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Chemical Compatibility of Lake Dredge for Abandoned Mine Land Reclamation

Jacob Pensky, presenter

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Ohio University Voinovich School of Leadership and Public Service

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Lake Dredge in Reclamation

- Storage and reuse of dredge needed to maintain lakes
- Sediments can contain metals and nutrients depending on location - heterogeneous
- Borrow for reclamation limited in some areas, especially in the unglaciated part of Ohio
- Inexpensive material
- Investigating the chemical capability in acidic conditions

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Rush Creek Watershed Perry County, Ohio

Extensive Coal Mining Legacy

Pre Law and Post Law (SMCRA 1977)

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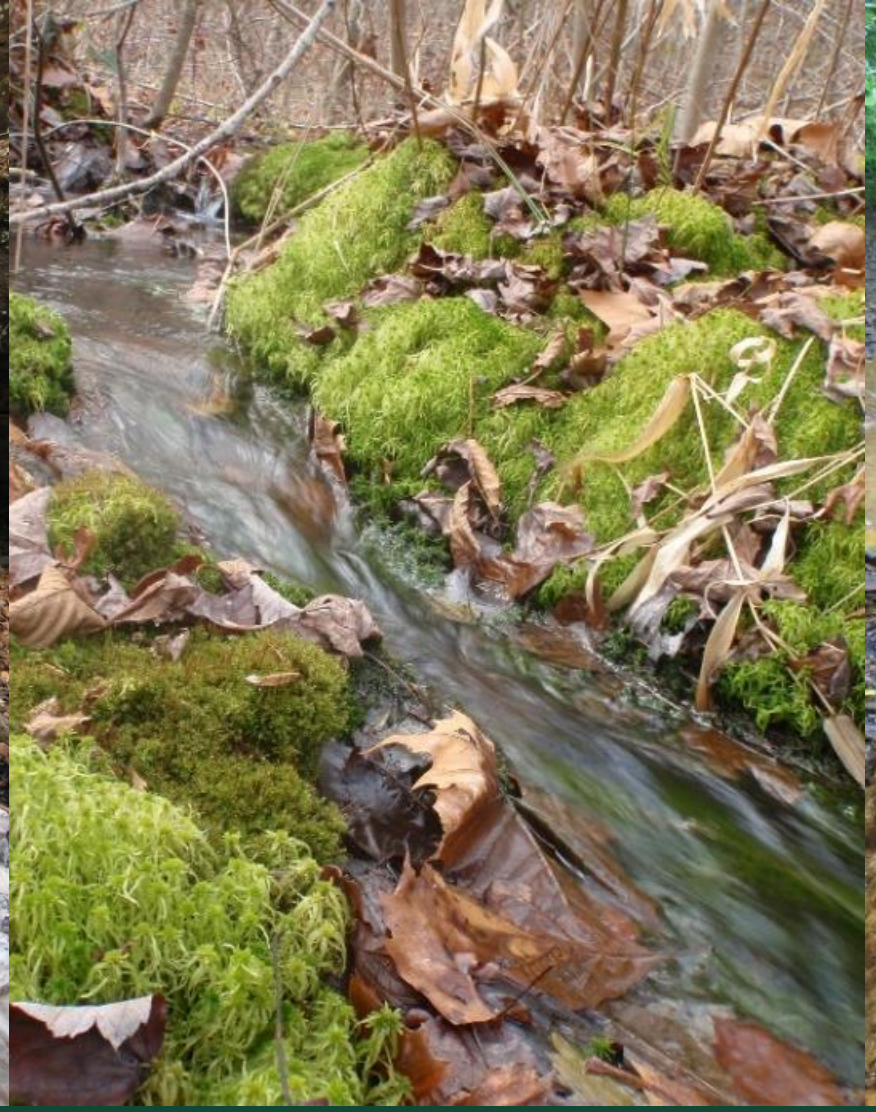

AMD seeps and discharges

Spoil in SE Ohio

-Acidic soils mixed with coal fines, clays, sandstones, other minerals, typically very acidic and has little buffering capacity, sparely vegetated

- Very high iron and sulfur content

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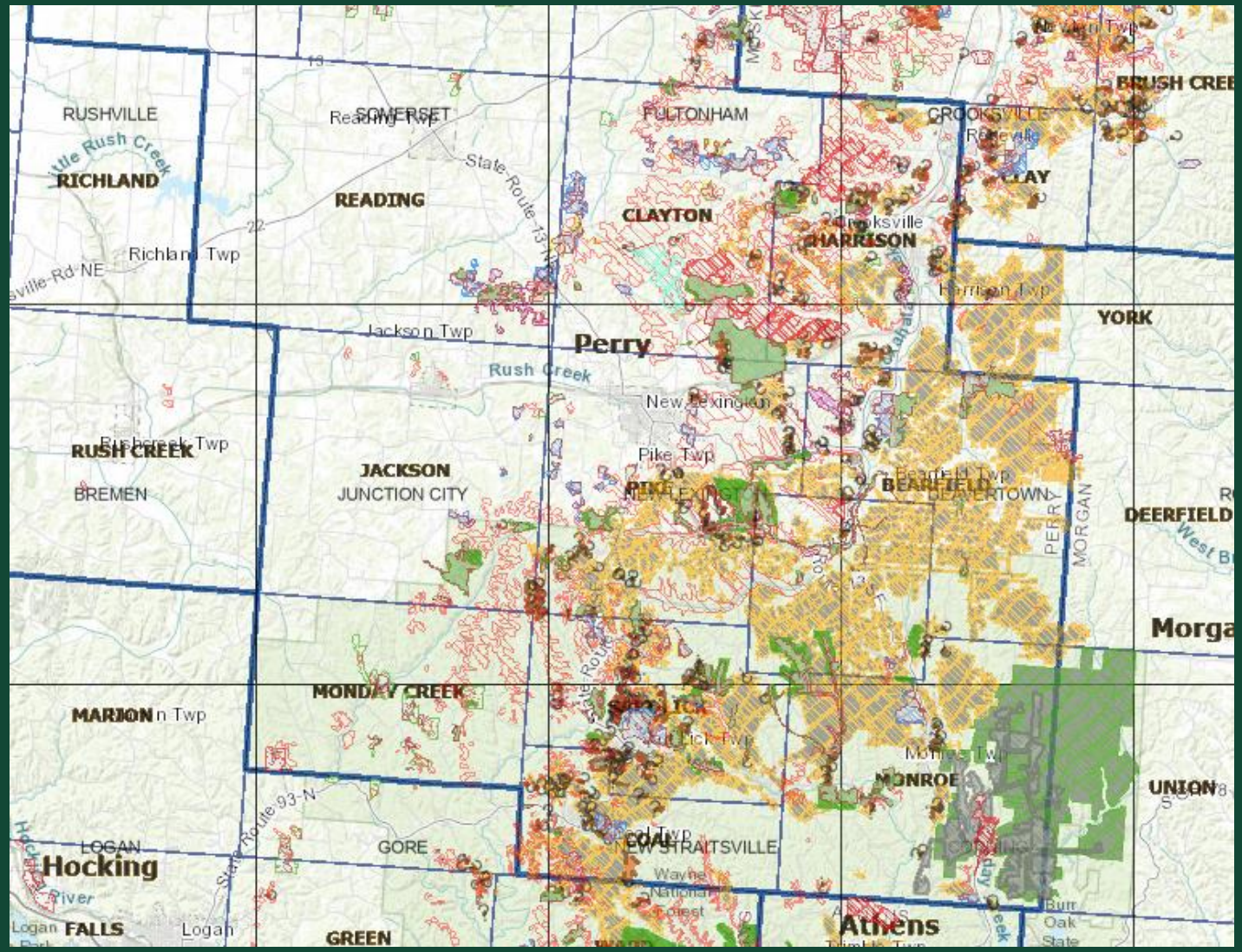
Mines in Perry County, Ohio



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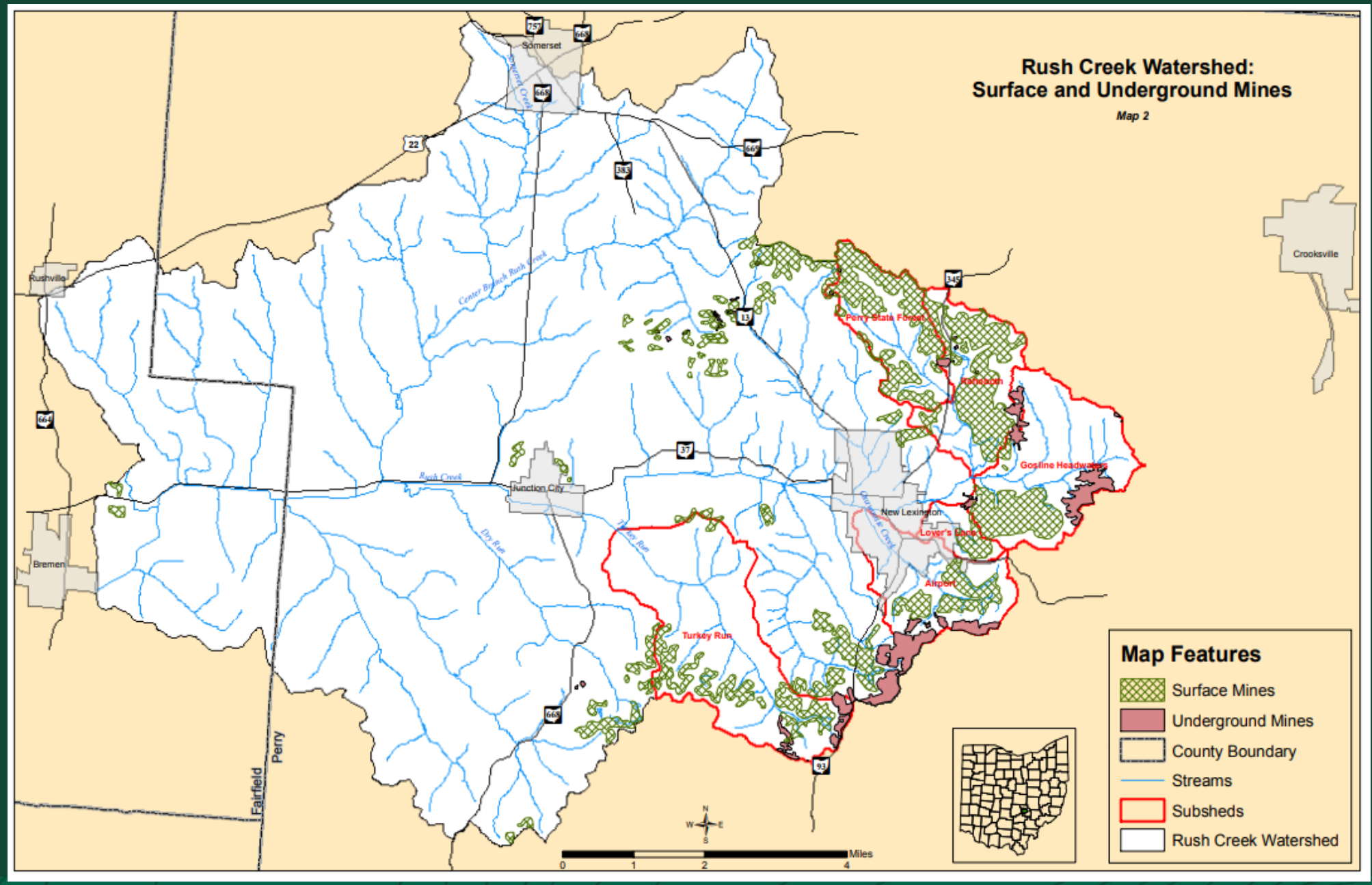

