

# Environmental Clean Up at SRS

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*Citizens Advisory Board*

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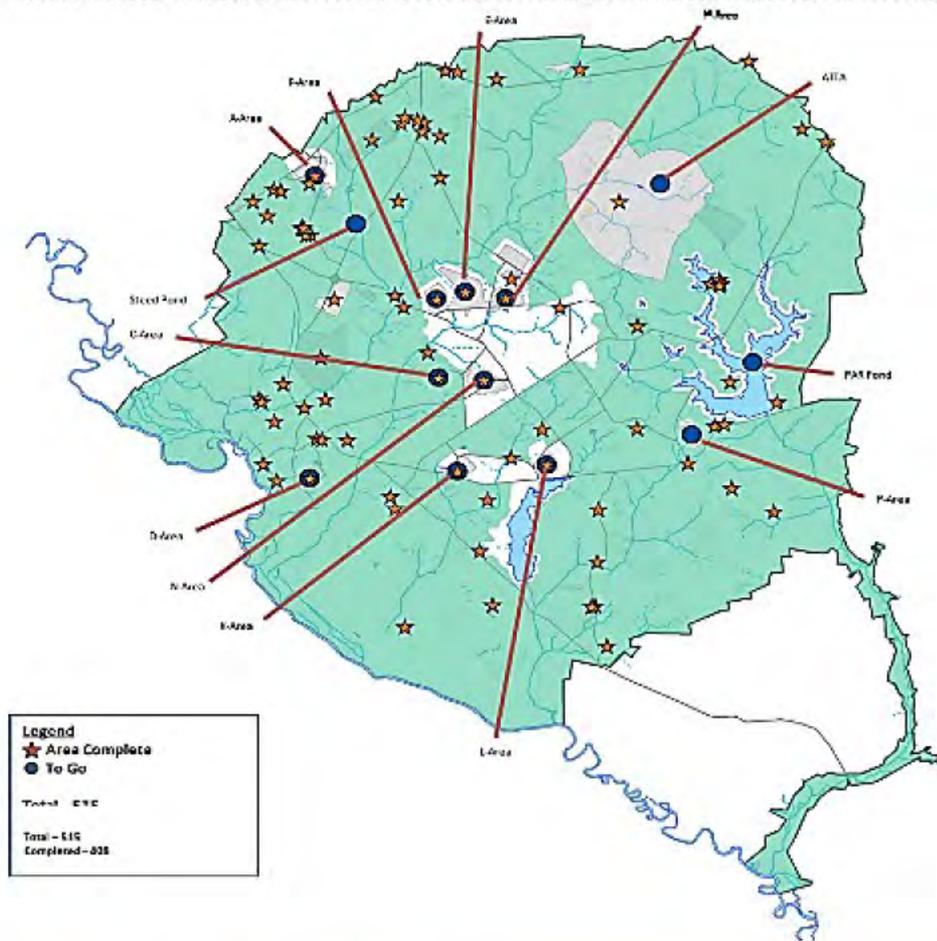
# Acronyms

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- SRS – Savannah River Site
- VOCs – Volatile Organic Compounds
- SVE – Soil Vapor Extraction
- FFA – Federal Facility Agreement
- m – meter
- CMP – chemicals, metals, and pesticides
- DUS – Dynamic Underground Stripping
- TCE – trichloroethylene
- ppb – parts per billion

# Environmental Clean up at SRS

- Cleanup started in late 1980's
- FFA signed 1993
- 408 of 515 Waste Sites completed
- 85% footprint reduction



# Area Closure

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# Area Closure



P-Reactor (Pre-D&D)



Reactor Stack Implosion



Reactor Disassembly  
Basin Demolition



P-Reactor Upon Completion



In Situ Decommissioning of P & R Production Reactors

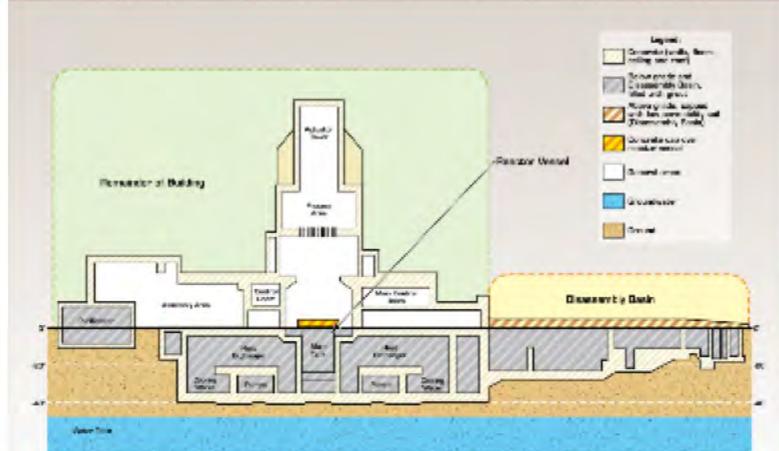
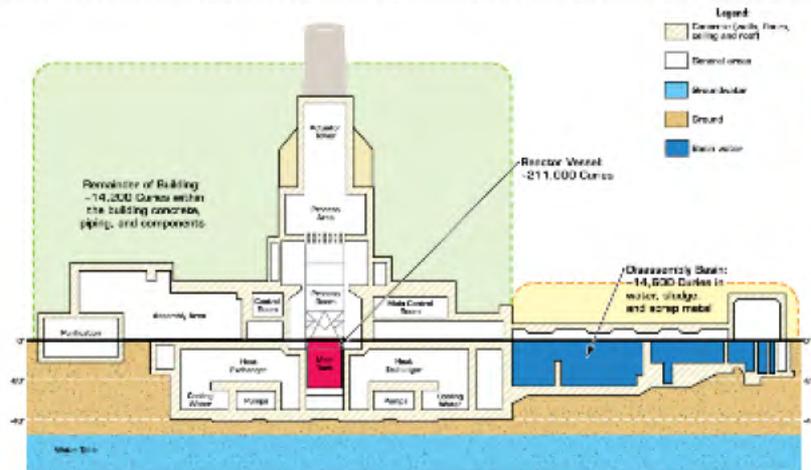
## Area Closure

