Value Engineering Study Report On

TNT AREA C
REMEDIAL INVESTIGATION

Former Plum Brook Ordinance Works
Sandusky, Ohio

Focused Feasibility Study for Soil and Sediment
(P2 Number 148718)
FY-2009

VE STUDY SPONSOR:
The U.S. Army Corps of Engineers Huntington District

VALUE ENGINEERING FIRM NAME:
Joint VE effort by COE Huntington and Nashville

January 2009

G05OH001815_03.10_0007_a

VALUE ENGINEERING TEAM STUDY TABLE OF CONTENTS

Page No.

Cover.....

Table of Contents.....2

Project Description and Background.....3

Location Map.....4

Site Map.....5

Executive Summary.....6

VE Team Certification / Signature Page 9

Approval / Authorization Signature Page.....10

VE Engineering Proposal (study) 11-80

- Cover
- Information
- Consultants
- Fast Diagram
- Original Proposal
- Original Cost Estimate
- Speculation List
- Function Comparison Analysis
- Economic Analysis Process/Cost Model
- Weighing Criteria List
- Comparative Analysis of Remedial Alternatives
- Individual Team Member's Analysis Matrix
- Averaged Analysis Matrix
- VE Team Recommendation(s)
- Financial Analysis
- Presentation Outline

Supporting Documents

Attachment 1:
Final TNT Areas A and C Remedial Investigation Former Plum Brook Ordinance Works, Sandusky Ohio. Volume 4 – Focused Feasibility Study for Soil and Sediment.

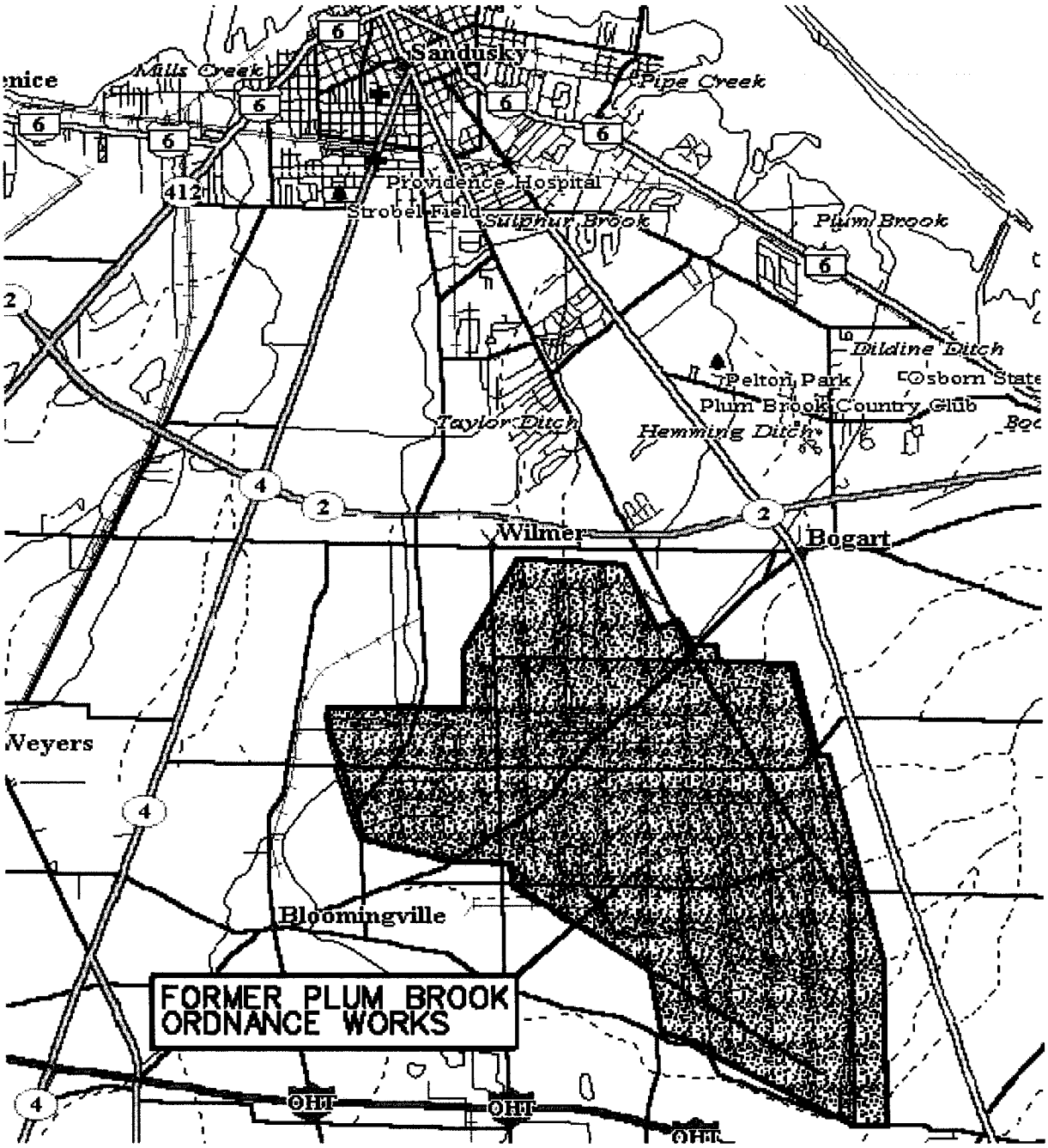
Attachment 2:
Feasibility Study Addendum TNT Area C Former Plum Brook Ordinance Works, Sandusky, Ohio

Project Description and Background

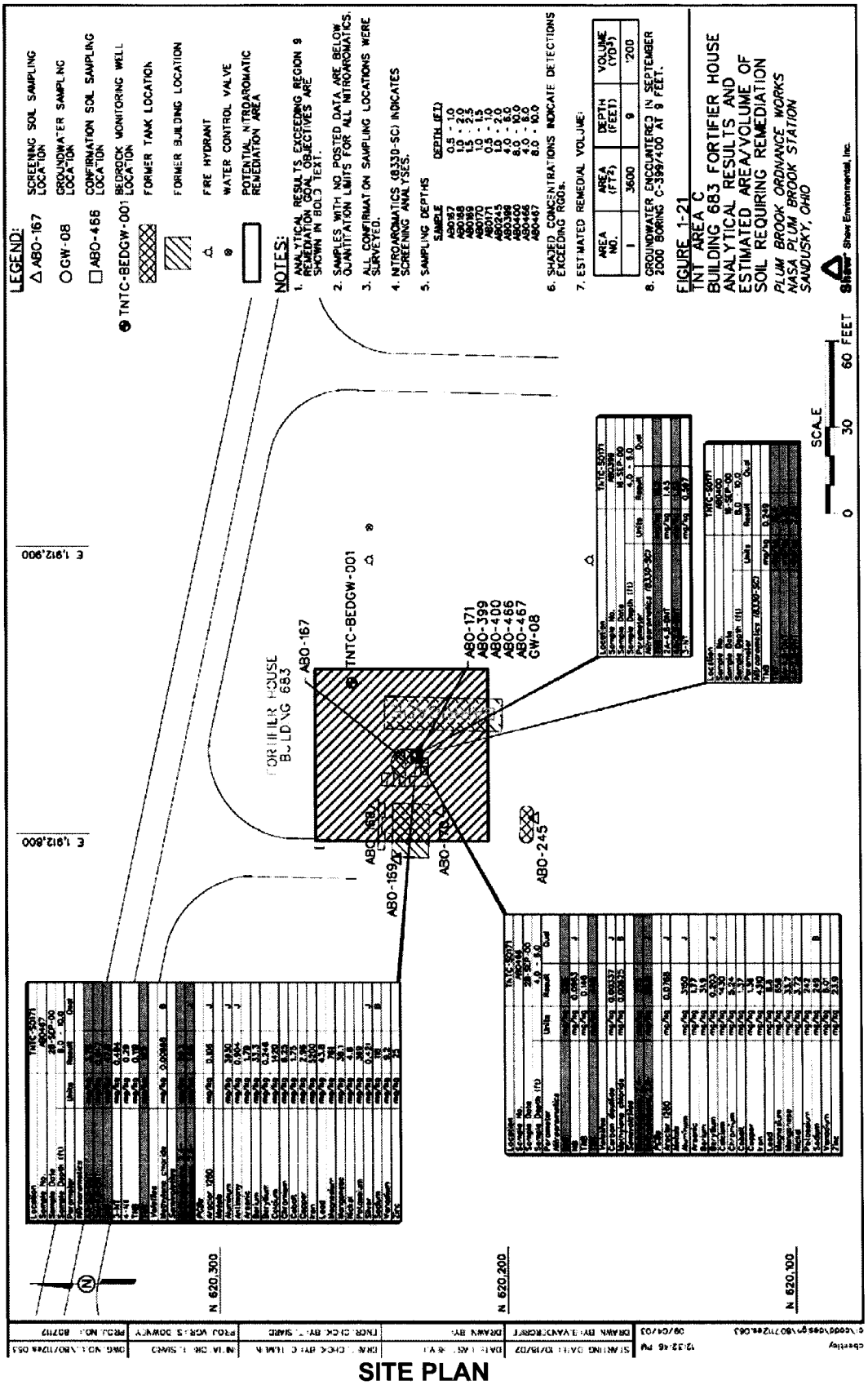
The 9,009-acre PBOW site was built in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. The site is located in north-central OH near Sandusky. Twelve process lines were used in the manufacture of TNT at PBOW; five of these lines were located at TNTC which is located in the southwestern portion of PBOW. Currently, TNTC is mostly overgrown with trees and brush; however, some of the roads, building foundations, and remnants of utilities from former TNT manufacturing operations are still recognizable. The PBOW site is currently utilized by the National Aeronautics and Space Administration (NASA).

A Focused Feasibility Study (FFS) was prepared by Shaw Environmental, Inc. (Shaw) in 2003 for TNT Areas A and C to address contamination in soil and sediment. For TNTC, this FFS identified 14 former building areas and a drainage ditch requiring remediation to reduce risk to human health and the environment to acceptable levels. Estimated surface areas and volumes associated with these areas are shown in Table 2-9 of the FFS. The total estimated in-situ volume of soil/sediment requiring remediation is 9,205 CY of which 2,310 CY is conservatively estimated as hazardous waste using the 20 times rule. Prior to development of the Proposed Plan (PP) for TNTC, the project team decided to prepare an addendum to the FFS to screen new remedial technologies that have been developed since the 2003 FFS, revise the technology screening to include recent treatability study results, and to update the cost tables. This addendum to the TNTC FFS was prepared and issued by Shaw in January 2009.

Five remedial alternatives were developed and evaluated in the FFS Addendum:
Alternative 1 – No Action
Alternative 2 – Excavation, Windrow Composting, and Off-Site Disposal
Alternative 3 – Excavation and Off-Site Disposal
Alternative 4 – Excavation, Windrow Composting, Chemical Stabilization, and Off-Site Disposal
Alternative 5 – Excavation, Alkaline Hydrolysis, Windrow Composting, Chemical Stabilization, On-Site and Off-Site Disposal



Vicinity Map not to scale


LEGEND:
ABO-167 SCREENING SOIL SAMPLING LOCATION
GW-08 GROUNDWATER SAMPLING LOCATION
ABO-466 CONFIRMATION SOIL SAMPLING LOCATION
TNTC-BEDGW-001 BEDROCK MONITORING WELL LOCATION
FORMER TANK LOCATION
FORMER BUILDING LOCATION
FIRE HYDRANT
WATER CONTROL VALVE
POTENTIAL NITROAROMATIC REMEDIATION AREA
NOTES:
1. ANALYTICAL RESULTS EXCEEDING REGION 9 REMEDIATION GOAL OBJECTIVES ARE SHOWN IN BOLD TEXT.
2. SAMPLES WITH NO POSTED DATA ARE BELOW QUANTITATION LIMITS FOR ALL NITROAROMATICS.
3. ALL CONFIRMATION SAMPLING LOCATIONS WERE SURVEYED.
4. NITROAROMATICS (8330-SC) INDICATES SCREENING ANALYSES.
5. SAMPLING DEPTHS
SAMPLE DEPTH (FT)
ABO167 0.5 - 1.0
ABO168 1.0 - 2.0
ABO169 1.5 - 2.5
ABO170 1.0 - 1.5
ABO171 0.5 - 1.0
ABO245 1.0 - 2.0
ABO398 4.0 - 6.0
ABO399 8.0 - 10.0
ABO466 4.0 - 6.0
ABO467 8.0 - 10.0
6. SHADED CONCENTRATIONS INDICATE DETECTIONS EXCEEDING RGOs.
7. ESTIMATED REMEDIAL VOLUME:
AREA NO. | AREA (FT²) | DEPTH (FEET) | VOLUME (YD³)
1 | 3600 | 9 | 1200
8. GROUNDWATER ENCOUNTERED IN SEPTEMBER 2000 BORING C-399/400 AT 9 FEET.
FIGURE 1-21
TNT AREA C
BUILDING 683 FORTIFIER HOUSE
ANALYTICAL RESULTS AND
ESTIMATED AREA/VOLUME OF
SOIL REQUIRING REMEDIATION
PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO
Shaw Environmental, Inc.
SCALE
0 30 60 FEET
FORTIFIER HOUSE
BUILDING 683
TNTC-BEDGW-001
ABO-167
ABO-171
ABO-399
ABO-400
ABO-466
ABO-467
GW-08
ABO-169
ABO-245
E 1,912,900
E 1,912,800
N 620,300
N 620,200
N 620,100

SITE PLAN

VE ENGINEERING TEAM STUDY
EXECUTIVE SUMMARY

This report presents the results of the former Plum Brook Ordnance Works (PBOW) TNTC VES The PBOW TNTC VES and was funded by the DERP-FUDS program.
The Value Engineering Study was conducted at the Nashville District ot the Corps of Engineers on January 21 and 22, 2009. The study was based on the Final TNT Areas A and C Remedial Investigation dated August 2003 (attachment 1) and the Feasibility Study Addendum TNT Area dated January 2009 (attachment 2).
The VE team was comprised of members carefully chosen with experience, background and, credentials to execute an overview, then targeted VE analysis within the tight allotted time constraints for study completion.

Value Engineering (VE) is a process used to study the functions a project is to achieve. The VE takes a critical look at how these functions are proposed to be met and it identifies potential alternative ways to achieve the equivalent function while increasing the value and the benefit ratio of the project. In the end, it is hoped that the project will realize a reduction in cost, but increased value is the focus of the process, rather than simply reducing cost. In many circumstances, the study validates the initial concept as being the best solution to achieve the desired function(s). The project was studied using the Corps of Engineers standard Value Engineering (VE) and SAVE International methodology, consisting of six phases:

Information Phase I: The Team gathers and tabulates information concerning the present design (including drawings, figures, descriptions of project work, and cost estimates) to fully understand the work to be performed and the functions to be achieved. Cost Models are compared to determine areas of relative high cost to ensure that the team focused on those parts of the project that offered the most potential for cost savings.
Problems, issues and constraints, both real and perceived are identified and performance attributes are determined to asses their value on a +/- basis.

Function Analysis Phase II: This phase consists of a series of verb/noun exercises designed to determine overall project and major element functions in their' most elemental forms.
Functional hierarchy and logic are investigated and determined.

Creative Phase III: The Team speculates by conducting brainstorming sessions to generate ideas for alternative designs. All team members contribute ideas and critical analysis of the ideas is discouraged (practicality is not considered at this point).

Evaluation Phase IV: Evaluation, testing and critical analysis of all ideas generated during the Creative Phase take place at this time. Determination of potential for savings and possibilities for risk are analyzed and ideas are ranked by priority for development. Alternatives which perform the basic function, maintain or improve quality, meet all legal and safety requirements, and potentially save dollars (first cost and/or life cycle cost) are taken to the next phase. Ideas that do not survive critical analysis are deleted.

Development Phase V: The priority ideas are developed into written proposals by VE team members during an intensive technical development session. Proposal descriptions, along with sketches (when applicable), technical support documentation, and cost estimates are prepared to support implementation of ideas. Additional VE team comments are included for items of interest that are not developed as proposals are included where appropriate.
If possible, the best alternative(s) are identified at this phase.

Presentation Phase IV: Presentation is generally a two-step process. First, the VE study report is distributed for review to all appropriate project supporters and decision-makers. Review comments are coordinated for decision on any proposals recommended by the study report.
Final coordination frequently includes a formal Presentation Conference with the approval authorities for recommendation of actions to be taken on specific VE proposals.
For this study, the formal presentation is not necessary since the Project Delivery Team (PDT) is the approving authority. The PDT was present during the studies execution and have a through knowledge of the contents and outcome of the study.

