



2003 AFCEE Technology Transfer Workshop

San Antonio, Texas

Promoting Readiness through Environmental Stewardship

AFCEE SOURCE ZONE INITIATIVE- TECHNICAL ASSISTANCE TO F.E. WARREN, NAS FORT WORTH & AFP 4

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February 25, 2003





Study Team

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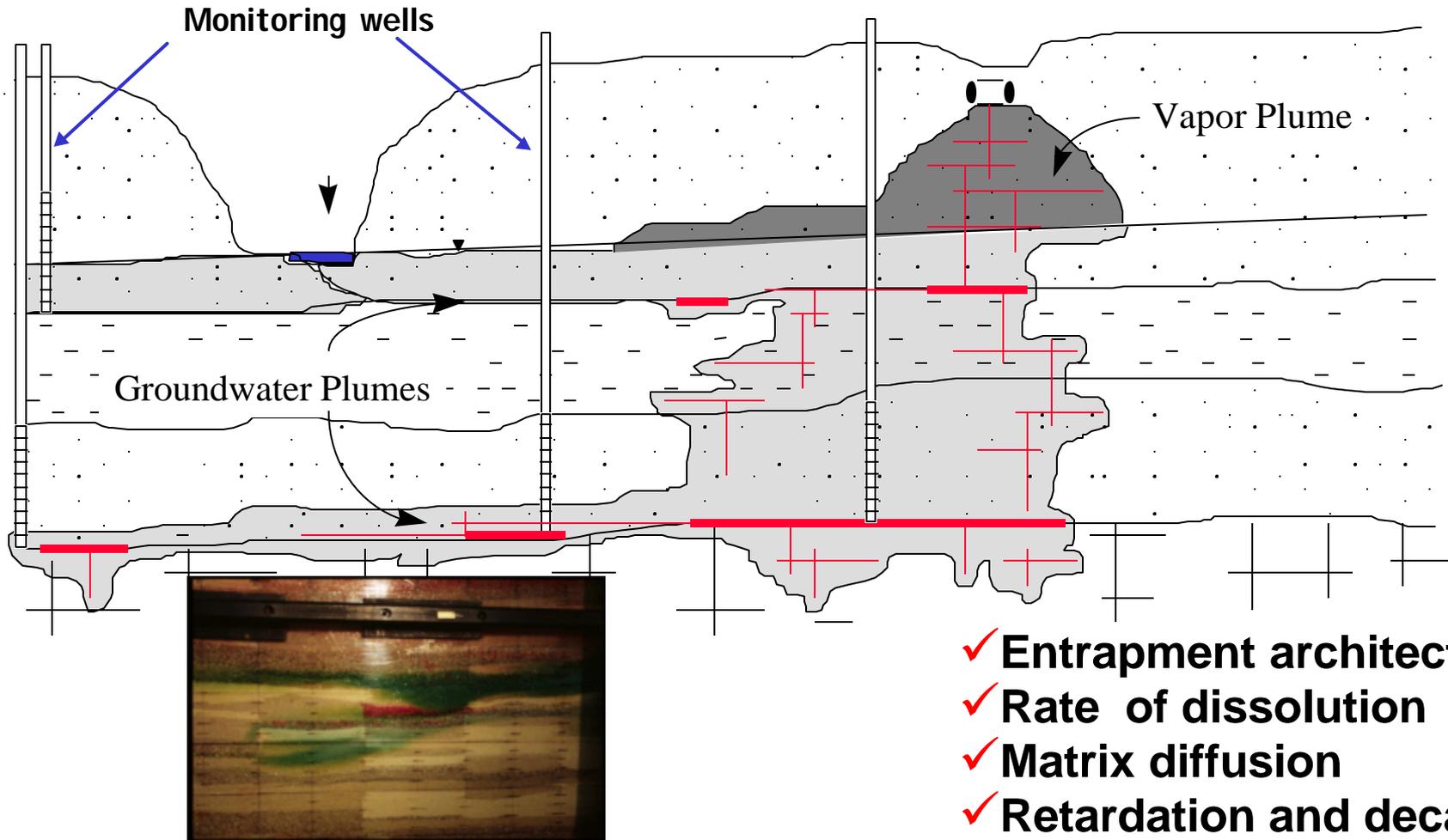
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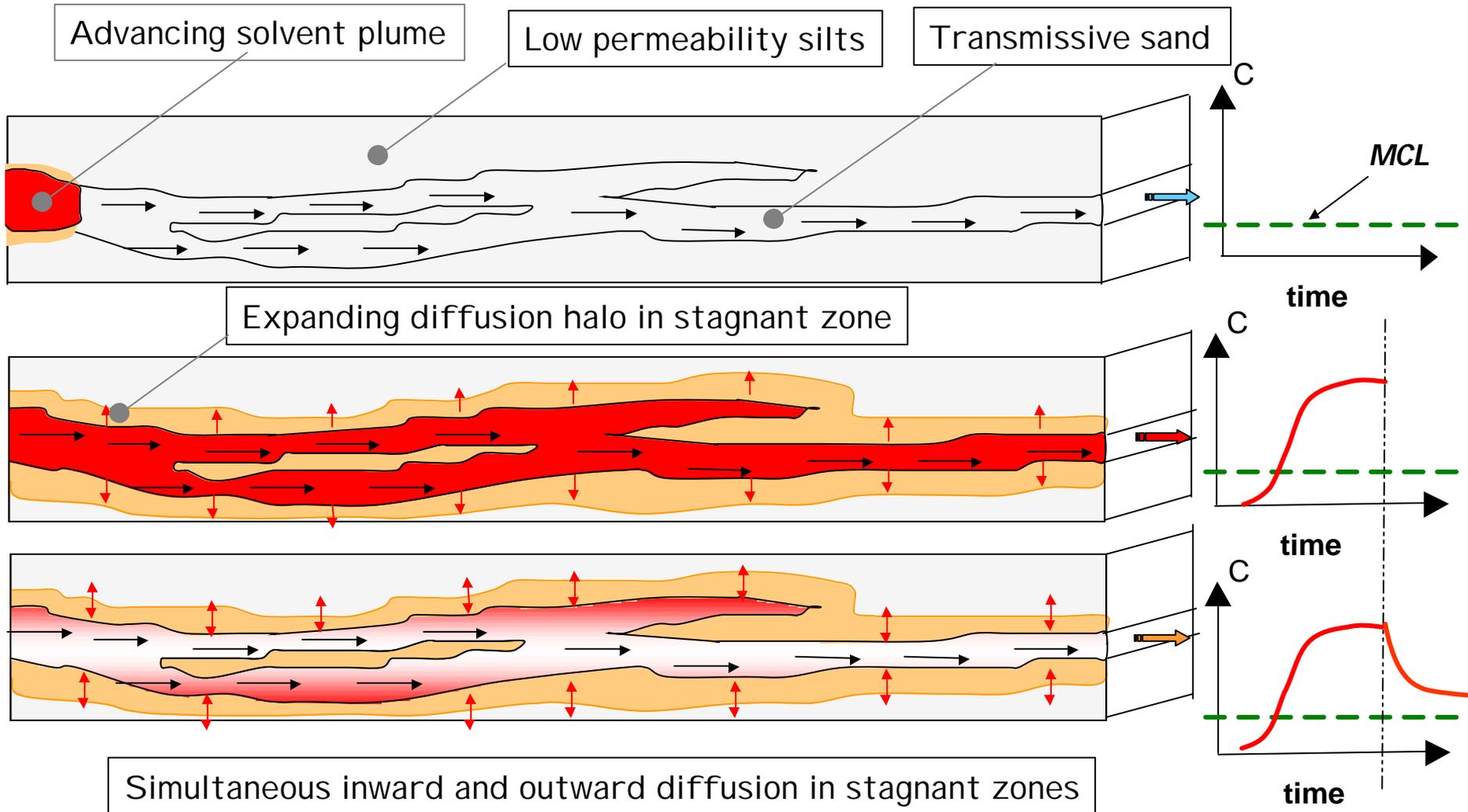
Factors Affecting Emission Concentrations

