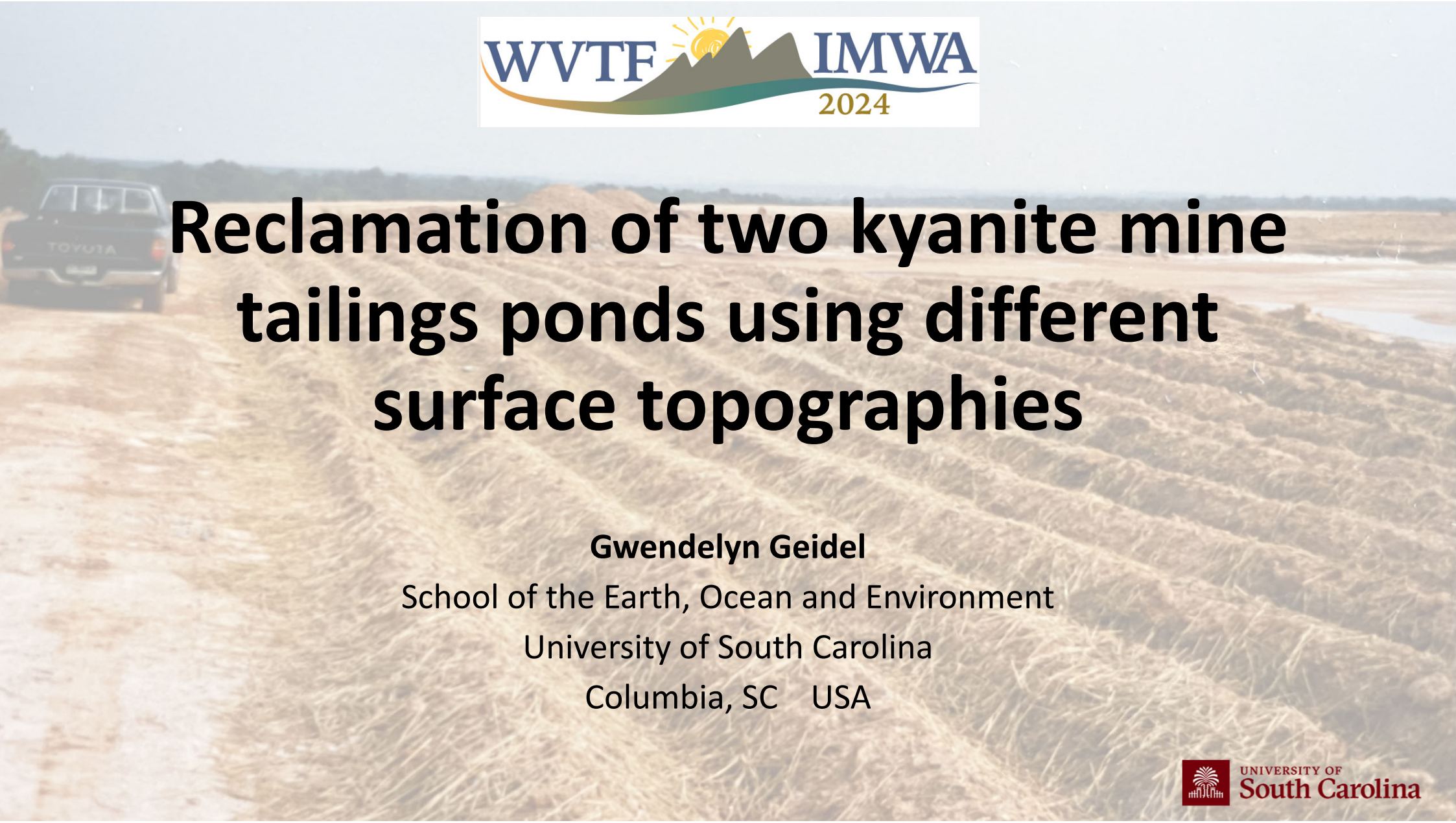


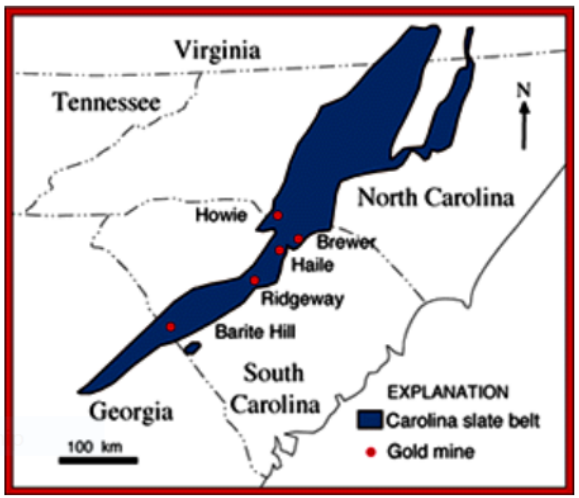
Reclamation of two kyanite mine tailings ponds using different surface topographies

