Headquarters U.S. Air Force

Integrity - Service - Excellence

Site Characterization With Diffusion Samplers

U.S. AIR FORCE

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U.S. Geological Survey
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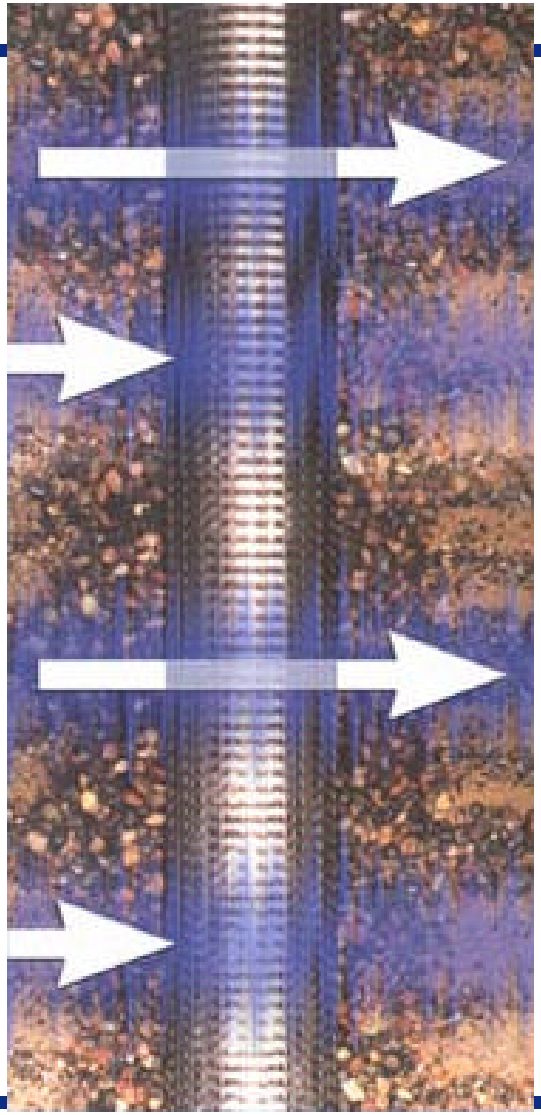
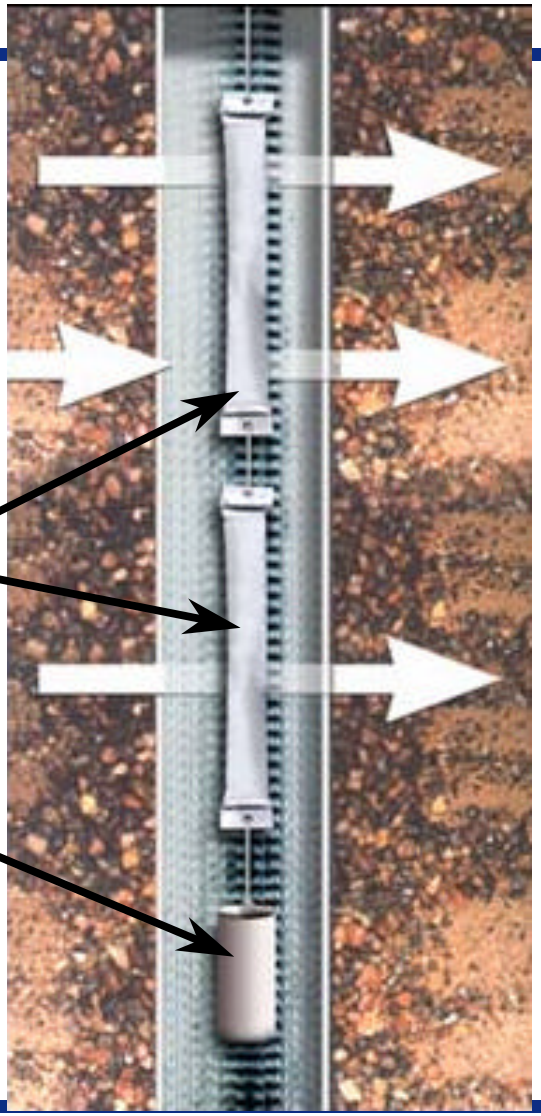
Groundwater and Contaminant Flow

Well Screen

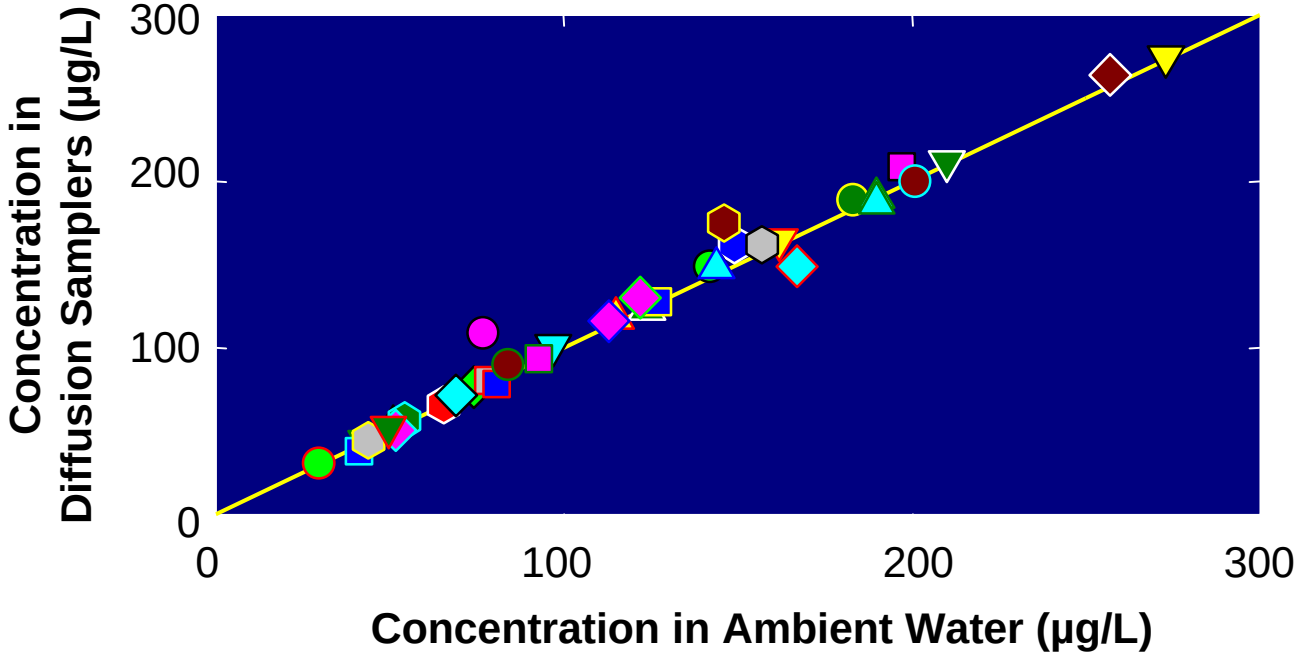


Diffusion Samplers in Well

Cross Section View



Lab Tests of Water-Filled Diffusion (PDB) Samplers



Benzene	EDB	1,2-DCA	Ethyl Benzene	1,1,2-TCA
BDCM	DBM	1,1-DCE	MC	TCE
Bromoform	1,2-DCB	*c*-DCE	Naphthalene	TCFM
Carbon Tet.	1,3-DCB	*t*-DCE	PCA	1,2,3-TCPA
Chlorobenzene	1,4-DCB	1,2-DCPA	PCE	Vinyl Chloride
Chloroethane	DCDFM	*c*-DCPE	Toluene	Total Xylenes
DBCM	1,1-DCA	*t*-DCPE	1,1,1-TCA	

Applicability of Diffusion Samplers

- **Not applicable to inorganic and highly-soluble or highly-insoluble organic compounds, including the following tested compounds:**
  - **MTBE (too soluble)**
  - **Pesticides (too insoluble)**
  - **Most PAHs (naphthalene is an exception)**

PDB Sampler Equilibration Time in Lab Studies

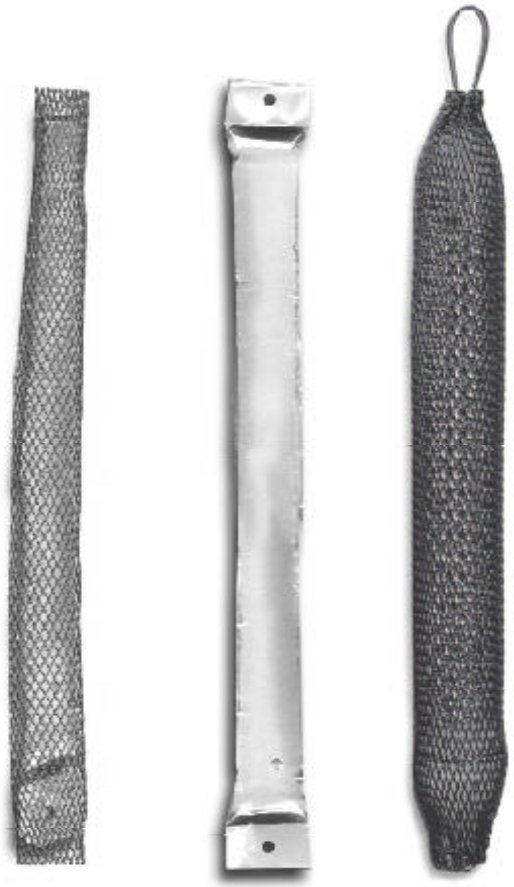
- 48 hours for TCE and several tested compounds (Vroblesky, 2000, USGS)
- 98 to 168 hours for VC and some chloroethenes (Sivavec and Baghel, 2000, General Electric Company)
- BUT: under field conditions, samplers should equilibrate long enough for well water, contaminant distribution, and flow dynamics to restabilize (typically 2 weeks, although EPA may require 3 weeks.)

