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Soil Treatability Study

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

Process Update for the Soil Treatability Study

ETEC STIG; July 19, 2012

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U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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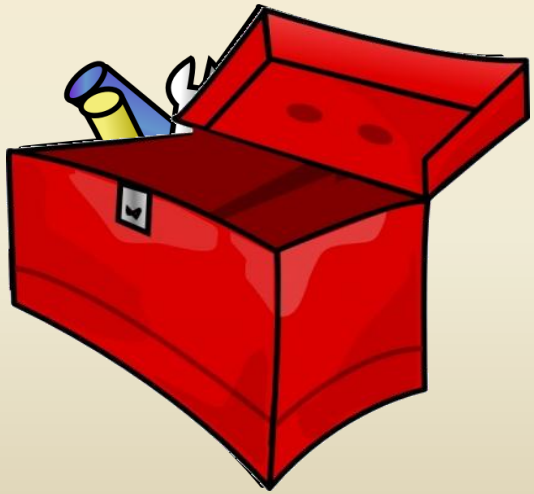
How will we select viable technologies for the ETEC site?

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 establishes the study boundaries.

These are outlined 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 in place 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
- Plants that are not native or not naturalized to SSFL will not be considered as part of phytoremediation technologies (native plants will be considered first, as applicable)

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 STIG.

Questions and Answers

Reactions and Responses

Soil Treatability Study

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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 (On-Site) 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

	Active					
	In-Situ Heat (0-200°C)	**Ex-Situ High Heat (200-500°C)**	**Bio-remediation**	**Phyto-remediation**	**In-Situ Nano**	**Ex-Situ Soil Washing**
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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Hg = Mercury
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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	Native or Naturalized Species - To Be Determined	nZVI; BNPs	Solvent Solution
Metals	As						Solvent Solution
	Cd						Solvent Solution
	Cr						Solvent Solution
	Cu						Solvent Solution
	Hg	Dependent on chemical form	> 400°C	Dependent on chemical form	Dependent on chemical form	Dependent on chemical form	Solvent Solution
	Pb				Native or Naturalized Species - To Be Determined		Solvent Solution
NDMA	NDMA	< 200°C	> 200°C	Dechlorinating Biota		nZVI; BNPs	Solvent Solution
PAHs	PAHs	< 200°C	> 300°C	Dechlorinating Biota		nZVI; BNPs	Solvent Solution
PCBs	PCBs	Partial remediation < 200°C	> 300°C	Dechlorinating Biota		nZVI; BNPs	Solvent Solution
PCTs	PCTs	Partial remediation < 200°C	> 400°C	Dechlorinating Biota		nZVI; BNPs	Solvent Solution
Perchlorate	Perchlorate		> 200°C	Dechlorinating Biota		nZVI; BNPs	Solvent Solution
Pesticides/ Herbicides	Pesticides/ Herbicides	< 200°C - Type Dependent	> 200°C - Type dependent	Dechlorinating Biota - Type Dependent		nZVI; BNPs	Type dependent
Rads	Co-60						Solvent Solution
	Cs-137						Solvent Solution
	Sr-90						Solvent Solution
	U-238						Solvent Solution
SVOCs	SVOCs	< 200°C	> 400°C	Dechlorinating Biota		nZVI; BNPs	Solvent Solution
TPHs	TPHs	< 200°C	> 400°C	Dechlorinating Biota		nZVI; Fenton Oxidation	Type dependent
VOCs	PCE	< 200°C	> 200°C	Dechlorinating Biota		nZVI; BNPs	Solvent Solution
	TCE	< 200°C	> 200°C	Dechlorinating Biota		nZVI; BNPs	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

