



# INNOVATIVE TWO-DIMENSIONAL HYDRAULIC APPLICATIONS

## RELOCATING A CHANNEL AND REPLACING TWO STRUCTURES ALONG A WESTERN PA HIGHWAY CORRIDOR

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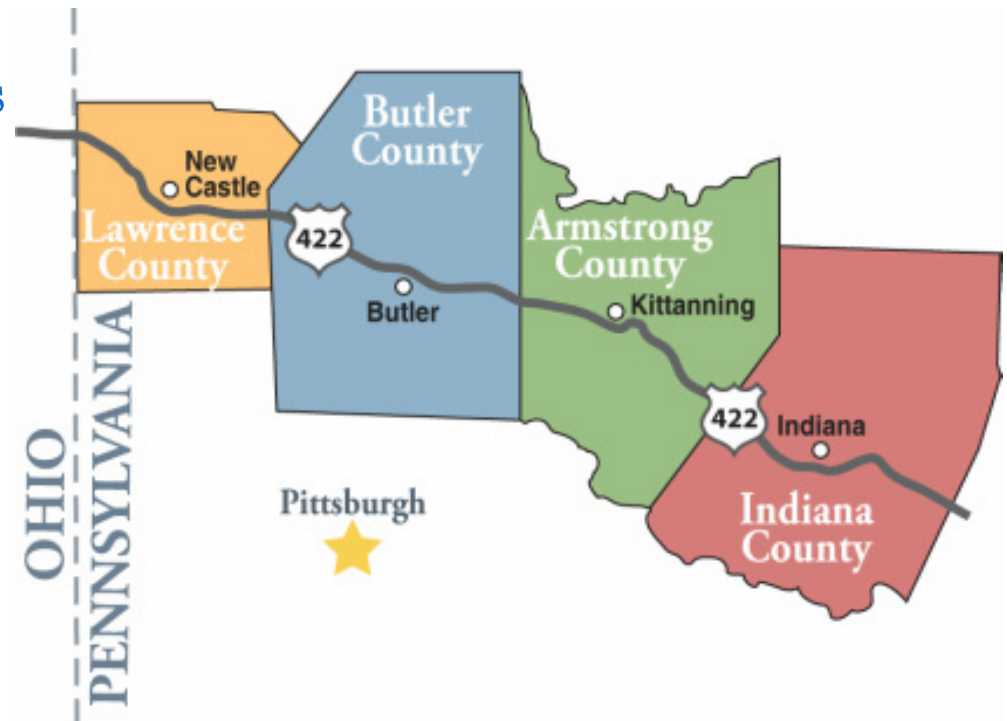
# SR 0422 BRIDGE REPLACEMENTS

- Project background
- Existing
  - Bridges
  - Floodplain characteristics
  - Embankment erosion
- Proposed
  - Culvert
  - Channel relocation
- 2D model
  - Input
  - Results
- Conclusions



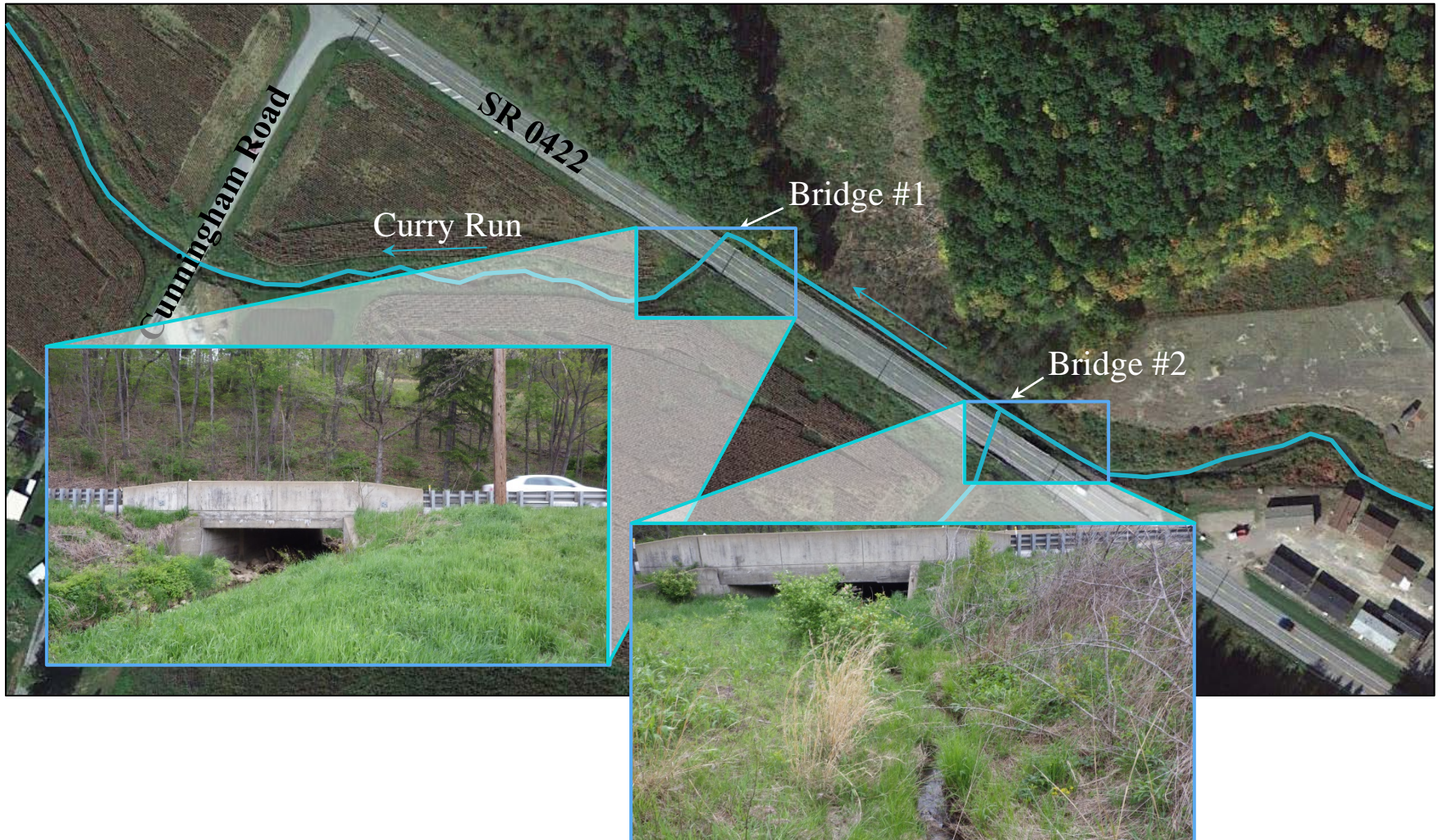
# PROJECT BACKGROUND

- Major PennDOT corridor in western PA
- Transportation improvements
  - Safety issues
  - Structural deficiencies
  - Flooding
  - Erosion control
  - Future maintenance



