13th Annual OSC Readiness Training Program

# Greening Response Actions II

Training by OSCs for OSCs

February 1-4, 2010
Orlando, Florida
www.oscreadiness.org

# Agenda

- Introduction (Carlos Pachon, OSRTI)
- Contracting Toolkit (Art Wing, Region 1)
- Barker Chemical Site Case Study (Kevin Matheis, Region 2)
- Discussion
- Break
- Camilla and Barite Hill Sites (Leo Francendese, Region 4)
- Phytoremediation with Solar Powered Irrigation (Miles Bartos, Region 3)
- Green Response and Transportation (Sean Sheldrake, Region 10)
- Delfasco Vapor Intrusion –A Green Remedy (Greg Fife Region 6)

»

13th Annual OSC Readiness Training Program

# Greening Response Actions

Presenter: Carlos Pachon, OSRTI

Date: February 1

Time: Afternoon sessions

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# Overview 2010 OSC Readiness Greening Response Action

1. What is a greener removal and what are our mandates and authorities. Carlos Pachon
2. Planning, implementing and reporting for green removals. Art Wing
3. Taking it to the site – just do it!

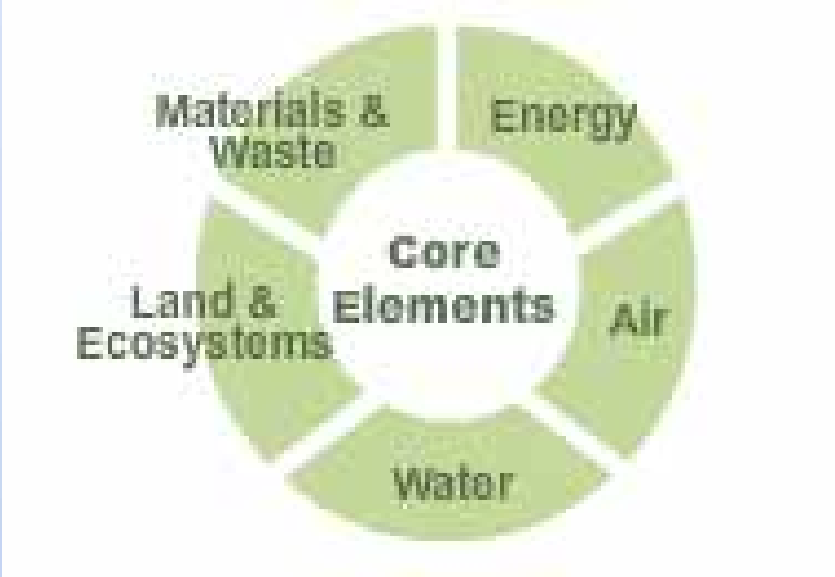
- Kevin Matheis (Baker Chemical)
- Leo Francendese (Camilla and Barite Hill)
- Myles Bartos (Crozet)
- Sean Sheldrake (Clean diesel)
- Greg Fife (Delfasco)

## What is “Green Remediation”?

*Green remediation is the practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprints of cleanup actions.*

# Green Remediation: Common Themes in Site Cleanup Programs

- Fits within existing frameworks
- Opportunities exist throughout site investigation, design, construction, operation, and monitoring
- Addresses core elements



| Diesel Consumption in an Illustrative Excavation and Soil Amendment Project | Diesel Consumption (gallons) | PM Emission (pounds)[a] | NOx Emission (pounds)[a] | $CO_2$ Emission (tons)[a] |
|---|---|---|---|---|
| Removing contaminated soil through use of an earth mover with a 1990 200-hp engine operating for 100 days | 6,400 | 100 | 1,100 | 70 |
| Hauling 35,000 yard$^3$ of excavated soil to an offsite waste disposal facility 300 miles away, by way of 60-yard$^3$, 425-hp tractor trailers[b] | 77,000 | 770 | 10,970 | 850 |
| Importing wood milling and agricultural waste from sources 50 miles away, by way of a 60-yard$^3$, 300-hp truck[b] | 2,400 | 100 | 1400 | 30 |
| Applying 2,000 tons of soil amendments over 20 acres, using a 1990 290-hp, 60-yard$^3$ dump truck and 1990 170-hp grader | 260 | 8 | 1 | 3 |
| Using two medium-duty pickup trucks for site preparation and remedy construction over six months[b] | 380 | 7 | 170 | 4 |
| **Total diesel consumption and air emissions** | **86,440 gallons** | **985 pounds** | **13,641 pounds** | **957 tons** |

[a] Diesel Emissions Quantifier; http://cfpub.epa.gov/quantifier/view/welcome.cfm

[b] including use of ULSD, as required for on-road applications

Adding retrofitting devices such as a NOx catalyst and a diesel particulate filter could reduce these emissions by as much as 25% for NOx and 90% for PM.

## Core Elements: Air Emissions

- Lower air emissions leading to reductions in harmful particulate matter and ground-level ozone precursors
- Alternative vehicles
- Advanced diesel technology retrofits
- Alternative fuels and fuel additives
- Effective operations and maintenance procedures to assure vehicle and equipment efficiency

*Diesel oxidation catalysts, diesel particulate filters, selective catalytic reduction, and ultra-low sulfur diesel are options for reducing emissions from onsite equipment*

*Diesel Multistage Filter retrofitting of this emergency response vehicle was completed in 2008 as part of Region 10's ongoing clean emission initiative.*

# Core Elements:
# Water Requirements & Resources

- Minimum fresh water use and maximum reuse
- Prevention of water quality impacts, e.g. nutrient-loading or disruption of natural hydraulics
- Reclaimed treated or stormwater for beneficial use or storage
- Alignment with proposed EPA rule on construction effluent:
  - Specific BMPs at all construction sites
  - Sediment basins at sites > 10 acres
  - Numeric limits of turbidity at sites > 30 acres with high rainfall and clay content

*Portable closed-loop wheel washing systems for reducing onsite and offsite trackout during construction*

*Rock-filled stormwater channels and erosion control blankets used for excavation and backfilling at former U.S. Navy landfill*


*http://cicacenter.org/cs.cfm*

## Core Elements: Land & Ecosystems

- Minimal habitat disturbance such as noise and lighting
- Soil and sediment protection from compaction, decon, or uncontrolled traffic
- Use of local byproducts such as fly ash or ag waste
- Ecosystem restoration and protection practices such as selecting native plant species and relocating affected animals

*"I promise I'll walk and feed him"*

*… alligator rescues during removal actions at contaminated swampland in Georgia*

*Ten years after applying municipal biosolids and assorted nutrients along the Arkansas River*

*Metal salt crust along Upper Arkansas River in Colorado prior to Superfund removal*

# Core Elements:
# Material Consumption & Waste Generation

- Site cleanups often require demolition work, use raw materials and generate waste
- Reuse and recycling of materials, including C&D debris and clean metal
- Reduction of secondary wastes such as soil corings, wastewater, expended chemicals, routine supplies, and single-use materials
- Passive sampling devices producing minimal waste
- Minimized extraction and disposal of natural resources

*10,000$^3$-yd soil removal in Georgia yielding 280 tons of scrap steel and 58 tons of tin left by past wood treating*

*Concrete salvaging during cleanup at Barksdale AFB in Louisiana to help meet federal "greening the government" goals*

*Triad planning for 10-day mobilization to investigate plus conduct removal at Paducah GDP in Kentucky, and only 23 lab samples*

## Core Elements: Energy Requirements

- Optimized passive-energy technologies (with little or no demand for external utility power) to treat low levels of contamination
- Energy efficient equipment operating at peak performance
- Renewable energy systems in remote locations or to offset grid electricity

*PV array for pumping 2-3 gpm of water through a low-energy mulch bioreactor at Altus AFB*


*Portable PV system for 5-month SVE operations after oil pipeline break at Rocky Mountain House air base in Alberta, Canada*

# Is It Your Job ?

## OSWER Policy: Principles for Greener Cleanups

*As a matter of policy, OSWER's goal is to evaluate cleanup actions comprehensively to ensure protection of human health and the environment and to reduce the environmental footprint of cleanup activities, to the maximum extent possible. (OSWER A.A. Mathy Stanislaus)*

## EPA Strategic Plan: Goal 5 Compliance and Environmental Stewardship

*Stewards of the environment recycle wastes to the greatest extent possible, minimize or eliminate pollution at its source, conserve natural resources, and use energy efficiently to prevent harm to the environment or human health. By 2011, enhance public health and environmental protection and increase conservation of natural resources by promoting pollution prevention and the adoption of other stewardship practices by companies, communities, governmental organizations, and individuals. (EPA Administrator Steve Johnson)*

## EO 13514: Federal Leadership in Environmental, Energy, and Economic Performance

*It is the policy of the United States that Federal agencies shall increase energy efficiency; measure, report, and reduce their greenhouse gas emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and stormwater management; eliminate waste, recycle, and prevent pollution (President Obama)*

## FEMA Post-Disaster Sustainability Mission Statement

*To promote and facilitate sustainable redevelopment at the local level by integrating the principles and practices of sustainable development into the broader goals of the post-disaster recovery process. EPA support to FEMA sustainability planners includes determining whether major environmental issues could be partially addressed through a sustainability initiative. Immediate disaster recovery processes (described in "Rebuilding for a More Sustainable Future: An Operational Framework") address sustainable public infrastructure including water, sewer, and energy systems. The guidance also may be used as a reference during non-disaster time.*

# Green Remediation and Fund-Lead CERCLA Removal Actions

- Triggers for conducting an action must be met
  - Release or threat of release of a hazardous substance
  - Release or threat of release of a pollutant or contaminant that causes an imminent and substantial endangerment
  - At least one of the NCP 300.410(b)(2) factors are met
- Once statutory and regulatory triggers are met, Section 300.410(b)(1) states:
  - ". . . the lead agency may take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or the threat of release."
  - NCP does not dictate how actions are to be conducted
- Use of green remediation concepts is an implementation issue decided on a site-specific basis

# Use of Green Remediation Concepts Fall Into the Same Category as Many Other Implementation Issues

- Implementation issues are determined by the OSC in consultation with the removal action contractor considering many different factors, including best management practices, health and safety, and community interests
- Examples of just a few implementation issues
  - Operating hours
  - Specific equipment to use
  - Need for internet connection
  - Office space and office equipment
  - Landscaping for site restoration
  - Future use of site
  - Use of local subcontractors

# Can EPA Recover Costs for Fund-Lead Removal Actions that Employ Green Remediation Concepts?

- CERCLA Section 107(a)(4)(A) and NCP Section 300.700(c)(1):
  - Responsible parties shall be liable for all response costs incurred by the United States government or a State or an Indian tribe not inconsistent with the NCP
- Cost recovery provisions apply to response costs for hazardous substance releases
- All response costs can be recovered as long as those costs are "not inconsistent with the NCP"
  - CERCLA and the NCP provide the lead agency great discretion in how removal actions are implemented once the lead agency determines that a removal action is necessary
- Implementation of green remediation concepts should not be inconsistent with the NCP

# What About PRP-lead Removal Actions?

- Actions conducted under Administrative Orders on Consent
  - The use of green remediation concepts could be negotiated with the PRP and made a part of the work plan
- Actions conducted under Unilateral Administrative Orders
  - There would be less flexibility in this case
  - UAOs would not necessarily compel the use of green remediation concepts
  - OSCs could, however, encourage the use of green remediation concepts on a voluntary basis

# Greening Your Projects: Strategies

- Two step process:
  1. Be aware of the options you have at your projects
  2. Use your authorities and resources to put them in place (more under toolkit presentation)
- Network with fellow OSCs
- Discuss with your management
- Keep an eye on other programs (BF, RCRA-CA, Superfund Remedial, UST, etc). Different programs, but similar activities

# For more and future information

## www.clu-in.org/greenremediation/osc

pachon.carlos@epa.gov

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# Contracting Toolkit

Presenter: Art Wing

Training by OSCs for OSCs

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# Barker Chemical Site
# Somerset, NY
# Greening Response Actions

Kevin Matheis, OSC Region 2

# Barker Chemical Site Background

- Operated as an agricultural chemicals blender. Primarily produced fungicides and herbicides that were used in local area orchids.
- 10 acres site, consisting of 4 buildings in front of site, a drainage ditch, two acidic lagoons, and one filled lagoon.

# Regulatory History

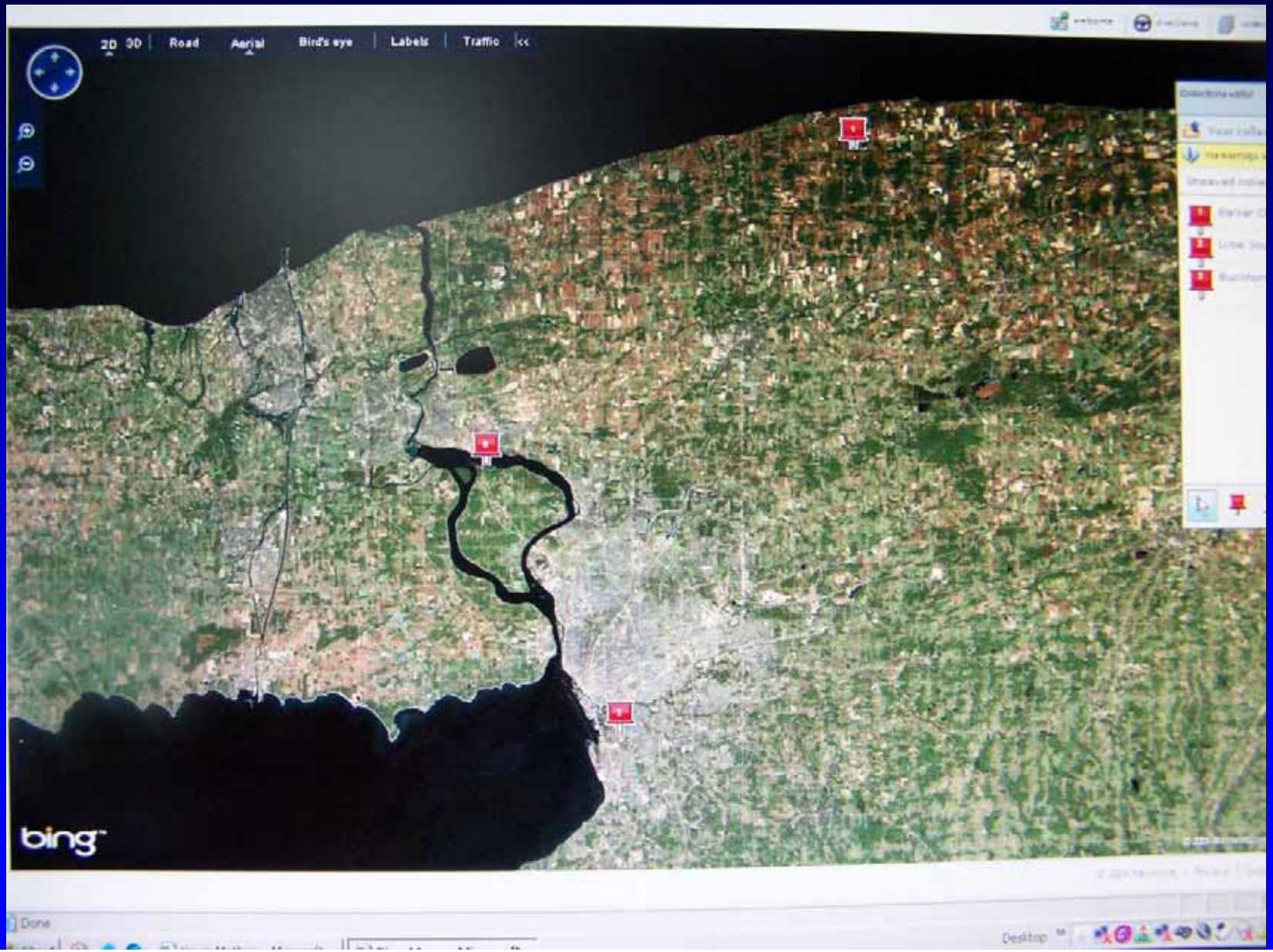
- 1999 – Niagara County Brownfields program places site on inventory; requests NYSDEC assistance.
- December 1999 and January 2000 – NYSDEC collects samples at the site.
- January 2000 – NCHD notifies citizens of low pH conditions at the site, issues a Public Health Advisory

