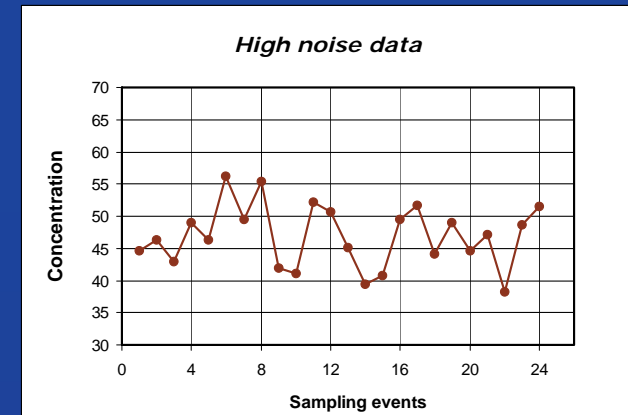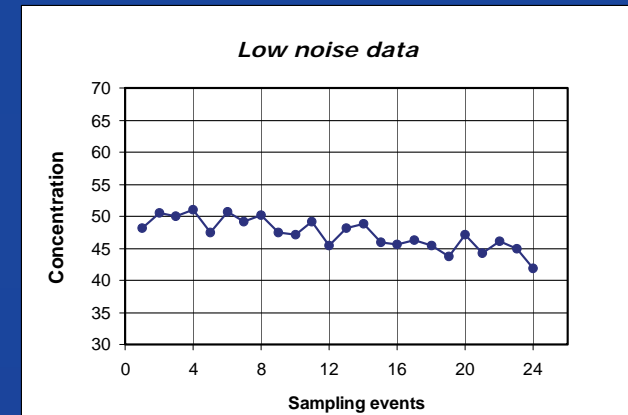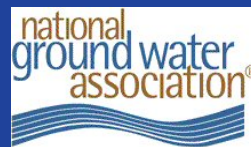# Sampling Variability and Trend Monitoring

North American Environmental Field Conference
Tampa, Florida
January 15, 2007

Mr. Sandy Britt, PG, CHG
ProHydro, Inc.
Fairport, New York
Sandy.Britt@ProHydroInc.com

Low noise data

High noise data

What are sources of data error and variability?

Laboratory?

Hold time

Cross-contamination

Manual vs. autosampler

Collection Method?

Bail purge and sample

Pump purge and sample
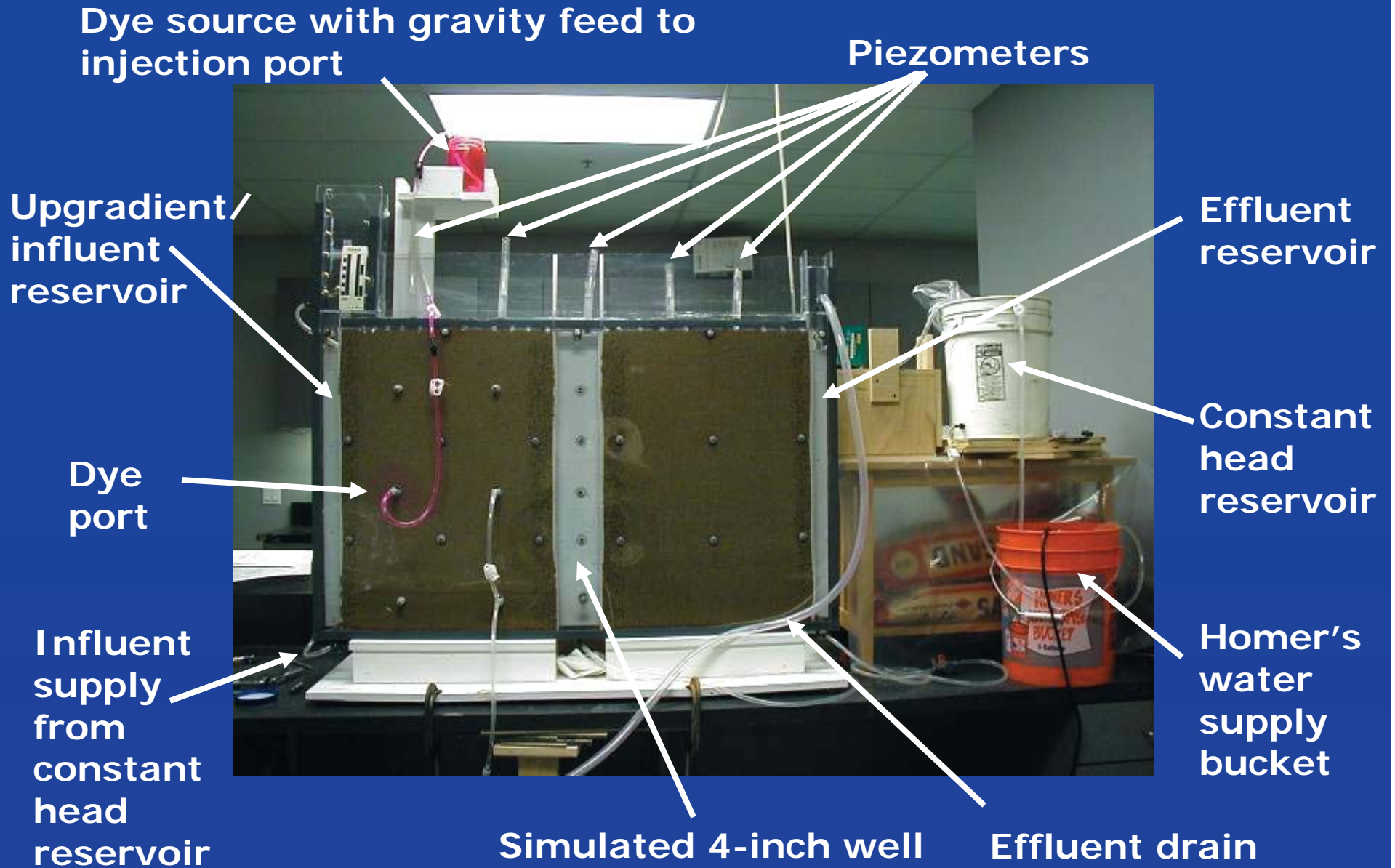
Low flow purge and sample

Passive (no-purge) sampling

Sample Handling?

Bottle filling

Transport

DTSC Sand Tank Well Model

"homogeneous" model well

Dye source with gravity feed to injection port

Piezometers

Effluent reservoir

Upgradient/influent reservoir

Constant head reservoir

Dye port

Influent supply from constant head reservoir

Homer's water supply bucket

Simulated 4-inch well

Effluent drain

Flow-weighted averaging effect

Figure 2. (A) Neutral buoyancy test run, first 18 hours. (B) Neutral buoyancy test run, continued (21 to 106 hours). Photograph captions indicate the number of hours since dye emerged in the model well. The data points identified as DYE, 106T, 106M, and 106B are locations where fluorescence samples were collected at the end of this test run. Percentages indicate dye saturation relative to the injected dye concentration.

