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Fort Devens Superfund Site
A Technical Support Success Story

Steven D. Acree

Office of Research and Development
National Risk Management Research Laboratory

May 3, 2012

Acknowledgements

Robert G. Ford

United States Environmental Protection Agency

FOCUS: Model Technical Support Project

- Everybody brings something to the table
- Everybody gets what they need
- Applied research project developed from technical support interactions
- Products include EPA reports and journal articles as well as technical assistance reviews

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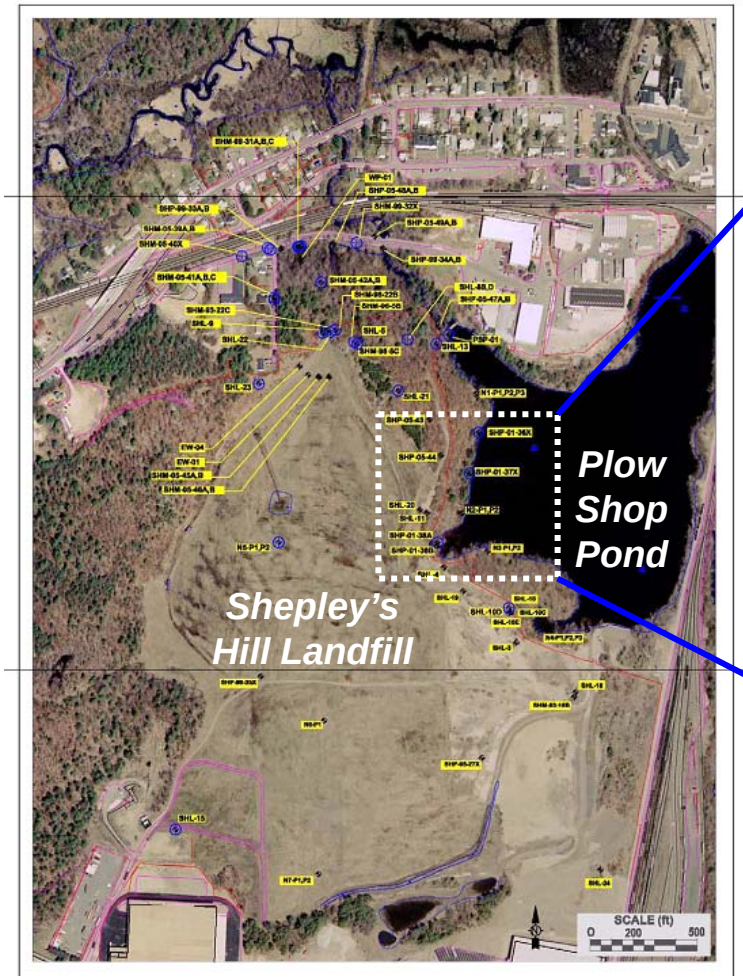
Cast of Characters (Including, but not limited to)

- EPA Region 1 – Ginny Lombardo, Bill Brandon, Rick Sugatt
- EPA Region 1 Laboratory – Dan Granz, Tim Bridges
- EPA/ORD (Cross-Divisional Collaboration & Expertise) – **Robert Ford**, Kirk Scheckel, Bob Lien, Steve Acree, Randall Ross, Patrick Clark, Todd Luxton, Aaron Williams, Thabet Tolaymat, Brad Scroggins
- MassDEP – Lynne Welsh, Brian Duvall, Hui Liang
- Site access and coordination of field activities made possible by: Robert Simeone (Dept of Army - BRAC

Setting: Shepley's Hill Landfill



Red Cove Study Area

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Project Background

- Naturally occurring arsenic
- Central Massachusetts landfills exhibit enhanced arsenic migration
- Shepley's Hill Landfill arsenic concentrations grossly exceeded concentrations at other landfills
- Elevated arsenic concentrations in pond sediments, especially in Red Cove
- Region 1 characterization indicated groundwater discharge likely significant source of arsenic in Red Cove

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Project Objective: Site Characterization to Support Remediation at/near Red Cove

ORD Project Goal – Characterize Arsenic Transport & Fate

- Identify mobile form of arsenic in groundwater
- Identify process(es) controlling arsenic uptake onto Red Cove sediments
- Evaluate stability of arsenic in Red Cove sediments

ORD Site Characterization

- GW hydrology and chemistry in Red Cove Study Area
- Sediment chemistry including arsenic speciation
- SW chemistry

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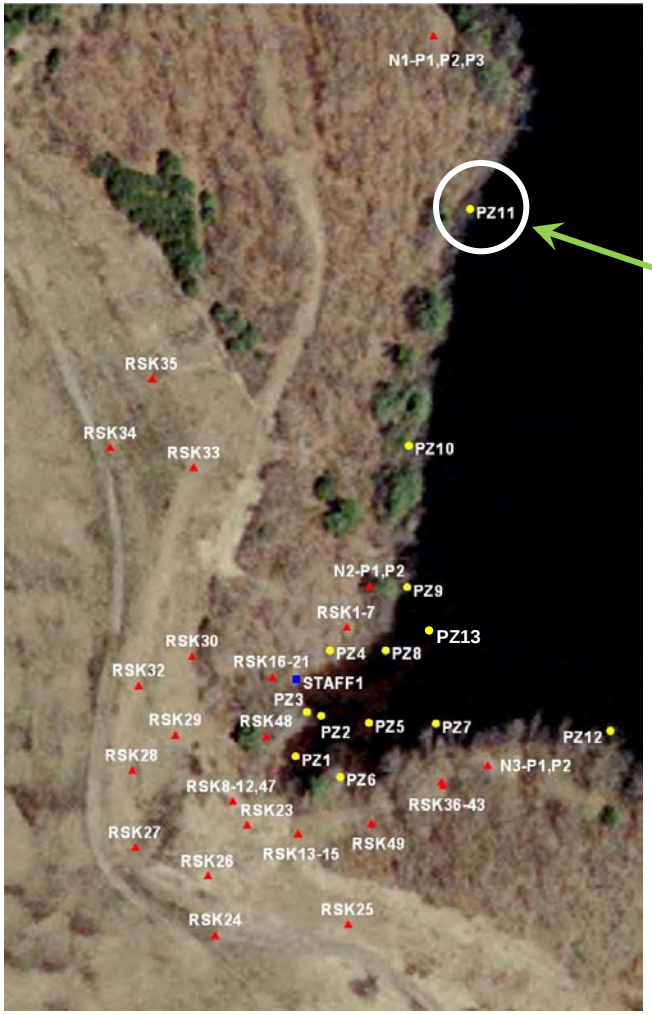
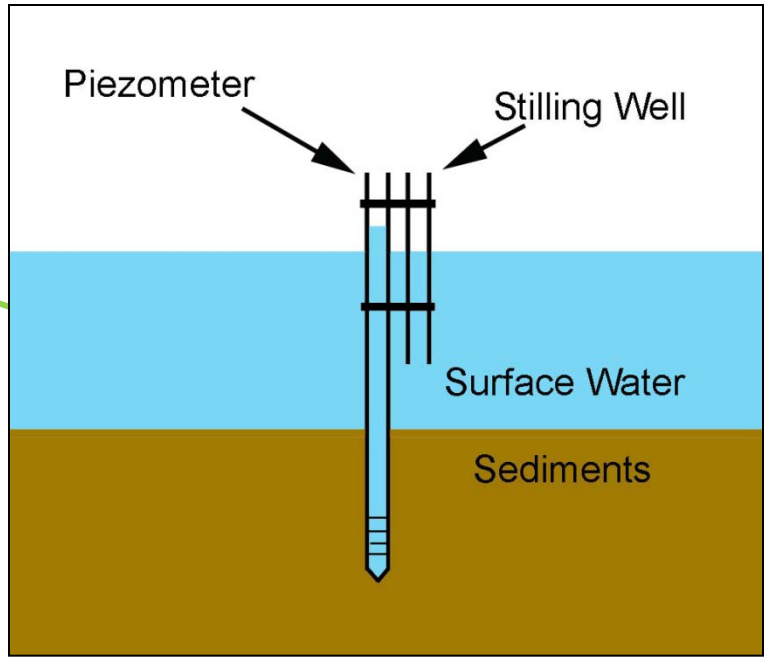
Hydrologic Characterization

