Floodplain Wetlands:

A nature-based solution to assimilate nutrients, reduce erosion, expand habitat, and facilitate a more natural flow & disturbance regime

SUSE6

May 31, 2023

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Sustainable Streams LLC

Acknowledgements

Resources

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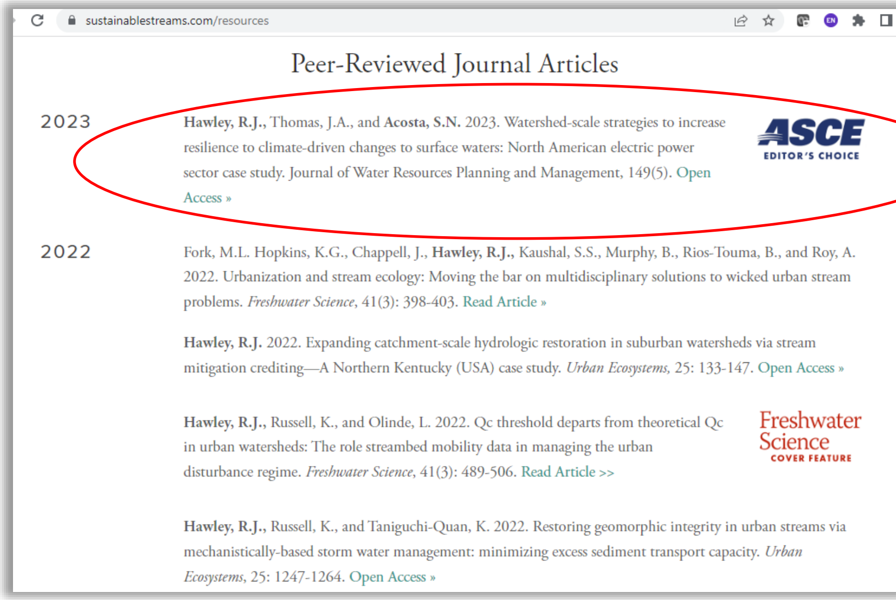


sustainablestreams.com/resources

Peer-Reviewed Journal Articles

2023

Hawley, R.J., Thomas, J.A., and **Acosta, S.N.** 2023. Watershed-scale strategies to increase resilience to climate-driven changes to surface waters: North American electric power sector case study. Journal of Water Resources Planning and Management, 149(5). Open Access »

ASCE EDITOR'S CHOICE

2022

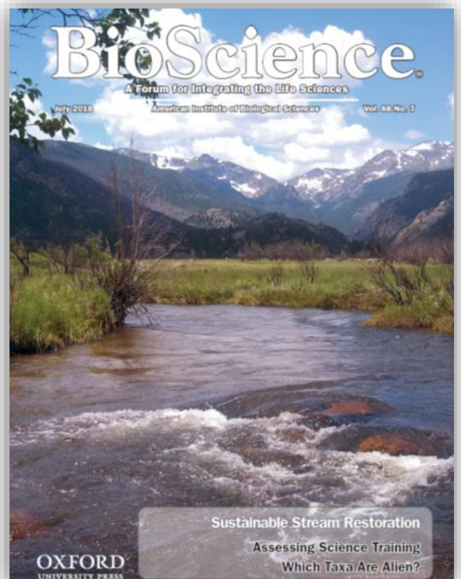
Fork, M.L. Hopkins, K.G., Chappell, J., **Hawley, R.J.**, Kaushal, S.S., Murphy, B., Rios-Touma, B., and Roy, A. 2022. Urbanization and stream ecology: Moving the bar on multidisciplinary solutions to wicked urban stream problems. *Freshwater Science*, 41(3): 398-403. Read Article »

Hawley, R.J. 2022. Expanding catchment-scale hydrologic restoration in suburban watersheds via stream mitigation crediting—A Northern Kentucky (USA) case study. *Urban Ecosystems*, 25: 133-147. Open Access »

Hawley, R.J., Russell, K., and Olinde, L. 2022. Qc threshold departs from theoretical Qc in urban watersheds: The role streambed mobility data in managing the urban disturbance regime. *Freshwater Science*, 41(3): 489-506. Read Article >>

Freshwater Science COVER FEATURE

Hawley, R.J., Russell, K., and Taniguchi-Quan, K. 2022. Restoring geomorphic integrity in urban streams via mechanistically-based storm water management: minimizing excess sediment transport capacity. *Urban Ecosystems*, 25: 1247-1264. Open Access »



guidebook

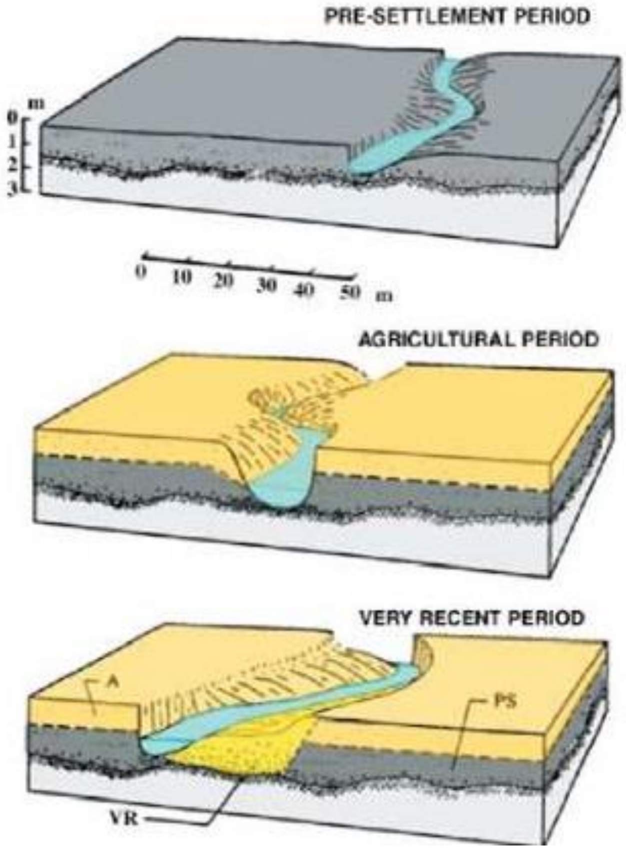
Why Restore Floodplains?

- Floodplain wetlands and off-channel habitats were common
- Expansive amounts of flood storage
- Energy dissipation/ natural disturbance regime
- Water quality processes & ecosystem services

Why Do Floodplains Need Restoration?

- **Historic & Contemporary Impacts in North America**
  - Beaver extirpation
  - Systematic deforestation
  - Stream channelization
  - Wetland/floodplain drainage