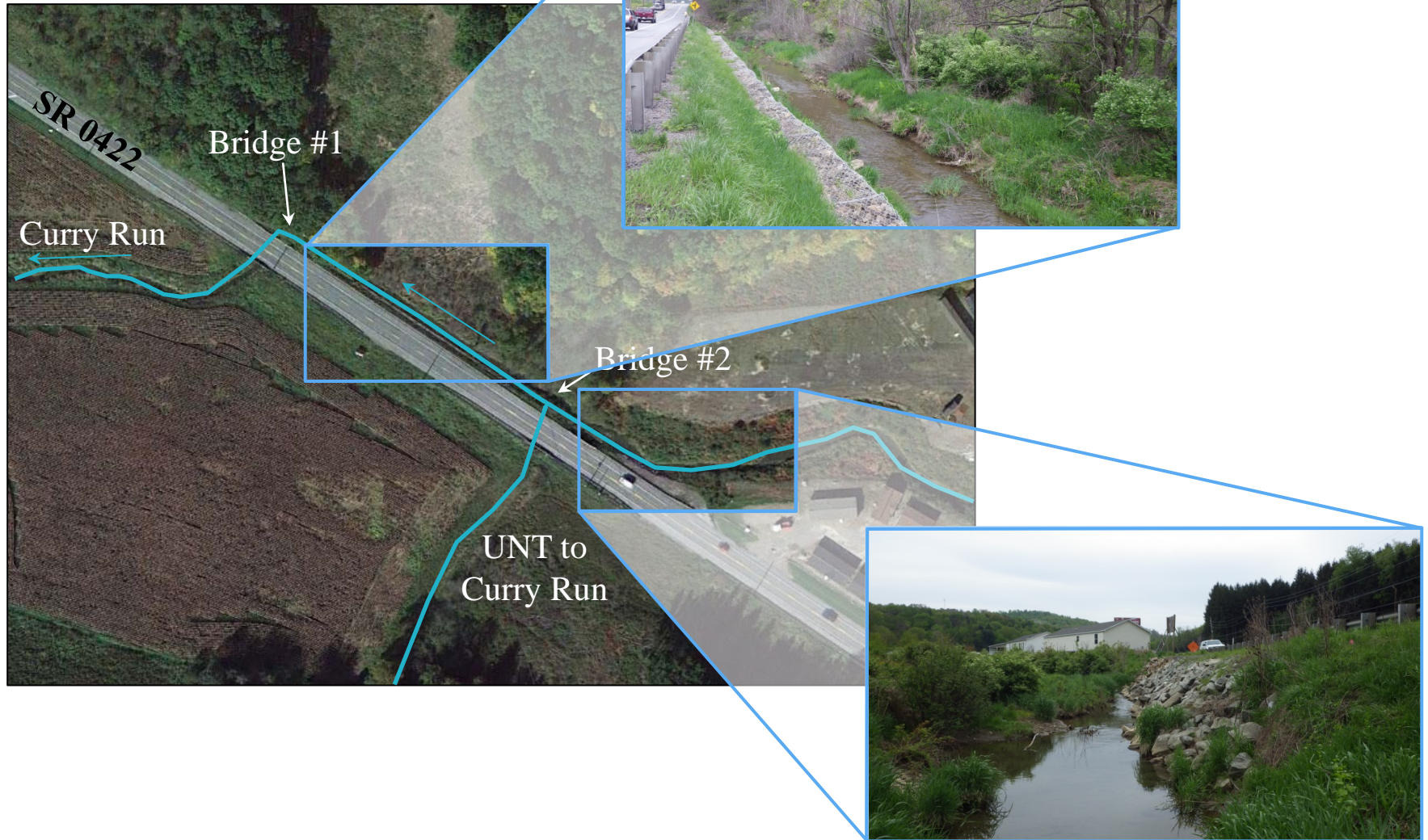


# EXISTING BRIDGES & FLOODPLAIN



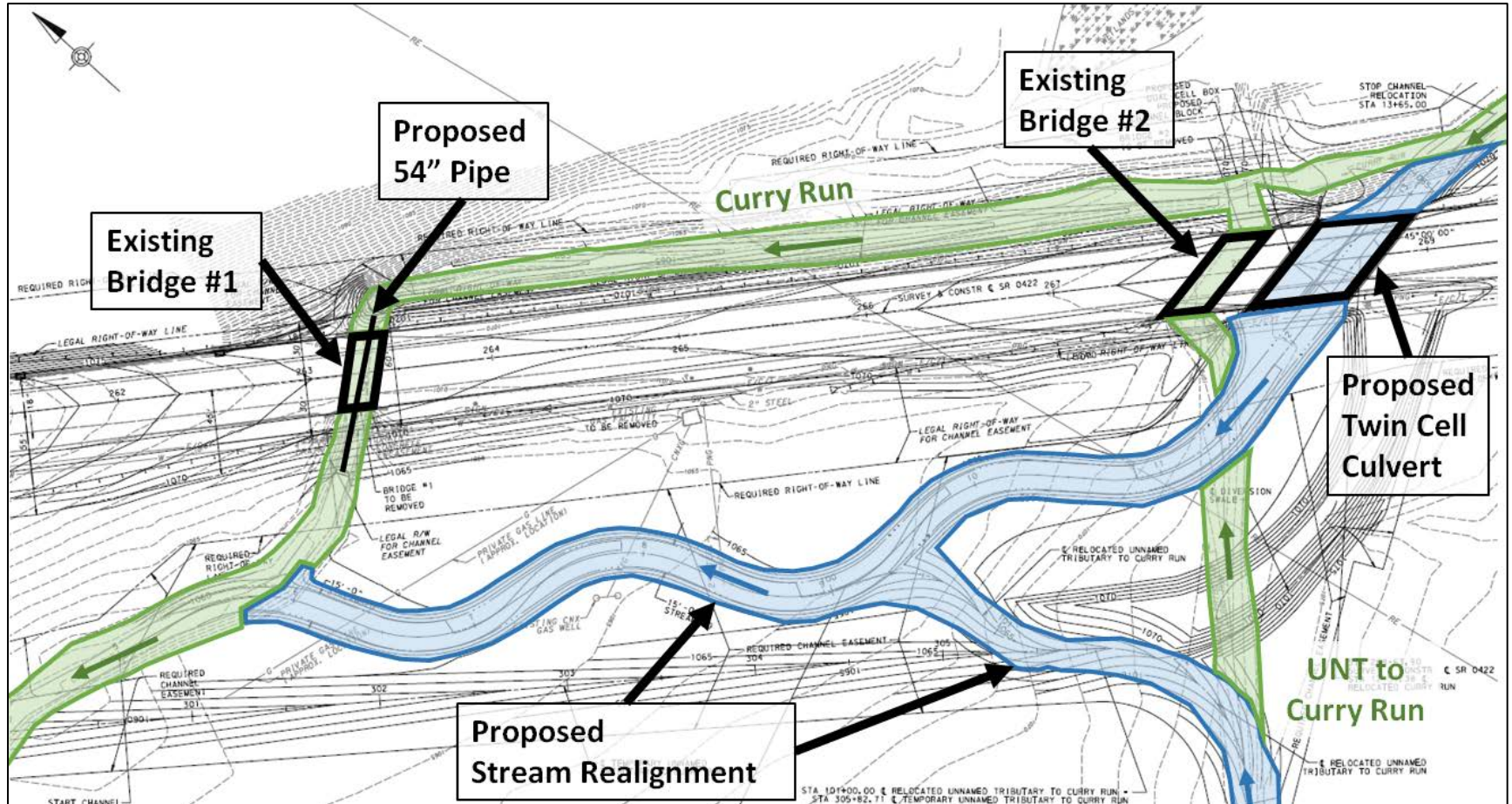


# EMBANKMENT EROSION

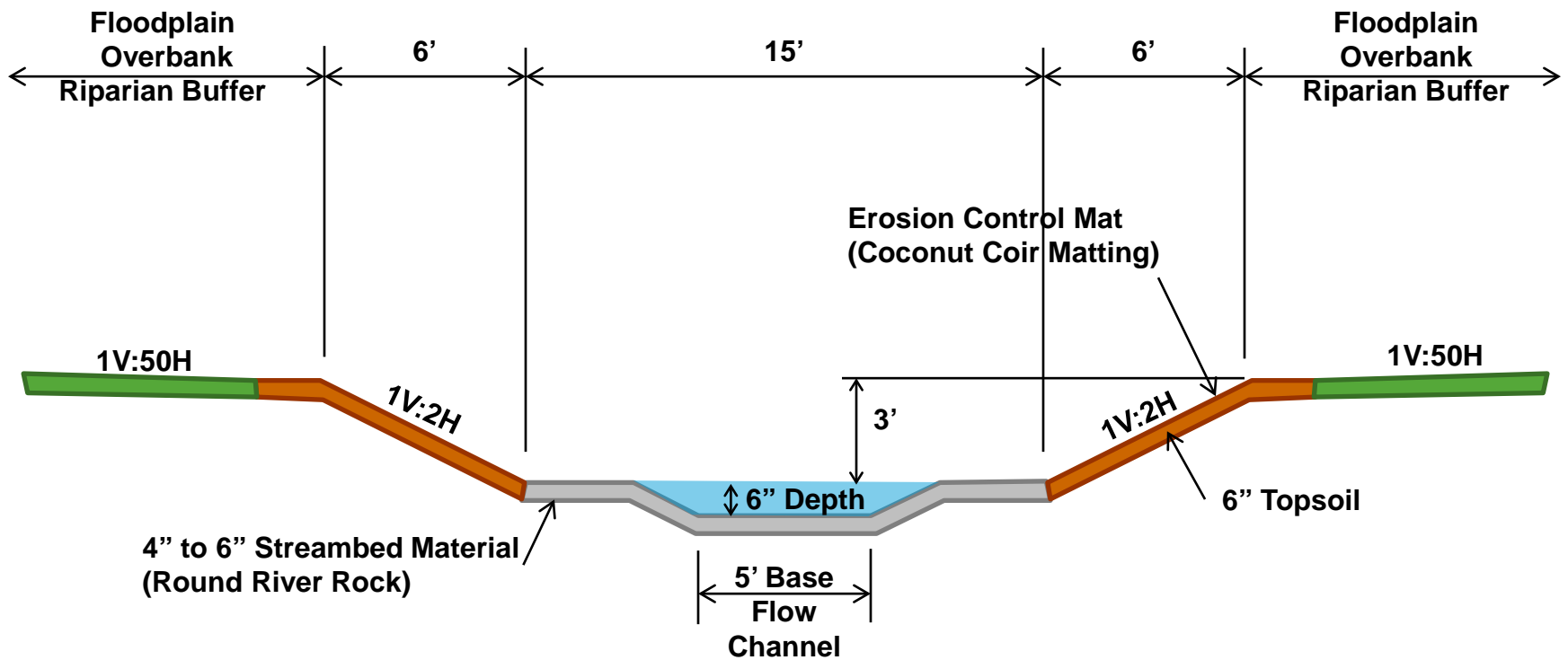




# PROPOSED CULVERT & CHANNEL RELOCATION



# PROPOSED CHANNEL TYPICAL SECTION



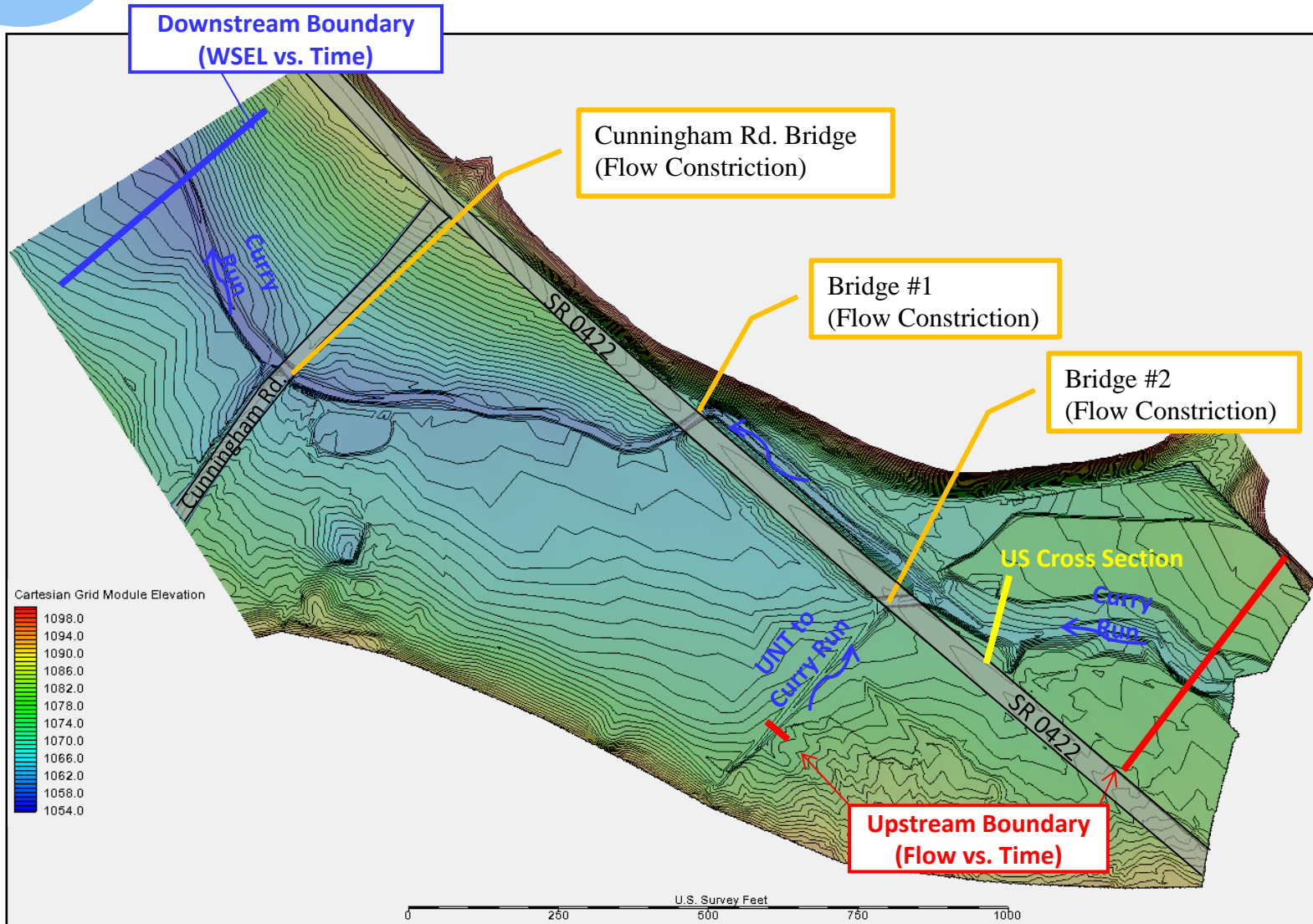


# 2D MODEL

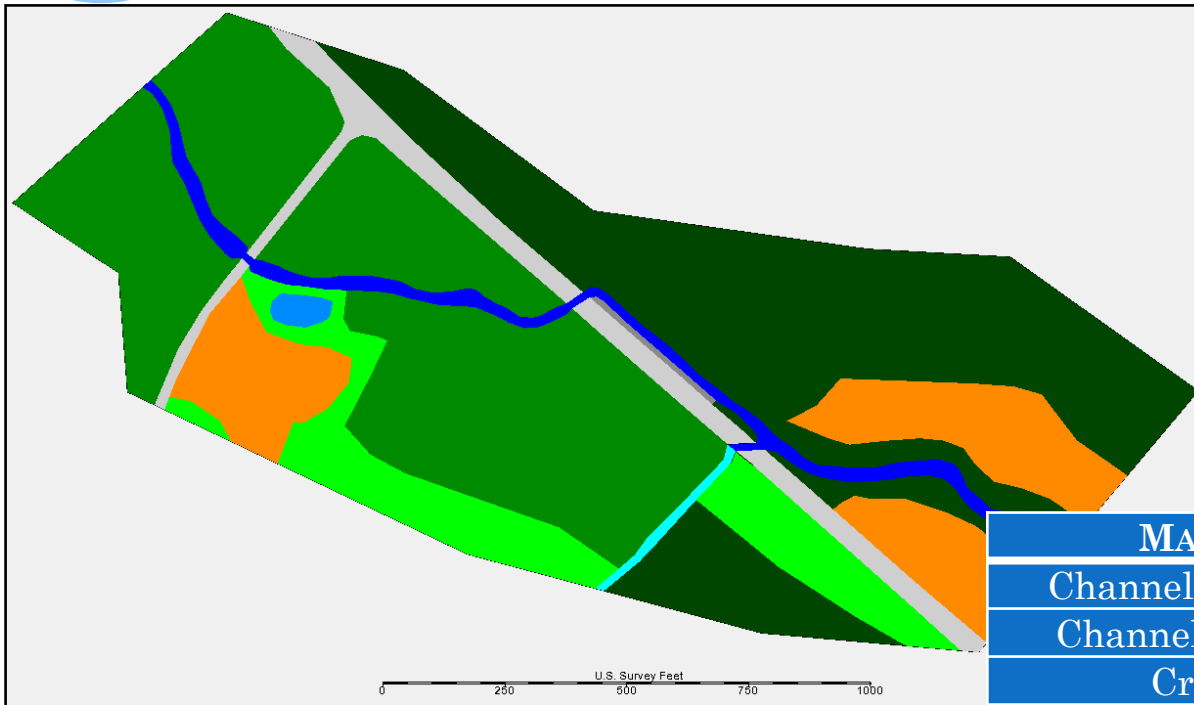
- Complex hydraulic conditions
  - Multiple opening hydraulic scenario during high flow events
  - Curry Run reverses the flow direction in Bridge #2 during high flood events
