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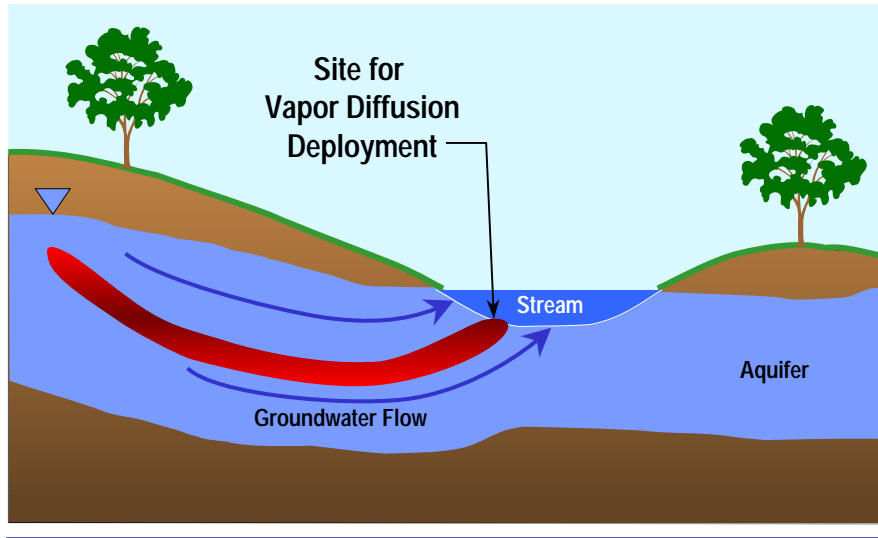
Alternate and New Approaches in Passive Sampling Technology

Don A. Vroblesky

Passive Vapor Diffusion Sampler



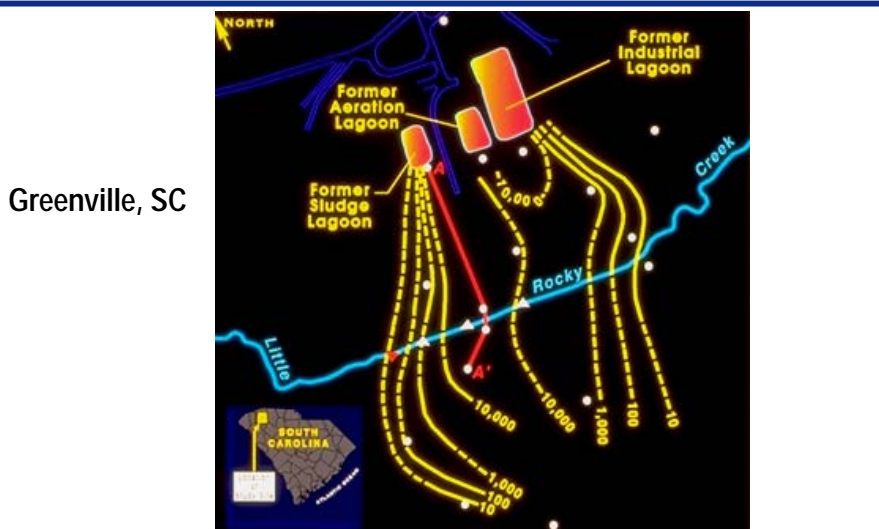
Contaminated Groundwater Discharge to a Stream



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Distribution of VOCs in Fractured-Rock Aquifer

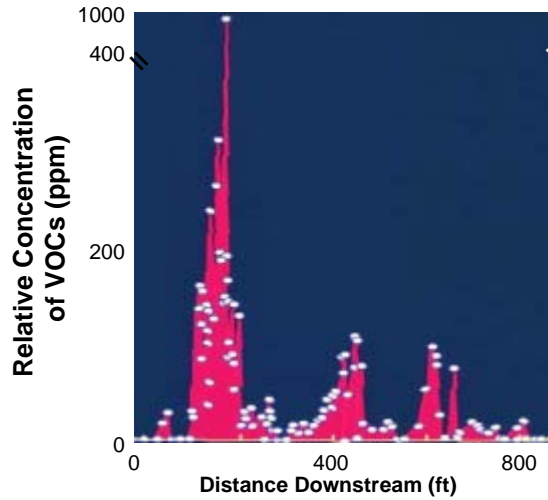


Greenville, SC

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VOCs in diffusion samplers at Little Rocky Creek, SC



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VOCs in diffusion samplers at Little Rocky Creek, SC

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



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Plan View of Little Rock Creek