# Regulatory History

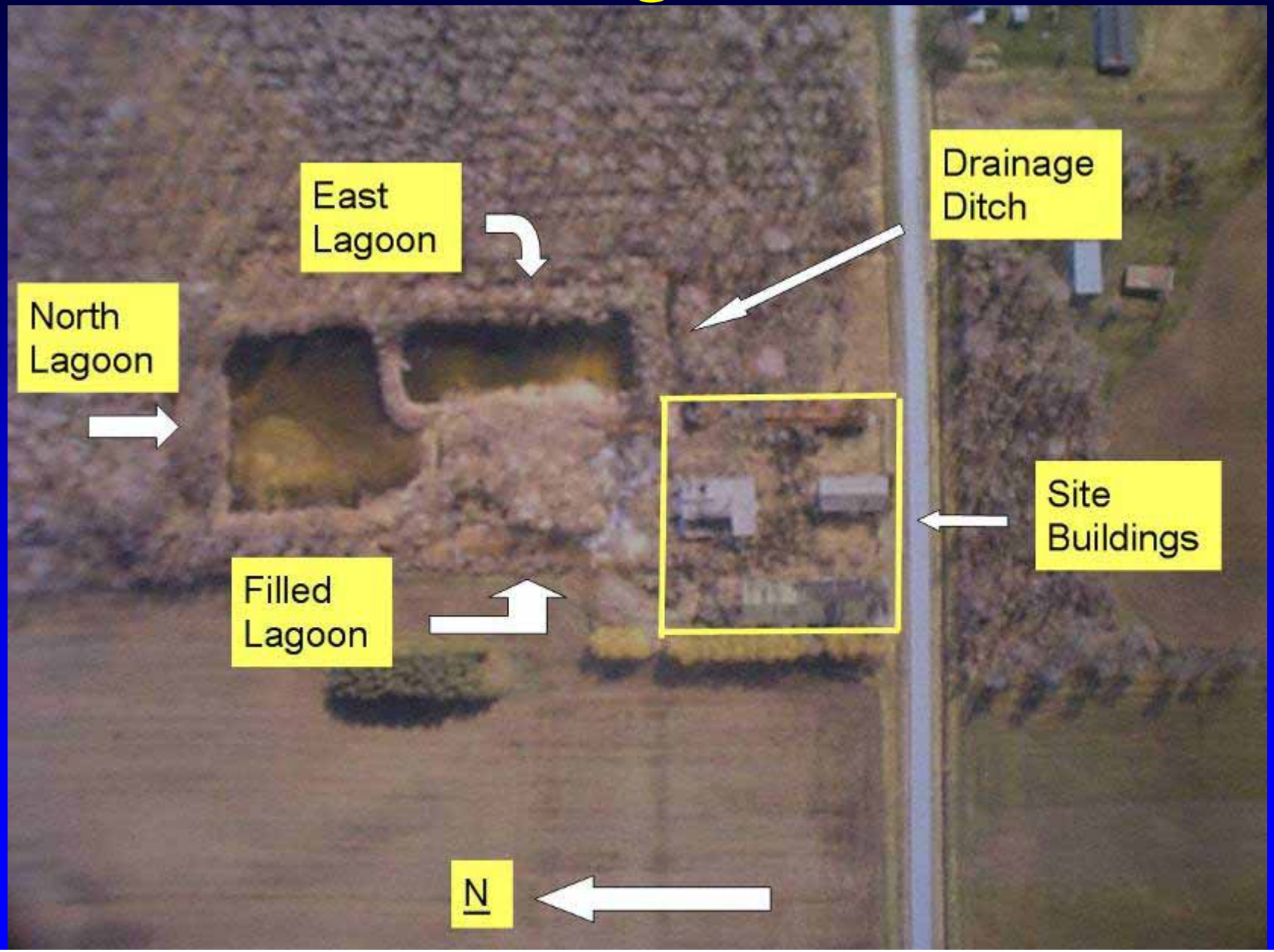
- February 2000 – NYSDEC erects fence around low-pH areas and posts warning signs.
- May 2000 – NYSDEC requests assistance from EPA to assess conditions at site.
- June 2000 – EPA on-site to collect samples.
- October 2000 – EPA on-site to begin site cleanup.

# Site Location

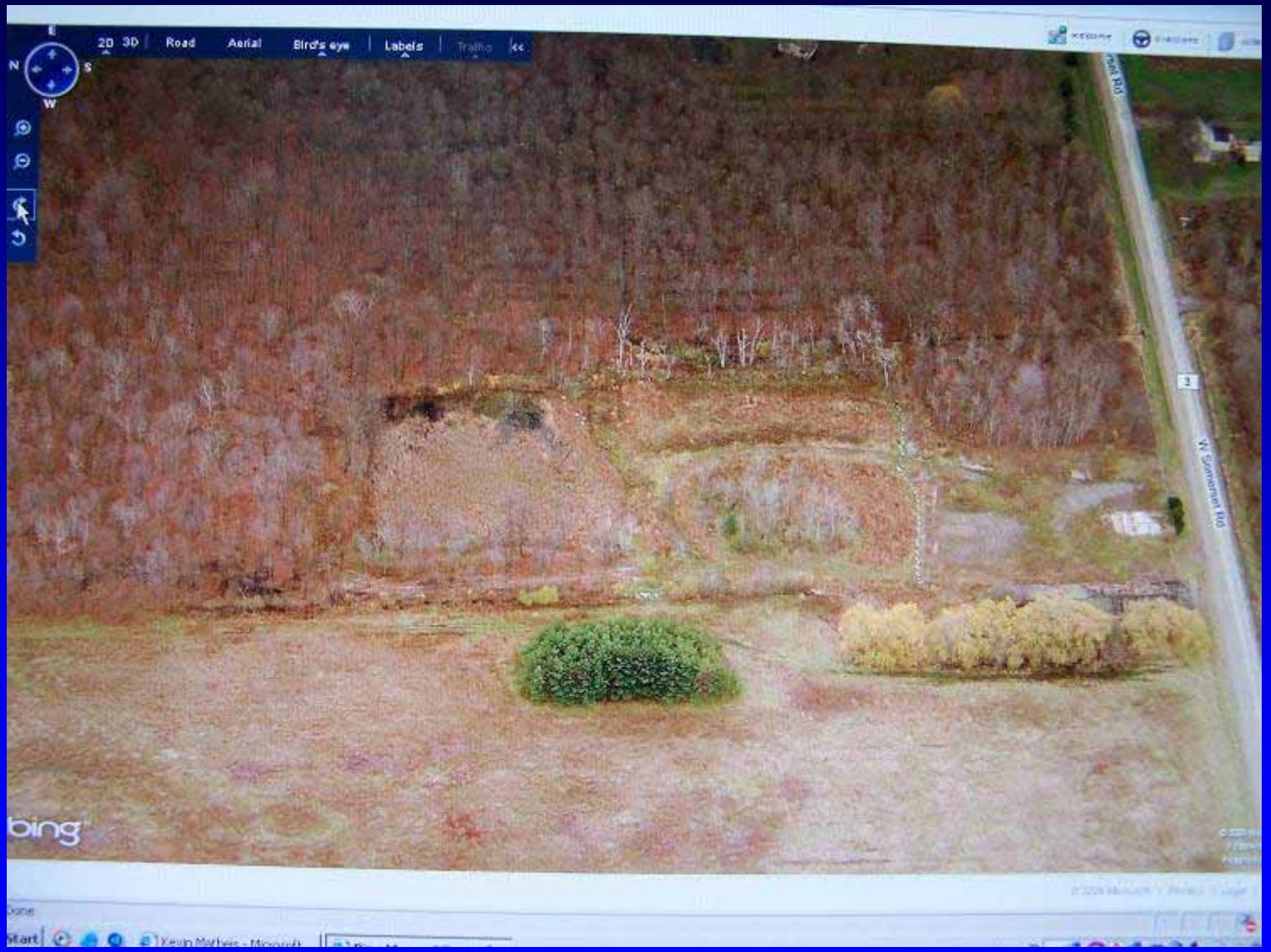
# Site Location



# Barker Site Background 1998 aerial



# Site Aerial Post-Removal ~ 2005



# Geological Information

- Former Lake Iroquois glacial lake bed ~ 55,000 years ago.
- Wisconsinan Glaciation occurred, and now is near Lake Ontario in present landform ~ 12,000 years
- Site located in glacial till and former lake bed, consisting of ground moraine of silty and sandy clay, and generally very impermeable.
- Bedrock @ 30 feet is shale/sandstone – Early Silurian (430my)

# ERT Sampling

# ERT Sampling

# ERT Sampling

# ERT Sampling

# ERT Sampling

# Results of ERT Assessment

- Low pH levels confirmed in 2 lagoons. North Lagoon had 1-2 feet of sludge, East lagoon 6 feet of sludge, and filled lagoon 4-8 feet of sludge.
- Drainage ditch contaminated with 321ppm arsenic.
- Northern area of North Lagoon contaminated with 2,100ppm or arsenic.

# Pleasant Surprises

- Lagoon sediment metals low, no pesticides and herbicides, non-haz, with low amounts of sulfur, iron and copper.
- Filled lagoon sediments also non-haz for metals and herb / pesticides.  Elevated levels of sulfur.
- Drainage ditch, though low in pH, had slightly elevated levels of arsenic, with no impact on unnamed creek, a tributary of Golden Hill Creek, which directly discharges into Lake Ontario.

# Scope of EPA Cleanup

- Excavation and off-site disposal of sulfur- and arsenic-contaminated soils.
- Pump water from ponds into an on-site waste water treatment system; verify treatment system is working properly and discharge into sewers. Operation to be coordinated with local sewer authority.
- Stabilize sediments from ponds and either cap sediments or dispose off-site.

# Scope of EPA Cleanup

- Demolish two on-site buildings and assess flooring to determine if contamination exists. Remove contamination, if necessary.
- Clean tank on-site (pesticide tack oil) and remove contaminated soils if found.
- Restoration of site at completion of on-site actions.

# Site Operations - Demolition

# Site Operations - Demolition

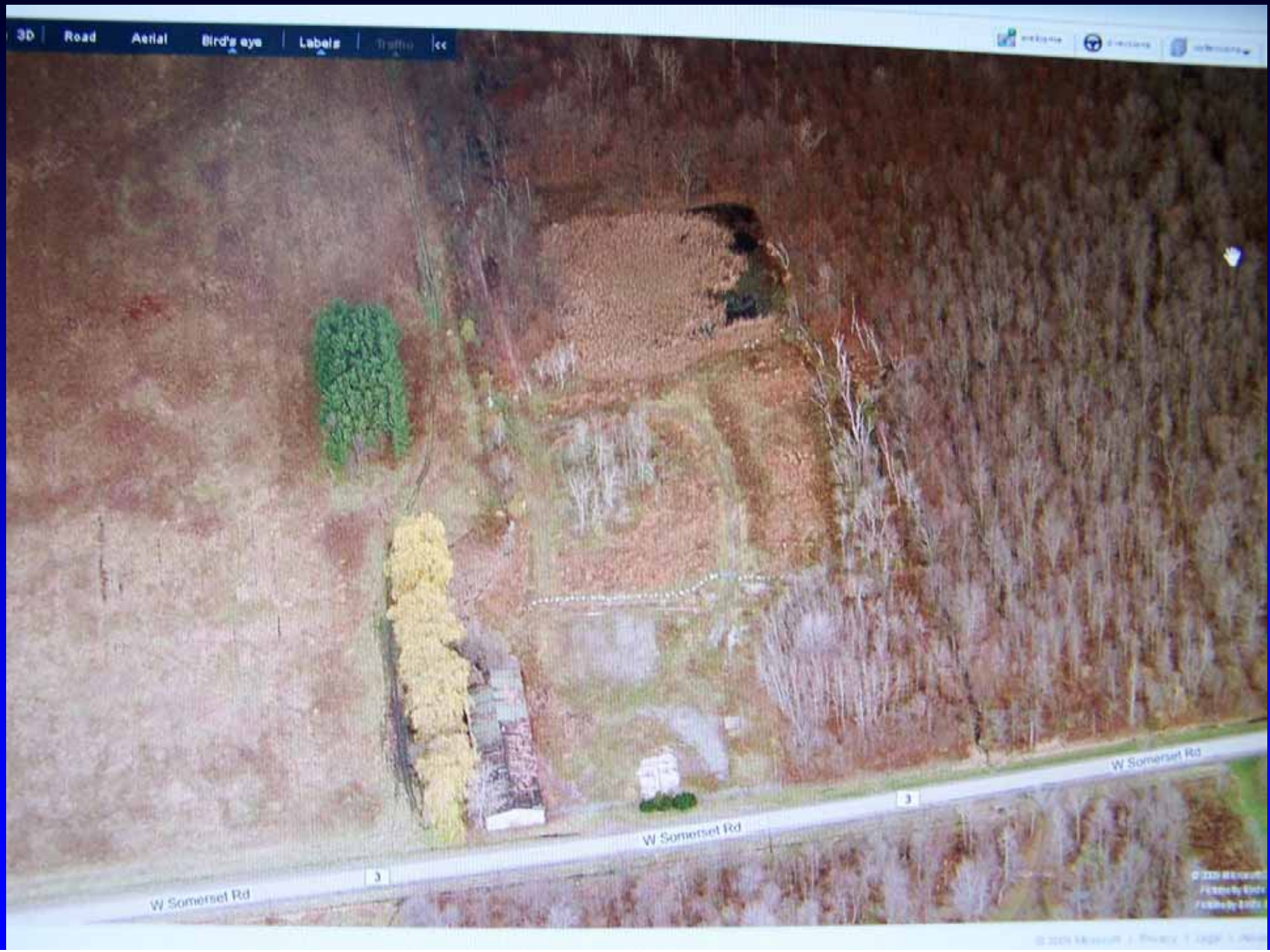
# Site Operations - Demolition

# Cleanup Operations - Demo

# Cleanup Operations – Site grading

# Lagoon Access

- Due to high water table, and sludge and stability, a loop roadway, capable of supporting trucks was constructed.
- East Lagoon acid water pumped into North Lagoon to dewater.
- Roadway with geo-textile, larger stone capped with smaller stone.  Used existing pond berms to construct.


3D
Road
Aerial
Bird's eye
Labels
W Somerset Rd
3
W Somerset Rd
3
W Somerset Rd

# Roadway Construction

# Roadway Construction

# Loop Roadway Construction

# Loop Roadway Construction

# Ditch Excavations

# Ditch Excavation

# East Ditch Consolidation

# Load-out of Sulfur and Ditch soils

# Load out of Sulfur and Ditch Soils

# Lagoon Test Pit

# Stabilization Recipe

- Since sludge was contributing factor with low-pH generation, but non-haz for all test results, stabilization and capping were the preferred remedy.
- ERRS contracted with specialty subcontractor to come up with stabilization recipe that could utilize slake lime (by-product of acetylene gas manufacturing) from a Buffalo, NY brownfield.

# Stabilization Recipe

- Sludge was stabilized with 5% Portland cement, 20% slake lime, and 75% sludge. For dewatering purposes, clay was also added to mix.
- Long reach excavator used for stabilization.

# Stabilized Material

# Stabilization Materials

- Lime from Brownfields site in Buffalo
- Portland Cement from local quarry
- Clay from local borrow pit

# Stabilization Process

- Trucked in Lime and Portland cement. Set materials aside and blended with long reach excavator.
- Once stabilization completed, 1 foot of clay and 1 foot of topsoil were used to complete the cap.

