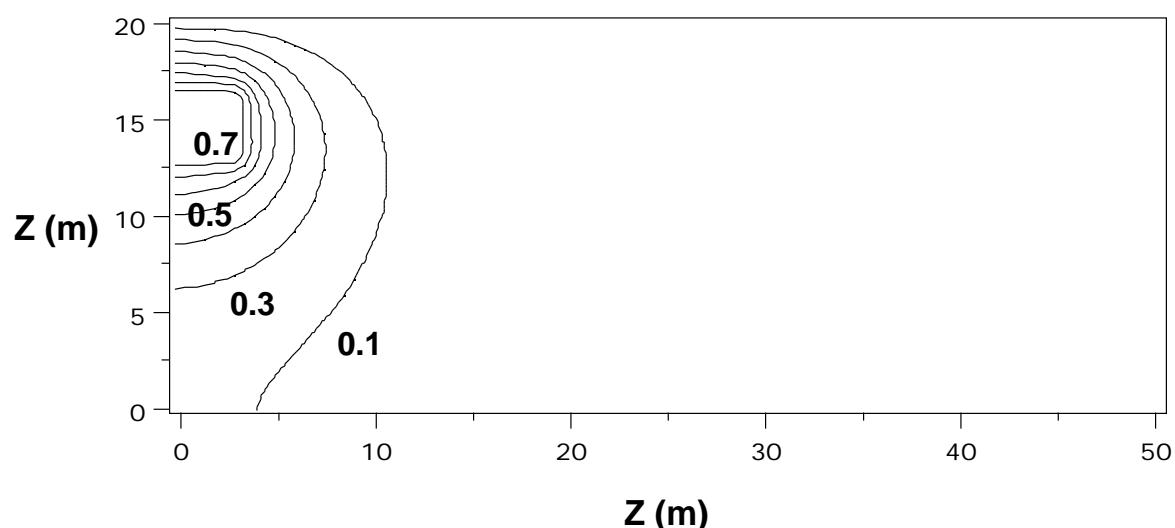
Field-Contamination Scenario

(after Falta et al. 1989)



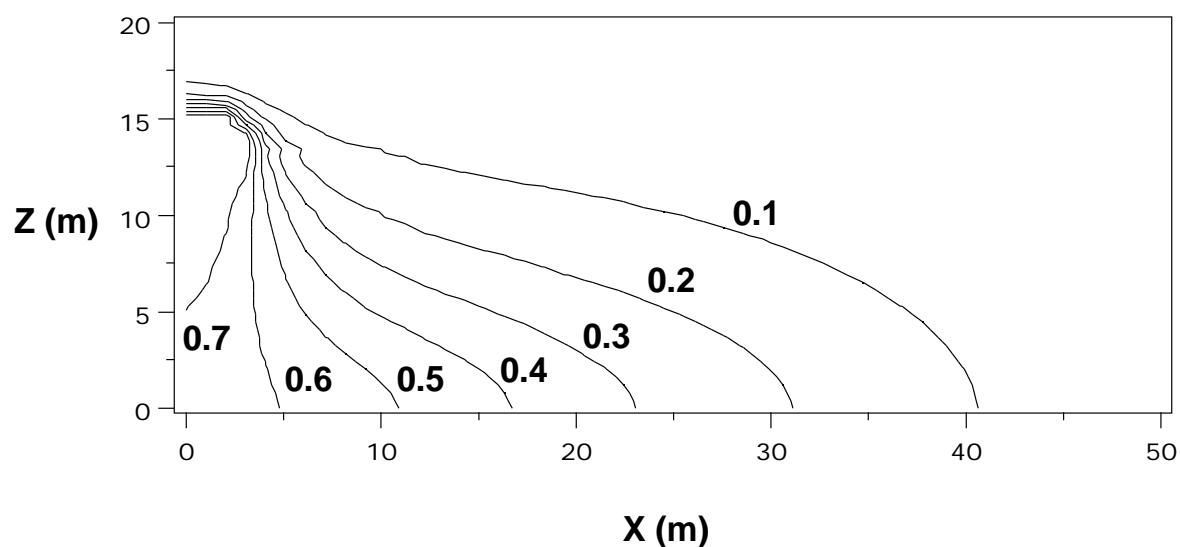
**Carbon Tetrachloride Gas Concentrations
(kg/m³) after 1 year**

(Diffusion only)



**Carbon Tetrachloride Gas Concentrations
(kg/m³) after 1 year**

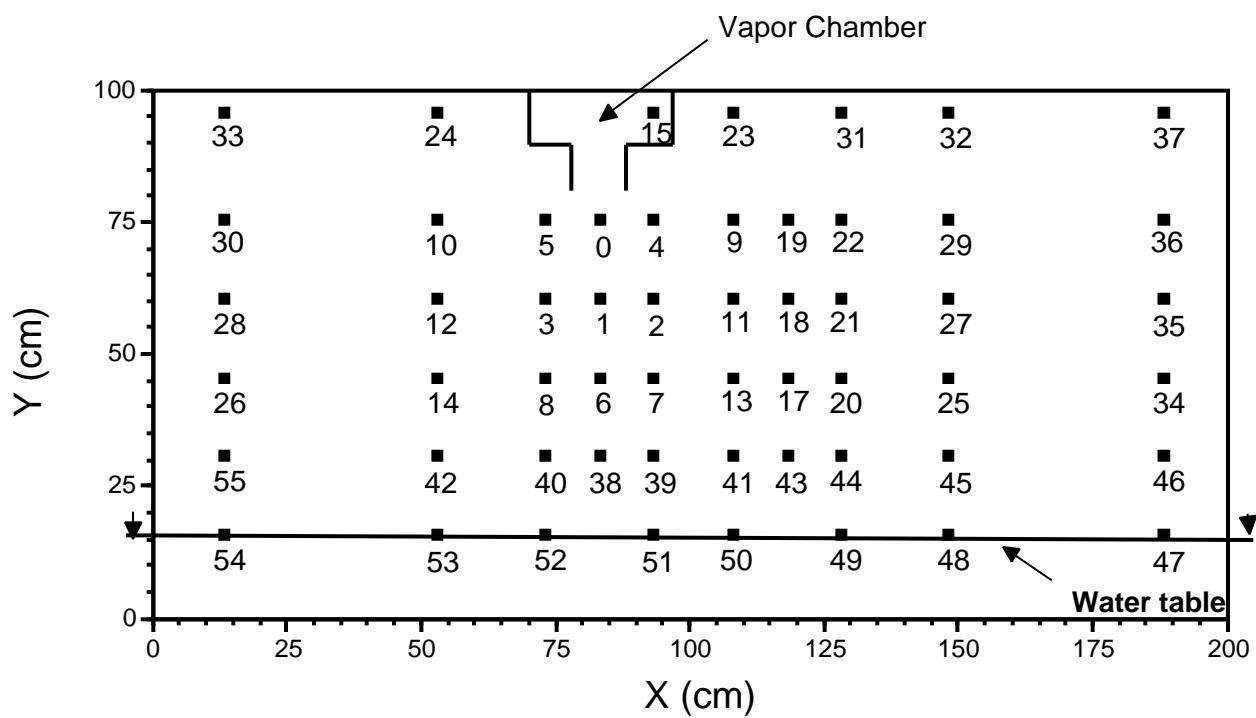
(Density effects and Diffusion)