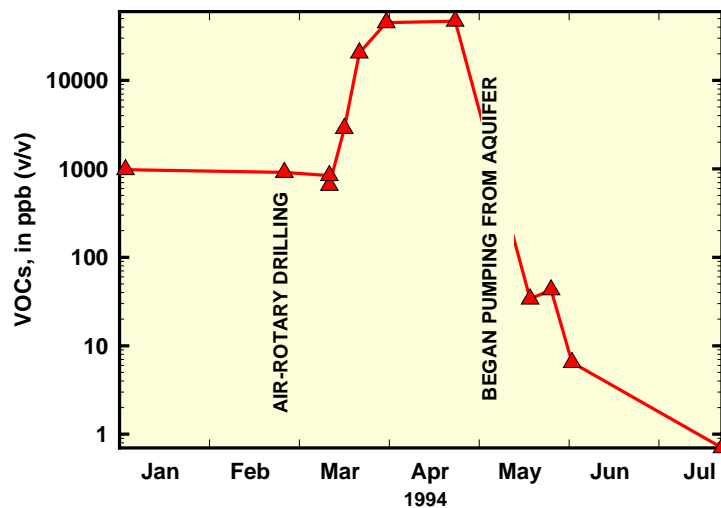
Greenville, SC



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VOC Changes in Diffusion Samplers, Little Rocky Creek



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TNX Upper Flood Plain

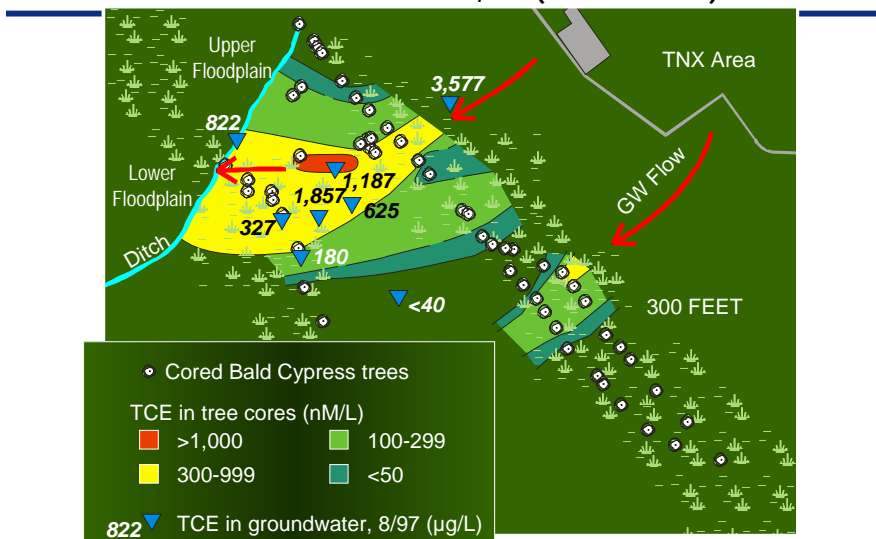


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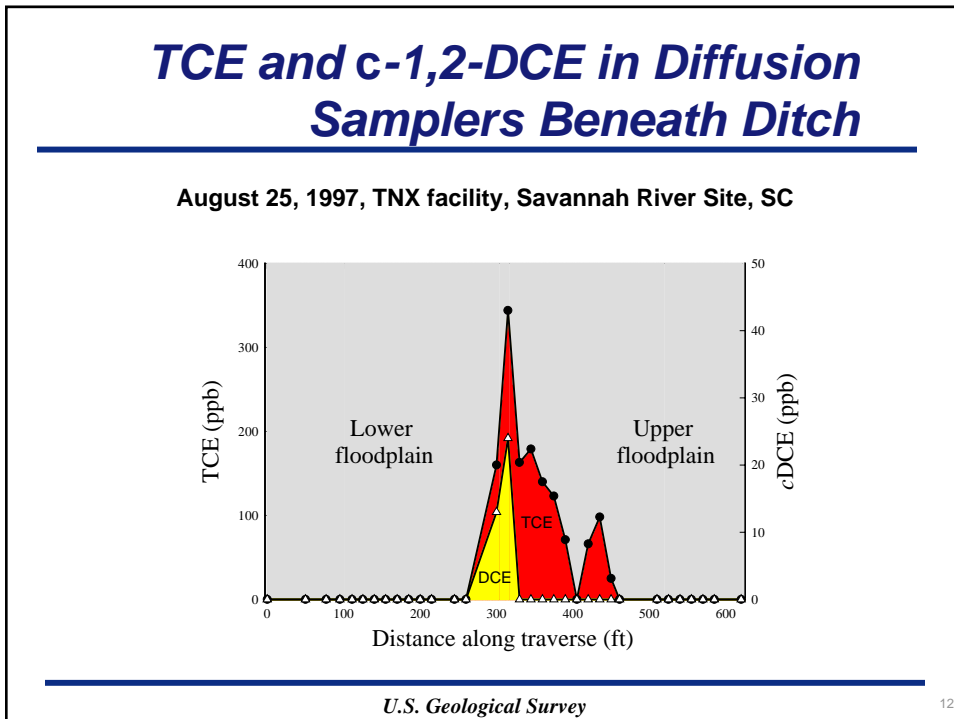
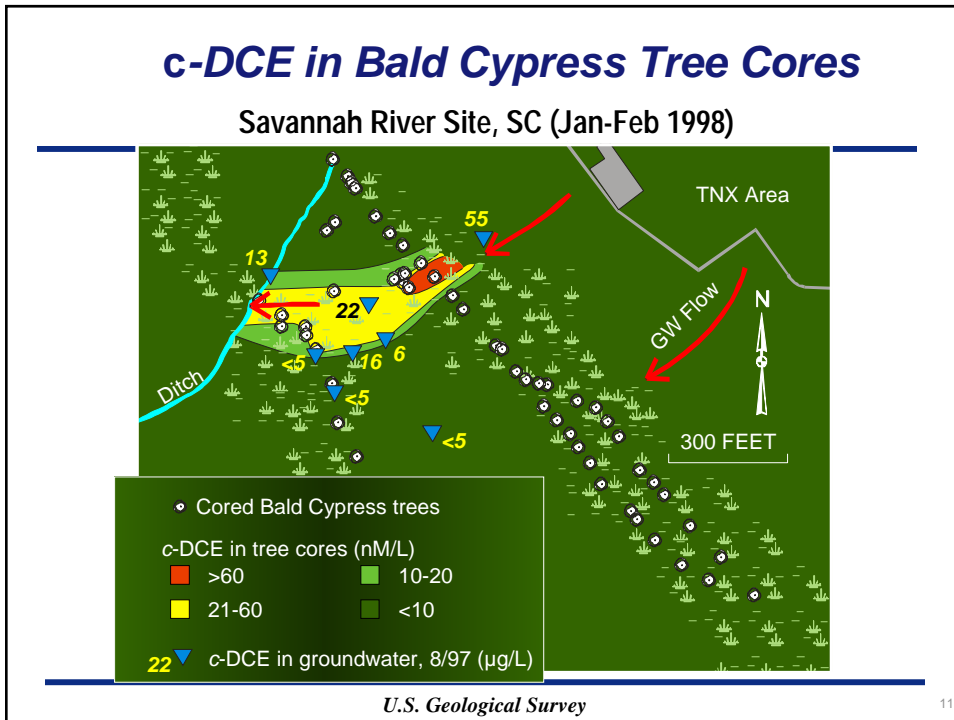
TCE in Bald Cypress Tree Cores

