Comprehensive GW/SW Evaluations Drive CSM Evolution from Denial to Remedial Success

Red Cove Case Study
Devens, MA

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DISCLAIMER

The findings and conclusions in this presentation have not been formally disseminated by the U.S. EPA and should not be construed to represent any agency determination or policy.
Case Study Devens, MA – Complex landfill site is a “containment in progress”.....
Site Chronology - circa 2005

• 2005 Pump and Treat with Monitoring Initiated at N end of Landfill

• Ongoing technical Debate:
  • Will Pump and Treat address GW discharge at Red Cove ?!
  • CSM (arsenic F/T)
  • Effectiveness of Capture
  • Landfill inputs to “Red Cove”
GW Extraction Simulations

Run 401 - EW-01 Pumping at 50 GPM
Run 402 - EW-01 Pumping at 40 GPM
Run 403 - EW-01 Pumping at 30 GPM
Sediment Arsenic Concentrations in Grove and Plow Shop Ponds
Working Hypotheses

• Arsenic in pond sediment strongly correlated spatially with Red Cove
• Landfill generates reducing GW conditions
• Reduced Ground Water from SHL discharges to Red Cove (oxidizing environment)
• Arsenic in discharging ground water is deposited into Red Cove Sediments (oxidizing)
• Arsenic from a combination of waste material and naturally-occurring arsenic present in soil and bedrock
Red Cove Investigation Technical Objectives

• Detailed Delineation of COCs in GW, SW, and Sediment
• Focus on Arsenic
• Test Hypotheses for Arsenic Transport and inter-media transport Mechanisms
• Develop Preliminary Conceptual Site Model (CSM) for GW-SW-Sediment Interactions
• Develop Initial Estimates of Contaminant flux from GW to SW and Sediment
## Red Cove Focus Area – GW/SW Investigation Components, Media and Methods

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THE FLOW QUESTION: DOES LANDFILL GW DISCHARGE TO RED COVE??

- DOES THIS MATTER?
- MODEL VERSUS REALITY
- HOW WILL THIS CHANGE WITH PUMPING AT NORTH END OF THE LANDFILL
- WHAT DENSITY OF GW WATER LEVEL DATA IS NEEDED TO MAKE A DEFENSIBLE CONCLUSION?
- TIME SERIES WATER LEVEL DATA
- TEMPERATURE DATA AT GW/SW INTERFACE
SHEPLEY'S HILL LANDFILL
MODELED PARTICLE TRACKS (ca. 2002)
Pumping vs. non-pumping conditions
Measured Water Levels and GW Flow Patterns - November 2004

• Consistent Flow Patterns
  • Eastward flow
  • All Hydrogeologic units
  • All times

• Modeled particle tracks NOT validated

• Landfill GW Discharges to Red Cove
Shoreline Pond Bottom Temperature Survey
March 2004

• Thermocouple mounted at tip of 5-ft stainless steel rod
• Insert into sediment up to 60 inches
• Relies on GW/SW temp contrast
• LOW COST $
Temperature Survey Results – March 2004

Strongly Support Ongoing GW Discharge to Red Cove

- GW Temperatures warmer than SW
- Ice melted in embayment
- Convergent GW Flow/Discharge
- Highest GW flux in embayment
- Little open water North of Red Cove
Water Quality Data Collection

- **Groundwater Sampling**
  - Monitoring well sampling (Army, EPA)
  - Shoreline vertical profiling of GW (EPA)
  - Geoprobe Systems

- **Pore Water Sampling**:
  - Shoreline and beneath Red Cove (EPA)
  - Push point samplers (MHE products)

- Surface water samples
Vertical Profiling of GW Quality Using Geoprobe - EPA Region 1
Arsenic in Ground Water (ppb) November 2004
Pore Water Sampling Results

- Red Cove Pore Water Iron, (ppb) 1-3 ft
- Red Cove Pore Water Arsenic, (ppb) 1-3 ft
Preliminary Estimate of Arsenic Flux From GW to SW and Sediments at Red Cove

- **Total Mass flux to cove ~** 17 Kg per year

**Assumptions:**
- GW Approaches Cove through cross sectional area of ~ 11,000 ft² (A)
- GW flux (Darcy’s Law) (q) = 0.36 ft/d
- Total vol. flow rate to cove (Q) = q x A = 3800 ft³/d
- Geometric Mean As Conc. In GW (ċ) = 430 ppb
- J = Q x ċ = 4.7x10⁴ mg/day = 17 Kg per year
Relative Sediment Arsenic Concentrations in Grove and Plow Shop Ponds

Frequency of Arsenic Levels in Soils
CENTRAL MASSACHUSETTS

MADEP Background limit 20 mg/kg
Database: 510 samples
Sediment Data Collection

- **Surface Sediment Chemistry (0-1 ft) Using Eckman Dredge**
  - 15 in Grove Pond
  - 19 in Plow Shop Pond (8 were in Red Cove)
  - 1 in Flanagan Pond
  - 1 in Sandy Pond

