Poplar-based Phytoremediation Processes

IPC Working Party

September 17, 2010

Dr. Lou Licht, PE

Ecolotree, Inc.

Since 1990 - Ecolotree Headquarters in Iowa USA

Ecolofarm Nursery Farm in Iowa, USA.

25 acres Nursery

Phytoremediation is Agronomy with a Twist

the science and management of

PREDICTABLE PLANT FUNCTION

&

Strategic Location

EBuffer Irrigated with Coal Bed Well Water

Coal Gas Site, Kaycee WY

PHYTO FUNCTIONS :

- Removes Water

Landfill Leachate EBuffer
Salisbury NC.

PHYTO FUNCTIONS :

- Remove Water
- Stabilization Soil Surface
- Capture Nutrients (N&P)
- Beneficially uses Nutrients

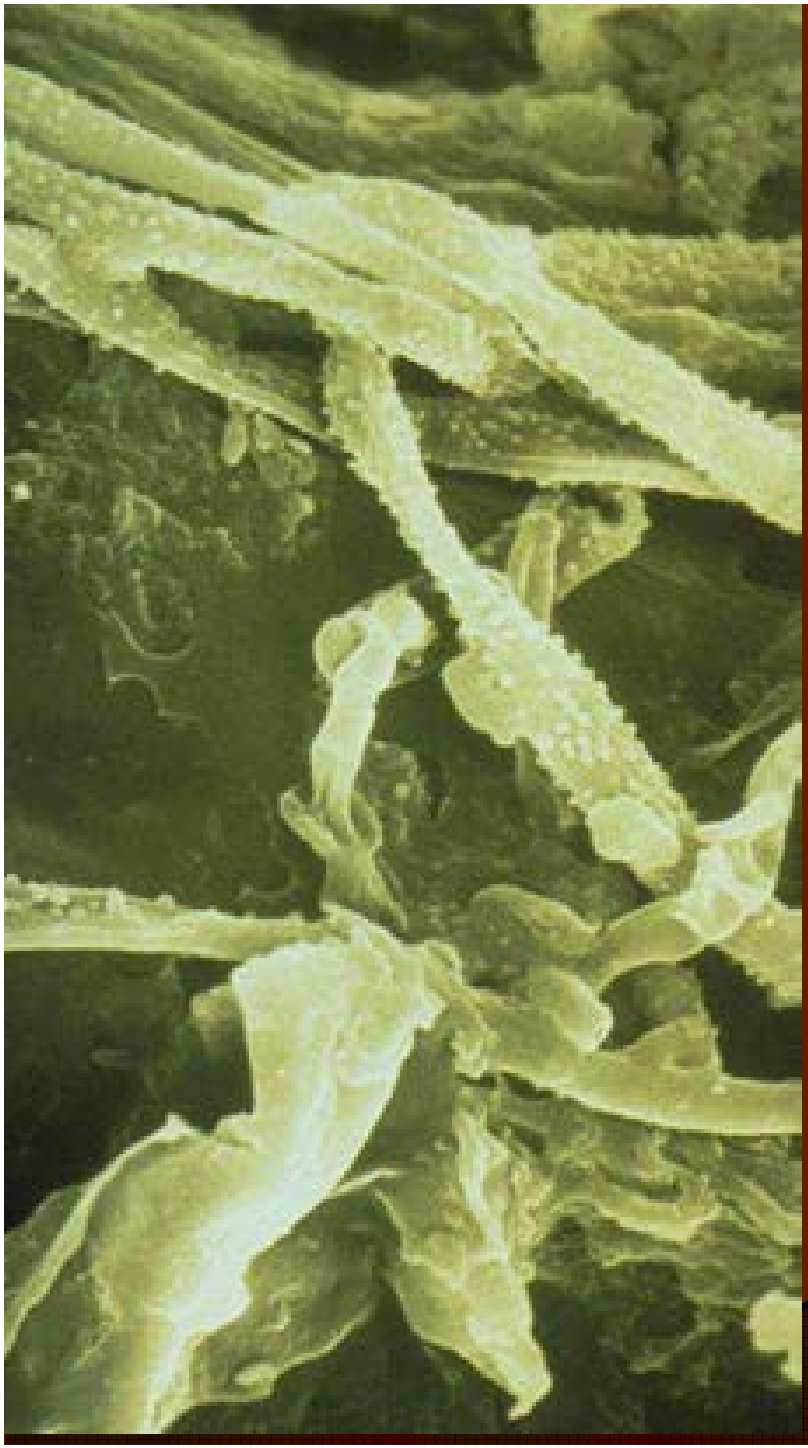
Solvent UST Spill EBuffer
Watertower Paint and Repair
Clear Lake Iowa

PHYTO FUNCTIONS :

- Remove Water
- Stabilization Soil Surface
- Capture & Use Nutrients (N&P)

- Add Carbon
- Adsorb Organic Chemicals
- Adds energy - electron donor
- Add Oxygen
- 10x anaerobic reaction rate
- Adds electron acceptor

Amana Riparian Buffer
Amana Iowa



PHYTO FUNCTIONS :

- Remove Water
- Stabilization Soil Surface
- Capture & Use Nutrients (N&P)
- Adds Carbon and Oxygen

- Stimulation Microbes
- Breakdown Organic BOD
- Oxidize metals
- Bio-complex metalloids

Solvent UST Spill EBuffer
Watertower Paint and Repair
Clear Lake Iowa

Why poplar & willow phyto?

