U.S. EPA Workshop on Monitored Natural Attenuation for Inorganic Contaminants

Characterizing Site Hydrology

November 6, 2008
Region 10 – Seattle, WA

Presentation Objectives

- **Hydrogeologic objectives**
- **Hydrogeologic data needs**
- **Typical data uses**

Discussion Focus

Saturated Porous Media

Complications:

Fractured media

Karst

Vadose Zone

What is Site Characterization for MNA??

Simply, characterization of contaminant distribution, transport, and fate.

Questions to be Addressed

- What are the controls on fluid flow?
- What are the transport pathways?
- What is the rate of fluid flow along critical transport pathways?
- What is the rate of contaminant flux attenuation along critical transport pathways?

Objective: Define Geologic Controls

- Setting, depositional environments
- Lithologies, stratigraphy, structure
- Man-made features
- Effects of heterogeneity
- Aquifer mineralogy

Objective: Define Hydrologic Controls

- Recharge/discharge characteristics
- Hydraulic properties distribution
- Hydraulic gradients & variability

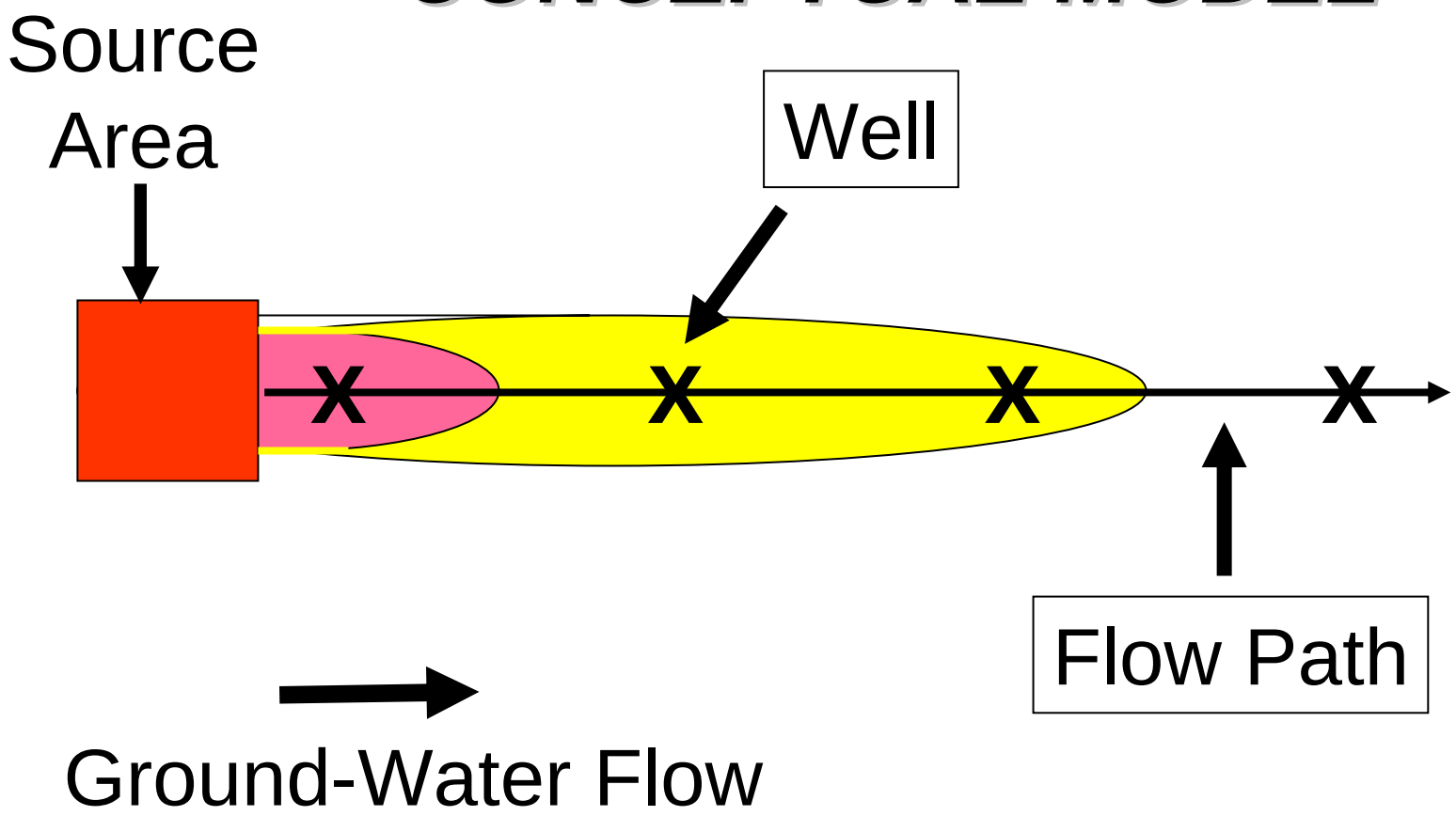
Hydrostratigraphy

The Third Dimension

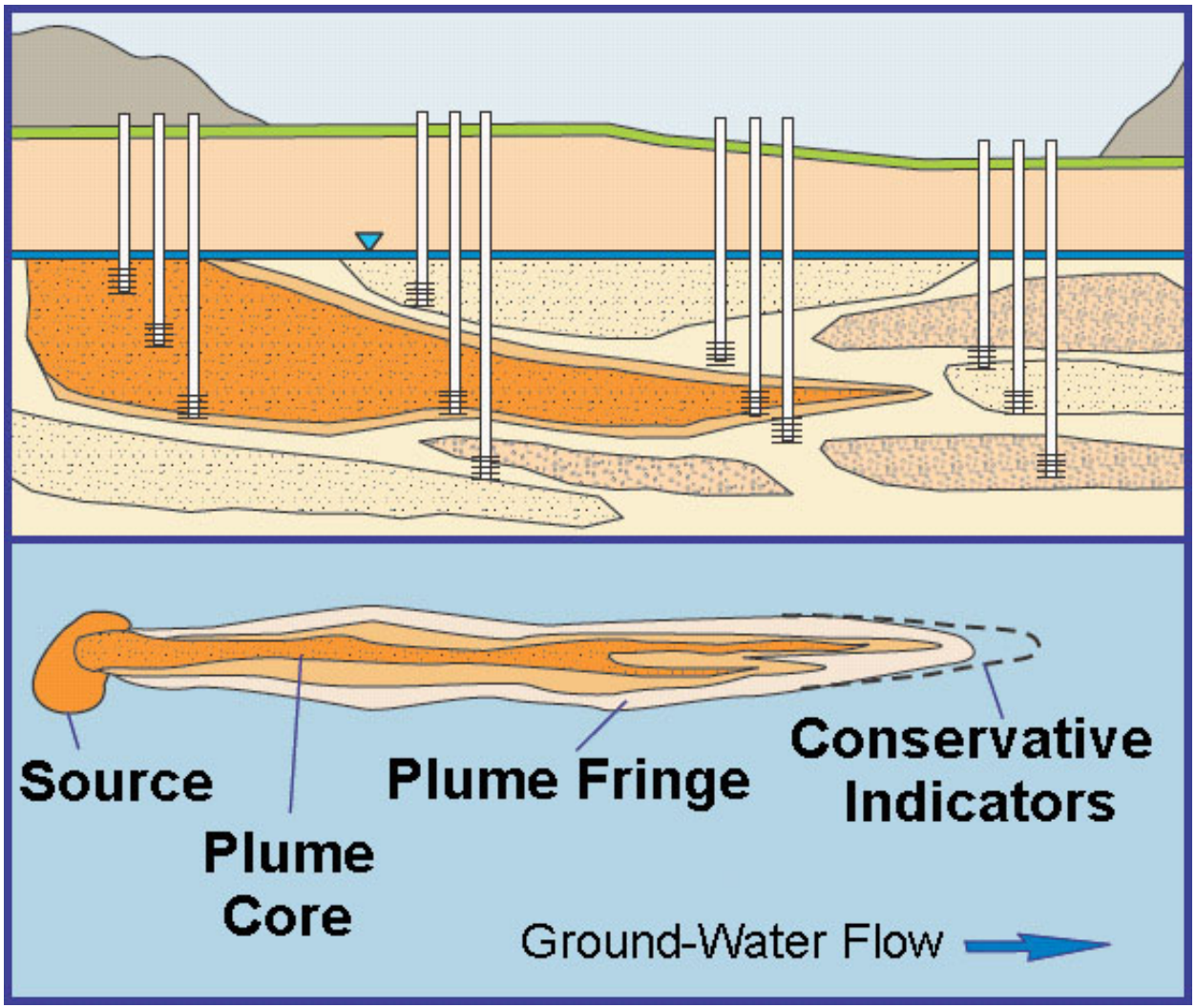
Reasons for vertical movement include:

- Pumping wells
- Recharge to ground water
- Preferential migration pathways
- Fluid density differences
- Proximity to discharge