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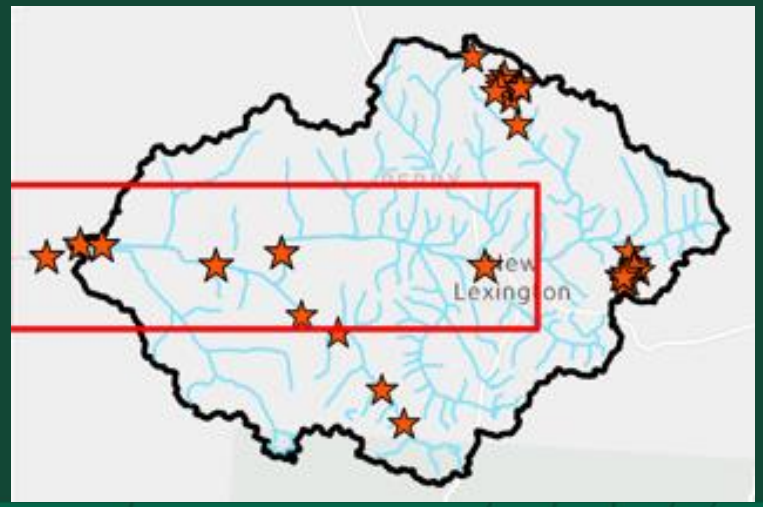
Rush Creek Mainstem Water Quality Data



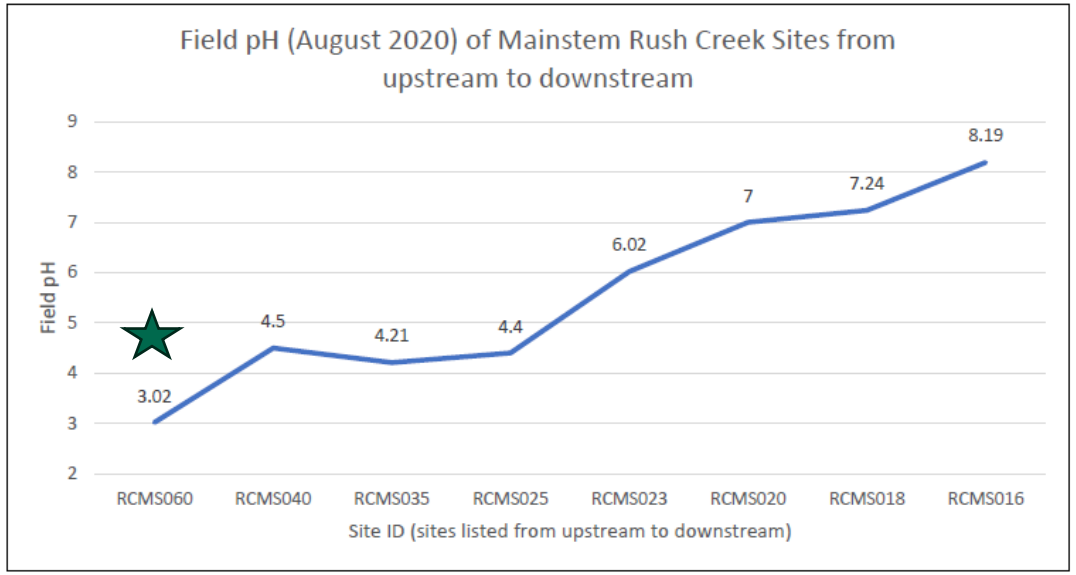


Figure 1. Field pH (August 2020) at Rush Creek mainstem sites from upstream (left) to downstream (right). pH values increased/improved moving along the mainstem downstream of Dry Run.

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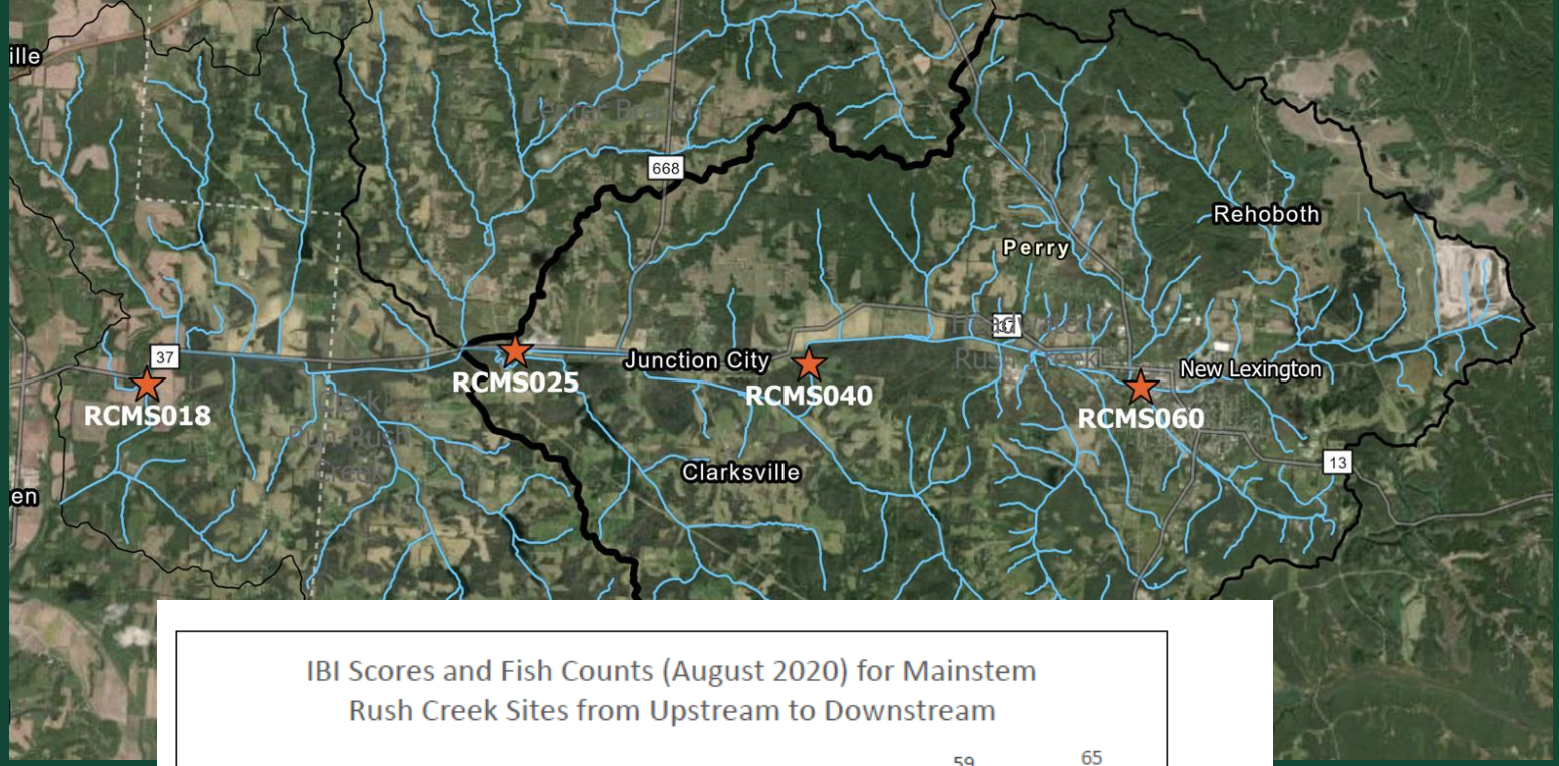
Rush Creek Mainstem Biological Data



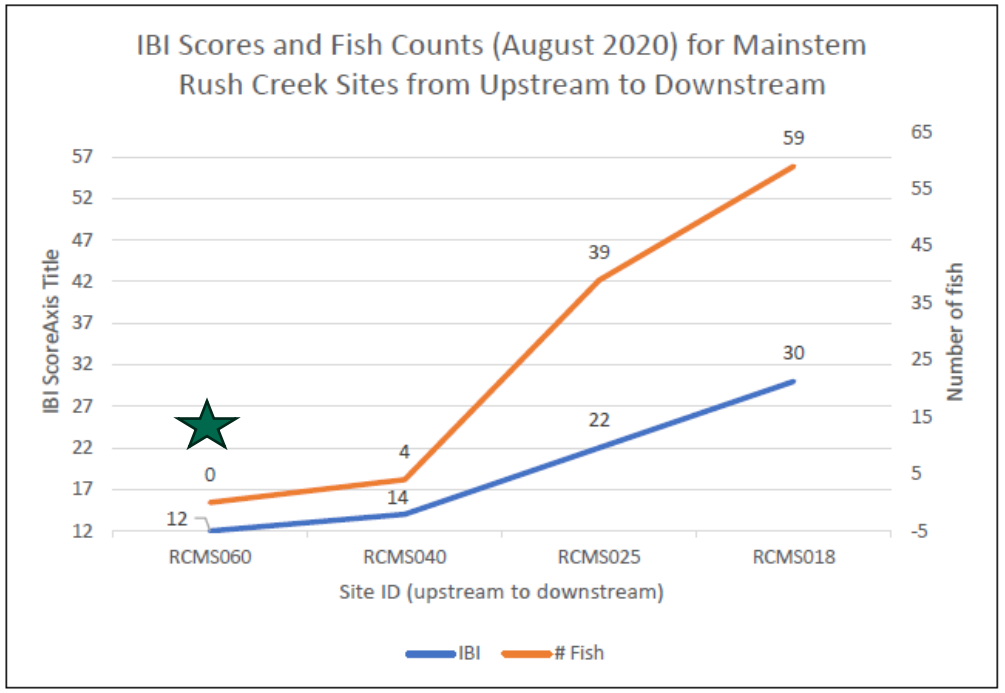


Figure 4. IBI Scores and Fish Counts (August 2020) at Rush Creek mainstem sites from upstream (left) to downstream (right).