1. Rapid growth, high water and nutrient uptake

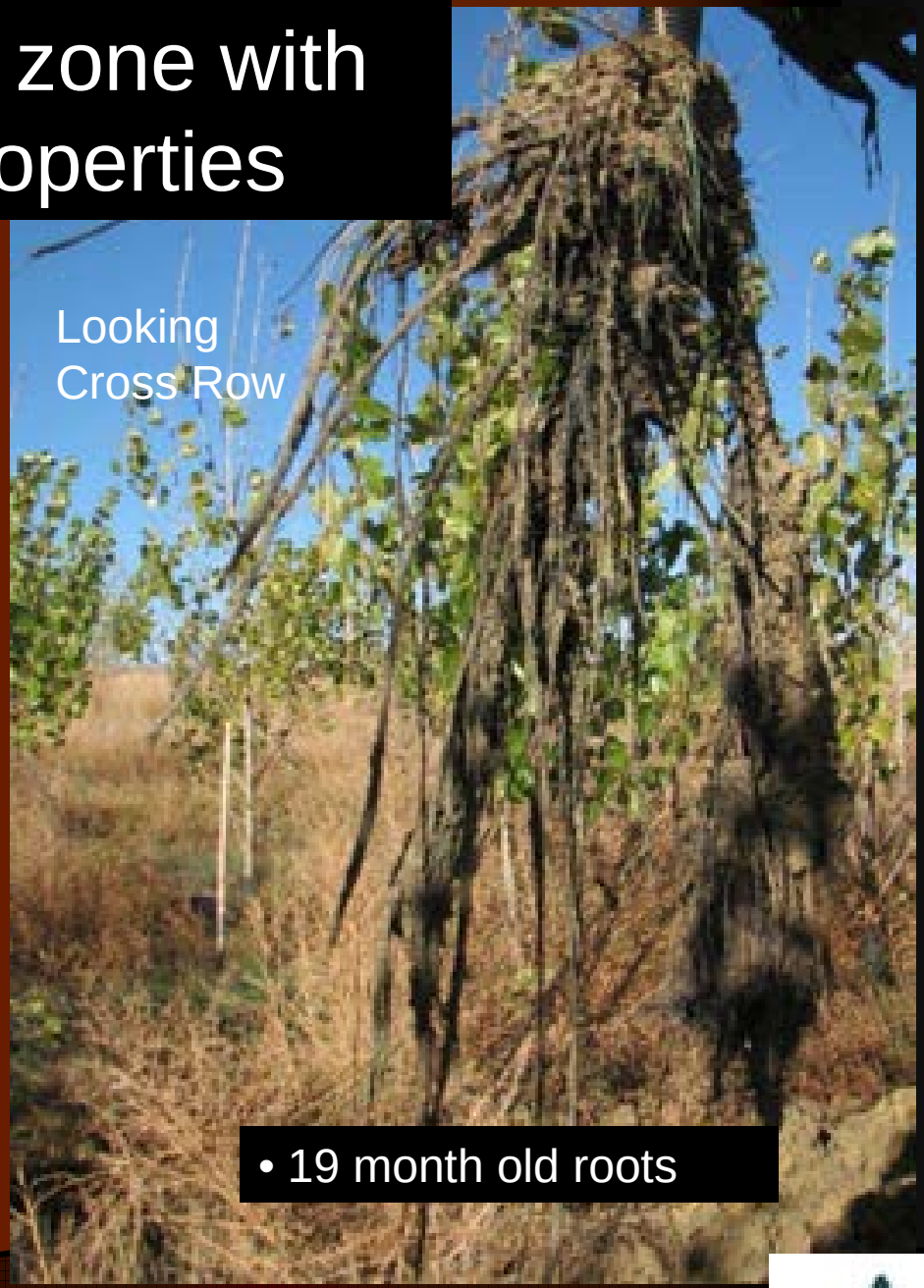
Why poplar phyto?

2. Deep, dense roots to desired depths for a

Predictable Reactor Volume

6 foot deep roots for 5-year old hybrid poplar in Iowa

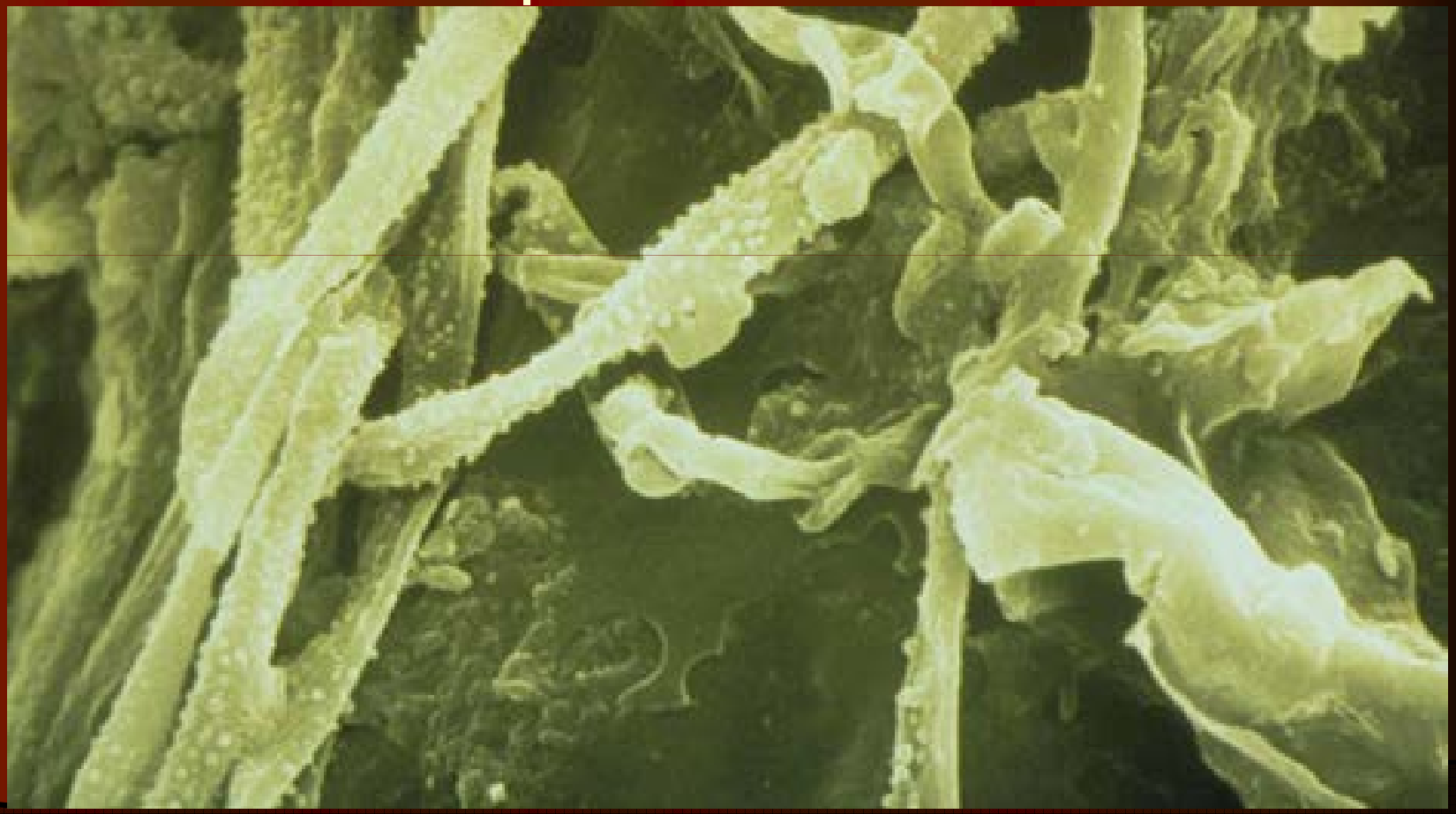
EBuffer root zone with predicted properties



- 19 month old roots

Root-associated

microbes + exudates + plant enzymes
= increased pollutant reaction rates



Why poplar phyto?
3. Controlled and selected genetics

Why poplar phyto?