  - 90° bend upstream of Bridge #1
  - 2D flow characteristics in the 100-year floodplain
  - Proposed stream realignment



# 2D MODEL INPUT | GRID & BOUNDARIES

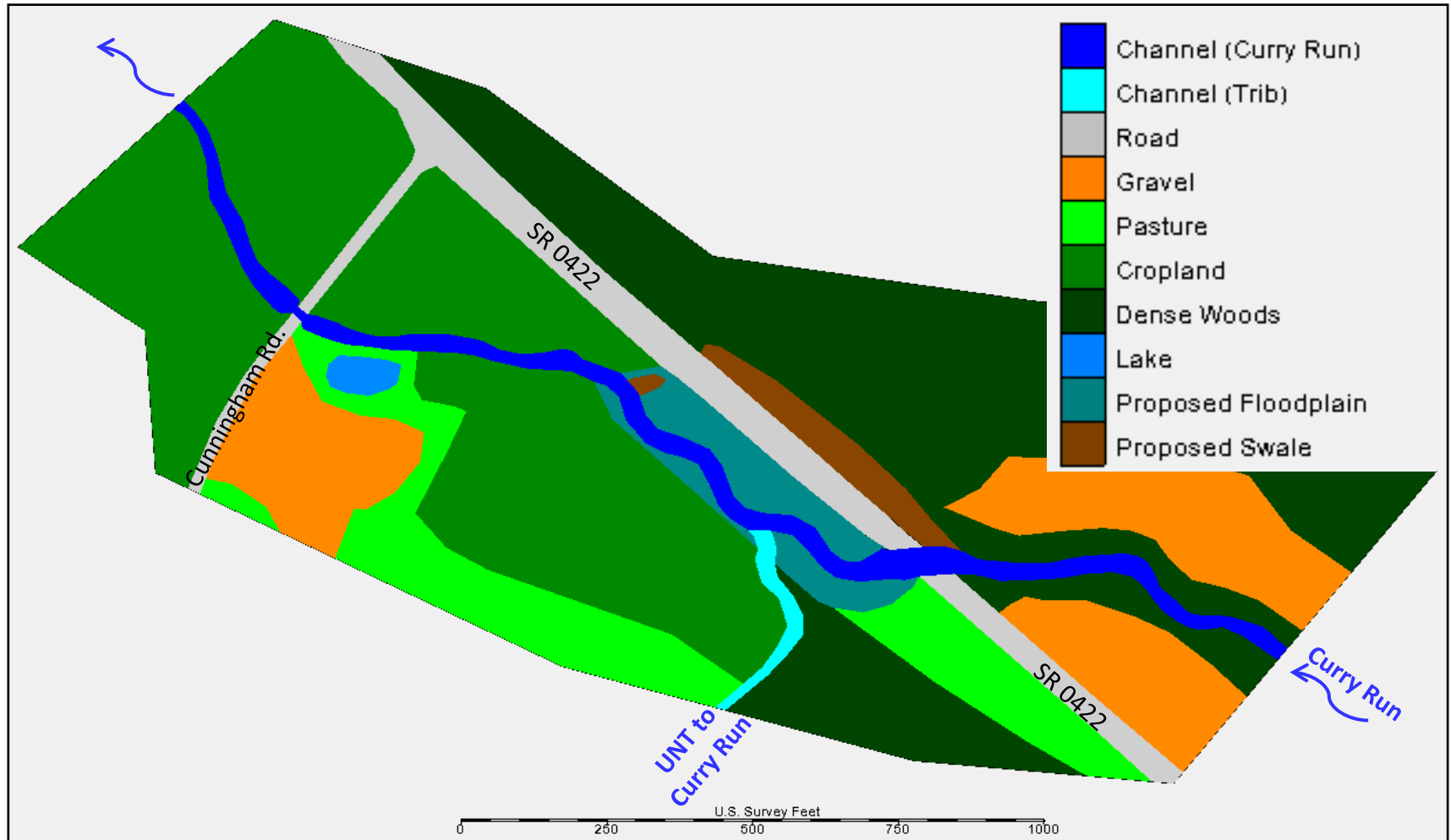


# 2D MODEL INPUT | EXISTING MATERIALS



MATERIAL	ROUGHNESS
Channel (Curry Run)	0.030
Channel (Tributary)	0.035
Cropland	0.050
Gravel	0.025
Dense Woods	0.080
Pasture	0.025
Lake	0.030
Road	0.015
Rock Gabions	0.020
Proposed Floodplain*	0.050*
Proposed Swale*	0.030*