- Installation of 3D network of monitoring wells
- Pneumatic slug testing to determine aquifer properties
- Continuous monitoring of groundwater and surface water elevations to estimate variations in groundwater flow
- Monitoring of hydraulic heads within pond sediments relative to surface water elevations
- Evaluation of sediment temperature profiles to identify areas of groundwater discharge
- Direct measurements of seepage rates

Basic Hydrologic Monitoring Network





- Wells screened at water table or nested 5-ft screens across saturated overburden
- Head gradient across sediment layer
- Staff gauge

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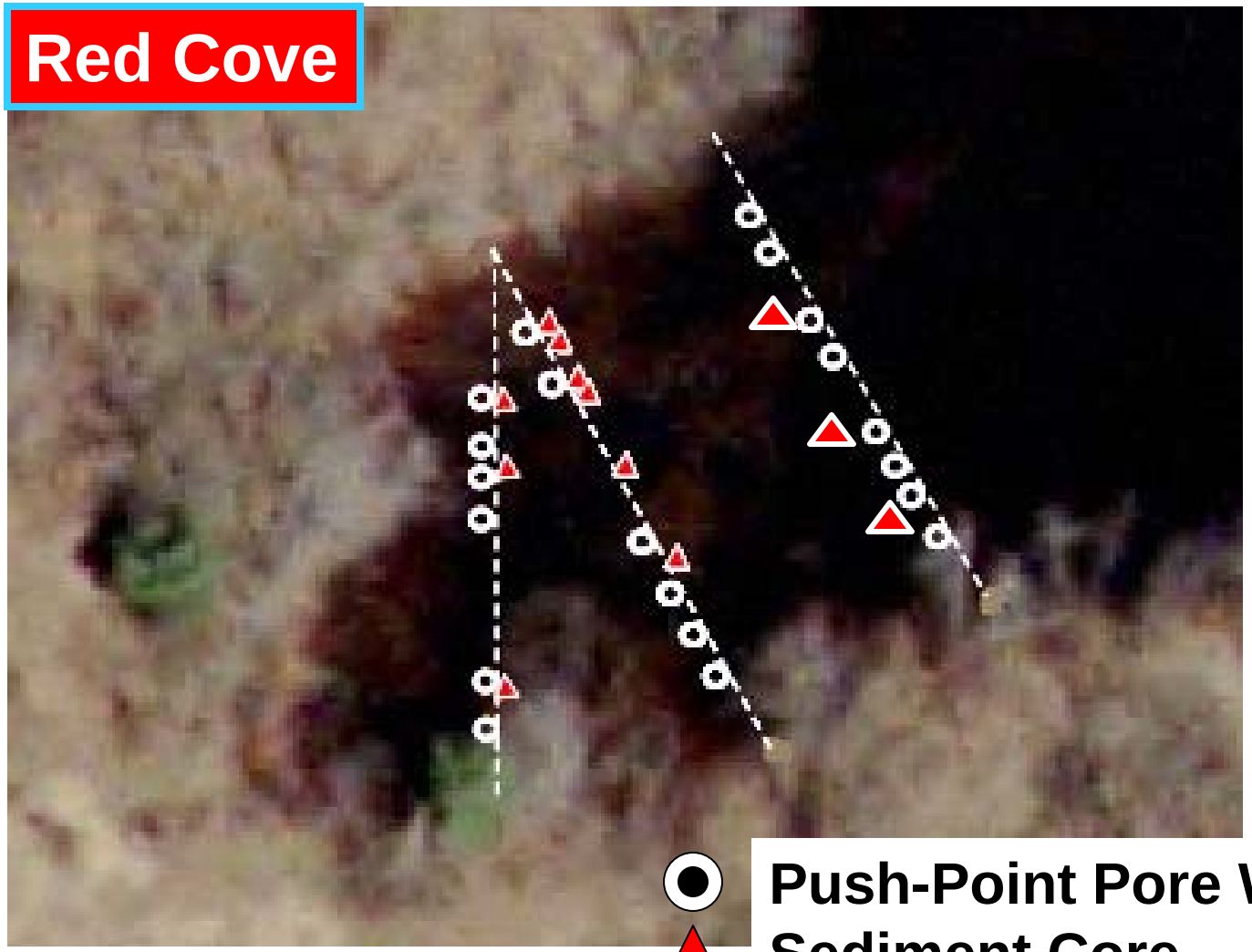
Geochemical Characterization

- Vertical surface water chemistry profiles
- Sediment cores
  - Elemental composition
  - Arsenic chemical speciation
  - Bulk mineralogy
- Sediment pore water in Red Cove
  - Water chemistry & arsenic chemical speciation
- Nested wells adjacent to Red Cove
  - Groundwater chemistry

