Remediation of Mixed Biological and Chemical Waste at Fort Detrick

US Army Corps of Engineers
Baltimore District

LTC Donald Archibald - US Army Garrison Fort Detrick
Joe Gortva - US Army Garrison Fort Detrick
Bruce Ware - US Army Corps of Engineers
Tom Meyer - US Army Corps of Engineers
Clint Kneten - US Army Corps of Engineer
Brent Graybill - US Army Corps of Engineers
Craig Maurer - US Army Corps of Engineers
Kimberly Gross - US Army Corps of Engineers
Kirk Ticknor - Shaw E&I
David Iseri - Shaw E&I
David Miller - Shaw E&I

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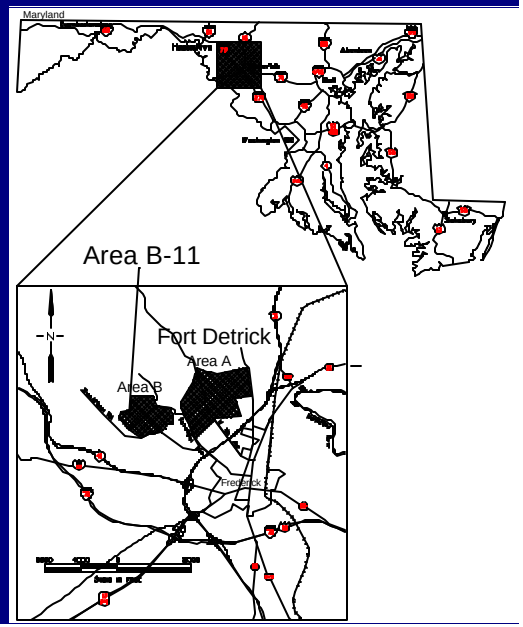
Fort Detrick Area B-11 Removal Action Overview

- **Control and characterization of biological and chemical contaminants in waste pits at Fort Detrick has represented a formidable challenge.**
- **The U.S. Army, in partnership with Shaw Environmental, Sentinel Labs, and other contractors have taken known and developed new processes to handle these challenges.**
- **The processes applied have specific applicability to:**
  - **environmental remediation**
  - **biotechnology, and**
  - **homeland defense**



Fort Detrick Area B-11 Disposal Pit Background

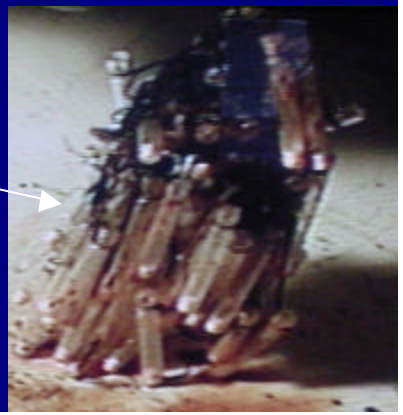
Fort Detrick was one of the Nation's largest biological warfare agent research facilities.

- The demilitarization of Fort Detrick began in 1970 after the U.S. outlawed biological research for offensive operations.
- Chemical waste generated by demilitarization was buried in Area B and has been determined to be the source of a one-mile long VOC groundwater plume.
- Numerous studies have delineated the location of the disposal pits.
- In order to eliminate threats to groundwater, a removal action of the chemical waste and commingled soil was approved in 2000.
- To date, pyrophoric chemicals, reactive chemicals that have created small explosions, and medical waste including vials containing lyophilized bacteria were discovered.

Photo Showing Chemical Waste Pit Before Backfill

Preserved Rat Recovered

Bundle of Vials with Lyophilized Bacteria



Removal Action Design

The Removal Design Specifications Required Development of:

- **An impermeable barrier to keep leaking chemical containers from impacting groundwater**
- **A containment structure to keep airborne contaminants from leaving the site**
- **Explosion and fire containment protection for workers and equipment**
- **Site worker bio-protection**
- **An air treatment system to remove chemical and biological contaminants (including *Bacillus anthracis*)**
- **Bio-disinfection processes for excavated material, equipment and personnel**
- **Medical and biological waste segregation processes**
- **On and off-site biological material identification processes**