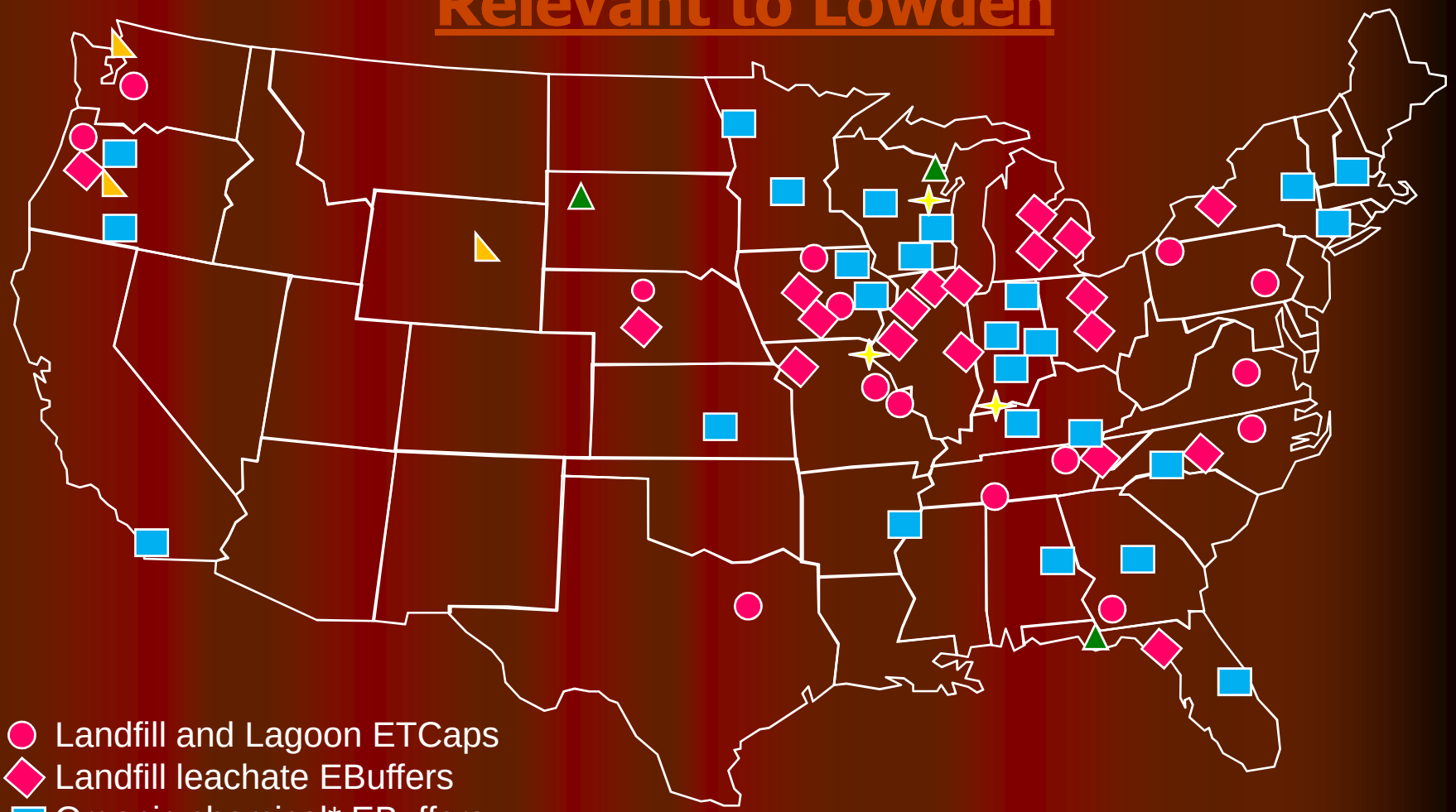
4. More peer-reviewed research than with any other tree The University of Iowa has 39 Ph.D. and 68 M.S. Theses

Why poplar phyto?
5. Over 100 Installed Sites

- Waste water Treatment
- Manufactured gas plants
- Refineries
- Fuel terminals & tank farms
- Military locations
- Cleaning solvent spills
- Landfills
- Urban Brownfields
- Urban and ag stream buffers

2009 Ecolotree Project Sites

Relevant to Lowden



- Landfill and Lagoon ETCaps
- Landfill leachate EBuffers
- Organic chemical* EBuffers
- Arsenic EBuffers
- Brownfield EBuffer
- EWastewater POTW

Why poplar?

6

6. Commodity Cash Crop

Woody Fiber

Lumber, Art, and Renewable Energy

Changes Economics!

25,000
acres trees

Sawmill

Greenwood Industries
Boardman OR

January 2009

Poplar Burn Trial
6 Acres – 9 yr old
Lowden IA.

