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SERDP and ESTCP Webinar Series

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Award Winning Projects
Environmental Restoration

March 9, 2017

SERDP DOD • EPA • DOE | ESTCP

Welcome and Introductions

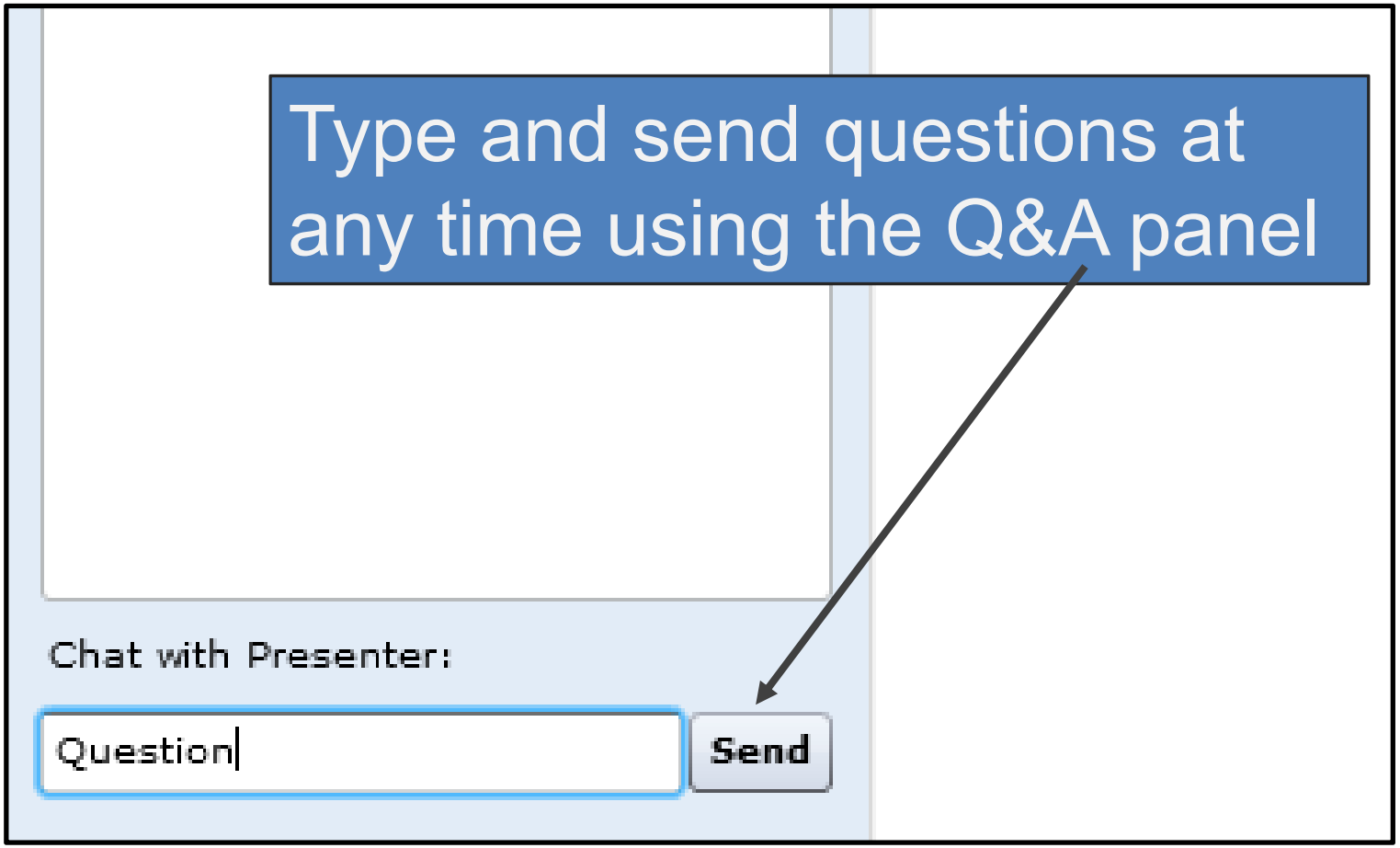
Jennifer Nyman, Ph.D., P.E.
Webinar Facilitator

SERDP DOD • EPA • DOE | ESTCP

Webinar Agenda

- **Webinar Logistics** (5 minutes)
  Dr. Jennifer Nyman, Geosyntec Consultants
- **Overview of SERDP and ESTCP** (5 minutes)
  Dr. Andrea Leeson, SERDP and ESTCP
- **Grenade Range Management using Lime for the Dual Role of Metals Immobilization and Explosives Transformation** (25 minutes + Q&A)
  Dr. Andy Martin, U.S. Army Engineer Research and Development Center
- **Evaluation of Biopolymer for Erosion Control of Protective Berms** (25 minutes + Q&A)
  Dr. Steve Larson, U.S. Army Engineer Research and Development Center
- **Final Q&A session**

How to Ask Questions



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SERDP and ESTCP Overview

Andrea Leeson, Ph.D.
SERDP and ESTCP

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SERDP

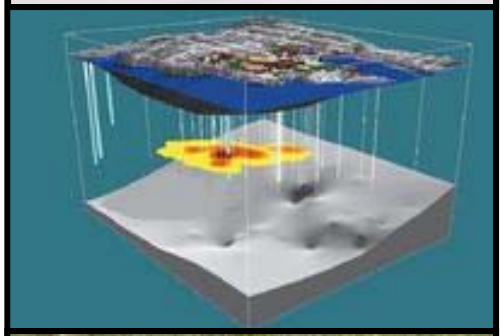
- Strategic Environmental Research and Development Program
- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

ESTCP

- Environmental Security Technology Certification Program
- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

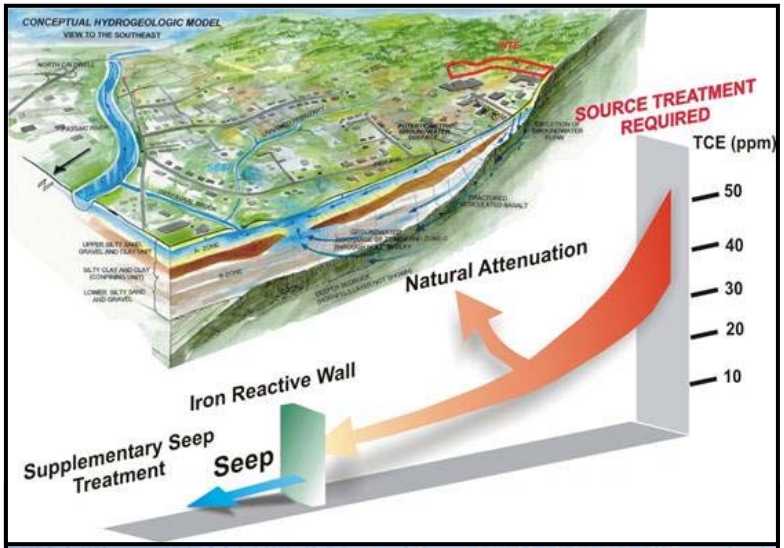
Program Areas

1. Energy and Water
2. Environmental Restoration
3. Munitions Response
4. Resource Conservation and Resiliency
5. Weapons Systems and Platforms



Environmental Restoration

- Major focus areas
  - Contaminated groundwater
  - Contaminants on ranges
  - Contaminated sediments
  - Wastewater treatment
  - Risk assessment



SERDP and ESTCP Webinar Series

Date	Topic
March 23, 2017	Monitoring and Risk Assessment of Environmental Risks Posed by Munitions Constituents in Aquatic Systems
April 6, 2017	1,4-Dioxane Impacts and Innovative Cleanup Technologies at DoD Contaminated Sites
April 20, 2017	Solutions for Installations' Participation in Energy Markets
May 4, 2017	Novel Coatings Systems for Use as High Performance Chemical Resistant Power Topcoats
May 18, 2017	High-Resolution Site Characterization at Chlorinated Solvents Sites

For upcoming webinars, please visit

http://serdp-estcp.org/Tools-and-Training/Webinar-Series

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SYMPOSIUM

2017 | Enhancing DoD's Mission Effectiveness

A three-day symposium showcasing the latest technologies that enhance DoD's mission through improved environmental and energy performance

- November 28 - November 30, 2017
- Washington Hilton Hotel
  1919 Connecticut Avenue, NW
  Washington, DC 20009

Registration information available soon

Grenade Range Management using Lime for the Dual Role of Metals Immobilization and Explosives Transformation

Andy Martin, Ph.D.
U.S. Army Engineer Research and Development Center (ERDC)

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Agenda

- Project goal
- Who is affected
- What is alkaline hydrolysis?
- Lime application
- Laboratory results
- Field studies: Effect of lime on munitions residues
- Field studies: Effect of lime on metals
- Lessons learned
- Benefits to the Army/DoD

Project Goal

- Reduce migration of munitions constituents from range areas
  - Heavy metals (e.g., Zn, Ni)
  - Explosives (i.e., TNT, RDX)
- Reduce future cleanup time and costs
- Prevent this problem in the future

Hand Grenade Residue

Who is Affected?

