



# Capabilities and Case Studies

Safe Neutralization of Explosives, Munitions and Munitions Constituents

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CEO/CTO

## Presentation Outline

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- Introduction to MuniRem Technology and Company
- MuniRem Reagent Case Studies
  - Chemical Warfare Materiel (CWM) Degradation
  - Remediation of OB/OD Sites
  - Soil and Groundwater Remediation
  - Demilitarization Support (Underwater & Land)
  - Equipment and Building Decontamination
  - Routine Maintenance of Energetics Facilities with MuniRem reagent
- Summary and Conclusion

A large, faint background graphic of a globe is centered on the slide. The globe is composed of several large, curved segments in shades of light green and white, creating a stylized, abstract representation of the Earth's continents and oceans.

## INTRODUCTION TO MUNIREM TECHNOLOGY

## What is MuniRem Reagent?

- MuniRem is the commercial name for a University of Georgia Research Foundation patented technology
- MuniRem Technology is licensed exclusively to MuniRem Environmental, LLC
- It employs reduction chemistry to rapidly neutralize and destroy explosives and energetics in different media.
- The end product is non-hazardous.
- MuniRem reagent also degrades chemical warfare materiel (CWM) and stabilizes metals.





# Advantages of MuniRem

**Faster**

Can destroy energetics hours compared to days/weeks for alternatives

**Safer**

Much reduced danger for the user. Alternative methods have resulted in fatalities

**Lower Cost**

Less equipment, less labor and less time to remediate means substantially lower total cost

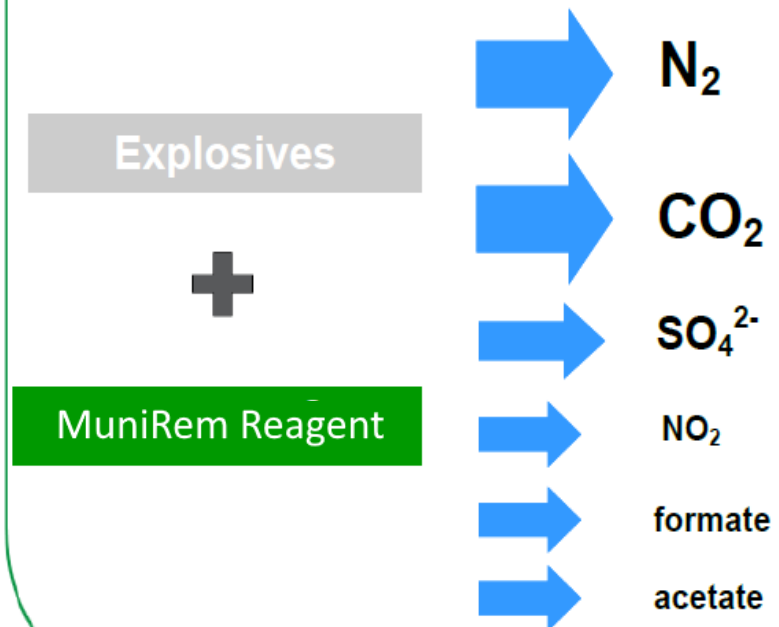
# Types of Explosives and Metals Remediated and End Products

## Effective in Neutralization and Remediation of



- Mustard (CWA)
- HMX / RDX / TNT
- DNTs / ADNTs
- NBs / NDMA
- Nitrocellulose Propellant
- PBX / PETN
- PCBs
- Lead Styphnate
- Lead Azide
- Picric Acid
- AN/TATP
- Comp A, B, & D
- Dynamite
- Reactive Aluminum
- As, Ba, Cd, Cr, Pb, Hg, U, etc.

## Reliable Green Technology for Remediation of Explosives



**MuniRem reagent is versatile in its ability to neutralize a variety of energetics**

## Effective Remediation of Heavy Metals

### Reliable Green Technology for Remediation of Heavy Metals

Heavy metals



MuniRem Reagent



**Metal  
Sulfide**



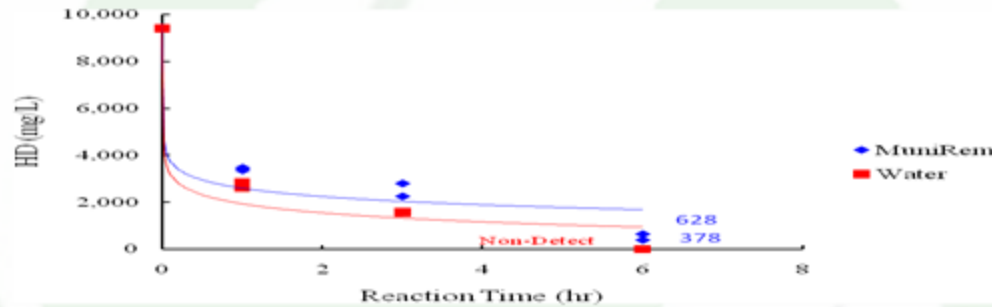
$\text{SO}_4^{2-}$

## CHEMICAL DESTRUCTION OF CHEMICAL WARFARE MATERIEL (CWM)

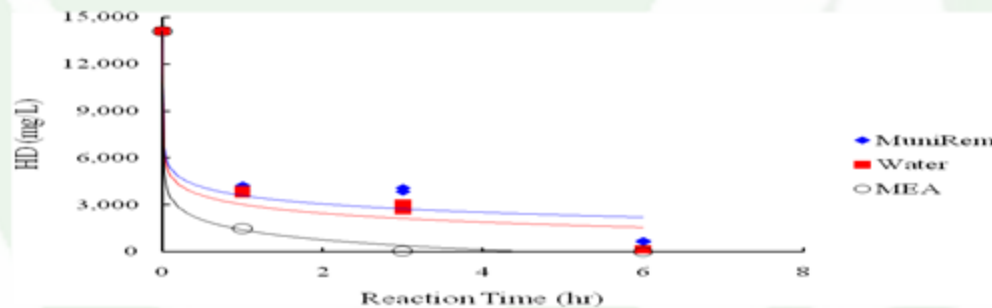
Contract #: W912PP-10-P-0034

Results presented are obtained from proof-of-concept test data for tests conducted at Non-Stockpile laboratory, Edgewood (2010)