# NYSDEC Restoration

# Lime Source

- 90 Hopkins Street Site in Buffalo, by product of acetylene gas production

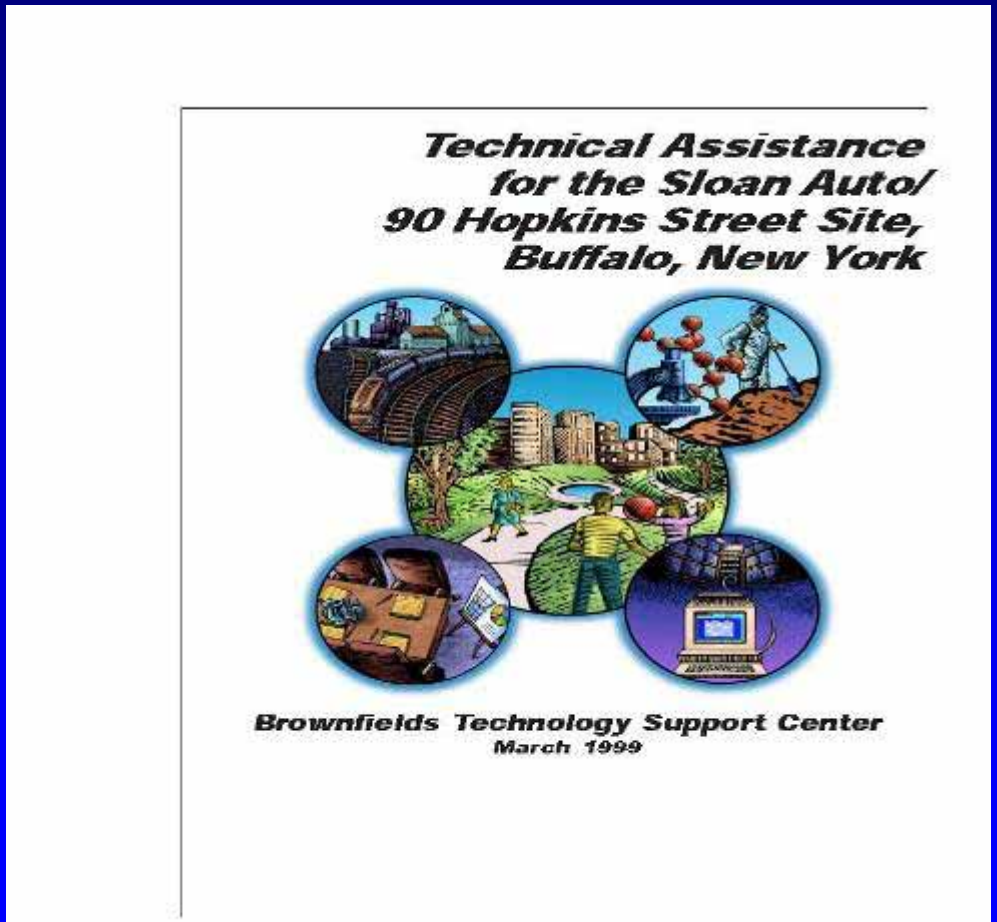
# NYSDEC Restoration

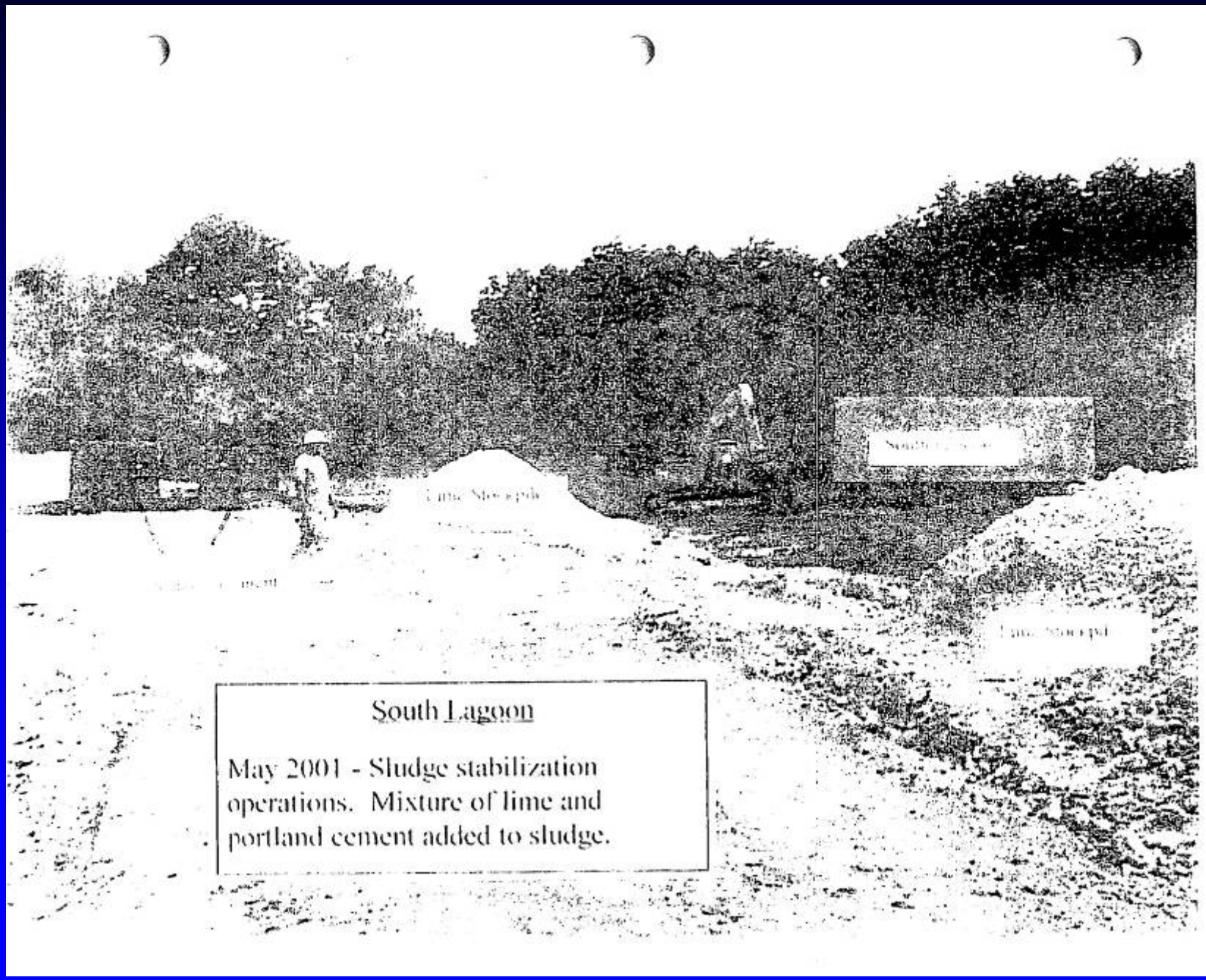
# Lime Source

- High pH material, but pH was 11-12, below 12.5 for cleanup eligibility.

# Lime Beneficial Use Study

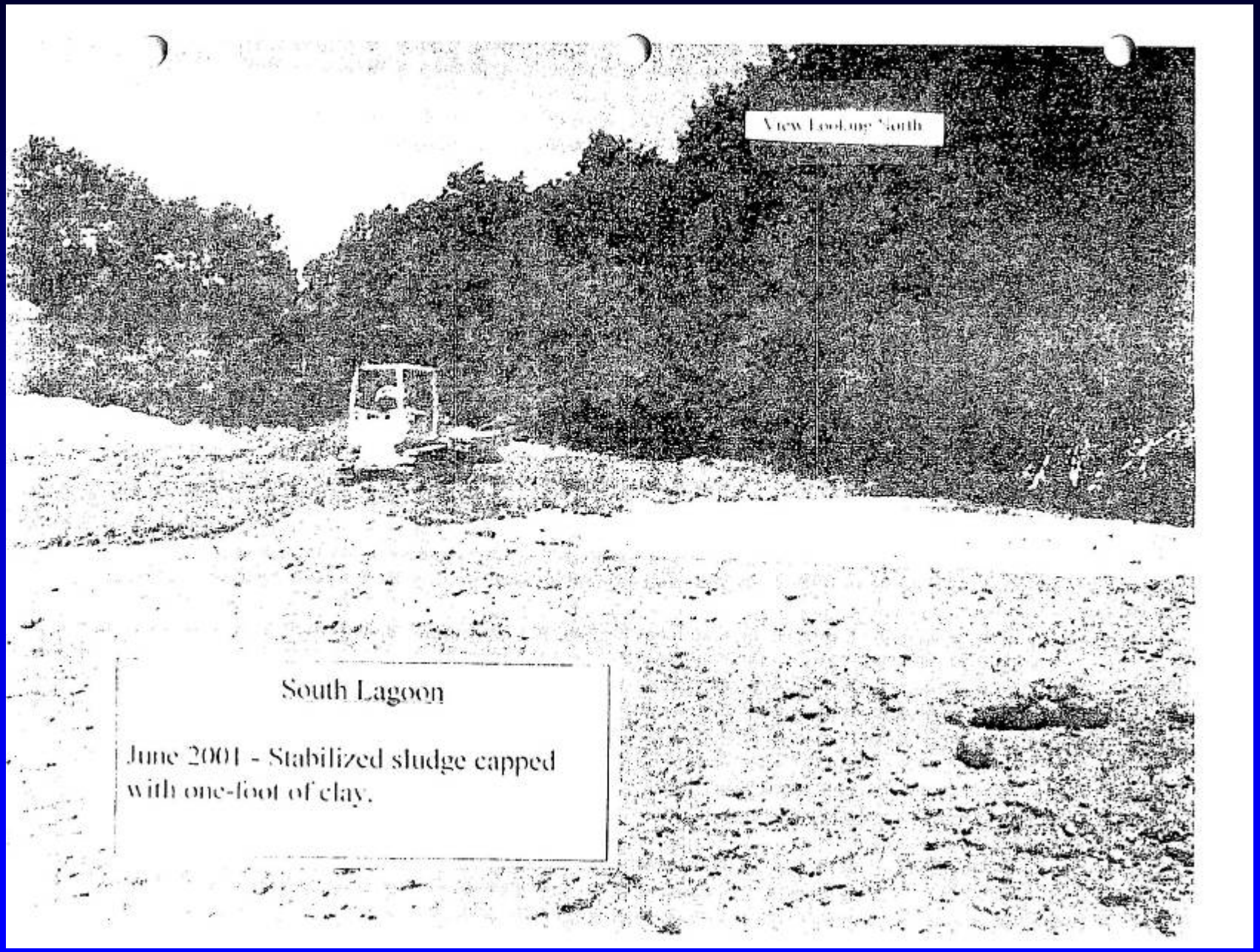
- Lime studied by EPA contractor and one beneficial use identified was stabilization





South Lagoon

May 2001 - Sludge stabilization operations. Mixture of lime and portland cement added to sludge.




South Lagoon

June 2001 - Stabilized sludge capped with one-foot of clay.

# Capping Site

- Clay, Topsoil, Seeding of East Lagoon
- Clay, Topsoil, Seeding of historical lagoon

# Seed Mixture and planting process

- Once lagoon was capped, 1 foot of clay and 1 foot of unscreened topsoil was put onto cap.
- Site was seeded with **Big Bluestem Grass - 15 pounds per acre, Little Bluestem Grass – 15 lbs per acre**
- **Indian Grass - 7 to 10 pounds per acre**
- **Switch Grass - 10 to 12 pounds per acre**
- **Barley was also used for quick germination.**

# Seed Planting

- Phase 1 - Broadcast the seed and let germinate, water as needed to establish.

# Seed Planting

- Phase 2, Till into soil, rebroadcast, and cover with clean straw.

# Year 8 Picture

# Big Blue Stem and Little Blue Stem

(Andropogon gerardil and Schizachyrium scoparius)

# Switch Grass and Indian Grass

(Panicum virgatum and Sorghastrum nutans)

# Nesting cover and food for wildlife

# Benefits of Native Grasses

- Though it may take 2 years to establish, grasses are drought tolerant, send out rhizomes and thicken turf, provide habitat and food source, and will crowd-out invasive weeds and species.
- Great for erosion control, grows in low to high pH conditions, thrives in poor soils when establish properly, and it native to North America.

# North Lagoon

- Water buffered with lime solution and neutralized. Sent off-site as waster water for treatment.
- Sludge not as deep, and dried with lime and sent for non-haz disposal.
- Clay lined bottom of pond, and it tested as clean.
- Removed 285,000 gallons of treated water off-site.

# North Lagoon

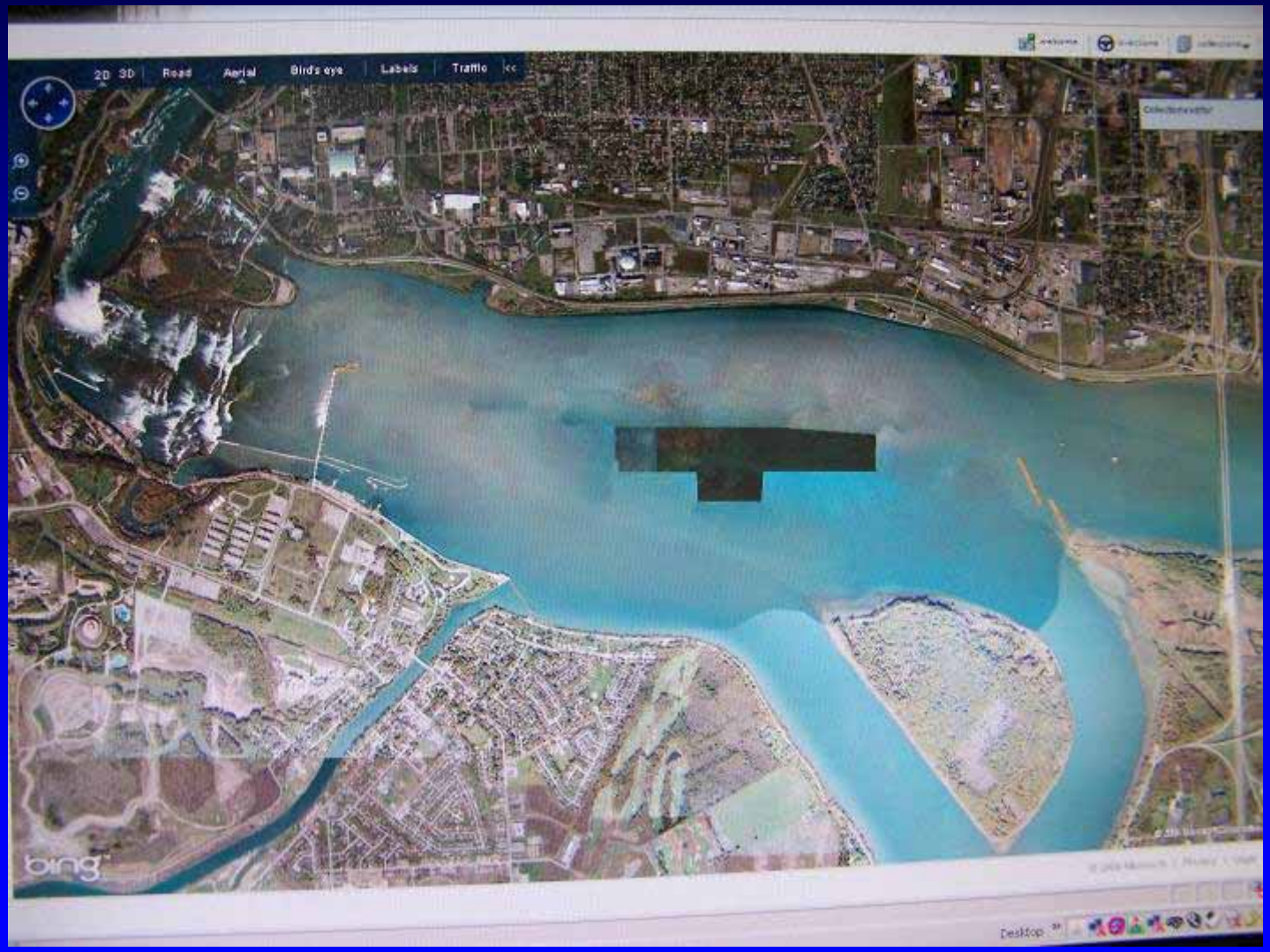
- Restoration of pond viable.
- Buckhorn marsh sediments available and EPA had used at a previous site.
- After site preparation, dredge material trucked to site. Bedded at 1 foot across surface, then flooded with hydrant water.
- Nature takes over after that.

# Buckhorn Marsh Dredge Material

- Along the Niagara River, channels were dredged through wetlands to provide fish habitat. Dredged material was staged in open field and available to State or Federal Partners for reuse.
- Dredge material contains cattails, bullrush, and other native wetland vegetation.

# Buckhorn Marsh Source

# Buckhorn Location



# Buckhorn Dredge Area

**New York State Office of Parks, Recreation and Historic Preservation**
Western District-Niagara Frontier Region
Niagara Reservation State Park, PO Box 1132, Niagara Falls, New York 14303-0132

716-278-1770
FAX: 716-278-1744
TDD: 716-278-1749

Bernadette Castro
Commissioner

Edward J. Rutkowski
Assistant Deputy
Commissioner

June 19, 2001

Mr. Kevin Matheis
United States Environmental Protection Agency, Region 2
2890 Woodbridge Avenue
Edison, New Jersey 08837

**RE: PERMIT – BUCKHORN ISLAND STATE PARK**
**HYDRIC SOIL WORK PLAN**
**EPA TOWN OF SOMERSET PROJECT**

Dear Mr. Matheis:

This letter will constitute permission, when properly signed, to proceed with the following work: **TO EXCAVATE AND TRANSPORT 1,000 CUBIC YARDS OF BUCKHORN MARSH DREDGINGS TO PROVIDE WETLAND VEGETATION TO EPA JOB SITE LOCATED IN THE TOWN OF SOMERSET, NEW YORK.**

The **UNITED STATES ENVIRONMENTAL PROTECTION AGENCY** hereby agrees to:

1. Indemnify, defend and save harmless "The People of the State of New York, New York State Executive Department, Office of Parks, Recreation & Historic Preservation, Region 1, their officers, agents or employees: from liability or claims for property damage and personal injuries (including injuries that result in death), resulting from **UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S** use of Niagara Frontier State Park & Recreation Commission lands for the above mentioned purposes.

2. The site shall be restored to a condition equal to the start of work.

3. All open excavations shall be adequately barricaded and lighted to properly protect the public.

4. The sole purpose of this permit is for **LOAD/HAUL APPROXIMATELY 1,000 CUBIC YARDS OF HYDRIC SOIL FROM BUCKHORN ISLAND STATE PARK TO THE TOWN OF SOMERSET, NEW YORK.**

# Restoration of North Lagoon

# Restoration of North Lagoon

# Restoration of North Lagoon

# Tribute sign with American Chestnut

# Post Restoration – Year 3

# Post Restoration Year 8

# Muskrat Habitats

# Wildlife Species at Barker

- Great Blue Heron,  Canadian geese, wood ducks, muskrats, foxes, deer, wild turkeys, and numerous finches, swallows, dragonflies, and aquatic wildlife (frogs, turtles, and fish).
- Tree Species – Native American elm, birch, shagbark hickory, beech, black ash, red oak, white oak, pin oaks.

# Wildlife

# American Elm Habitat

# American Elm Plantings

- Survivor elm trees became available from local tree farmer and EPA obtained them for free. Citizen Volunteer planted 25 elms, and 15 have survived for 8 years.

# American Elm Tree Plantings

# Drainage Ditch Restoration

# Redevelopment Potential

# Redevelopment Potential

- Front portion of site is covered in stone and all but one building removed.  Covers 2 acres.
- Niagara County has been recently marketing the use of the front of the property, potentially for farm product storage, or apple cider manufacturing.
- No redevelopment to date.