Gwendelyn Geidel

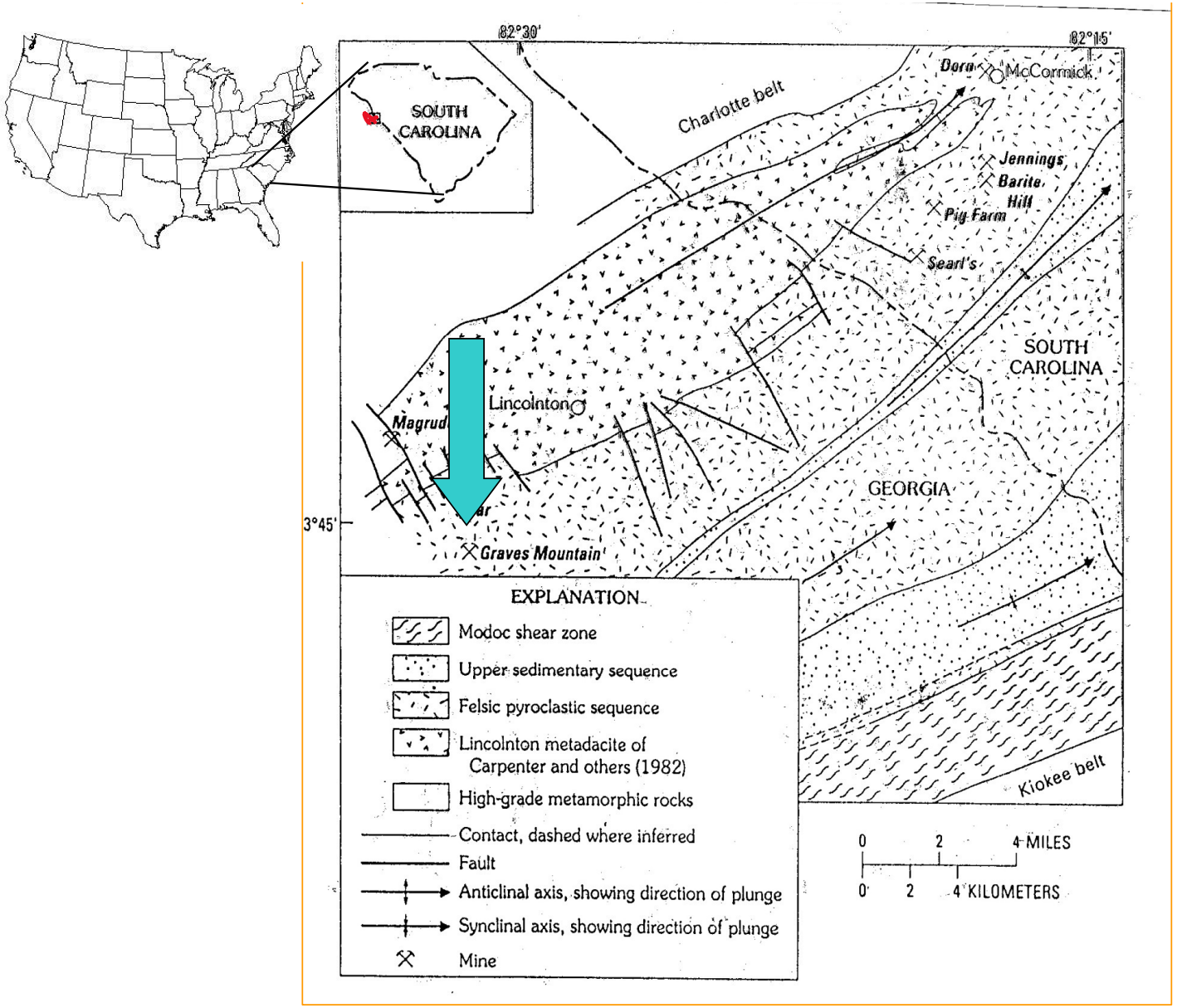
School of the Earth, Ocean and Environment

University of South Carolina

Columbia, SC USA

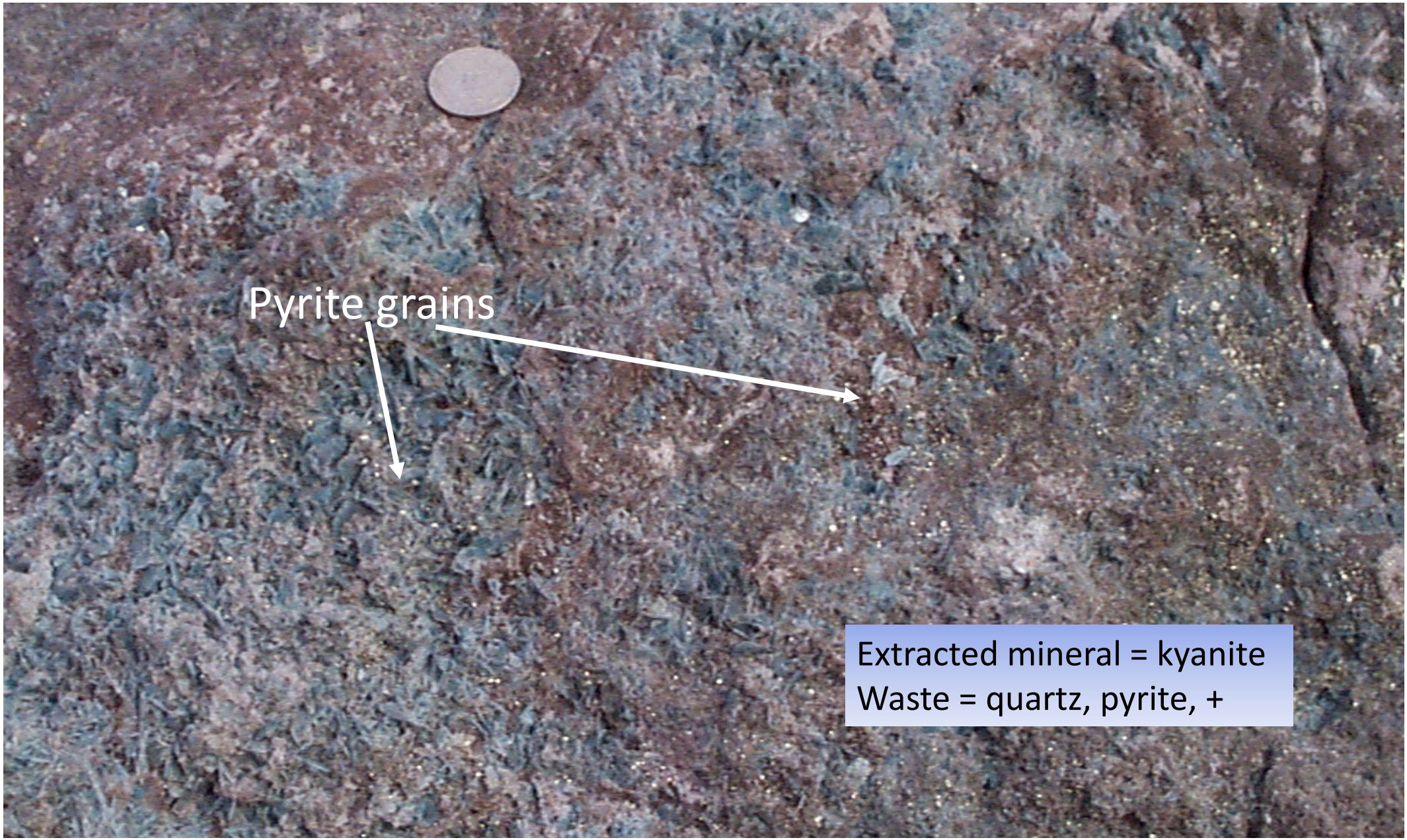


Location of the Graves Mountain Kyanite Mine, Lincolnton, GA, USA



Historically, mine known for Rutile (TiO) – extracted in early 1900's by Tiffany's & many museums worldwide have crystals from site

