

Evaluation of Innovative Soil Remediation Technologies at Camp Edwards, MMR

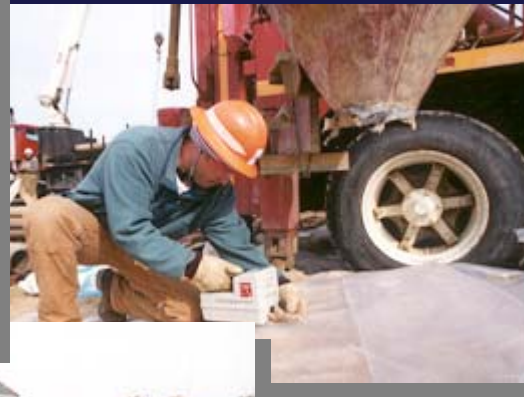
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Presented by:

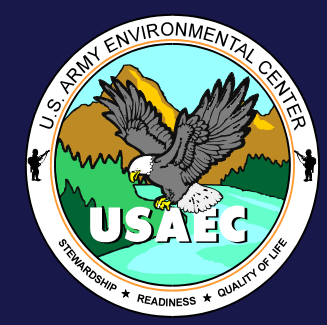
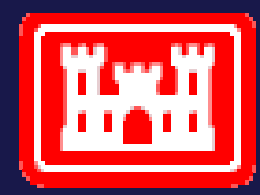
Katherine Weeks,

Scott Veenstra



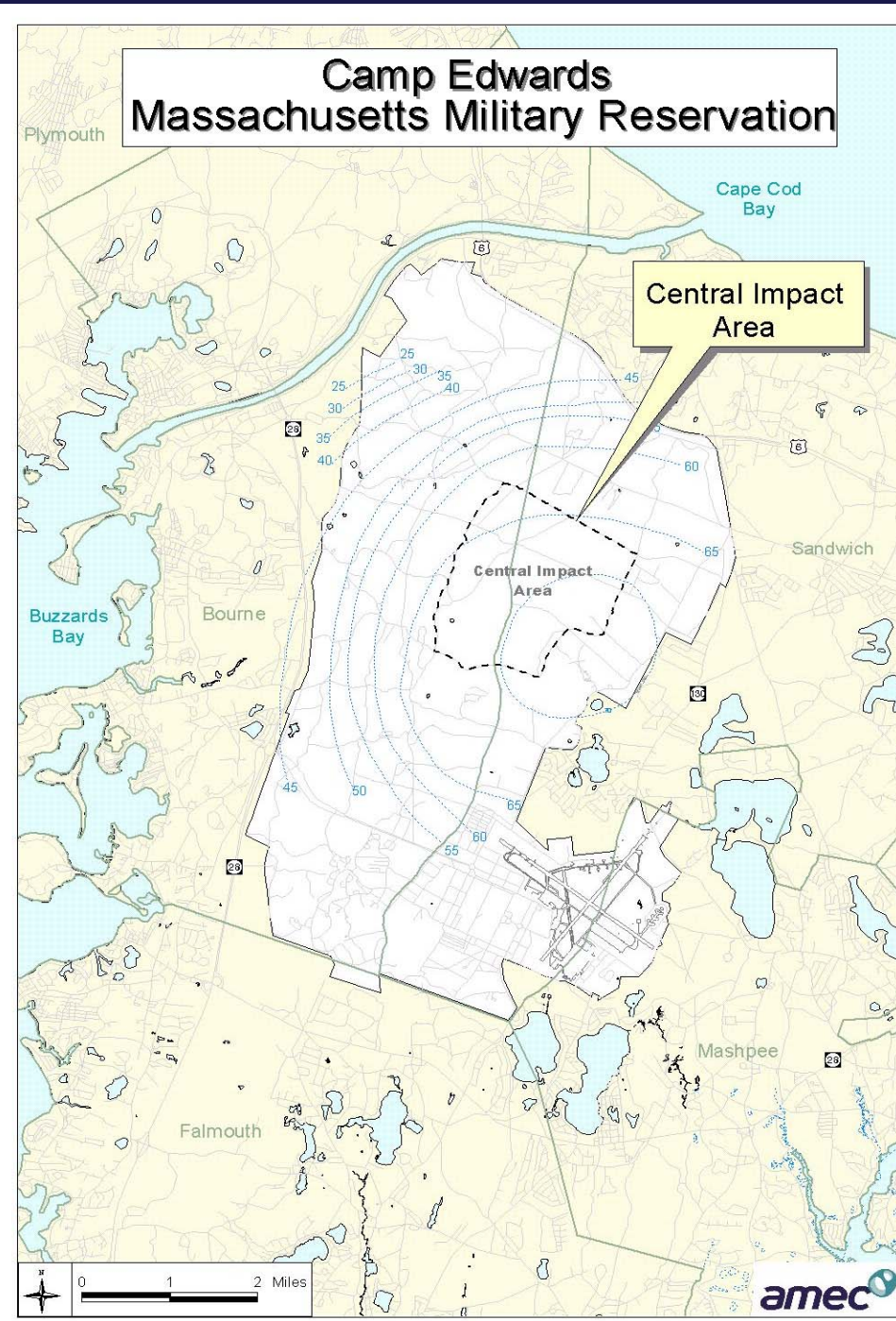
Innovative Technology Evaluation Team (ITE)

- Army National Guard
 - LTC Joe Knott, Ben Gregson, Dave Hill
- Army Corps of Engineers
 - Heather Sullivan, Ian Osgerby
- Army Environmental Center
 - Wayne Sisk, Mark Hampton
- AMEC Earth and Environmental