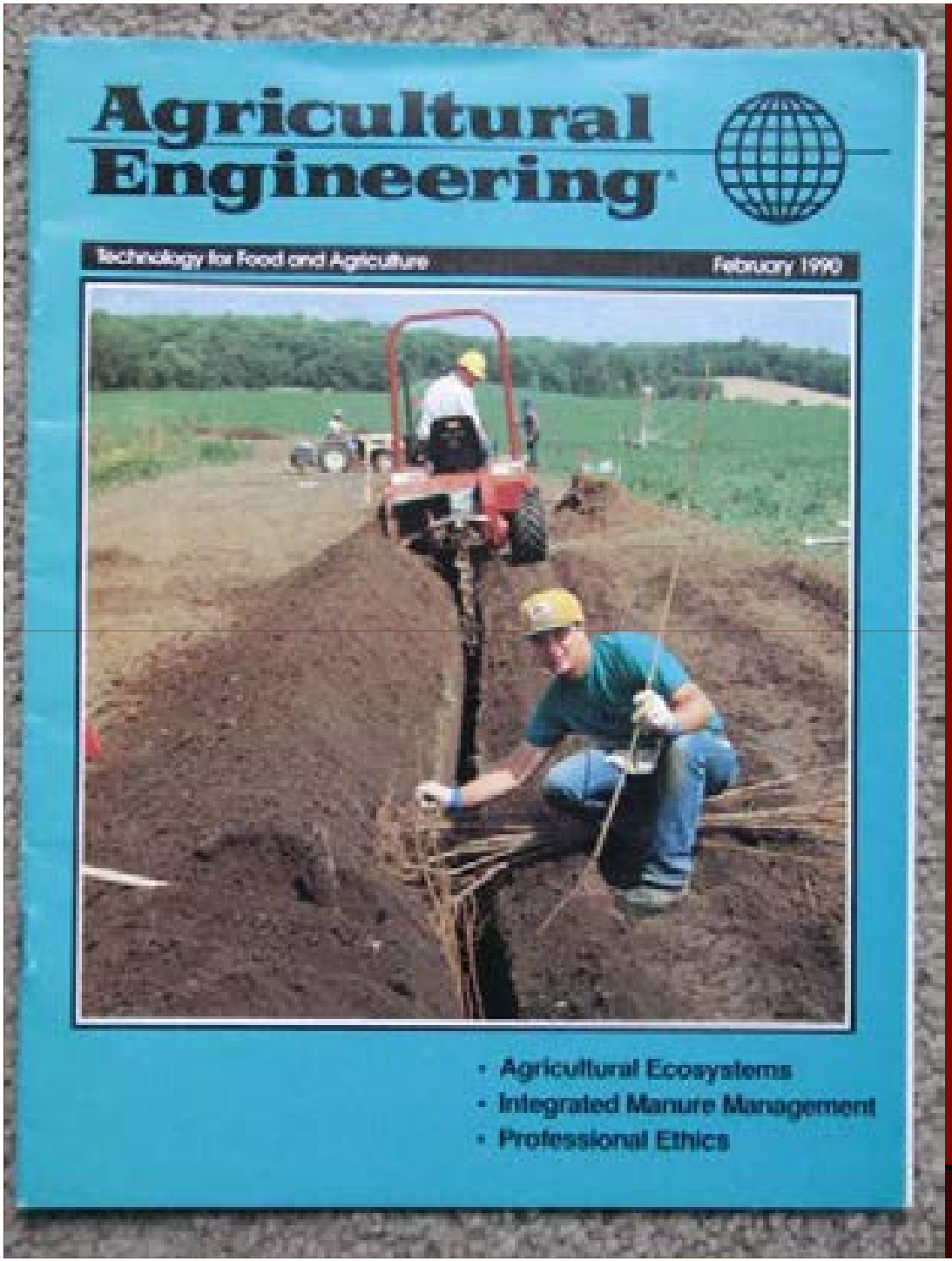
December 2010

Poplar Burn Trial
200 tons
Blended with coal

December 2010

Why poplar?

7. Good-to-Go Now!



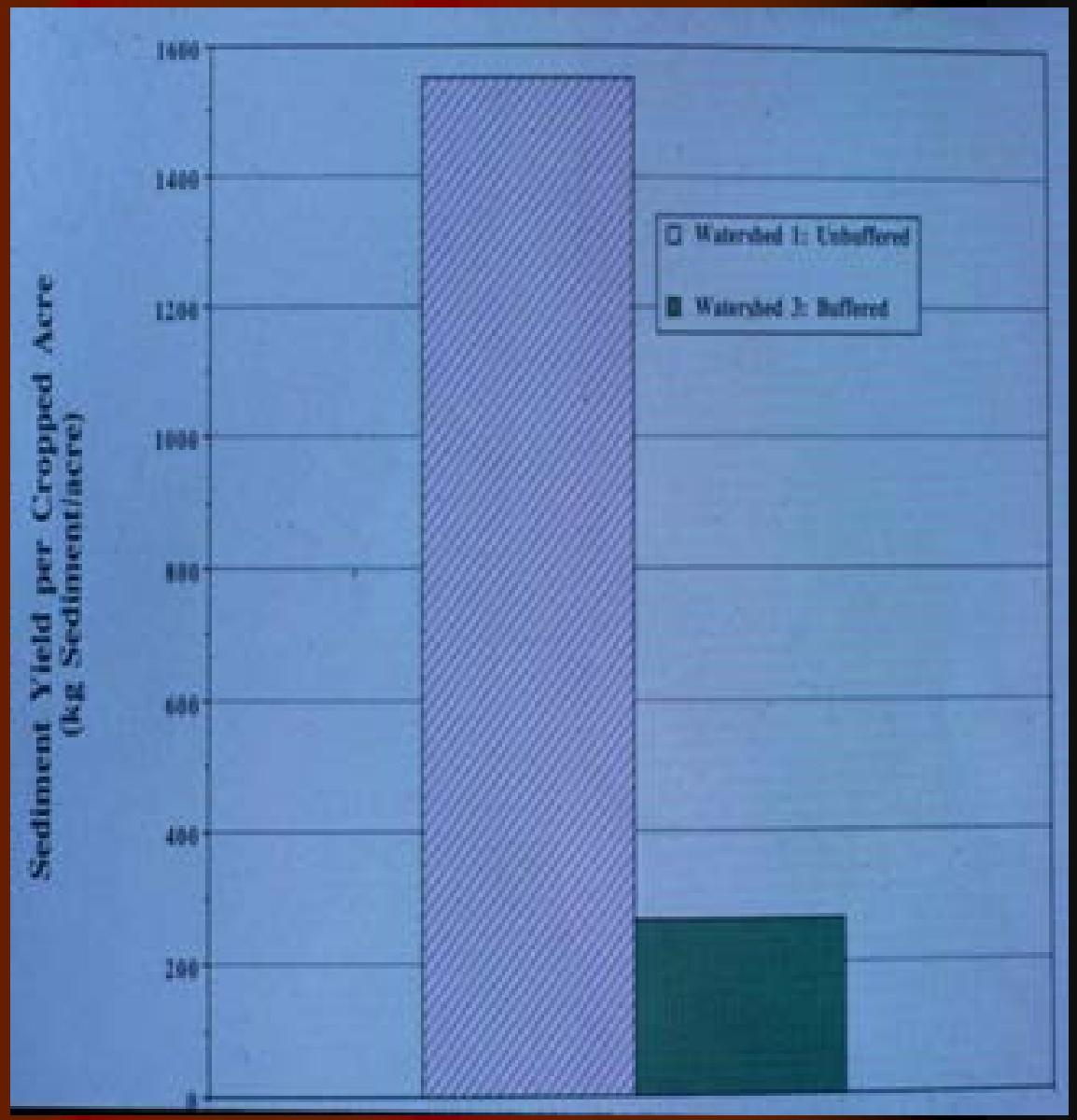
It was 22 years ago that we planted our first poplar Riparian water treatment buffer

funded by Leopold Center for Sustainable Agriculture

The buffer and stream now looks like this!

Amana Iowa

11 years after planting



1993 – two-year riparian poplar buffer reduces sediment in stream by >80%, Amana Iowa

First ECap Prototype - Lakeside Landfill
After planting 7,500 hybrid poplar whips (Earth Day 1990)

Lakeside after 7 Years

October 10, 2009 Welsh Road Landfill, Morgantown PA – 4th Growing season

Goal – No **Further** Engineered Action

October 10, 2009 Welsh Road Landfill, Morgantown PA – 4th Growing season

Good growth & diversity = Water uptake & stability

2010 Landfill Cover Full Site Start Up 3 months – Chicago IL.

EBuffers treat Seeping Landifll Leachate

May 2009 around Air Force Landfill

Zone 3

Chanute AFB, EBuffer 2 Months after installation,

Evansville IN: Retired Oil Distributor ‘Brown Field’ Cleanup

This site was ugly. Soil was 2% Diesel fuel in places

Site west boundary looking North.