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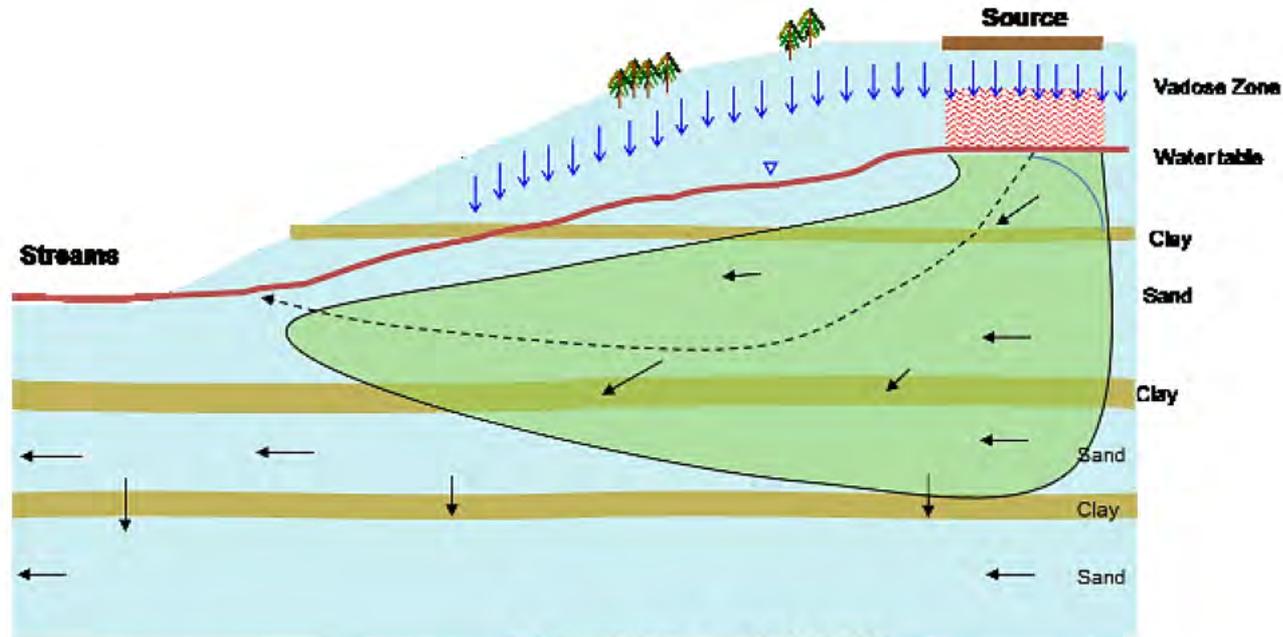


Portions of the reactor buildings below grade were filled with grout.