# In Summary

- If restoration is feasible, based upon site conditions, by all means try it.  It may not cost that much and ecologically it makes sense.
- Try to gather community or neighboring property support.
- Try to use resources available to you that may keep costs down, such as marsh dredge, trees, or other sources of eco-materials.
- Set aside part of site where buildings were located to encourage future development if possible.

# Camilla Wood Preserving Removal to Reuse

Camilla, Georgia

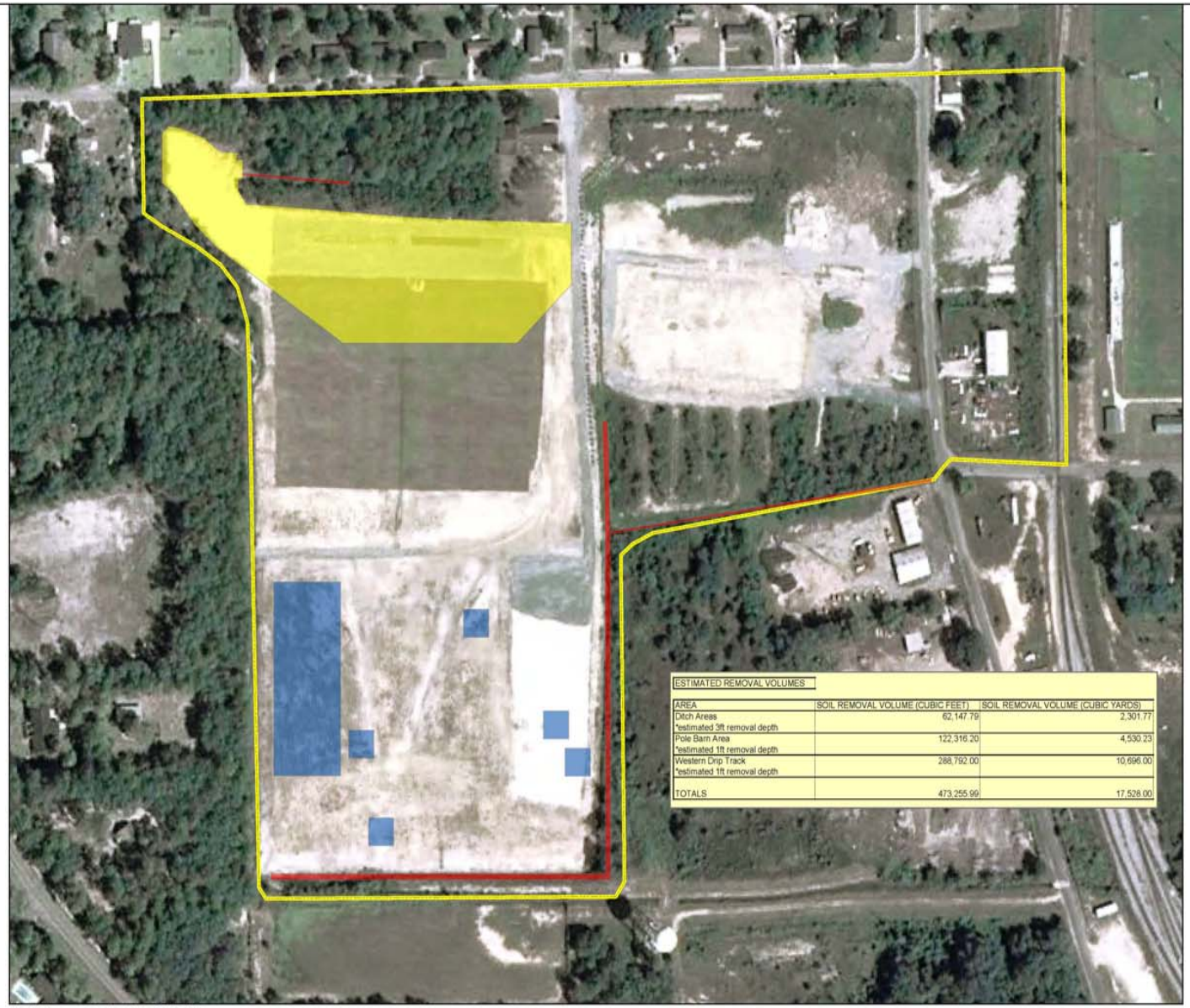
5000ish folks

$ 3.5 million Removal Action FY 08

Leo Francendese R4 OSC

# Camilla Wood Site Boundaries

# Basically a Big Ole Surgical Dirt Job



Legend

- Ditch Removal Area
- Western Drip Track
- Pole Barn Area
- Site Boundary

Note:
December 2007 property parcel data provided by Montgomery County GIS department. Soil removal volumes provided by CMC, Inc.

N

0 200 400

Feet


ESTIMATED REMOVAL VOLUMES

| AREA | SOIL REMOVAL VOLUME (CUBIC FEET) | SOIL REMOVAL VOLUME (CUBIC YARDS) |
|---|---|---|
| Ditch Areas *estimated 3ft removal depth | 62,147.79 | 2,301.77 |
| Pole Barn Area *estimated 1ft removal depth | 122,316.20 | 4,530.23 |
| Western Drip Track *estimated 1ft removal depth | 288,792.00 | 10,696.00 |
| TOTALS | 473,255.99 | 17,528.00 |

United States Environmental Protection Agency

CAMILLA WOOD PRESERVING
CAMILLA, MITCHELL
COUNTY, GEORGIA
TDD No. TNA-05-001-0049

REMOVAL AREAS &
VOLUME ESTIMATIONS

TN & A T N & Associates, Inc.
EPA Region 4 START

C:\GIS_Workspace\Camilla Wood Preserving\mxds\Camilla Wood_removal-areas.mxd

Aerial Image: September 13, 2007

# A Very Wet Dig

# 10,000 CYS Gone 10,000 left Behind

# Millions Saved as the Community Concurs

# Recycling Metals … Something we all do

# Timing, Marketing, Luck ?

# No Longer the Swampland

# Taking Shape

Aerial Photo of the Site
3/4/2007

# The Value of the Planned Reuse Document








## Planning for the Future:

A Revised Recreational Reuse Framework for the Camilla Wood Preserving Company Superfund Site
Camilla, Georgia

June 2007

EPA Region 4
Superfund Redevelopment Initiative

*funded by*
United States Environmental Protection Agency

*prepared for*
City of Camilla, GA

*prepared by*
Camilla Wood Preserving Company Site Land Use Committee
E² Inc.

# Key Reuse and Regulatory Groups

*Land Use Committee Members:*

| | |
|---|---|
| Bryant Campbell | City Council - Land Use Committee Chair |
| Shan Daniels | Recreation Director for Camilla and Pelham |
| D.F. Irwin | Camilla Fire Chief |
| Marilyn Royal | Mitchell County Development Authority |
| Michael Scott | City Manager |
| Alice Shelton | Resident |
| James Shelton | Resident |

*Local Officials:*

| | |
|---|---|
| Alfred J. Powell, Jr. | Mayor |
| Zelda Collier | City Council |
| Phillip Kelson | City Council |
| Oberia Mills | City Council |
| W.D. Palmer, III | City Council |
| Vernon Twitty, Jr | City Council |
| Michael Bankston | City Attorney |

*US EPA and Georgia Department of Natural Resources:*

| | |
|---|---|
| Edward Bates | US EPA, Cincinnati |
| Jill Clark | Georgia Department of Natural Resources |
| Mark Fite | Regional Reuse Coordinator, US EPA Region IV |

# The Final Plan

# This Rendition got em Going

CAMILLA WOOD PRESERVING COMPANY SUPERFUND SITE REVISED REUSE FRAMEWORK


Looking west from the top of the covered contaminated stockpile, at the drip track zone, as the contractor builds a stockpile of backfill material used to backfill and help restore the western half of the site. (Courtesy of EPA, 2/22/07)

**Existing Camilla Wood Preserving Company Site**

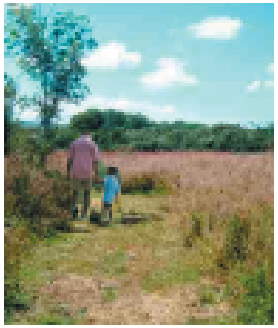

**Proposed Recreational Reuse Framework**

# Native Grasses and Invasive Plants

**Wildflower Meadow Mixes**

| *Latin Name* | *Common Name* |
|---|---|
| *Centaurea cyanus* | Dwarf Cornflower |
| *Chamaecrista fasciculata* | Partridge Pea |
| *Coreopsis lanceolata* | Lance-Lanced Coreopsis |
| *Coreopsis tinctoria* | Plains Coreopsis |
| *Cosmos sulphureus* | Sulphur Cosmos |
| *Echinacea purpurea* | Purple Coneflower |
| *Gaillardia pulchella* | Annual Gaillardia |
| *Gaura lindheimeri* | Gaura |
| *Gypsophila elegans* | Annual Baby's Breath |
| *Ipomopsis rubra* | Gilia |
| *Lavatera trimestris* | Tree Mallow |
| *Linum grandiflorum rubrum* | Scarlet Flax |
| *Lupinus perennis* | Perennial Flax |
| *Mirabilis jalapa* | Four-O'Clock |
| *Monarda citrodora* | Lemom Mint |
| *Papaver rhoeas* | Corn Poppy |
| *Phlox drummondii* | Annual Phlox |
| *Rudbeckia amplexicaulis* | Clasping Coneflower |
| *Rudbeckia hirta* | Black-eyed Susan |
| *Salvia coccinea* | Scarlet Sage |
| *Verbena tenuisecta* | Moss Verbena |

Switchgrass
(*Panicum virgatum*)



View of a Grassy Meadow

**Native Grass Mixes**

| *Latin Name* | *Common Name* |
|---|---|
| *Andropogon gerardii* | Big bluestem |
| *Schizachyrium scoparium* | Little bluestem |
| *Sorghastrum nutans* | Indiangrass |
| *Panicum virgatum* | Switchgrass* |
| *Tripsacum dactyloides* | Eastern gamagrass** |

* Switchgrass and eastern gamagrass should not be pre-mixed with fluffy-seeded species

** Eastern gamagrass is best when used alone for these applications

**Turf Grasses**

| *Latin Name* | *Common Name* |
|---|---|
| *Festuca arundinacea* | Turf-Type Tall Fescue |
| *Lolium perenne* | Turf-Type Perennial Ryegrass |
| *Poa pratensis* | Kentucky Bluegrass |
| *Lolium multiflorum* | Annual Ryegrass |

**Invasive Plants -- *NOT* Recommended**

| *Latin Name* | *Common Name* |
|---|---|
| *Elaeagnus umbellata* | Autumn Olive |
| *Hedera Helix* | English Ivy |
| *Imperata cylindrica* (L.) Beauv. | Cogongrass |
| *Ligustrum sinense* | Chinese privet |
| *Lonicera japonica* | Japanese Honeysuckle |
| *Paulownia tomentosa* | Empress or Paulownia Tree |
| *Pueraria lobata* | Kudzu |
| *Rosa multiflora* | Multiflora Rose |

