

**Field Evaluation of  
Phytoremediation of  
Perchloroethylene with  
*Populus* Clones at LaSalle  
Electric Utilities**

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**Electric Utilities**

**LaSalle, Illinois**

**World War II Effort**

**Capacitors**

**Small-Pole- Industrial**



**1960's**

**PCB related illnesses**

**Japan**

# LaSalle Non-Compliance

- **Toxic Substance Control Act (TOSCA) 1979**
- **High Levels PCB**
  - 113000 ppm – Soil
  - 300000 ppm – Water
- **Trichloroethylene (TCE)**
- **1,1,1-Trichloroethane (TCA)**

# Off Site PCB Contamination

- **Vehicle and human traffic**
- **Wind erosion of soil**
- **Oil for driveways**

# Remedial Action History

- **Phase – I Off-site Soils RA 04/88 – 06/90**  
**Incineration 23000 yds of soil**  
**150 properties**
- **Phase – II On-site Soils, Buildings & Groundwater 07/90 - 2/94**  
**Demolition – building**  
**Incineration – 67000 yds of soil**  
**1500 yds of sediments**  
**Cleaning – Storm sewers**



# Perchloroethylene (Perc, PCE)

- Halogenated hydrocarbon –  $C_2Cl_4$
- Commercial solvent – dry cleaning
- Insulating fluid – electrical transformers
- Carcinogen – animals
- Effects – central nervous system and liver

# **Groundwater Collection System**

- **Drain system**
- **Groundwater treatment unit – 50 gpm**
- **Soil vapor extraction – air stripper**

# **Cost to Public – To Date**

- **\$55,000,000**
- **Electric Utilities Company -  
Bankrupt**





# Remedial Action Goals

- Excavation and thermal destruction of PCB contaminated soils to less than 5 ppm total PCB's 0 to 1 ft and 10 ppm greater than 1 ft to bed rock (~28 ft)
- Collection and treatment to MCL's of chlorinated VOC contaminated groundwater
- Collection and treatment of PCB contaminated groundwater to < 1ppb total PCB's
- Site groundwater to be returned to MCL's
- Treated water to be discharged to local POTW at or below MCL's

# Polishing Phase

- **Phytoremediation with Poplars**
- **Total Remediation Goal –  
Reduce rebound effect when  
groundwater treatment ends**
- **Monitoring – assess phyto  
performance and regulatory clean-up  
goals (MCL<5 micrograms/L)**

# **Overall Phyto Objective**

**To determine the effectiveness of using phyto to clean up a PCE plume of soil and groundwater at the former LaSalle Electric Utilities site in LaSalle, Illinois**



# Specific Objectives

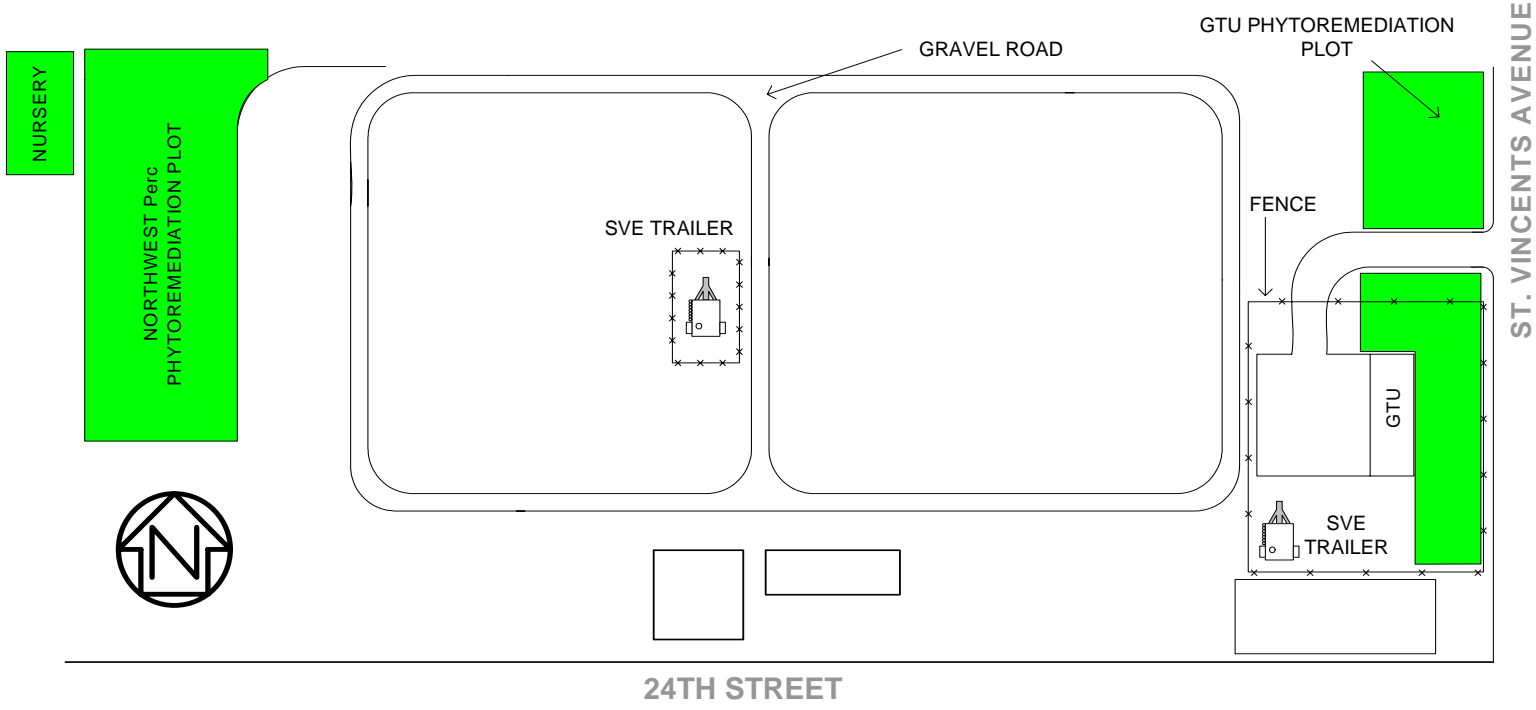
1. **Compare 18 poplar clones for their phyto potential at the site**
2. **Determine the significance of rhizosphere microbes in removing chlorinated solvents at the site**
3. **Develop low-cost field methods for monitoring PCE uptake by the poplar trees**