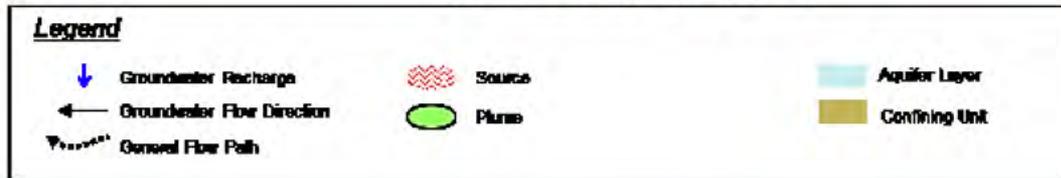
# Area Closure



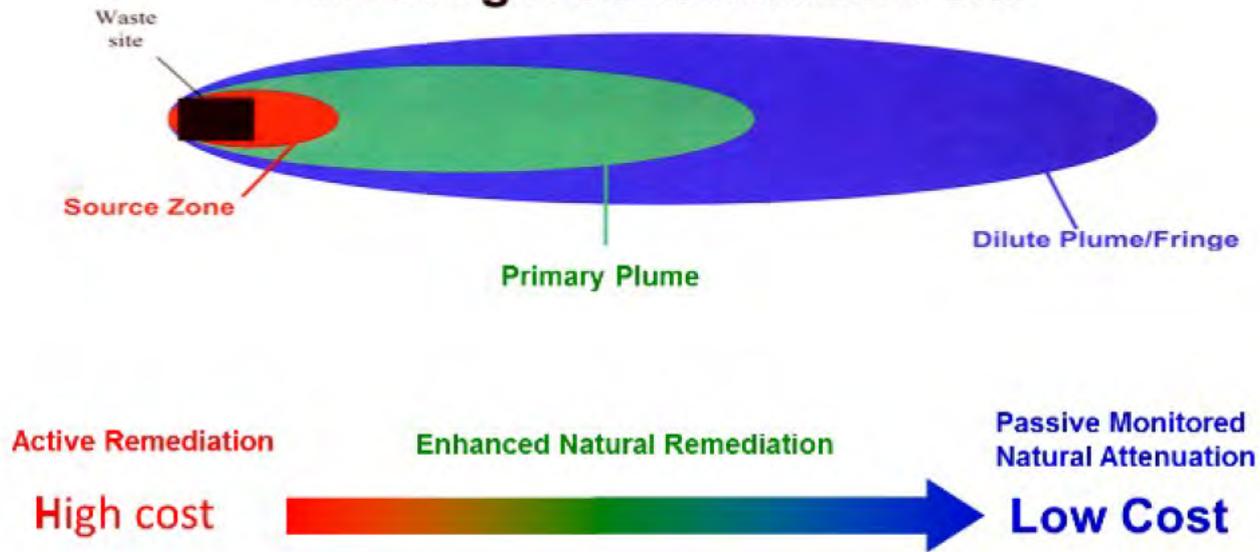
# Conceptual Site Model



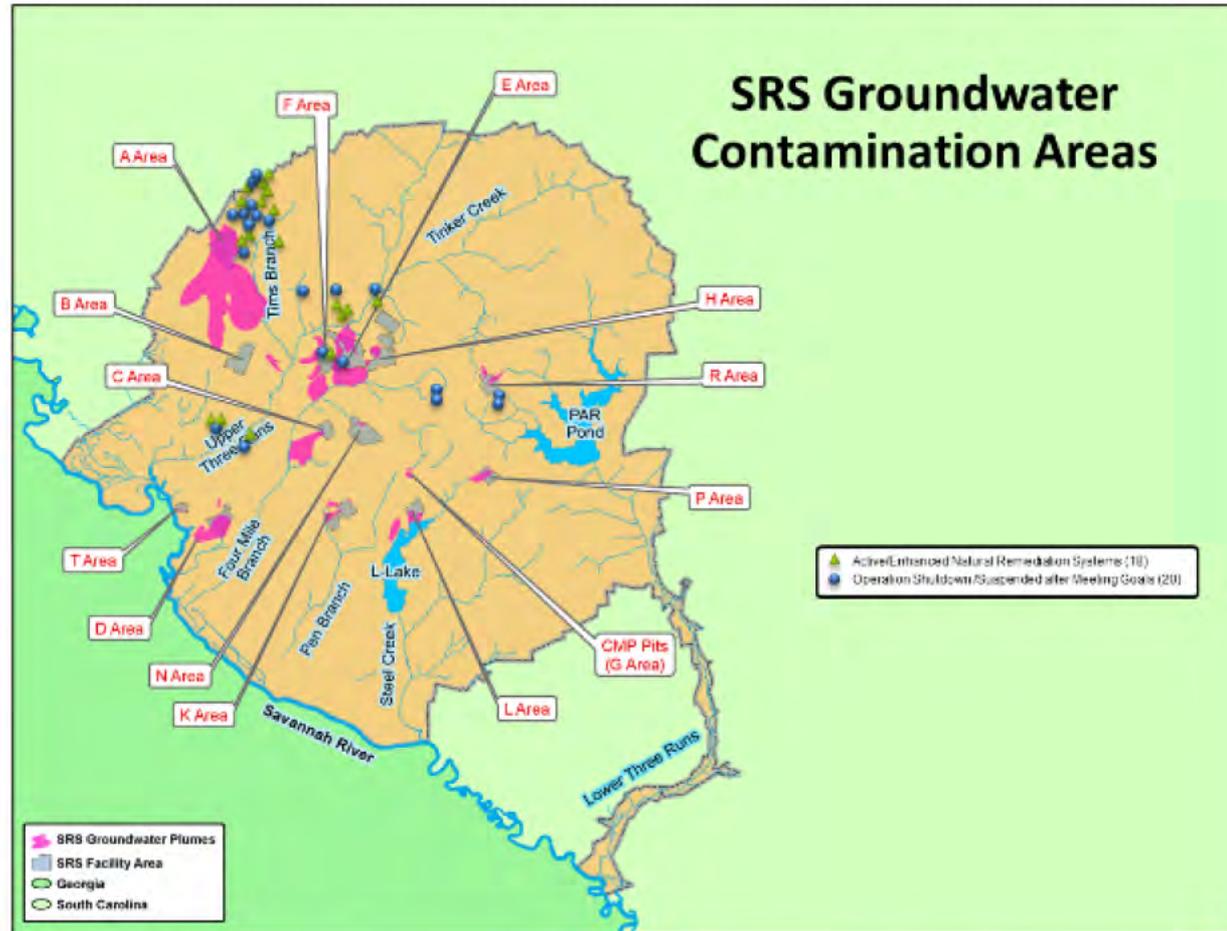
(Conceptual Diagram - Not to Scale)



## Treating a Contaminated Site



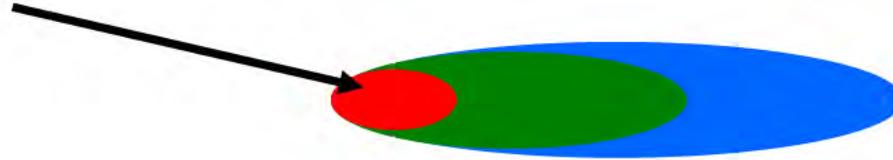
# Groundwater



## Source Zone

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- Excavation
- Soil Stabilization
- Low permeability covers
- Thermal technologies
- In-situ chemical oxidation
- Soil vapor extraction (SVE)



# Excavation



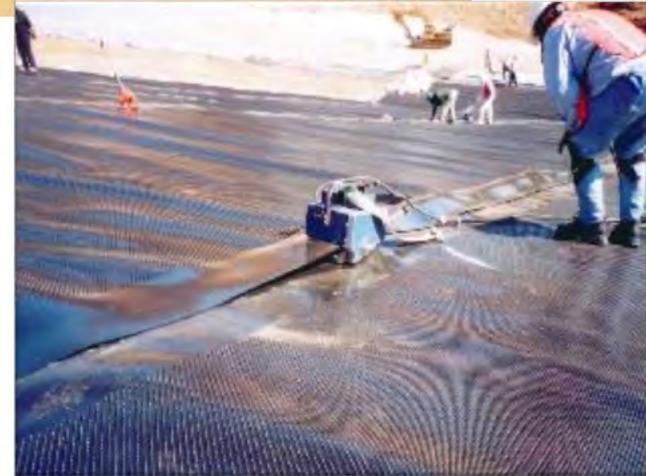
# Stabilization of Radioactively Contaminated Soil