Cost and Availability

- PDB samplers commercially available at approximately $16.50 to $22.00 each

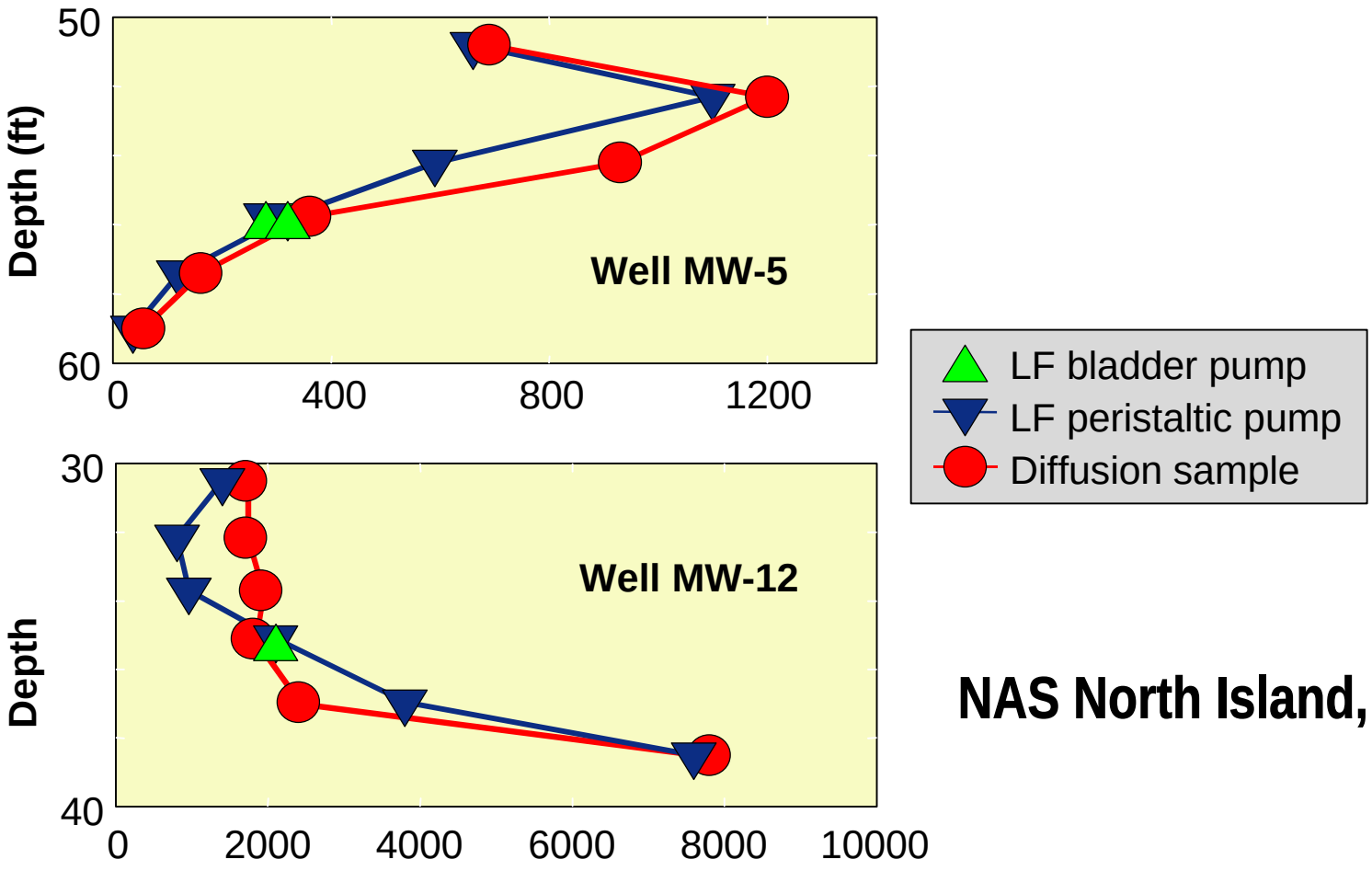
Vendors

- Columbia Analytical Services
  - 206-824-8933
- Eon Products
  - 800-474-2490



Multiple Diffusion Samplers

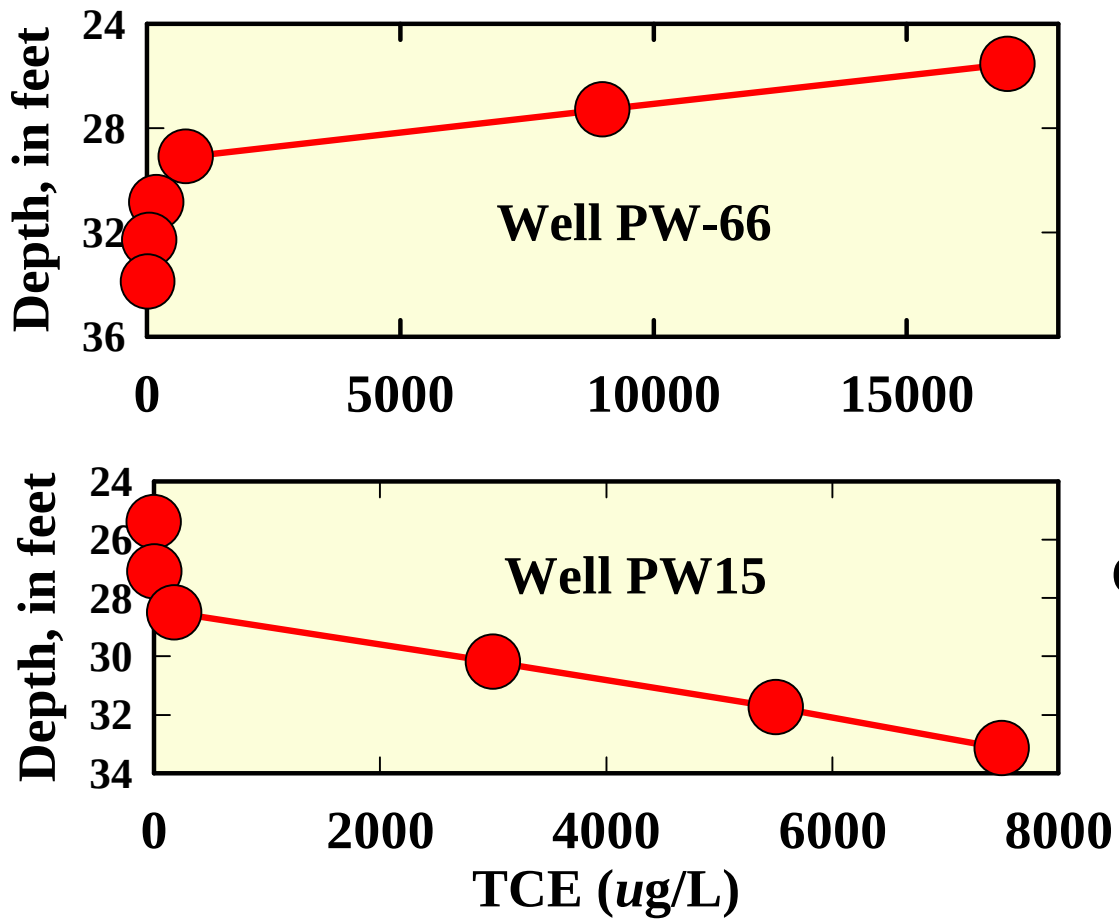
TCE Stratification in 10-Ft Well Screens



NAS North Island, CA

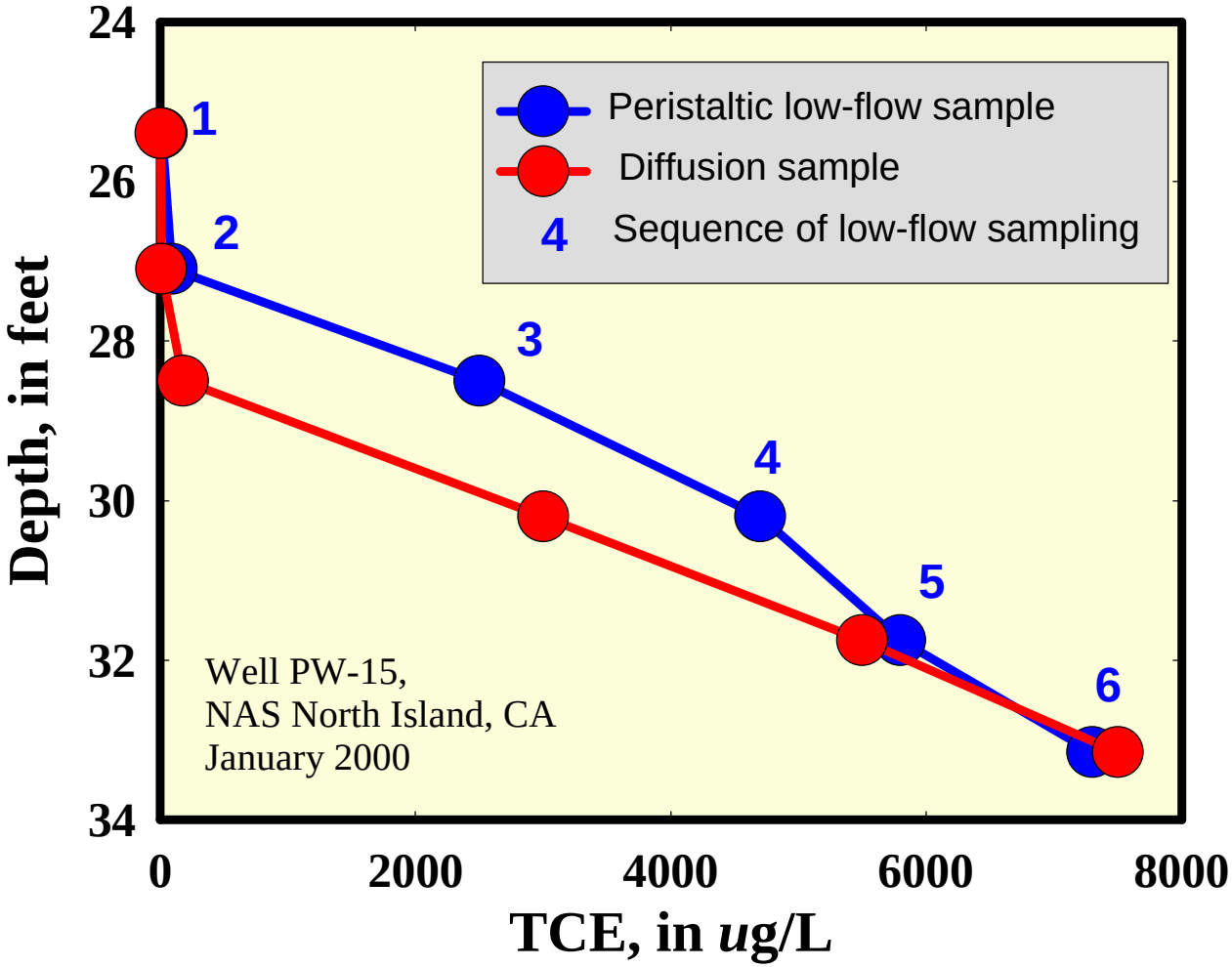
TCE Stratification in 10-ft Well Screens