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Rush Creek Mainstem Chemical Field Data

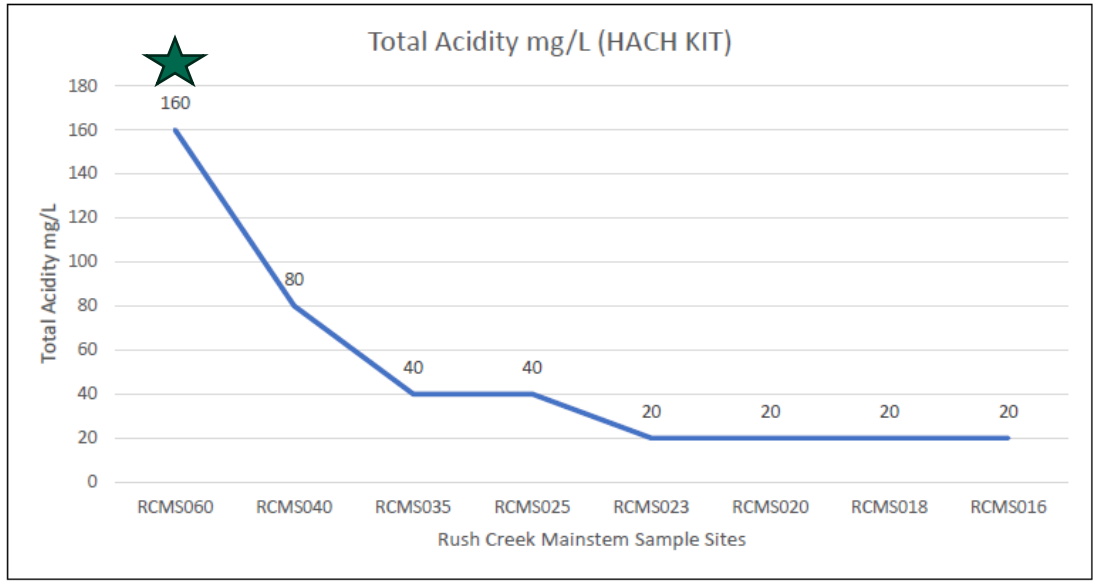

Figure 2. Field Acidity (August 2020) at Rush Creek mainstem sites from upstream (left) to downstream (right). Acidity decreased/improved moving downstream along the mainstem.

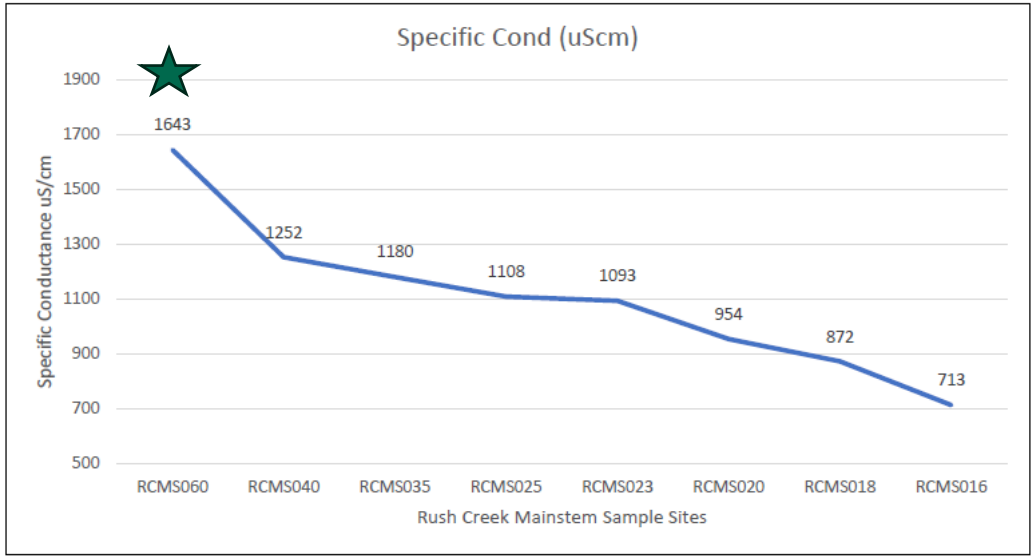

Figure 3. Field Specific Conductivity (August 2020) at Rush Creek mainstem sites from upstream (left) to downstream (right). Conductivity values decreased/improved moving downstream but still reflective of water still impacted at site RCMS018.

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Pre-reclamation AMD impacts

Sparsely vegetated spoil

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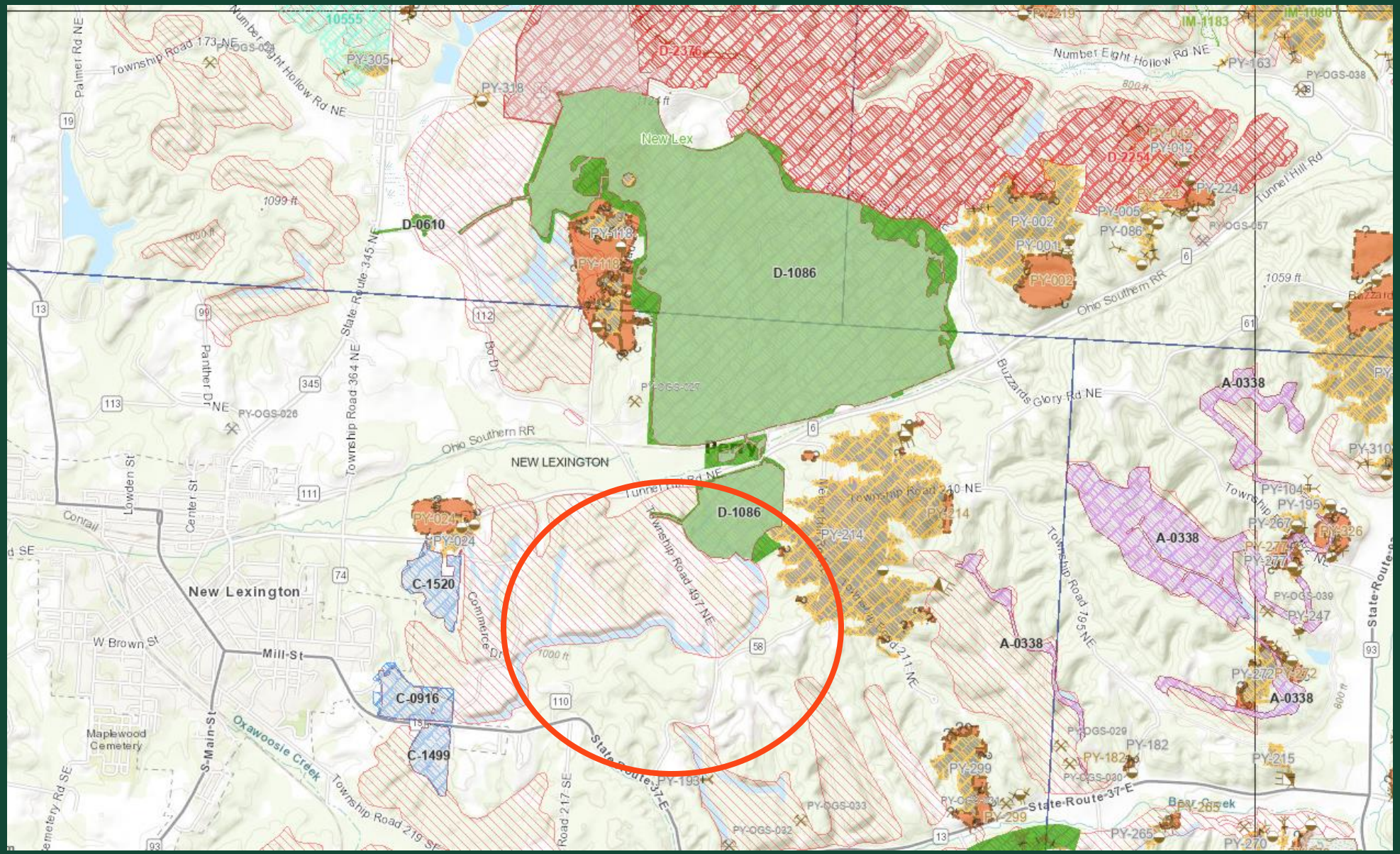

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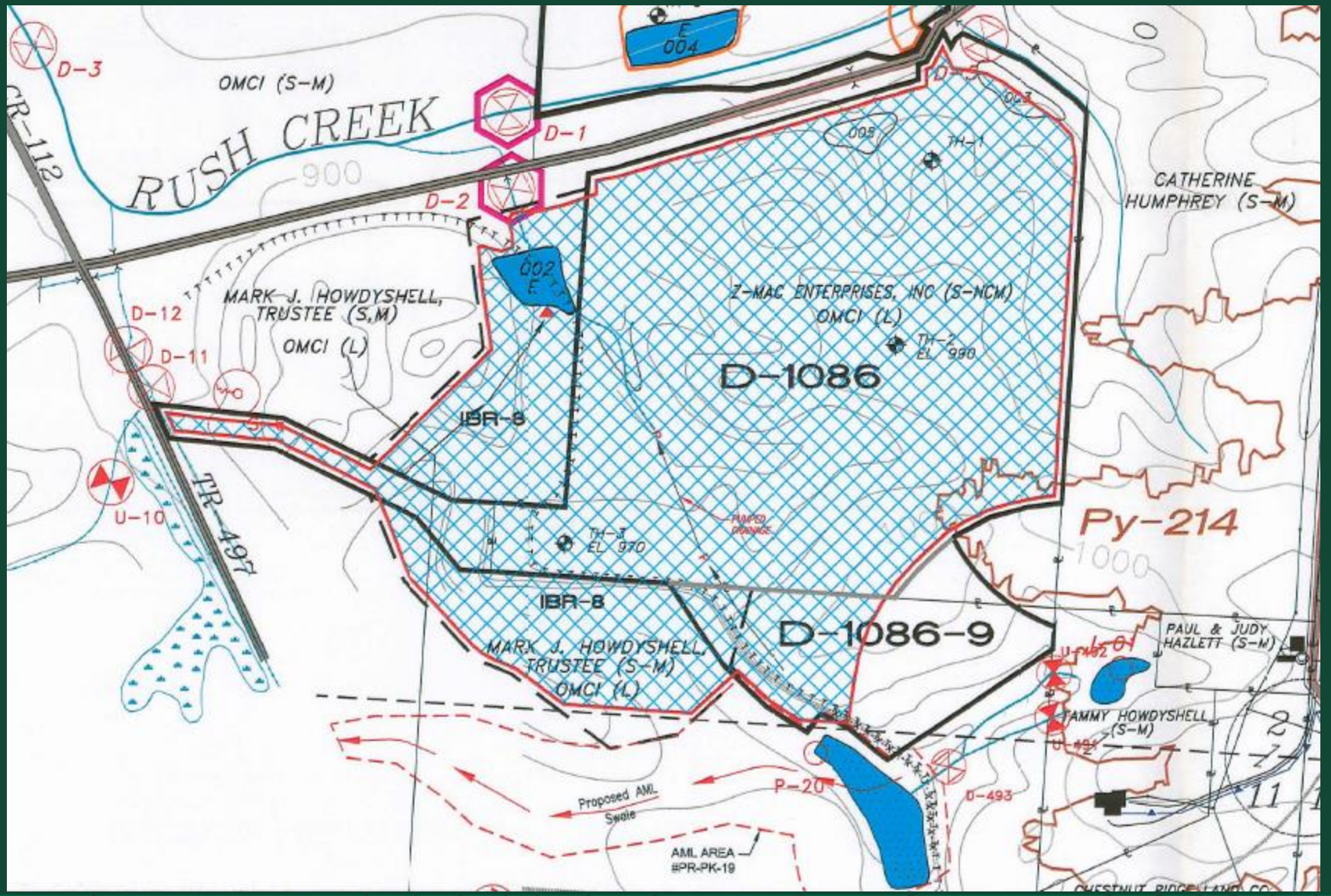