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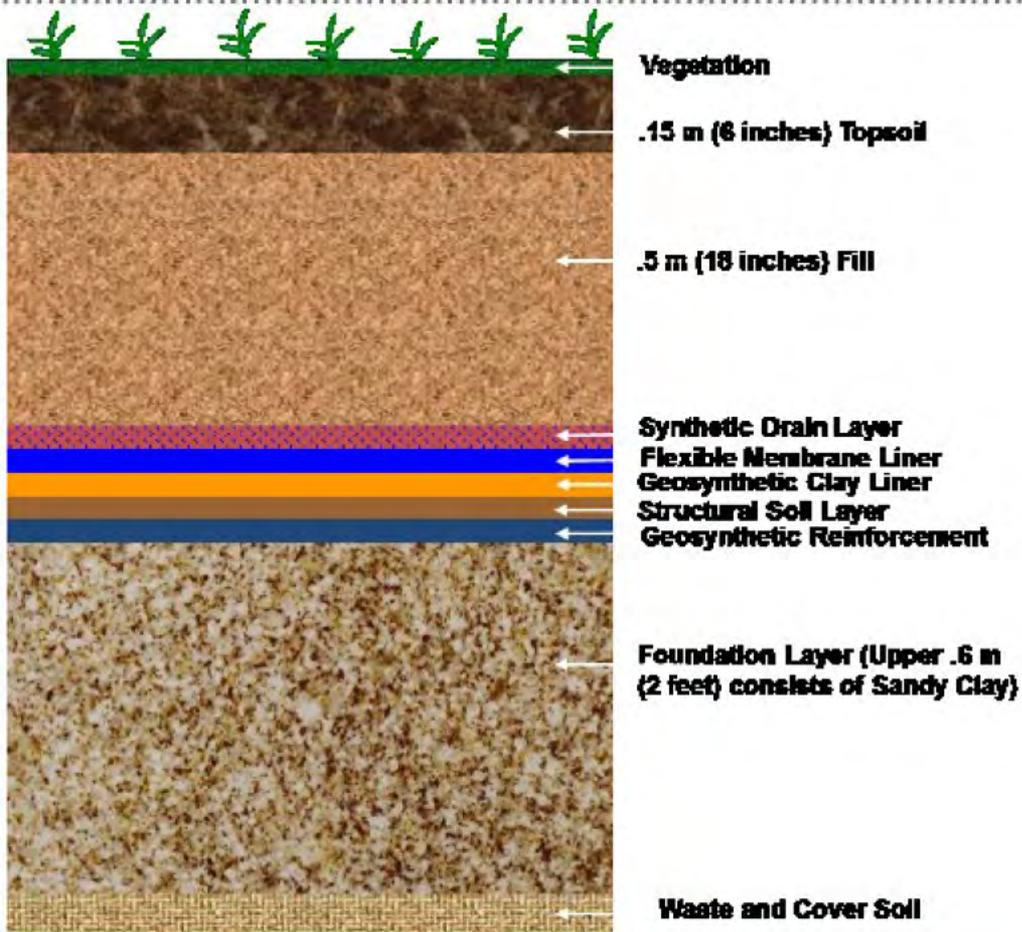


# Low Permeability Cap

- D Area Ash Project



# Low Permeability Cap



## Low Permeability Cap

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# Thermal Remediation of VOCs

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## Dynamic Underground Stripping



- Large scale application
- Steam injection
- ~500,000 pounds of Volatile Organic Compounds (VOCs) removed in M Area

## Electrical Resistance Heating



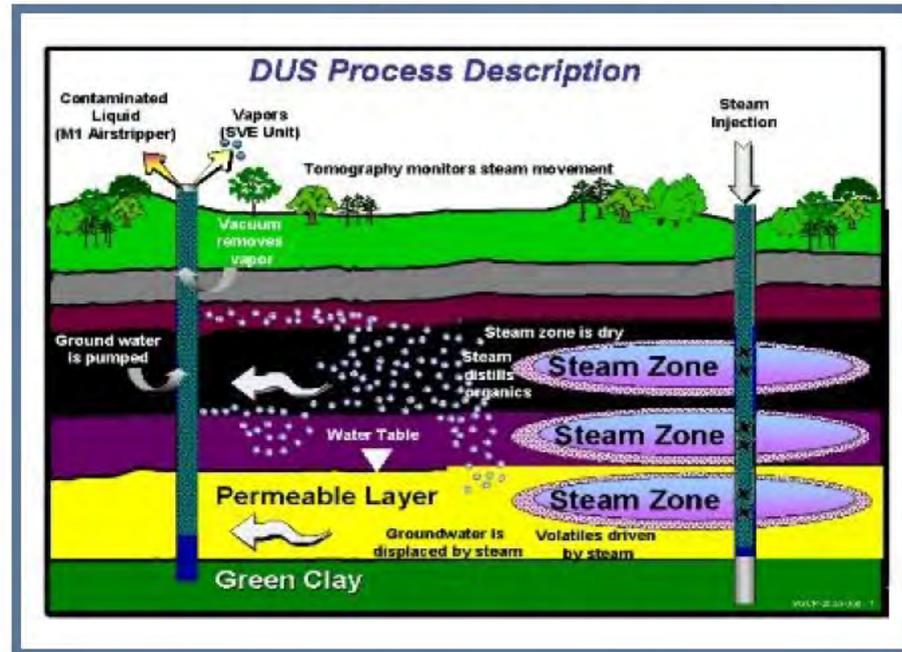
- Smaller scale
- ~ 4 months of operation
- 99% effective, ~ 700 pounds removed
- Multiple deployments at SRS

# Dynamic Underground Stripping

- Inject Steam
- Extract and treat vapor and water

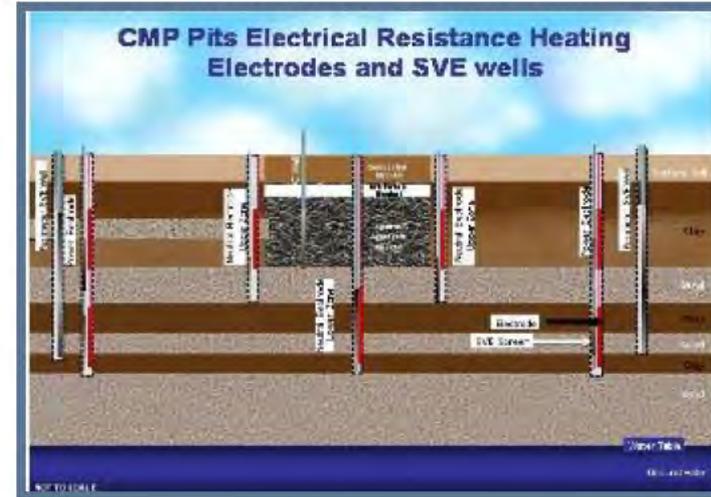


Dense Non-Aqueous Phase Liquids (DNAPL)



# Electrical Resistance Heating

- Electrodes heat the ground
- Contaminants volatilize
- SVE removes vapors
- Removed ~99% of VOCs

