

# Phytoremediation Success and Experience at a Site in Southern New Jersey

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# Phytoremediation

- Still a relatively new technology.
- Many successful and exciting laboratory and growth room results have been published.
- Many good phytoremediation sites initiated.
- Many more good ideas.
- However, there is a lack of long-term monitoring data obtained under field conditions.

# Phytoremediation *in situ*

- No two sites are the same.
- Most sites are typically heterogeneous.
- Field conditions introduce many “real-life” obstacles and variables.
- “Average” weather is just that, an average of extremes!!
- Problems with site access, vandalism, etc.

U.S.EPA/ERT and REAC have been supporting and monitoring several phytoremediation sites during the past decade.

- J-Field. Aberdeen Proving Ground (Edgewood, MD)
- Kauffman and Minter (Jobstown, NJ)
- Oregon Poplar (Clackamas, OR)
- Naples Truck Stop (UT)
- Edward Sears Property (New Gretna, NJ)



# Edward Sears Property Site

## New Gretna, New Jersey



# Background

- Mr. Edward F. Sears operated a business at his property from the mid-1960s to 1992.
- He would purchase off-specification or expired material from U.S. Government shipyards.
- The material would then be re-mixed and/or resold.

# Edward Sears Property

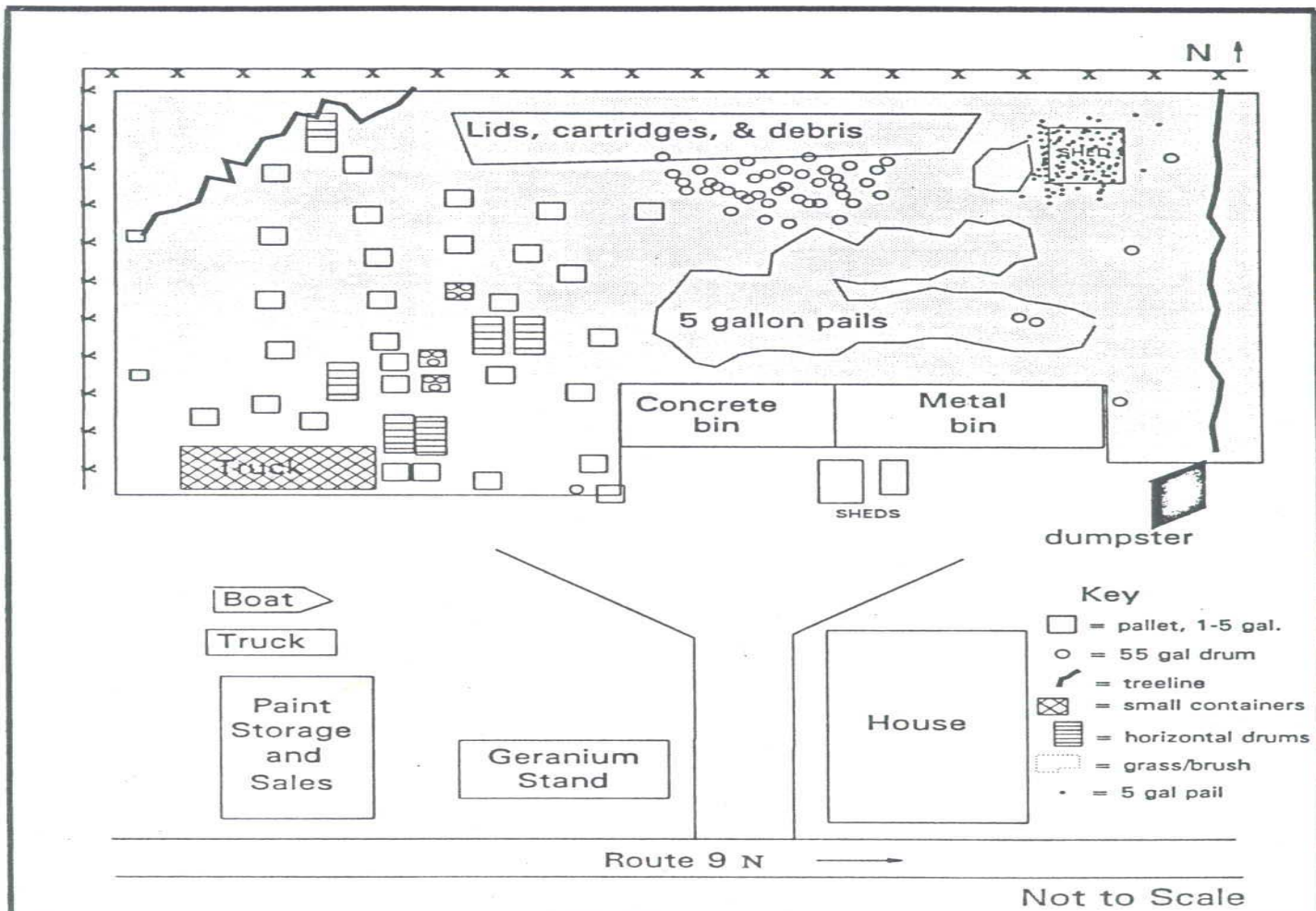
## New Gretna, New Jersey

- Release of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) designated hazardous substance resulting in a potential threat to human health, welfare, and the environment.
- First request to evaluate the property on December 27, 1993.

## Approximately one acre property in a rural area of Route 9.

- Hundreds of deteriorated and aged containers were found improperly stored on site.
- A shed roof was found partially collapsed onto the material stored inside.
- The public could easily access site materials.
- Great potential for additional releases existed.
- A CERCLA Removal Action was warranted.





**WESTON**  
MANAGEMENT GROUP CONSULTANTS

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MAJOR PROGRAMS DIVISION