# We Dug and Certified Clean Trenches

# The City Provided and Installed Utilities

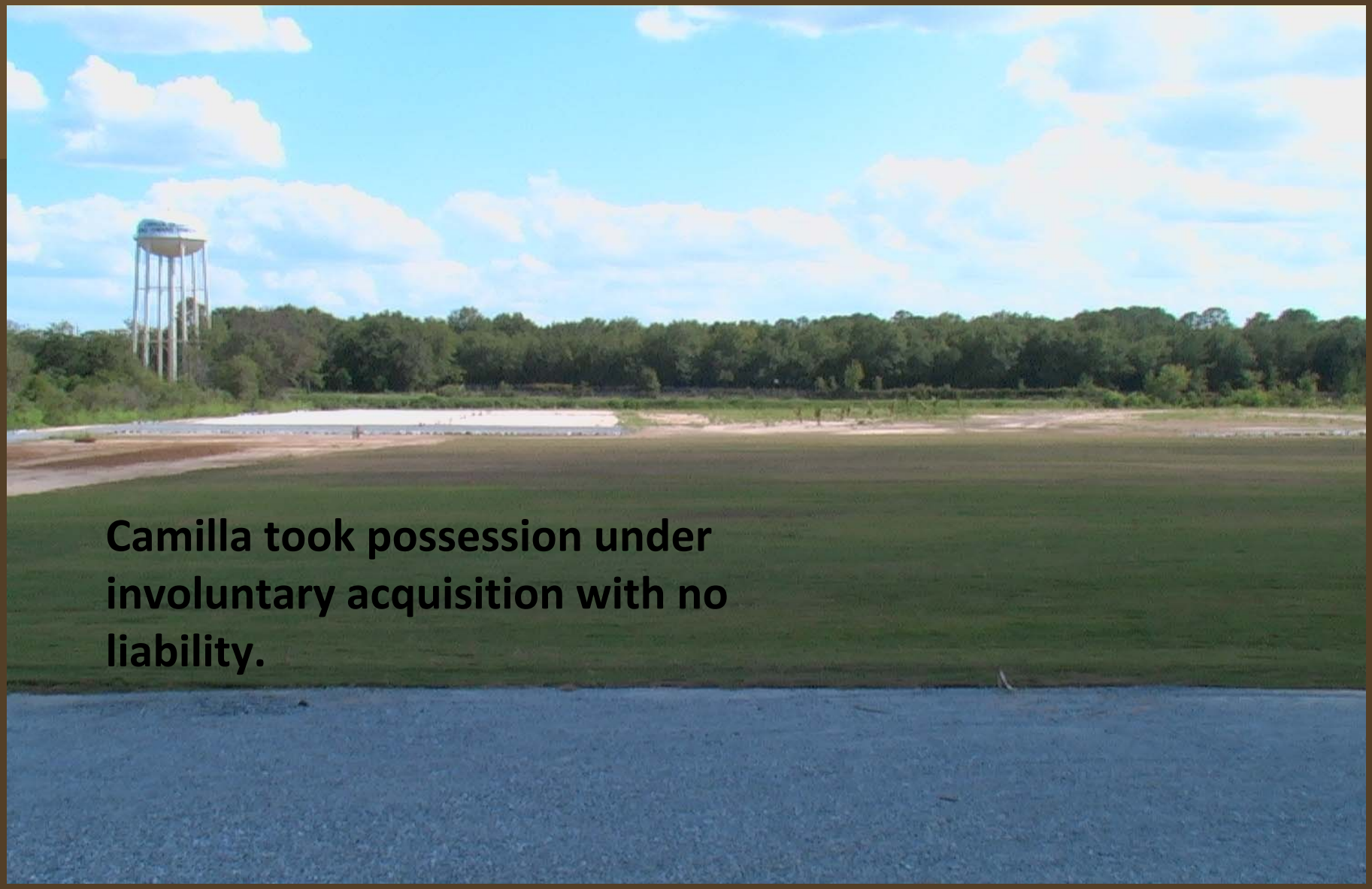
# Making Mounds for Topographic Variety


**Sod from a local vendor at no extra cost versus hydroseeding**

# Its Corny, but True … Build It and …

# County Labor also Laid the Sod

# Remember the Contaminated Swampland ?



# Tri County Complex in Under a Year


**2008 National Notable Achievement Award for Cross Program Land Revitalization**

# Low Cost Treatment of a Highly Contaminated Pit Lake Using Innovative Technology

# Barite Hill Gold Mine Site

**Leo Francendese USEPA OSC, Mike Gobla BOR, Joe Harrington Alexco,**

**Ed Bates EPA/ORD (retired)**

**OSC Readiness Presentation 2010**

# Barite Hill Gold Mine Site

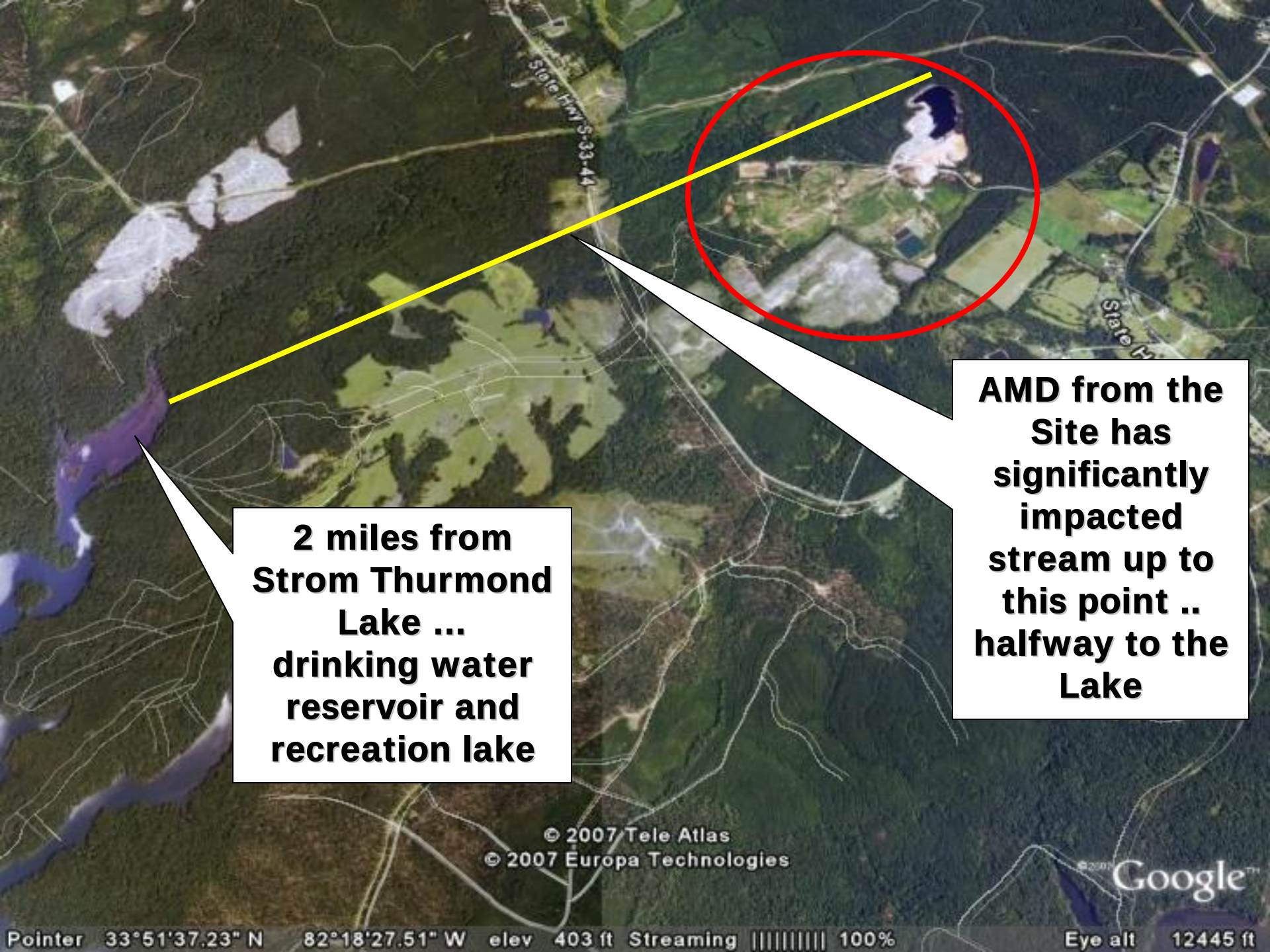
McCormick, South Carolina

Mined from 1991 to 1995

Abandoned in 1999

Removal Project 2007 to 2009

NPL Listed in 2008


State Hwy S-33-44
2 miles from Strom Thurmond Lake ... drinking water reservoir and recreation lake
AMD from the Site has significantly impacted stream up to this point .. halfway to the Lake
© 2007 Tele Atlas
© 2007 Europa Technologies
Google
Pointer 33°51'37.23" N 82°18'27.51" W elev 403 ft Streaming 100%
Eye alt 12445 ft

# What's so innovative here?

**Made Soil on site**

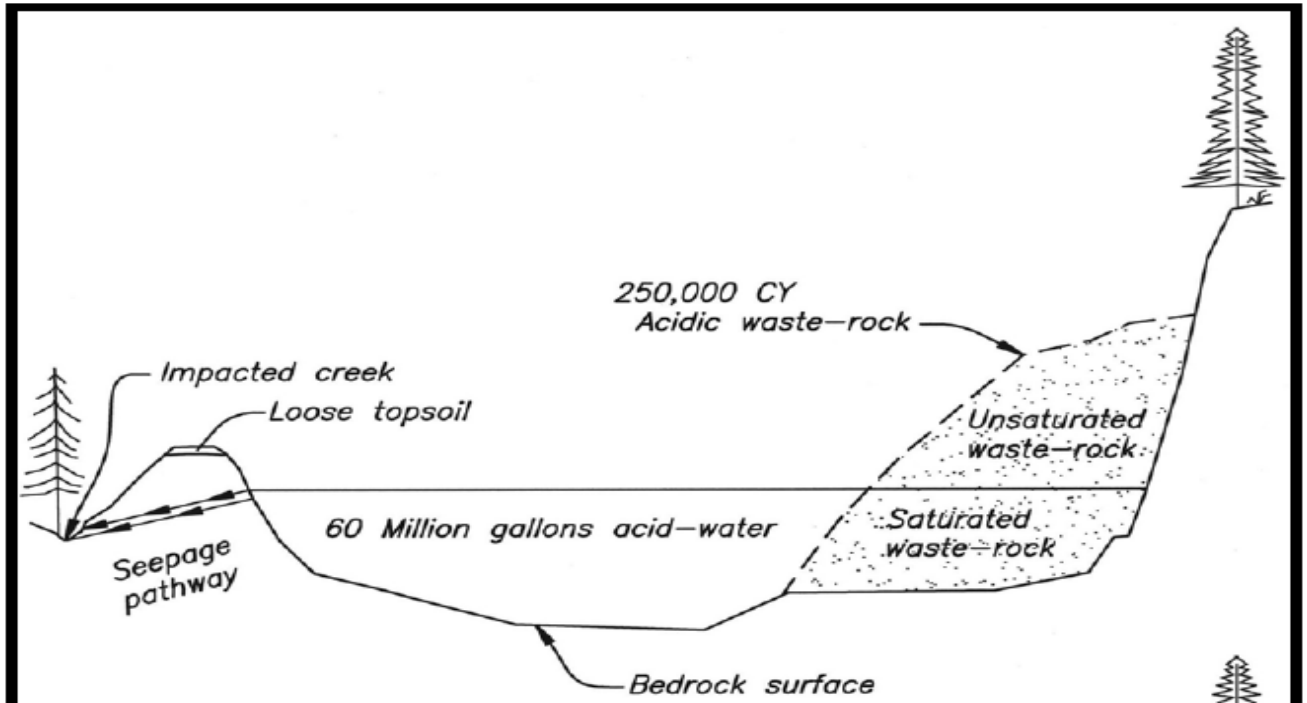
**Flexterra**
***What it is?***

**Carbide Lime**
**Waste product of (acetyline)**
**Mixing with lake water**

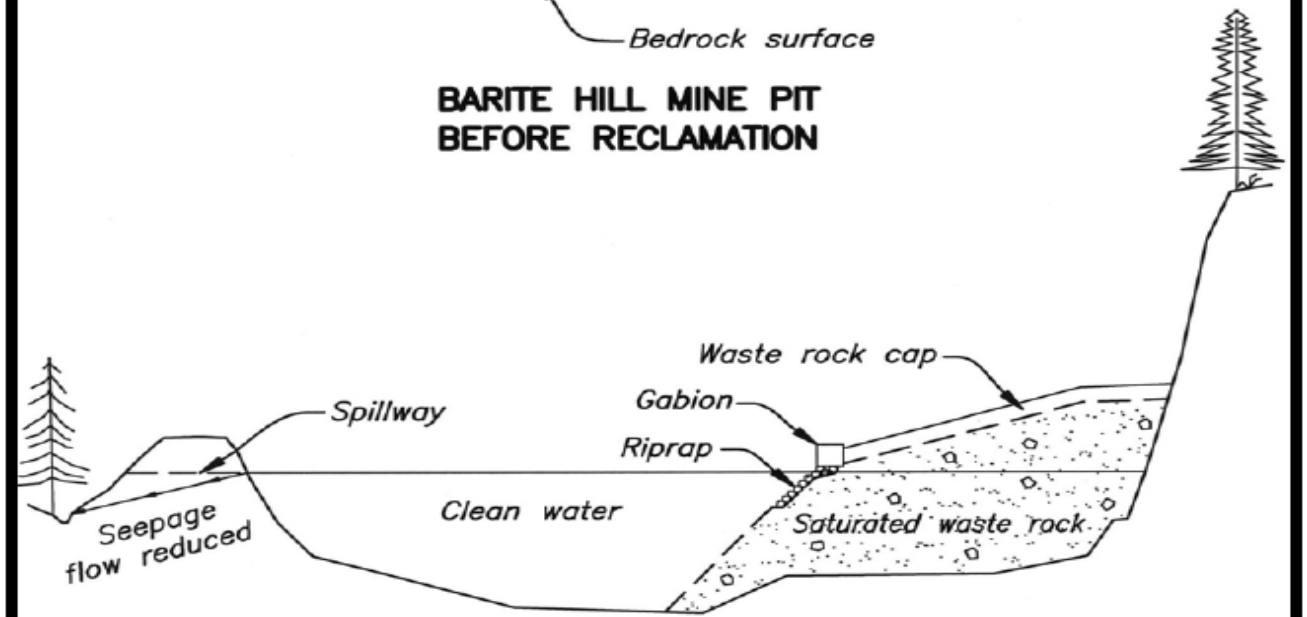
**Created Flow-Thru Lake**
**Acidic lake to pH 7**
**Living Organisms**

## BOR conducted a Streamlined Remedy Review in under 60 days and option 6 was selected

| | Remedy Option | Cost |
|---|---|---|
| 1 | No action | **$0**. Risk of catastrophic failure would remain. |
| 2 | Construct spillway and fencing | **$300,000.** A 1" rain would cause 500,000 gallons of acid water to flow out of the pit. |
| 3 | Perpetual water treatment | **$5,700,000. Plus $1 million/year for operation.** Acid would be contained but an acid lake would still be present at the site. |
| 4 | Neutralize, backfill, and reclaim | **$21,710,000.** 1.15 million cubic yards of waste would be hauled in to fill the pit. The fill would cover the sulfide bedrock exposures, but some seepage could remain. |
| 5 | Blast the pit rim, partially backfill, and reclaim as a dry basin | **$12,390,000.** Difficult to implement, a dry basin would remain, some acid seepage likely. |
| 6 | Minimal waste backfill, lime neutralization, carbon loading | **$2,600,000.** The acid pit lake would be transformed to a clean lake requiring minimal long term maintenance. Waste fills would be graded and capped. This is the selected remedy. |



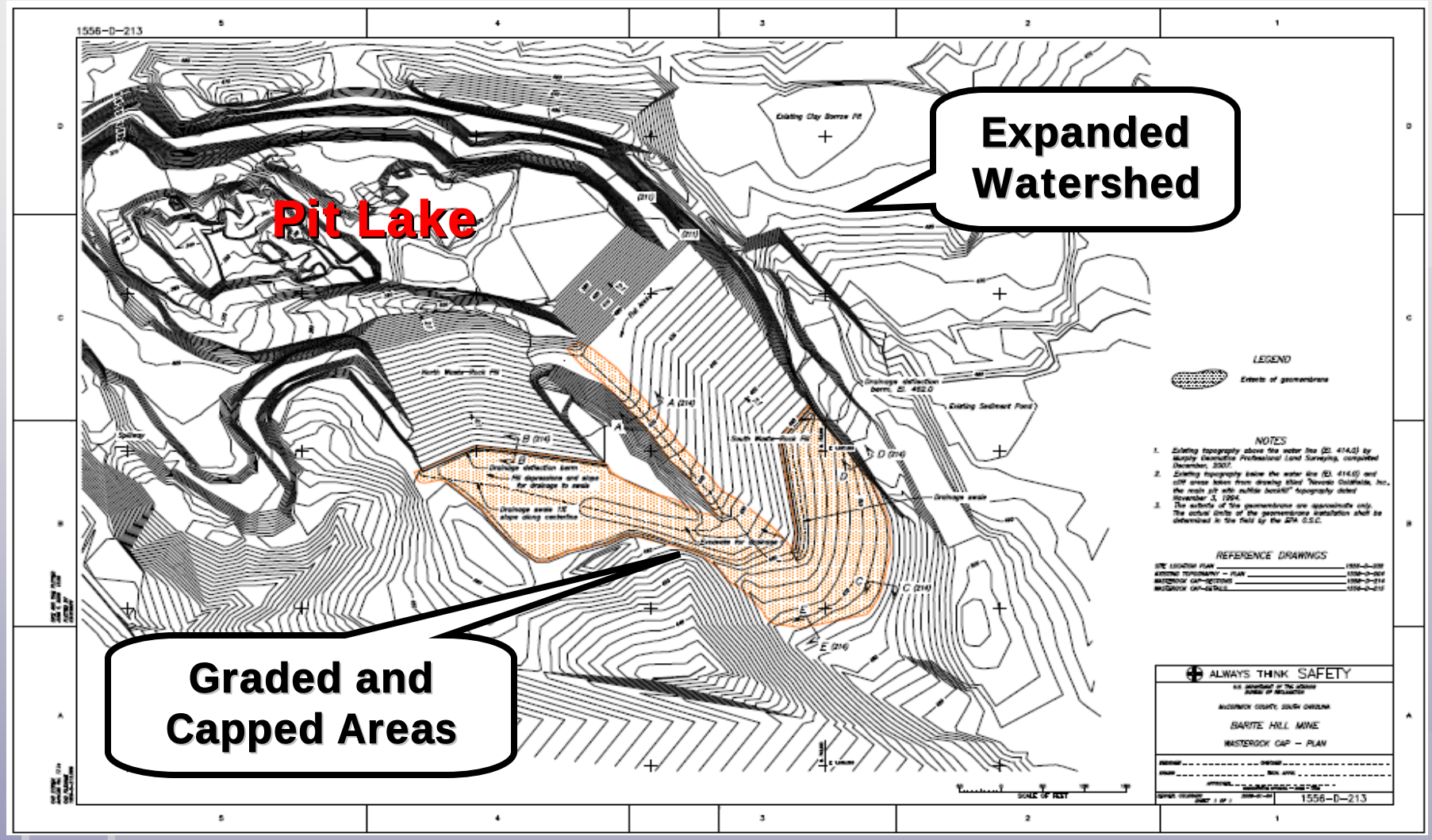

**BARITE HILL MINE PIT**
**BEFORE RECLAMATION**




**BARITE HILL MINE PIT**
**AFTER RECLAMATION**


Subaqueous Capping of approximately 50,000 CYS
The rate of pyrite oxidation is reduced by approx 200,000 X via subaqueous capping