Technology Screening Update

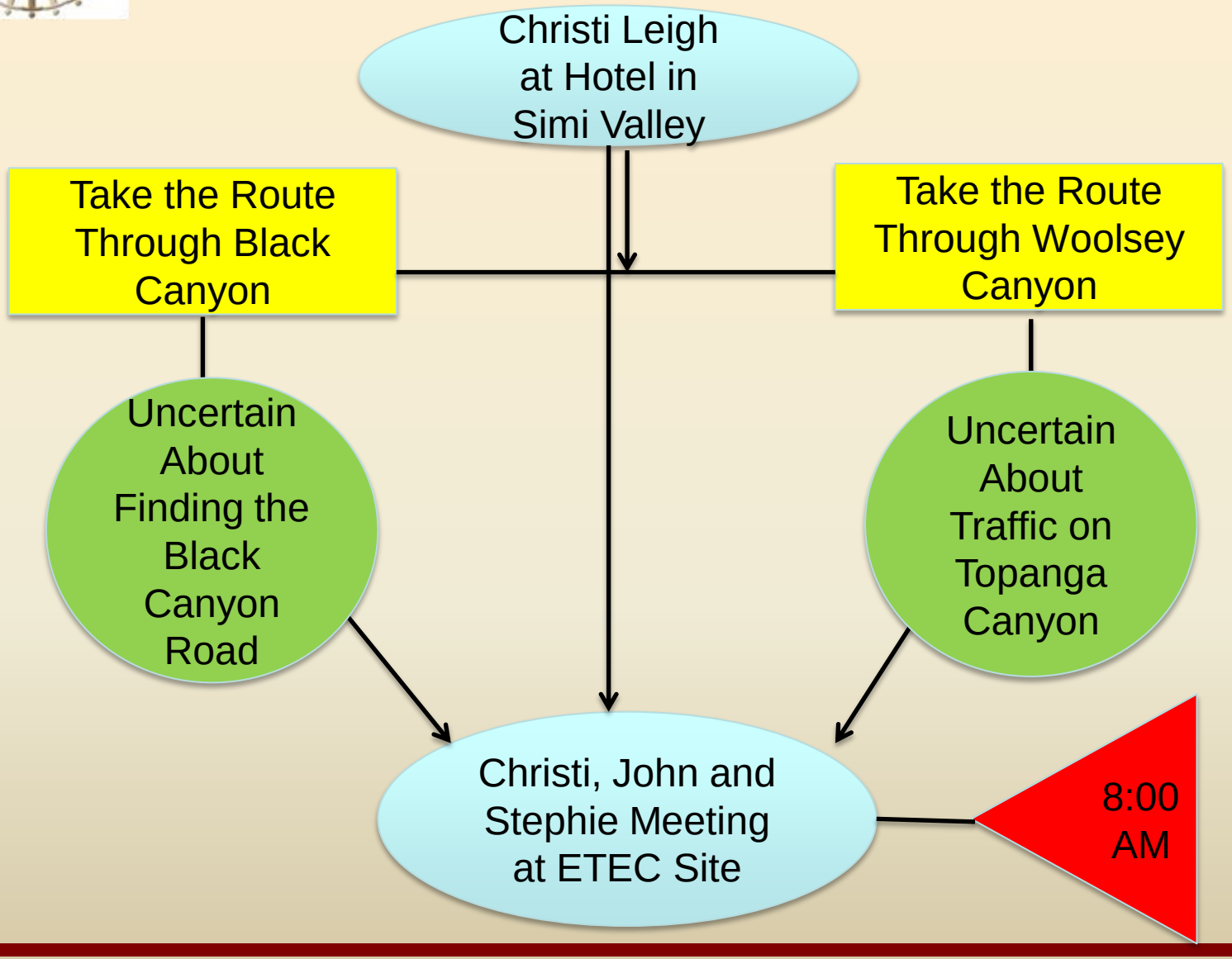
E:\Technology Screening Memo.pdf

Questions and Answers

Reactions and Responses

Concept of Uncertainty

- Identifying Uncertainties
  - Where do we have unanswered questions?
  - What are we uncertain about?
  - What will help us make a decision?
- Resolving Uncertainty
  - Research resolves uncertainty.
  - Treatability studies – not necessarily full demonstrations.
  - Modeling, laboratory work, and field work can resolve uncertainties.