Army

Former Munitions Manufacturing Areas

Hand grenade range

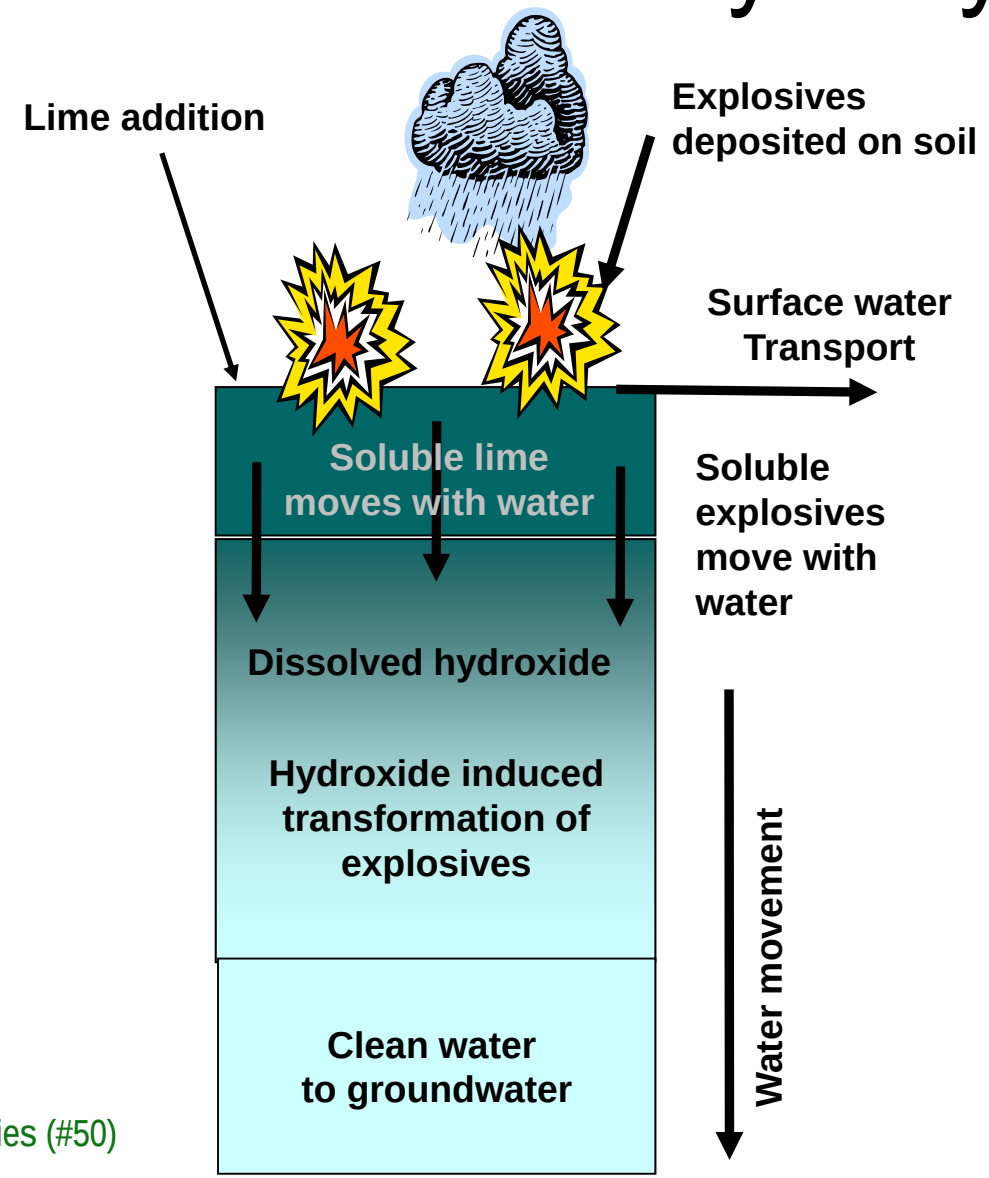
Navy

Open burn/open detonation (OBOD)

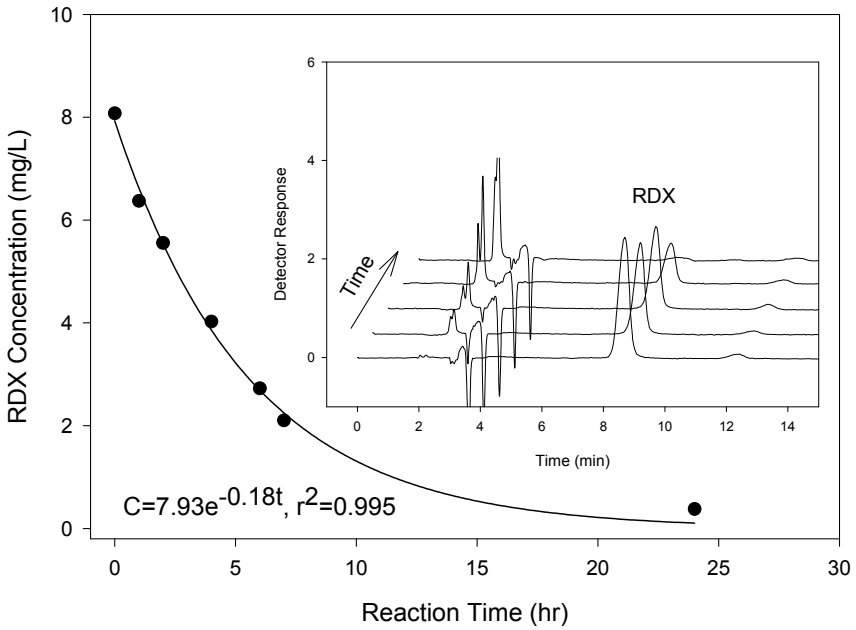
Blow-in-place (BiP) facility

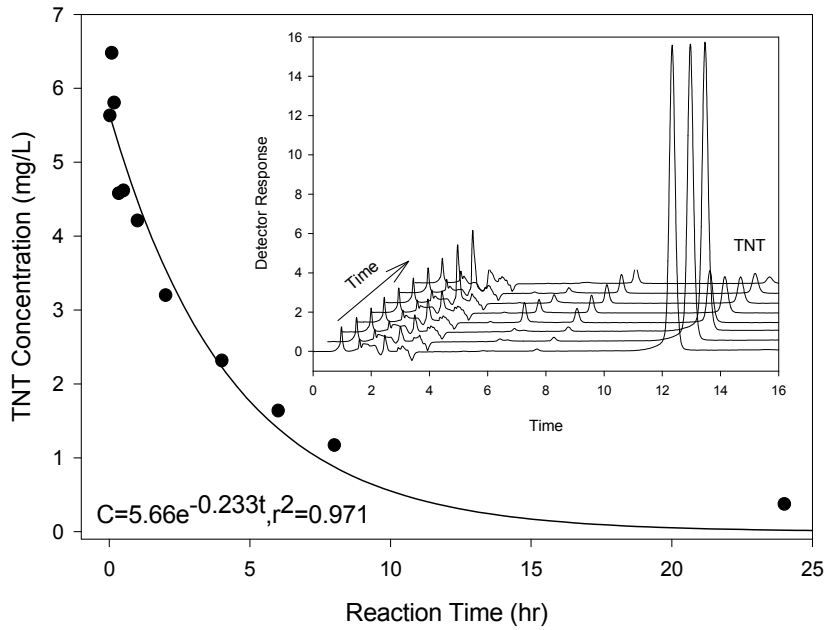
Formerly Used Defense Sites (FUDS)

