OHIO UNIVERSITY

Flood mitigation planning in a heavily mined community

Dr. Natalie Kruse Daniels

FOREVER OHIO

OHIO UNIVERSITY

Site Introduction

Hydraulic Modeling

Mine Reclamation

Complementary Flood Mitigation

Summary

FOREVER OHIO

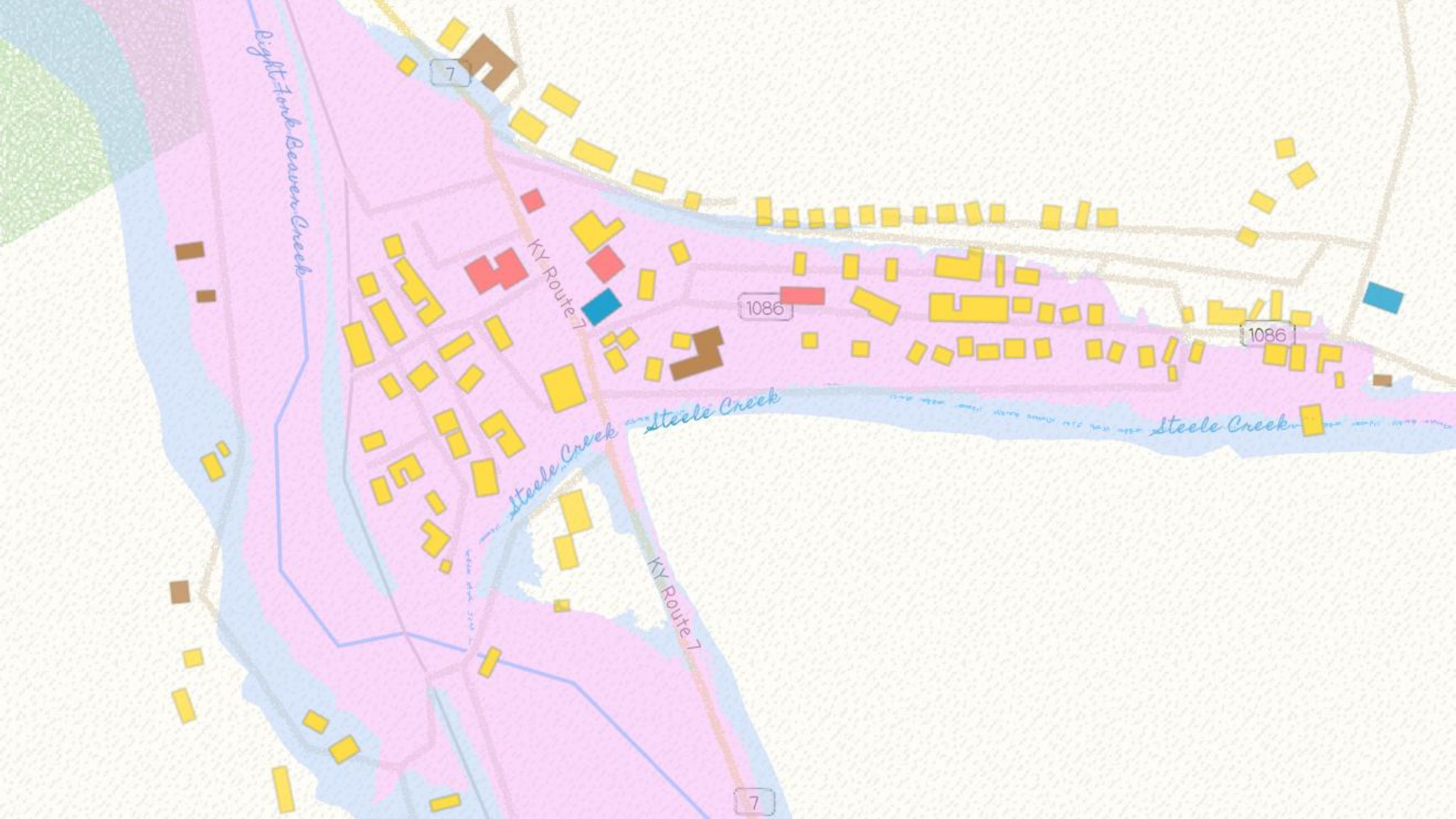
OHIO UNIVERSITY

Wayland, KY

- Mine Camp established by Elkhorn Coal Company
- Peak population of several thousand residents
- Currently ~350 residents

Kentucky Waterways Alliance

Protecting and Restoring Waterways Across the State


Right Fork Beaver Creek
7
KY Route 7
1086
1086
Steele Creek
Steele Creek
Steele Creek
KY Route 7
7

OHIO
UNIVERSITY


Unreclaimed Mine
City of Wayland, KY
Levisa Fork
Location of sediment photo
Steele Creek
3 box culvert with sedimentation
Wayland
Steele Crk
KY Route 1086

OHIO UNIVERSITY

Mining History

- Elk Horn Coal Company bought the land in 1911, opened the mine 2 years later
- Wayland was a booming mine camp, now home ot about 350 people
- Mine was active for 4 decades
- Originally reclaimed as AML land
- Remined ~20 years ago – resulted in a bond forfeiture
- Land is owned by City of Wayland