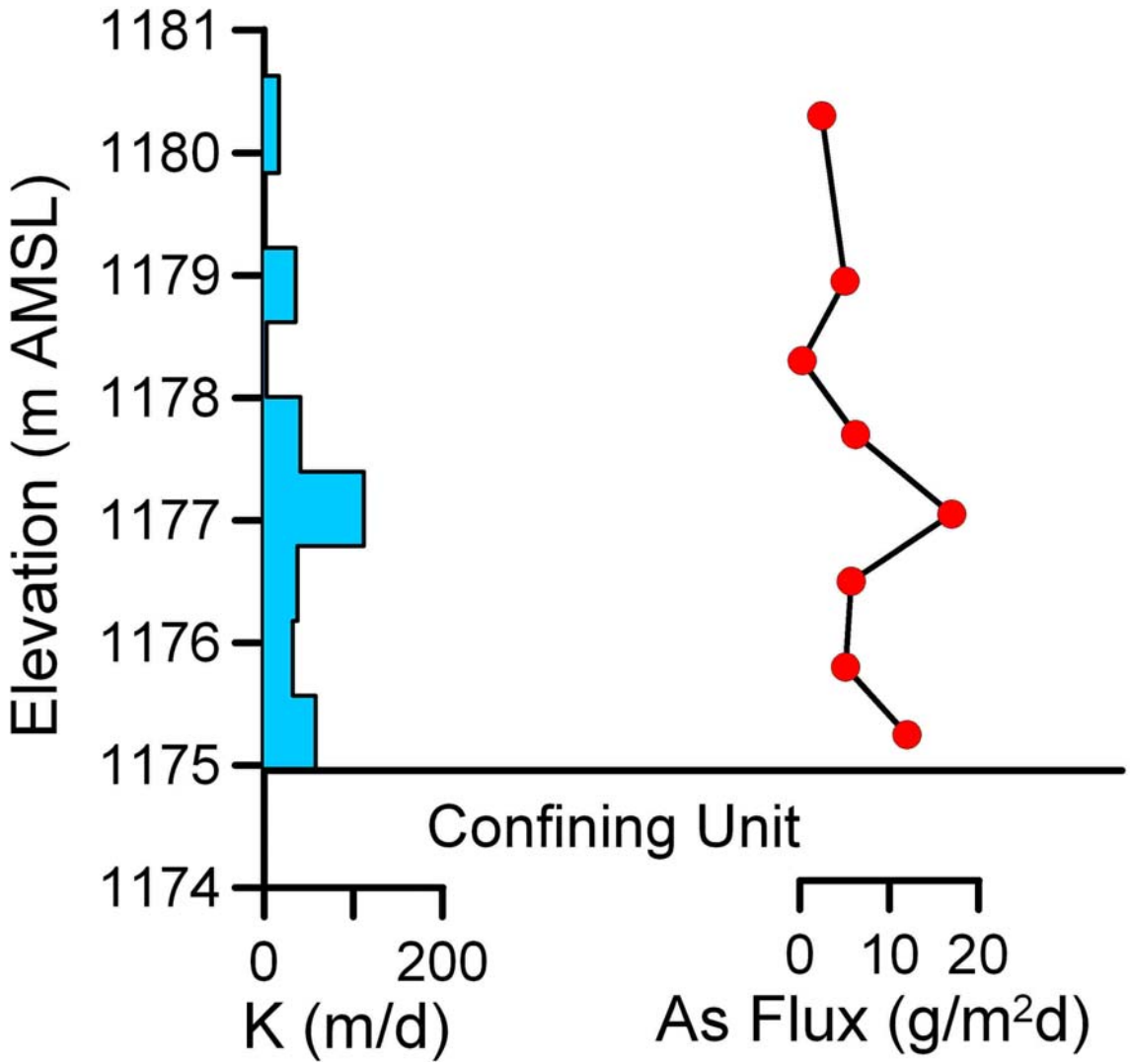
DEFAULT CONCEPTUAL MODEL



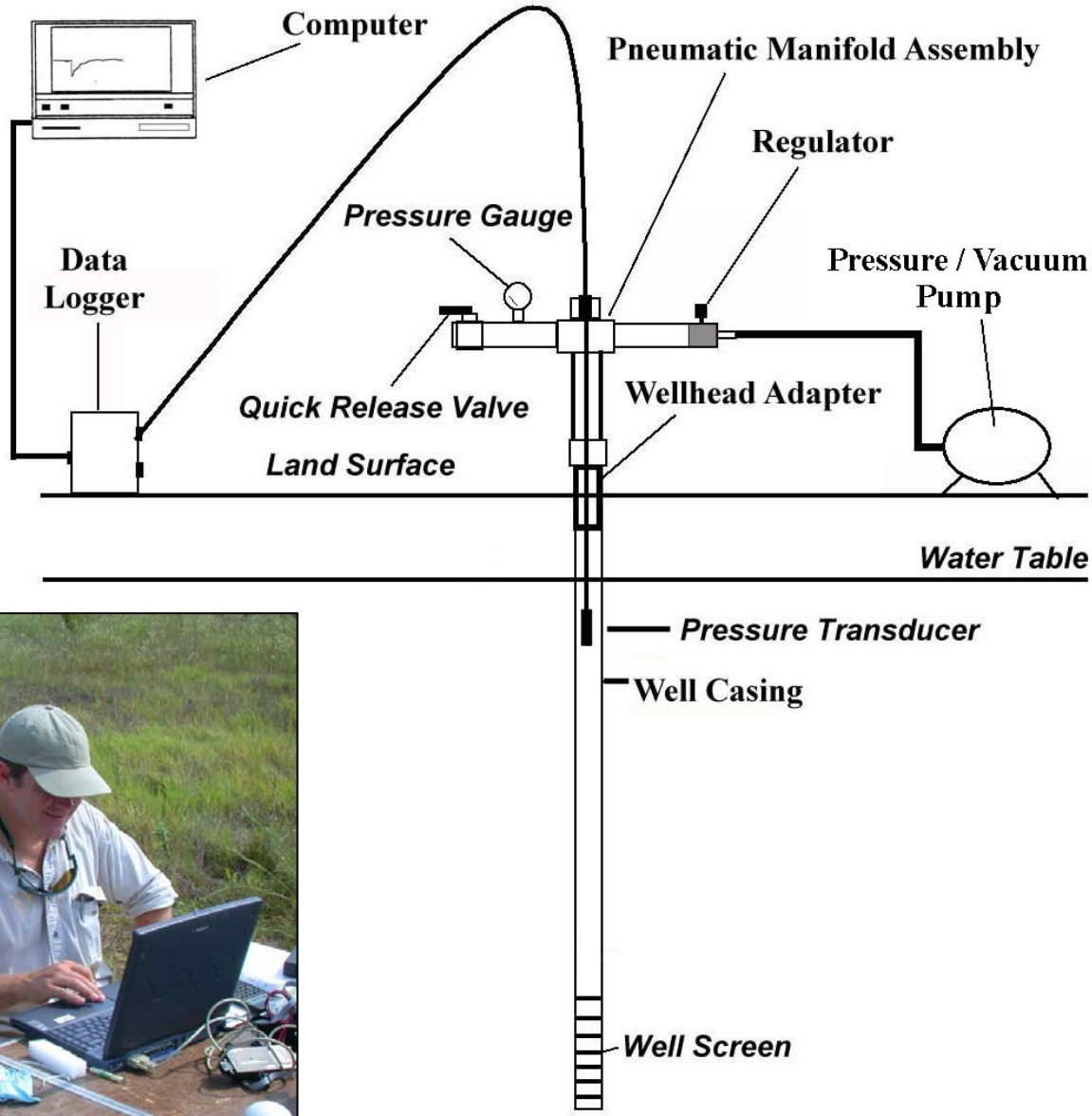
In Reality

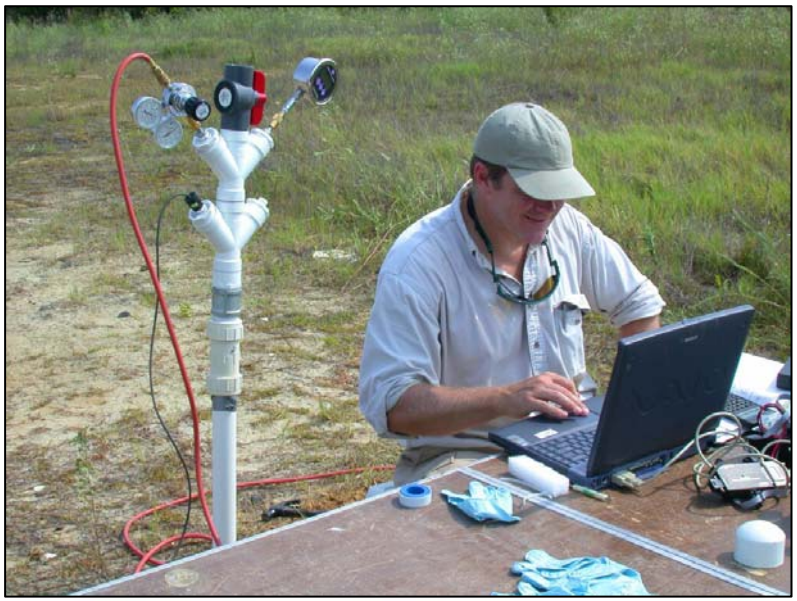

Source
Plume Core
Plume Fringe