# 2D MODEL INPUT | PROPOSED MATERIALS

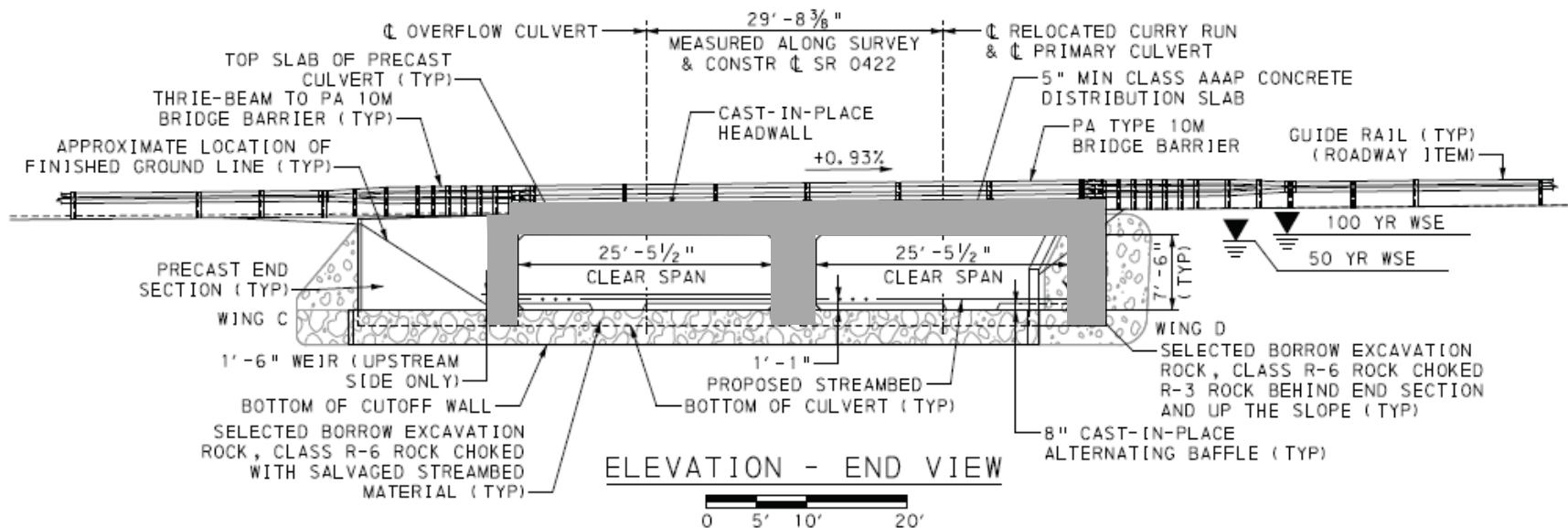




# 2D MODEL INPUT | PROPOSED STRUCTURE

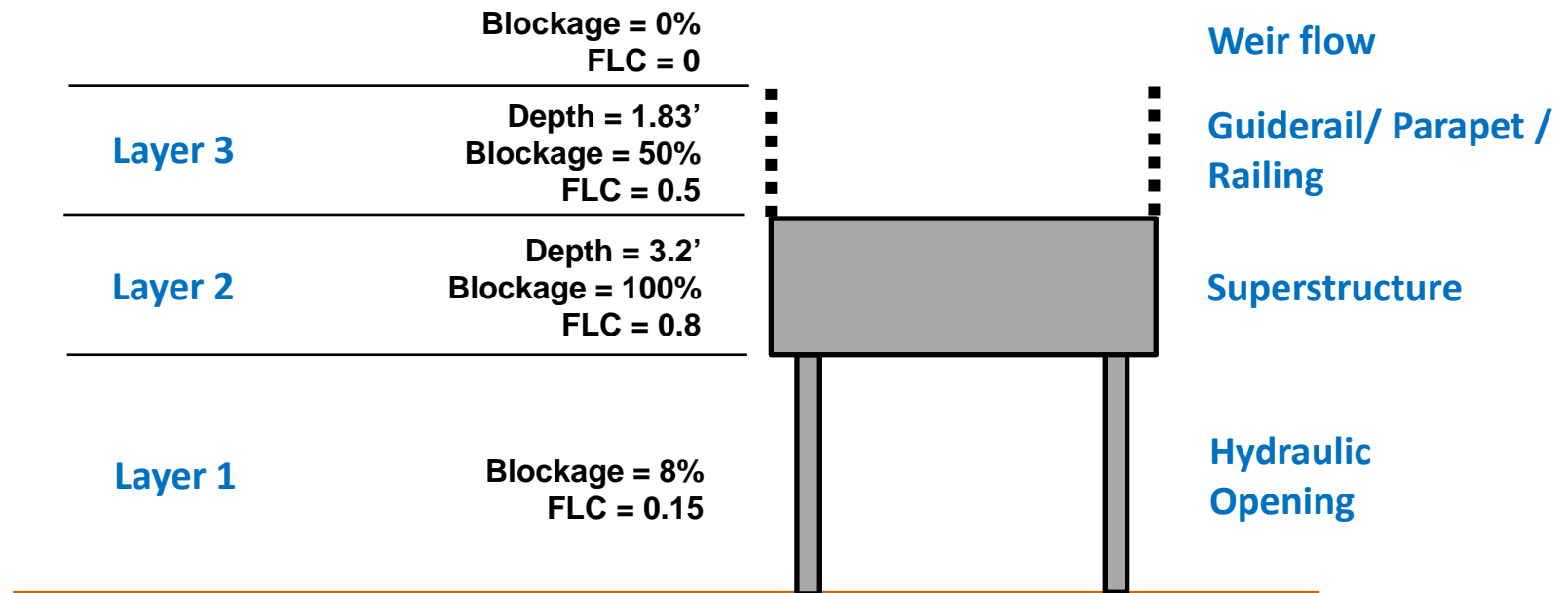
## ○ Proposed twin cell

- 25'-5 ½" primary cell, depressed 12" with 8" alternating baffles
- 25'-5 ½" overflow cell with 18" weir
- PA Type 10M Bridge Barrier



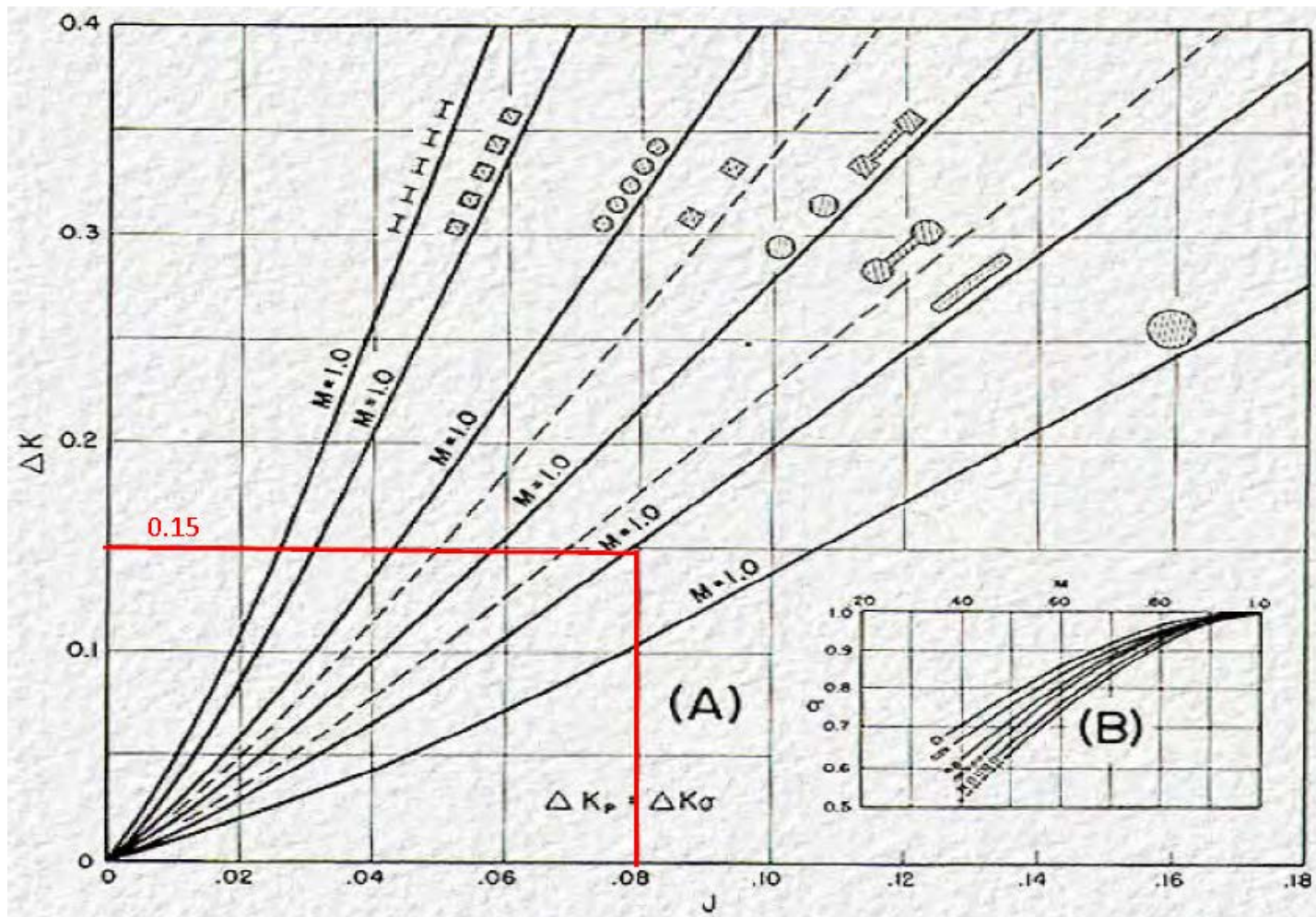
# 2D MODEL INPUT | PROPOSED STRUCTURE

- 2D layered flow constriction
  - Assign % blockage and form loss coefficient (FLC) per layer