Before Planting Site Appearance – March 13, 2007

Site excavation and Sampling – March 28, 2007

1. Top soil 18 inches
2. Gravel layer 4 inches
3. Carbon material 42 inches
4. Native clay below

Note: Buried pipe and groundwater with ‘sheen’

Heavy asphaltic layer with worm at soil interface

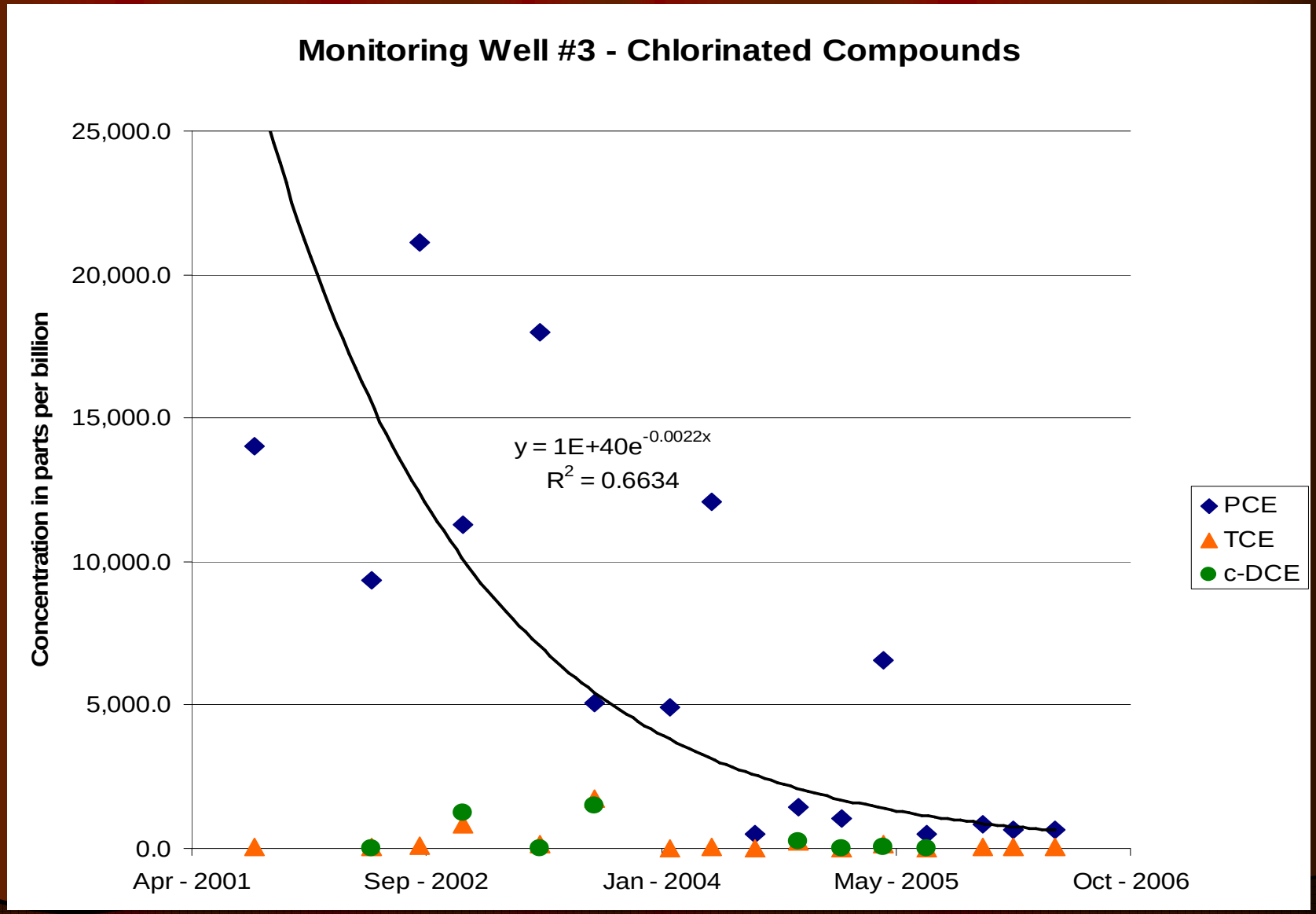
Planting Site – 14 ft rooted poplar in 6 – 8 ft trench