“Emission” concentrations are higher than regulatory standards





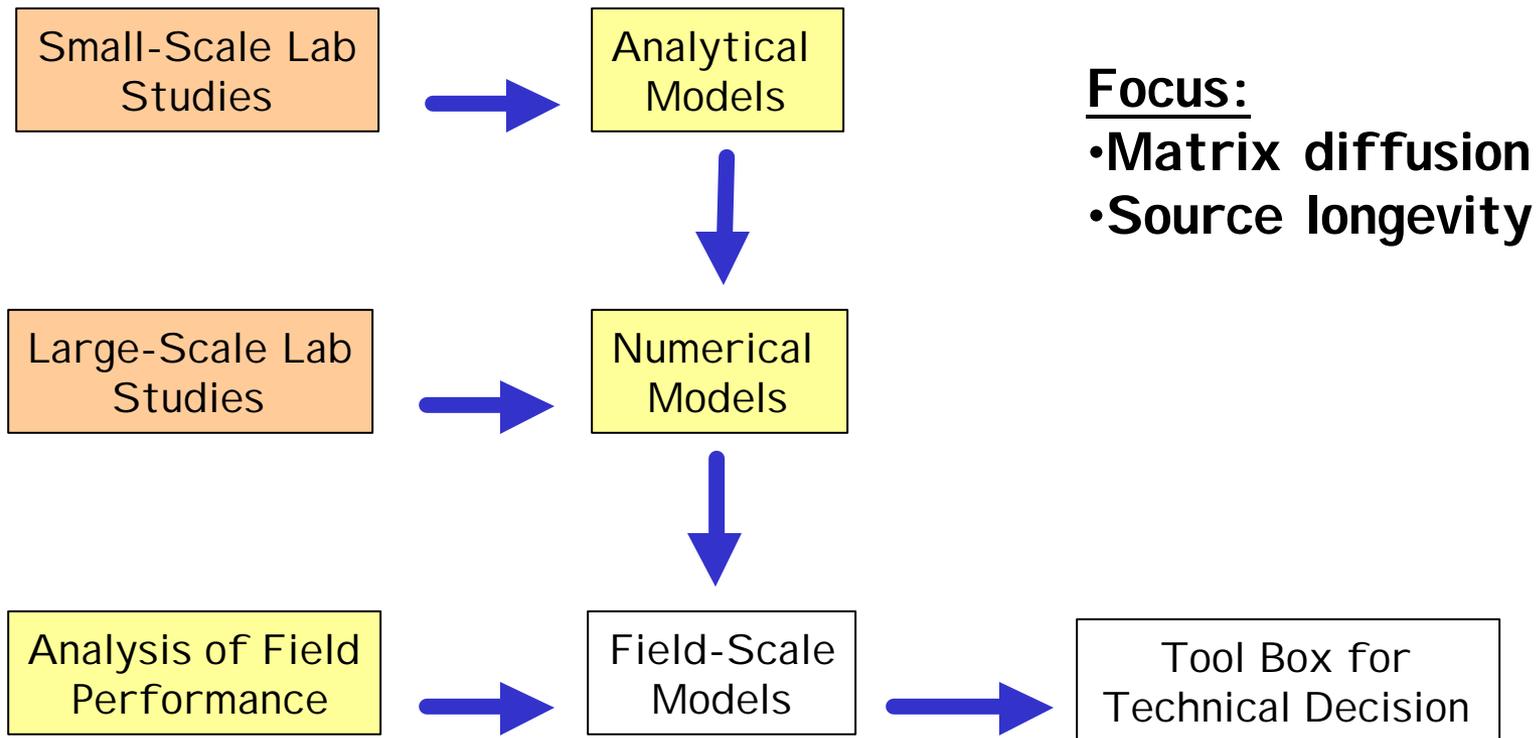
Mass Attenuation by Matrix Diffusion





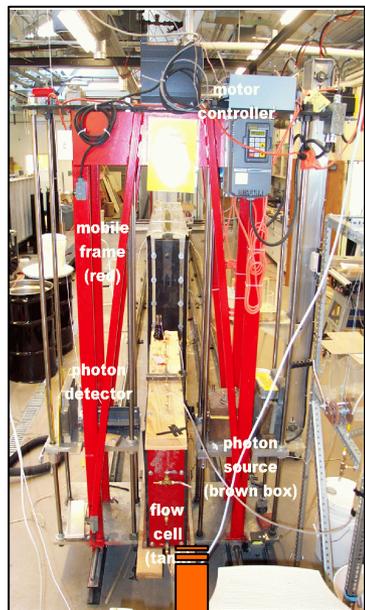
Study Goals

Premise is that an improved **“a priori understanding”** can be developed by conducting investigations of governing processes at field sites



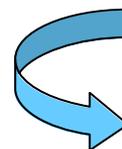


Experimental Facility



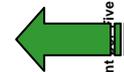
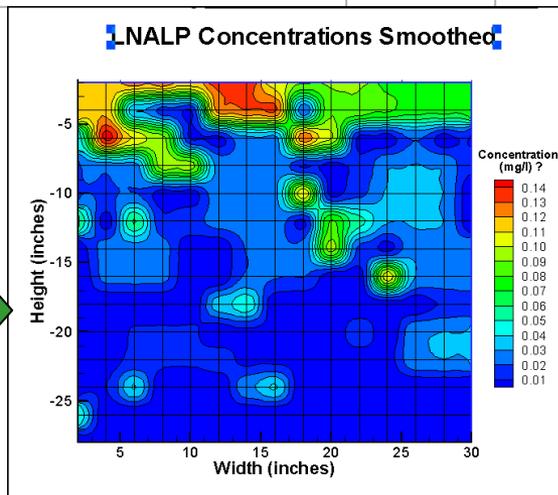
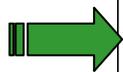
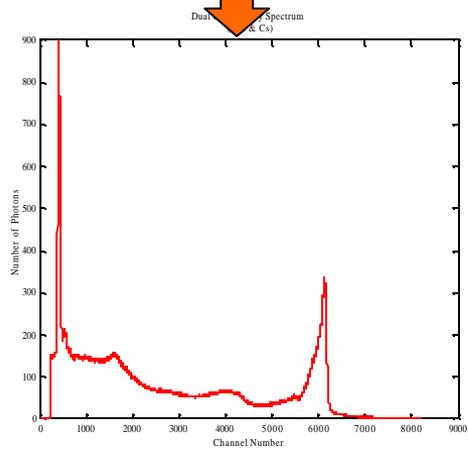
Test bed facility

$$I(L) = I_0 \exp \left(- \sum_i n_i r_i L \right)$$

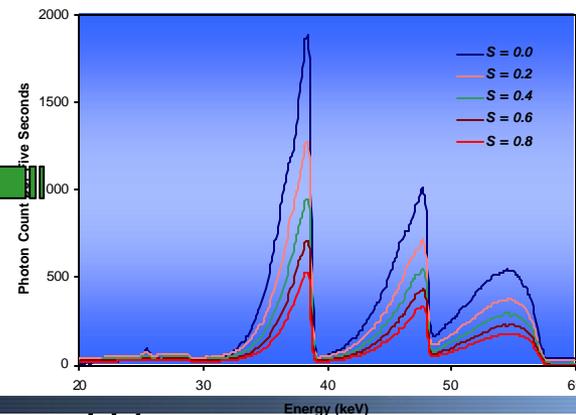


Attenuation coefficient

Path length



X-Ray Spectra for Indicated W Saturation in #70 Sand (5 cm)



Promoting Readiness through Environmental Stewardship



Testing of F.E Warren Soils



Column studies for estimate of flow and transport properties



Dissolution of three NAPLs (MTBE, PCE, and TCE)



Testing with NAS Fort Worth Soils



- Tank dimensions (16'x4')
- Gamma system to track NAPL saturation
- Sieve the soil for sand/silt
- Packing to represent different architecture
- Solute plume monitored