# Rate of Degradation of HD by MuniRem Reagent VS. Rate of Reversible Hydrolysis of HD by Water

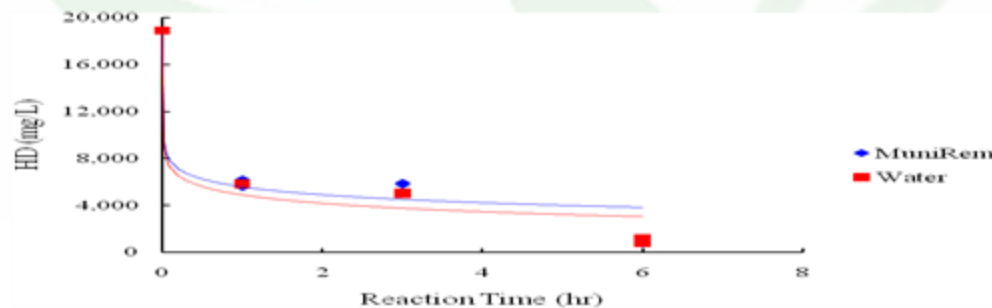


Initial = 40 uL (9,000 mg/L)



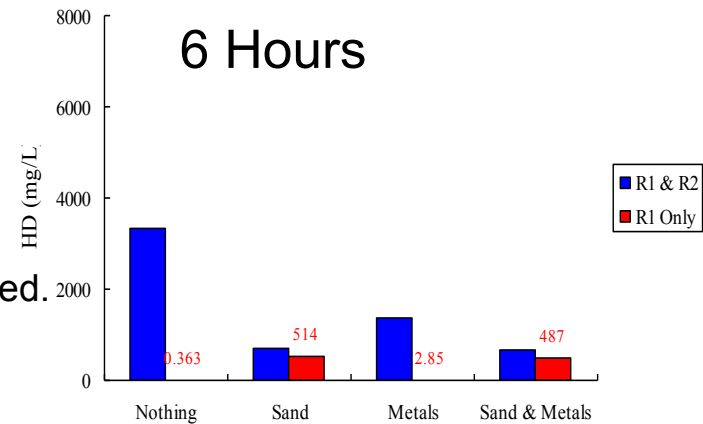
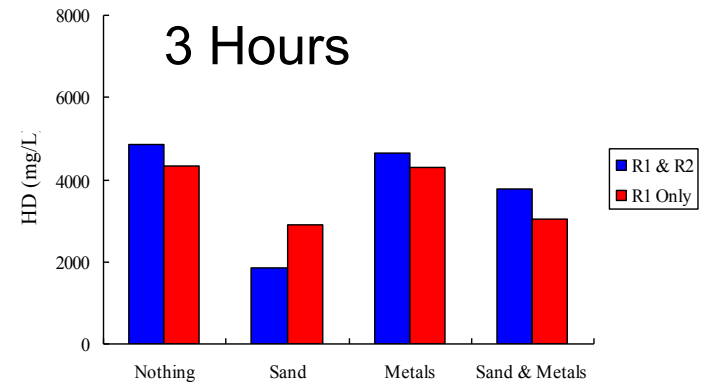
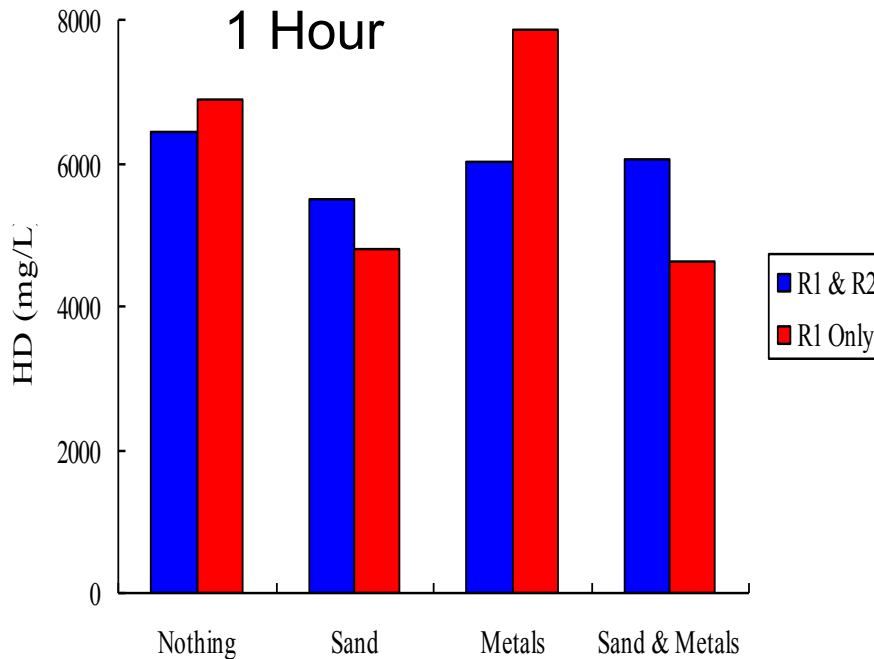
Initial = 60 uL (14,000 mg/L)

MEA forms Hazardous Waste



Initial = 80 uL (18,500 mg/L)