S.L. Britt Ground Water Monitoring & Remediation 25, no. 3: 73–81   77

percent of initial dye concentration

33%

40%

35%

Flow weighted averaging

Britt, SL, 2005, Testing the In-Well Horizontal Laminar Flow Assumption with a Sand Tank Well Model. *Ground Water Monitoring and Remediation 25,* **no. 3 p.73-81**

Active (Purge) Sampling Methods

▽ **Water chemistry changes as a well is pumped**

▽ **Why does chemistry change?**

▽ **"Stagnant" water?**

   Or...

▽ **A varying mix of water entering the pump?**

Pumping
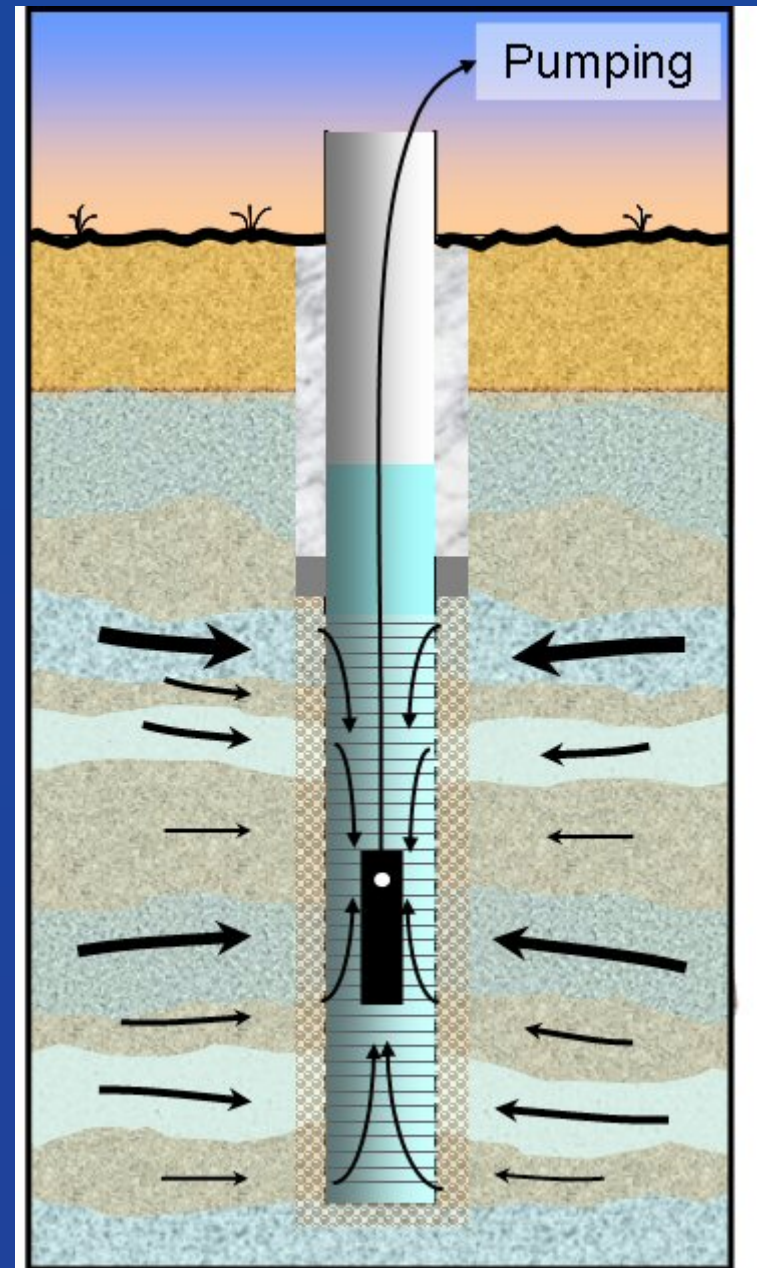
Traditional and Low Flow Purging
Static vs. _Dynamic_
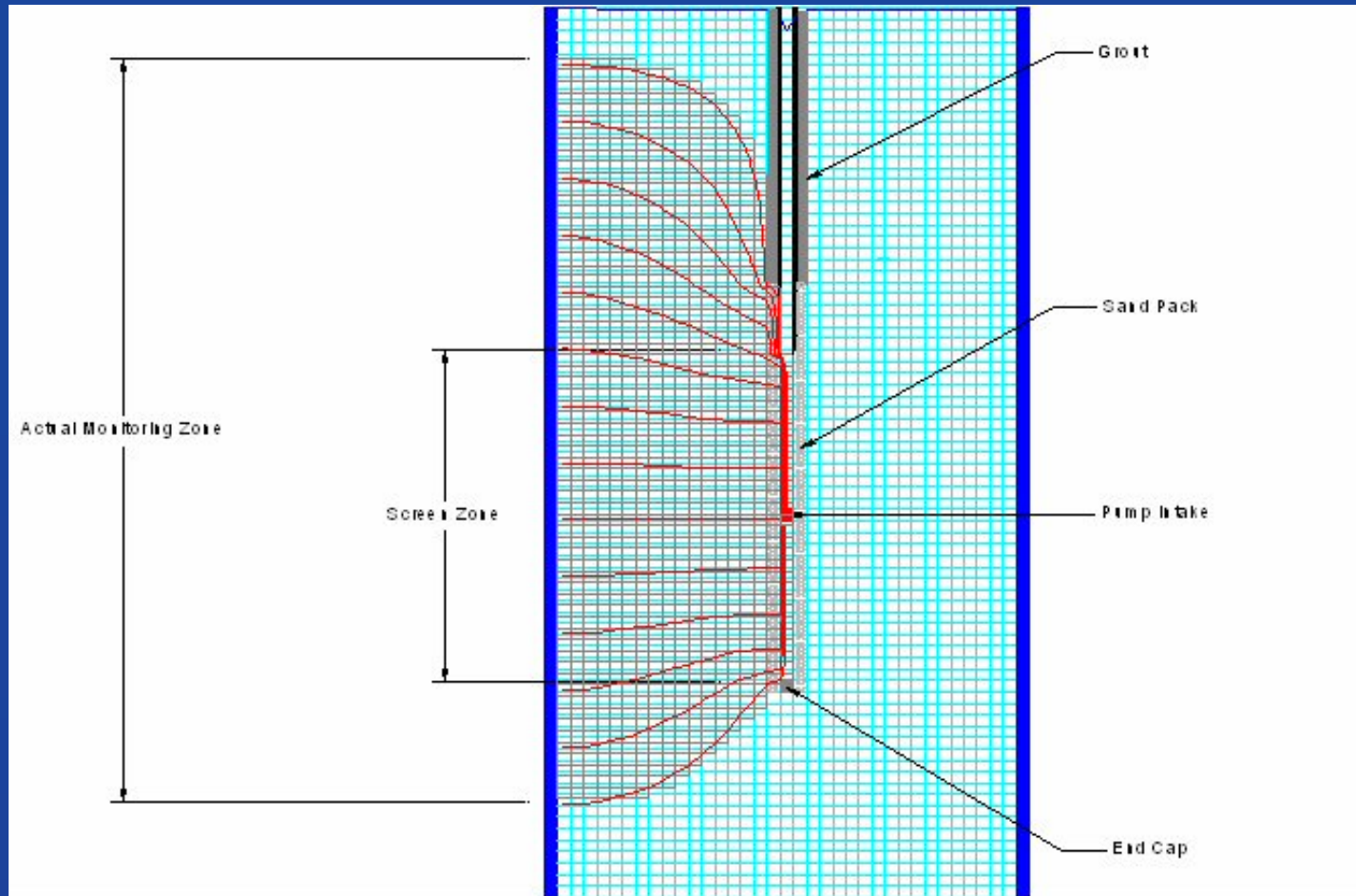
Varljen, _et al._, 2006, Numerical Simulations to Assess the Monitoring Zone Achieved during Low-Flow Purging and Sampling, GWMR, 26: p. 44-52

