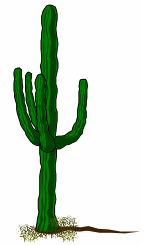
Demonstration and Installation of MTBE Biobarriers at Naval Base Ventura County, Port Hueneme, CA

Karen Miller
Naval Facilities Engineering Service Center
karen.miller1@navy.mil

Dr. Paul Johnson
Arizona State University
paul.c.johnson@asu.edu

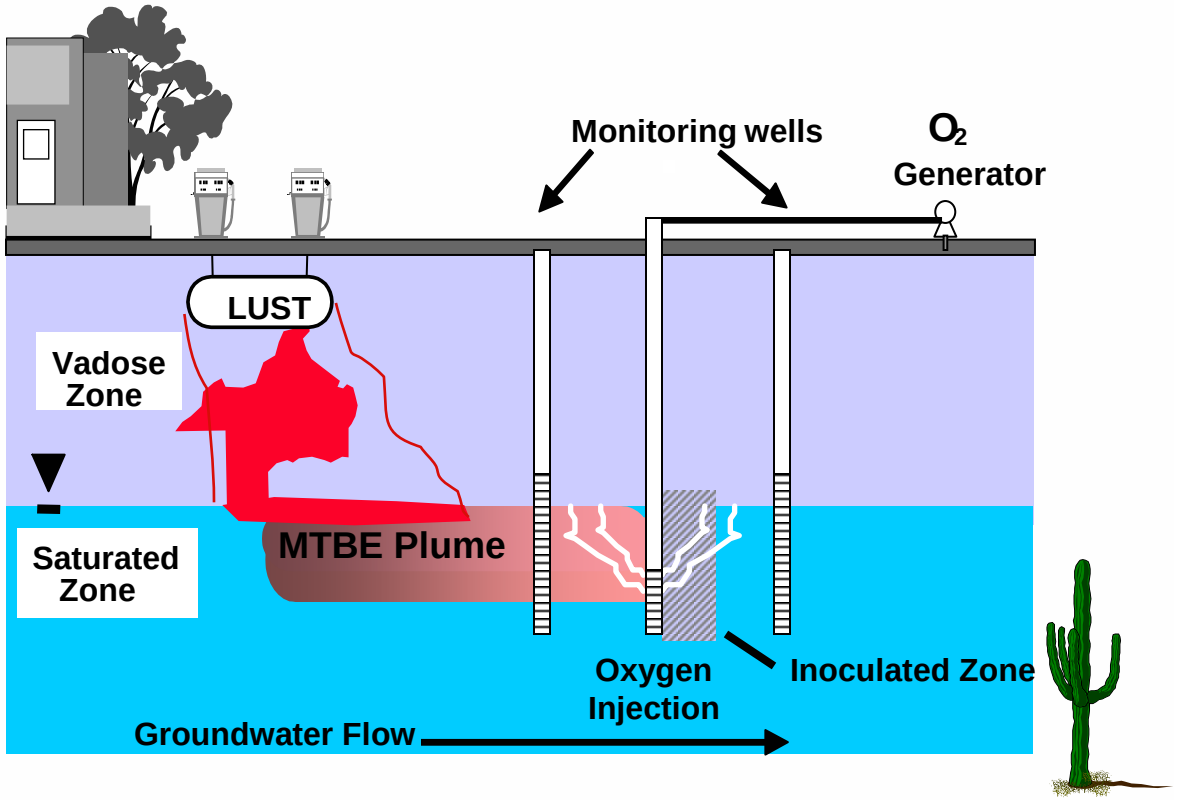


Biobarrier Technology Overview

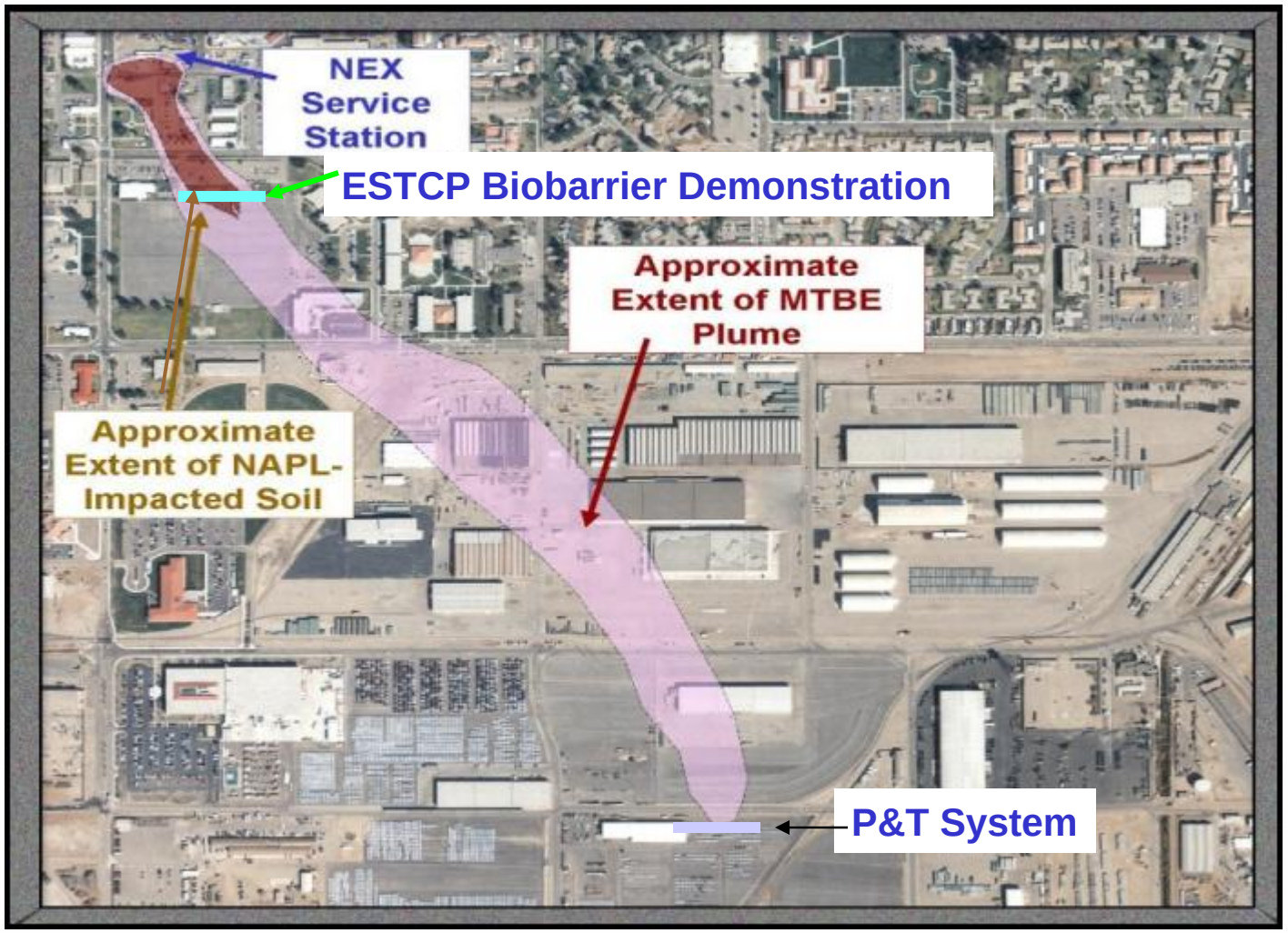
Treatment of MTBE-contaminated aquifers through:

- inoculation with MTBE-degrading organisms (MC-100 and SC-100)
- aeration/ oxygenation of the aquifer

Apply biobarrier technology to a mixed MTBE-BTEX dissolved plume



NBVC, Port Hueneme, CA



N

Demonstration System Design

(1) Treatment system must not alter the natural flow path

(2) Modular and flexible with respect to operating conditions.

