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Early Water Quality Changes From Stream and Wetland Restoration in Former Agriculture Land

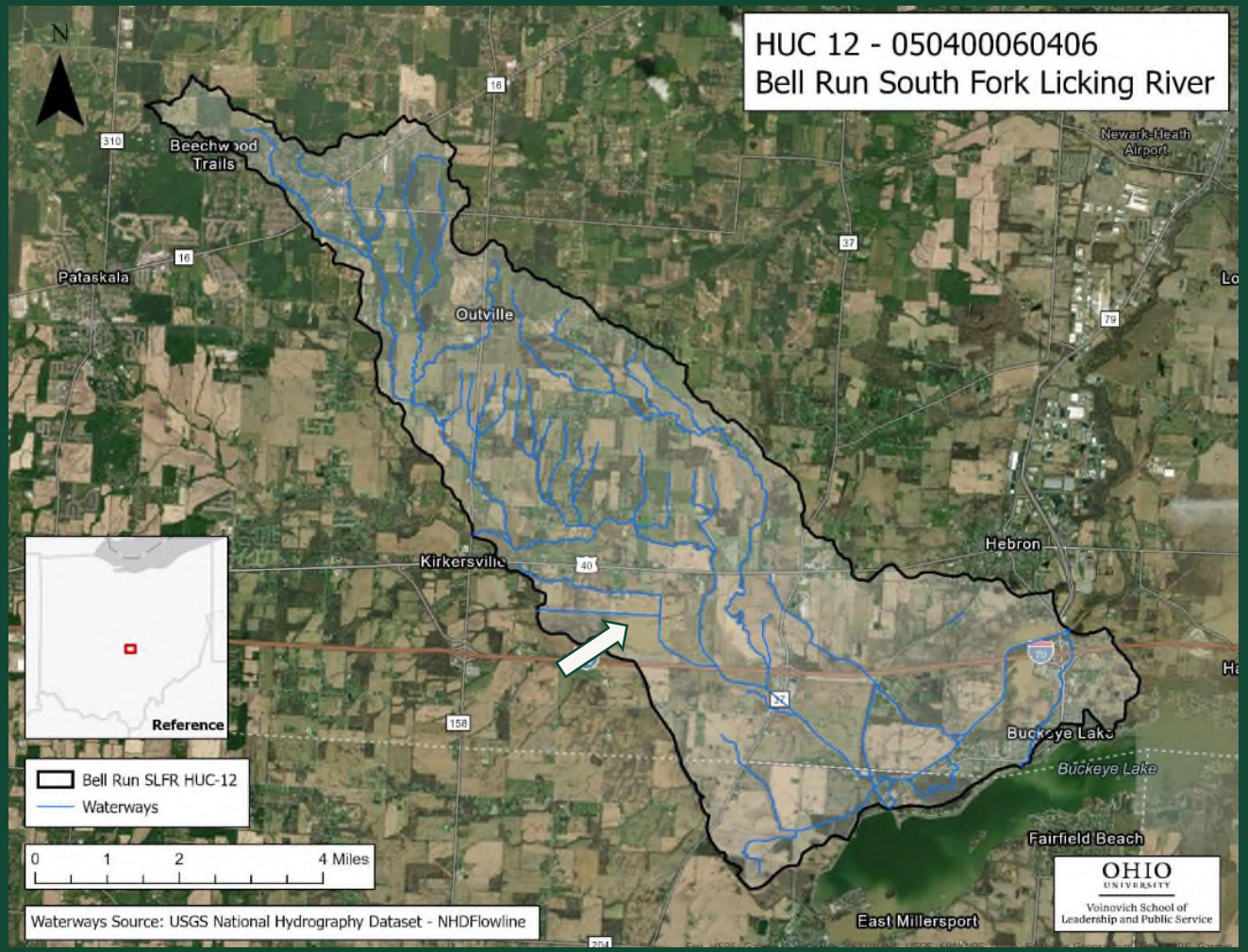
Sebastian Teas, Environmental Specialist, Ohio University

Stream + Wetlands Foundation

Photos courtesy of Stream + Wetlands Foundation

Bell-Run South Fork Licking River Watershed

- 25 miles east of Columbus
- Surface area of approx. 26 square miles

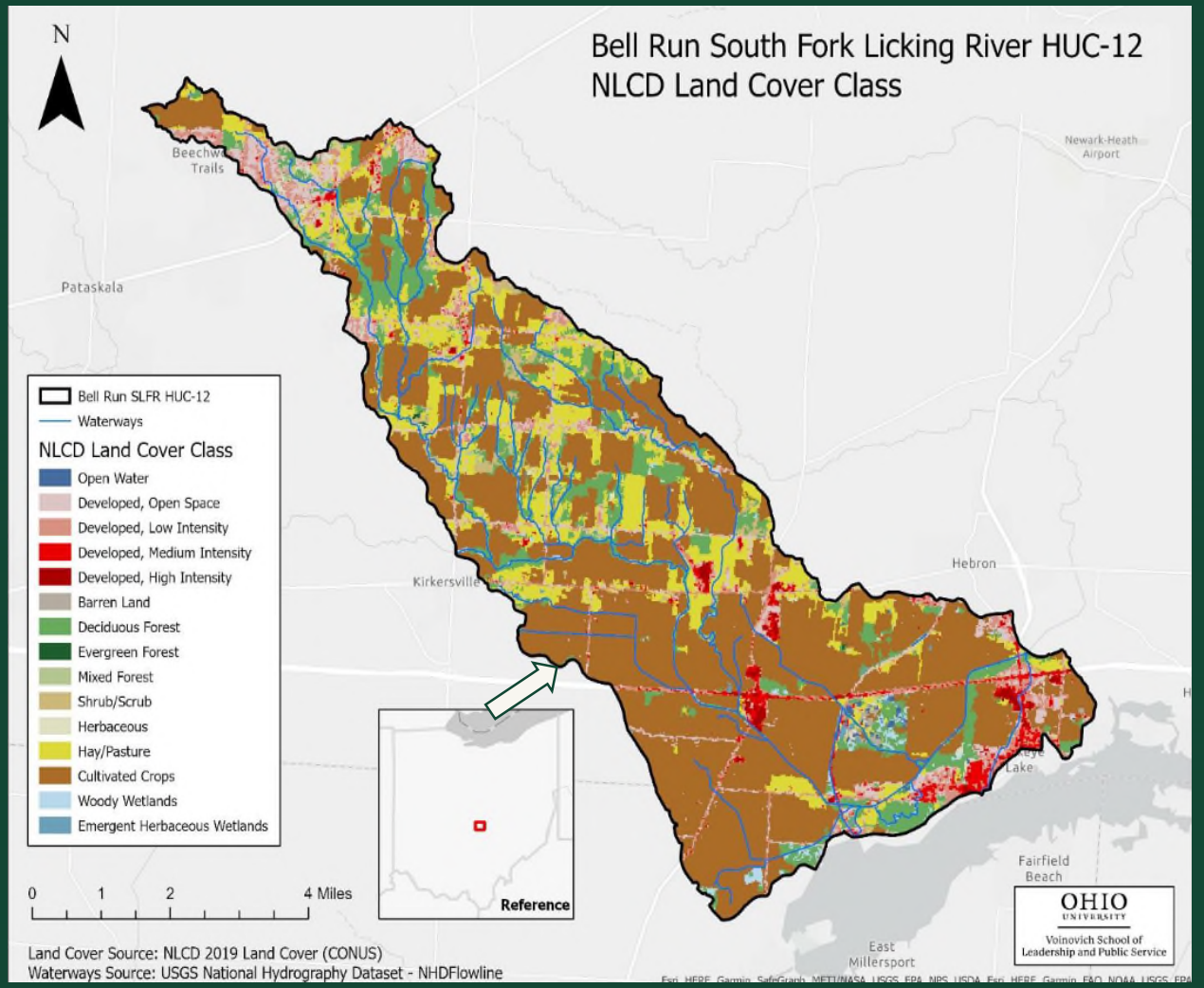


Ohio University (2021)

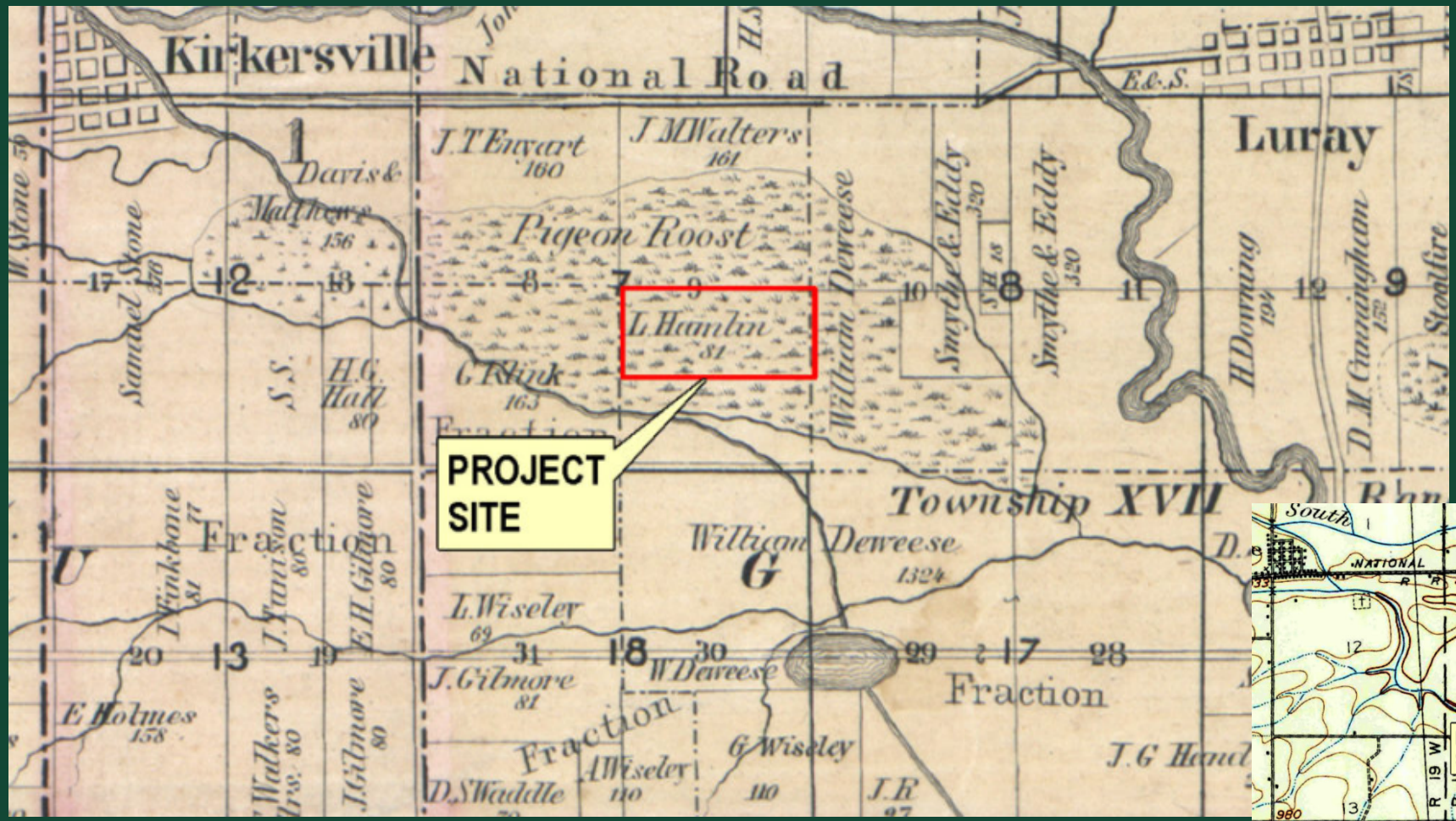
Land Cover Classes in the Watershed

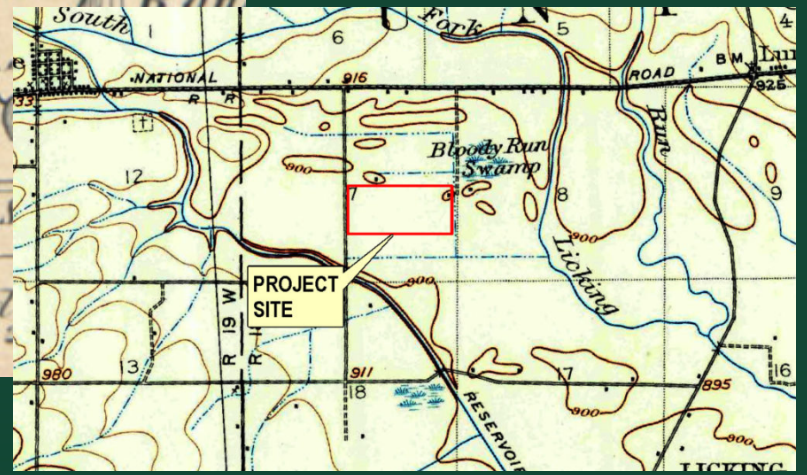
- Primary Uses:
  - 55% row crop
  - 16% forest
  - 15% pasture
  - 14% residential areas

(Ohio University, 2021)



Ohio University (2021)





Maps courtesy of BLM General Land Office Records

Nutrient Pollution

- Nutrient pollution is a major problem in America
- Excessive N&P loading impaired over 1,600 km of Ohio Surface waters as of 2000 (Ohio EPA, 2000)

Photo courtesy of K. Ositimehin

Algal Blooms

- Nutrient pollution is a major problem in Ohio
- Eutrophication causes harmful algal blooms
- Incentives to reduce nutrients across many agencies

S. Hendren (2017)

Photo courtesy of Ohio EPA

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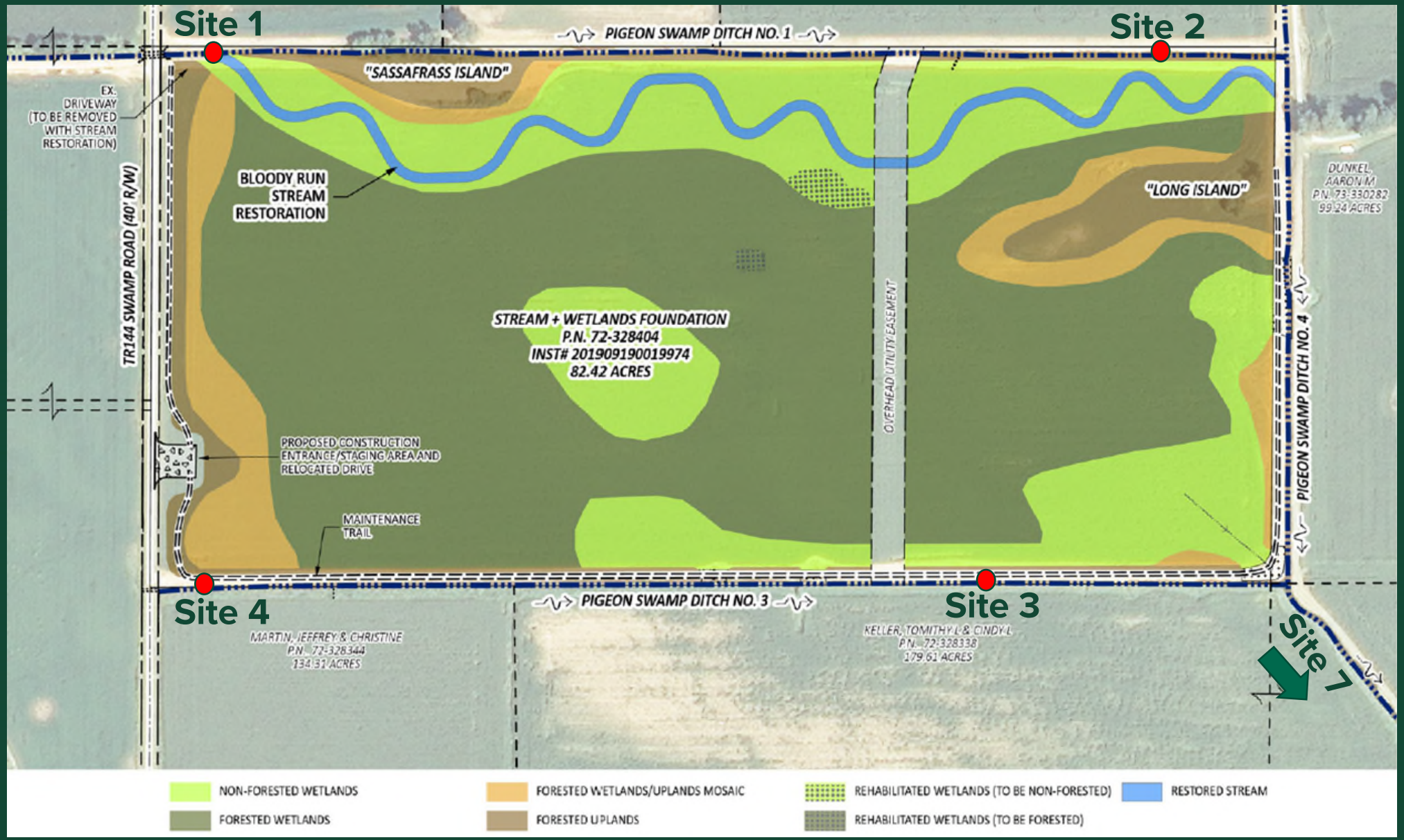