Analysis of

Steady-State

purging

Hydraulics controls flow, including water coming from beyond the screen zone

But **purge time** controls what water discharges from the pump

Purge Equilibration

## Stability parameters monitored...

Achieving "stability" depends on:

▽ Pre-purge well stratification
▽ Stratification in the aquifer
▽ <u>Inflow characteristics</u>
▽ Shadow effects in the aquifer
▽ <u>Density effects</u>

▽ <u>Stability criteria</u>
   ▽ Barn door (e.g. 10%)
   ▽ Reasonable measures (EC or ORP +/- 10 units, without directional drift)
▽ <u>How often you measure</u>

This is what "Stability" looks like

Pumping
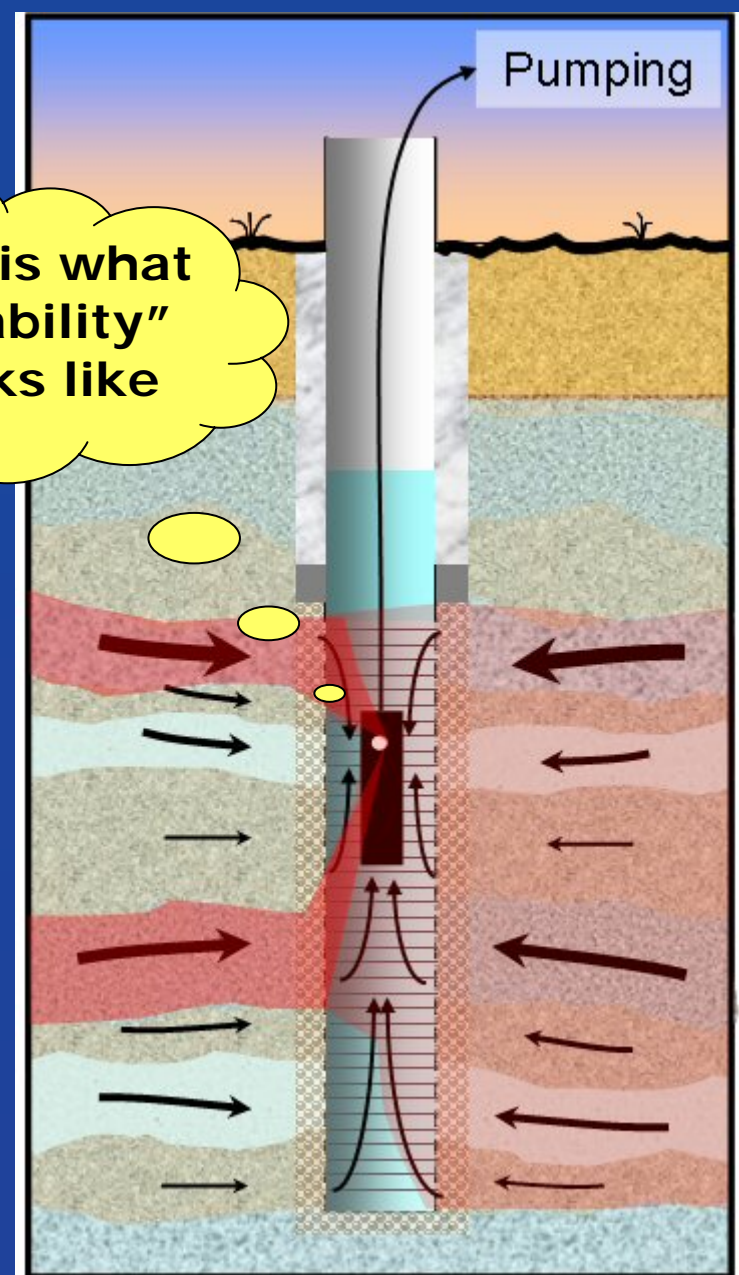
How long does purge equilibration take?

- 🔴 **Not too long?**
- 🟢 **???**

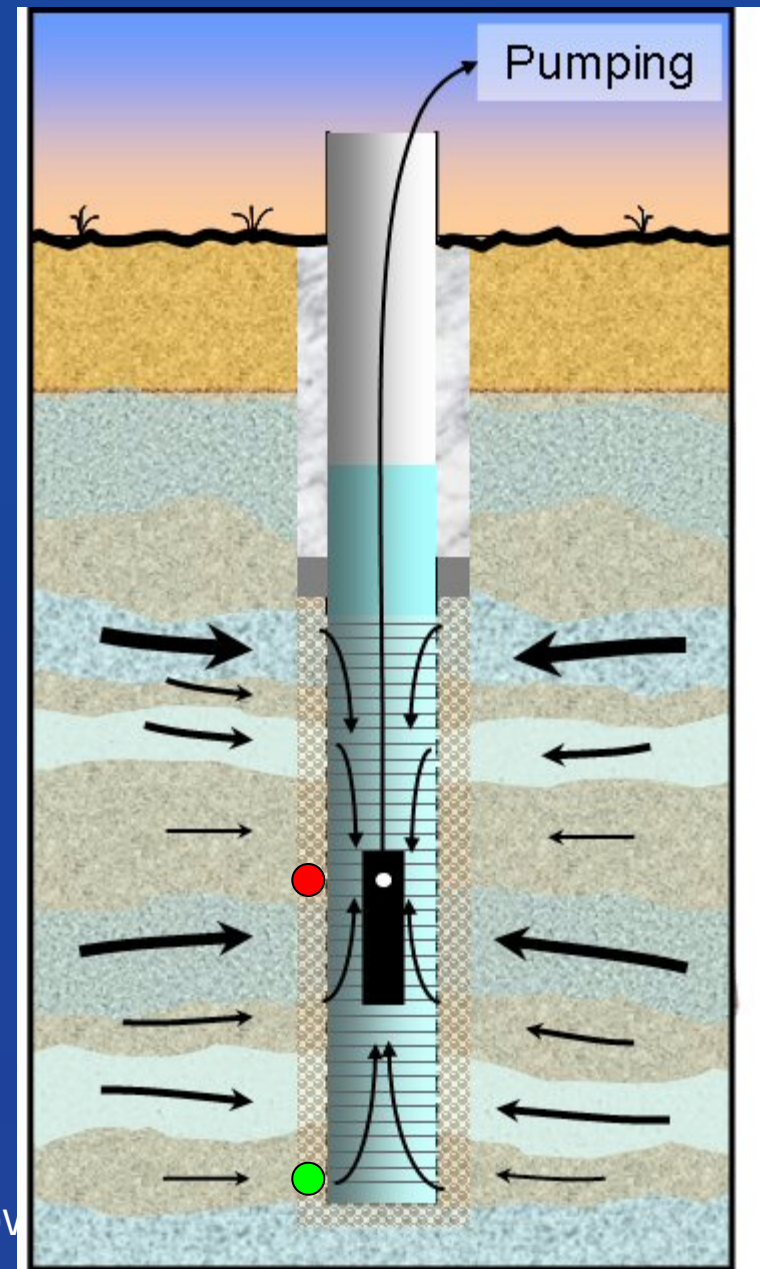Achieving true "stability" (i.e. **flow-weighted-average**) depends on:

- ▽ Well diameter
- ▽ Well length
- ▽ Pump position
- ▽ Contaminant position
- ▽ Other heterogeneity

Quick Calculation:

4" well, 10 foot screen, pump in the middle, 250 ml/min purge rate

$(2.5L/ft)*5 ft/(0.25L/min) = 50 min$ (plug flow

- 🟢 **>50 minutes**

Pumping

What about Sampling Passively?