# Moving the Mountain




**BOR provided “as built” engineering support resulting in Engineer Certified (Remedial Quality) design/plans.**

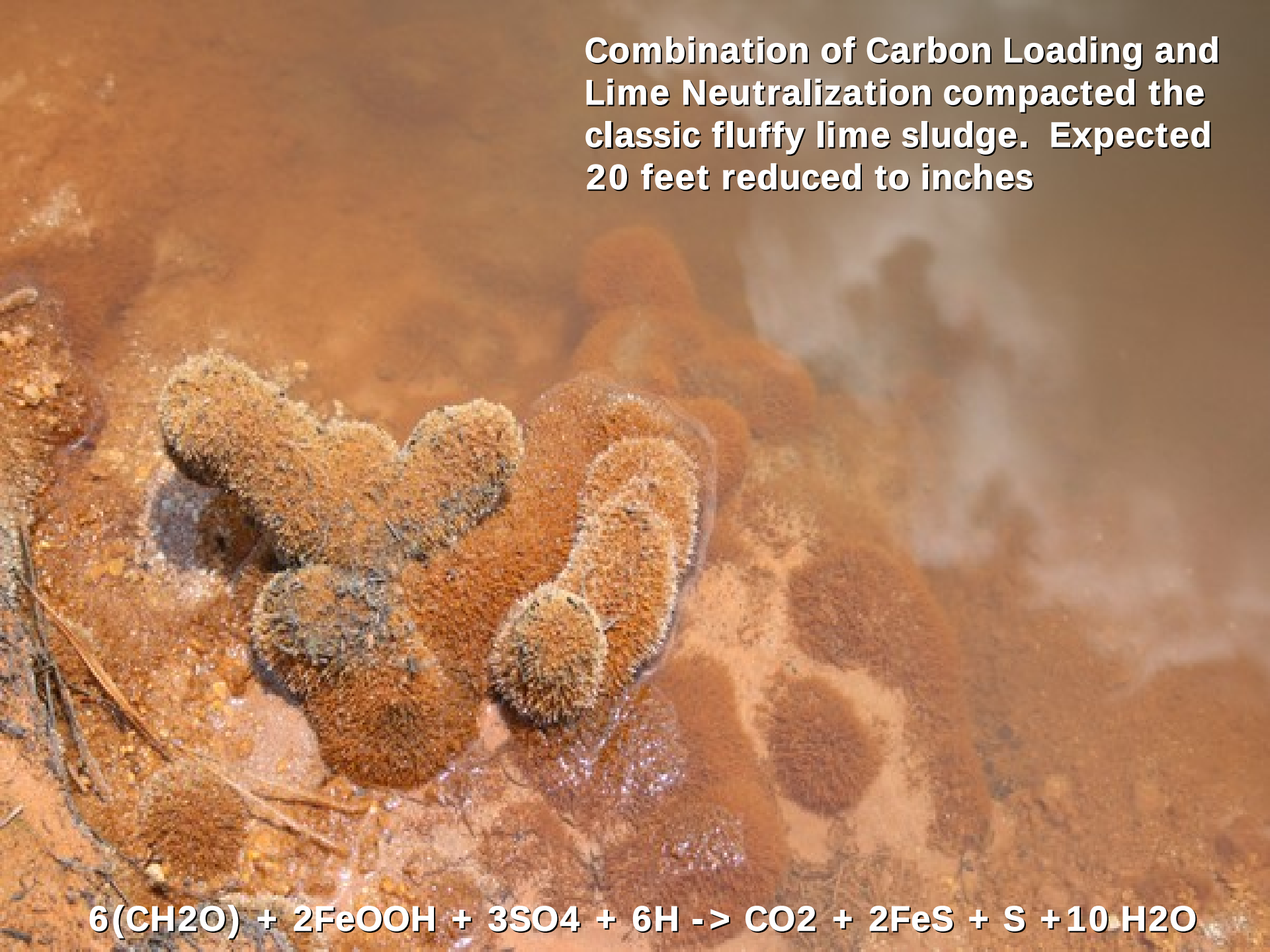
**10% project cost.**

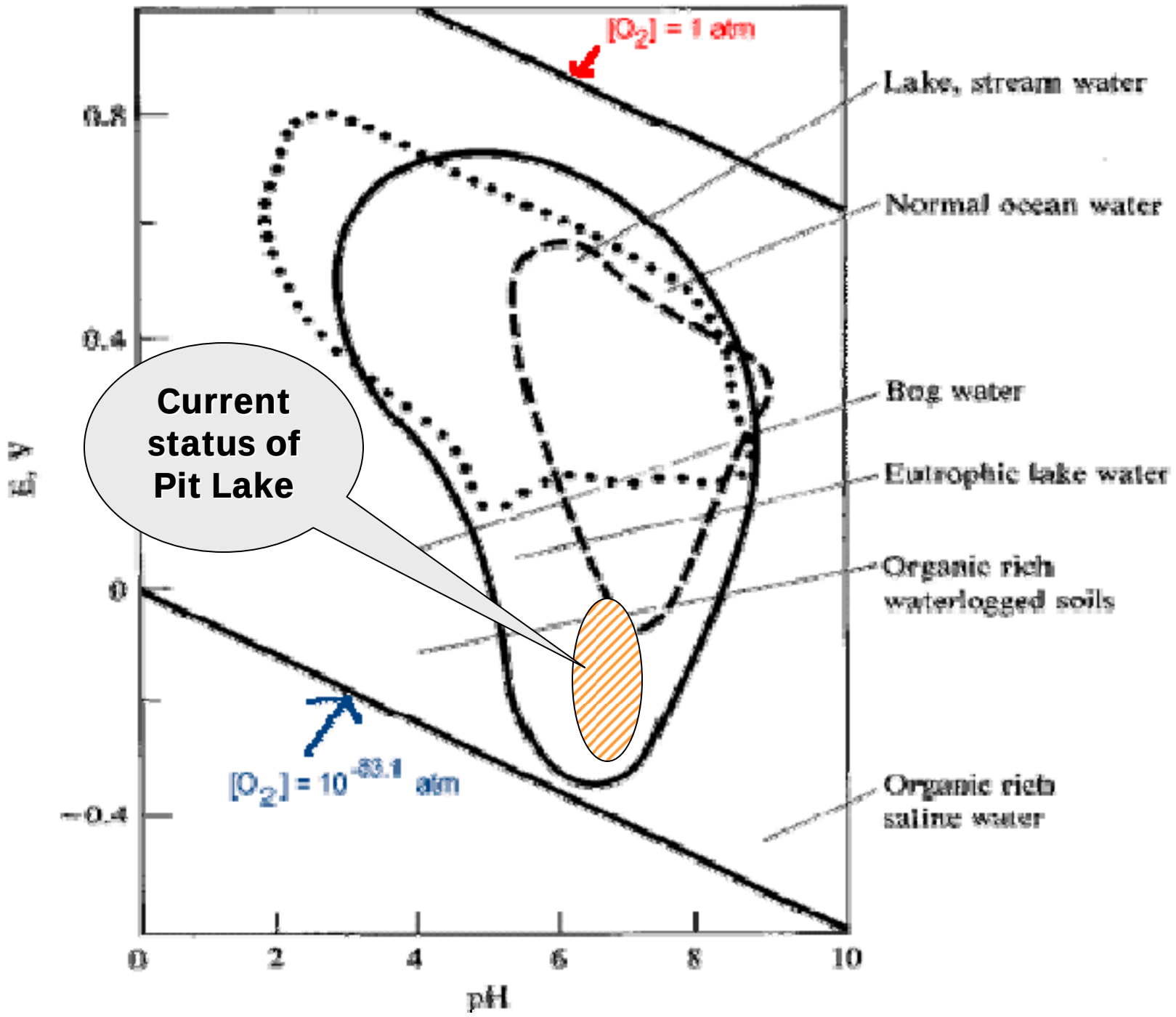
## Taking Shape

**Carbide Lime used for Chemical Neutralization**

**Contractor Designed and Built Aerated Batch System**


Chemical Neutralization
Carbon Amendments
Grading Continues


Combination of Carbon Loading and Lime Neutralization compacted the classic fluffy lime sludge. Expected 20 feet reduced to inches
6(CH2O) + 2FeOOH + 3SO4 + 6H -> CO2 + 2FeS + S +10 H2O


$[O_2]$ = 1 atm
Lake, stream water
Normal ocean water
Bog water
Eutrophic lake water
Organic rich waterlogged soils
Organic rich saline water
Current status of Pit Lake
$[O_2] = 10^{-83.1}$ atm
0.8
0.4
0
−0.4
0
2
4
6
8
10
pH


All earthen materials used in the cap came from the nearby borrow pit which was then incorporated into the watershed design. In addition, Georgia Pacific donated all the mulch necessary to create SCDHEC recommended topsoil blends.


Approximately 10 acres of topsoil created, 1 foot thick


This could have been a green alternative (used concrete rubble)


Stoichiometrically, the Pit Lake has been calculated to currently possess enough acid neutralization potential to handle three 25-year drought events.


The cap …
2 feet of saprolite base
1 foot of clay
1 foot of topsoil
½ HDPE lined
Gabion toe
Watershed Overflow
Spillway Overflow

# Phytoremediation with Solar Powered Irrigation

Myles Bartos

*disclaimer

- **ICS** (not just for breakfast anymore), **IMT, INS,**
- **“Path forward”, “Think tank”**
- **“Homeland Security”**
- **HSEEP**
- **Pointsec** (no one got my already public polrep!...not even me)
- **Beyond Trust**
- **ECMS or ACMIS**
- **Peopleminus** (saved and attested 5 days early because it’s a holiday weekend)
- **CORE ER, CORE NAR,**
- **Quickplace**
- **HQ**
- **Ethics Training**

# Crozet Arsenic

- Former Apple Orchard Area(s) that have historically applied a variety of chemicals including:
    - Lead Arsenates
    - 4,4'-DDT
    - 4, 4'-DDD
    - 4,4'-DDE

    * Mostly top 6-8 inches
- Many of the areas are now developed

# Removal Action

- No cost recovery
- Potential problem across America
- Action level of 58 ppm
- Traditional dig and dispose
- *Phytoremediation*
- *Solar Power*

# Two Areas

- Community Area
  - 13 homes out of 150
  - All dig and dispose
- Larger Property Area *
  - 27 acres
  - Hillside
  - Access issues

# Phytoremediation

- Researched by the University of Florida
- Pteris Vittata (Chinese Brake Fern)
- Hyper-Accumulate Arsenic in the fronds
- Licensed to Edenspace Systems Corporation through University of Florida.
- The *use* of arsenic accumulating ferns belonging to the Pteris genus for phytoremediation is protected under US Patent 6280500 ***

# EDENFERN®

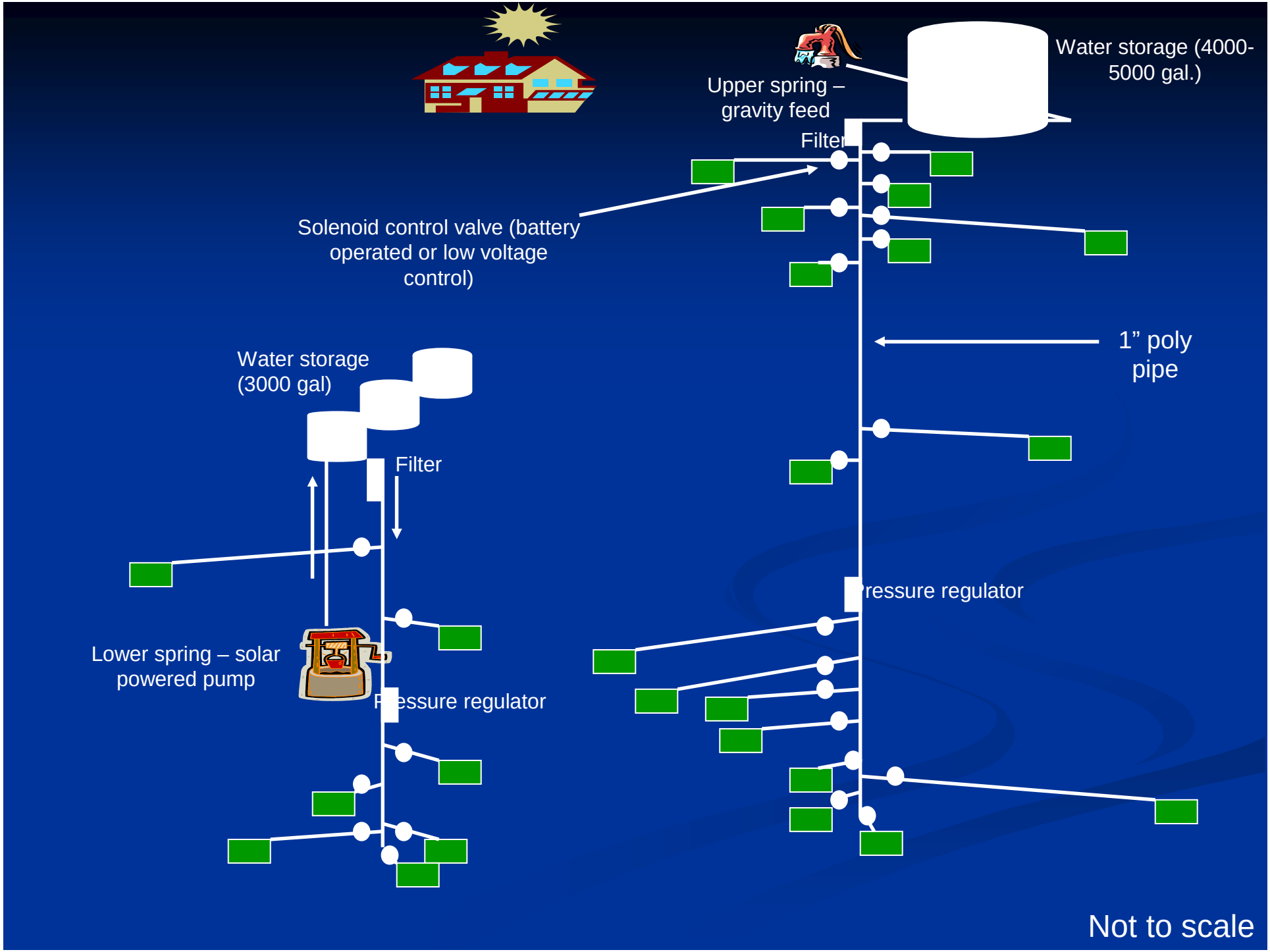
- Can extract 20-50 ppm per growing season
- Extracts arsenic through the roots system and stores it in the fronds.

# The Numbers

- 20,000 ferns (a tractor trailer load)
- 24 plots  (about 900 square feet each)
- Planted at 1 foot intervals (span of root system)

# Irrigation

- Water Water everywhere (but not a drop to drink)
- 2 springs (holding tanks)
- 390 W solar panel array (3, 12volt panels)
- Solar pump
  - 30 gallons/min
  - 30 feet of elevation capacity
  - 10k gallons/day (6 hours full sun)


Water storage (4000-5000 gal.)
Upper spring – gravity feed
Filter
Solenoid control valve (battery operated or low voltage control)
1” poly pipe
Water storage (3000 gal)
Filter
Pressure regulator
Lower spring – solar powered pump
Pressure regulator
Not to scale


EP4

# Key Principles

- Minimizing overall effect on the environment.
- Reducing carbon footprint.
- Minimizing erosion issues.

“Big Picture” evaluation.

# Scope of work…
# The Action Memorandum

- If the OSC determines that excavation is impracticable in the area for any of the following reasons:
  - Limited physical access due to steep slopes, creeks, or other waterways
  - Potentially significant erosion issues that could arise during excavation
  - Heavily forested areas that could be negatively affected.

# Action Memo Language

- Plant arsenic absorbing ferns
- Maintain the ferns during the growing season
- Harvesting of the ferns at the end of the growing season

…for up to three growing seasons

# HOW?

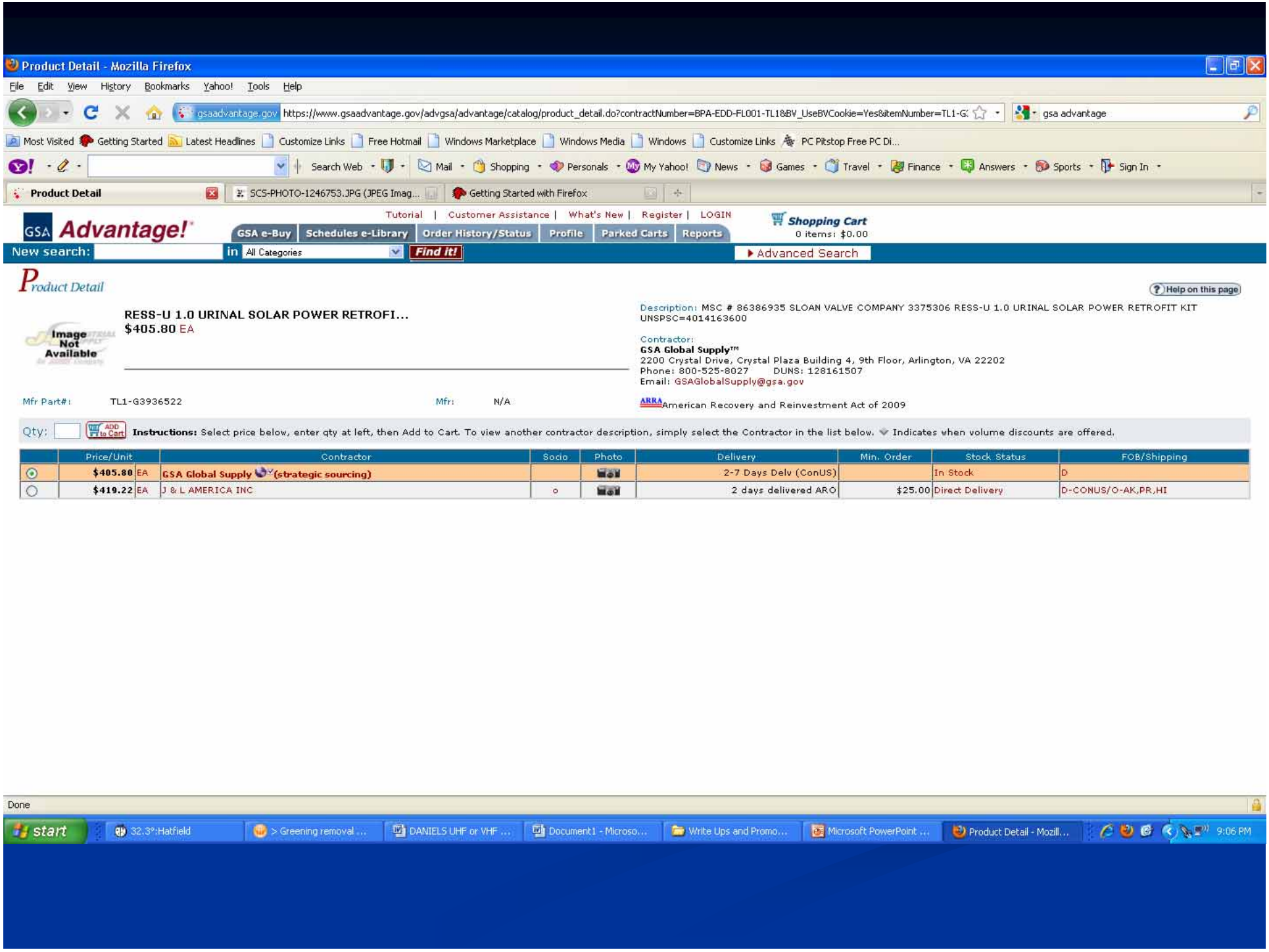
# Contracting Issues

# Rent

- Can't "rent" the ferns
- At the time, couldn't rent the solar equipment (at least we couldn't find it)

# GSA

- No "excessed" equipment available
- No GSA Advantage! Equipment available (at the time…)