Impermeable Barrier (Freeze Wall)

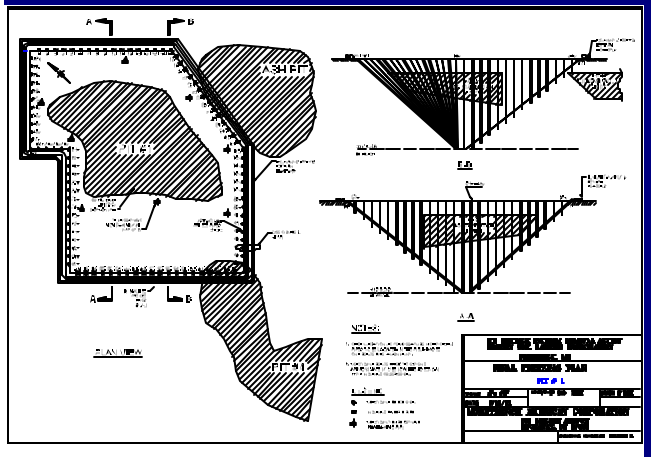
- In 1997, investigations indicated that pure-phase PCE had been released to groundwater from Area B-11. The Army and State required an impermeable barrier to prevent this from reoccurring if attempting source removal.

A Frozen Barrier was installed in order to:

- Obtain complete isolation from groundwater in the event of chemical container breakage
- Provide for slope stability.

Design

- 103 vertical and sloped freeze pipes installed.
- Freeze plant installed to circulate brine refrigerant
- Up to six-feet of frozen soil encapsulated all waste



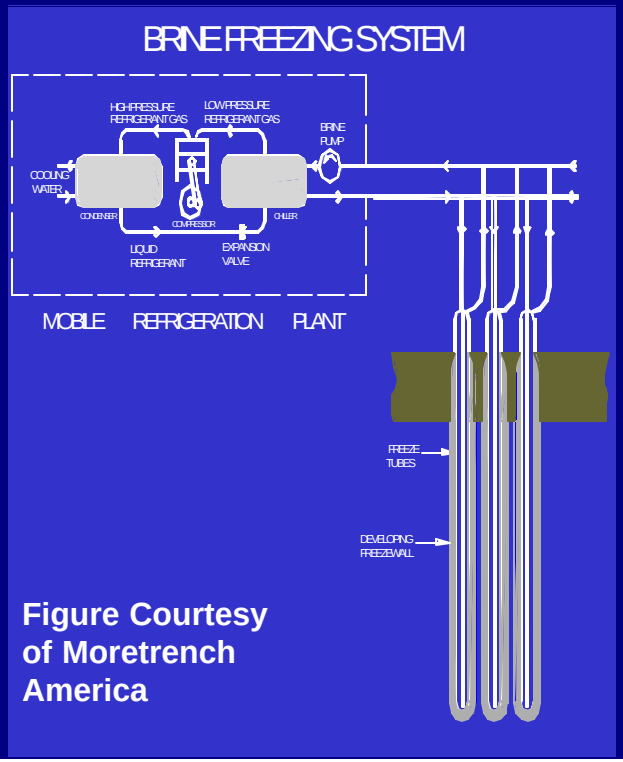


Figure Courtesy of Moretrench America

Impermeable Barrier (Freeze Wall)

Angle Boring for Freeze Pipe Installation

Refrigeration Plant

Installed Freeze Pipes (note frost on pipes)

Containment Structure

An approximately 200’ x 100’ x 35’ fabric containment structure was erected to enclose site operations and contain airborne releases of contaminants during excavation.

This structure, although not unique in design, was required to be moved in order to install the frozen soil barrier prior to excavation

Explosion and Energetic Release Protection

As a result of an explosion during the waste pit delineation, explosion and energetic release controls were implemented.

Fire in Removed Material

Biological Material Threats

During excavation medical and experimental bio-lab waste was discovered that included:

- Preserved animals
- Lyophilized Bacteria in Vials
- Incubator equipment
- Syringes and needles

The list of potential biohazards was developed in consultation with microbiology experts at the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) Special Pathogens Sample Test Laboratories and Edgewood Chemical and Biological Center (ECBC) Microbiology Team.