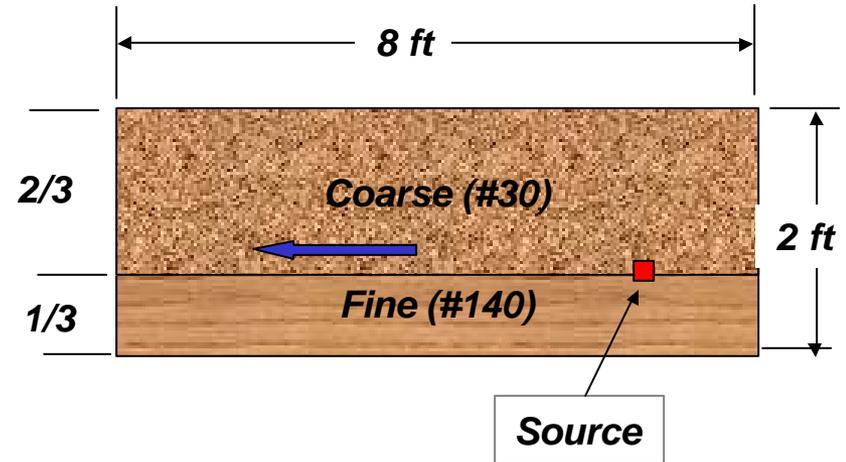
Experiments in Progress

Two-dimensional Intermediate Scale



Tank : 2 ft x 8 ft x 2 inch

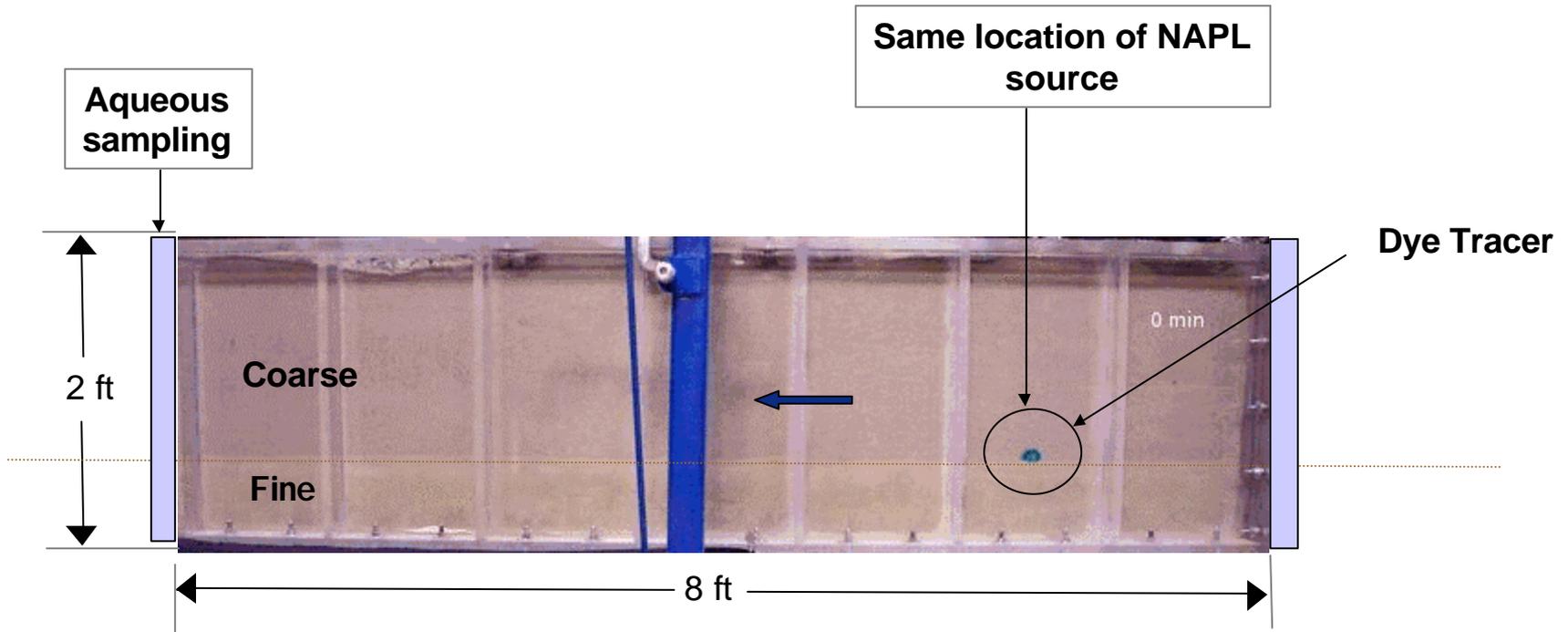
Emission concentrations monitored
(automated sampling)



Source depletion monitored with x-ray
(automated for long time monitoring)



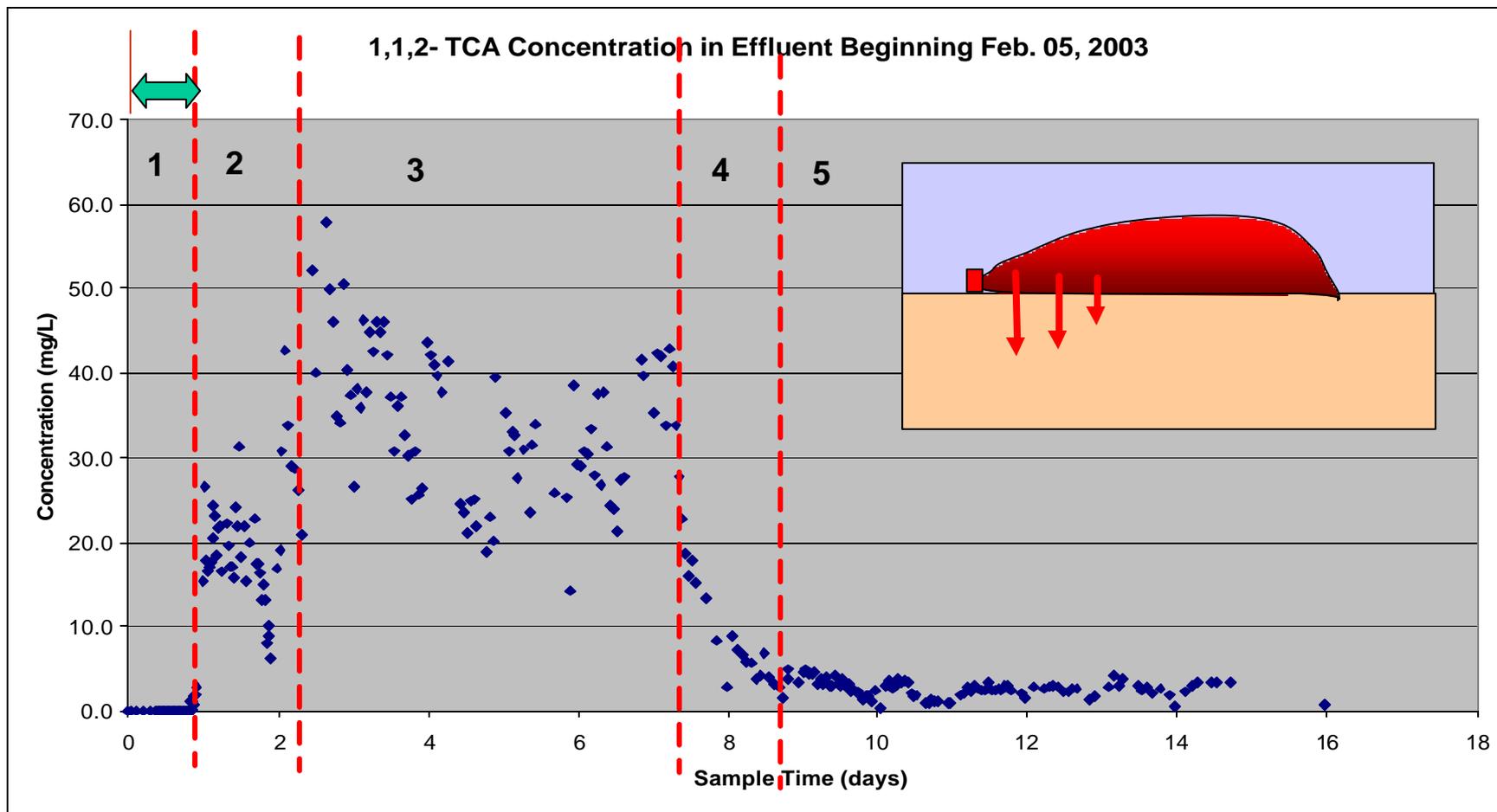
Tracer Study



Purpose: Dye injected in order to calibrate dispersivity of current configuration.