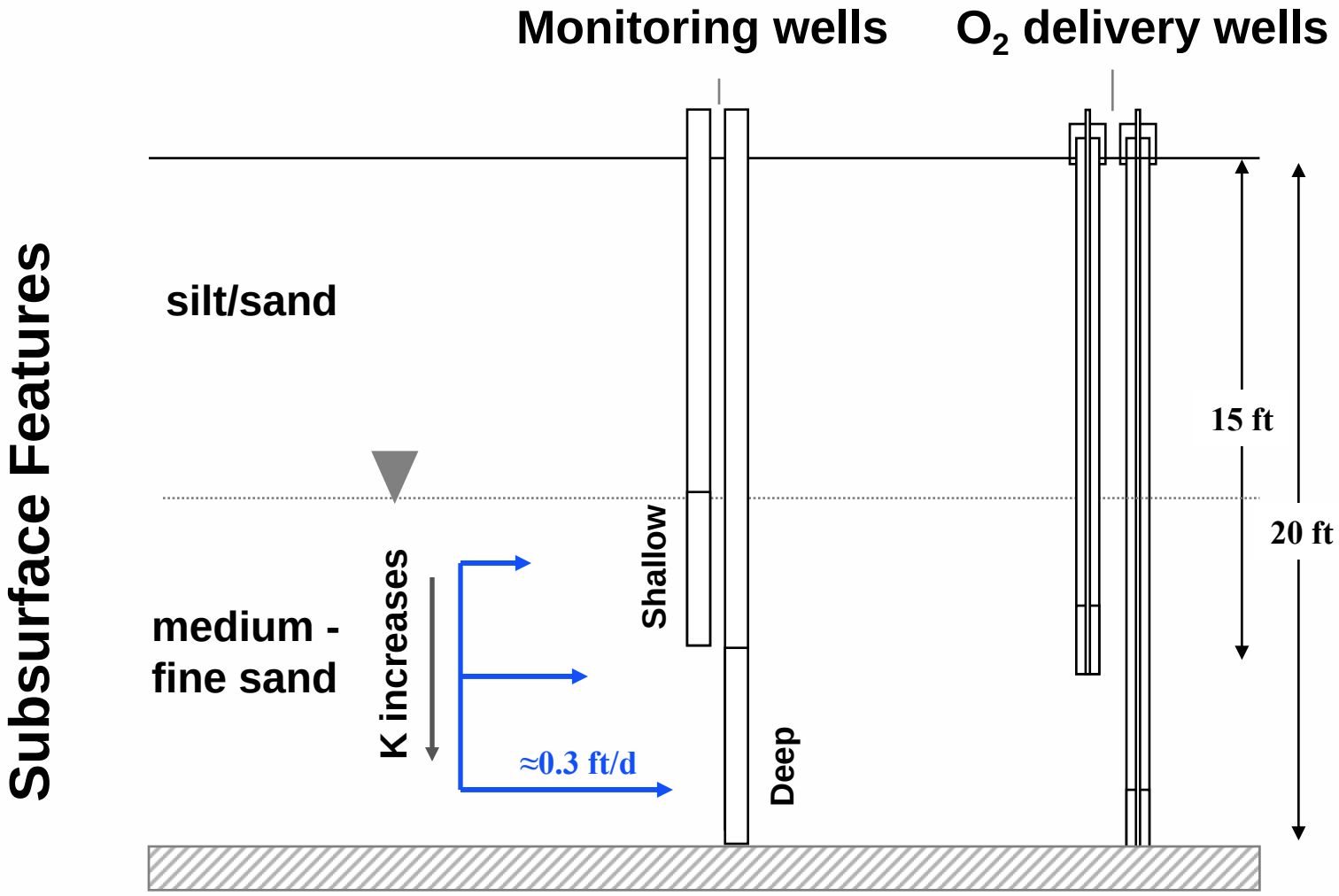
(1) Close well spacing

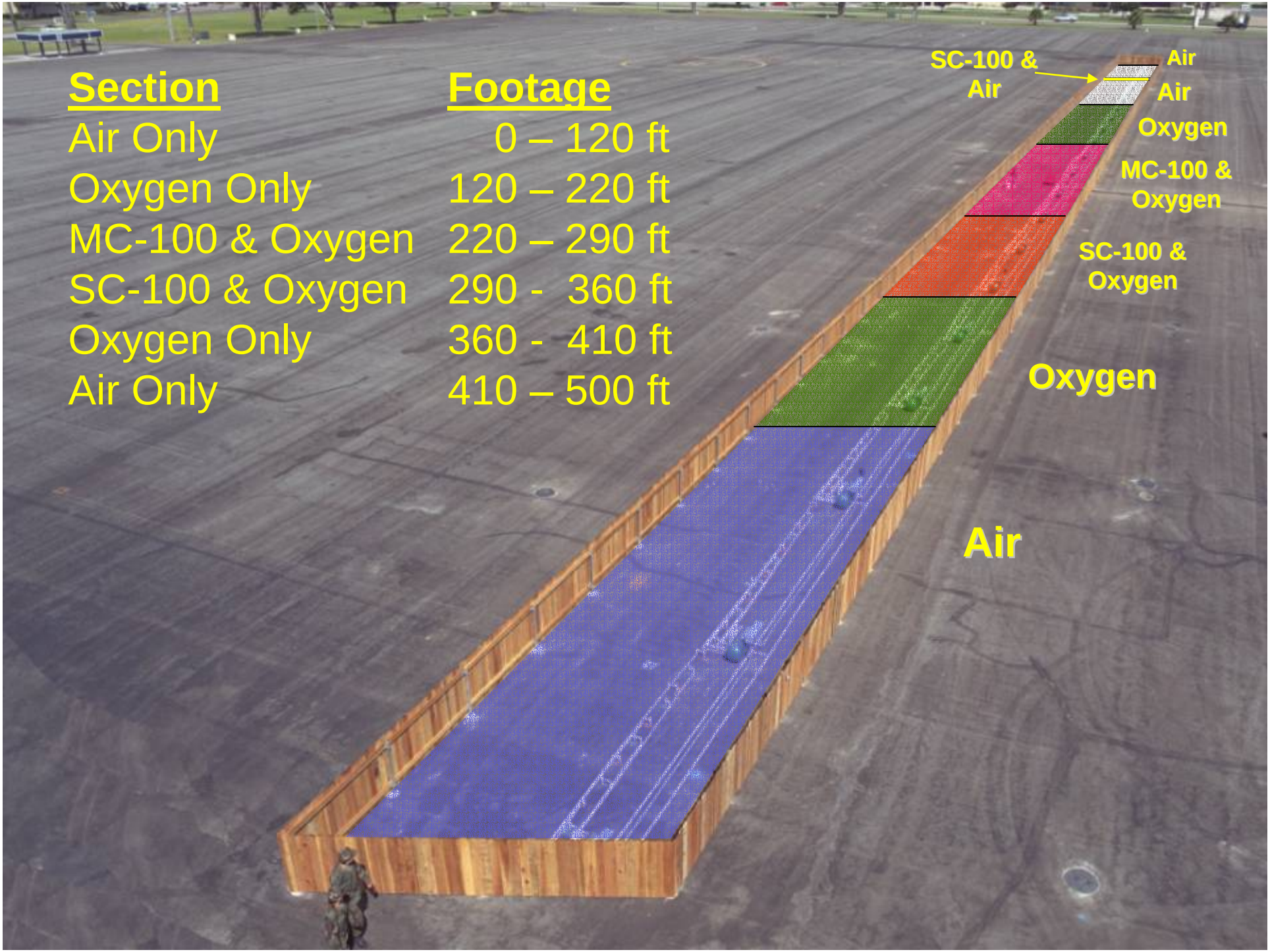
(2) Injection at two depths

(3) Pulsed gas injection (air and O_2)