What is Alkaline Hydrolysis



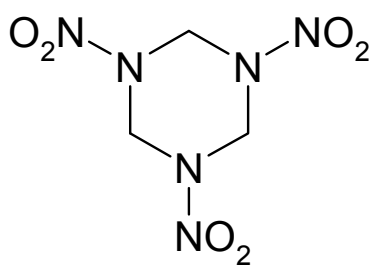
Laboratory Results





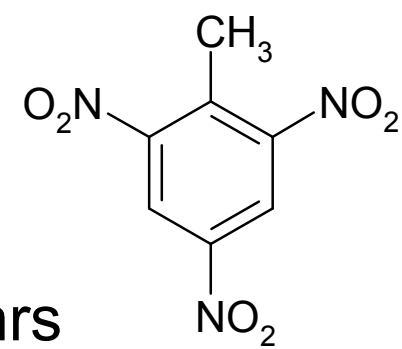
RDX

- Aqueous
- pH=12
- Half Life ≈ 5 hrs



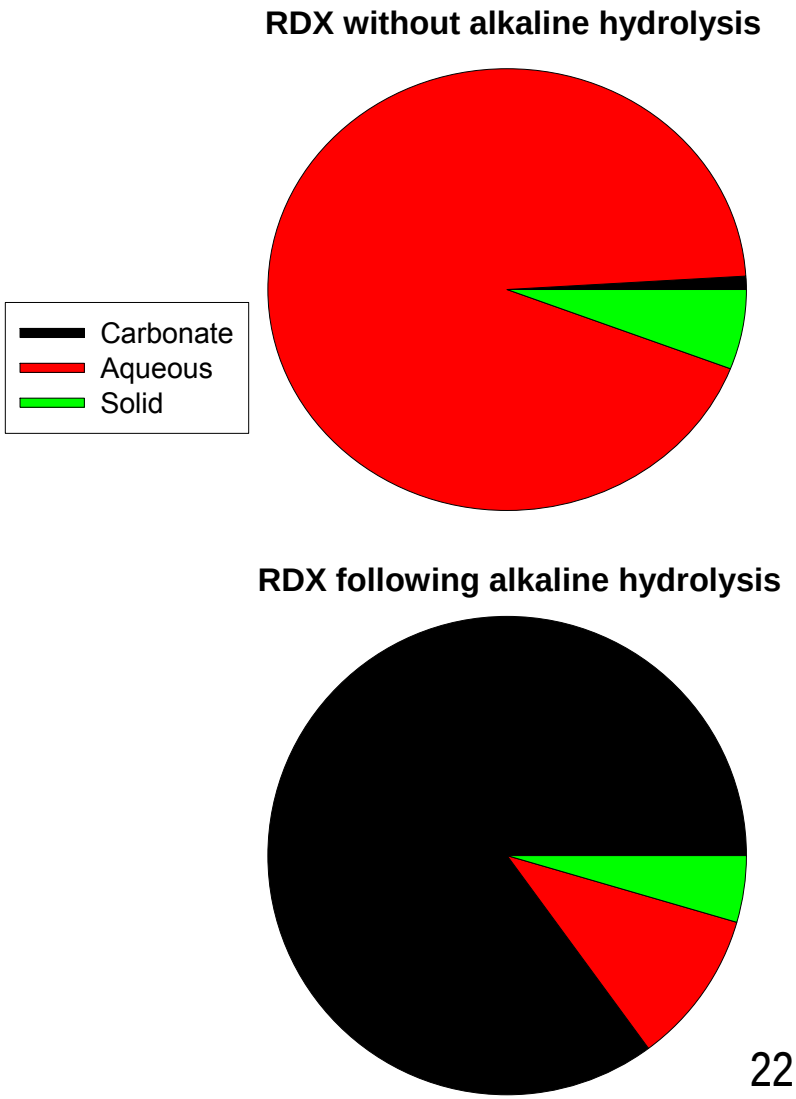
TNT

- Aqueous
- pH=11.5
- Half Life < 2 hrs



Bio-Mineralization of RDX Base-Hydrolysis Products

- RDX base-induced transformation products continue to undergo both anaerobic and aerobic degradation
- ≥75% aerobic mineralization obtained in ^{14}C labeled study after a few weeks
- Transformation products are non-toxic, low molecular weight compounds such as CO_2 and formate



Lime Application and Mixing

- Apply lime to soil to bring pH above 11
- Custom application depends on soil type and concentration of munitions (generally 0.5% w:w)
- Mix lime into the soil

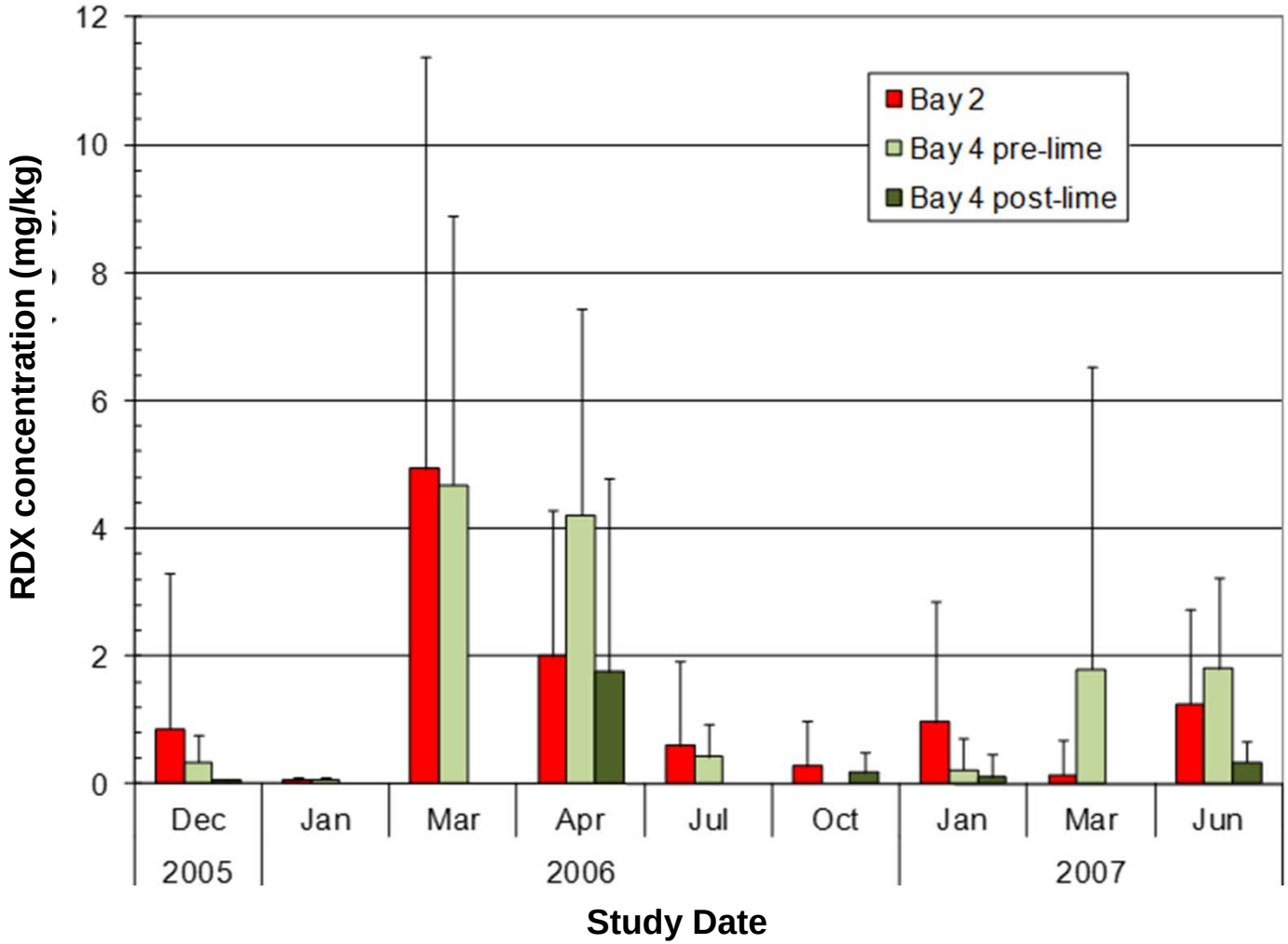
Field Studies: Lime Application

- Apply lime with drop spreader
- Disc to depth
- Lime depends on area treated

Field Studies: Lime Application

- Place bags next to OD operation
- Allow detonation to disperse lime
- Lime depends on area treated