# Poplars Planted

- **April, 2002**
- **Rooted barbatelles**
- **Auger**
- **Spacing 10'x 3' (3 m x 0.9 m)**

ClonePedigreeOrigin

7300501	<i>P. deltoides</i>	Southern Illinois
119.16	<i>P. deltoides</i>	Ohio x (Nebraska x Minnesota)
220-5	<i>P. deltoides</i>	Ohio
252-4	<i>P. deltoides</i>	Central Missouri
42-7	<i>P. deltoides</i>	Southern Indiana
51-5	<i>P. deltoides</i>	Southern Ohio
80x00601	<i>P. deltoides</i>	Southern Illinois x Southern Illinois
80x01015	<i>P. deltoides</i>	Southern Illinois x Southern Illinois
80x01107	<i>P. deltoides</i>	Southern Illinois x Southern Illinois
ISU 25-21	<i>P. deltoides</i>	Southern Illinois x Southern Illinois
ISU 25-35	<i>P. deltoides</i>	Southern Illinois x Southern Illinois
ISU 25-R4	<i>P. deltoides</i>	Southern Illinois x Southern Illinois
ISU 25-R5	<i>P. deltoides</i>	Southern Illinois x Southern Illinois
Eugenei	<i>P. deltoides</i> x <i>P. nigra</i>	North America x Europe
I 45/51	<i>P. deltoides</i> x <i>P. nigra</i>	North America x Europe
Belgian 25	<i>P. deltoides</i> x <i>P. maximowiczii</i>	North America x Japan
NM-2	<i>P. nigra</i> x <i>P. maximowiczii</i>	Europe x Japan
Crandon	<i>P. alba</i> x <i>P. grandidentata</i>	Europe x Southern Iowa