NAS North Is. CA



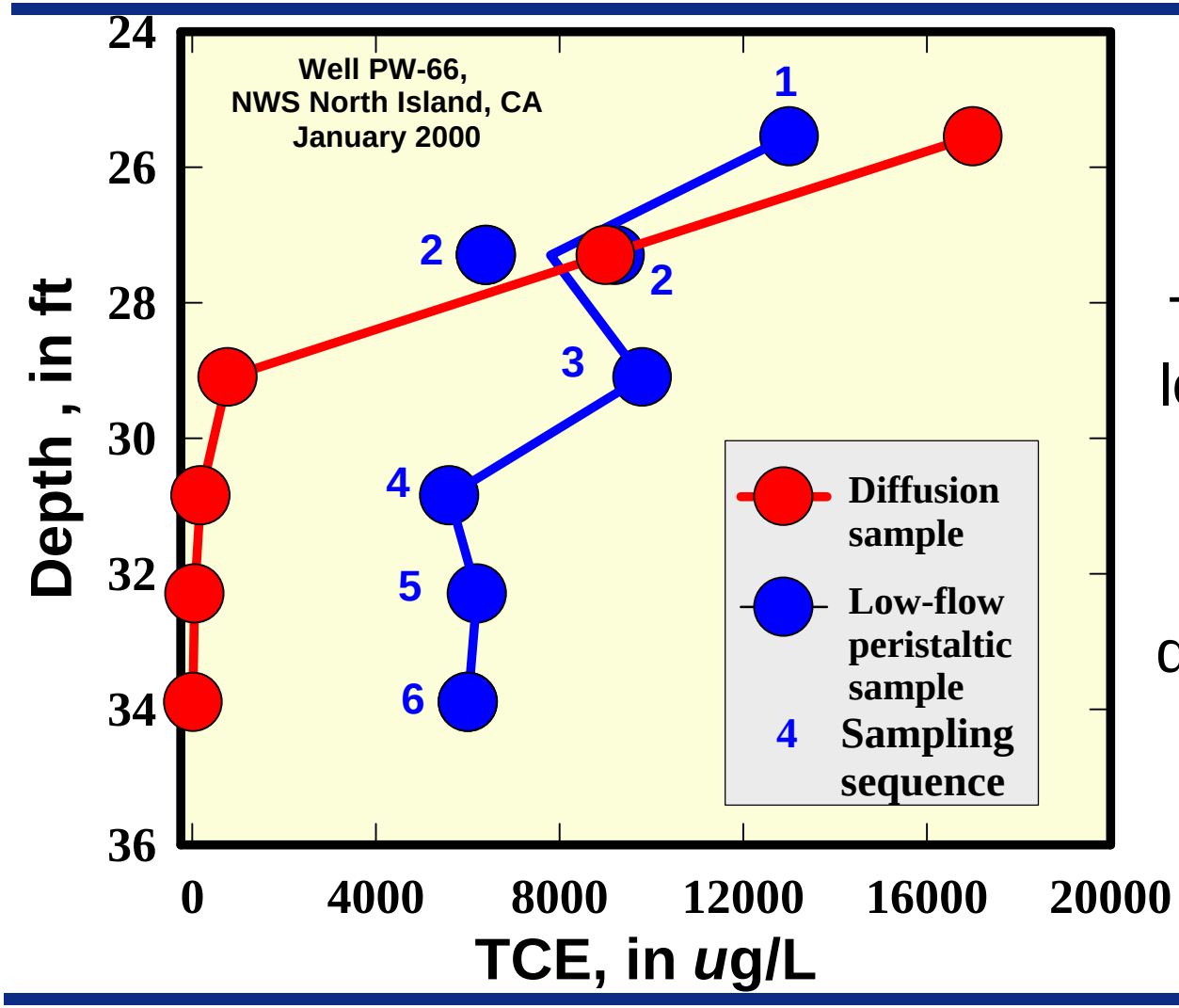
Contained LNAPL

Low-flow Sampling effects near TCE stratification



As the sequential low-flow sampling approaches a chemical interface, in-well mixing may obscure the TCE profile

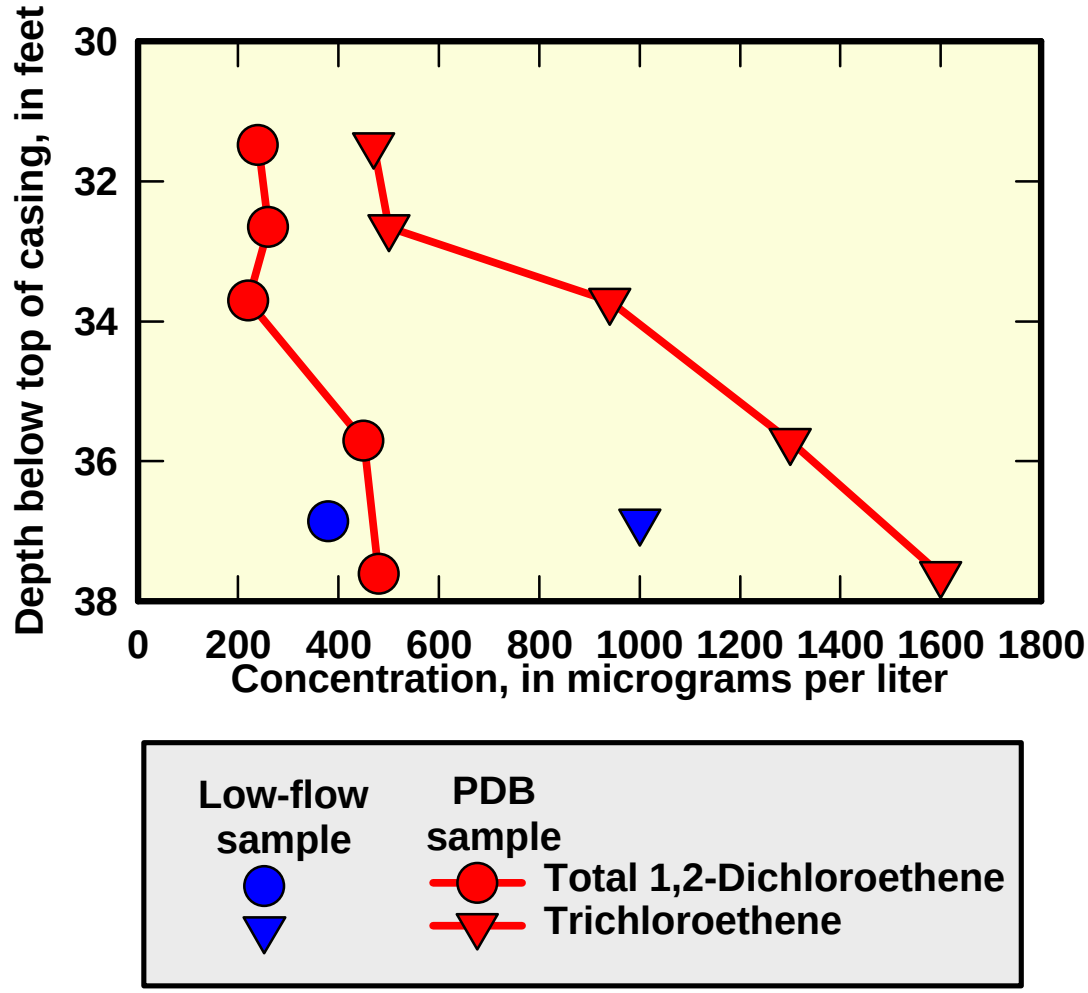
Sequential sampling from high to low concentrations



In this well, the TCE profile from low-flow sampling is a subdued version of the profile from diffusion sampling

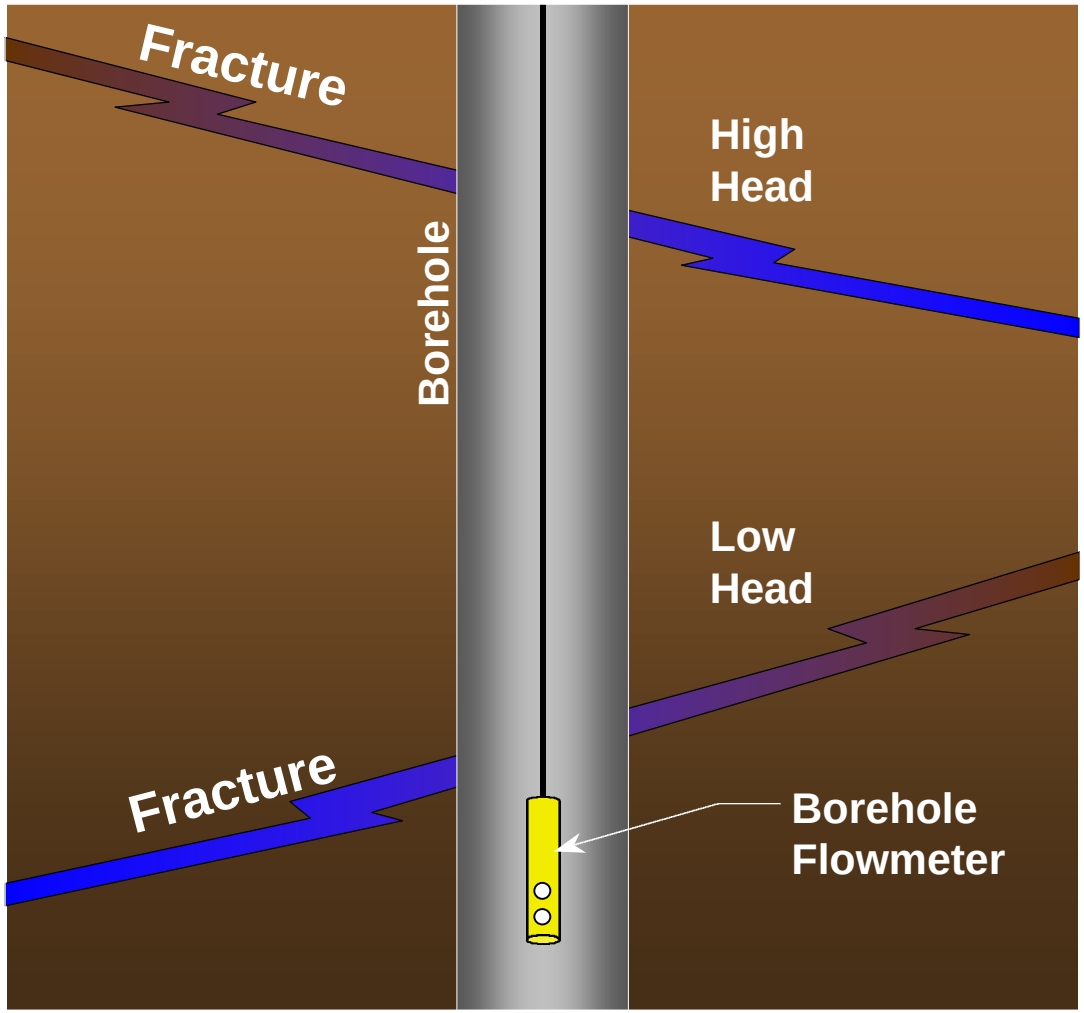
Low-Flow Sampling

- These data imply that the low-flow sampling results can be a mixture of waters within the screened interval