What is Passive Sampling?

Sampling without purging
>Deploy in advance
>Relies on "passive" flushing

Examples:
Polyethylene Diffusion Bag sampler (USGS)
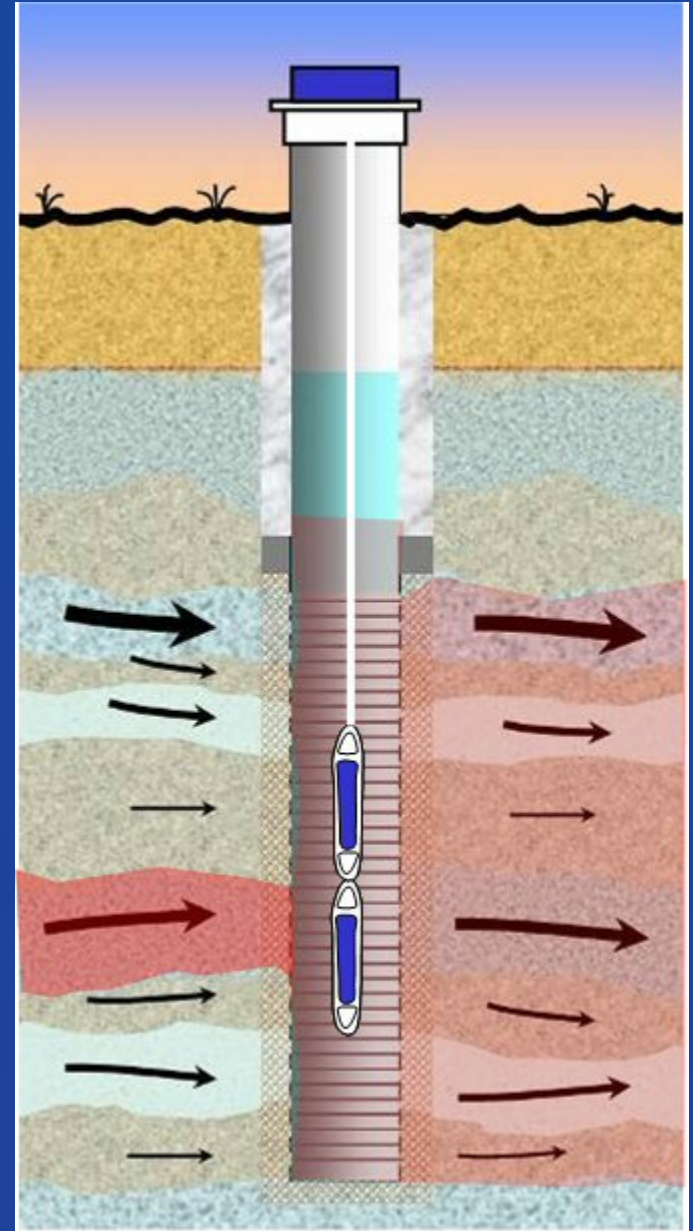Rigid Porous Pipe sampler (USGS)
Dialysis Membrane Sampler (USGS)
Gore Sorber (WL Gore)

Snap Sampler (ProHydro)

Passive Equilibration Can Limit Variables

- **Natural flow delivered to well**

- **Ambient (passive) mixing according to native flow dynamics**

- **Stratification testing?**

- *Sample from same position (the key to consistency)*

The *Snap Sampler* is a *dedicated* passive sampling system

- Deploy double-ended bottles in an open position.

- Sample after short or long residence time in the well— *1-2 weeks or 3 or 6 months*

- Mechanical or electric trigger closes bottles *in situ*.

- *Sample transfer is not required* at the well head for VOCs -No exposure to air

How the Snap Sampler works….

- Load & Set Snap Caps

Insert

40ml

125ml

Set Snap Cap
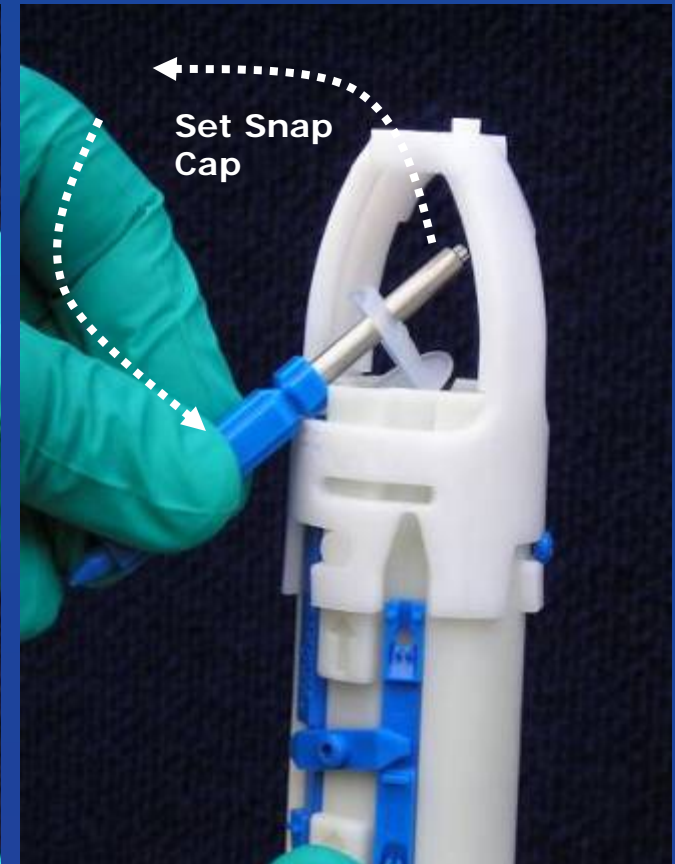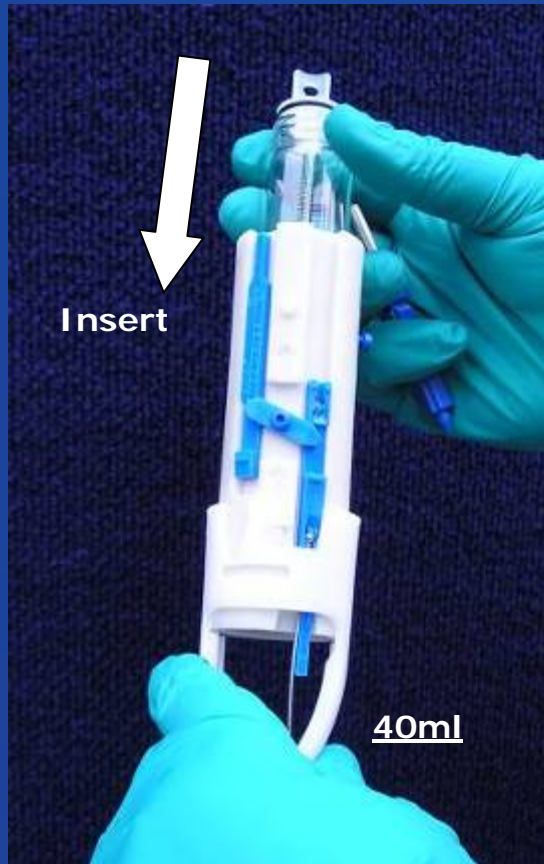
How the Snap Sampler works...continued

