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Full Scale Bioremediation of PCP Contaminated soil : Treatment Optimization Using a Biotreatability Study

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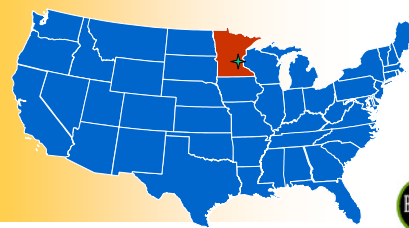
Context

- Mandate: Remediation of 11,500 m³ of contaminated soil
- Selected remedy : *Ex-situ* Biopile Process
- Timeframe : 20 weeks
- Biotreatability study undertaken simultaneously to on-site work



Site Description

- MacGillis and Gibbs Superfund Site



Site Description

- MacGillis and Gibbs Superfund Site
- Former wood treatment facility

Time Period	Wood Preservative Used	Contamination
1920 to 1950's	Creosote	PAHs
Late 1940's to mid 1970's	Oil and Pentachlorophenol	PCP
Mid 1970's to 1989	CCA	Metals



Remediation Objectives



CATEGORY 1

- [PCP] : < 200 mg/kg
- Max [PCP] : 190 mg/kg
- Objective : [PCP] < 10 mg/kg
- Backfilled on site

CATEGORY 2

- [PCP] : > 200 mg/kg
- Max [PCP] : 350 mg/kg
- Objective : [PCP] < 74 mg/kg
- Off-site disposal

Field Work and Biotreatability Study



Biotreatability study objectives

- Optimize on-site treatment conditions
- Identify potential problems
- Develop corrective measures



Treatment Conditions

Mesocosm #1

- Standard (mineral fertilizer)



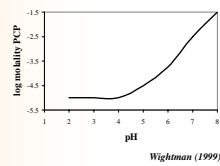
Treatment Conditions

Mesocosm #1

- Standard (mineral fertilizer)

Mesocosm #2

- Mineral fertilizer
- pH adjustment (from 7 to 8)



Treatment Conditions

Mesocosm #1

- Standard (mineral fertilizer)

Mesocosm #2

- Mineral fertilizer
- pH adjustment (from 7 to 8)

Mesocosm #3

- Organic amendment



Treatment Conditions

Mesocosm #1

- Standard (mineral fertilizer)

Mesocosm #2

- Mineral fertilizer
- pH adjustment (from 7 to 8)

Mesocosm #3

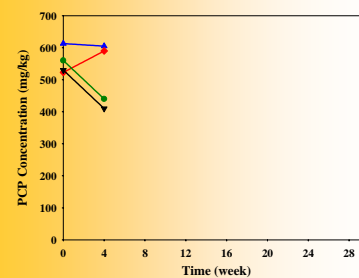
- Organic amendment

Mesocosm #4

- Organic amendment
- Fungal inoculation



Treatment Evolution (4 weeks)



Mesocosms

- #1 ▲
- #2 ◆
- #3 ●
- #4 ▼



Actions Taken

On site

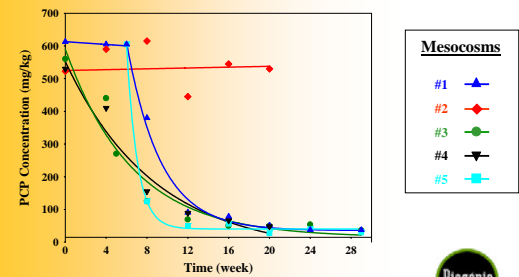
- Soil tilling
- Addition of an organic amendment

In the Lab

- New mesocosm (Mesocosm #1 + organic amendment)



Final Results



Biotreatability Study vs Full scale

Treated Soil	PCP Removal (%)
Biotreatability Study (29 weeks)	
Mesocosm #1	94
Mesocosm #2	0
Mesocosm #3	94
Mesocosm #4	91
Mesocosm #5	95
Full-scale project	
Category 1 (32 weeks)	94
Category 2 (35 weeks)	97

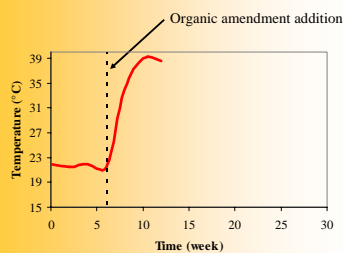


Complementary Work

Additional tests performed in the laboratory



Influence of Temperature



Influence of Temperature

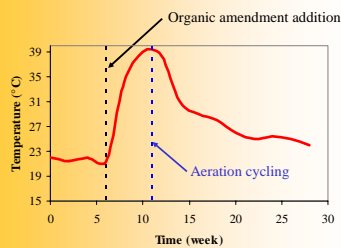
➤ Microbial growth

Incubation Temperature (°C)	Total Microflora (CFU/ml)	PCP-specific Microflora (CFU/ml)
15	10 ⁶	10 ⁶
23	10 ⁷	10 ⁷
30	10 ⁷	10 ⁵
45	10 ⁵	10 ²



Influence of Temperature

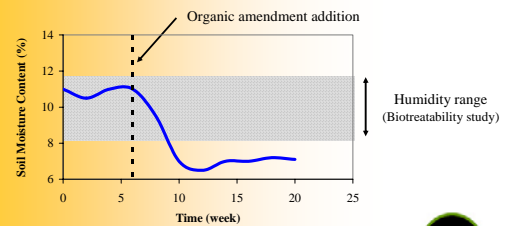
➤ Modification to the on-site operating parameters



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Influence of Temperature

➤ Soil humidity



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Influence of pH

➤ Microbial growth

pH	Total Microflora (CFU/ml)	PCP-specific Microflora (CFU/ml)
5	10 ⁵	10 ⁵
6	10 ⁶	10 ⁶
7	10 ⁷	10 ⁷

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Chemical Oxidation

➤ Challenging soils

- 1,150 m³ still above the cleanup objective
- Decrease in PCP biodegradation rate

➤ Selected oxidant : potassium permanganate

➤ Applied as a concentrated solution



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Chemical Oxidation

Oxidant Proportion (% w/w)	PCP Initial Concentration (mg/kg)	PCP Final Concentration (mg/kg)	PCP Elimination (%)
0.1	18.5	5.0	73
0.5	18.5	4.1	78

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Conclusion

- **Successful biotreatment of 11,500 m³ of a listed Hazardous Waste**
 - 95% PCP reduction
 - Third party confirmatory samples
 - 118 samples showed PCP concentrations below 10 mg/kg
 - Soil backfilled on site
- **Optimization of treatment conditions**
- **Identification of potential limiting factors**
- **Testing of a complementary treatment technology**



Questions ?



Assess

Design

Implement

Guaranteed Site Remediation Solutions