Massachusetts Military Reservation (MMR)

- Located on Cape Cod
- Central Impact Area, training ranges used for target practice and range training operations
- Covers >14,000 acres
- Surface soils
 - Glacial end moraine
 - Fine sand - boulders, little clay
 - pH 5.5 to 6.0
 - Thin layer of organics



Explosives Residues in Soils at MMR

- Explosives deposition attributes
 - Deposited in particulate form from live fire training
 - Low concentrations
 - Heterogeneously distributed
- Soil Cleanup Goals are low to support groundwater protection
 - RDX - 120 $\mu\text{g}/\text{kg}$
 - HMX - 250 $\mu\text{g}/\text{kg}$
 - TNT - 250 $\mu\text{g}/\text{kg}$

ITE Mission

- Support responses to EPA Administrative Orders to protect groundwater at MMR
- Select innovative soil and groundwater remediation technologies to address explosives contamination at MMR
- Future applications at other DoD/ARNG training installations



Treatability Study Technology Selection

- Selection criteria
 - Media treated - soils
 - Experience with explosives
 - Clean-up levels achieved
 - Time frame to complete clean up
- Vendors chosen based on competitive bid proposals

Treatability Study Technology Selection

- Physical Processes
 - Soil Washing
 - Low Temperature Thermal Destruction
- Biological Processes
 - Composting
 - Solid Phase Bioremediation
 - Bioslurry
- Chemical Processes
 - Chemical Oxidation
 - Chemical Reduction

Treatability Study Technologies

Soil Washing at MMR



Photo courtesy of Brice, Inc.



Composting in the field

Photo courtesy of BSI, Inc.

Treatability Study Technologies

Thermal Destruction in the field



Photo courtesy of TerraTherm, Inc.

Solid Phase Bioremediation in the field

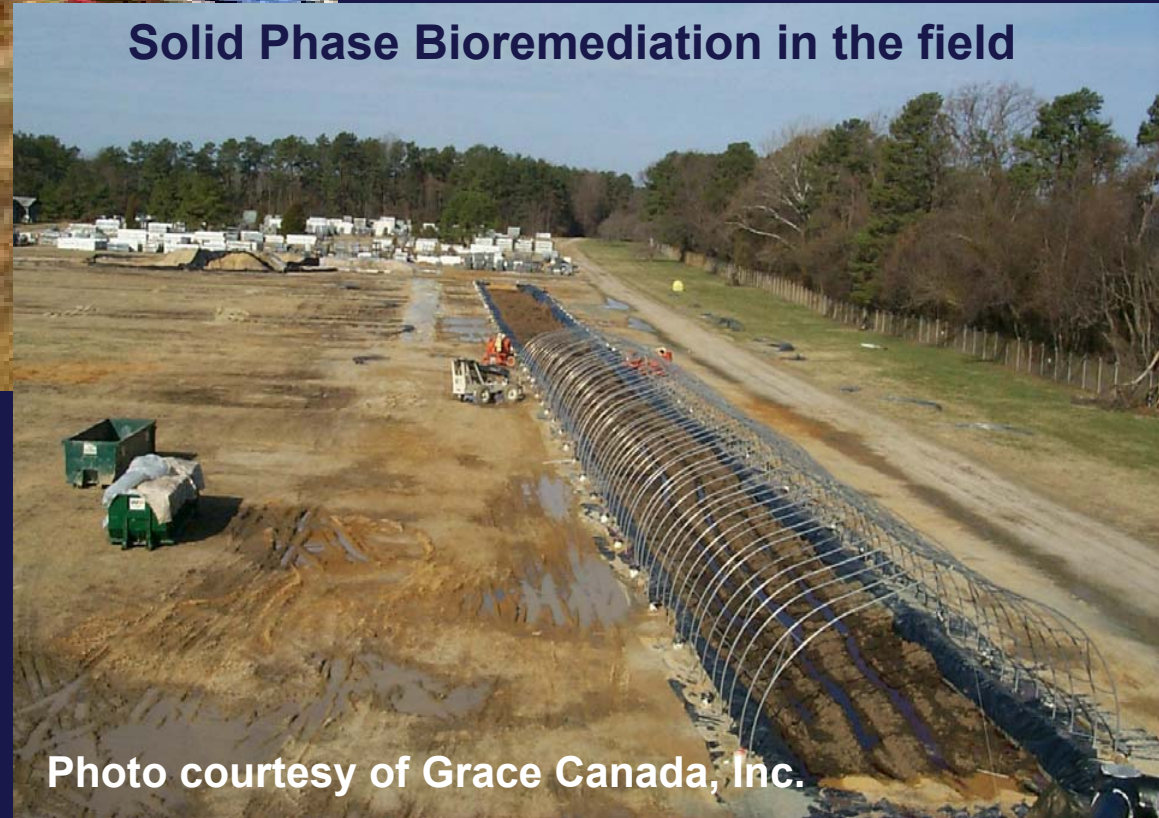
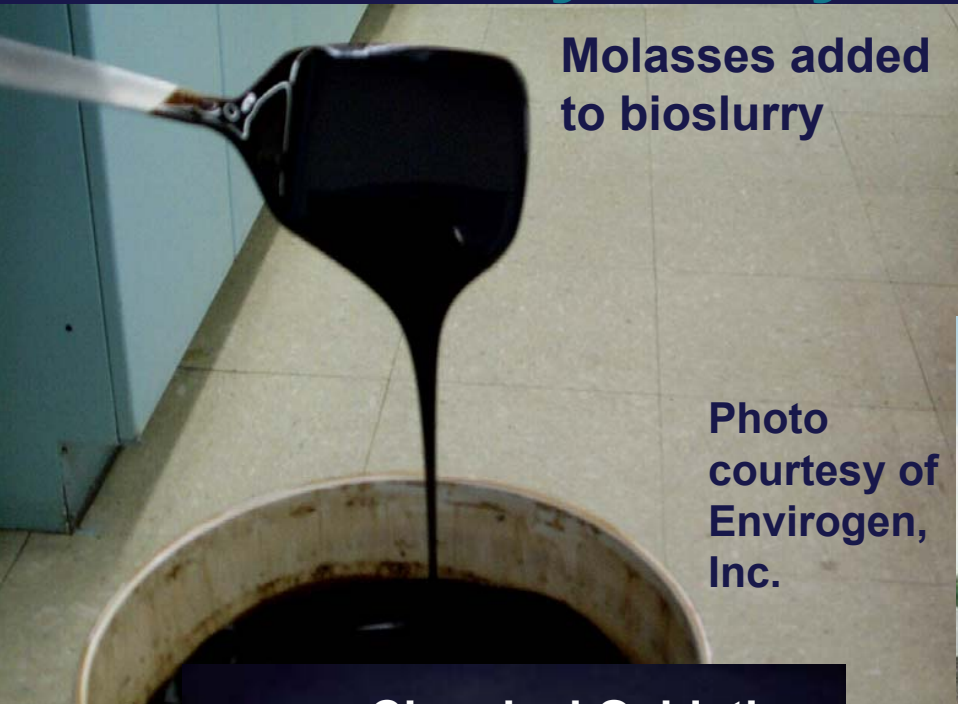