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Edward F. Sears  
Property

IN ASSOCIATION WITH FOSTER WHEELER CORP.,  
C.C. JOHNSON & MALHOTRA, P.C., RESOURCE  
APPLICATIONS, INC. AND R.E. SARRIERA ASSOCIATES

TAT PM  
I. Huhn

Figure 2  
Site Map



# Removal Activities

- 53 (1)-cubic yard DOT hazardous waste boxes containing approximately 4,000 containers removed.
- 120 55-gallon drums of waste removed.
- 450 cubic yards of contaminated soil excavated.
- EPA conducted a limited ground water investigation in the fall of 1995 and found elevated levels of volatile organic compounds (VOCs).

# U.S.EPA/ERT and REAC Activities in 1995 and 1996 included:

- Installation of additional permanent and temporary monitoring wells.
- Chemical analysis of soil and ground water samples.
- Hydraulic tests.
- Proposed applicable remedial alternatives for the site including: 1. Removal of source soil. 2. Pump and treat. 3. Phytoremediation. 4. No action (providing potable water to local residents).

# Appropriate Site for Phytoremediation Technology!

- Contaminated zone is within sand, silt, and clay unit located approximately 5 to 18 feet below ground surface (bgs).
- Contamination is somewhat localized.
- Pilot tests of other technologies, such as pump and treat using air stripping and activated carbon, were expensive and inefficient.
- Pilot-scale Phytoremediation!!

- Site preparation was initiated in October of 1996.
- Thomas Consultants, Inc. (Columbus, OH), was subcontracted by REAC.
- Created a planting grid 113 x 100 feet.
- Hybrid poplars (*Populus charkowiensis* x *P. incrassata*, NE 308) were chosen.
- Trees were spaced at 10 feet (north-south axis) by 12.5 feet (east-west axis).

- Trees planted in December of 1996.
- Trees averaged 14 feet in length.
- Holes dug with a 12-inch width auger, 15-feet deep.
- A 4-foot sonotube was placed in the upper portion of the hole, from 1 to 5 feet bgs.
- A plastic barrier placed on top, around the tree trunk.
- Trees planted down about 9 feet bgs.
- Amended soil and nutrients placed in the hole.