Disinfection, worker bio-protection, soil milling, and testing processes were developed to manage these hazards.

Containment Structure Air Treatment System

Soil Milling/Crushing Improvements

Shredding Bin

Allu® Shredder

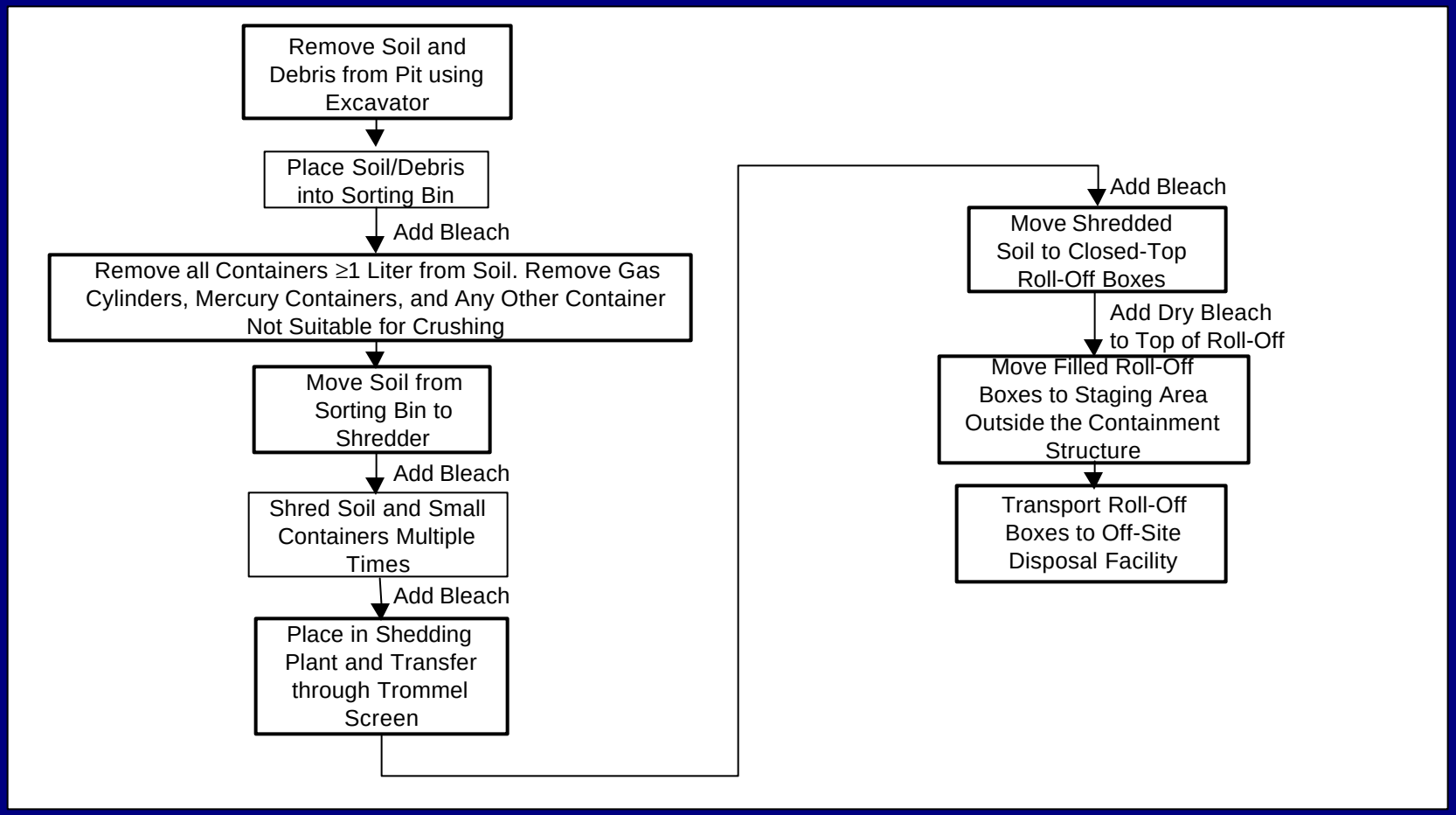
Hammer Mill and Trommel Screen

Bio-Disinfection Process Development

Bio-Disinfection Process was Developed Through:

- **Laboratory Treatability Testing**
- **Field Tests**
- **Final Field Implemented Process**

Bio-Disinfection Process Development (Continued)



Excavation Process

Monitoring for Microbes

On-Site Laboratory

PCR using Idaho Technologies' R.A.P.I.D$_{TM}$ System for

- ***Bacillus anthracis***
- ***Yersinia pestis***
- ***Brucella sp.***
- ***Fransicella tulerensis***
- **Orthopox viruses using reagent supplied by USAMRIID Special Pathogens Sample Test Laboratories**

Samples collected by

- **2-Stage bioaerosol impactor on 5% BAP**
- **Cyclonic impinger with isotonic sterile saline**
- **Sterile swab with phosphate buffered transport solution**

R.A.P.I.D$_{TM}$ System

Cyclonic Impinger

Monitoring for Microbes

Off-Site Laboratories:

USAMRIID Special Pathogens Sample Test Laboratories

- Secondary Laboratory Confirmation
- Daily impactor plate culture and inspection for *Bacillus anthracis*

ECBC Microbiology Team

- Secondary Laboratory Confirmation
- Culture and identification of sealed lyophilized biological materials in vials

Sentinel Laboratories, Inc.

- Primary Laboratory for identification of DOT etiological agents in soil, wipes, air filters, swabs, etc.
  - PLET plate culture presumptive test for *Bacillus anthracis*
  - Enrichment broth for pathogens followed by selective growth media culturing techniques
  - Isolates selected and identified by microscopic, FAME, and Biolog techniques

Microbial Library Development

Problem: Less than 40% of common, recognized bacterial species are included in the currently available commercial FAME library.

Result: Bacterial species which are not included in the library are misidentified, requiring additional, time-consuming tests.

Solution: Fort Detrick, USACE, Shaw and Sentinel Labs, Inc. developed a new FAME library by adding type strain bacterial species omitted by MIDI®.

Sentinel Type Strain Library development to date:

- Phase one examined 130 strains of gram positive spore-forming rods resulting in 108 separate new library entries
- Phase two efforts examined 200 strains of gram positive non-spore-forming rods resulting in 160 new library entries
- Phase three efforts generated 60 Gram positive, catalase positive, cocci entries

Microbial B-11 Case Study

A total of 86 isolates from the most recent roll-offs were examined and evaluated based on the enhanced Type Strain Library and compared to the existing up-dated commercial MIDI® library.

- **62 isolates (73%) were Gram-positive organisms and 24 (27%) were Gram-negative.**
- **Of the Gram-positive isolates, the Sentinel Type Strain Library produced only 7 no matches (11%)**
- **The MIDI® library produced 11 no matches (18%)**
- **Out of the identified isolates, the Sentinel Type Strain Library and the MIDI® library provided the same identification only 20% of the time.**
- **Of the remaining isolates that were identified differently by both libraries, the MIDI® library was incorrect at least 14 out of 40 times (35%) based on cell morphology and Gram reaction alone.**
- **The MIDI® library produced 8 false positive identifications to DOT/bioterrorism targets.**
- **The Sentinel Type Strain Library produced no false positives.**

Summary

Area B-11 Pit 1 Interim Removal Action Successfully Demonstrated the Use of:

- Frozen Soil Barrier for Hydraulic Containment
- Explosive Container Management using Remote Shredding
- Biohazard Management through on-site Disinfection with Bleach
- On-site and Off-site Biological Characterization of Air, Soil, and Wipe Samples
- Greatly Enhanced Identification of Bacterial Species through Development of a Type Strain Library

Future Work:

- Excavation of Three More Waste Pits
- Potential Continuation of Sentinel's Type Strain Library Development Efforts

Deployment Feasibility:

- Engineered Processes are Readily Available
- Type Strain Library can be Tailored to Application