Summary of VE Study Results
During the speculation phase of this study, 12 possible alternatives were identified including the original alternatives included in the original reports. Ultimately, 4 of the alternatives were judged to be worthy of consideration with one identified as the best balance of cost-vs-effectiveness.
Costs were not identified for certain proposals that had no cost data available at the time of the VES and/or were deemed to fail codes, legal requirements or safety criteria.
The following table presents a summary of the ideas filtered into recommendations and design comments with cost implications where applicable. Ironically, the 4 selected are the same 4 that were presented in the original A-E proposal; therefore this study serves as validation of the veracity of the PDT and the original report. Cost is an important issue for comparison of VE proposals. The costs presented in this report are based upon original design quantities. The estimates provided should be of sufficient detail to allow a decision regarding implementation, but the estimates should not be used to compute actual savings associated with adoption of any one recommendation.

SUMMARY OF PROPOSALS

Alternative number (#1 being no action)	DESCRIPTION	POTENTIAL SAVINGS ($COST) Measured against the most expensive of the 4 alternatives
2	Excavation, Windrow Composting, and Off-Site Disposal	$0
3	Excavation and Off-Site Disposal	$0.4 million
4	Excavation, Windrow Composting, Chemical Stabilization, and Off-Site Disposal	$0.1 million
5	Excavation, Alkaline Hydrolysis, Windrow Composting, Chemical Stabilization, On-Site and Off-Site Disposal	$0.9 million

The total present value cost (including 30% contingency) for each of the five alternatives is as follows:

No Action	Alternative 2	Alternative 3	Alternative 4	Alternative 5
$0	$3.3 million	$2.9 million	$3.2 million	$2.4 million

Acknowledgments
The study members should be commended for their effort and perseverance in accomplishing this very successful study. A special thanks is extended to the PDT team members for their cooperation and who met with the VE team during the VE study sharing their insight to the project functions.

PROJECT DELIVERY TEAM MEMBERS and PHONE NUMBERS

Steve Downey (Shaw Environmental)	865-621-6093
Lisa Humphreys (LRH Environmental & Remediation)	304-399-5953
Lannae Long (LRN-EC-R)	615-736-2049
Kathy McClanahan (LRN-EC-R-M)	615-736-7554
Rick Meadows (LRH Project Manager)	304-399-5388
Doug Mullendore (LRN, Chief, Technical Design Section)	615-736-7556

CERTIFICATION

VE Study Number PBOW TNT C 09-01
Dated: 22-Jan-09

This is to verify that the Value Engineering (screening) Study was conducted in accordance with standard Value Engineering principles and practices.

John C. Manor III — 2/6/09 date
John C. Manor III, RA, NCARB, IDSA
CELRN-VEO
Value Engineering (screening) Study Team Leader/ Facilitator

Linda Ingram — 6 FEB 2009 date
Linda Ingram, LRN Construction

Nickolas McHenry — 2/5/09 date
Nickolas McHenry, LRH Environmental & Remediation

Daniel Stark — 2/5/09 date
Daniel Stark, LRH Environmental & Remediation

Walter R. Green Jr. — 2/5/09 date
Walter Green, LRN Project Management

APPROVAL / AUTHORIZATIONS

VE Study Number PBOW TNT C 09-01
Dated: 22-Jan-09

We, the undersigned are the approving authority and have reviewed this VE (screening) Study Summary and accept / reject the Alternative 5 as proposed by the VE Study Team.

X
Accept _____ Reject

Lisa Humphreys, CELRH-EC-CE — 2-5-09 date

Lannae Long, CELRN-EC-R — 6 FEB 09 date

Kathy McClanahan, CELRN-EC-R — 6 Feb 2009 date

Rick Meadows, CELRH-PM-PP-P — 2-5-09 date

Doug Mullendore, CELRN-EC-R — 2-6-09 date

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Value Engineering (screening) Study Team Leader/ Facilitator

Linda Ingram, LRN Construction — date

2/5/09
Nickolas McHenry, LRH Environmental & Remediation — date

2/5/09
Daniel Stark, LRH Environmental & Remediation — date

Walter Green, LRN Project Management — date

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date

Lannae Long, CELRN-EC-R date

Kathy McClanahan, CELRN-EC-R-M date

Rick Meadows, CELRH-PM-PP-P 2-5-09
date

Doug Mullendore, CELRN-EC-R date

VALUE ENGINEERING PROPOSAL

Study Number:	PBOW TNT C 09-01	Date:	22-Jan-09

Project
PBOW TNT Area C VE Study

P2 # 148718

Study Item
Final Feasibility Study for TNT Area C for Soil and Sediment

Study Team		Office Symbol	Telephone	Discipline
Leader	John C. Manor, LRN-VEO	EC-A	615-736-5678	Architect
Members	Linda Ingram, LRN Construction	EC-C	615-736-5622	Civil Engineer
	Nickolas McHenry, LRH Enviromental & Remediation	EC-CE	304-399-5909	Environmental Engineer
	Daniel Stark, LRH Environmental & Remediation	EC-CE	304-399-5363	Geologist
	Walter Green, LRN Project Management	PM-P	615-736-7854	Civil Engineer

savings: $ -9,170

Present System or Design

Five options presented in the Feasability Study

Current Status of Project

Focused Feasability Study and Addendum Completed

Corps members of the Progect Delivery Team have design approval authority.

Individual	Approval Authority Position/Organization	Telephone
Lisa Humphreys, Environmental Engineer	CELRH-EC-CE	304-399-5953
Lannae Long, Environmental Engineer	CELRN-EC-R	615-736-2049
Kathy McClanahan, Engineer, Biologist	CELRN-EC-R-M	615-736-7554
Rick Meadows, Civil Engineer	CELRH-PM-PP-P	304-399-5388
Doug Mullendore, Chief, Technical design section	CELRN-EC-R	615-736-7556

Historic Data

This site is the former Plum Brook Ordinance Works built in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite.

Codes

EPA and State Environmental regulations apply

Special Criteria

Site is currently occupied by NASA.

Restrictions

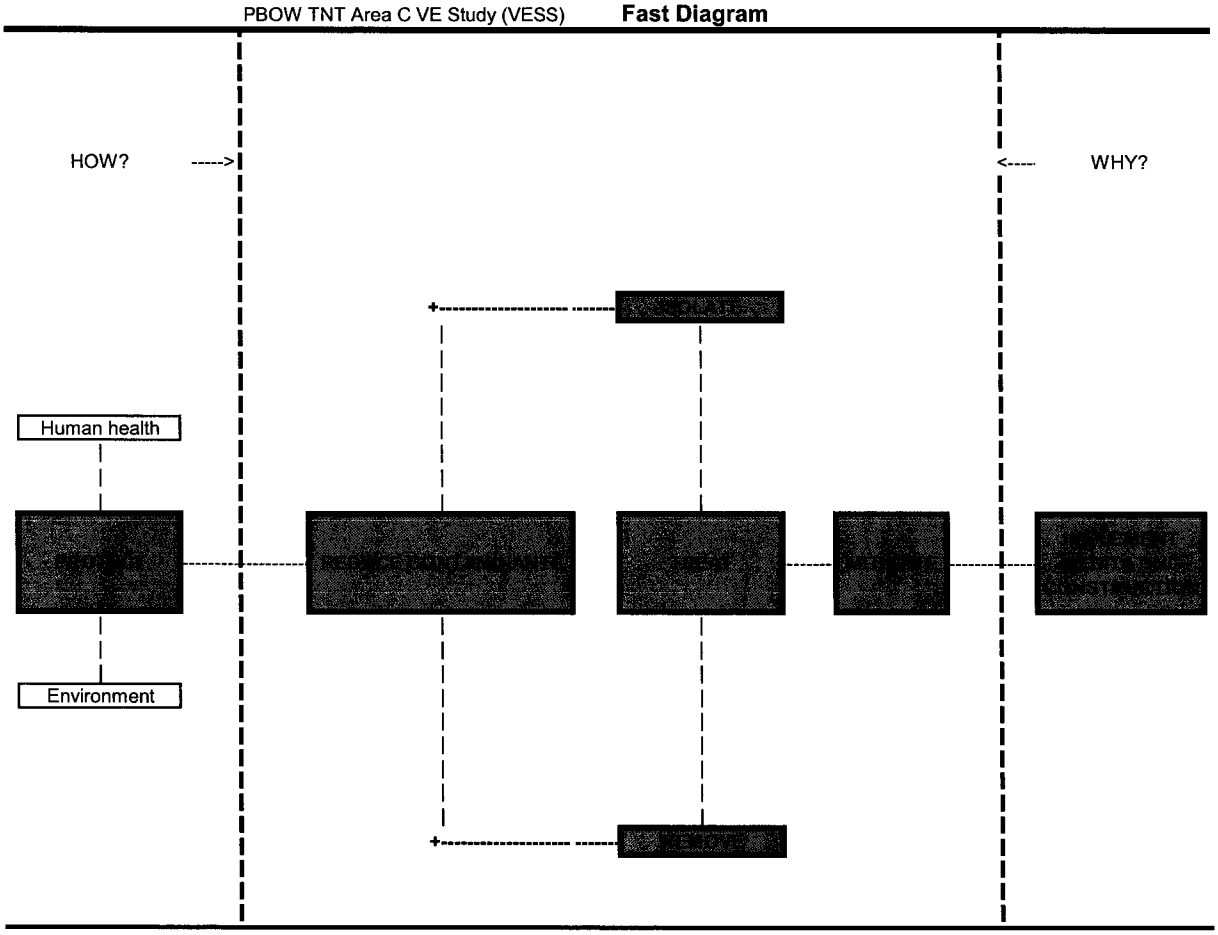
NASA not in a position to abandon site

Other

Consultants

Name - Title	Address	Telephone
Steve Downey	Shaw Engineering	865-621-6093
Lisa Humphreys	LRH Environmental & Remediation	304-339-5953
Kathy McClanahan	LRN, EC-R-M	615-736-7554
Tom Siard, Risk Assesor	Shaw Engineering	865-621-6093

PBOW TNT Area C VE Study (VESS) **Fast Diagram**



Original Proposal: Excavation, Alkaline Hydrolysis, Windrow Composting, Chemical Stabilization, On-Site and Off-Site Disposal.

Original Proposal Estimate

Site:	TNT Area C
	Plum Brook Ordnance Works
Date:	10/31/2008

Excavation/Alkaline Hydrolysis/Windrow Composting/ Stabilization/Onsite and Offsite Disposal Site Restoration Cost Estimate

Scope:
1. Prepare work plans and
2. Mobilize/demobilize equipment and personnel.
3. Prepare site for remedial activity.
4. Excavate contaminated soil, perform confirmation sampling & characterize waste.
5. Alkaline hydrolysis and neutralization of soil that is hazardous due to 2,4-DNT TCLP.
6. Windrow composting of 60% of the alkaline hydrolysis treated soil.
7. Maectite chemical stabilization of soil that is hazardous due to lead TCLP.
8. On site disposal of soil treated via alkaline hydrolysis and windrow composting.
9. Off-site disposal of non-hazardous untreated soil.
10. Site restoration.

1.0 Treatability Study, Work Plans, Reports and Procurement

Includes:
1. Labor to generate work plans,

2. Procure equipment and materials.

Service	Unit	Unit Cost		Subtotal	
Work Plans and Final Report	1	$15,000.00	/ls	$15,000.00	
Procurement	1	$10,000.00	/ls	$10,000.00	
				Subtotal	**$25,000.00**

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:
1. Mobilization and demobilization of local equipment and personnel.
2. Set-up/tear down office trailer.

Assumptions:
1. Labor and equipment are available locally.
2. Pressure washer to be purchased for use during project.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor/Equipment:					
Mobe/Demobe	1	$5,000.00	/ls	$5,000.00	
Office Trailer (set up/tear down)	1	$500.00	/ls	$500.00	
Pressure Washer	1	$500.00	/ls	$500.00	
				Subtotal	**$6,000.00**

3.0 Site Preparation

Assumptions:
1. Existing site can be used and no additional site preparation costs are required.

4.0 Excavation of Contaminated Soil

Includes:

1. Excavation of soil with contaminants exceeding RGOs.
2. Screen oversize material.
3. Collect confirmatory samples to verify extent of excavation.
4. Staging and characterizing waste stream.

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	9205
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	11967
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	13163
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket.	
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	24
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. No. of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	300
15. No. of soil samples collected for waste characterization =	40
16. Number of excavation crew =	2
17. Number of screening crew =	3
18. Lineal foot of excavation per confirmation sample =	20
19. Resampling factor for confirmation sampling =	1.1
20. No. of confirmatory samples from excavated area =	286
21. Excavation area (ft^2) =	35583
22. Cost multiplier for 1-week turnaround on analytical data =	1.25
23. Fraction of excavation work performed in Level C PPE =	0.10
24. Labor productivity factor for Level C work =	0.67
25. Days excavation crew in Level C =	3
26. Days screening crew in Level C =	2
27. Perimeter of excavation area (ft) =	3415
28. Excavation area (sf) =	35583
29. Volume of pit water requiring offsite disposal (gal) =	20000

30. Standard work week is 5 days per week at 8 hours per day. Thus, assuming 22 working days per 31 day month.

Service/Materials	Unit	Unit Cost	Subtotal
Labor:			
Site Superintendent	192	$49.00 /hr	$9,408.00
QA (Sampling) Coordinator	192	$36.00 /hr	$6,912.00
H&S Coordinator	192	$49.00 /hr	$9,408.00
Chemist (home office)	48	$51.00 /hr	$2,448.00
Equipment Operator	24	$406.00 /day	$9,744.00
Equipment Operator	20	$406.00 /day	$8,120.00
Equipment Operator	20	$406.00 /day	$8,120.00
Laborers	44	$341.60 /day	$15,030.40
Truck Drivers	48	$341.60 /day	$16,396.80

Equipment:

Excavator	2	$4,000.00	/mo	$8,000.00
100-ton/hr Screening Plant	4	$1,800.00	/wk	$7,200.00
Radial Stacking Conveyor	4	$1,222.00	/wk	$4,888.00
Dozer	1	$3,500.00	/mo	$3,500.00
Dump Truck	2	$3,890.00	/mo	$7,780.00
Dump Truck	2	$3,890.00	/mo	$7,780.00
3000 gal. Water Truck	24	$402.00	/day	$9,648.00
21,000 gal Frac Tank	8	$1,400.00	/mo	$11,200.00
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00
Office Trailer	2	$800.00	/mo	$1,600.00
Porta Jon	2	$175.22	/mo	$350.44
Generator	2	$170.35	/mo	$340.70
P/U Truck	2	$1,800.00	/mo	$3,600.00

Analytical:

TCLP Extraction	40	$12.88	/ea	$515.00
SVOCs (8270C)	326	$300.00	/ea	$97,800.00
NACs (8330)	326	$197.50	/ea	$64,385.00
Lead	326	$30.00	/ea	$9,780.00
PCBs	326	$103.75	/ea	$33,822.50
NAC field analyses	286	$40.00	/ea	$11,440.00
Lead field analyses	2	$4,200.00	/mo.	$8,400.00
Shipping	87	$40.00	/ea	$3,477.33

Materials & Services:

Level D PPE	96	$10.00	/day	$960.00
Level C PPE	12	$35.00	/day	$420.00
PID rental	2	$974.00	/mo.	$1,948.00
CGI rental	2	$380.00	/mo.	$760.00
Pit Water Disposal	20	$1.62	/kgal	$32.40

Subtotal **$397,591.00**

5.0 Alkaline Hydrolysis and Neutralization of Contaminated Soil

Includes:

1. Treat the 2,4-DNT contaminated soil with caustic soda pellets and 30% ferric chloride solution.
2. Neutralize alkaline hydrolysis treated soil with ferrous sulfate.
3. Temporary storage for the caustic soda pellets, 30% ferric chloride, and ferrous sulfate.