# How to Plant A Tree



# Ready for Planting



# Additional Microwells for Ground Water Monitoring Installed Throughout the Site



# Almost One Year Later

97% Survival!!



# Monitoring and Maintenance

- Annual ground water sampling
- Transpiration gas sampling
- Sap flow rate measurements
- Tree growth rate and health evaluation
- Soil samples
- Fertilization of the trees
- Mowing and pruning

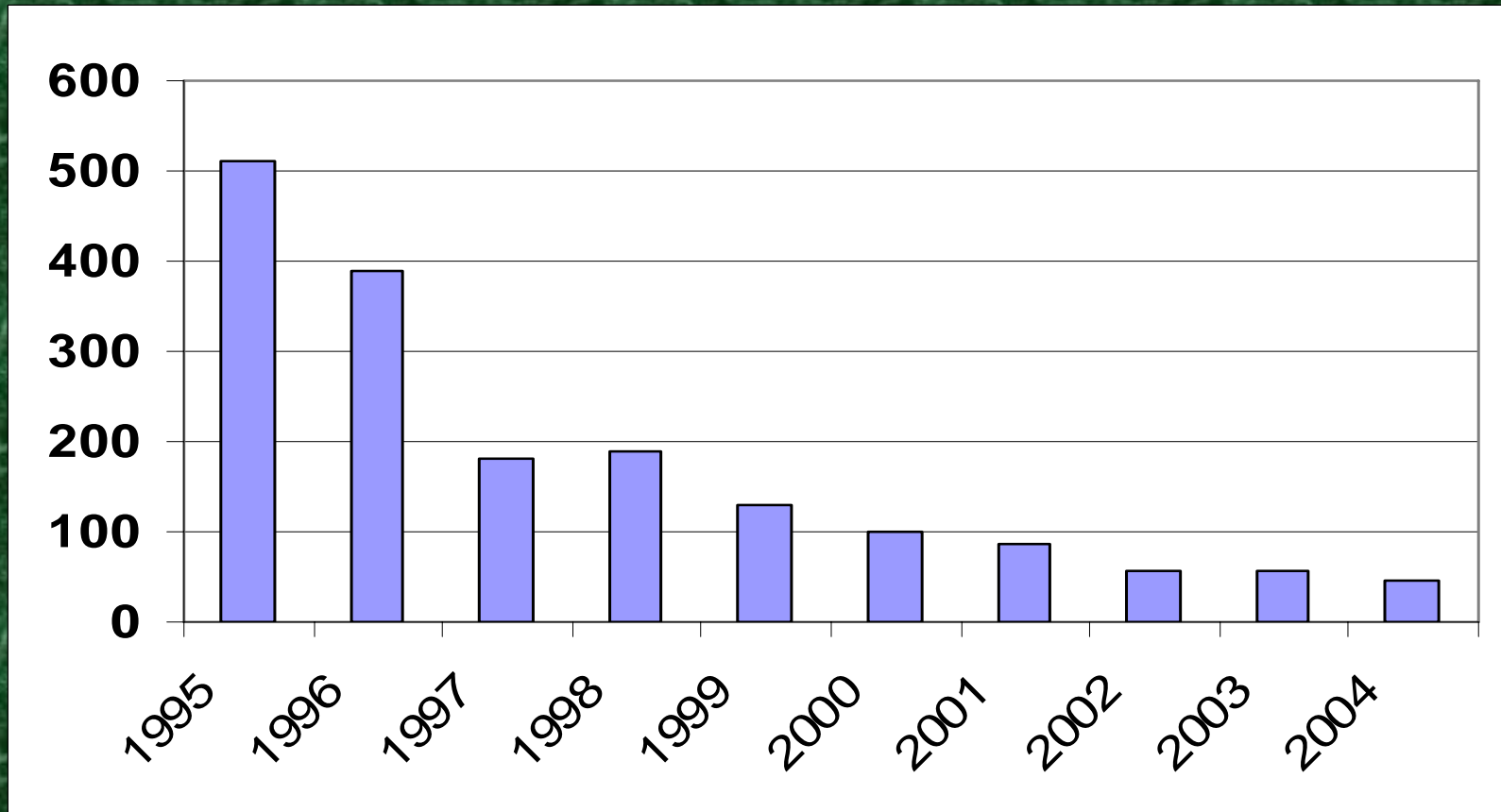
# Ground Water Sampling



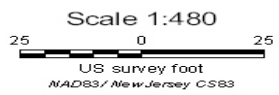
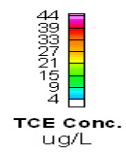
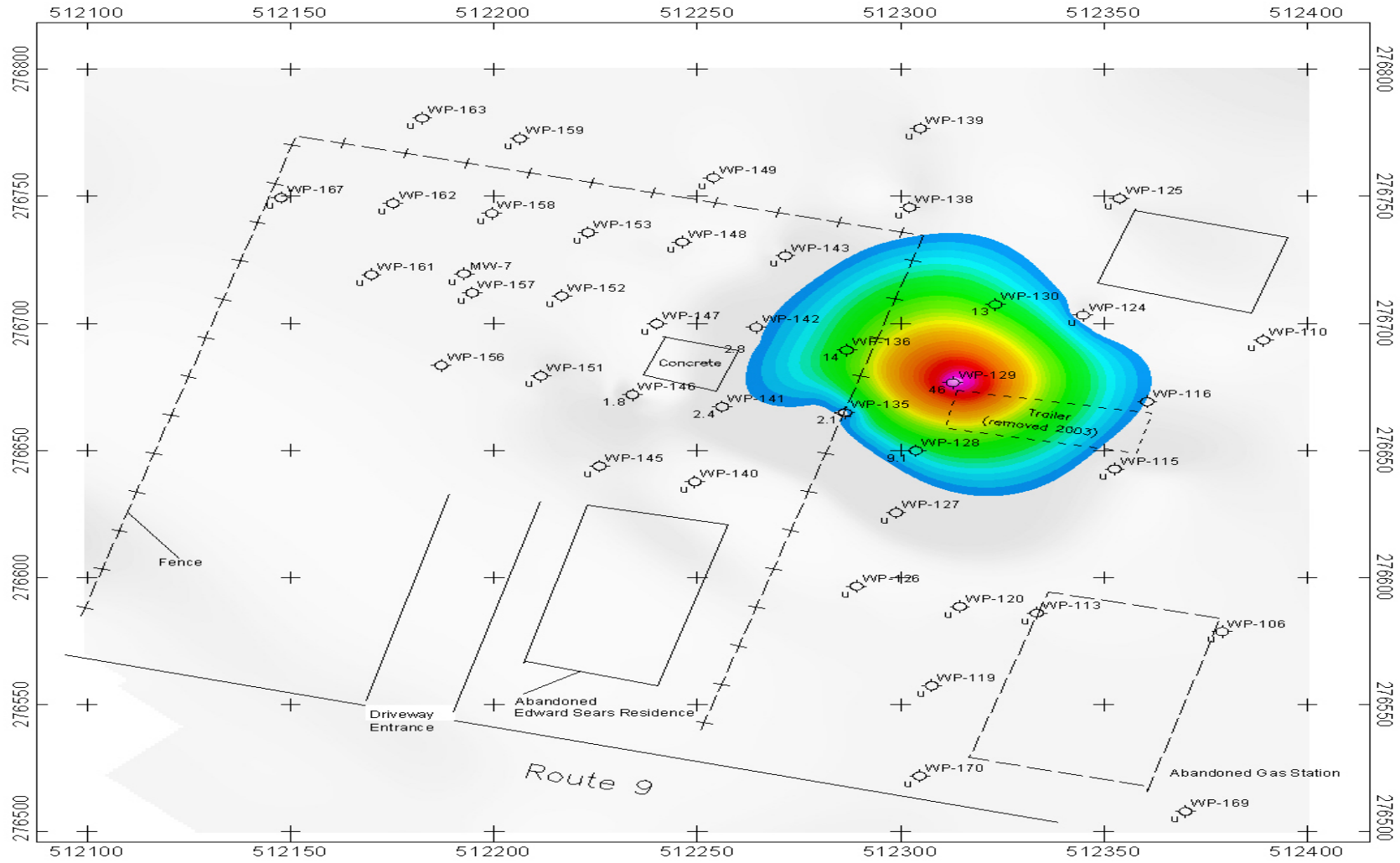
- Occurs at least once per year (late August)
- **VOCs within the plot have dropped considerably!**
- VOCs outside the plot remain high.