OHIO
UNIVERSITY


MIKE'S
SALVAGE

OHIO UNIVERSITY

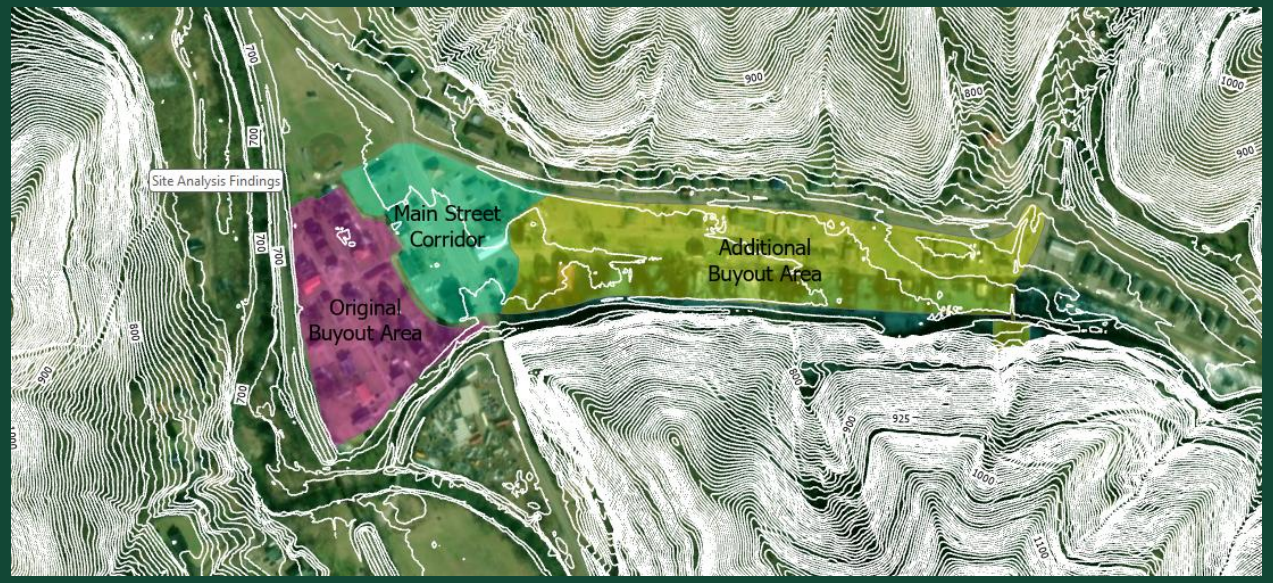
Flooding in Wayland Is Getting Worse

- Flood Events Are More Frequent
  - Five Major Floods Since 2021
- Flood Events Are More Severe
  - Three "100-Year" Floods in 2021
  - "1,000-Year" Flood in 2025
  - "50,000-Year" Flood in 2022
- Right Fork Beaver Creek, Steele Creek, and Mill Creek All Overflow
- Bridges and Culverts Overtop
- Major Sedimentation and Erosion

FOREVER OHIO

OHIO UNIVERSITY

Buyout Progress

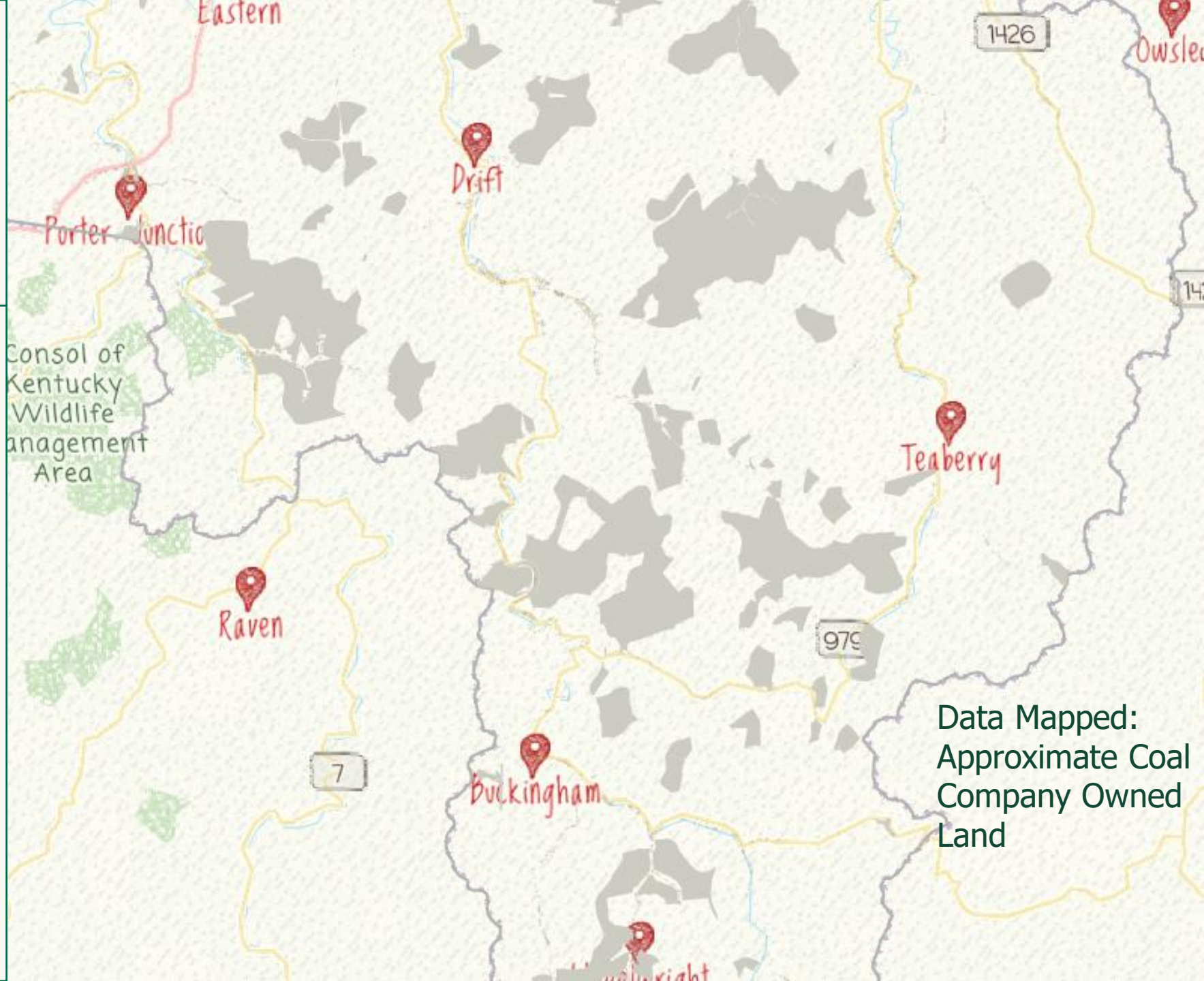


- Wayland Bottom (purple)
  - Lowest Elevation in Wayland
  - Flooding occurs from Right Fork Beaver Creek and Steele Creek overflow due to lack of floodplain storage
  - Fully bought out
- Additional Buyout Area (yellow)
  - Flooding caused by steep slopes to the north and south
  - Additional flows brought from stormwater runoff generated by unreclaimed surface mine
  - Some properties bought out
- Main Street Corridor (green)
  - Floods as water pools from surrounding flooded zones and intensified by culvert constraints

FOREVER OHIO

A Community-Centered Approach

- Participatory mapping
- Partnering with trusted local leaders
- Navigating buyout areas with care, opportunities
- Talk about climate change without saying climate change
- Deliver what you say you will deliver