D-1086
Permit


Bo Dr
Rush Creek
Tunnel Hill Rd NE
RCGH030
East Gosline
RCGH036t
RCGH040t
RCGH040p
RCGH050t
BP1
West Gosline
RIDGETOP2
BP2
RIDGETOP

East Gosline Reclamation with Buckeye Lake Dredge application

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West Gosline Reclamation -with Borrow Soil/No Lake Dredge

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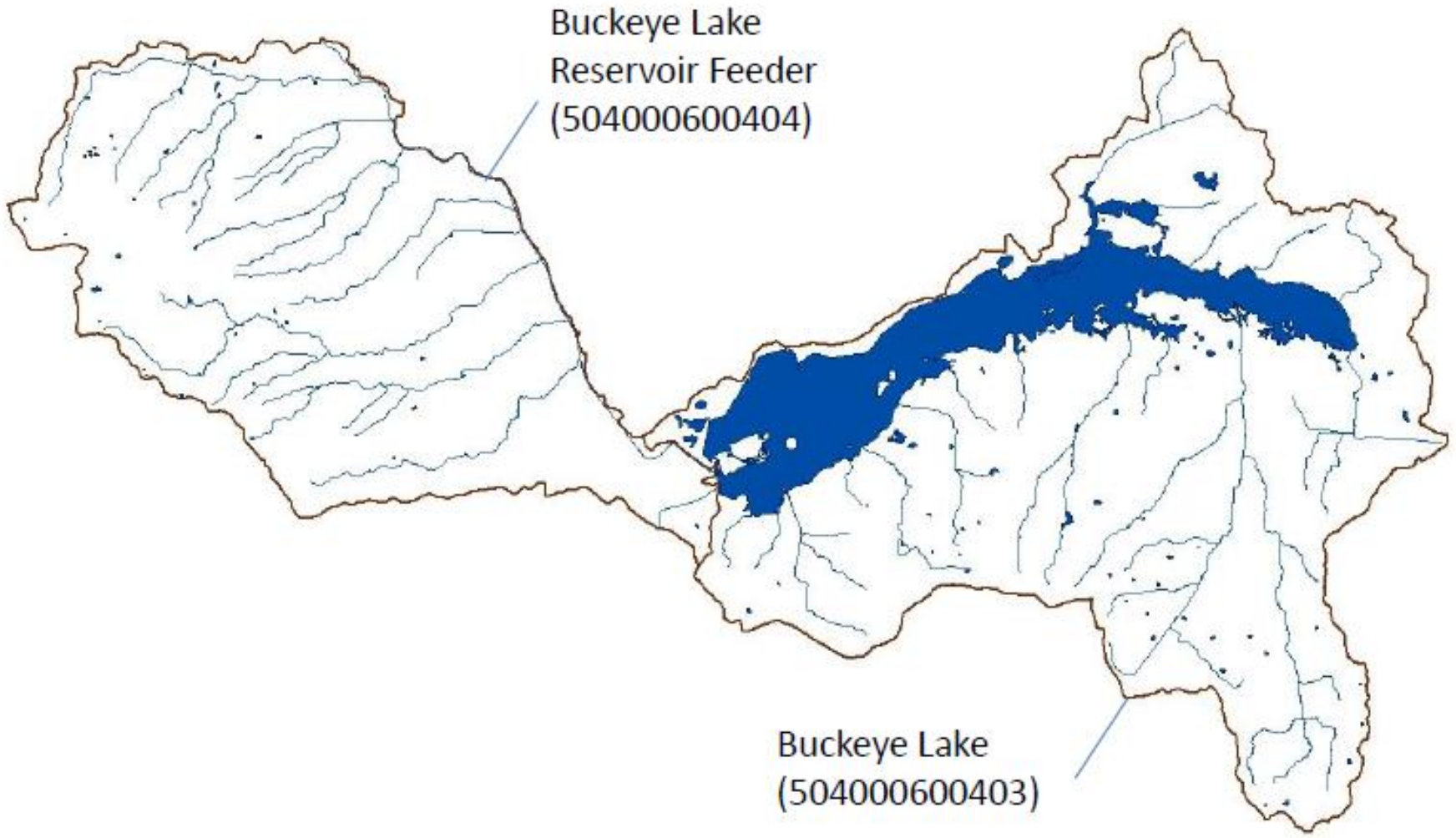
Lake Dredge Application

- Limited borrow soil available
- Heavily mined, very little cover
- Nearby lake dredged for recreation, limited storage space

Buckeye Lake Watershed (2-HUC 12's)




L1
L2
L3

Buckeye Lake Cross Section

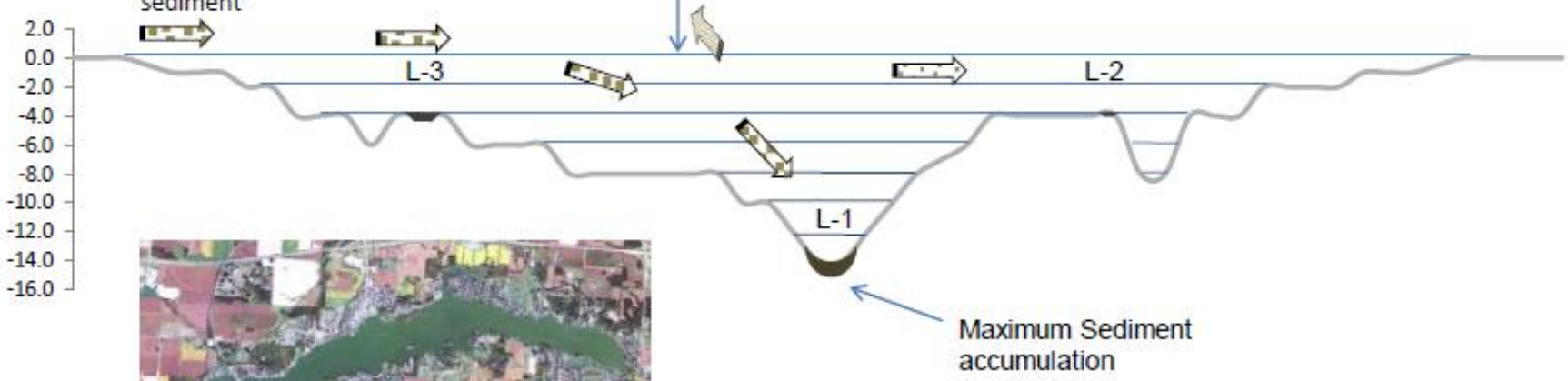
Sediment movement

Prevailing Winds

Feeder Creek inflow

Weir Run Outflow

Suspended sediment



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East Pond

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Liebs Island

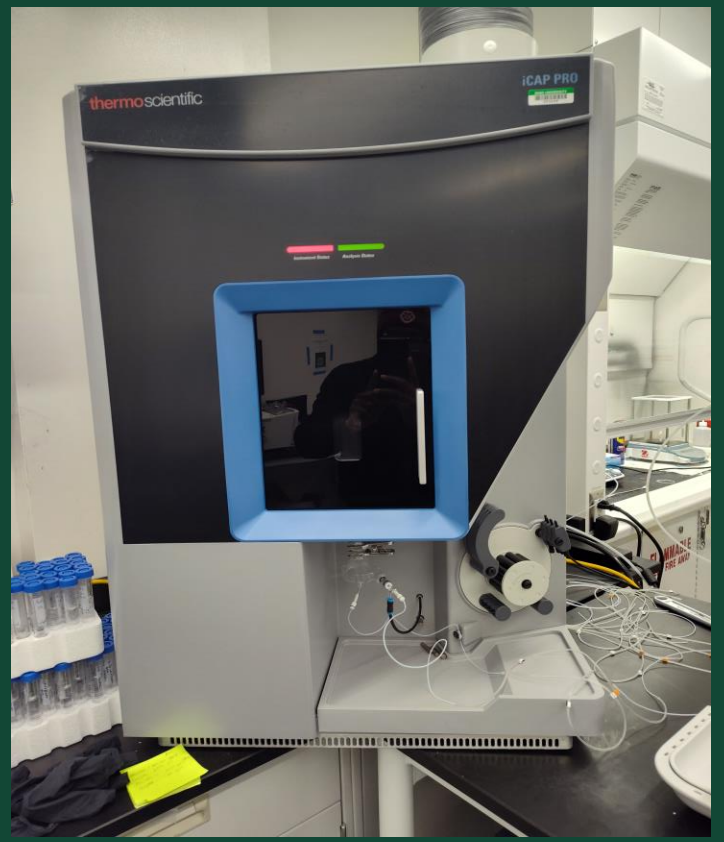
Chemical compatibility methods

- **Materials**
  - Buckeye Lake Dredge -East Pond
  - Gosline Mine Spoil -4 locations, dried, sieved, homogenized, 5 grams

- **Mixing ratios - LD:MS** 100% Mine Spoil, 25/75, 50/50, 75/25, 100% Lake Dredge

- **Leach test -** Distilled water and Mine water from Gosline site RCGH036t, triplicates (35 ml)

- **Methods**
  - Shake and leach for 24 hours, filtered
  - HACH DR 3900 Vis Spectrophotometer:
    Nitrate, Total Nitrogen, Orthophosphate, Total phosphorus (mg/L)
  - ICP-0ES: Al , P, Mo , Sb , Zn , Pb , Cd , Co , Ni , B , Si, Mn,
    Fe ,Cr, Mg, V , Ti, Cu, Ca, K , As, Ba, Na, Li (mg/L)



