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Sandia National Laboratories

Soil Treatability Study

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

Recommended Studies for the Soil Treatability Study

ETEC STIG; September 27, 2012

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SAND2012-7948P

U.S. DEPARTMENT OF ENERGY NNSA

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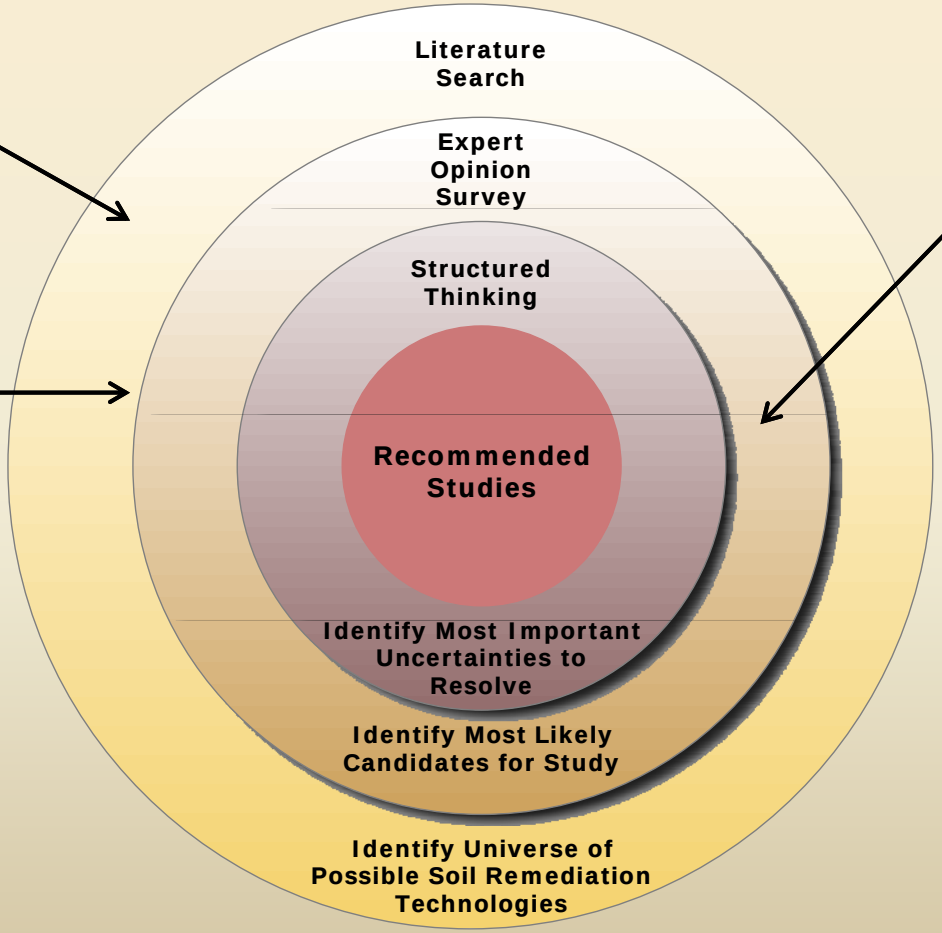
Conclusion of Our Last Meeting

- 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 recommended studies to resolve the most important uncertainties.

Where we are now

Study Boundaries

Study Objectives



Treatment Technologies

Concept of Uncertainty

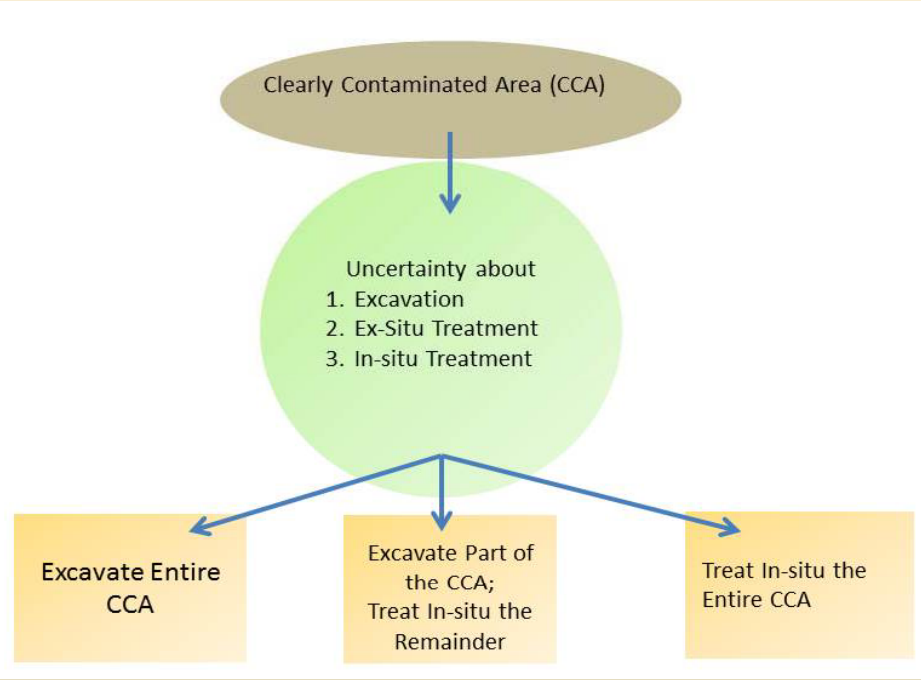
- Identifying Uncertainties
  - Where are there unanswered questions?
  - What are people uncertain about?
  - What will help the DOE make a decision?
- Resolving Uncertainty
  - Research resolves uncertainty.
  - Treatability studies – not necessarily full demonstrations.
  - Modeling, laboratory work,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