From 1960's to mid 1980's site mined for kyanite; used in refractory brick and on space shuttle heat shield


Pyrite grains
Extracted mineral = kyanite
Waste = quartz, pyrite, +

pH of water from tailings ~ 2.2 – 3

pH of tailings ~2.5

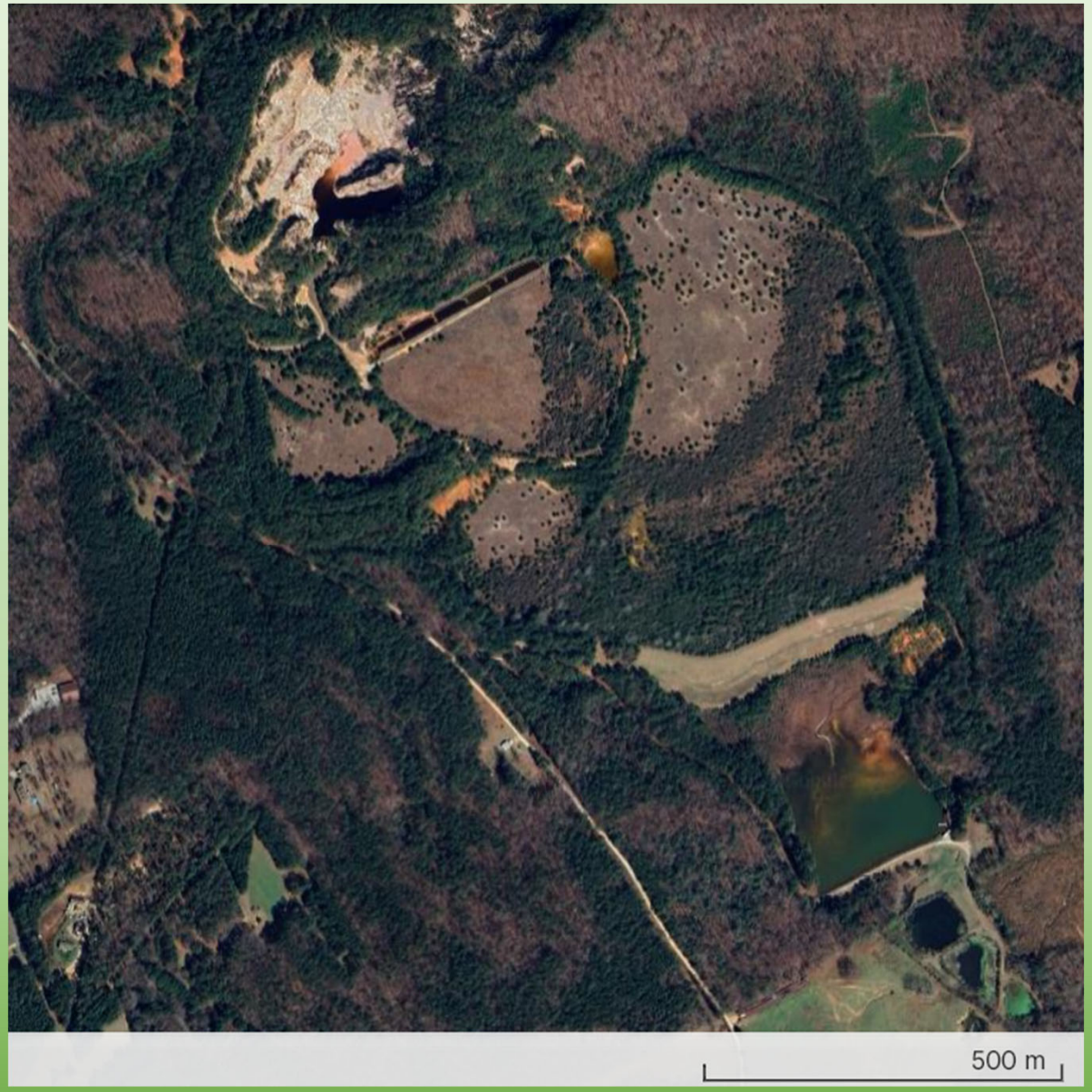
We began reclamation efforts of ETP & WTP in 1994.