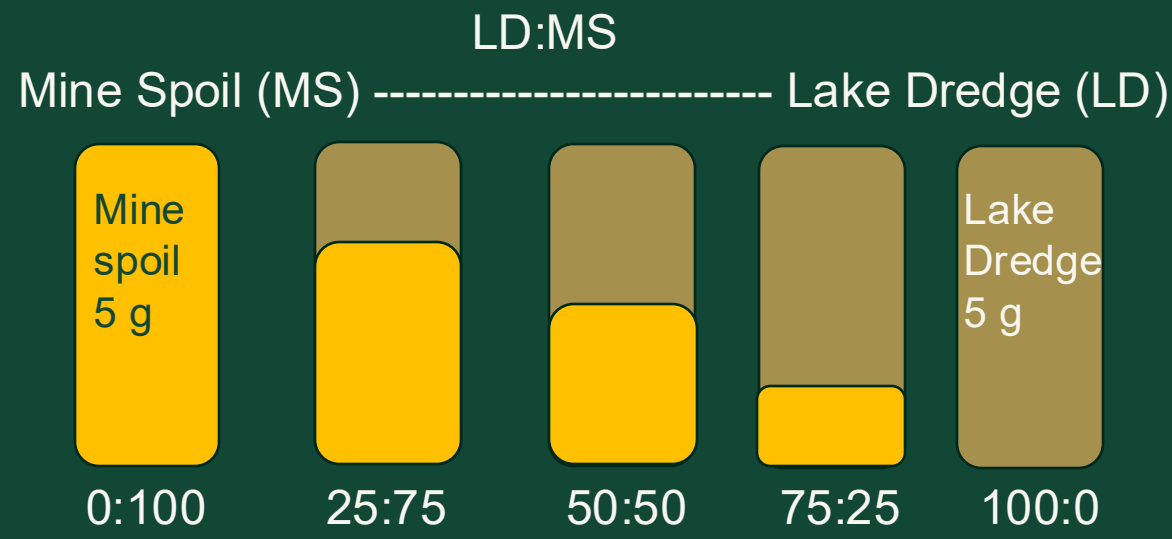
Leaching Experiment

Shake, 24 hours leaching

Filtered

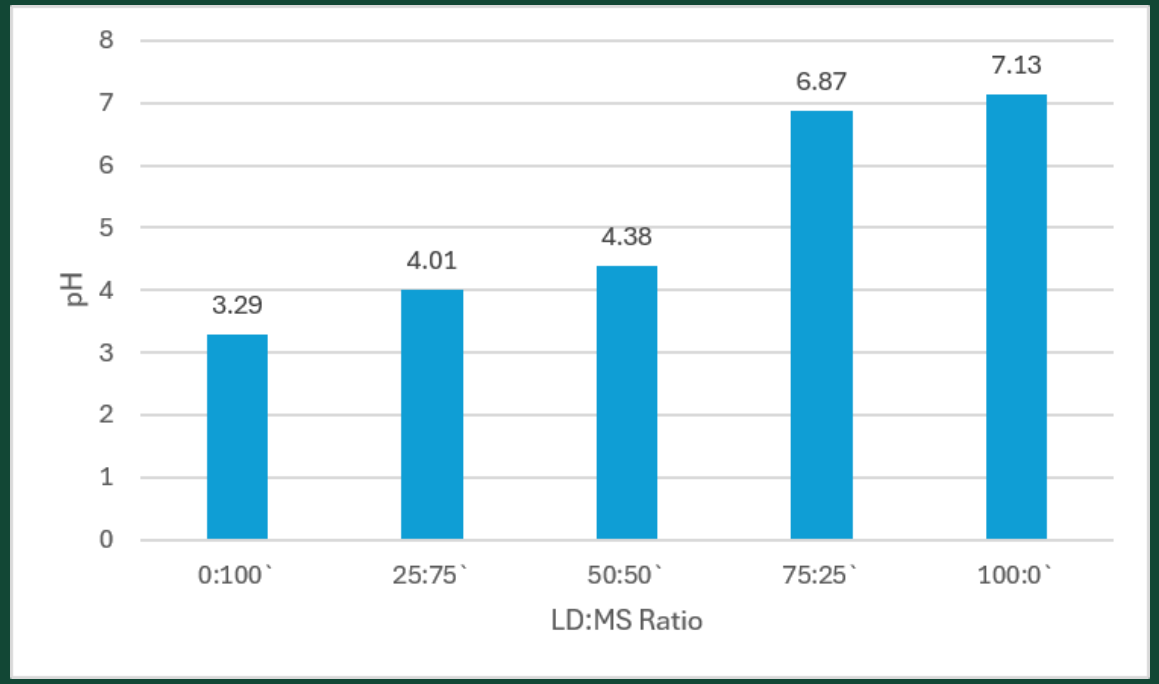
Analyzed

Triplicates



Chemical Leach Analysis

- Clusters of parameters -Mining metals, Nutrients, Common elements, trace metals (all low detections)
- Acute and chronic aquatic life thresholds and MCLs (Pb, Zn, Ni)
- Starting pH of the mine water is 3.2 - pH after 24 hours of equilibration



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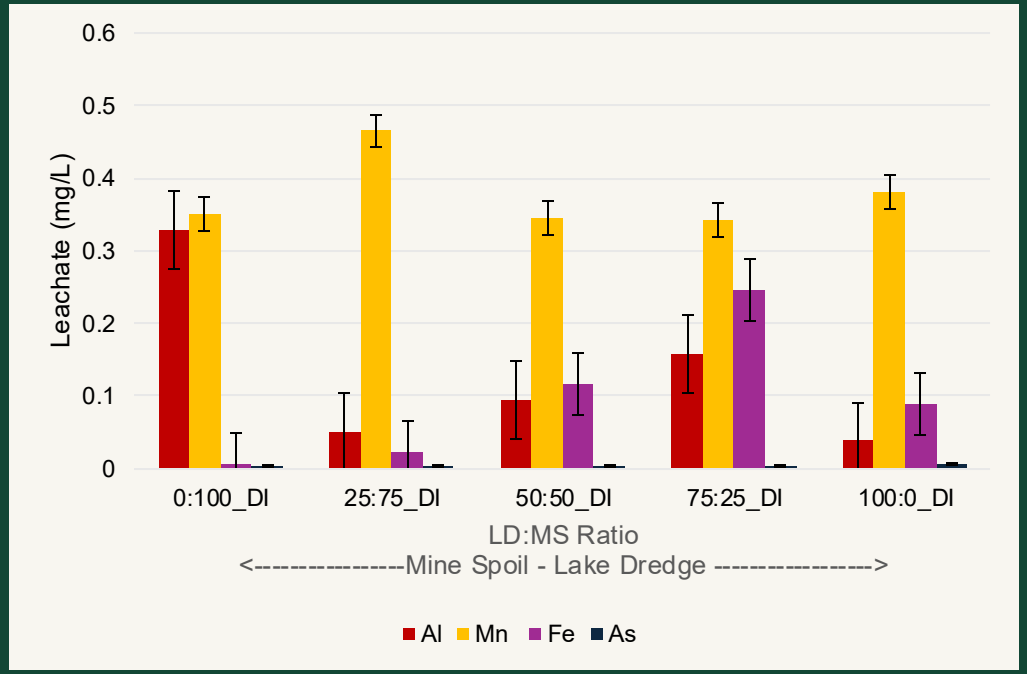
Mining metals

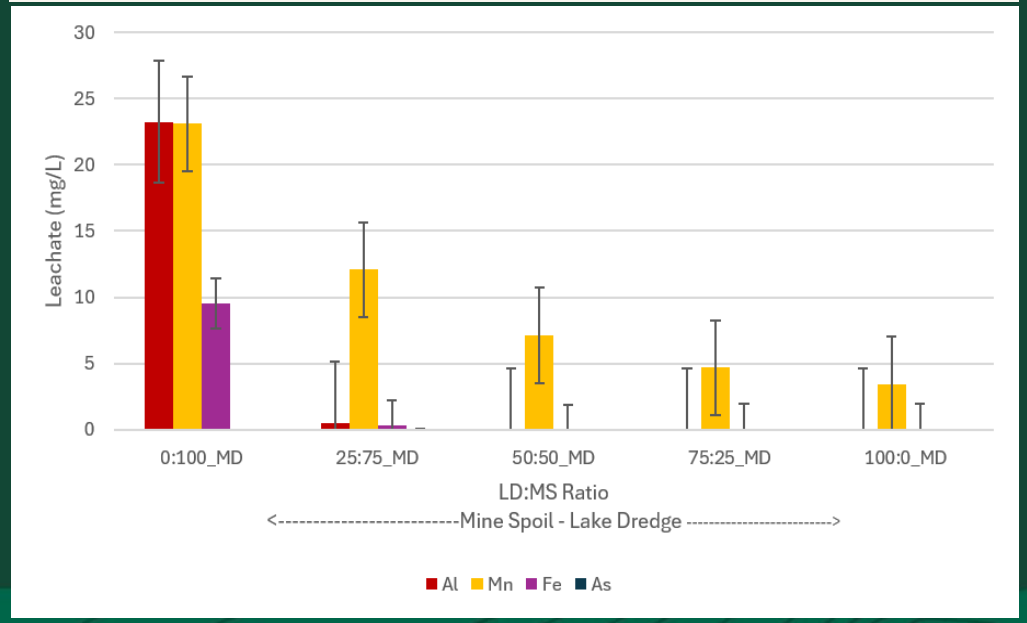
AMD Metals concentration in Distilled Water (DI)

No trends are detected in the mining metals when leached with distilled water across all mixing ratios, all concentrations are low.

AMD Metals concentrations in Mine Drainage (MD)

AMD concentrations decrease as the mixing ratio of lake dredge becomes higher when leached by acidic mine drainage (combo of sorption as pH adjusts and dilution occurs)





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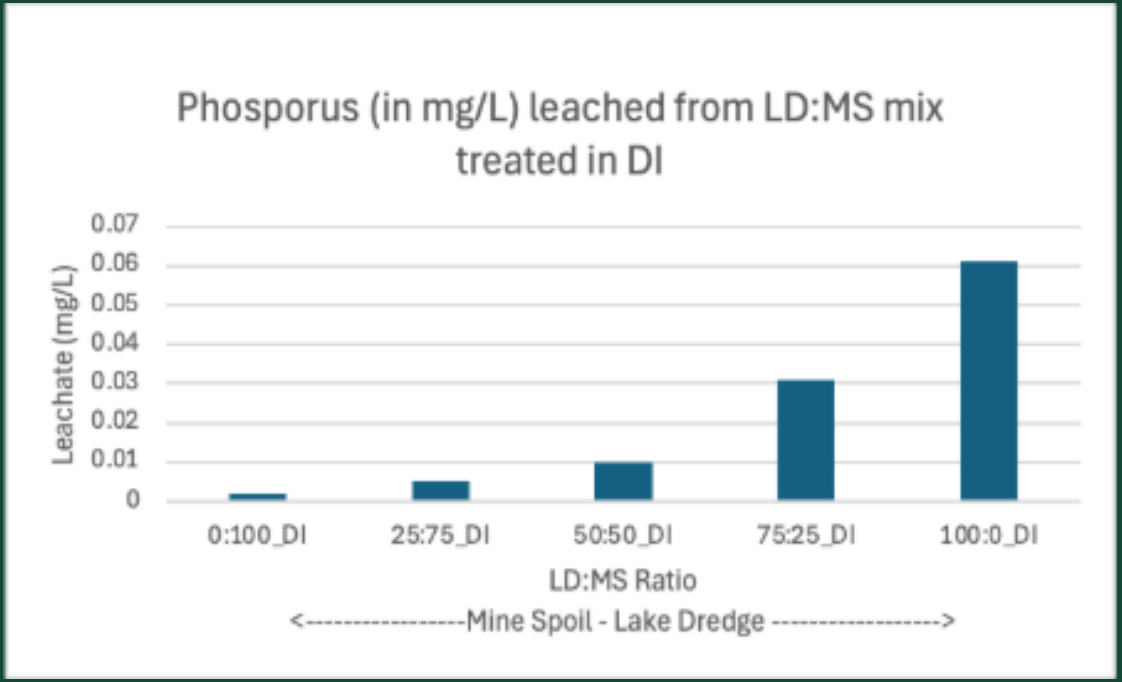
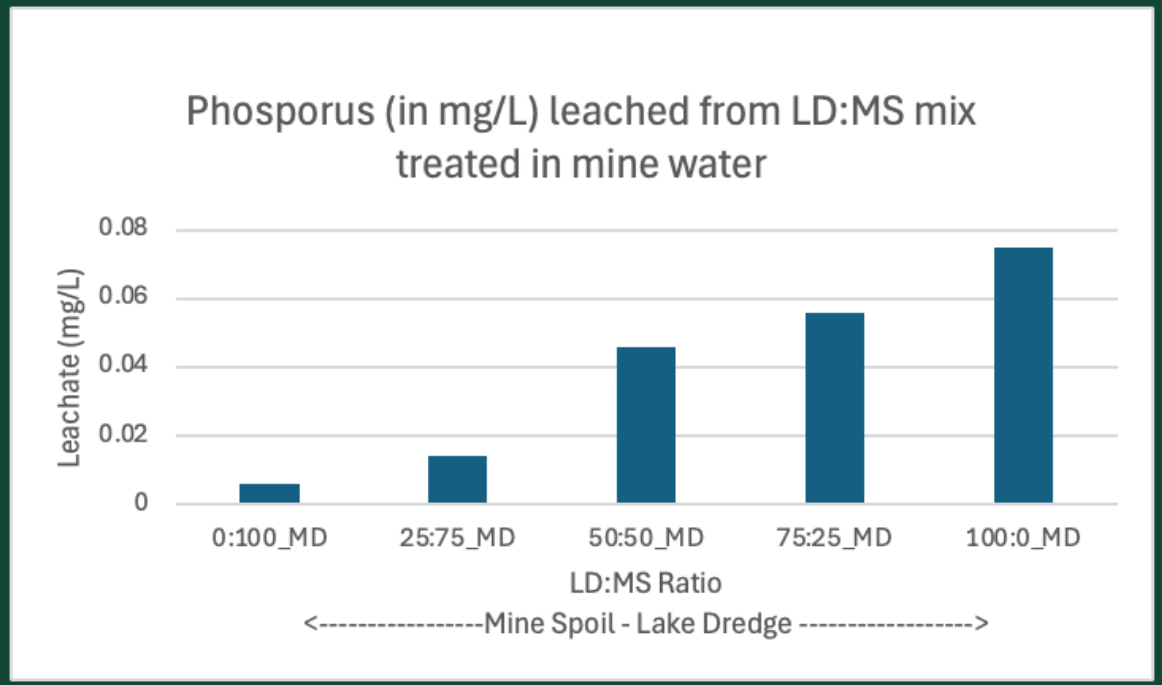
Nutrients – Reactive Phosphorus (ICP)