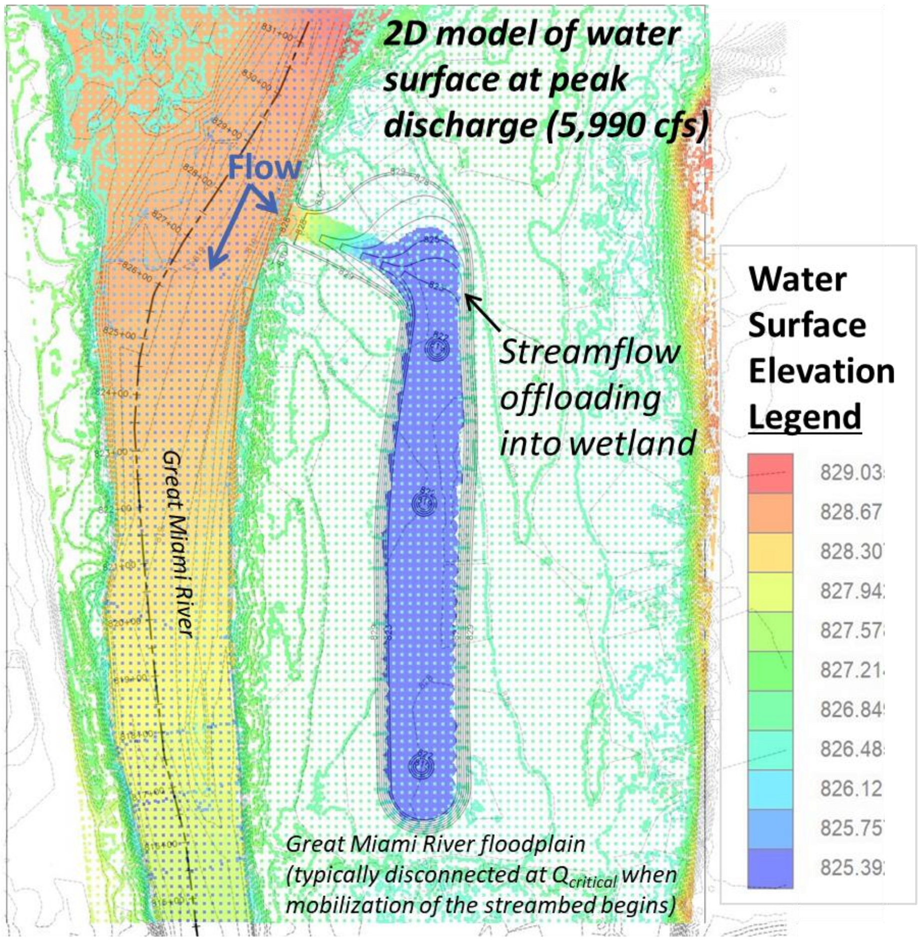
N. American Floodplains Can Have up to ~2-3 meters of Post-Settlement Alluvium

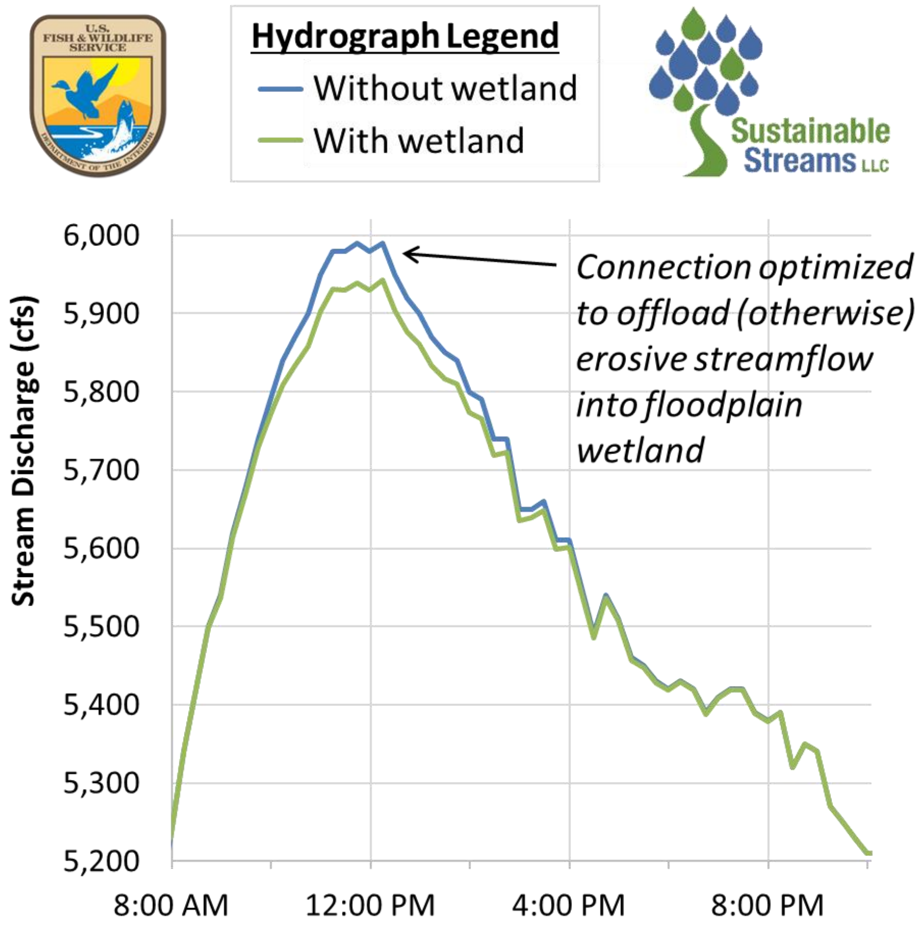


Conceptual graphic of post-settlement alluvium sequence adapted from Wohl and Merritts (2007), What is a natural river?

How Can We Restore Floodplains?

Optimize the Connection to Offload Erosive Streamflow into the Floodplain Wetland



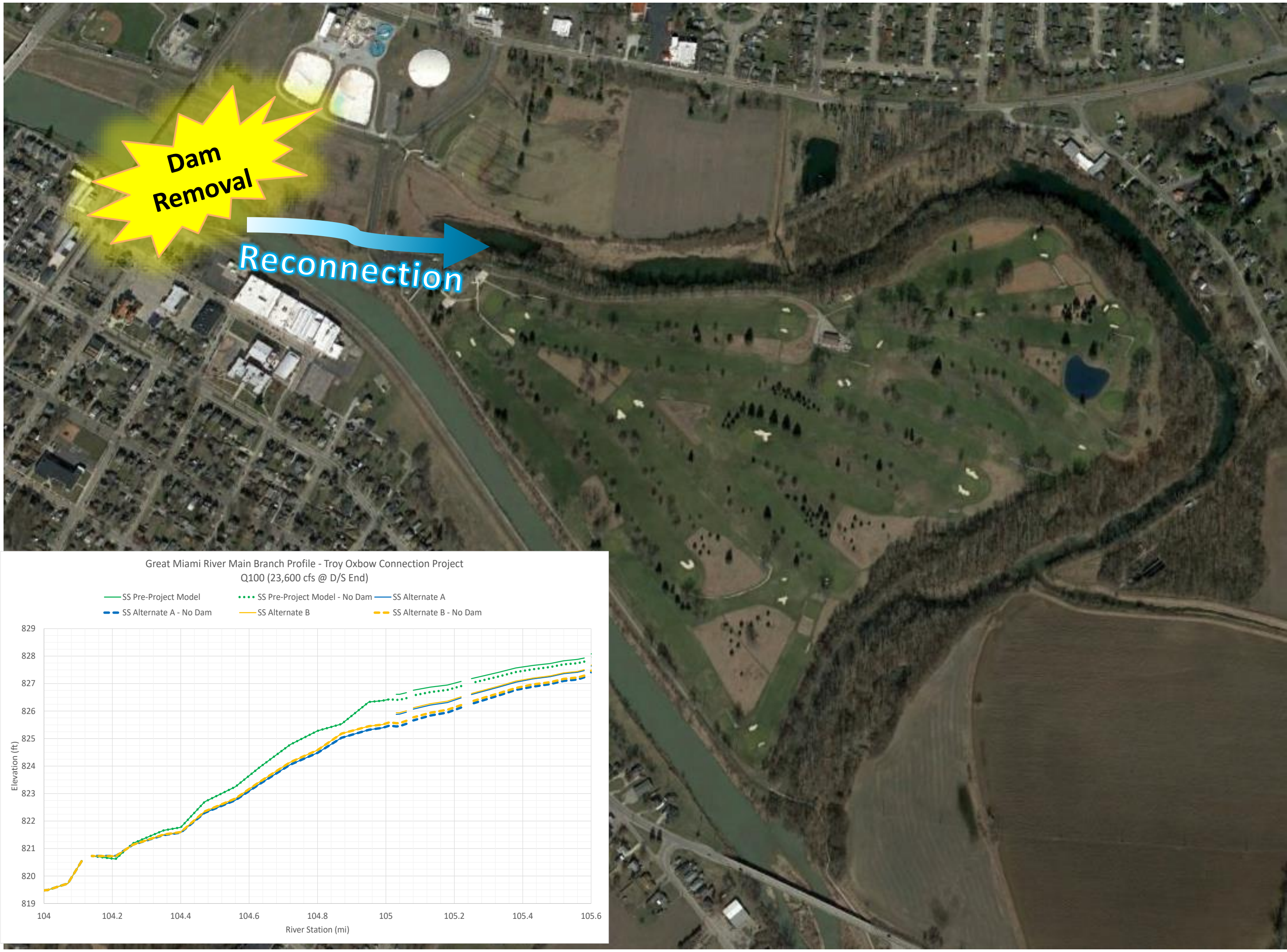


Offloading Erosive Flows

- Hydraulically connected to streams/rivers during otherwise erosive flow events.
- Restore a more natural disturbance regime.

