Lime Treatment Study Pilot
Pentolite Road Red Water Ponds (PRRWP) Area
Plum Brook Ordnance Works
Sandusky, OH

U. S. Army Corps of Engineers
Huntington District

FUDS Program Review
San Diego, Ca
21 March 2007

Plum Brook Ordnance Works Laboratory Tests

U.S. Army Engineer Research and Development Center

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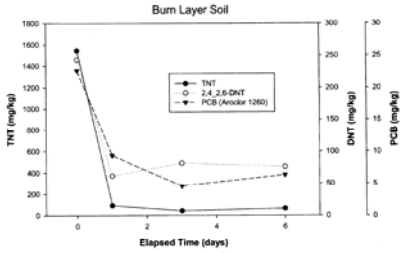
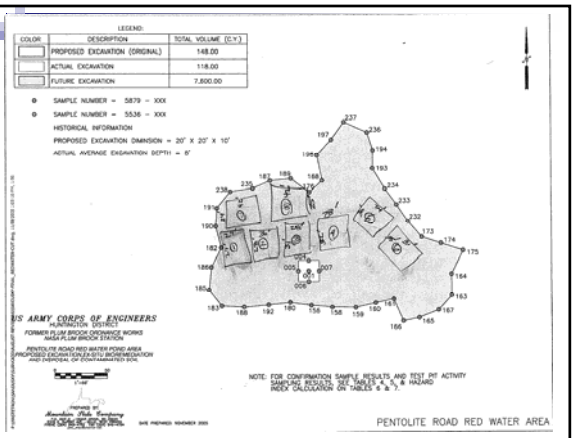
Slurry Tests of Burn Area

- Tests conducted with soils from PBOW Burn Area in slurry reactors
  - Burn Layer soil
  - Surface soil from west of burn area
- One of the treatments investigated was alkaline hydrolysis via addition of hydrated lime.
- Lime treatment achieved best results for TNT removal and is the simplest to use.

Lime Slurry Treatment





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DID IT WORK ?

Or were we just playing in the dirt ?

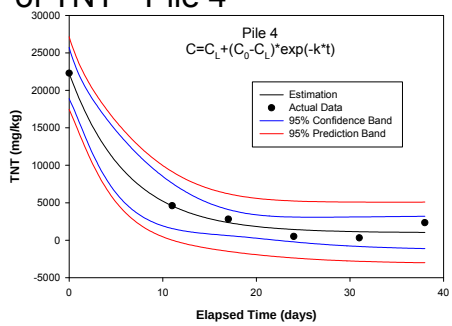
Actual TNT Data

Sample Date	Pile 1 TNT	Pile 2 TNT	Pile 3 TNT	Pile 4 TNT	Pile 5 TNT	Pile 6 TNT	Pile 7 TNT	Pile 8 TNT
12/18/2006	ND	11.8	2940	22300	3080	114	15.3	3.67
12/29/2006	3.06	19.3	3040	4600	544	ND	46.1	6.62
1/4/2007	ND	154	5040	2800	11.7	ND	20.6	ND
1/11/2007	ND	37.7	427	492	33.4	ND	18.3	1.79
1/18/2007	0.735	4.20	7640	298	175	ND	31.9	ND
1/25/2007	0.575	4.19	609	2340	41.3	ND	24.4	ND

Analysis

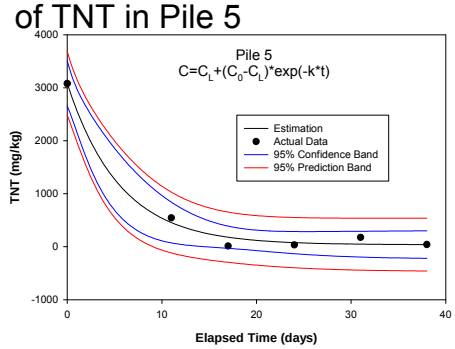
- Pile 1: Levels are below RGO.
- Pile 2: Unable to fit data but final levels appear to be very low.
- Pile 3: Unable to fit data and levels are far above RGO.
- Pile 4: 1st- order regression of data successful.
- Pile 5: 1st- order regression of data successful.
- Pile 6: All but initial sample levels are below RGO.
- Pile 7: Unable to fit data and levels are above RGO.
- Pile 8: Levels are below RGO.