Site 1
PIGEON SWAMP DITCH NO. 1
Site 2
"SASSAFRASS ISLAND"
EX. DRIVEWAY (TO BE REMOVED WITH STREAM RESTORATION)
BLOODY RUN STREAM RESTORATION
"LONG ISLAND"
DUNKEL, AARON M P.N. 73-330282 99.24 ACRES
TR144 SWAMP ROAD (40' R/W)
STREAM + WETLANDS FOUNDATION P.N. 72-328404 INST# 201909190019974 82.42 ACRES
OVERHEAD UTILITY EASEMENT
PIGEON SWAMP DITCH NO. 4
PROPOSED CONSTRUCTION ENTRANCE/STAGING AREA AND RELOCATED DRIVE
MAINTENANCE TRAIL
Site 4
PIGEON SWAMP DITCH NO. 3
Site 3
Site 7
MARTIN, JEFFREY & CHRISTINE P.N. 72-328344 134.31 ACRES
KELLER, TOMITHY L & CINDY L P.N. 72-328338 179.61 ACRES
NON-FORESTED WETLANDS
FORESTED WETLANDS/UPLANDS MOSAIC
REHABILITATED WETLANDS (TO BE NON-FORESTED)
RESTORED STREAM
FORESTED WETLANDS
FORESTED UPLANDS
REHABILITATED WETLANDS (TO BE FORESTED)

Site 1

Site 2

Site 3

Site 4

Sampling Plan

- Pre-construction sampling: March – September 2022
- Construction Sampling: September 6 – November
- Bimonthly field measurements for student data
- Seasonal lab analysis for nutrient concentrations in water and sediment

Sampling Parameters

- Nitrogen (nitrates, nitrites, ammonia, total N)
- Phosphorus (orthophosphates, total P)
- Total suspended solids, total dissolved solids, total solids
- Total Carbon
- Metals

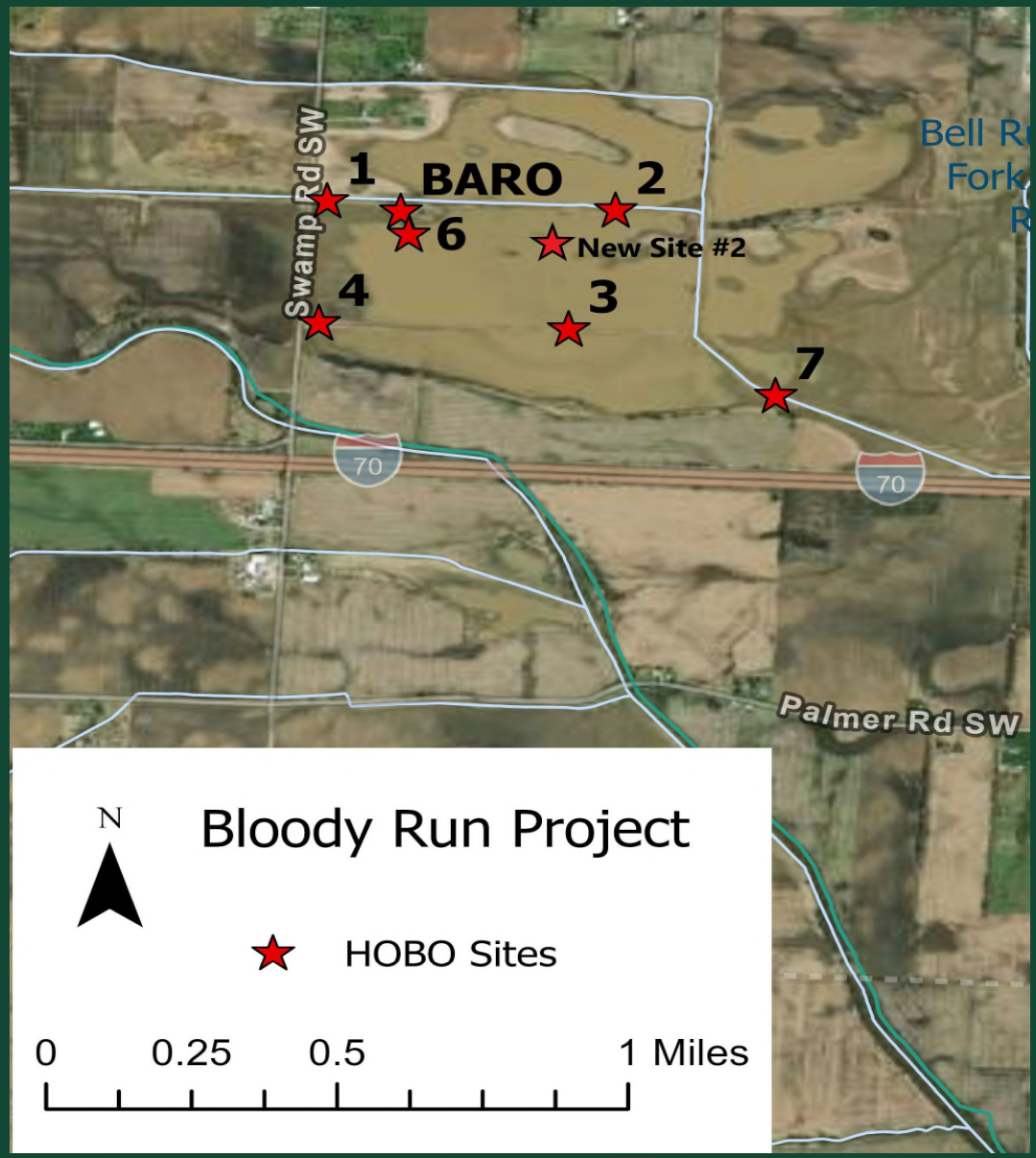
Field Parameters

- pH
- Conductivity
- Total Dissolved Solids
- Dissolved Oxygen
- Temperature
- Oxidation-Reduction Potential
- Flow

Water Depth

- Changing the hydrology of the site affected water level in the ditches
- Water level was measured using Onset's HOBO Water Level loggers
- Pressure data was collected every ten minutes
- Data downloaded monthly and calibrated using barometric pressure

Photo courtesy of Onset


Swamp Rd SW
1
BARO
2
6
New Site #2
4
3
7
70
70
Palmer Rd SW
N
Bloody Run Project
HOBO Sites
0
0.25
0.5
1 Miles

Antecedent Precipitation Index

- API is an index of soil moisture or watershed ‘wetness’
  - Based on precipitation on previous days

API Formula

$$API_{d0} = (K*API_{d-1}) + P_d$$

- API_{d0} is the API on day 0.
- K is a constant representing the outflow of the soil (K= 0.95)
- API_{d-1} is the API of the previous day
- P_d is the cumulative precipitation on that calendar day (mm)

Research Questions

- **How does nutrient loading to Bloody Run change after restoration?**
- Will nutrient concentrations change during construction?
- How does water retention change?
- Does construction impact soil erosion rates?

Early Results - Nutrients

- Pre-Construction: Bloody Run was impaired by high concentrations of phosphorus and moderate concentrations of nitrogen

- Water quality improved at Bloody Run during construction
  - Greater changes seen in nitrogen concentrations than phosphorus
  - Possible effects from the removal of tile drainage and lower precipitation/API

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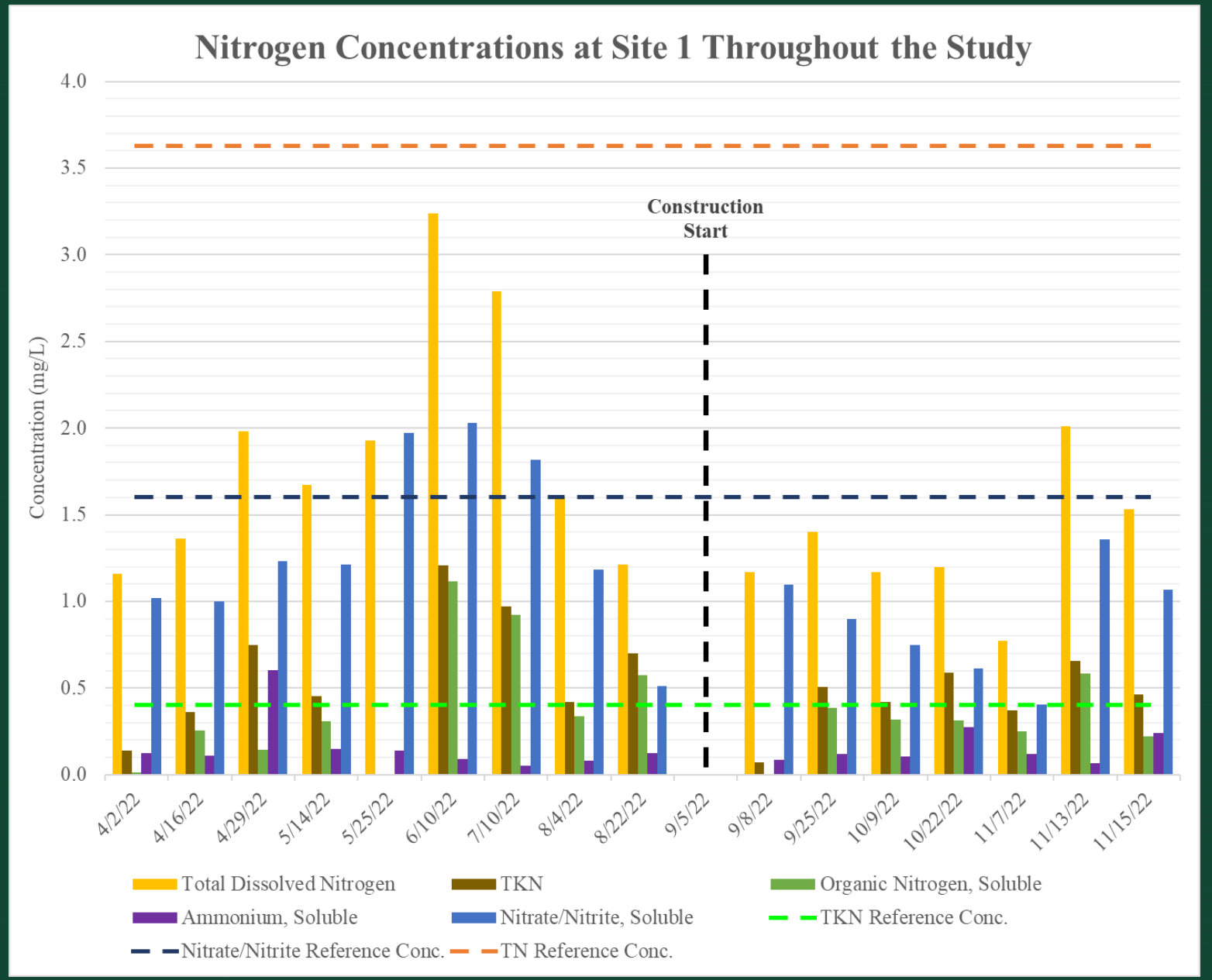