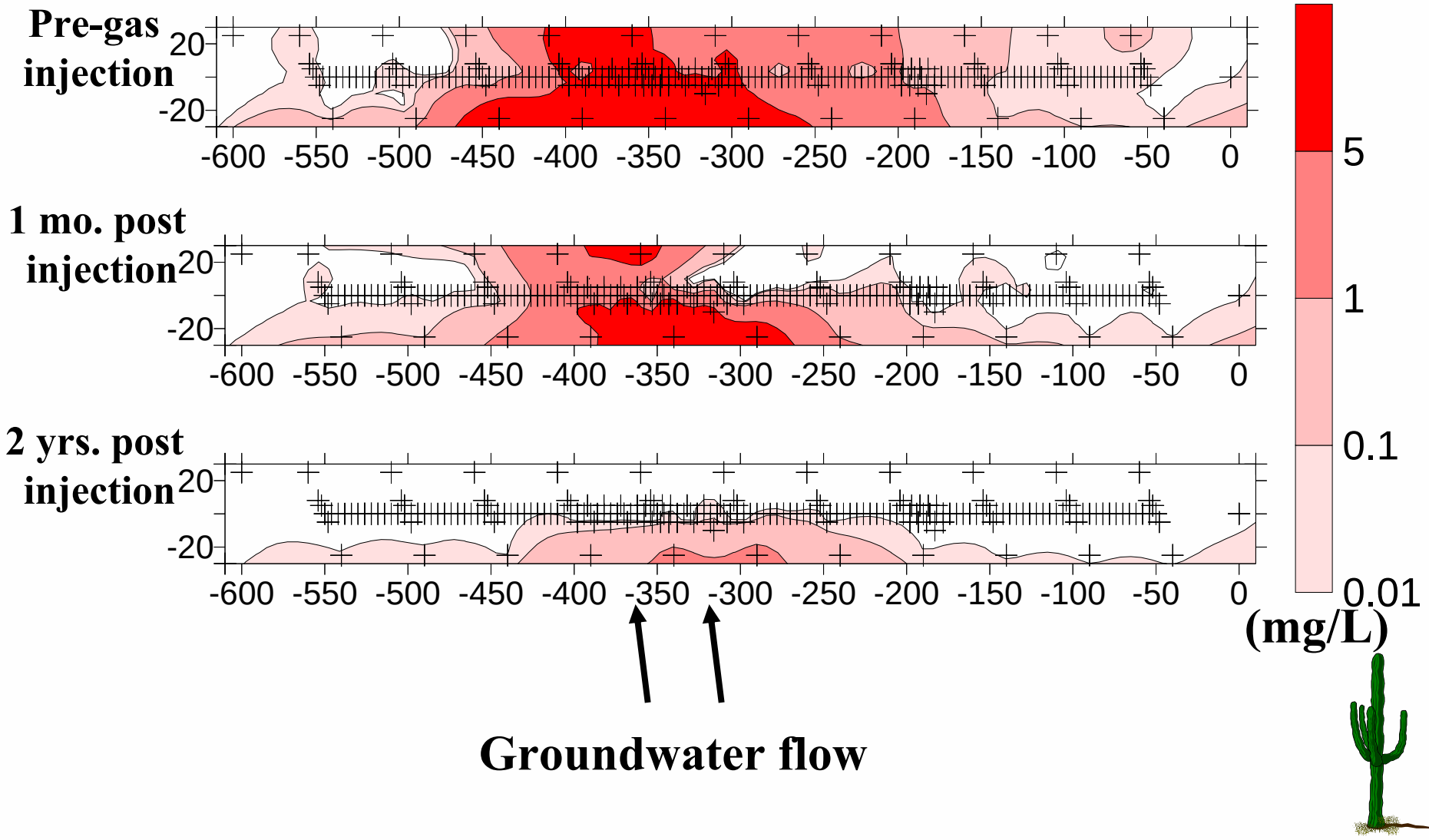
[trapped gas supplies oxygen for days after injection]

Biobarrier Subsurface Features



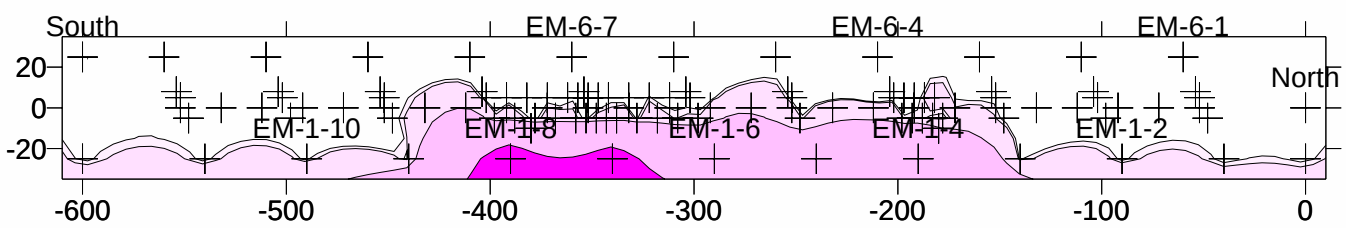

Section
Footage
Air Only 0 – 120 ft
Oxygen Only 120 – 220 ft
MC-100 & Oxygen 220 – 290 ft
SC-100 & Oxygen 290 - 360 ft
Oxygen Only 360 - 410 ft
Air Only 410 – 500 ft
SC-100 & Air
Air
Air
Oxygen
MC-100 & Oxygen
SC-100 & Oxygen
Oxygen
Air

MTBE Distribution

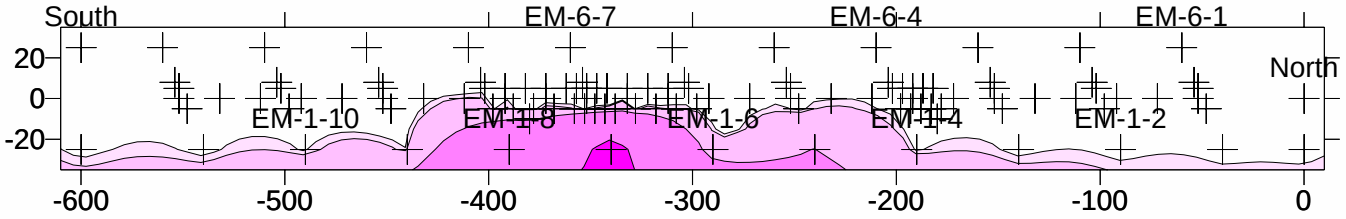


TBA Concentrations

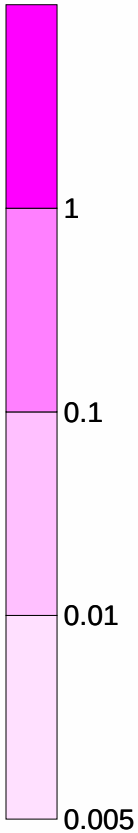
March 2002



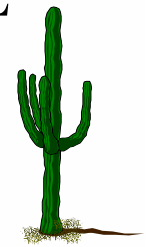
October 2002



Groundwater flow



mg/L



Final Remedy Options for NBVC

Installation of Two Additional Biobarriers

- **Installation Costs:**

  $500K to install two additional biobarriers (a 400 foot wide and a 500 foot biobarrier)

- **O&M Costs**:

  $125K/year

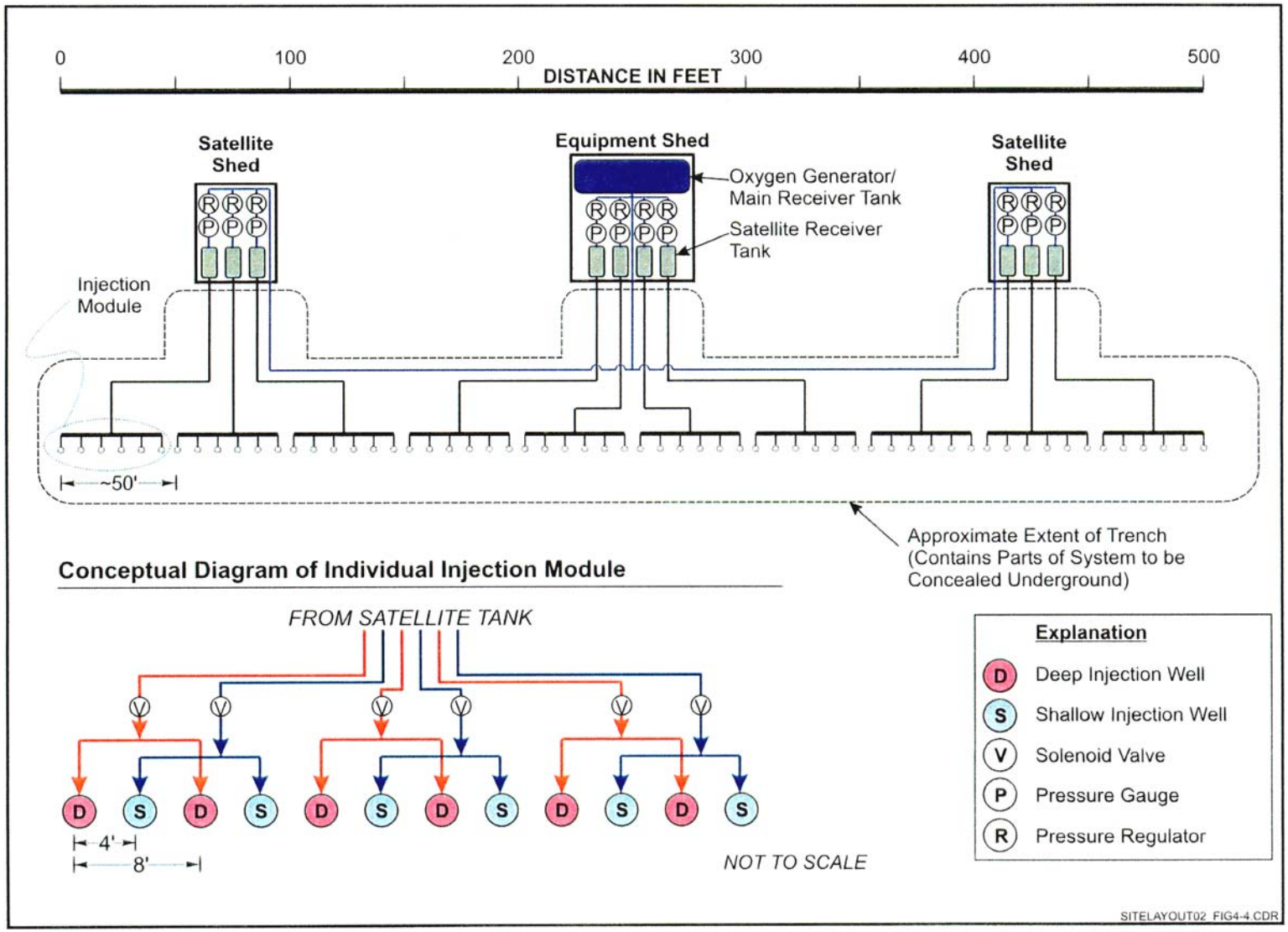
- **Advantage:**

  –Completely contains MTBE plume

  –Protects against future spills

  –No groundwater or other disposal costs

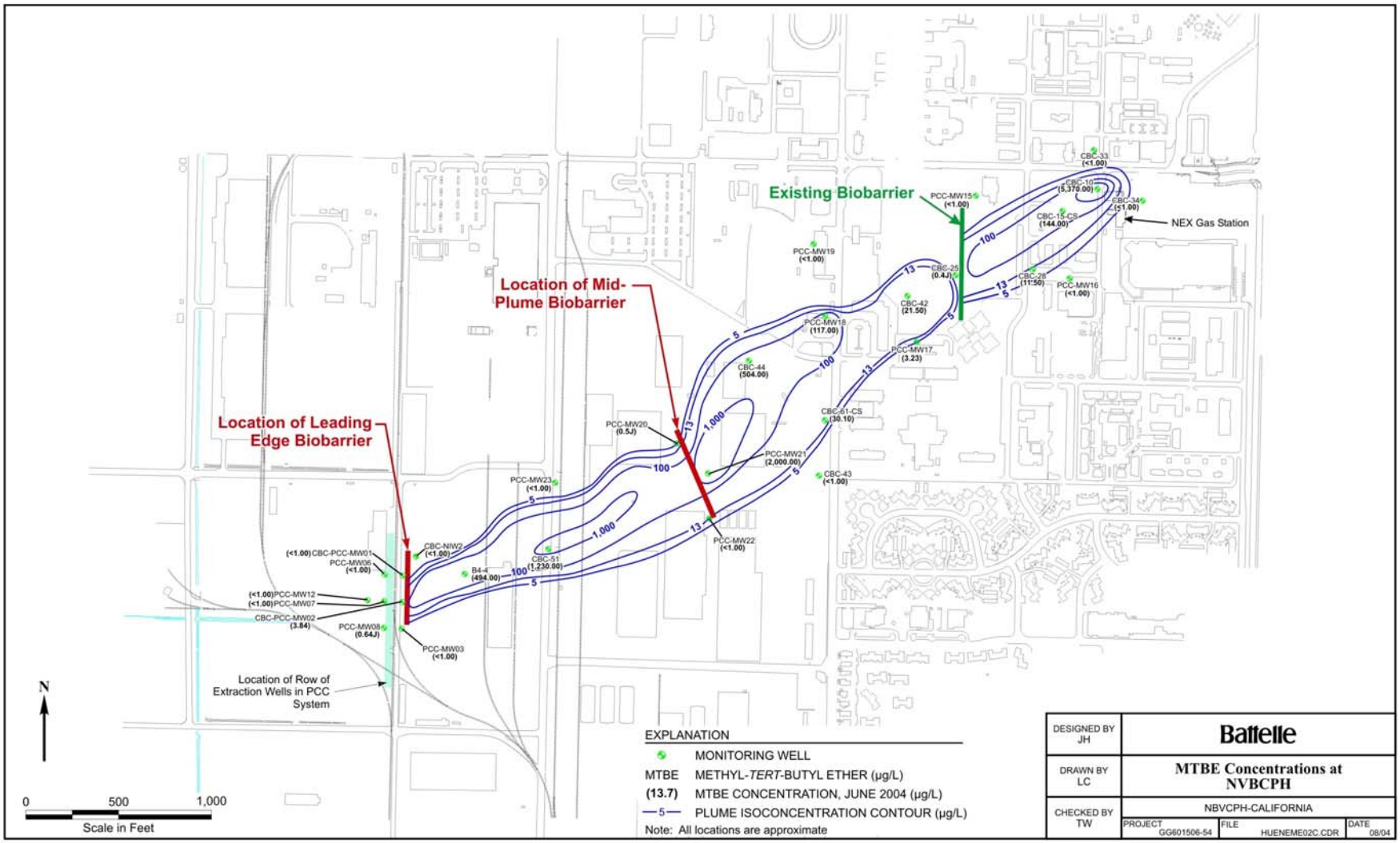
MTBE Biobarrier Diagram



Leading Edge Biobarrier

- 400 feet wide biobarrier
- Wells on 8 foot spacing (96 wells)
- Multi-level injection depth

MTBE Isoconcentration Contour Map, October 2004

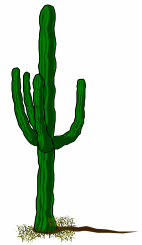


Status of NBVC Biobarriers, Oct 2004

- Eleven wells sampled along the lateral boundaries of the historical MTBE plume indicate that the lateral extent of the plume is remaining relatively stable.

- The monitoring data indicates that the leading-edge biobarrier is effectively containing the MTBE plume.

- The Navy is planning to shut down the pump and treat system after receiving approval from the Los Angeles Regional Water Quality Control Board.

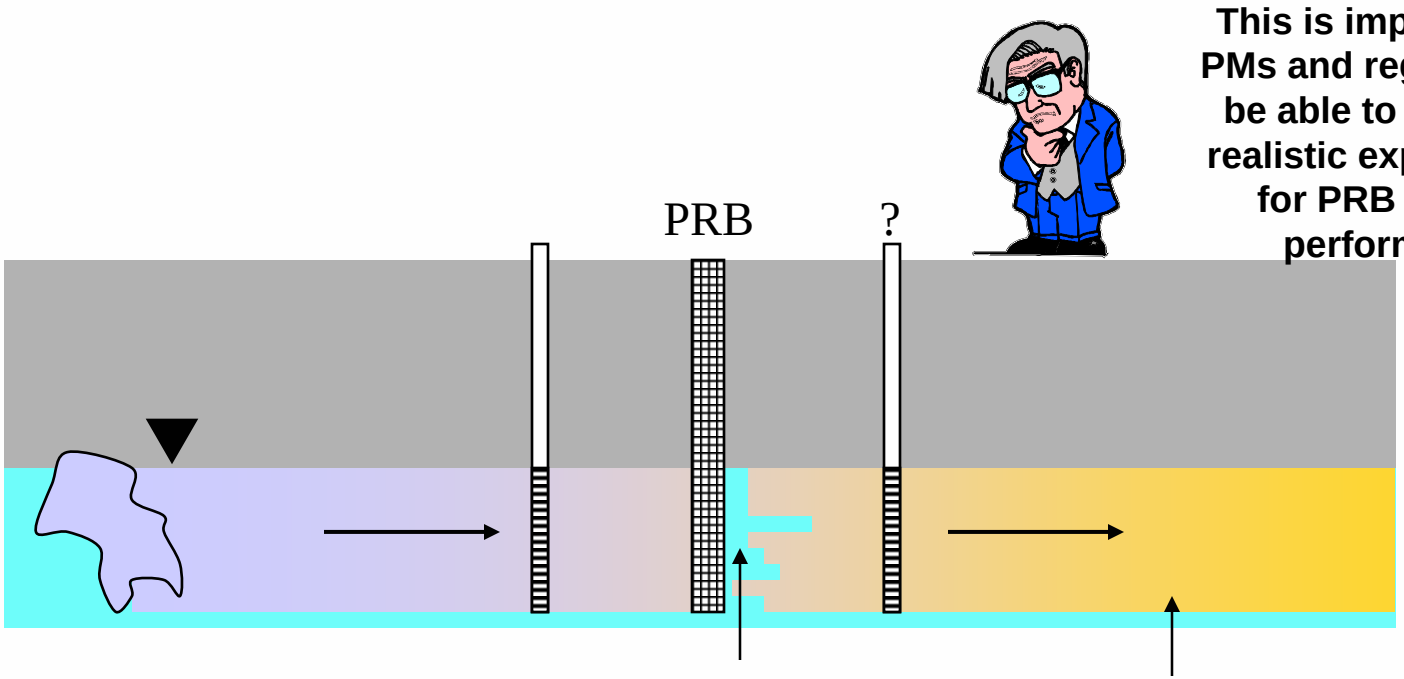


Prediction of Groundwater Quality Improvement Down-Gradient of In-Situ Permeable Treatment Barriers and Fully Remediated Source Zones

NFESC POC: Laura Yeh
ASU Investigators: Paul Dahlen, Pamela Maass, Dr. Paul Johnson