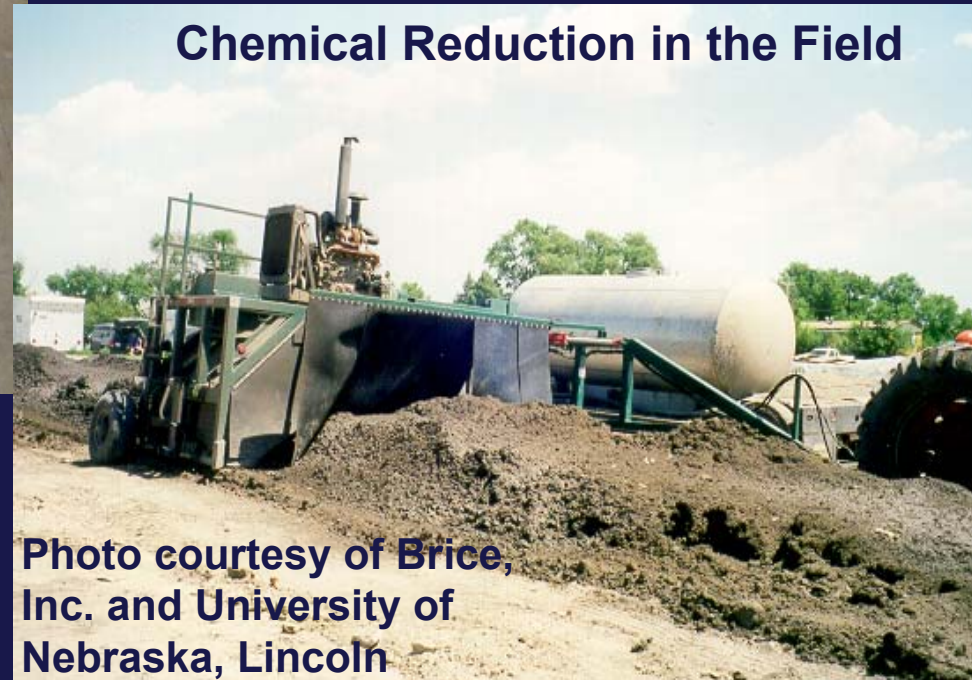
Photo courtesy of Grace Canada, Inc.

Treatability Study Technologies



Molasses added to bioslurry

Photo courtesy of Envirogen, Inc.