- **Sediment Profiles by Coring (0-5 feet)**
  - 5 Profiles in Red Cove Area
Sediment Data Collection
Arsenic in Surface Sediment

UNITS: mg/Kg
Arsenic Concentration vs Sediment Depth

<table>
<thead>
<tr>
<th>SITE</th>
<th>DEPTH (inch)</th>
<th>ARSENIC (mg/Kg)</th>
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<tbody>
<tr>
<td>PSPC13</td>
<td>5</td>
<td>2,000</td>
</tr>
<tr>
<td>PSPC13</td>
<td>12</td>
<td>100</td>
</tr>
<tr>
<td>PSPC13</td>
<td>23</td>
<td>29</td>
</tr>
<tr>
<td>PSPC14</td>
<td>5</td>
<td>6,800</td>
</tr>
<tr>
<td>PSPC14</td>
<td>12</td>
<td>820</td>
</tr>
<tr>
<td>PSPC14</td>
<td>23</td>
<td>510</td>
</tr>
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Pond Bottom Sediment Cores
Sediment Toxicity Stations

- Sediment toxicity (1 species & 2 endpoints)
- Water column toxicity (2 species & 4 endpoints)
Toxicity Testing Results

- Sediment toxicity testing indicates toxicity associated with known source areas
- Railroad Roundhouse sediments acutely toxic to both species
- Growth effects associated with Tannery Cove and Red Cove/Shepley’s Hill Landfill
- Toxicity Data incorporated into final Ecological Risk Assessment and provided to U.S. Army for further action
Updated Conceptual Model

- **Groundwater**
  - Low ORP, high dissolved Fe and As
  - Discharges to pond

- **Pore water**
  - Fe and As decrease approaching sediment / SW interface

- **Sediment**
  - Fe and As accumulate near interface

- **Surface water**
  - Fe and As very low

- **Ecological impact**
  - Sediment toxicity
CSM Consensus Remains Elusive...

- Despite overwhelming evidence...
- *Site Owner Still Not Convinced ???!!!*
- CSM consensus remains elusive...

- No Momentum to address Red Cove Impacts....
- *When All Else Fails....*

- **WHO YA GONNA CALL !!!!**
- **ENTER EPA ORD !**
ORD Follow-on Investigation Goals

◆ Document all aspects of As Fate and Transport in Red Cove
  ◆ Hydraulics
  ◆ Chemistry
  ◆ Ecological

◆ Comprehensive GW/Aquifer Assessment
  ◆ Nested piezometers installed at 5-ft vertical intervals
  ◆ Slug testing
  ◆ Continuous water level recorders/ transducers
  ◆ High resolution GW Monitoring relative to Red Cove and SHL Pump and Treat

◆ Pond – Aquifer Interactions evaluated at detailed scale of investigation

◆ Further Evaluation of Ecological Impacts
Additional Monitoring Relative to Red Cove and SHL Pump and Treat
Additional Groundwater Control Points
Groundwater Flow August 2008

GW continues to discharge to cove even while P&T operates continuously
Consensus Conclusion: Additional Containment Needed on East Side of Landfill

◆ ORD Data and Technical Arguments are ultimately persuasive
◆ Site Owner Agrees to pursue additional remedial measures focused on Red Cove
◆ Beach-head to successful Remediation Established!
NEXT STEPS: REVISED CSM HAS AN IMMEDIATE AND SIGNIFICANT IMPACT TO REMEDIATION ACTIONS

- Slurry Wall (GW Containment) installed 2012
- Ponds dewatered and sediment excavated in 2013
Slurry Wall installed for GW Containment

- Containment Success Critical to Red Cove Remediation Path Forward
- 850 ft. Slurry Wall to Bedrock in 2012
- Cut-off GW flow to Red Cove
- Sediment Excavation conducted in 2013
- Post-2013 LTM indicates continued improvement and Restoration of impaired ecosystem
Take-Home Messages

◆ GW/SW Evaluations can pay big dividends

◆ Simple, Inexpensive tools can “establish a beach-head” to a better CSM

◆ More elaborate/in-depth/long-term studies (ORD) may be useful in order to convince the un-enlightened

◆ Significant Changes in Project Direction and Momentum may follow

◆ Remedy modified twice during LTM because of GW/SW investigations – Now more protective
Publications

600/R09/063

Journal Article

600/R09/064

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

by

Brett K. Luep
Land Restoration and Pollution Control Division
National Risk Management Research Laboratory
Cincinnati, Ohio 45233
Selected ORD Publications on Red Cove


• And More in Progress
FINAL WORD – Post Remedy Restoration of Red Cove

2015

2017