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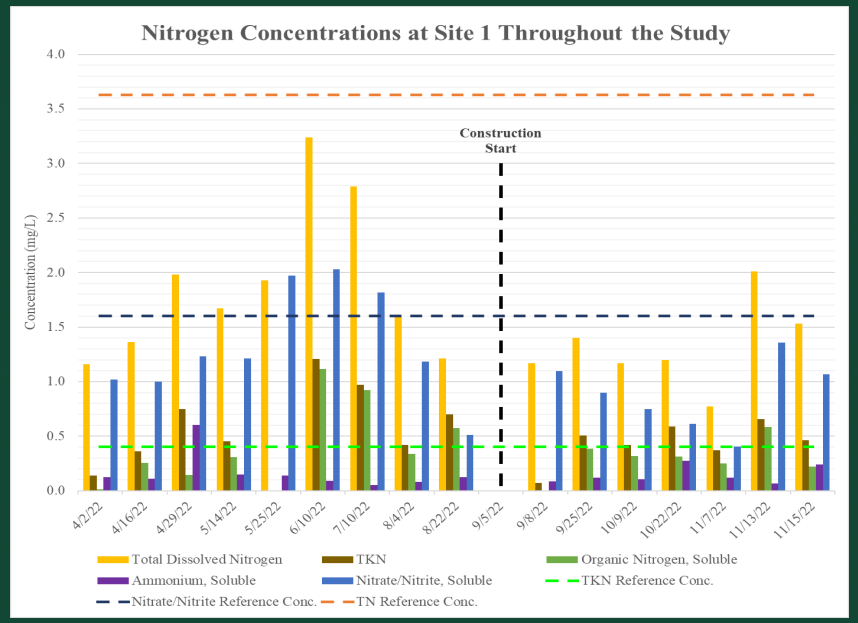
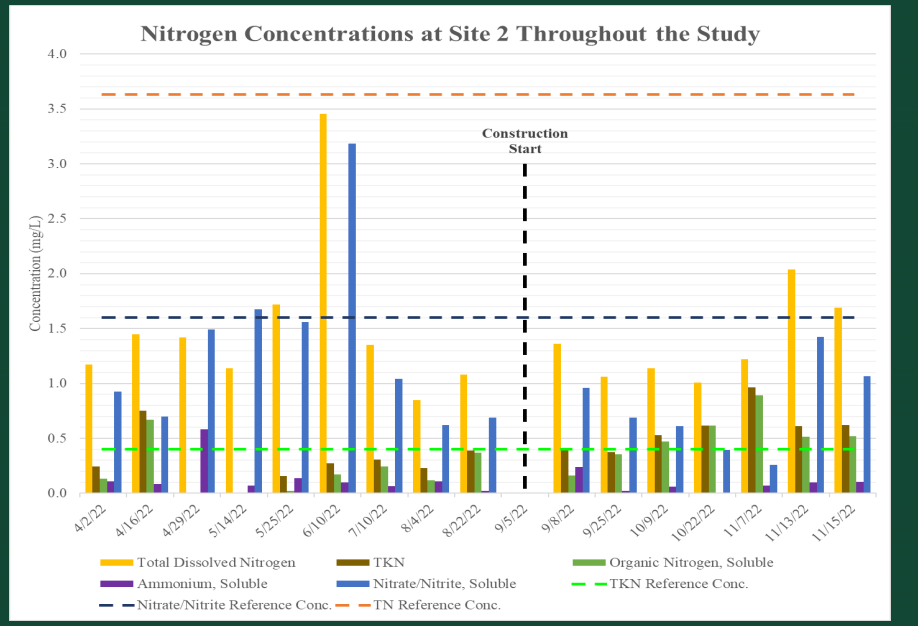
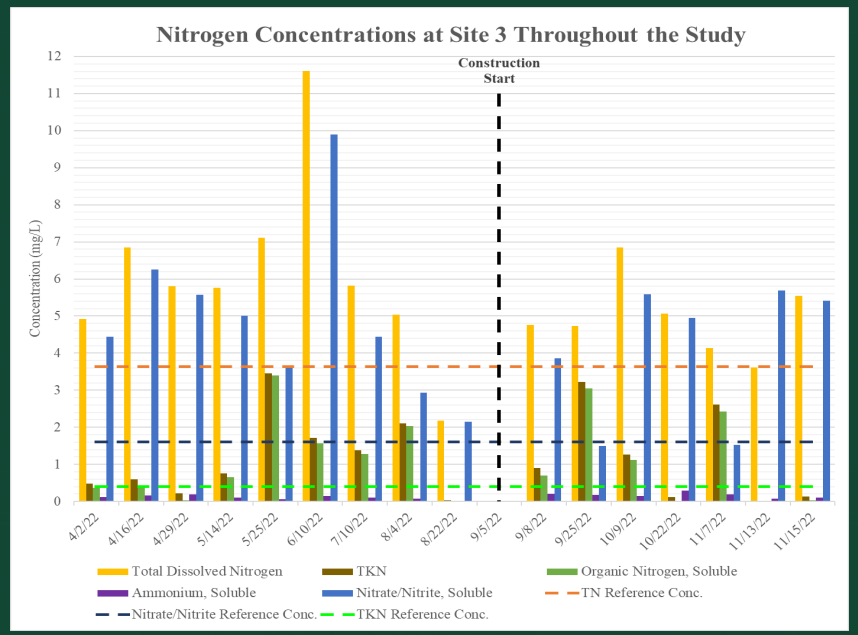
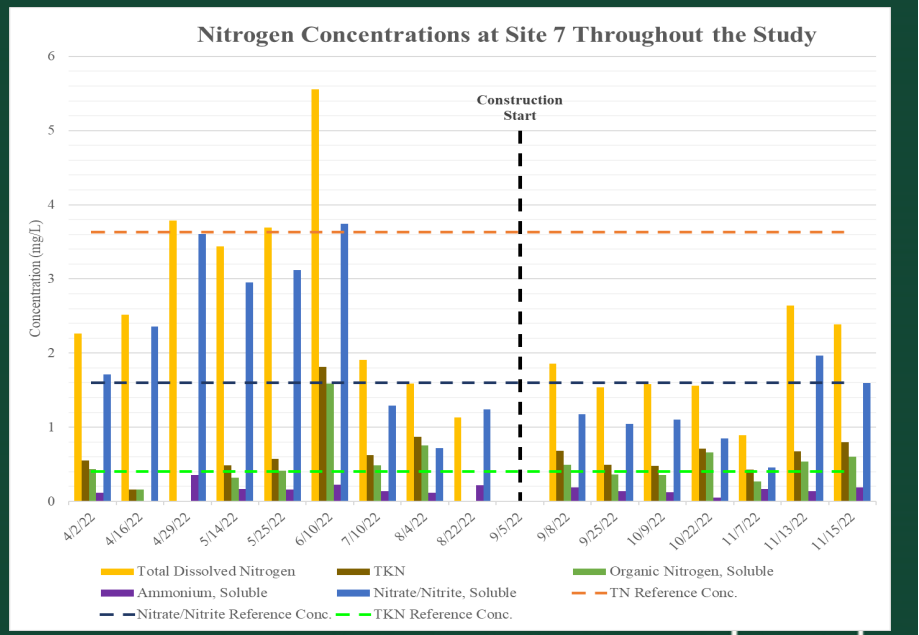
Nitrogen Concentration At Sites 1, 2, 3, & 7

Credit @ Zachary Rundell (MSES '23)









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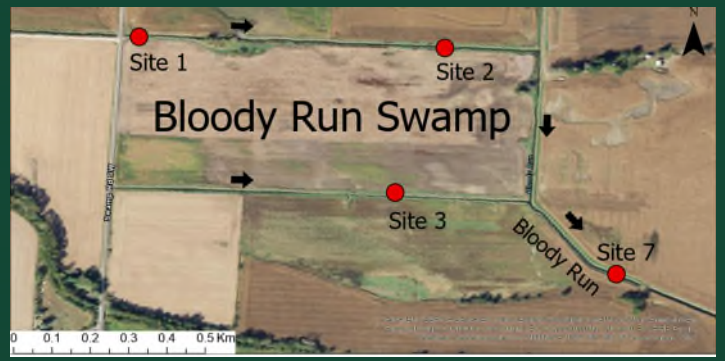
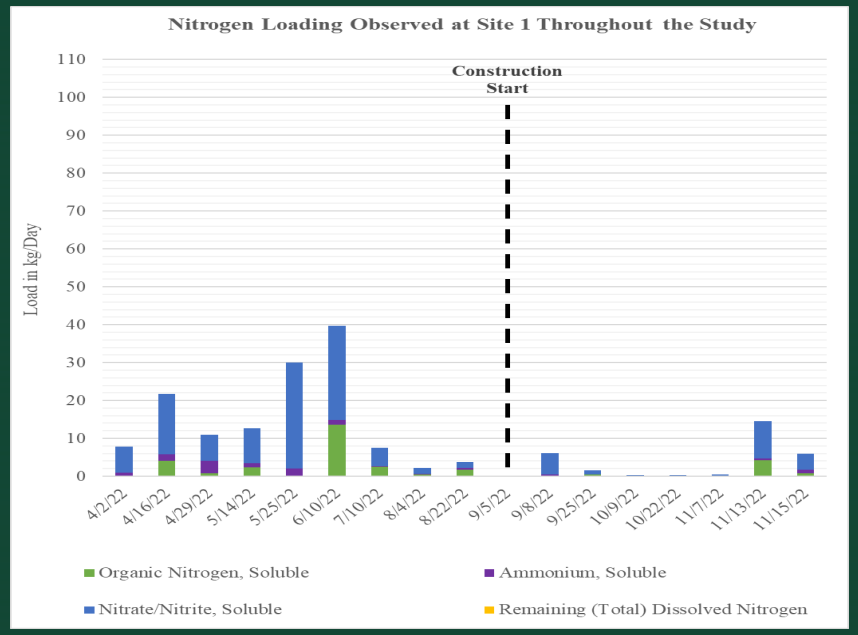
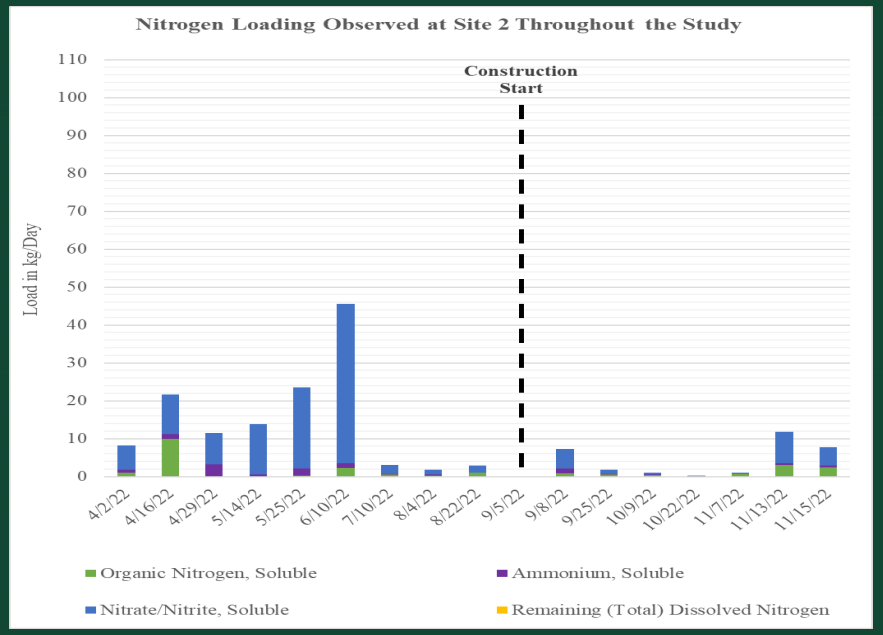
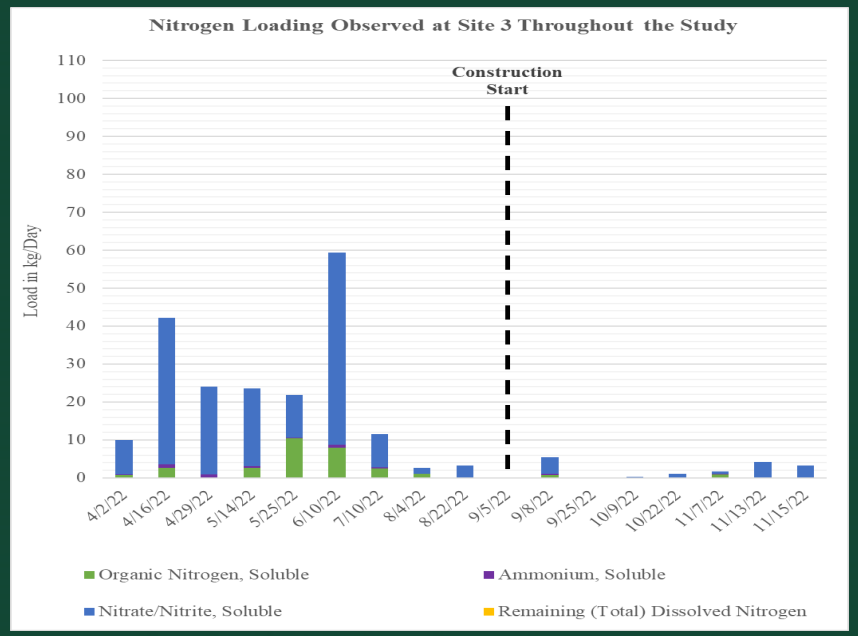
Nitrogen Loading At Sites 1, 2, 3, & 7

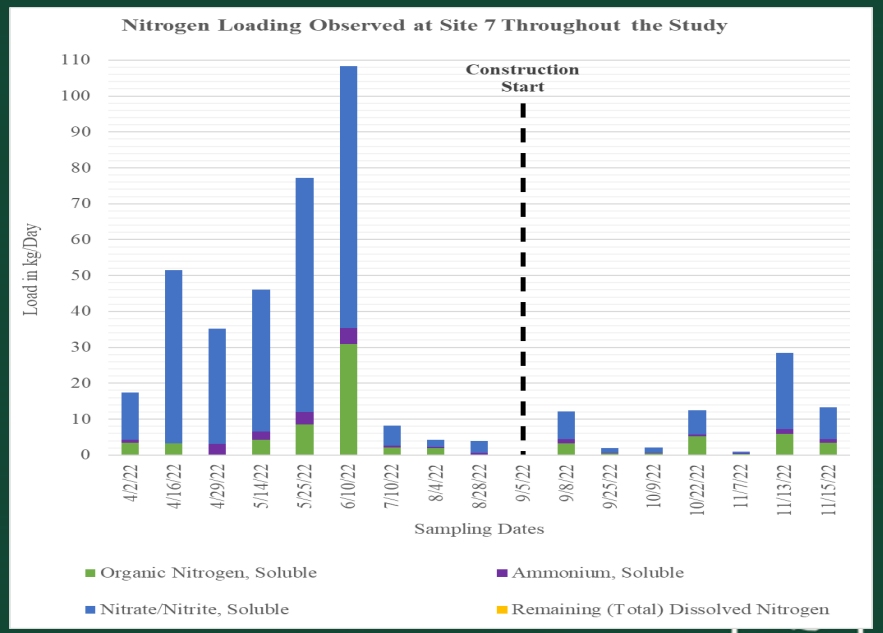


Credit @ Zachary Rundell (MSES '23)









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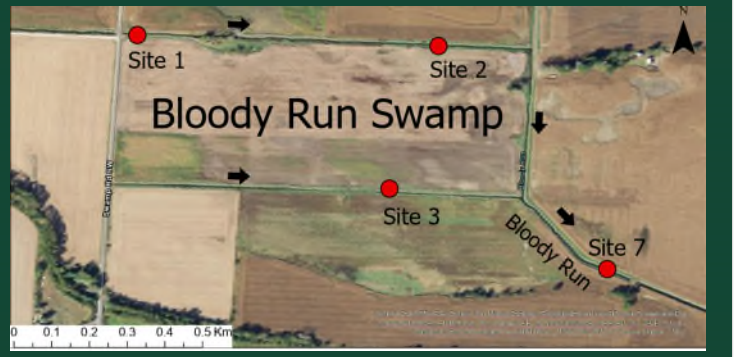
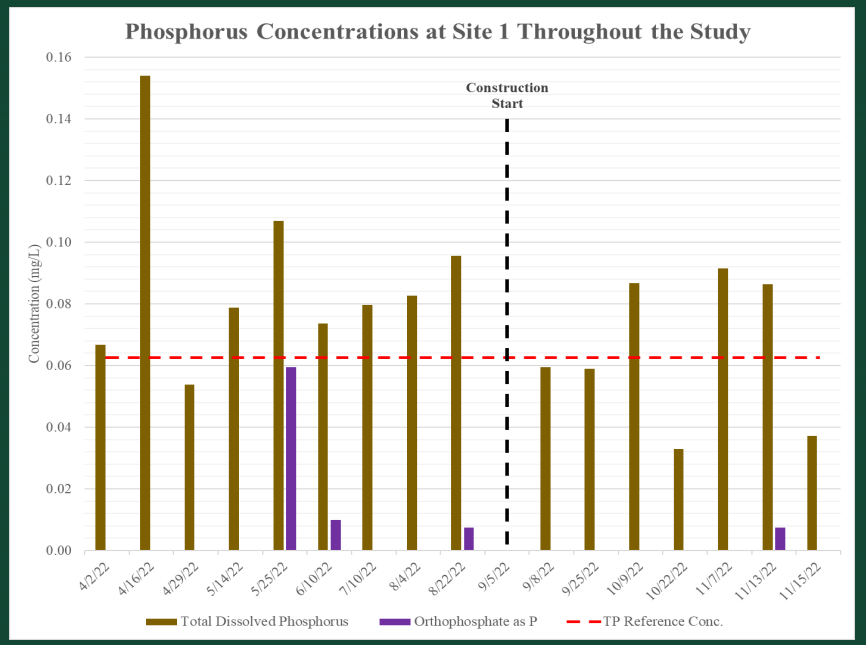
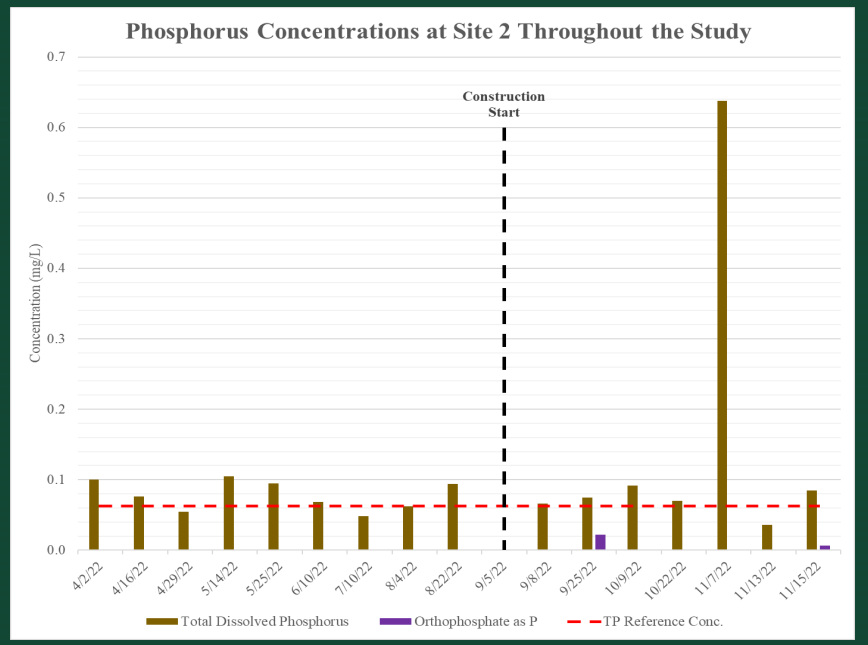
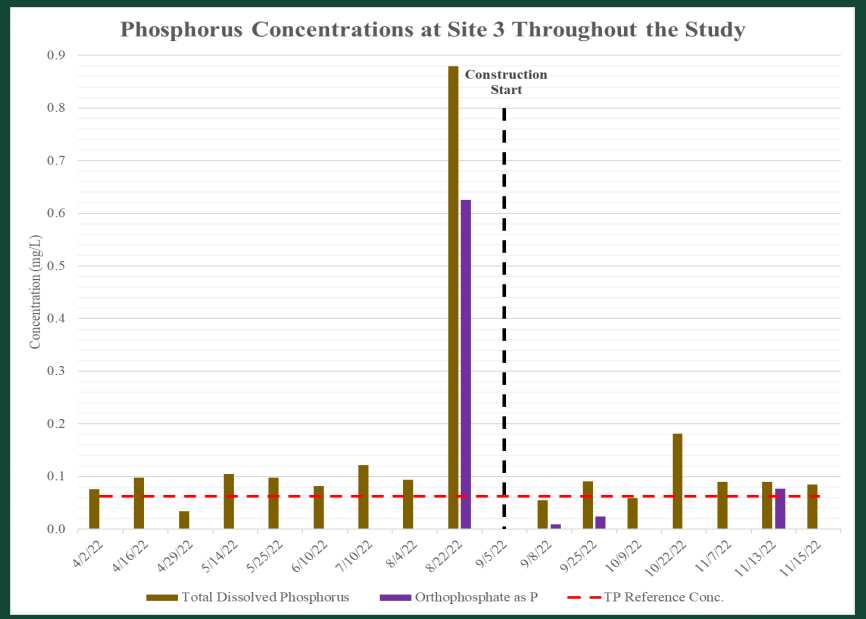
Phosphorus Concentrations At Sites 1, 2, 3, & 7