Geochemical Network

- Well - 1” (nested, 5’ screen)
- Tubing well (6” S/S screen)
- Existing Wells

And Yet More Geochemistry



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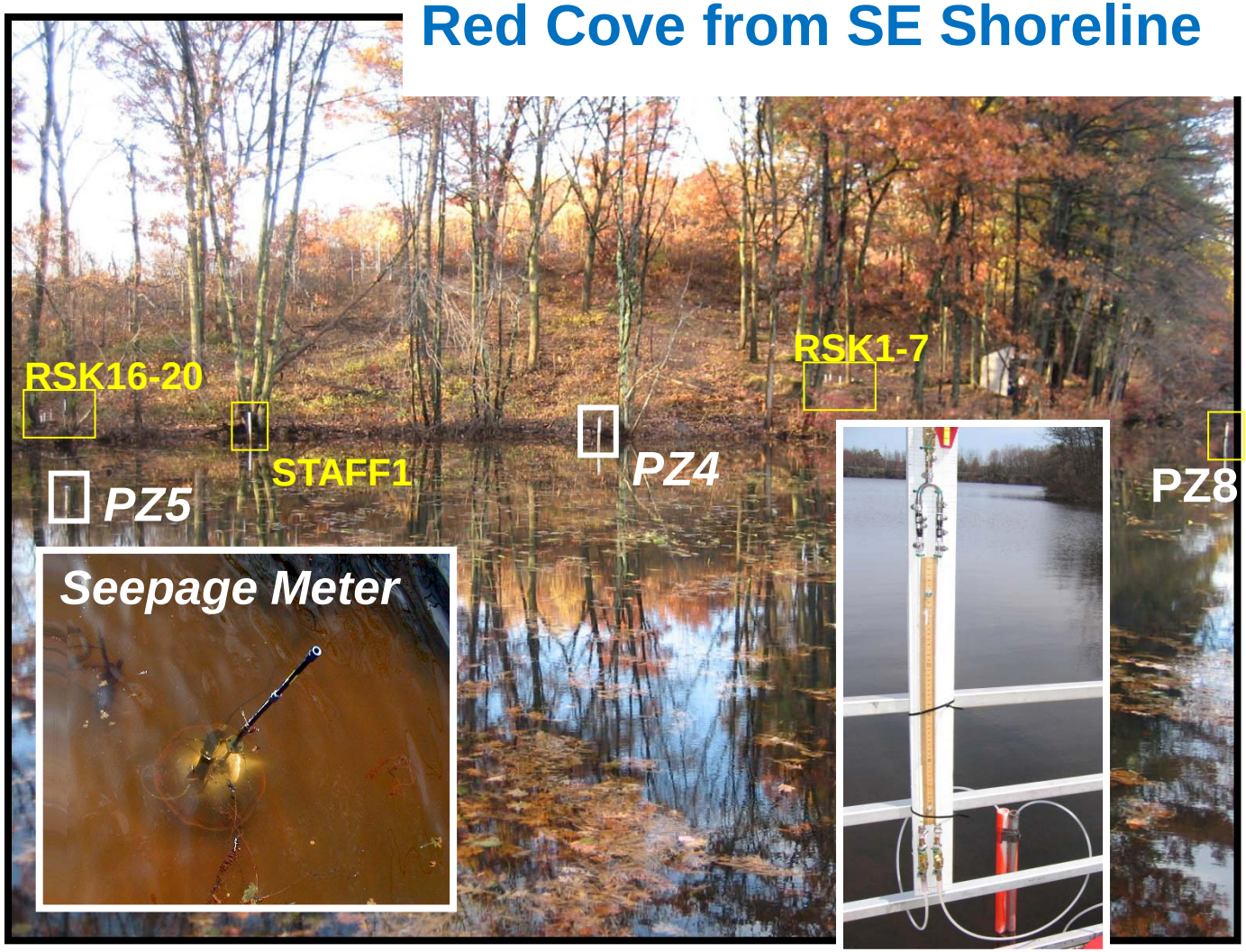
Red Cove from SE Shoreline



Pond Piezometer

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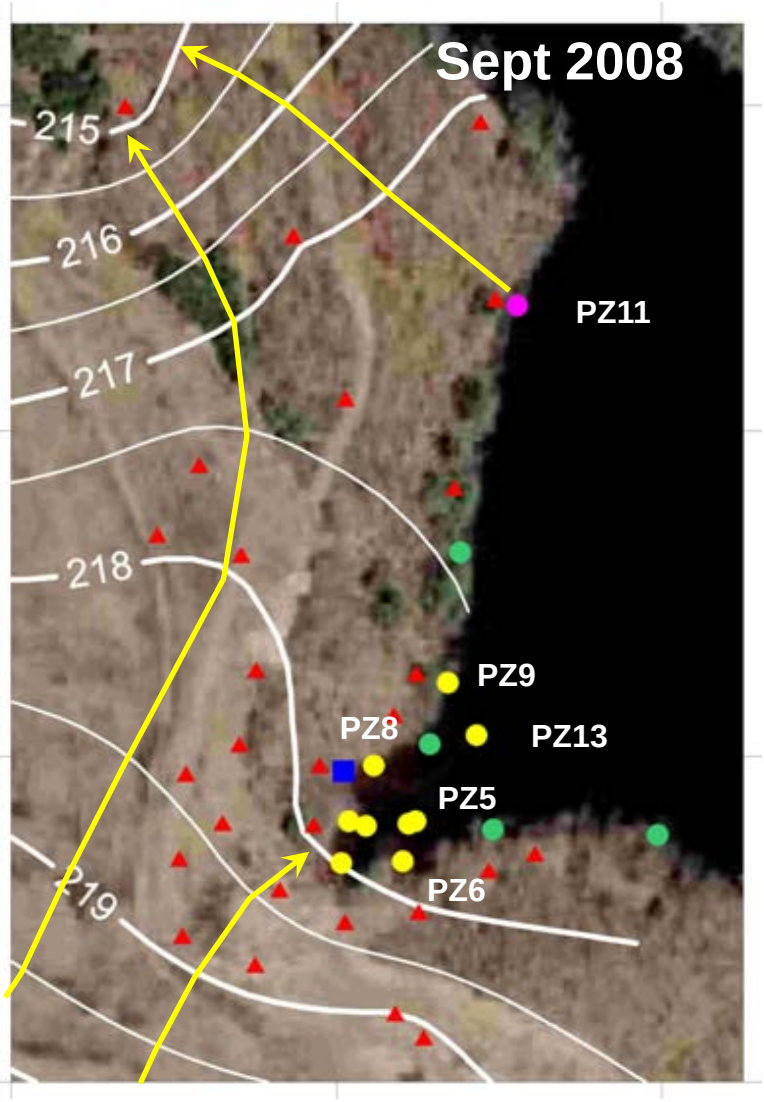
Results: Flow Gradients