Google Earth, ~ 1990

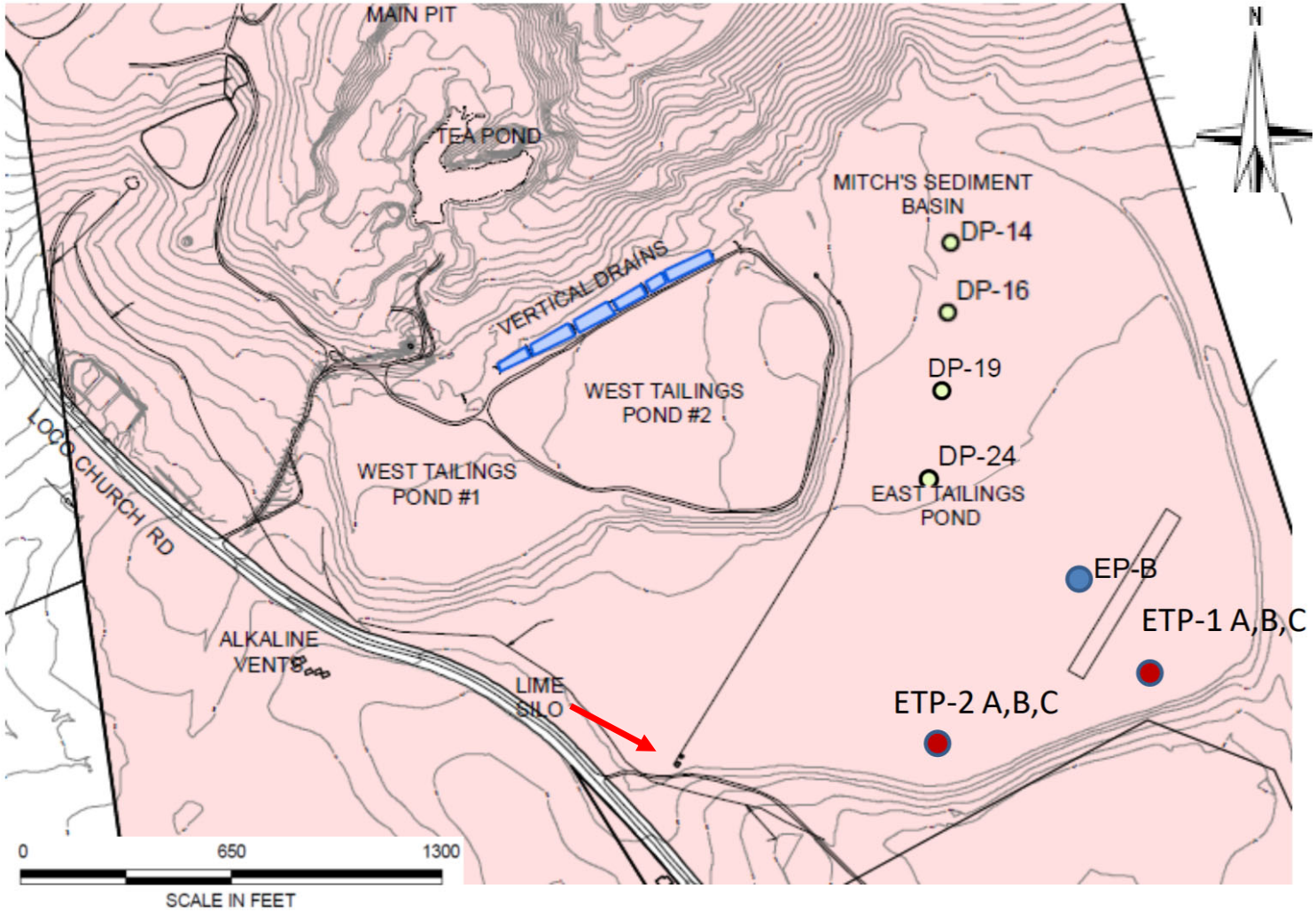
Prior papers on:
ETP reclamation,
Hydrology,
Passive
treatments.

Google
2009

https://earth.google.com/web/@33.72853699,-82.50124866,146.67797233a,7040.4461236d,35y,7.02624231h,0t,0r/data=CjISMBIgNTQ0M