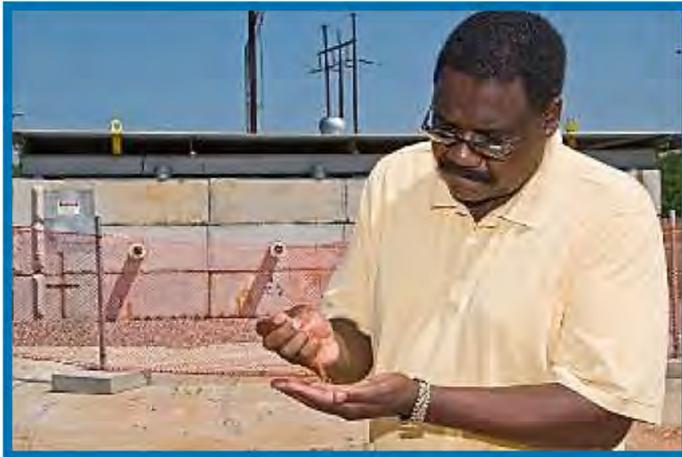


# Thermal Detritiation

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- **Thermal Treatment Cell:**
  - Concrete block walls
  - Electrical heating elements
  - Roof
- **Drive tritium from contaminated concrete and soil**
- **D Area**



# Soil Vapor Extraction



# Fracturing

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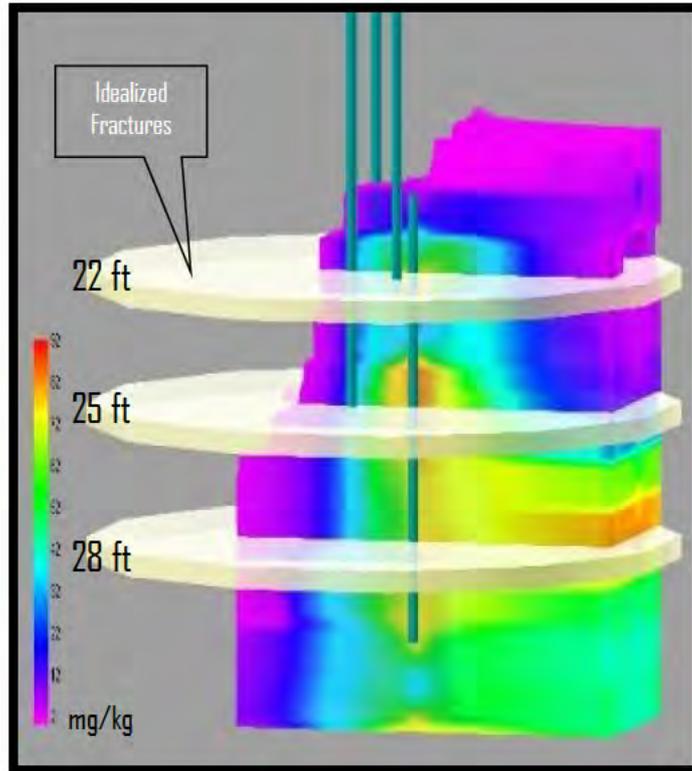
Soil notching using a high pressure jet – initiates fractures horizontally



Mixed guar/sand slurry loading into the pumping hopper

# Soil Hydraulic Fracturing

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- High pressure fractures
- Inject sand, water, and guar slurry
- Horizontal fractures (~10 feet radius)
- SVE flow rates increased an order of magnitude

# Primary Plume

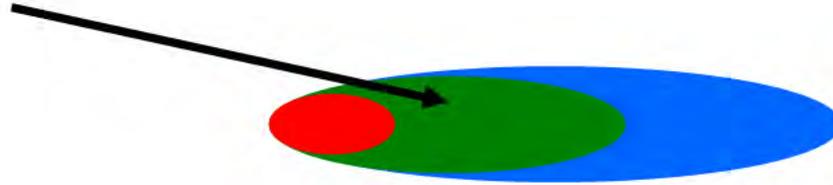
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- **Hydraulic Control**

- Pump and Treat
- Barrier walls
- Phytoremediation pond

- **In situ**

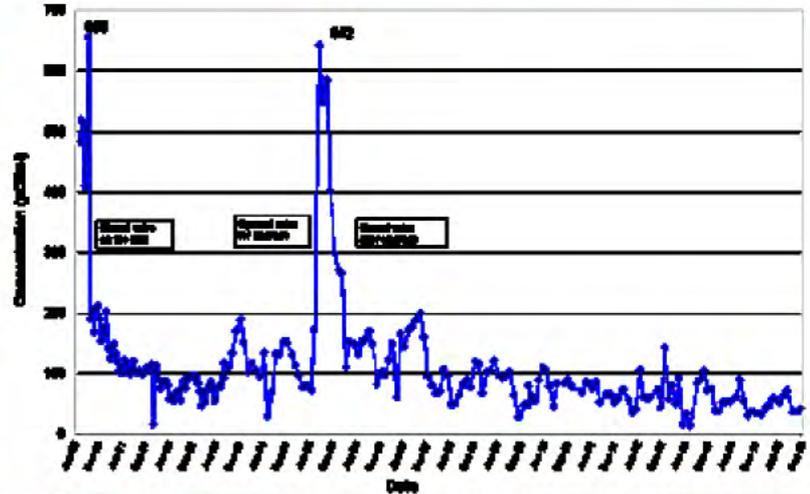
- Subsurface injection
- Chemical oxidation injection
- Nutrient injection to enhance bioremediation