Water Table Elevation (ft MSL)

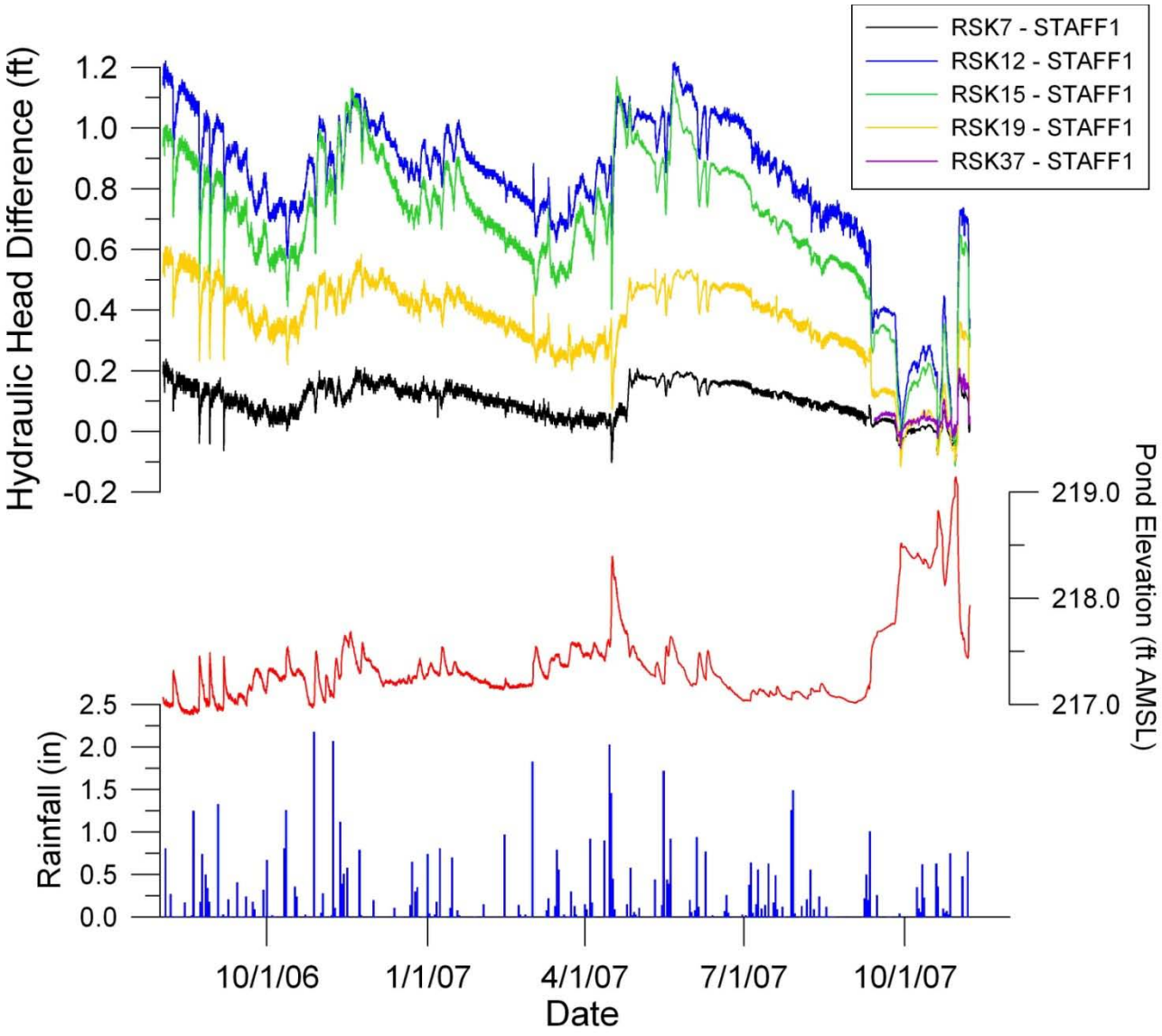
Wells

Flow Potential Across Sediments

- Up
- Negligible
- Down

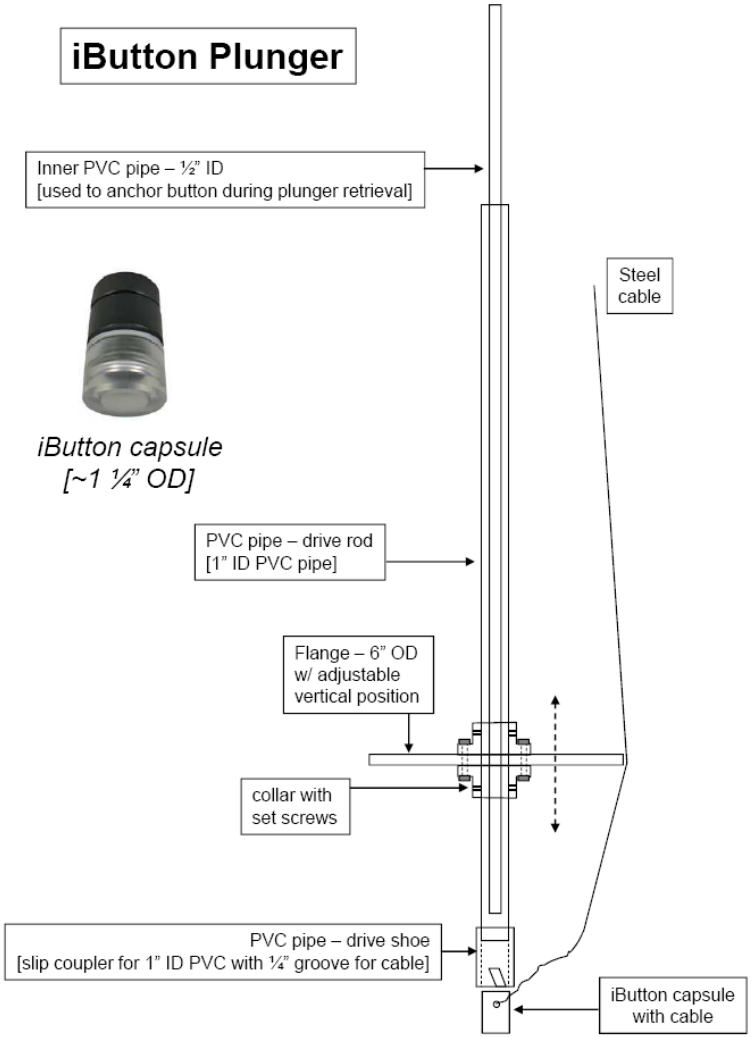
GW Flow Potential – Head Difference (ft)					
	9/11/07	11/6/07	5/1/08	8/20/08	9/17/08
PZ11	0.04	-0.26	NM	-0.10	-0.08
PZ9	0.04	0.02	0.05	0.03	0.03
PZ8	0.00	0.03	0.02	0.02	0.01
PZ5	0.05	0.08	0.13	0.11	0.10
PZ6	0.11	0.14	NM	NM	0.17