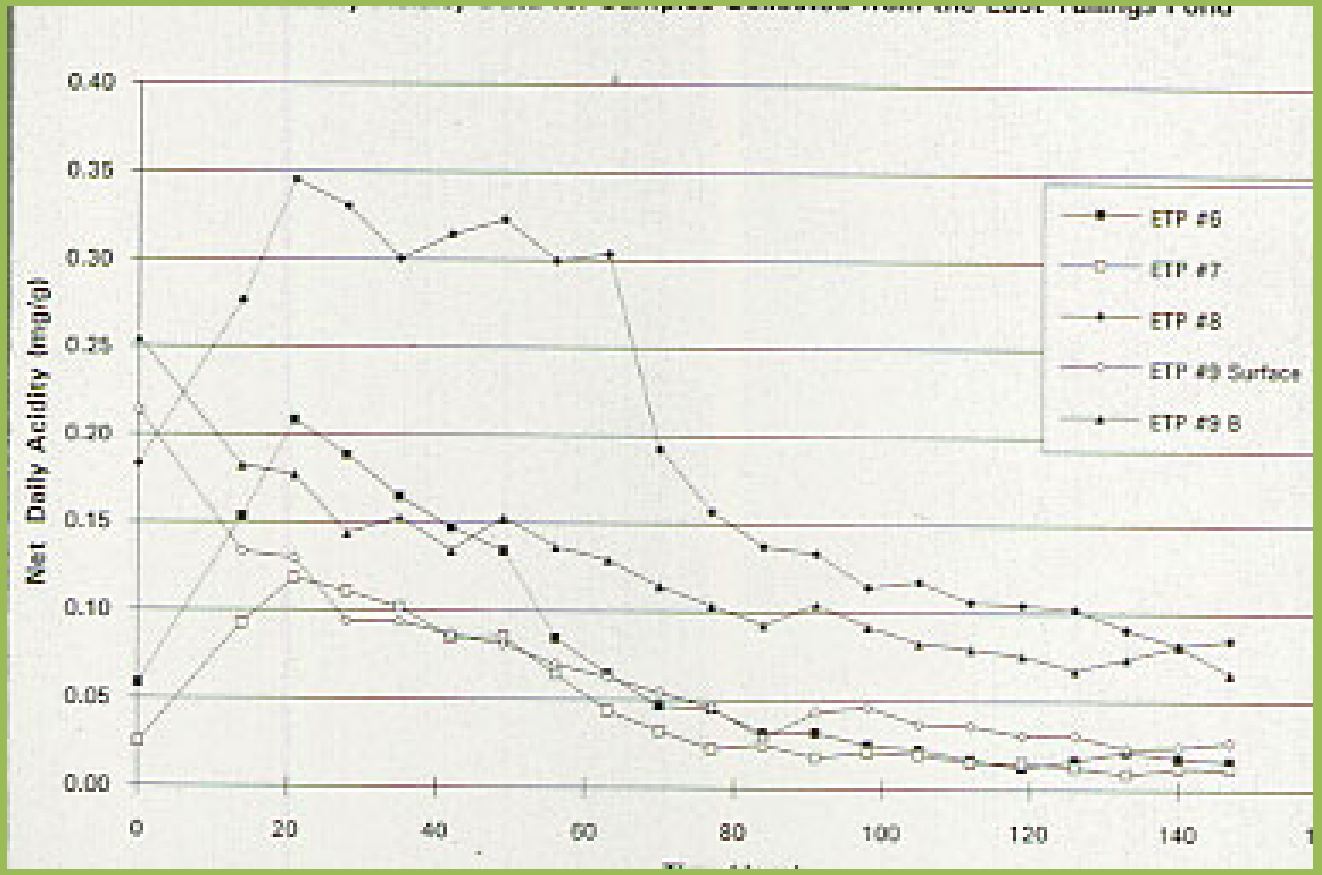


Google Earth - 02/23/2024 33°44'13"N 82°31'27"W



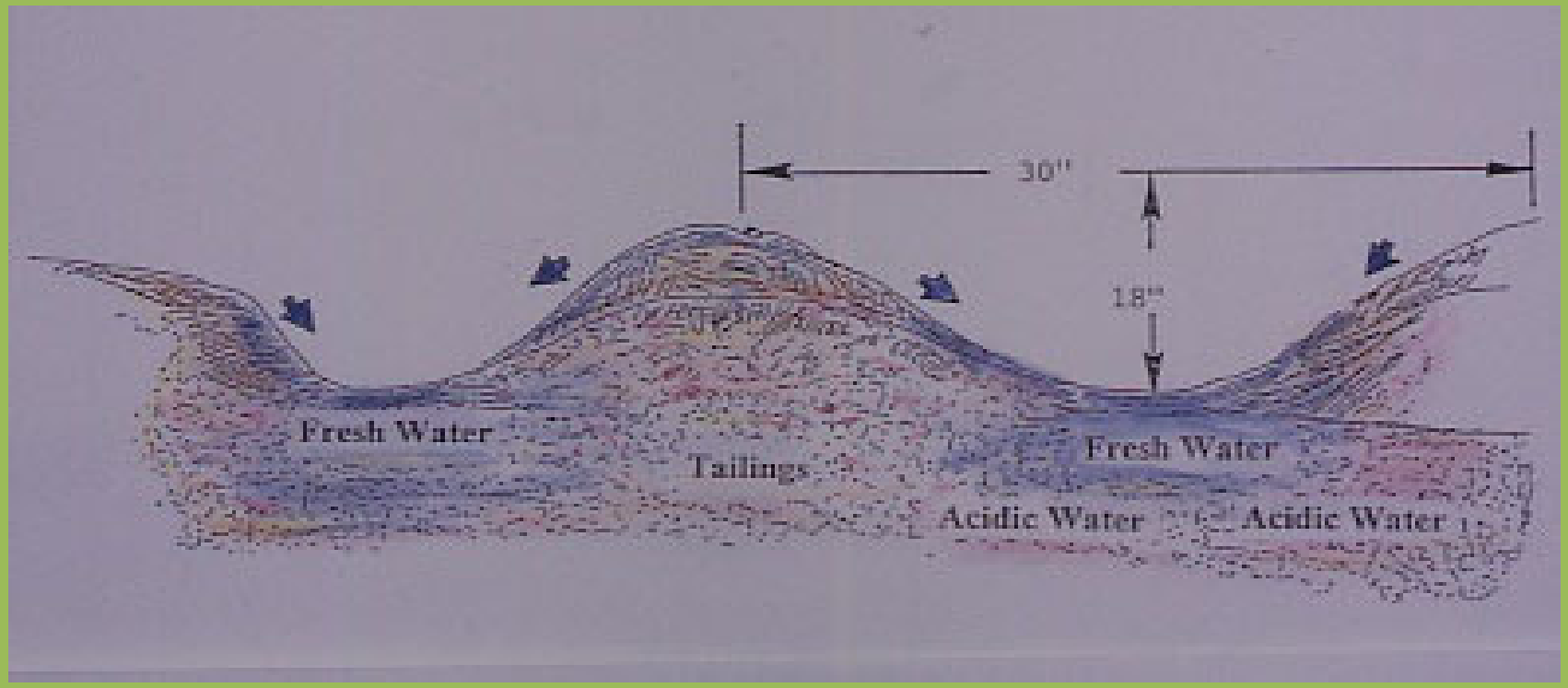
5 ft contours

Acidity of Tailings samples from ETP



Time (Days)

Details of Ridge and Furrow (RAF) Technique - ETP

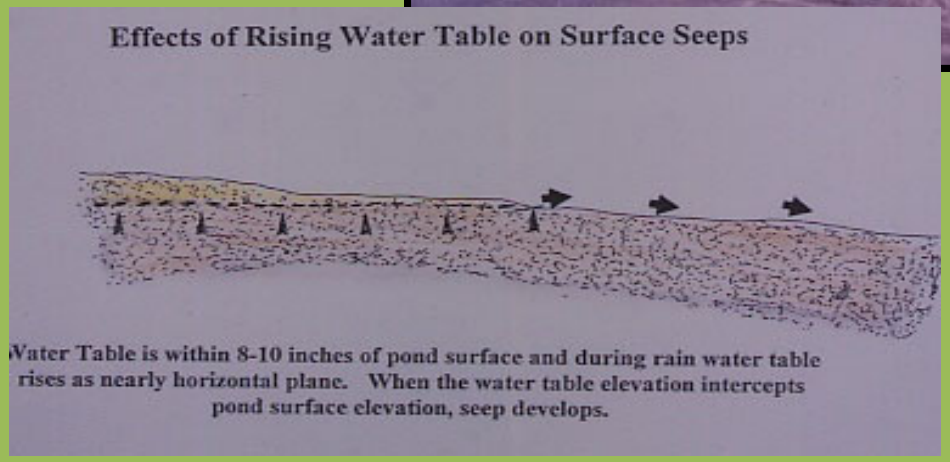


The surface configuration of a scarified tailings pond surface encourages rainfall to accumulate in the furrows. The less dense rainwater establishes pockets of fresh water that float within the acidic matrix. Through time the ridges become purged of acidity and fresh water zones become established.

ETP Reclamation Success Depended on a Multi-Component Integrated Technology

1. Improve Near Surface Water Quality and Lower Water Table

Water Table 0.1 -0.3m
During rain, water table rises as nearly horizontal plane and seeps developed when the water table elevation intercepts pond surface elevation.