Potential Decreases in Flood Stage

- **Miami Shores** (Troy): preliminary water surface reductions in Great Miami River at Q100
- **Oxbow Reconnection:** ~<u>18-20 cm</u> drop
- **Oxbow Reconnection with Dam Removal:** ~<u>23-25 cm</u> drop



Potential Water Quality Benefits

- Inundated during moderate & high flows, which can carry high sediment and nutrient loads

- Induce sediment deposition → remove TSS and adsorbed nutrients

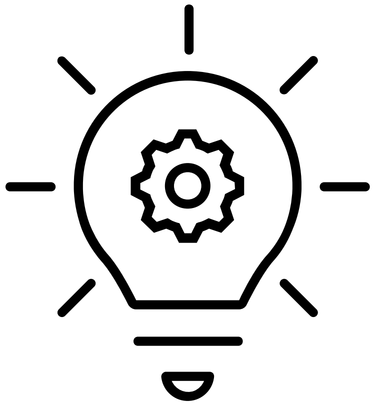
Projected annual removal ranges at Troy Wetland (26,000 m^3):

- ~100 to 600 metric tons of TSS
- ~2 to 10 metric tons of Nitrogen
- ~0.5 to 3 metric tons of Phosphorus

Site-level pollutant reduction estimates do not account for network-scale reductions associated with decreased stream erosion

Design Insights

Restoring Floodplain Wetlands

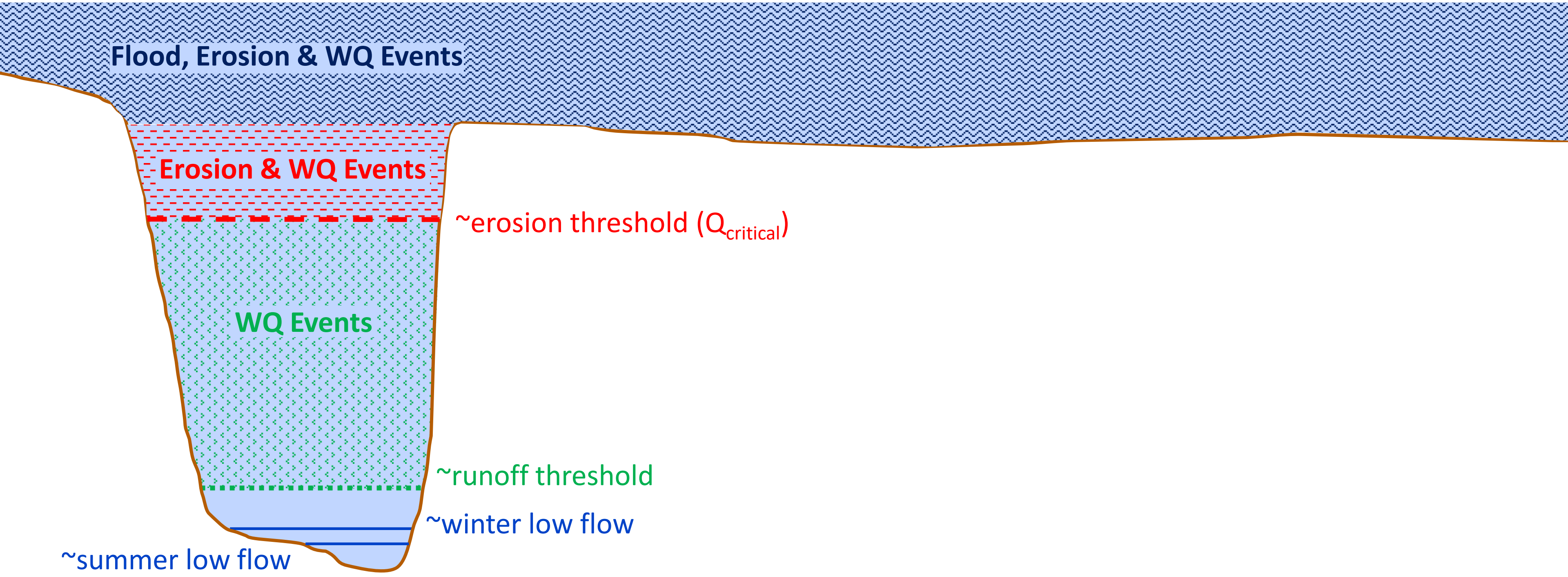


- ✓ Reduce Flooding
- ✓ Reduce Erosion
- ✓ Improve Water Quality
- ✓ Restore Habitat
- ✓ Promote Natural Flow & Disturbance Regimes
- ✓ Contribute to Ecosystem Resilience