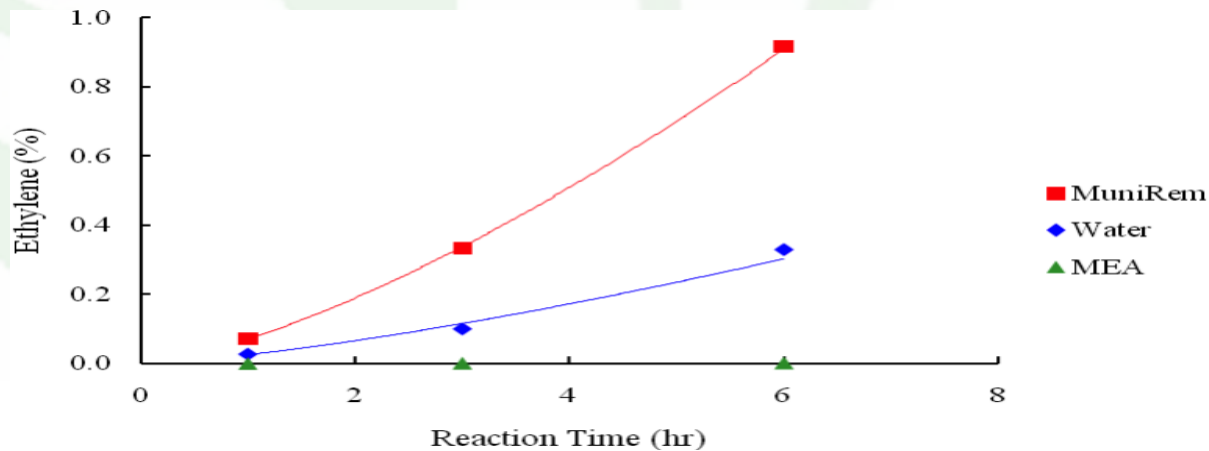
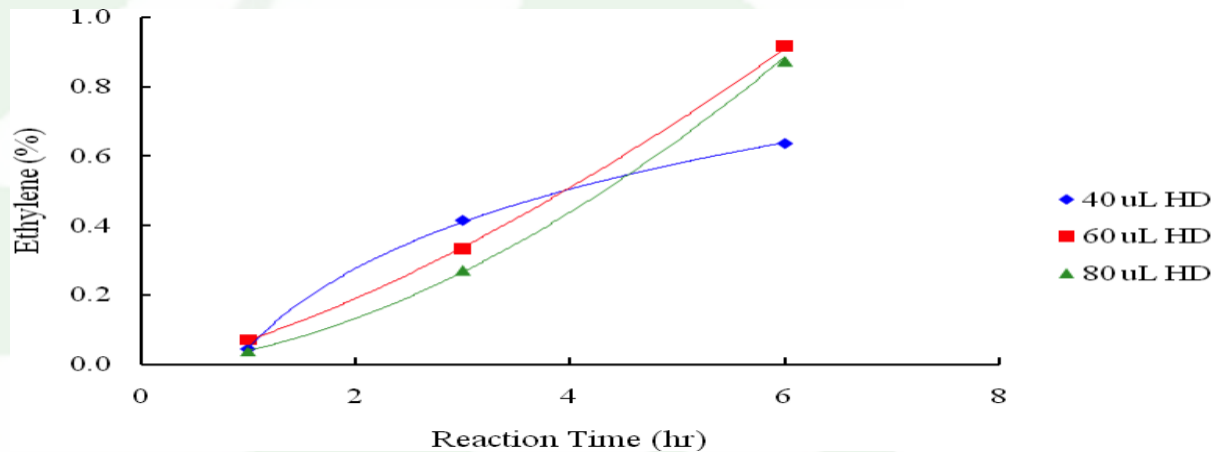
# Neutralization of Mustard (HD) with MuniRem Reagent



Nothing = Homogeneous Solution of MuniRem; no solids added.  
 Sand and Metal (Iron) was added to simulate reality  
 Initial Concentration of Mustard = 18,500 mg/L  
 Results for: 1 hour; 3 hours; **6 hours**

