

**US Army Corps
of Engineers**

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Sustaining the Environment...

Remember the EOPs!

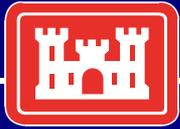
**2007
Environmental & Natural
Resources Conference**

San Antonio
Crowne Plaza Riverwalk
29 Oct - 1 Nov 2007

**US Army Corps
of Engineers.**

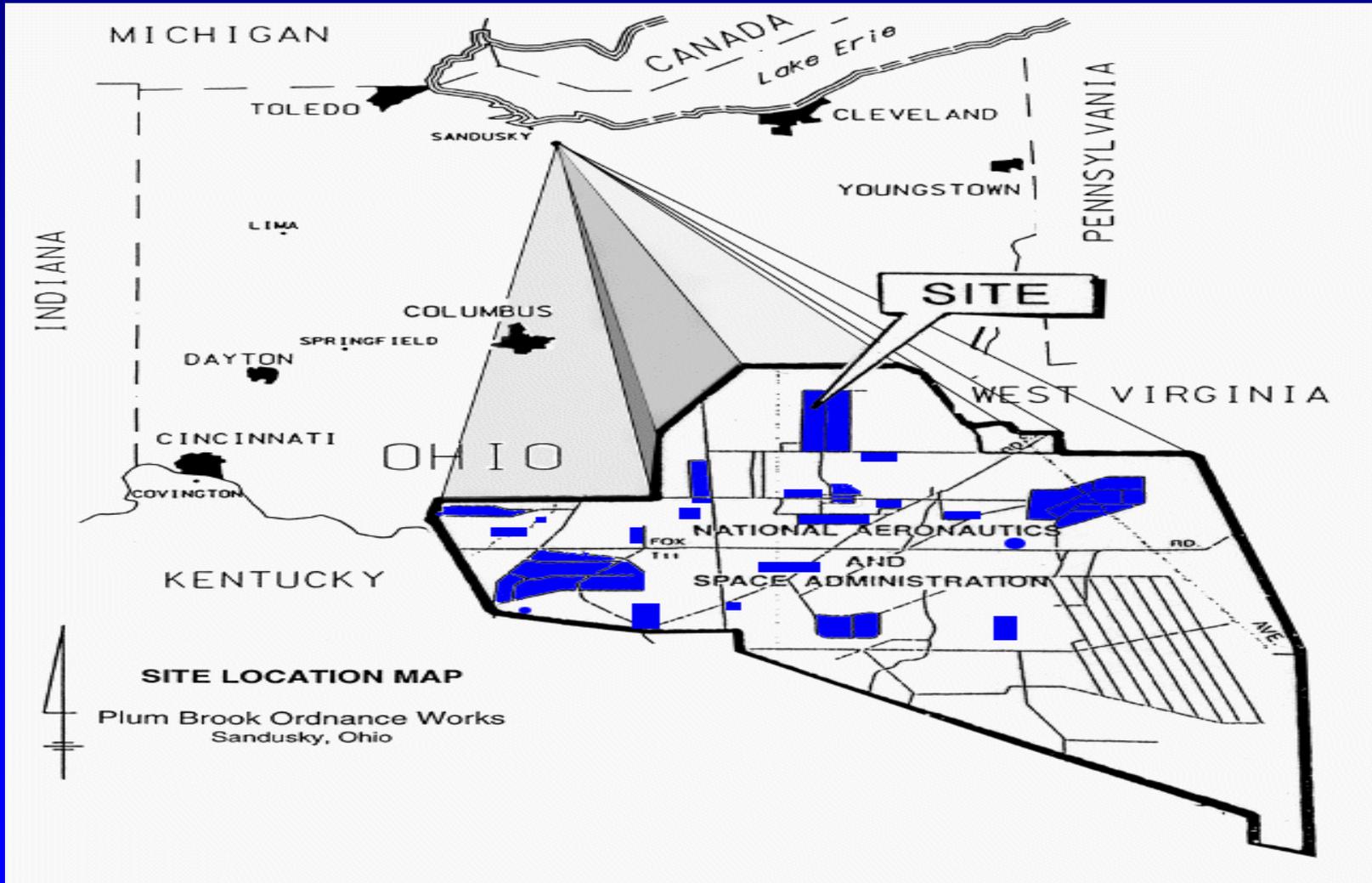
**USACE Huntington District
502 8th Street
Huntington, WV 25701-2070**

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Plum Brook Ordnance Works

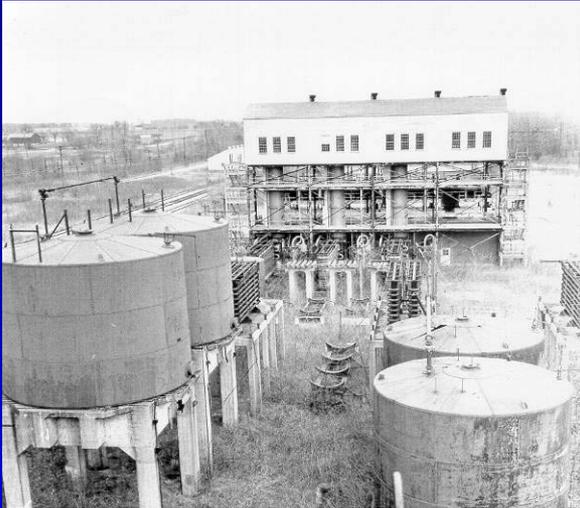


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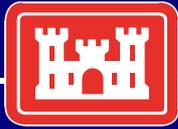


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Plum Brook Ordnance Works



- World War II TNT manufacturing facility
- 6,400 acres
- Located near Sandusky, Ohio and Sandusky Bay, Lake Erie
- Surrounding area is mostly residential and agricultural