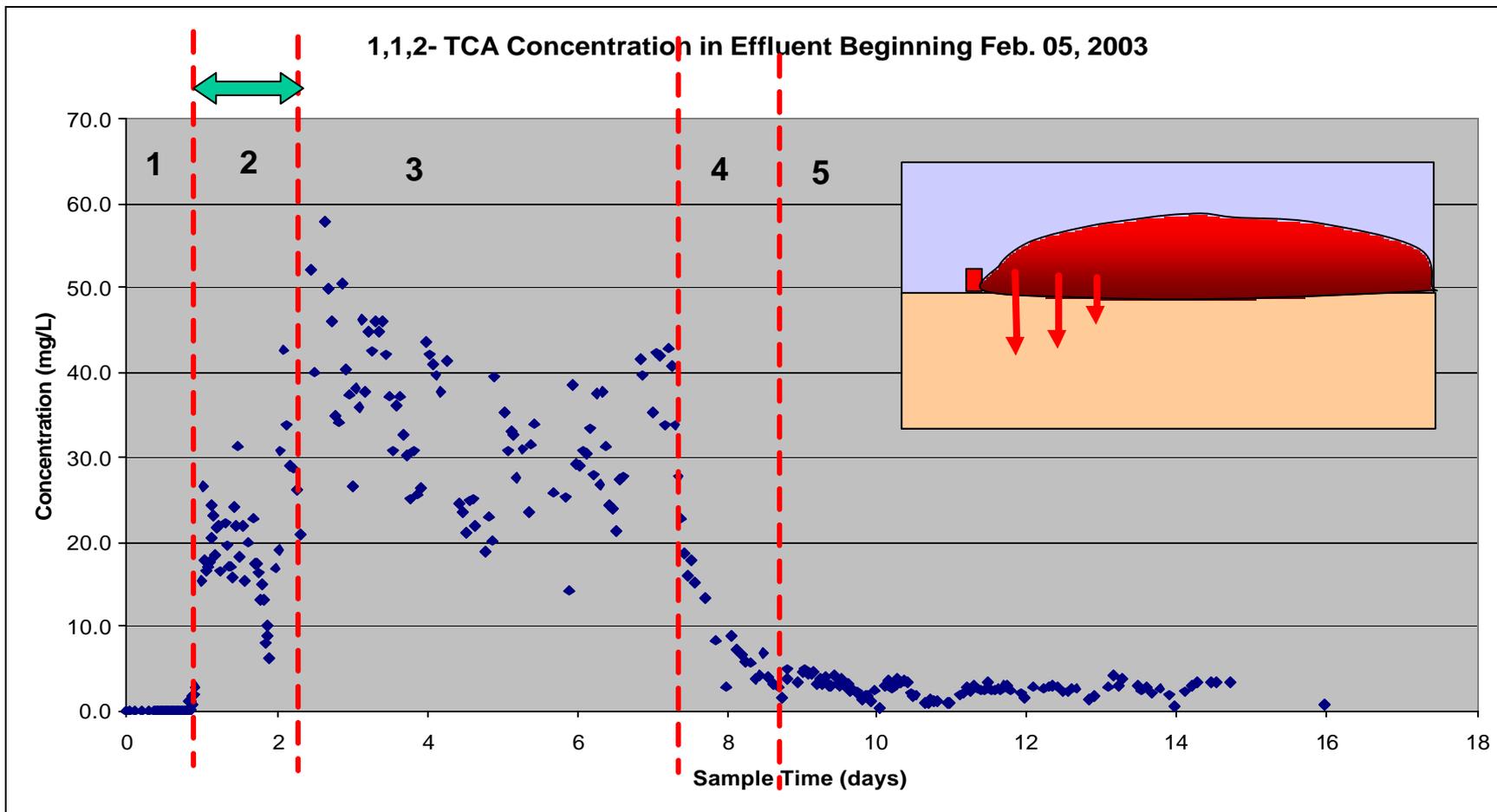


Effluent Concentration-prior to breakthrough (1)



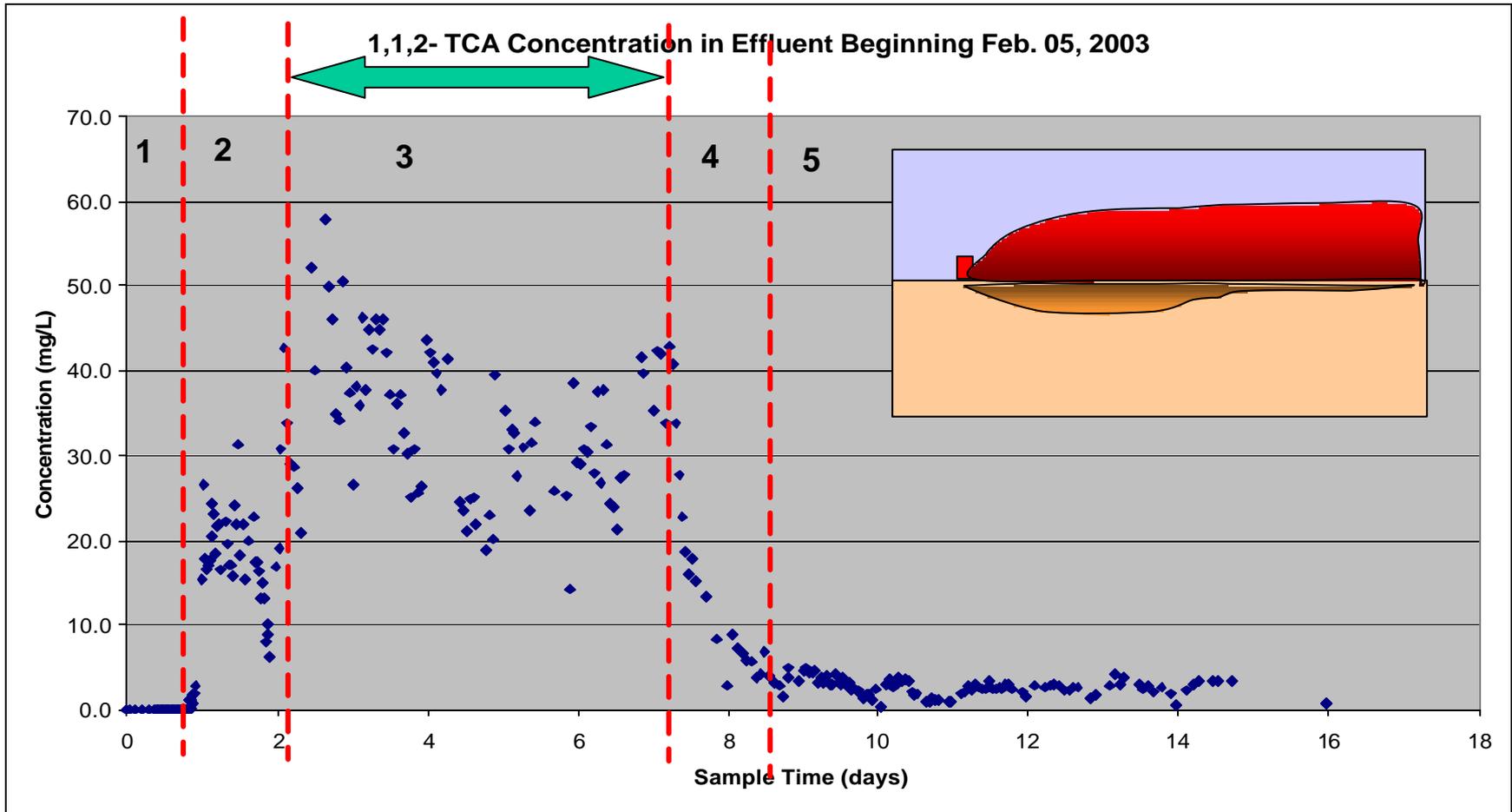


Effluent Concentration- matrix diffusion at high concentration gradients (2)