# Evidence of Mustard (HD) Destruction by MuniRem

## Ethylene Production as a Function of Time



# CWM/BWM Decontamination Methods

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## **Old Methods**

1. Chlorine bleach-based products
2. Highly caustic solutions

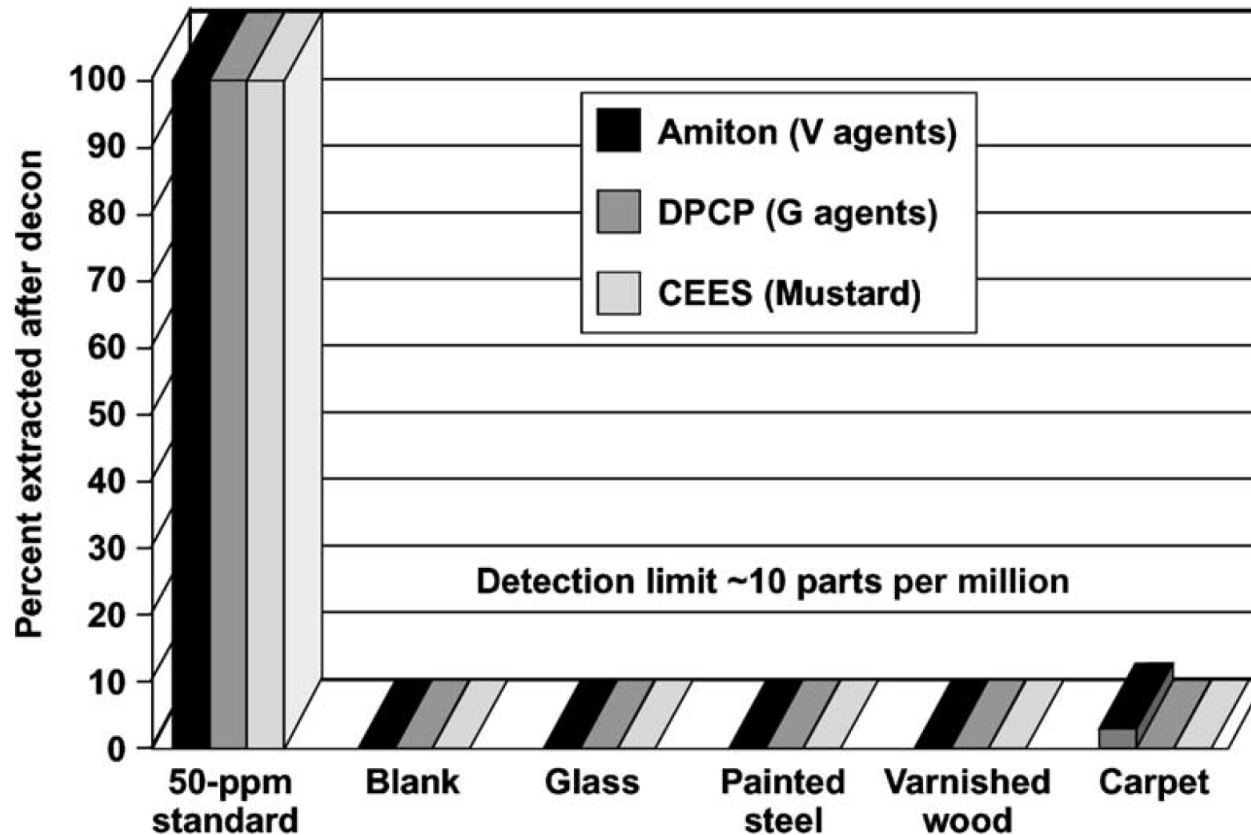
## **New Method**

3. MuniRem Decontamination Gels – Formulated to minimize dispersal and run-off
  - Chemical Reduction Gel
  - Chemical Oxidation Gel



# Percent of extracted CW agent from substrates after decontamination

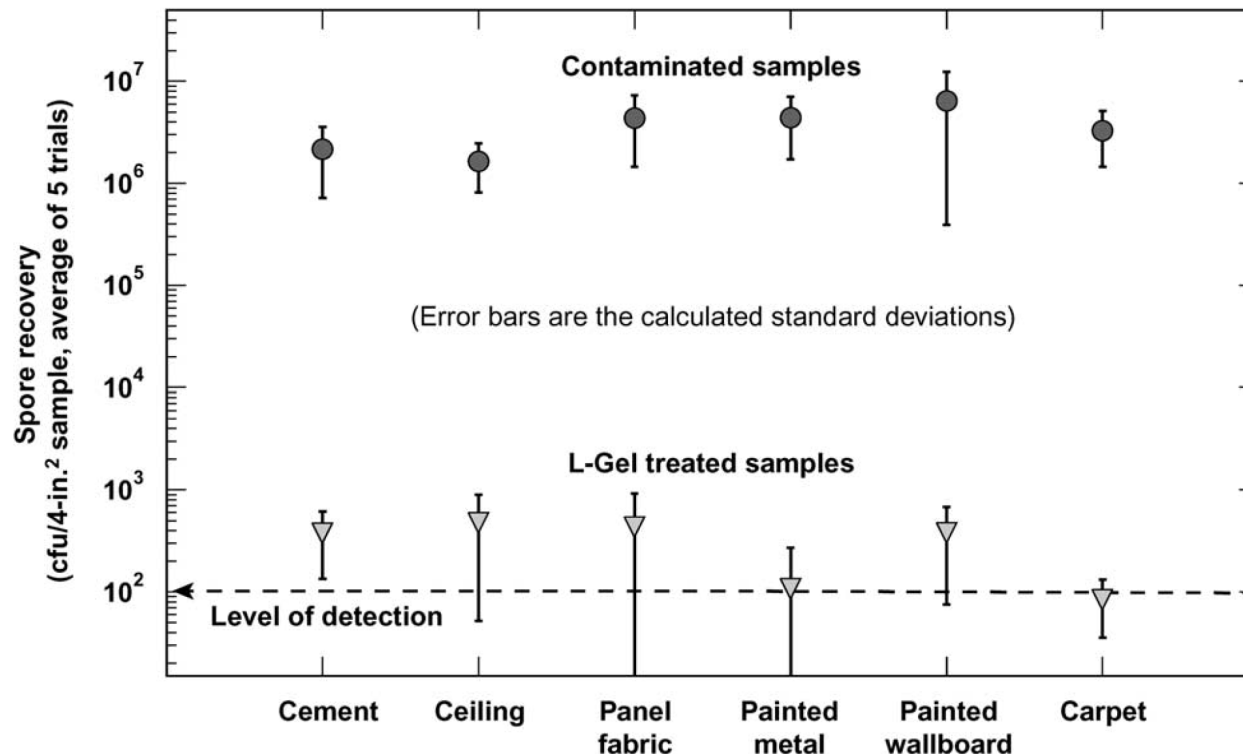
Using GC-MS detection methods (Lawrence Livermore National Laboratory Study)



# Results of field tests on six materials contaminated with BG Spores

Chart shows spores before and after application of decontamination gel.

BG spores were reduced by an average of 99.988% by the decon gel.



## Independent laboratory and field testing of LLNL Gel

- Field testing at the Military Technical Institute of Protection, Brno, the Czech Republic (October 1998);
- Lab testing at Edgewood Chemical Biological Forensic Analytical Center (ECBC), Aberdeen Proving Ground, MD (November 1999);
- Lab testing with thickened agents at the Defence Evaluation and Research Agency (DERA), Porton Down, UK (October 1999).



## ON-SITE DEMILITARIZATION OF RECOVERED UNDERWATER MUNITIONS

MuniRem supports Savannah Harbor Expansion Project (SHEP)