# 2D MODEL INPUT | PIER COEFFICIENT

- Interior vertical wall modeled as a pier



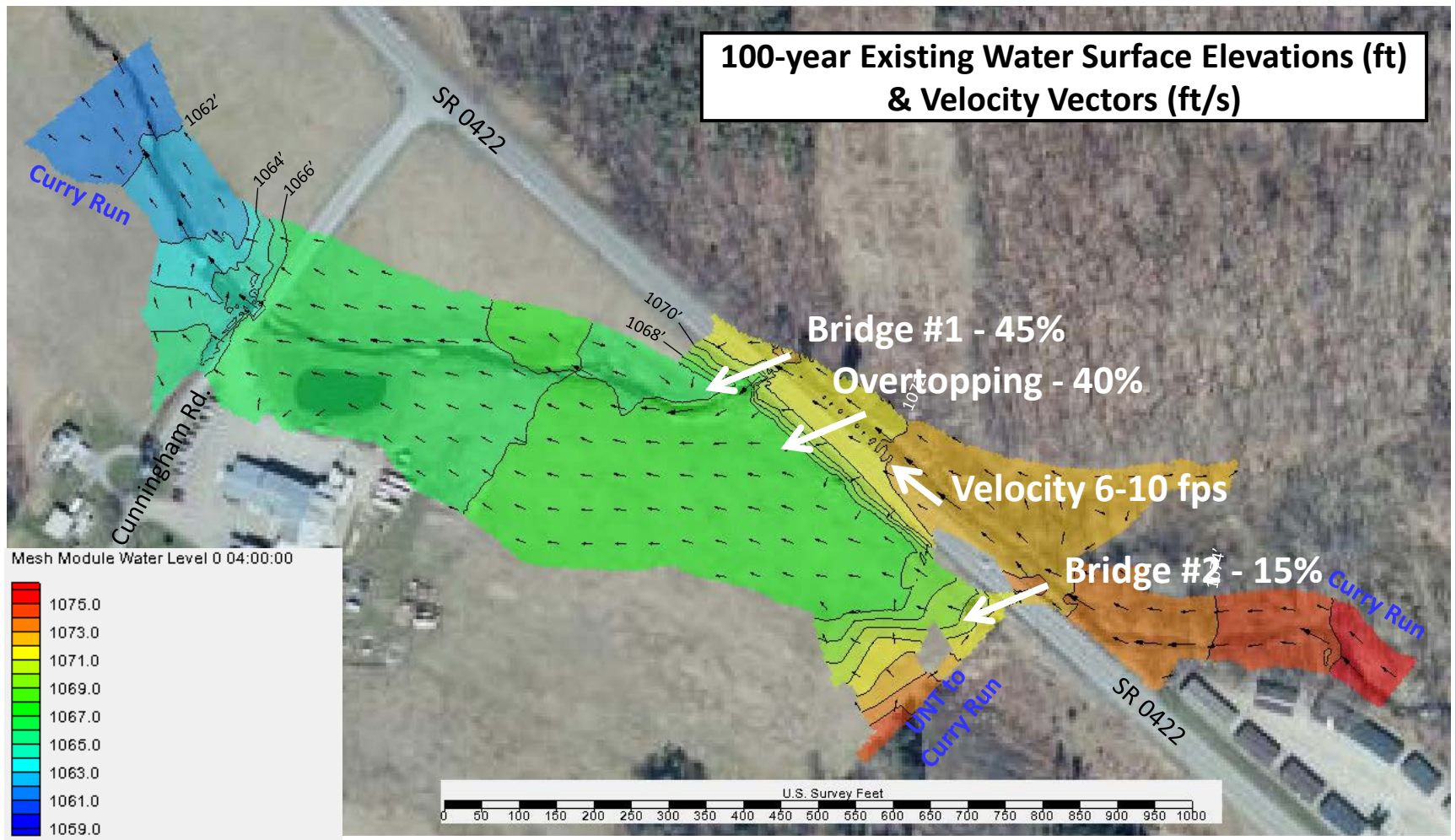




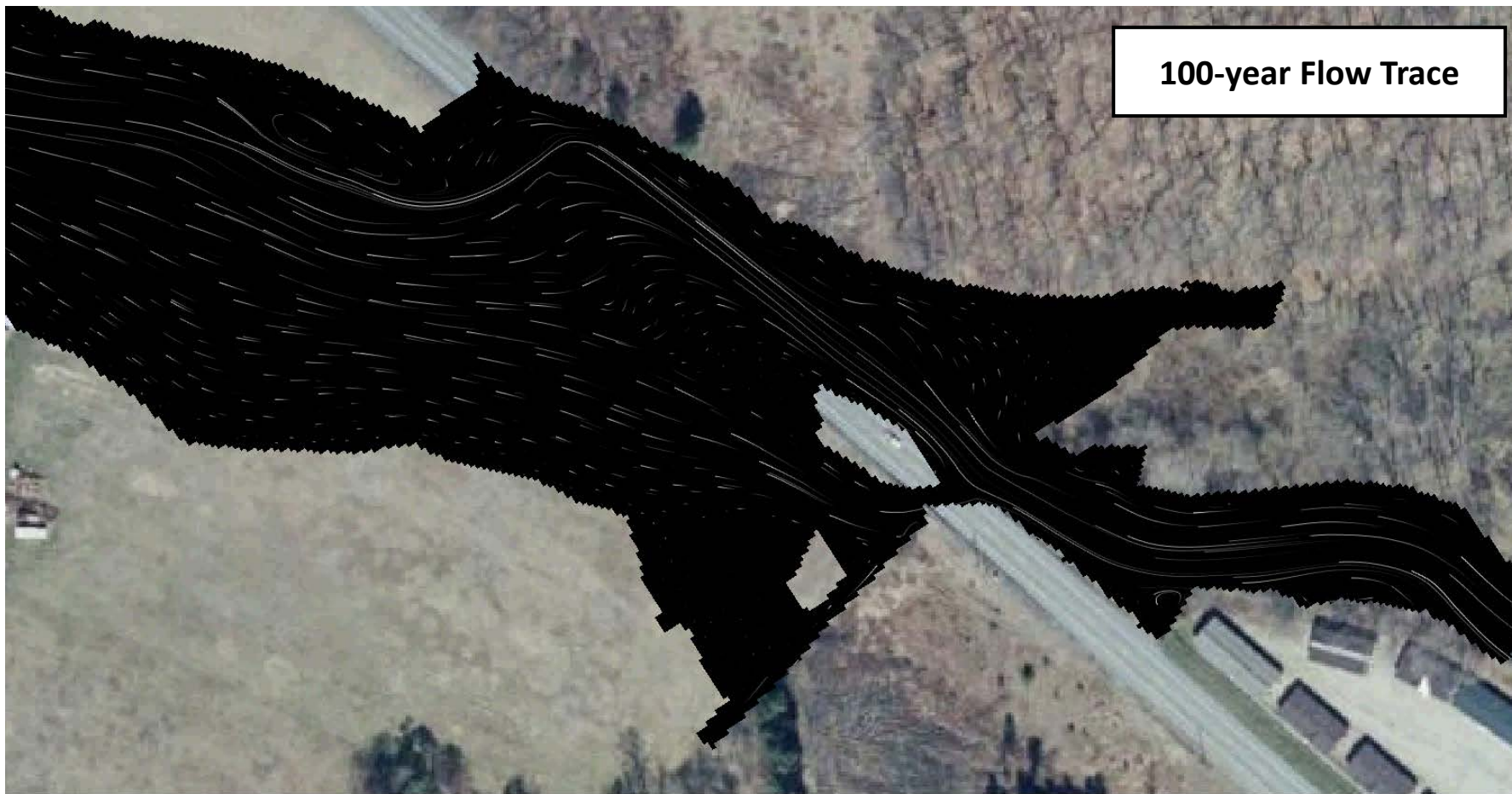
## 2D MODEL RESULTS | SUMMARY

- 50- and 100-year results:
  - Backwater decreases
    - Average of 2 feet upstream of proposed twin cell
  - Overtopping reduction
  - Less erosion potential along SR 0422
- Reasons for improved hydraulic conditions
  - Larger hydraulic opening of proposed culvert
    - Existing 125 sf (combined) vs. Proposed 224 sf
  - Improved stream alignment of Curry Run