Product Detail - Mozilla Firefox
File Edit View History Bookmarks Yahoo! Tools Help
https://www.gsaadvantage.gov/advgsa/advantage/catalog/product_detail.do?contractNumber=BPA-EDD-FL001-TL1&BV_UseBVCookie=Yes&itemNumber=TL1-G
gsa advantage
Most Visited Getting Started Latest Headlines Customize Links Free Hotmail Windows Marketplace Windows Media Windows Customize Links PC Pitstop Free PC Di...
Search Web Mail Shopping Personals My Yahoo! News Games Travel Finance Answers Sports Sign In
Product Detail
SCS-PHOTO-1246753.JPG (JPEG Imag...
Getting Started with Firefox
GSA Advantage!
Tutorial | Customer Assistance | What's New | Register | LOGIN
GSA e-Buy Schedules e-Library Order History/Status Profile Parked Carts Reports
Shopping Cart
0 items: $0.00
New search: in All Categories Find it!
Advanced Search
Product Detail
Help on this page
Image Not Available
RESS-U 1.0 URINAL SOLAR POWER RETROFI...
$405.80 EA
Description: MSC # 86386935 SLOAN VALVE COMPANY 3375306 RESS-U 1.0 URINAL SOLAR POWER RETROFIT KIT
UNSPSC=4014163600
Contractor:
GSA Global Supply™
2200 Crystal Drive, Crystal Plaza Building 4, 9th Floor, Arlington, VA 22202
Phone: 800-525-8027 DUNS: 128161507
Email: GSAGlobalSupply@gsa.gov
Mfr Part#: TL1-G3936522
Mfr: N/A
ARRA American Recovery and Reinvestment Act of 2009
Qty:
Add to Cart
Instructions: Select price below, enter qty at left, then Add to Cart. To view another contractor description, simply select the Contractor in the list below. Indicates when volume discounts are offered.
Price/Unit Contractor Socio Photo Delivery Min. Order Stock Status FOB/Shipping
$405.80 EA GSA Global Supply (strategic sourcing) 2-7 Days Delv (ConUS) In Stock D
$419.22 EA J & L AMERICA INC o 2 days delivered ARO $25.00 Direct Delivery D-CONUS/O-AK,PR,HI
Done
start
32.3°:Hatfield
> Greening removal ...
DANIELS UHF or VHF ...
Document1 - Microso...
Write Ups and Promo...
Microsoft PowerPoint ...
Product Detail - Mozill...
9:06 PM

# ERRS

- Task order/DWO
  - “plant ferns”
  - “maintenance of ferns” (irrigation)
- Provided ERRS specifications for parts
  - http://www.altestore.com/store/
  - Approximately $5000 for entire system (panels, wiring, pump, switch, etc)

# FERNS

- Biggest issue
- Sole source due to patent = $5.95 vs $1.95
- Try to explain that to the IG!
- Contract directly with Edenspace for ferns
  - Provided a fern management plan (via START)
  - Parts list for irrigation (via START)

# Pros and Cons

- 12 cubic yards of disposal (harvested ferns) per year vs.  400-528 cubic yards for soil removal…. Plus backfilling.
- Lots of preparation for the ferns
- Expensive (like any “new” technology… balance between fiscal responsibility and mission)
- Ferns failed TCLP… shipped to Michigan

# Pros and Cons

- 390 W solar panel array (3, 12volt panels)
  - FREE energy
- Solar pump
  - 30 gallons/min
  - 30 feet of elevation capacity
  - 10k gallons/day (6 hours full sun)
    - More than a tanker a day for 150 days
- Sun dependent.
- Ran out of water during drought.

# In the end….

- Had do dig several of the plots….
- Change of scope in Action Memo.
- No rhyme or reason as to why ferns worked in some areas and didn't in others.
- Principles were good…effectiveness was...

# And That's How I am Helping to Save the World

Questions?

# Green Response and Transportation

## OSC Readiness

February, 2010

Sean Sheldrake, EPA Region 10

WEST COAST COLLABORATIVE

Public-private partnership to reduce diesel emissions

# Why Transportation?

- Transportation/heavy duty diesel equipment is often the biggest energy consumer for site response.
- Transportation and other vehicles used can be the biggest polluters for each unit of energy required to do the cleanup at your site, increasing short term risks.

EPA
United States
Environmental Protection
Agency

# West Coast Collaborative Goals

- Protect/Improve Public Health by:
  - Helping to meet National Ambient Air Quality Standards (PM2.5, Ozone)
  - Meeting air toxics goals (both federal and state/local partners)
  - Nonattainment / EJ areas
- Support Energy Security and Green House Gas Reductions by:
  - Using cleaner fuels (biodiesel, biogas/natural gas, electric …) relative to total diesel fuel
  - Advance regional/local production of renewable fuels supporting local agriculture and forestry sectors
  - Utilize SmartWay and other programs to virtually eliminate on-road, locomotive, and non-road HDD idling (ports, corridors, distribution locations)

EPA
United States Environmental Protection Agency

# Why is Reducing Emissions Important?

## Degrades Air Quality

- Particulate Matter (PM)
- Ozone precursors

## Energy and Climate Change

- Over 40% of green house gas emissions from mobile sources
- Over 90% of fuel imported petroleum

## Serious Health Effects

- Diesel exhaust is a **“likely human carcinogen”** and respiratory irritant
- Harmful diesel PM
- Diesel exhaust contains “likely” and “known” (e.g., benzene) human carcinogens, and also have respiratory, neurological, developmental, and immunological health effects.

EPA United States Environmental Protection Agency

# Why is Reducing Emissions Important?

(continued)

Costs for Society

- $Billions in healthcare per year related to PM exposure
- $5 million/year spent on health care in California

What Are The Benefits?

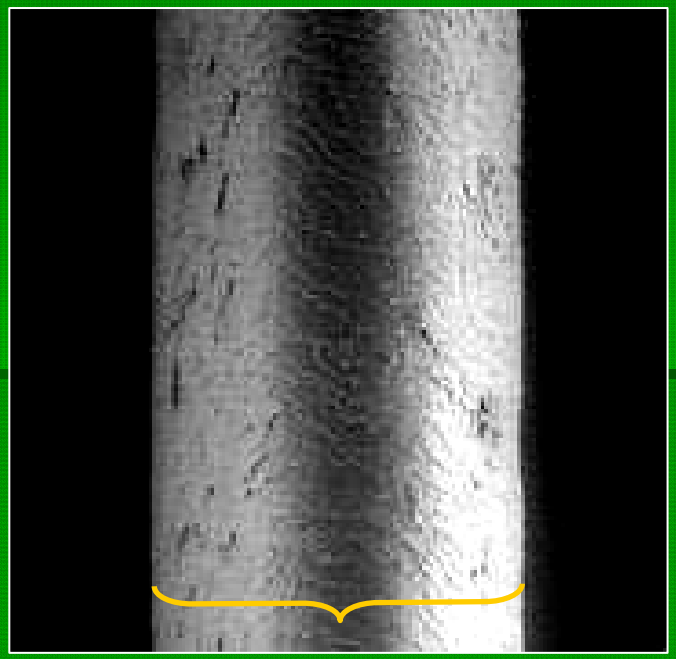
- Significantly reduces harmful particulate matter and ground-level ozone precursors
- Reduces exposure in communities and sensitive populations nearby Superfund & redevelopment sites
- $1 invested in diesel emissions reductions → $13 in health benefits
  - Decrease in hospital admissions (Asthma attacks, heart attacks, cardiopulmonary illnesses)
  - Fewer lost work and school days

See: http://epa.gov/region09/cleanup-clean-air/index.html for more details

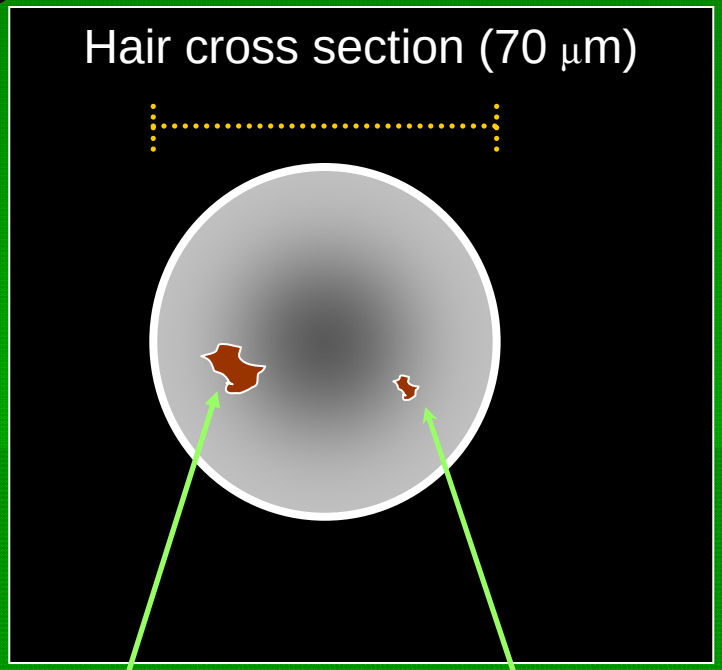
EPA United States Environmental Protection Agency

# Particulate Matter (PM) In Diesel Exhaust Is The Driver Of Risk

- Mix of particles and liquid droplets
- Considerably smaller in size than human hair
- Penetrates deeply into the lungs



Human Hair (70 µm diameter)




EPA United States Environmental Protection Agency

# Avoiding Or Substantially Reducing Emissions

- Switch from truck to rail transport
- Integrate diesel emissions issues into response planning

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Environmental Protection
Agency

# What If Rail Transport Isn't Practical? What Now?

- Diesel emissions controls may be a viable and cost effective option at your site.

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Agency

# Diesel Oxidation Catalyst (DOC)

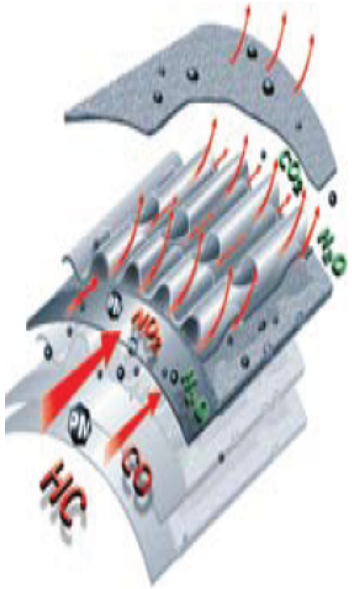
**Emissions Reductions**

- 20% - 50% reduction in PM
- 60% - 90% reduction in HC
- >90% reduction in CO
- DOC: $2,000 - $4,000

# Diesel Multistage Filters (DMFs)

## High Efficiency Filtration *with* No Maintenance

.... DMF Mufflers DO NOT require routine ash cleaning




The DMF Muffler uses a two-stage metallic filter to trap and reduce diesel particulate matter (PM). Each filter stage consists of alternating layers of a corrugated metal and a porous sintered metal fleece. The unique catalyst coating reduces PM, HC and CO, while minimizing $NO_2$ emissions (<20% increase).

### Broad Engine Coverage

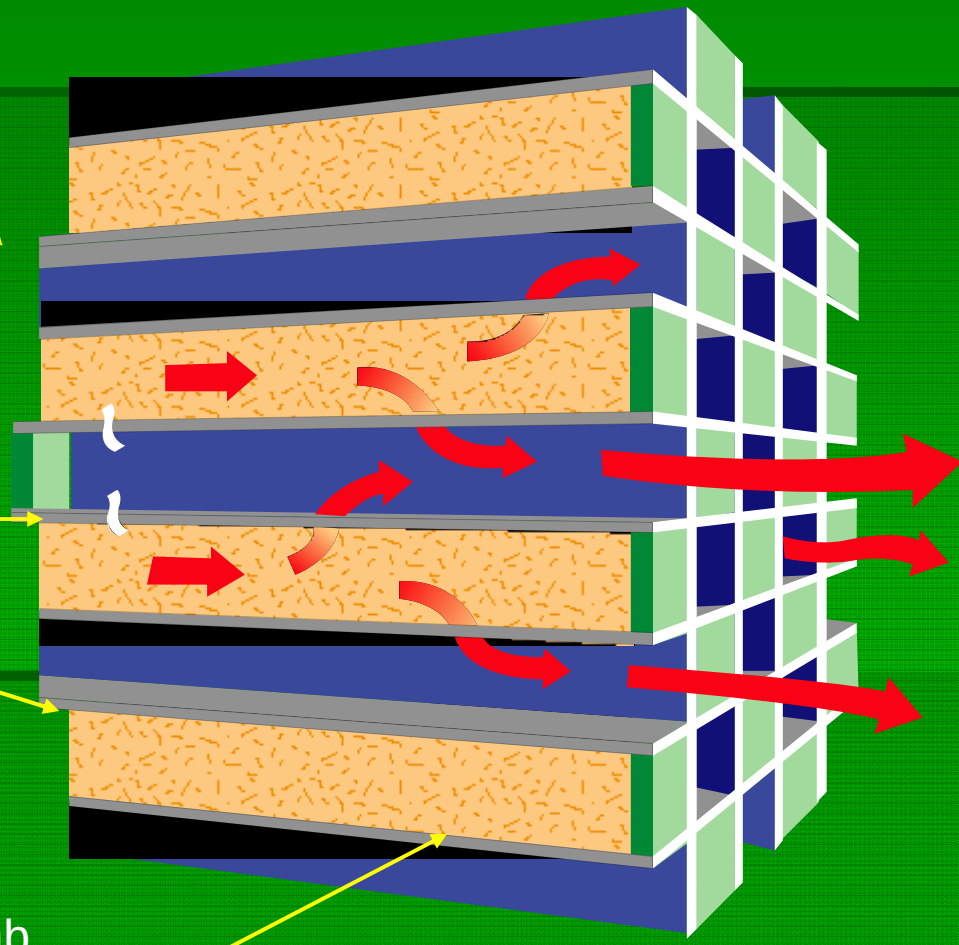
- Approved for four-stroke diesel engine on-road applications with engine horsepower ranges of 150-600 hp
  - 1991-1993 model year engines (0.25 g/bhp-hr PM or less) with exhaust temperatures above 230° C at least 40% of the time.
  - 1994-2002 model engines (0.10 g/bhp-hr PM or less) with exhaust temperatures above less than 210° C at least 40% of the time.

### Maintenance-Free

NOx - 0%
PM - 50%
HC - 75%
CO - 75%
CO2 - 0%
DMF: $6,000 - $8,000

For more information, see:
http://www.donaldson.com/en/exhaust/support/datalibrary/042722.pdf
http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm

# Diesel Particulate Filter




Exhaust ($CO_2$, $H_2O$)
Out

**Emissions Reductions**

- 95% PM reduction
- 90% HC reduction
- 90% CO reduction
- $8,000 - $11,000

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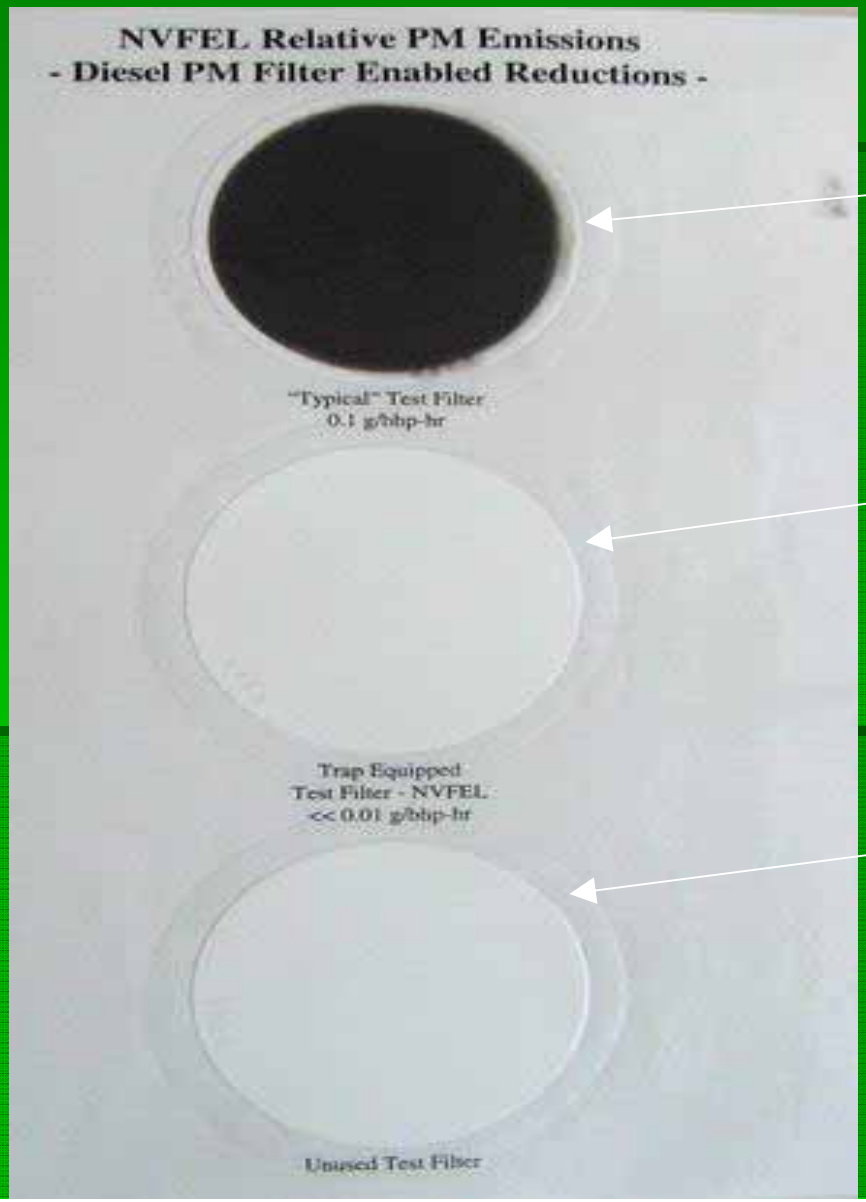
Environmental Protection
Agency