Finishing Zone 3 with grass interplant & drip irrigation

Finished MGP Site Installation – Full Site Closure

Alliant Energy, Fond du Lac WI. MGP site – 24 months after planting

Chlorinated solvent concentration in groundwater samples



Garrett Struckhoff, 2006

Phyto Municipal Wastewater Treatment

Woodburn Oregon

Planted 1995 – Present

Woodburn

Treating N, P, temperature

Irrigating 900,000 gal/day secondary effluent

2006 – 100 irrigated acres

Woodburn

Treating N, P, temperature

Irrigating 900,000 gal/day secondary effluent

2006 – 100 irrigated acres

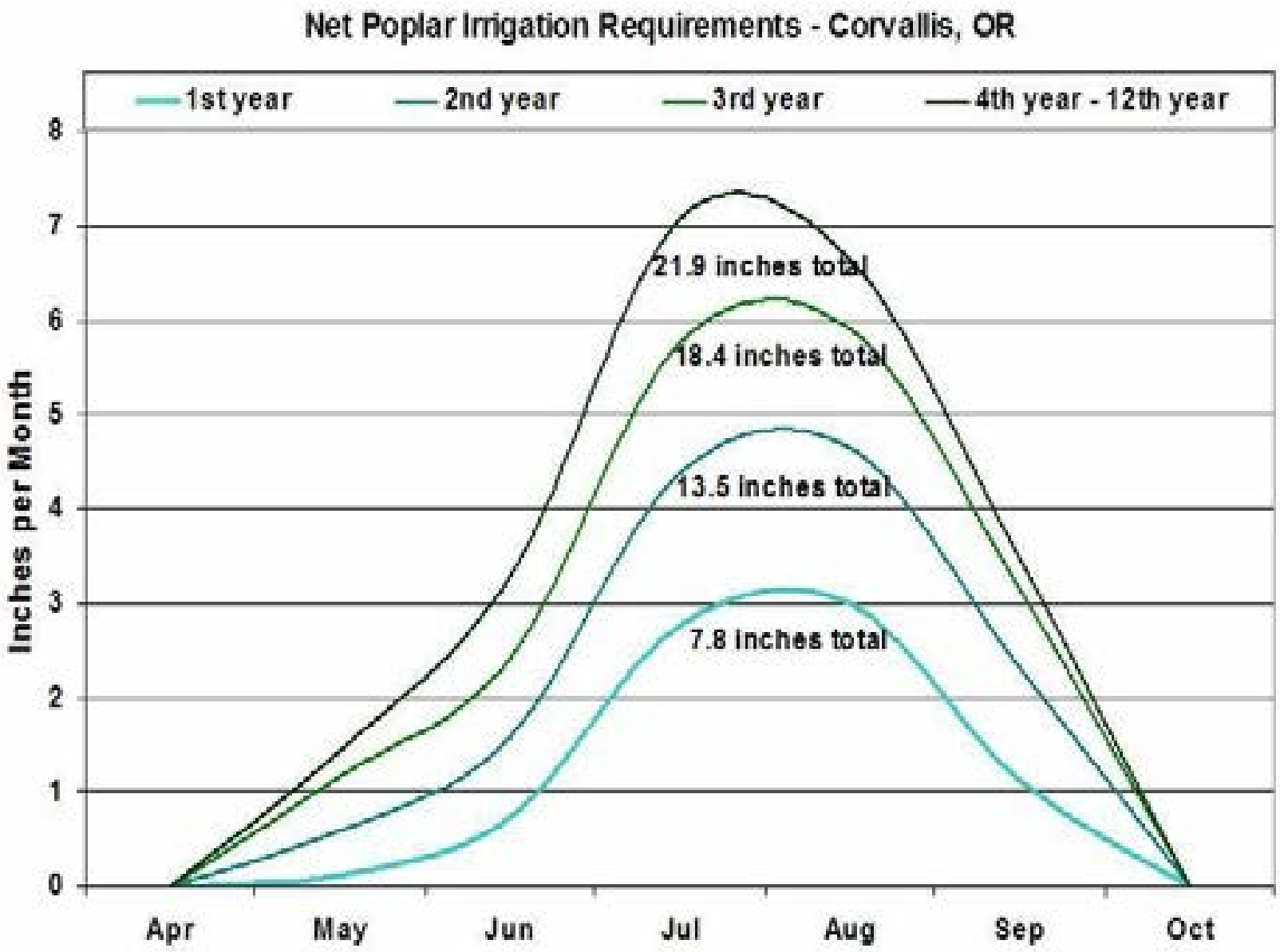
Woodburn

Treating N, P, tempera

Irrigating 900,000 gal/
secondary effluent

2006 – 100 irrigated a

Irrigation Water Use Pattern for Poplar in Washington Like Oregon (Smesrud, 2004)