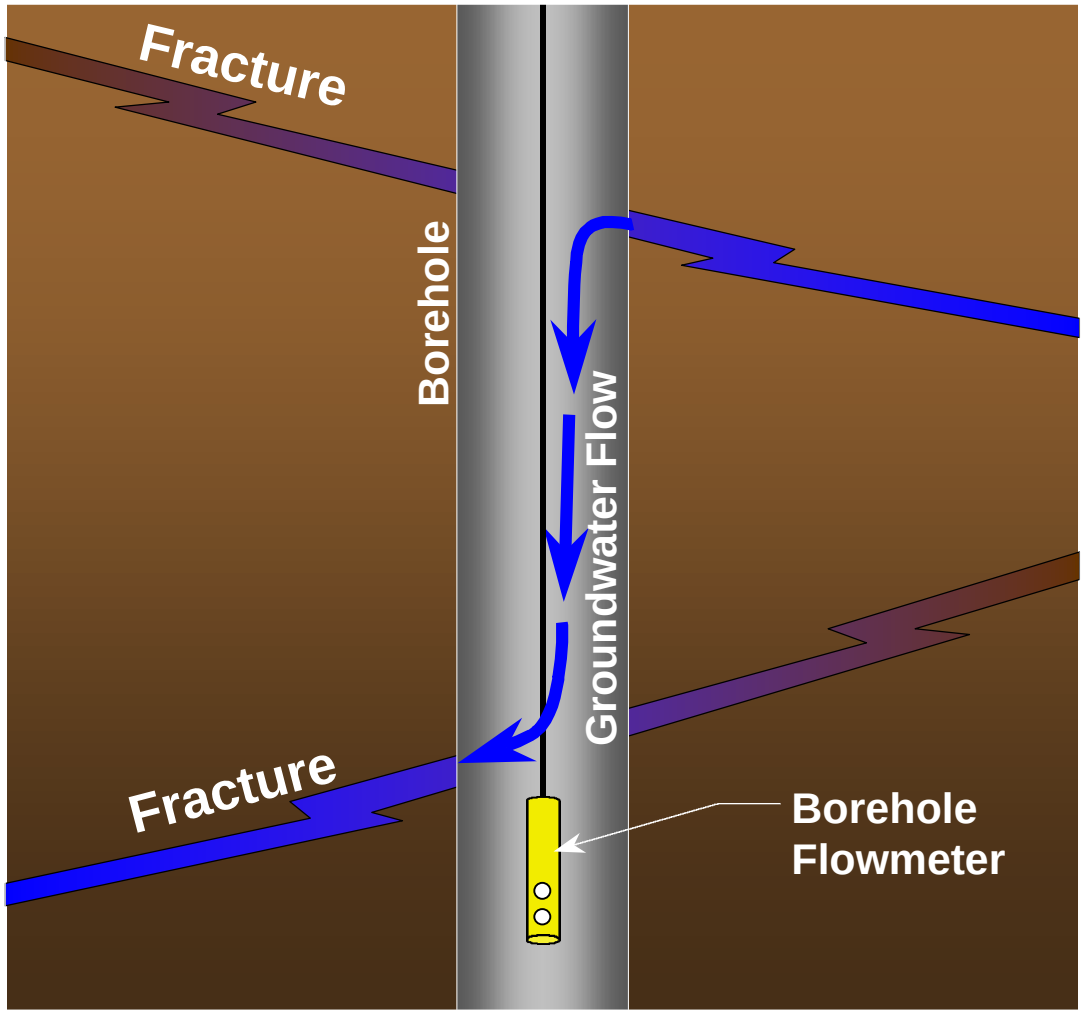


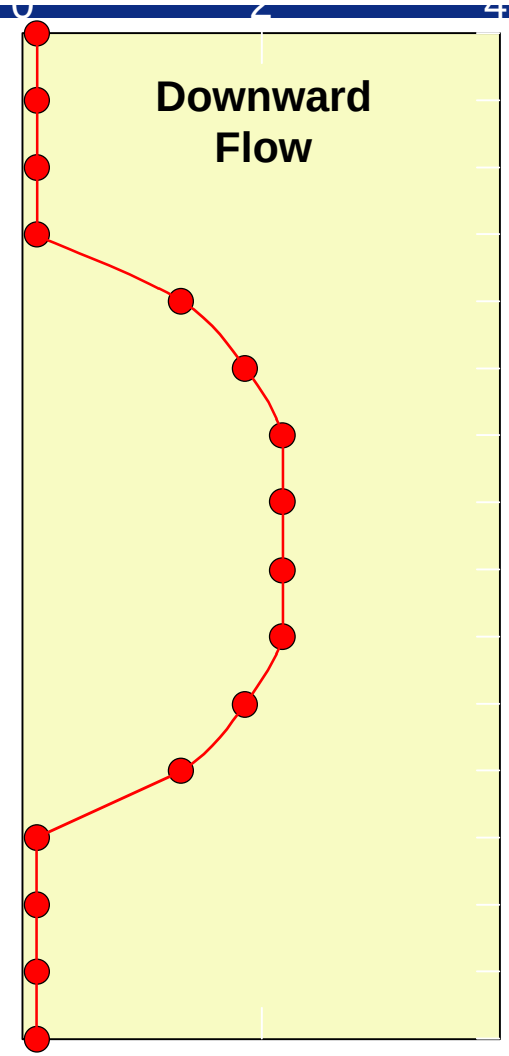
Fridley, MN (May 2000)