Assumptions and Calculations:

1. Volume of consolidated 2,4 DNT soil to be treated (cy) =		2103	
2. Swell factor for soil upon excavation =		1.3	
3. Cubic yards of unconsolidated soil =		2734	
4. Soil shall be treated via alkaline hydrolysis using caustic acid in 300 cy batches within the treatment area.			
5. Each 300 cy area =	52 ft Wide	52 ft Long	
6. Batch size (cy) =		300	
7. Soil to be spread out to a depth of (ft) =		3	
8. Treatment chemical requirements based on treatability study conducted by Shaw E&I Technology Dev. Lab			
9. Caustic soda required for treatment =		61	lb/cy soil
10. Water, used to saturate soil with water =		37	gal/cy soil
11. Ferric chloride 30% solution =		1	gal/cy soil
12. NaOH mol wt =		40	lb/lb mol
14. Ferrous sulfate needed to neutralize NaOH =		108	lb/cy soil
16. Number of days for completed treatment with neutralization =		10	
17. Number of batches =		10	

18. Number of batches during one treatment cycle =		5
19. Number of treatment cycles =		2
20. Standard work week is 5 days per week at 8 hours per day. Thus, assuming 22 working days per 31 day month.		
21. Number of field days =		20
22. Number of field crew =		12
23. Mass of caustic soda (lb) =		166774
24. Volume of ferric chloride, 30% solution (gal) =		2734
25. Density of 30% ferric chloride solution (lb/gal) =		10.77
26. Volume of water (gal) =		101158
28. Confirmation sampling for alkaline hydrolysis prior to		
29. Upon neutralization with ferrous sulfate confirmation		
30. Temporary storage is required for the caustic soda pellets, 30% ferric chloride, and		
31. The caustic soda pellets		
32. Number of caustic soda		84
33. Required storage capacity		4032
34. The 30% ferric chloride solution comes in 330 gallon		
35. Number of 30% ferric		9
36. Required storage capacity		541
37. The ferrous sulfate comes in		
38. Number of ferrous sulfate	149	
39. Required storage capacity	7152	
40. Temporary storage shall be provided utilizing a 48-foot		
41. Available capacity in the		1920

5.0 Alkaline Hydrolysis with Neutralization (continued)

42. Number of Land-Sea Cargo	3
43. Number of Land-Sea Cargo	1
44. Number of Land-Sea Cargo	4

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	160	$49.00	/hr	$7,840.00	
QA (Sampling) Coordinator	160	$36.00	/hr	$5,760.00	
H&S Coordinator	160	$49.00	/hr	$7,840.00	
Sampling Technician	160	$28.00	/hr	$4,480.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Laborer	20	$341.60	/day	$6,832.00	
Laborer	20	$341.60	/day	$6,832.00	
Equipment:					
Dozer	1	$3,500.00	/mo	$3,500.00	
Excavator	2	$4,000.00	/mo	$8,000.00	
Front End Loader	1	$5,000.00	/mo	$5,000.00	
Fork Lift	2	$6,480.00	/mo	$12,960.00	
4000 gal. Water Truck	1	$402.00	/day	$402.00	
21,000 gal Frac Tank	2	$1,400.00	/mo	$2,800.00	
Air Monitoring	1	$750.00	/ls	$750.00	
Office Trailer	1	$800.00	/mo	$800.00	
Porta Jon	1	$175.22	/mo	$175.22	
Generator	1	$170.35	/mo	$170.35	
P/U Truck	1	$1,800.00	/mo	$1,800.00	
Materials:					
Caustic Soda	166774	$0.45	/lb	$75,048.30	Brenntag - Pgh
Ferric Chloride 30% Solution	29446	$0.15	/lb	$4,416.90	Brenntag - Pgh
Water	101	$9.40	/1000 gal	$949.40	
Ferrous Sulfate	296366	$0.11	/lb	$32,303.89	Crown Technology
Level C PPE	240	$35.00	/day	$8,400.00	
PID rental	2	$974.00	/mo.	$1,948.00	
CGI rental	2	$380.00	/mo.	$760.00	
Chem. Storage - NaOH pellets	3	$100.00	/mo.	$300.00	
Chem. Storage - 30% $FeCl_3$	1	$100.00	/mo.	$100.00	

6.0 Windrow Composting of Contaminated of Soil

Includes:

1. Rental of composting equipment.
2. Procurement & stockpiling of composting amendments.
3. Mix and compost soil and amendments.
4. Pre-compliance testing: after compost formation & at end of treatment.
5. Pre-compliance testing using definitive field analysis for NAC.

Assumptions:

1. Laydown area is 260' feet wide x 800 feet long.
2. 75% of laydown area is available for windrows ad 25% is available for stockpiling amendments.
3. Compost recipe is 25% soil, 2.9% agricultural amendment (manure) and 72.1% bulking amendment (straw).
4. Widrows are spaced 5 feet apart from one another.
5. There is a 35-foot space at each end of the windrow allotting for movement of the windrow turner.
6. Duration per batch (wk) = 2
7. The windrows will be staggered by 1 week.
8. Fraction of alkaline hydrolysis treated soil to be composted = 20%
9. Volume of alkaline hydrolysis treated soil to be composted (cy) = 421
10. Fraction of remaining soil treated via alkaline hydrolysis only = 80%
11. Volume of remaining alkaline hydrolysis treated soil (cy) = 1682
12. Swell factor for soil upon excavation = 1.3
13. Volume of unconsolidated soil to be treated (cy) = 547 (composted material)
14. Compost treatment duration (weeks) = 4
15. Each windrow is 6 feet high x 16 feet wide x 530 feet long, trapezoidal configuration.
16. Capacity of windrow turner (tons/hr) = 3,200
17. Operating life of flails (hrs) = 25
18. Number of flails on windrow turner = 172
19. Volume of compost per windrow (cy) = 1,178
20. Per windrow the soil volume is, at 25% (cy) = 294
21. Per windrow the manure volume is, at 2.9% (cy) = 34
22. Per windrow the straw volume is, at 72.1% (cy) = 849
23. Number of required windrows (ea) = 1.9
24. Volume of manure (cy) = 63
25. Volume of straw (cy) = 1577
26. Compost additive volume correction factor = 0.8
27. Total volume of compost prior to treatment (cy) = 1,750
28. Bulk density of compost (tons/cy) = 0.368
29. Number of field crew = 6
30. Tractor and straw blower are in-use 1 day/week and on stand-by the rest of the week.
31. Pre-compliance testing shall
    - EnSys TNT 20, one per 4
    - EnSys TNT 20, no. of 19
    - Total NAC, one per batch. 4
32. Compliance testing shall be
    - Total Semivolatiles. 2
    - Total NACs. Number of 2
    - TCLP 2,4-DNT. Number 2
33. Standard work week is 7 days per week at 8 hours per day. Thus, assuming 30 working days per month.

6.0 Windrow Composting of Contaminated of Soil (continued)

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	224	$49.00	/hr	$10,976.00	
QA (Sampling) Coordinator	224	$36.00	/hr	$8,064.00	
H&S Coordinator	224	$49.00	/hr	$10,976.00	
Windrow Turner Operator	28	$567.20	/day	$15,881.60	
Equipment Operator	28	$406.00	/day	$11,368.00	
Equipment Operator	28	$406.00	/day	$11,368.00	
Equipment Operator	28	$406.00	/day	$11,368.00	
Laborer	28	$341.60	/day	$9,564.80	
Environmental Tech	28	$200.00	/day	$5,600.00	
Equipment:					
Windrow Turner (6' x 19')	1	$45,000.00	/mo	$45,000.00	
Dozer	1	$3,500.00	/mo	$3,500.00	
Excavator	1	$4,000.00	/mo	$4,000.00	
Wheel Loader	1	$5,000.00	/mo	$5,000.00	
Tractor	32	$50.00	/hr	$1,600.00	In-use
Tractor	192	$30.00	/hr	$5,760.00	Stand-by
Straw Blower	32	$40.00	/hr	$1,280.00	In-use
Straw Blower	192	$20.00	/hr	$3,840.00	Stand-by
21000 gallon Frac Tank	1	$1,400.00	/mo	$1,400.00	
21000 gallon Frac Tank	1	$1,400.00	/mo	$1,400.00	
Trash/Pump Hose	1	$3,749.00	/ea	$3,749.00	
Office Trailer	1	$800.00	/mo	$800.00	
Porta Jon	1	$175.22	/mo	$175.22	
Generator	1	$170.35	/mo	$170.35	
P/U Truck	1	$1,800.00	/mo	$1,800.00	
Spectrophotometer	1	$3,012.00	/ls	$3,012.00	
Materials:					
Repl. Flails for Windrow Turner	344	$9.50	/ea	$3,268.00	
Straw	1577	$11.25	/cy	$17,740.28	
Manure	63	$25.00	/cy	$1,585.66	
Water	1027	$9.40	/kgal	$9,653.80	
Level C PPE	168	$35.00	/day	$5,880.00	
Air Monitoring Screening Kits	1	$2,500.00	/ls	$2,500.00	
Moisture/Temp Probes	1	$700.00	/ea	$700.00	
Analytical:					
Pre-Compliance Sampling:					
EnSys Kit (TNT 20) - 19 samples per kit	1	$572.00	/ea	$572.00	
Total NACs	4	$145.00	/ea	$580.00	
Compliance Sampling:					
TCLP Semivolatiles	2	$175.00	/ea	$350.00	
Total NACs	2	$145.00	/ea	$290.00	
TCLP 2,4-DNT	2	$175.00	/ea	$350.00	
				Subtotal	**$221,123.00**

7.0 Chemical Stabilization of Lead-Contaminated Soil

Includes:

1. Stabilization of lead contaminated soil utilizing Maectite chemical stabilization technology.

Assumptions and Calculations:

1. Volume of in-place lead contaminated soil to be stabilized (cy)= 400
2. Swell factor for soil upon excavation = 1.3
3. Volume of unconsolidated lead-contaminated soil (cy) = 520
4. Density of soil (ton/cy) = 1.1
5. Lead contaminated soil remains in-place for chemical stabilization.
6. An excavator will make depressions in the soil for Maectite chemical application.
7. The excavator will turn the soil and the chemical for ample mixture.
8. Time required to stabilize soil (days) = 2
9. The lump sum price for the Maectite chemical and technician is $10,000 per Serverson Environmental.
10. Number of field crew = 1
11. Standard work week is 5 days per week at 8 hours per day. Thus, assuming 22 working days per 31 day month.
12. The 400 cy of in-place lead soil included 193 cy of in-place soil also containing 2-4, DNT.
13. Volume of in-place soil to receive treatment via alkaline 193
14. The soil treated via alkaline
15. Volume of soil to receive Maectite chemical stabilization only (cy) = 207

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	16	$49.00	/hr	$784.00	
QA (Sampling) Coordinator	16	$36.00	/hr	$576.00	
H&S Coordinator	16	$49.00	/hr	$784.00	
Sampling Technician	16	$28.00	/hr	$448.00	
Equipment Operator	2	$406.00	/day	$812.00	
Equipment:					
Excavator	0.1	$4,000.00	/mo	$400.00	
Office Trailer	0.1	$800.00	/mo	$80.00	
Porta Jon	0.1	$175.22	/mo	$17.52	
Generator	0.1	$170.35	/mo	$17.04	
P/U Truck	0.1	$1,800.00	/mo	$180.00	
Materials:					
Maectite Chemical Stabilization	1	$10,000.00	/ls	$10,000.00	(Sevenson tech incl)
Level D PPE	2	$10.00	/day	$20.00	
PID rental	0.1	$974.00	/mo.	$97.40	
CGI rental	0.1	$380.00	/mo.	$38.00	
Analytical:					
TCLP Extraction	1	$10.30	/ea	$10.00	
Lead	1	$24.00	/ea	$24.00	
SVOCs (8270C)	1	$175.00	/ea	$175.00	
NACs (8330)	1	$145.00	/ea	$145.00	
PCBs	1	$83.00	/ea	$83.00	
Shipping	1	$40.00	/ea	$40.00	
				Subtotal	**$14,731.00**

8.0 On-Site Disposal

Includes:

1. Load treated compost, truck to site, spread compost with dozer.
treated soil and stockpile for use
as backfill material. The
3. Confirmation testing under contaminated soil stockpiles.

Assumptions and Calculations:

Composted material (treated via alkalyne hydrolysis and windrow composting):

1. Total volume of compost before treatment (cy) =	1,750
2. Bulk density of compost (tons/cy) =	0.368
3. Weight of treated compost, non-haz waste (ton) =	644
4. Loader output (cy/day) =	1735
5. Days to load treated compost =	2
6. Dump truck capacity (cy) =	12
7. Dump truck haul distance (mi.) =	0.5
8. Dump truck output (cy/day) =	300
9. No. of dump trucks per day =	6
10. Dozer (D-6H) capacity (cy/day) =	595
11. Number of dozers =	2
12. Days to spread treated compost =	2
activities shall be performed	
consecutively. The spreading	
14. The duration to load, haul, and spread composted material (days) =	10

Remaining treated soil via alkaline hydrolysis only:

15. Volume of alkaline hydrolysis treated soil (cy) =	1,682
treated via alkaline	193
hydrolysis and Maectite	
17. Volume of alkalyne hydrolysis treated soil for on-site disposal (cy) =	1,489
18. Swell factor for soil upon excavation =	1.3
19. Volume of unconsolidated soil used as backfill material (cy) =	1936
20. Loader output (cy/day) =	1735
21. Days to load alkaline hydrolysis treated soil =	2
22. Dump truck capacity (cy) =	12
23. Dump truck haul distance (mi.) =	0.5
24. Dump truck output (cy/day) =	300
25. No. of dump trucks per day =	6
26. The treated soil via alkaline	
hydrolysis only shall be	
27. The loading and hauling	
28. The duration to load, haul, and spread composted material (days) =	2

Equipment:						
	Service/Materials	**Unit**	**Unit Cost**		**Cost**	
	Wheel Loader	1	$5,000.00	/mo	$5,000.00	
Labor:	Dump Truck (6 ea)	1	$3,890.00	/mo	$4,279.00	
	Site Supervisor (2 ea)	96	$3,500.00	/mo	$3,500.00	
	QA Officer	96	$800.00	/mo	$3,250.00	
	Equipment Operator	4	$406.00	/day	$1,625.00	
	Equipment Operator	2	$406.00	/day	$812.00	
	Equipment Operator	2	$400.00	/day	$1,600.00	
	Laborer/Oiler	4	$293.00	/day	$1,172.00	
Material:	Laborer/Oiler	2	$293.00	/day	$586.00	
	Laborer/Oiler	2	$293.00	/day	$586.00	
	Truck Driver	24	$380.00	/day	$8,360.00	
	Level D PPE	40	$10.00	/day	$400.00	
					Subtotal	**$38,869.00**

9.0 Off-Site Disposal

Includes:

1. Dispose untreated and lead-stabilized soil at a non-hazardous facility.

Assumptions and Calculations:

1. Consolidated volume of D008 soil for haz disposal (cy) =	0	
2. Consolidated volume of D030 soil for haz disposal (cy) =	0	
3. Consolidated volume of PCB soil for haz disposal (cy) =	0	
4. Consolidated (in-place)	2310	Table 2-9
5. Unconsolidated volume of treated soil (cy) =	3003	
6. Weight of treated soil (tons) =	3303	
7. Unconsol vol untreated soil	8964	
8. Weight of untreated soil (ton)	9860	
9. Consolidated volume of lead - contaminated soil treated	400	
10. Swell factor for soil upon excavation =	1.3	
lead-contaminated soil via only Maectite chemical stabilization for non-hazardous	520	
12. Total volume of non-haz waste for disposal (cy) =	9484	
13. Weight of lead-contaminated soil via	572	
14. Total weight of non-haz waste for disposal (tons) =	10432	
15. Non-haz waste transportation cost ($/hr) =	72	
16. Non-haz waste disposal costs ($/ton) =	24.5	Erie County Landfill
17. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
17. Haz waste transportation cost ($/ton) =8	35	
19. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
20. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
21. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
22. Haz waste regulatory fees ($/ton) =	10	
23. No. of field crew =	4	
24. Load capacity of a 20 ton truck (tons) =	15	
25. Round trip travel time to non-haz waste landfill (hr) =	1	
26. Loads of non-haz waste or trips (hrs)=	696	
27. Output of wheel loader (cy/day) =	550	
28. No. of wheel loaders on site =	2	
29. No. of field days =	9	
30. No. of truckloads of stormwater for off-site disposal =	4	
31. Volume of water truck (gal) =	4000	
32. Volume of stormwater requiring off-site disposal (gal) =	16000	

33. Stormwater shall be analyzed for TCLP semivolatiles prior to transport.
34. At one sample per truckload, number of samples (ea) = 4
35. Excavated soil is staged in 500 ton piles.
36. One 10-point composite sample shall be collected from each 500-ton pile as part of compliance testing.
37. Standard work week is 5 days per week at 8 hours per day.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	72	$49.00	/hr	$3,528.00	
QA Coordinator	72	$36.00	/hr	$2,592.00	
H&S Coordinator	72	$49.00	/hr	$3,528.00	
Equipment Operator	9	$406.00	/day	$3,654.00	
Equipment Operator	9	$406.00	/day	$3,654.00	
Laborer/Oiler	9	$293.00	/day	$2,637.00	
Laborer/Oiler	9	$293.00	/day	$2,637.00	
Materials:					
Level D PPE	36	$10.00	/day	$360.00	
Equipment:					
Wheel Loader	0.5	$5,000.00	/mo	$2,500.00	
Wheel Loader	0.5	$5,000.00	/mo	$2,500.00	
Office Trailer	0.5	$800.00	/mo	$400.00	
Porta Jon	0.5	$175.22	/mo	$87.61	
Generator	0.5	$170.35	/mo	$85.18	
P/U Truck	0.5	$1,800.00	/mo	$900.00	
Disposal Costs:					
Transportation (Non-Haz Waste)	696	$72.00	/hr	$50,112.00	truck & driver
Disposal Cost (Non-Haz waste)	10432	$24.50	/ton	$255,584.00	
Transportation (Haz Waste)	0	$35.00	/ton	$0.00	
Disposal Cost (D008 haz waste)	0	$85.00	/ton	$0.00	
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00	
Disposal Cost (PCB haz waste)	0	$85.00	/ton	$0.00	
Stormwater Disposal	16000	$0.25	/gal	$4,000.00	Enviro-Tank Clean
Analytical:					
Compliance Sampling:					
TCLP SVOC/NAC/metals	20	$400.00	/ea	$7,888.00	
Stormwater Sampling:					
TCLP 2,4-DNT	4	$175.00	/ea	$700.00	
				Subtotal	**$347,347.00**

10.0 Site Restoration

Includes:
1. Backfill excavated areas with alkaline hydrolysis traded soil and clean backfill.
2. Re-seed site.
3. Perform road repair.