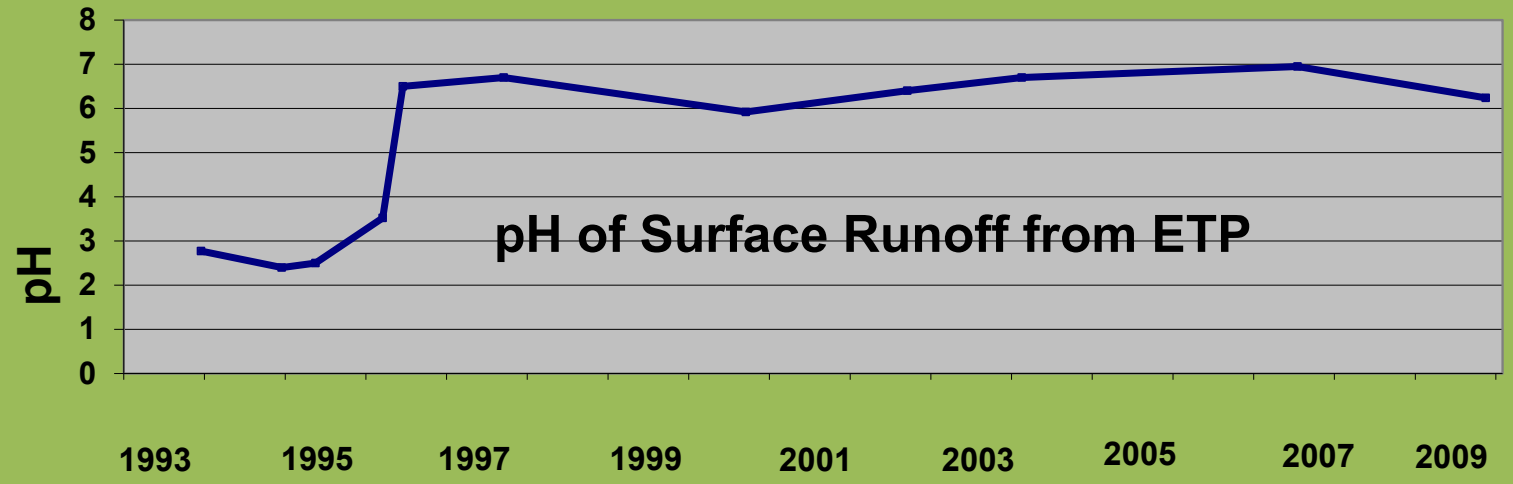


2. Decrease acid levels in the near surface, vegetative zone.

Dec. 1994

June 2000

May 2010



3’ Peizometers installed in ETP in 2003

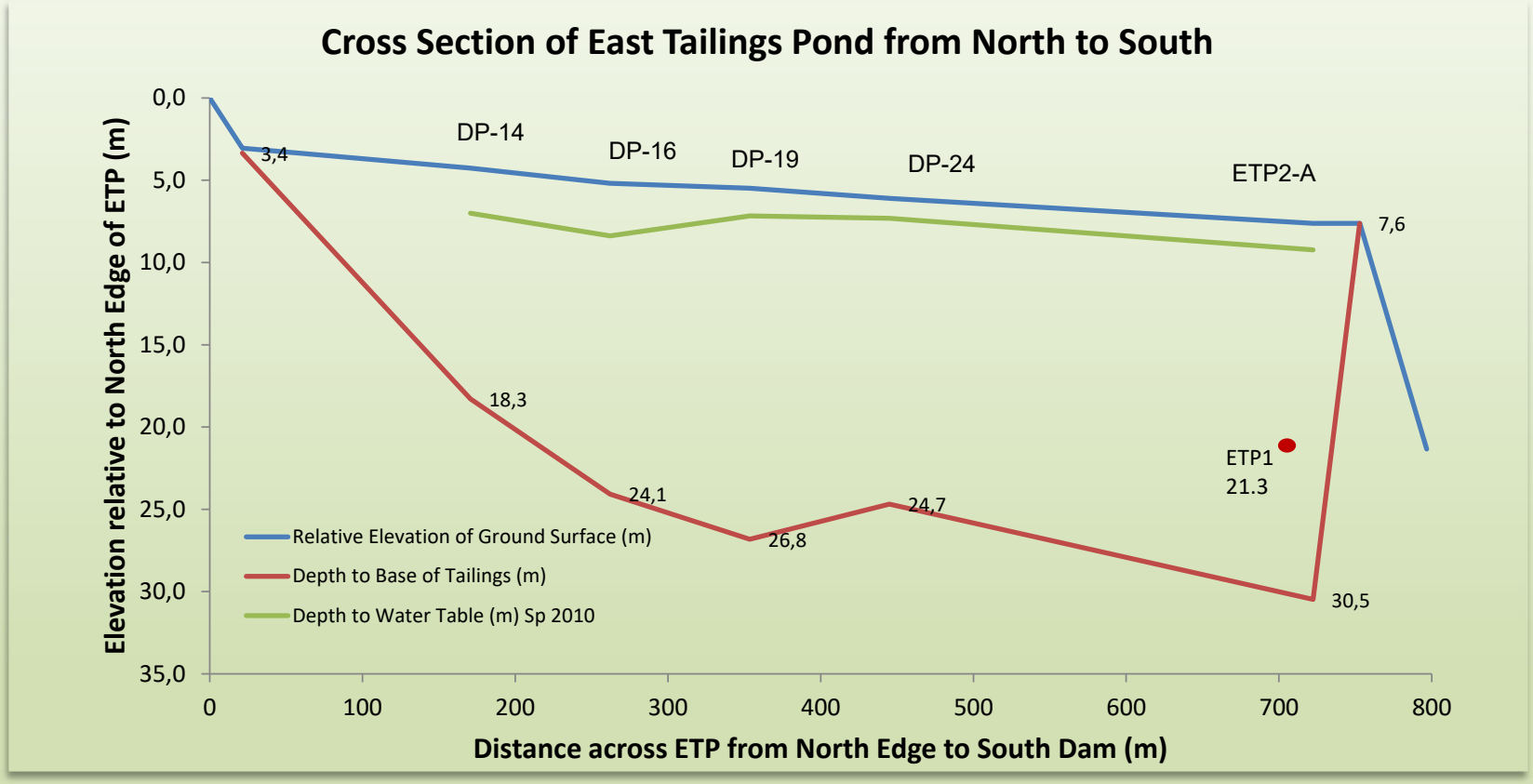
Dry by 2008

EP-B
2003

ETP 1: A,B, C

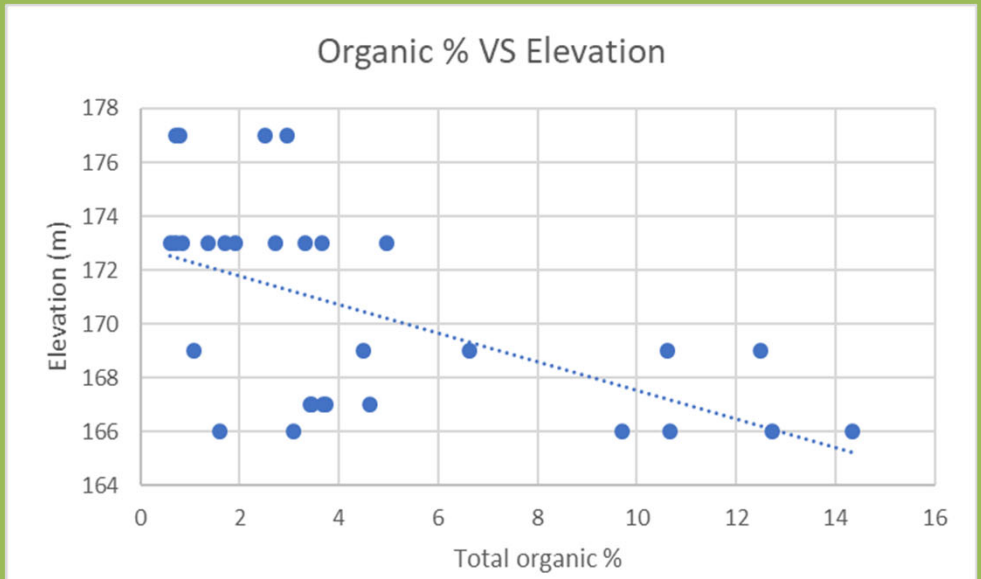
2 sets of wells installed 3/2011

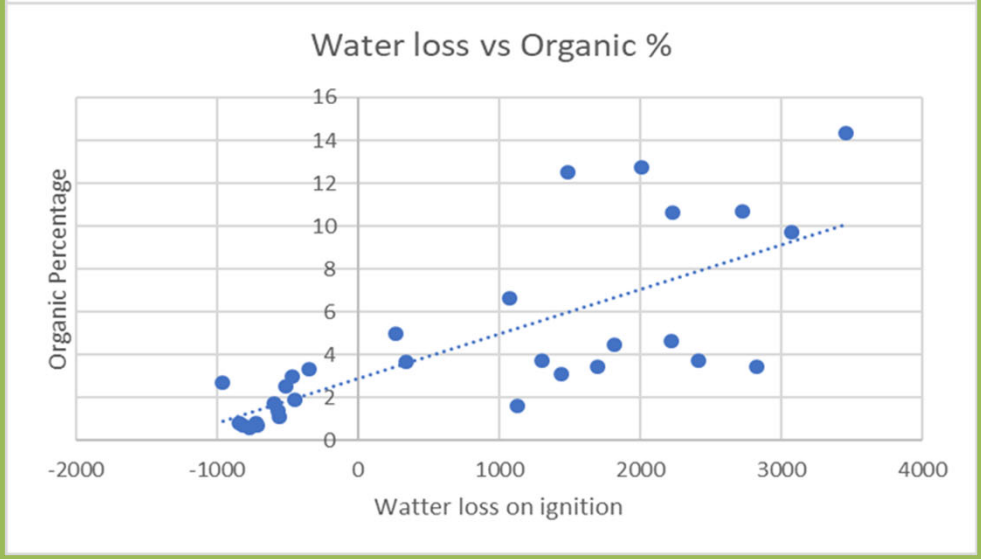
5/22/2023 – Surrounded by trees


Cross Section of East Tailings Pond from North to South
Elevation relative to North Edge of ETP (m)
0,0
5,0
10,0
15,0
20,0
25,0
30,0