Designs Can Be Optimized for Stakeholder Goals

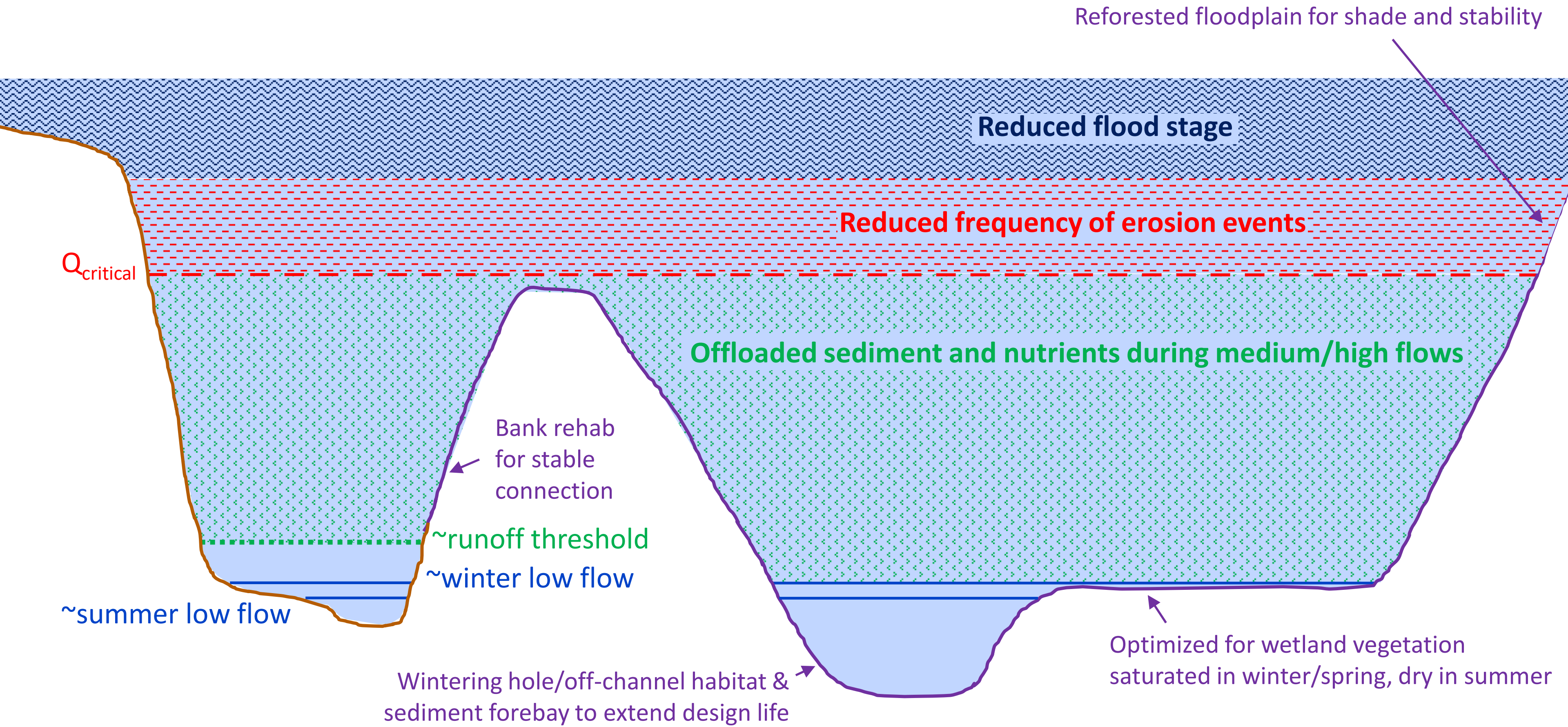
Existing Conditions

Entrenched, unstable channel with limited floodplain access and no off-channel habitat