OHIO UNIVERSITY

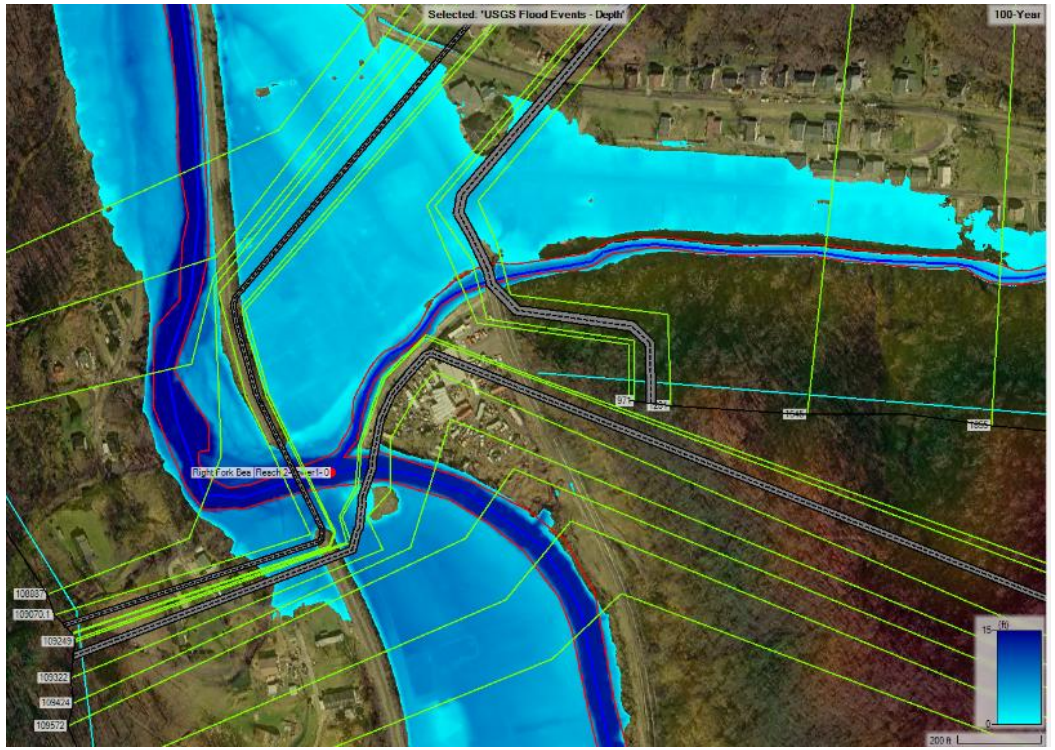
Hydraulic Modeling

FOREVER OHIO

OHIO UNIVERSITY

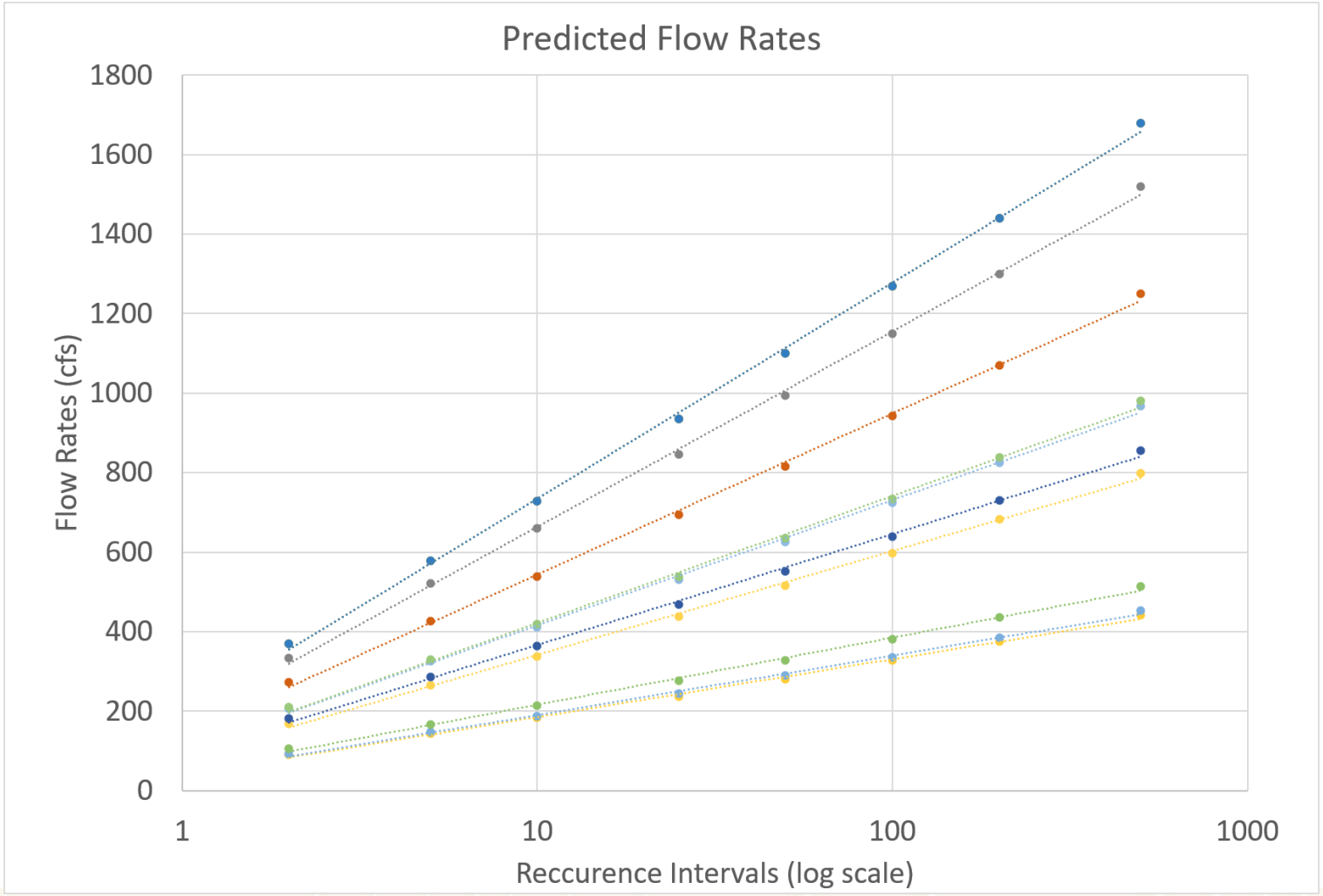
Initial HEC-RAS Mapping

- Developed new HEC-RAS model
- Generated Inundation Maps Using USGS Flow Data
  - Steady-State Analysis
  - 78 Cross Sections
  - 500-Year, 200-Year, 100-Year, 50-Year, 25-Year, 10-Year, 5-Year, and 2-Year Flood Events
- Similarities between HEC-RAS and FEMA Panels