RESEARCH OBJECTIVE

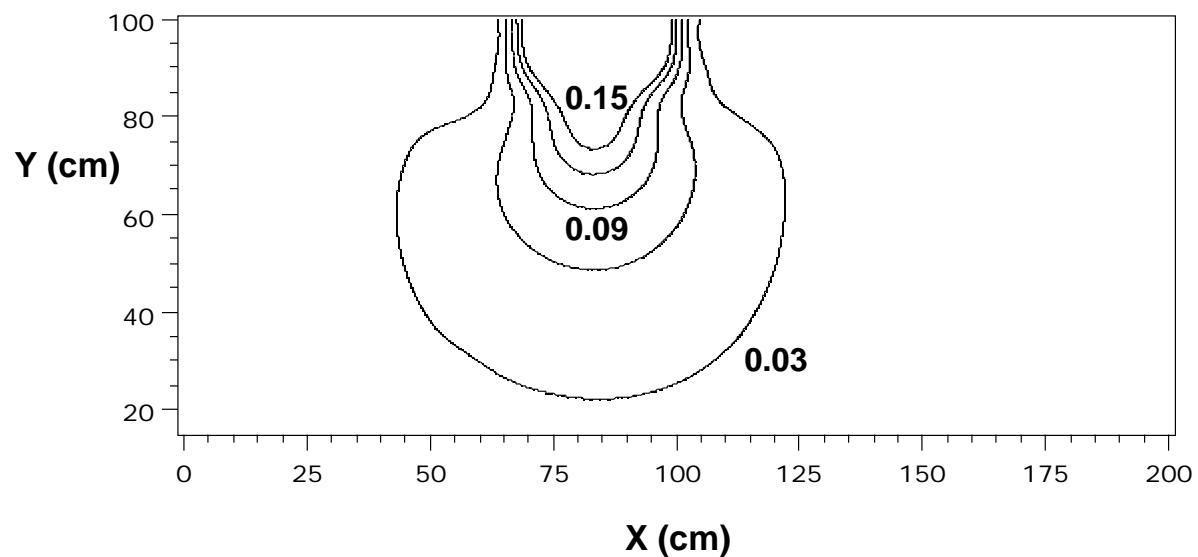
**to determine if density-driven vapor flow is a significant
transport mechanism at DOE sites**

- conduct quantitative intermediate-scale experiment
- analyze results and compare to theoretical predictions