Assumptions and Calculations:

1. Required volume of consolidated soil for excavated area (cy) =	9205	
2. Compaction factor =	1.15	
3. Volume of soil required for backfill (cy) =	10586	
4. Volume of alkaline hydrolysis treated soil (cy) =	1936	(less the lead contaminated soil)
5. Volume of required clean backfill (cy) =	8650	
6. Cost of clean backfill soil delivered to site ($/cy) =	12	
7. Output of front-end loader (cy/day) =	550	
8. Field days required to backfill soil =	20	
9. No. of field crew =	3	
10. Upon completion of remedial		

11. The laydown area shall be divided into 4 quarters and a 5-point composite collected (4 samples total).

12. No. of soil samples (ea) =	4
13. Allow 1 week for reseeding site and road repair.	
14. Task duration (days) =	25

15. Standard work week is 5 days per week at 8 hours per day. Thus, assuming 22 working days per month.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	200	$49.00	/hr	$9,800.00	
QA Coordinator	200	$36.00	/hr	$7,200.00	
H&S Coordinator	200	$49.00	/hr	$9,800.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Laborer	20	$341.60	/day	$6,832.00	
Reseeding	1	$5,000.00	/area	$5,000.00	
Road Repair	1	$175,000.00	/ls	$175,000.00	Erie Blacktop

Equipment:						
	Dozer	1	$3,500.00	/mo	$3,500.00	
	Wheel Loader	1	$5,000.00	/mo	$5,000.00	
	Office Trailer	2	$800.00	/mo	$1,600.00	
	Porta Jon	2	$175.22	/mo	$350.44	
	Generator	2	$170.35	/mo	$340.70	
	P/U Truck	2	$1,800.00	/mo	$3,600.00	
Material:						
	Backfill	8650	$12.00	/cy	$103,794.36	delivered to site
	PID rental	1	$974.00	/mo.	$974.00	
	CGI rental	1	$380.00	/mo.	$380.00	
	Level D PPE	75	$10.00	/day	$750.00	
Analytical:						
	SVOCs	4	$175.00	/ea	$700.00	
	NACs (8330)	4	$145.00	/ea	$580.00	
	Shipping	4	$40.00	/ea	$160.00	
					Subtotal	**$351,602.00**
11.0 Overall Cost						
					Total Capital Cost	**$1,656,831.00**
					Contingency (30%)	**$497,049.00**
					PM Multiplier (7.5%)	**$124,262.00**
					Fee/Profit (10%)	**$165,683.00**
					Total Cost	**$2,444,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

CREATIVE SPECULATION PHASE

SPECULATION LIST:

E = evaluate idea
D = delete idea
CMT = comment
1,2,...7,... = proposal ID number
R = Remarks / Explanations

Proposal	Proposal Description	Value Potential	To Be Developed
1	No Action	D	R
2	Excavation, Windrow Composting, and Off-Site Disposal	E	E
3	Excavation and Off-Site Disposal	E	E
4	Excavation, Windrow Composting, Chemical Stabilization, and Off-Site Disposal	E	E
5	Excavation, Alkaline Hydrolysis, Windrow Composting, Chemical Stabilization, On-Site and Off-Site Disposal	E	E
6	Natural Attenuation	E	D/R
7	Insitu Chemical Oxidation	E	D/R
8	Capping	D	D
9	Fencing	D	D
10	NASA Evacuate Property	D	R
11	Cut-off Wall for Contamination	D	R
12	Combine Remediation of Areas A and C	D	R

Remarks:
ID# 1- Does not fulfill the requirement to remediate the soil.
ID# 6- Not feasible because several of the contaminates do degrade.
ID# 10-NASA would not leave and would not fulfill the requirement to remediate the soil.
ID# 11-Does not fulfill the requirement to remediate the soil.
ID# 12- Conflicts in funding issues/timing/amounts and coordination too great to resolve.

SUBJECT: PBOW TNT Area C VE Study

Criteria Weighing

blanks to be filled in by team

CRITERIA

	A aesthetics	B health	C $ cost	D community acceptance	E ARAR	F effectiveness	G long term maintenance	H regulators approval	I ease of implementation	J new study cost and requirements	K o	L o			ORDER
A	A 0	A 0	A 0	A 0	A 0	A 0	A 0	A 0	A 0	A 0			A	0	8
B		B 4	B 4	B 5	B 5	B 4	B 5	B 5	B 0			B	32	1
C			C 2	C 5	C 0	C 5	C 2	C 3	C 5			C	22	2
D				D 5	D 0	D 1	D 0	D 2	D 3			D	11	4
E					E 0	E 0	E 0	E 0	E 0			E	0	9
F						F 5	F 2	F 4	F 5			F	16	3
G							G 2	G 3	G 5			G	10	5
H								H 3	H 5			H	8	6
I									I 5			I	5	7
J												J	0	
K												K	0	
L												L	0	

Preference Weightings

0 - No difference

1 - Minor

2

3 - Medium

4

5 - Major

COST ESTIMATES FOR ALTERNATIVES TO BE EVALUATED

The Economic Analysis Process

The steps to estimate the economic consequences of a decision, as are summarized below:
1. Define the problem and the objective.
2. Identify feasible alternatives for accomplishing the objective, taking into account any constraints.
3. Determine whether an economic analysis is necessary, and if so, the level of effort which is warranted.
4. Select a method or methods of economic analysis.
5. Select a technique that accounts for uncertainty and/or risk if the data to be used with the economic method are uncertain.
6. Compile data and make assumptions called for by the economic analysis method(s) and risk analysis technique.
7. Compute a measure of economic performance.
8. Compare the economic consequences of alternatives and make a decision, taking into account any non-quantified effects and the risk attitude of the decision maker.

Area and Volume of Contaminated Soil and Sediment Requiring Remediation
Feasibility Study
TNT Area C, Former Plum Brook Ordnance Works
Sandusky, Ohio

Building No.	Building Name	Area No.	Area (ft^2)	Perimeter (feet)	Depth (feet)	Total Volume (yd^3)	Volume Hazardous Waste 2,4-DNT[a] (yd^3)	Volume Hazardous Waste Lead[b] (yd^3)	Total Volume Hazardous Waste (yd^3)	Volume PCB Waste[c] (yd^3)	Figure No.
602	Bi-Tri House	I	400	80	6	89	0	0	0	0	1-27
603	Fortifier House	I	400	80	8	119	45	0	45	0	1-28
606	Wash House-Line 10	I	400	80	7	104	0	0	0	0	1-29
616	Wash House-Line 11	I	1619	200	8	480	0	59	59	0	1-30
626	Wash House-Line 12	I	400	80	8	119	0	0	0	0	1-31
629	Acid & Fume Recovery	I	3600	240	10	1333	667	74	667	0	1-32
657	Wastewater Settling Basins	I	400	80	7	104	0	0	0	0	1-33
682	Bi-Tri House	I	3644	280	4	540	270	59	270	0	
		II	763	232	5	141	71	0	71	0	
		II	2885	316	8	855	0	0	0	0	
		Total	7292	828		1536	341	59	341	0	1-20
683	Fortifier House	I	3600	240	9	1200	720	0	720	0	1-21
686	Wash House-Line 8	I	8277	455	4	1226	0	59	59	0	1-22
689	Acid & Fume Recovery	I	400	80	8	119	119	60	119	0	1-23
692	Bi-Tri House	I	2851	254	8	845	211	0	211	0	1-24
693	Fortifier House	I	567	96	7	147	0	0	0	0	1-25
696	Wash House-Line 9	I	3301	392	12	1467	0	89	89	0	
		II	1476	90	5	273	0	0	0	0	
		Total	4777	482		1740	0	89	89	0	1-26
NA	Drainage Ditch north of Bld 616	I	600	140	2	44	0	0	0	0	1-34
Total			35583	3415		9205	2103	400	2310	0	
								400			

Notes:
= Estimated volume of soil that cannot be effectively composted to attain RGOs
[a] Volume of soil with conc. of 2,4-DNT > 2.4 mg/kg (20X TCLP limit)
[b] Volume of soil with conc. of Pb > 200 mg/kg (150 mg/kg x 1.33 blending factor for composting). Factor of 1.33 is used because soil is projected approximately 75 weight percent of compost mixture. Therefore, lead in soil up to 200 mg/kg would be below the LDR limit after composting.
[c] Volume of soil with total PCBs > 50 mg/kg is classified as a bulk PCB remediation waste.

ALTERNATIVE COST ESTIMATES

Alternative 2 Cost Estimate TNT Area C Former Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 2 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 2
Excavation/Composting/Off-Site Disposal and Site Restoration
Cost Estimate

Site: TNT Area C
Plum Brook Ordnance Works
Date: 10/31/2008

Scope:
1. Prepare composting work plan, H&S plan, materials list, and procurement along with the final report
2. Mobilize equipment and personnel.
3. Prepare site for remedial activity.
4. Excavate contaminated soil, perform confirmation sampling & characterize waste.
5. Treatment of soil contaminated with nitroaromatic compounds via windrow composting.
6. Off-site disposal of treated material.
7. Site restoration.
8. Demobilize equipment and personnel.

1.0 Work Plans and Procurement

Includes:
1. Labor to generate work plans, including engineering specifications and Health and Safety Plan, along with the Final Report.
2. Procure equipment and materials.

Service	Unit	Unit Cost		Subtotal	
Work Plans and Final Report	1	$15,000.00	/s	$15,000.00	
Procurement	1	$10,000.00	/s	$10,000.00	
				Subtotal	**$25,000.00**

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:
1. Mobilization and demobilization of local equipment and personnel.
2. Set-up/tear down office trailer.

Assumptions:
1. Labor and equipment are available locally.
2. Pressure washer to be purchased for use during project.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor/Equipment:					
Mobe/Demobe	1	$5,000.00	/s	$5,000.00	
Office Trailer (set up/tear down)	1	$500.00	/s	$500.00	
Pressure Washer	1	$500.00	/s	$500.00	
				Subtotal	**$6,000.00**

Alternative 2 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Site Preparation

Assumptions:
1. Existing site can be used and no additional site preparation costs are required.

4.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs.
2. Screen oversize material.
3. Collect confirmatory samples to verify extent of excavation.
4. Staging and characterizing waste stream.

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	9205
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	11967
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	13163
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket.	
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	24
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. Number of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	300
15. Number of soil samples collected for waste characterization =	40
16. Number of excavation crew =	2
17. Number of screening crew =	3
18. Lineal foot of excavation per confirmation sample =	20
19. Resampling factor for confirmation sampling =	1.1
20. Number of confirmatory samples from excavated area =	286
21. Excavation area (ft^2) =	35583
22. Cost multiplier for 1-week turnaround on analytical data =	1.25
23. Fraction of excavation work performed in Level C PPE =	0.10
24. Labor productivity factor for Level C work =	0.67
25. Days excavation crew in Level C =	3
26. Days screening crew in Level C =	2
27. Perimeter of excavation area (ft) =	3415
28. Excavation area (sf) =	35583
29. Volume of pit water requiring offsite disposal (gal) =	20000

30. The excavation duration is 24 days yielding 1 month working the standard work week.

Service/Materials	Unit	Unit Cost		Subtotal
Labor:				
Site Superintendent	192	$49.00	/hr	$9,408.00
QA (Sampling) Coordinator	192	$36.00	/hr	$6,912.00
H&S Coordinator	192	$49.00	/hr	$9,408.00
Chemist (home office)	48	$51.00	/hr	$2,448.00
Equipment Operator	24	$406.00	/day	$9,744.00
Equipment Operator	20	$406.00	/day	$8,120.00
Equipment Operator	20	$406.00	/day	$8,120.00
Laborers	44	$341.60	/day	$15,030.40
Truck Drivers	48	$341.60	/day	$16,396.80

Alternative 2 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Excavation of Contaminated Soil (continued)

Equipment:					
Excavator	2	$4,000.00	/mo	$8,000.00	
100-ton/hr Screening Plant	4	$1,800.00	/wk	$7,200.00	
Radial Stacking Conveyor	4	$1,222.00	/wk	$4,888.00	
Dozer	1	$3,500.00	/mo	$3,500.00	
Dump Truck	2	$3,890.00	/mo	$7,780.00	
Dump Truck	2	$3,890.00	/mo	$7,780.00	
3000 gal. Water Truck	24	$402.00	/day	$9,648.00	
21,000 gal Frac Tank	8	$1,400.00	/mo	$11,200.00	
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00	
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00	
Office Trailer	2	$800.00	/mo	$1,600.00	
Porta Jon	2	$175.22	/mo	$350.44	
Generator	2	$170.35	/mo	$340.70	
P/U Truck	2	$1,800.00	/mo	$3,600.00	
Analytical:					
TCLP Extraction	40	$12.88	/ea	$515.00	
SVOCs (8270C)	326	$300.00	/ea	$97,800.00	
NACs (8330)	326	$197.50	/ea	$64,385.00	
Lead	326	$30.00	/ea	$9,780.00	
PCBs	326	$103.75	/ea	$33,822.50	
NAC field analyses	286	$40.00	/ea	$11,440.00	
Lead field analyses	2	$4,200.00	/mo.	$8,400.00	
Shipping	87	$40.00	/ea	$3,477.33	
Materials & Services:					
Level D PPE	96	$10.00	/day	$960.00	
Level C PPE	12	$35.00	/day	$420.00	
PID rental	2	$974.00	/mo.	$1,948.00	
CGI rental	2	$380.00	/mo.	$760.00	
Pit Water Disposal	20	$1.62	/kgal	$32.40	
				Subtotal	**$397,591.00**

Alternative 2 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Windrow Composting of Contaminated of Soil

Includes:

1. Purchase of composting equipment.
2. Procurement & stockpiling of composting amendments.
3. Mix and compost soil and amendments.
4. Pre-compliance testing: after compost formation & at end of treatment.
5. Pre-compliance testing using definitive field analysis for NAC.

Assumptions:

1. Laydown area is 260' feet wide x 800 feet long.
2. 75% of laydown area is available for windrows ad 25% is available for stockpiling amendments.
3. Compost recipe is 25% soil, 2.9% agricultural amendment (manure) and 72.1% bulking amendment (straw).
4. Widrows are spaced 5 feet apart from one another.
5. There is a 35-foot space at each end of the windrow allotting for movement of the windrow turner.
6. Duration per batch (wk) = 6
7. The windrows will be staggered by 1 week.
8. Volume of consolidated soil to be treated (cy) = 2103
9. Swell factor for soil upon excavation = 1.3
10. Volume of unconsolidated soil to be treated (cy) = 2734
11. Compost treatment duration (weeks) = 16
12. Each windrow is 6 feet high x 16 feet wide x 530 feet long, trapezoidal configuration.
13.. Capacity of windrow turner (tons/hr) = 3,200
14.. Operating life of flails (hrs) = 25
15. Number of flails on windrow turner = 172
16. Volume of compost per windrow (cy) = 1,178
17. Per windrow the soil volume is, at 25% (cy) = 294
18. Per windrow the manure volume is, at 2.9% (cy) = 34
19. Per windrow the straw volume is, at 72.1% (cy) = 849
20 . Number of required windrows (ea) = 9.3
21. Volume of manure (cy) = 317
22. Volume of straw (cy) = 7885
23. Compost additive volume correction factor = 0.8
24. Total volume of compost prior to treatment (cy) = 8,748
25. Bulk density of compost (tons/cy) = 0.368
26. Number of field crew = 6
27. Tractor and straw blower are in-use 1 day/week and on stand-by the rest of the week.
28. Pre-compliance testing shall weekly per windrow and consist of:
    - EnSys TNT 20, one per batch. Number of samples = 60
    - EnSys TNT 20, no. of samples per kit = 19
    - Total NAC, one per batch. Number of samples = 60
29. Compliance testing shall be performed per windrow and upon compost treatment. Sampling shall consist of:
    - Total Semivolatiles. Number of samples = 10
    - Total NACs. Number of samples = 10
    -TCLP 2,4-DNT. Number of samples = 10
30. Standard work week is 7 days per week at 8 hours per day. Thus, assuming 30 working days per month.