# Trichloroethylene Concentration in Ground Water (Micrograms/Liter)







WP-000 — Well ID  
 Sample Point  
 Trichloroethane (TCE) Concentration in Groundwater  
 (u = undetected, Data from August 2004)  
 ug/L = micrograms per liter

Figure 4. TCE Concentrations in Groundwater  
 Edward Sears Property  
 New Gretna, New Jersey  
 March 2005

**U.S. EPA Environmental Response Team Center**  
 Response Engineering and Analytical Contract  
 EPC - 04 - 032  
 W.O. # EAC00062

## Considerable Reduction of VOCs in Ground Water

- Trimethylbenzene (total) reduced from 1,890  $\mu\text{g/L}$  to 19.1  $\mu\text{g/L}$  .
- Xylenes (total) reduced from 545  $\mu\text{g/L}$  to nondetectable.
- All VOC contamination plumes have shrunk in size.
- No VOC reductions in an untreated, positive control area.

# Transpiration Gas Sampling

- No positive results at this site, probably due to the relatively low VOC concentrations in the ground water *but* highly successful at other sites.
- Values obtained are relative, not to be used for mass balance.



# Sap Flow Rates

- Measure ground water removal by the trees.
- Varies with season, weather, size, location, and health of the trees.
- Allows comparison of the native trees with the hybrid poplars.