Phosphorus concentration increase as more lake dredge is mixed with the mine spoil, all concentrations are below 0.08 mg/l

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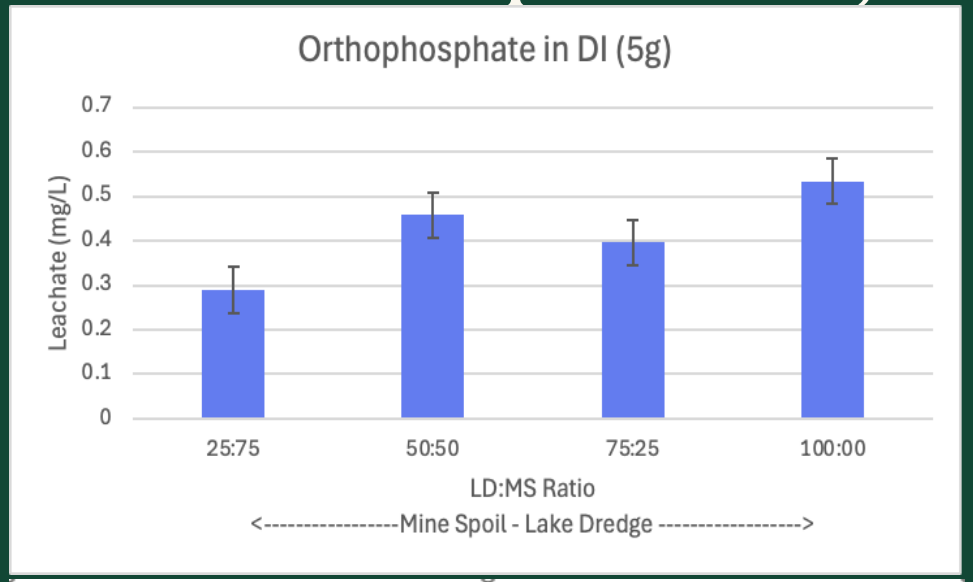
Total Phosphorus, Orthophosphate - HACH



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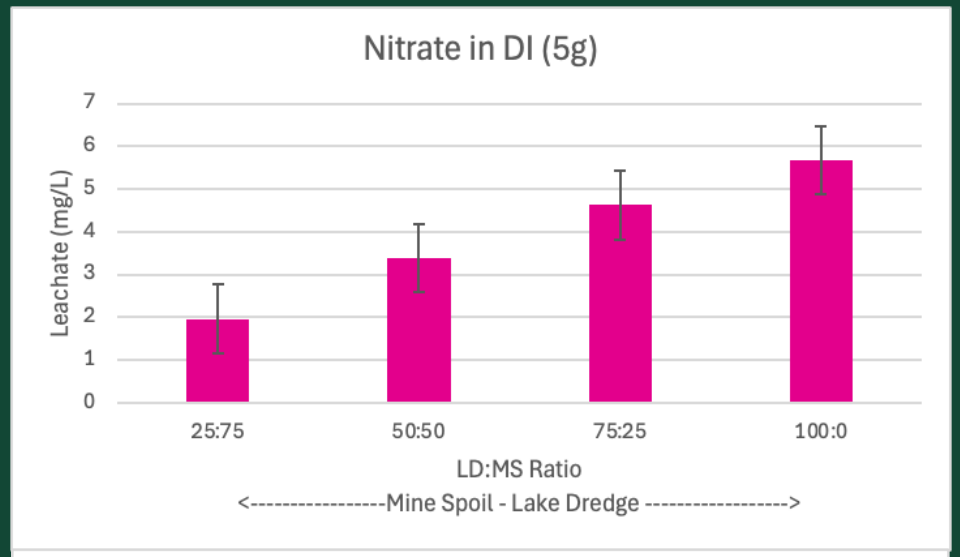
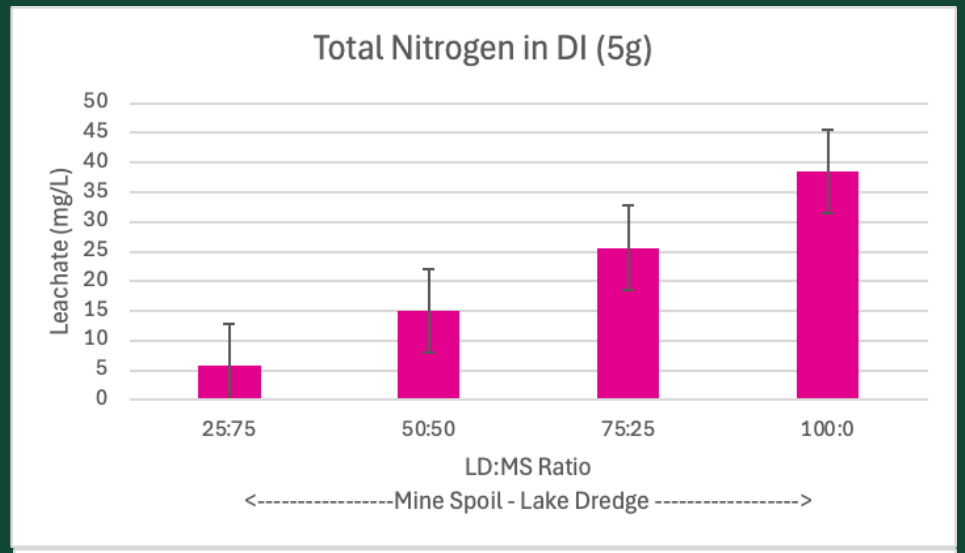
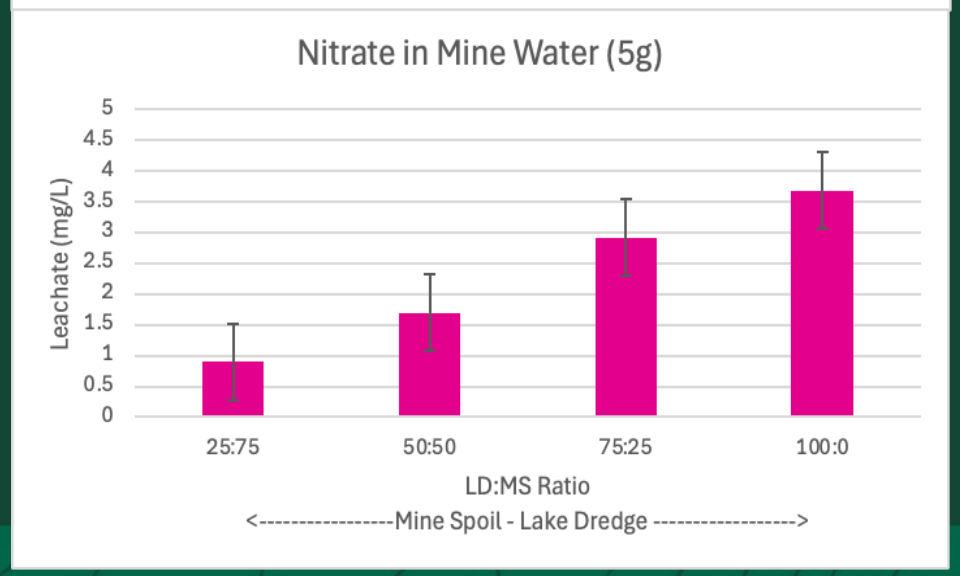
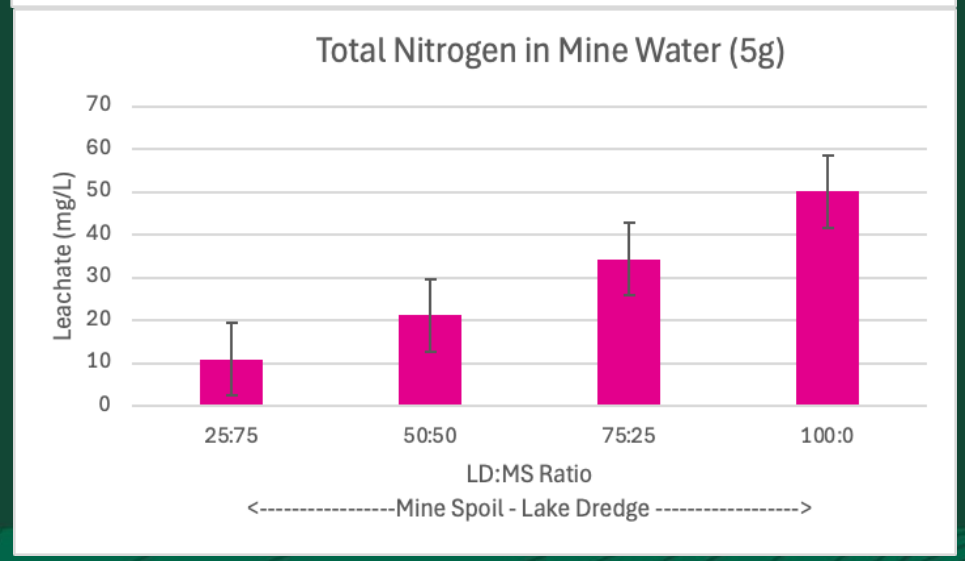
Nutrients – Total Nitrogen, Nitrate - HACH