Alternative 2 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Windrow Composting of Contaminated of Soil (continued)

Service/Materials	Unit	Unit Cost		Subtotal		
Labor:						
Site Superintendent	896	$49.00	/hr	$43,904.00		
QA (Sampling) Coordinator	896	$36.00	/hr	$32,256.00		
H&S Coordinator	896	$49.00	/hr	$43,904.00		
Windrow Turner Operator	112	$567.20	/day	$63,526.40		
Equipment Operator	112	$406.00	/day	$45,472.00		
Equipment Operator	112	$406.00	/day	$45,472.00		
Equipment Operator	112	$406.00	/day	$45,472.00		
Laborer	112	$341.60	/day	$38,259.20		
Environmental Tech	112	$200.00	/day	$22,400.00		
Equipment:						
Windrow Turner (6' x 19')	4	$45,000.00	/mo	$180,000.00		
Dozer	4	$3,500.00	/mo	$14,000.00		
Excavator	4	$4,000.00	/mo	$16,000.00		
Wheel Loader	4	$5,000.00	/mo	$20,000.00		
Tractor	128	$50.00	/hr	$6,400.00	In-use	
Tractor	768	$30.00	/hr	$23,040.00	Stand-by	
Straw Blower	128	$40.00	/hr	$5,120.00	In-use	
Straw Blower	768	$20.00	/hr	$15,360.00	Stand-by	
21000 gallon Frac Tank	4	$1,400.00	/mo	$5,600.00		
21000 gallon Frac Tank	4	$1,400.00	/mo	$5,600.00		
Trash/Pump Hose	1	$3,749.00	/ea	$3,749.00		
Office Trailer	4	$800.00	/mo	$3,200.00		
Porta Jon	4	$175.22	/mo	$700.88		
Generator	4	$170.35	/mo	$681.41		
P/U Truck	4	$1,800.00	/mo	$7,200.00		
Spectrophotometer	1	$3,012.00	/ls	$3,012.00		
Materials:						
Repl. Flails for Windrow Turner	6708	$9.50	/ea	$63,726.00		
Straw	7885	$11.25	/cy	$88,701.39		
Manure	317	$25.00	/cy	$7,928.31		
Water	1027	$9.40	/kgal	$9,653.80		
Level C PPE	672	$35.00	/day	$23,520.00		
Air Monitoring Screening Kits	1	$2,500.00	/ls	$2,500.00		
Moisture/Temp Probes	1	$700.00	/ea	$700.00		
Analytical:						
Pre-Compliance Sampling:						
EnSys Kit (TNT 20) - 19 samples per kit	4	$572.00	/ea	$2,288.00		
Total NACs	60	$145.00	/ea	$8,700.00		
Compliance Sampling:						
TCLP Semivolatiles	10	$175.00	/ea	$1,750.00		
Total NACs	10	$145.00	/ea	$1,450.00		
TCLP 2,4-DNT	10	$175.00	/ea	$1,750.00		
				Subtotal		**$902,996.00**

Alternative 2 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Off-Site Disposal

Includes:

1. Dispose of stabilized soil and non-hazardous soil (not stabilized) at a non-hazardous waste
2. Dispose of treated compost at a non-hazardous landfill.
3. Dispose of PCB waste at a TSCA approved landfill.
4. Compliance sampling and analysis for off-site waste disposal.

Assumptions and Calculations:

1. Consolidated volume of D008 soil for haz disposal (cy) =	400	
2. Consolidated volume of D030 soil for haz disposal (cy) =	0	
3. Consolidated volume of PCB soil for haz disposal (cy) =	0	
4.Volume of compost, non-haz disposal (cy) =	8748	
5. Bulk density of compost (tons/cy) =	0.368	
6. Weight of treated compost, non-haz waste (ton) =	3219	
7. Consolidated volume of treated soil (cy) =	2310	
8. Unconsolidated volume of treated soil (cy) =	3003	
9. Unconsolidated volume untreated soil (cy) =	8964	
10. Weight of untreated soil (tons) =	9860	
11. Total volume of non-haz waste for disposal (cy) =	17712	
12. Total weight of non-haz waste for disposal (tons) =	13079	
13. Non-haz waste transportation cost ($/hr) =	72	
14. Non-haz waste disposal costs ($/ton) =	24.5	Erie County Landfill
15. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
16. Haz waste transportation cost ($/ton) =	35	
17. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
18. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
19. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
20. Haz waste regulatory fees ($/ton) =	10	
21. Number of crew =	3	
22. Load capacity of a 20 ton truck (tons) =	15	
23. Round trip travel time to non-haz waste landfill (hr) =	1	
24. Loads of non-haz waste or trips (hrs)=	872	
25. Output of front-end loader (cy/day) =	550	
26. No. of wheel loaders =	2	
27. Number of field days =	17	
28. No. of truckloads of stormwater for disposal =	4	
29. Volume of stormwater per truckload (gal) =	4000	
30. Volume of stormwater requiring off-site disposal (gal) =	16000	

31. Stormwater shall be analyzed for TCLP semivolatiles prior to transport.
32. At one sample per truckload, number of samples (ea) = 4
33. Excavated soil is staged in 500 ton piles.
34. One 10-point composite sample shall be collected from each 500-ton pile as part of compliance testing.
35. Standard work week is 5 days per week at 8 hours per day.

Alternative 2 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Off-Site Disposal (continued)

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	136	$49.00	/hr	$6,664.00	
QA Coordinator	136	$36.00	/hr	$4,896.00	
H&S Coordinator	136	$49.00	/hr	$6,664.00	
Equipment Operator	17	$406.00	/day	$6,902.00	
Equipment Operator	17	$406.00	/day	$6,902.00	
Oiler	17	$293.00	/day	$4,981.00	
Materials:					
Level D PPE	51	$10.00	/day	$510.00	
Equipment:					
Wheel Loader	0.8	$5,000.00	/mo	$4,000.00	
Wheel Loader	0.8	$5,000.00	/mo	$4,000.00	
Office Trailer	0.8	$800.00	/mo	$640.00	
Porta Jon	0.8	$175.22	/mo	$140.18	
Generator	0.8	$170.35	/mo	$136.28	
P/U Truck	0.8	$1,800.00	/mo	$1,440.00	
Disposal Costs:					
Transportation (Non-Haz Waste)	872	$72.00	/hr	$62,784.00	truck & driver
Disposal Cost (Non-Haz waste)	13079	$24.50	/ton	$320,442.62	Erie County Landfill
Transportation (Haz Waste)	572	$35.00	/ton	$20,020.00	
Disposal Cost (D008 haz waste)	572	$85.00	/ton	$48,620.00	
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00	
Disposal Cost (PCB haz waste)	0	$85.00	/ton	$0.00	
Stormwater Disposal	17	$0.25	/gal	$4.25	Enviro-Tank Clean
Analytical:					
Compliance Sampling:					
TCLP SVOC/NAC/metals	21	$400.00	/ea	$8,345.48	
Stormwater Sampling:					
TCLP 2,4-DNT	4	$175.00	/ea	$700.00	
				Subtotal	**$508,792.00**

Alternative 2 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Site Restoration

Includes:
1. Backfill excavated areas with clean backfill.
2. Re-seed site.
3. Perform road repair.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	9205
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	10586
4. Cost of clean backfill soil delivered to site ($/cy) =	12
5. Output of front-end loader (cy/day) =	550
6. Field days required to backfill soil =	20
7. Number of field crew =	3

8. Upon completion of remedial action soil samples shall be taken within the laydown area to determine if any soil removal is required.
9. The laydown area shall be divided into 4 quarters and a 5-point composite collected (4 samples total).

10. Number of soil samples (ea) =	4
11. Allow 1 week for reseeding site and road repair.	
12. Task duration (days) =	25

13. Standard work week is 5 days per week at 8 hours per day.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	200	$49.00	/hr	$9,800.00	
QA Coordinator	200	$36.00	/hr	$7,200.00	
H&S Coordinator	200	$49.00	/hr	$9,800.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Laborer	20	$341.60	/day	$6,832.00	
Reseeding	1	$5,000.00	/area	$5,000.00	
Road Repair	1	$175,000.00	/ls	$175,000.00	Erie Blacktop
Equipment:					
Dozer	1	$3,500.00	/mo	$3,500.00	
Wheel Loader	1	$5,000.00	/mo	$5,000.00	
Office Trailer	2	$800.00	/mo	$1,600.00	
Porta Jon	2	$175.22	/mo	$350.44	
Generator	2	$170.35	/mo	$340.70	
P/U Truck	2	$1,800.00	/mo	$3,600.00	
Material:					
Backfill	10586	$12.00	/cy	$127,029.00	delivered to site
PID rental	1	$974.00	/mo.	$974.00	
CGI rental	1	$380.00	/mo.	$380.00	
Level D PPE	75	$10.00	/day	$750.00	
Analytical:					
SVOCs	4	$175.00	/ea	$700.00	
NACs (8330)	4	$145.00	/ea	$580.00	
Shipping	4	$40.00	/ea	$160.00	
				Subtotal	**$374,836.00**

Alternative 2 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

8.0 Overall Cost	
Total Capital Cost	**$2,215,215.00**
Contingency (30%)	**$664,565.00**
PM Multiplier (7.5%)	**$166,141.00**
Fee/Profit (10%)	**$221,522.00**
Total Cost	**$3,267,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Alternative 3 Cost Estimate TNT Area C Former Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 3 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 3
Excavation/Off-Site Disposal/Site Restoration Cost Estimate

Site: TNT Area C
Plum Brook Ordnance Works
Date: 10/31/2008

Scope:
1. Prepare work plan, H&S plan, materials list, and procurement along with the final report
2. Mobilize/demobilize equipment and personnel.
3. Prepare site for remedial activity.
4. Excavate contaminated soil, perform confirmation sampling & characterize waste.
5. Off-site disposal.
6. Site restoration.
7. Demobilize equipment and personnel.

1.0 Work Plans and Procurement

Includes:
1. Labor to generate work plans, including engineering specifications and Health and Safety Plan, along with the Final Report.
2. Procure equipment and materials.

Service	Unit	Unit Cost	Subtotal
Work Plans and Final Report	1	$15,000.00 /ls	$15,000.00
Procurement	2	$10,000.00 /ea	$20,000.00
		Subtotal	**$35,000.00**

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:
1. Mobilization and demobilization of local equipment and personnel.
2. Set-up/tear down office trailer.

Assumptions:
1. Labor and equipment are available locally.
2. Pressure washer to be purchased for use during project.

Service/Materials	Unit	Unit Cost	Subtotal
Labor/Equipment:			
Mobe/Demobe	1	$5,000.00 /ls	$5,000.00
Office Trailer (set up/tear down)	1	$500.00 /ls	$500.00
Pressure Washer	1	$500.00 /ls	$500.00
		Subtotal	**$6,000.00**

Alternative 3 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Site Preparation

Includes:

1. Delineate the laydown area, approximately 5 acres (800 feet long by 260 feet wide).
2. Clear laydown area.
3. Grade site for a 2% slope aiding in stormwater control.
4. Construct 12" erosion control berm around laydown area. Perimeter (ft)= 2120
5. Excavate soil for contact water retention pond (260 feet long by 30 feet wide by 3 feet deep).
6. Install 60-mil liner along retention pond.

Assumptions:

1. Survey Crew for delineation of the laydown area. The cost includes all survey area and is a lump sum cost.
2. Volume of con. soil excavated for contact water retention pond (cy) = 867
3. Swell factor for soil upon excavation = 1.3
4. Volume of unconsolidated soil for contact water retention pond (cy) = 1,127
5. Equipment for excavation; excavator: hydraulic backhoe, 1 cy bucket and roller.
6. Excavator output (cy/day) = 600
7.. Days to excavate soil = 3
8. Erosion control berm shall be along the site perimeter and to include silt fence and straw bales.
9. Volume of containment berm (cy) = 157
10. Duration (weeks): 2
11. Standard work week is 5 days per week at 8 hours per day. Thus, assuming 22 working days per month.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	80	$49.00	/hr	$3,920.00	
QA Coordinator	80	$36.00	/hr	$2,880.00	
Equipment Operator	10	$406.00	/day	$4,060.00	
Equipment Operator	10	$406.00	/day	$4,060.00	
Laborer	10	$341.60	/day	$3,416.00	
Laborer	10	$341.60	/day	$3,416.00	
Surveying	1	$24,000.00	/ls	$24,000.00	
Site Clearing	5	$2,300.00	/acre	$11,500.00	
60-mil Polymeric Liner (installed)	9540	$3.09	/sf	$29,436.62	
Equipment:					
Roller	80	$55.00	/hr	$4,400.00	
Excavator	1	$4,000.00	/mo	$4,000.00	
Office Trailer	1	$800.00	/mo	$800.00	
Porta Jon	1	$175.22	/mo	$175.22	
Generator	1	$170.35	/mo	$170.35	
P/U Truck	1	$1,800.00	/mo	$1,800.00	
Materials:					
Earthen Containment Berm	157	$6.00	/cy	$942.00	
Silt Fence	2120	$1.50	/lf	$3,180.00	
2' x 2' x 3' Straw Bales (delivered)	1060	$5.00	/ea	$5,300.00	
				Subtotal	**$107,456.00**

Alternative 3 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs.
2. Screen oversize material.
3. Collect confirmatory samples to verify extent of excavation.
4. Staging and characterizing waste stream.

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	9205
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	11967
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	13163
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket.	
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	24
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. Number of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	300
15. Number of soil samples collected for waste characterization =	40
16. Number of excavation crew =	2
17. Number of screening crew =	3
18. Lineal foot of excavation per confirmation sample =	20
19. Resampling factor for confirmation sampling =	1.1
20. Number of confirmatory samples from excavated area =	286
21. Excavation area (ft^2) =	35583
22. Cost multiplier for 1-week turnaround on analytical data =	1.25
23. Fraction of excavation work performed in Level C PPE =	0.10
24. Labor productivity factor for Level C work =	0.67
25. Days excavation crew in Level C =	3
26. Days screening crew in Level C =	2
27. Perimeter of excavation area (ft) =	3415
28. Excavation area (sf) =	35583
29. Volume of pit water requiring offsite disposal (gal) =	20000

30. The excavation duration is 24 days yielding 1 month working the standard work week.

Service/Materials	Unit	Unit Cost	Subtotal
Labor:			
Site Superintendent	192	$49.00 /hr	$9,408.00
QA (Sampling) Coordinator	192	$36.00 /hr	$6,912.00
H&S Coordinator	192	$49.00 /hr	$9,408.00
Chemist (home office)	48	$51.00 /hr	$2,448.00
Equipment Operator	24	$406.00 /day	$9,744.00
Equipment Operator	20	$406.00 /day	$8,120.00
Equipment Operator	20	$406.00 /day	$8,120.00
Laborers	44	$341.60 /day	$15,030.40
Truck Drivers	48	$341.60 /day	$16,396.80

Alternative 3 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Excavation of Contaminated Soil (continued)

Equipment:					
Excavator	2	$4,000.00	/mo	$8,000.00	
100-ton/hr Screening Plant	4	$1,800.00	/wk	$7,200.00	
Radial Stacking Conveyor	4	$1,222.00	/wk	$4,888.00	
Dozer	1	$3,500.00	/mo	$3,500.00	
Dump Truck	2	$3,890.00	/mo	$7,780.00	
Dump Truck	2	$3,890.00	/mo	$7,780.00	
3000 gal. Water Truck	24	$402.00	/day	$9,648.00	
21,000 gal Frac Tank	8	$1,400.00	/mo	$11,200.00	
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00	
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00	
Office Trailer	2	$800.00	/mo	$1,600.00	
Porta Jon	2	$175.22	/mo	$350.44	
Generator	2	$170.35	/mo	$340.70	
P/U Truck	2	$1,800.00	/mo	$3,600.00	
Analytical:					
TCLP Extraction	40	$12.88	/ea	$515.00	
SVOCs (8270C)	326	$300.00	/ea	$97,800.00	
NACs (8330)	326	$197.50	/ea	$64,385.00	
Lead	326	$30.00	/ea	$9,780.00	
PCBs	326	$103.75	/ea	$33,822.50	
NAC field analyses	286	$40.00	/ea	$11,440.00	
Lead field analyses	2	$4,200.00	/mo.	$8,400.00	
Shipping	87	$40.00	/ea	$3,477.33	
Materials & Services:					
Level D PPE	96	$10.00	/day	$960.00	
Level C PPE	12	$35.00	/day	$420.00	
PID rental	2	$974.00	/mo.	$1,948.00	
CGI rental	2	$380.00	/mo.	$760.00	
Pit Water Disposal	20	$1.62	/kgal	$32.40	
				Subtotal	**$397,591.00**

5.0 Off-Site Disposal

Includes:
1. Dispose of stabilized soil and non-hazardous soil (not stabilized) at a non-hazardous waste
2. Dispose of treated compost at a non-hazardous landfill.
3. Dispose of PCB waste at a TSCA approved landfill.
4. Analysis for off-site waste disposal.