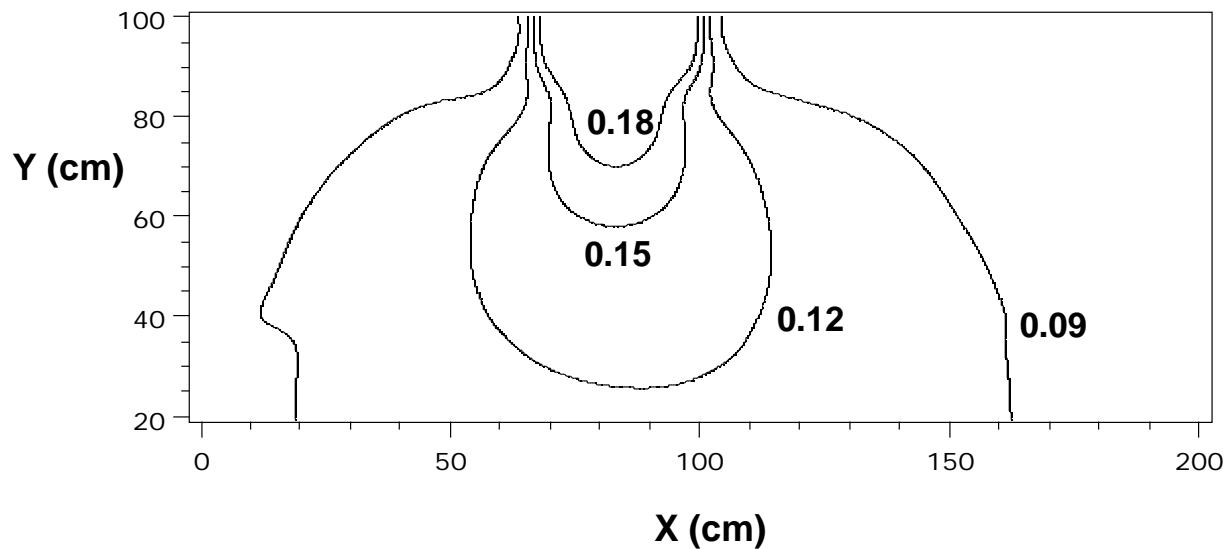


Location of Extraction Ports, Vapor Chamber and Water Table

TCE concentrations (g/l) after 12 hours



TCE concentrations (g/l) after 180 hours



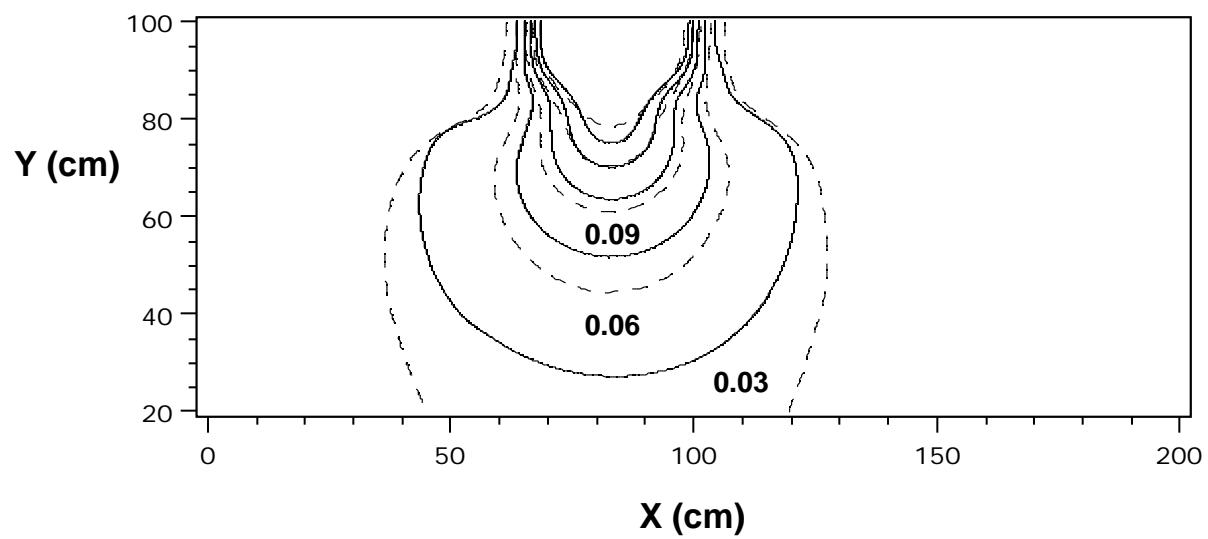
Comparison of Modeling Results and Experimental Data

NUMERICAL CODE

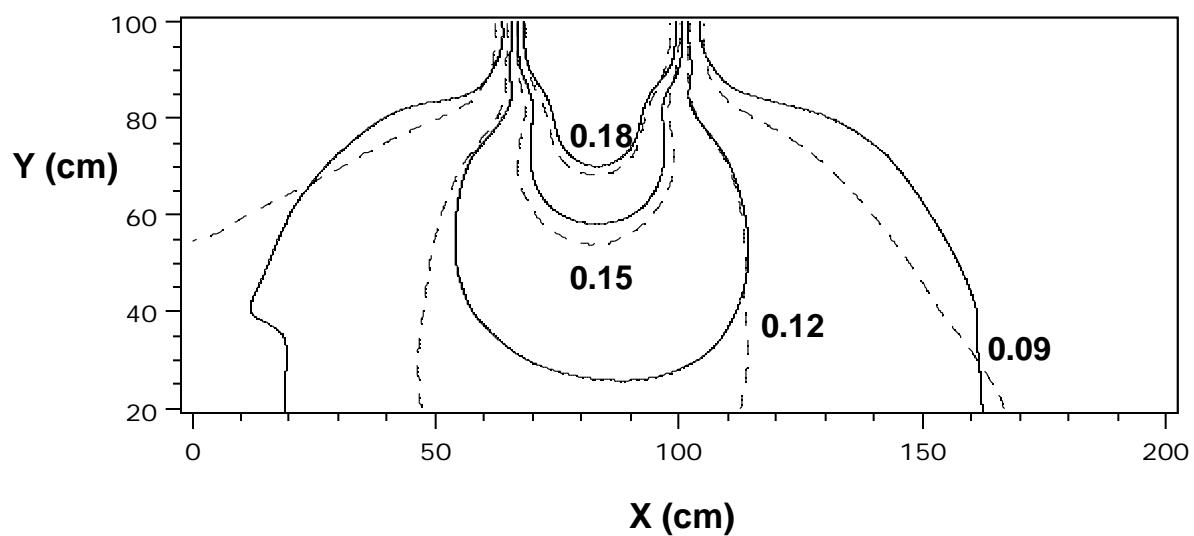
STOMP: Subsurface Transport Over Multiple Phases

