Poster # 162
Project ER-0630

Demonstration/Validation of the Snap Sampler Passive Ground Water Sampling Device for Inorganic Analytes

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Objective

Demonstrate that the Snap Sampler can provide technically defensible analytical data for a wide spectrum of analytes of interest to DoD

Demonstrate the utility and potential cost savings of this technology

Technical Approach

1) Complete proof-of-concept studies (i.e., lab studies)

Previous studies demonstrated applicability of sampler for explosives & VOCs (Parker & Mulherin 2007)

Needed proof for other analytes of interest

i.e., metals, perchlorate & natural attenuation parameters

2) Field studies/demonstrations

- Compare analyte concentrations in samples taken with
  - Snap Sampler
  - Low-flow purging & sampling
  - Diffusion sampler
    - – Passive Diffusion Bag (PDB) sampler
    - – Regenerated Cellulose (RGC) sampler

  Including diffusion samplers allows us to examine role of colloidal-borne contaminants
- Wide spectrum of analytes of interest to DoD

  VOCs, explosives, metals, & natural attenuation parameters
- Five DoD test sites
  - √ Former Pease AFB, NH (US EPA Region 1 site)

    Primarily Arsenic & cations
  - – Port Hueneme, CA (NETTS site)

    Light hydrocarbon spills (MTBE)
  - – Joliet Army Ammunition Plant & Savanna Army Ammunition Depot, IL Explosives
  - – Former McClellan Air Force Base, CA

    VOCs (1,4-dioxane), metals (Cr +6)
  - – Longhorn Army Ammunition Plant, TX

    Perchlorate

Demonstration at Former Pease AFB

Location: Newington & Portsmouth, NH

On a peninsula surrounded by Great Bay, Little Bay & the Piscataqua River

Geology:

Unconsolidated units: Fill, Upper Sand, Marine Clay & Silt, Lower Sand, & Glacial Till

Bedrock: Kittery or Elliot formation

Monitoring wells used in the study:

Eight 4-in. diameter PVC wells

Six 10-ft screens, one 5-ft screen, two 15-ft screens

Bottom of wells ranged from 13' to 60' bgs

Area 13 Bulk fuel storage area
1 overburden well
1 bedrock well

Area 32 Building 113 UST
3 overburden wells
3 bedrock wells

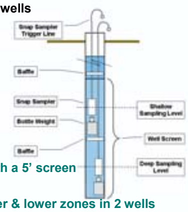
Top of screens were 2' to 35' below the water table

Preliminary Activities for Demo

1) Equipment blanks (pumps, Snap Samplers, & RGC samplers)
2) Redevelop wells
3) Characterize flow pattern in well under ambient & pumped conditions

   Used a heat pulse flowmeter
4) Profile analyte concentrations with depth in wells

   Upper baffle 6" above screen
   Lower baffle at midpoint of screen
   Two Snap Samplers, each at midpoint of upper & lower zones



Flow patterns in wells

Ambient Conditions

No vertical flow in 7 wells

Very slight downward flow in only well with a 5' screen

Pumped Conditions

Nearly equivalent contributions from upper & lower zones in 2 wells

Three (of 4) bedrock wells showed preferential flow

Three wells had significant contributions from shallow portion of well screen (including 2 bedrock wells)

One (bedrock) well had significant contributions from deeper zone

Analyte stratification in wells under ambient flow

Concentration (mg/L)

Well	Depth	As	Ca	Fe	Mg
13-5045	shallow	0.15	67	17	11
	deep	0.14	61	17	12
13-6095	shallow	0.140	29	7.9	6.3
	deep	0.065	28	3.7	5.9
32-5020	shallow	0.15	190	9.8	44
	deep	0.25	230	160	82
32-6008	shallow	0.066	65	1.5	24
	deep	0.057	69	1.2	24
32-6064	shallow	0.11	150	2.6	42
	deep	0.03	140	0.2	40
32-6135	shallow	0.022	3.7	2.1	1.6
	deep	0.021	4.5	2.9	1.6

Samples from well 32-5020

For most wells, there was no substantial difference in analyte concentrations in wells

Differences in concentrations in samples from well 32-5020 were due to differences in turbidity

Based on data, we predict that there will be little difference in analyte concentrations in low-flow & Snap Sampler samples

Experimental Methods for Field Demonstration

Ten sampling events

Two wells sampled twice

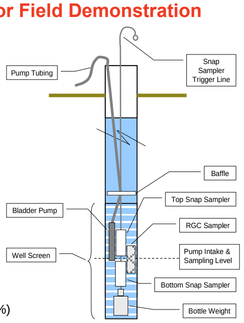
Samplers deployed (at same depth)

2 Snap Samplers
1 RGC sampler
¾-in. bladder pump
w/ baffle and weight

Deployment time 14 - 17 days

Samples collected

Snap Sampler
filtered & unfiltered
RGC sampler
Low-flow Purging & Sampling
filtered & unfiltered
QA/QC samples
Field duplicates (10%)
Matrix spikes & MSDs (5%)