Heat-Pulse Flowmeter

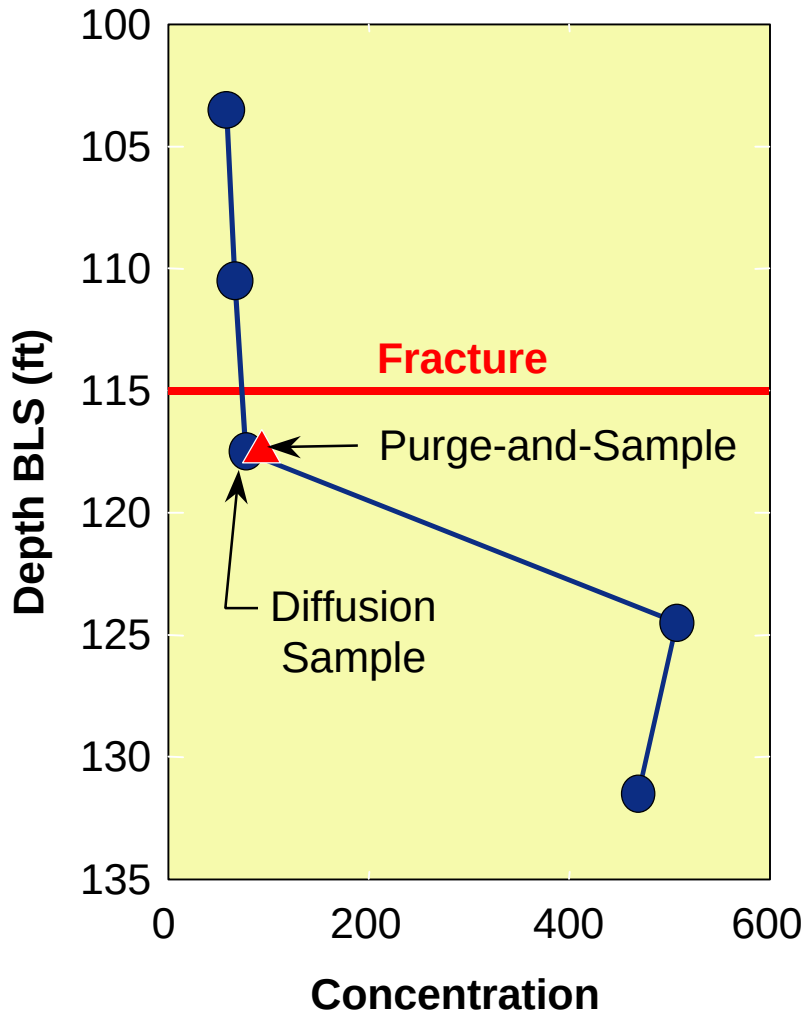


Heat-Pulse Flowmeter





High TCE Concentrations in the Zone of Stagnation



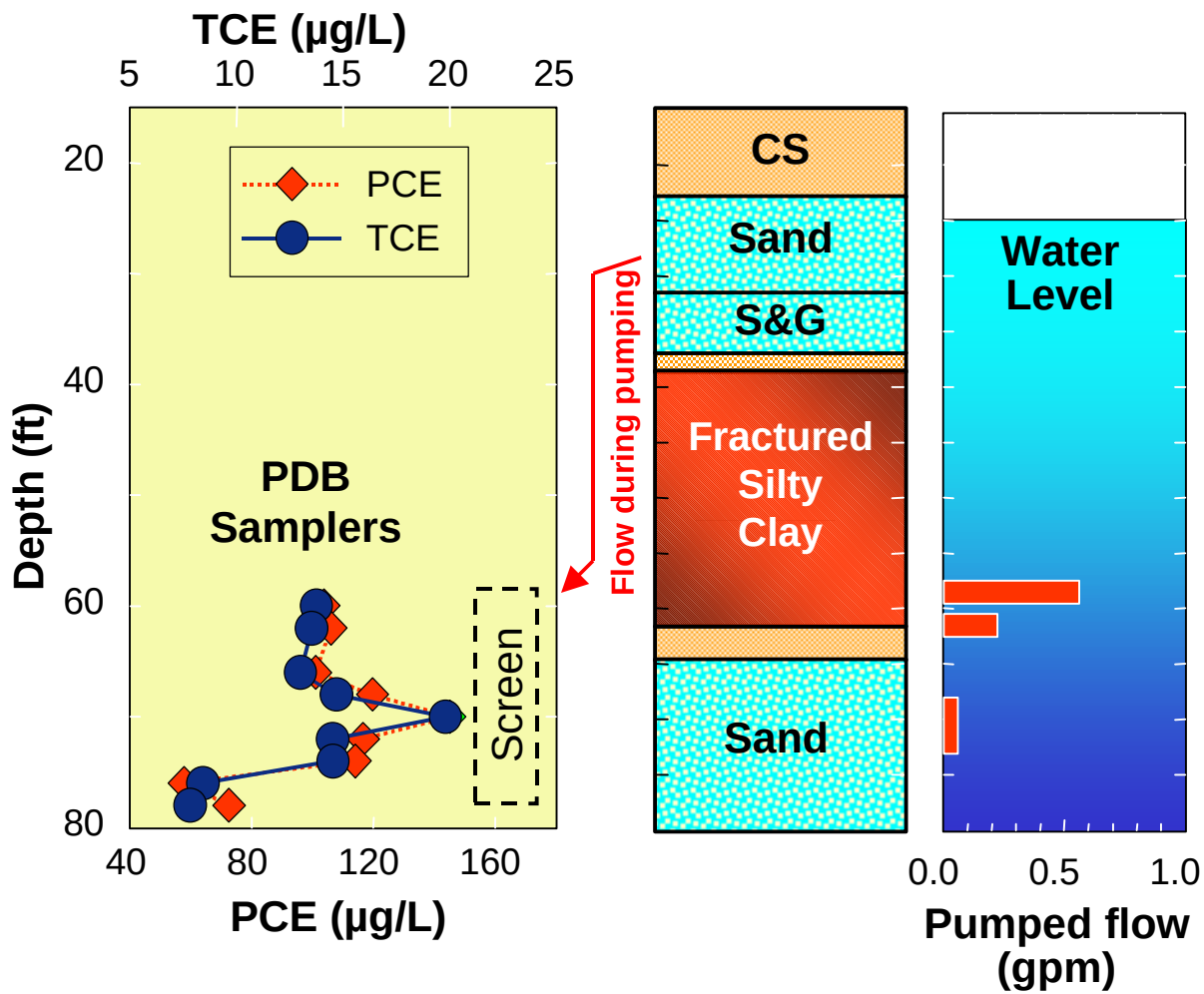
Zone of Downward Flow

Zone of Stagnation

Well PO2-2R
Data from Peter Church, USGS

Differing Source Waters for PDB and Purge Methods

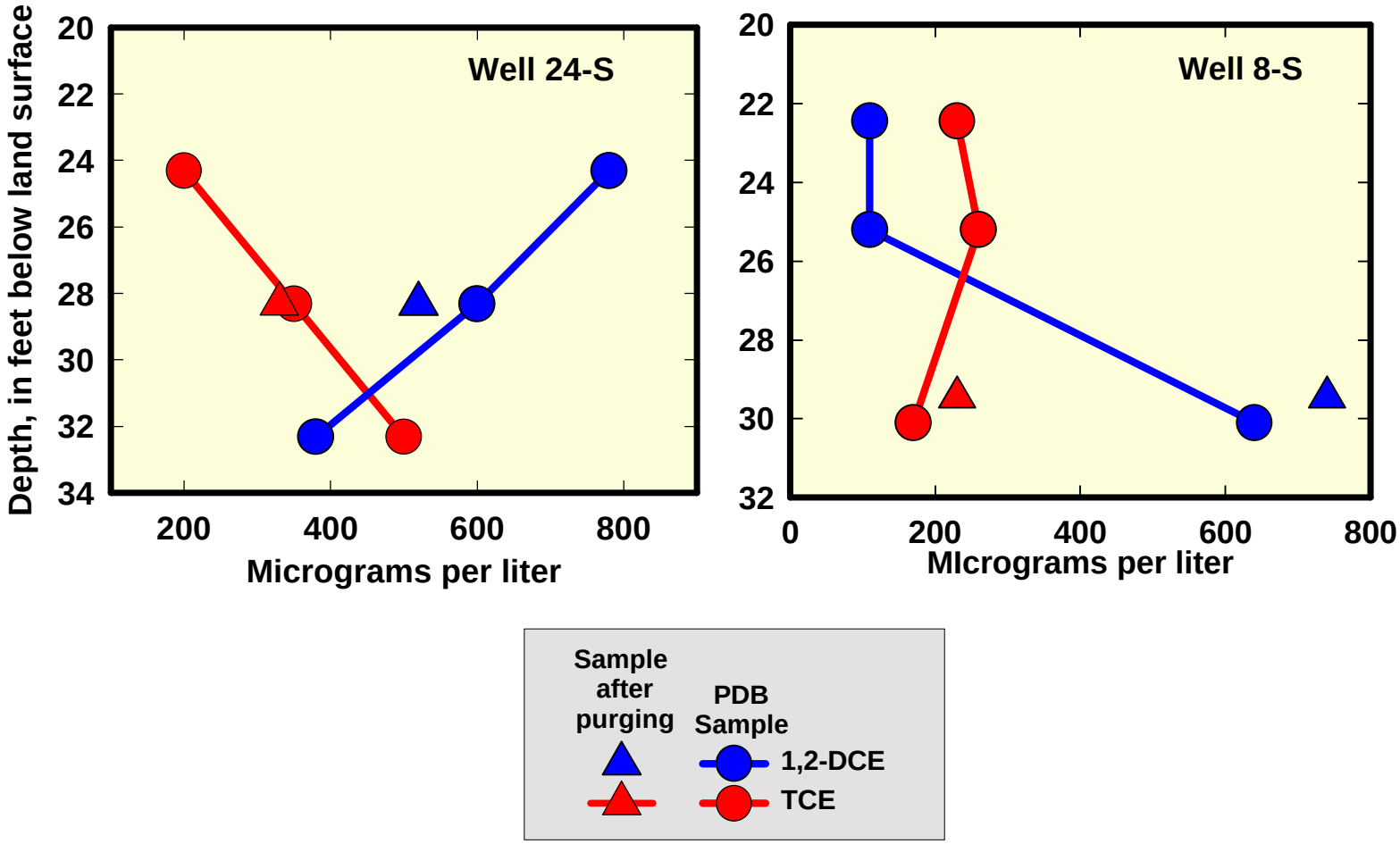
- Low-permeability aquifer
- VOCs were higher in purged sample than in PDB sample.
- PDB samples were local. Pumped sample was from above the screen.