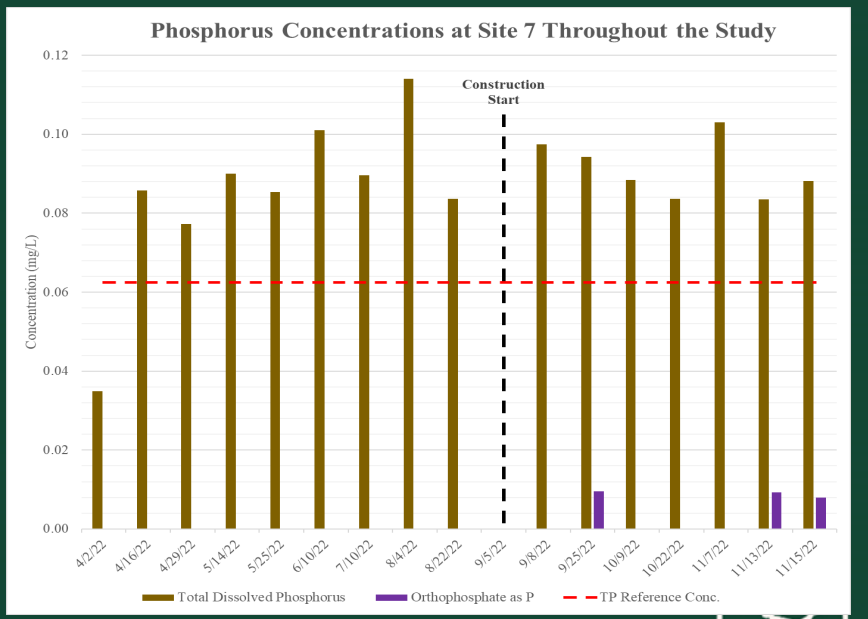


Credit @ Zachary Rundell (MSES '23)









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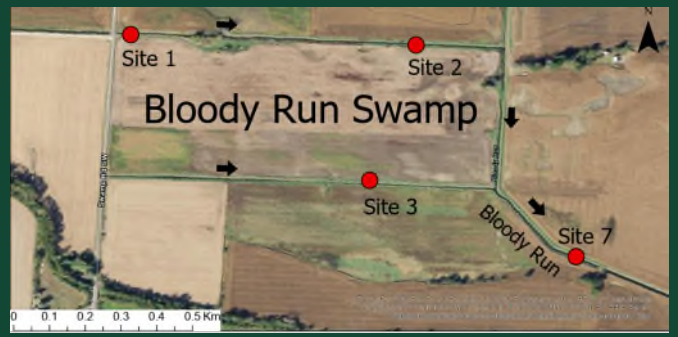
Phosphorus Loading At Sites 1, 2, 3, & 7



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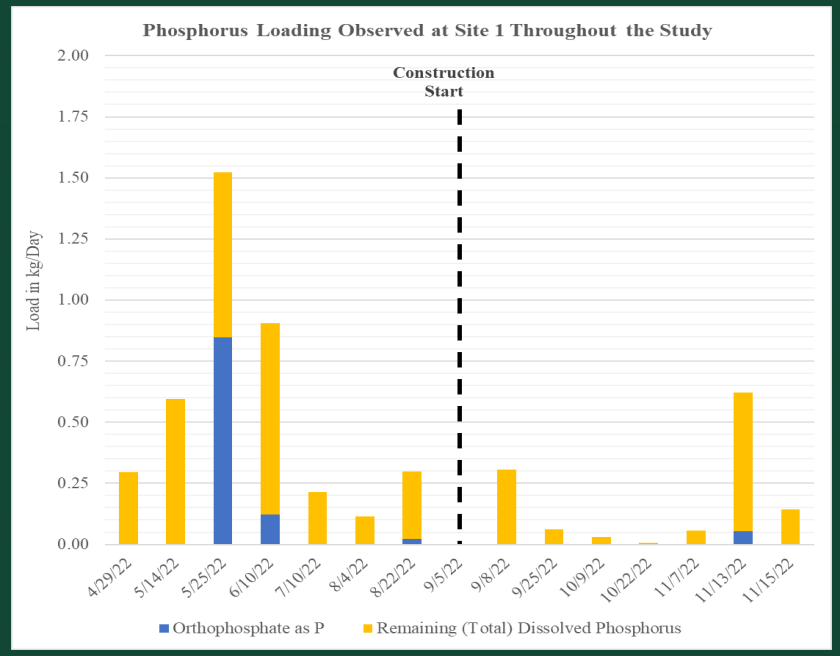
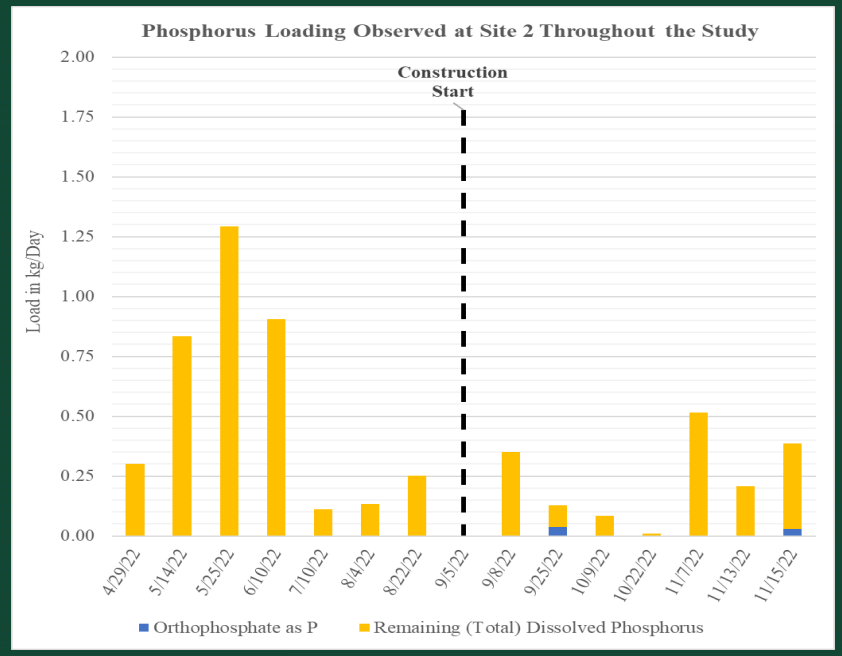
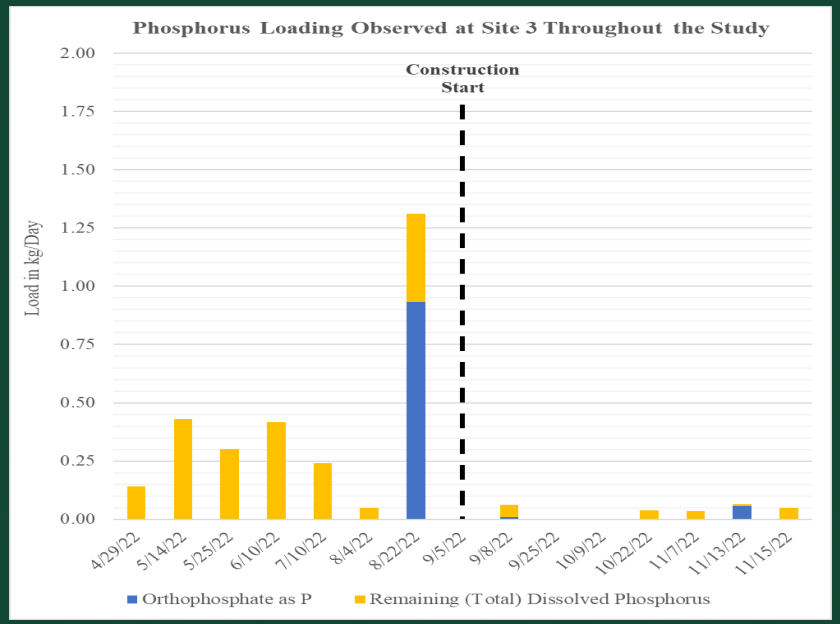
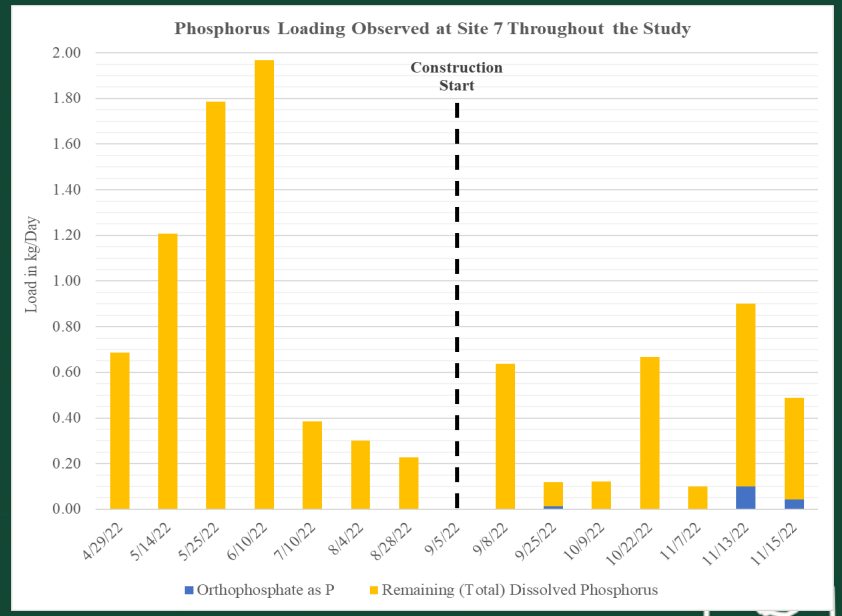
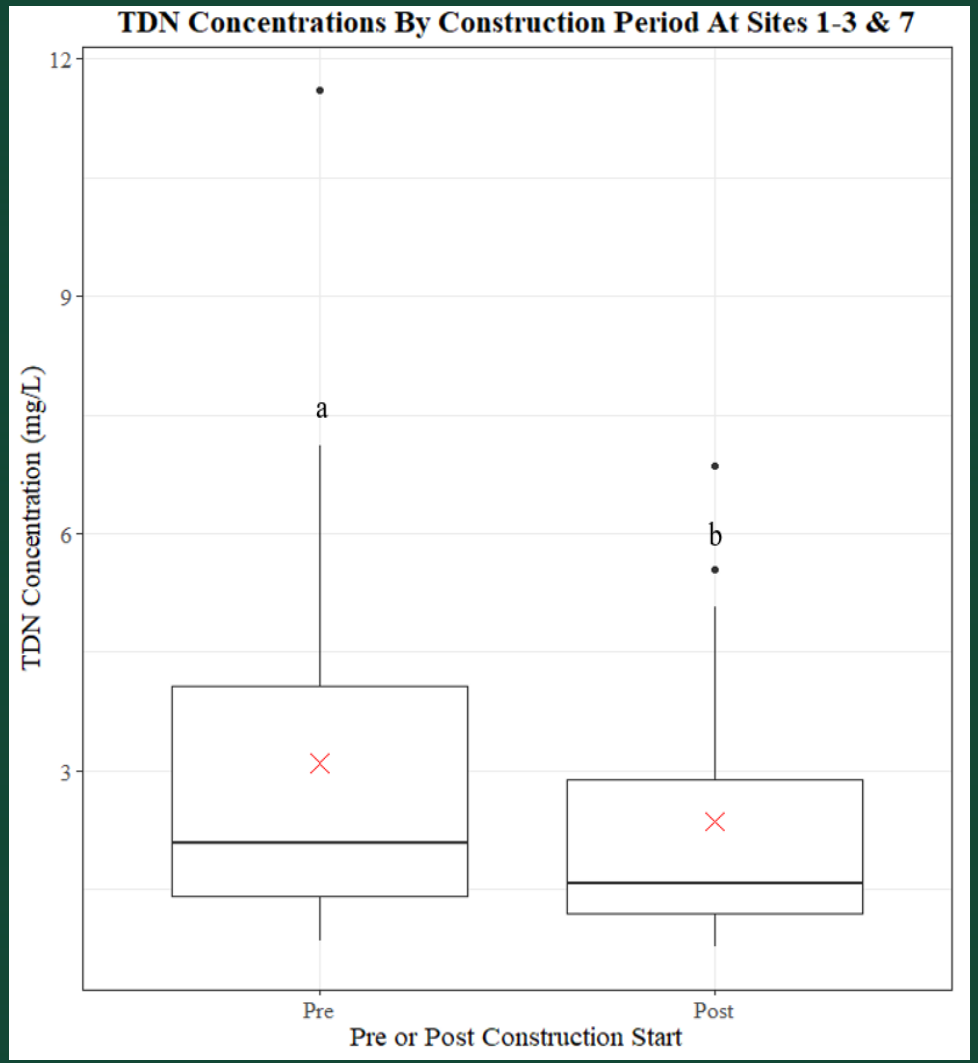