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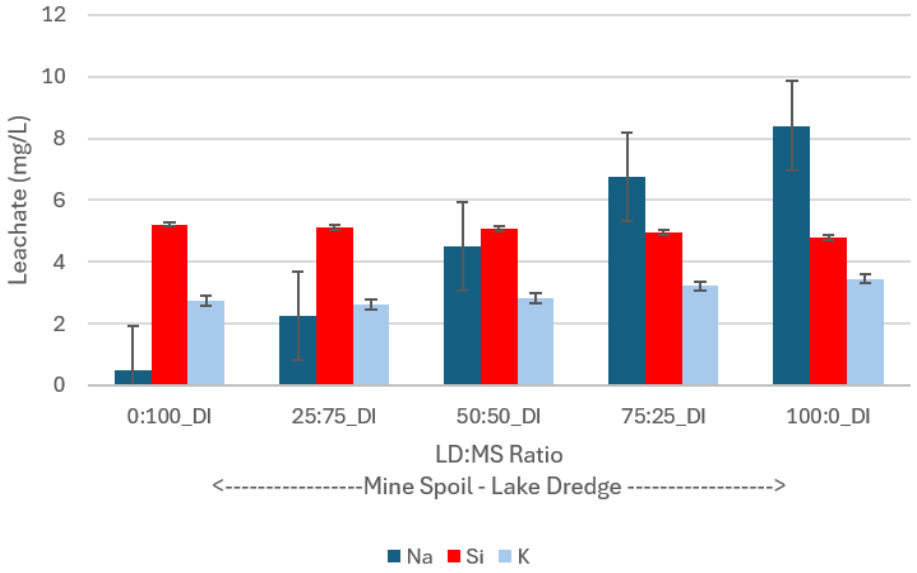
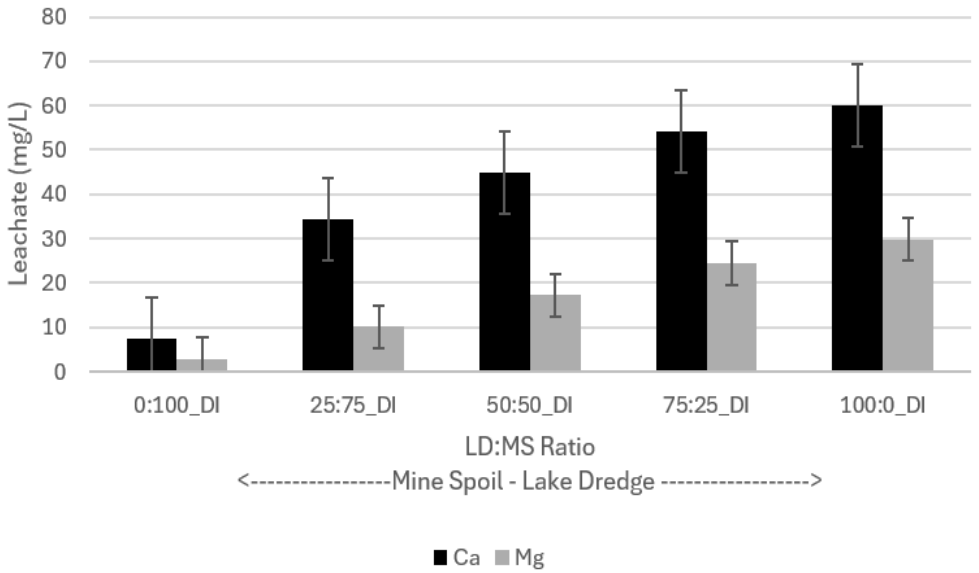
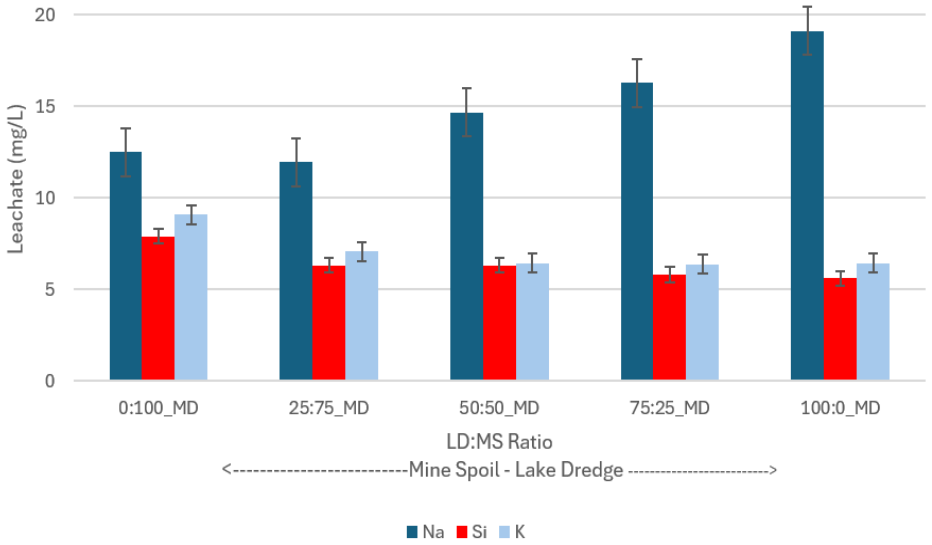
Common Elements

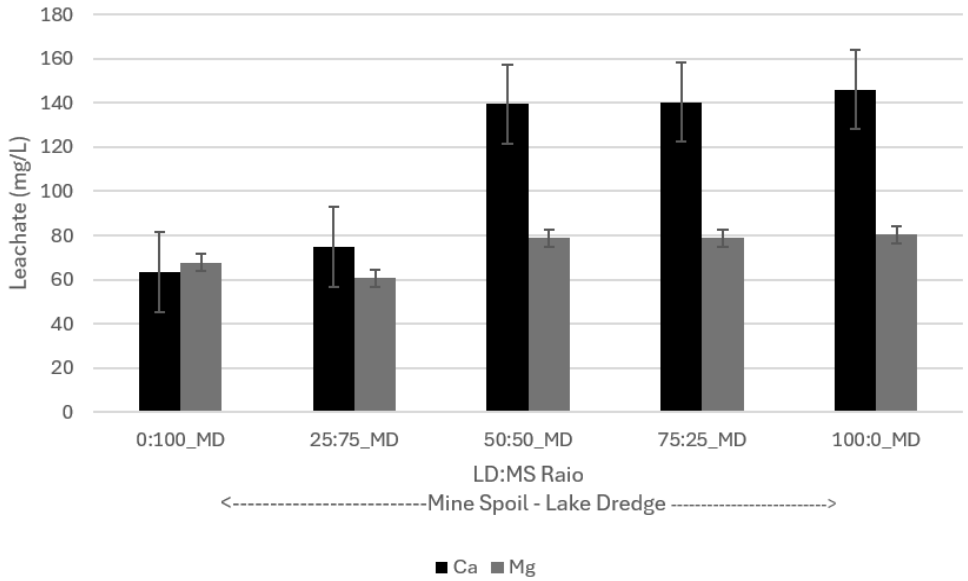
Leached in DI---->

Leached in Mine Water ---->









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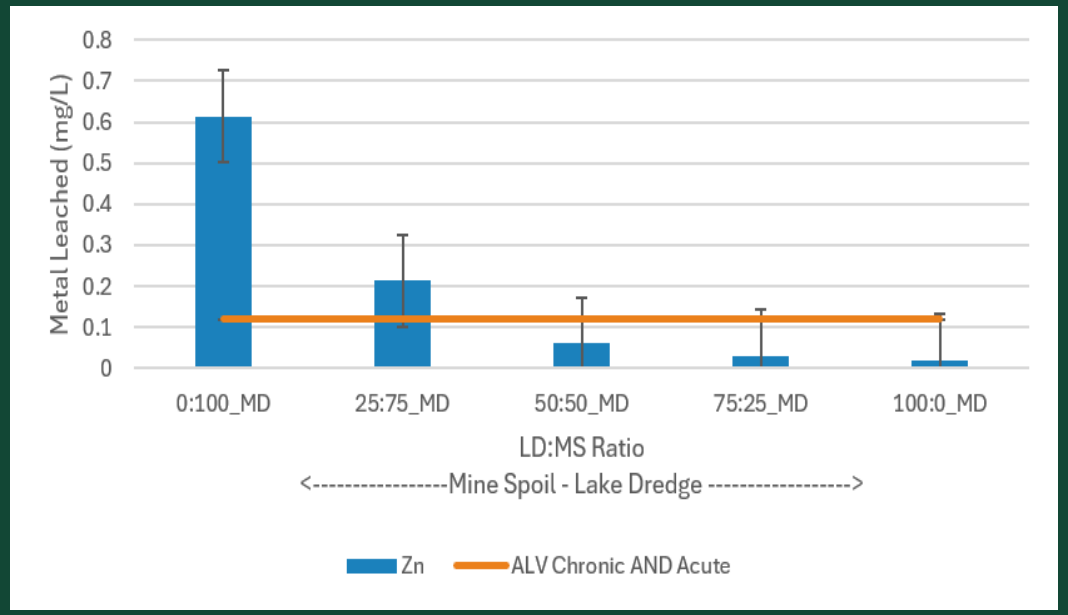
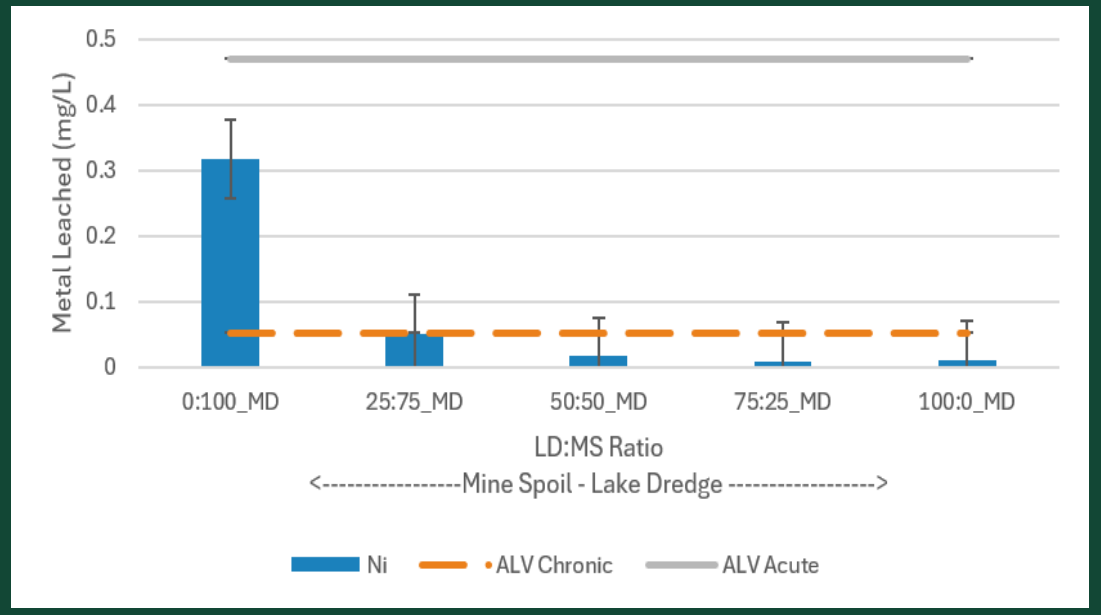
Acute and Chronic Aquatic Life Thresholds

- The source of Zn and Ni are highest in the mine spoil, the lake dredge doesn't add any additional source of these elements.