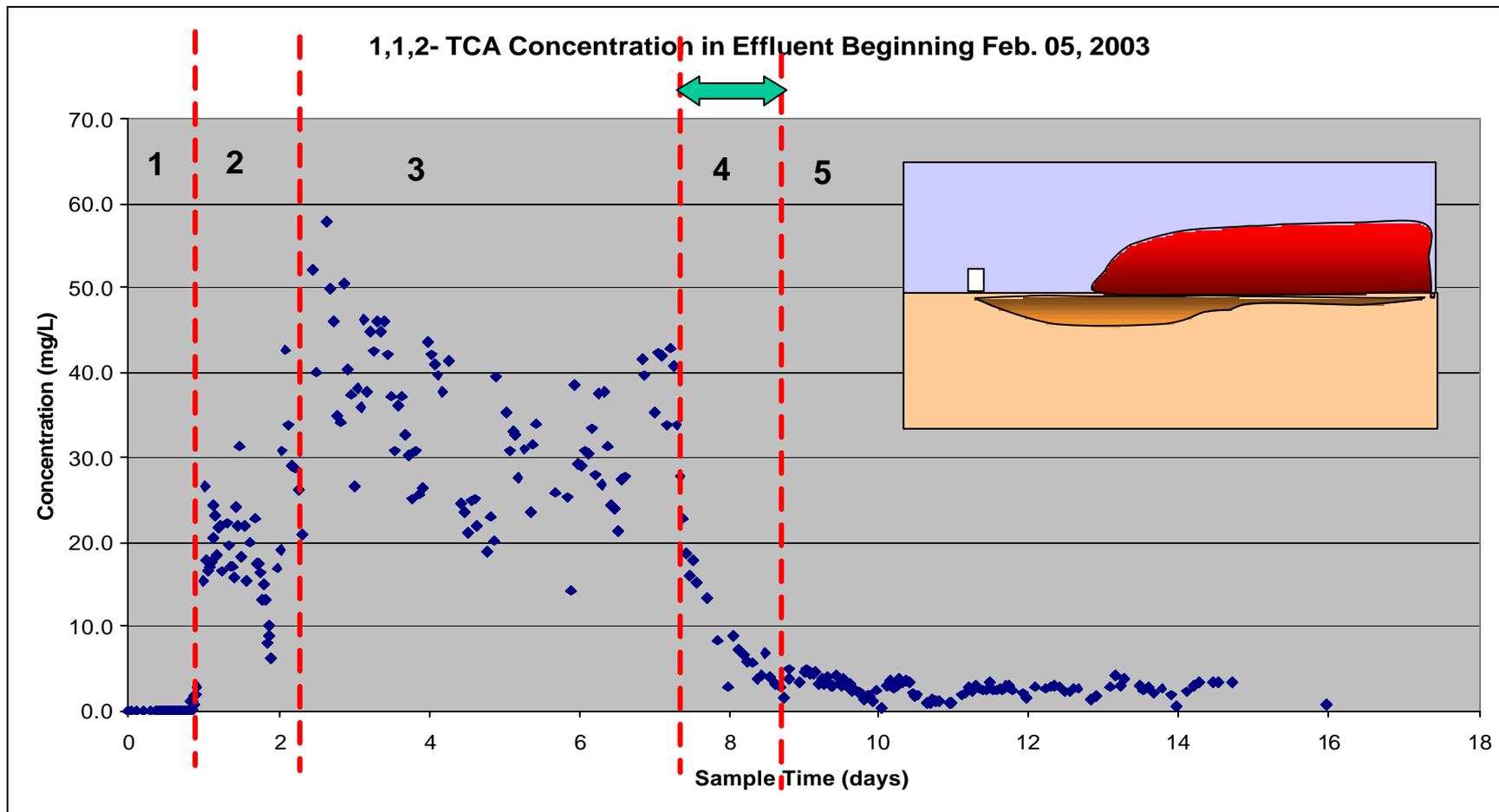


Effluent Concentration- DNAPL source depletion (3)



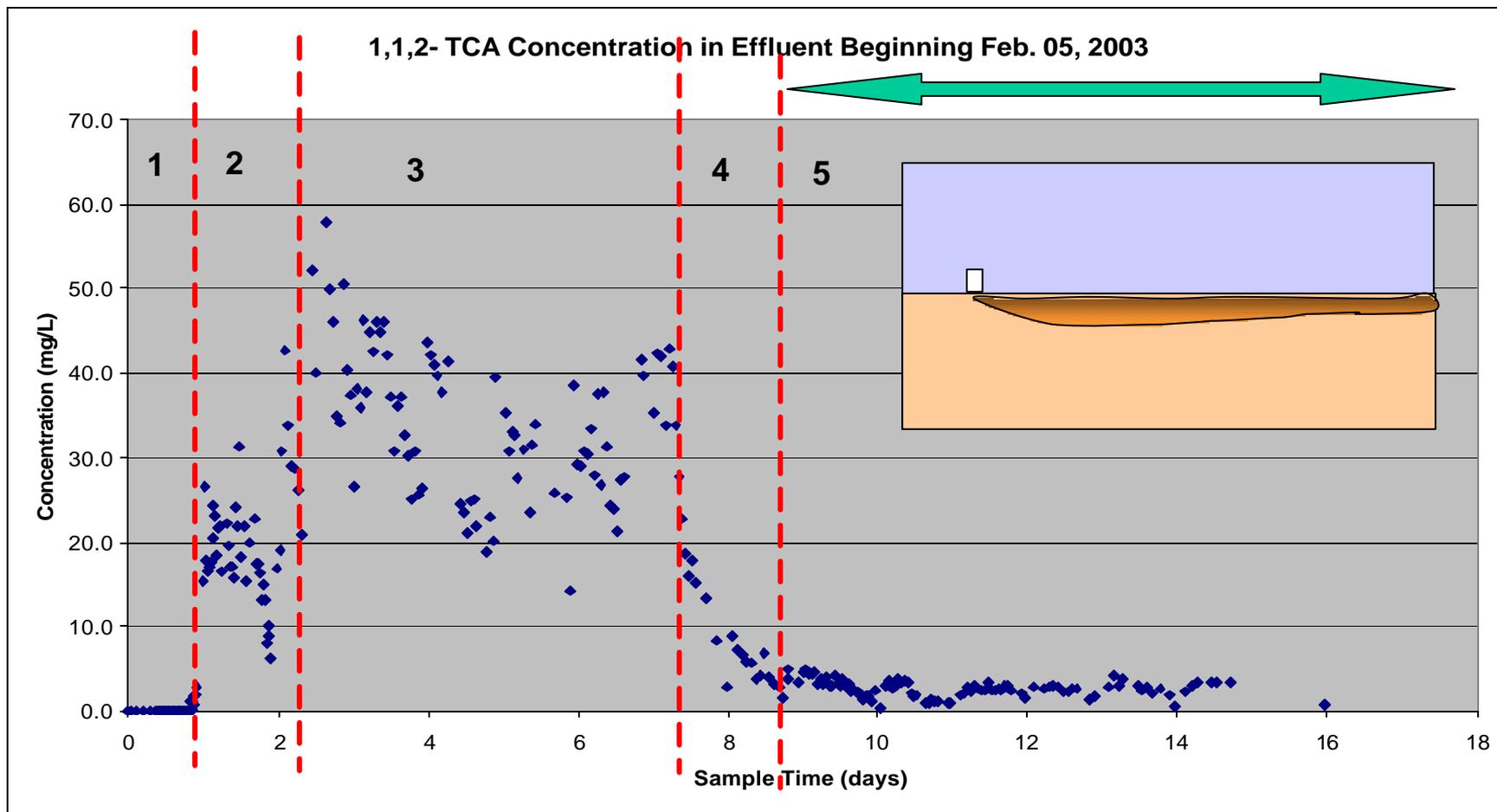


Effluent Concentration- Flushing of coarse layer (4)