Technical Objective

Test our ability to anticipate changes in down-gradient water quality with time for permeable reaction barriers (PRB) that bisect dissolved plumes



This is important for PMs and regulators to be able to establish realistic expectations for PRB system performance

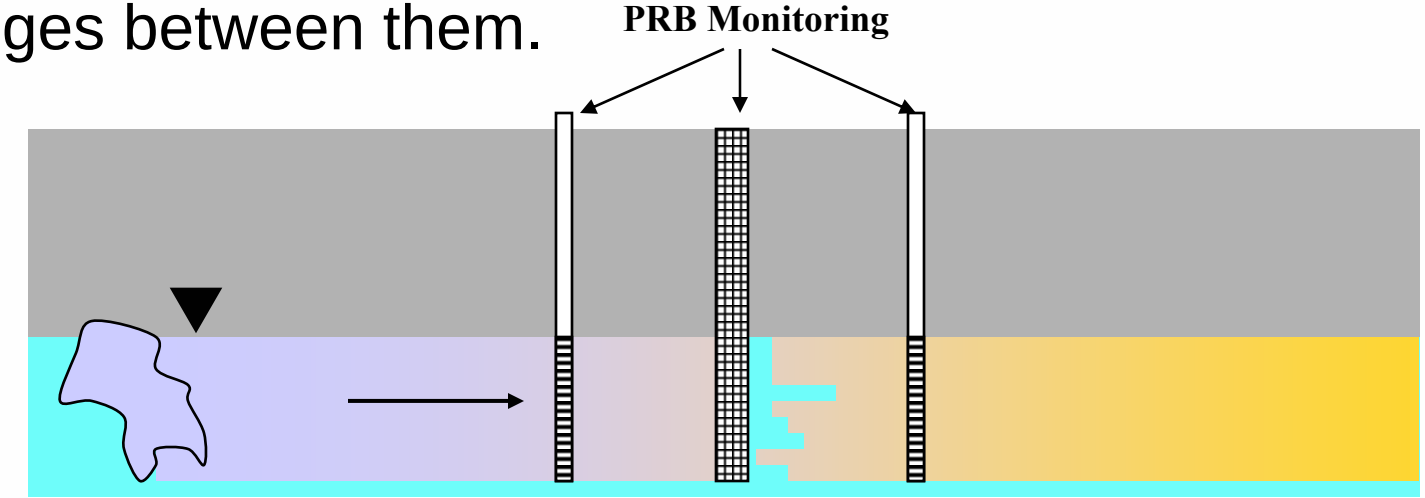
The movement of treated water and water quality improvements with time are the focus of this study

NOT the dynamics of detached plume movement

Background

PRB Performance Monitoring & Issues

- Ideally, a PRB is installed at the leading edge of a plume; however, other factors may dictate its placement up-gradient - thereby bisecting the plume.
- Performance of PRB systems is generally determined by monitoring up- and down-gradient concentrations as well as concentrations in the treatment zone, and then looking for changes between them.

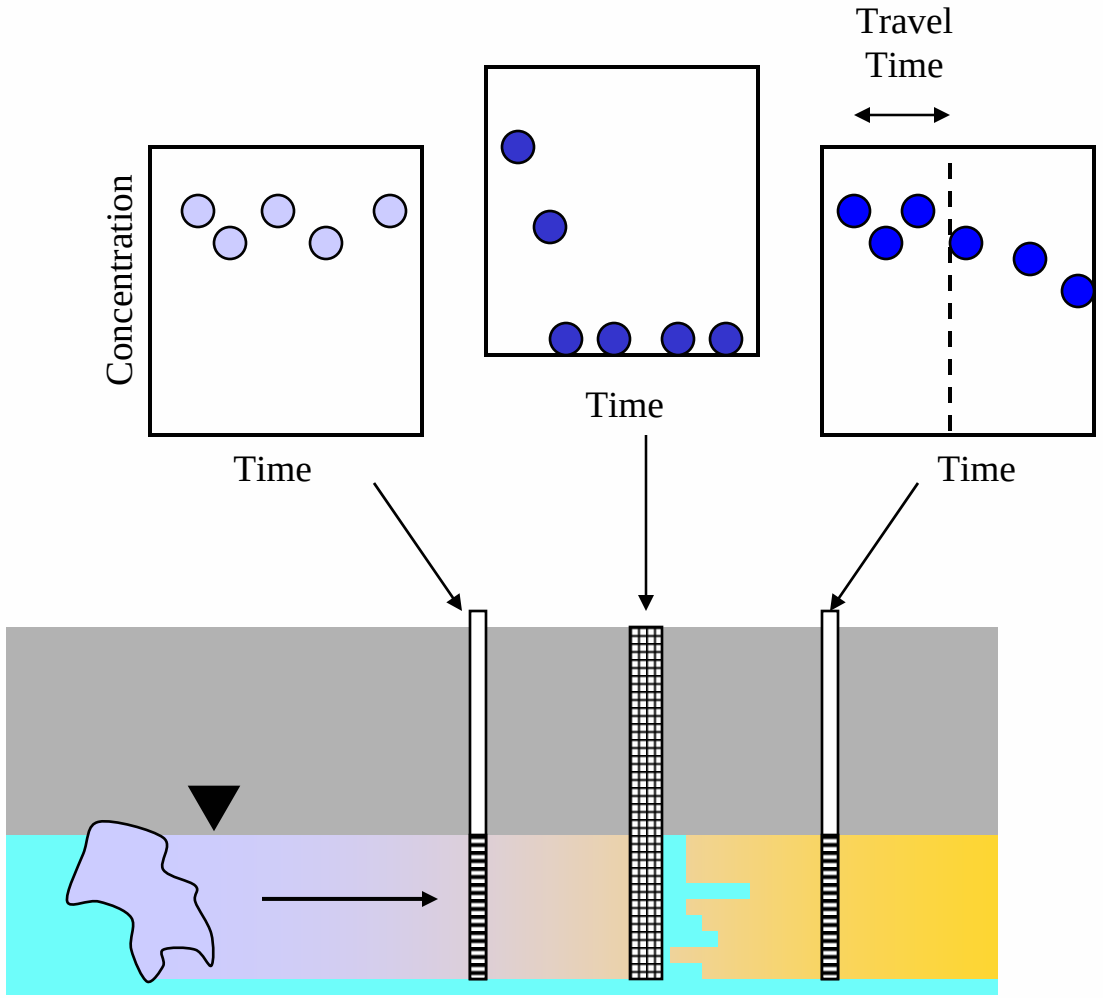


Background

PRB Performance Monitoring & Issues

Based on empirical observations, groundwater quality down-gradient of PRB's rarely responds as quickly as anticipated based on concentrations measured in the treatment zone and conventional groundwater travel time/modeling estimates.

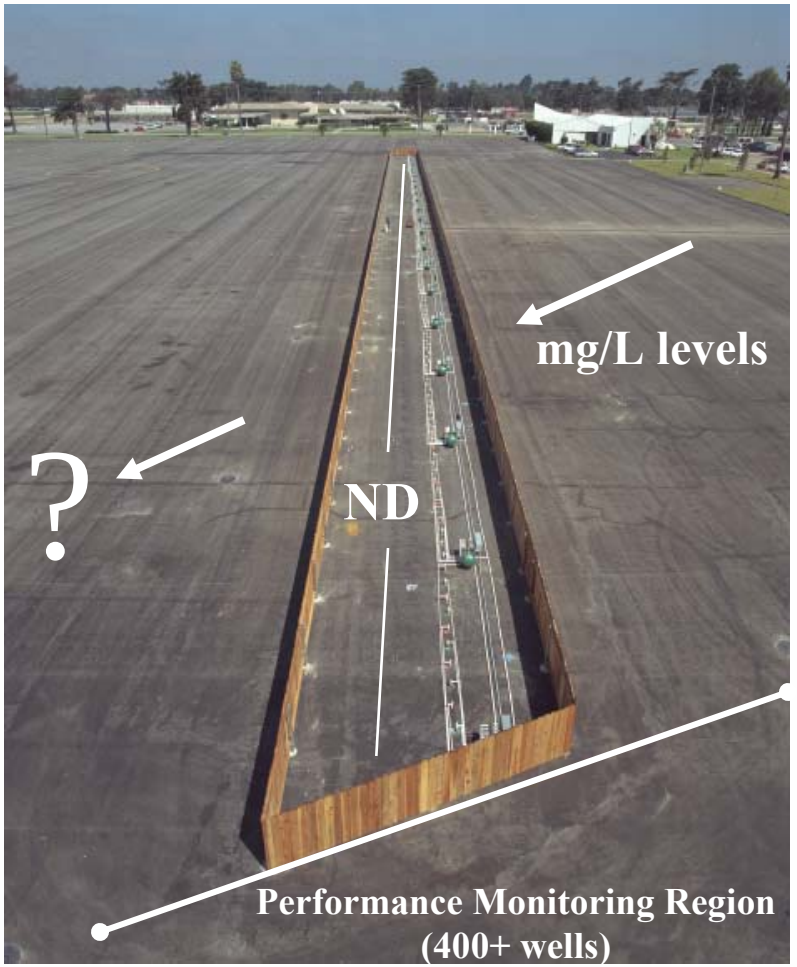
This can lead some to conclude that the system is "not working".