Results: Hydrologic Temporal Aspects

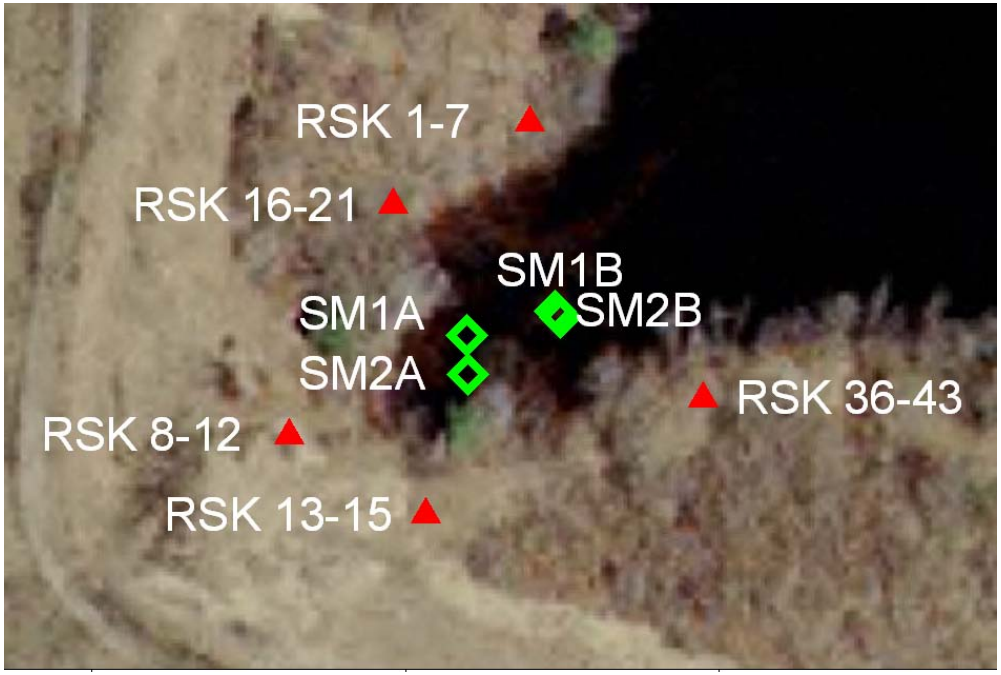


Results: Sediment Temperature

Side Benefit: Inventions



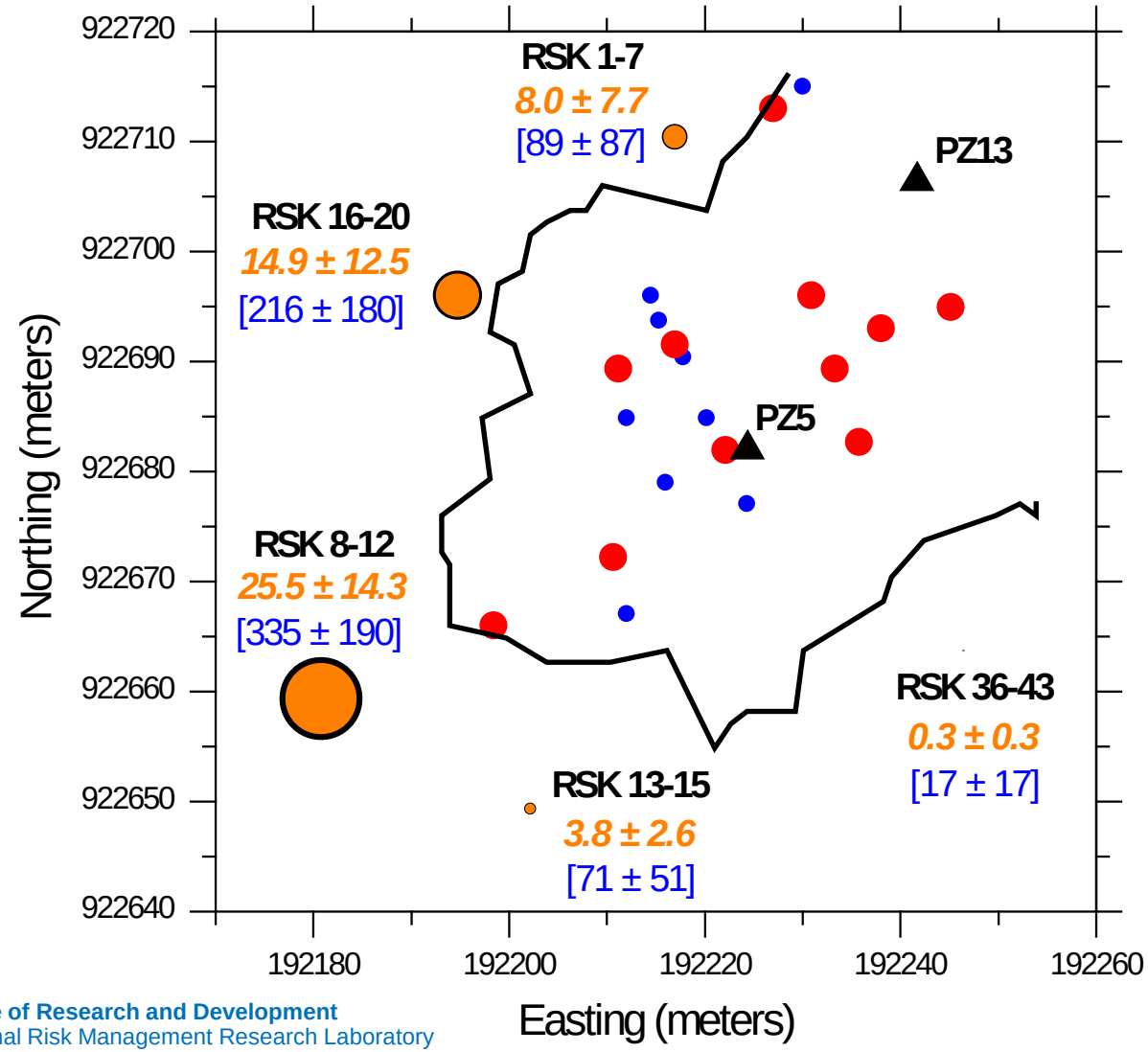
Results: Seepage Meter



Measurement Location

Location	Date	Seepage Flow (ft^3/d)	Flow Direction
SM1A	4/24/07	0.229 +/- 0.060	UP
SM2A	4/24/07	0.224 +/-0.034	UP
SM2B	4/26/07	0.197 +/-0.084	UP
SM1B	4/26/07	0.223 +/-0.039	UP
SM1B	8/21/07	0.158 +/-0.009	UP
SM1B	11/6/07	0.091 +/-0.015	UP