Assumptions and Calculations:

1. Volume of consolidated, non-hazardous soil (cy) =	6895	
2. Volume of unconsolidated, non-hazardous soil (cy) =	8964	
3. Tons of non-hazardous soil for disposal =	9860	
4. Consolidated volume of D008 soil for haz disposal (cy) =	207	
5. Consolidated volume of D030 soil for haz disposal (cy) =	2103	
6. Consolidated volume of PCB soil for haz disposal (cy) =	0	
7. Total volume of unconsolidated hazardous soil (cy) =	3003	
8. Non-haz waste transportation cost ($/hr) =	72	
9. Non-haz waste disposal costs ($/ton) =	24.5	Erie County Landfill
10. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
11. Haz waste transportation cost ($/ton) =	35	
12. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
13. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
14. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
15. Haz waste regulatory fees ($/ton) =	10	
16. Number of crew =	3	

17. Load capacity of a 20 ton truck is 15 ton/truck.
18. Travel duration to non-haz landfill is 1 hour, round trip. Thus, one load yield 1 hour of transportation.

20. Loads of non-haz waste or trips (hrs)=	657
21. Output of front-end loader (cy/day) =	550
22. Number of field days =	22
23. Standby time for haz waste disposal (approvals) =	6
24. Total number of days in field (incl standby) =	28

23. Four (4) truckloads of stormwater requiring off-site disposal.
24. 4000 gallons of stormwater per truckload.

25. Volume of stormwater requiring off-site disposal (gal) =	16000

26. Stormwater shall be analyzed for TCLP semivolatiles prior to transport.

27. At one sample per truckload, number of samples (ea) =	4

28. Excavated soil is staged in 500 ton piles.
29. One 10-point composite sample shall be collected from each 500-ton pile as part of compliance testing.
30. Standard work week is 5 days per week at 8 hours per day.

Service/Materials	Unit	Unit Cost		Subtotal
Labor:				
Site Superintendent	224	$49.00	/hr	$10,976.00
QA Coordinator	224	$36.00	/hr	$8,064.00
H&S Coordinator	224	$49.00	/hr	$10,976.00
Equipment Operator	28	$406.00	/day	$11,368.00
Equipment Operator	28	$406.00	/day	$11,368.00
Oiler	28	$293.00	/day	$8,204.00
Materials:				
Level D PPE	84	$10.00	/day	$840.00
Equipment:				
Wheel Loader	1.3	$5,000.00	/mo	$6,500.00
Wheel Loader	1.3	$5,000.00	/mo	$6,500.00
Office Trailer	1.3	$800.00	/mo	$1,040.00
Porta Jon	1.3	$175.22	/mo	$227.78
Generator	1.3	$170.35	/mo	$221.46
P/U Truck	1.3	$1,800.00	/mo	$2,340.00

Alternative 3 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Off-Site Disposal (continued)					
Disposal Costs:					
Transportation (Non-Haz Waste)	657	$72.00	/hr	$47,328.68	truck & driver
Disposal Cost (Non-Haz waste)	9860	$24.50	/ton	$241,573.48	
Transportation (Haz Waste)	3303	$35.00	/ton	$115,605.28	
Disposal Cost (D008 haz waste)	296	$85.00	/ton	$25,196.81	
Disposal Cost (D030 haz waste)	3007	$160.00	/ton	$481,052.00	
Disposal Cost (PCB haz waste)	0	$85.00	/ton	$0.00	
Stormwater Disposal	16000	$0.25	/gal	$4,000.00	Enviro-Tank Clean
Analytical:					
Compliance Sampling:					
TCLP SVOC/NAC/metals	26	$400.00	/ea	$10,530.52	
Stormwater Sampling:					
TCLP 2,4-DNT	4	$175.00	/ea	$700.00	
				Subtotal	**$1,004,612.00**

Alternative 3 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Site Restoration

Includes:
1. Backfill excavated areas with clean backfill.
2. Re-seed site.
3. Perform road repair.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	10072
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	11582
4. Cost of clean backfill soil delivered to site ($/cy) =	12
5. Output of front-end loader (cy/day) =	550
6. Field days required to backfill soil =	22
7. Number of field crew =	3

8. Upon completion of remedial action soil samples shall be taken within the laydown area to determine if any soil removal is required.
9. The laydown area shall be divided into 4 quarters and a 5-point composite collected (4 samples total).

10. Number of soil samples (ea) =	4

11. Allow 1 week for reseeding site and road repair.

12. Task duration (days) =	27

13. Standard work week is 5 days per week at 8 hours per day.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	216	$49.00	/hr	$10,584.00	
QA Coordinator	216	$36.00	/hr	$7,776.00	
H&S Coordinator	216	$49.00	/hr	$10,584.00	
Equipment Operator	22	$406.00	/day	$8,932.00	
Equipment Operator	22	$406.00	/day	$8,932.00	
Laborer	22	$341.60	/day	$7,515.20	
Reseeding	1	$5,000.00	/area	$5,000.00	
Road Repair	1	$175,000.00	/ls	$175,000.00	Erie Blacktop
Equipment:					
Dozer	1	$3,500.00	/mo	$3,500.00	
Wheel Loader	1	$5,000.00	/mo	$5,000.00	
Office Trailer	2	$800.00	/mo	$1,600.00	
Porta Jon	2	$175.22	/mo	$350.44	
Generator	2	$170.35	/mo	$340.70	
P/U Truck	2	$1,800.00	/mo	$3,600.00	
Material:					
Backfill	11582	$12.00	/cy	$138,989.00	delivered to site
PID rental	1	$974.00	/mo.	$974.00	
CGI rental	1	$380.00	/mo.	$380.00	
Level D PPE	81	$10.00	/day	$810.00	
Analytical:					
SVOCs	4	$175.00	/ea	$700.00	
NACs (8330)	4	$145.00	/ea	$580.00	
Shipping	4	$40.00	/ea	$160.00	
				Subtotal	**$391,307.00**

Alternative 3 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Overall Cost	
Total Capital Cost	**$1,941,966.00**
Contingency (30%)	**$582,590.00**
PM Multiplier (7.5%)	**$145,647.00**
Fee/Profit (10%)	**$194,197.00**
Total Cost	**$2,864,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Alternative 4 Cost Estimate TNT Area C Former Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 4 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Alternative 4
Excavation/Composting/Stabilization/Off-Site Disposal and Site Restoration Cost Estimate

Site: TNT Area C
Plum Brook Ordnance Works
Date: 10/31/2008

Scope:
1. Prepare composting work plan, H&S plan, materials list, and procurement along with the final report
2. Mobilize equipment and personnel.
3. Prepare site for remedial activity.
4. Excavate contaminated soil, perform confirmation sampling & characterize waste.
5. Treatment of soil contaminated with nitroaromatic compounds via windrow composting.
6. Chemically stabilize soil that is hazardous based on lead TCLP.
7. Off-site disposal.
8. Site restoration.
9. Demobilize equipment and personnel.

1.0 Work Plans and Procurement

Includes:
1. Labor to generate work plans, including engineering specifications and Health and Safety Plan, along with the Final Report.
2. Procure equipment and materials.

Service	Unit	Unit Cost		Subtotal	
Work Plans and Final Report	1	$15,000.00	/ls	$15,000.00	
Procurement	1	$10,000.00	/ea	$10,000.00	
				Subtotal	**$25,000.00**

2.0 Mobilization/Demobilization of Equipment and Personnel

Includes:
1. Mobilization and demobilization of local equipment and personnel.
2. Set-up/tear down office trailer.

Assumptions:
1. Labor and equipment are available locally.
2. Pressure washer to be purchased for use during project.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor/Equipment:					
Mobe/Demobe	1	$5,000.00	/ls	$5,000.00	
Office Trailer (set up/tear down)	1	$500.00	/ls	$500.00	
Pressure Washer	1	$500.00	/ls	$500.00	
				Subtotal	**$6,000.00**

Alternative 4 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

3.0 Site Preparation

Assumptions
1. Existing site can be used and no additional site preparation costs are required.

4.0 Excavation of Contaminated Soil

Includes:
1. Excavation of soil with contaminants exceeding RGOs.
2. Screen oversize material.
3. Collect confirmatory samples to verify extent of excavation.
4. Staging and characterizing waste stream.

Assumptions and Calculations:

1. Cubic yards of consolidated soil excavated =	9205
2. Swell factor for soil upon excavation =	1.3
3. Cubic yards of unconsolidated soil =	11967
4. Density of unconsolidated soil (tons/cy) =	1.1
5. Mass of unconsolidated soil (tons) =	13163
6. Capacity of screening plant (tons/hr) =	100
7. Excavator: hydraulic backhoe, 1 cy bucket.	
8. Excavator output (cy/day) =	600
9. Days to excavate soil =	24
10. Dump truck capacity (cy) =	12
11. Dump truck haul distance (mi.) =	0.5
12. Dump truck output (cy/day) =	250
13. Number of required dump trucks per day =	2
14. Soil sample collected for waste characterization / cy =	300
15. Number of soil samples collected for waste characterization =	40
16. Number of excavation crew =	2
17. Number of screening crew =	3
18. Lineal foot of excavation per confirmation sample =	20
19. Resampling factor for confirmation sampling =	1.1
20. Number of confirmatory samples from excavated area =	286
21. Excavation area (ft^2) =	35583
22. Cost multiplier for 1-week turnaround on analytical data =	1.25
23. Fraction of excavation work performed in Level C PPE =	0.10
24. Labor productivity factor for Level C work =	0.67
25. Days excavation crew in Level C =	3
26. Days screening crew in Level C =	2
27. Perimeter of excavation area (ft) =	3415
28. Excavation area (sf) =	35583
29. Volume of pit water requiring offsite disposal (gal) =	20000

30. The excavation duration is 24 days yielding 1 month working the standard work week.

Service/Materials	Unit	Unit Cost		Subtotal
Labor:				
Site Superintendent	192	$49.00	/hr	$9,408.00
QA (Sampling) Coordinator	192	$36.00	/hr	$6,912.00
H&S Coordinator	192	$49.00	/hr	$9,408.00
Chemist (home office)	48	$51.00	/hr	$2,448.00
Equipment Operator	24	$406.00	/day	$9,744.00
Equipment Operator	20	$406.00	/day	$8,120.00
Equipment Operator	20	$406.00	/day	$8,120.00
Laborers	44	$341.60	/day	$15,030.40
Truck Drivers	48	$341.60	/day	$16,396.80

Alternative 4 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

4.0 Excavation of Contaminated Soil (continued)

Equipment:					
Excavator	2	$4,000.00	/mo	$8,000.00	
100-ton/hr Screening Plant	4	$1,800.00	/wk	$7,200.00	
Radial Stacking Conveyor	4	$1,222.00	/wk	$4,888.00	
Dozer	1	$3,500.00	/mo	$3,500.00	
Dump Truck	2	$3,890.00	/mo	$7,780.00	
Dump Truck	2	$3,890.00	/mo	$7,780.00	
3000 gal. Water Truck	24	$402.00	/day	$9,648.00	
21,000 gal Frac Tank	8	$1,400.00	/mo	$11,200.00	
150 gpm Pump	2	$2,439.00	/ea.	$4,878.00	
300 gpm Pump	2	$3,749.00	/ea.	$7,498.00	
Office Trailer	2	$800.00	/mo	$1,600.00	
Porta Jon	2	$175.22	/mo	$350.44	
Generator	2	$170.35	/mo	$340.70	
P/U Truck	2	$1,800.00	/mo	$3,600.00	
Analytical:					
TCLP Extraction	40	$12.88	/ea	$515.00	
SVOCs (8270C)	326	$300.00	/ea	$97,800.00	
NACs (8330)	326	$197.50	/ea	$64,385.00	
Lead	326	$30.00	/ea	$9,780.00	
PCBs	326	$103.75	/ea	$33,822.50	
NAC field analyses	286	$40.00	/ea	$11,440.00	
Lead field analyses	2	$4,200.00	/mo.	$8,400.00	
Shipping	87	$40.00	/ea	$3,477.33	
Materials & Services:					
Level D PPE	96	$10.00	/day	$960.00	
Level C PPE	12	$35.00	/day	$420.00	
PID rental	2	$974.00	/mo.	$1,948.00	
CGI rental	2	$380.00	/mo.	$760.00	
Pit Water Disposal	20	$1.62	/kgal	$32.40	
				Subtotal	**$397,591.00**

Alternative 4 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Windrow Composting of Contaminated of Soil

Includes:
1. Purchase of composting equipment.
2. Procurement & stockpiling of composting amendments.
3. Mix and compost soil and amendments.
4. Pre-compliance testing: after compost formation & at end of treatment.
5. Pre-compliance testing using definitive field analysis for NAC.

Assumptions:
1. Laydown area is 260' feet wide x 800 feet long.
2. 75% of laydown area is available for windrows ad 25% is available for stockpiling amendments.
3. Compost recipe is 25% soil, 2.9% agricultural amendment (manure) and 72.1% bulking amendment (straw).
4. Widrows are spaced 5 feet apart from one another.
5. There is a 35-foot space at each end of the windrow allotting for movement of the windrow turner.
6. Duration per batch (wk) = 6
7. The windrows will be staggered by 1 week.
8. Volume of consolidated soil to be treated (cy) = 2103
9. Swell factor for soil upon excavation = 1.3
10. Volume of unconsolidated soil to be treated (cy) = 2734
11. Compost treatment duration (weeks) = 16
12. Each windrow is 6 feet high x 16 feet wide x 530 feet long, trapezoidal configuration.
13.. Capacity of windrow turner (tons/hr) = 3,200
14.. Operating life of flails (hrs) = 25
15. Number of flails on windrow turner = 172
16. Volume of compost per windrow (cy) = 1,178
17. Per windrow the soil volume is, at 25% (cy) = 294
18. Per windrow the manure volume is, at 2.9% (cy) = 34
19. Per windrow the straw volume is, at 72.1% (cy) = 849
20 . Number of required windrows (ea) = 9.3
21. Volume of manure (cy) = 317
22. Volume of straw (cy) = 7885
23. Compost additive volume correction factor = 0.8
24. Total volume of compost prior to treatment (cy) = 8,748
25. Bulk density of compost (tons/cy) = 0.368
26. Number of field crew = 6
27. Tractor and straw blower are in-use 1 day/week and on stand-by the rest of the week.
28. Pre-compliance testing shall weekly per windrow and consist of:
    - EnSys TNT 20, one per batch. Number of samples = 60
    - EnSys TNT 20, no. of samples per kit = 19
    - Total NAC, one per batch. Number of samples = 60
29. Compliance testing shall be performed per windrow and upon compost treatment. Sampling shall consist of:
    - Total Semivolatiles. Number of samples = 10
    - Total NACs. Number of samples = 10
    -TCLP 2,4-DNT. Number of samples = 10
30. Standard work week is 7 days per week at 8 hours per day. Thus, assuming 30 working days per month.