Field Site

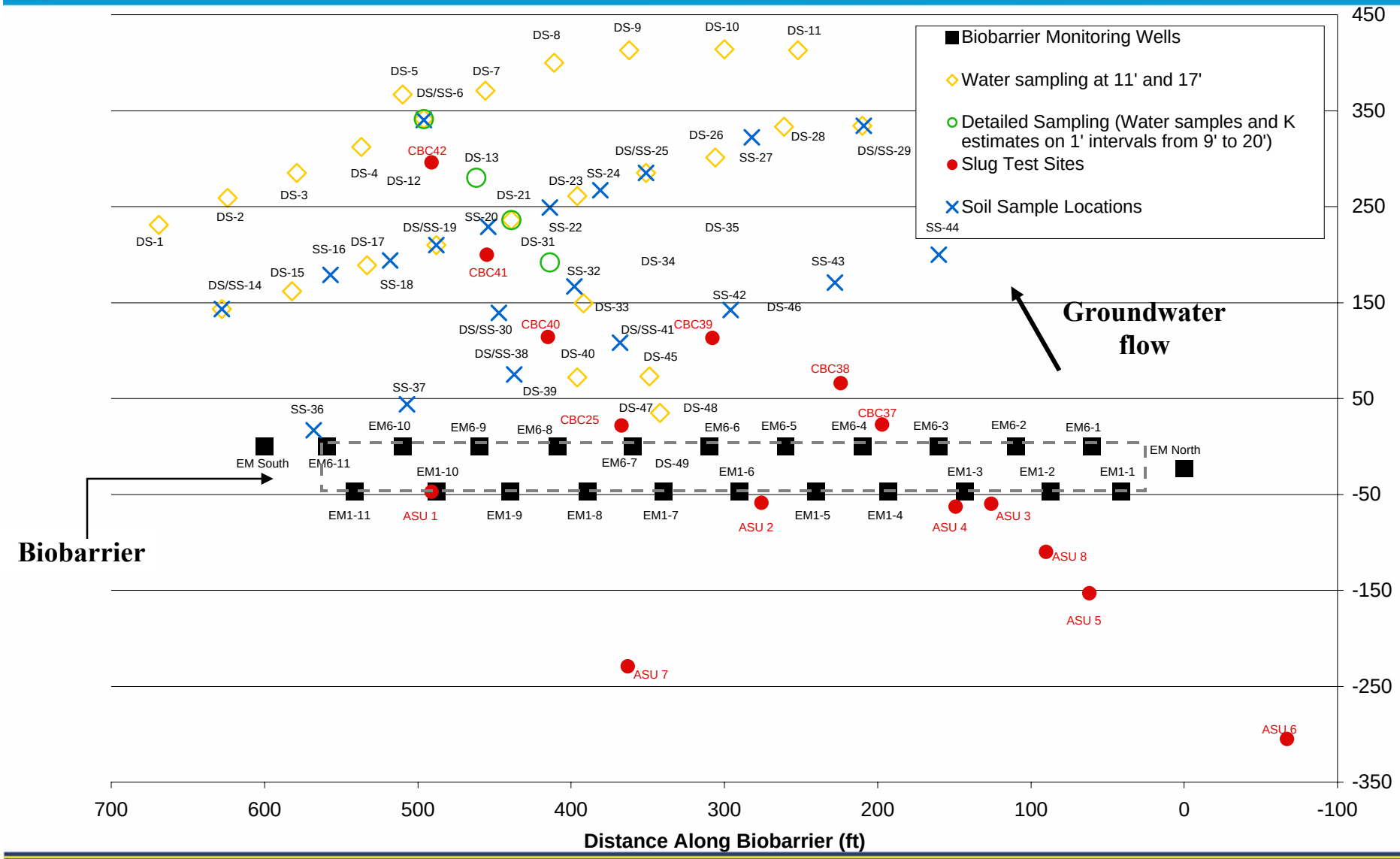
NBVC Port Hueneme was chosen because:

- The site is already reasonably well-characterized
- There is a well-understood large-scale PRB, with extensive operating data, an accessible GeoProbe unit, and shallow groundwater.
- MTBE is a reasonable surrogate for other relatively recalcitrant chemicals



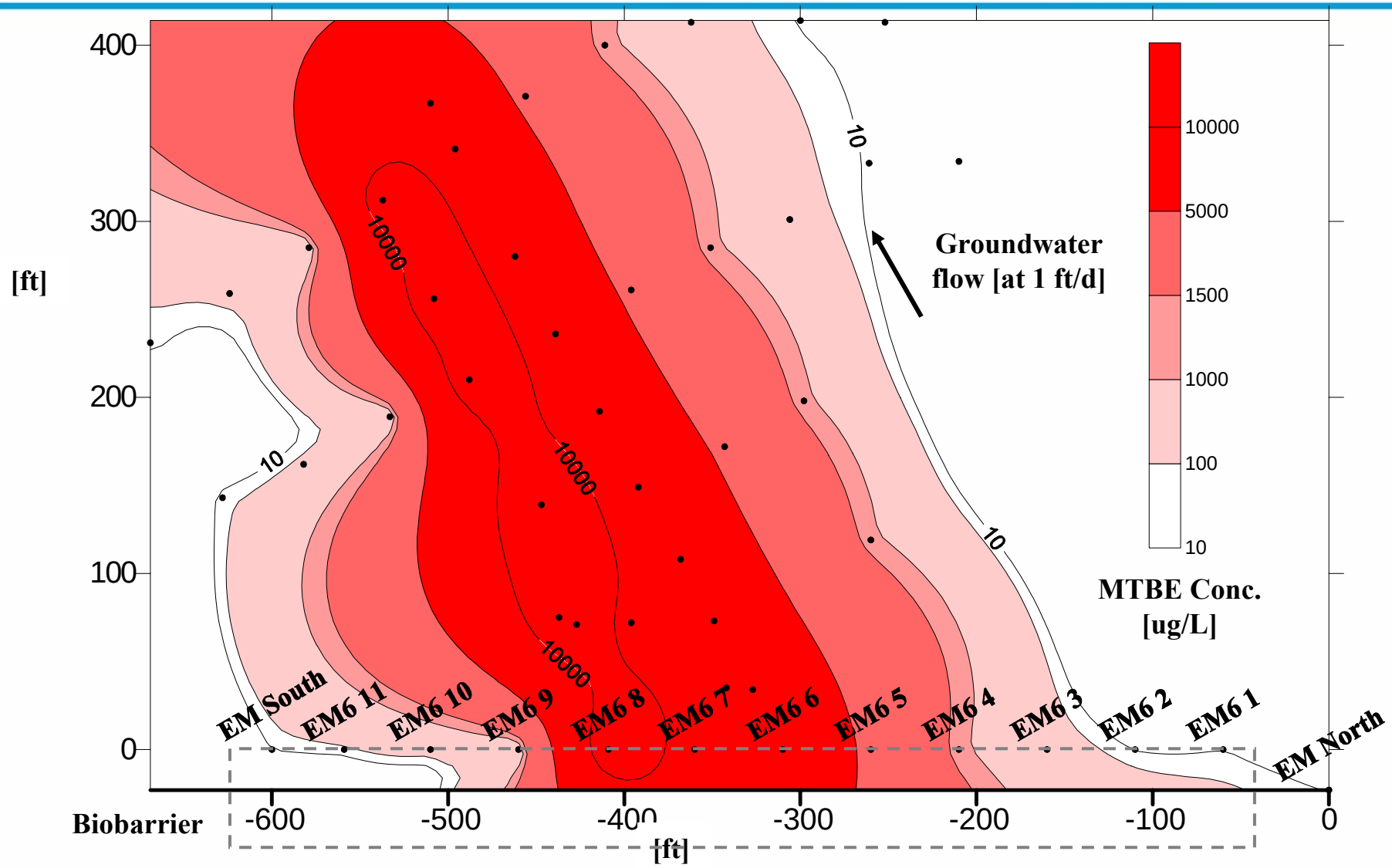
System start-up Sept. 2000
Groundwater velocity: 1 ft/d