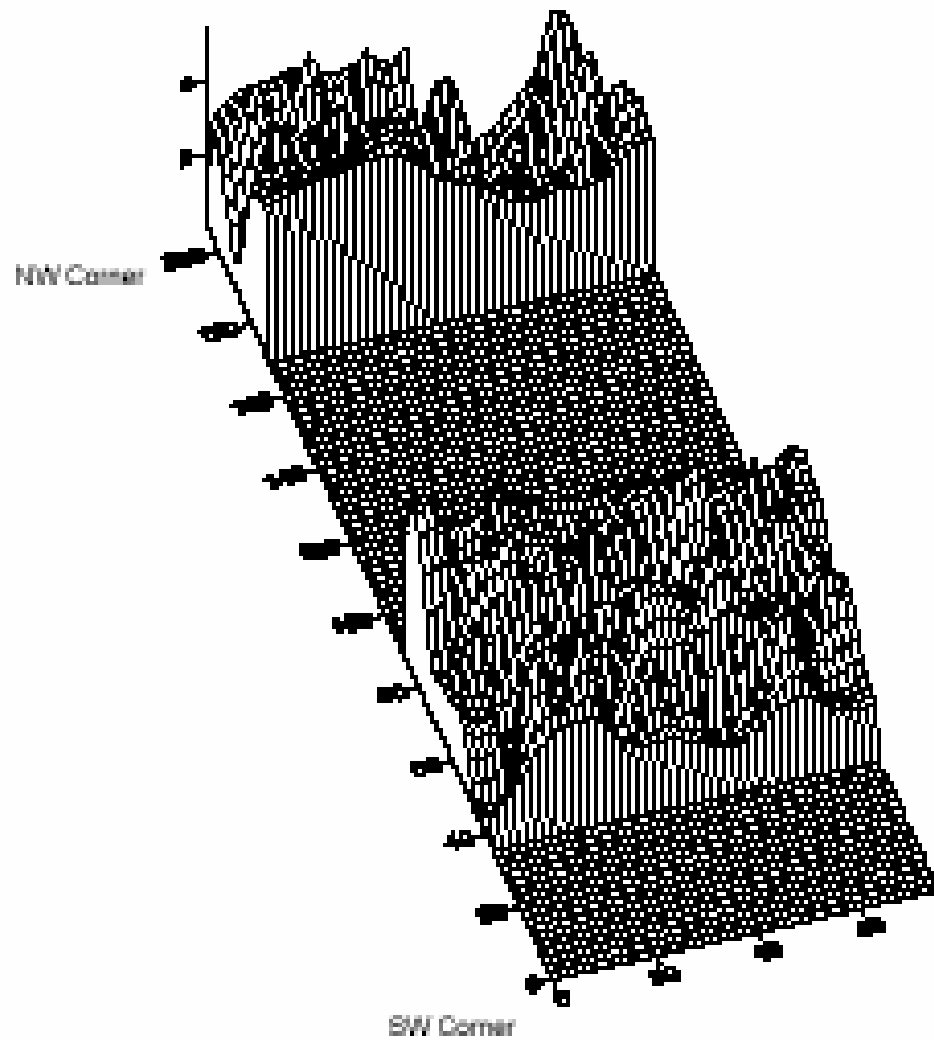






## Top Performers ( 3 years)

<u>Clone</u>	<u>Height (m)</u>	<u>Diameter (cm)</u>
25-R4	8.5	7.7
25-21	8.4	7.3
51-5	7.8	7.5
25-R5	7.9	6.9
Crandon	8.1	6.8
<b>DN34</b>	<b>7.4</b>	<b>7.0</b>
<b>Average</b>	<b>7.5</b>	<b>6.3</b>



