Citizens Advisory Board Meeting

Area Completion Projects
New Technologies on the Horizon

Presentation By
CHRIS BERGREN
PROJECT MANAGER
AREA COMPLETION PROJECTS
Savannah River Nuclear Solutions, LLC

July 28, 2009
## List of Acronyms

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<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tr>
<td>DOE</td>
<td>Department of Energy</td>
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<tr>
<td>Ft</td>
<td>Feet</td>
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<tr>
<td>FY</td>
<td>Fiscal Year</td>
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<td>I-129</td>
<td>Iodine-129</td>
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<td>MicroCED</td>
<td>Micro-organism Chloro-Ethene Dechlorination</td>
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<td>MSL</td>
<td>Mean Sea Level</td>
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<td>PCE</td>
<td>Tetrachloroethylene</td>
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<td>PPM</td>
<td>Parts Per Million</td>
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<td>SRNL</td>
<td>Savannah River Nuclear Solutions</td>
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<td>SRS</td>
<td>Savannah River Site</td>
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<td>SVE</td>
<td>Soil Vapor Extraction</td>
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<td>TCE</td>
<td>Trichloroethylene</td>
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<td>VOCs</td>
<td>Volatile Organic Compounds</td>
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Agenda

• Purpose
• Overview of SRS Groundwater Strategy
• New Technologies
  – Source treatment (high contaminant concentration)
  – Intermediate treatment (moderate contaminant concentration)
  – Distal / low contaminant treatment (low contaminant concentration)
Purpose

• Provide an overview of SRS technology selection criteria with examples of new / emerging technologies
SRS Groundwater Strategy

- Over the last 15 years, the SRS cleanup strategy has evolved into a mature and successful program recognized within the Department of Energy as a leader in environmental remediation. SRS selects remediation technologies that:
  - Remediate the worst first (high risk)
  - Are customized to the problem
  - Focus on source contamination
  - Are cost effective
  - Meet regulator and stakeholder expectations
  - Can be deployed within a needed timeframe
Overview of Groundwater Conditions

• Mature Groundwater Program
• All known / suspect plumes identified
  – 14 Groundwater Contamination Areas
    • 11 active
    • 17 enhanced
    • 9 passive
    • 3 shutdown
    • 4 pending final decisions
• Remedial actions ongoing since the mid-1980s
Savannah River Site
Groundwater Contamination Areas

**South Carolina**

14 Groundwater Contamination Areas

11 Active Remediation Systems
Airstrippers (2), Recirculation (2), Dynamic Underground Stripping, Soil Vapor Extraction Units (A/M - 4), Airstripper (TNX), Base Injection (F-Hazardous Waste Management Facility)

17 Enhanced Systems
Baroballs (A/M, Miscellaneous Chemical Basin, P- and A-Burning Rubble Pits, Chemical, Metals, & Pesticides Pits - Field B, M-Area Inactive Process Sewer Lines (2))
Microblowers (A- and C-Burning Rubble Pits, M-Area Inactive Process Sewer Lines (2), and Miscellaneous Chemical Basin)
Barrier walls (F&H Hazardous Waste Management Facility)
Phytoremediation (Mixed Waste Management Facility)
Edible Oil (T Area)
Silver Chloride Injection (F-Hazardous Waste Management Facility)

9 Passive Systems
Monitored Natural Attenuation (Chemical, Metals, & Pesticides Pits; D-Oil Seepage Basin; R-Reactor Seepage Basin; K-, C-, P-, and L-Burning Rubble Pits, Sanitary Landfill, and L-Area Southern Groundwater)

3 Systems In Shutdown
Biosparge (Sanitary Landfill)
Groundwater Waste Treatment Units (F&H)

4 Systems Pending
Technology Deployment

• Develop and implement alternative technologies
• Regulator support using innovative technologies
• Allows SRS to evaluate technology effectiveness in the field
  – Technologies developed specifically for SRS
  – Technologies “borrowed” from industry
• Serves as “proving ground” for future implementation
• Successful history of sharing technologies with regulators, industry, and other federal facilities
Remediation Strategy / New Technologies

**Source Area**

- Physical Processes:
  - Thermal Detritiation
  - Chemical Oxidation

**Primary Plume Zone**

- Biological Processes:
  - Edible Oil Injection
  - MicroCED

**Dilute Plume Zone**

- Polishing Steps:
  - I-129 capture with silver chloride
  - Solar SVE MicroBlowers
New Technologies / Source Area