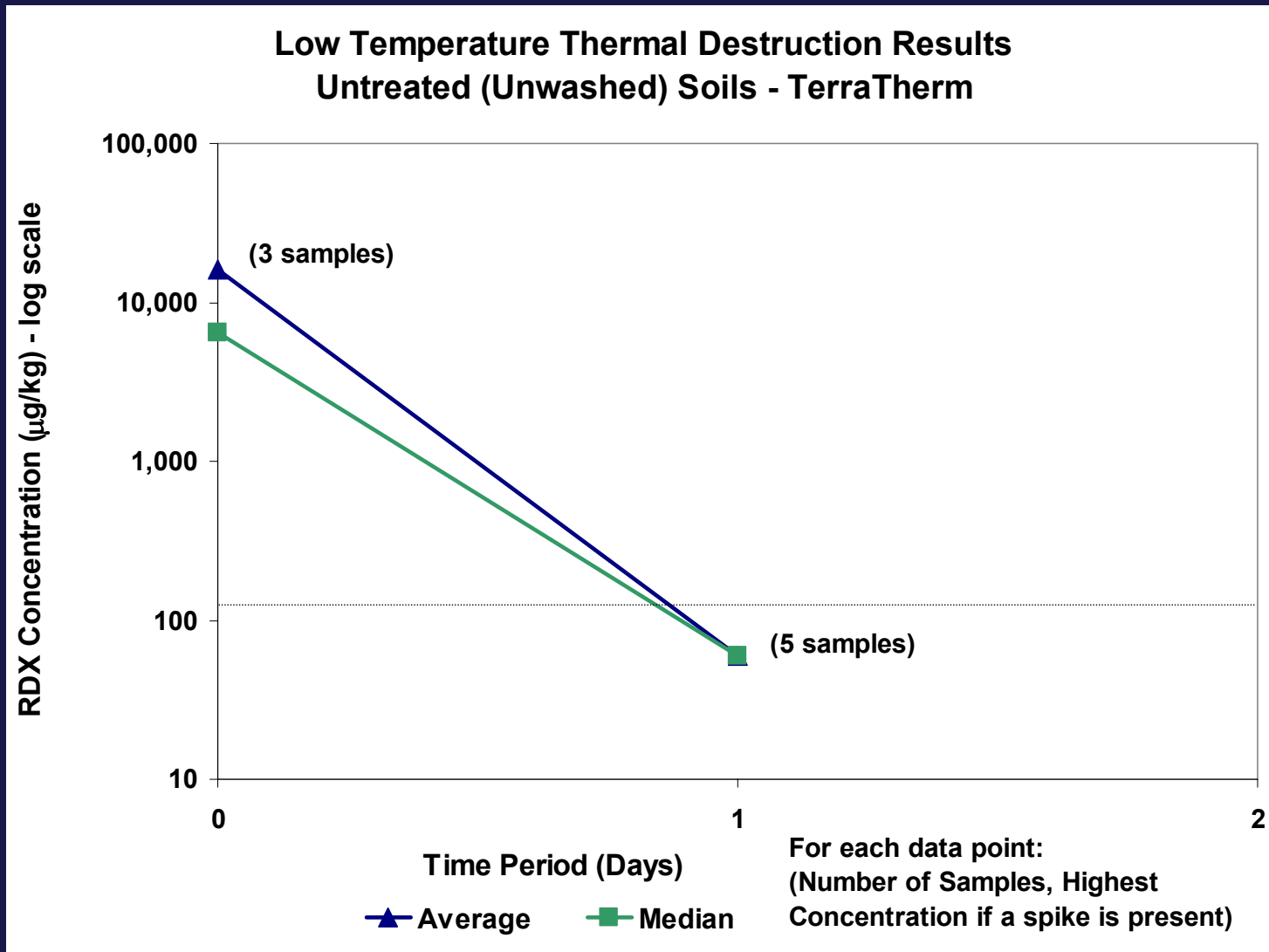
Chemical Reduction in the Field

Photo courtesy of Brice, Inc. and University of Nebraska, Lincoln