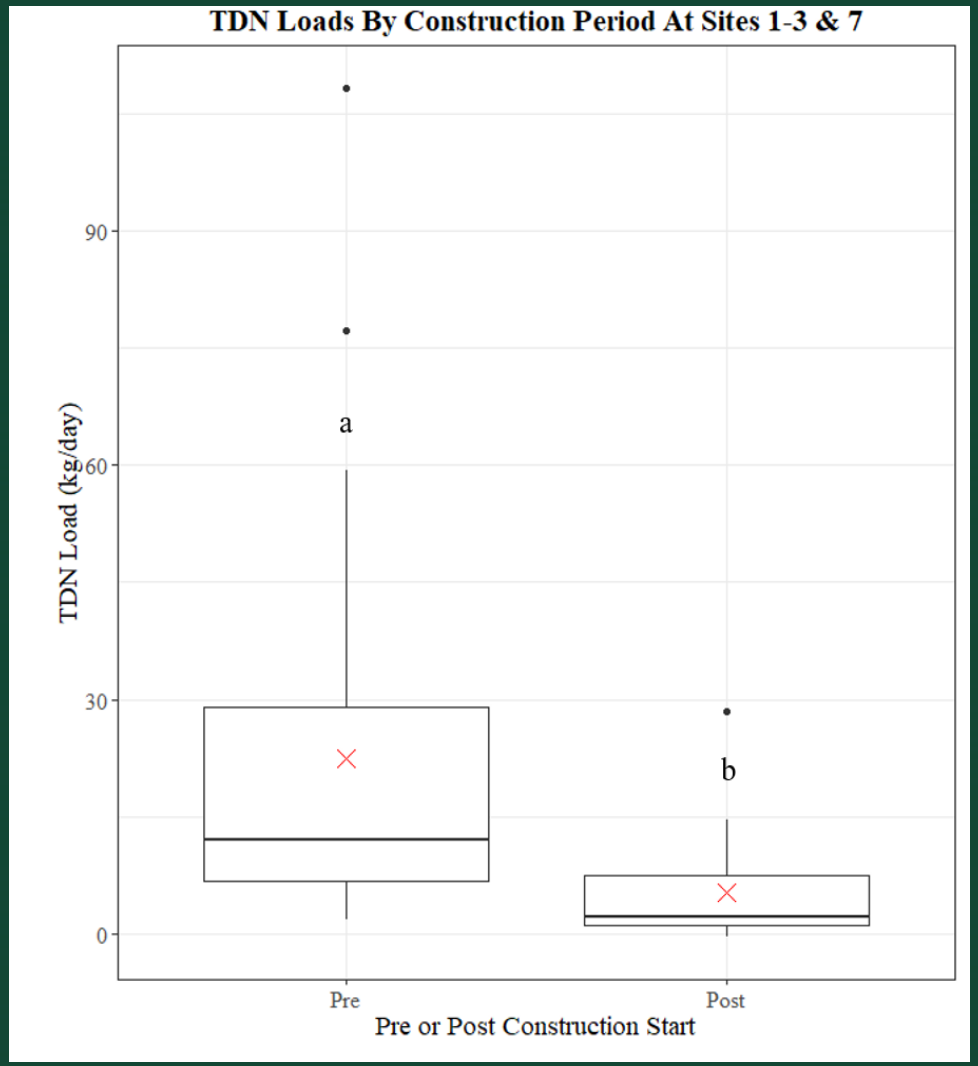






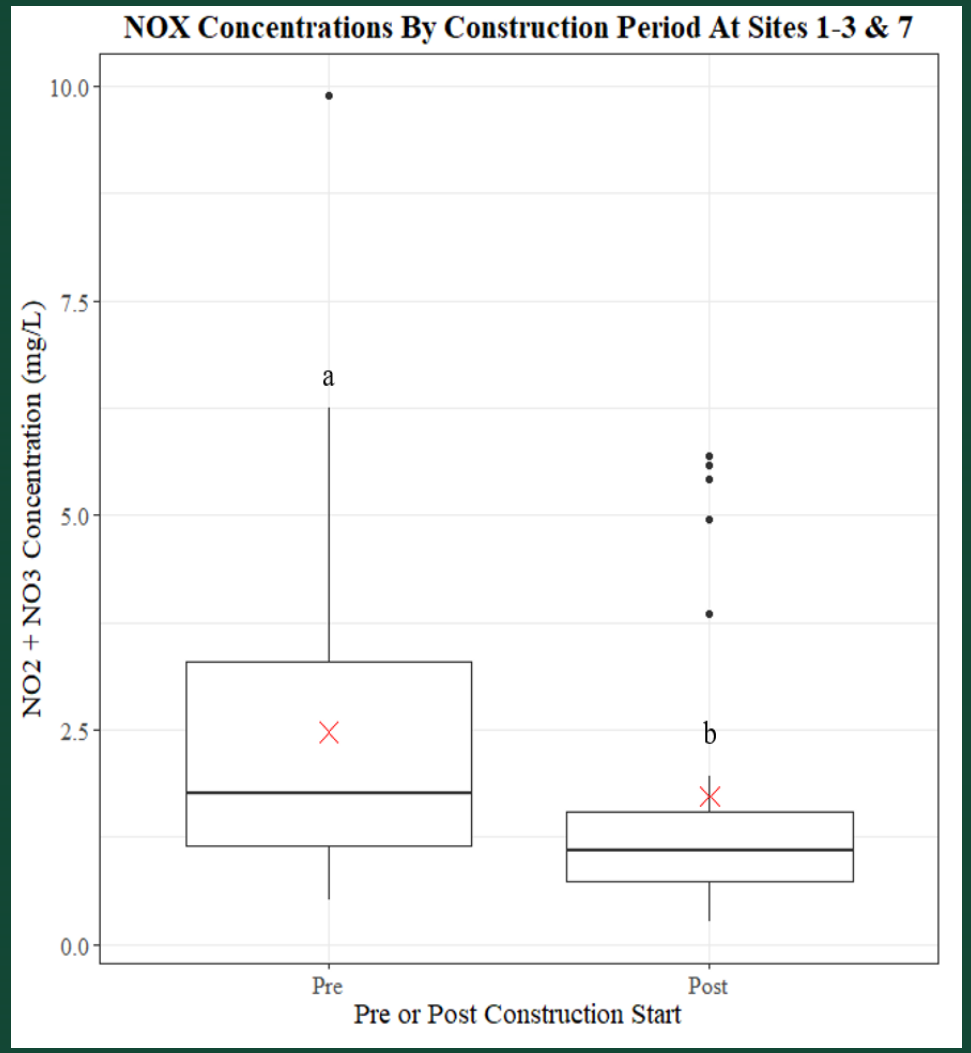
Total Dissolved Nitrogen

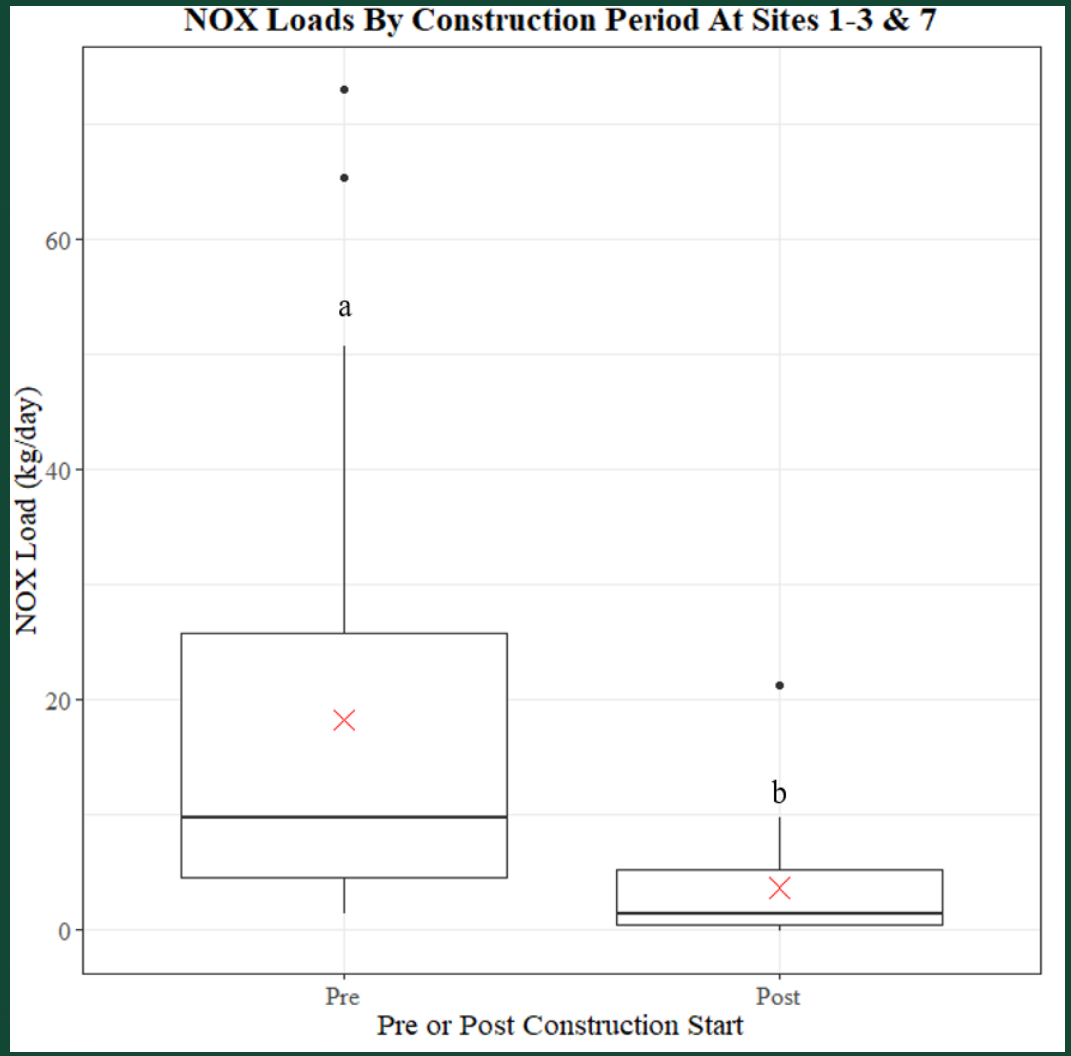




Credit @ Zachary Rundell (MSES '23)

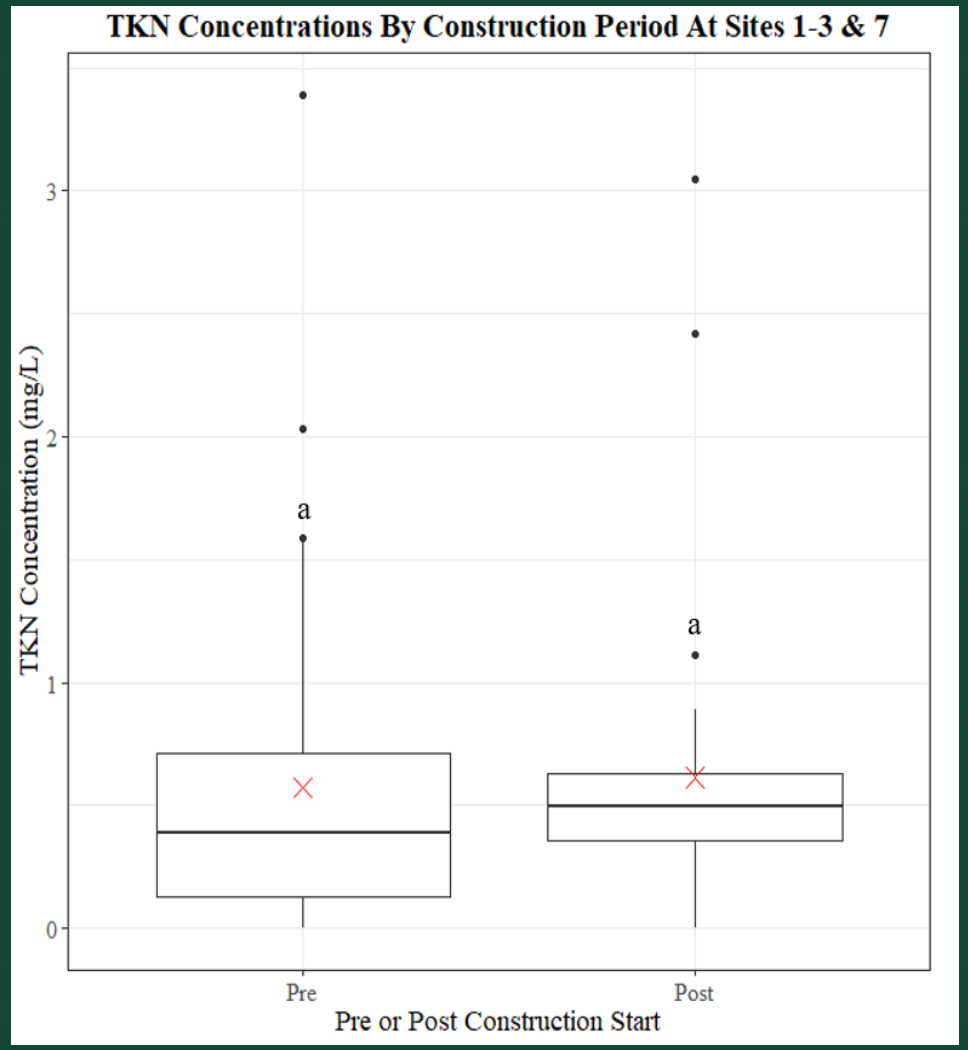
Dissolved Nitrate/Nitrite

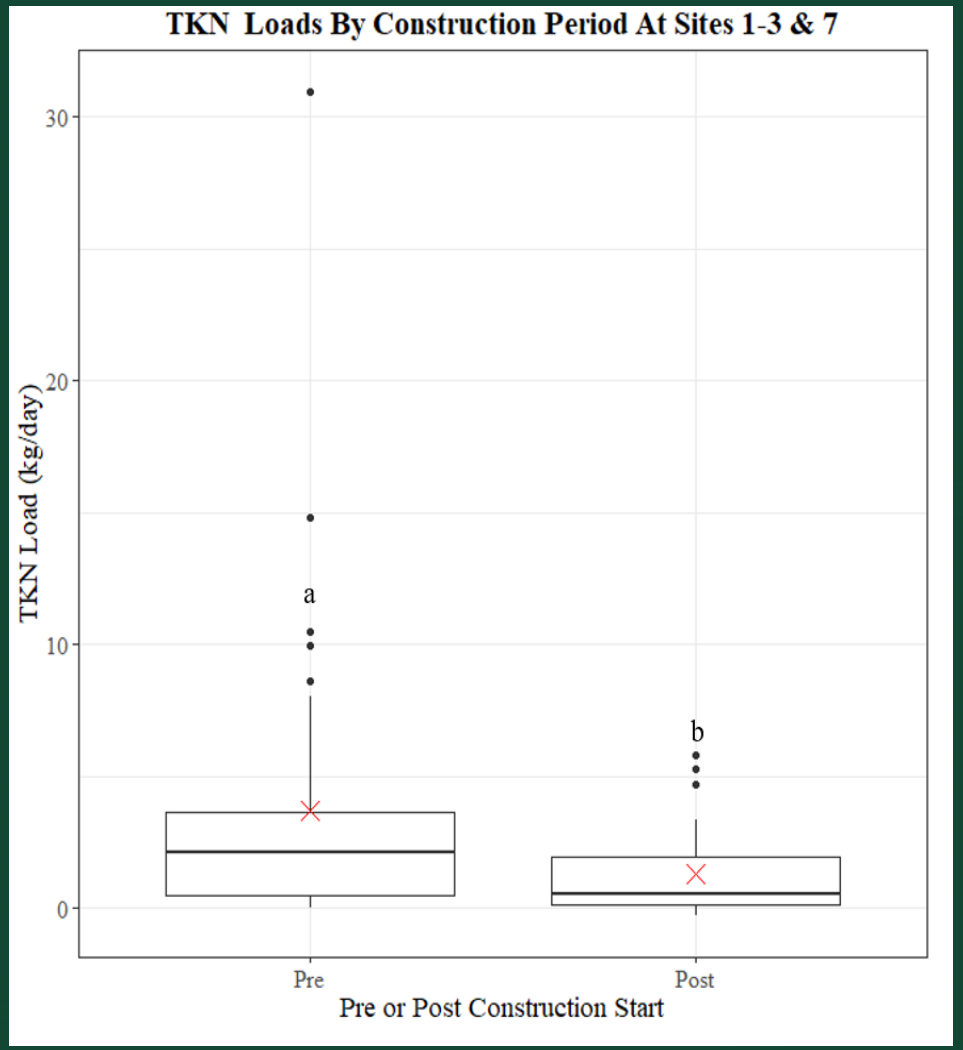




Credit @ Zachary Rundell (MSES '23)