Three Uncertainty Perspectives

- Uncertainty About Treatment Technologies
  - What is unknown about the technology for application at ETEC?
- Uncertainty About Specific Contaminants
  - Is there something unusual about this contaminant that makes the job harder?
- Uncertainty About Specific Clearly Contaminated Areas (CCA)
  - Is there something unusual about this CCA that makes the job harder?

Structured Thinking Process

- Identifies uncertainties that impact choices to be made.
- Helps prioritize uncertainties.
- Allows the decision maker to choose between alternatives.



Prioritizing Possible Studies

- What are the most important uncertainties to resolve?
  - Relative extent of contamination.
  - Difficult (recalcitrant) contaminants.
  - Multiple contaminants.

What is a Treatability Study?

- Laboratory Testing
  - 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 interaction (mass exchange) between the soil and the groundwater?
  - How long does the CCA stay "hot"?
- Literature and Historical Data Studies
  - Is there natural attenuation of contaminants?

Questions and Answers

Soil Partitioning/Separation Studies

- Why conduct soil partitioning/separation studies?
  - Can potentially reduce the volume of soil for off-site disposal, if excavated.
  - Supports a simple treatment technology – soil separation.
  - Addresses multiple contaminants.
  - Benefits other potential studies.
- What should be studied?
  - What are the particle size distributions for ETEC soils?
  - Do contaminants known to be present at ETEC reside preferentially with the soil fines or are they distributed throughout the soil with the various particle sizes?
  - Which contaminant groups associate themselves preferentially with the fines and which do not?
  - Can multiple contaminants be remediated at the same time utilizing this technique, and if so, which contaminant groups?

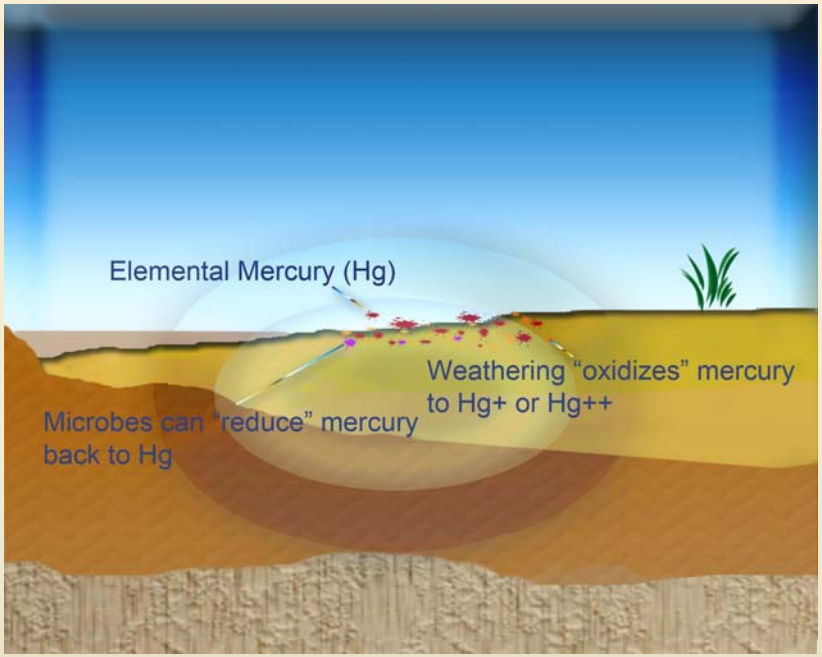
Soil Partitioning/Separation Studies

- How should soil partitioning/separation be studied?
  - Small volume analyses (Collect both contaminated and uncontaminated soil; determine geotechnical properties, chemical properties, and thermal properties).
  - Large volume analyses (Excavate required volume, perform dry soil partitioning, perform contaminant analysis, develop a mass balance).
  - Enhanced separation analyses (Excavate required volume, perform wet soil partitioning, perform contaminant analysis, develop a mass balance).
  - Soil washing/thermal analyses (Excavate required volume, perform wet soil partitioning, add a soil washing/thermal step, perform contaminant analysis, develop a mass balance).
- Additional benefits
  - Small volume analyses will provide useful information to other studies (e.g. particle size distribution, soil thermal conductivity, chemical properties).
  - Large volume analyses may remediate the soils on which they are performed.