# Options for Recovery of Bomb Fillers (Bulk Energetics)

- Water jet
- Water saw
- Milling
- Cryogenic Breaching



Breaching and Recovery of Bulk Energetics



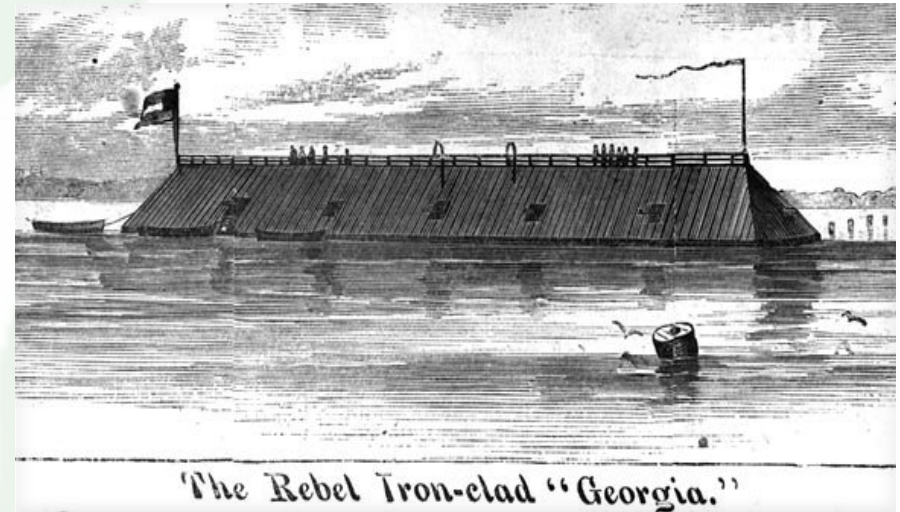
Projectile Casings



Recovered Bulk Energetics

## CSS Georgia Background

- Ironclad gunboat built for the Confederacy in 1862
- Completed Vessel was too heavy
- CSS Georgia spent her life as a floating battery in what is now the north edge of the Savannah Harbor navigation channel
- CSS Georgia scuttled by Confederate troops on December 24, 1864
- Recovery of CSS Georgia and its munitions was part of the Savannah Harbor Expansion Project





# Munitions Recovered from Underwater Environment



## Breaching of Recovered Projectiles

Total projectiles breached and neutralized = 170

Breaching throughput = 12 projectiles per hour





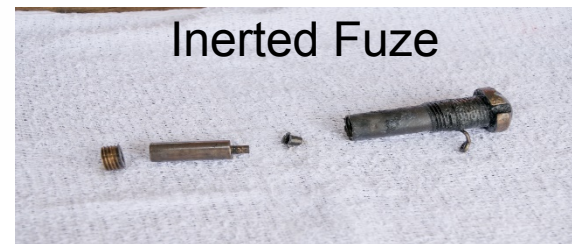
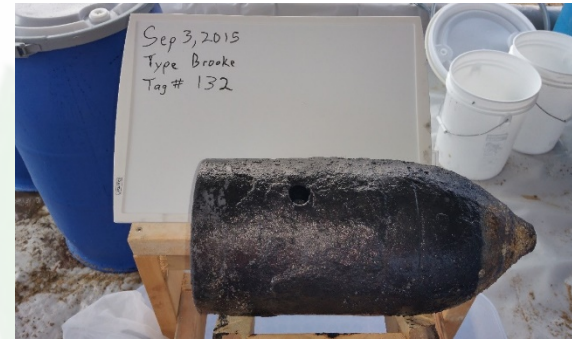
## Neutralization of the Breached Munitions

- After 150 years explosives still well preserved
- Explosives washout using MuniRem solution
- Explosives neutralized
- Fuzes safely removed and inerted
- Munitions certified by SUXOS as safe
- Characterization and disposal of non-hazardous waste



# Summary – Underwater Munitions Demilitarization

- 170 Civil War munitions neutralized on-site in 2015
- Munitions transferred to U.S. Army Corps
- Munitions preserved for historical purposes
- No hazardous waste produced
- Largest on-site neutralization of recovered underwater Confederate munitions
- Follow up project November 2017





## MUNIREM APPLICATION IN SUPPORT OF DEMILITARIZATION



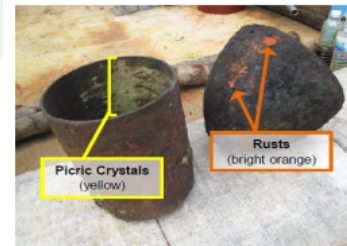
# Thermal Vs. Non-thermal Decontamination

## Thermal Decontamination

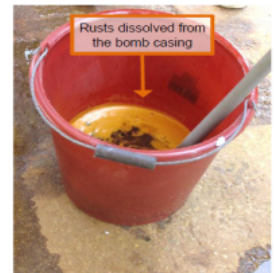
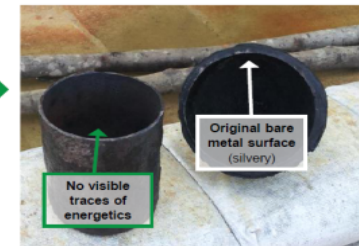


## MuniRem Bath Decontamination

Before Treatment



30-mins after MuniRem® Bath



# MuniRem Application at a Demilitarization Plant in SE Asia



30mins MuniRem® bath



MuniRem® spray down





# Application of MuniRem to support demilitarization in SE Asia



Visible picric crystals on building surfaces (in bright yellow) before treatment.



Instant color change to reddish brown signifies neutralization reaction.



MuniRem® continues to breakdown the yellow picric crystals.



MuniRem®-treated area is left to air-dry.