Conservative Indicators
Ground-Water Flow

Value of 3D Assessment

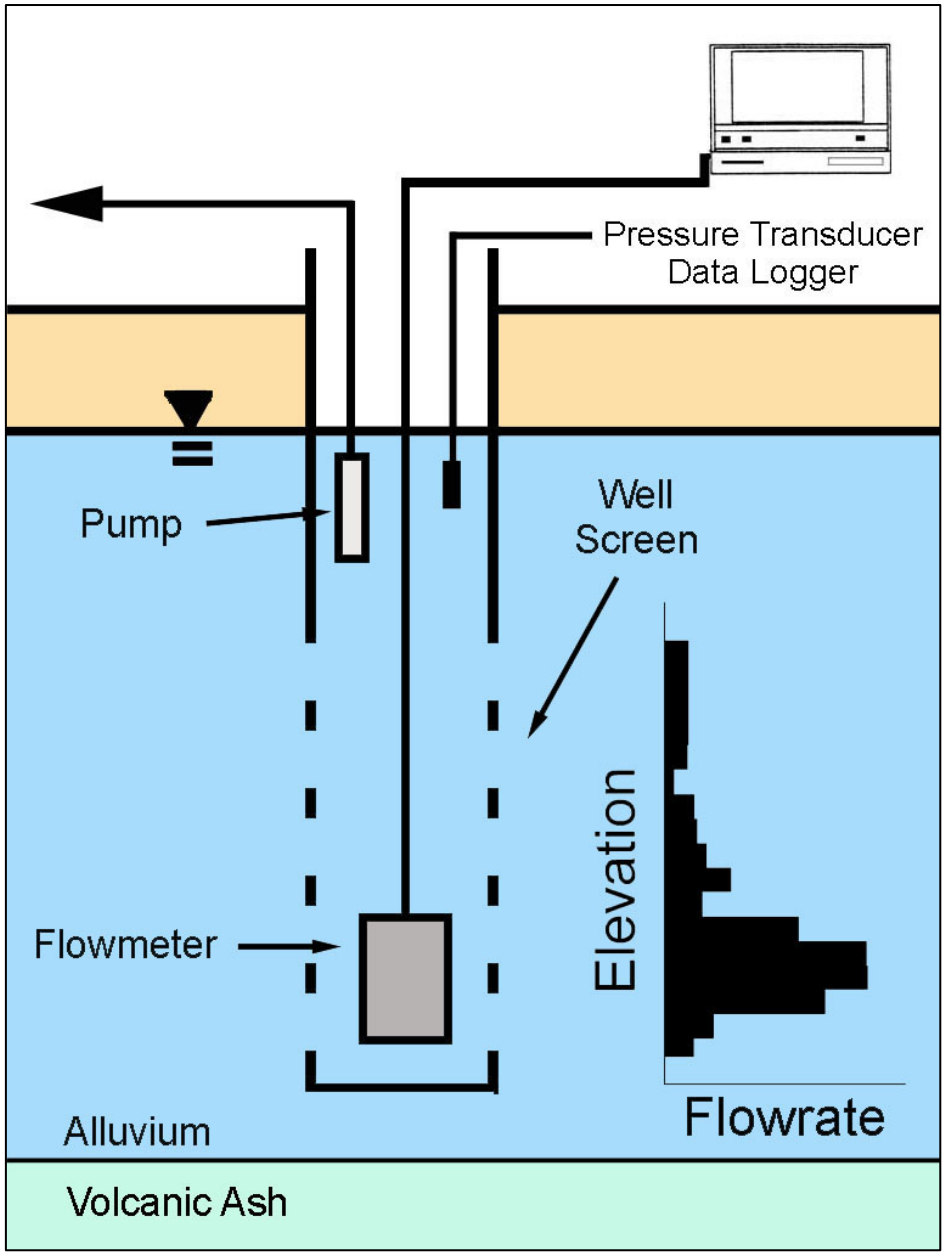


Pneumatic Slug Test





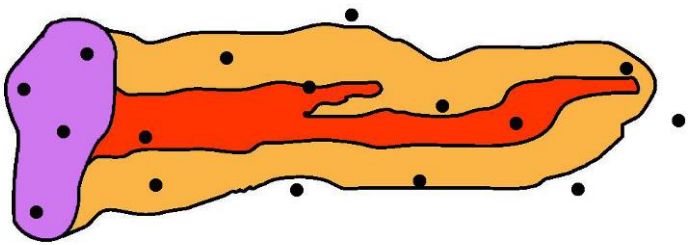
Borehole Flowmeter



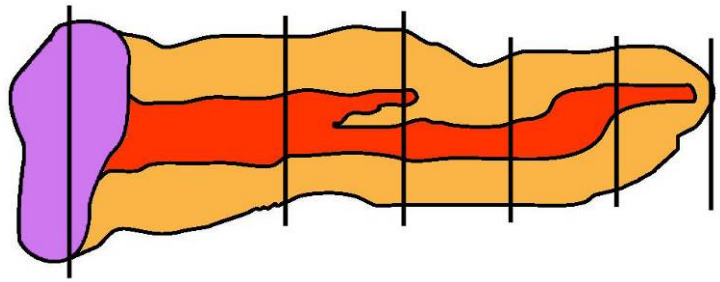
Characterization Strategies

Considerations include:

- Likely controls on transport and fate
- Proposed interpretation methods
- Tolerance for uncertainty