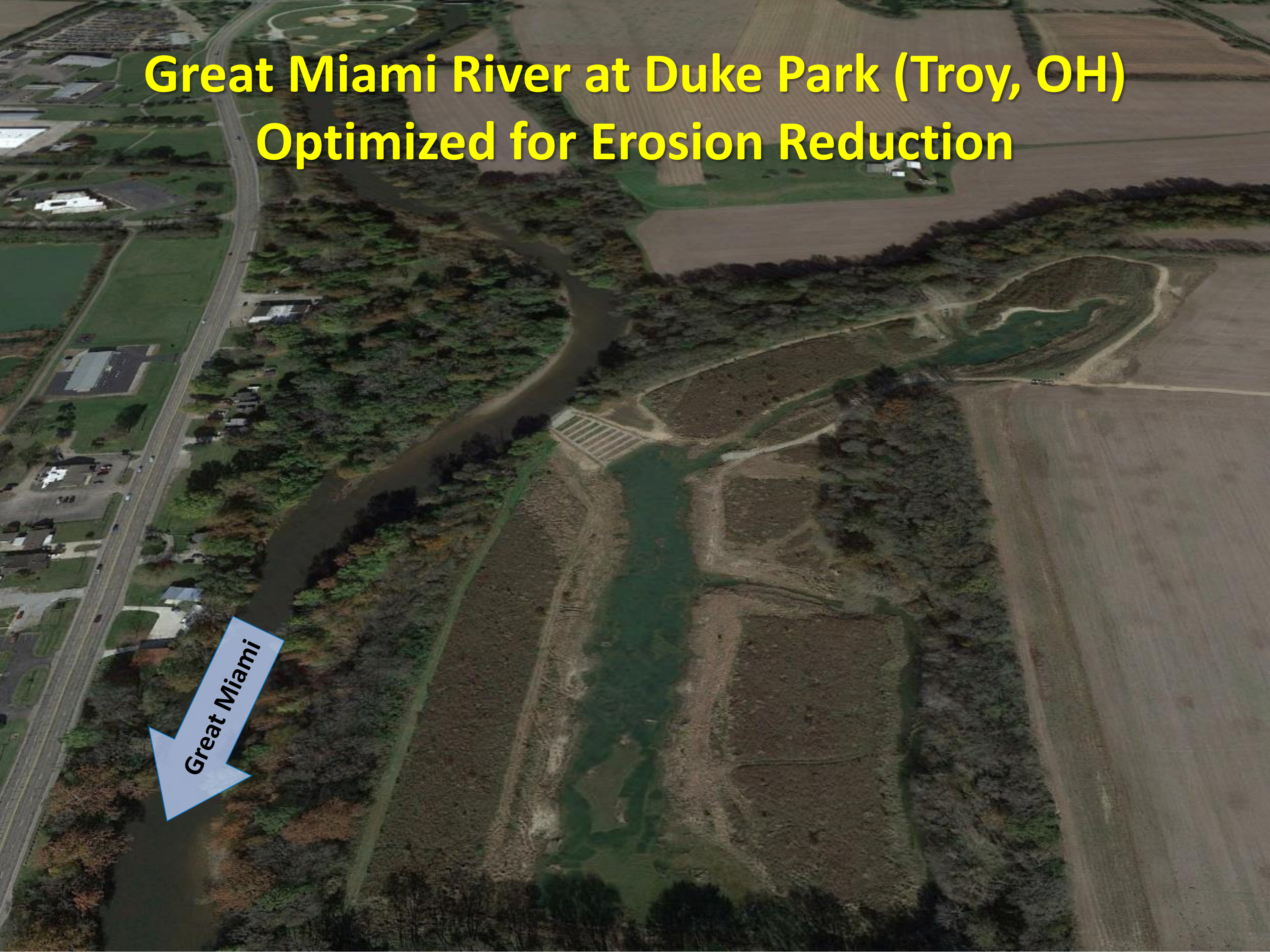


Optimized for Erosion Reduction

Offload flows that would otherwise contribute to stream erosion

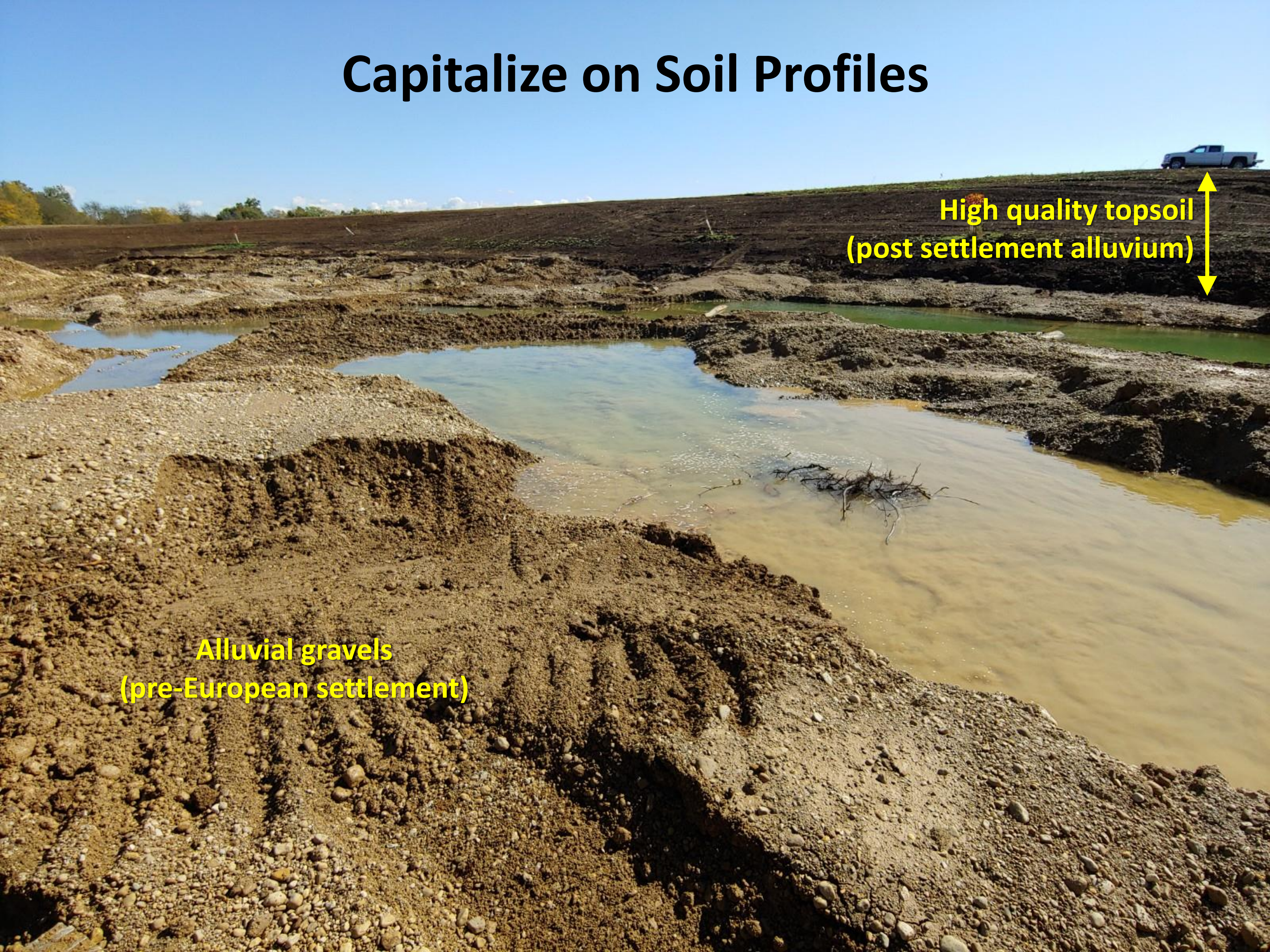


Great Miami River at Duke Park (Troy, OH) Optimized for Erosion Reduction



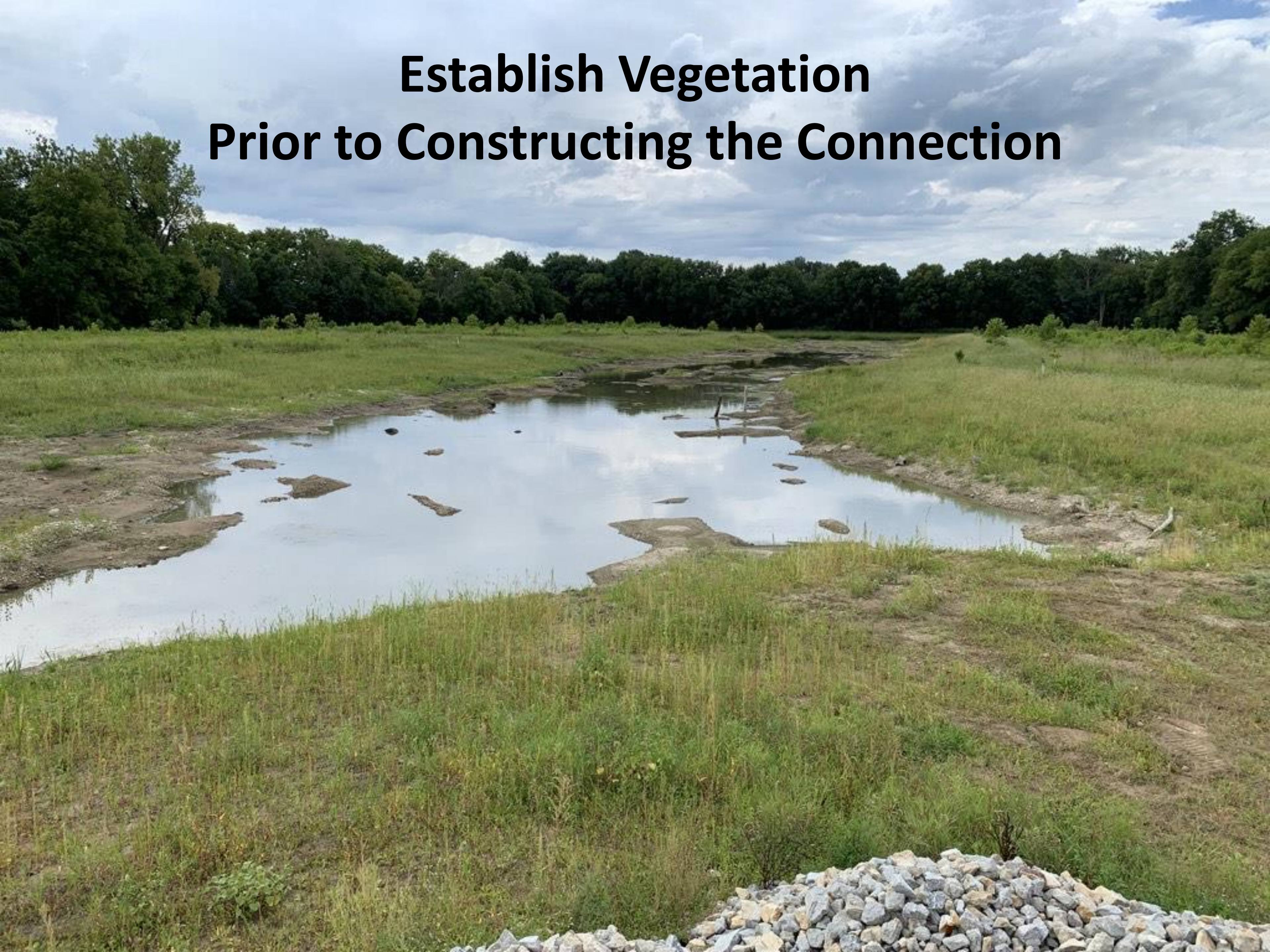
Excavate and Construct Habitat Element Elements Prior to Constructing River Connection