Savannah River Site, SC (Jan-Feb 1998)

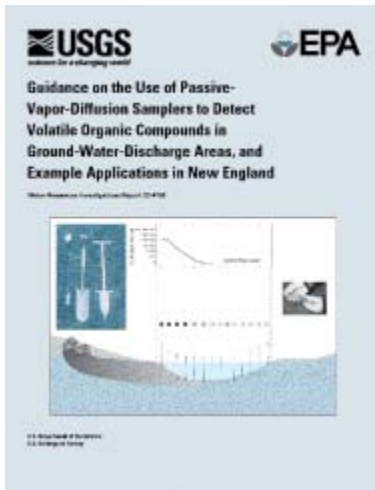


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USER'S GUIDE FOR PVD SAMPLERS



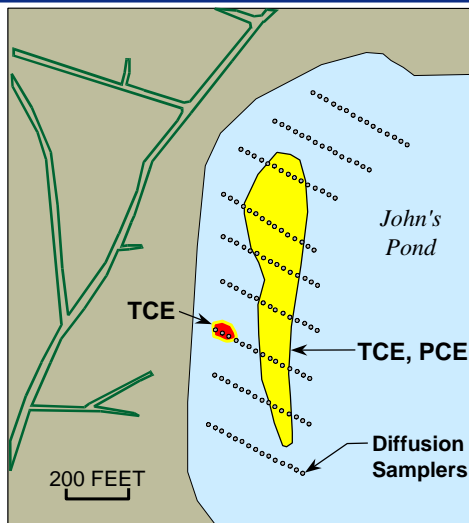
USGS Water Resources
Investigations Report 02-
4186.

Available online at
<http://ma.water.usgs.gov/publications/wrir/default.htm>

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Diffusion Samplers Beneath John's Pond, MMR, Mass.