Traditional



Transect Approach

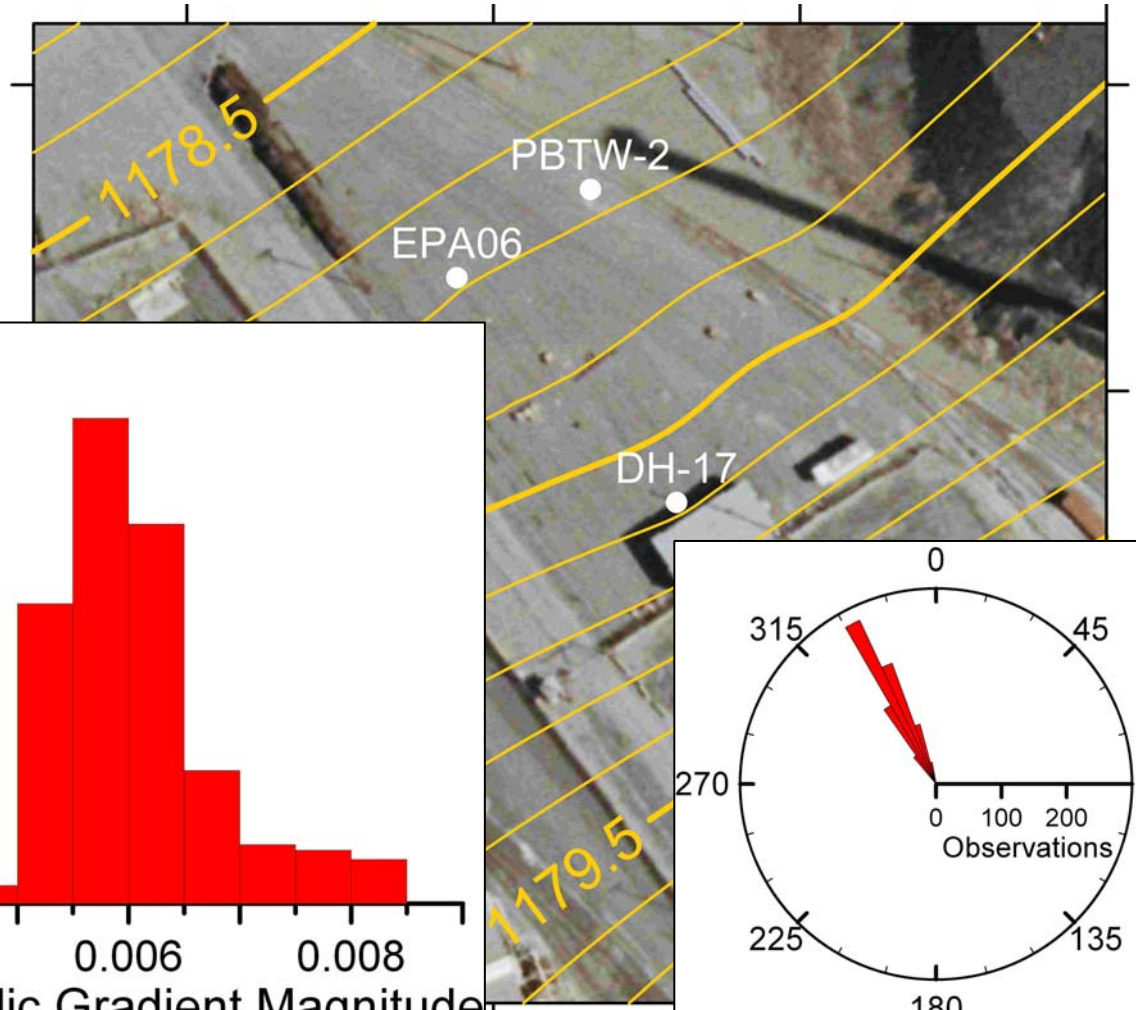
The Fourth Dimension

Wells are static.
Plumes may be dynamic.

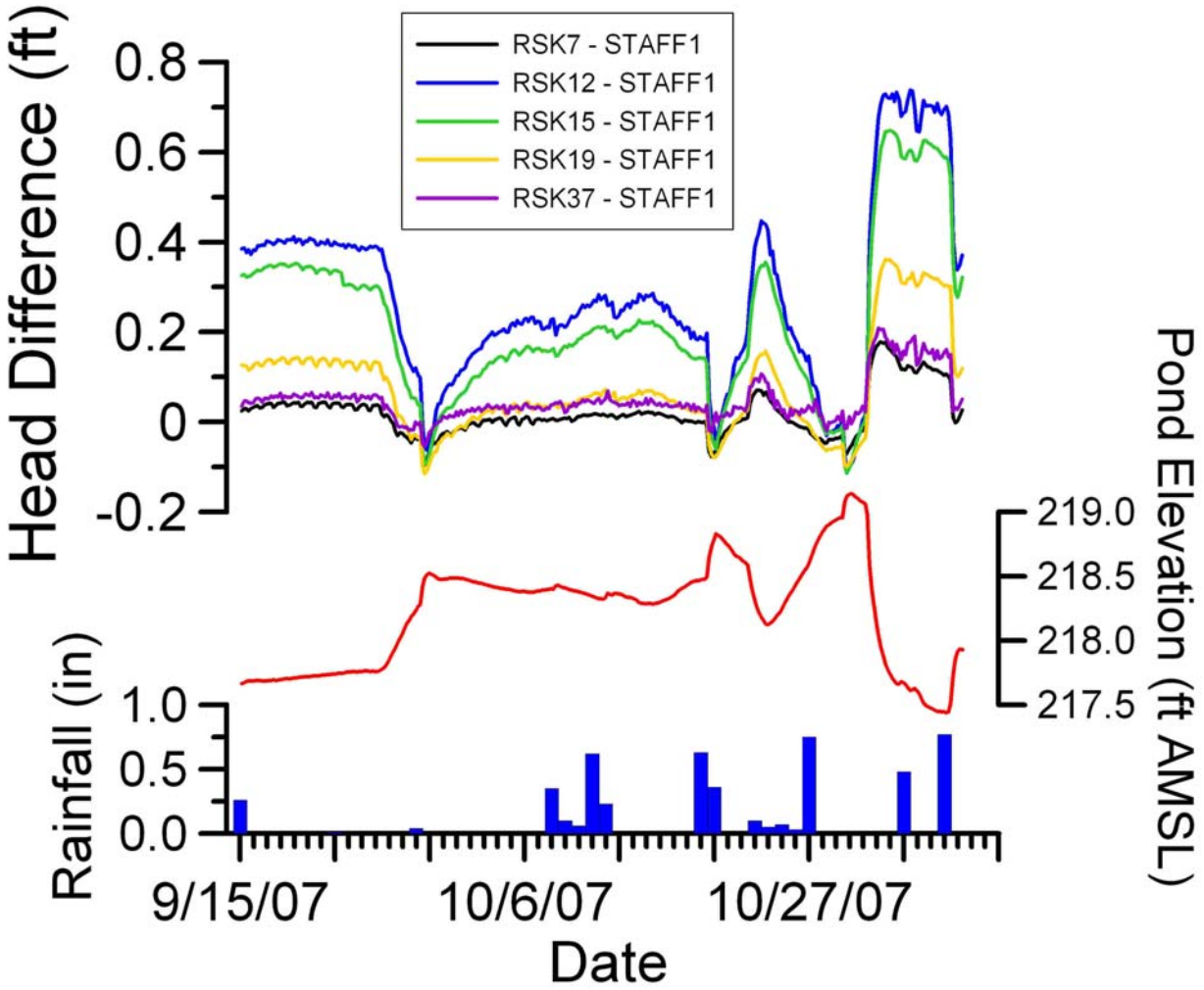
Sources of temporal variation include:

- Changes in recharge rates or patterns
- Changes in discharge location/rates
- Changes in chemistry