- Mechanical or electric trigger

Attach Trigger

Lower downhole

Hang on Dock Ring

Secure

- Modular samplers allow up to 4 bottles per trigger
- Multiple triggers can be used for multiple sampling depths

Seal **in situ**,

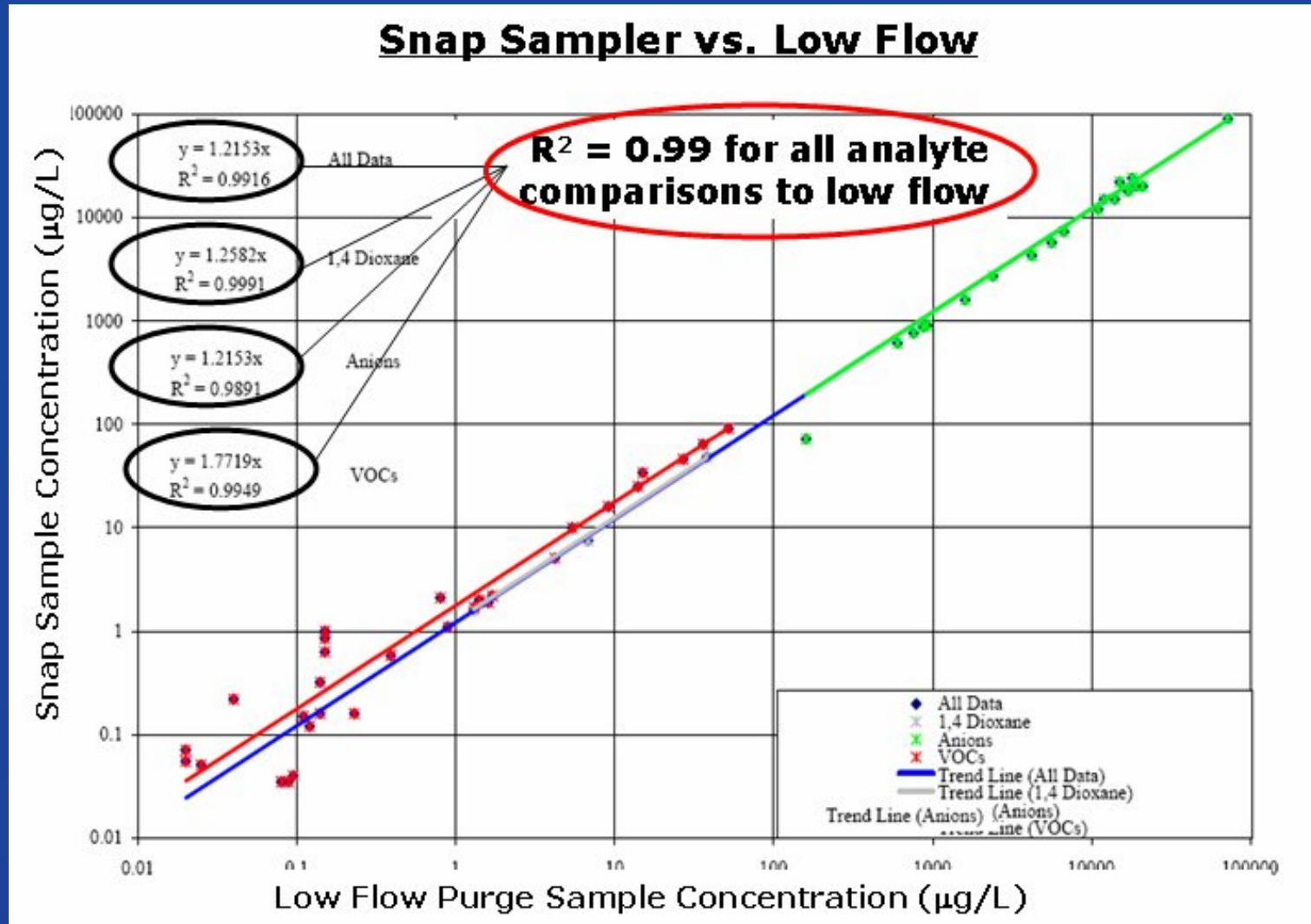### *reduce surface handling*

In Situ*:*

- Sample at the same position each sampling event

- Sample collection takes place submerged in the well

No well-head sample transfer required

Example data

Snap Sampler vs. Low Flow

- • **Very good correlations**
- • **VOCS, 1,4-dioxane, anions**

Parsons, 2005, McClellan Air Force Base, Sacramento, CA

Spotting data trends may depend on consistency of your collection method…

Many variables for purge: actual concentration, pump position, pumping duration, stability criteria requirements, wind, temperature, site surface or ambient air contamination, bottle fill rate, pour technique, speed of bottle closure, filtration, transport, analytical variability.

Fewer variables with _in situ sealed samples:_ actual concentration, transport, analytical variability.