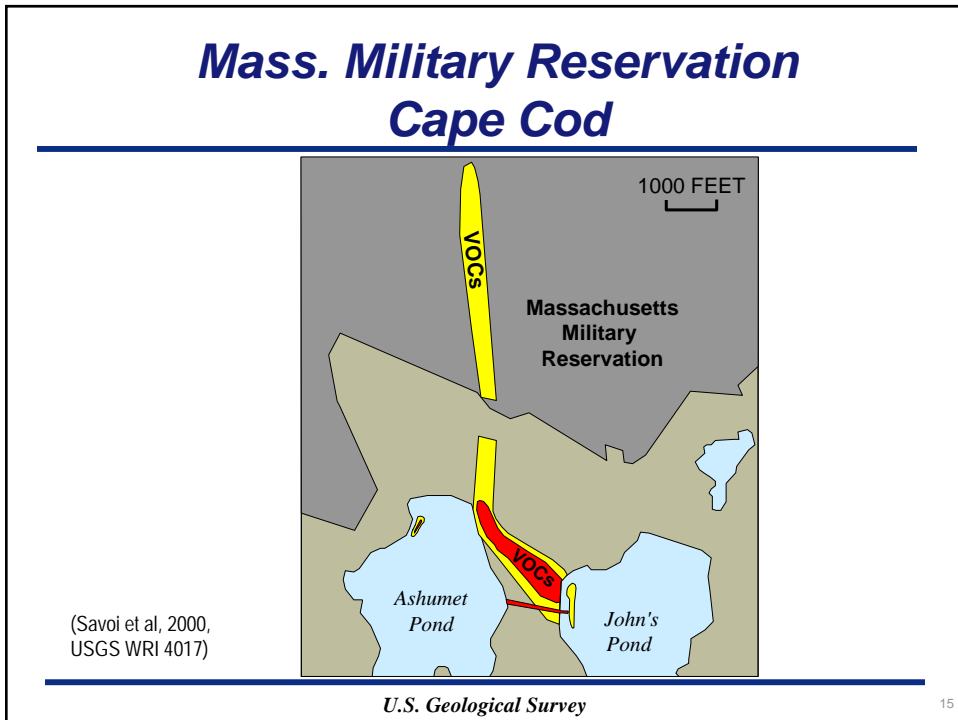


(Savoi et al, 2000,
USGS WRI 4017)

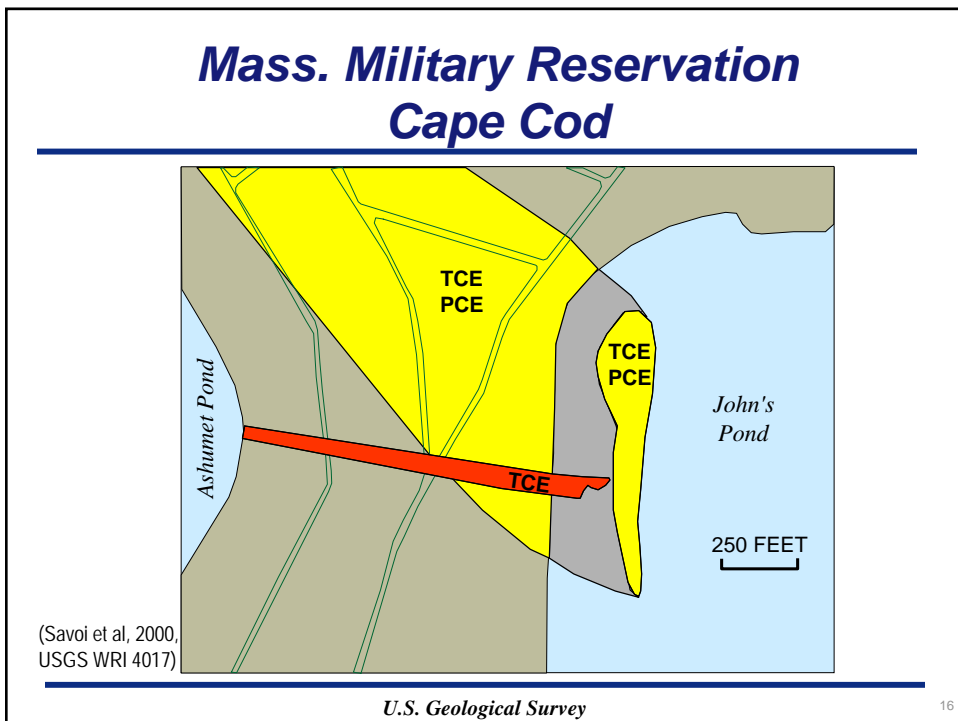
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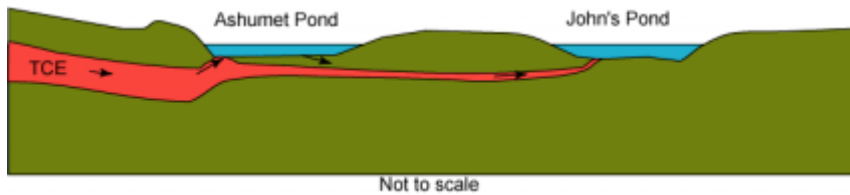
Mass. Military Reservation Cape Cod



Mass. Military Reservation Cape Cod



Probable contaminant transport beneath Ashumet and John's Pond



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Nylon-screen diffusion sampler



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Plastic Jar and Nylon-Mesh Sampler