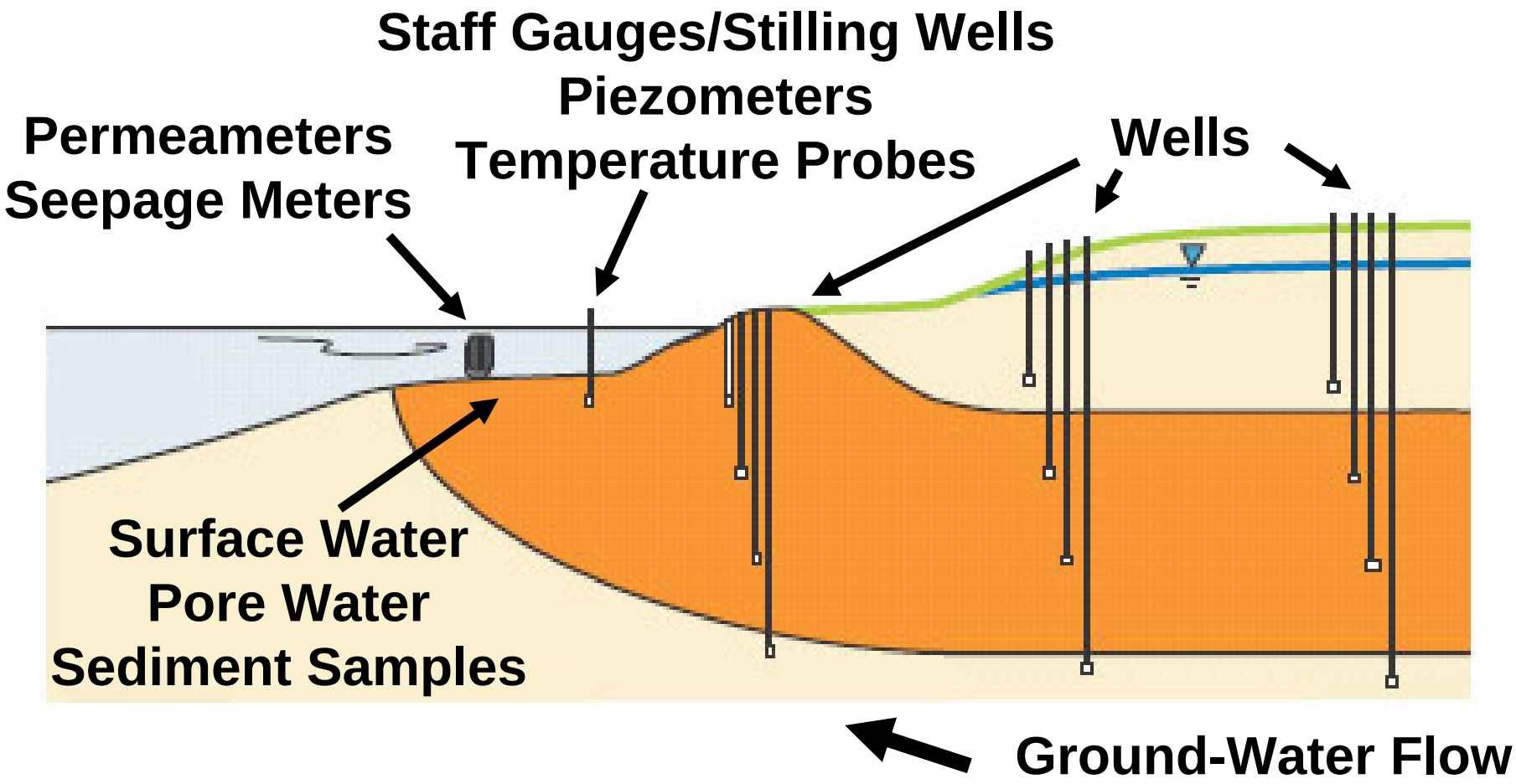
Assessing Effects of Variation in Recharge/Discharge



Assessing Ground Water/Surface Water Interactions



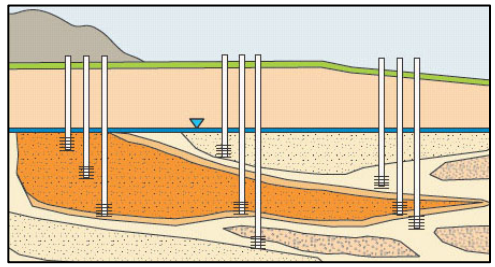
Ground Water/Surface Water: A Special Situation



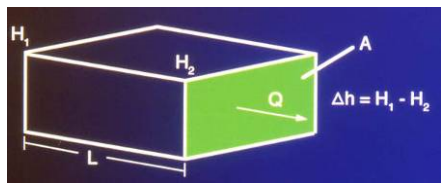
Hydrogeologic Data Use

Typical uses include:

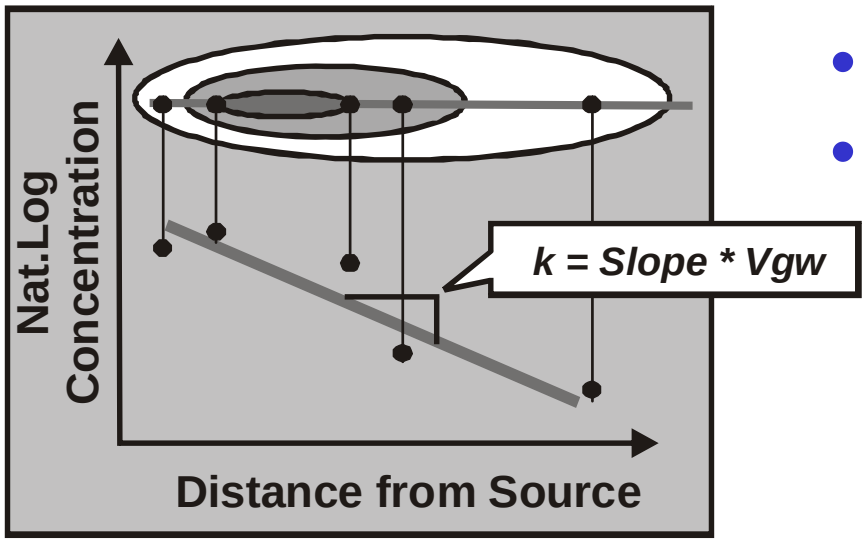
- Build coherent conceptual model
- Improve monitoring network



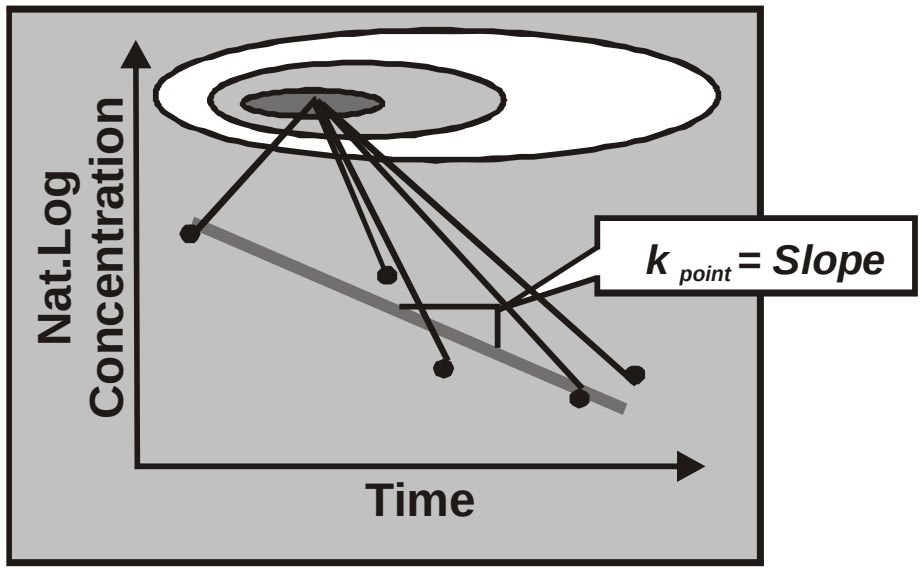
- Quantify flow, transport, and attenuation
- Provide input for ground-water flow and reactive transport models



Attenuation Rate Estimates



- Useful tools
- Be aware of assumptions



Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies

http://www.epa.gov/ada/download/issue/540S02500.pdf

Models: Friends or Foes?

Mathematical models can be used to:

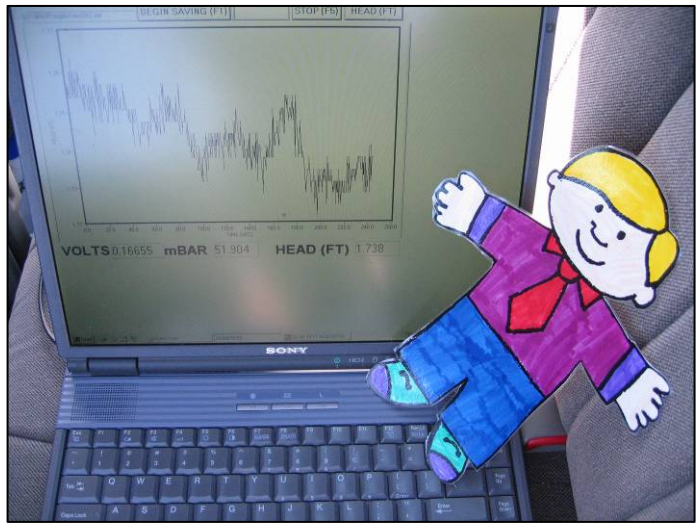
- Provide characterization focus
- Identify uncertainties
- Estimate range of possible outcomes
- Facilitate hypothesis testing
- Assess potential attenuation capacity & longevity

BUT

Are only as good as the supporting data

Modeling Rules of Thumb

- Fuzzy Objectives = Fuzzy Answers.
- All models are “wrong”. However, some are useful.
- Model should be only as complex as needed to satisfy objectives.



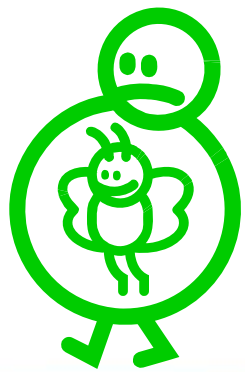
Implications for MNA Evaluations

Assessments based on:

- Average hydraulic properties
- 1D and, possibly, 2D assumptions
- Assumption of static conditions

Will Often Incorporate Significant

Uncertainty



Conclusions