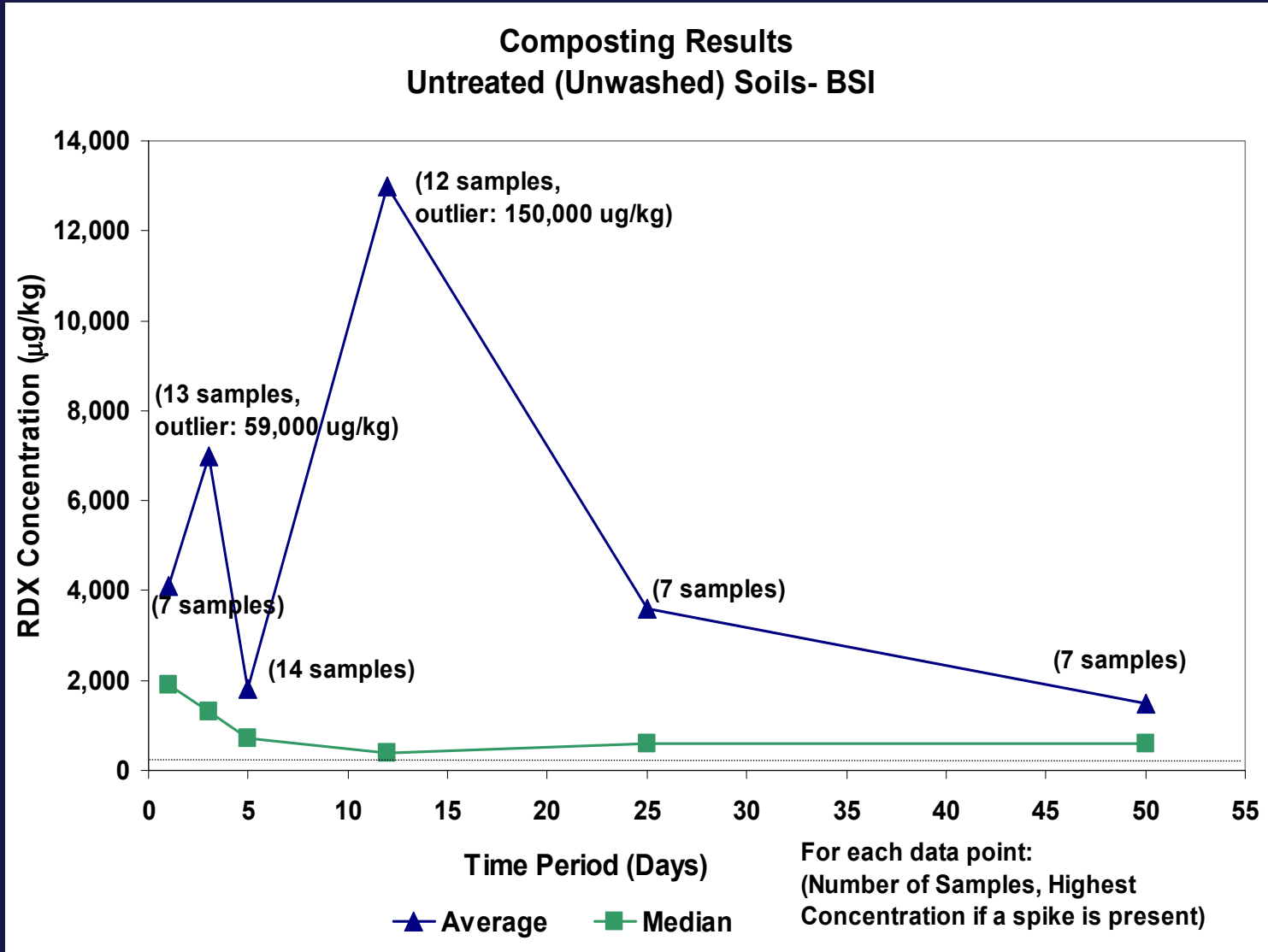
Chemical Oxidation



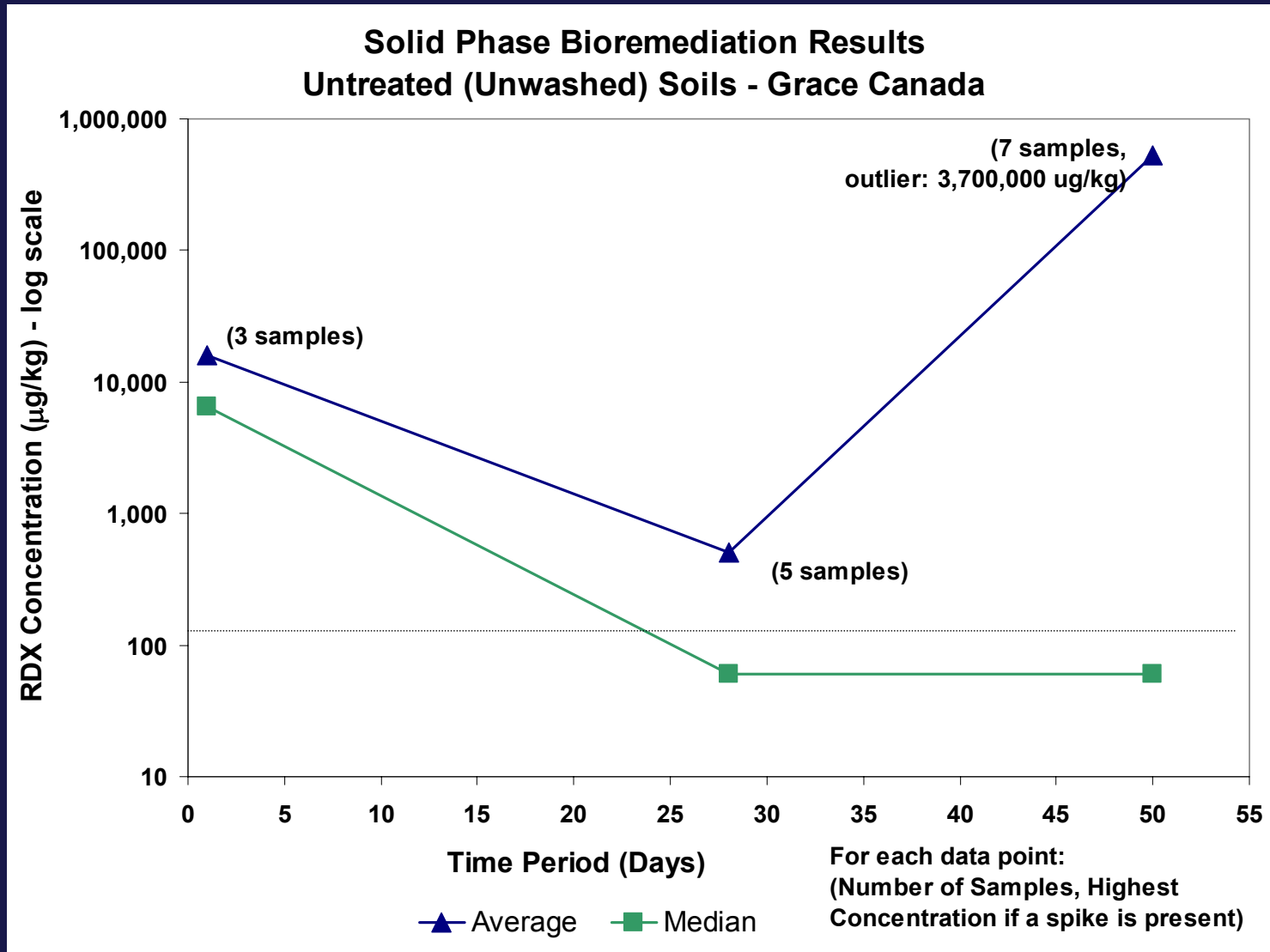
ITE Treatability Study Results