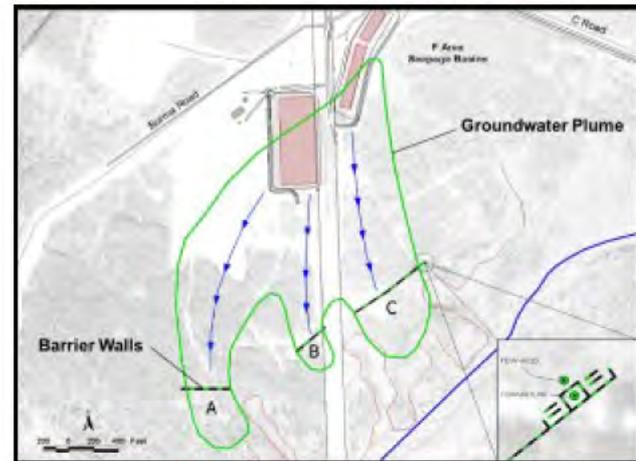
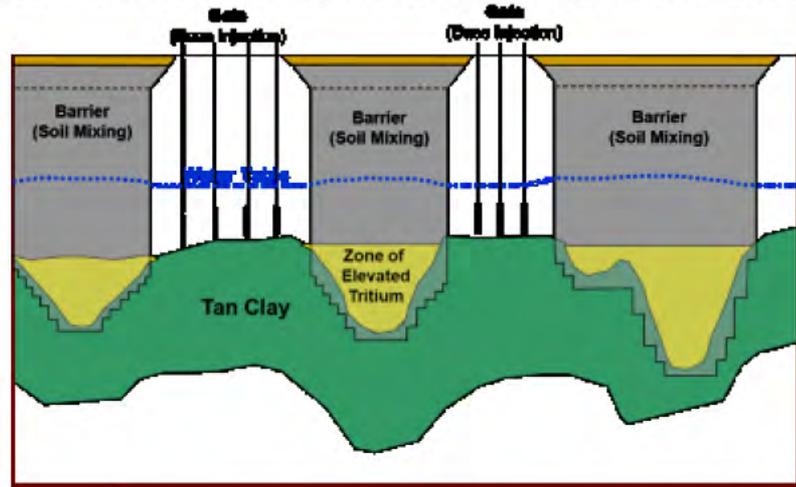
# M1 Air Stripper



# Phyto-remediation: Collection Pond with Irrigation



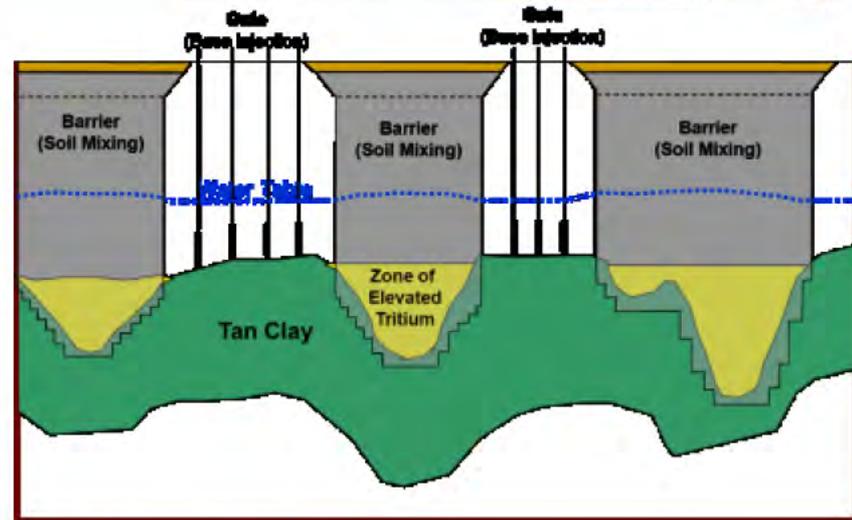
# Subsurface Barriers



F Area Subsurface Barriers

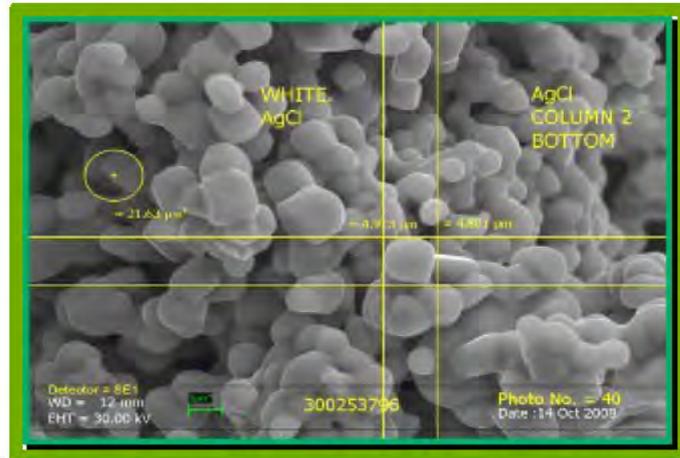
# Base Injection

- Inject base chemicals to increase pH and immobilize metals in groundwater

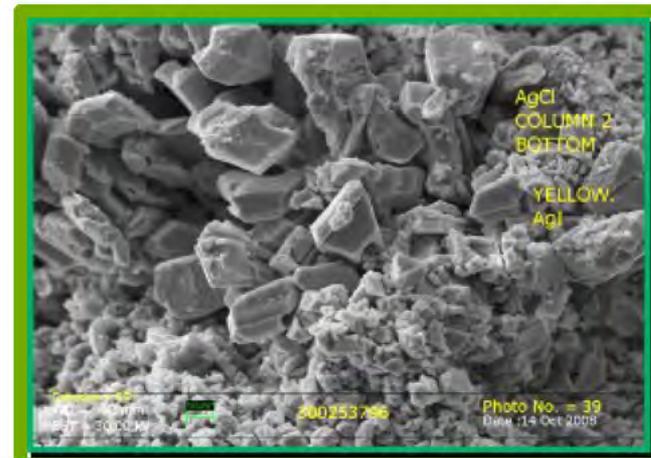


# Silver Chloride Injection

- In Situ Remediation of Iodine-129
- Injection of Silver Chloride
- F Area



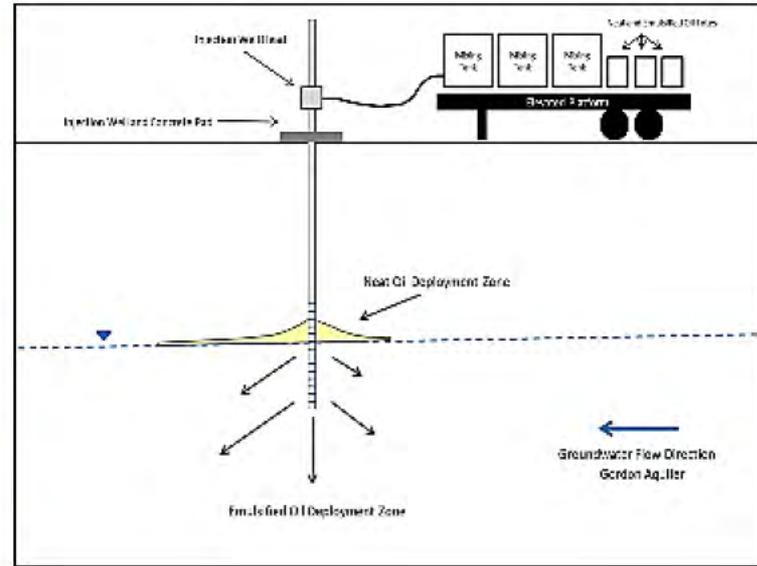
**Silver Chloride Before Capture of Iodine**