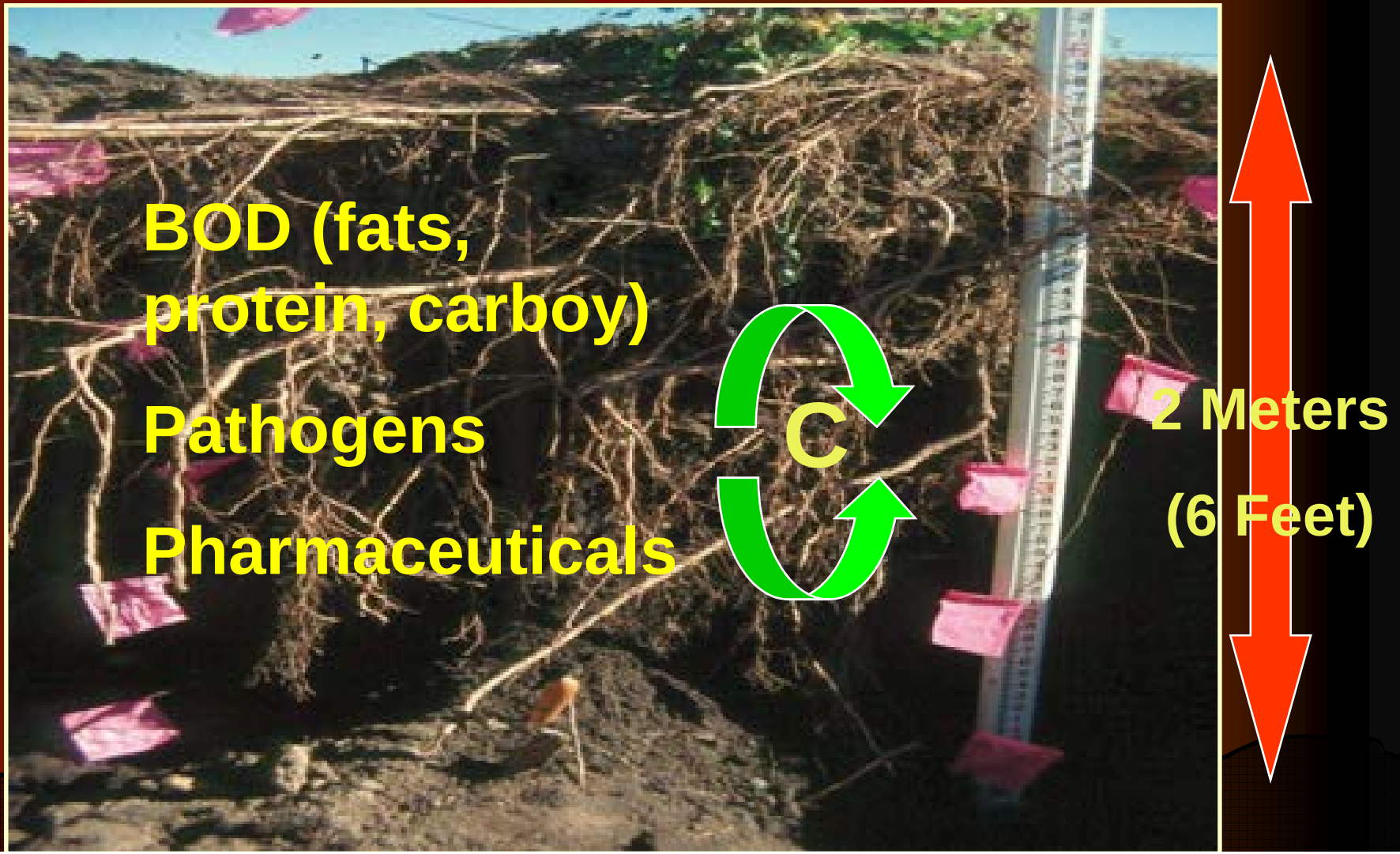


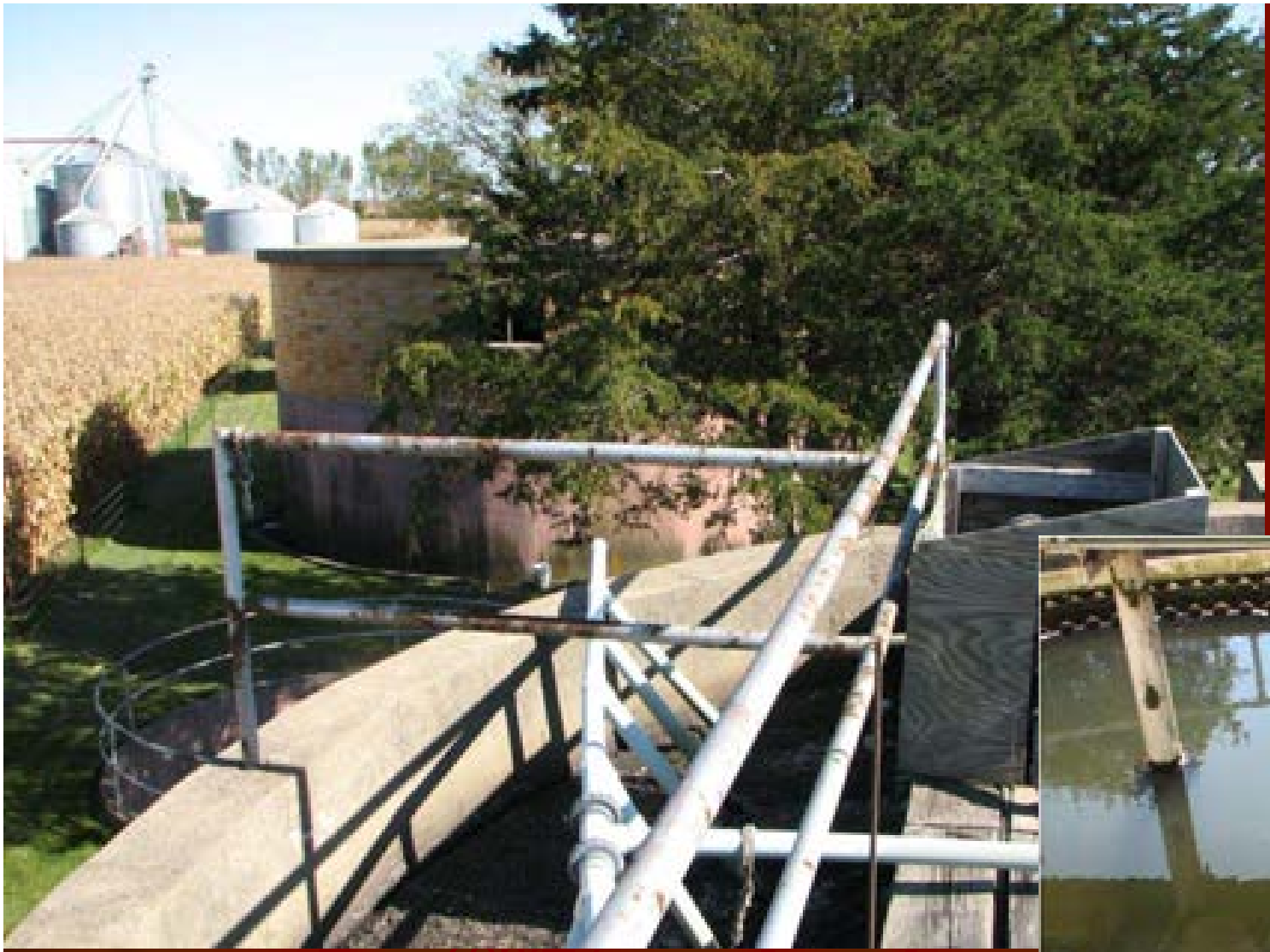
Patterns:

1. Older bigger trees use more water
2. Trees use more water in hotter summer months
3. Midwest water use pattern will be same

Nitrification/Denitrification

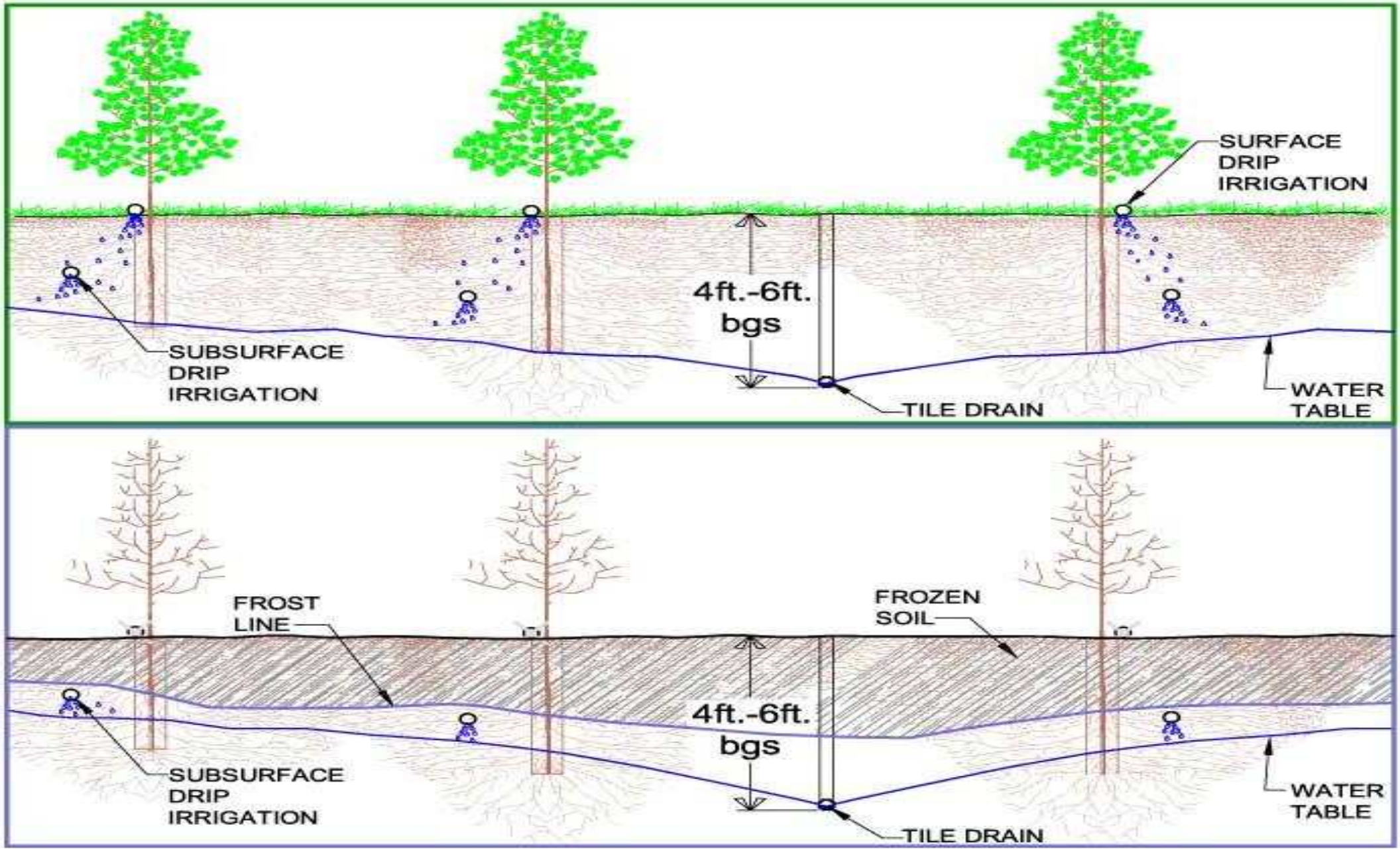
Expect Organics, Pathogens & Pharmaceuticals to be mineralized