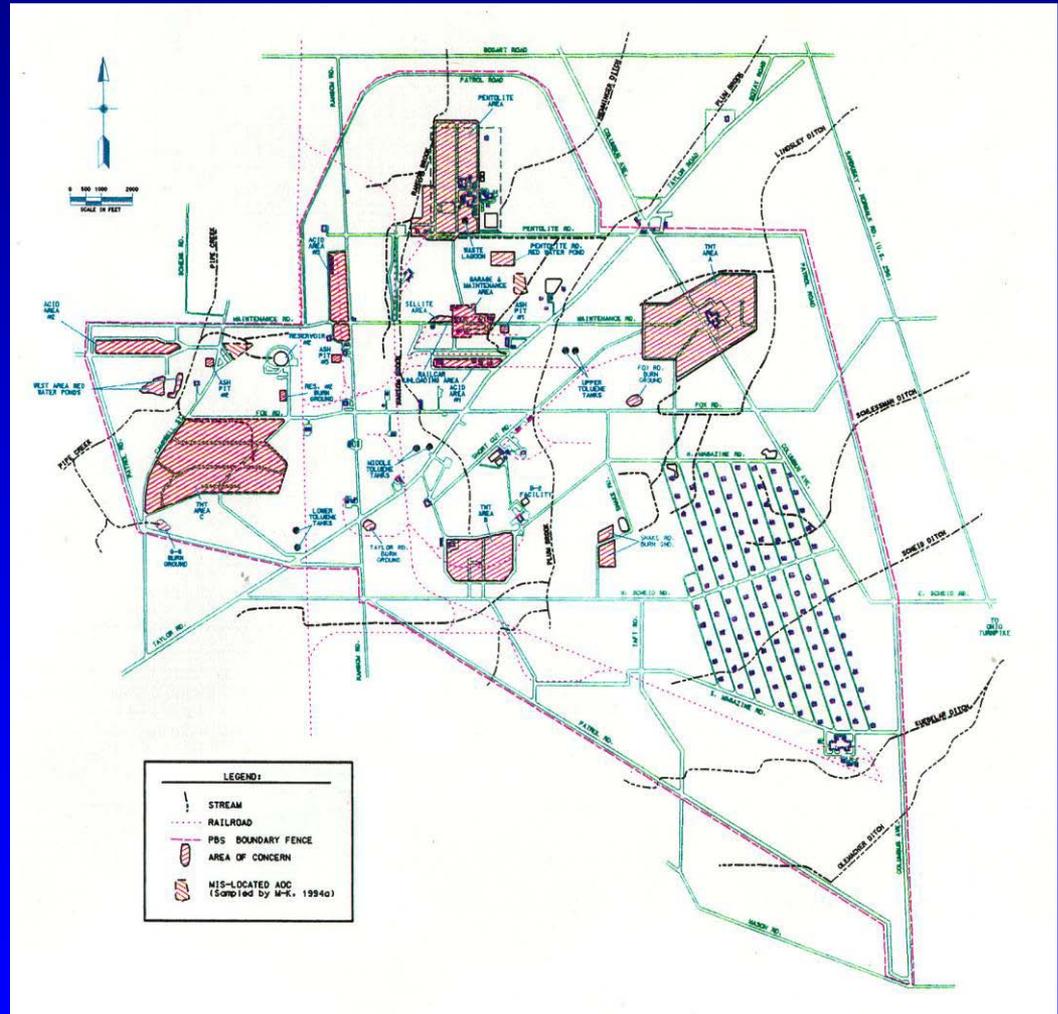


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History and AOC Locations

- 1941 thru 1945 – PBOW produced over 1 billion pounds of explosives (i.e., TNT, DNT and Pentolite)

- 1963 – NASA acquired property and currently maintains and utilizes the 6,400 acres for research (most noted for reactor, hypersonic testing facility and space propulsion facility)





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Plum Brook Ordnance Works



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Lime Treatment Pilot Study

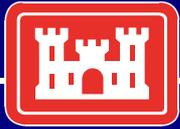
- Treatment Options for Plum Brook include Alkaline Hydrolysis
- Research information was gathered from U.S. Army Engineer Research and Development Center – Vicksburg, MS