# 100-YEAR RESULTS | EXISTING CONDITIONS

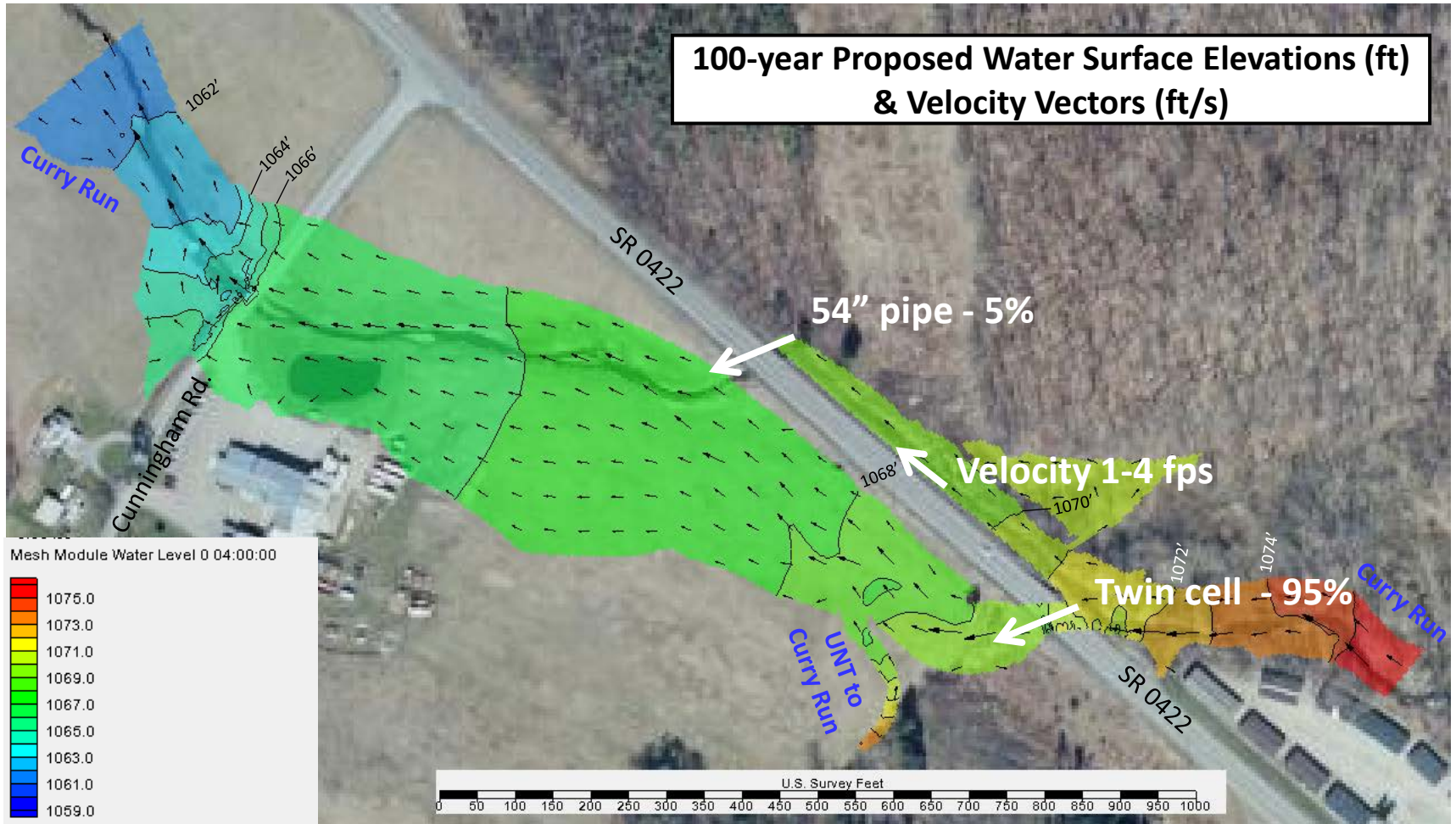


# 100-YEAR RESULTS | EXISTING CONDITIONS

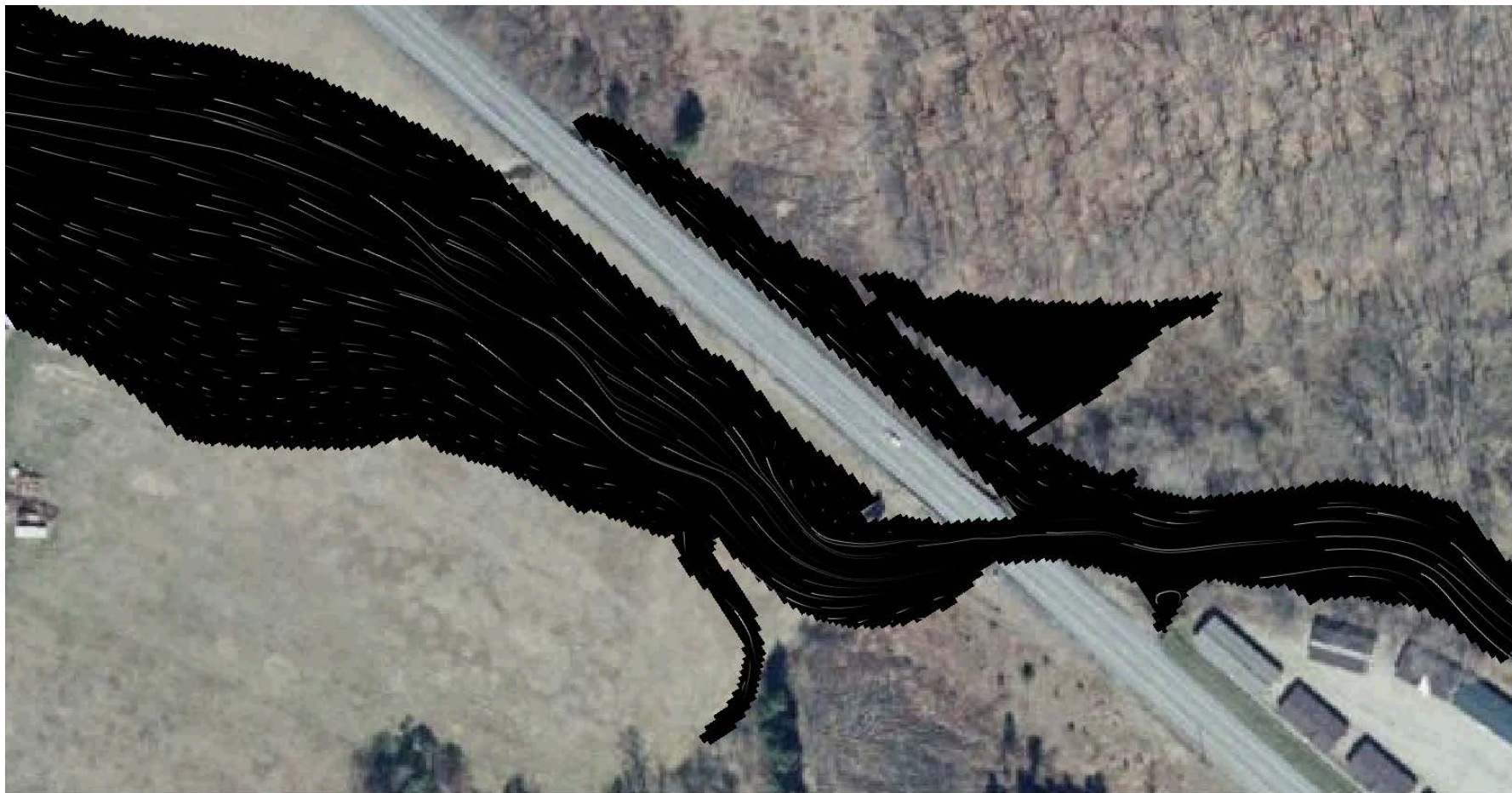




# 100-YEAR RESULTS | PROPOSED CONDITIONS

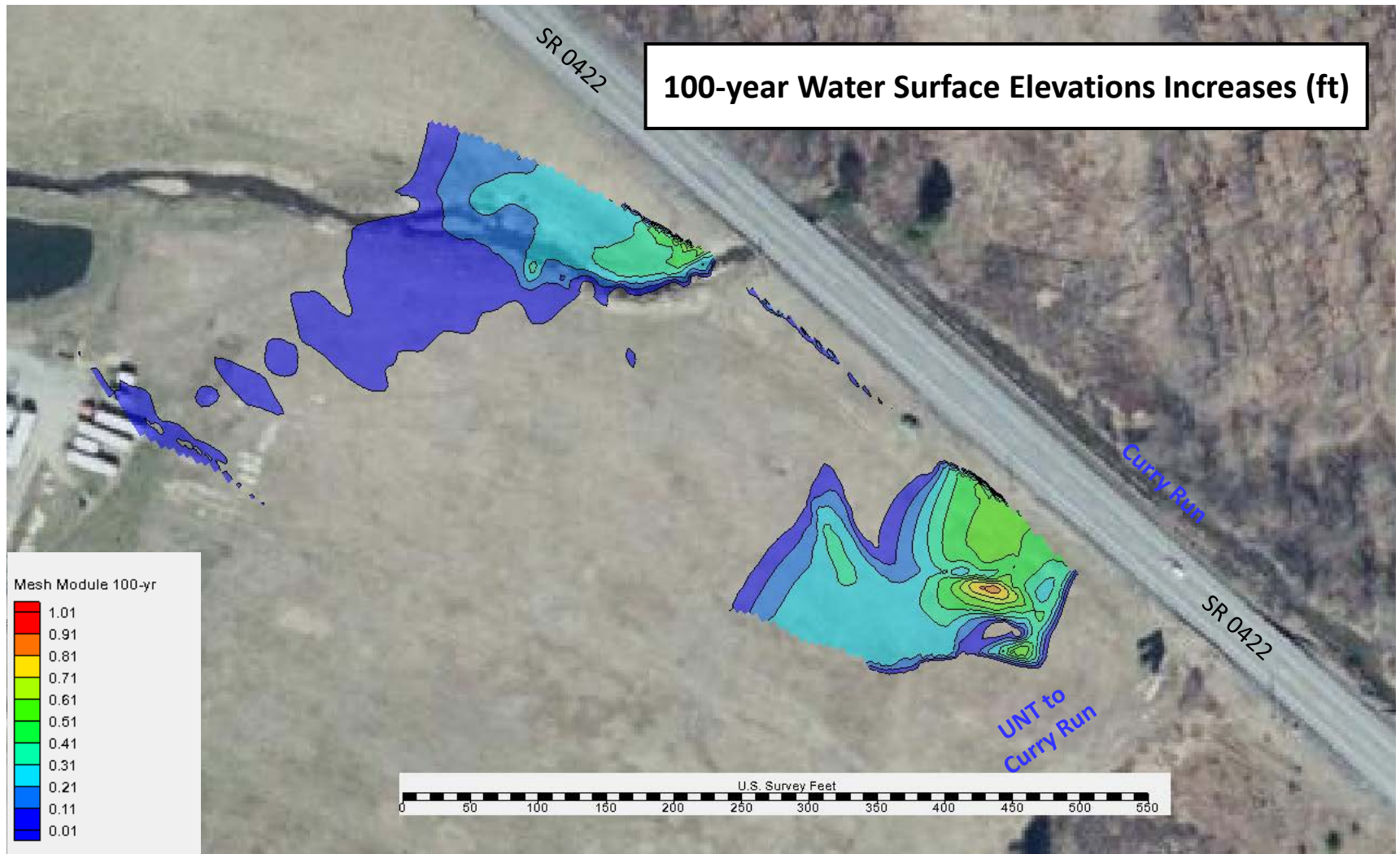


# 100-YEAR RESULTS | PROPOSED CONDITIONS



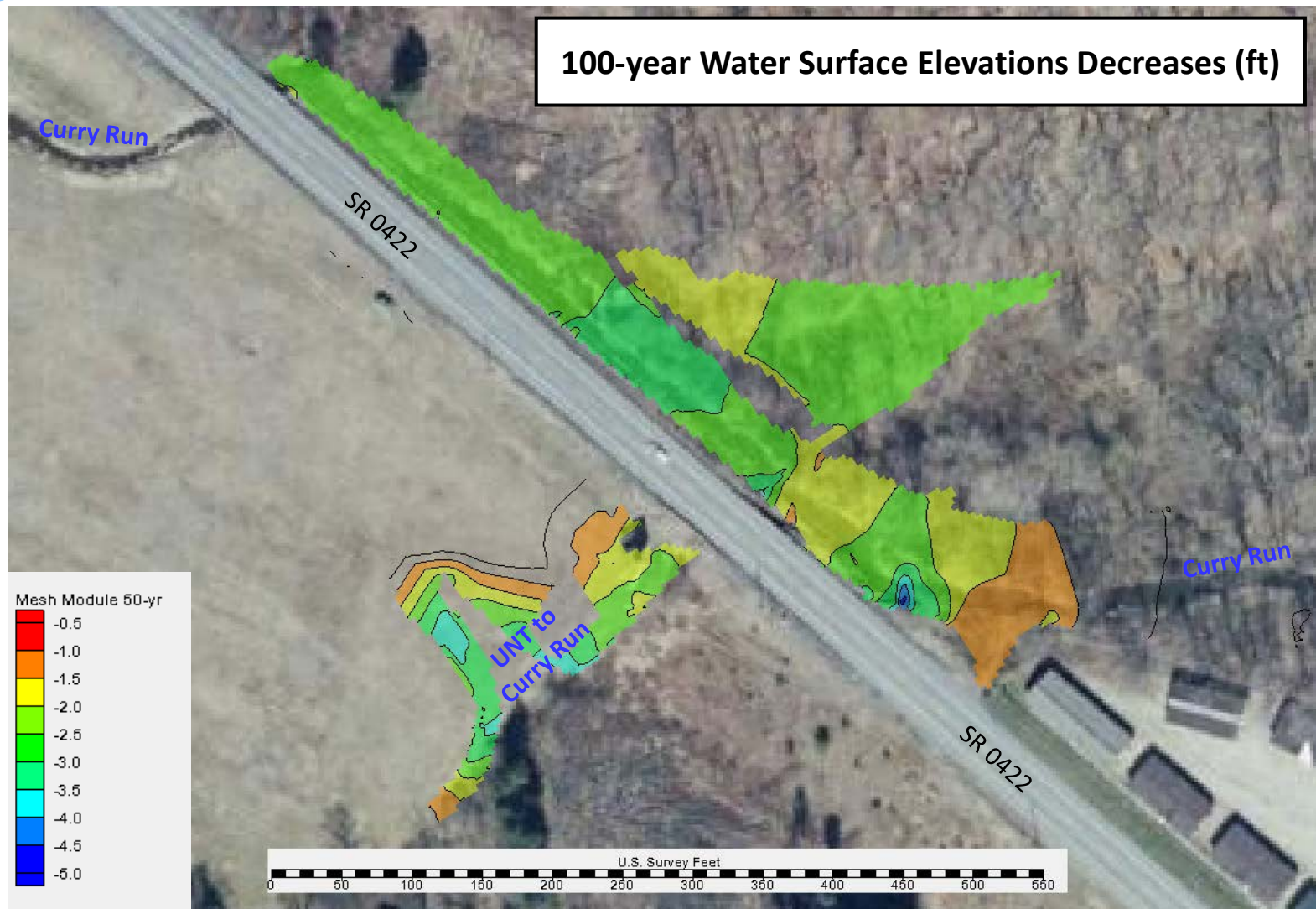


# 100-YEAR RESULTS | EXISTING VS. PROPOSED

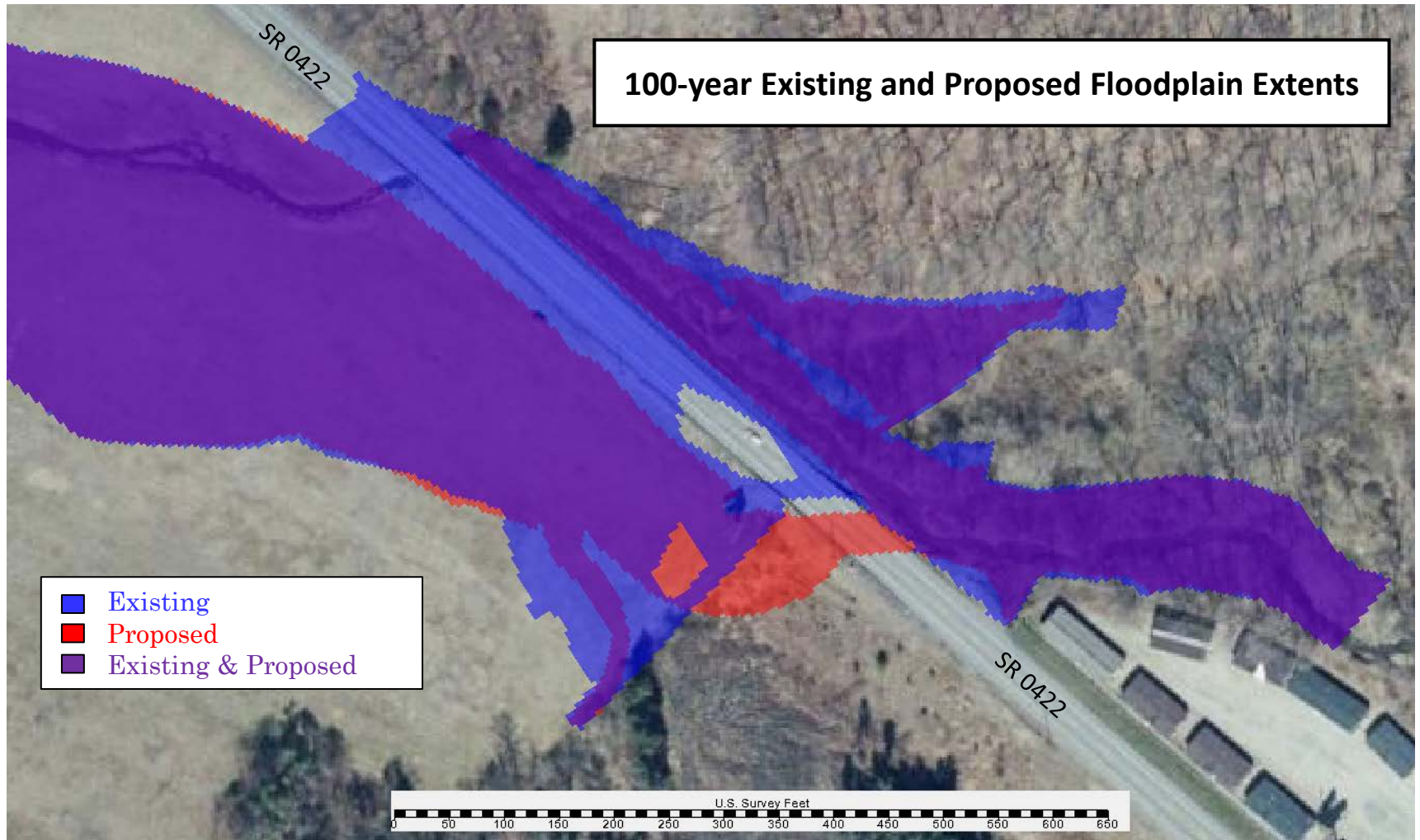




# 100-YEAR RESULTS | EXISTING VS. PROPOSED

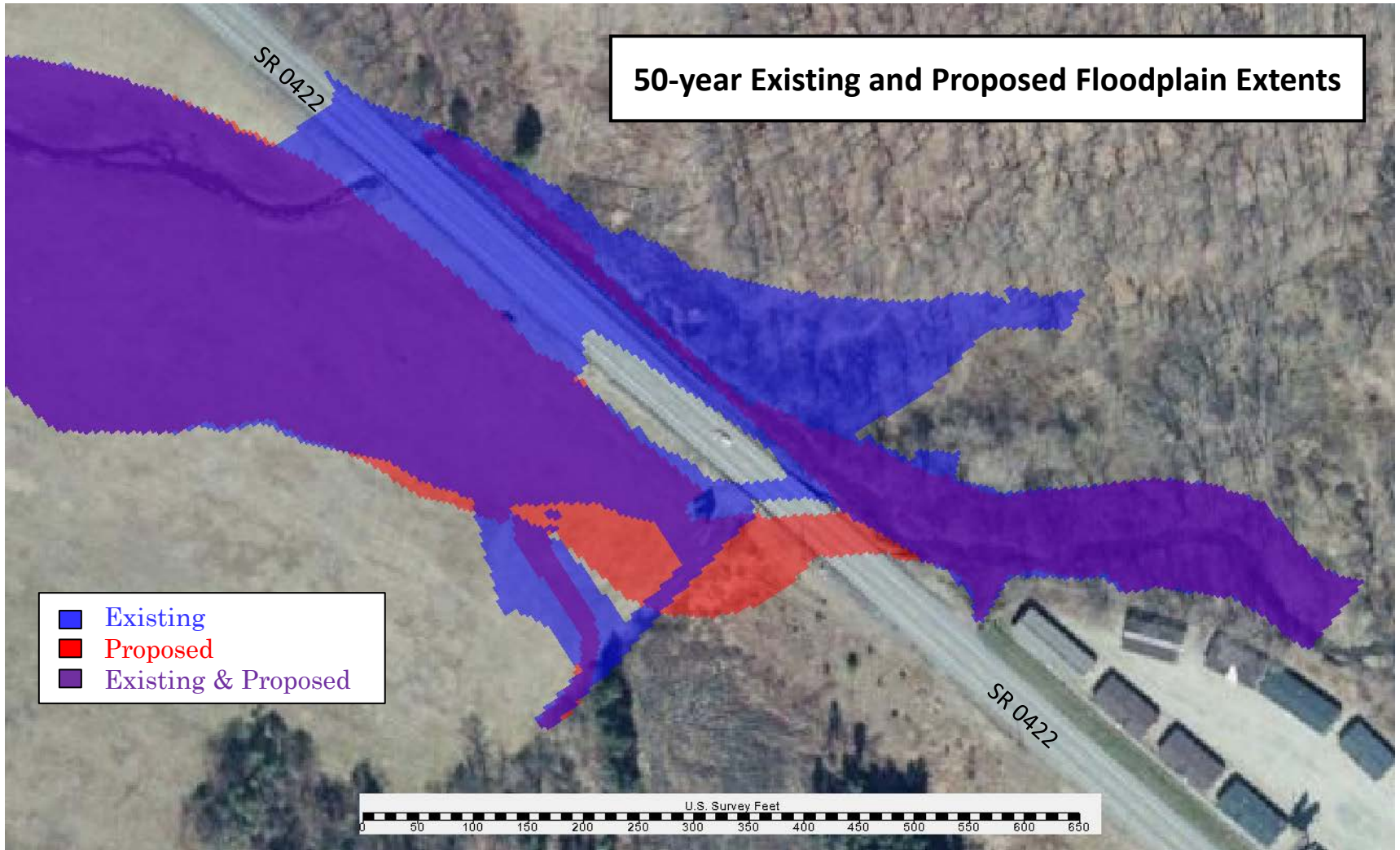


# 100-YEAR RESULTS | EXISTING VS. PROPOSED





# 50-YEAR RESULTS | EXISTING VS. PROPOSED





# CONCLUSIONS

## ○ 2D Application

- Model multiple openings and overtopping
- Account for 2D flow direction in floodplain and split channel
- Reflect different confluence locations for the 50-year and 100-year events
- Incorporate the proposed stream realignment

## ○ Results

- Accurately calculate hydraulic capacity of existing structures
- Determine required hydraulic opening of twin cell
- Quantify changes in flood elevations and velocities
- Evaluate risk and floodplain management criteria





