Complex Remediation Case Study
Air Force Plant PJKS

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Complex Case Study PJKS
Site Description

- Fuel Test/Development Facility
  - (1957–Present)
- NPL Site and Order on Consent established State of Colorado as Lead Agency
- Record of Decision Complete
- Soils Closed
- Three Ground Water Plumes
- Two COCs, TCE and NDMA
- Seven poorly-defined bedrock source areas
- Two types of bedrock,
  - Fractured sandstone
  - Fractured crystalline rock
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Site Description

53 soil sites – all are closed
36 closed without restriction
12 closed with restriction
5 closed with restriction plus limited cover

Figure 3: Soil SWMU with Restricted Closure
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Results of Investigations

- 3 groundwater plumes with associated bedrock source areas
- 2 COCs - TCE & NDMA
- TCE plume boundaries are stable
- Vapor Intrusion not significant
- NDMA plumes are stable & boundaries within TCE Plumes
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Conceptual Site Model

- Diffuse bedrock source areas
- 100 to 135 Ft bgs
- Low porosity/low transmissivity,
- Bedrock/alluvium flux @ ≈ 25 Ft bgs
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Remediation Risk Management

- Identifying Technical Challenges to Groundwater Restoration
  - Contaminant-Related Challenges (TCE, NDMA)
  - Hydrogeologic Challenges
    - Low porosity/low transmissivity & depth
  - Other Challenges
    - Plume migration to adjacent property and “inordinate cost”

- Evaluating the Likelihood of Technical Cleanup Challenges
  - Technology Performance Assessments, pilot- or full-scale
  - Site data assessment
  - Integration into the CSM

- Evaluating the Adverse Impacts of Technical Cleanup Challenges
  - Noncompliance with regulations, remedies do not achieve ARARs
  - Long-term property restrictions
  - Public perception
  - Litigation
  - Destabilize plume boundaries
PKJS Pilot Studies:

- **TCE – Enhanced Bioremediation**
  12,000 µg/L to 25 µg/L @ D-1 site

- **NDMA – no in-situ approach**
  - Reducing conditions – did not work
  - Co-metabolism – (TCE toxic to process) equivocal preliminary success with methane, butane, & propane

- **Ex-situ technology – UV oxidation is Standard**
  - Expensive to operate
  - Energy intensive

- **Tested ex-situ nickel hydrogen treatment - technology not scalable**
### Site data assessment:

**PJKS TCE Source Area Treatment**

<table>
<thead>
<tr>
<th>Source Area</th>
<th>Current source area TCE concentration</th>
<th>Distance from source area cross-over point to property boundary (feet)</th>
<th>Source area TCE concentration needed for natural attenuation to achieve CBSG at property boundary (ppb)</th>
<th>Time required to reduce source area to concentration needed for natural attenuation to achieve CBSGs by property boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPL</td>
<td>6,600</td>
<td>0 (N)</td>
<td>5</td>
<td>49 months</td>
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<td></td>
<td></td>
<td>1400 (S)</td>
<td>1400</td>
<td>11 months</td>
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<td>SCA</td>
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<td>40 months</td>
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<tr>
<td></td>
<td></td>
<td>10,000</td>
<td>700 (S)</td>
<td>80</td>
</tr>
<tr>
<td>D-1</td>
<td>7,200</td>
<td>2700 (N)</td>
<td>&gt;20,000</td>
<td>0 months</td>
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<td></td>
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<td>2000 (S)</td>
<td>16,000</td>
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<tr>
<td>CSSA</td>
<td>460</td>
<td>200 (N)</td>
<td>10</td>
<td>25 months</td>
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<tr>
<td></td>
<td></td>
<td>1200 (S)</td>
<td>600</td>
<td>0 months</td>
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<tr>
<td>OTL</td>
<td>140</td>
<td>900</td>
<td>180</td>
<td>0 months</td>
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<tr>
<td>T-8A</td>
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<td>25 months</td>
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<tr>
<td></td>
<td></td>
<td>400 (S)</td>
<td>25</td>
<td>14 months</td>
</tr>
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</table>
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Groundwater RAOs