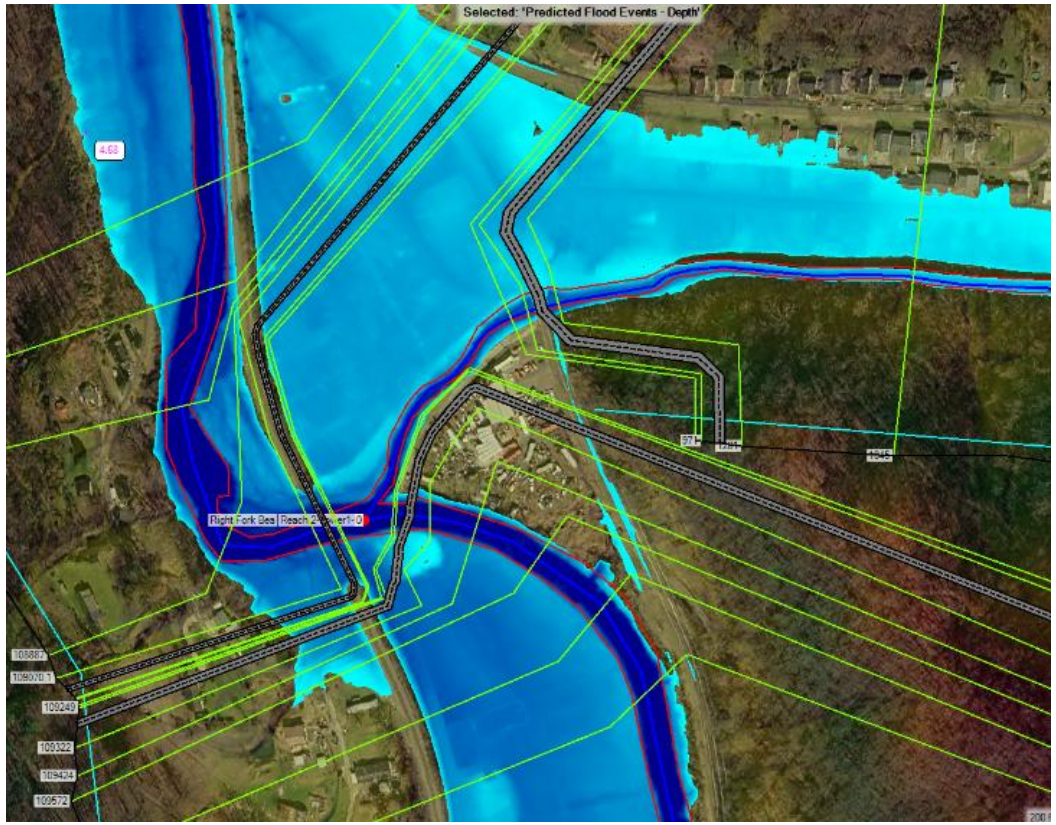
FOREVER OHIO

Predicting Larger Flow Events



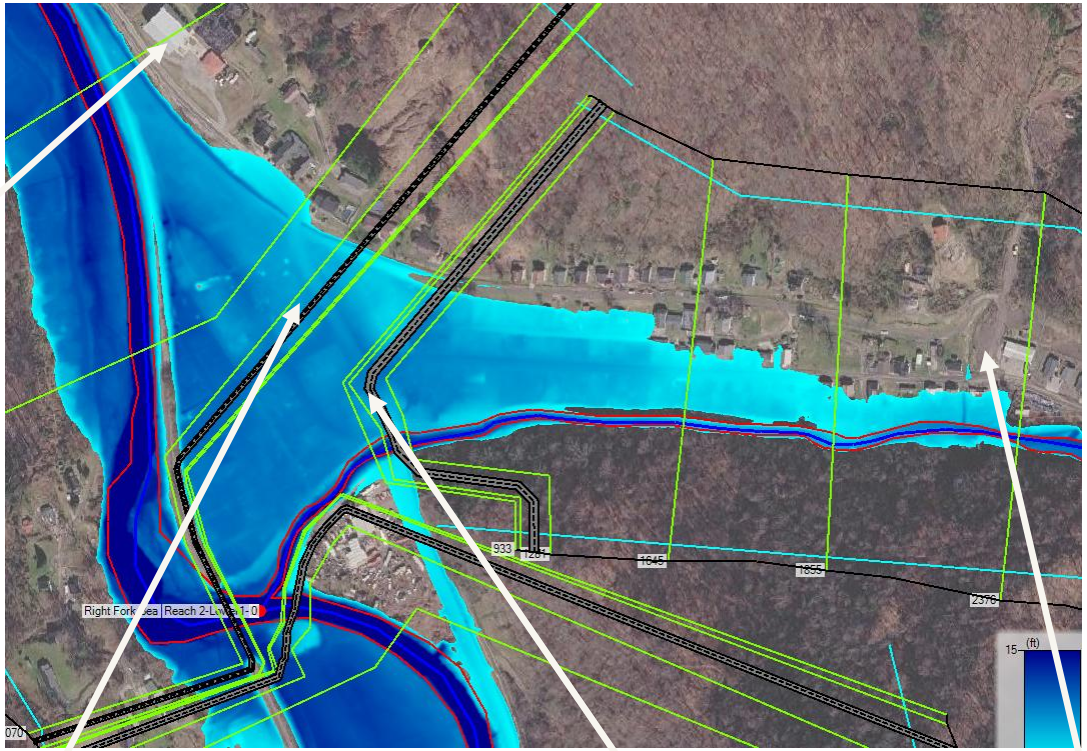
Larger Event HEC-RAS Mapping

- Generation Inundation Maps Using Predicted Flow Rates
  - Larger Recurrence Intervals
  - 1,000-Year, 2,500-Year, 5,000-Year, 10,000-Year, 25,000-Year, 50,000-Year, 100,000-Year, 500,000-Year, and 1,000,000-Year Flood Events
- Quantified Flood Events For Historic Wayland Floods
  - Estimated recurrence intervals based on high water marks in recent floods.