Results: Arsenic Flux



Groundwater

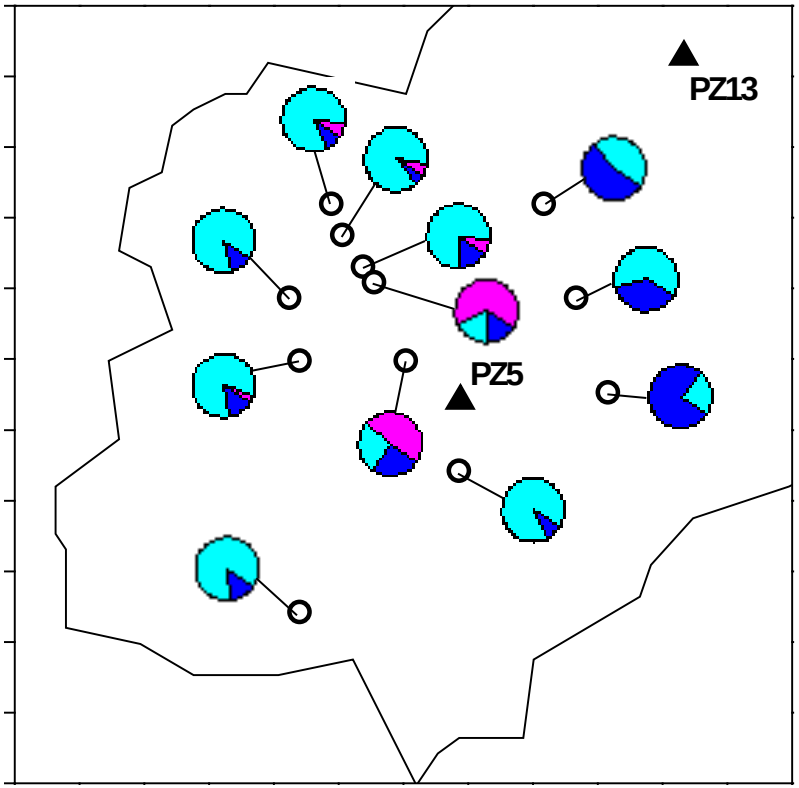
As Flux (g/d)
[K Flux (g/d)]

Sediment

<1500 mg/kg As
>1500 mg/kg As

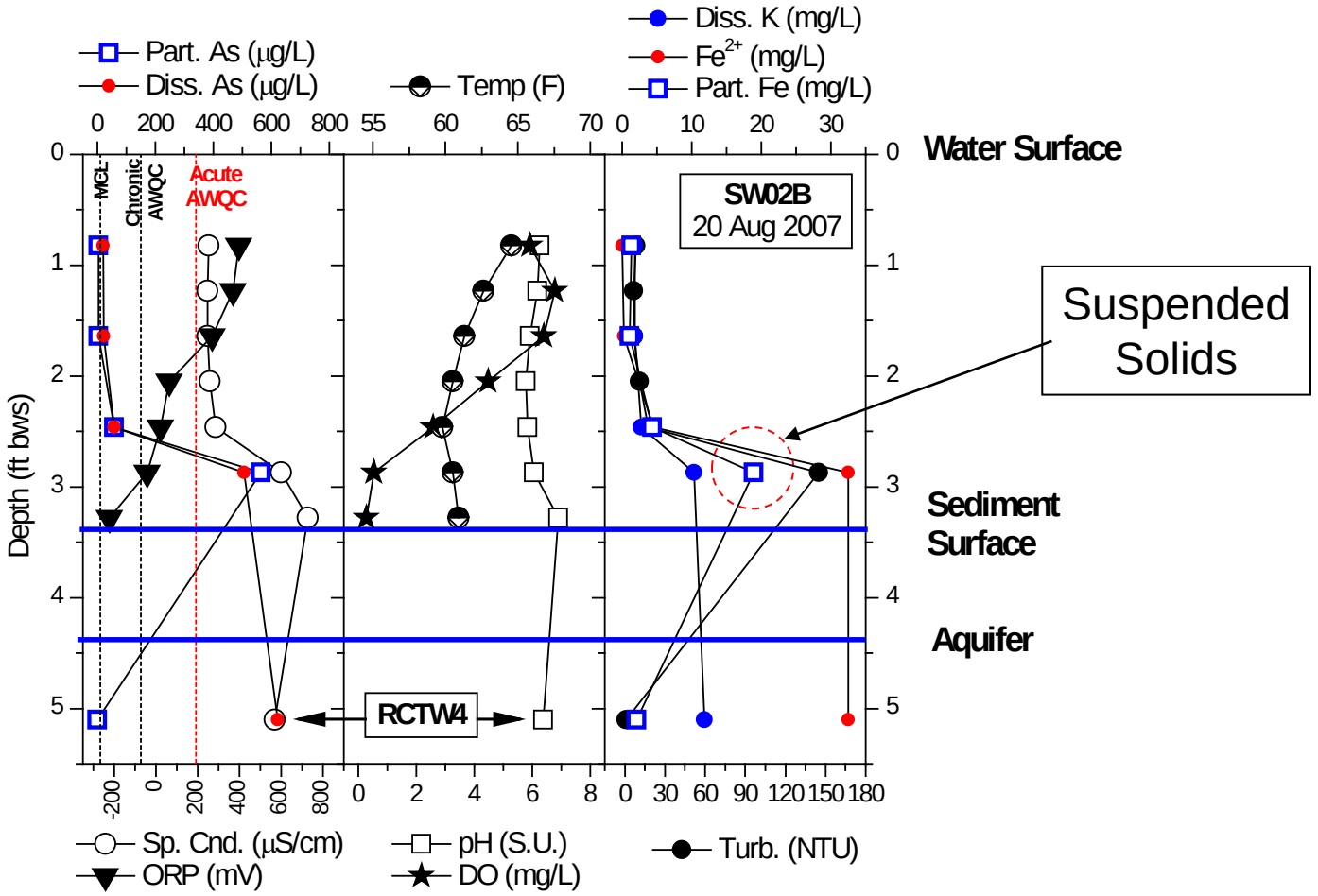
Results: Arsenic Speciation

- Sediment As associated with Fe minerals
- As(III) in western & central transect; As(V) more significant in eastern transect due to less discharge/more oxidizing condition