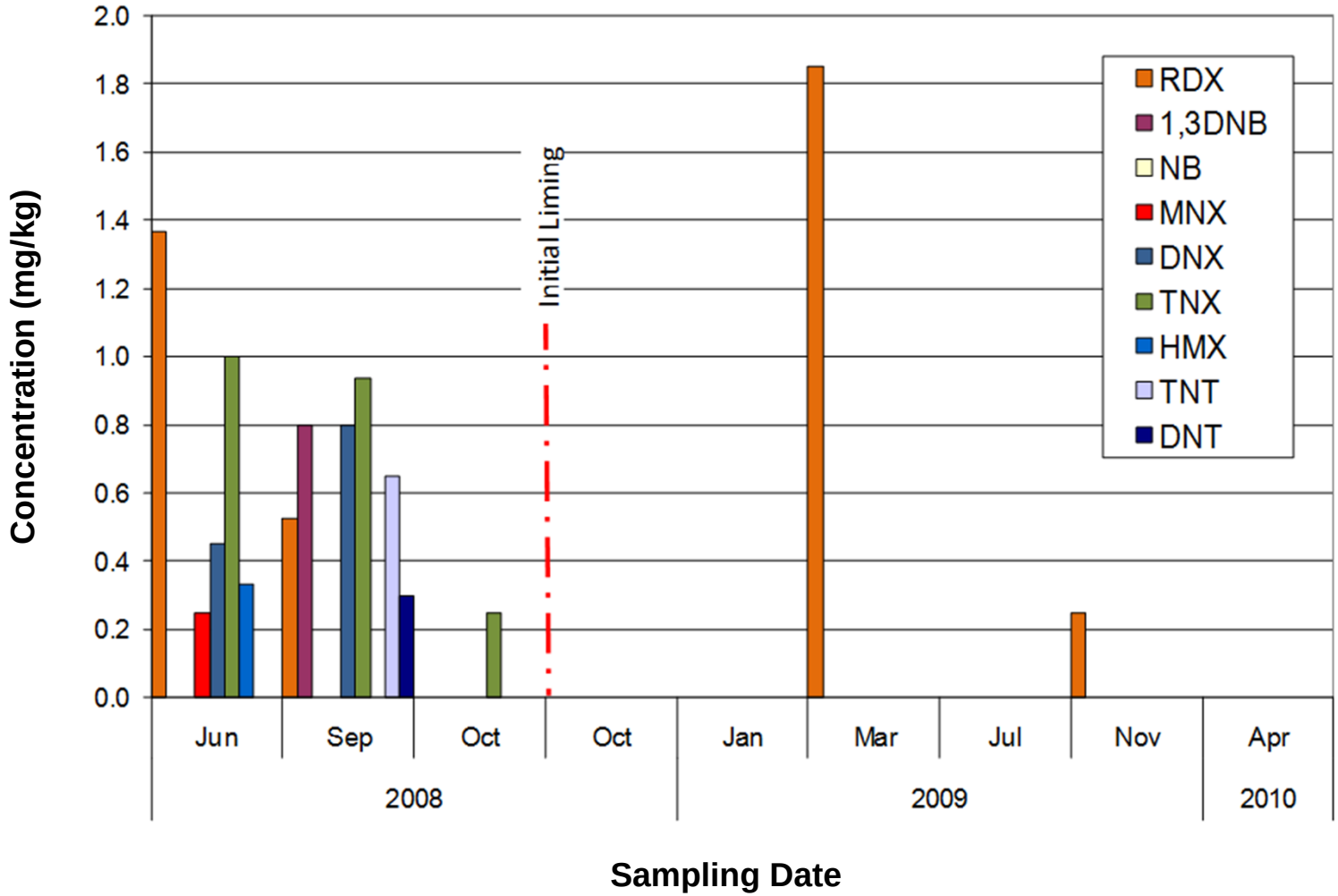
Field Study Results: RDX in Soil



Fort Jackson HGR
Bay 2 – untreated control, Bay 4 – limed

Field Study Results

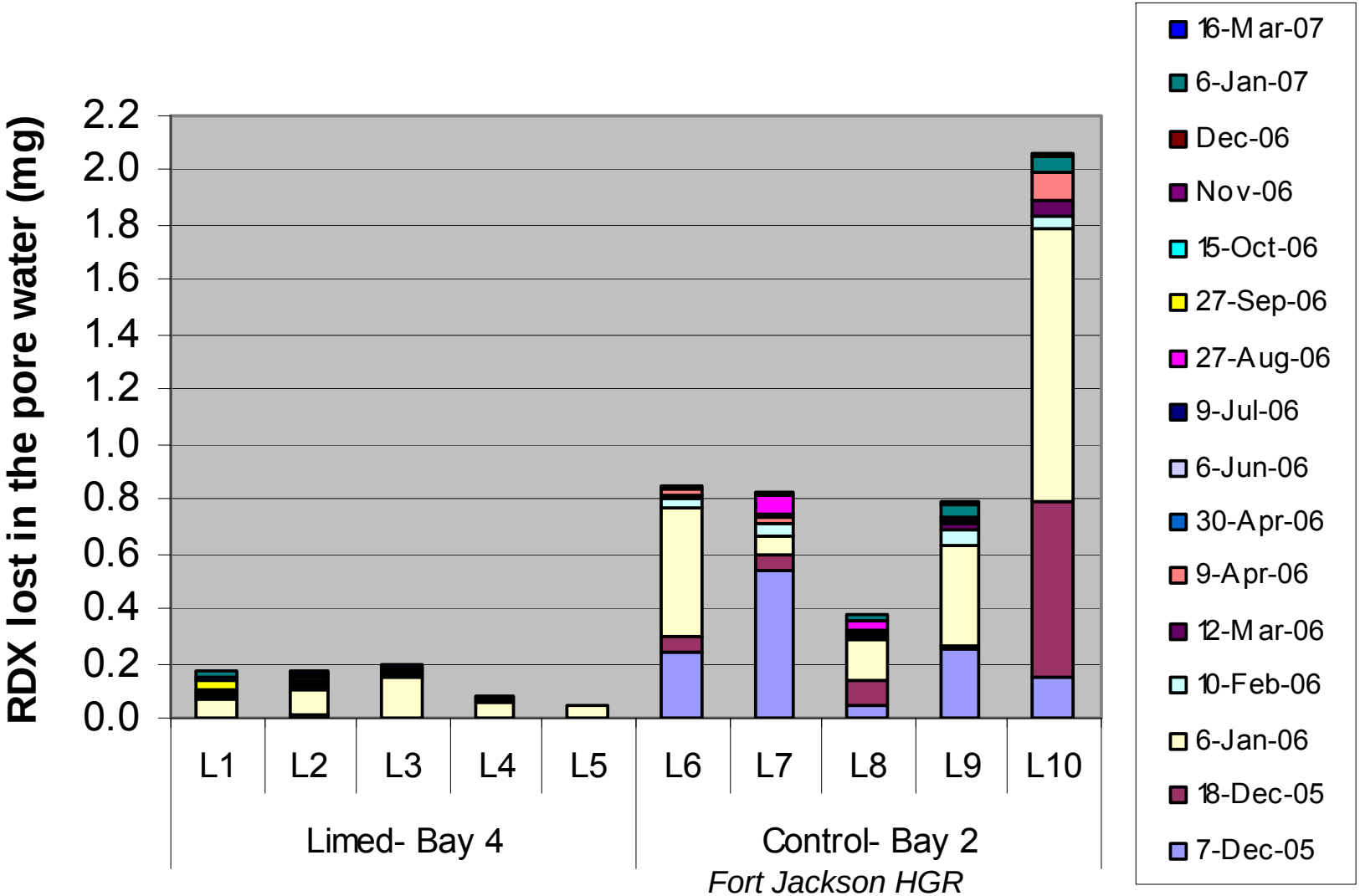
Munition Compounds in Surface Soil



Aberdeen Proving Ground, OD facility

Field Study Results

Mass Balance for RDX in Pore Water

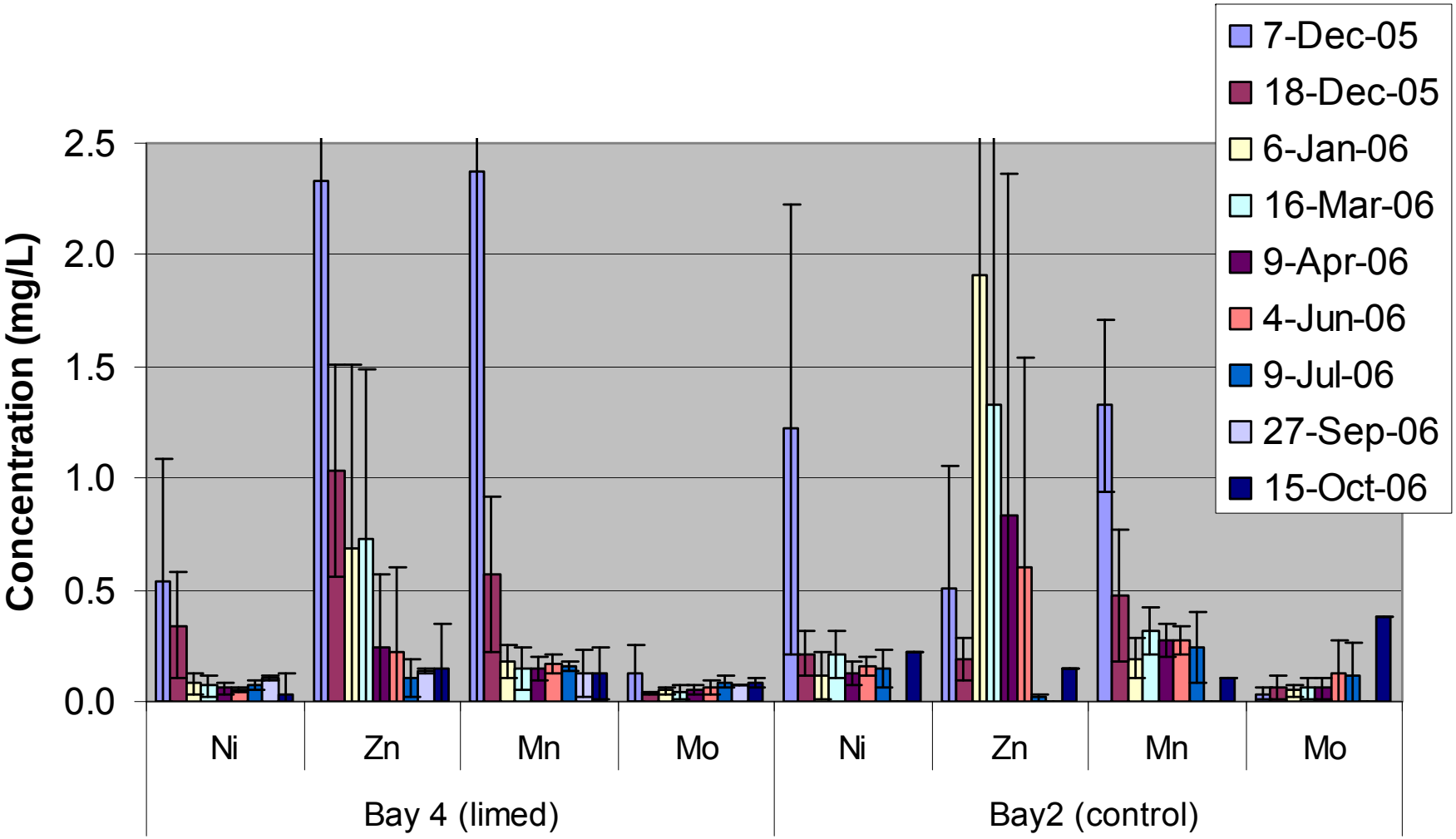


Fort Jackson HGR

Bay 2 – untreated control, Bay 4 – limed

Field Study Results

Average Pore Water Soluble Metals



Fort Jackson HGR
Bay 2 – untreated control, Bay 4 – limed

Lessons Learned

- Lime is an effective option for management of munitions constituents in range soil
  - Transforms explosive compounds
  - Stabilizes metals
  - Reduces off-site migration
  - Doesn’t contribute to water issues
  - Reduce potential future liability associated with migrating munition constituent compounds and source zone contamination

Lessons Learned

- Low cost of treatment
  - Low cost (<$2,134/acre/year, based on 2016$)
  - Lime is inexpensive and readily available
  - Necessary equipment to deliver and mix lime into the soil is also readily available, either on-site or rental
  - Doesn't require specialized operator training
  - Time required for application is measured in hours, not days
    - Training disruptions were minimal to none

Lessons Learned

- Factors affecting lime application rate
  - Soil particle size
  - Range use and maintenance schedule
  - Number of grenades detonated per year, range munitions loading rate, or level of soil contamination (depending on the site being remediated)
  - Annual rainfall

Benefits to Army and DoD

- Alkaline hydrolysis can be used for different types of facilities as well as in civil works applications
  - Hand grenade ranges
  - Demilitarization of munitions – BiP, OD
  - Blasting areas, construction/demolition
  - Munition production facility
  - Small arms firing ranges
  - Effective – rapidly transforms munitions constituents into small non-toxic compounds
- Immobilizes metals associated with common munitions
- Reasonable costs using readily available equipment