ITE Treatability Study Results

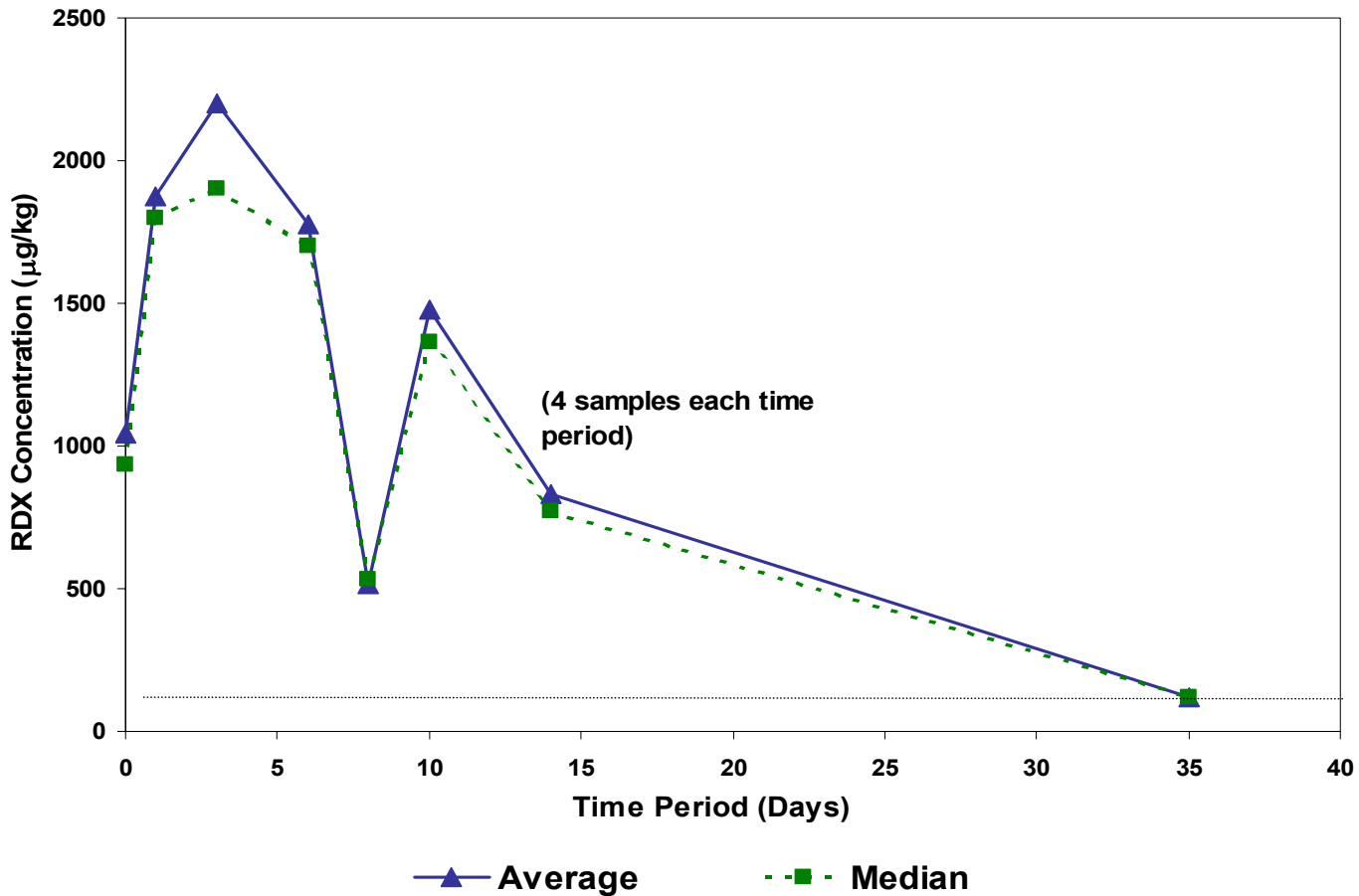


ITE Treatability Study Results

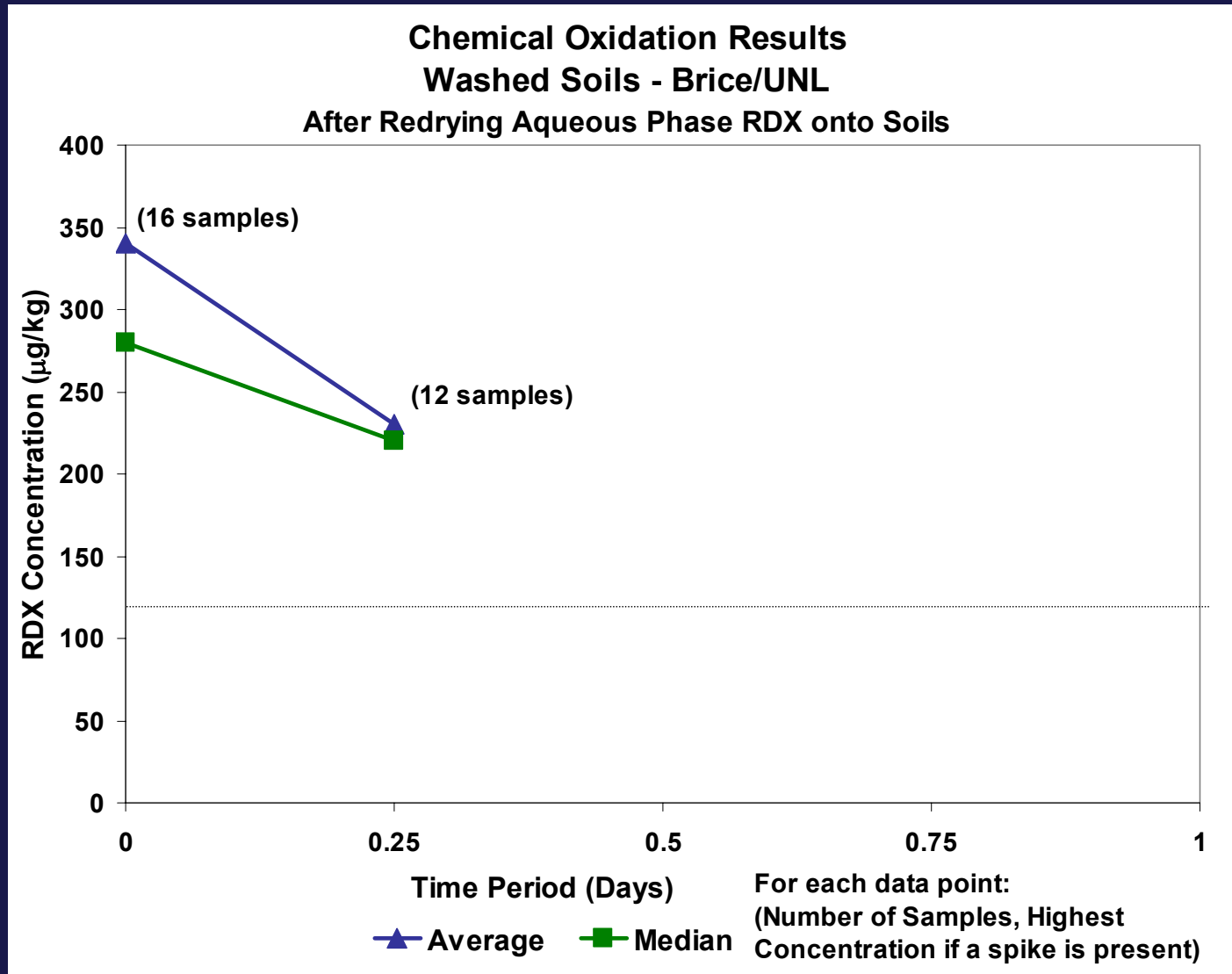


