PUMP-AND-TREAT CONVERSION TO IN SITU BIOREMEDIATION FOR TREATMENT OF PERCHLORATE IN GROUNDWATER

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Background

- Former 450-acre RCRA facility
- 220 buildings on site
- Conducted RFI for VOCs in late 1980s
- Implemented Corrective Actions for VOCs:
  - Soil excavation for on-site treatment
  - Initiation of long-term pump & treat for deep groundwater impacts
TOTAL VOLATILE ORGANIC COMPOUNDS (VOCs)
CONCENTRATION OVER TIME AT EXTRACTION WELL
FORMER P&T SYSTEM

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Background (cont.)

- Pump & treat system effective:
  - Hydraulic control of VOCs plume
- In 2001, perchlorate detected in deep groundwater pump effluent
- Consequently, initiated Supplemental RFI to investigate presence of perchlorate
- Facility closed/relocated operations
- Property preparing for redevelopment
Perchlorate

- Anion of ammonium perchlorate (AP) – major component of solid rocket fuel
- Highly soluble, generally non-reactive under environmental conditions
- Toxicological studies have linked perchlorate to thyroid dysfunction
- Currently only 2 states have drinking water standard (CA, MA)
Geologic Conditions

• Jurassic diabase:
  – Up to 300-feet thick
  – Absent of fractures/water-bearing zones

• Triassic metamorphosed siltstone / sandstone (metasediments):
  – Outcrops in north-central portion of site
  – Overlain by diabase over 2/3 of site
  – Highly-fractured and water-bearing

• Regolith:
  – Thin alluvial/saprolitic layer
  – Creates shallow (perched) groundwater zone
Supplemental RFI – Initial Results

- Installed 37 deep groundwater monitoring wells to depths of 300 to 350 feet
- Installed 224 shallow groundwater monitoring wells to top of bedrock (~10 to 15 feet bgs)
- Identified deep groundwater perchlorate plume:
  - Generally same extent as VOCs plume
  - Perchlorate concentrations exceeded 8,000 ppb
- Implemented phased pilot testing of deep groundwater recirculation system:
  - Maintain hydraulic control of perchlorate & VOC plumes
  - Extract groundwater, treat for VOCs, amend treated water with electron donor substrate, reinject upgradient
  - Electron donor to stimulate biologically-mediated anaerobic reduction of both perchlorate and VOCs
Pilot Test Phase 1

- Converted 2 former P&T wells to extraction and injection wells (IWs)
- Existing air-stripper for VOCs treatment
- CMA salt substrate
- Installed downhole inflatable packer in injection well
- Identified issues with reinjection:
  - Bio-fouling
  - Mineral fouling (result of air-stripper and CMA)
  - High backpressure at injection well
  - Need for system interlock
Pilot Test Phase 1A

- Installed interlock system
- Change to methanol substrate
- Change to GAC for VOCs treatment
- Install automated control unit to regulate flow and telemetry to allow remote operation and monitoring
- Batch injections to 5 southern (passive) IWs along downgradient plume edge
- Installed 3 additional IWs and injection gallery:
  - Target high-concentration source areas in north of facility identified through ongoing SRF Investigation
  - Deep and upper zones subjected to substrate addition
Pilot System Phase 2

- Expand to include southern recirculation system:
  - Target southern downgradient edge of perchlorate plume
  - Reduce substrate travel/distribution times
  - Low extraction rate, low injection rate
  - Reduce labor cost

- Southern system design:
  - 1 new extraction well
  - Convert 4 former passive IWs to active IWs
  - Methanol substrate
  - Set up southern remediation compound

- Final system consists of:
  - 2 separate control units
  - 2 extraction wells
  - Over 6,200 feet of below ground piping
TOTAL VOLATILE ORGANIC COMPOUNDS (VOCs)
CONCENTRATION OVER TIME AT EXTRACTION WELL

Start of Phase 1
1095 ppb

End of Phase 1

Start of Phase 1A
74.4 %
Reduction since initiation of Phase 1A
PERCHLORATE CONCENTRATION OVER TIME AT EXTRACTION WELL

- Start of Phase 1
- End of Phase 1
- Start of Phase 1A
- 10.7 mg/L
- 79.4% Reduction since initiation of Phase 1A

PERCHLORATE CONCENTRATION (mg/L)

DATE

09/06/01
10/16/02
11/20/02
01/14/03
02/05/03
04/02/03
06/11/03
02/18/04
04/06/04
07/15/04
09/13/04
11/10/04
01/13/05
03/17/05
05/10/05
11/29/05
01/03/06
03/06/06
03/06/06

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TOTAL VOLATILE ORGANIC COMPOUNDS (VOCs)
CONCENTRATION OVER TIME AT UPGRADIENT WELL

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Start of Phase 1A
472 ppb

Start of Phase 1

End of Phase 1

34.0% Reduction since initiation of Phase 1A

Reduction

TOTAL VOLATILE ORGANIC COMPOUNDS (VOCs)
CONCENTRATION OVER TIME AT UPGRADIENT WELL

Start of Phase 1

02/16/05

End of Phase 1

05/10/05

Start of Phase 1A
08/19/04

472 ppb

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DATE
PERCHLORATE CONCENTRATION OVER TIME AT UPGRADE WELl

Start of Phase 1: 1.42 mg/L
End of Phase 1: 97.6% Reduction since initiation of Phase 1A
Pilot Test Results to Date

- Maintained hydraulic control of perchlorate and VOC plumes
- Significant reductions in perchlorate:
  - Decrease in extent of plume
  - 88% in plume core/pumping well
- Significant reductions in VOCs:
  - Decrease in extent of plume
  - 62% in plume core/pumping well
Conclusions & Future Studies

• Phased pilot test approach appropriate for large, complex sites:
  – Evaluate small area, then expand to include additional areas or target specific zones
  – Minimize capital costs by reuse of existing remedial equipment (P&T to recirculation system)
  – Final CMI design better after long-term pilot testing

• Future studies:
  – Evaluation of mixed soluble substrates
  – Ongoing SRF Investigation to improve source area delineation