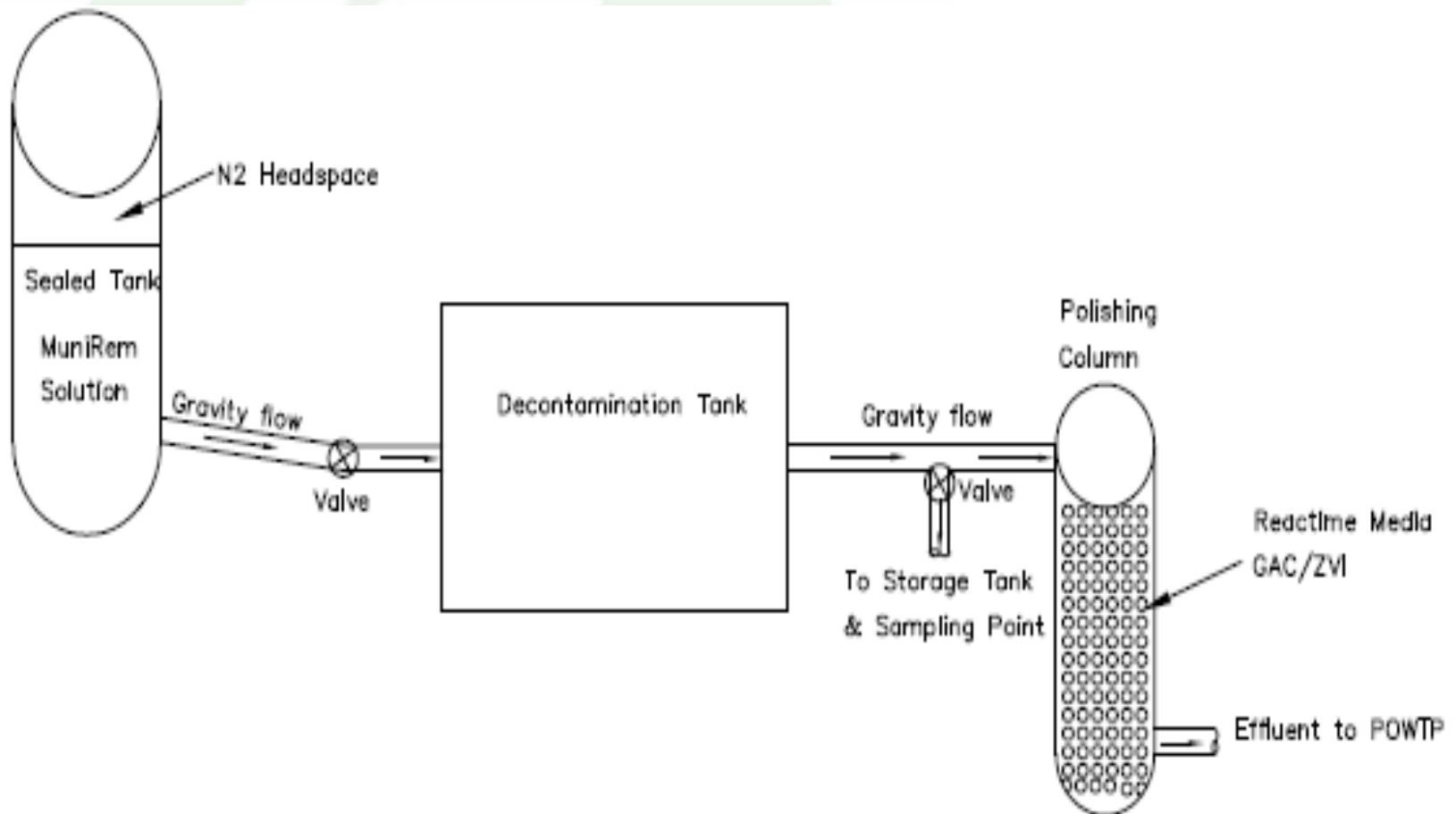


**24 Hours Later**  
Visible and significant reduction of picric crystals.



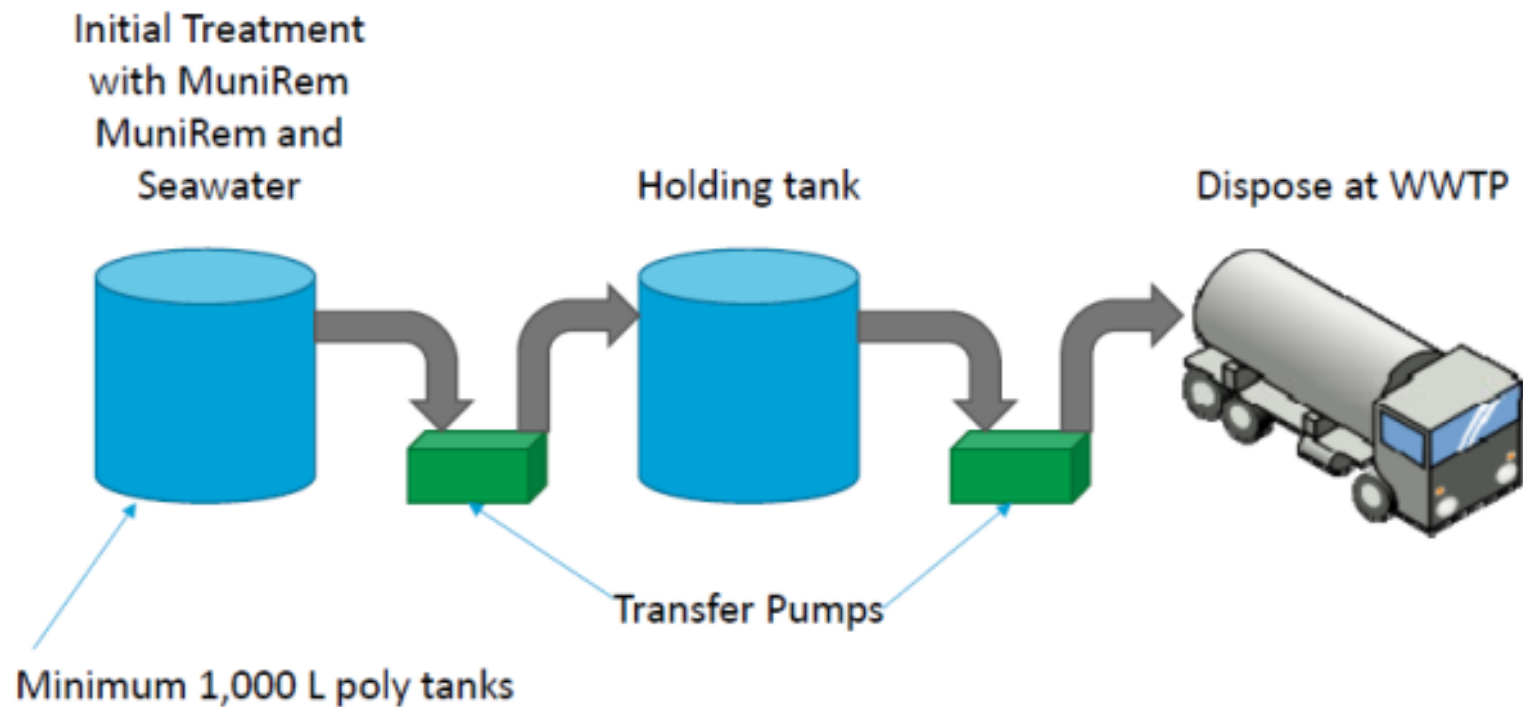
**2 Weeks Later**  
No re-crystallization of picric acid.