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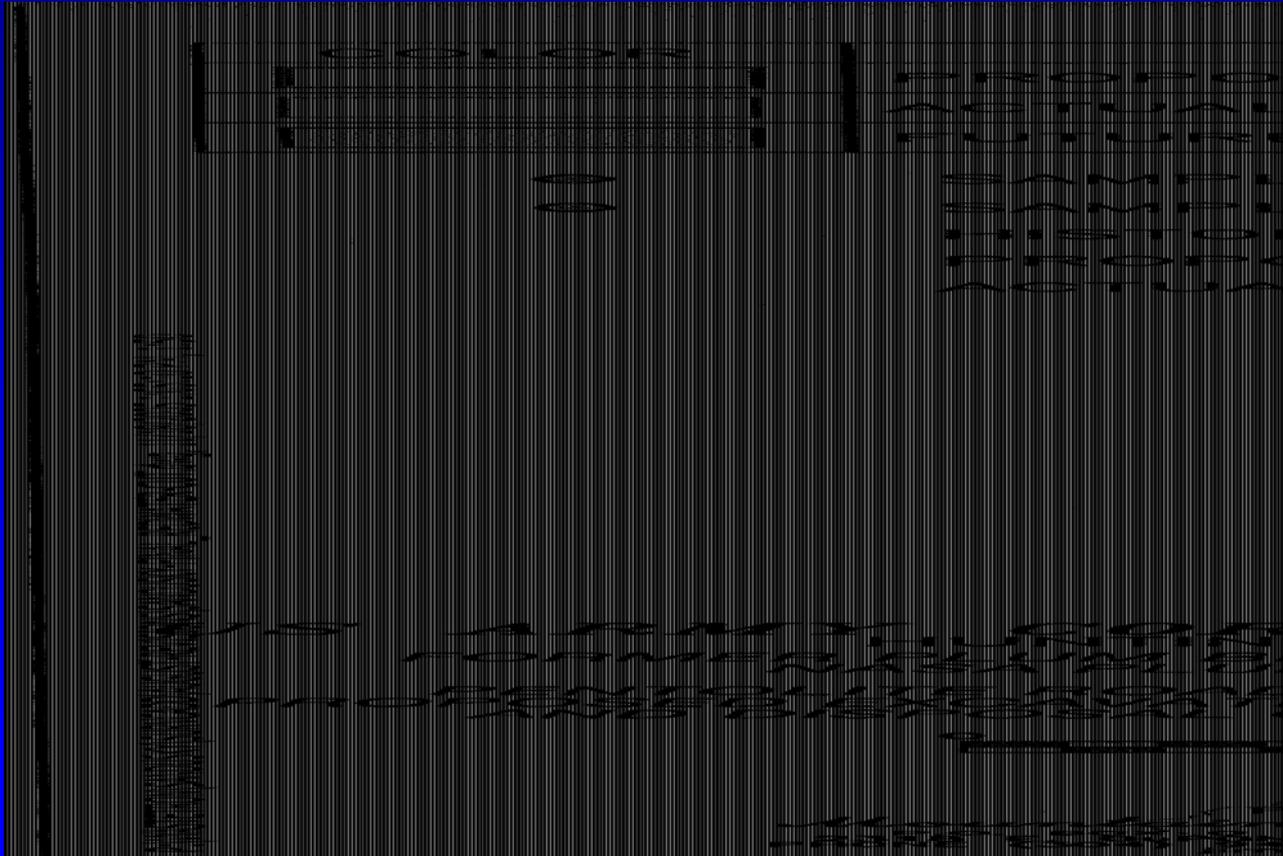
PRRWP Lime Treatment Pilot Study

- The purpose of this Pilot Study was to evaluate the application and field implementation of this innovative technology, alkaline hydrolysis, using the nitroaromatic contaminated soils of the PRRWP area.
- The study duration was six weeks during December 2006 through January 2007.
- The PRRWP site was chosen so that contaminated soil used in the study would not impact uncontaminated soils at this site.



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PRRWP Site Map - Extent of Contamination





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Initial Site Activities



- The basic approach was to excavate soil in the area of known contamination.
- The area of the excavation for the pilot study was approximately 20' x 20' x 8'.

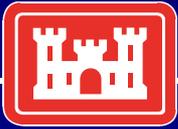


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Treatment Pile Placement

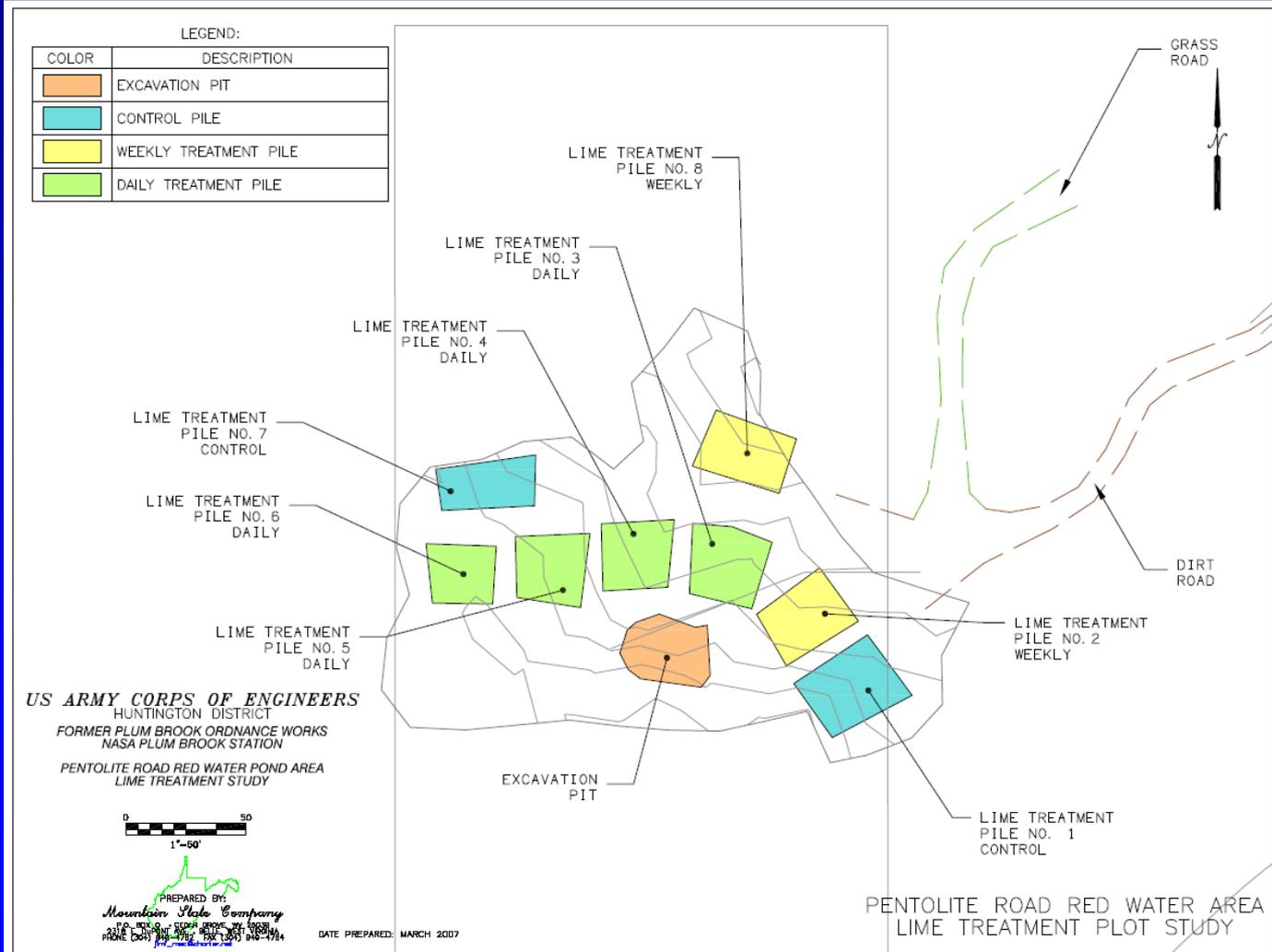
- The excavated soil was placed into eight piles within the known area of contamination.
- The piles were approximately 20' x 20' x 1'.
- The piles were designated as numbers 1 to 8.