- The State of Colorado promulgated groundwater standards (e.g. CBSGs) are the basis of the media cleanup standards (MCSs) for individual COCs in PJKS groundwater
- USAF, EPA, and CDPHE established Preliminary RAOs for groundwater at PJKS in Dec 2005
  - RAOs may reduce exposure or reduce chemical concentrations
  - Not always possible to remediate all groundwater to unrestricted exposure levels
- Groundwater is not currently used on site
- The RAO to protect human health is intended to prevent future use until concentrations are reduced to the point use can be unrestricted and exposure unlimited
- Use will be restricted through the LUCs imposed by the Environmental Covenant
RAOs for TCE:

- Reduce TCE contamination at the transition points (where bedrock groundwater transitions into the alluvial system)
- Reduce TCE concentrations in bedrock source areas to levels that achieve CBSGs for groundwater beyond the PJKS point of compliance
- Projected in approximately 10-20 years considering uncertainty about response to in-situ treatment
RAOs for NDMA:

- Protect human health by preventing contact with, and ingestion of, TCE or NDMA contaminated groundwater until unlimited use/unrestricted exposure levels are achieved.
- Contain NDMA in the alluvium through the continued monitoring of the plume stability until the groundwater is remediated to beneficial use, except where a waiver is justified based on technical impracticability.
  - No physical remedial system is required since the NDMA alluvium plume is stable.
- Utilize a technical impracticability waiver for restoring NDMA within bedrock groundwater in a reasonable timeframe.
  - Protectiveness in this zone will rely on Land Use Controls and monitoring.
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Groundwater Selected Remedy

Remedial Action for TCE:
- In-situ bioremediation with environmental covenant selected for TCE
- TI waiver with environmental covenant selected for NDMA in contaminated bedrock groundwater
- Operate and Maintain Interim Groundwater Remedial Actions
  - Remedial action performance monitoring
  - Assess remedial action progress
  - Optimize performance monitoring
Complex Case Study PJKS Groundwater Selected Remedy

Remedial Action Construction for TCE:
- Interim remedies address seven bedrock TCE source areas in contaminated bedrock groundwater
- Bioremediation – carbon source, nutrients & bioaugmentation
- Carbon source installed using vertical and horizontal wells and temporary injection points
- Biobarrier installation at bedrock/alluvium transition

- Operate and Maintain Interim Groundwater Actions
  - Remedial action performance monitoring
  - Assess remedial action progress
  - Optimize performance and monitoring
- Industrial land use restriction in warranty deed at transfer
- Negotiated landowner agreement to implement enforceable environmental covenant upon completion of ROD
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Groundwater Remedy Construction

Remedial Action Construction for NDMA:

- CDPHE approved a technical impracticability (TI) waiver for restoring NDMA within bedrock groundwater in a reasonable timeframe

- Basis for TI waiver
  - Large volume of NDMA contaminated bedrock
  - Poor permeability of bedrock (i.e., pumpability) and inability to access contaminated groundwater
  - Fractured bedrock with unpredictable flow characteristics and associated matrix back diffusion
  - Pumping with ex-situ treatment in PJKS bedrock groundwater is not technically or economically practical

- Contain NDMA in alluvium through monitoring of plume stability
  - No physical remedial system required (the alluvial plume is stable)
  - Protectiveness in this zone will rely on Land Use Controls and monitoring.
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Groundwater Remedy Construction

Conceptual Site Model

Property Boundary

Adjacent Property – Environmental Covenant

Point of Compliance

ICM

ICM Addendum

Bedrock
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Groundwater Remedy Construction
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Horizontal Well Locations
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Adaptive Site Management

- Implement Environmental Covenant to assure Protective Criterion
- Alternative Point of Compliance
- Implement Innovative Technology for in-situ remediation of ground water in plume
  - AFCEE BAA Project (follow-on to ESTCP Project)
  - Nutrient Supplementation (Propane or methane)
- Employs Treatment Train Concept – remediate TCE to reduce inhibition of NDMA bioremediation – followed by nutrient supplement tailored to NDMA
- Address Performance Objectives, Remediation Schedule and Contingency Planning
- Evaluate post remediation TI waver for TCE @ asymptotic effect
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Summary

- USAF, Regulators and Property owner worked together for sustainable remedies
- CERCLA and RCRA Programs can work together
- Remediation team agreed to:
  - Protect human health and the environment
  - Do the best we can
  - Don’t spend unrealistic amounts of money
- Made reasonable judgments as a team
  - Used simple assessments & appropriate tools
  - Long-term focus
  - Implemented phased approaches
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Questions?

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