OHIO UNIVERSITY

- HEC-RAS Inundation Map For Historical Flood on July 28, 2022



- Photograph from Historical Flood on July 28, 2022

OHIO UNIVERSITY

HEC-RAS Findings

- Significant Flow Increase in Steele Creek Cross-Sections Downstream of Surface Mine
- Extremely high velocity in Right Fork Beaver Creek
- Limited Storage in Wayland Bottom
- Backwater Around Three Box Culvert

FOREVER OHIO

OHIO UNIVERSITY

Mine Reclamation Plans

FOREVER OHIO

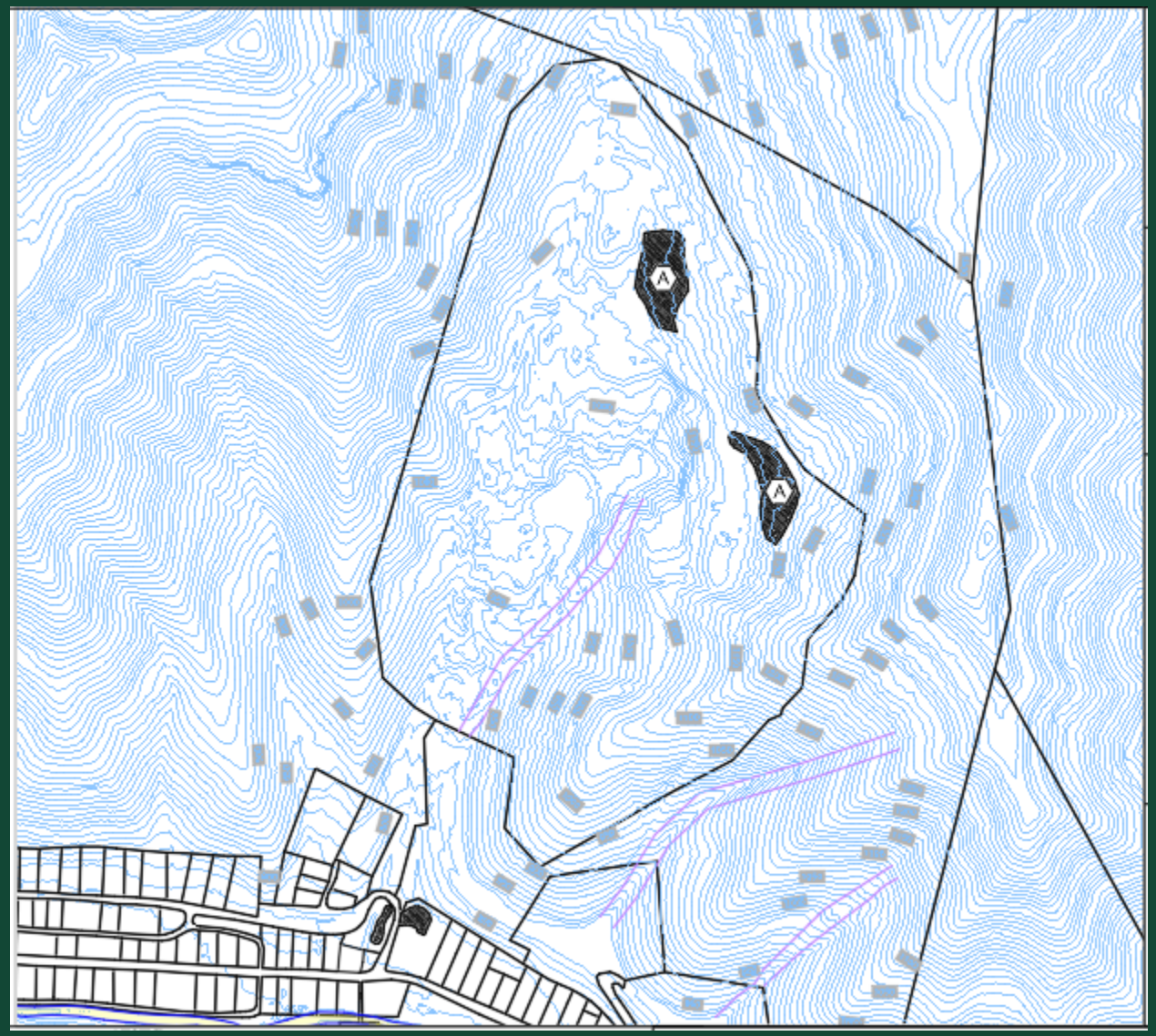
OHIO UNIVERSITY

Mine Reclamation Plan for Sediment and Flood Control

- Weathered soil stockpiles labeled with 'A'
  - Treatment Concept: lime and fertilizer
- Grading, resoiling, and revegetating
- Channels and sediment basins to control sediment

Challenge to Implementation:

Funding Limbo



FOREVER OHIO

OHIO UNIVERSITY

Mine Reclamation Plan for Sediment and Flood Control

- Weathered soil stockpiles labeled with 'A'
  - Treatment Concept: lime and fertilizer
- Grading, resoiling, and revegetating
- Channels and sediment basins to control sediment

Challenge to Implementation:

Funding Limbo

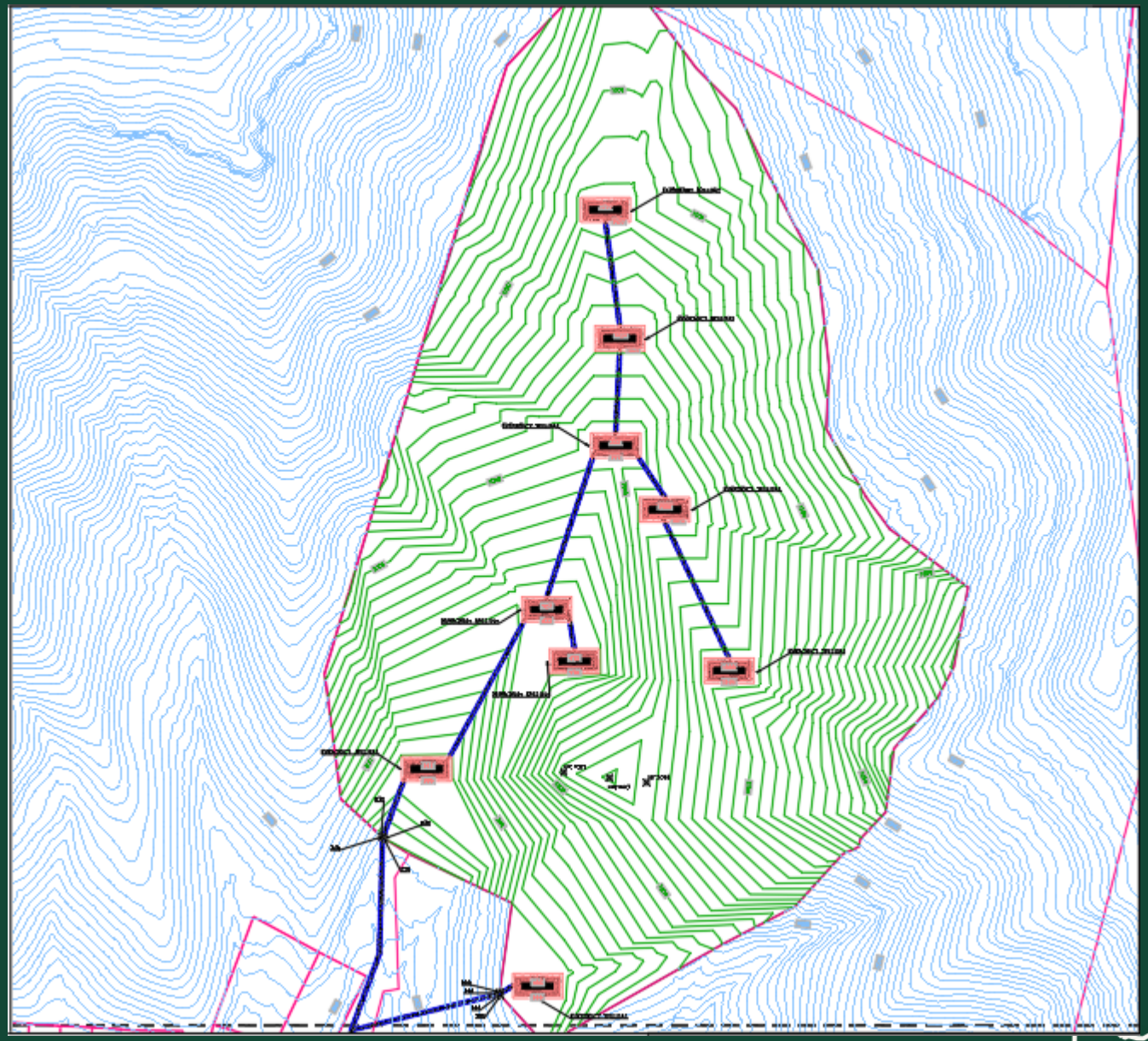
FOREVER OHIO

OHIO UNIVERSITY

Mine Reclamation: Sediment Retention

- Sediment Retention Goal:
  - Reducing the sedimentation in Steele Creek, especially at the 3-box culvert

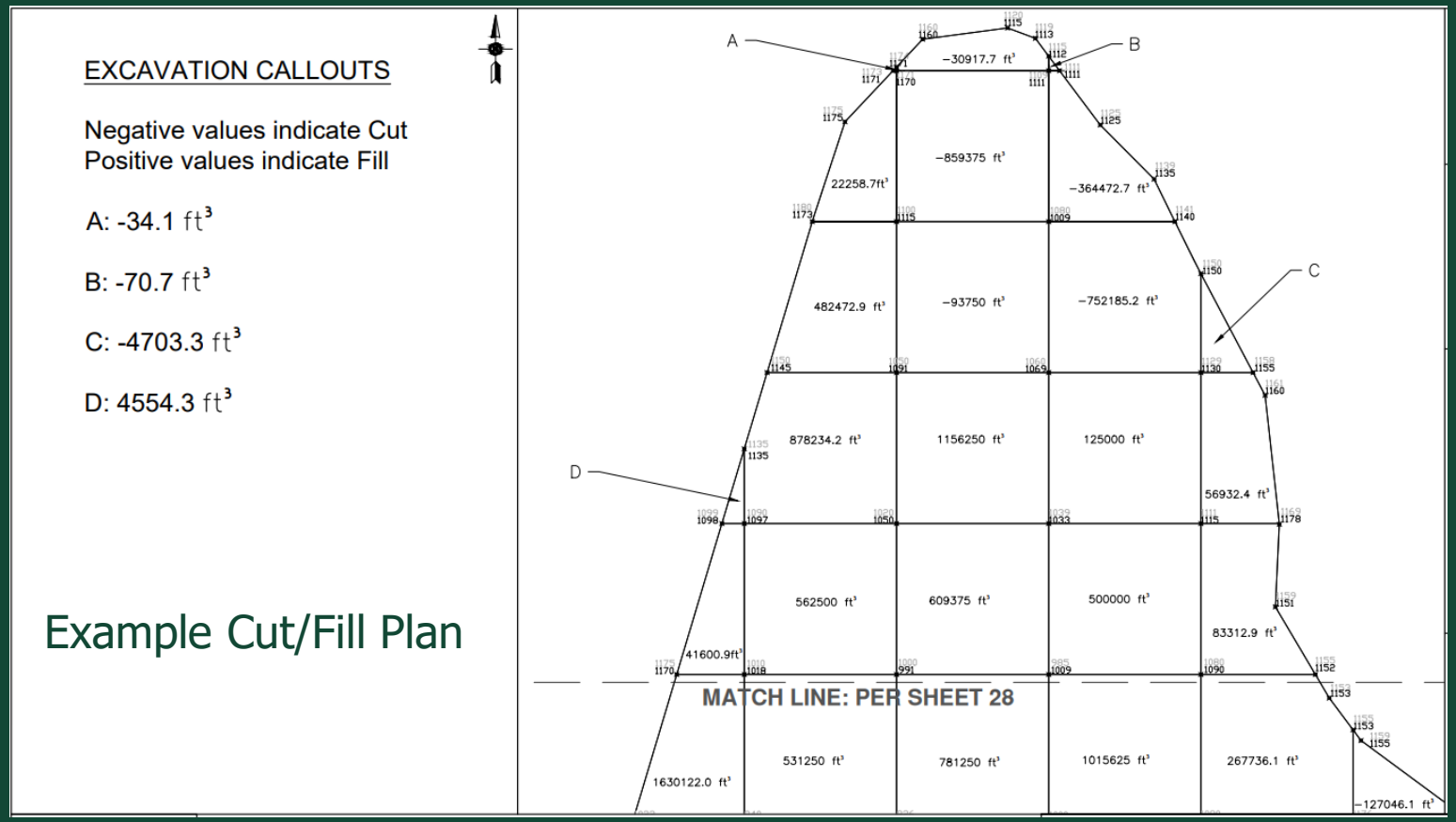
- Each sediment basin 5-acre drainage area
- Designed for dredging
- Rip rap channels to convey water



FOREVER OHIO

Mine Reclamation: Re-Grading

- Use local soils from retention basin excavation in Wayland Bottom
- ~240,000 cubic yards of additional fill required



Example Cut/Fill Plan

OHIO UNIVERSITY

Stormwater Reduction from Mine Site

- Rational Method
- Weighted Average For Runoff Coefficient
- Calculated For 100-Year and 1000-Year Event

Area Condition	Area (Ac)	Area (%)	C
100% Veg	22.47506887	49.22%	0.4
80% Veg	2.060858586	4.51%	0.55
60% Vegetated Area S	3.129499541	6.85%	0.65
Weathered Soil Stockpile	1.358149679	2.97%	0.8
Unreclaimed	16.63482553	36.43%	0.85
SUM	45.6584022	100.00%	0.599753706