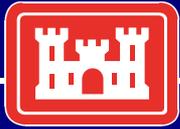


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Final Site Survey



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Lime application

- Application rate was 250 pounds per treatment.
- Piles 1 & 7 were control piles (no lime added during pilot study).
- Piles 2 & 8 were “weekly treatment piles”.
- Piles 3 through 6 were “daily treatment piles”.



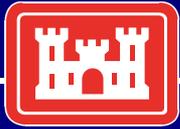


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pH Monitoring



- The pH was measured every day using 3 different methods which provided inexpensive Quality Control.
Exstik Meter Garden Meter pH Paper
- Based on previous studies, the target pH for this study was 11 or above.

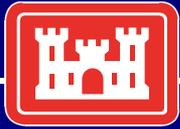


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Soil and Lime Mixing



- **Mixing was accomplished using a skid steer mounted tiller.**
- **This ensured a thorough mixing of lime for the entire pile depth.**
- **All piles were tilled daily regardless of lime application.**



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Soil Sampling & Analysis



Composite samples
were collected from
each pile weekly.



Samples were submitted for
laboratory analysis of pH and
Semi-volatiles using EPA
Method 8330.



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Backfilled excavation



At the completion of field activities, the treatment piles were placed back into the original excavation and graded.



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- DID IT WORK ?

Or were we just playing in the dirt ?



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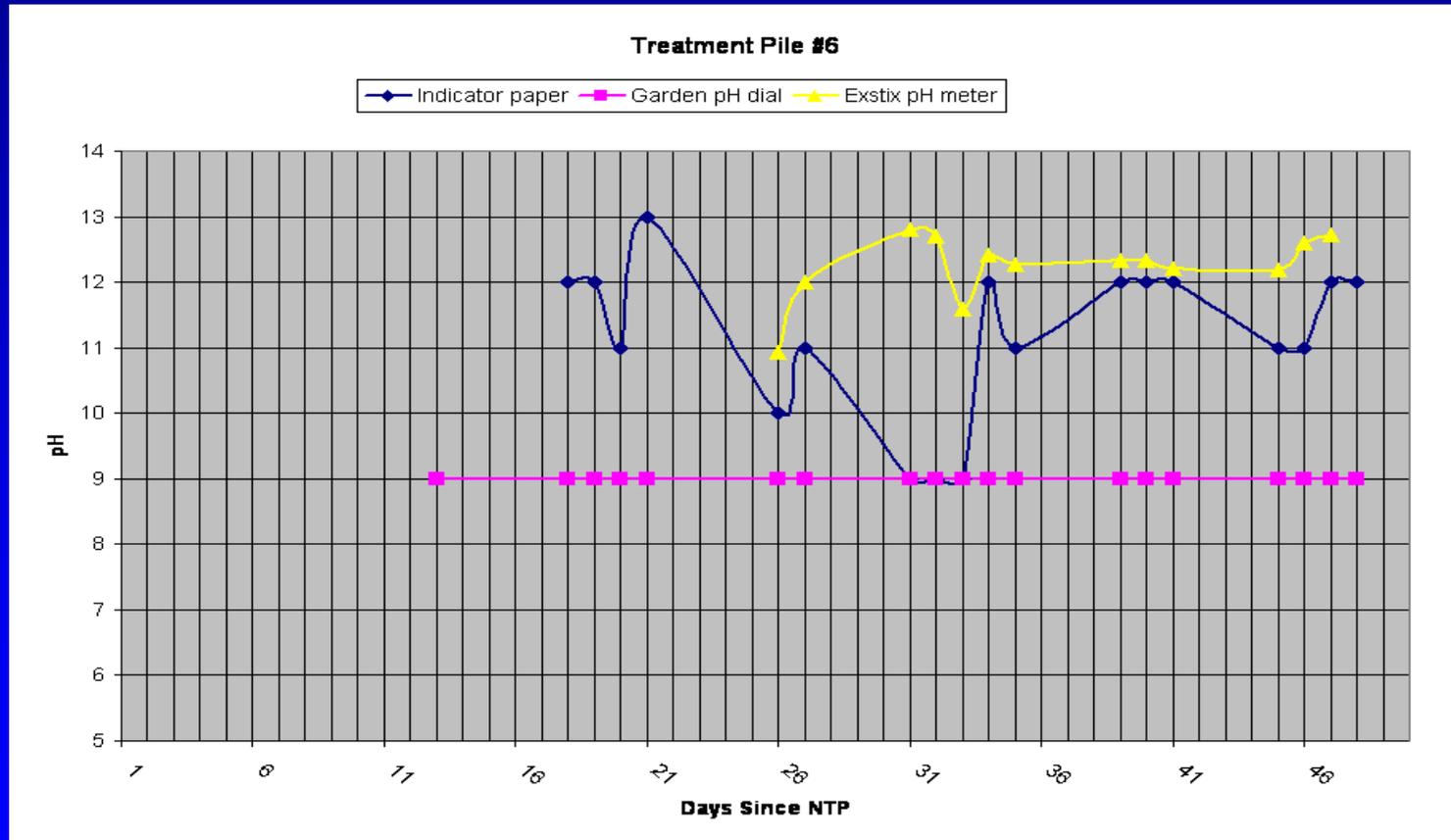
Study Parameter Evaluation