ITE Treatability Study Results

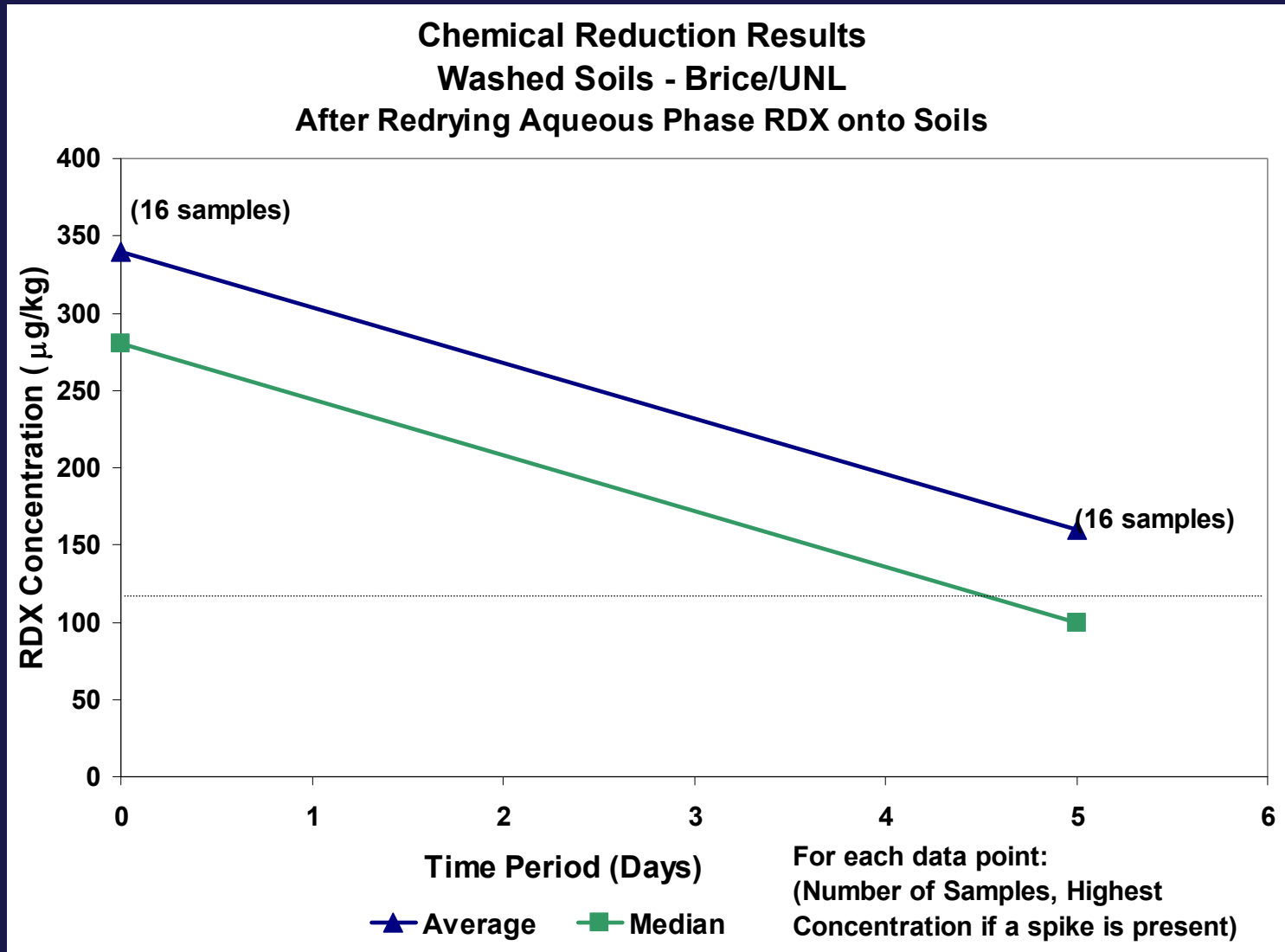
**Bioslurry Results, Intermittent Stirring
Unwashed (Untreated) Soils - Envirogen**



