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An Innovative Sampling and Solventless Field Extraction Technique for Determination of Explosives Residues in Groundwater

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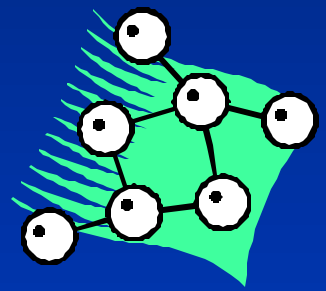
Long Term Monitoring Focus Area

- Long Term Monitoring (LTM) of groundwater :
  - Required component of closure.
  - All military services, other Federal agencies (e.g., DOE), states, and responsible parties share similar responsibility.
  - Costs associated with sampling and laboratory analysis over 10 years estimated to approach $500M.
  - Sample collection and laboratory analysis
    - 70% of the total monitoring cost.
    - 50% of the total investigation cost.

Interim Improvements

- ✓ COT/GOTS
- ✓ QA Processes & Protocols
- ✓ Direct Push Wells & Samplers
- ✓ Solventless Extraction Technologies
- ✓ Solventless Extraction Technologies Interfaced to Miniature GC



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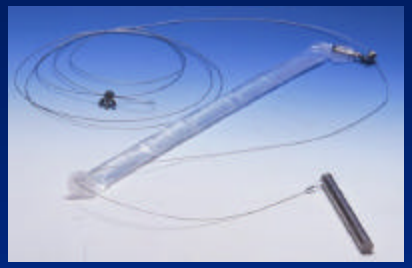
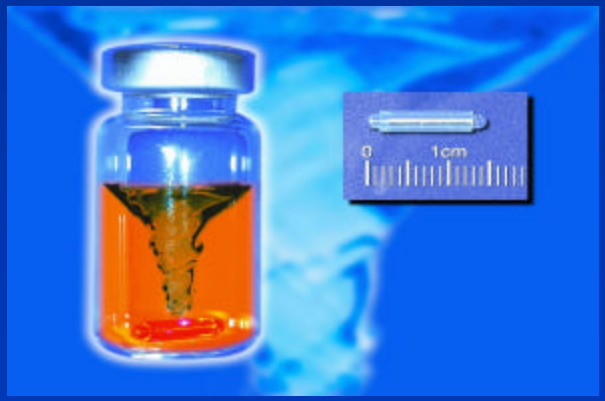
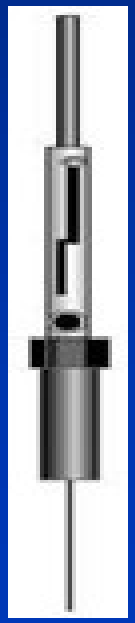
Solventless Extraction Technologies



- ✓ Identify & Develop Solventless Ext Technologies
- ✓ Perform Lab & Field Studies
- ✓ Investigating use of Twister and SPME for ORCs
- ✓ Evaluation of Potential for On-Site Extraction





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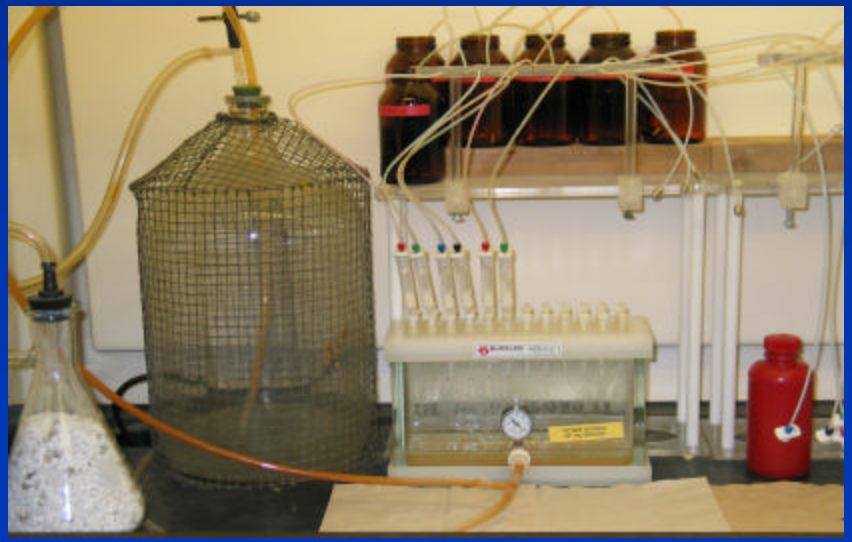
Fixed Lab – Sample Receipt

- Lots of coolers.
- Lots of ice.
- Lots of heavy lifting.
- Lots of sample bottles.
- Lots of time.
- Lots of MONEY! Approximately $500 to ship 20 samples in seven coolers from field to the laboratory via overnight delivery services.

Fixed Lab – Extraction Procedures

- 2 x 1-L amber bottles/sample (44 bottles for 20 samples including QC samples)
- Double salting out procedure – SW-846, method 8330, 1994-1997. Preparation time: 6-8 hours
- Solid Phase Extraction – SW-846, method 3535A, Jan. 1998. Preparation time: 3-5 hours.



Solventless Extraction

- Collect known volume of sample.
- Perform Solid Phase Extraction in the field.
- Send only SPE cartridges to the laboratory for analysis.

ULTIMATE GOAL: SAVE MONEY THROUGH LOWER SHIPPING COSTS.