**NW Area Tree Diameter**





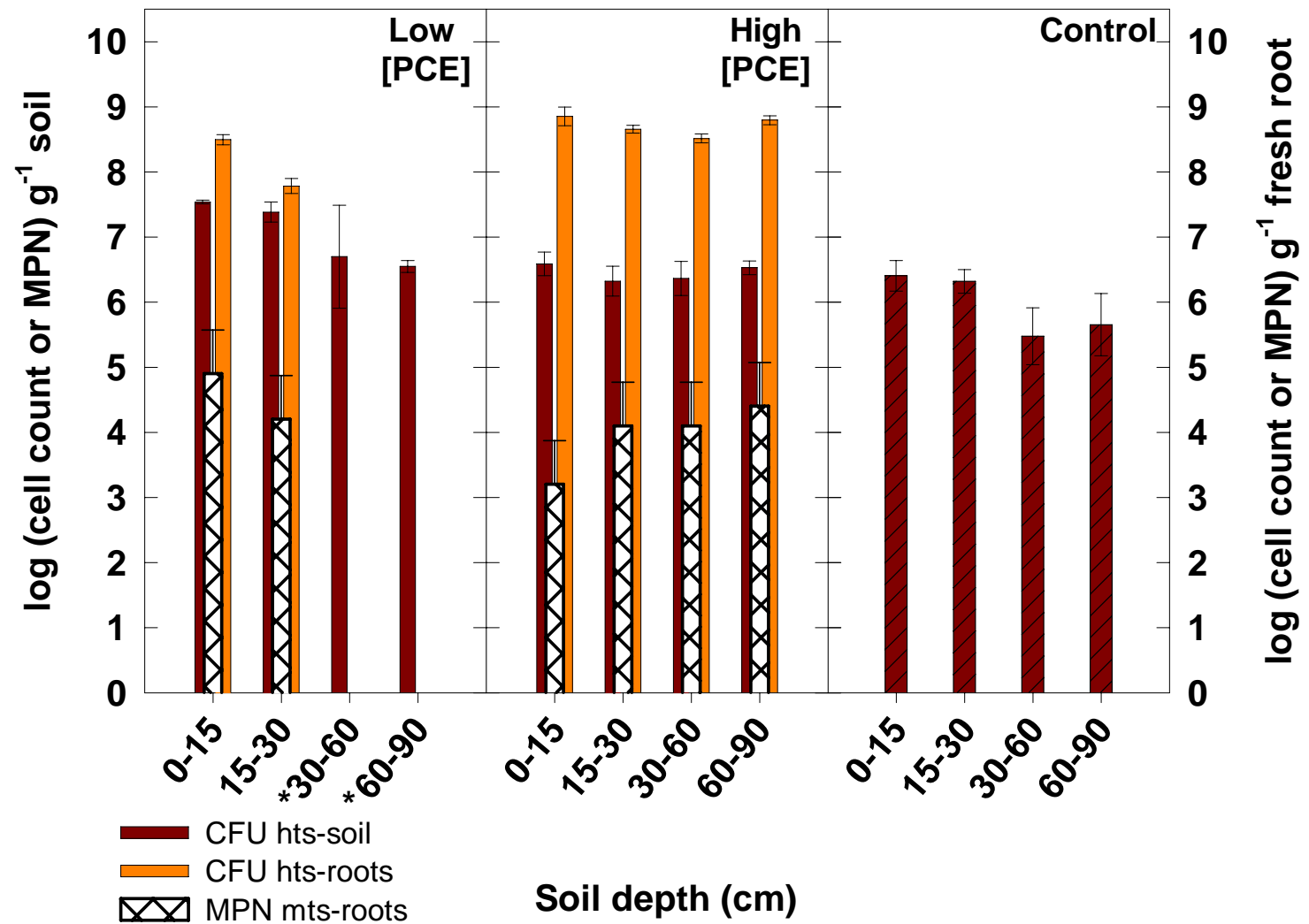




# **Microbial Activity**







# PCE Monitoring



# Field Evaluation Methodology

- **Reliable**
- **Low cost**
- **Non-destructive**
- **On-site**

# Methodology Goals

- **Minimize handling time**
- **Minimize shipping time**
- **Avoid analytical laboratory queues**
- **Expensive laboratory fees**

# October 2003 Sampling

- 4 poplar clones – 2 trees / clone
- 4 trees within PEC plume
- 4 trees outside PEC plume
- Stem cores (2 / tree), branch samples and destructive stem disks



# Poplar Clones Sampled - 2003

- ISU 25-R5                      D x D
- I 45/51                         D x N
- DN 34 (Eugenei)             D x N
- Crandon                         A x G

# Matched Samples Taken

- **Analytical Laboratory – GC MS**

  - Ecology and Environment, Inc. - Chicago**

  - University of Florida – Gainesville**

  - (US EPA Method SW 8260B)**

- **Color Tec (E and E copyright )**

  - On site**

# **Color Tec Method**

**Ecology and Environment  
Inc.**

# Color Tec \* Equipment and Materials

- 100 cc gas tight syringe
- Colorimetric indicator tubes
- Activated carbon scrubber tubes
- 8 to 16 gauge hollow needles
- Hot water bath with temperature control
- Thermometer

\* Copyright Ecology and Environment, Inc, 2003.











07.28.2004



07.28.2004

# **Sampling Results**

**October, 2003**

## Clone

## In Plume

## Outside Plume

### ISU 25-R5

GC	X	ND
Color Tec	X	ND
U Florida	X	ND

### I 45/51

GC	X	ND
Color Tec	X	ND
U Florida	X	NA

### DN 34

GC	X	ND
Color Tec	X	ND
U Florida	X	NA

### Crandon

GC	Trace (Disk only)	ND
Color Tec	ND	ND
U Florida	ND	NA

# July 2004 Sampling

- 7 clones – Same as 2003 + 2 related
- 5 trees in plume
- 5 trees outside plume
- Matched non-destructive branch samples
  - GC-MS (E and E)
  - Color Tec (on-site)



# **Sampling Results**

**July, 2004**

## Clone

## In Plume

## Outside Plume

ISU 25-R5

GC  
Color Tec

NA  
X (Low)

ISU 25-R4

GC  
Color Tec

NA  
X (Low)

ISU 25-21

GC X  
Color Tec X

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ISU 25-35

GC X  
Color Tec X

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I 45/51

GC X  
Color Tec X

NA  
X (Low)

DN 34

GC X  
Color Tec X

X (Low)  
X (Low)

Crandon

GC X  
Color Tec X

X (Low)  
X (Low)



# Conclusions

- **Growth rate was impressive**
- **Clonal variation significant**
- **PCE concentration affected growth**
- **Microbial activity greater with trees**
- **Promising low-cost on-site method developed**
- **Phyto effective for PCE uptake**
- **Public support**



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