Capitalize on Soil Profiles



Reuse Logs and Gravels as Habitat Elements

Establish Vegetation
Prior to Constructing the Connection

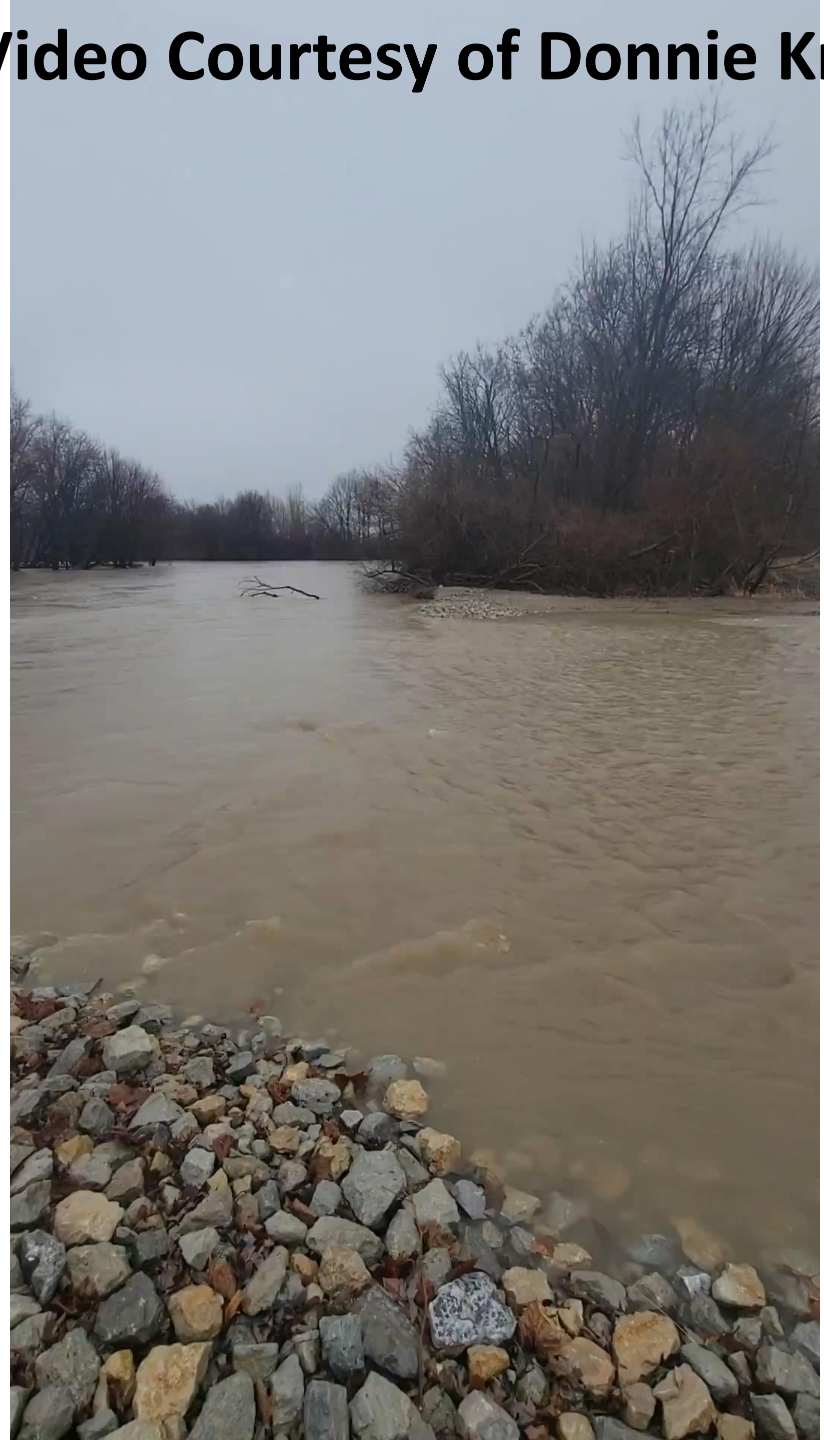


Connection Armoring

River Energy Deflection via “Tree Vanes”

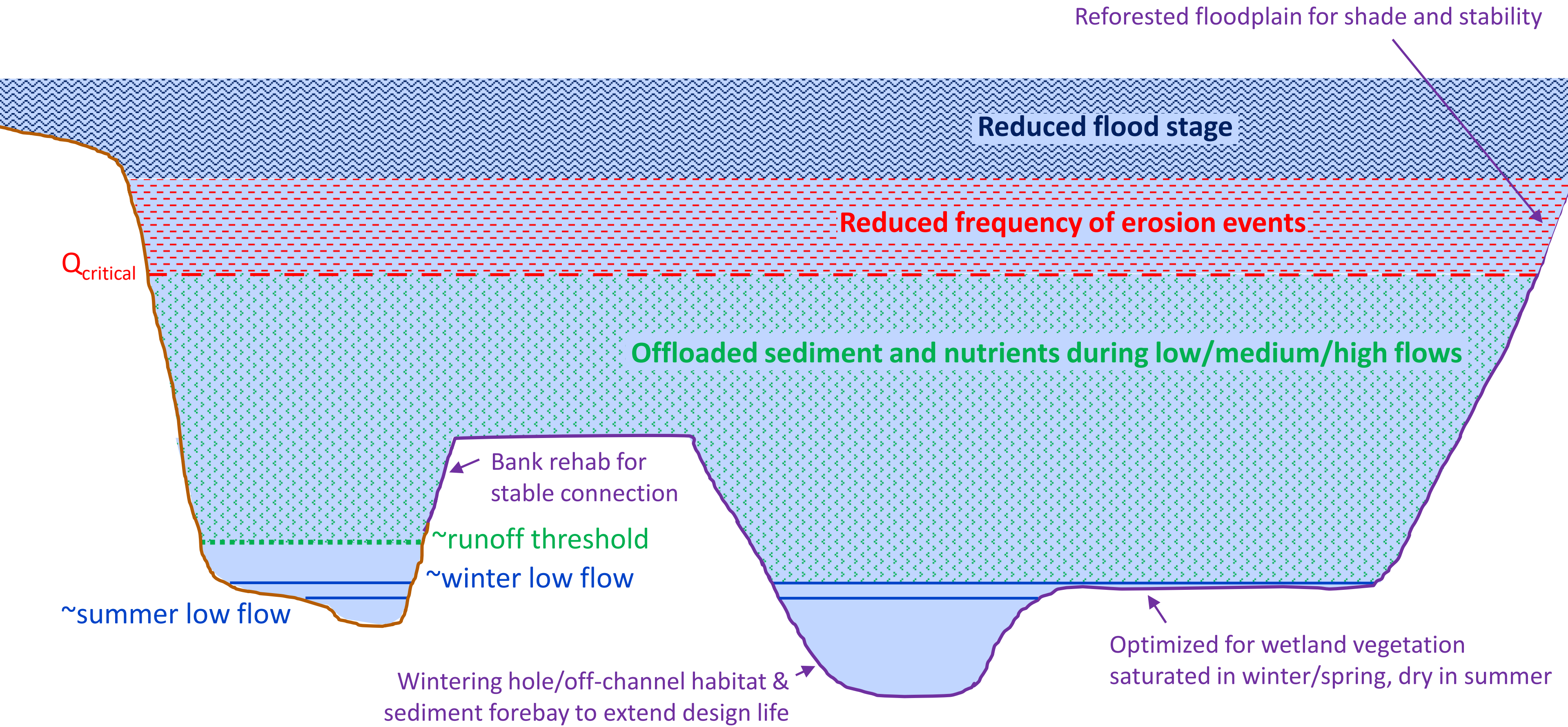
Offloading Erosive Flows

Offloading Video Courtesy of Donnie Knight (USFWS)