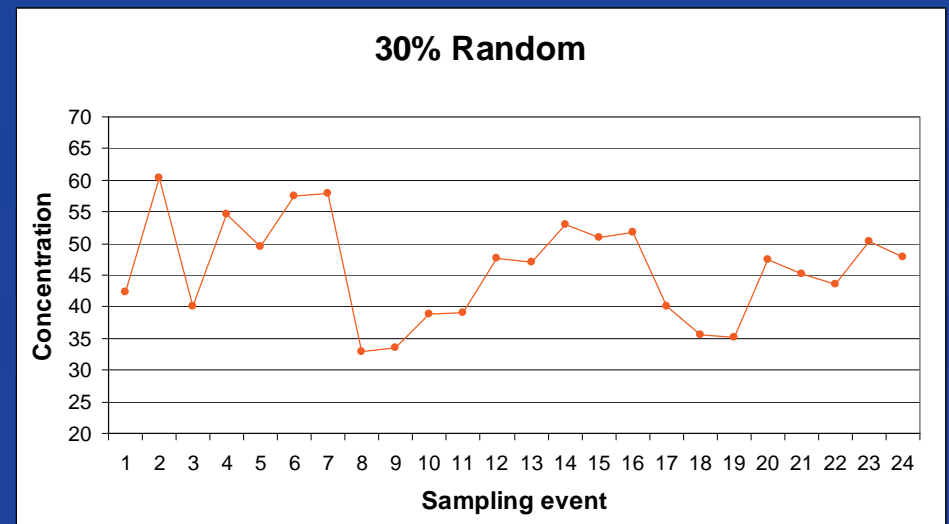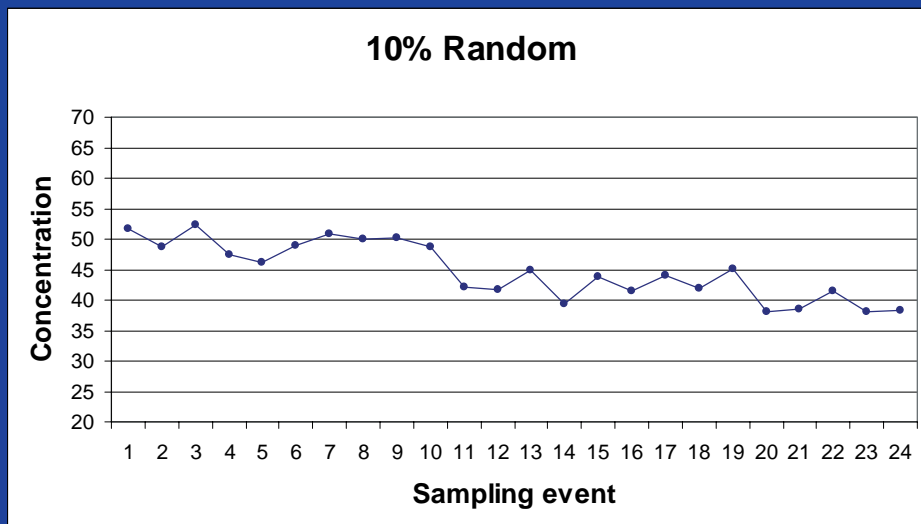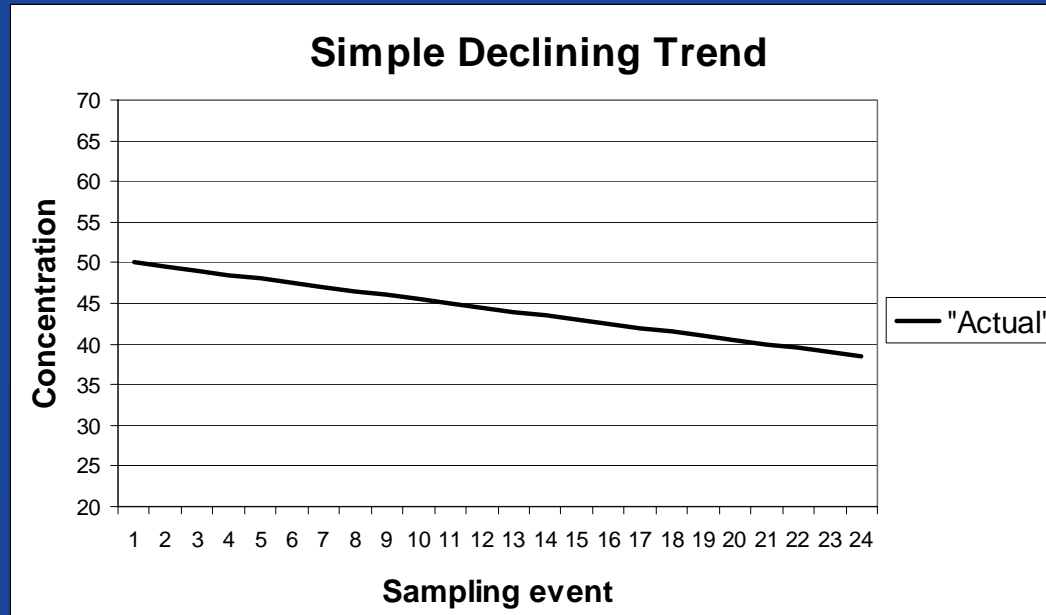# Interpretation of *simple data trends* is easier with less random error

Simple Declining Trend

10% Random

30% Random

Interpretation of *more complicated* data trends is easier with *less random error*