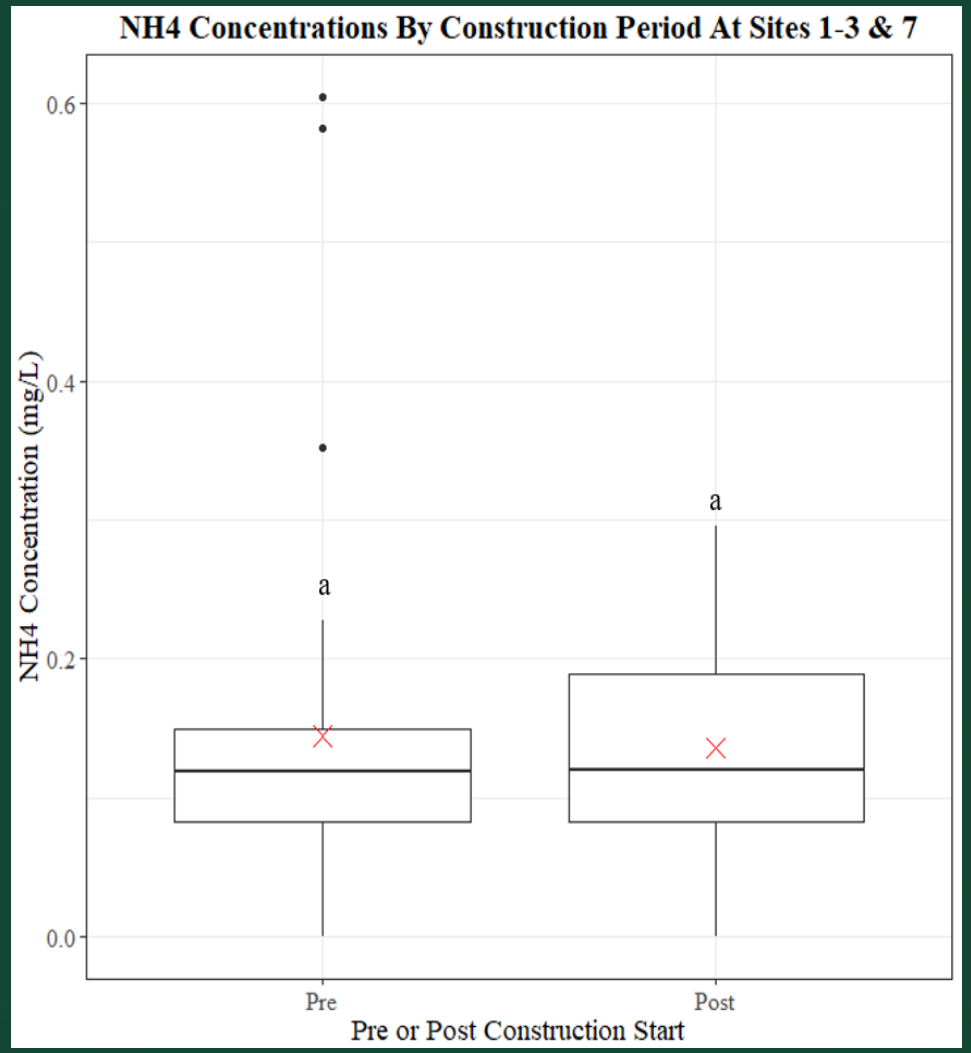
Dissolved Total Kjeldahl Nitrogen (TKN)

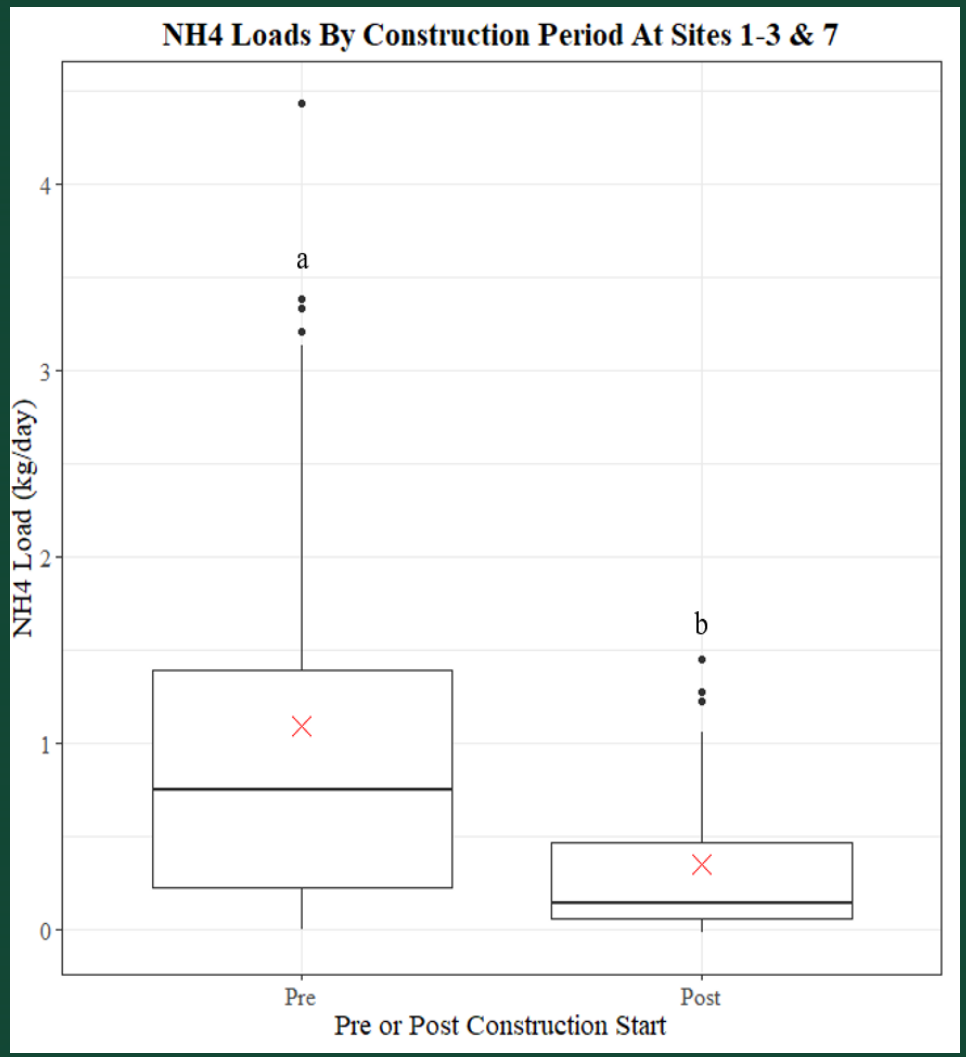




Credit @ Zachary Rundell (MSES '23)

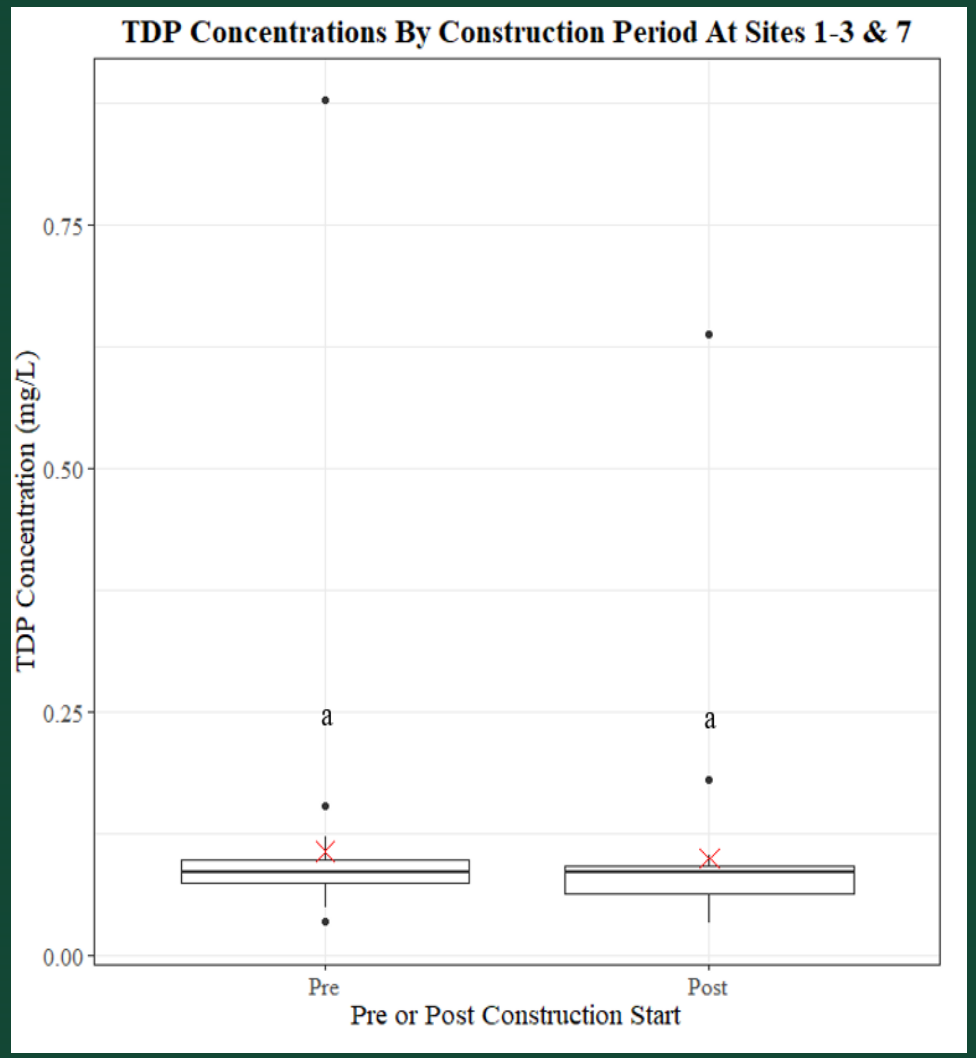
Dissolved Ammonia/Ammonium

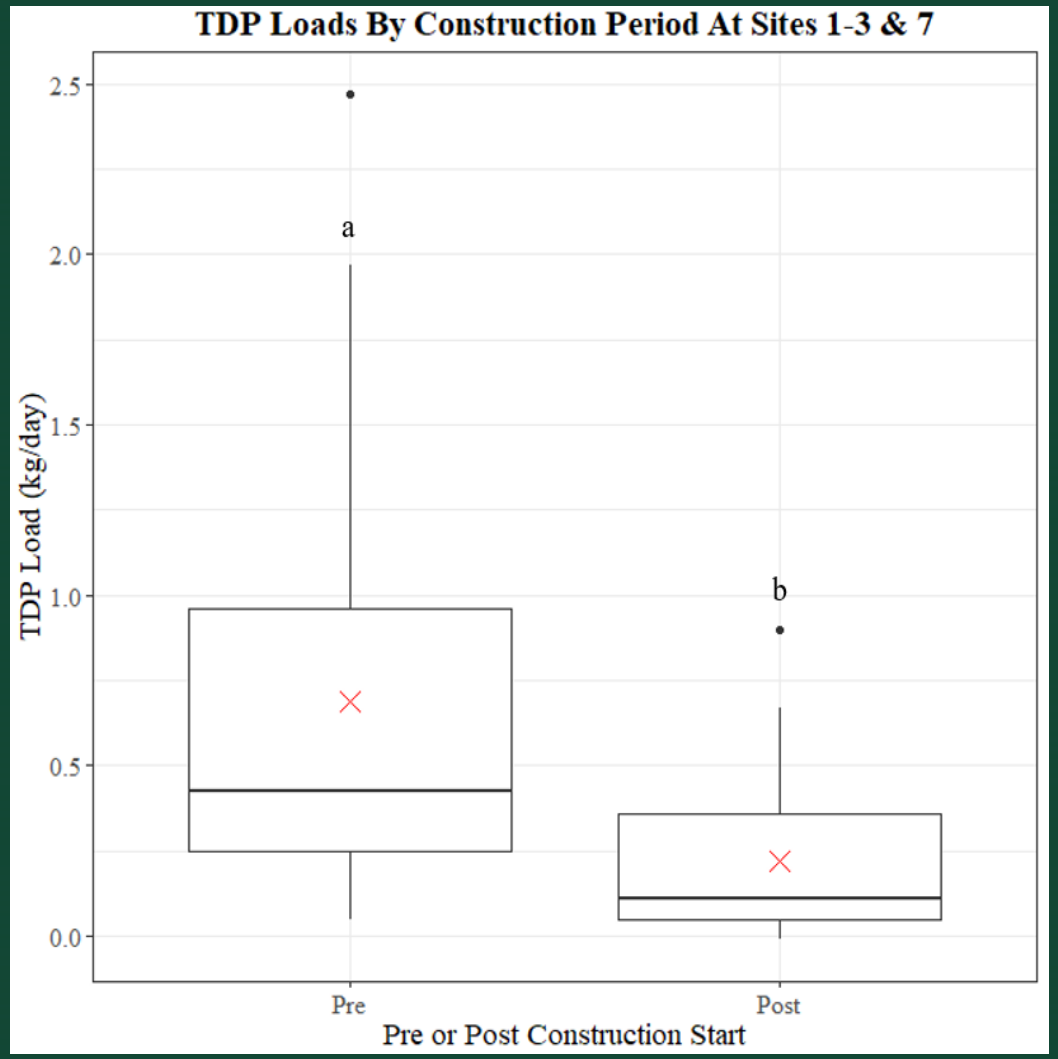




Credit @ Zachary Rundell (MSES '23)