ITE Treatability Study Results



ITE Treatability Study Results



ITE Treatability Study Conclusions

- LTDD - Effective at temperatures $\geq 250^{\circ}\text{C}$ on washed & unwashed soils
- Composting - Effective in washed soils, not unwashed soils
- Solid phase bioremediation - Effective in washed soils and in one of two unwashed soil studies
- Bioslurry - Effective in intermittently stirred reactors on washed & unwashed soils
- Chemical Reduction - Effective on washed soils
- Chemical Oxidation - Not effective on washed soils

ITE Field Scale Designs

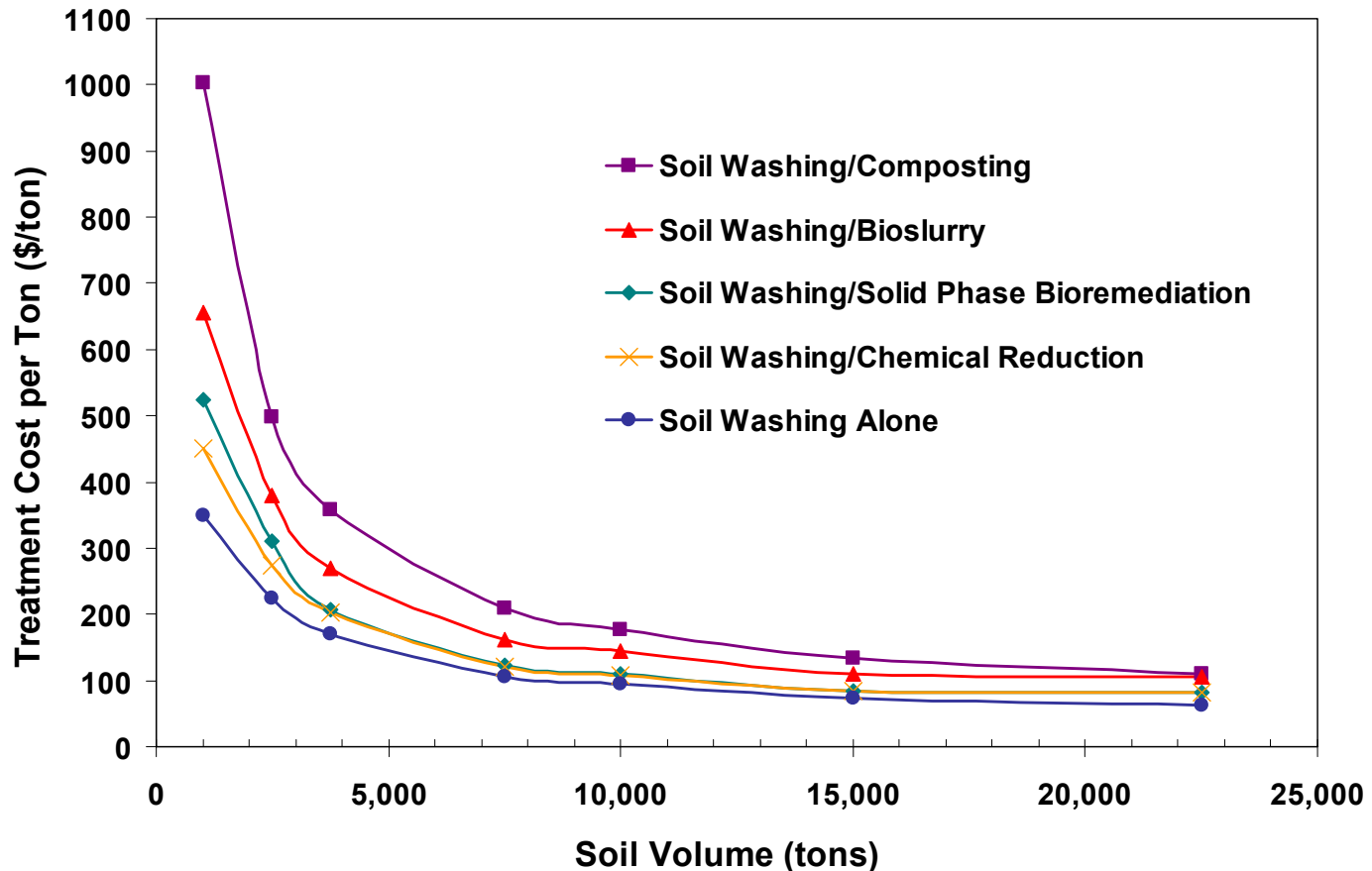
- In situ / ex situ:
 - In situ treatment favors composting or solid phase bioremediation
 - However, UXO removal requires ex situ solutions
 - Once ex situ is required, soil washing becomes attractive as a stand-alone or first step
- New England climate limits biological remedies to three seasons, unless structures are built

ITE Field Scale Designs

- Soil Washing - 10 tons/hr, $\geq 75\%$ soil treated
- LTDD - Heating rods in concrete containers, extract vapors from rods, run vapor through GAC
- Composting - Windrows of 30% soil, 70% amendments, using hen and dairy manure
- Solid phase bioremediation - Soil windrows with 2% DARAMEND®, 0.2% powdered iron
- Bioslurry - 135-ton mixing tank: 30% soil, 70% water, 1 drum molasses
- Chemical Reduction - Watered soil windrows with 5% ZV iron, aluminum sulfate, acetic acid

ITE Field Demonstration Costs

Comparison of Estimated Costs for Soil Treatment



ITE Next Steps

- Assess applications for ITE field demonstration at MMR
- Perform detailed design and planning for field demonstrations including scale-up costs
- Select technologies for field demonstration (i.e., based upon specific applications and scale-up costs)