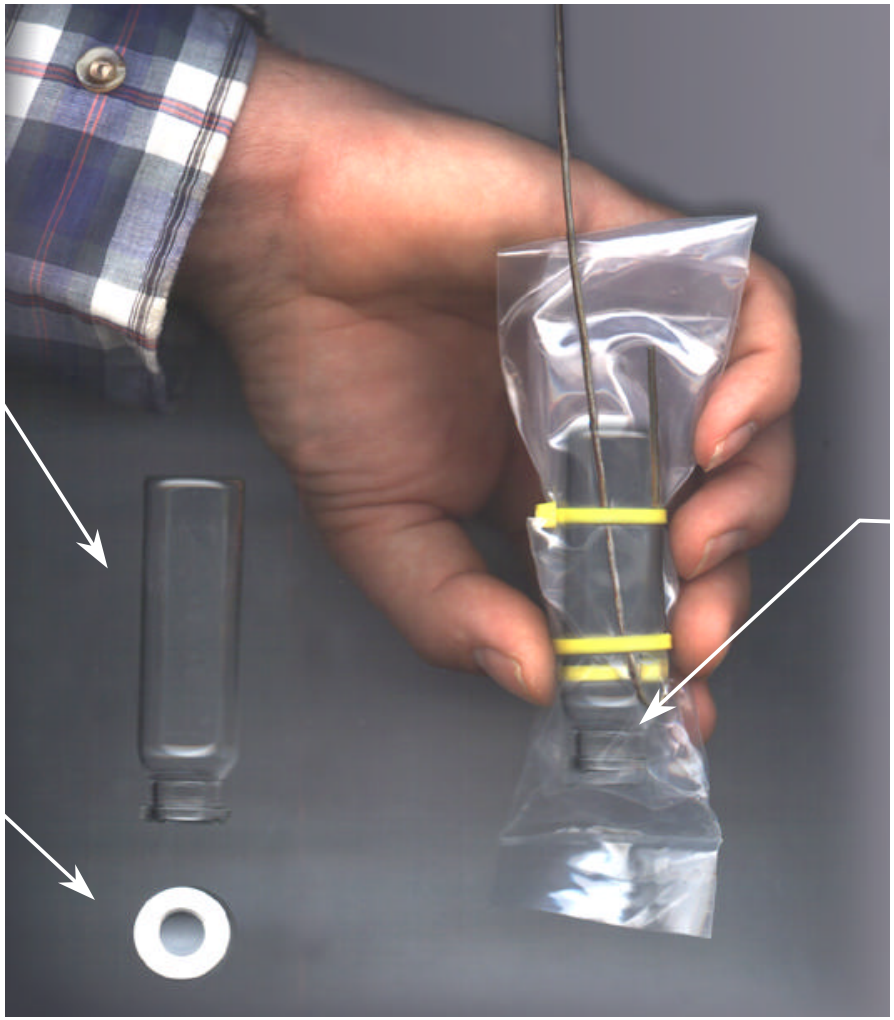
Davis Global Comm., CA,:
Well DMW-5

Changes in TCE/DCE Ratio Along Profile in Screened Interval

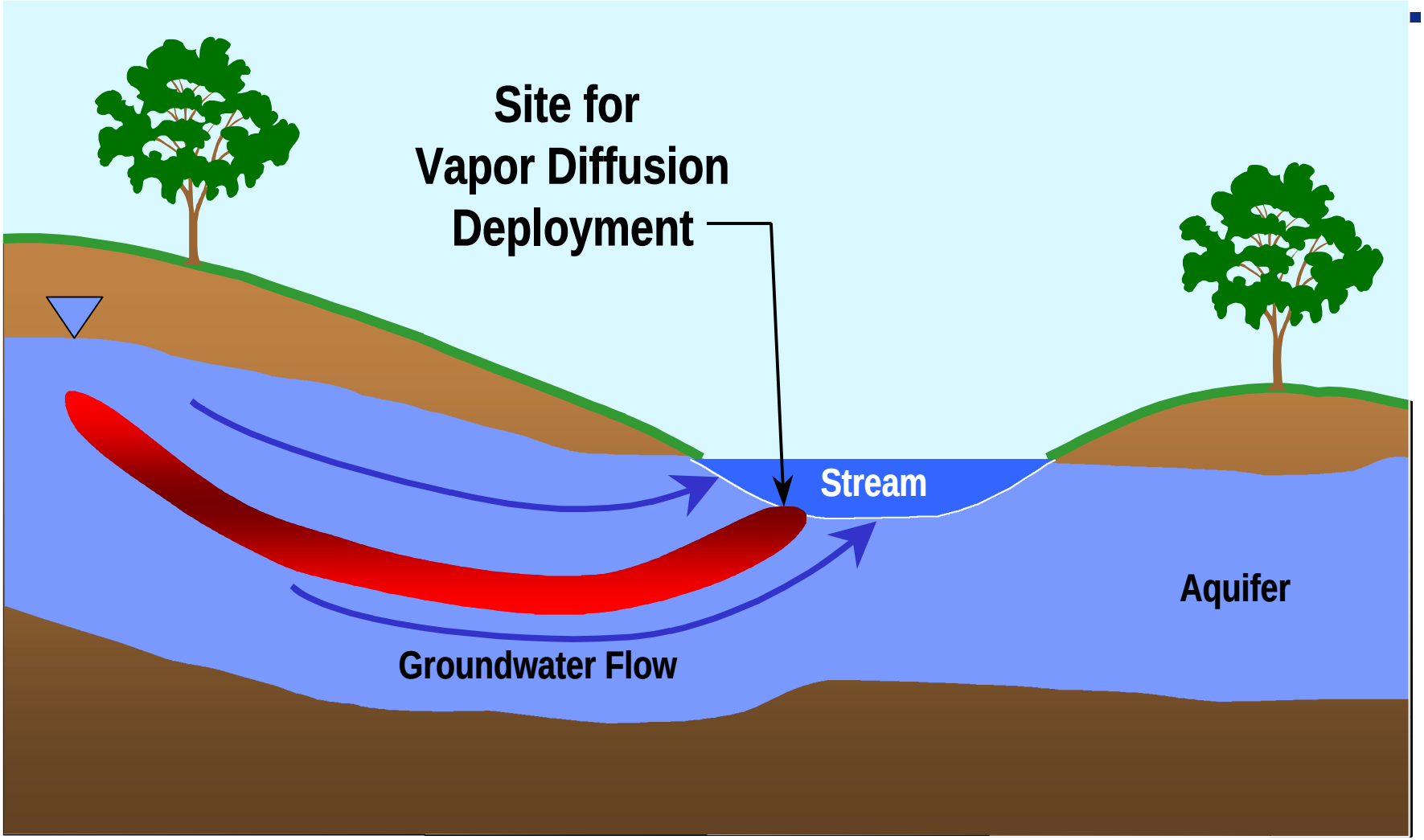
NAS North Is., CA



Passive Vapor Diffusion Sampler

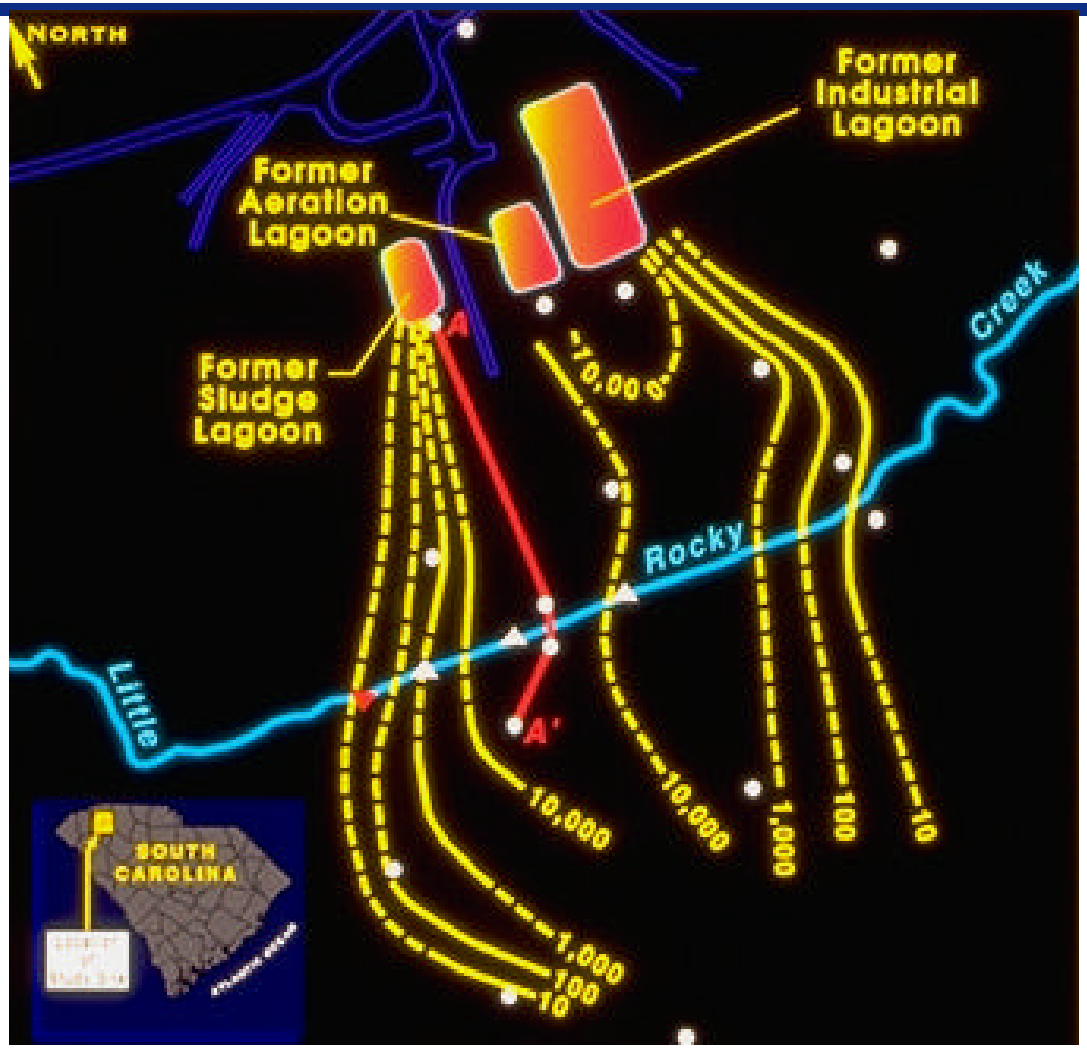


Contaminated Groundwater Discharge to a Stream

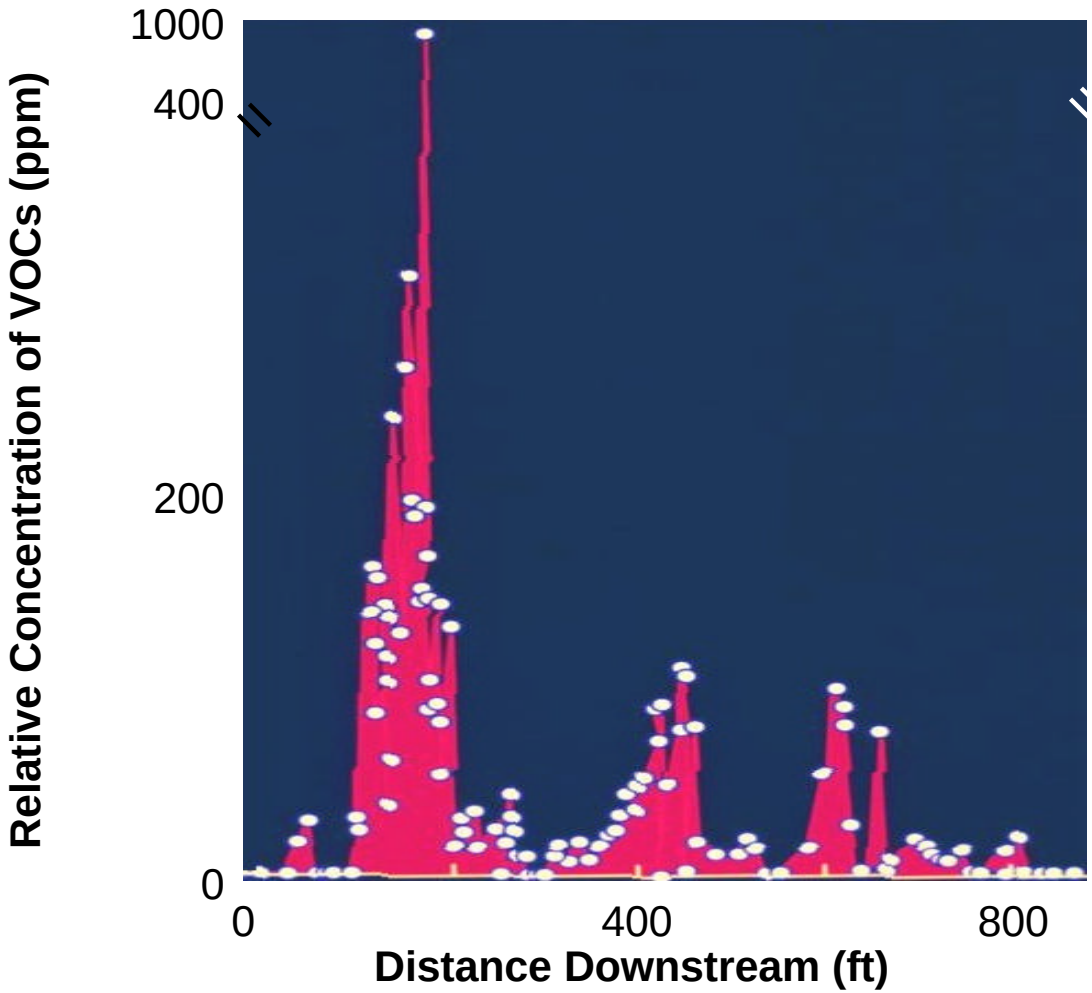


Distribution of VOCs in Fractured-Rock Aquifer

Greenville, SC



VOCs in diffusion samplers at Little Rocky Creek, SC

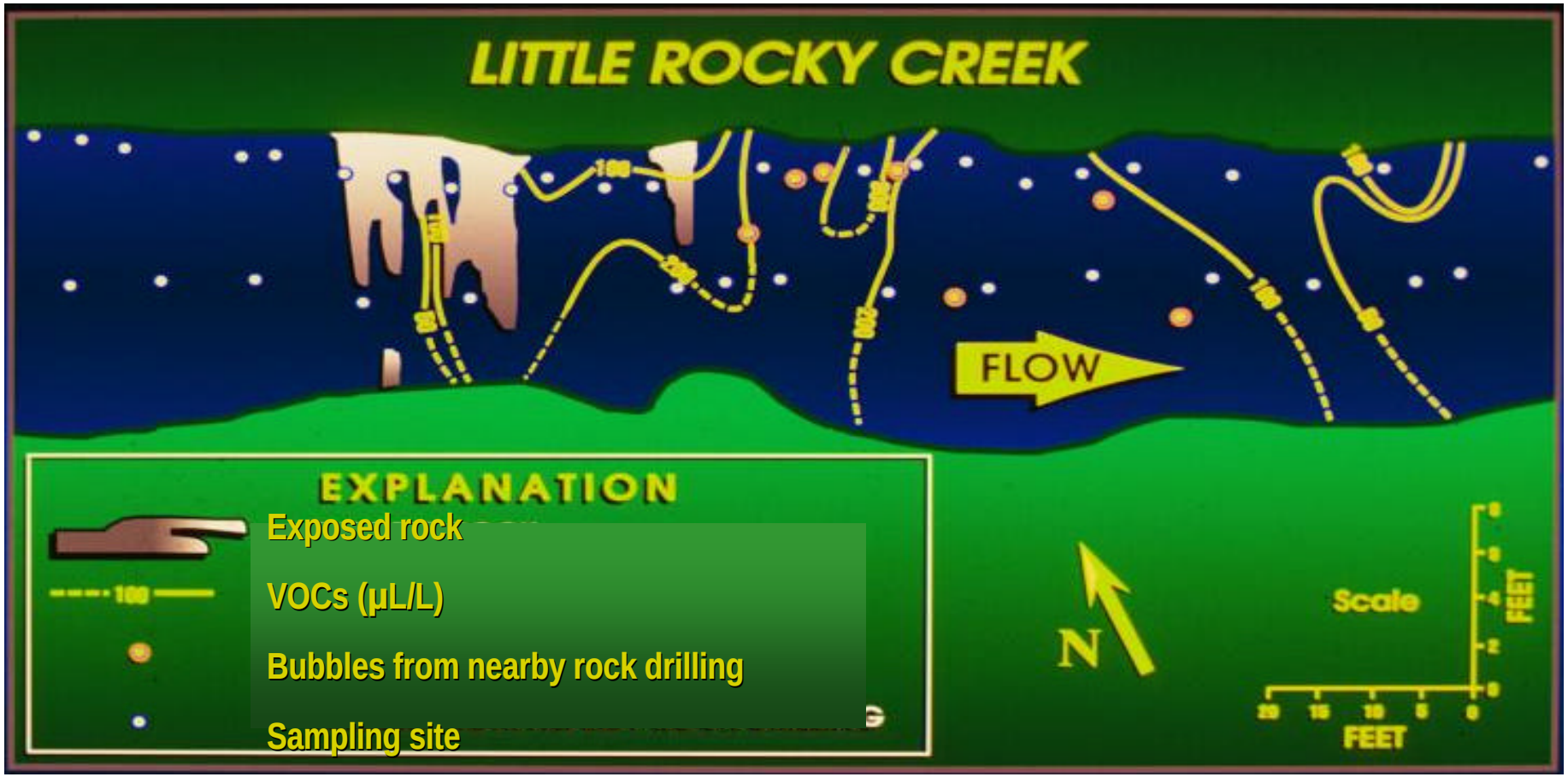


VOCs in diffusion samplers at Little Rocky Creek, SC

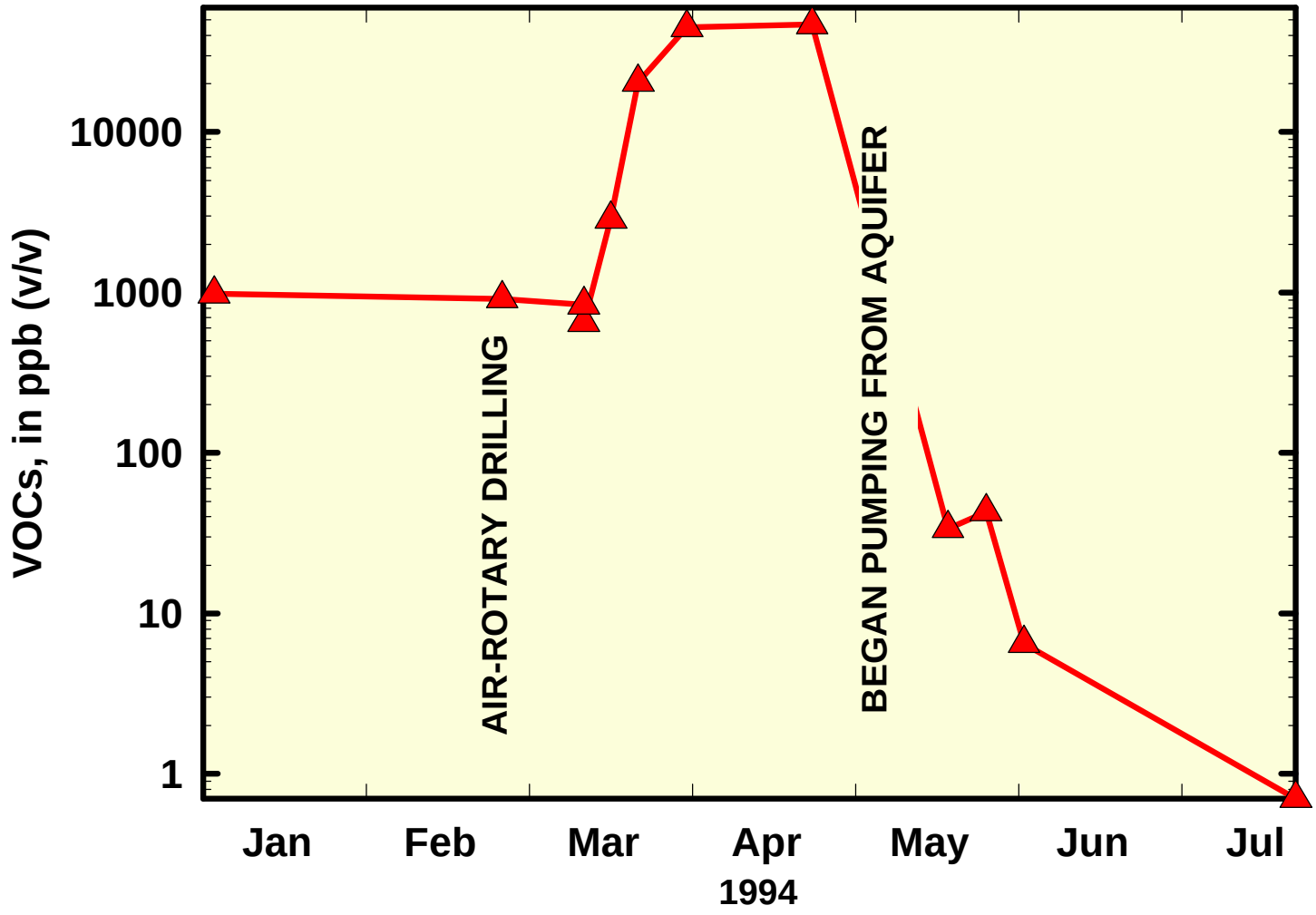
- **Diffusion samplers show primary VOC discharge zones are at intersection of creek and fractures**