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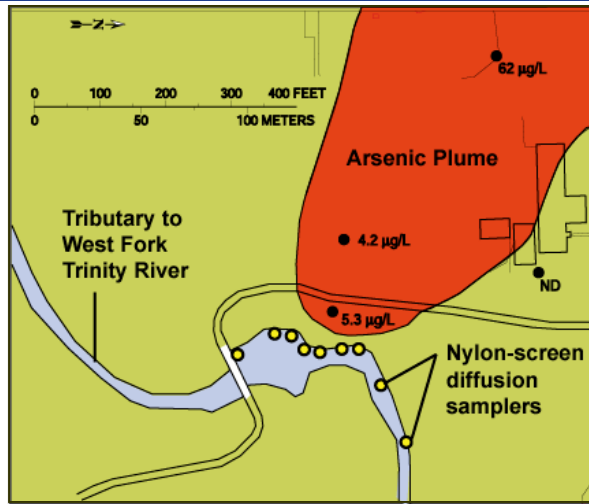
Tributary to West Fork Trinity River, Fort Worth, Texas



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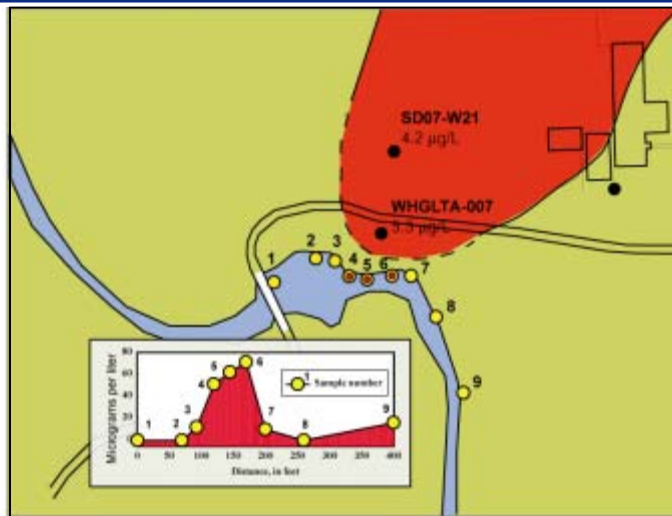
Arsenic in GW. Diffusion Sampler Locations, Ft. Worth, TX



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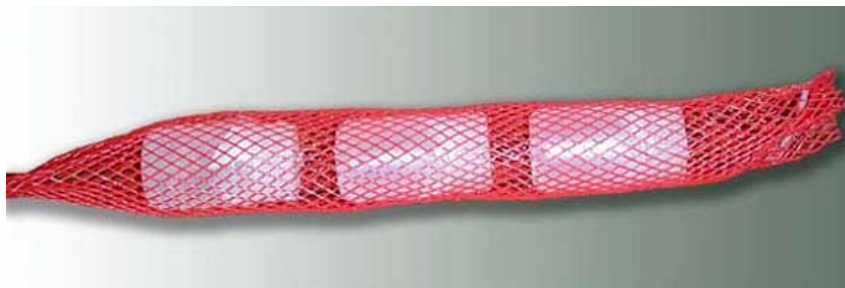
Arsenic in GW (July 1999) and Diffusion Samplers (July 2000), Ft. Worth, TX



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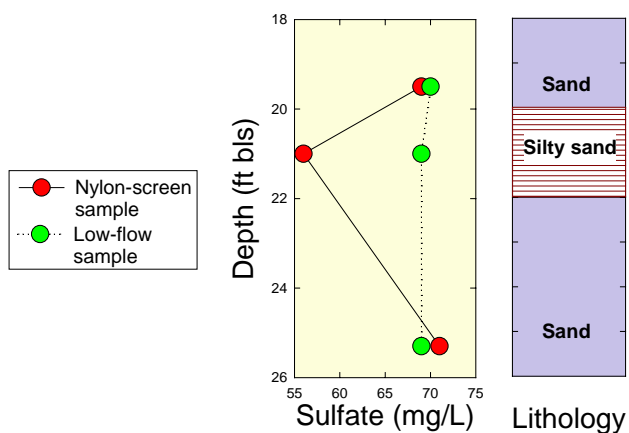
Nylon mesh jars in LDPE tubing



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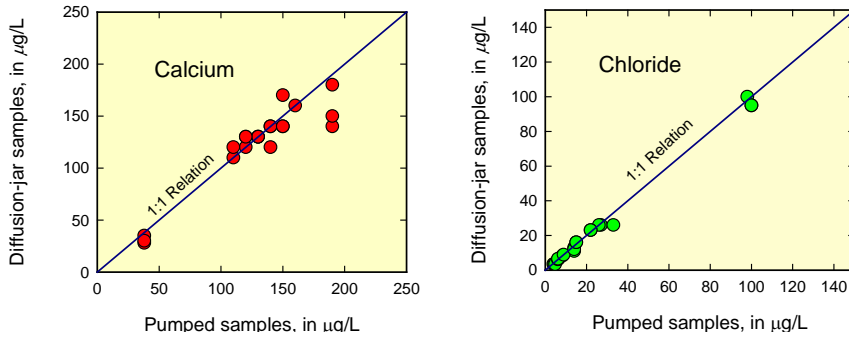
Sulfate in nylon-screen and low-flow samples, NAS Fort Worth JRB, March 2001



