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Sandia National Laboratories

Soil Treatability Study

Energy Technology Engineering Center • U.S. Department of Energy

Process Update for the Soil Treatability Study

ETEC STIG; April 5, 2012

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Repository Performance Department, 6212

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U.S. DEPARTMENT OF ENERGY | NNSA

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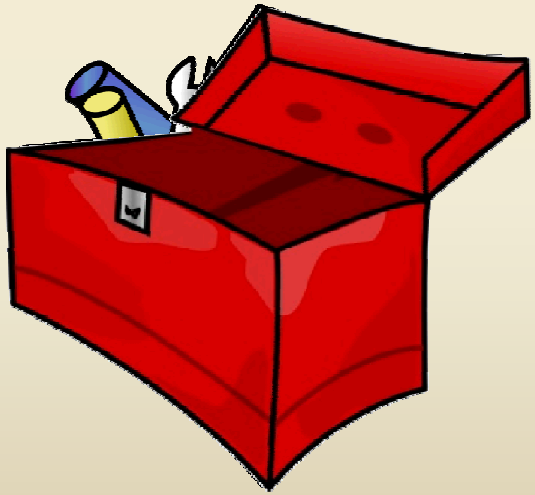
How will we select viable technologies for the ETEC site?

Soil Treatability Study



Soils Remedial Action Implementation Plan

How do we put that toolbox together?

Testing

Many Technologies are Available	Many Criteria Must be Considered	Technology Groupings will Emerge
Phase I *Literature Search* *Stakeholder Input* *Expert Opinion Poll*	Phase II *Down Select Based on Criteria*	Phase III *Choose Technologies for Bench or Pilot Scale Testing*

Study Boundaries

The DOE sets the study boundaries

These are set in part based on consideration of the AOC

- The goal of the chosen remediation alternatives will be to meet the established cleanup levels or reduce the contaminant concentrations/volume of soil to be excavated
- There will be no "leave in place" or on site burial/landfilling of contaminated soils
- Remediation alternatives will be initiated by 2017
- Incineration (burning that forms an ash) will not be used as a remediation alternative
- Remediation alternatives will not exacerbate existing contamination issues or create new contamination problems
- Treatability studies being conducted for groundwater and unweathered bedrock are ongoing and will not be duplicated

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Objectives

- Dig and haul/excavation will be minimized as much as possible
- Remediation alternatives will be designed to consider the wild fires, native vegetation, and natural environment as much as possible
- Land and site disturbance will be minimized as much as possible
- Green and innovative/cutting edge technologies will be assessed as much as possible

The objectives are consistent with the AOC and are a reflection of the expressed concerns of the public through this working group

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Treatment Strategies

- This is where we are now…….

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Treatment Strategies

This is where Sandia comes in.
We have to think about the treatment strategies with the highest probability for success.
Success is defined as meeting the Study Boundaries completely and meeting the objectives as much as possible

Expert Opinion Poll

Active (Short-Term Strategies)
In-Situ Thermal (0°-200°C)
Ex-Situ Thermal (200°-500°C)
Bioremediation
Phytoremediation
In-Situ Nanotechnology
Ex-Situ Soil Washing

Passive (Long-Term Strategies)
Phytoremediation *(if required)*
Engineered Barrier
(only if recontamination is possible)

Active Strategies

In-Situ Heat (0-200°C)	Ex-Situ High Heat (200-500°C)	Bioremediation	Phytoremediation	In-Situ Nano	Ex-Situ Soil Washing
Dioxins	Dioxins	Dioxins	Dioxins	Dioxins	Dioxins
NDMA	Hg	PAHs	Metals	NDMA	Metals
PAHs	NDMA	PCBs	NDMA	PAHs	NDMA
PCBs	PAHs	PCTs	PAHs	PCBs	PAHs
PCTs	PCBs	Perchlorate	PCBs	PCTs	PCBs
Pesticides/ Herbicides	PCTs	Pesticides/ Herbicides	PCTs	Perchlorate	PCTs
SVOCs	Perchlorate	SVOCs	Perchlorate	Pesticides/ Herbicides	Perchlorate
TPHs	Pesticides/ Herbicides	TPHs	Pesticides/ Herbicides	SVOCs	Pesticides/ Herbicides
VOCs	SVOCs	VOCs	Rads	TPHs	Rads
	TPHs		SVOCs	VOCs	SVOCs
	VOCs		TPHs		TPHs
			VOCs		VOCs

ACRONYMS -

Hg = Mercury
NDMA = *N*-Nitrosodimethylamine
PAHs = Polyaromatic hydrocarbons
PCBs = Polychlorinated biphenyls
PCTs = Polychlorinated triphenyls
Rads = Radioactive elements
SVOCs = Semivolatile organic compounds
TPH = Total petroleum hydrocarbons
VOCs = Volatile organic compounds