# Rapid Decontamination of Scrap and Accessed Sub-Munitions



# Scale-up Option

## Small Scale Demilitarization (Schematic)





# CHEMICAL NEUTRALIZATION OF BULK EXPLOSIVES ABANDONED ON DEMILITARIZATION EQUIPMENT

Camp Minden, Louisiana

# Abandoned Bulk Explosive Neutralization

- Melter/Flaker machine contained bulk H-6 (TNT, RDX, AL, Binder) explosives
- Large crystallized chunks of H-6 on equipment
- Wall surfaces and miscellaneous materials contaminated with explosives
- Lead paint chips mixed in with explosives



## Small Footprint of MuniRem Solution Application



Explosives Neutralization Station Behind Building



# MuniRem Solution Provided Safe Recovery of Crystallized Explosives

- Large H-6 chunks safely removed while spraying MuniRem solution
- Large explosive pieces transferred to neutralization reactor
- Neutralization of recovered explosives achieved rapidly in reaction tanks



## Neutralization of Recovered Explosives



- 2,000 Lbs of H-6 explosives estimated as present on and in equipment
- >1000 lbs destroyed in place by spraying concentrated MuniRem solution
- >900 lbs recovered and neutralized on-site in reactor with MuniRem solution
- Sludge and wastewater characterized as non-hazardous waste



## **BUILDING 83 DECONTAMINATION AND DEMOLITION**

Project Managed by Mr. Kevin Healy, Huntsville Support Center

## Old Way vs New Way

### Building Decon and Demolition – Old Method



### Building Decon and Demolition – New Method





## Building 83 LCAAP, MO





# MuniRem application to decontaminate explosives on building exterior



# MuniRem application to decontaminate explosives in building interior





# Equipment decontamination using MuniRem solution



# Explosive contaminated pipe before and after decontamination with MuniRem





# Confirmation of MuniRem Pipe Decontamination using EXPRAY



# Deconstruction of MuniRem Decontaminated Building





## MuniRem Benefits at Building 83 LCAAP

- After about 20 years of waiting for a safe solution, MuniRem did the job.
- The MuniRem decontaminated building fixtures were characterized as MDAS (5X).
- MuniRem decontamination liquid penetrated the concrete floor cracks and neutralized the accumulated explosives.
- Thanks to the MuniRem solution, the project was completed ahead of schedule.