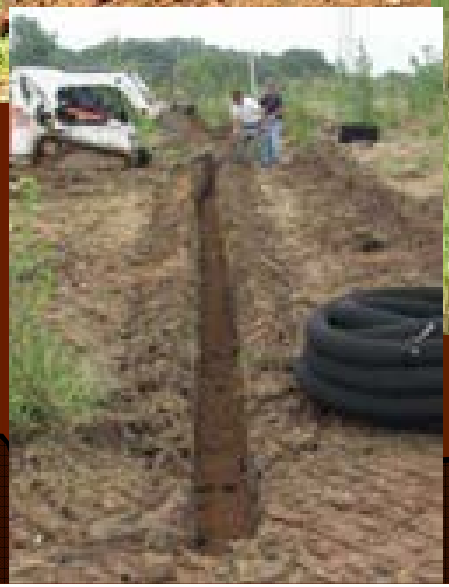


Zone 2

Post-secondary filter, pump, valves



Finished EWastewater Site Operation – Growing & Dormant Seasons



ecolatree

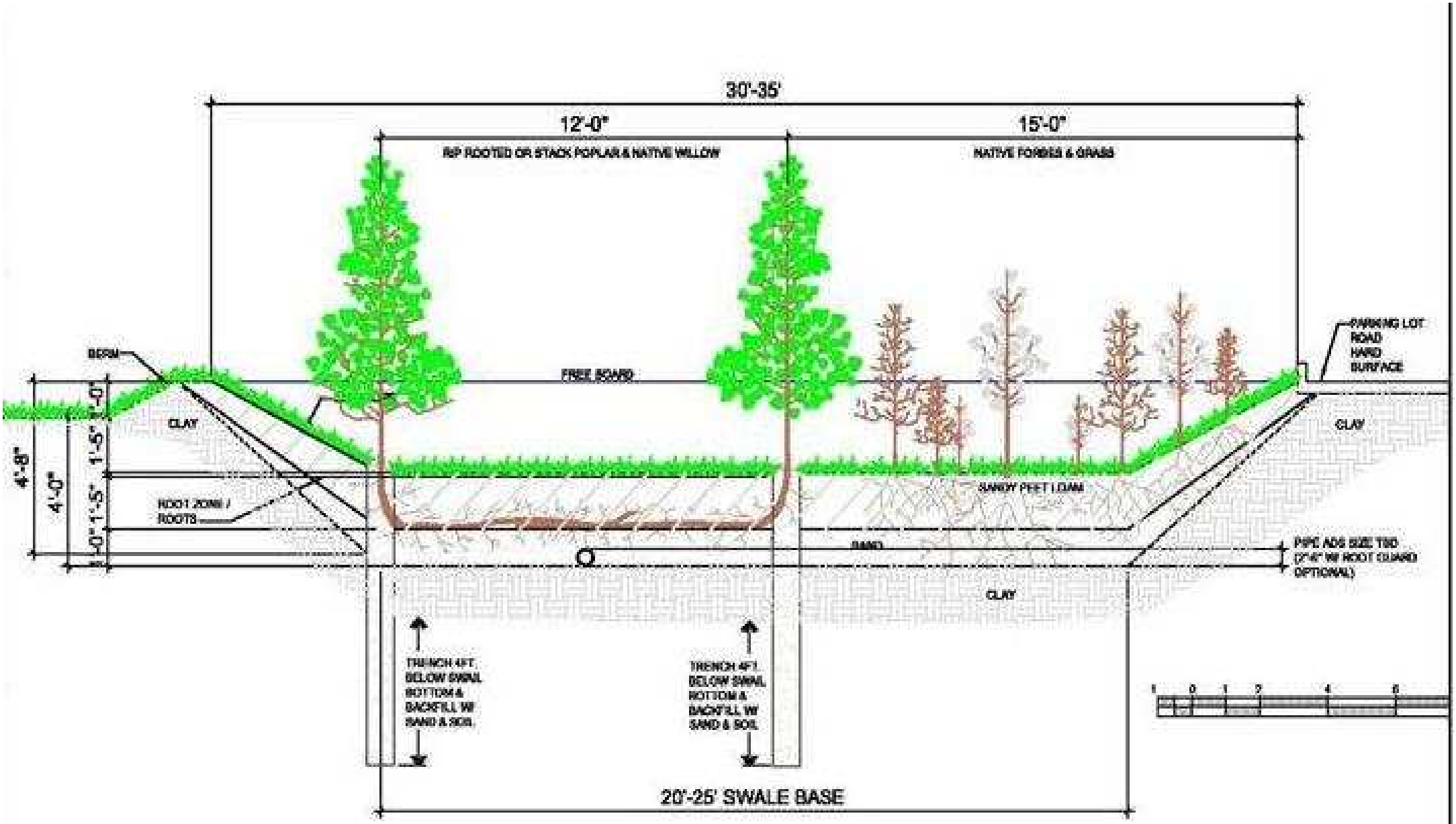
Finished EWastewater Site Installation – Full Site Installation

Proposed location for Ewaste water swail

Existing new Retention Basin Downgrade from Future EBuffer Swale Location

Proposed location for Ewaste water swail

HYUNDAI


30'-35'
12'-0"
15'-0"
BP ROOTED OR STACK POPLAR & NATIVE WILLOW
NATIVE FORBES & GRASS
BERM
FREE BOARD
PARKING LOT ROAD HARD SURFACE
CLAY
CLAY
4'-8"
4'-0"
1'-0"
1'-5"
1'-5"
1'-0"
ROOT ZONE / ROOTS
SANDY PEET LOAM
SAND
PIPE ADS SIZE TBD (2"x6" W/ ROOT GUARD OPTIONAL)
CLAY
TRENCH 4FT. BELOW SWAL BOTTOM & BACKFILL W/ SAND & SOIL
TRENCH 4FT. BELOW SWAL BOTTOM & BACKFILL W/ SAND & SOIL
20'-25' SWALE BASE

2-year Trees on Water treatment Site

•Predicted Rhyzofiltration Pollutant Removal Effect:

Yes! Capture	•Mineral solids – sand, cobble, silt, clay
Yes! Adsorb, Humus	•Organic matter -(BOD)
Yes! Adsorb,Uptake	•Nutrients that accelerate algae growth (N & P)
Yes! Capture many	•Fecal pathogens (Virus, bacteria, fungus)
Some! Adsorb& Breakdown	•Pharmaceuticals – man-made drugs and hormones
Yes! Capture, Adsorb, Humus & Breakdown	•Petrochemicals Pesticides, herbicides, •Automotive oils, fuels, grease •Industrial & home – paint, degreaser
Yes!Precipitate, No! Not table salt	•Metals (Cu, Zn, Pb) •Salts – sodium chloride, ice remover, sea spray

Phyto's BIG IDEA:

1. Every drop
2. passes within an inch of a root
3. before it reaches a drain pipe or percolates.

Barje Landfill Sept. 14, 2010

Ljubljana Slovenia

Landfill Phyto Cover

10 Hectares Planted in ‘93

Now Repurposed as Golf Course

Pollutant Management by Phyto

1. Soil/Plant covers – keep pollutants from moving
2. Root/amendment/water – capture and break down
3. Swale/percolate/treat – runoff pollutant treatment
4. Irrigate/percolate –water pollutant treatment plant

1. Air pollutant capture – solids and aerosols
2. Sound energy reduction

1. Greenhouse gas uptake or conversion