35,0
0
100
200
300
400
500
600
700
800
Distance across ETP from North Edge to South Dam (m)
DP-14
DP-16
DP-19
DP-24
ETP2-A
3,4
18,3
24,1
26,8
24,7
30,5
7,6
ETP1
21.3
Relative Elevation of Ground Surface (m)
Depth to Base of Tailings (m)
Depth to Water Table (m) Sp 2010

2019 - ETP Organic layer

Oct 11, 2019, ETP; sampling for soil carbon.





Positive correlation to water loss vs organic %

Increase in organic carbon material down slope

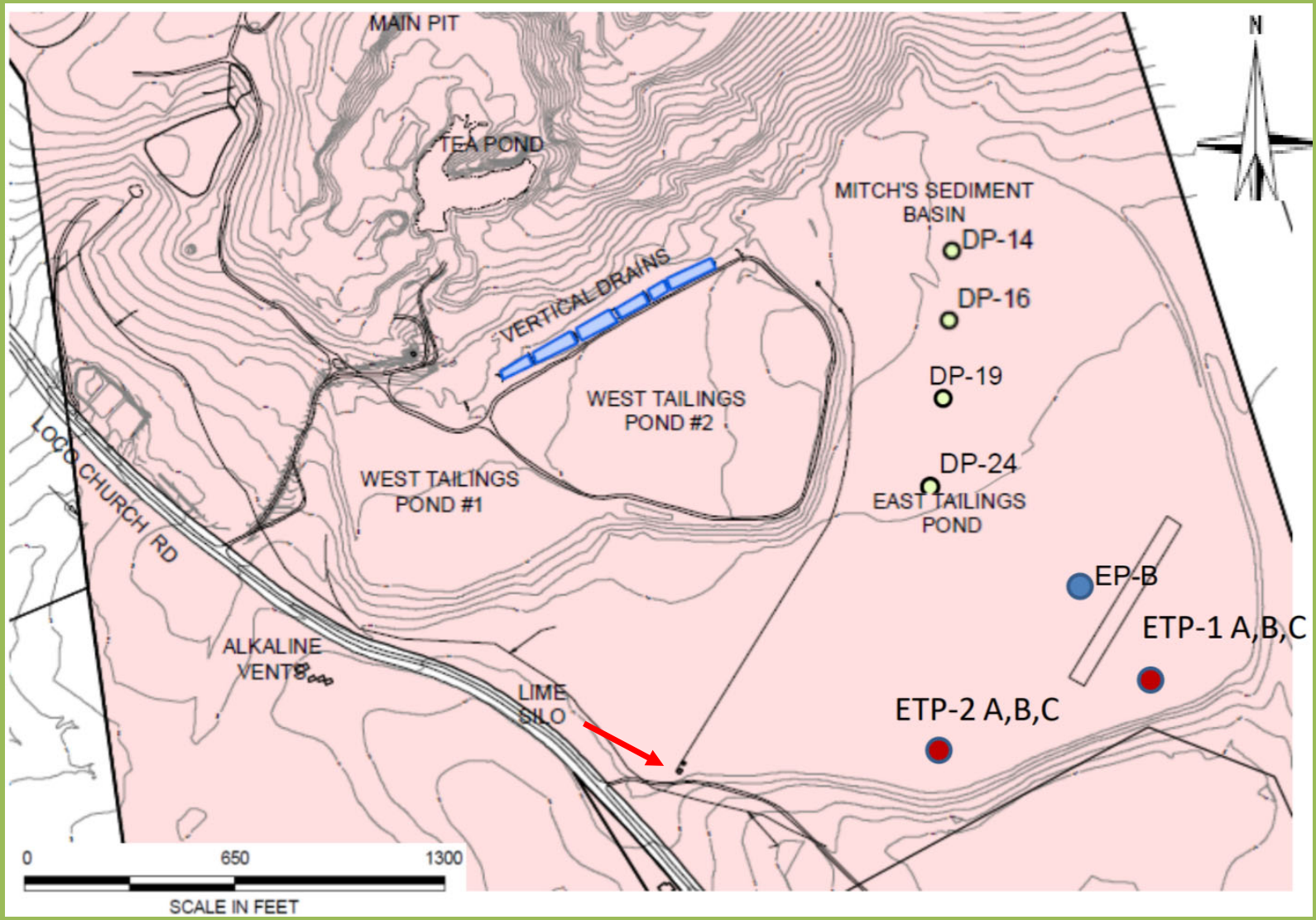
Increase in organic material through site progression