Experimental Methods continued

Sampling order

First two wells (32-6064, 32-5020)

Snap (left in well), RGC, & low-flow, & recover Snap

However turbidity in wells was a problem

All remaining wells

Snap (left in well), low-flow, RGC, & recover Snap

Chemical Analyses

EPA Method 6020B, ICP/MS

Data Analyses

For each analyte, concentrations in Snap Sampler were compared with concentrations in the low-flow samples & RGC samples

Both filtered & unfiltered samples were compared with the RGC samples

Statistical Analyses

Repeated Measures ANOVA (RM-ANOVA) test for normally distributed data with homogeneous variances or

Freidman RM-ANOVA test (non-parametric)

Results from demonstration

Concentration Ca (mg/L) in each well– unfiltered samples

Well #	Low-flow	RGC	Snap
13-5045	72	71	66
13-6095	42	43	41
32-5020	230	250	190
32-5020	150	130	150
32-5031	75	86	97
32-5076	58	58	53
32-6008	98	98	100
32-6064	170	170	180
32-6064	110	110	110
32-6135	4.3	4.4	5.1
Mean	**101**^{a}	**102**^{a}	**99**^{a}

No statistically significant difference between mean values with same letter

Results for Unfiltered Low-Flow & Snap Samples vs. RGC Samples

Mean Conc. (mg/L) for 10 sampling events

Analyte	Range % RSD*	*Unfiltered* Low-flow	RGC	*Unfiltered* Snap
As	0-3.8%	0.086^{c}	0.090^{c}	0.10^{c}
Ca	0-4.9%	101^{c}	102^{c}	99^{c}
Fe	0-12%	3.8^{c}	4.2^{c}	7.4^{d}
Mg	0%	27^{c}	27^{c}	27^{c}
Mn	2.7-5.7%	1.8^{c}	1.9^{c}	1.9^{c}
K	3.1-6.4%	6.7^{c}	6.7^{c}	7.0^{c}
Na	2.0-10%	77^{c}	68^{c}	66^{c}

* For field duplicates

No statistically significant difference between mean values with same letter

Findings for unfiltered samples

No statistically significant difference between concentrations in Snap Sampler & low-flow samples, with exception of Fe

No statistically significant difference between concentrations in RGC & low-flow samples

Pore size of RGC sampler (0.002μ) would exclude all but smallest of colloids

Would expect a lower conc. of analytes if colloidal transport was involved

Therefore, we concluded that colloidal transport of these analytes is not an important mechanism at this site

Results for filtered Low-Flow and Snap Sampler Samples vs. RGC Samples

Mean Conc. (mg/L) for 10 events

Analyte	Range of % RSD*	*Filtered* Low flow	RGC	*Filtered* Snap
As	0-2.6	0.055^{a}	0.090^{b}	0.045^{a}
Ca	1.7-5.1	100^{a}	102^{a}	103^{a}
Fe	0	1.1^{a}	4.2^{b}	1.2^{a}
Mg	4.4-9.3	27^{a}	27^{a}	27^{a}
Mn	1.8-3.3	1.9^{a}	1.9^{a}	1.9^{a}
K	4.0-4.4	6.8^{a}	6.7^{a}	6.7^{a}
Na	0-11	74^{a}	68^{b}	$69^{a,b}$

*For lab duplicates

Findings for filtered samples

No statistically significant difference between concentrations in Snap Sampler& low-flow samples

No statistically significant difference between concentrations in RGC & low-flow samples, with the exception of As, Fe, & Na

Believe these differences are due to how samples were handled

Low-flow & Snap Sampler samplers were filtered in lab

This gave too much time for oxidation/precipitation reactions to occur with Fe, & the As was then co-precipitated by iron oxides

Conclusions

Snap Sampler shown to be able to recover equivalent concentrations of inorganic analytes vs. those recovered using low-flow sampling

True for both filtered and unfiltered samples, with possible exception of unfiltered Fe

True for both bedrock and overburden wells

What is next?

Former Pease AFB

√ Former McClellan AFB

Analytes include VOCs (1,4-dioxane) & metals (Cr 6+)

Port Hueneme Light hydrocarbons (MTBE)

Longhorn Army Ammunition Plant (AAP) Perchlorate

Joliet Army Ammunition Plant & Savanna Army Ammunition Depot, IL

Explosives

Where can I find additional information on passive sampling?

At the ITRC website
http://www.itrcweb.org

References

Parker, L. V., and N.D. Mulherin. 2007. *Evaluation of the Snap Sampler for sampling ground water monitoring wells for VOCs and explosives*. US Army Engineer Research & Development Center Cold Regions Research & Engineering Laboratory Technical Report ERDC/CRREL TR-07-14

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