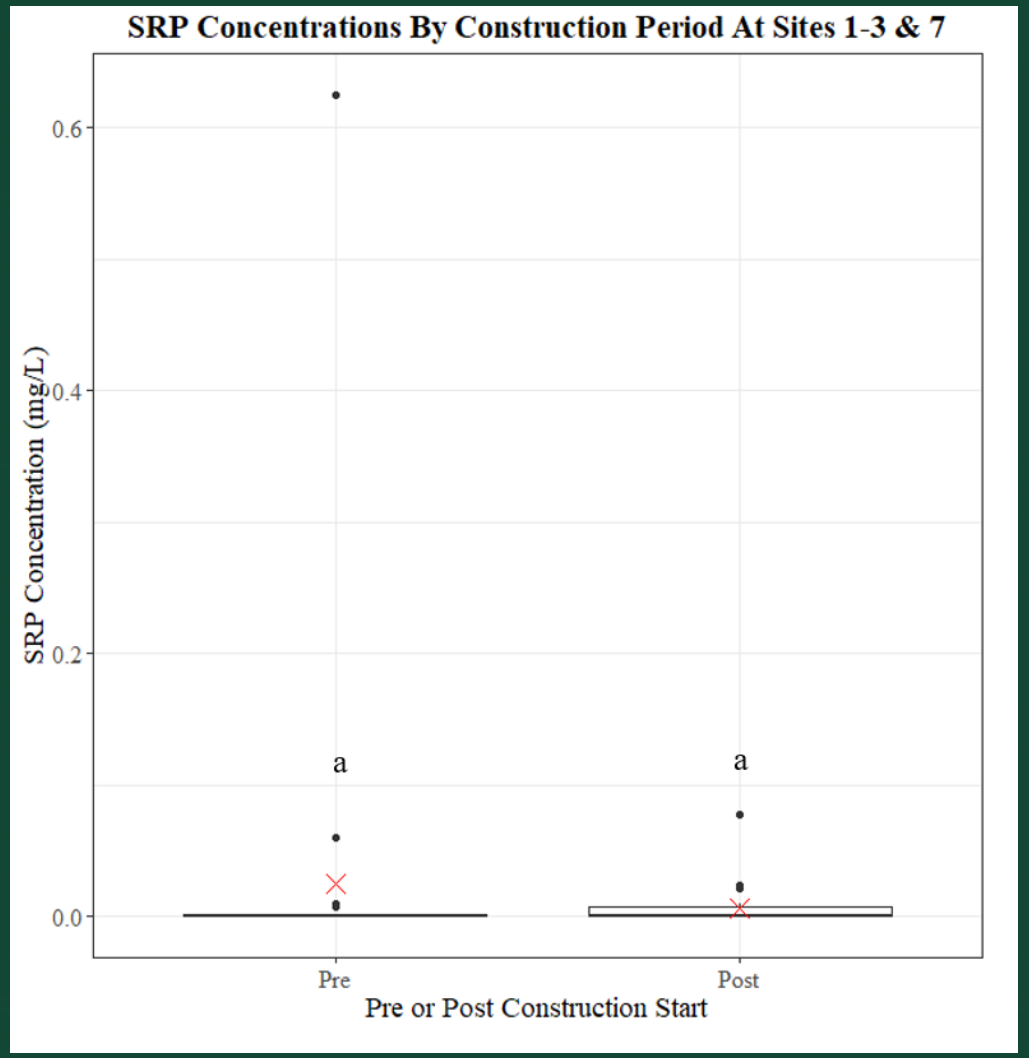
Total Dissolved Phosphorus (TDP)

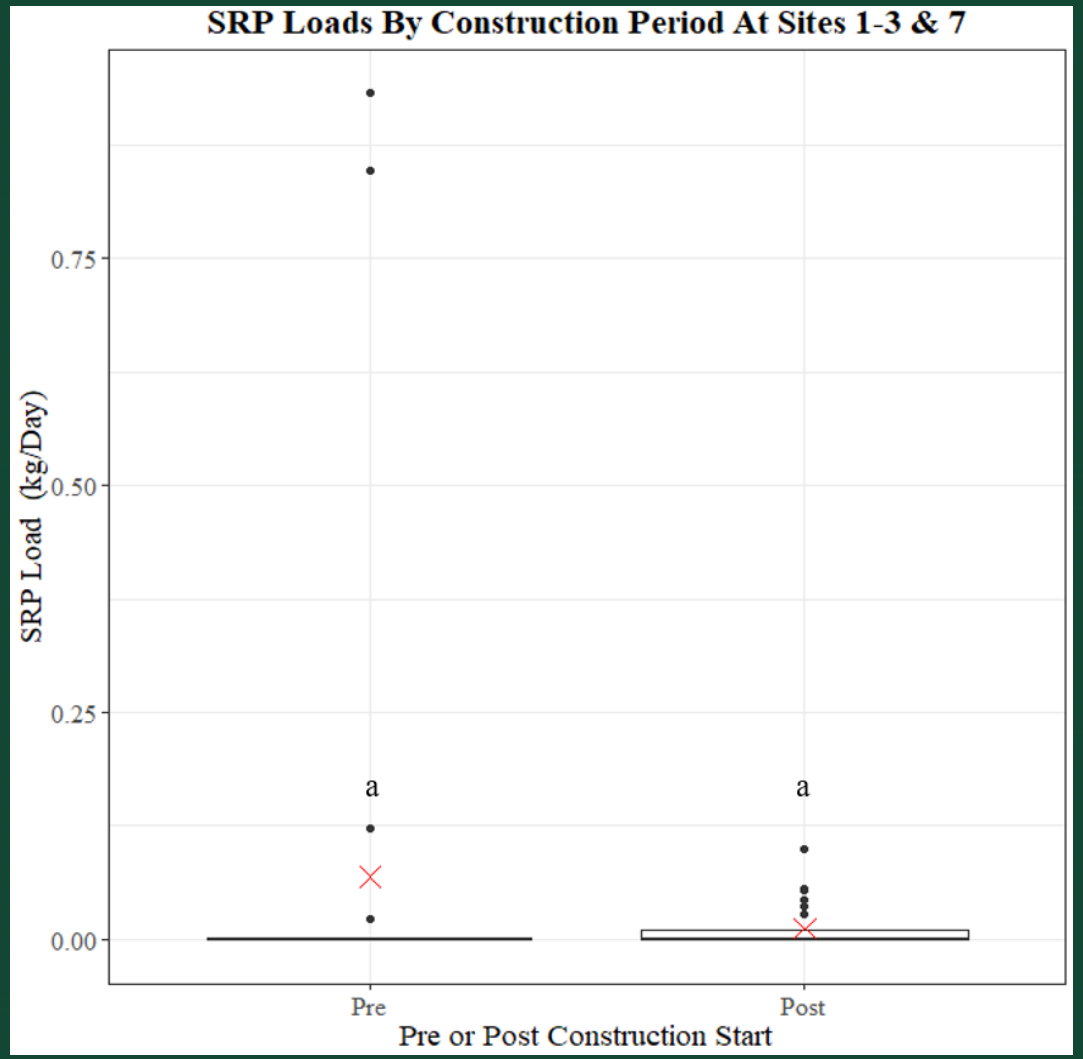




Credit @ Zachary Rundell (MSES '23)

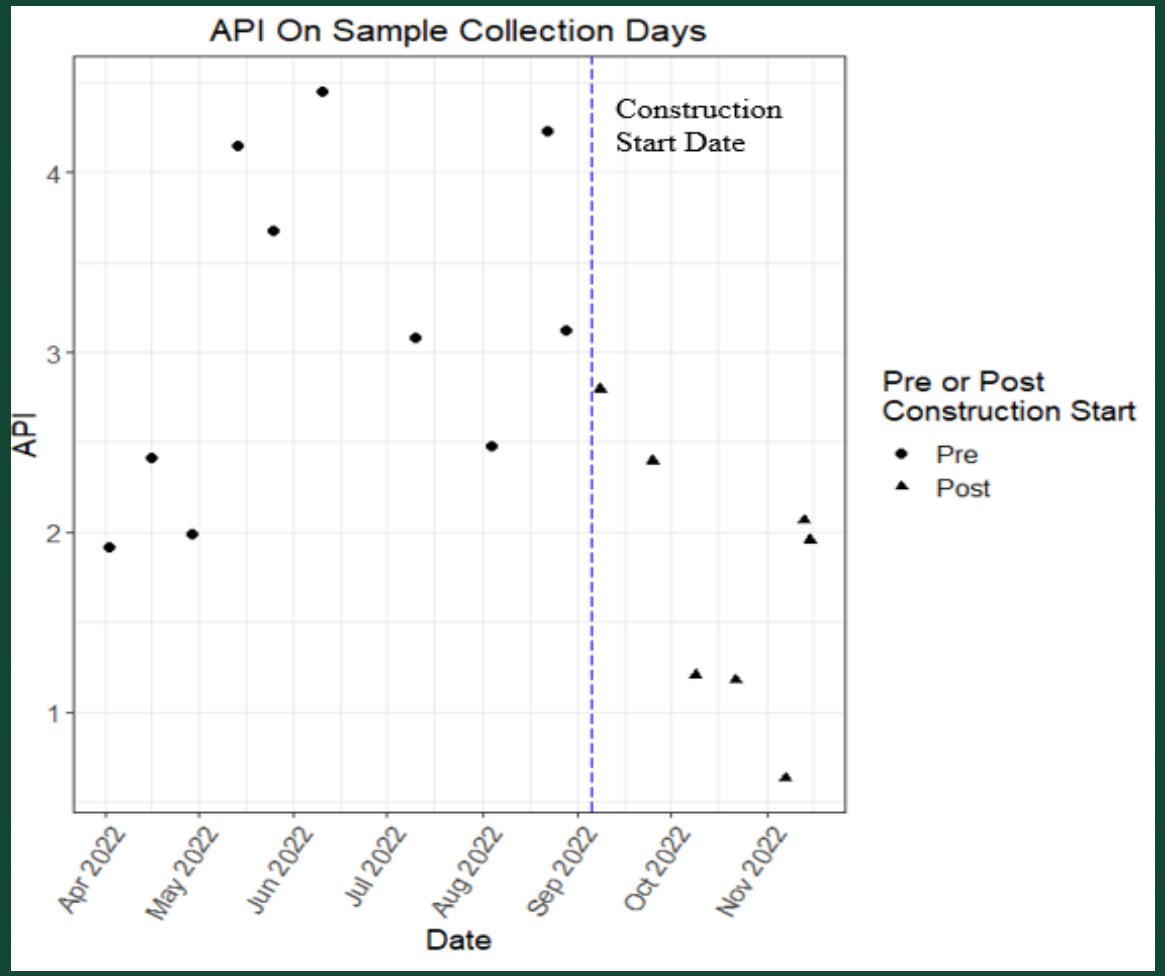
Soluble Reactive Phosphorus (SRP)

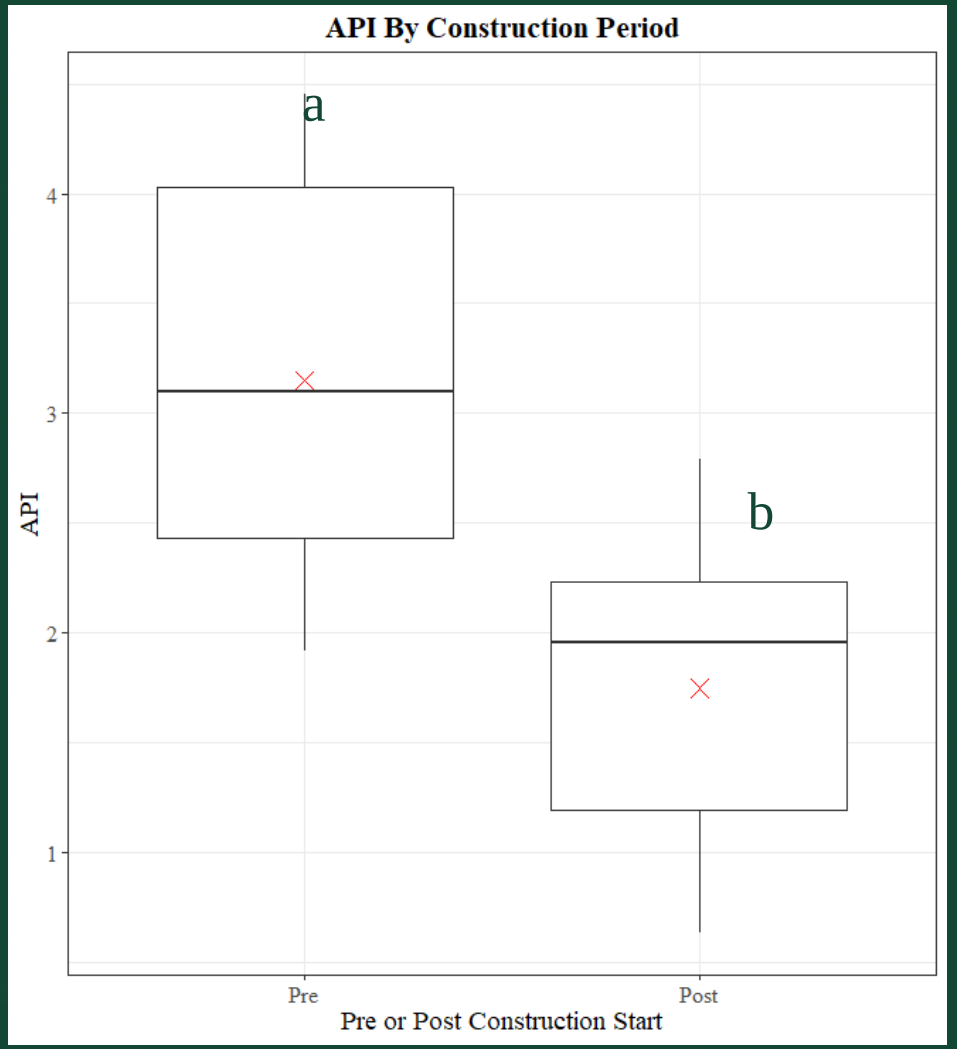




Credit @ Zachary Rundell (MSES '23)

API On Sampling Days



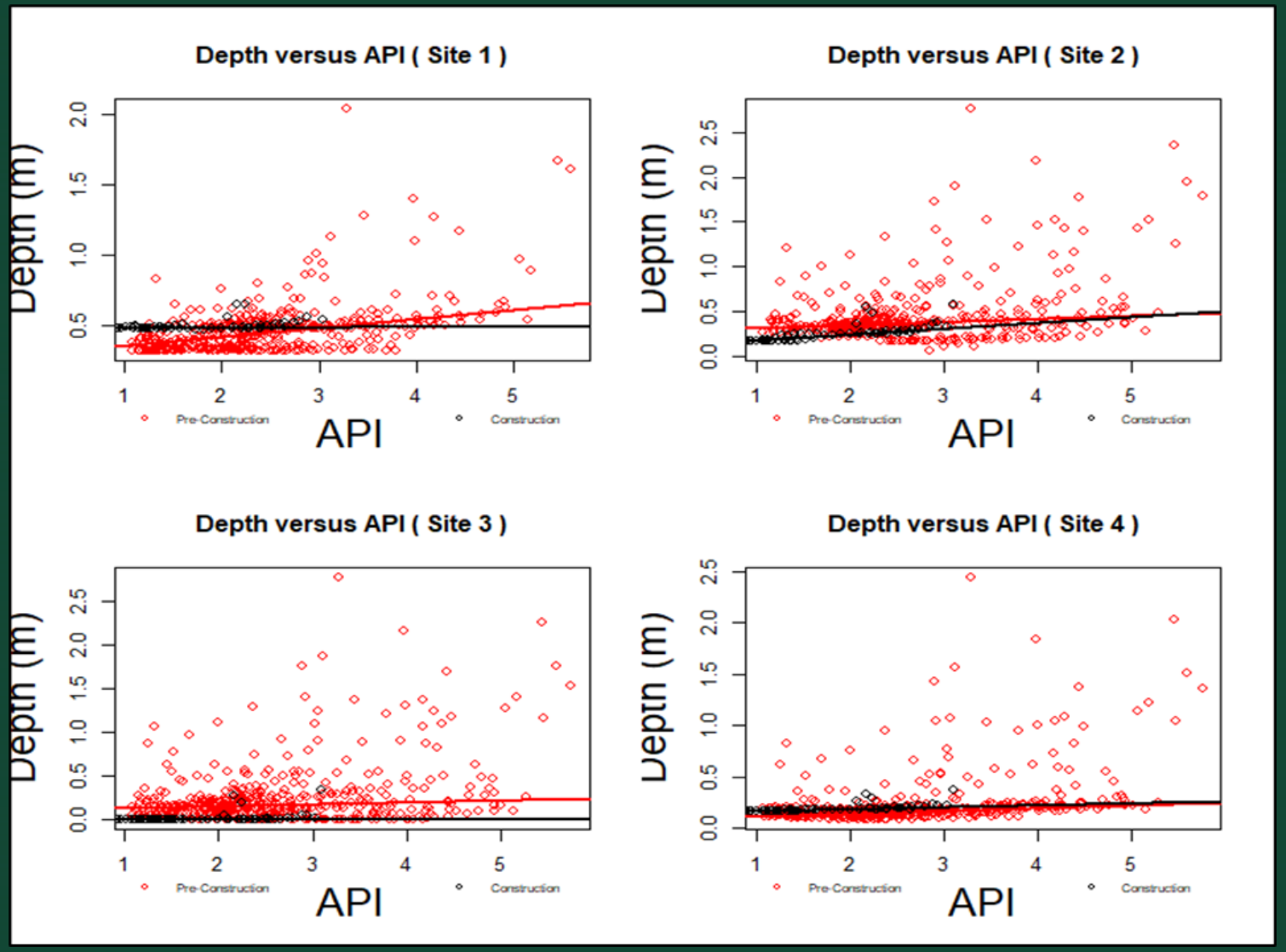


Credit @ Zachary Rundell (MSES '23)

Early Results – Water Retention

- When correlated with antecedent precipitation index, the response of water level to precipitation was less during construction than prior to construction, suggesting that more water is being retained in the site as construction proceeds.