~1000-year event

Existing Mine Conditions (Unreclaimed)				
C	I (in/hr)	A (acres)	=	Q (cfs)
0.59975A	6	45.66	=	164.3085
Proposed Mine Conditions (Reclaimed)				
C	I (in/hr)	A (acres)	=	Q (cfs)
0.524108	6	45.66	=	124.175
Peak Flow Reduction (Unreclaimed - Reclaimed)				
Qu	-	Qr	=	ΔQ
164.3085	-	124.175	=	40.13356
			Percent Reduction (%):	24.43%

FOREVER OHIO

OHIO UNIVERSITY

Complimentary Flood Mitigation Plans

FOREVER OHIO

OHIO UNIVERSITY

Stream Restoration

FOREVER OHIO

Level 1 Stream Classification

Cross Section	Entrenchment Ratio	W/D Ratio	Sinuosity	Slope	Stream Type	Interpretation
Mill Creek	3.38	6.98	1.197	0.0175	E	Stable. Well-connected to floodplain. Not a primary aggradation source.
Right Fork Beaver 3 (Upstream)	0.79	18.15	1.204	0.025	F	Entrenched. Floodplain disconnected before any tributary joins.
Right Fork Beaver 2 (Post-Mill)	0.81	15.23	1.157	0.0025	F	Remains entrenched after Mill Creek joins. Very low slope secondary deposition zone.
Steele Creek	0.87	22.94	1.143	0.0125	F	Highest W/D ratio. Wide shallow classic aggraded channel geometry.
Right Fork Beaver 1 (Post Mill & Steele)	0.76	11.24	1.36	0.015	G	Actively incising. Unstable. Primary problem reach at the community.

OHIO UNIVERSITY

Level 2 Stream Classification

Section	Median D50	Bed Type	Final Class
Right Fork Beaver 3	0.26 mm	Gravel	F4b
Right Fork Beaver 2	1.45 mm	Gravel	F4
Steele Creek	1.03 mm	Gravel	F4
Mill Creek	1.29 mm	Gravel	E4
Right Fork Beaver 1	0.03 mm	Gravel	G4c

KEY FINDING — PARTICLE SIZE DROP

1.45 mm

RFB 2 — upstream of Steele Creek

↓

0.03 mm

RFB 1 — Wayland confluence

This 48× drop in median particle size marks the Wayland confluence as the primary sediment deposition trap — where flow velocity drops sharply and the channel loses its ability to transport the incoming sediment load.

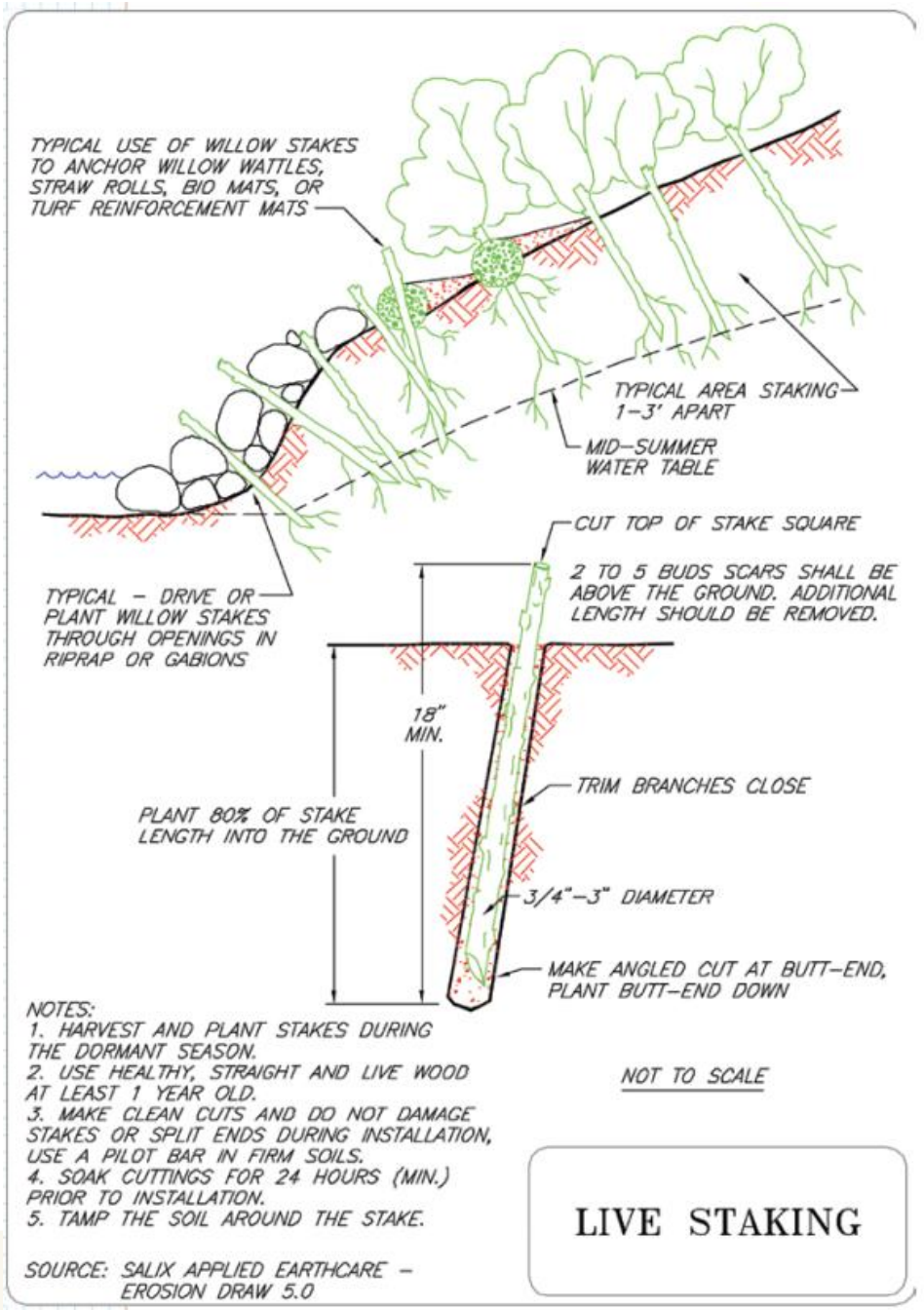
FOREVER OHIO

Stream Restoration

- Floodplain Reintegration
  - Buyout land lowered below floodplain stage directly upstream of the Beaver Creek Steele Creek confluence
  - Floodwaters naturally overflow onto the bench during high flow events.
  - Sediment overbank flow deposits on the floodplain surface rather than the streambed
  - Channel receives cleaner water with excess energy naturally degrades aggraded bed.