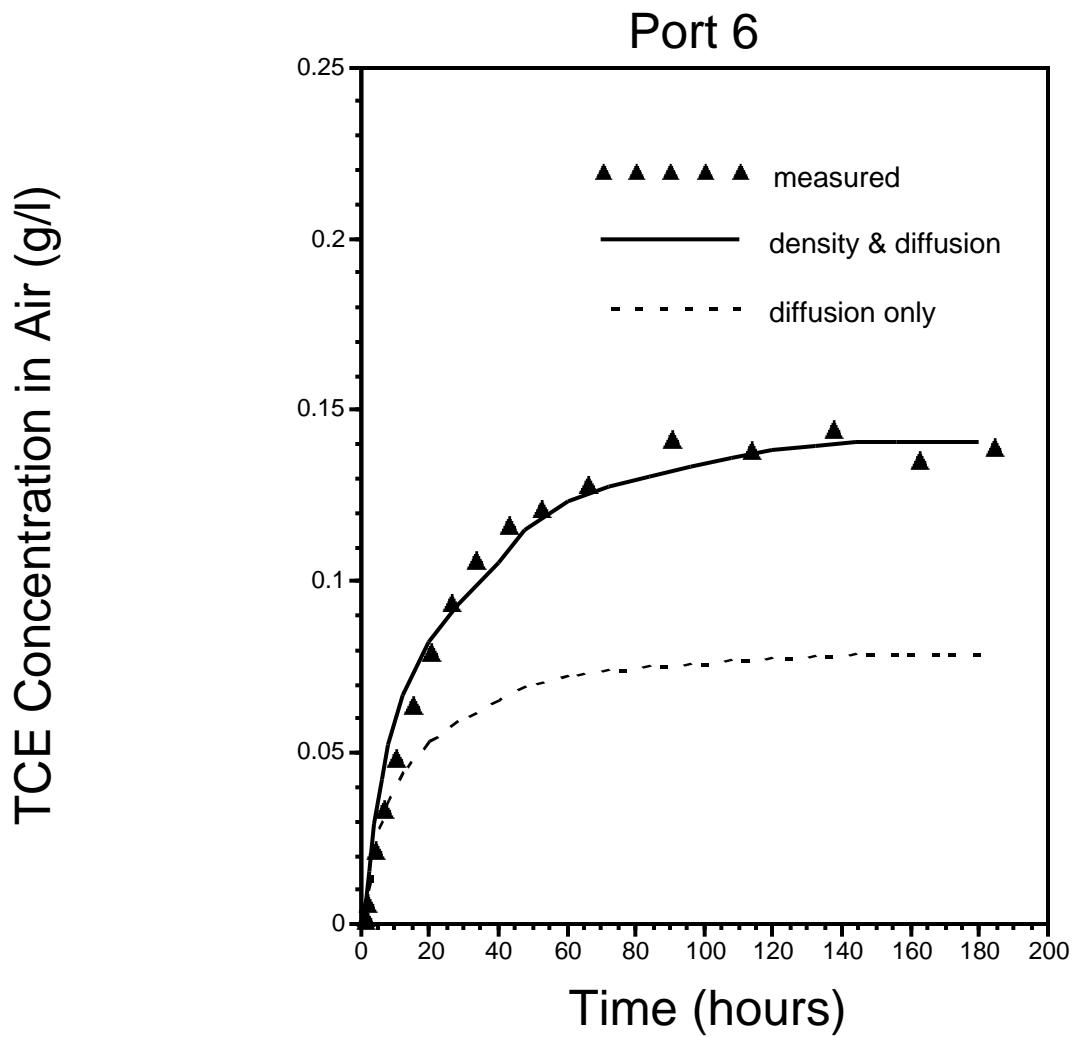
- integrated finite difference
- gaseous flow and transport have been verified against analytical solutions

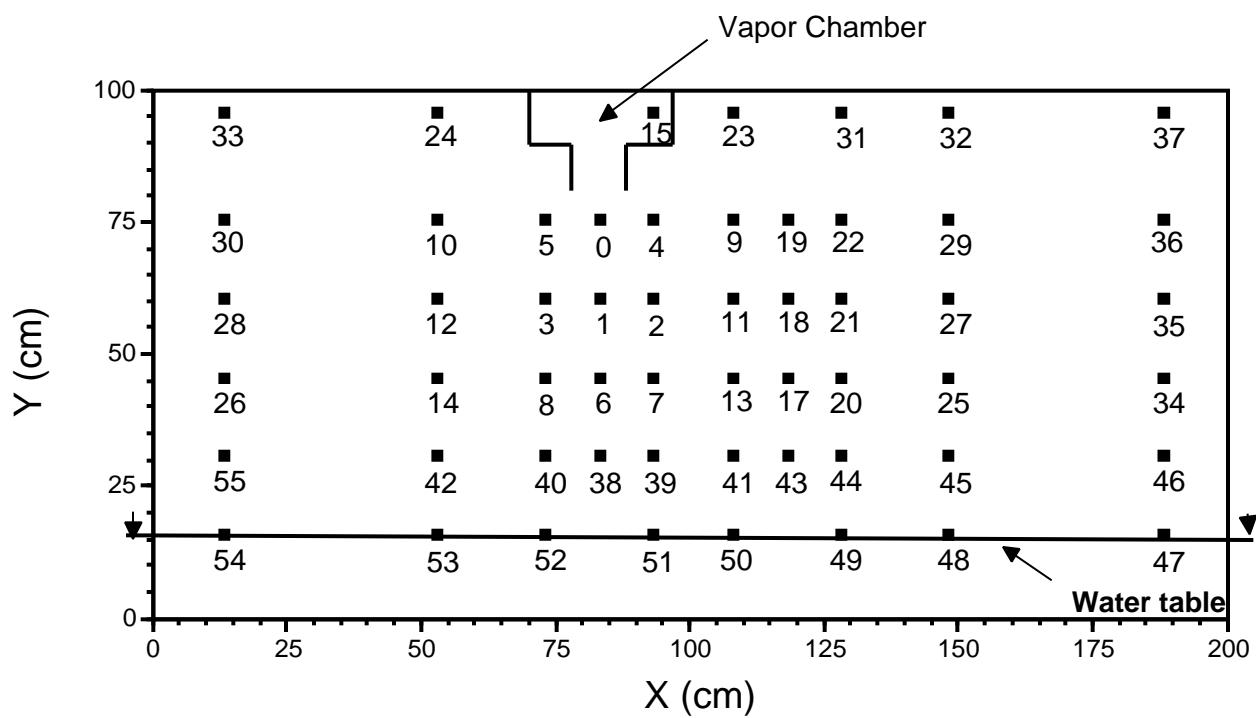
**Observed (solid lines) and predicted
(broken lines) TCE concentrations (g/l) after
12 hours**