Effluent Concentration- Rebound from fine matrix (5)

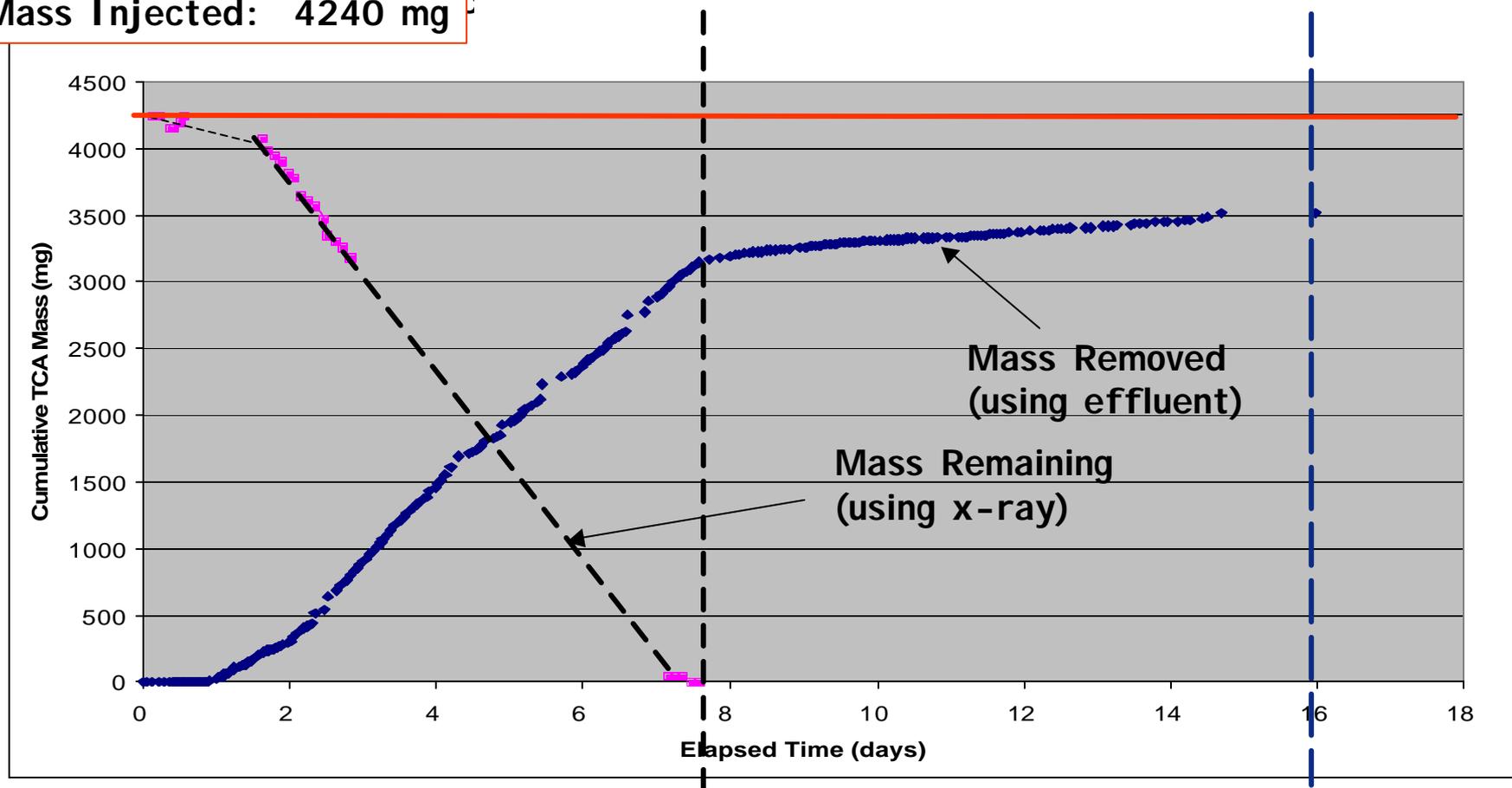


Mass Removed at 16 days: 83%



Cumulative Mass Removal

Mass Injected: 4240 mg



NAPL source depleted: 99%

Mass Removed : 83%



Numerical Models

- **MODFLOW 2000 (Modular Groundwater Model)**
 - **Outputs heads and cell-to-cell velocities using implicit finite difference technique**

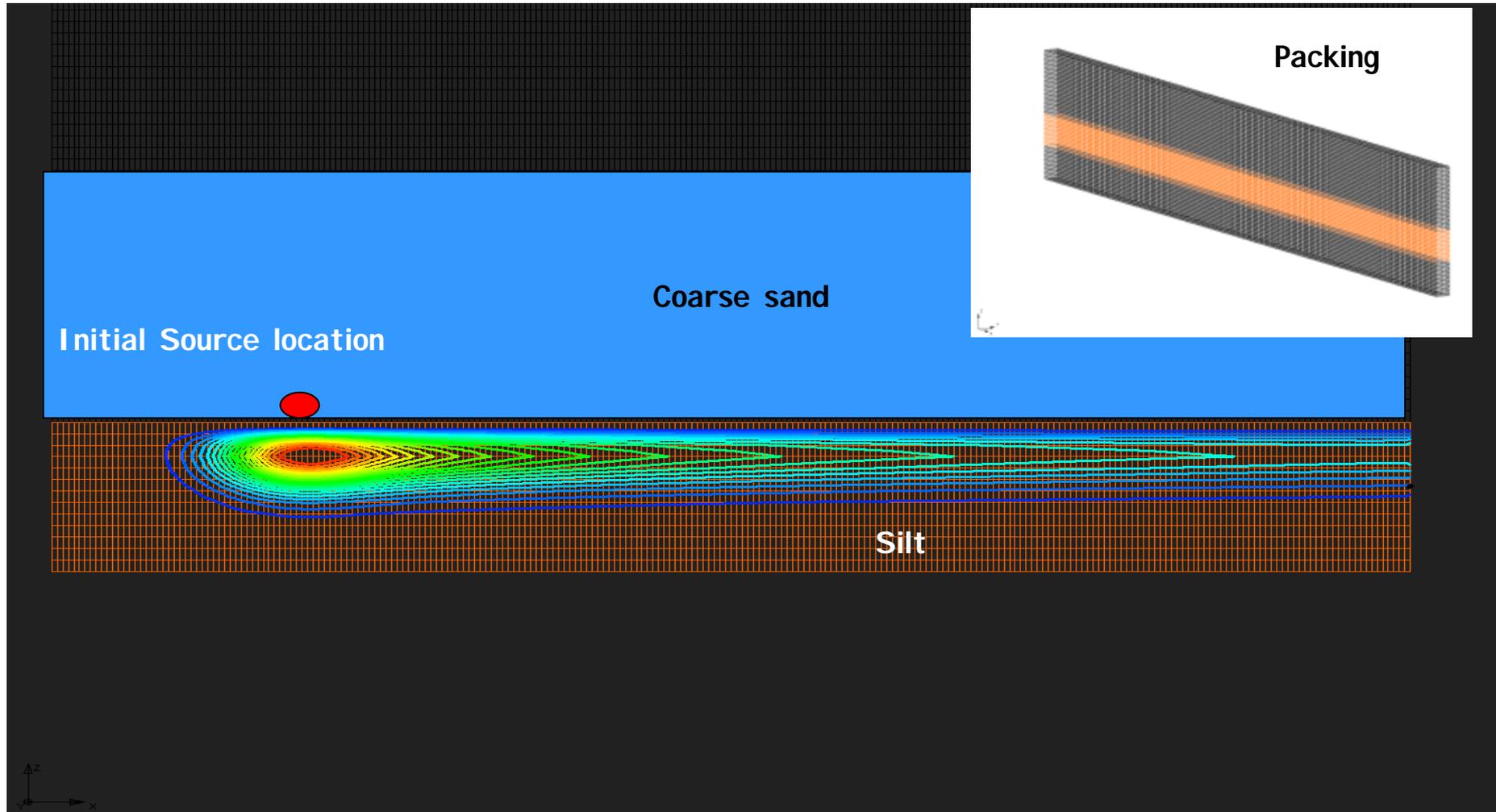
- **MT3D (Modular Transport Model)**
 - **Uses MODFLOW 2000 output and solves for the cell-to-cell constituent concentrations using explicit and implicit techniques**