Optimized for Water Quality

Offload as many runoff-producing events as feasible



East Fork Little Miami River at Williamsburg, OH Optimized for Water Quality

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Optimized for Water Quality

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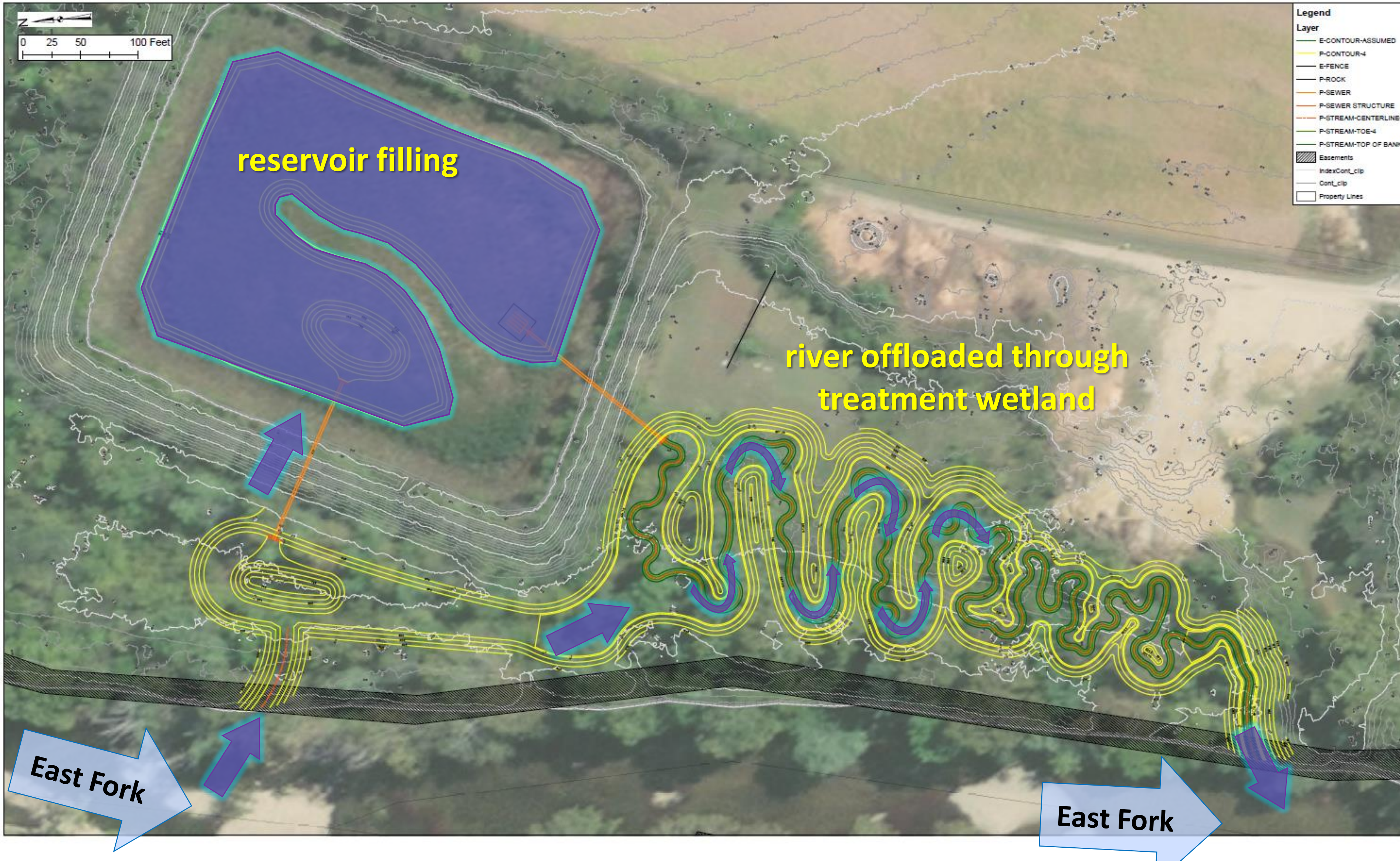
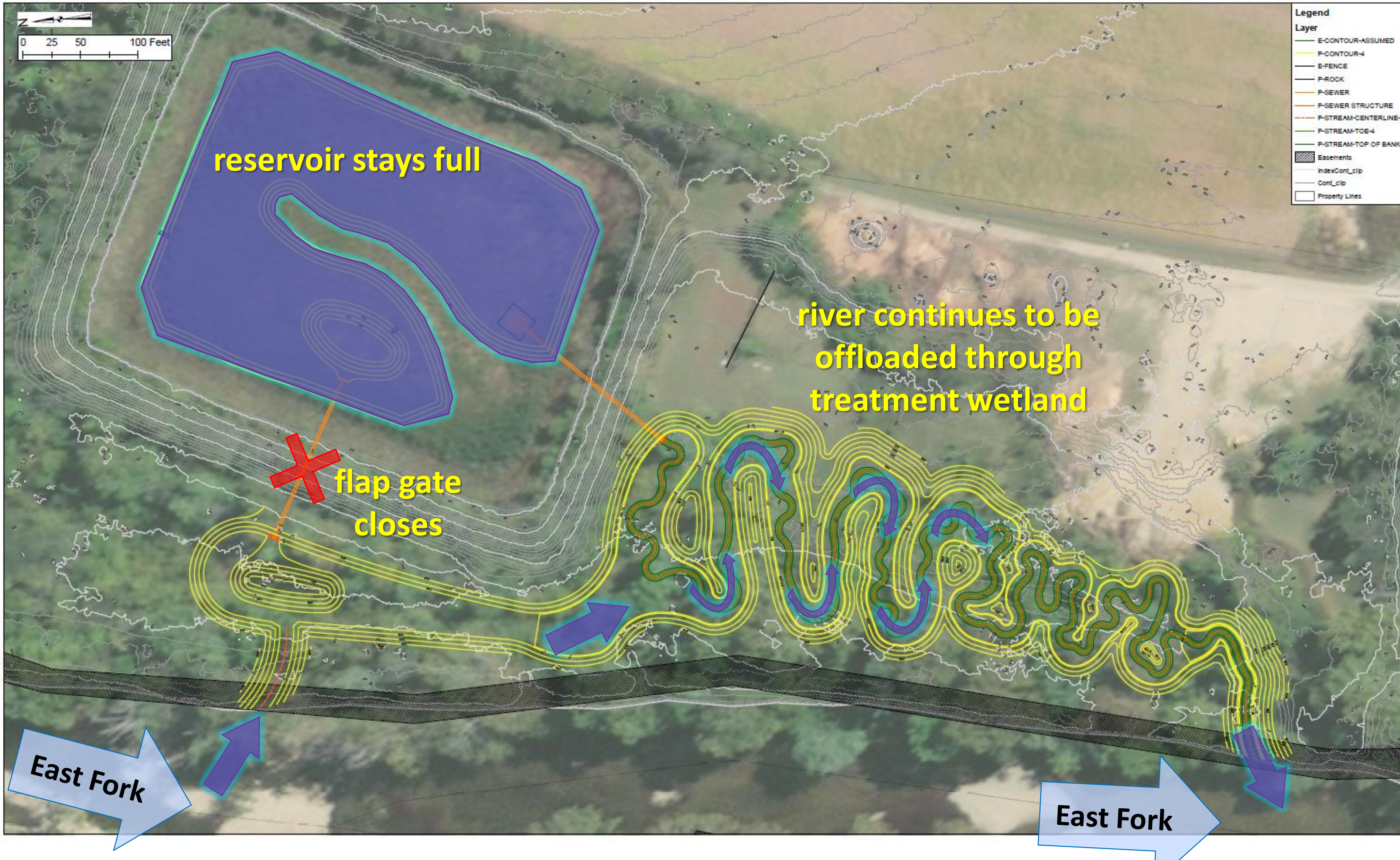
Rising Limb