Larger vegetation shows increase in organic %

Carbon sequestration through organic decomposition

23 years @1/2” → .55 mm per year sequestered carbon

ETP Data from J. Niles, 2019 report



5 ft contours

West Tailings Pond (WTP) reclamation

WTP –Test Plots on prior reclamation efforts.

Prior Reclamation = 2-4” soil layer placed on top of tailings in ~1992-3 and seeded. Test plots with Ridge and Furrows in 1994.

- Based on density of plant cover and predominant species (Weeping lovegrass), the soil covered WTP was scheduled to have ridge and furrows installed with lime and organic matter (straw) incorporated, then fertilized and seeded with 11 seed mix in summer 1996.

- Plans were revised by engineers and 2/3 of the WTP surface was only scarified approximately 1-2” deep, limed, fertilized and seeded. Straw mulch cover with asphalt tacking.

Plant Species seeded in WTP in 1996

Common name	*Latin name*
Sericea lespedeza	*Lespedeza cuneata*
Weeping lovegrass	*Eragrostos curvula*
Common Bermudagrass	*Cynodon dactylon*
Carpet grass	*Axonopus compressus*
Clovers	*Trifolium spp.*
Deertongue	*Panicum clandestinum*
Foxtail Millett	*Setaria italica*
Japanese Millet	*Echinochloa crusgalli*
Pearl Millet	*Pennisetum glaucum*
Rescuegrass	*Bromus catharticus*
Sorghum	*Sorghum bicolor*

Eastern 1/3 end of WTP
October 1994

Highly acidic seeps and
water flowing from WTP.

Initial Reclamation of western portion of WTP in 1994

WTP –lower 1/3 filled with tailings from small TP, RAF with lime & straw incorporated. Then fertilizer, seed and straw mulch layer

WEST TAILINGS POND –WTP

Approx. 17 ac (6.9 ha)

02/2019

https://earth.google.com/web/@33.73713618,-82.52541393,182.47026792a,569.78994415d,35y,356.86381868h,0t,0r

WTP 7/21/2015

Oct 2019

Plant Species seeded WTP in 1996 and 1999

Common name	*Latin name*
Sericea lespedeza	*Lespedeza cuneata*
Weeping lovegrass	*Eragrostos curvula*
Common Bermudagrass	*Cynodon dactylon*
Carpet grass	*Axonopus compressus*
Clovers	*Trifolium spp.*
Deertongue	*Panicum clandestinum*
Foxtail Millett	*Setaria italica*
Japanese Millet	*Echinochloa crusgalli*
Pearl Millet	*Pennisetum glaucum*
Rescuegrass	*Bromus catharticus*
Sorghum	*Sorghum bicolor*

WTP Species from non-tree area 2022

Weeping lovegrass	*Eragrostis curvula*
Sericea lespedeza	*Lespedeza cunaeta*
Prairie Fleabane	*Erigeron strigosus*
Carolina Desert-chicory	*Pyrrhopappus carolinianus*
Small's ragwort	*Packera anonyma*
Dogfennel	*Eupatorium capillifolium*
Purpletop vervain	*Verbena bonariensis*
Maypop	*Passiflora incarnata*
Japanese chess	*Bromus japonicus*
Sawtook blackberry	*Rubus argutus*
Late Boneset	*Eupatorium seratinum*
Bushy Bluestem	*Andropogon glomeratus*
Bihiagrass	*Paspalum notatum*
Horseweed	*Erigeron canadensis*
Common rush	*Juncus effusus*
Eastern gamagrass	*Tripsacum dactyloides*
Clasping Venus's looking glass	*Triodanis perfoliata*

WTP Species within Tree area 2022

Wax myrtle	*Morella cerifera*
Loblolly pine	*Pinus taeda*
Princess Tree	*Paulownia tomentosa*
Sweetgum	*Liquidambar styraciflua*
Black Willow	*Salix nigra*
Rocky mountain juniper	*Juniperus scopulorum*
Pitch Pine	*Pinus rigida*
American Sycamore	*Platanus occidentalis*
Eastern Red Cedar	*Juniperus virginiana*
Common Persimmon	*Diospyros virginiana*

Conclusions

- Ridge and Furrows in tailings (RAF) improved surface RO water quality and upper soil horizons.
- RAF diverted near surface flow and RO to vertical infiltration; then, vegetation increased evapotranspiration & lowered TP water table.
- RAF provided for volunteer establishment of tree species.
- In wetter areas and areas with more trees, increased organic Carbon in soil horizon.

Conclusions

WTP - Surface veneer of soil & no RAF, provided for volunteer grasses and herb establishment only.

Only 2 of original 11 planted species remain, but now in excess of 17 grass and herbaceous species (15 volunteer, some native)

No trees were planted; at least 10 tree species now in TPs- mixed conifer and deciduous.

Acknowledgements:

ABB, Inc.

Frank T. Caruccio

Ray Dotson, Jake Niles


Questions?
Gwen Geidel
Geidel@sc.edu
WVTF IMWA
2024