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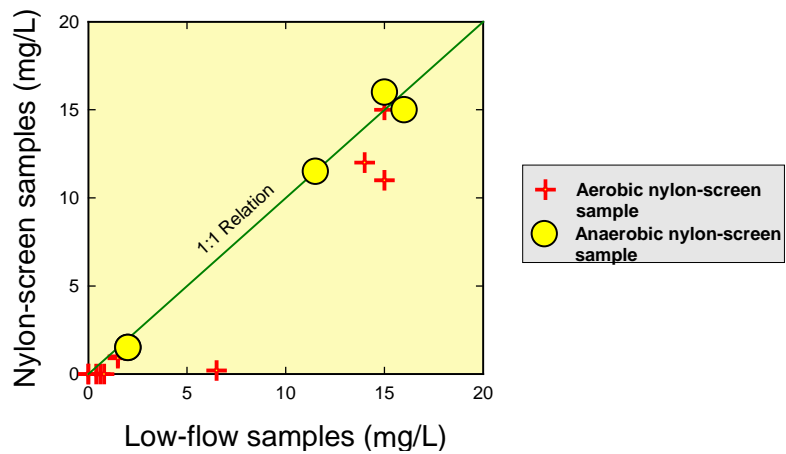
Nylon-mesh diffusion samplers, NAS Forth Worth JRB, March 2001



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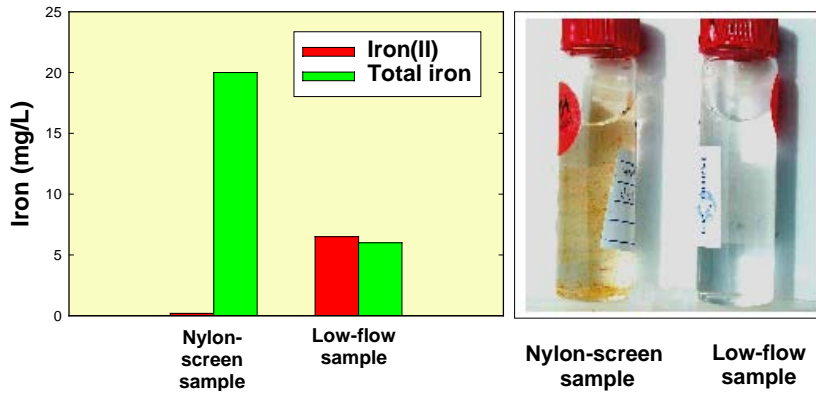
Iron in nylon-screen and low-flow samples, NAS Fort Worth JRB, March 2001



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Comparison of Fe(II) and Fe(total), NAS Fort Worth JRB, March 2001



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Typical types of dialysis membranes

- Cellulose ester or acetate
- Polyvinylidene fluoride (PVDF)
- Polysulfone
- Regenerated cellulose
- Others (ie polycarbonate, polyester)

Membrane Compatibility Table				
	Cellulose Ester	PVDF	Polysulfone	Regenerated Cellulose
Benzene	G	G	N	G
Toluene	G	G	N	G
Xylene	G	G	N	G
PCE	G	G	N	G
TCE	N	N	N	G
CT	G	G	N	G
CF	N	F	N	G
Ethers	N	F	N	G

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Regenerated Cellulose Dialysis

- Used by many researchers since about 1976 in lakebed studies.
- Ronen and others used a multi-level sampler with cellulose-based membranes for dialysis in wells in 1987 – The multilevel sampler later became the commercially available DMLS sampler.
- Tom Imbrigiotta and Ted Ehlike (USGS) tried a simpler configuration in wells with success in the late 1990s.

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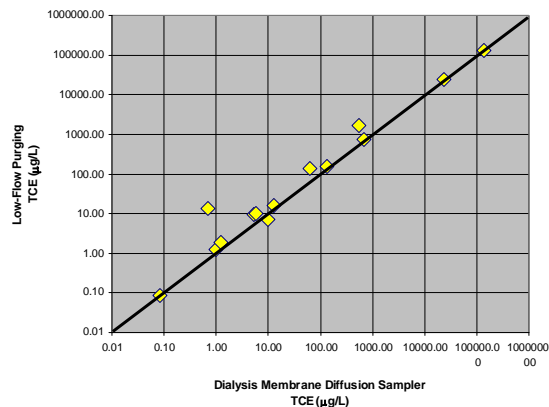
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One type of Regenerated Cellulose Dialysis Sampler



Ted Ehlike, USGS, Trenton, N.J.