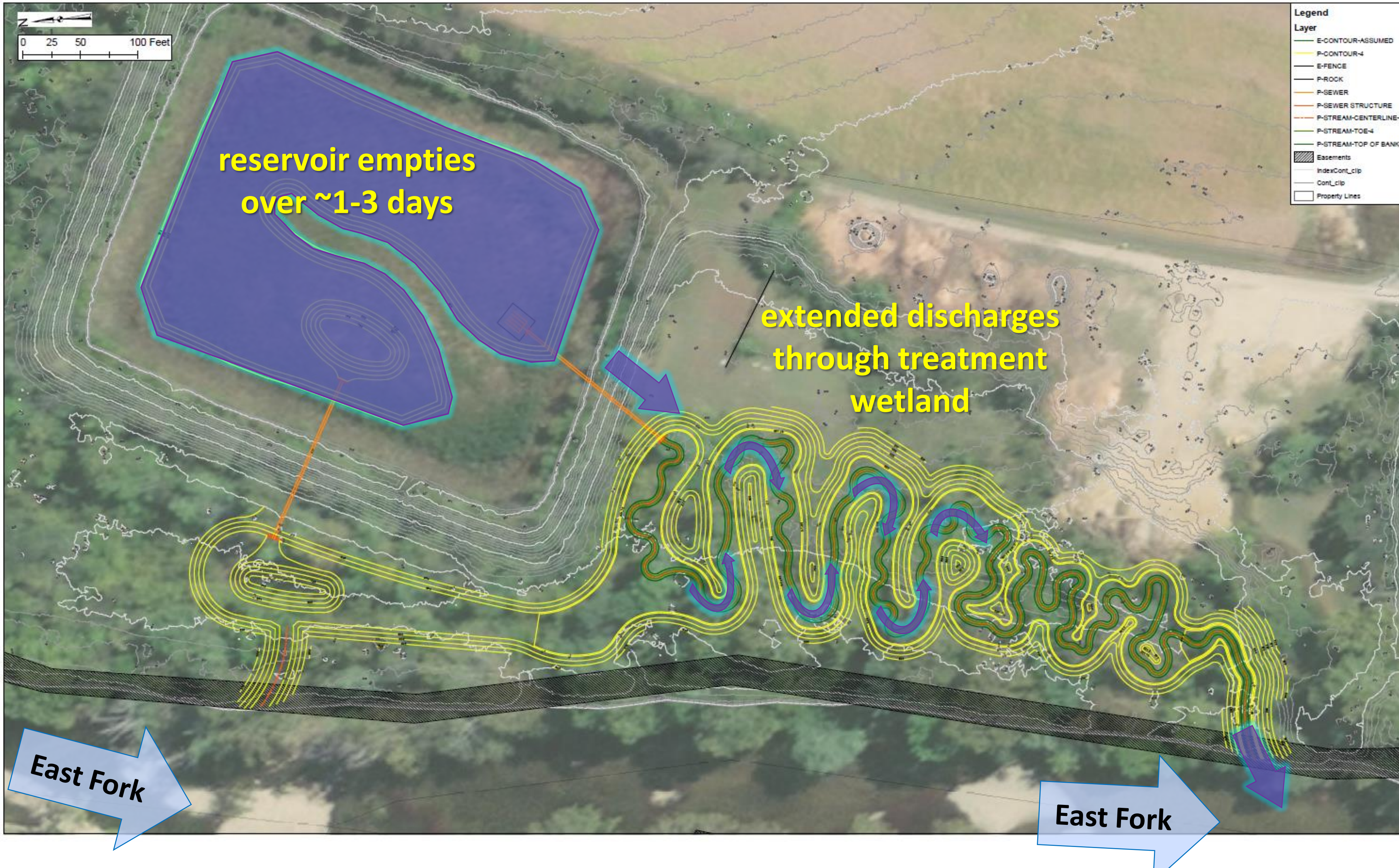
East Fork Little Miami River at Williamsburg, OH

Falling Limb



East Fork Little Miami River at Williamsburg, OH

Post-event



Inlet

Reservoir


Treatment Wetland


Outlet

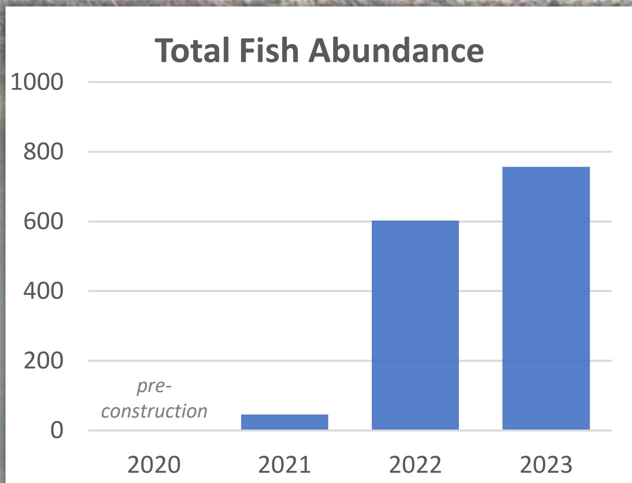

Reservoir

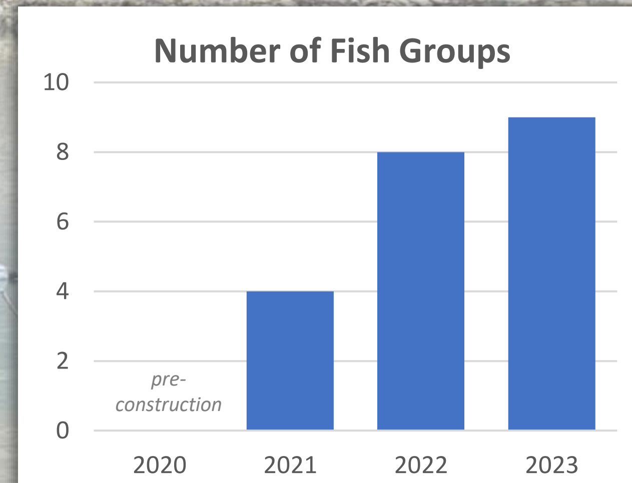

Wetland Channel

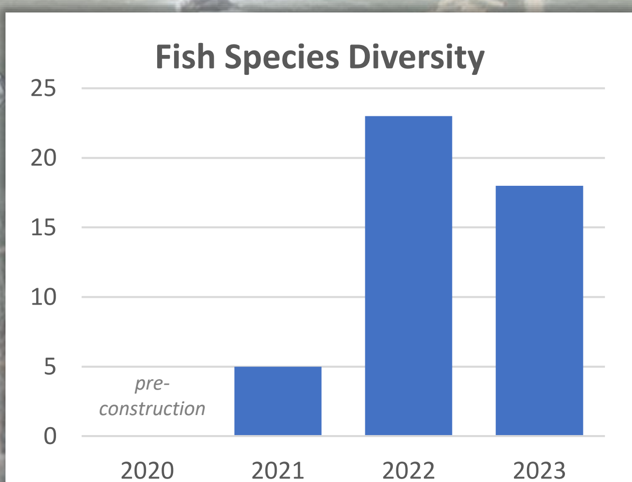

Wetland Channel
1 of 4 large (12+ inch) carp observed in the Williamsburg Wetland channel on 4/28/23

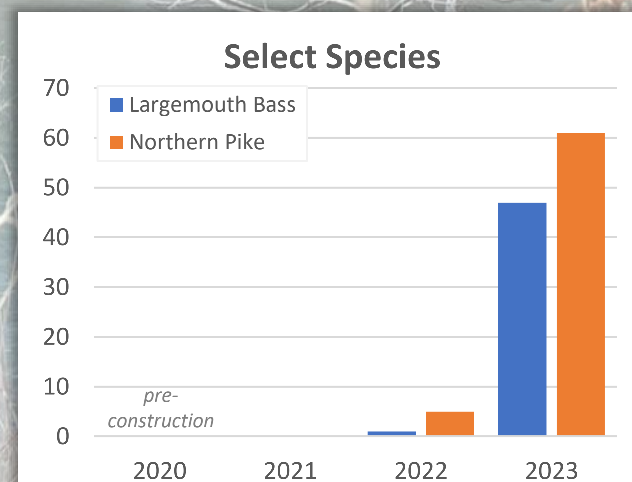
Riffle at Wetland Connection

How Do the Fish Like Restored Floodplain Wetlands?
Troy – Constructed in Summer/Fall 2020









Conclusions

- **Benefits**
  - Cost-effective network-scale benefits/large rivers
  - Habitat, WQ, erosion reduction, natural flow regime, flood reduction, Threatened & Endangered species benefits, ecosystem resilience
  - Sustainable source of topsoil
- **Design Insights**
  - Larger basins = more offloading potential
  - Pick sites with minimum extraneous costs
    - floodplains, limited tree clearing, nearby use for topsoil, etc.
  - Erosion Reduction – connect just below $Q_{critical}$
  - WQ improvement – connect as low as feasible
  - Smart construction phasing
    - Keep equipment dry, establish vegetation prior to river connection, etc.

Thank you!

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