Declining then Increasing Trend
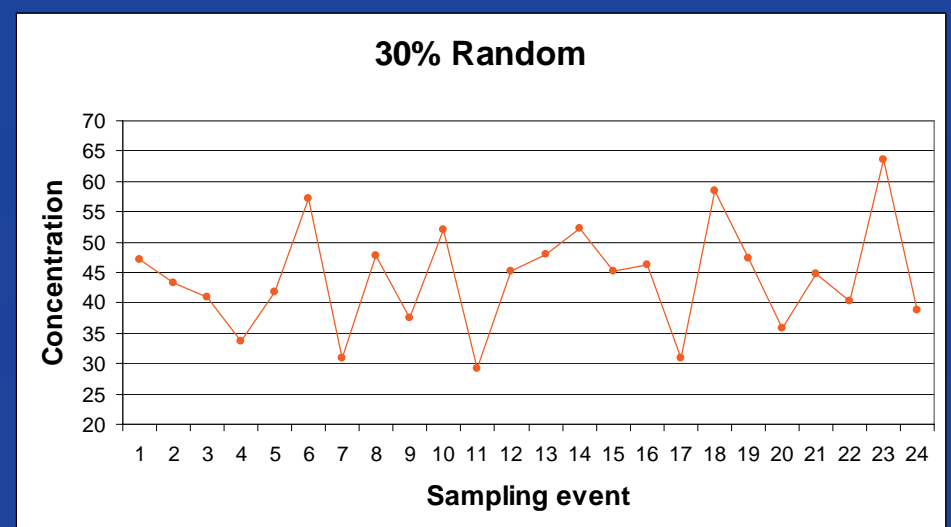

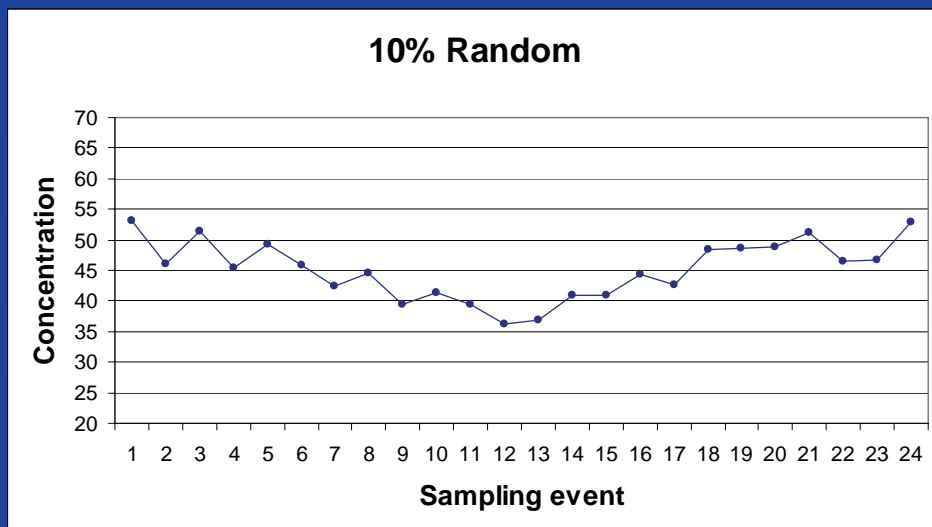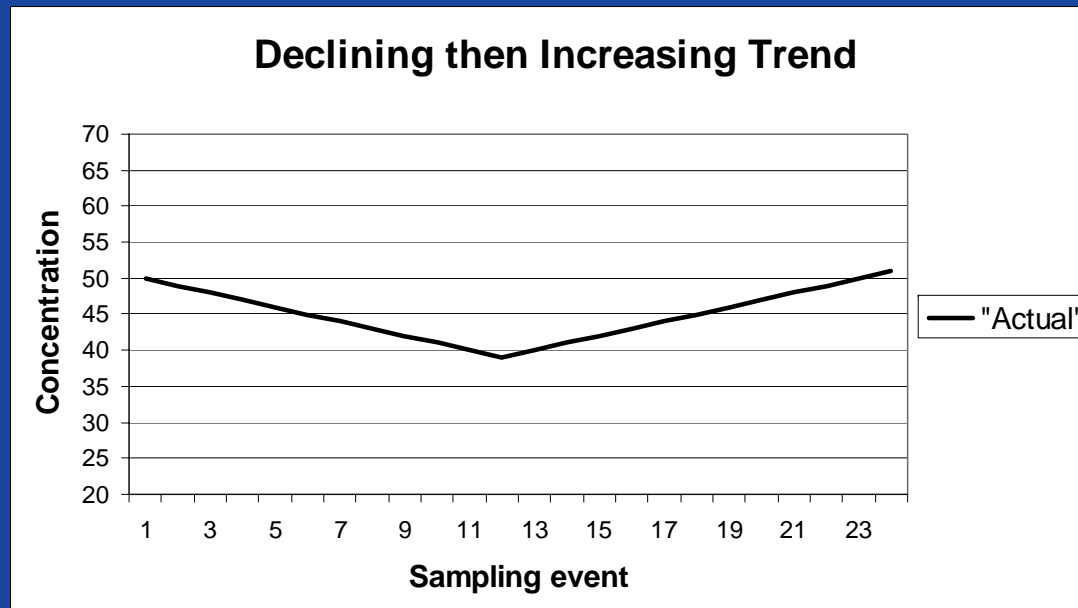## 10% Random

30% Random

Illustration only, not site data

Interpretation of *very complicated* data trends is easier with *less random error*

TCE Example, site in Southern California
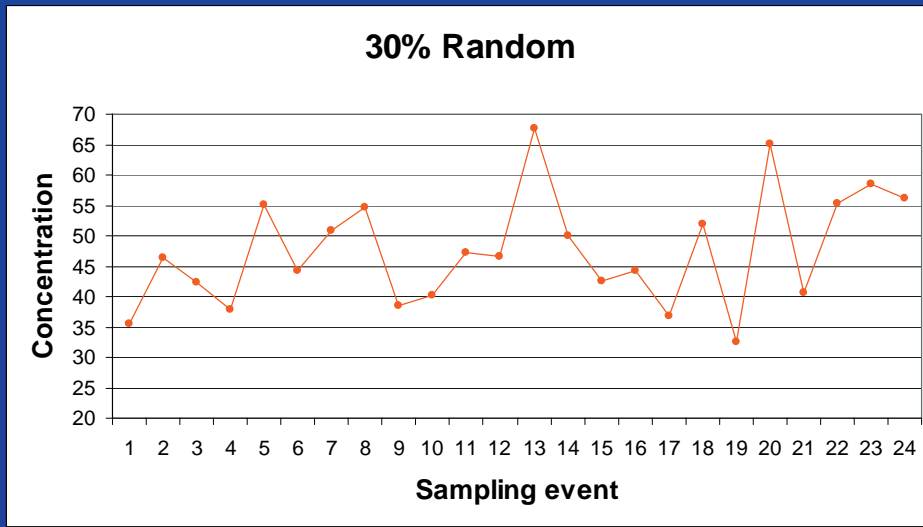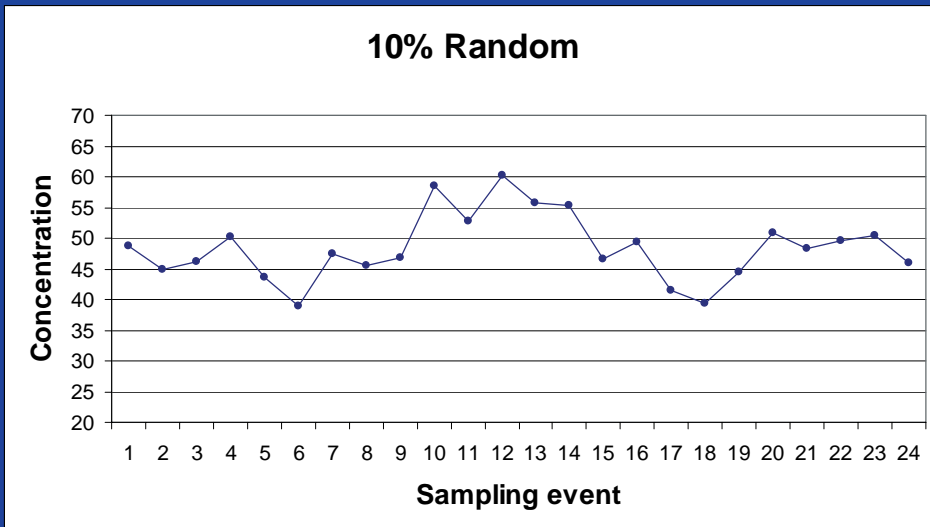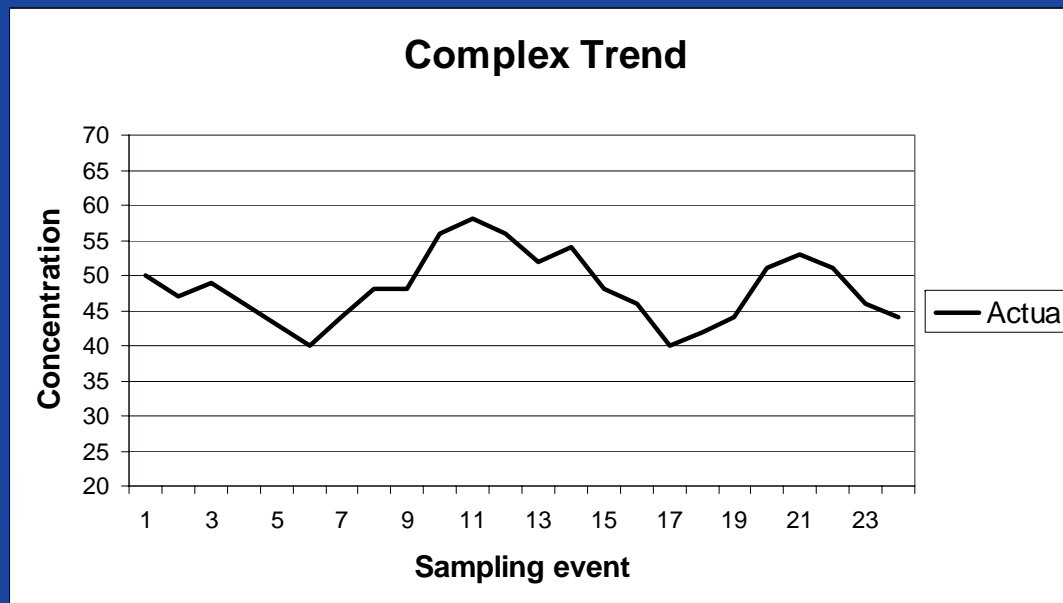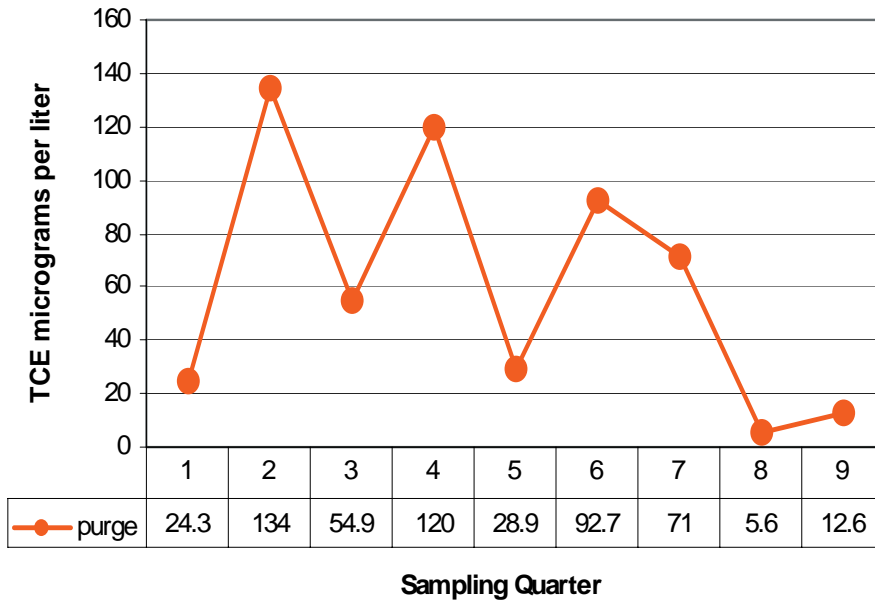
Purge