Well Sampling Technique Comparison
Trichloroethene, 2002



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Dialysis Bag on Perforated Tube

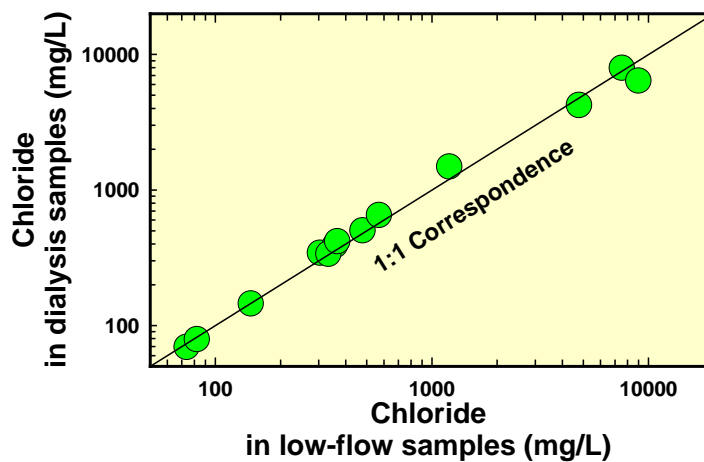


Vroblesky and others, 2002, USGS WRI 02-4031

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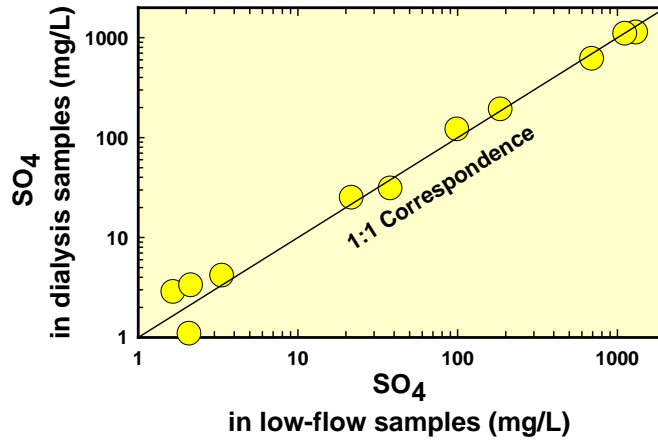
Chloride in dialysis samples and low-flow samples, Hickam AFB, July 2001



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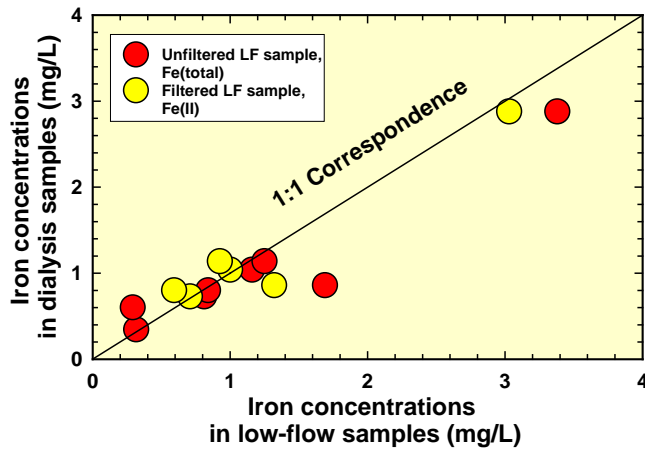
**Sulfate in dialysis and low-flow samples,
Hickam AFB, July 2001**



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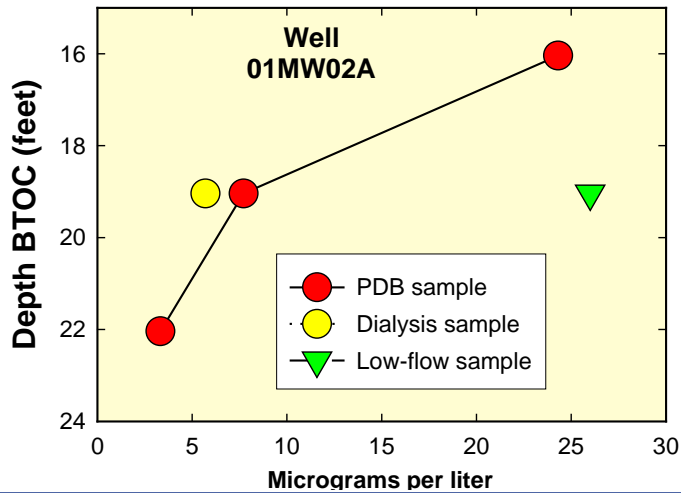
**Iron in dialysis and low-flow samples,
Hickam AFB, July 2001**