Alternative 4 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

5.0 Windrow Composting of Contaminated of Soil (continued)

Service/Materials	Unit	Unit Cost		Subtotal		
Labor:						
Site Superintendent	896	$49.00	/hr	$43,904.00		
QA (Sampling) Coordinator	896	$36.00	/hr	$32,256.00		
H&S Coordinator	896	$49.00	/hr	$43,904.00		
Windrow Turner Operator	112	$567.20	/day	$63,526.40		
Equipment Operator	112	$406.00	/day	$45,472.00		
Equipment Operator	112	$406.00	/day	$45,472.00		
Equipment Operator	112	$406.00	/day	$45,472.00		
Laborer	112	$341.60	/day	$38,259.20		
Environmental Tech	112	$200.00	/day	$22,400.00		
Equipment:						
Windrow Turner (6' x 19')	4	$45,000.00	/mo	$180,000.00		
Dozer	4	$3,500.00	/mo	$14,000.00		
Excavator	4	$4,000.00	/mo	$16,000.00		
Wheel Loader	4	$5,000.00	/mo	$20,000.00		
Tractor	128	$50.00	/hr	$6,400.00	In-use	
Tractor	768	$30.00	/hr	$23,040.00	Stand-by	
Straw Blower	128	$40.00	/hr	$5,120.00	In-use	
Straw Blower	768	$20.00	/hr	$15,360.00	Stand-by	
21000 gallon Frac Tank	4	$1,400.00	/mo	$5,600.00		
21000 gallon Frac Tank	4	$1,400.00	/mo	$5,600.00		
Trash/Pump Hose	1	$3,749.00	/ea	$3,749.00		
Office Trailer	4	$800.00	/mo	$3,200.00		
Porta Jon	4	$175.22	/mo	$700.88		
Generator	4	$170.35	/mo	$681.41		
P/U Truck	4	$1,800.00	/mo	$7,200.00		
Spectrophotometer	1	$3,012.00	/ls	$3,012.00		
Materials:						
Repl. Flails for Windrow Turner	6708	$9.50	/ea	$63,726.00		
Straw	7885	$11.25	/cy	$88,701.39		
Manure	317	$25.00	/cy	$7,928.31		
Water	1027	$9.40	/kgal	$9,653.80		
Level C PPE	672	$35.00	/day	$23,520.00		
Air Monitoring Screening Kits	1	$2,500.00	/ls	$2,500.00		
Moisture/Temp Probes	1	$700.00	/ea	$700.00		
Analytical:						
Pre-Compliance Sampling:						
EnSys Kit (TNT 20) - 19 samples per kit	4	$572.00	/ea	$2,288.00		
Total NACs	60	$145.00	/ea	$8,700.00		
Compliance Sampling:						
TCLP Semivolatiles	10	$175.00	/ea	$1,750.00		
Total NACs	10	$145.00	/ea	$1,450.00		
TCLP 2,4-DNT	10	$175.00	/ea	$1,750.00		
				Subtotal		**$902,996.00**

Alternative 4 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

6.0 Chemical Stabilization of Lead-Contaminated Soil

Includes:
1. Stabilization of lead contaminated soil utilizing Maectite chemical stabilization technology.

Assumptions and Calculations:
1. Volume of in-place lead contaminated soil to be stabilized (cy)= 400
2. Swell factor for soil upon excavation = 1.3
3. Volume of unconsolidated lead-contaminated soil (cy) = 520
3. Density of soil (ton/cy) = 1.1
4. Lead contaminated soil remains in-place for chemical stabilization.
5. An excavator will punch holes in the soil for installation of the Maectite chemical.
6.The Maectite shall be pumped into the holes.
7. The excavator will turn the soil and the chemical for ample mixture.
8. The production rate is 2 hours to mix 400 cy of soil.
9. Time required to stabilize soil (days) = 2
10. The lump sum price for the Maectite chemical and technician is $10,000 per Serverson Environmental.
11. Number of field crew = 1
12. Standard work week is 5 days per week at 8 hours per day. Thus, assuming 22 working days per 31 day month.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	16	$49.00	/hr	$784.00	
QA (Sampling) Coordinator	16	$36.00	/hr	$576.00	
H&S Coordinator	16	$49.00	/hr	$784.00	
Sampling Technician	16	$28.00	/hr	$448.00	
Equipment Operator	2	$406.00	/day	$812.00	
Equipment:					
Excavator	0.1	$4,000.00	/mo	$400.00	
Office Trailer	0.1	$800.00	/mo	$80.00	
Porta Jon	0.1	$175.22	/mo	$17.52	
Generator	0.1	$170.35	/mo	$17.04	
P/U Truck	0.1	$1,800.00	/mo	$180.00	
Materials:					
Maectite Chemical Stabilization	1	$10,000.00	/ls	$10,000.00	(Sevenson tech incl)
Level D PPE	2	$10.00	/day	$20.00	
PID rental	0.1	$974.00	/mo.	$97.40	
CGI rental	0.1	$380.00	/mo.	$38.00	
Analytical:					
TCLP Extraction	1	$10.30	/ea	$10.00	
Lead	1	$24.00	/ea	$24.00	
SVOCs (8270C)	1	$175.00	/ea	$175.00	
NACs (8330)	1	$145.00	/ea	$145.00	
PCBs	1	$83.00	/ea	$83.00	
Shipping	1	$40.00	/ea	$40.00	
				Subtotal	**$14,731.00**

Alternative 4 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Off-Site Disposal

Includes:

1. Dispose of treated compost at a non-hazardous landfill.
2. Dispose of Maectite stabilized soil, and non-hazardous (not stabilized) soil at a non-hazardous waste landfill.
3. Analysis for off-site waste disposal.

Assumptions and Calculations:

1. Consolidated volume of D008 soil for haz disposal (cy) =	0	
2. Consolidated volume of D030 soil for haz disposal (cy) =	0	
3. Consolidated volume of PCB soil for haz disposal (cy) =	0	
4.Volume of compost, non-haz disposal (cy) =	8748	
5. Bulk density of compost (tons/cy) =	0.368	
6. Weight of treated compost, non-haz waste (ton) =	3219	
7. Volume of unconsolidated stabilized soil (cy) =	520	
8. Density of soil (ton/cy) =	1.1	
9. Weight of treated stabilized soil (tons) =	572	
10. Consolidated volume of treated soil (cy) =	2103	
11. Unconsolidated volume of treated soil (cy) =	2734	
12. Unconsolidated volume untreated soil (cy) =	9233	
13. Weight of untreated soil (tons) =	10156	
14. Total volume of non-haz waste for disposal (cy) =	18501	
15. Total weight of non-haz waste for disposal (tons) =	13947	
16. Non-haz waste transportation cost ($/hr) =	72	
17. Non-haz waste disposal costs ($/ton) =	24.5	Erie County Landfill
18. Non-haz waste regulatory fees ($/ton) =	0	included in disposal
19. Haz waste transportation cost ($/ton) =	35	
20. D008 Haz waste disposal cost ($/ton) =	75	EO Environmental
21. D030 Haz waste disposal cost ($/ton) =	150	EO Environmental
22. PCB Haz waste disposal cost ($/ton) =	75	EO Environmental
23. Haz waste regulatory fees ($/ton) =	10	
24. Number of crew =	3	
25. Load capacity of a 20 ton truck (tons) =	15	
26. Round trip travel time to non-haz waste landfill (hr) =	1	
27. Loads of non-haz waste or trips (hrs)=	930	
28. Output of front-end loader (cy/day) =	550	
29. No. of wheel loaders =	2	
30. Number of field days =	17	
31. No. of truckloads of stormwater for disposal =	4	
32. Volume of stormwater per truckload (gal) =	4000	
33. Volume of stormwater requiring off-site disposal (gal) =	16000	

34. Stormwater shall be analyzed for TCLP semivolatiles prior to transport.
35. At one sample per truckload, number of samples (ea) = 4
36. Excavated soil is staged in 500 ton piles.
37. One 10-point composite sample shall be collected from each 500-ton pile as part of compliance testing.
38. Standard work week is 5 days per week at 8 hours per day.

Alternative 4 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

7.0 Off-Site Disposal (continued)

Service/Materials	Unit	Unit Cost		Subtotal		
Labor:						
Site Superintendent	136	$49.00	/hr	$6,664.00		
QA Coordinator	136	$36.00	/hr	$4,896.00		
H&S Coordinator	136	$49.00	/hr	$6,664.00		
Equipment Operator	17	$406.00	/day	$6,902.00		
Equipment Operator	17	$406.00	/day	$6,902.00		
Oiler	17	$293.00	/day	$4,981.00		
Materials:						
Level D PPE	51	$10.00	/day	$510.00		
Equipment:						
Wheel Loader	0.8	$5,000.00	/mo	$4,000.00		
Wheel Loader	0.8	$5,000.00	/mo	$4,000.00		
Office Trailer	0.8	$800.00	/mo	$640.00		
Porta Jon	0.8	$175.22	/mo	$140.18		
Generator	0.8	$170.35	/mo	$136.28		
P/U Truck	0.8	$1,800.00	/mo	$1,440.00		
Disposal Costs:						
Transportation (Non-Haz Waste)	930	$72.00	/hr	$66,960.00	truck & driver	
Disposal Cost (Non-Haz waste)	13947	$24.50	/ton	$341,708.87	Erie County Landfill	
Transportation (Haz Waste)	0	$35.00	/ton	$0.00		
Disposal Cost (D008 haz waste)	0	$85.00	/ton	$0.00		
Disposal Cost (D030 haz waste)	0	$160.00	/ton	$0.00		
Disposal Cost (PCB haz waste)	0	$85.00	/ton	$0.00		
Stormwater Disposal	16000	$0.25	/gal	$4,000.00	Enviro-Tank Clean	
Analytical:						
Compliance Sampling:						
TCLP SVOC/NAC/metals	20	$400.00	/ea	$8,124.69		
Stormwater Sampling:						
TCLP 2,4-DNT	4	$175.00	/ea	$700.00		
				Subtotal		**$469,369.00**

Alternative 4 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

8.0 Site Restoration

Includes:
1. Backfill excavated areas with clean backfill.
2. Re-seed site.
3. Perform road repair.

Assumptions and Calculations:

1. Volume of consolidated soil excavated (cy) =	9205
2. Compaction factor =	1.15
3. Volume of soil required for backfill (cy) =	10586
4. Cost of clean backfill soil delivered to site ($/cy) =	12
5. Output of front-end loader (cy/day) =	550
6. Field days required to backfill soil =	20
7. Number of field crew =	3

8. Upon completion of remedial action soil samples shall be taken within the laydown area to determine if any soil removal is required.
9. The laydown area shall be divided into 4 quarters and a 5-point composite collected (4 samples total).

10. Number of soil samples (ea) =	4
11. Allow 1 week for reseeding site and road repair.	
12. Task duration (days) =	25

13. Standard work week is 5 days per week at 8 hours per day.

Service/Materials	Unit	Unit Cost		Subtotal	
Labor:					
Site Superintendent	200	$49.00	/hr	$9,800.00	
QA Coordinator	200	$36.00	/hr	$7,200.00	
H&S Coordinator	200	$49.00	/hr	$9,800.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Equipment Operator	20	$406.00	/day	$8,120.00	
Laborer	20	$341.60	/day	$6,832.00	
Reseeding	1	$5,000.00	/area	$5,000.00	
Road Repair	1	$175,000.00	/ls	$175,000.00	Erie Blacktop
Equipment:					
Dozer	1	$3,500.00	/mo	$3,500.00	
Wheel Loader	1	$5,000.00	/mo	$5,000.00	
Office Trailer	2	$800.00	/mo	$1,600.00	
Porta Jon	2	$175.22	/mo	$350.44	
Generator	2	$170.35	/mo	$340.70	
P/U Truck	2	$1,800.00	/mo	$3,600.00	
Material:					
Backfill	10586	$12.00	/cy	$127,029.00	delivered to site
PID rental	1	$974.00	/mo.	$974.00	
CGI rental	1	$380.00	/mo.	$380.00	
Level D PPE	75	$10.00	/day	$750.00	
Analytical:					
SVOCs	4	$175.00	/ea	$700.00	
NACs (8330)	4	$145.00	/ea	$580.00	
Shipping	4	$40.00	/ea	$160.00	
				Subtotal	**$374,836.00**

Alternative 4 Cost Estimate
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

(Page 10 of 10)

9.0 Overall Cost	
Total Capital Cost	**$2,190,523.00**
Contingency (30%)	**$657,157.00**
PM Multiplier (7.5%)	**$164,289.00**
Fee/Profit (10%)	**$219,052.00**
Total Cost	**$3,231,000.00**

*This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

TOTAL COSTS FOR EACH ALTERNATIVES

The total present value cost (including 30% contingency) for each of the five alternatives is as follows:

No Action	Alternative 2	Alternative 3	Alternative 4	Alternative 5
$0	$3.3 million	$2.9 million	$3.2 million	$2.4 million

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVE

Source: attachment 2

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal	**Alternative 6:** Excavation, Alkaline Hydrolysis, Ex-Situ Stabilization, and Off-Site Disposal
Overall Protectiveness					
Human Health Protection	No reduction in risk.	Reduces the concentration of COCs to levels below RGs.	Reduces the concentration of COCs to levels below RGs.	Reduces the concentration of COC to levels below RGs.	Reduces the concentration of COC to levels below RGs.
Environmental Protection	No reduction in risk.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.	Significantly reduces the hazard quotients calculated for ecological receptors, and lowers the likelihood of contaminant spread to other media.
Compliance with ARARs					
Chemical-Specific ARARs	No chemical-specific ARARs.	No chemical-specific ARARs.	No chemical-specific ARARs.	No chemical-specific ARARs.	No chemical-specific ARARs.
Location-Specific ARARs	No location-specific ARARs.	Complies with all location-specific ARARs.	Complies with all location-specific ARARs.	Complies with all location-specific ARARs.	Complies with all location-specific ARARs.
Action-Specific ARARs	No action-specific ARARs.	Complies with all action-specific ARARs.	Complies with all action-specific ARARs.	Complies with all action-specific ARARs.	Complies with all action-specific ARARs.

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal	**Alternative 6:** Excavation, Alkaline Hydrolysis, Ex-Situ Stabilization, and Off-Site Disposal
Other Criteria and Guidance	Permits exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.	Prevents exposures to soil exceeding the USEPA 400 mg/kg screening level for lead in soil.
Long-Term Effectiveness and Permanence					
Magnitude of Residual Risk	Existing risk will remain.	Residual risk will be within the risk management range.	Residual risk will be within the risk management range.	Residual risk will be within the risk management range.	Residual risk will be within the risk management range.
Adequacy and Reliability of Controls	No controls over remaining contamination. No reliability.	No long-term controls required at site.	No long-term controls required at site.	No long-term controls required at site.	No long-term controls required at site.
Reduction of Toxicity, Mobility, or Volume through Treatment					
Treatment Process Used	None	Biological treatment of nitroaromatic compounds and PAHs using windrow composting.	No on-site treatment.	Biological treatment of nitroaromatic compounds and PAHs using windrow composting. Ex-situ chemical stabilization of lead.	Chemical and biological treatment of nitroaromatic compounds and PAHs using alkaline hydrolysis and windrow composting. Ex-situ chemical stabilization of lead.

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal	**Alternative 6:** Excavation, Alkaline Hydrolysis, Ex-Situ Stabilization, and Off-Site Disposal
Amount Destroyed or Treated	None	25% of contaminated soil treated on-site.	No on-site treatment.	25% of contaminated soil treated on-site.	25% of contaminated soil treated on-site.
Irreversible Treatment	None.	Research has demonstrated that a high percentage (>80%) of TNT-carbon is irreversibly bound to the soil through covalent binding with humic substances.	No on-site treatment.	Research has demonstrated that a high percentage (>80%) of TNT-carbon is irreversibly bound to the soil through covalent binding with humic substances. Stabilization may not be an irreversible process, but placement of stabilized waste in an engineered disposal cell minimizes the possibility that conditions conducive to leaching will be created.	Alkaline hydrolysis irreversibly transforms NACs in soil to less toxic end products. Research has demonstrated that a high percentage (>80%) of TNT-carbon is irreversibly bound to the soil through covalent binding with humic substances. Stabilization may not be an irreversible process, but placement of stabilized waste in an engineered disposal cell minimizes the possibility that conditions conducive to leaching will be created.

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	Alternative 1: No Action	Alternative 2: Excavation, Windrow Composting, and On-Site/Off-Site Disposal	Alternative 4: Excavation and Off-Site Disposal	Alternative 5: Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal	Alternative 6: Excavation, Alkaline Hydrolysis, Ex-Situ Stabilization, and Off-Site Disposal
Type and Quantity of Residuals Remaining after Treatment (all volumes are based on in-place, consolidated soil)	Contaminated soil remains.	8,805 cy of treated and untreated soil for offsite disposal as a nonhazardous waste at a solid waste landfill. 400 cy lead-contaminated soil for off-site treatment and disposal at a Subtitle C TSDF	6,805 cy of untreated soil for offsite disposal as a nonhazardous waste at a solid waste landfill. 2,310 cy 2,4-DNT and lead-contaminated soil for off-site treatment and disposal at a Subtitle C TSDF.	9,205 cy of treated and untreated soil for offsite disposal as a non-hazardous waste at a solid waste landfill.	7,295 cy of treated and untreated soil for offsite disposal as a non-hazardous waste at a solid waste landfill.
Short-Term Effectiveness					
Community Protection	May present future risk to community	Normal safeguards would be required during transportation of waste materials offsite.	Normal safeguards would be required during transportation of waste materials offsite.	Normal safeguards would be required during transportation of waste materials offsite.	Normal safeguards would be required during transportation of waste materials offsite.