Christi Leigh at Hotel in Simi Valley
Take the Route Through Black Canyon
Take the Route Through Woolsey Canyon
Uncertain About Finding the Black Canyon Road
Uncertain About Traffic on Topanga Canyon
Christi, John and Stephie Meeting at ETEC Site
8:00 AM

Three Uncertainty Perspectives

- Uncertainty About Treatment Technologies
  - What don't I know about the technology?
- Uncertainty About Specific Contaminants
  - Is there something unusual about this contaminant that makes my job harder?
- Uncertainty About Specific Clearly Contaminated Areas (CCA)
  - Is there something unusual about this CCA that makes my job harder?

Three Types of Treatment Technology Uncertainty to Consider:

- Uncertainty About Feasibility
  - Will Plant A remove Contaminant B?
  - Will Biota ("bugs") C degrade Contaminant B?
  - If I add Nanoparticle D, will Contaminant B degrade?
- Uncertainty About Applicability
  - If I heat this soil in place, how long will it take to cool?
  - If I introduce Biota ("bugs") X, will it thrive?
  - If I remove this soil and heat it, will it form a glass?
- Uncertainty About Optimum Operation
  - What "detergent" will best remove Contaminant B?
  - What fertilizer will enhance the growth of Plant A?
  - What is the best operating temperature for thermal technologies?

Three Types of Contaminant Uncertainty to Consider:

- Uncertainty About Chemical Form
  - What specific chemical forms exist on site (e.g., mercury, perchlorate, radionuclides)?
- Uncertainty About Physical Form
  - Is the contaminant partitioned to the soil fines?
- Uncertainty About Existing Degradation
  - Is natural attenuation occurring and what is the effective rate?

Three Types of CCA Uncertainty to Consider:

- Uncertainty About Communication with Groundwater
  - Does the CCA have potential recontamination issues from groundwater plumes?
- Uncertainty About Accessibility
  - Is the CCA in a rocky and/or steep terrain that limits accessibility for in-situ technologies?
- Uncertainty About Contaminant Mix
  - Will the contaminant mix limit proposed treatment technologies?

What is a Treatability Study?

- Laboratory 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.
- Field 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.

What is a Treatability Study?

- On-Site "As-Is" Testing (Surveys/Sampling)
  - What is the chemical form of a contaminant?
  - How much contamination resides in plant material right now?
  - How much clay is there in the soil?
- Modeling Studies (Simulations)
  - Is there communication between the soil and the groundwater?
  - How long does the CCA stay "hot"?
- Literature and Historical Data Studies
  - Is there natural attenuation of contaminants?

Technology Specific Uncertainties - Example

Technology	Feasibility	Applicability	Optimum Operation
Phytoremediation	Are plants on-site taking up contaminants?	Will the plant grow in this particular soil?	What are the ideal growing conditions for the plant?
Phytoremediation	Will the plant remove the contaminant(s)? If yes, how much?	Will the plant grow with a particular contaminant mix?	
Phytoremediation		Where does the contaminant reside in the plant?	

Recommended Studies to Address Uncertainties - Example

Technology	Feasibility	Applicability	Optimum Operation
Phytoremediation	Survey of on-site plant materials	Laboratory study of growth in soil types at ETEC	Laboratory study of plant growth enhanced by additives
Phytoremediation	Laboratory study of contaminant uptake by on-site plants	Laboratory study of contaminant mix uptake by on-site plants	
Phytoremediation		Laboratory study of plant accumulation (necropsies)	

Contaminant Specific Uncertainties - Examples

Contaminant	Chemical Form	Physical Form	Other
Mercury	What is the current chemical form of mercury at ETEC?	Is this contaminant partitioned to the fines?	
Dioxins		Is this contaminant partitioned to the fines?	What is the rate of natural attenuation for dioxins?
Radionuclides	What is the speciation of the radionuclides at ETEC site?	Is this contaminant partitioned to the fines?	