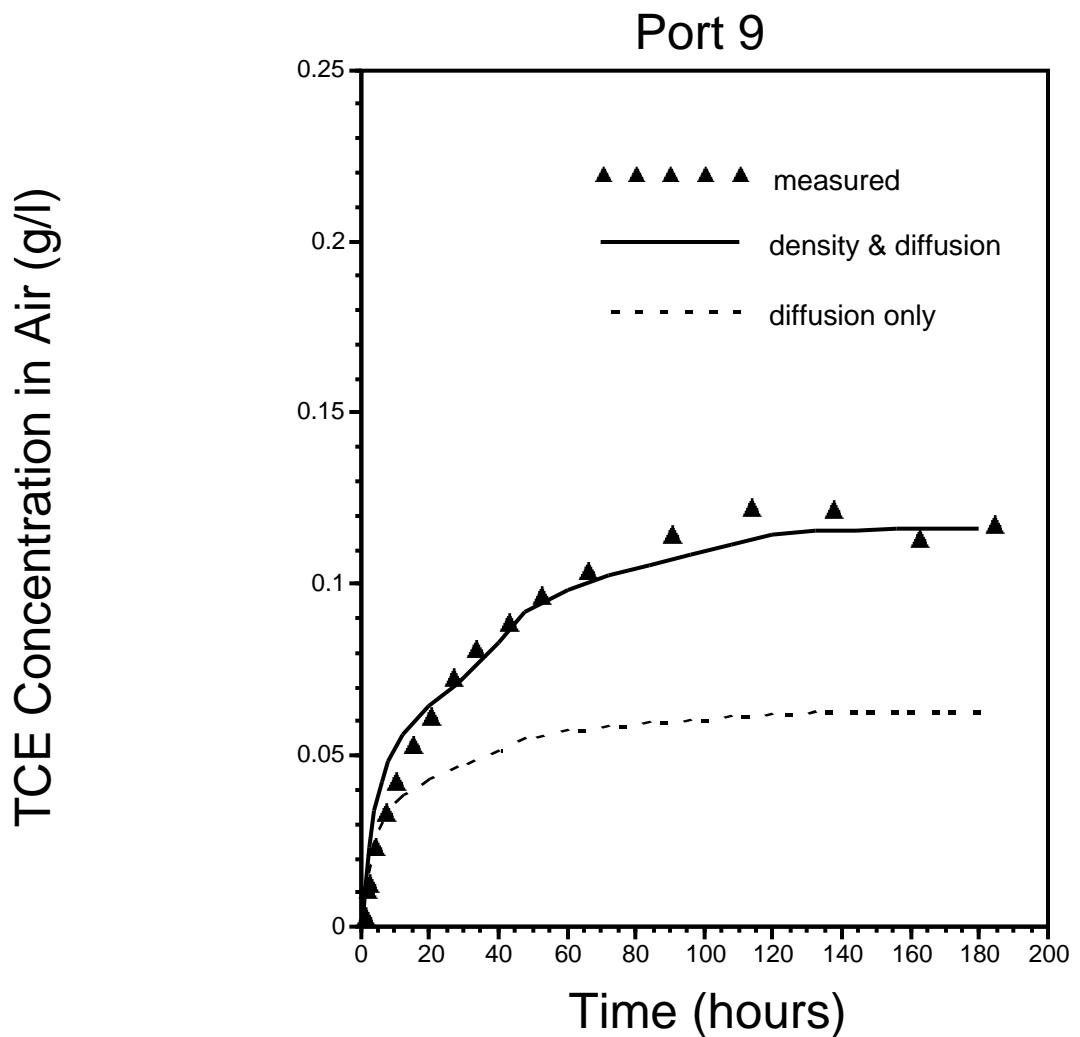
**Observed (solid lines) and predicted
(broken lines) TCE concentrations (g/l) after
180 hours**