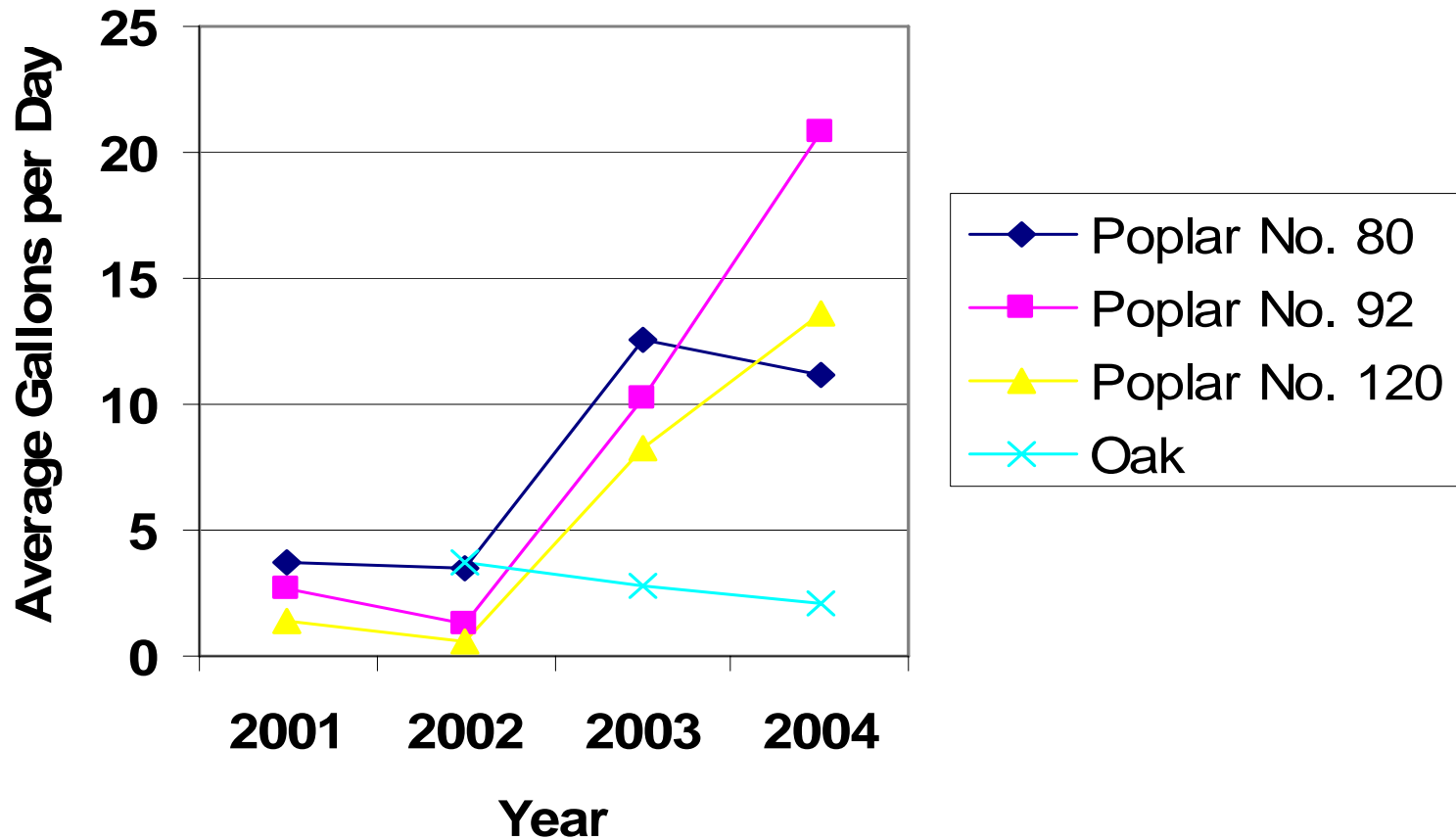


# August 2004 Average Sap Flow Rates of Selected Trees (Gallons per Day)

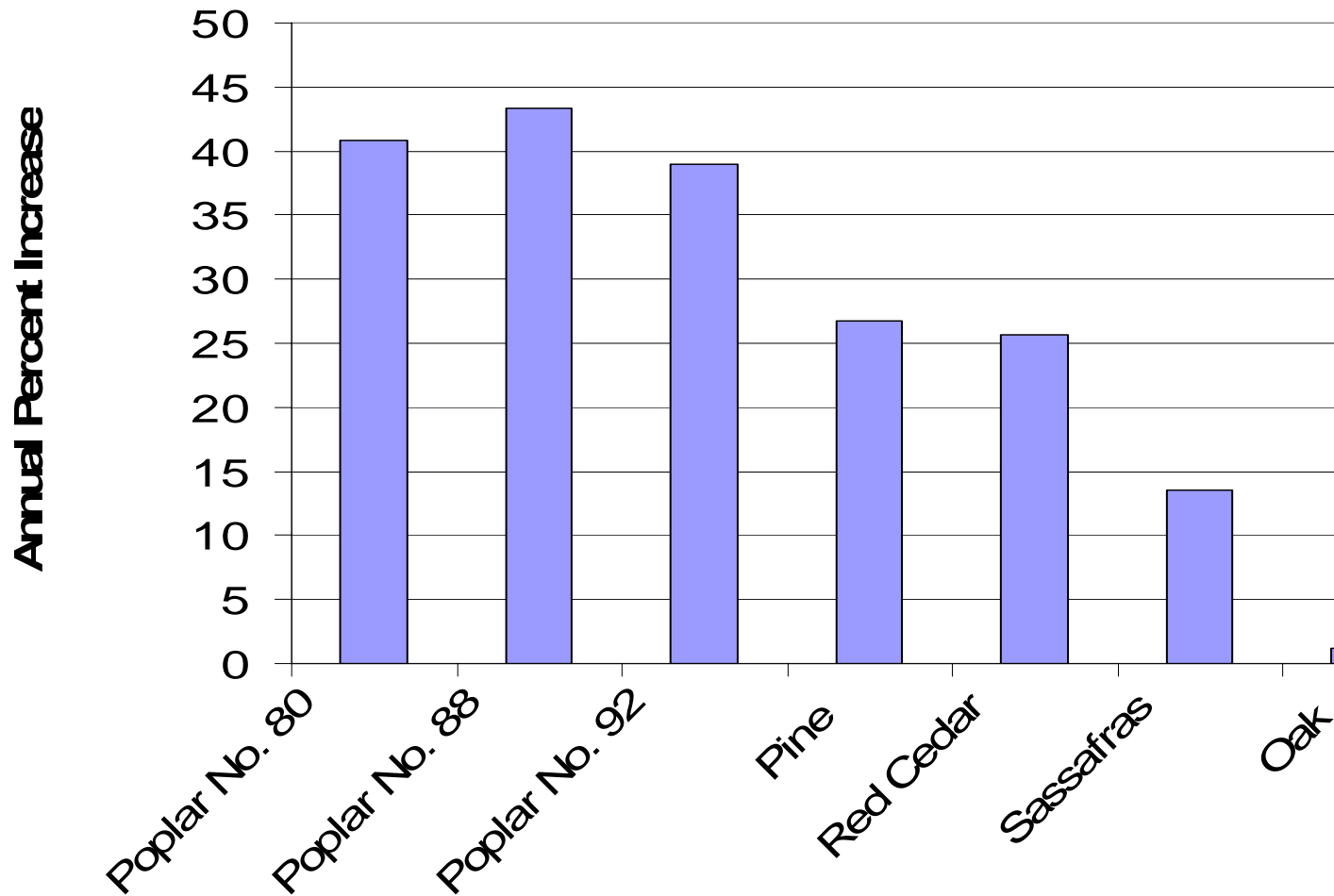


- Poplar No. 67= 9.62
- Poplar No. 92= 20.76
- Poplar No. 94= 7.58
- Pine= 5.54
- Red Cedar= 1.94
- Spruce= 10.51
- Sassafras= 16.54
- Oak= 2.08
- Poplar (avg.)= 9.64

# Average Sap Flow Rate of Four Selected Trees at the Edward Sears Property Site



# Annual Average Percent Increase in Trunk Area of Select Trees



# Tree Growth Monitoring

After eight growing seasons (1997-2004):

- Average diameter of all the trees at breast height (dbh= 4.5 feet above ground surface) was 3.79 inches (9.62 cm).
- Largest diameter was 7.83 inches (19.86 cm).
- Average tree height was 43.77 feet (13.34m).
- Tallest tree was 59.27 feet tall (18.06 m).









2002 8 15





2004 8 26

# How About the Roots??

- Poplar No. 55 examined May 2004.
- A small backhoe was used to dig along one side of the tree.
- Surface roots continue more than 12 feet (4 meters) from the tree base.



# Down They Go!



- Plastic surface barrier still intact and filled with gnarled roots.
- The sonotube was almost gone, but the root distribution showed evidence of it's former presence.
- Roots were still present at 7 feet (2.1 meters) bgs, becoming increasingly sparse and finer with depth.

# Problems Encountered

- Drought
- Vandalism
- Insects  
(especially caterpillars)
- Deer
- Canker





# Plants are Living Things

- Select plants appropriate for your site contaminants and conditions.
- Soil should be sampled for agronomic analysis (pH, salinity, texture, nutrients)
- Soil amendments applied based on soil tests and observations of plant growth.
- Proper attention to soil moisture, especially during establishment.
- Insects and other pests controlled (spraying, fencing, smelly repellents)
- Reduce competition from weeds (mowing, herbicide).

# Phytoremediation also blends with the local ecological community



# Continue to Monitor

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