Case Study – Focused CVOC Source Area Remedial Investigation to Refine the Conceptual Site Model within a Complex Fractured and Faulted Sedimentary Volcanic Bedrock

John Ifkovits (HDR), Caroline Kwan (EPA), Katherine Mishkin (EPA), Christoph Stannik (HDR), Morgan Violette (HDR)
Presentation Outline

• Project Background
• Conceptual Site Model
• Data gaps
• Focused Source Remedial Investigation
• Revised Conceptual Site Model
• Feasibility Study
Background Information

• The Tutu Wells Superfund Site, USVI
  • Curriculum Center
  • Former Dry Cleaning Operation
• Contamination First Detected (1987)
• NPL Listing (February 1992)
• Initial RI/FS (1992 to 1995)
  • Source Area and Groundwater Plume
• ROD (1996)
Tutu Wells Superfund Site

- 1.5 Square Miles
- Tutu Valley
- Turpentine Run Drainage Basin
- CVOC Plume Comingled with BTEX Plumes
  - Curriculum Center
  - Service Stations
  - Dry Cleaners
- 3/4 Mile Long Plume
  - Mid and Lower Plume Attenuating
  - Curriculum Center Source Area is Persistent
Conceptual Site Model Basics:
- Thin Layer of Alluvium
- Bedrock - Andesitic Tuff

Hydrogeology:
- Groundwater Flow in Bedrock Fractures

Contamination:
- PCE Waste Discharge to Surface
- Hydrocarbon Release Co-Located North of PCE Release

Remediation:
- SVE/Soil Remediation (2004 to 2006)
- Groundwater Remediation (April 2004)
- Operation of the Groundwater Remedy Transferred to USVI/DPNR (April 2013)
Influent CVOC Concentration to Pump & Treat Groundwater Remedy Remains High (18 mg/L) After 13 Years of Pumping.

Persistent Off-Site Groundwater Plume

Remedy Not Functioning as Intended Potentially Due to:
• Incomplete Source Characterization
• Secondary Source
  • DNAPL
  • Sedimentary Bedrock Porewater
• Partial Source Area Hydraulic Containment
• Pumping Elevation Restrictions
Focused CVOC Source RI Field Investigation

• Electrical Resistivity (GeoTrax™) Survey
• Rock Core Sampling/Matrix Diffusion Analysis
• Hydraulic Capture Analysis
• Additional Groundwater Characterization
  • Monitoring Well Drilling
  • Borehole Geophysics
  • Packer Sampling
  • Groundwater Sampling
Electrical Resistivity (GeoTrax\textsuperscript{TM}) Survey

Results

- Anisotropic Bedrock Aquifer
- Structural Features – Deformation Zone
- Permeable and Weathered Zones
- Lower Resistivity (i.e. Potentially Due to Bioactivity)
- Higher Resistivity (i.e., Dissolved Phase, NAPLs)

Used to Locate Additional Monitoring Wells for Additional Characterization Sampling and Matrix Diffusion Borings
Bedrock Matrix Diffusion Assessment

Proof of Concept Approach

Methodology

- Cored Bedrock at 2 Locations
- Collected Bedrock Samples at 2 Foot Intervals and at Fracture Faces
- Analyzed Bedrock for VOCs & Physical Properties
- Calculated CVOC Concentration in Porewater

Results

- Porosity of Andesitic Tuff = 1-2 percent
- CVOCs are Diffusing into Porewater
- Highest Concentration = 14 mg/L
- Bedrock Porewater is Acting as a Secondary Source
- DNAPL in Fractures Connected to Sources
- 1 Foot DNAPL Pooled at Bottom of Borehole.
Hydraulic Capture Analysis

Pump & Treat Groundwater Remedy

Shallow Bedrock <80 Feet Below Ground Surface
- Two Extraction Wells - 12 gpm

Deep Bedrock >80 Feet Below Ground Surface
- One Extraction Well – 100 gallons per week

Capture Estimate from Groundwater Elevations and Response to Pumping Combined with Physical Properties of Bedrock
Potential Sources and Secondary Sources

- Waste Pit
- Dry Cleaning Process
- Drum Disposal Area
- Wells with Dissolved Phase CVOCs > 1% Solubility
- Matrix Diffusion / Porewater
Shallow Ground Water Distribution of Total Ethenes

Additional Shallow Groundwater Characterization
- Monitoring Well Drilling
- Borehole Geophysics
- Packer Sampling
- Groundwater Sampling

Goal of New Wells
- Further Delineate CVOCs Up and Downgradient

Co-located hydrocarbon release results in anaerobic conditions leading to reductive dechlorination of CVOCs in the northern portion of plume. Southern Portion of Plume less Reductive Dechlorination.
Deep Ground Water Distribution of Total Ethenes

Additional Deep Groundwater Characterization
• Monitoring Well Drilling
• Borehole Geophysics
• Packer Sampling
• Groundwater Sampling

Goal of New Wells
• Further Delineate CVOCs Downgradient and in the Deep Zone
Conceptual Site Model

Geology:
- Shallow and Deep Zones
- Bedrock Features
- Fracture Trends

Hydrogeology:
- Preferential Flow Paths
- 1-2% Porosity
- Incomplete Capture

Contamination:
- Greater Source Area Extent
- Partial Hydraulic Containment
- Secondary Sources
  - DNAPL and Porewater
  - Consistent with Off Site Plume
Remedial Action Alternatives

• No Action
• Expand Existing Groundwater Pump and Treat System
  • Air Stripping
  • Dual Phase Extraction / Enhanced Fluid Recovery
  • Flexible Pumping From High Concentration Wells
• Enhancements:
  • Reinjection
  • Air Sparging and Soil Vapor Extraction
  • In Situ Chemical Oxidation
  • Surfactant Flushing
• In Situ Thermal Treatment
• In Situ Steam Injection
Thank you
John Ifkovits
john.ifkovits@hdrinc.com