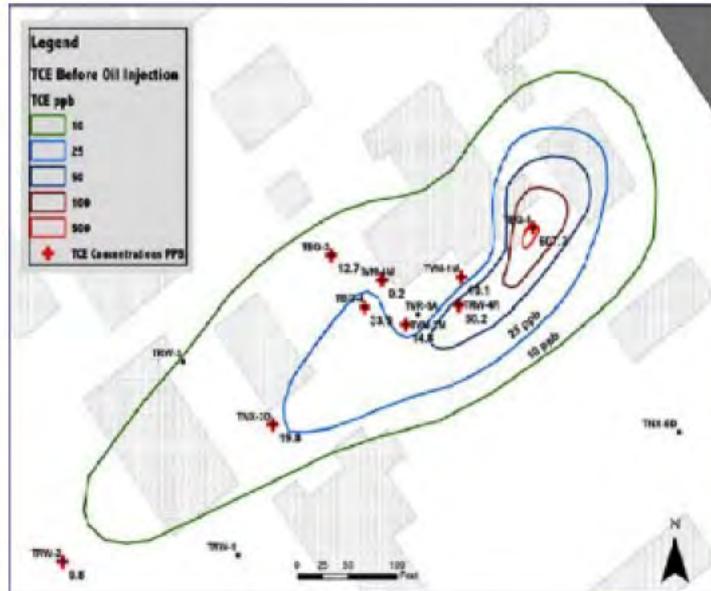
**Silver Chloride After Capture of Iodine**

# Edible Oil Injection

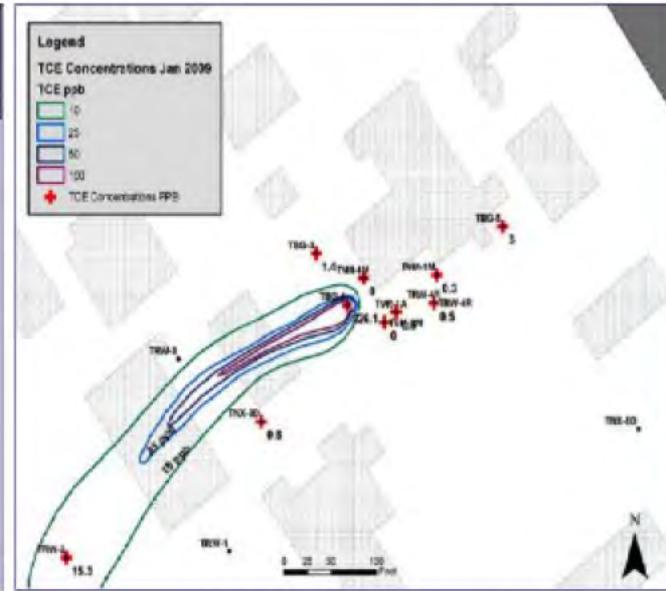
- Bio-remediation
- Inject nutrients to enhance growth of naturally occurring microbes
- Microbes consume the contaminants (VOCs)



## T Area Edible Oil (Before and After)



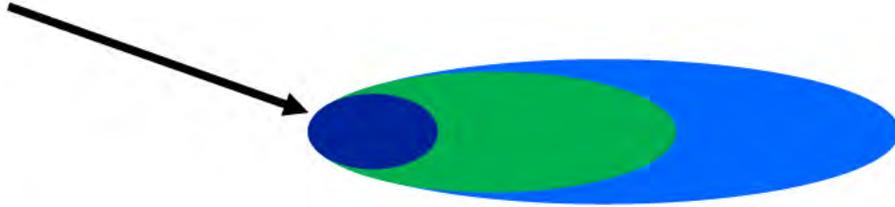
Plume before oil injection.



Plume after oil injection.

## Depleted Source Areas

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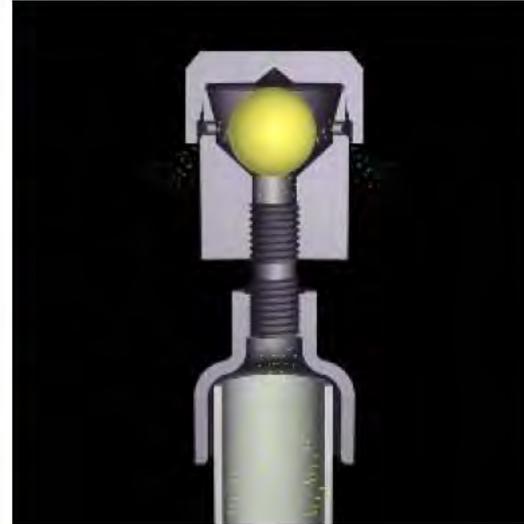
- Solar Powered Soil Vapor Extraction
- Passive Soil Vapor Extraction

# Soil Vapor Extraction with Solar Powered Micro-blowers



## Soil Vapor Extraction with Barometric Pumping (Baroballs)

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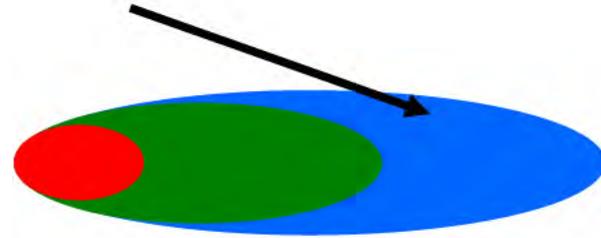


When the subsurface pressure is higher than at ground surface, contaminants naturally move upward through venting wells.

When the above ground pressure is greater, air is prevented from traveling down by a simple plastic sphere.