Stream Restoration

Example Cross section of Bank stabilization:



OHIO UNIVERSITY

Culvert Replacement

FOREVER OHIO

OHIO UNIVERSITY

Existing Culvert Conditions

- Three Box Culvert
  - 10' x 10' Barrels
  - 1’ Partition Walls In Between
- Commonly Filled With Sediment Which Intensifies Flooding
- Redesign Must Raise Structure Height Above Floodplain
- New Span Bridge to replace the existing culvert

FOREVER OHIO

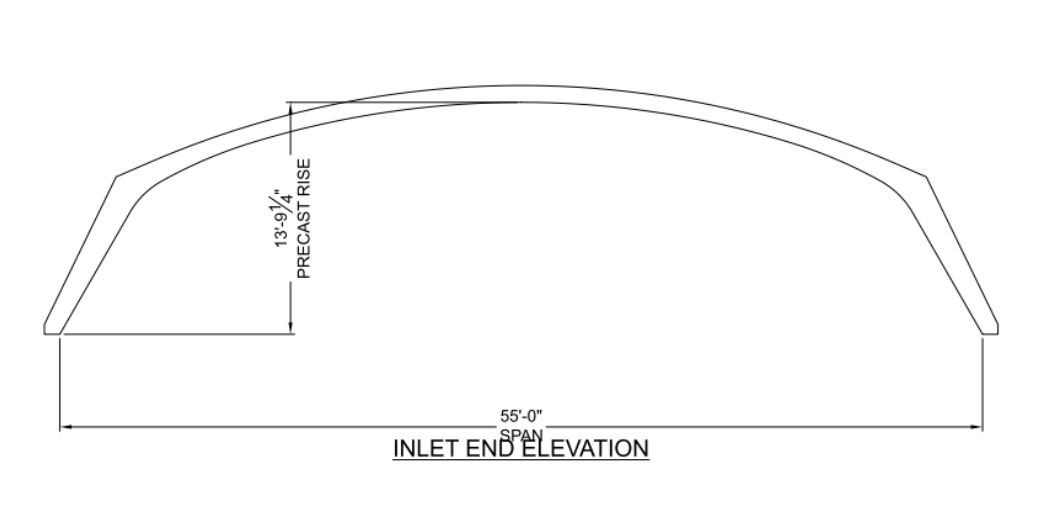
OHIO UNIVERSITY

Replacement CONTECH O-Series

- Span: 55'
- Precast Rise: 13' 9 ¼"
- Length: 24’
- Designed to meet local, state, and federal regulations

FOREVER OHIO

CONTECH O-900



- New bridge in full compliance with HY-8
- New roadway to sit above BFE of 714.3 ft
- New bridge to reduce sediment buildup alongside mine reclamation
- Elevated roadway to mitigate flow blockage during floods

OHIO UNIVERSITY

Additional O-Series Details

- Leg thickness of 11 in, total waterway area of 590 sq ft
- Reduce water being forced into Main Street from Steele Creek

FOREVER OHIO

OHIO UNIVERSITY

Detention Basins

FOREVER OHIO

OHIO UNIVERSITY

Detention Basins in Wayland Bottom

- Flooding mainly due to lack of storage in Right Fork Beaver & topography
- Existing homes to be demolished
- Site to be regraded and detention basins to be installed

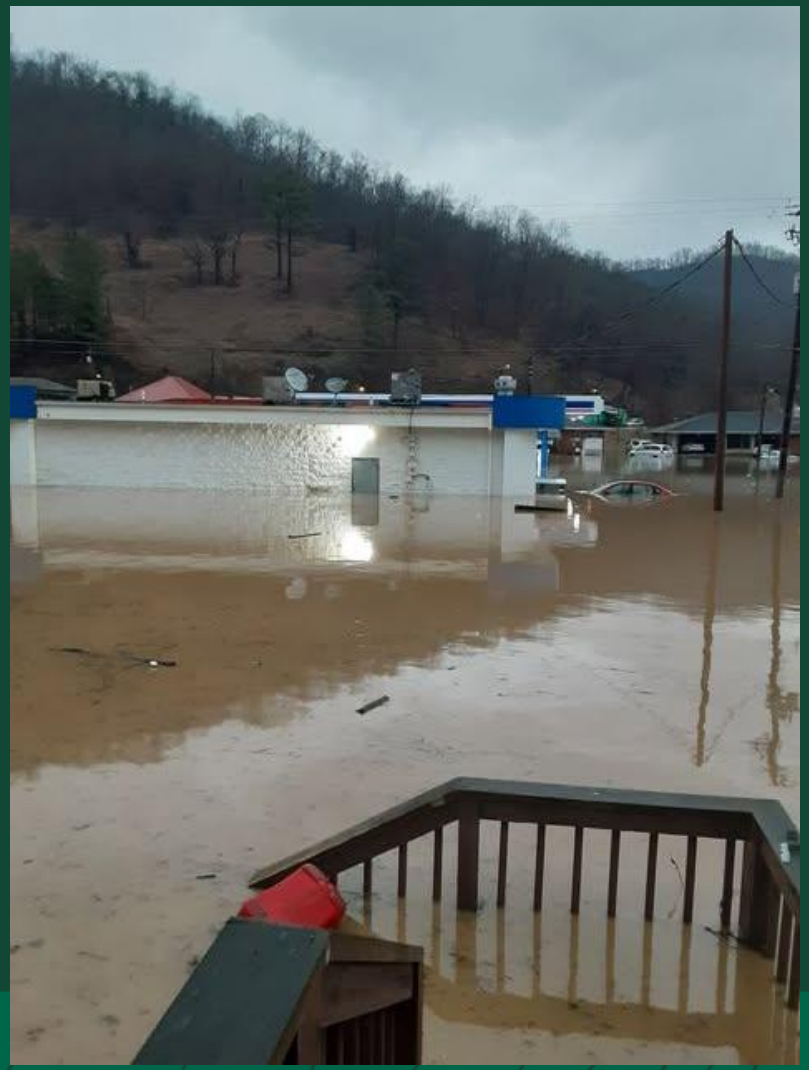
FOREVER OHIO

Goals of Detention Basins

- Act as emergency floodwater storage
- Cut used for mine reclamation
- Porous bottoms to avoid standing water
- Connected with development of recreational economic development in the county

OHIO UNIVERSITY

Summary



- Community and data driven flood mitigation planning
- Partnership with local, county, and state leadership
- Plans for:
  - Mine Reclamation
  - Stream Restoration
  - Culvert Replacement
  - Detention Basin
- Next Steps: Phased Implementation

FOREVER OHIO

OHIO UNIVERSITY

Thank you:

Floyd County Fiscal Court

Mayor Jerry Fultz

Ruthie Caldwell

Russ College of Engineering and Technology

Central Appalachian Network

Climate Smart Communities Initiative

FOREVER OHIO