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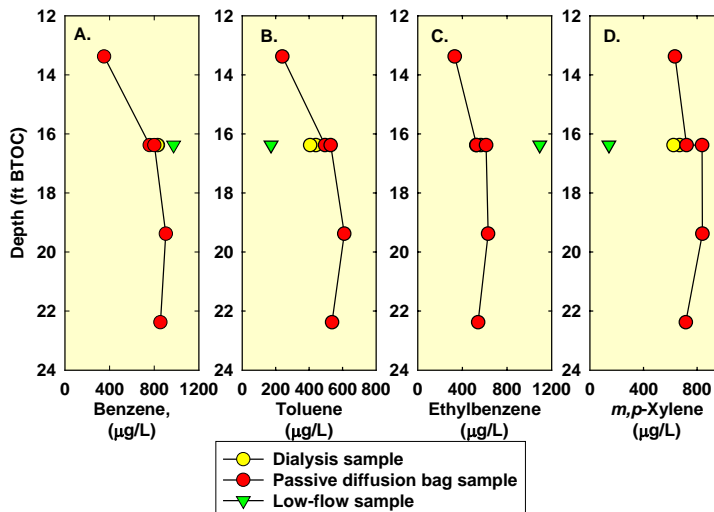
Benzene in dialysis, PDB, and low-flow samples, Hickam AFB, July 2001



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BTEX in dialysis, PDB, and low-flow samples, Well 01MW12, Hickam AFB, July 2001



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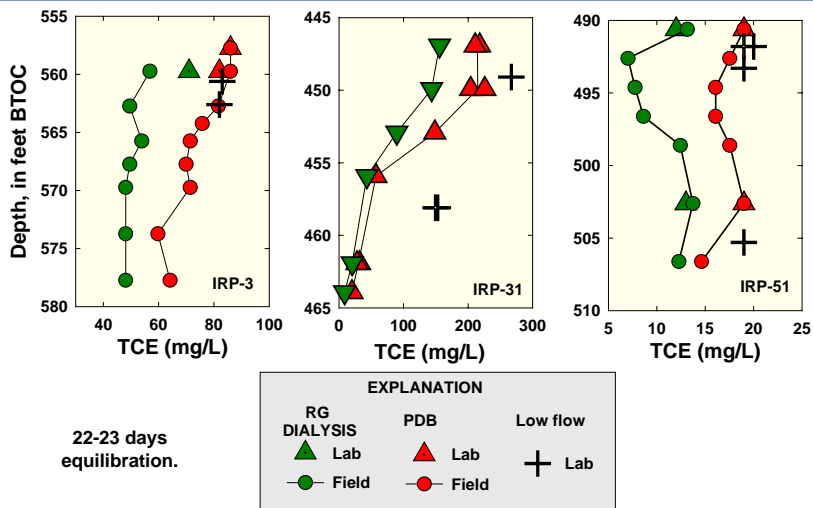
Dialysis membrane with coating after two weeks



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Comparison of Regenerated Cellulose Dialysis and PDB for TCE analysis, Andersen AFB, Guam (April 2002)



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Dry regenerated cellulose dialysis membranes

Available as dry rolls: cheaper (About \$110-180 for a 30-m roll) but requires cleaning

- May contain glycerol, sulfide, and metals
- Cleaning steps
 - Soak in DI water for 15 minutes
 - Heat (80 °C) precut membrane for 30 min while stirring in large container of sodium bicarbonate
 - Soak in Na₂ EDTA solution for 30 minutes
 - Soak and stir in DI water for 30 min at 80 °C
 - Store cooled membrane in refrigerator in a solution of sodium azide, sodium benzoate, or ethanol
 - Before use, wash thoroughly with distilled water and dialysis buffer.

Pretreated regenerated cellulose dialysis membrane

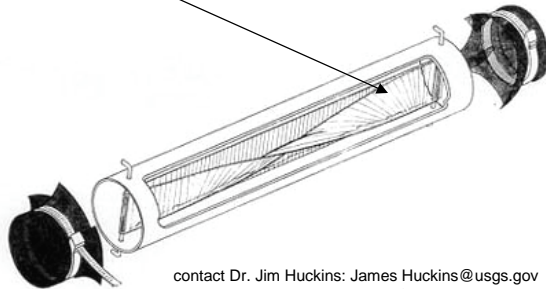
- About \$178 for a 10-M roll
- Pretreated to remove metals and glycerol.
- Cleaning requirements
 - Rinse with distilled water

Semipermeable Membrane Devices (SPMDs)

A HORIZONTAL DEPLOYMENT APPARATUS FOR SPMDs

Designed by Jon Lebo, of CERC

Triolein (lipid) in
sleeve of LDPE



contact Dr. Jim Huckins: James Huckins@usgs.gov
or Dr. Jim Petty: Jim Petty@usgs.gov

Historically used
as a surrogate for
determining
bioconcentration
of organic
contaminants in
fish tissue in
surface water.

Not yet
extensively
tested in
groundwater
applications.

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SUMMARY

- PVD samplers are simple, rapid tools for mapping VOC-discharge zones.
- Diffusion samplers can be used for H₂, organic, and inorganic solutes.
- Types of diffusion samplers include polyethylene, nylon screens, dialysis membranes.
- Dialysis membranes typically require pre-use preparation and not allowing them to dry before use.
- Care must be taken when sampling for iron and other solutes that rapidly react with oxygen because of the potential for precipitation.

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Thank You!