- **SEAM3D (NAPL Dissolution Package)**
 - **Use NAPL dissolution package with MT3D to model NAPL source**

- **GMS (Groundwater Modeling System)**
 - **Graphically displays heads, concentrations, and velocity fields**



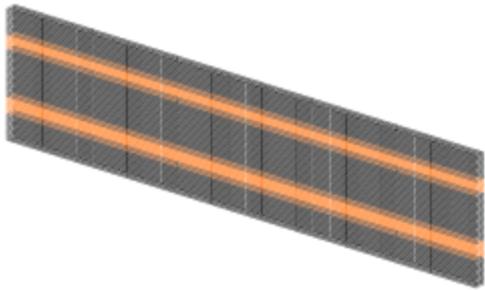
Plume in silt layer



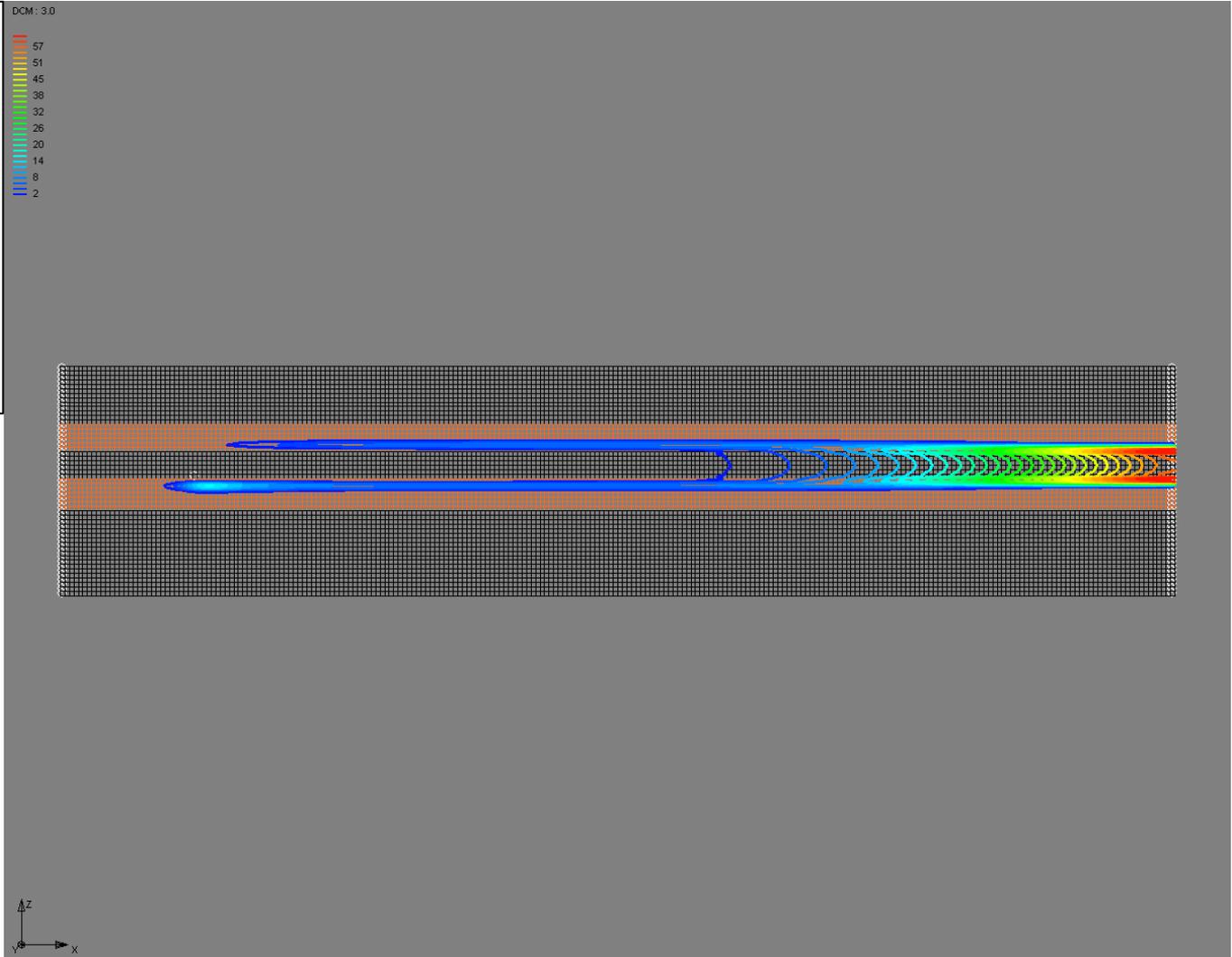
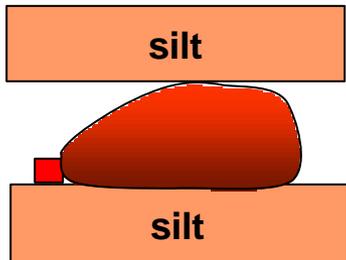