Field Work - Year 1



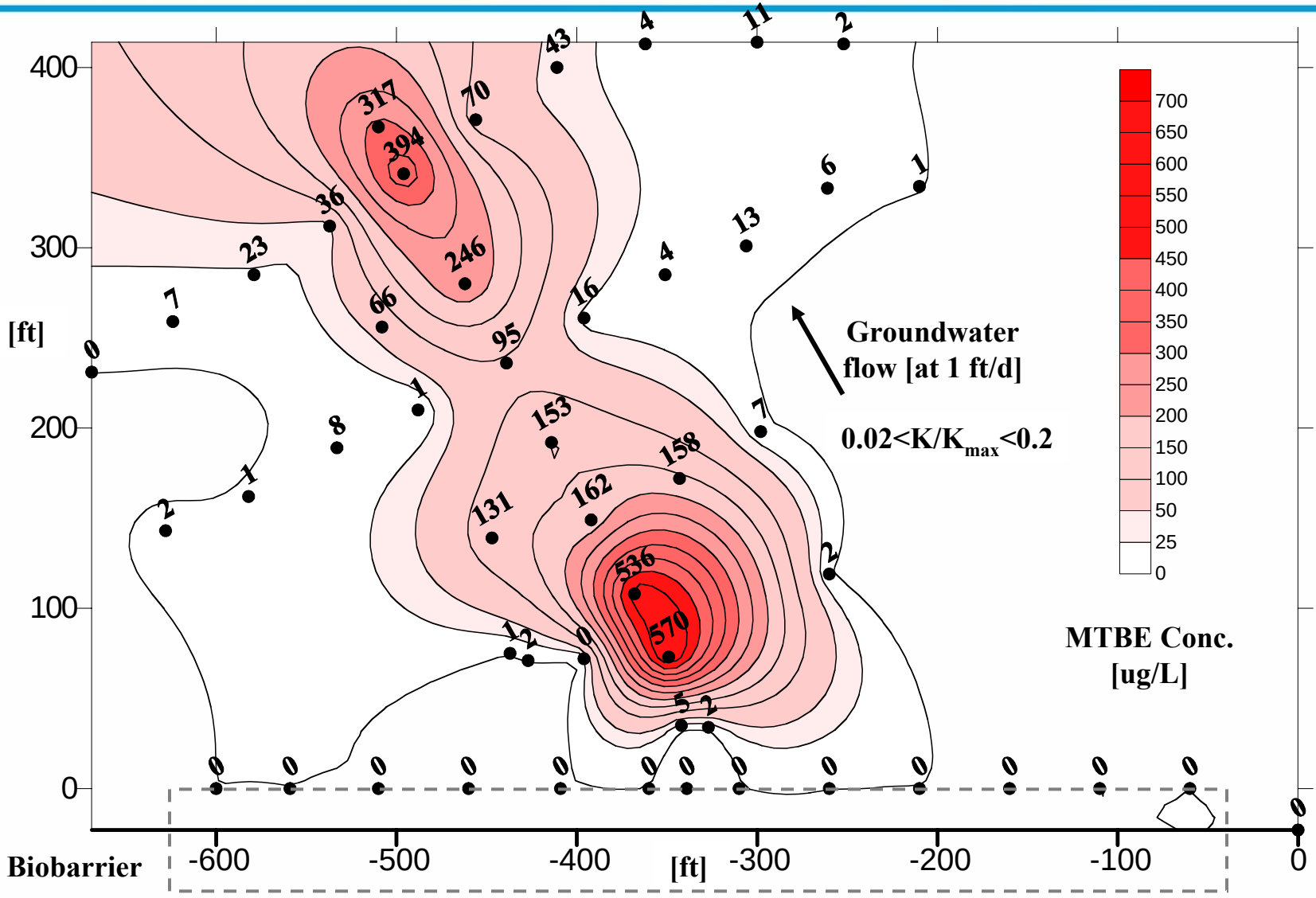
Initial Plume…

Recreated from pre-demonstration EM6-X concentrations and limited well data



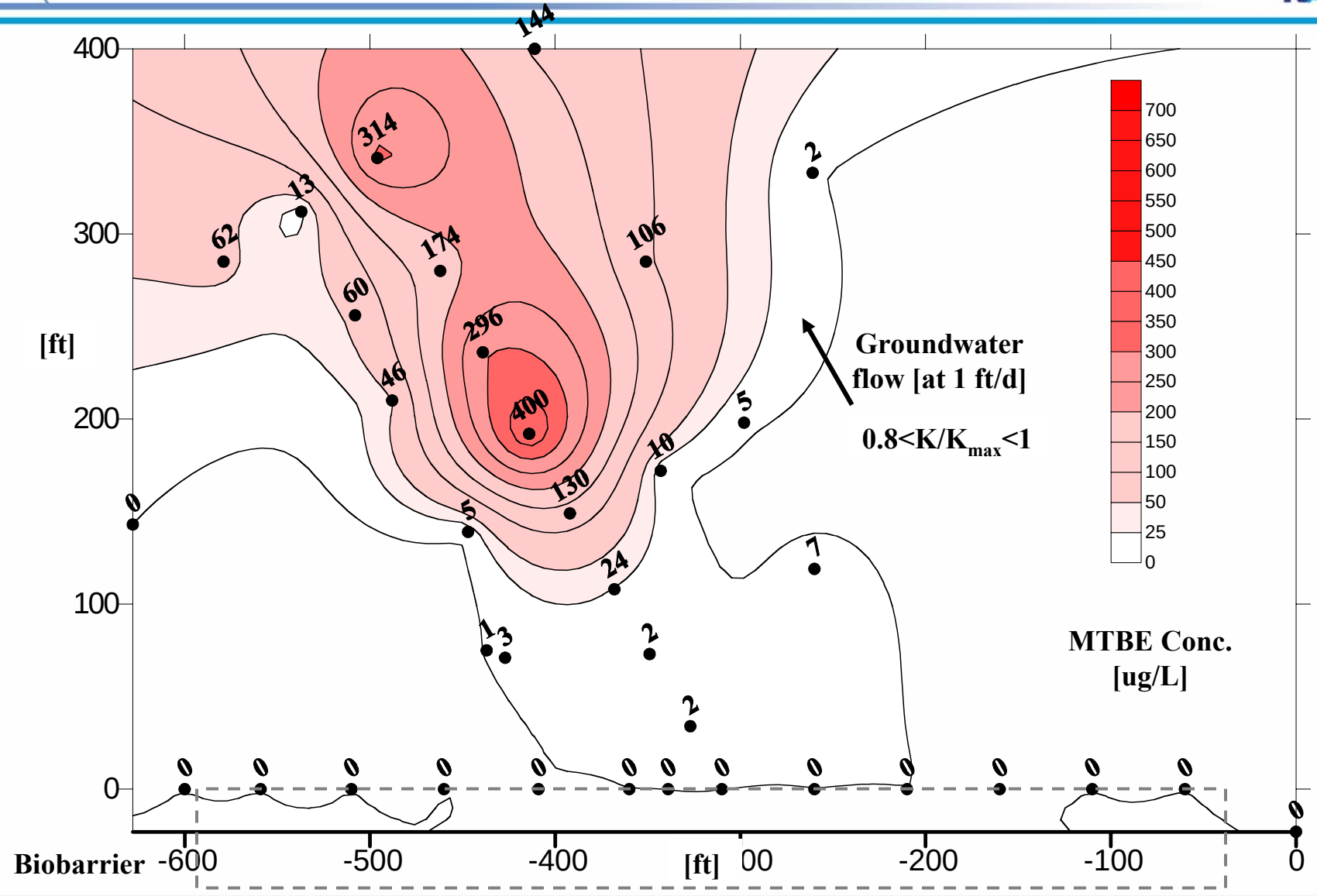
Year 1 Field Work

Concentrations at 11 ft BGS (April + July data)