- Lime Application Rates
- Elevation of pH
- pH Maintenance
- Time and Temperature Effects
- Homogeneity of Piles
- Reduction of TNT (below RGO 13.8 mg/kg)



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Daily Treatment Pile pH

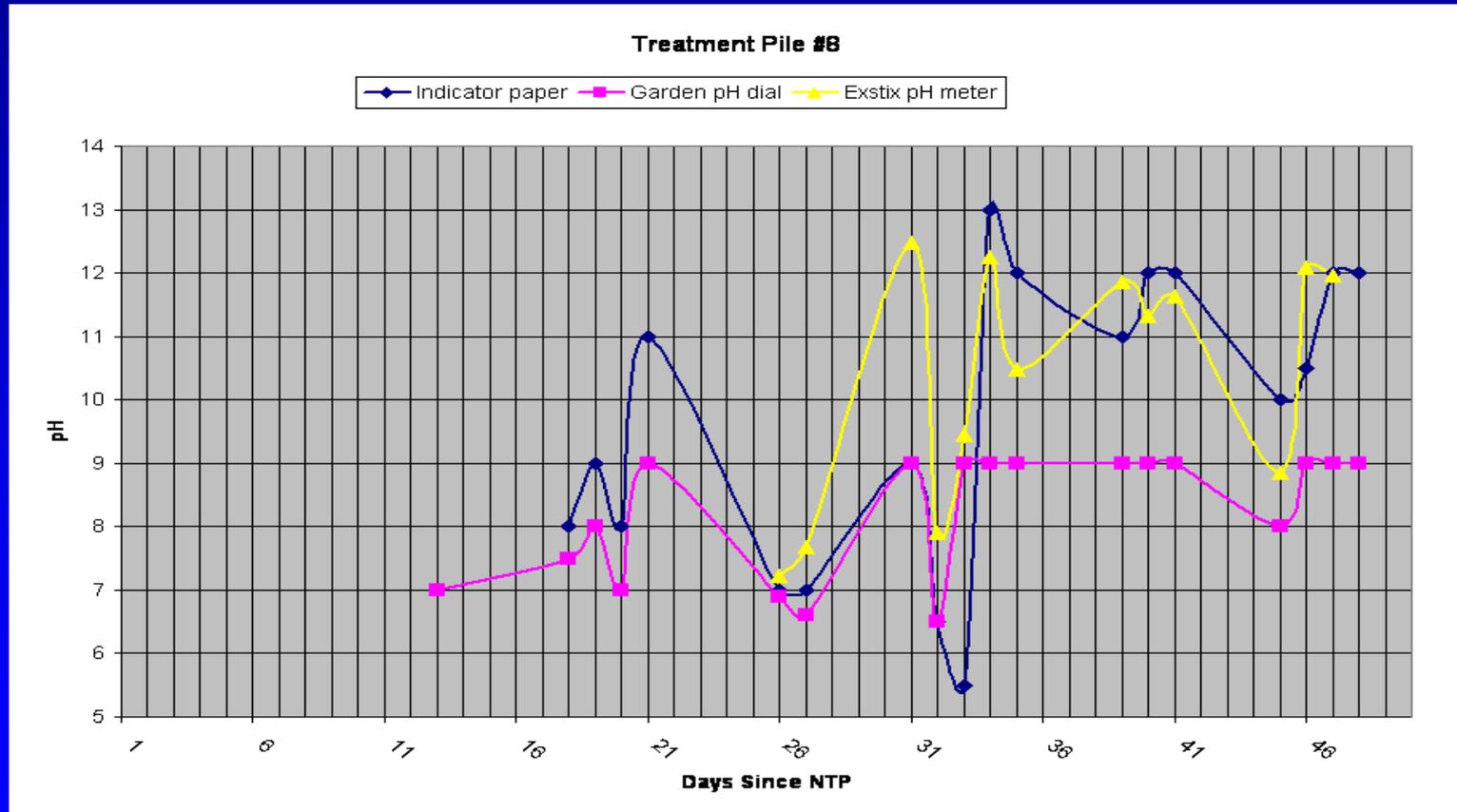


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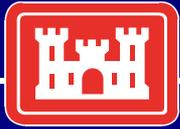