# Diesel Particulate Filter Emissions Reductions




Typical test filter – no DPF

Test filter – with DPF

Unused test filter

EPA United States Environmental Protection Agency

# Other Emissions Control Technologies & Cleaner Fuels

- Selective Catalytic Reduction (SCRs)
  - 20% - 50% reduction in PM
  - 60% - 90% reduction in HC
  - >90% reduction in CO
  - 25% - 50% reduction in NOx
- Biodiesel – Neet or blends (~$5/gallon - virgin biodiesel)
  - 10% to 50 % reduction in PM, Sulfates, & HC
- Ultra Low Sulfur Diesel (ULSD), PM 13% NOx 3% CO 6% HC 13%

See: http://www.epa.gov/otaq/retrofit/verif-list.htm
http://epa.gov/region09/cleanup-clean-air/index.html
http://cfpub.epa.gov/quantifier/view/index.cfm for more details

EPA United States Environmental Protection Agency


Front Loader

Dredging

Hauler

Earth Mover

Back Hoe

EPA
United States
Environmental Protection
Agency

# Region 10 Success Stories

- ERRS contract now includes emission reduction language
- On the way—biodiesel usage in some field EPA owned and GSA vehicles
- Use of rail transport instead of trucks for soils disposal at Boomsnub removal site, Vancouver, WA

EPA
United States Environmental Protection Agency

Port of Portland Terminal 4 dredging with ULSD—reducing emissions: PM 13%, NOx 3%, CO 6%, HC 13%



# Divers will Breathe Cleaner Air

*40% less carbon monoxide*


EPA dive boat in Puget Sound

EPA
REGION 10 DIVE TEAM
http://yosemite.epa.gov/r10/oea.nsf/webpage/dive+team

**2007 Volvo Penta**

**1997 Yanmar**

| Pollutant | 2007 Volvo Penta (Tier 2 emissions) vs. 1997 Yanmar (pre-controlled) % Reduction of emissions * | Pounds/Year Reduced i * |
|---|---|---|
| PM | 77.8 | 10.5 |
| NOx | 39.0 | 93.5 |
| CO | 43.8 | 16.9 |
| HC | 22.0 | 2.0 |

* Emission reductions are estimates based on Tier 2 standards and emission factor calculations for pre-controlled marine engines. Wayne Elson, September 2007

# ERU truck retrofits / alternative fuels

- B100 usage where available, average B50 usage reducing SOx, CO, HC, PM by approximately 50% overall
- DMFs added to ERU trucks to reduce the remaining output of PM by another 50%

# Taylor Lumber, Sheridan, OR

B20/ULSD used at the Taylor site, reducing overall emissions substantially:
PM 13%, NOx 3%, CO 6%, HC 21%, Sulfates 20%, $CO_2$ 15%

**H.33 CLEAN TECHNOLOGIES**

The contractor will use clean technologies and/or fuels on all diesel equipment to the extent practicable and/or feasible. The preference is for clean diesel technologies, but alterative fuels, such as biodiesel or natural gas-powered vehicles are also acceptable. These alternative fuels will be used where they are available and within a reasonable distance to sites. For equipment retrofits, the contractor will employ the Best Available Control Technology (BACT) on non-road and on-road diesel powered equipment used at a site. Examples of clean diesel technologies include diesel particulate filters (DPFs), and diesel oxidation catalysis (DOCs). For alternative fuel usage, the contractor will use at least a B20 blend (i.e., 20% biodiesel and 80% petrodiesel) or higher in the equipment engines that are used at a site.

# Mechanisms

- Addition of greener contract/statement of work (SOW) language in ERRS contracts
- Include language in AOCs/CDs (PRP lead), and Action Memos
- Retrofit diesel ER equipment used regularly on response actions
- Voluntary use on PRP sites

EPA United States Environmental Protection Agency


Questions?

Region 10:
Sean Sheldrake – 206-553-1220
Wayne Elson – 206-553-1463
On the Web:
Region 9:
http://epa.gov/region09/cleanup-clean-air/index.html
West Coast Collaborative:
http://www.westcoastcollaborative.org/

EPA United States Environmental Protection Agency

13th Annual OSC Readiness Training Program

# Delfasco Vapor Intrusion – A Green Remedy

Presenter: Greg Fife

Date: February 1, 2010

Time: Afternoon

Training by OSCs for OSCs

February 1-4, 2010

Orlando, Florida

www.oscreadiness.org

# Delfasco Forge

- Delfasco Forge
- Grand Prairie, TX
- Vapor Intrusion
- RCRA Enforcement

# Delfasco Forge - History

- Delfasco, as in Delaware Forge and Steel Company
- Made practice bombs for DOD
- Outgrew the facility
- Auto repair shop now

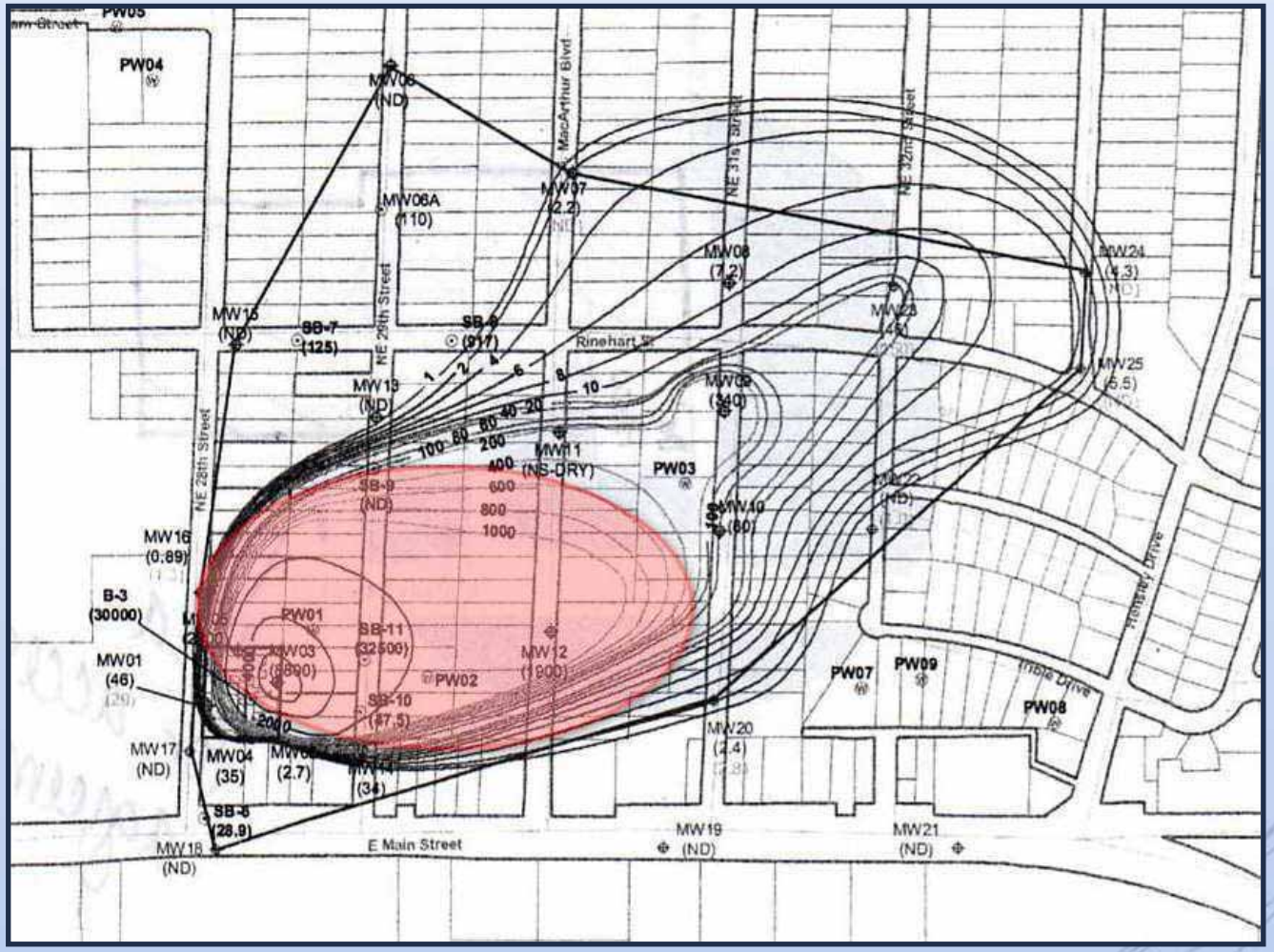
# Delfasco Forge

- Trichloroethylene used in the process
- Spills, releases, and poor housekeeping led to contamination of groundwater
- Residential to the north and east
- Direction of groundwater, Northeast.

# Delfasco Forge Neighborhood.

# Delfasco Forge Neighborhood.

# Delfasco Groundwater Plume

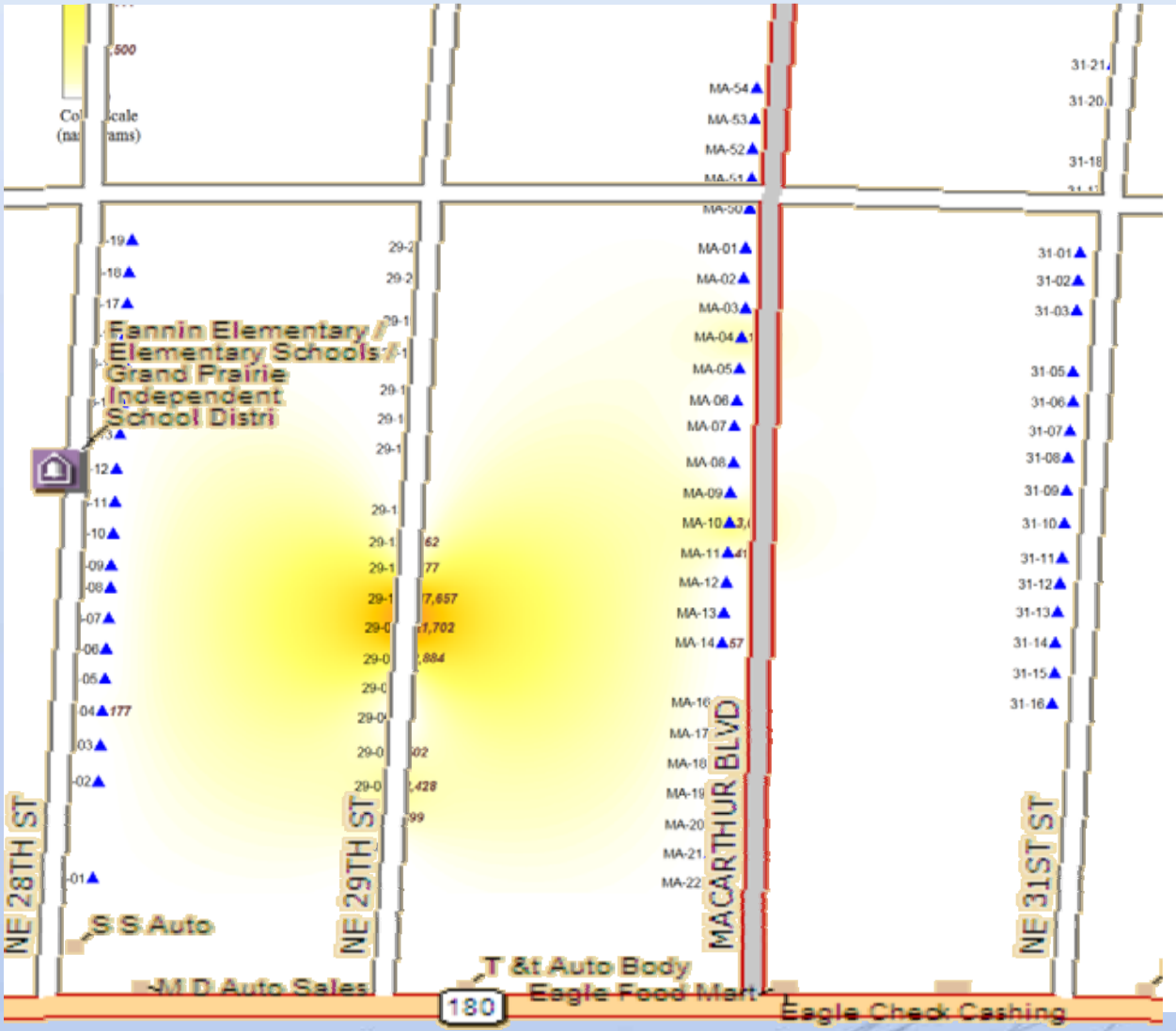


# RCRA & TX Indoor Air Sampling

# Passive Soil Gas Sampling

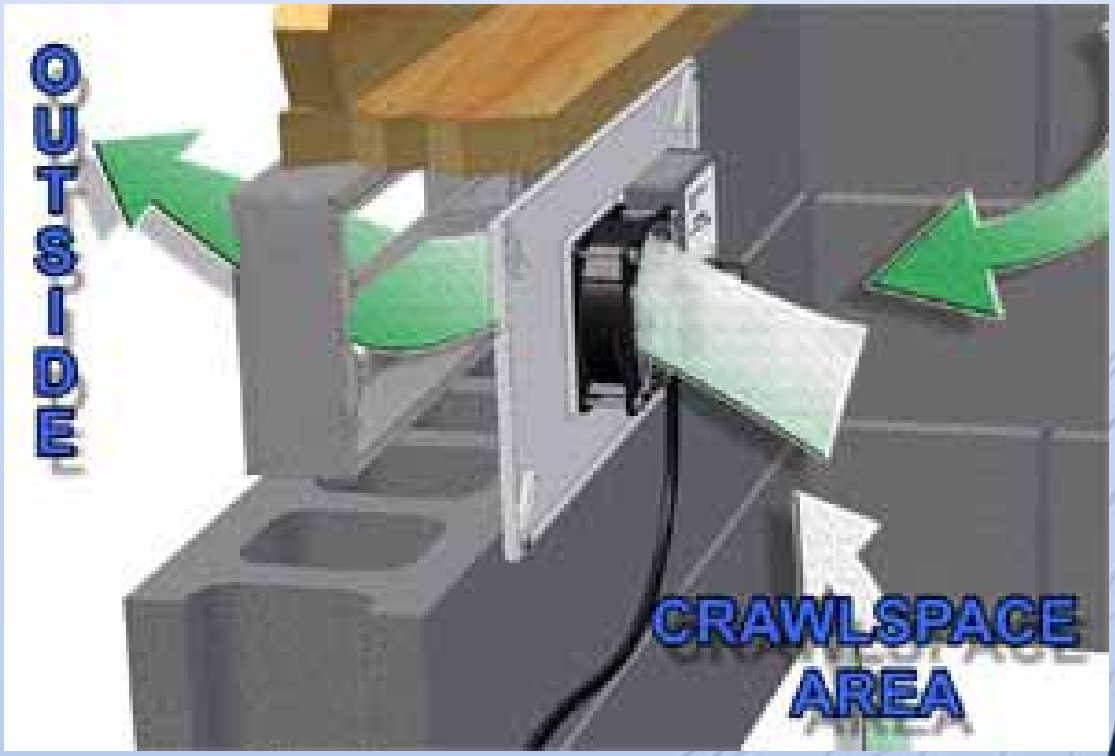
- Semi-quantitative
- In-Ground
- 100 points
  + dups, blanks
- 1-2 weeks
- $18/sample
- Beacon
  Environmental

# Soil Vapor Results



# Crawl Space Fan

- Pier and beam construction
- Commercially available exhaust fans



# Fan Comparison

- Radon fan - - 60-90 CFM
  $1,500 per unit

- Crawlspace fan - - 200 CFM
  $200 per unit

- Each fan running 24/7/365
- $3 to $8 per month

# Impact of Electrical Cost on Budget

- $8 per month, $96 per year
- Compare to increase price of gasoline
- Federal Standard is 15,000 miles per year
- Avg miles per gallon is 21
- That is 714 gallons per year.
- The $96 in additional electricity cost is equivalent to **$0.134 per gallon**

# Solar Power Exhaust Fan

- Solar powered
- Panel: 10”x16”x0.7”
  10 Watt
  Fan: 6” dia.
  2500 RPM
  200 CFM
  55 DB

# Crawl Space Fan Effectiveness

- Reduced the concentration in the first home to right at the action level.
- The concentration in the other home was orders of magnitude below the action level.
- Subsequent system include a battery for longer duration of run time.
- As well as the original two homes.

# Solar Powered Fan Installed

# Solar Panels

- Solar panels and the fans were commercially available
- Same source, package.
- EcoVantange Energy, Weatherford, TX
- Hail and wind resistant

# Installation of Solar Panels

- Point South.
- Unobstructed southern exposure to the sun
- Sun is overhead in the summer, south in winter
- Somewhere between 25 and 50 degrees
- 45 minutes to an hour install time.

# Maintenance

- Relatively no maintenance
- Battery is 5 to 7 years

# Solar Radon Fans

- Wattage
- Radon fans require 20 to 70 watts

  For a 200 CFM radon fan, 65 watts

- 10 watts per 10” x 16”

  Roughly a sheet of paper per 5 watts

65 watt radon fan require a panel 36” x 36”

$600 - $800 per panel