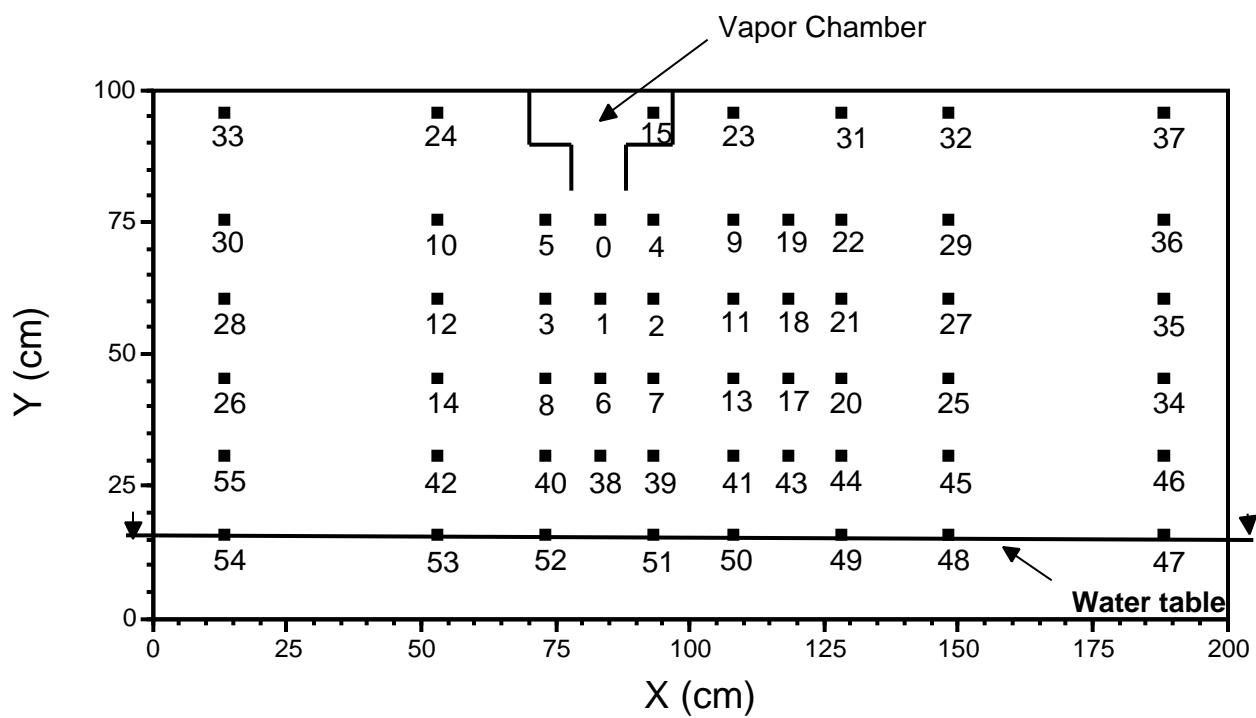




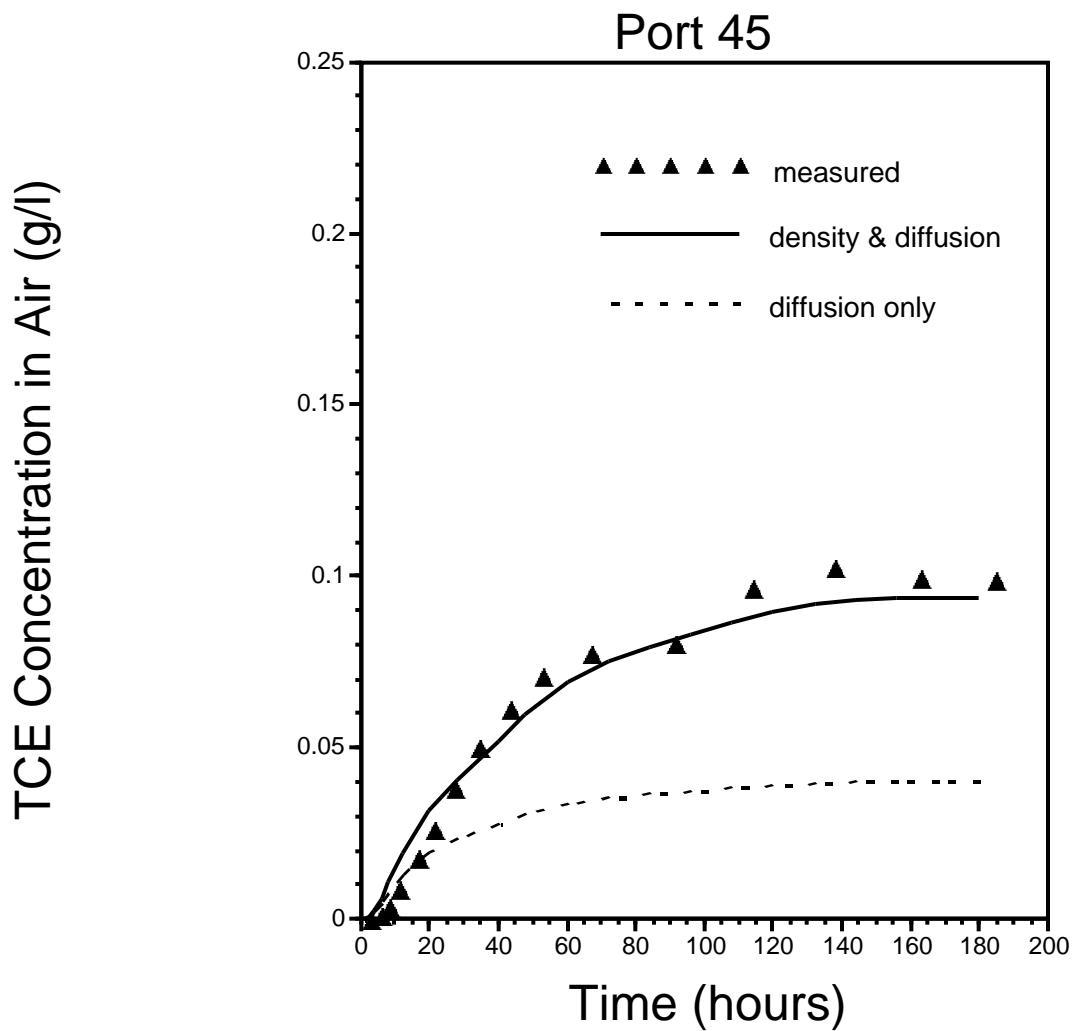


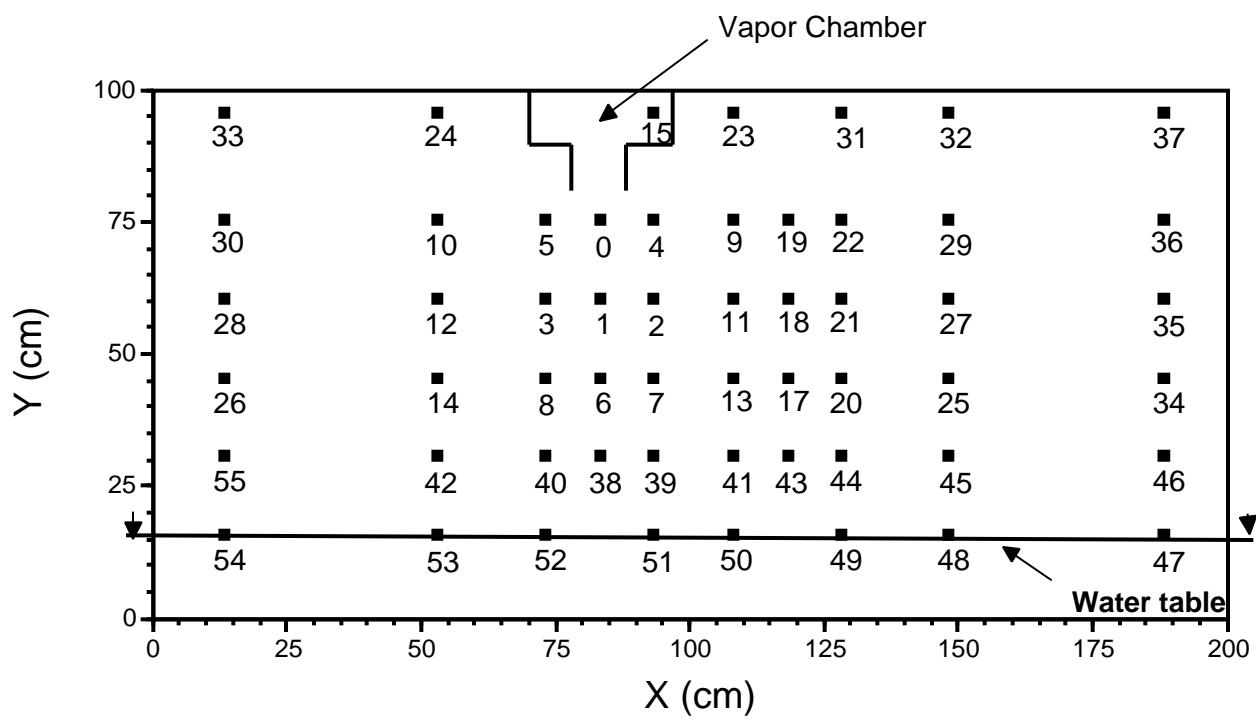
Location of Extraction Ports, Vapor Chamber and Water Table