# INNOVATIVE TWO-DIMENSIONAL HYDRAULIC APPLICATIONS

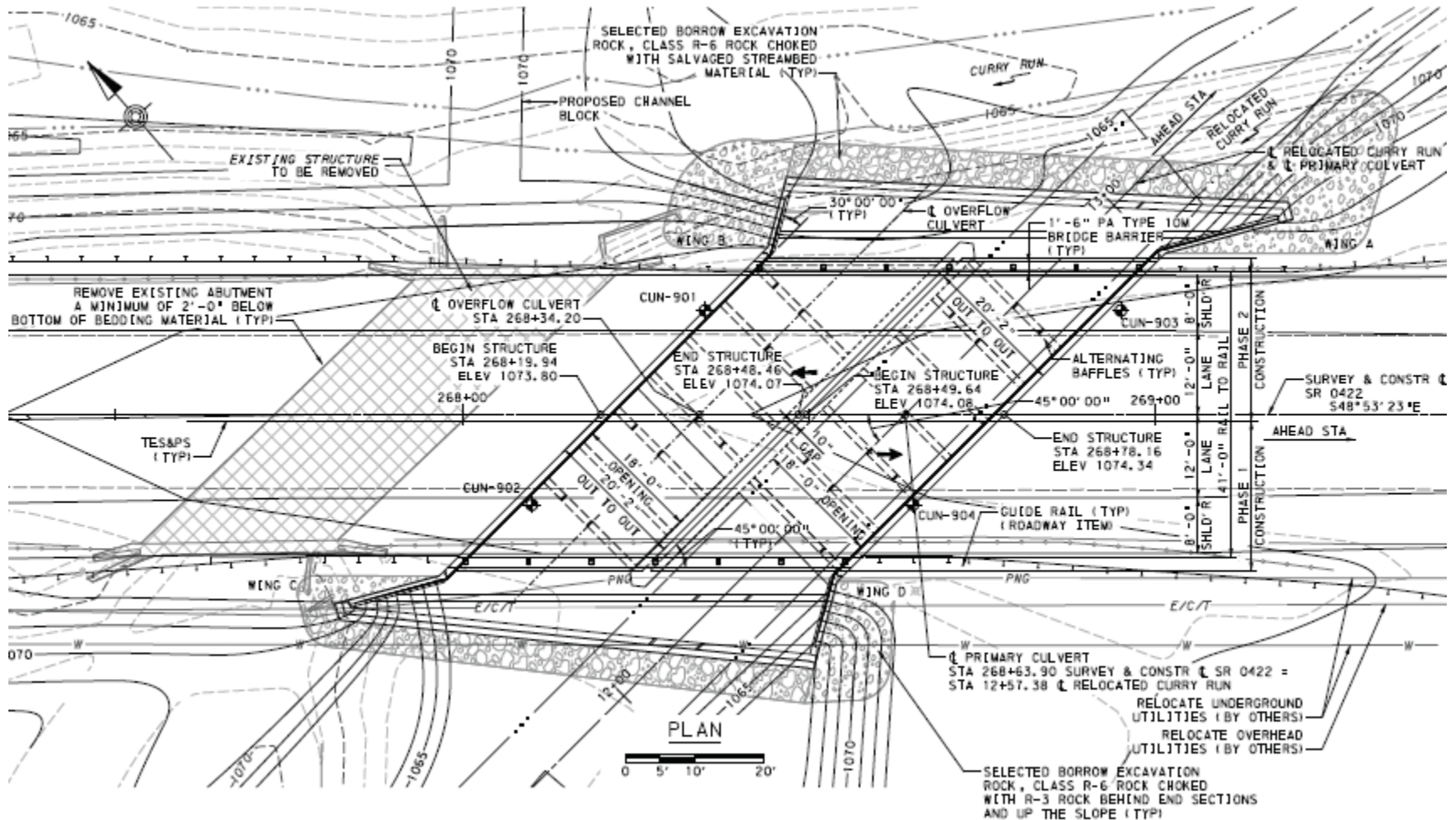
## QUESTIONS?

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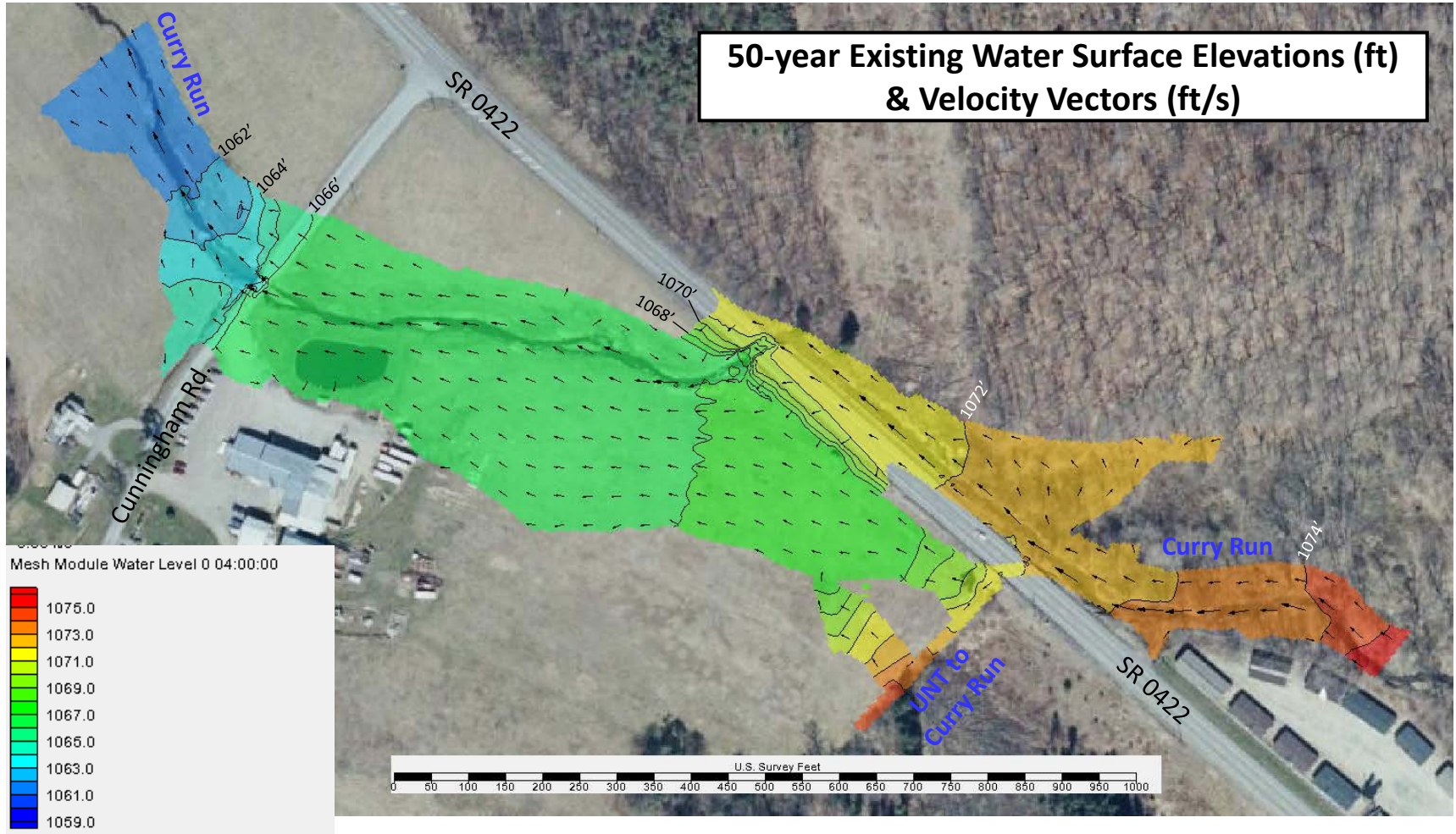
# 2D MODEL INPUT | HYDRAULIC STRUCTURES

## Proposed twin cell





# 50-YEAR RESULTS | EXISTING CONDITIONS



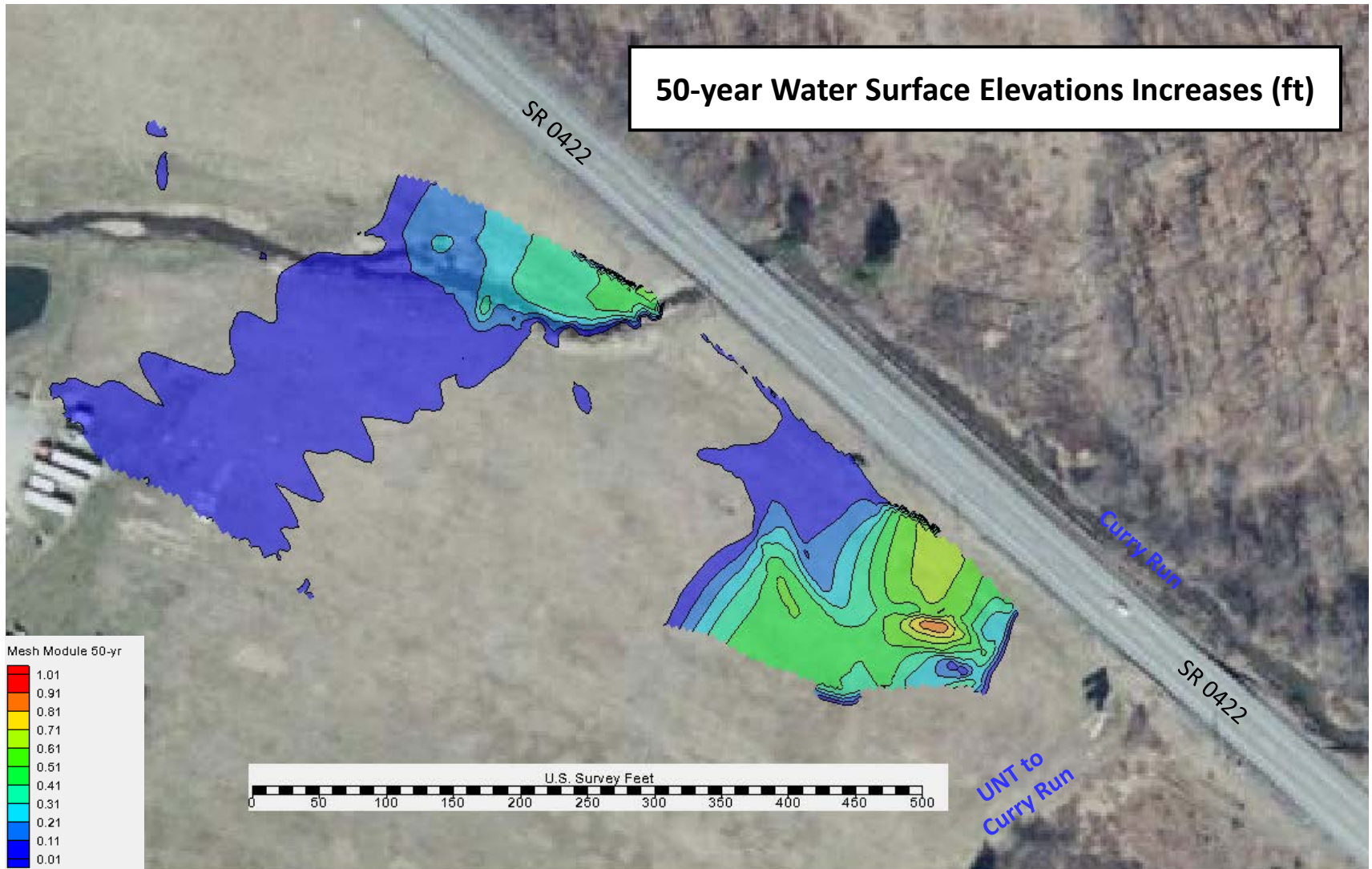
# 50-YEAR RESULTS | PROPOSED CONDITIONS





# 50-YEAR RESULTS | EXISTING VS. PROPOSED

50-year Water Surface Elevations Increases (ft)



# 50-YEAR RESULTS | EXISTING VS. PROPOSED