- Application does not interfere with training activities

For additional information, please visit

https://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminants-on-Ranges/Protecting-Groundwater-Resources/ER-200742

Speaker Contact Information

Andy.Martin@usace.army.mil; 601-634-3710

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Q&A Session 1

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Evaluation of Biopolymer for Erosion Control of Protective Berms

Steven Larson, Ph.D.
U.S. Army Engineer Research and Development Center (ERDC)

SERDP DOD • EPA • DOE | ESTCP

Agenda

- What is the challenge?
- A Solution: Biopolymer
- What is a “biopolymer”?
- How is it produced?
- Where has it been used?
- Additional biopolymers = additional uses
- Benefits to the Army and DoD

The Challenge

- Military facilities require sustainable, environmentally sound management
  - Eliminate/reduce sediment transport off-site
  - Eliminate/reduce dust production
  - Maintain berms
  - Reduce wind/water erosion* of road beds and training areas
  - Enhance revegetation of difficult soils

**Cost of treating water/wind erosion of soil has been estimated at $7B at one facility, 2009*

The Challenge

- Petroleum-based polymers are currently used as soil amendments for engineering purposes
  - High cost
  - Low rates of biodegradation
  - Toxicity
  - Production contributes to atmospheric carbon

The Solution

- Biologically-produced polymers
  - Lower cost
  - Higher rates of biodegradation
  - Non-toxic end-products
  - Potential storage of atmospheric carbon

What is a Biopolymer?

- *Rhizobium tropici* is a symbiotic bacteria that nodulates the roots of legumes, like soybeans
- It uses the plant sugars to produce an extracellular polymeric substance (EPS), a biopolymer
- Biopolymers are referred to by the name of the bacteria that produce it

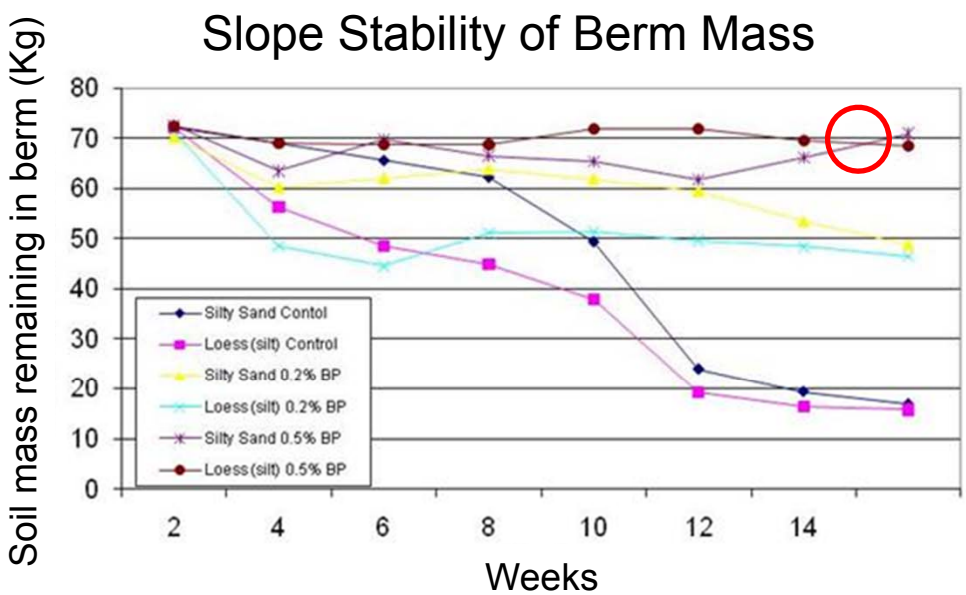
How a Biopolymer is Produced*

- Produced as a monoculture in a bioreactor
- Separated from the bacterial cells
- Extracted from solution and concentrated