- Chemical, thermal, and physical processes
  - Thermal Detritiation at D Area
  - Chemical Oxidation of Volatile Organic Compounds (VOCs) at A-14 and P Area
D-Area Operable Unit - Thermal Detritiation Pilot

- Approved Treatability Study Plan to treat tritium contaminated concrete
- Thermal Treatment Unit (24’ x 18’ x 4’) consists of concrete block walls, electrical heating elements, and roof structure
- Treated 77 cubic yards of tritium contaminated concrete and soil (45 Curies) from 420-D slab
- Maintained 815 degrees Celsius for 30 days to drive tritium from concrete
- Post operational testing underway
- Offers potential cost savings alternative for treatment / burial of tritiated media elsewhere at SRS and the DOE Complex
Chemical Oxidation

- In situ technology to remediate solvents within vadose zone / aquifers
- Previously demonstrated in M Area using hydrogen peroxide (over 98 percent destruction)
- New deployments in A and P Areas will utilize sodium persulfate
  - Safer
  - Less toxic byproducts (carbon dioxide, sulfate, chloride, sodium, hydrogen ions)
  - Longer lasting (treatment time)
  - Positive bench scale results
- Partnering with experienced commercial vendor
- A Area deployment (aquifer)
  - Inject approximately 9250 pounds of sodium persulfate (5000 gallons)
  - Inject in small batches over one-week period
  - Monitor groundwater concentrations over time
Chemical Oxidation with Persulfate at A-14 Outfall

A-014 Outfall Source Area

Monitor Well  Monitor Well  Injection Well  Monitor Well  Monitor Well  Monitor Well

Vadose Zone

Green Clay Confining Zone

Lost Lake Aquifer Zone

ft / msl

350
300
250
200
150

10’  15’  25’  600’  70’
Primary Plume Zone

- Biological Processes
  - Edible Oil Injection at T Area
  - MicroCED at P Area
Edible Oil Deployment

- Recently deployed in T Area to remediate solvent contaminated groundwater
  - Injection / extraction to enhance treatment zone

- Promotes enhanced attenuation
  - Aquifer becomes anaerobic, initiating reductive dechlorination

- Positive test results
  - Solvent (TCE) plume size decrease
  - Biological / chemical parameters confirm reductive dechlorination is occurring (i.e., methane generation)

- Allows shutdown of existing pump-and-treat system
Emulsified Oil Deployment

A = concentrated emulsified food grade vegetable oil, nutrients and buffer/base
B = metering and flow monitoring system
C = emulsified oil injection well
D = extraction well to control oil zone geometry
E = air stripper – VOC water treatment system (equipped with tank/pump for recirculation)
Future Technology Development - MicroCED

• What is MicroCED?
  – Micro-organism Chloro-Ethene Dechlorination
  – Indigenous bacteria discovered at SRS
  – Robust, highly active dehalogenating culture
  – Injected into the subsurface to promote bioremediation of solvents
MicroCED Deployment Test: P-Area Groundwater

• Previous operations resulted in groundwater being contaminated with trichloroethylene (TCE) and tetrachloroethylene (PCE)
• Groundwater plume is long and narrow; flow is relatively slow
• High concentrations {17-22 parts per million (ppm)} near the source zone
• Groundwater depth is less than 50 feet
• Evidence of limited dechlorination associated with natural attenuation

By applying this technology in conjunction with source reduction measures, the impact to groundwater will be reduced in a cost effective approach.
Dilute Plume

- Polishing Steps
  - Iodine-129 (I-129) capture with silver chloride
  - MicroBlowers
Radioactive Iodine Capture with Silver Bearing Materials

- Initiated first application in the F-Seepage Basin groundwater
- I-129 can be captured with silver chloride to form silver iodide which has a very low solubility
- Bench scale studies indicate that the materials developed are very effective
- Savannah River National Laboratory (SRNL) will patent the invention for use
Electron Photomicrographs

Before
Silver chloride before capture of iodine

After
Silver chloride in a soil matrix after capture of iodine (crystal structure change)
Solar Powered SVE MicroBlowers

• Semi-passive Soil Vapor Extraction source remediation
• Solar power minimizes impact on facilities and operations
• “Green” technology – no fossil fuels utilized / no carbon (greenhouse gas) emissions

Typical Solar Powered MicroBlower Well
Conclusion

• Continue to explore application of new technologies
  – Chemical Oxidation
  – Soil Fracturing
  – Edible Oil Injection
  – Bioremediation

• Aggressively pursue remedial optimization
  Active ➔ Passive ➔ Natural

• Protect human health and environment