Results: Surface Water

- High particulate Fe in SW from GW discharge of Fe^{2+}
- Oxidation & precipitation of Fe^{2+} captures As, but only after contact with DO in SW



General Findings

1) GW discharge is a continuing source of As input into Red Cove
2) While a significant fraction of As is captured during precipitation of Fe from GW discharge, this occurs within SW (above sediment)
   - Elevated levels of As exist in deep SW
3) Sediments composed of a significant amount of As-laden Fe oxides can result in elevated concentrations of As in SW in the absence of GW discharge

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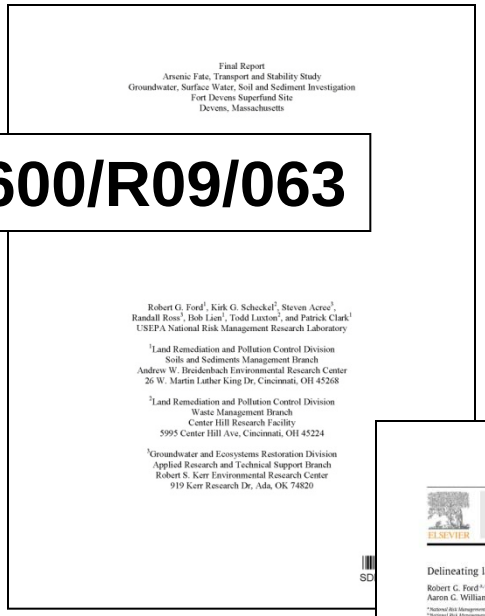
Publications

600/R09/063



Final Report
Arsenic Fate, Transport and Stability Study
Groundwater, Surface Water, Soil and Sediment Investigation
Fort Devens Superfund Site
Devens, Massachusetts

Robert G. Ford[1], Kirk G. Scheckel[2], Steven Acree[3], Randall Ross[3], Bob Lien[1], Todd Luxton[2], and Patrick Clark[1]
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600/R09/064

EPA/600/R-09/064
June 2009

Devens 2008 Monitoring Update
Arsenic Fate, Transport and Stability Study
Groundwater, Surface Water, Soil and Sediment Investigation
Fort Devens Superfund Site
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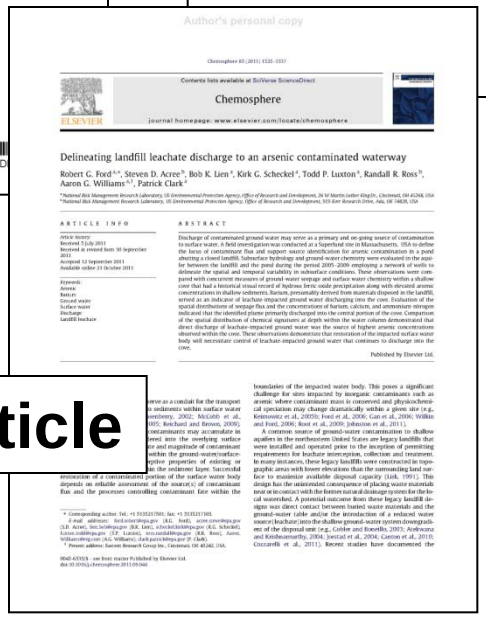
SDMS DocID 455171

Journal Article



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Contents lists available at SciVerse ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Delineating landfill leachate discharge to an arsenic contaminated waterway

Robert G. Ford[a,*], Steven D. Acree[b], Bob K. Lien[a], Kirk G. Scheckel[a], Todd P. Luxton[a], Randall R. Ross[b], Aaron G. Williams[a,1], Patrick Clark[a]

ARTICLE INFO

ABSTRACT

Discharge of contaminated ground water may serve as a primary and on-going source of contamination to surface water. A field investigation was conducted at a Superfund site in Massachusetts, USA to define the locus of contaminant flux and support source identification for arsenic contamination in a pond abutting a closed landfill. Subsurface hydrology and ground-water chemistry were evaluated in the aquifer between the landfill and the pond during the period 2005–2009 employing a network of wells to delineate the spatial and temporal variability in subsurface conditions. These observations were compared with concurrent measures of ground-water seepage and surface water chemistry within a shallow cove that had a historical visual record of hydrous ferric oxide precipitation along with elevated arsenic concentrations in shallow sediments. Barium, presumably derived from materials disposed in the landfill, served as an indicator of leachate-impacted ground water discharging into the cove. Evaluation of the spatial distributions of seepage flux and the concentrations of barium, calcium, and ammonium-nitrogen indicated that the identified plume primarily discharged into the central portion of the cove. Comparison of the spatial distribution of chemical signatures at depth within the water column demonstrated that direct discharge of leachate-impacted ground water was the source of highest arsenic concentrations observed within the cove. These observations demonstrate that restoration of the impacted surface water body will necessitate control of leachate-impacted ground water that continues to discharge into the cove.

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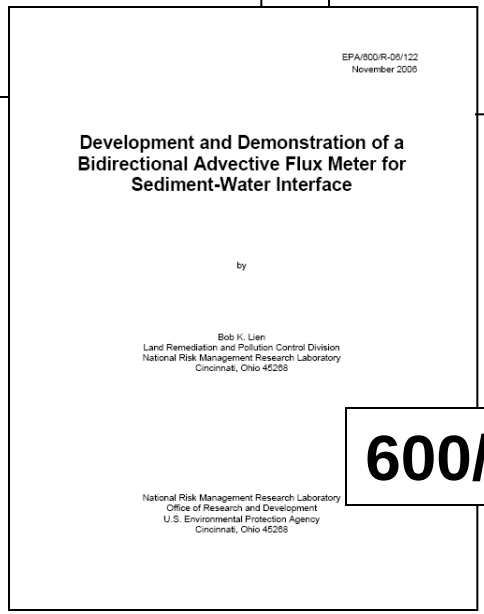
600/R10/110



EPA/600/R-08/122
November 2008

Development and Demonstration of a Bidirectional Advective Flux Meter for Sediment-Water Interface

by

Bob K. Lien
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Outcomes

- Remediation plans for Red Cove sediments & contaminated groundwater discharge
- Further assessment of the effectiveness of the groundwater extraction system