Zinc – Treated in Mine Water



Nickel – Treated in Mine Water

Sources: MCL https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations,
-ALV acute and Chronic https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table

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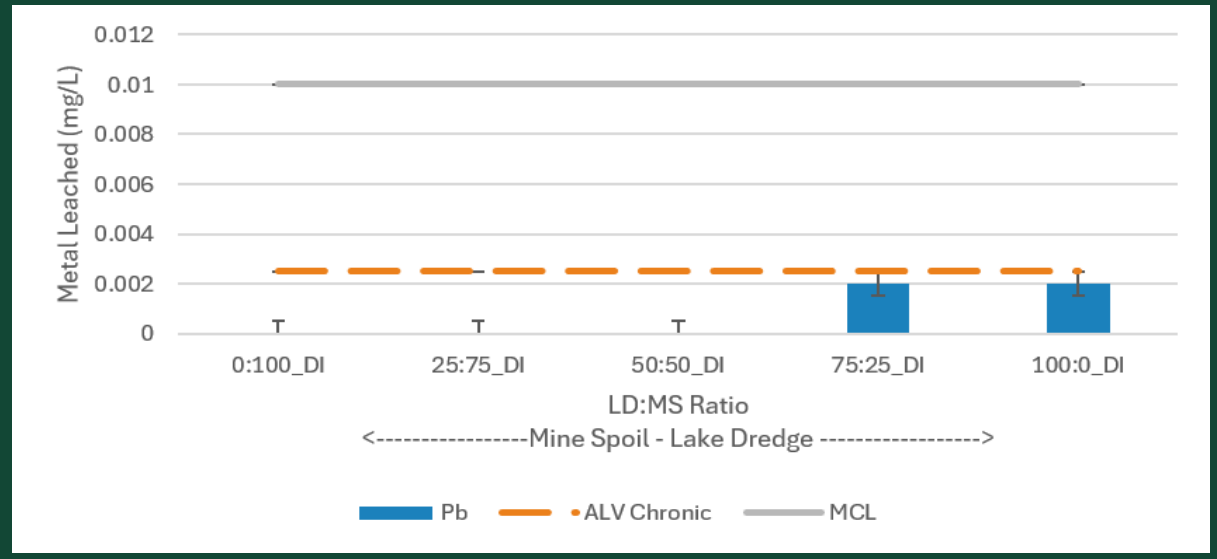
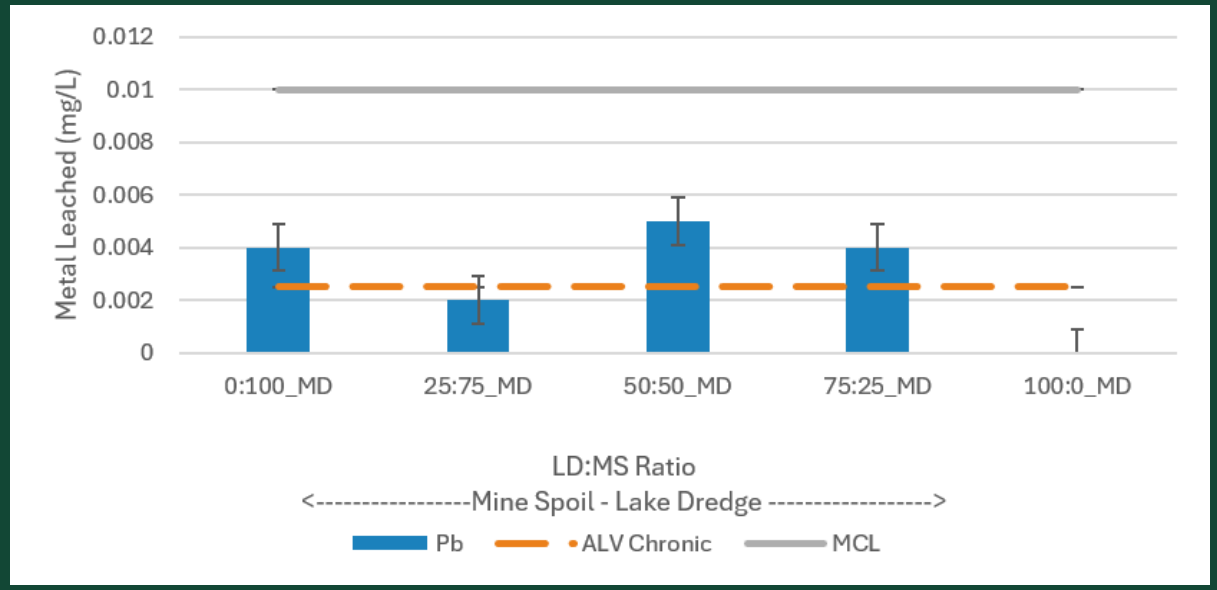
Aquatic Life Values for Lead

- Pb should continue to be monitored

Leached in DI --->



Leached in Mine Water --->



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Reclamation with Lake Dredge Application – 3 inches

Chemical Interaction

- AMD dominated site – potential for sorption or co-precipitation with Lake Dredge (ex. Phosphorus)
- Receiving water body is phosphorus limited, added low levels of P likely to not lead to aquatic enrichment
- Acute and chronic parameter: Ni and Zn trends are high in AMD spoil, lake dredge doesn’t increase these levels. Pb needs to be continued to be monitored.

Next Steps

With Partners:

- Collect samples from reclamation after construction is fully complete
- Monitor the vegetation growth and erosion on West Gosline (Borrow Soil) and compare to East Gosline (Lake Dredge Application)

Research Questions

- Does the lake dredge support more vegetation than borrow soil?
- Does the lake dredge support a greater number of species than the borrow soil?
- How does the distribution of species in each treatment compare the distribution of the seed mix?
- What species are most abundant in each soil treatment?
- Does the lake dredge stay in place? (presence of erosion)
- How do soil nutrient levels (N and P) compare between soil treatments?
- What is the relationship between soil nutrient levels and vegetation on each treatment site?

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Monitoring Vegetation

Gosline Site in Perry County, Ohio

Seed Mix Applied to Each Site

Common Name	Scientific Name	% of Mix
Partridge Pea	Chamaecrista fasciculata	0.18
Switchgrass	Panicum virgatum	0.15
Indiangrass	Sorghastrum nutans	0.13
Pennsylvania Smartweed	Polygonum pensylvanicum / Persicaria pensylvanica	0.122
Orchardgrass	Dactylis glomerata	0.09
Perennial Ryegrass	Lolium perenne	0.09
Common Oats	Avena sativa	0.08
Purple Coneflower	Echinacea purpurea	0.035
Blue Vervain	Verbena hastata	0.03
Browneyed Susan	Rudbeckia triloba	0.025
Purple Prairie Clover	Dalea purpurea	0.015
Roundhead Lespedeza	Lespedeza capitata	0.015
Plains Coreopsis	Coreopsis tinctoria	0.013
Wild Bergamot	Monarda fistulosa	0.01
Maximilian's Sunflower	Helianthus maximiliani	0.01
Bigleaf Mountain Mint	Pycnanthemum muticum	0.005

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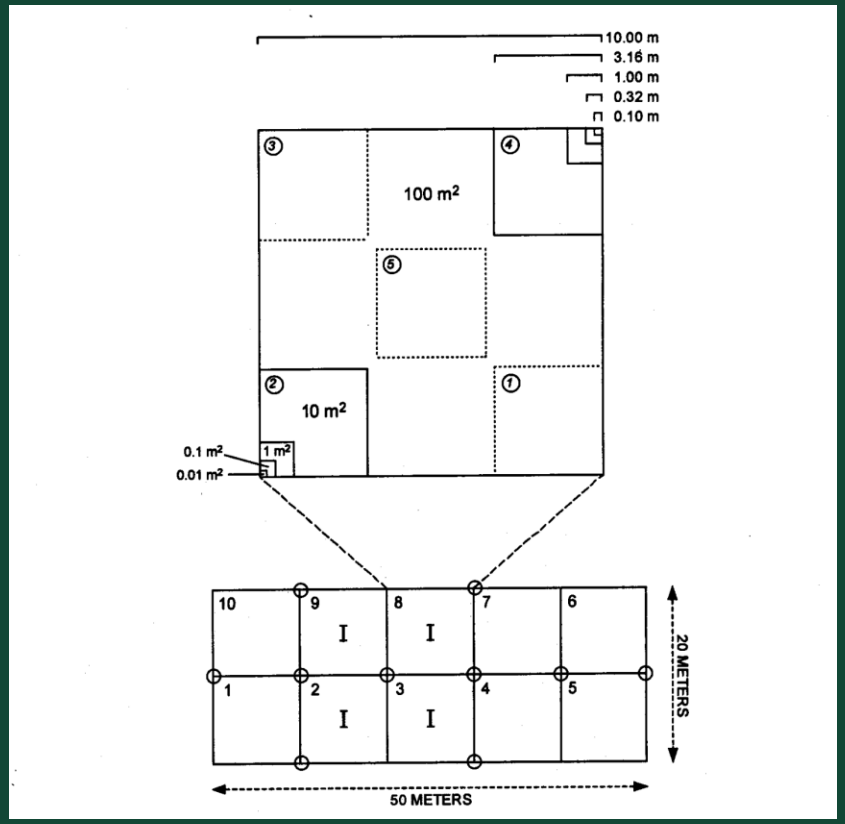
Study Design

- Will be conducted in 5m x 5m plots along transects
- 25 1m x 1m squares will be nested in each plot
- Each meter square will be analyzed for total percent cover, species richness, and species ID
- Each meter square will also be photographed for further analysis in Sample Point
- 3-5 soil cores (15-30 cm) will be taken from each soil treatment site for nutrient testing with spectrophotometer



Based on the nested plot design outlined in the North Carolina Vegetation Survey (NCVS) (Peet el al., 1998)

Peet, R. K., Wentworth, T. R., & White, P. S. (1998). A flexible, multipurpose method for recording vegetation composition and structure. *Castanea*, 262-274.

Vegetation Surveys ----> Main Objective

- For each treatment site, data will be collected for:

Percent vegetative cover

Species richness

Abundance of each species

Herbaceous species ID

Soil nutrients (N and P)

Is lake dredge material conducive to the revegetation and overall reclamation of abandoned mine-lands?

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Questions

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