Plan View of Little Rock Creek

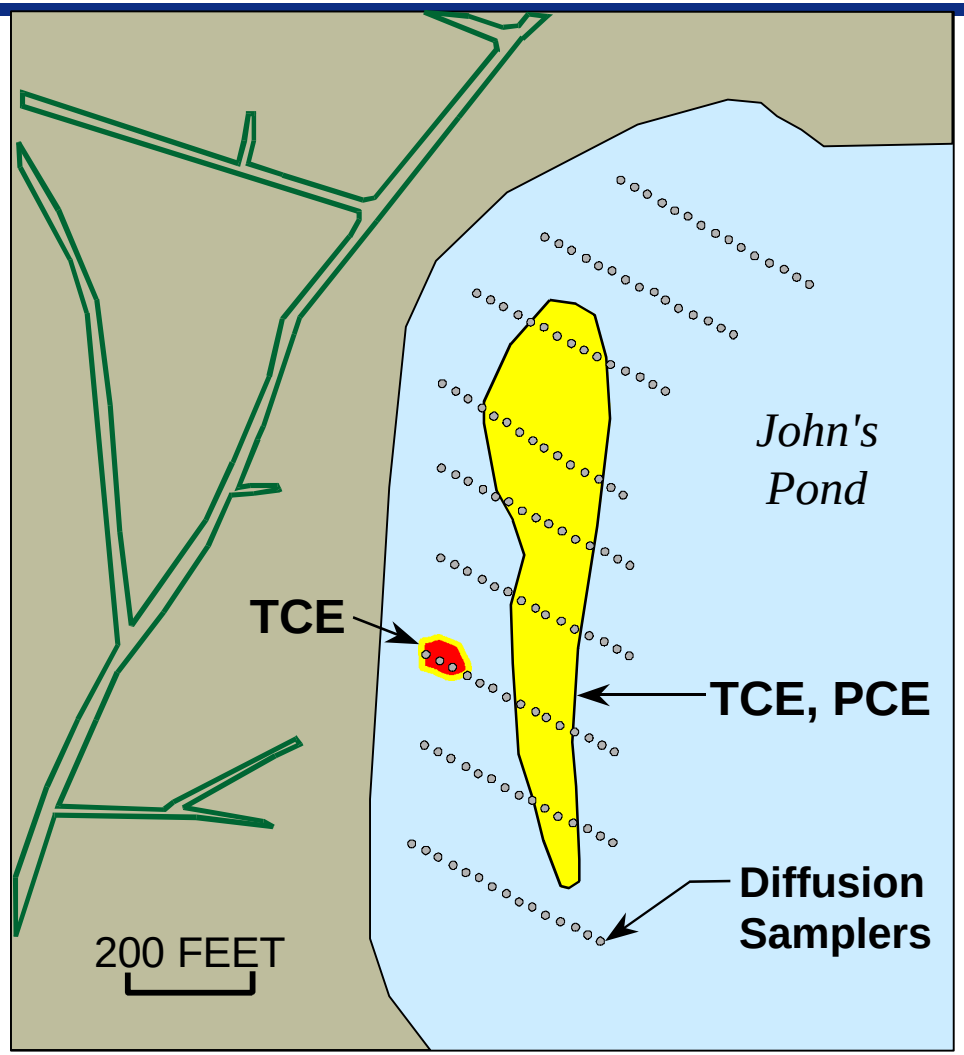
Greenville, SC



VOC Changes in Diffusion Samplers, Little Rocky Creek

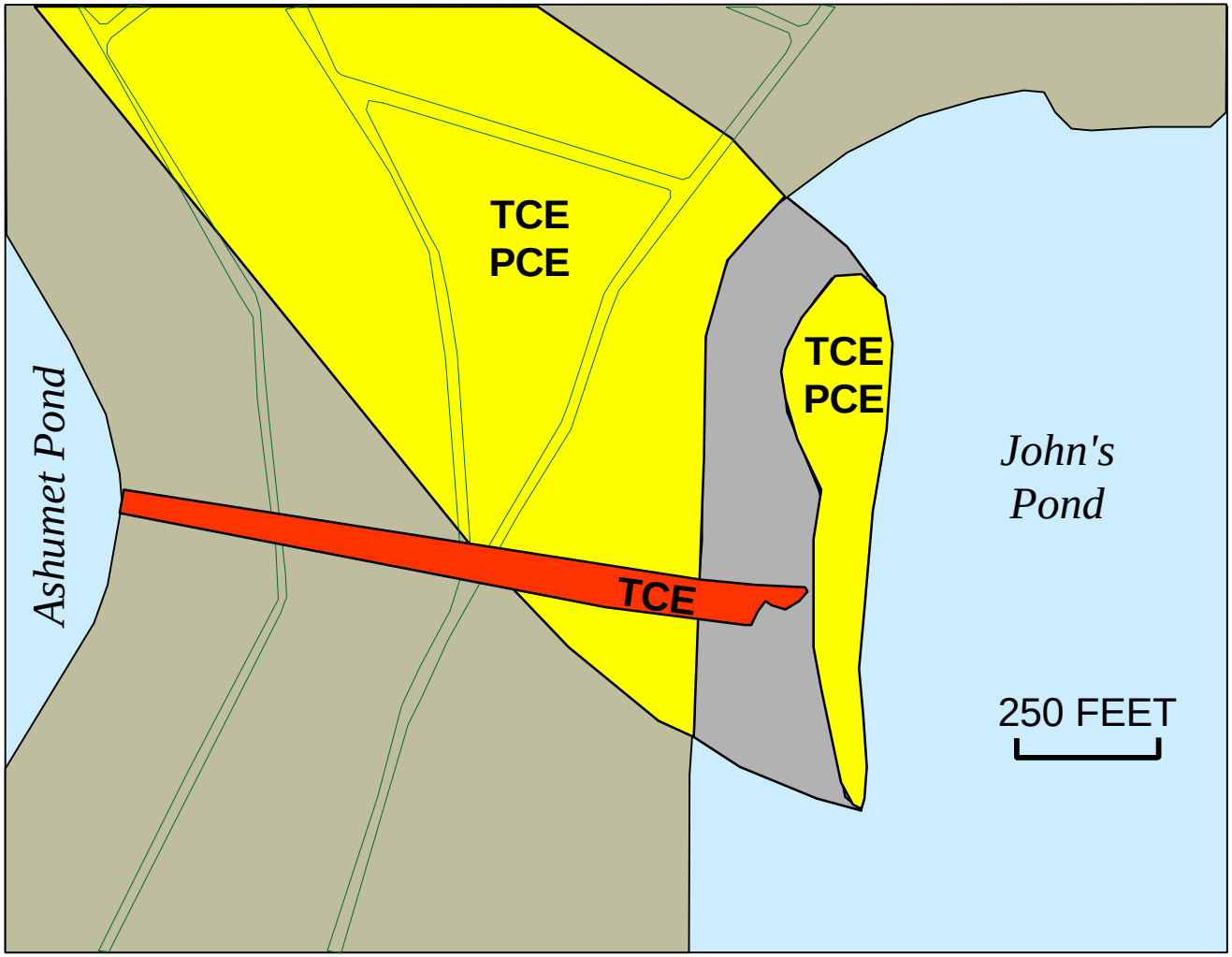


Diffusion Samplers Beneath Johns Pond, MMR, Mass.



(Savoi et al, 2000, USGS WRI 4017)