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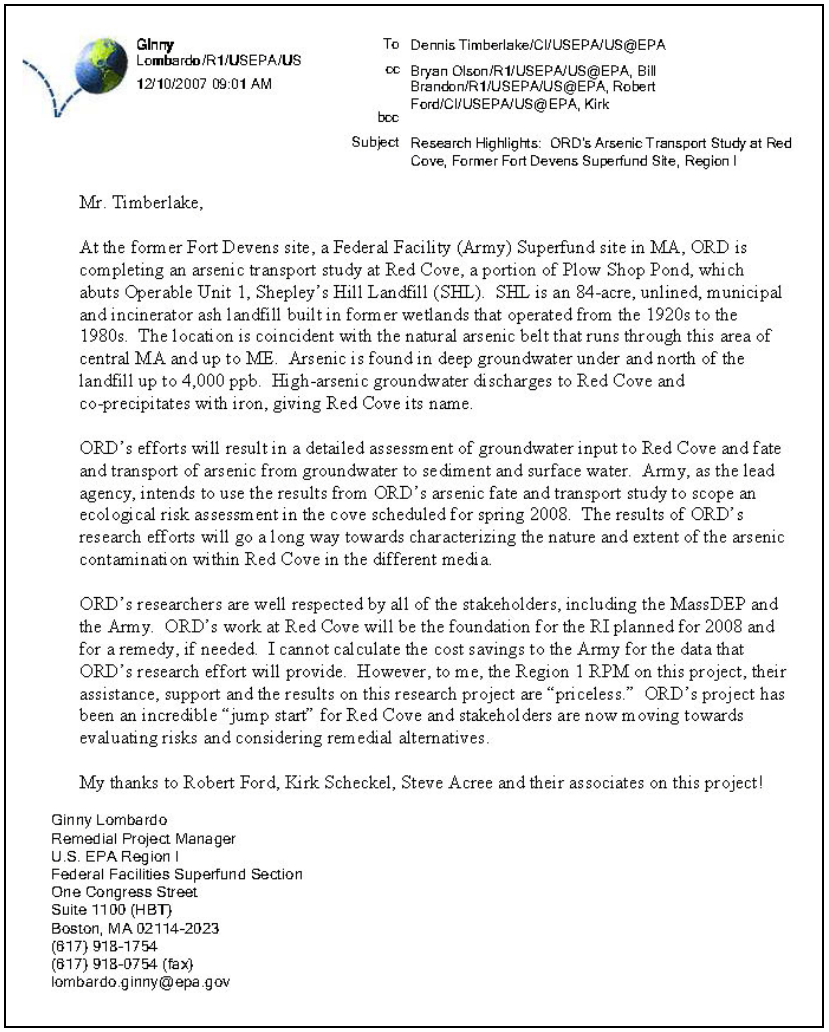
Door Prizes

- 2008 National Notable Achievement Award
  - Regional Science Award, Fort Devens Superfund Site, “Red Cove” Team
- 2010 Bronze Medal
  - Fort Devens Red Cove Team

Satisfaction Guaranteed



Ginny
Lombardo/R1/USEPA/US
12/10/2007 09:01 AM

To Dennis Timberlake/CI/USEPA/US@EPA
cc Bryan Olson/R1/USEPA/US@EPA, Bill Brandon/R1/USEPA/US@EPA, Robert Ford/CI/USEPA/US@EPA, Kirk
bcc
Subject Research Highlights: ORD's Arsenic Transport Study at Red Cove, Former Fort Devens Superfund Site, Region I

Mr. Timberlake,

At the former Fort Devens site, a Federal Facility (Army) Superfund site in MA, ORD is completing an arsenic transport study at Red Cove, a portion of Plow Shop Pond, which abuts Operable Unit 1, Shepley's Hill Landfill (SHL). SHL is an 84-acre, unlined, municipal and incinerator ash landfill built in former wetlands that operated from the 1920s to the 1980s. The location is coincident with the natural arsenic belt that runs through this area of central MA and up to ME. Arsenic is found in deep groundwater under and north of the landfill up to 4,000 ppb. High-arsenic groundwater discharges to Red Cove and co-precipitates with iron, giving Red Cove its name.

ORD's efforts will result in a detailed assessment of groundwater input to Red Cove and fate and transport of arsenic from groundwater to sediment and surface water. Army, as the lead agency, intends to use the results from ORD's arsenic fate and transport study to scope an ecological risk assessment in the cove scheduled for spring 2008. The results of ORD's research efforts will go a long way towards characterizing the nature and extent of the arsenic contamination within Red Cove in the different media.

ORD's researchers are well respected by all of the stakeholders, including the MassDEP and the Army. ORD's work at Red Cove will be the foundation for the RI planned for 2008 and for a remedy, if needed. I cannot calculate the cost savings to the Army for the data that ORD's research effort will provide. However, to me, the Region 1 RPM on this project, their assistance, support and the results on this research project are "priceless." ORD's project has been an incredible "jump start" for Red Cove and stakeholders are now moving towards evaluating risks and considering remedial alternatives.

My thanks to Robert Ford, Kirk Scheckel, Steve Acree and their associates on this project!

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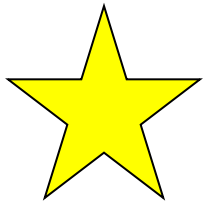
Dissecting the Aftermath
(Why It Worked So Well)

- Teamwork
  - Engaging the appropriate technical disciplines
  - Effective interaction between ORD & Region 1
- Shared resources
- Effective Region 1 project management
- Cooperative site owner



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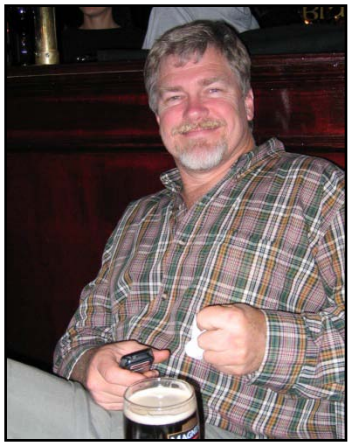
Project Evolution

- Effectiveness of existing groundwater capture system
- Fate of contaminants in groundwater in other areas of the site
- Estimation of seepage flux using high resolution sediment temperature data



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Contact for groundwater technical support services:

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For More Detailed Information

- Ford, R.G., et al. 2008. Final Report: Arsenic Fate, Transport and Stability Study; Groundwater, Surface Water, Soil and Sediment Investigation; Fort Devens Superfund Site, EPA/600/R09/063.

- Ford, R.G., et al. 2011. Delineating landfill leachate discharge to an arsenic contaminated waterway. *Chemosphere* 85:1525-1537.