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Weekly Treatment Pile pH

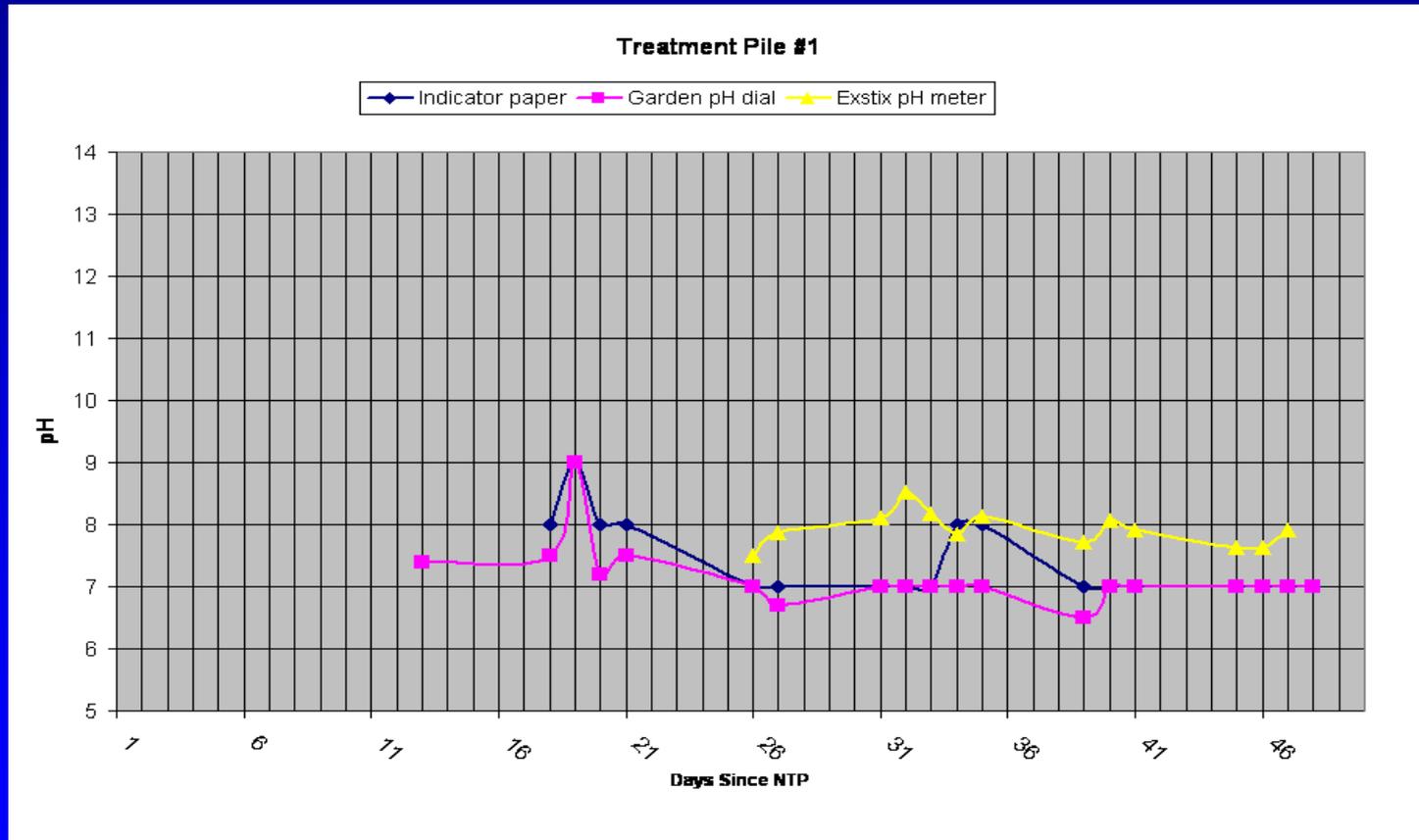


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Control Pile pH

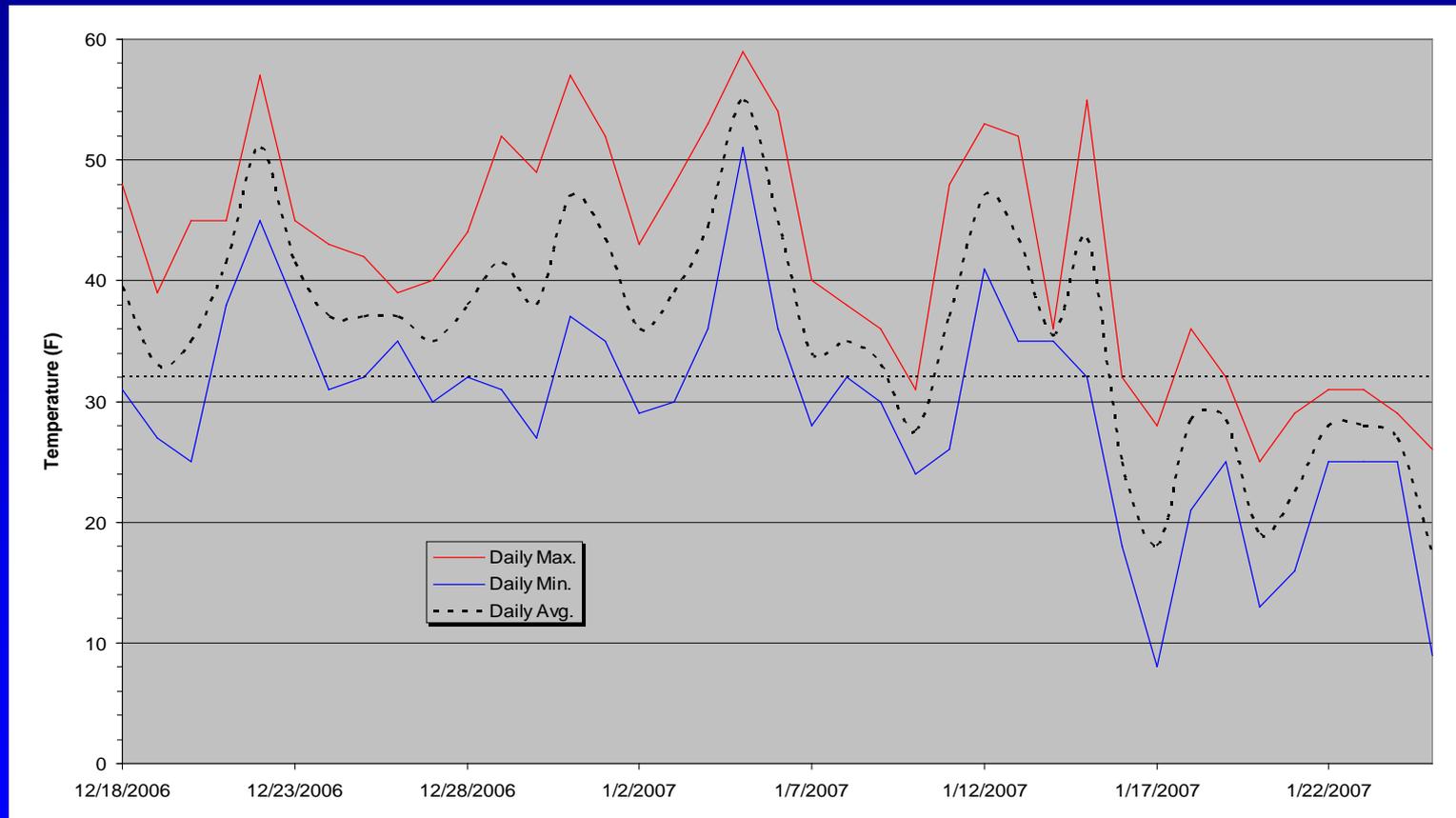


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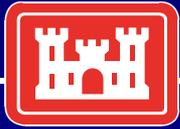


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Daily Temperatures for Area



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TNT Laboratory Results

SAMPLE DATE	PILE 1	PILE 2	PILE 3	PILE 4	PILE 5	PILE 6	PILE 7	PILE 8
12/18/2006	ND	11.8	2940	22300	3080	114	15.3	3.7
12/29/2006	3.06	19.3	3040	4600	544	ND	46.1	6.6
1/4/2007	ND	154.0	5040	2800	12	ND	20.6	ND
1/11/2007	ND	37.7	427	492	33	ND	18.3	1.8
1/18/2007	0.74	4.2	7640	298	175	ND	31.9	ND
1/25/2007	0.58	4.2	609	2340	41	ND	24.4	ND

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Analysis of General Trends

- Used Mann-Kendall test to detect significant trend in data.
 - (USEPA Guidance for Data Quality Assessment – Practical Methods for Data Analysis)
- Only Piles 4, 6, and 8 showed a significant trend (decreasing) in the data.