*Newman et al. 2010. Patent No. US 7,824,569

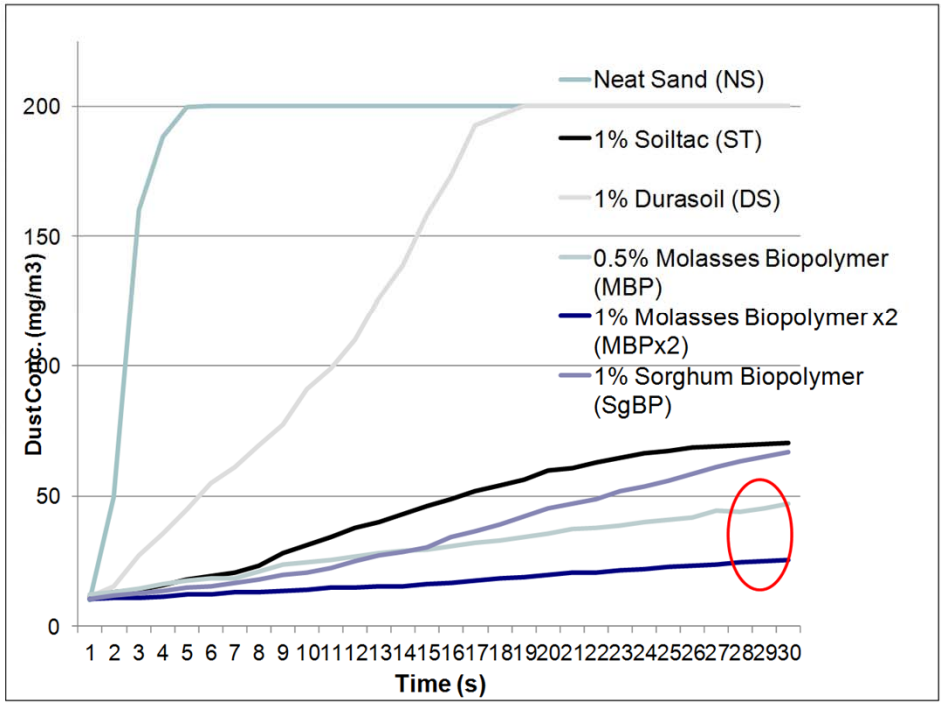
Laboratory Results

Improved soil retention on slopes



Loess and Silty sand soils treated with 0.5% biopolymer were most effective at erosion control

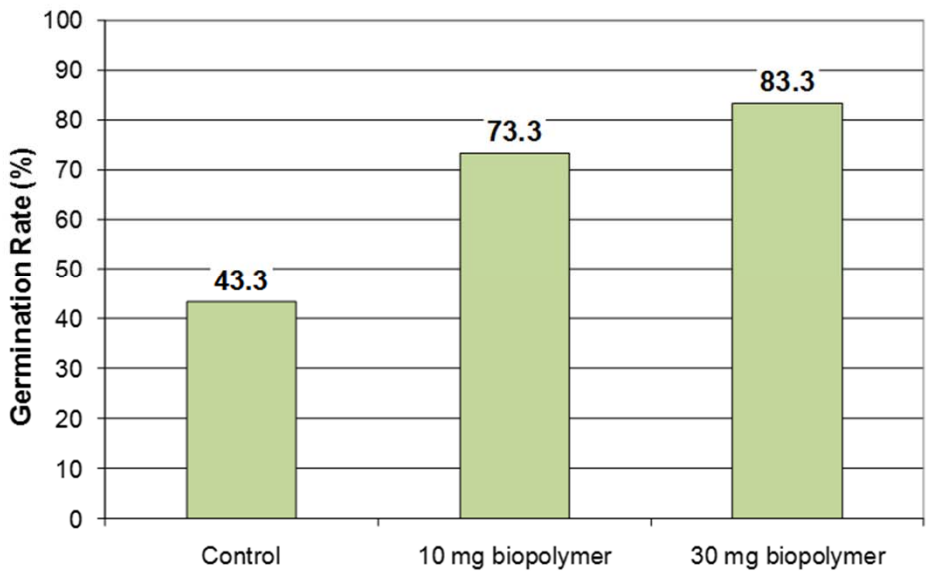
Decreased production of fugitive dust

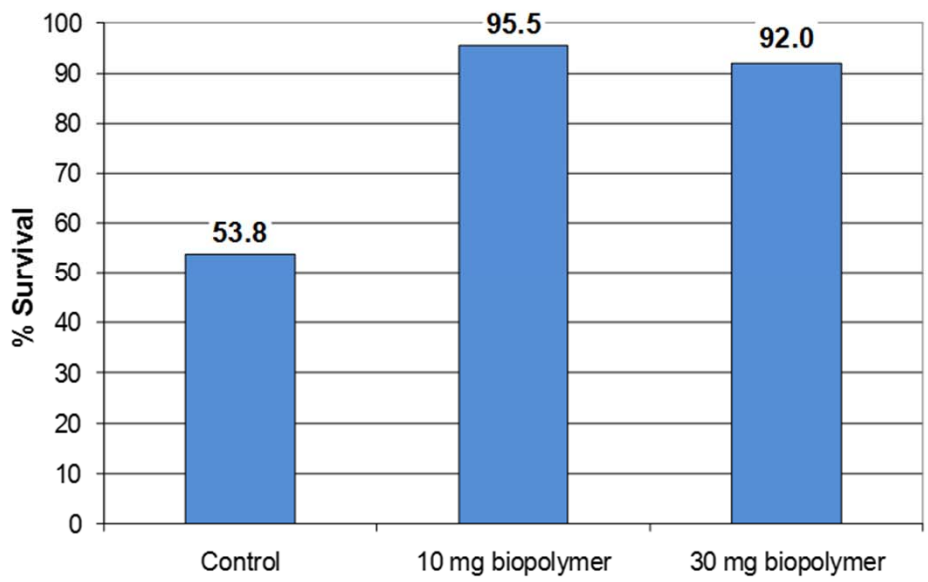


Loess soil treated with 0.5% or 1.0 % biopolymer were most effective at preventing formation of fugitive dust

Laboratory Results

Improved Seed Germination and Drought Tolerance

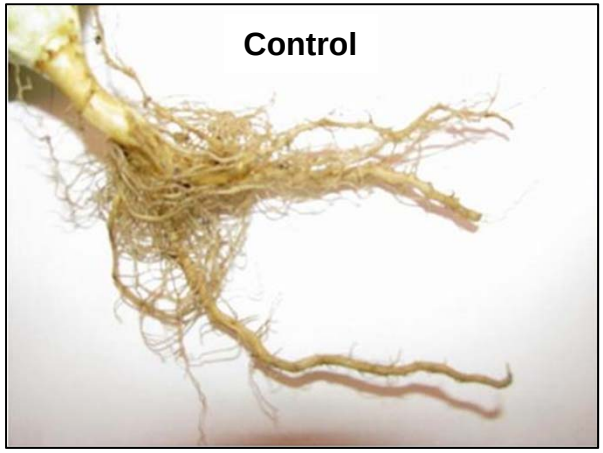


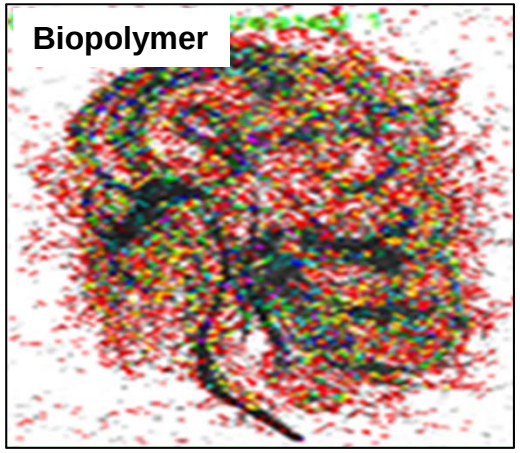


Laboratory Results

Improved Root Development and Architecture

- Highly branched root systems are more effective at holding soil and reducing erosion