Water Depth and API



- API has a statistically significant relationship ($p < 0.05$) with the mean depth during the pre-construction and construction phase at sites 1,2,3 and 4.
- This implies that as the API increases, the depth also increases.

Credit @ Kehinde Moyosola Ositimehin (MSES '23)

Early Results – Soil Erosion

- Total dissolved solids (TDS) and total solids (TS) were lower during construction than prior to construction.

TSS, TDS, TS concentration versus API

- Concentrations of TDS were higher than those of suspended solids (TSS).

Credit @ Kehinde Moyosola Ositimehin (MSES '23)

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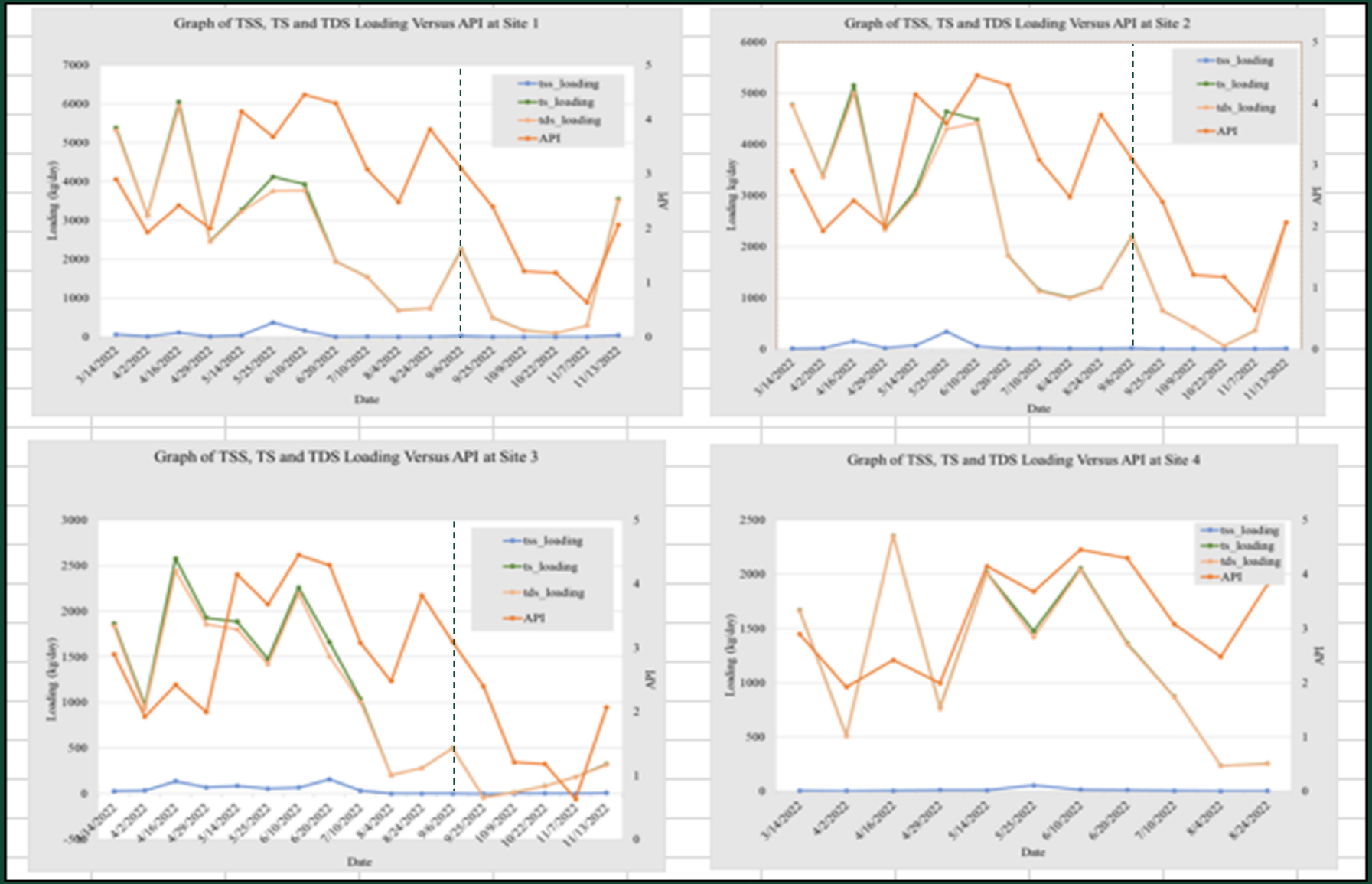
TSS, TDS and TS Loading Versus API



- Increased precipitation leads to higher TSS, TS, and TDS loadings, indicating greater potential for soil erosion and runoff as more suspended/dissolved materials are carried into sites.

Credit @ Kehinde Moyosola Ositimehin (MSES '23)

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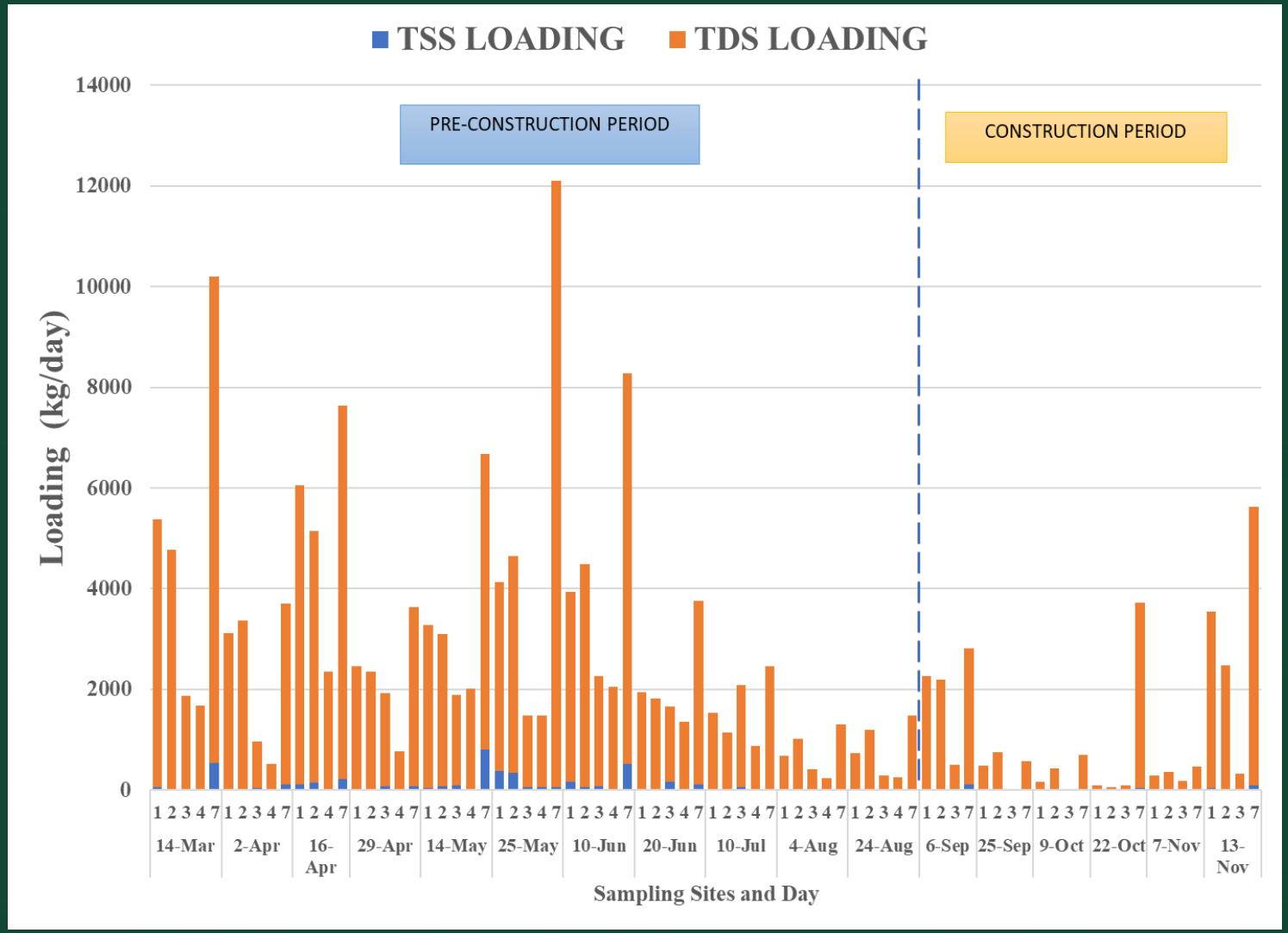
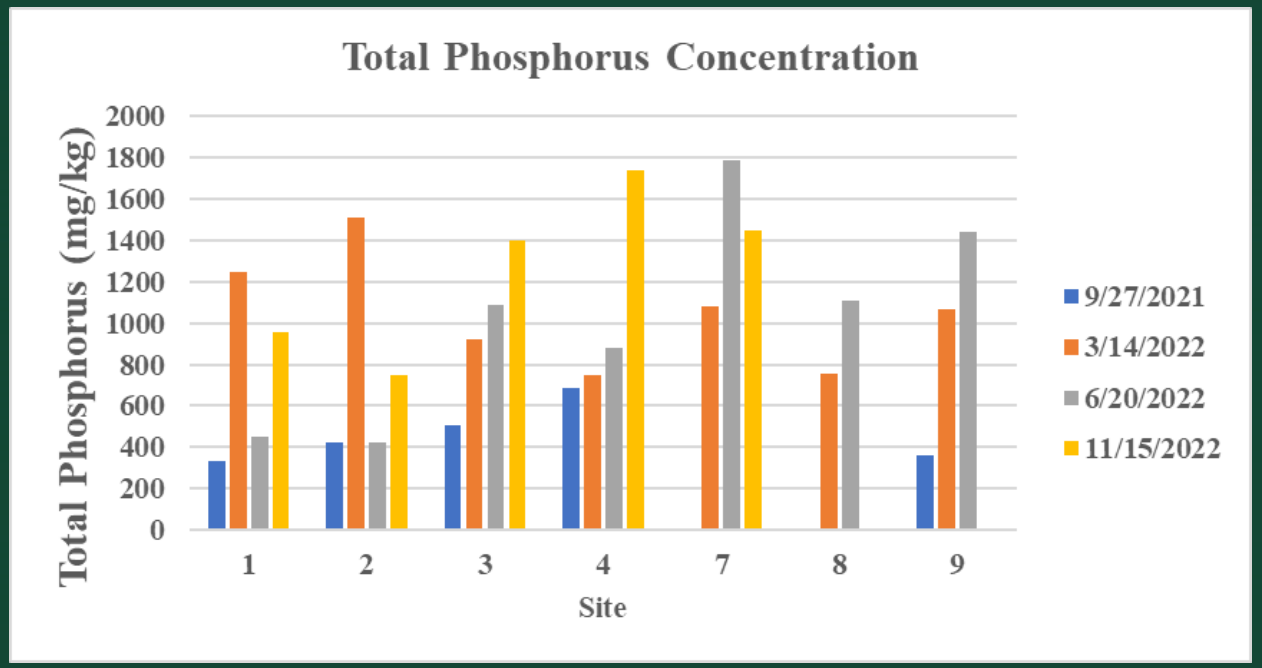
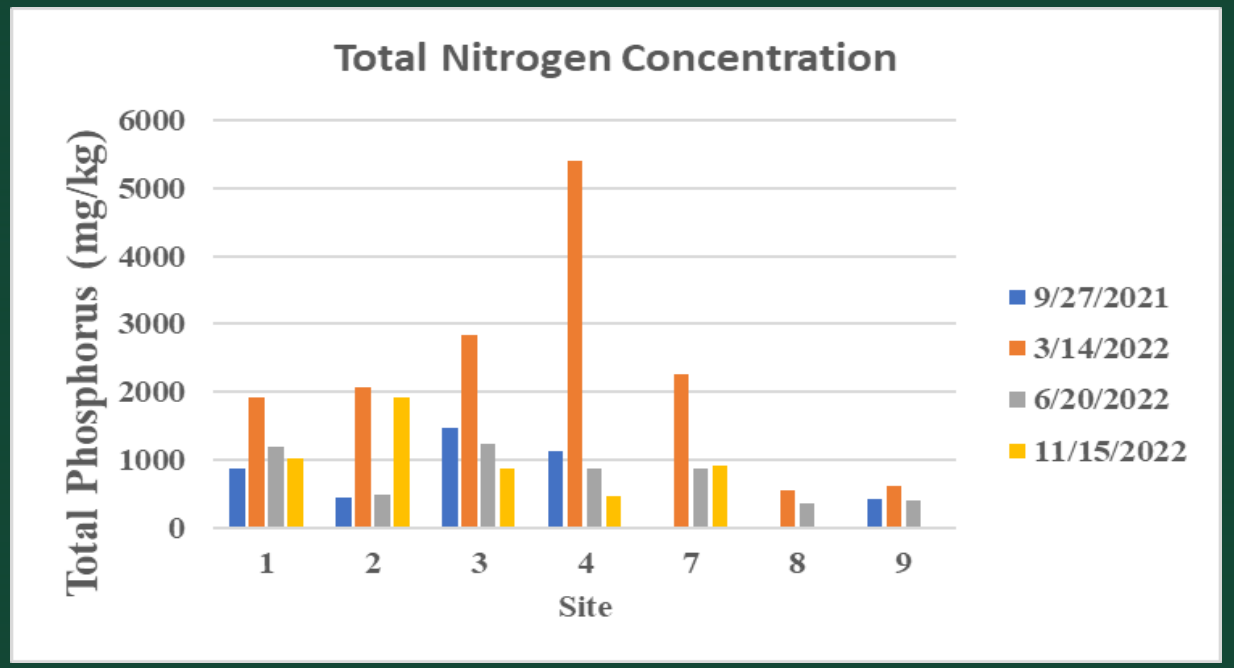
TSS, TS and TDS loadings



Credit @ Kehinde Moyosola Ositimehin (MSES '23)

Sediment: Total Phosphorus Concentration





Credit @ Kehinde Moyosola Ositimehin (MSES '23)

Post-Construction Plan

- The data so far supports a method of combined stream and wetland restoration for nitrogen and solids reduction and transient water storage.
- Monitoring will continue until summer 2025
  - Biweekly sampling in the summer/fall, quarterly lab testing
- SRP concentrations may increase over the next two years
- On-field sediment will be tested for nutrient concentrations
- Continued student support

Challenges

- Highly vegetated
- Sediment build up in ditches
- Continual logger maintenance

Future Land Use

From swamp to agriculture

Now agriculture to urban development

Water quality will continue to play an important role in the region

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Acknowledgments

The Stream + Wetlands Foundation
The Faculty and Staff at the Voinovich School of Leadership & Public Service
Dr. Natalie Kruse Daniels
Kehinde Moyosola Ositimehin
Zachary Rundell
Ellen Pokuah

Thank you!

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