Questions and Answers

Mercury Studies

- Why conduct mercury studies?
  - A relatively large volume of soil at ETEC is contaminated with mercury.
  - In-situ treatment of mercury poses potential challenges.
- What should be studied?
  - Chemical form of mercury – elemental or weathered?



Mercury Studies

- How should mercury be studied?
  - Small volume analyses (Collect soil samples and analyze the chemical form).
  - Biological conversion to elemental mercury (Collect soil samples, inventory biota, test biota in laboratory for reduction of mercury).
  - No large volume analyses recommended.
  - No thermal field test with mercury contaminated soils is recommended.
- Additional benefits
  - Identification of the biota in the site soils will benefit the bioremediation studies.

Questions and Answers

Phytoremediation Studies

- Why conduct phytoremediation studies?
  - Many of the soils at ETEC are contaminated with heavy metals.
  - Some of the soils at ETEC are contaminated with radionuclides.
  - Phytoremediation is the only in-situ technology (within the study boundaries) for potential remediation of soils contaminated with heavy metals/radionuclides.
  - Phytoremediation is seen by SNL as a possible secondary or passive in-situ treatment for all contaminants.
  - The STIG expressed a strong interest in phytoremediation.

Phytoremediation Studies

- What should be studied?
  - What plant species currently growing at ETEC can remove contaminants from the soil?
  - Which contaminants specifically can be removed by these plants?
  - How efficient is this plant uptake? How clean will the soil be? How long will it take?
  - What is the mechanism by which plants remove specific contaminant? Is it hyperaccumulation, rhizosphere stimulation or phytotranspiration?
  - Can the uptake by plants be improved by composting, fertilization, irrigation, and/or the addition of microbes?

Phytoremediation Studies

- How should phytoremediation be studied?
  - Site plant species inventory (Perform an inventory of plant species growing on the CCAs, develop a crosswalk of CCAs, contaminants, and plant species; identify plant species that are like the species shown to demonstrate remediation).
  - Site-wide plant species sampling (Collect plant species samples from a number of CCAs listed in the crosswalk. The highest priority sampling should be plants that may hyperaccumulate metals).
  - Laboratory phytoremediation studies (For plants that are shown under the site-wide plant species sampling study to have removed contaminants from the soil or plants thought to phytotranspire contaminants).
- Additional benefits
  - Phytoremediation allows for minimal destruction/disturbance of the environment.

Questions and Answers

Bioremediation Studies

- Why conduct bioremediation studies?
  - Bioremediation technologies act synergistically with other soil remediation technologies to aid in soil remediation.
  - Bioremediation may already be occurring (naturally) in the soils.
  - Effective for treatment of petroleum hydrocarbons and organics.
- What should be studied?
  - Natural biota in the ETEC soils.
  - Enhancing the performance of existing biota.
  - Possibility of introducing non-native biota.

Bioremediation Studies

- How should bioremediation be studied?
  - Site biota inventory.
  - Laboratory analyses (The highest priority contaminant for this recommendation is TPH).
- Additional benefits
  - Biota can enhance phytoremediation and natural attenuation.

Questions and Answers

Thermal Treatment Studies

- Why conduct thermal studies?
  - Thermal treatment technologies can apply to many contaminants.
  - May be only in-situ treatment option for mercury, dioxins, and PCBs.
- What should be studied?
  - Achievable soil temperatures.
  - Thermal conductivity and heat capacity of the soil.
  - Condition of soil after in-situ thermal treatment.
  - Vapor containment.

Thermal Treatment Studies

- How should thermal treatment be studied?
  - In-situ thermal remediation for shallow soils (Thermal blanket concept, less than 3 feet, contaminated only with PCBs).
  - In-situ thermal remediation for deeper soils (Heater probe concept, greater than 3 feet, contaminated only with PCBs).
- Additional benefits
  - Can treat several contaminants at once.
  - Field test on the CCAs containing PCBs may remediate the CCAs.

Questions and Answers

Natural Attenuation Studies

- Why conduct natural attenuation studies?
  - Non-invasive technology.
  - Likely to already be occurring at the site.
  - May be applied to a variety of contaminants.
- What should be studied?
  - Is natural attenuation occurring? If so, at what rate?
  - Possible enhancement of natural attenuation.
  - Dioxins, PAHs, SVOCs, VOCs, TPHs, perchlorates, and NDMA.

Natural Attenuation Studies

- How should natural attenuation be studied?
  - Examination of historical sampling data.
  - Field demonstration at ETEC site.
  - Laboratory demonstration of natural attenuation.
- Additional benefits
  - May be helpful for areas that must be protected and undisturbed.

Questions and Answers

Thank you