Contaminant distribution in double silt layers 3 days after injection

Packing



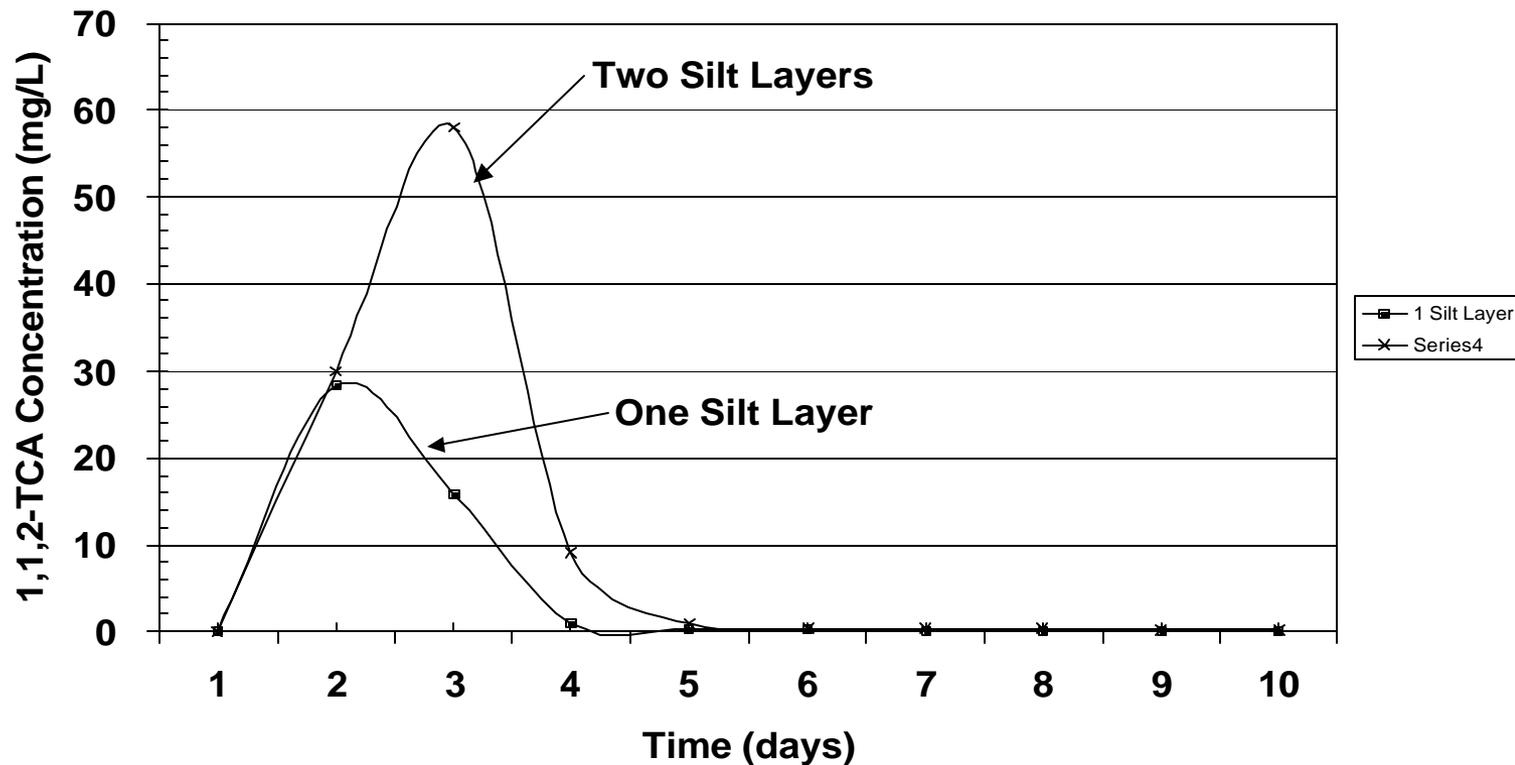
Source





Effect of Architecture on Emission

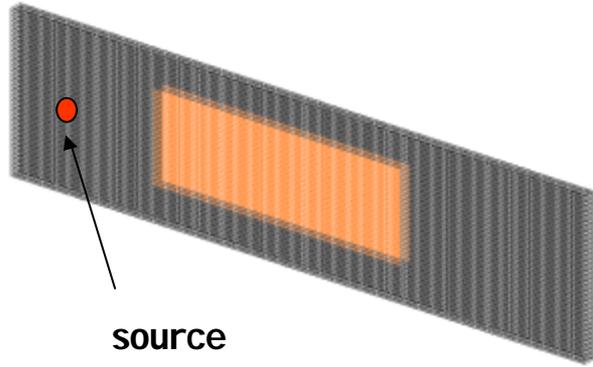
Emission Curves of Two Architectures





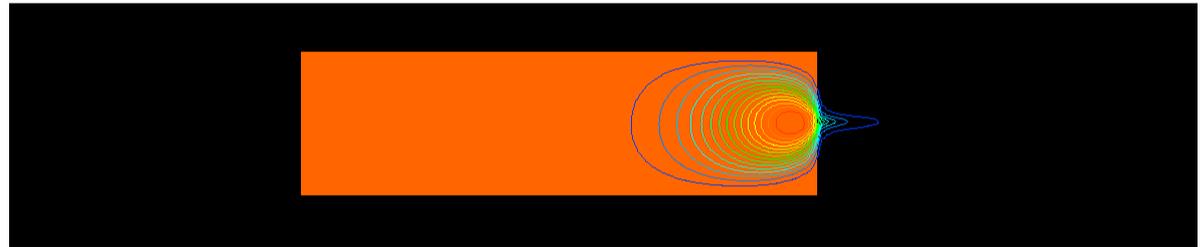
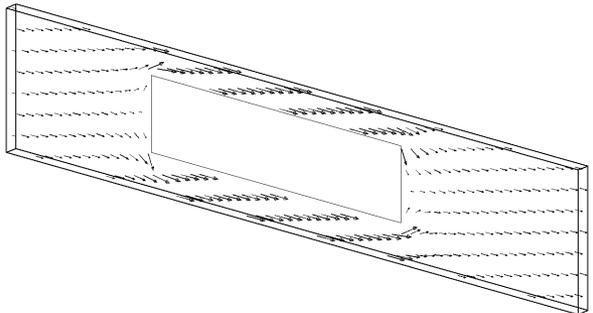
Attenuation in the silt lens

Packing



At 50 days, the DCM concentrations to the right of the silt block were near zero.

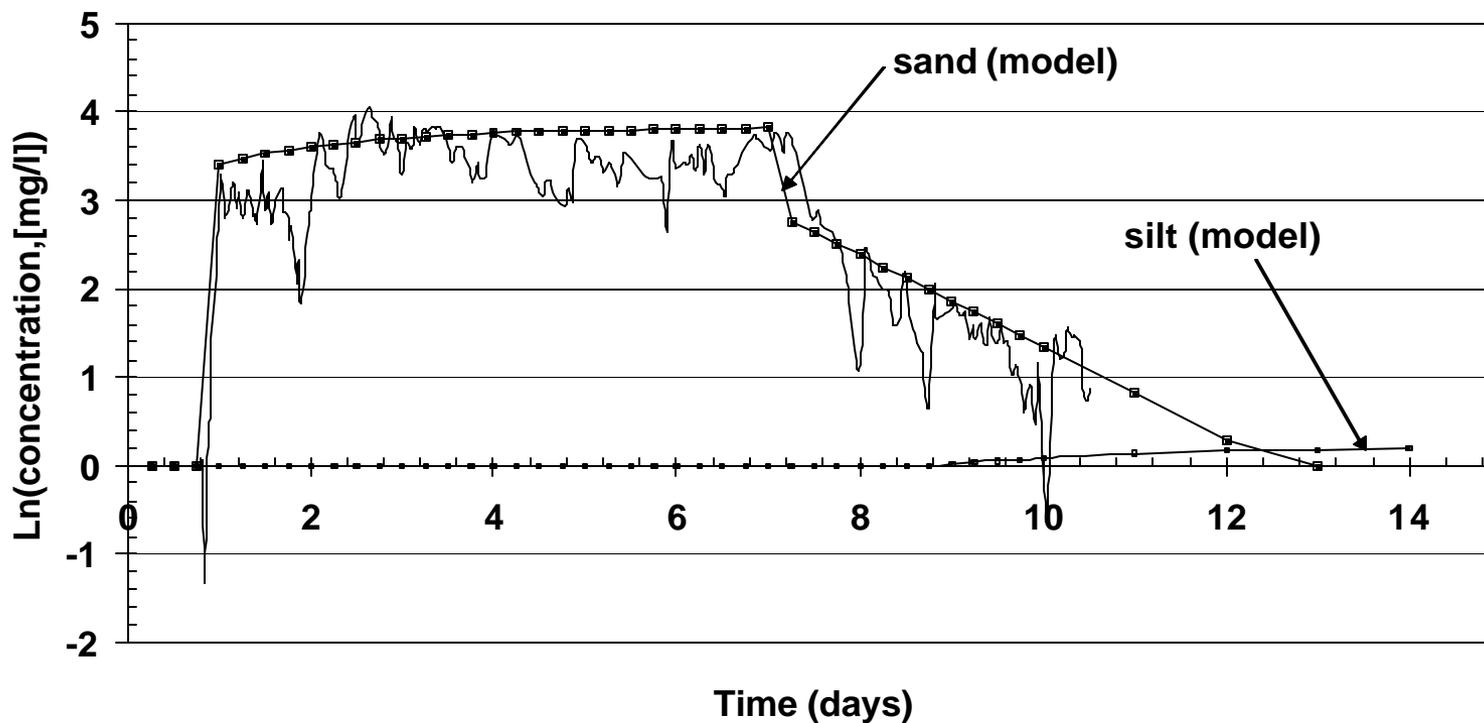
Flow field





Initial model predictions

Log Transformed 1,1,2-TCA Effluent Data vs Model Prediction
(Sand Layer [244,43], Silt Layer [244,45])





Summary/Conclusions

- Experimental methods have been developed
- Modeling tools are able to capture the critical processes
- Models need to be validated with laboratory data from tanks
- Effect of architecture on the emission has been demonstrated
- Preliminary results help in improving conceptual site models
- Methods needed for up-scaling