Recommended Studies to Address Uncertainties - Examples

Contaminant	Chemical Form	Physical Form	Other
Mercury	Laboratory study to determine the chemical form of mercury at ETEC	Laboratory study of distribution of mercury between fines and larger particles using soils from ETEC	
Dioxins		Laboratory study of distribution of dioxins between fines and larger particles using soils from ETEC	1. Literature search on dioxin natural attenuation 2. Field study of natural degradation of dioxins at ETEC 3. Analysis of historical information from ETEC to determine degradation rate of dioxins
Radionuclides	Laboratory study to determine the speciation of radionuclides at ETEC	Laboratory study of distribution of radionuclides between fines and larger particles using soils from ETEC	

CCA Specific Uncertainties

CCA	Groundwater	Terrain
For each CCA	Does this CCA have a potential recontamination issue from the tritium, TCE, or perchlorate plumes?	Is this CCA on rocky steep terrain? Does the terrain preclude in-situ treatment technologies?

Recommended Studies to Address Uncertainties

CCA	Groundwater	Terrain
For Each CCA	Question can be answered with current information. No study is needed.	Question can be answered with current information. No study needed.

Questions and Answers

Reactions and Responses

Preliminary List of Proposed Studies (by Technology)

Technology	Study
Phytoremediation	Survey of on-site plant materials
Phytoremediation	Laboratory study of growth in soil types at ETEC
Phytoremediation	Laboratory study of plant growth enhanced by additives
Phytoremediation	Laboratory study of contaminant uptake by on-site plants
Phytoremediation	Laboratory study of contaminant mix uptake by on-site plants
Phytoremediation	Laboratory study of plant accumulation (necropsies)
In-Situ Thermal	Laboratory study or literature search of the vaporization point of PCBs, etc.
In-Situ Thermal	Survey or laboratory study of thermal conductivity of ETEC Soils
In-Situ Thermal	In-Situ thermal treatment using heating probes vs heating blanket of CCAs 10, 15, 24, 25, 31, 32 for PCBs
In-Situ Thermal	Simulation of soil heating/cooling for ETEC soils
In-Situ Thermal	In-Situ thermal treatment using heating probes of CCAs 10, 15, 24, 25, 31, 32 for PCBs
In-Situ Nanotechnology	Laboratory study of contaminant degradation by nanoparticles
In-Situ Nanotechnology	Field study of in-situ application techniques for nanoparticles at the ETEC Site
In-Situ Nanotechnology	Survey of geochemistry of ETEC Soils

Preliminary List of Proposed Studies (by Technology) (cont'.)

Technology	Study
In-Situ Bioremediation (native)	Survey of naturally occurring biota at the ETEC Site
In-Situ Bioremediation (native)	Laboratory study of biota cultivation enhanced by additives
In-Situ Bioremediation (native)	Laboratory study of contaminant degradation by native biota
In-Situ Bioremediation (Non-native)	Laboratory study of contaminant degradation of non-native biota
In-Situ Bioremediation (Non-native)	Laboratory study of non-native biota and soil chemistry
In-Situ Bioremediation (Non-native)	Laboratory study of biota cultivation enhanced by additives
Ex-Situ Thermal	Laboratory study of thermally induced soil remediation with ETEC Soils
Ex-Situ Thermal	Literature search on vaporization temperatures or laboratory study of required temperatures
Ex-Situ Thermal	Laboratory study of processes to return the soil to normal conditions after thermal treatment
Ex-Situ Thermal	Survey of ex-situ thermal technology suppliers
Ex-Situ Soil Washing	Survey of clay content in ETEC Soils
Ex-Situ Soil Washing	Laboratory study of solvents and contaminants
Ex-Situ Soil Washing	Survey of fines content in ETEC Soils
Ex-Situ Soil Washing	Survey of soil washing technology suppliers
Engineered Barrier	Literature and site data study with modeling to determine subsurface fluctuations
Engineered Barrier	Study of engineered barrier types for the contaminants of concern