Pump purge and bail sample

Sampling Quarter	1	2	3	4	5	6	7	8	9
purge	24.3	134	54.9	120	28.9	92.7	71	5.6	12.6

TCE micrograms per liter

Range: **5.6 to 134**
Avg. RPD Q to Q: **100%**
Median RPD Q to Q: **94%**

Sealed *in situ*

Passive Snap Sample

Sampling Quarter	1	2	3	4	5	6	7	8	9
Snap	56.9	72.6	64.1	103.0	39.7	65.6	40.9	50.8	50.4

TCE micrograms per liter

Range: **39.7 to 103**
Avg. RPD Q to Q: **36%**
Median RPD Q to Q: **35%**

Private site, unpublished data

TCE Example, Quarter to Quarter change

TCE data superimposed

Sampling Quarter	1	2	3	4	5	6	7	8	9
Snap	56.9	72.6	64.1	103.0	39.7	65.6	40.9	50.8	50.4
purge	24.3	134	54.9	120	28.9	92.7	71	5.6	12.6
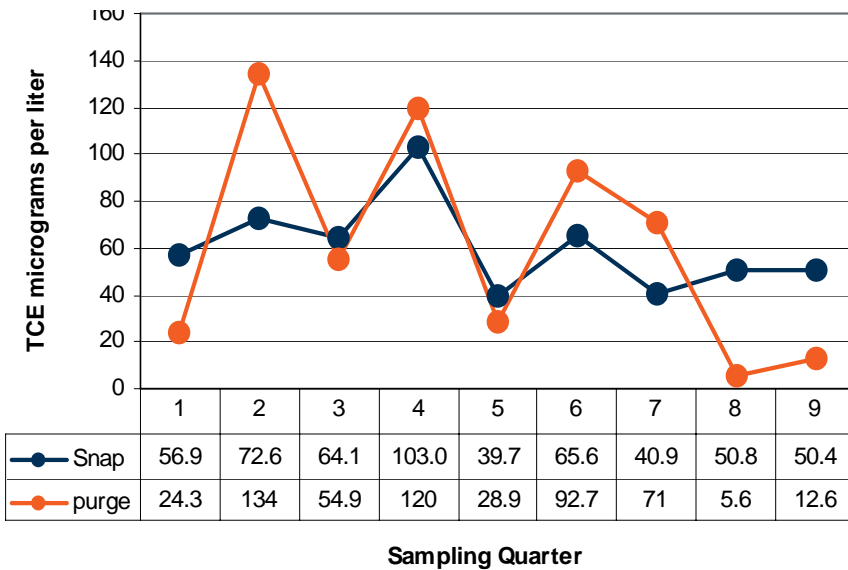
Quarter to Quarter Relative Change

Snap Sample — Pump Purge
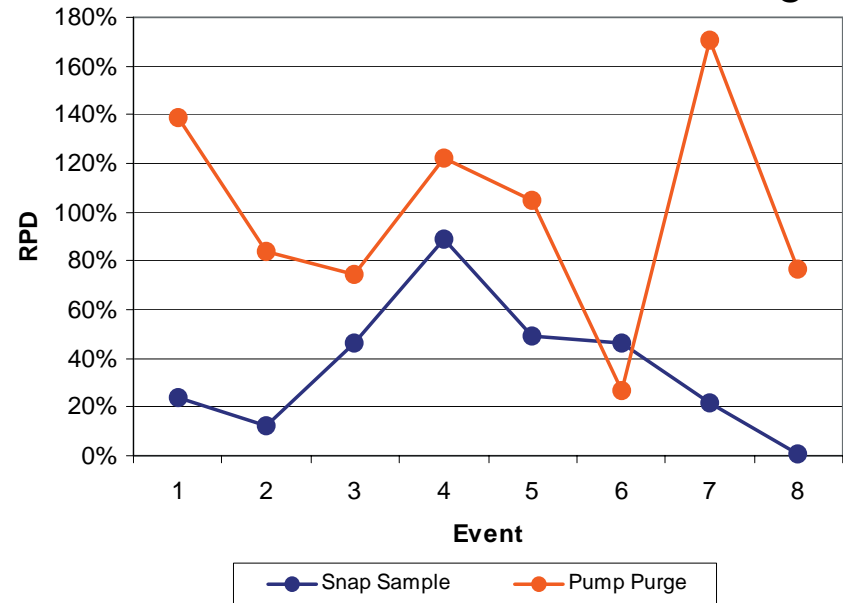
- **Directional dynamic unchanged**
- **Quarterly concentration change less exaggerated**

Overall statistics indicate differences in methods:

Purge

n = 100 comparison pairs

Mean RPD Q to Q: 66%

Median RPD Q to Q: 51%

Mean % change Q-Q: 298%

Median % change: Q-Q: 71%

Sealed *in situ*

n = 81 comparison pairs

Mean RPD Q to Q: 48%

Median RPD Q to Q: 37%

Mean % change Q-Q: 138%

Median % change: Q-Q: 55%

Note: differences include the underline actual changes in concentration...

Summary

Harbec Plastics   Ontario, New York

"Technical Innovation with Environmental Responsibility"

- Reduced variation possible through consistent downhole passive sampling method

- *In Situ* sealed samples avoid error from surface handling

- Passive method adds consistency by avoiding variables introduced during purge step

- Data trend more closely reflects downhole condition

www.SnapSampler.com