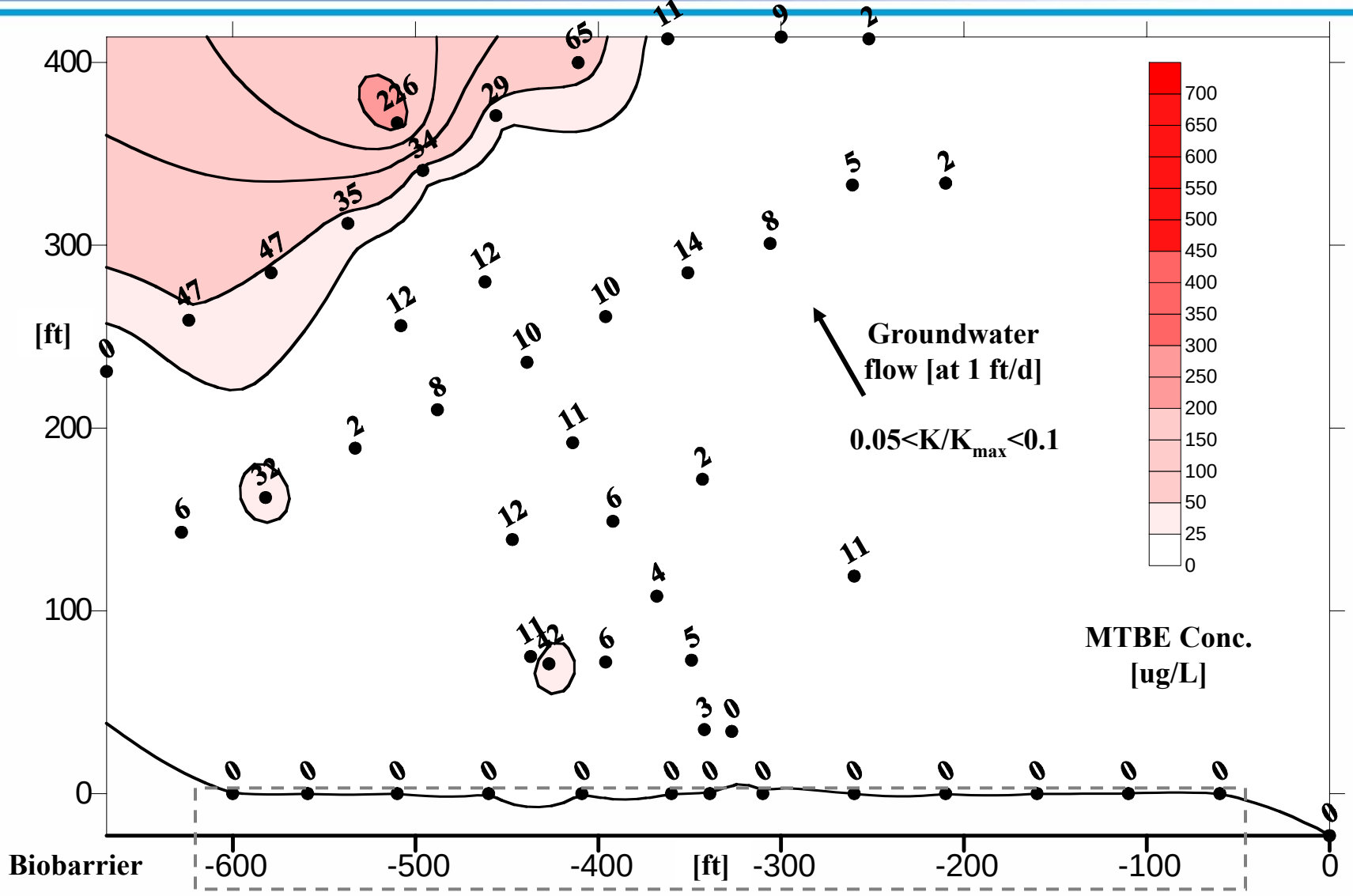
Year 1 Field Work

Concentrations at 13 ft BGS (April + July data)



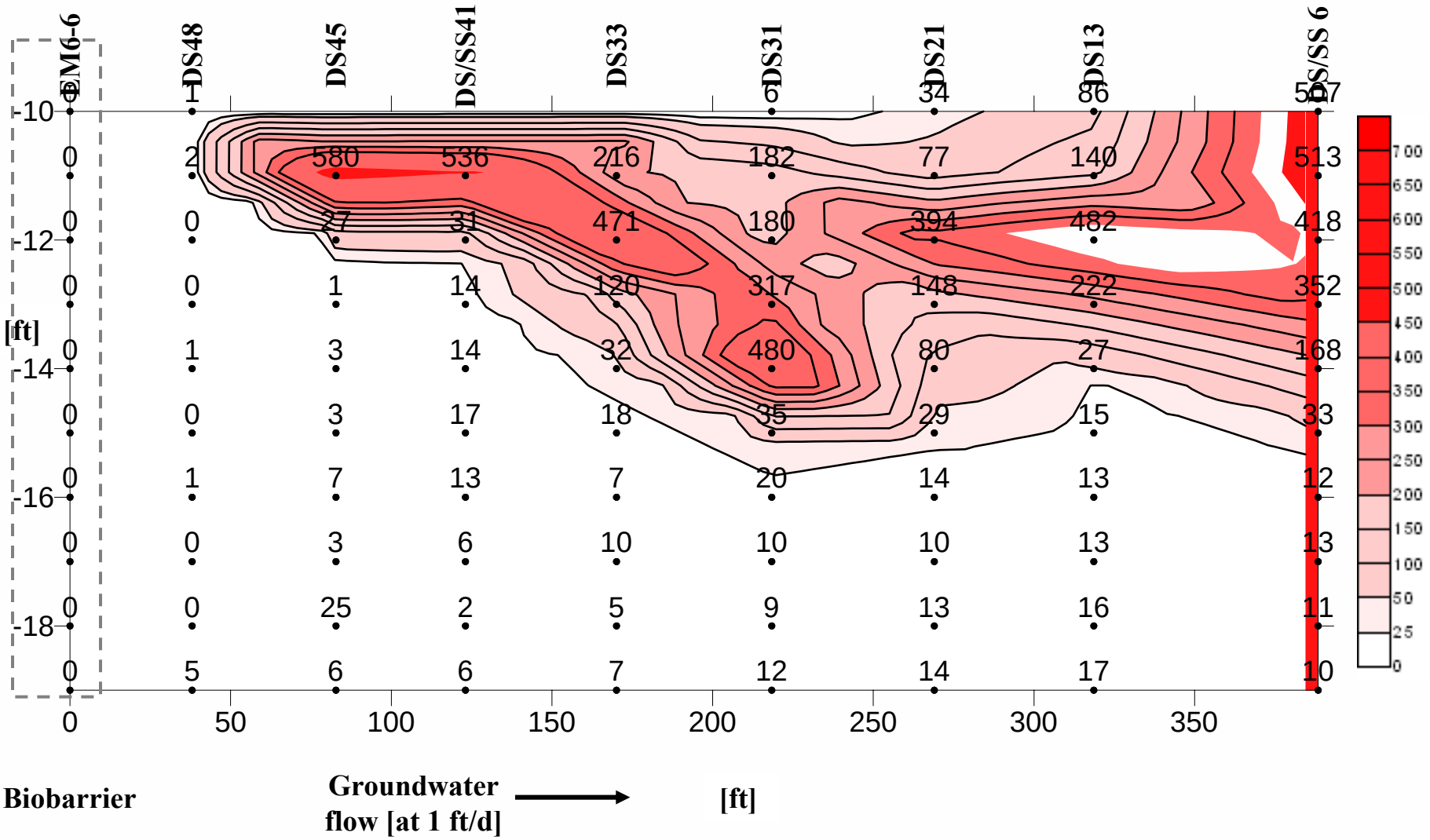
Year 1 Field Work

Concentrations at 17 ft BGS (April + July data)



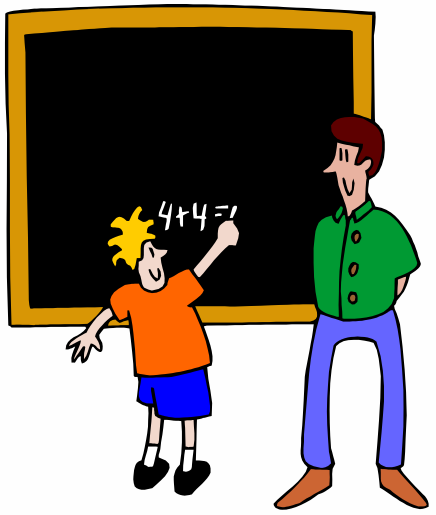
Year 1 Field Work

Concentrations along plume centerline (vertical slice) (April + July data)



Transition Plan

- Disseminate results to RPMs via NFESC's Technology Transfer Program (RITS, RPM newsletters, web page).
- Final Report to be "how to" manual with example and any new calculation tools developed from this work.
- Peer reviewed Journal article
- Workshop/presentation/poster (as desired), at the end of the project to be presented at the SERDP/ESTCP Symposium, Tri-Service Environmental Conference or a Battelle conference.



Publications

- Johnson, P.C., K.D. Miller, and C.L. Bruce 2004. A Practical Approach to the Design, Monitoring, and Optimization of In-Situ MTBE Aerobic Biobarriers. *NFESC Technical Report TR-2257-ENV*
- Johnson, P.C., K.D. Miller, and C.L. Bruce. 2003. ESTCP Final Report, In-Situ Bioremediation of MTBE in Groundwater. *NFESC Technical Report TR-2222-ENV*
- Miller, K.D., P.C. Johnson and C.L. Bruce. 2003. ESTCP Cost and Performance Report, In-Situ Bioremediation of MTBE in Groundwater. *NFESC Technical Report TR-2216-ENV*