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal	**Alternative 6:** Excavation, Alkaline Hydrolysis, Ex-Situ Stabilization, and Off-Site Disposal
Worker Protection	No risk to workers	Safeguards would be required to protect workers from chemical exposures during windrow turning operations. Dust released during excavation, screening, amendment mixing, and windrow turning may require controls.	Dust released during excavation and screening may require controls.	Safeguards would be required to protect workers from chemical exposures during windrow turning operations. Dust released during excavation, screening, amendment mixing, windrow turning, and stabilization may require controls.	Chemicals used in the treatment process are very corrosive. Material handling processes must be carefully designed to protect workers from chemical exposures. Safeguards would be required to protect workers from chemical exposures during windrow turning operations. Dust released during excavation screening, amendment mixing, windrow turning, and stabilization may require controls

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal	**Alternative 6:** Excavation, Alkaline Hydrolysis, Ex-Situ Stabilization, and Off-Site Disposal
Environmental Impacts	Continued impact from existing conditions.	Design of staging piles (contaminated soil and amendments) would require safeguards to prevent migration of contaminants. Treatment area would be bermed and a contact water retention system provided to control stormwater run-on and run-off.	Design of staging piles would require safeguards to prevent migration of contaminants.	Design of staging piles would require safeguards to prevent migration of contaminants. Treatment area would be bermed and a contact water retention system provided to control stormwater run-on and run-off	Design of staging piles would require safeguards to prevent migration of contaminants. Treatment area would be bermed and a contact water retention system provided to control stormwater run-on and run-off. Hazardous chemicals would be managed to segregate incompatible chemicals and prevent uncontrolled releases to the environment.
Time Until Action is Complete	Not applicable	16 to 22 months	10 to 16 months	16 to 22 months	16 to 22 months

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal	**Alternative 6:** Excavation, Alkaline Hydrolysis, Ex-Situ Stabilization, and Off-Site Disposal
Implementability					
Ability to Construct and Operate	No construction or operation.	Technology well developed and implemented on a full-scale basis at numerous sites.	No significant issues.	Technologies well developed and implemented on a full-scale basis at numerous sites.	Alkaline hydrolysis using caustic soda to treat NACs in soil is a relatively new process, but has been field tested at one site. Composting is a contingency component of remedial alternative that will be used to treat soil that does not meet RGs or LDR criteria after alkaline hydrolysis. Composting is a well developed technology implemented on a full-scale basis at numerous sites.
Ease of Doing More Action if Needed	May require ROD amendment if future problems arise.	Does not preclude additional remedial action for soil.	Does not preclude additional remedial action for soil.	Does not preclude additional remedial action for soil.	Does not preclude additional remedial action for soil

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

(Page 8 of 9)

Criteria	**Alternative 1:** No Action	**Alternative 2:** Excavation, Windrow Composting, and On-Site/Off-Site Disposal	**Alternative 4:** Excavation and Off-Site Disposal	**Alternative 5:** Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal	**Alternative 6:** Excavation, Alkaline Hydrolysis, Ex-Situ Stabilization, and Off-Site Disposal
Ability to Monitor Effectiveness	No monitoring required.	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis. Effectiveness of composting is evaluated by post-treatment sampling and analysis of compost.	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis.	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis. Effectiveness of stabilization process evaluated through leaching tests. Effectiveness of composting is evaluated by post-treatment sampling and analysis of treated soil.	Effectiveness of excavation is evaluated by confirmatory soil sampling and analysis. Effectiveness of stabilization process evaluated through leaching tests. Effectiveness of alkaline hydrolysis and composting is evaluated by post-treatment sampling and analysis of treated soil.
Ability to Obtain Approvals and Coordinate with Other Agencies	None required.	OEPA approval of disposal facility would be required.	OEPA approval of disposal facility would be required.	OEPA approval of disposal facility would be required.	OEPA approval of disposal facility would be required.
Availability of Equipment, Specialists, and Materials	None required.	Equipment, technical specialists, and materials available locally.	Equipment, technical specialists, and materials available locally.	Equipment, technical specialists, and materials readily available.	Equipment, technical specialists, and materials available locally.

Comparative Analysis of Remedial Alternatives
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Criteria	Alternative 1: No Action	Alternative 2: Excavation, Windrow Composting, and On-Site/Off-Site Disposal	Alternative 4: Excavation and Off-Site Disposal	Alternative 5: Excavation, Windrow Composting, Ex-Situ Stabilization, and On-Site/Off-Site Disposal	Alternative 6: Excavation, Alkaline Hydrolysis, Ex-Situ Stabilization, and Off-Site Disposal
Availability of Technologies	None required	Available	Available	Available	Available
Cost					
Capital Cost	None	$3.3 million	$2.9 million	$3.2 million	$2.4 million
Annual O&M Cost	None	None	None	None	None
Present Worth Cost	None	$3.3 million	$2.9 million	$3.2 million	$2.4 million
State Acceptance	Not acceptable	To be determined	To be determined	To be determined	To be determined
Community Acceptance	Not acceptable	To be determined	To be determined	To be determined	To be determined

ARAR - Applicable or relevant and appropriate requirement.
COC - Contaminant of concern.
cy - Cubic yard.
mg/kg - Milligrams per kilogram.
O&M - Operation and maintenance.
OEPA - Ohio Environmental Protection Agency.
PAH - Polynuclear aromatic hydrocarbon.
RCRA - Resource Conservation and Recovery Act.
RG - Remedial goal.
ROD - Record of decision.
TNT - Trinitrotoluene.
TSDF - Treatment, storage, and disposal facility.
USEPA - U.S. Environmental Protection Agency.

Individual Team Member's Analysis Matrix

BASIC FUNCTION

List the best ideas from ranking and comparisons techniques. Determine which one stacks up best against the desired criteria.

Desired criteria	aesthetics	health	$ cost	community acceptance	ARAR	effectiveness	long term maintenance	regulators approval	ease of implementation	new study cost and requirements	o	o	
Weight from criteria Matrix	A	B	C	D	E	F	G	H	I	J	K	L	
	0	32	22	11	0	16	10	8	5	0	0	0	**Totals**
Present Plan	1 0	1 32	5 110	1 11	1 0	1 16	1 10	3 24	5 25	1 0	0	0	228
Alternative 1 – No Action													
Alternative 2 – Excavation, Windrow Composting, and Off-Site Disposal	1 0	5 160	1 22	3 33	1 0	5 80	1 10	3 24	2 10	1 0	0	0	339
Alternative 3 – Excavation and Off-Site Disposal	1 0	5 160	2 44	3 33	1 0	5 80	1 10	3 24	2 10	1 0	0	0	361
Alternative 4 – Excavation, Windrow Composting, Chemical Stabilization, and Off-Site Disposal	1 0	5 160	1 22	3 33	1 0	5 80	1 10	3 24	2 10	1 0	0	0	339
Alternative 5 – Excavation, Alkaline Hydrolysis, Windrow Composting, Chemical Stabilization, On-Site and Off-Site Disposal	1 0	5 160	3 66	3 33	1 0	5 80	1 10	3 24	2 10	1 0	0	0	383
Alternative 6 - Natural Attenuation	1 0	1 32	5 110	1 11	1 0	1 16	5 50	3 24	5 25	1 0	0	0	268
Alternative 7 - Insitu Chemical Oxidation	1 0	3 96	1 22	3 33	1 0	2 32	1 10	3 24	1 5	1 0	0	0	222
0	0	0	0	0	0	0	0	0	0	1 0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0

Excellent - 5 **Very Good - 4** **Good - 3** **Fair - 2** **Poor - 1**

Analysis Matrix

BASIC FUNCTION

List the best ideas from ranking and comparisons techniques. Determine which one stacks up best against the desired criteria.

Desired criteria	aesthetics	health	$ cost	community acceptance	ARAR	effectiveness	long term maintenance	regulators approval	ease of implementation	new study cost and requirements	o	o	
Weight from criteria Matrix	A	B	C	D	E	F	G	H	I	J	K	L	
	0	32	22	11	0	16	10	8	5	0	0	0	**Totals**
Present Plan	1	1	5	1	1	1	5	1	5	1			
Alternative 1 – No Action	0	32	110	11	0	16	50	8	25	0	0	0	252
Alternative 2 – Excavation, Windrow Composting, and Off-Site Disposal	1 0	5 160	2 44	2 22	1 0	5 80	5 50	1 8	3 15	1 0	0	0	379
Alternative 3 – Excavation and Off-Site Disposal	1 0	5 160	3 66	2 22	1 0	5 80	5 50	1 8	3 15	1 0	0	0	401
Alternative 4 – Excavation, Windrow Composting, Chemical Stabilization, and Off-Site Disposal	1 0	5 160	2 44	2 22	1 0	5 80	5 50	1 8	2 10	1 0	0	0	374
Alternative 5 – Excavation, Alkaline Hydrolysis, Windrow Composting, Chemical Stabilization, On-Site and Off-Site Disposal	1 0	5 160	4 88	3 33	1 0	5 80	5 50	1 8	2 10	1 0	0	0	429
Alternative 6 - Natural Attenuation	1 0	3 96	2 44	5 55	1 0	3 48	1 10	1 8	2 10	1 0	0	0	271
Alternative 7 - Insitu Chemical Oxidation	1 0	3 96	2 44	5 55	1 0	3 48	5 50	1 8	1 5	1 0	0	0	306
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0

Excellent - 5 **Very Good - 4** **Good - 3** **Fair - 2** **Poor - 1**

BASIC FUNCTION

List the best ideas from ranking and comparisons techniques. Determine which one stacks up best against the desired criteria.

Desired criteria	aesthetics	health	$ cost	community acceptance	ARAR	effectiveness	long term maintenance	regulators approval	ease of implementation	new study cost and requirements	o	o	
Weight from criteria Matrix	A	B	C	D	E	F	G	H	I	J	K	L	
	0	32	22	11	0	16	10	8	5	0	0	0	**Totals**
Present Plan Alternative 1 – No Action	1 0	1 32	5 110	1 11	1 0	1 16	1 10	1 8	1 5	1 0	0	0	192
Alternative 2 – Excavation, Windrow Composting, and Off-Site Disposal	1 0	4 128	3 66	4 44	1 0	4 64	5 50	4 32	4 20	1 0	0	0	404
Alternative 3 – Excavation and Off-Site Disposal	1 0	5 160	4 88	3 33	1 0	5 80	5 50	4 32	5 25	1 0	0	0	468
Alternative 4 – Excavation, Windrow Composting, Chemical Stabilization, and Off-Site Disposal	1 0	4 128	3 66	4 44	1 0	4 64	5 50	5 40	4 20	1 0	0	0	412
Alternative 5 – Excavation, Alkaline Hydrolysis, Windrow Composting, Chemical Stabilization, On-Site and Off-Site Disposal	1 0	5 160	5 110	5 55	1 0	4 64	5 50	5 40	4 20	1 0	0	0	499
Alternative 6 - Natural Attenuation	1 0	1 32	4 88	2 22	1 0	2 32	1 10	2 16	5 25	1 0	0	0	225
Alternative 7 - Insitu Chemical Oxidation	1 0	3 96	2 44	2 22	1 0	2 32	2 20	2 16	2 10	1 0	0	0	240
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0

Excellent - 5 **Very Good - 4** **Good - 3** **Fair - 2** **Poor - 1**

BASIC FUNCTION

List the best ideas from ranking and comparisons techniques. Determine which one stacks up best against the desired criteria.

Desired criteria	aesthetics	health	$ cost	community acceptance	ARAR	effectiveness	long term maintenance	regulators approval	ease of implementation	new study cost and requirements	o	o	
Weight from criteria Matrix	A	B	C	D	E	F	G	H	I	J	K	L	
	0	32	22	11	0	16	10	8	5	0	0	0	**Totals**
Present Plan	5	1	5	1	5	1	5	3	5	1			
Alternative 1 – No Action	0	32	110	11	0	16	50	24	25	0	0	0	268
Alternative 2 – Excavation, Windrow Composting, and Off-Site Disposal	1	4	1	2	1	4	4	4	3	1			
	0	128	22	22	0	64	40	32	15	0	0	0	323
Alternative 3 – Excavation and Off-Site Disposal	1	4	1	1	1	5	5	4	4	1			
	0	128	22	11	0	80	50	32	20	0	0	0	343
Alternative 4 – Excavation, Windrow Composting, Chemical Stabilization, and Off-Site Disposal	1	4	3	3	1	4	3	4	3	1			
	0	128	66	33	0	64	30	32	15	0	0	0	368
Alternative 5 – Excavation, Alkaline Hydrolysis, Windrow Composting, Chemical Stabilization, On-Site and Off-Site Disposal	1	4	4	4	1	5	1	4	3	1			
	0	128	88	44	0	80	10	32	15	0	0	0	397
Alternative 6 - Natural Attenuation	5	1	4	1	5	1	1	1	3	1			
	0	32	88	11	0	16	10	8	15	0	0	0	180
Alternative 7 - Insitu Chemical Oxidation	4	4	1	2	1	3	2	3	2	1			
	0	128	22	22	0	48	20	24	10	0	0	0	274
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0

Excellent - 5 **Very Good - 4** **Good - 3** **Fair - 2** **Poor - 1**

Analysis Matrix Average

Analysis Matrix Average

BASIC FUNCTION

List the best ideas from ranking and comparisons techniques. Determine which one stacks up best against the desired criteria.

Desired criteria	aesthetics	health	$ cost	community acceptance	ARAR	effectiveness	long term maintenance	regulators approval	ease of implementation	new study cost and requirements	o	o	Average Totals	RANK
Weight from criteria Matrix	A	B	C	D	E	F	G	H	I	J	K	L		
	0	32	22	11	0	16	10	8	5	0	0	0		
Present Plan	2	1	5	1	2	1	3	2	4	1	0	0		
Alternative 1 – No Action	0	32	110	11	0	16	30	16	20	0	0	0	235	7
Alternative 2 – Excavation, Windrow Composting, and Off-Site Disposal	1	5	2	3	1	5	4	3	3	1	0	0		
	0	144	39	30	0	72	38	24	15	0	0	0	361	4
Alternative 3 – Excavation and Off-Site Disposal	1	5	3	2	1	5	4	3	4	1	0	0		
	0	152	55	25	0	80	40	24	18	0	0	0	393	2
Alternative 4 – Excavation, Windrow Composting, Chemical Stabilization, and Off-Site Disposal	1	5	2	3	1	5	4	3	3	1	0	0		
	0	144	50	33	0	72	35	26	14	0	0	0	373	3
Alternative 5 – Excavation, Alkaline Hydrolysis, Windrow Composting, Chemical Stabilization, On-Site and Off-Site Disposal	1	5	4	4	1	5	3	3	3	1	0	0		
	0	152	88	41	0	76	30	26	14	0	0	0	427	1
Alternative 6 - Natural Attenuation	2	2	4	2	2	2	2	2	4	1	0	0		
	0	48	83	25	0	28	20	14	19	0	0	0	236	6
Alternative 7 - Insitu Chemical Oxidation	2	3	2	3	1	3	3	2	2	1	0	0		
	0	104	33	33	0	40	25	18	8	0	0	0	261	5
	0	0	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	0	0	0		
	0	0	0	0	0	0	0	0	0	0	0	0	0	

Excellent - 5 **Very Good - 4** **Good - 3** **Fair - 2** **Poor - 1**

VE TEAM RECOMMENDATION

The VE Team's conclusions and recommendation is to implement **Alternative 5**; excavation, alkaline hydrolysis, windrow composting, chemical stabilization, and on & off-site disposal.

This selection fulfills all of the functional requirements for the least cost.

FINANCIAL ANALYSIS

FINANCIAL ANALYSIS

Summary of Cost of Present Design:

Initial Cost	$2,400,000	
or		
Life Cycle Cost	$0	
Cost of Present Design		$2,400,000

Summary of Cost of Proposed Design:
(W/O implementation costs)

Initial Cost	$2,400,000	
or		
Life Cycle Cost	$0	
Cost of Proposed Design		$2,400,000
Gross Savings (Present Minus Proposed)		$0

Summary of Implementation Costs for Proposed Design:

Cost of Study	$9,170	
Cost of Re-Design	$0	
Cost of Modification	$0	
Total Cost of Implementation		$9,170
Net Savings: (gross savings minus cost of implementation)		($9,170)