Non-linear Estimation of TNT - Pile 4



$R^2 = 0.990$
$K = 0.16\ day^{-1}$
$C_0 = 22{,}310$
$C_L = 989$ mg/kg
$\Delta = 96\%$

Non-linear Estimation of TNT in Pile 5



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

TNT Removal Efficiency

Treatment/ Soil	Initial (mg/kg)	Final (mg/kg)	% Reduction
Lime Slurry/ Burn Layer	1547	67	96
Lime Slurry/ West Surface	14.9	0.92	94
Pile 4	22,310	989	96
Pile 5	3084	37	99

TNT/Soil Sorption

- The level of treatment is limited by sorption of TNT to soil surface.
- The rate of TNT desorption is significantly slower than the rate of TNT alkaline hydrolysis.
- How can we increase the availability/rate of desorption?
  - Surfactant?
  - Heat?

Ongoing Lab Tests

- Small pan tests with the following goals:
  - Validate results seen in the field.
  - Stabilize treatment conditions for comparison.
  - Produce data that is statistically significant and comparable.

Upcoming Lab Tests

- Larger scale tests in lysimeters
  - Investigate the use of solar heating to increase rates and limits of treatment.
  - Investigate the use of surfactant to increase rates and limits of treatment.

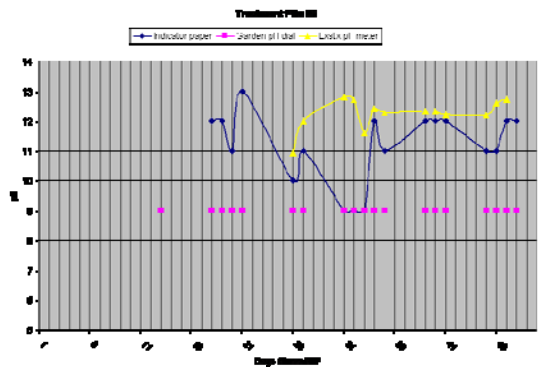
ESTCP Proposal

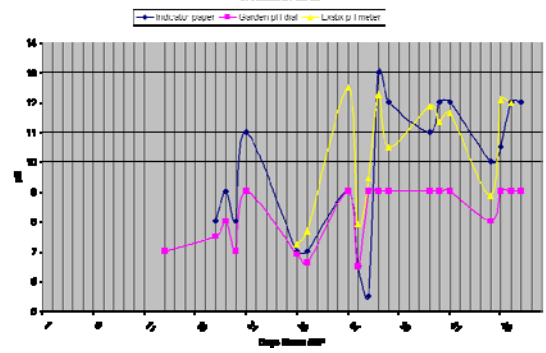
- Environmental Security Technology Certification Program
  - Purposes are to validate use of a new & emerging technologies and document cost data and technology guidance.
  - Items necessary to a successful proposal include: need for technology, good demonstration site(s), support from user community.

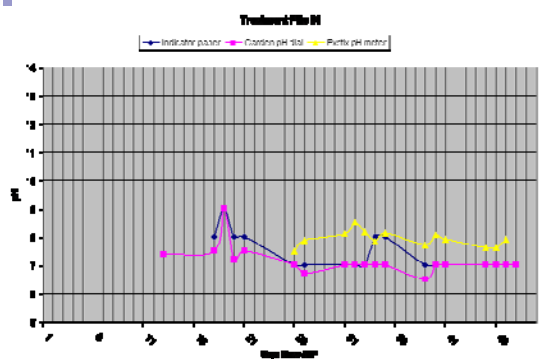
Conclusions

- Alkaline hydrolysis works.
- Maintain pH levels.
- Temperature?
- More study warranted.
- Longer study period.
- Cost benefit analysis needed.

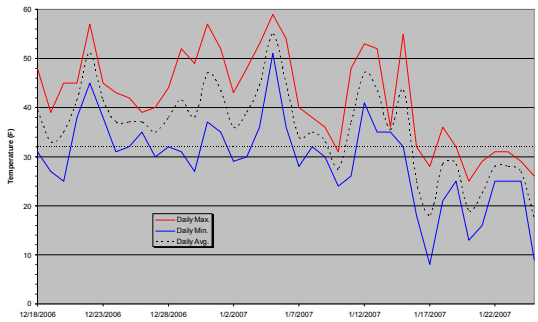
QUESTIONS







Daily Temperatures for Area



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.