Mass. Military Reservation Cape Cod



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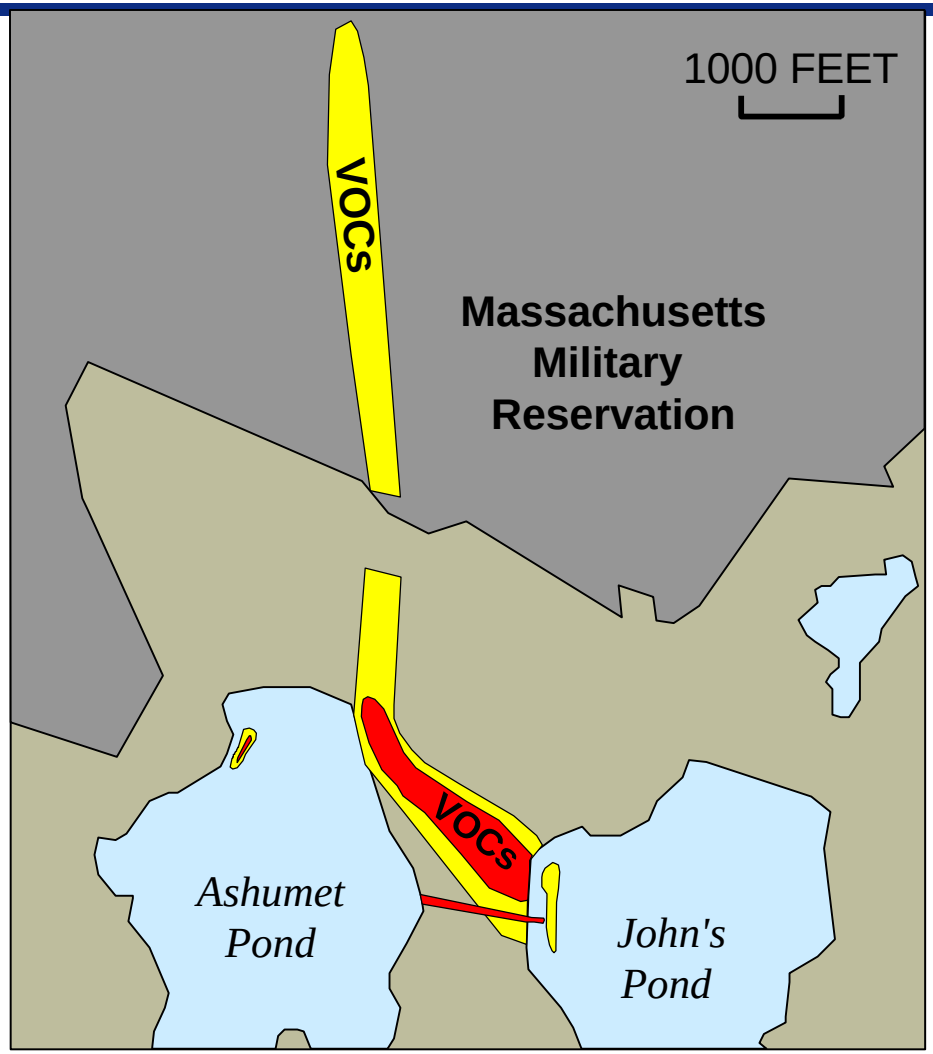
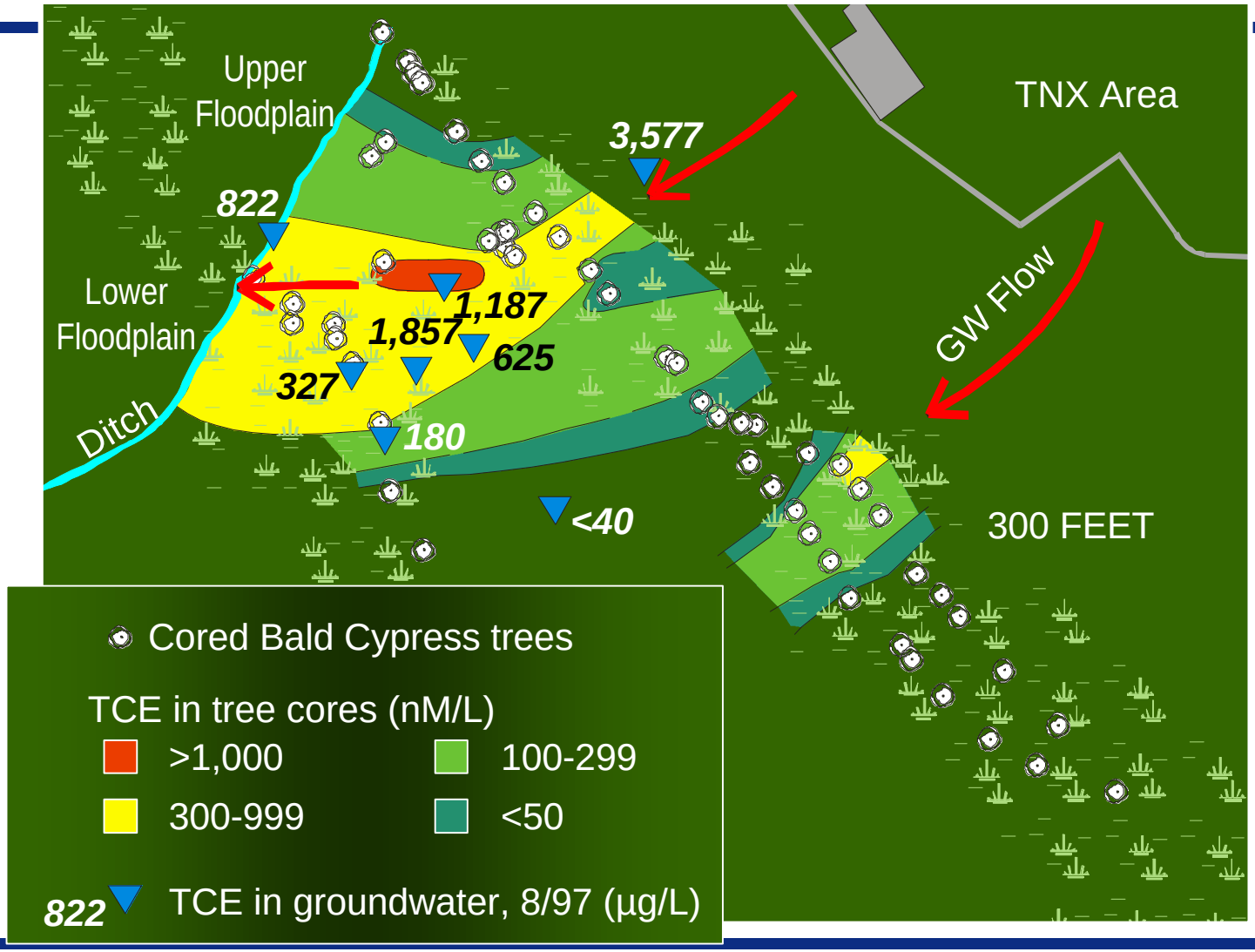


(Savoi et al, 2000, USGS WRI 4017)

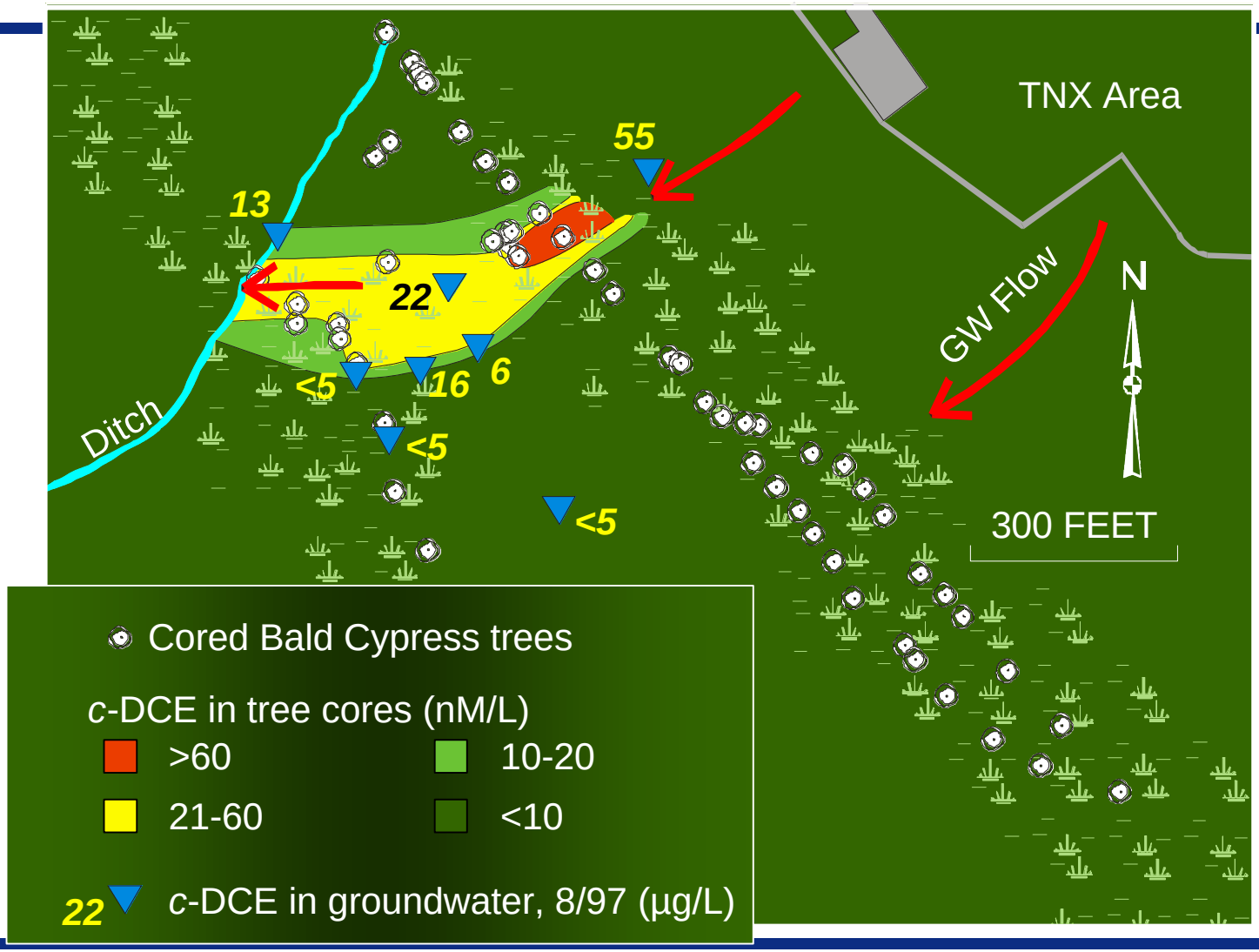
TCE in Bald Cypress Tree cores

Savannah River Site, SC (Jan-Feb 1998)



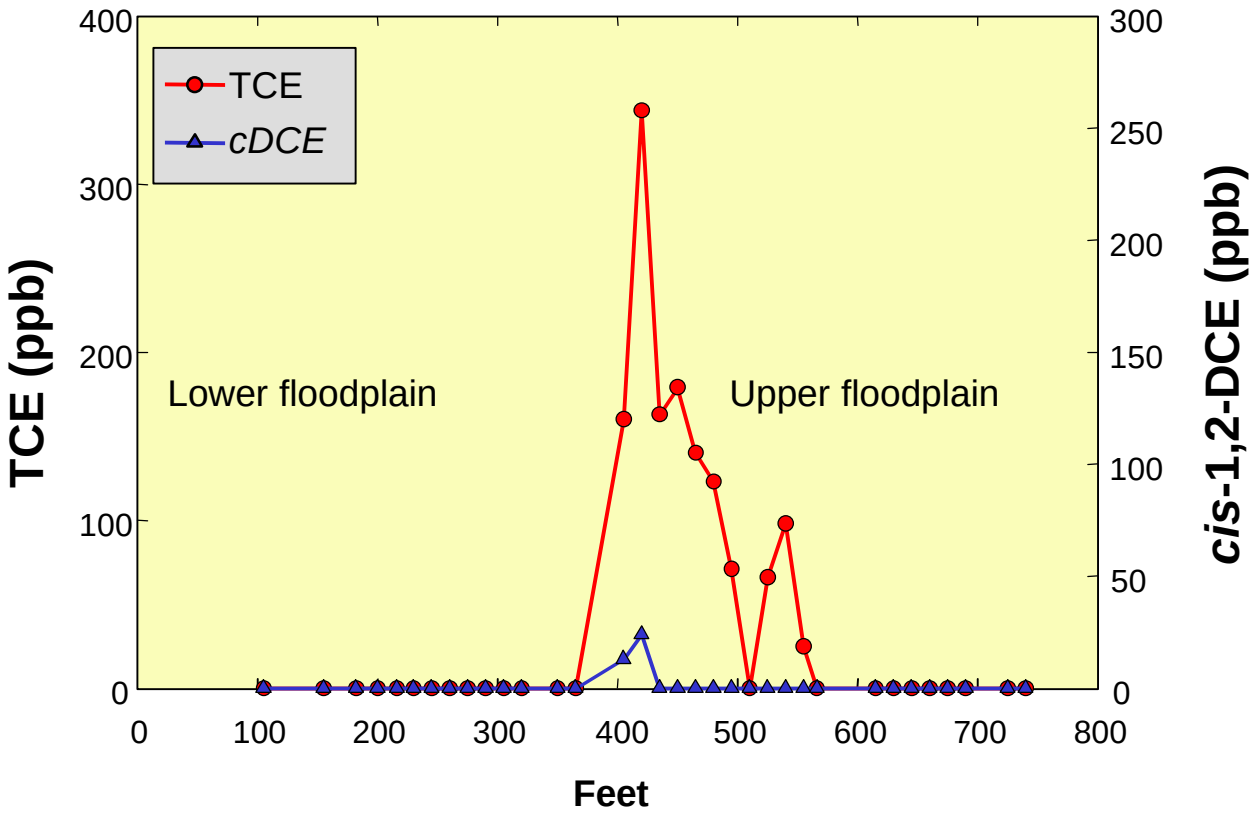
c-DCE in Bald Cypress Tree Cores

Savannah River Site, SC (Jan-Feb 1998)



TCE and c-1,2-DCE in Diffusion Samplers Beneath Ditch

August 25, 1997, TNX facility, Savannah River Site, SC



Summary

Diffusion Samplers

- Multiple diffusion samplers can provide information on contaminant stratification in wells, particularly when used in conjunction with borehole flowmeters.
- Diffusion samplers in ground-water discharge zones can be used to map contaminant-discharge.
- The samplers are inexpensive and easy to use.