InSTED

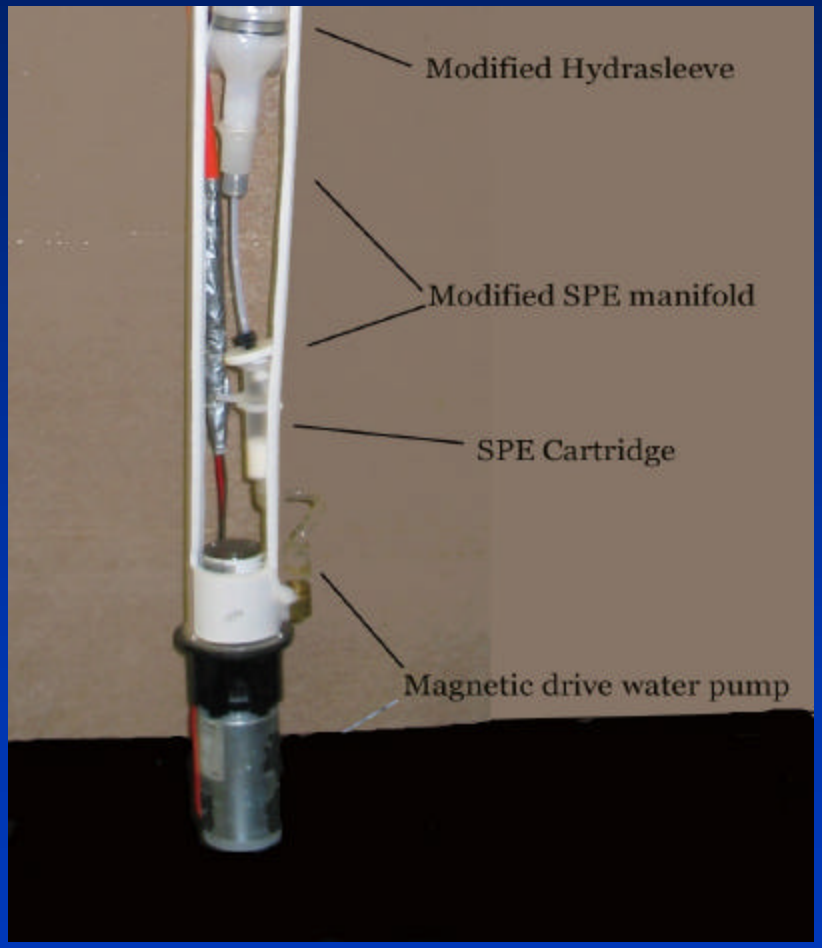
ECB prototype

"*In-Situ* Tubular Extraction Device"

- **Uses a modified HydraSleeve™ for sample collection (EON Products, Inc, Snellville, GA).**
- **SPE cartridge (Porapak RDx, Waters Corporation, Milford, MA).**
- **Submersible pump assembly (Clark Solutions, Hudson, MA).**

InSTED

ECB prototype *In-Situ* Tubular Extraction Device



InSTED

Experimental Design

- Blank Spikes Study
- Real World Composited Samples Study
- Initial Time Study
- Standpipe Study

InSTED

Results for Blank Spike Extraction of Explosives at 10 ug/L (ppb)

	InSTED	Traditional Method 8330
Analyte	% Recovery	Recovery
HMX	82	90
RDX	93	99
Tetryl	106	89
TNT	93	89
2,4-DNT	88	83

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InSTED

Results for Composited Real World Extraction of Explosives

Analyte	InSTED ug/L (ppb)	Traditional Method 8330 ug/L (ppb)
HMX	21.4	21.6
RDX	153	158
4-A-DNT	1.5	1.5
2-A-DNT	0.1	0.1

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InSTED

Results for Composited Real World Extraction of Explosives – Time Study

Analyte	InSTED immediate ug/L (ppb)	InSTED 10-days later ug/L (ppb)	% Loss
HMX	21.4	19.3	10
RDX	153	137	10
4-A-DNT	1.5	1.0	33
2-A-DNT	0.1	0.06	40

InSTED

Results for Standpipe Extraction of Explosives at 10 ug/L (ppb)

	InSTED	Traditional Method 8330
Analyte	% Recovery	Acceptable Recovery Ranges
HMX	81	39 - 126
RDX	86	35 - 119
Tetryl	43	14 - 120
TNT	85	71 - 117
2,4-DNT	89	76 - 110

Potential Cost Savings

- **Traditional Sampling Costs:**

  $120 sample bottles, $560 seven coolers, $150 technician time.

  TOTAL: $830.

- **InSTED Costs:**

  $400 for HydraSleeves, $80 for one cooler.

  TOTAL: $480.

COST SAVINGS: 85% in shipping charges.

40% in total sampling costs.

Future Work

- Complete Time Studies: How long can the SPE cartridges be held on-site? Ice necessary?
- Surrogate Spike: Monitor extraction efficiency. Add to bag prior to sending to field?
- Field Evaluation: Side-by-side sampling at existing site(s).
- Independent Laboratory Evaluation: Send SPE cartridges to referee laboratory to compare results.
- GOAL: Incorporate into COE EM-200-1-3 or into SW-846.
- GOAL: Investigate patentability.

Conclusions

- Potential for use in field applications.
- Results from the InSTED compare favorably with results from fixed laboratory extraction.
- Cost savings are significant.

Acknowledgements

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- Project: Solventless Extraction Technologies for Long Term Monitoring of Military Unique Compounds. Work Item Code: B730JF.

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