## MUNIREM APPLICATION AS A SOLUTION FOR OB/OD CONTAMINATION

## MuniRem Application as a Solution for Munitions Constituents in OB/OD Trenches in SE Asia



Contaminated water  
Before MuniRem® treatment



MuniRem® powder reacts  
instantly with water...  
5 secs after application



... to turn bright red:  
oxidation is underway  
10 secs after application

# Faster lower cost solution for explosives contaminated soils, OB/OD ash, sludge, and spent activated carbon



MuniRem® mixed into contaminated soil



Water immediately activates the neutralization



24 hours after MuniRem®



2 weeks after MuniRem®



# MuniRem Application to Remediate Munitions Constituents in OB/OD Soil at a Legacy Site – DRDC and DCC Canada



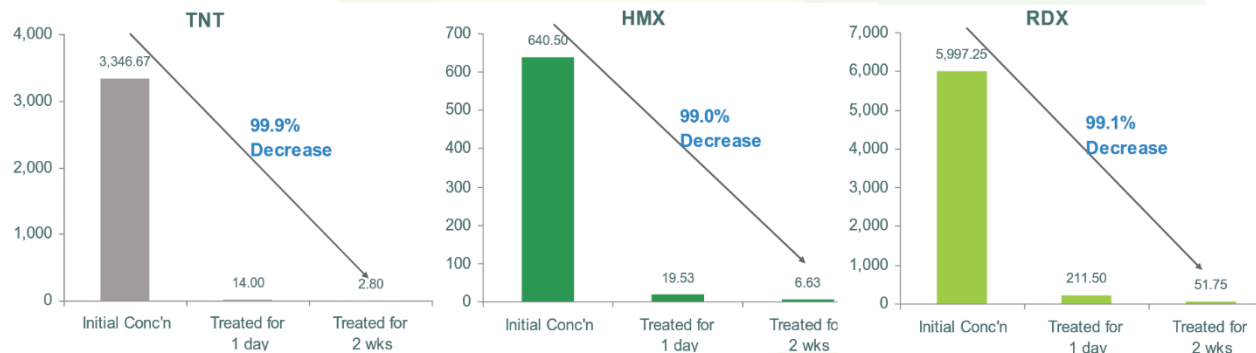


# MuniRem Reagent at Ravenna Army Ammunitions Plant

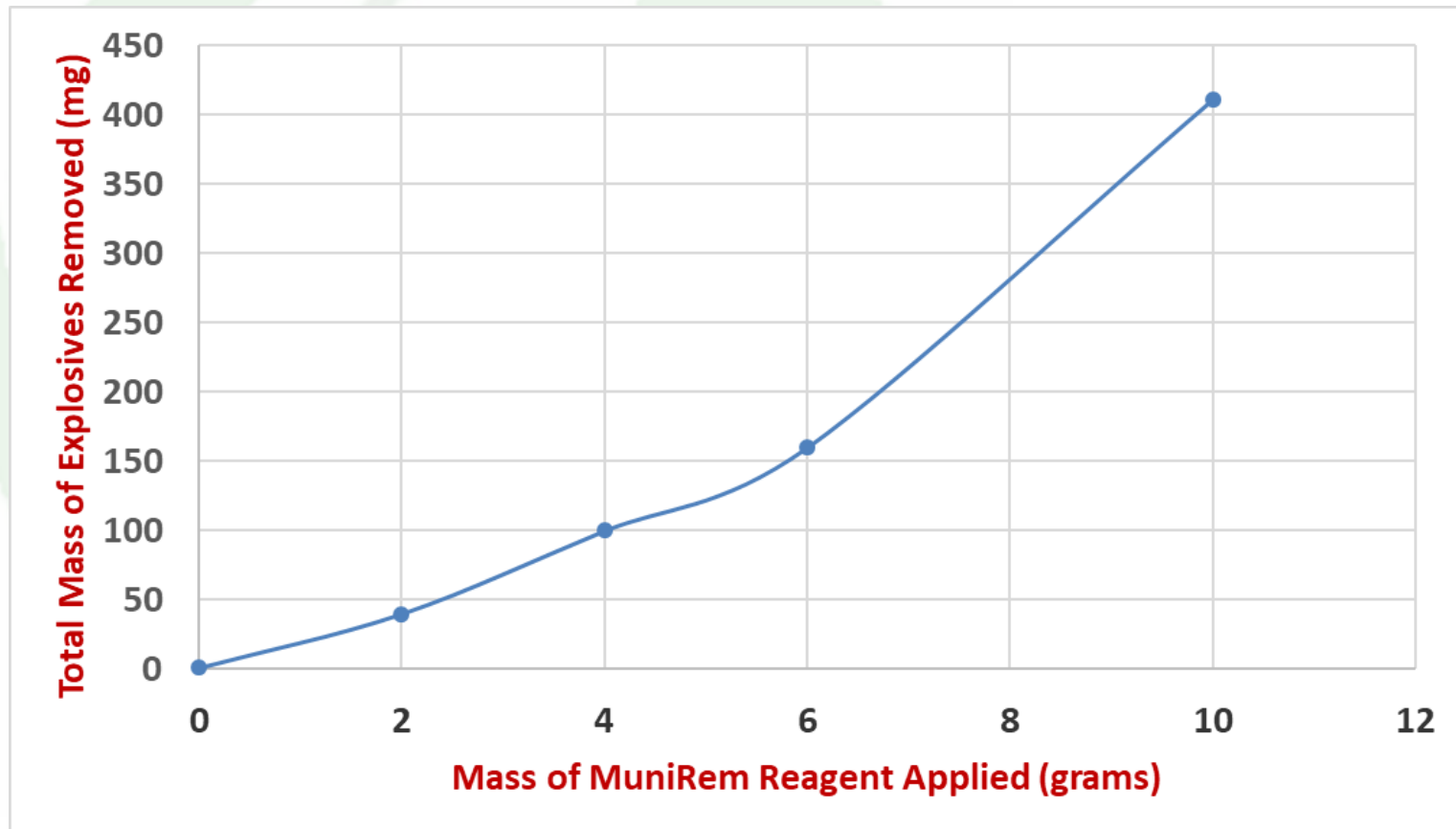
- Soil at Ravenna AAP was contaminated with TNT and other explosive compounds
  - EPA Methods 8330 A & B, TAL Metals & Products Analysis
- Demonstration details:
  - Dimension: 19ft by 45ft
  - Soil sample type: Silty-clay with rock
  - Targeted treatment depth: Top 2 feet
  - Explosives compounds of concern: TNT, HMX, RDX



## Results for Rapid Remediation of Explosives Contaminated Soils



# Optimization of MuniRem Reagent Dose for Remediation of Explosives in Soil



# Groundwater Remediation DoD (AEC) Independent study

- Soil/Groundwater Applications
  - Energetics
  - Chlorinated compounds
  - Metals



## USE OF BENIGN CHEMICAL TREATMENT FOR MUNITIONS CONSTITUENTS BREAKDOWN IN VARIOUS MEDIA

### Draft Field Protocol for the Application of MuniRem to Remove Explosives from Groundwater

**December 2, 2014**

Distribution D  
Distribution authorized to Department of Defense and U.S. DoD contractors only.  
(Critical Technology) (December 2, 2014)

Other requests for this document shall be referred to:  
Office of the Assistant Secretary of the Army for  
Installations, Energy and Environment (OASA[IE&E]) ESOH  
5850 21st Street, Bldg 211, Second Floor  
Fort Belvoir, VA 22060-5527

Contract No. W91ZLK-10-D-0005  
Task No. 0825  
CDRL No. A004

Submitted by  
 *Concurrent Technologies Corporation*  
100 CTC Drive  
Johnstown, PA 15904

## MUNIREM RATING AND SUMMARY



# MuniRem Technology Rating

No.	Criteria	Rating
1	Maturity	Already applied at full scale to demilitarize discarded military munitions and neutralize bulk explosives Compliments other demilitarization technologies
2	Process Efficacy	Demonstrated and validated at bench, pilot and full scale
3	Process Throughput	10s to 100s pounds per hour. Determined by breaching and neutralization method
4	Process Safety	<b>Very safe.</b> Near instant neutralization of most energetics
5	Public & Regulatory Acceptance	Already approved on multiple State and Federal projects
6	Secondary Waste Issue	Not a concern
7	Destruction Verification Capacity	Available and Rapid. EXPRAY Test Kits and similar commercially available wet chemistry explosives sensors
8	Process Flexibility	Very scalable and adaptable. Easily transportable for on-site demilitarization. Fixed facility not a requirement for application



A large, faint, light green graphic in the background of the slide. It is a circular emblem with three stylized, overlapping leaf-like shapes that form a circular pattern, similar to the MuniRem logo icon but much larger and lighter in color.

**MUNIREM IS A SAFE, WELL-PROVEN TECHNOLOGY THAT SHOULD BE  
PART OF EVERY PROJECT REQUIRING MUNITIONS DESTRUCTION**

## Our Clients

- Orbital ATK (Northrup Grumman)
- Austin Powder
- ORICA
- EMI Israel
- AEL Mining Services (South Africa)
- Multiple USDoD Army Ammunition Plants
- US Army Corps of Engineers
- US Marine Corps
- US General Service Administration
- Canadian Defense Forces
- General Dynamics
- CH2M (Jacobs)
- TETRA Tech
- PIKA International
- Donjon Marine
- EXPAL USA
- OTIE
- Concurrent Technologies Corporation
- Continental Motors International
- Dyno Noble

# Thank you.

Feel free to contact me directly for any further information you need.

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