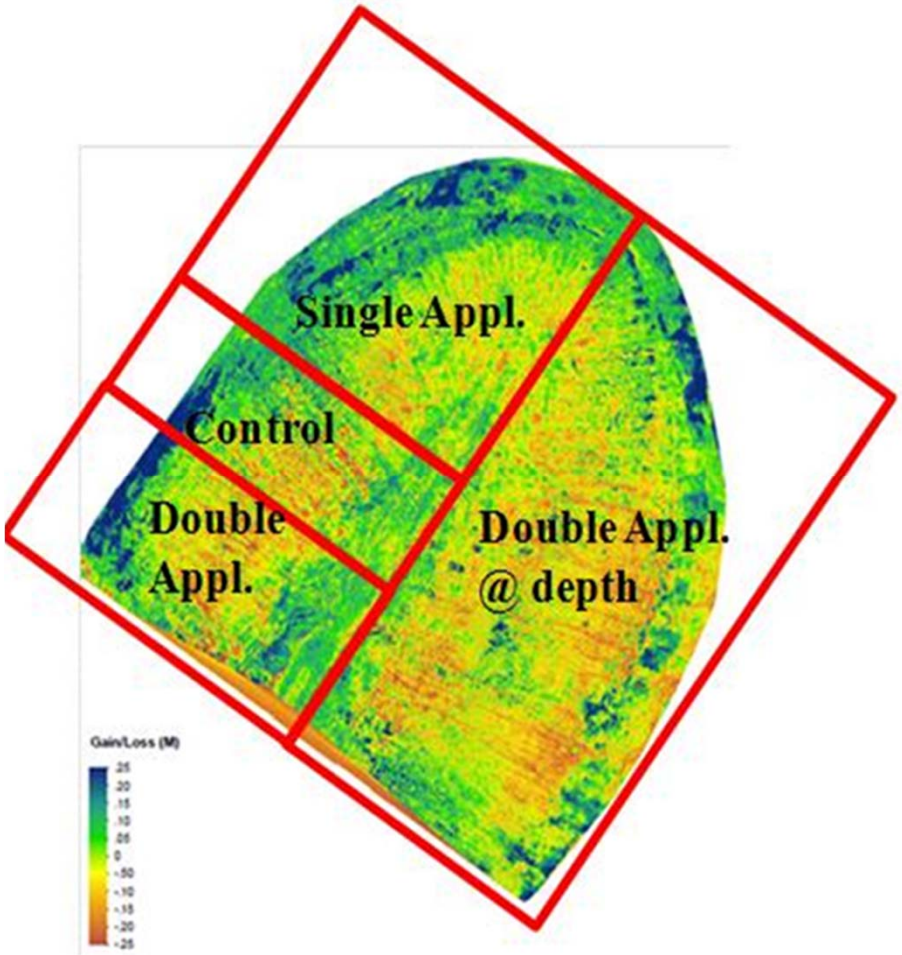




Where Has Biopolymer Been Used

Military Field Applications

Explosion Protection Berm, Iowa Army Ammunition Plant (IAAAP)

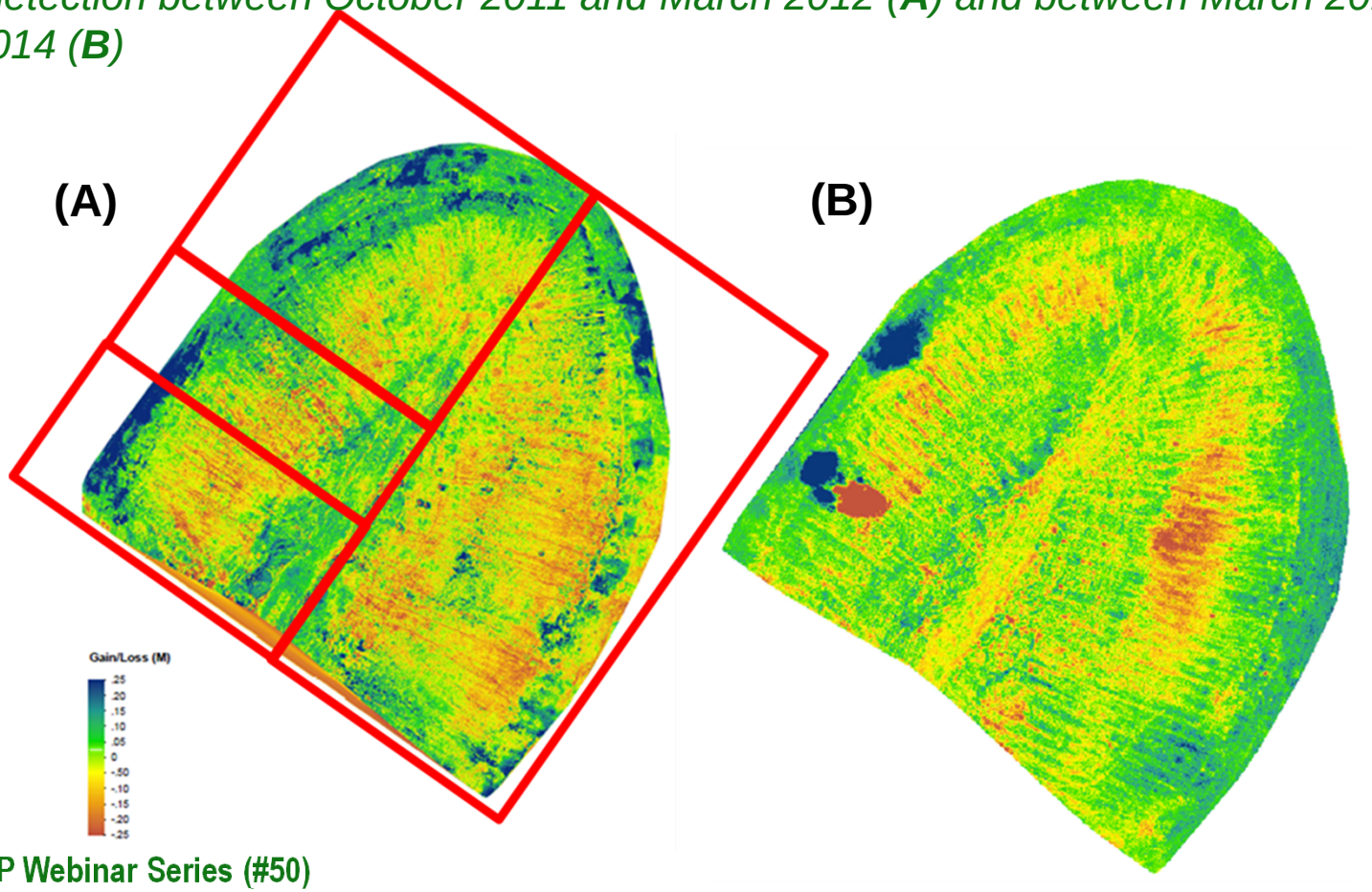


Where Has Biopolymer Been Used

Military Field Applications

Explosion Protection Berm, IAAAP

*Change detection between October 2011 and March 2012 (**A**) and between March 2012 and August 2014 (**B**)*