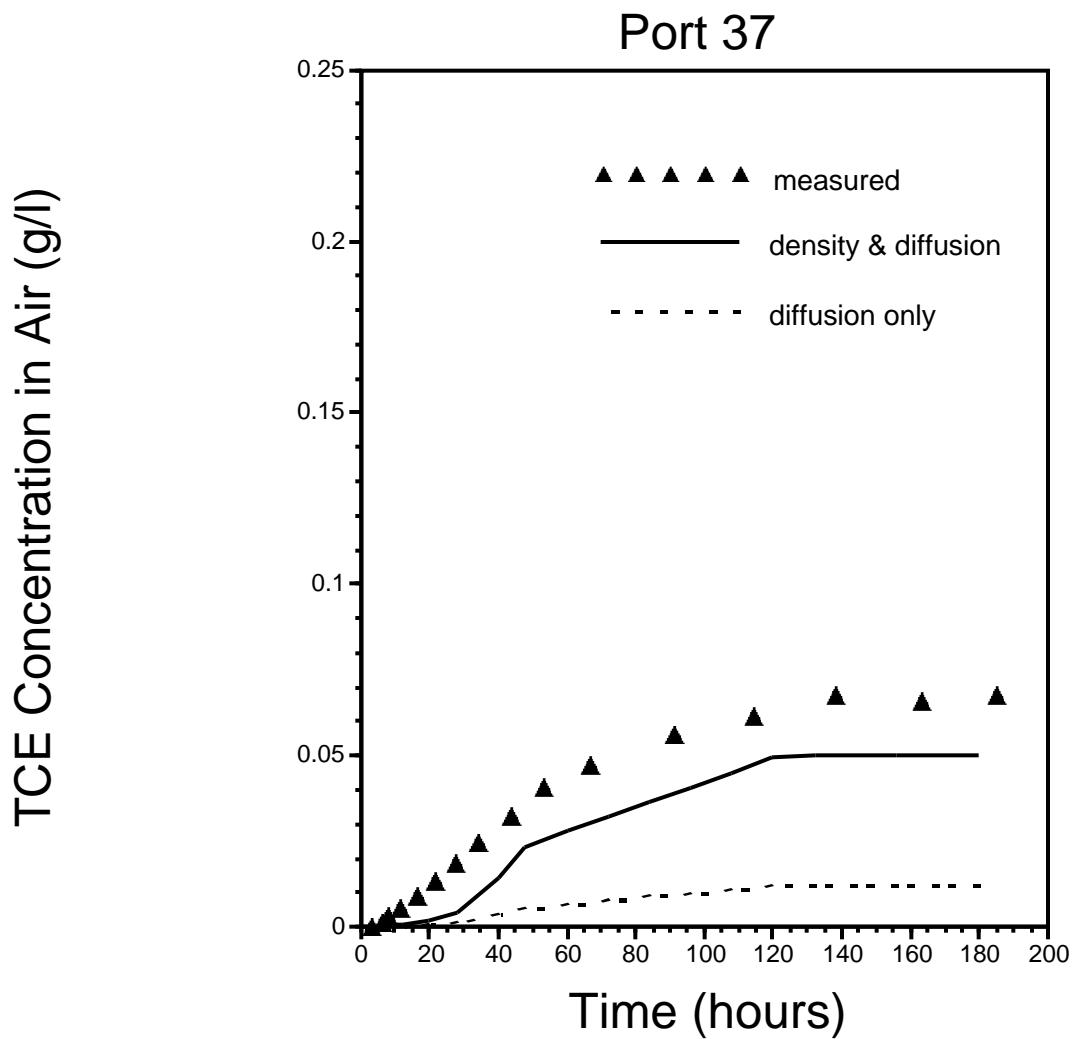


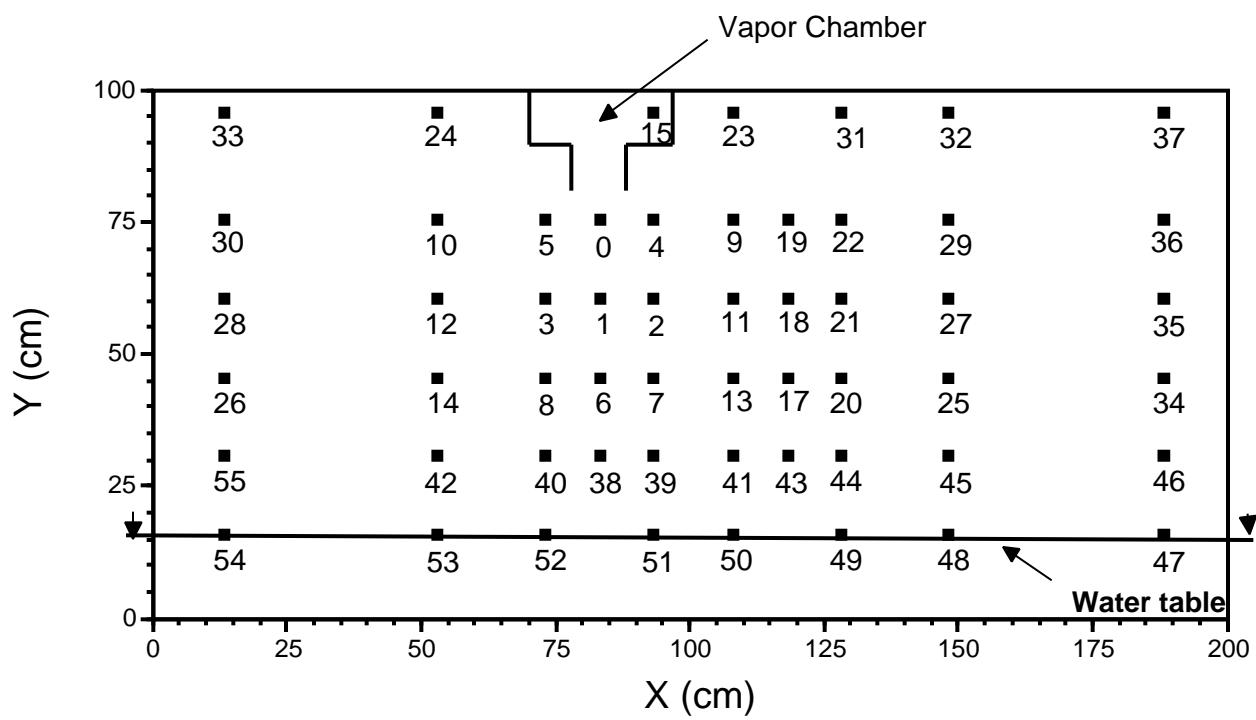
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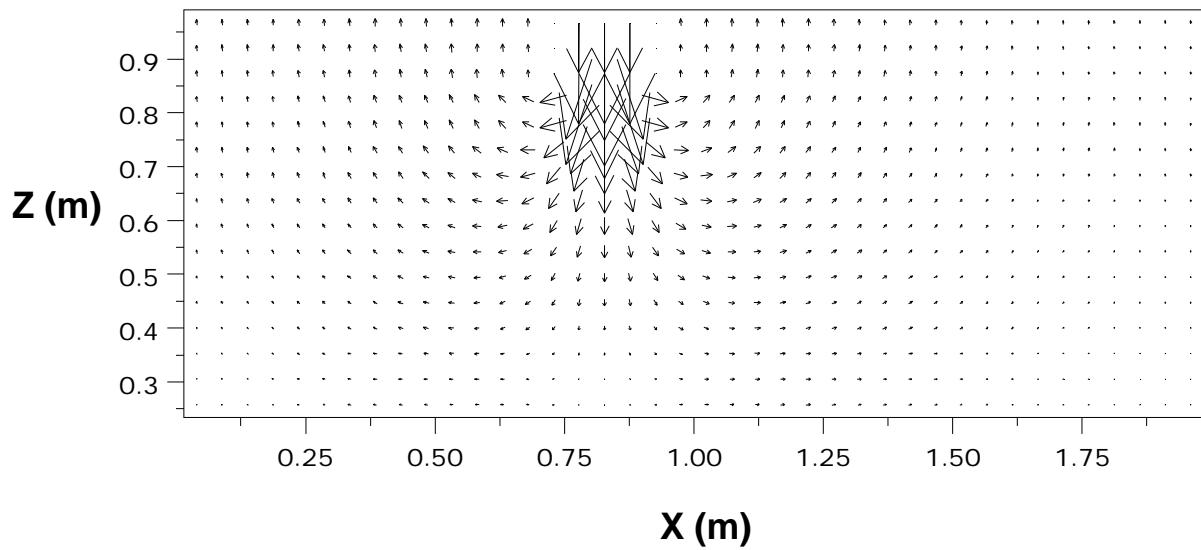
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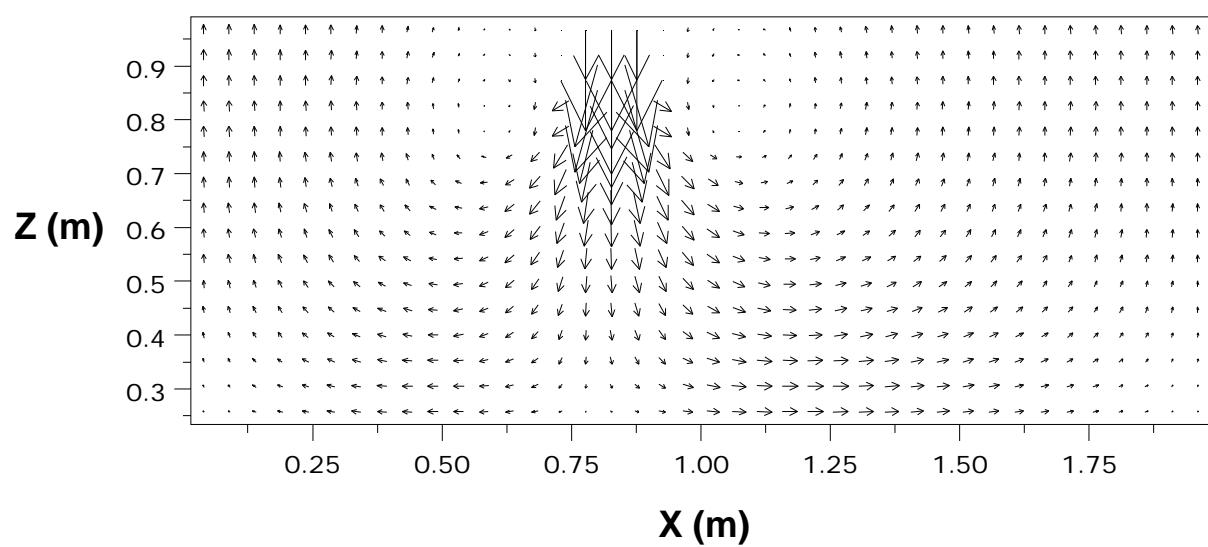


Location of Extraction Ports, Vapor Chamber and Water Table

Gaseous-Phase Darcian Velocities
at time = 1 hour



Gaseous-Phase Darcian Velocities
at time = 180 hours



CONCLUSIONS

- **Density-driven advection of TCE vapors is an important transport mechanism in this experiment.**
- **Diffusion does not describe gas-phase transport accurately for TCE.**
- **Density-driven advection of organic compounds that have relatively high vapor pressures and molecular weights needs to be included in predictive codes.**