Preliminary List of Proposed Studies (by Contaminant)

Contaminant	Study
Mercury	Laboratory study to determine the chemical form of mercury at ETEC
Mercury	Laboratory study of distribution of mercury between fines and larger particles using soils from ETEC
Dioxins	Laboratory study of distribution of dioxins between fines and larger particles using soils from ETEC
Dioxins	1. Literature search on dioxin natural attenuation 2. Field study of natural degradation of dioxins at ETEC 3. Analysis of historical information from ETEC to determine degradation rate of dioxins
PCBs	Laboratory study of distribution of PCBs between fines and larger particles using soils from ETEC
PAHs	Laboratory study of distribution of PAHs between fines and larger particles using soils from ETEC
PAHs	1. Literature search on PAHs natural attenuation 2. Field study of natural degradation of PAHs at ETEC 3. Analysis of historical information from ETEC to determine degradation rate of PAHs
Perchlorate	Laboratory study to determine the speciation of perchlorate at ETEC
Perchlorate	Laboratory study of distribution of perchlorate between fines and larger particles using soils from ETEC
Perchlorate	1. Literature search on perchlorate natural attenuation 2. Field study of natural degradation of perchlorate at ETEC 3. Analysis of historical information from ETEC to determine degradation rate of perchlorate

Preliminary List of Proposed Studies (by Contaminant) (cont'.)

Contaminant	Study
Metals	Laboratory study to determine the speciation of metals at ETEC
Metals	Laboratory study of distribution of metals between fines and larger particles using soils from ETEC
Radionuclides	Laboratory study to determine the speciation of radionuclides at ETEC
Radionuclides	Laboratory study of distribution of radionuclides between fines and larger particles using soils from ETEC
NDMA	Laboratory study to determine the speciation of NDMA at ETEC
NDMA	Laboratory study of distribution of NDMA between fines and larger particles using soils from ETEC
PCTs	Laboratory study of distribution of PCTs between fines and larger particles using soils from ETEC
Pesticides/Herbicides	Laboratory study of distribution of pesticides/herbicides between fines and larger particles using soils from ETEC
SVOCs	Laboratory study of distribution of SVOCs between fines and larger particles using soils from ETEC
SVOCs	1. Literature search on SVOC natural attenuation 2. Field study of natural degradation of SVOCs at ETEC 3. Analysis of historical information from ETEC to determine degradation rate of SVOCs
SVOCs	Historical data research or laboratory study of SVOCs that exist in the soil vapor versus SVOCs sorbed to the soil particles

Preliminary List of Proposed Studies (by Contaminant) (cont'.)

Contaminant	Study
VOCs	Historical data research or laboratory study of VOCs that exist in the soil vapor versus VOCs sorbed to the soil particles
VOCs	1. Literature search on VOC natural attenuation 2. Field study of natural degradation of VOCs at ETEC 3. Analysis of historical information from ETEC to determine degradation rate of VOCs
TPHs	Laboratory study of distribution of TPHs between fines and larger particles using soils from ETEC
TPHs	1. Literature search on TPH natural attenuation 2. Field study of natural degradation of TPHs at ETEC 3. Analysis of historical information from ETEC to determine degradation rate of TPHs
TPHs	Historical data research or laboratory study of TPHs that exist in the soil vapor versus TPHs sorbed to the soil particles

Next Steps in This Process

- DOE and Sandia will accept input from the STIG regarding
  - the uncertainties identified
  - the studies suggested
- DOE and Sandia will then work together to prioritize the suggested studies to resolve the most important uncertainties so that DOE and DTSC can select the most EFFECTIVE remediation strategies.