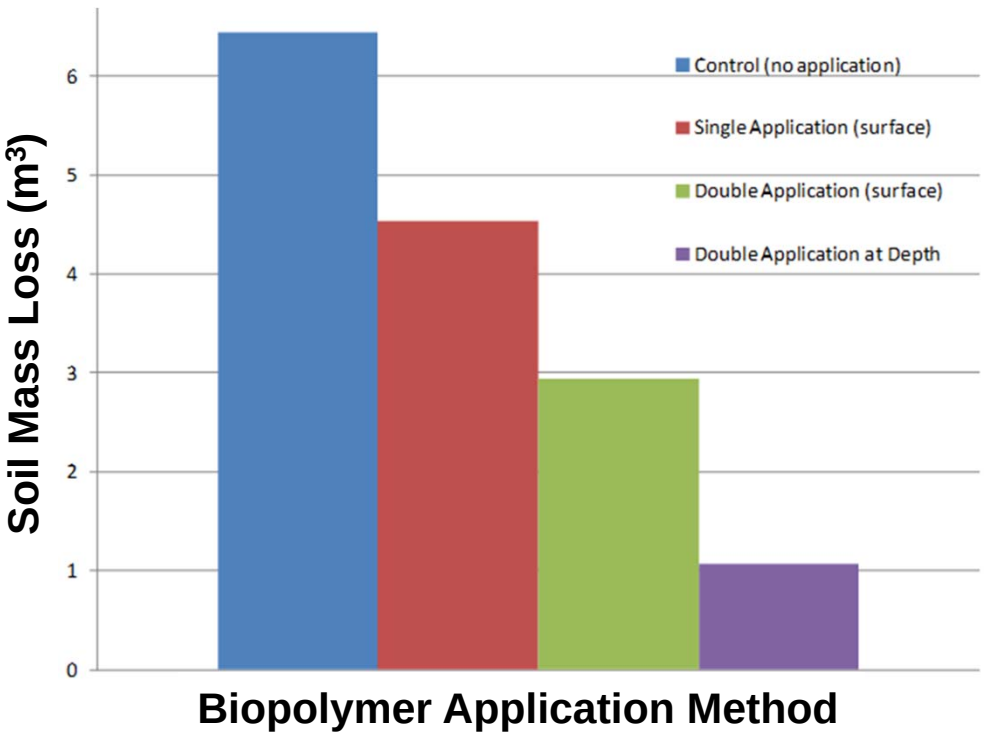


Where Has Biopolymer Been Used

Military Field Applications

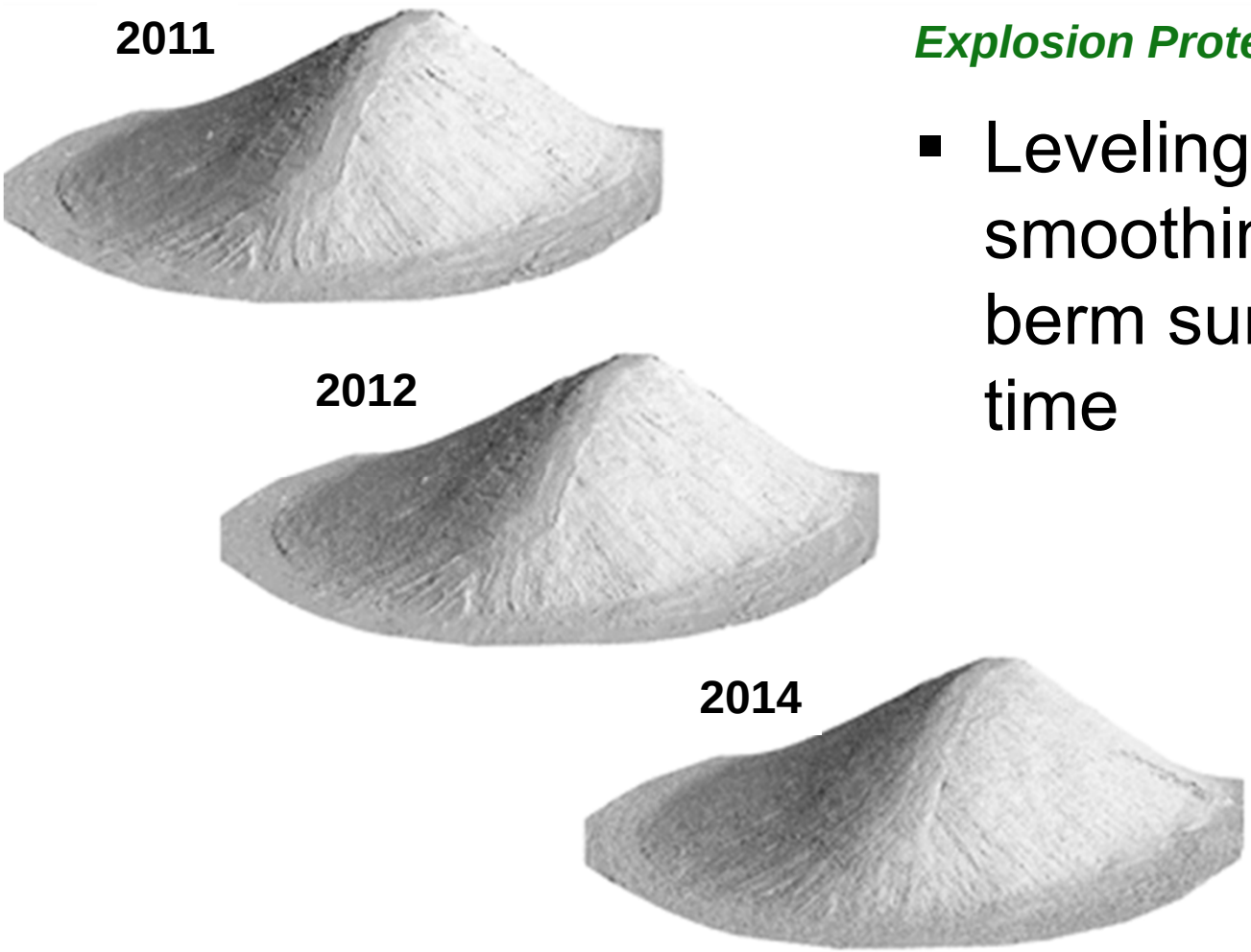
Explosion Protection Berm, IAAAP

- Compares soil lost after 6 months by treatment as calculated through Light Detection and Ranging (LiDAR) imaging of the berm surface. LiDAR is a remote sensing method that uses light in the forma of a pulsed laser to measure distance and elevation



Where Has Biopolymer Been Used

Military Field Applications



Explosion Protection Berm, IAAAP

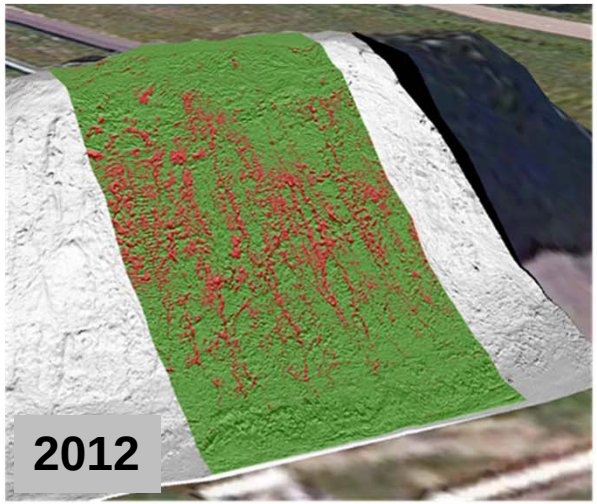
- Leveling and smoothing of the berm surface over time

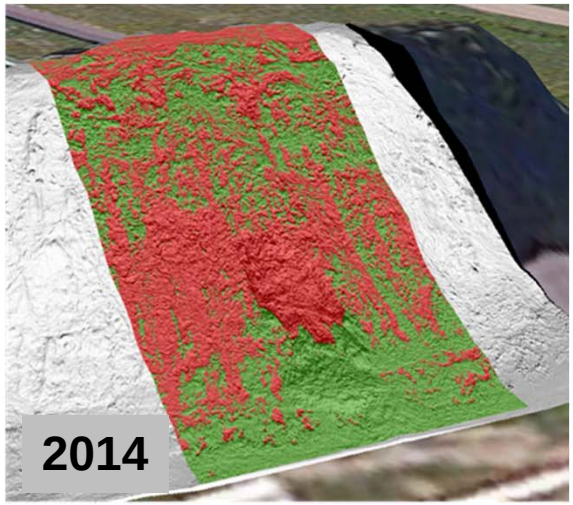
Where Has Biopolymer Been Used

Military Field Applications

Explosion Protection Berm, IAAAP

Area C landslip:
275 ft^3 of soil





Where Has Biopolymer Been Used

Military Field Applications

Explosion Protection Berm, IAAAP

- Cost drivers
  - Quantity of biopolymer required
  - Delivery to site
  - Availability of grass seed, hydroseeder and operator
  - Soil quality
    - Poor soils may need compost and/or fertilizer
- Cost of building and maintaining 100 feet of berm with a single application of biopolymer is approximately half (0.52) of what it costs for a traditional earthen berm over a 30-year lifetime

Where Has Biopolymer Been Used

Civil Works Field Applications

Kaufmann Levee, Texas

- Levee slope maintained under flood conditions
- Increased Bermuda grass vegetation over control area
- Decreased invasive species over control

Additional Biopolymers = Additional Uses

- Improved re-vegetation in saline soils
- Improved hydroponic yield of vegetables
- Improves agricultural yield from marginalized land
- Riparian restoration

Conclusions

Environmentally Engineered Solutions Using Biopolymer

Military

Erosion control
Sustainable ranges
Soil disturbance detection
Dust suppression
Petrochemical polymer replacement

Agricultural

Drought resistance
Erosion control
Increased crop yields
Consumer products

BP (left), Control (Right)

Civil

Bank stabilization
Levee armoring/vegetation
Erosion control
Reactive sediment caps

DoD Benefits

- Lower project construction and maintenance costs for facilities
  - Fewer trips for repair and maintenance
  - Self-healing
- Limits incidence of invasive plant species
- Provides a positive focus on Army stewardship of land

For additional information, please visit:

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Speaker Contact Information

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Q&A Session 2

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The next webinar is on March 23, 2017

Monitoring and Risk Assessment of Environmental Risks Posed by Munitions Constituents in Aquatic Systems

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Survey Reminder

Please take a moment to complete the survey that will pop up on your screen when the webinar ends

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