REMEDIATION STRATEGIES FOR OIL AND GAS FACILITIES

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Should you have technical problems during the session, please raise your hand using the hand icon on your navigation panel. The organizer will assist you.

You will have the opportunity to ask questions. Please type your question into the “Question” box and we will address it during the Question and Answer session towards the end of the presentation.
Typical remediation scenario
Dig and haul

Typical release identified via:
- Surfacing
- Equipment replacement/Facility Upgrades
- Emergency Response/Acute Equipment Failure
- P&A

Advantages of dig and haul:
- 100% effective
- Easy to conceptualize
- Short Timeframe
- Remediation Infrastructure Developed
Typical remediation scenario
Dig and haul - horrors

- Waste is moved, not remediated
- Long truck trip to landfills
- Driving increases safety risk
- $$$$$ - expensive
- May be out of alignment with ESG goals
Typical remediation scenario
Dig and haul

Estimated Cost: >$110,000

Horrors of Dig and Haul - Simple Cost Model

Excavation: 50’ x 50’ x 10’

- > 1,100 yards @ 20% expansion
- @ > $100/yard for excavation, backfill, compaction, trucking, landfill tipping fee
Remediation technology selection

How do we know when to change or implement new technologies?
How can we justify these decisions?
Remediation technology selection
Best practices

1. ER transition
2. CSM - Site conditions and constraints
   - Access
   - Stakeholders
   - Fate and Transport
   - Geology/hydrogeology
3. Technologies and limitations
   - Persistence of technology
   - Pilot testing
4. Regulatory - endpoints/milestones
5. Aware of resources (people/time/tools)
6. Liability evaluation - Risk vs. Cost
7. Creative approach
8. Continual data and performance evaluation
9. Multiple technologies
Consideration Technologies

- **Physical**
  - Excavation/Source Removal
  - Soil Vapor Extraction/Air Sparging
  - Fluid Extraction/DPE/MPX
  - Thermal Desorption

- **Chemical**
  - ISCO/ISCR
  - Soil Shredding
  - Thermal Destruction

- **Biological**
  - Enhanced attenuation/biostimulation
  - Electron Acceptor Stimulation
  - Bio-augmentation
  - Carbon Adsorption
### Consideration

**Technology cost data**

#### EPA Cost Data - EPA-542-R-01-009

<table>
<thead>
<tr>
<th>Mechanism</th>
<th># sites</th>
<th>High ($) / yard</th>
<th>Low ($) / yard</th>
<th>Average ($) / yard</th>
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<td>SVE</td>
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#### WSP Cost Data

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<th>Low ($) / yard</th>
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<td>Case Study #3</td>
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</table>
Carbon and Air Sparging Case Study
Carbon and Air Sparging Case Study

- Fast timeframe due to receptor
- Multi-technology approach
- Source excavation, carbon barrier wall, and air sparging
- Remote location - utilize local rental equipment
- Total project costs: $150k
- If only excavation $600k
- If only carbon injection $200k

Savings $45k-$500k
Dual Phase Extraction Case Study
Dual phase extraction
Case study
Dual phase extraction Case study

- Alternative DPE well design using equipment available to the operator
- Depth variable across the site
- Bakken crude is relatively volatile (2017 89 bbls LNAPL, 85 bbls equivalent vapor phase). Total 479 bbls removed
- First active in-situ remediation system within the former NDIC
Benefits to alternative approach

- Excavation cost prohibitive
  $2.5M to $4M+

- Dual phase extraction – equipment and installation
  $150k, total project cost $200k

- Approach non-disruptive to site operations

- Reduction in GHG Emissions (less heavy equipment and minimal heavy truck trips)
Solar Soil Vapor Extraction Case Study
Solar soil vapor Extraction case study

- Historic skim pit requires remediation - 60x40x30 with TPH and benzene impact
- SVE chosen technology following pilot test - remote but utilize solar power (6 kw array - 20 panels) runs a 5-horsepower regenerative blower
- Top 20 feet in compliance, now focusing on bottom 10 feet. Anticipate 1-2 additional years of operation
- Dig and Haul - $200k-$300k

Savings $150k (for one pit)
Benefits to alternative remediation vs. excavation

**Social**
- Dig and haul negative aspects of truck traffic (safety, dust, noise and road degradation)
- Dig and haul would provide more jobs; however, only temporary
- Reduction of capacity of local landfill

**Environment**
- Less waste (3,000 cubic yards vs. 5 cubic yards)
- Less GHGs (152 metric tons CO2e vs. 16 metric tons CO2e)
- Less onsite and off-site NOx, Sox and PM
- No loss of topsoil

**Economic**
- Dig and Haul => $200k
- Solar SVE = $150k
- Using same system for remediation portfolio (3 pits) => $600k vs. $300k
Question today
Imagine tomorrow
Create for the future
Thank you for joining us!

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