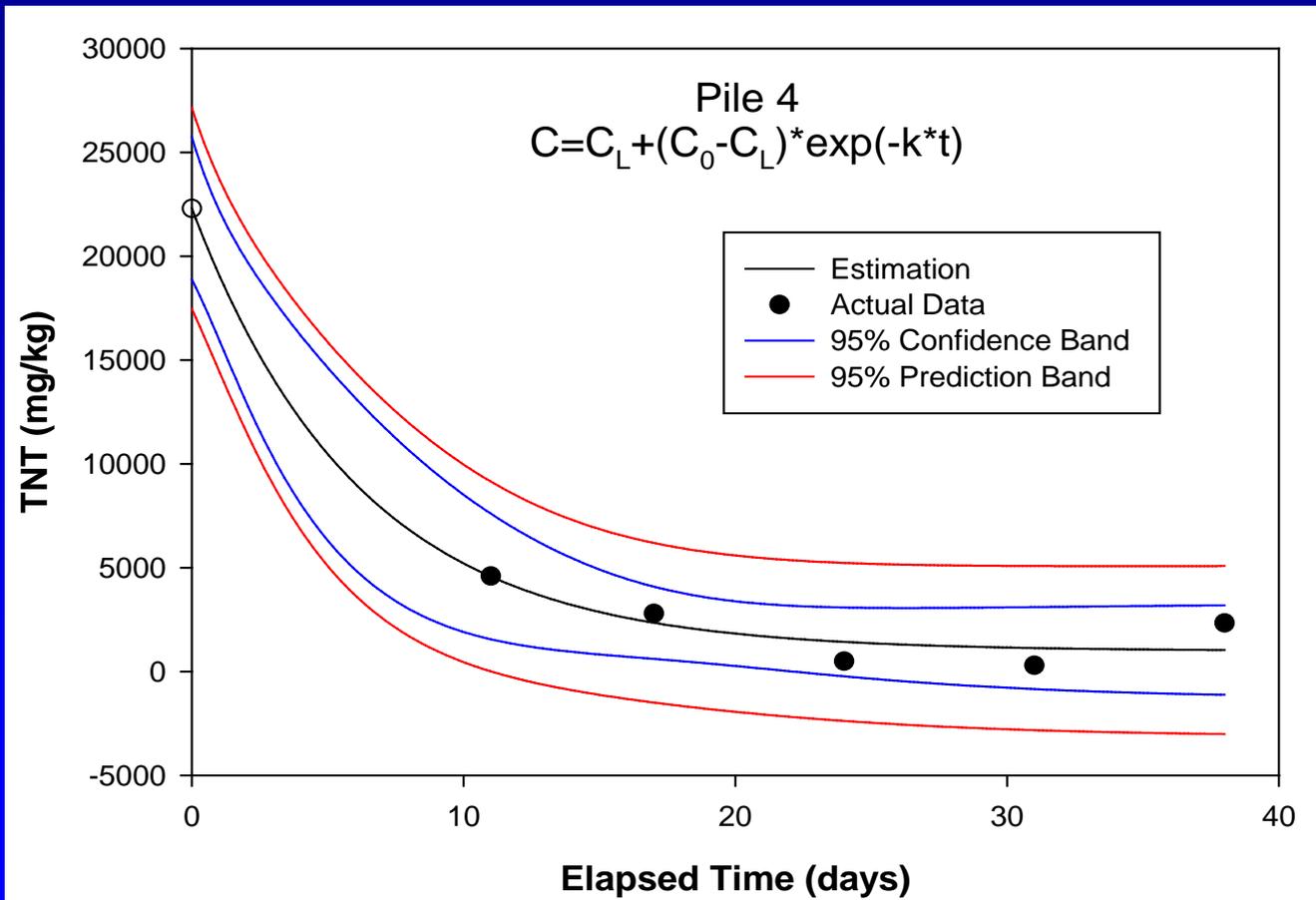
Analysis

Pile 1 - Control	Levels are below the RGO.
Pile 2 - Weekly	Unable to fit data, final levels were very low.
Pile 3 - Daily	Unable to fit data and levels are above RGO.
Pile 4 - Daily	1 st order regression of data successful.
Pile 5 - Daily	1 st order regression of data successful.
Pile 6 - Daily	All but initial samples are below RGO.
Pile 7 - Control	Unable to fit data and levels are above RGO.
Pile 8 - Weekly	Levels are below the RGO.

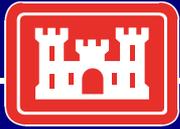


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Non-linear Estimation of TNT - Pile 4

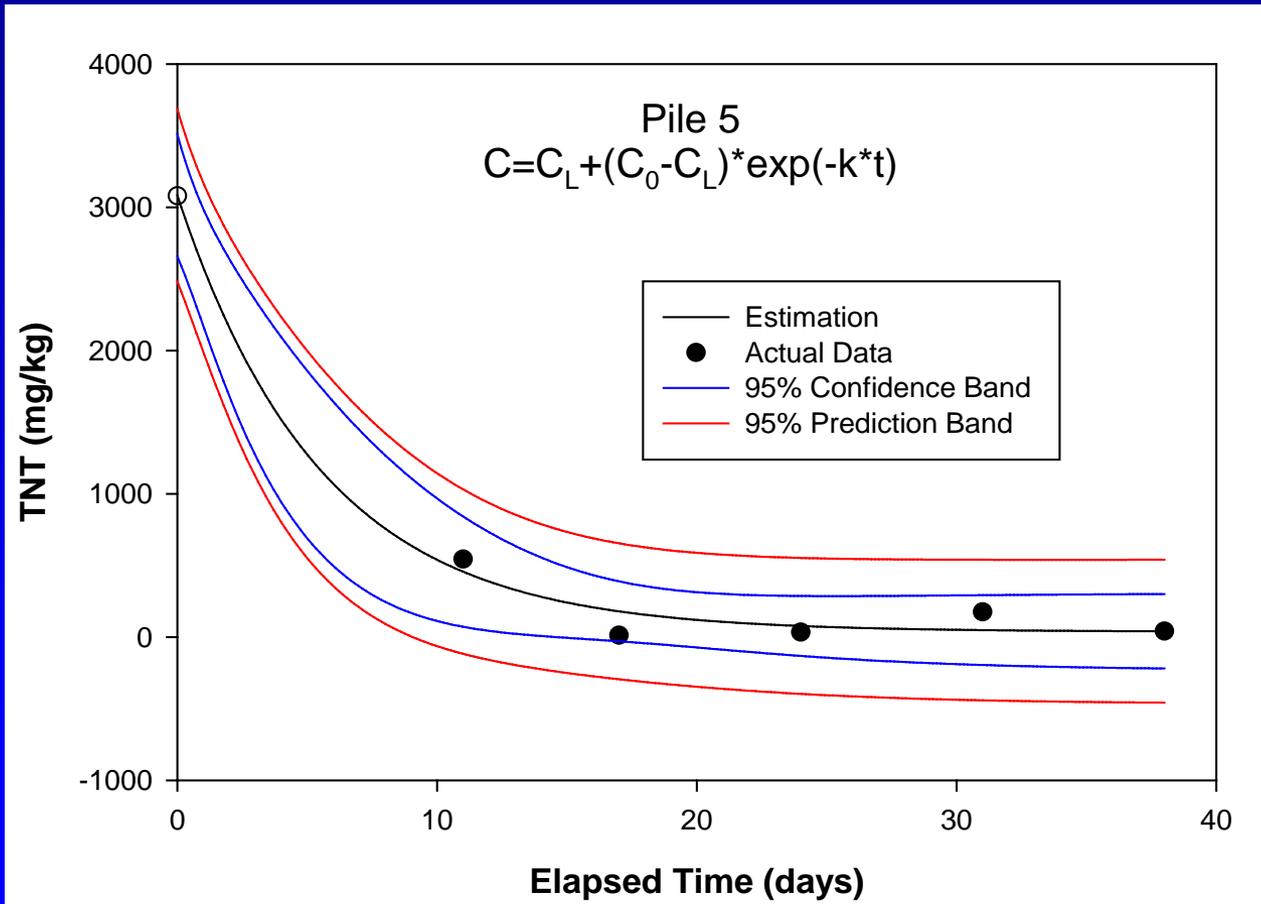


R² = 0.990
K = 0.16 day⁻¹
C₀ = 22,310
C_L = 989 mg/kg
Δ = 96%



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Non-linear Estimation of TNT in Pile 5

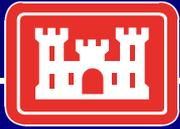


$R^2 = 0.993$
 $K = 0.18 \text{ day}^{-1}$
 $C_0 = 3084$
 $C_L = 37 \text{ mg/kg}$
 $\Delta = 99\%$



Conclusions

- Alkaline hydrolysis works.
- Maintain pH levels.
- Temperature?
- More study warranted.
- Longer study period.
- Evaluation of treatment costs needed.



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Questions?

- <http://www.lrh.usace.army.mil/projects/fuds/PBOW.htm>
- <http://www.lrh.usace.army.mil/>