Active/Passive Strategies

	In-Situ Heat (0-200°C)	Ex-Situ High Heat (200-500°C)	Bio-remediation	Phyto-remediation	In-Situ Nano	Ex-Situ Soil Washing
Active						
Passive	**Phyto-remediation** Dioxins Hg PAHs PCBs PCTs Pesticides/ Herbicides SVOCs TPHs VOCs	**Engineered Barrier** Dioxins Metals NDMA PAHs PCBs PCTs Perchlorate Pesticides/ Herbicides Rads SVOCs TPHs VOCs	**Phyto-remediation** Dioxins PAHs PCBs PCTs Pesticides/ Herbicides SVOCs TPHs VOCs	**Phyto-remediation** Dioxins Metals NDMA PAHs PCBs PCTs Perchlorate Pesticides/ Herbicides Rads SVOCs TPHs VOCs	**Phyto/Bio-remediation** End products from Active Strategy	**Engineered Barrier** Dioxins Metals NDMA PAHs PCBs PCTs Perchlorate Pesticides/ Herbicides Rads SVOCs TPHs VOCs

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		Summary of Strategies					
Contaminant Types	**Contaminants**	**In-Situ Heat (0°C-200°C)[1]**	**Ex-Situ Heat (200°C-500°C)**	**Biostimulation/ Bioaugmentation**	**Phytoremediation/ Phytodegradation**	**In-Situ Nanotechnology**	**Ex-Situ Soil Washing[2]**
Dioxins	Dioxins	< 200°C	> 400°C	Dechlorinating Biota	Ryegrass, Fescue, Bermuda Grass and Yellow Clover, plus Dechlorinating Biota	nZVI; BNPs; SOMS; SAMMS™	Solvent Solution
Metals	As				Ferns	*The metals could be remediated to a more stable, less hazardous, and less mobile state, but would not be removed*	Solvent Solution
	Cd				Indian Mustard		Solvent Solution
	Cr				Indian Mustard, Sunflower		Solvent Solution
	Cu				Indian Mustard		Solvent Solution
	Hg		> 400°C				Solvent Solution
	Pb				Indian Mustard, Sunflower		Solvent Solution
NDMA	NDMA	< 200°C	> 200°C	Dechlorinating Biota	Willows, Poplars, and Paulownia	nZVI; BNPs; SOMS; SAMMS™	Solvent Solution
PAHs	PAHs	< 200°C	> 300°C	Dechlorinating Biota	Ryegrass, Fescue, Bermuda Grass and Yellow Clover, plus Dechlorinating Biota	nZVI; BNPs; SOMS; SAMMS™	Solvent Solution
PCBs	PCBs	Partial remediation < 200°C	> 300°C	Dechlorinating Biota	Ryegrass, Fescue, Bermuda Grass and Yellow Clover, plus Dechlorinating Biota	nZVI; BNPs; SOMS; SAMMS™	Solvent Solution
PCTs	PCTs	Partial remediation < 200°C	> 400°C	Dechlorinating Biota	Ryegrass, Fescue, Bermuda Grass and Yellow Clover, plus Dechlorinating Biota	nZVI; BNPs; SOMS; SAMMS™	Solvent Solution
Perchlorate	Perchlorate		> 200°C	Dechlorinating Biota	Ryegrass, Fescue, Bermuda Grass and Yellow Clover, plus Dechlorinating Biota	nZVI; BNPs; SOMS; SAMMS™	Solvent Solution
Pesticides/ Herbicides	Pesticides/ Herbicides	< 200°C - Type Dependent	> 200°C - Type dependent	Dechlorinating Biota - Type Dependent	Ryegrass, Fescue, Bermuda grass and Yellow Clover + Dechlorinating Biota - Type dependent	nZVI; BNPs; SOMS; SAMMSTM - Type dependent	Type dependent
Rads	Co-60				Indian Mustard		Solvent Solution
	Cs-137				Kochia, Sunflower and Indian Mustard		Solvent Solution
	Sr-90				Kochia		Solvent Solution
	U-238				Kochia		Solvent Solution
SVOCs	SVOCs	< 200°C	> 400°C	Dechlorinating Biota	Ryegrass, Fescue, Bermuda Grass and Yellow Clover, plus Dechlorinating Biota	nZVI; BNPs; SOMS; SAMMS™	Solvent Solution
TPHs	TPHs	< 200°C	> 400°C	Dechlorinating Biota	Ryegrass, Fescue, Bermuda Grass and Yellow Clover, plus Dechlorinating Biota	nZVI; Fenton Oxidation	Type dependent
VOCs	PCE	< 200°C	> 200°C	Dechlorinating Biota	Ryegrass, Fescue, Bermuda Grass and Yellow Clover, plus Dechlorinating Biota	nZVI; BNPs; SOMS; SAMMS™	Solvent Solution
	TCE	< 200°C	> 200°C	Dechlorinating Biota	Poplar or Mulberry Trees	nZVI; BNPs; SOMS; SAMMS™	Solvent Solution

Not Applicable

[1] - Provided temperatures for In-Situ Heat are high to account for efficiency and expediency of the remediation cycle; the strategy could be applied at lower temperatures

[2] - Soil washing applicability is highly dependent on the soil characteristics, which have not been considered for this summary

Bench- and Pilot-Scale Testing

- Bench-Scale Testing
  - Generally conducted in a laboratory under very controlled conditions.
  - Used as a general “proof-of-principle” test.
  - Considered for technologies that have not been fielded or that are being considered for use in an application that is unproven.
- Pilot-Scale Testing
  - Will be conducted on the ETEC site.
  - Used as specific “proof-of-principle” test.
  - Considered for technologies that have been fielded in conditions similar (site characteristics and contaminants) to those at ETEC.

The process includes public involvement at each stage