# Plume Fringe and Depleted Plumes

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- **Monitored Natural Attenuation**

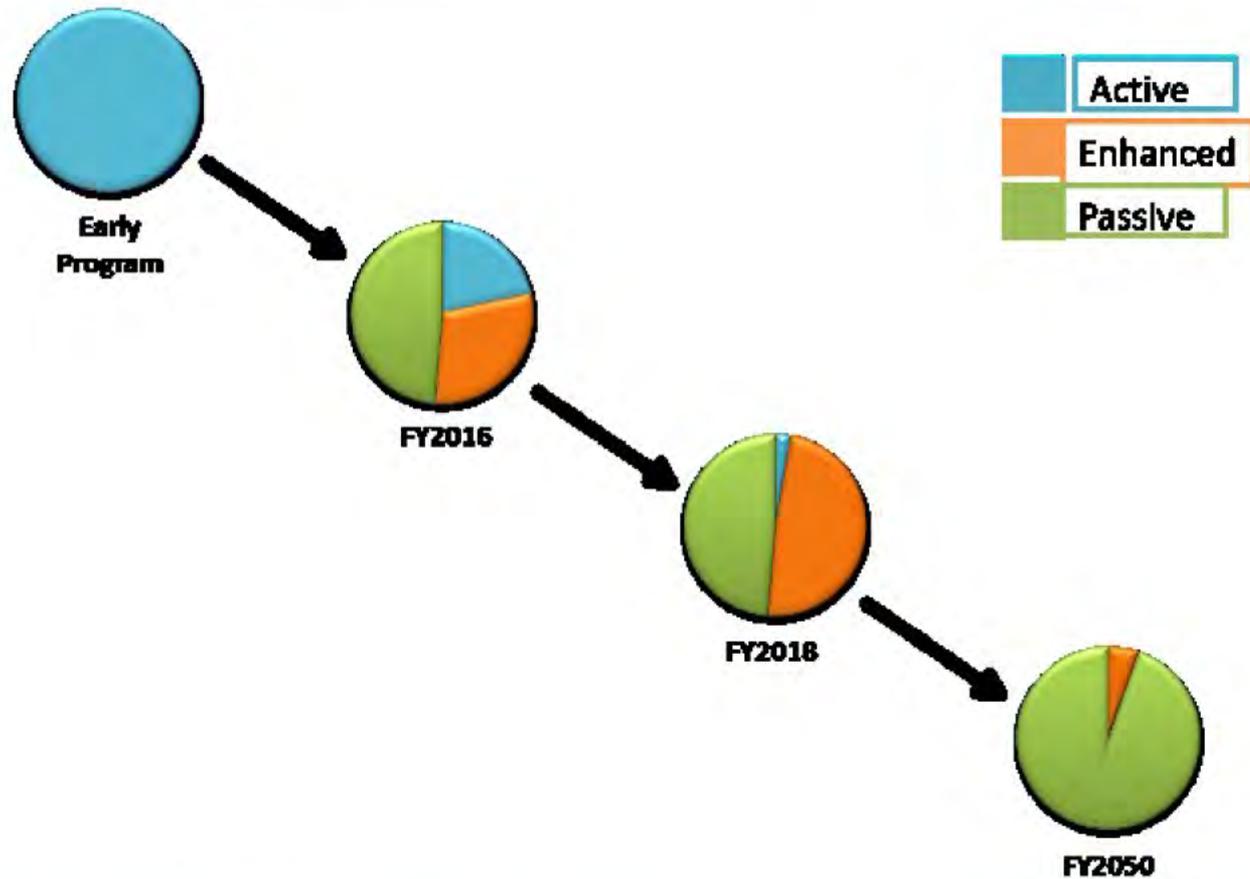


# Monitoring



# Active to Passive Transition

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## Remedial Decisions Coming Soon

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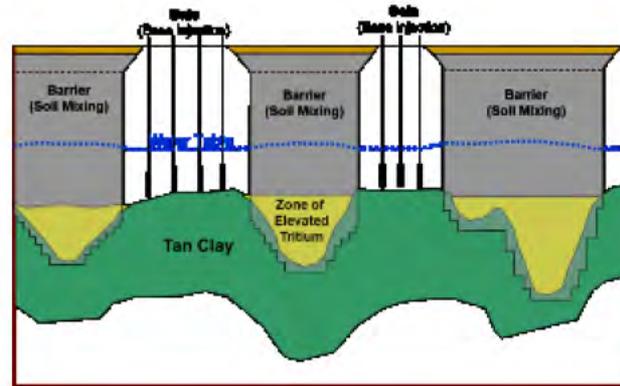
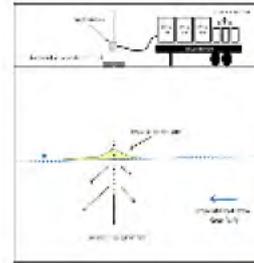
- Lower Three Runs
- D Area Groundwater
- G Area Oil Seepage Basin





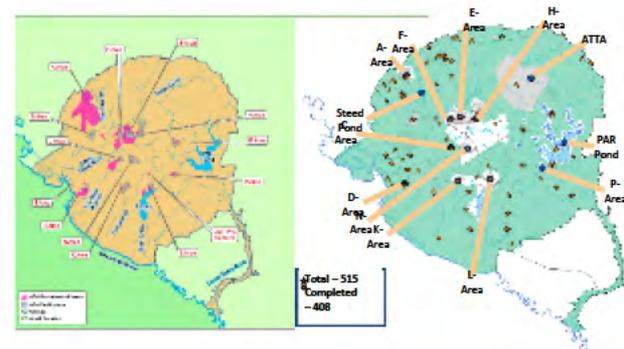
# Long Term Work

- **Soil and Groundwater remediation:**
  - M Area, F Area, H Area, MWMF
- **Five Year Remedy Reviews**
- **Long Term Monitoring**



# In the Future

- Ash Projects
- N Area Groundwater
- K Area Groundwater
- Close Remaining Areas



## Lessons Learned

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- Collaboration breeds innovation



- Robust source control offers return on investment



- Working with nature works well

# Conclusion

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- Active to passive remedial strategy
- Leverage natural processes
- More work to do



