2D Hydraulic Modeling, Steering Stream Restoration Design

PREPARED FOR:

EcoStream 2018 Stream Ecology & Restoration Conference

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Civil & Environmental Consultants, Inc.

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Overview

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- **Two-Dimensional Modeling Approach**
- **1D vs. 2D Modeling**
- **Representative Projects Overview**
- **Representative Projects Models**

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Two-Dimensional Modeling Approach

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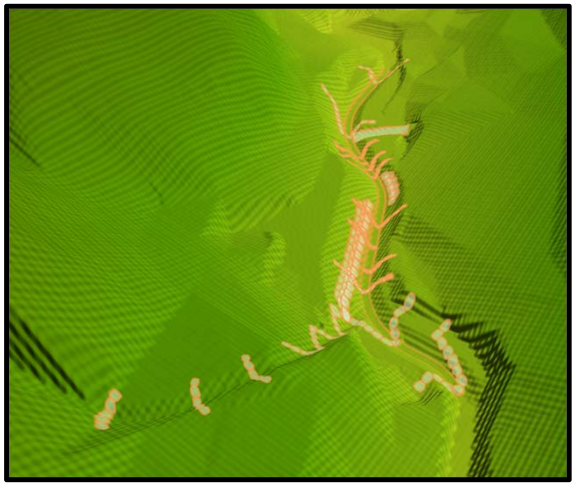
Hydraulic Modeling for Stream Design Utilizing GeoHEC-RAS 2D

- 2D hydrodynamic flow routing within unsteady flow analysis
- 1D, 2D or combined 1D/2D unsteady-flow routing
- 2D flow areas in HEC-RAS can be used in a number of ways
  - Detailed 2D channel modeling
  - Detailed 2D channel and floodplain modeling
  - Combined 1D channels with 2D floodplain areas
  - Combined 1D channels with 2D flow behind levees
  - Directly connect a 2D flow area to 1D storage area with a hydraulic structure
  - Simplified to very detailed Dam Breach analyses



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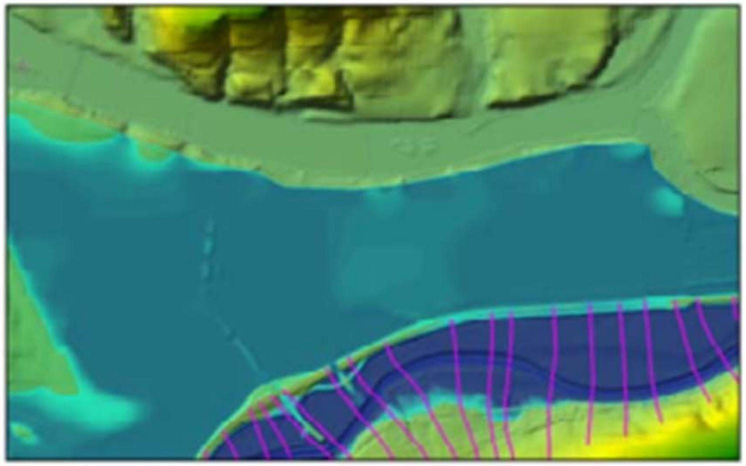
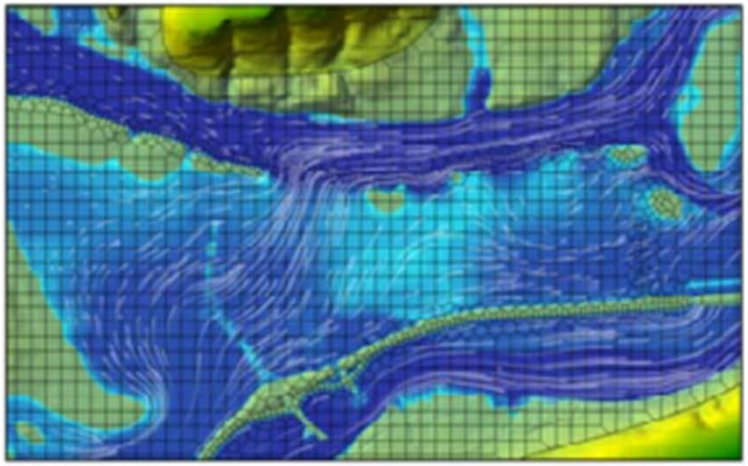
Two-Dimensional Modeling Approach

Hydraulic Modeling Utilizing GeoHEC-RAS 2D

Definitions

- **1D Modeling**
  Solves the fully dynamic St. Venant equations of conservation of mass and momentum along a singular dimension.
- **2D Modeling**
  Solves the fully dynamic St. Venant equations of conservation of mass and momentum along two dimensions.





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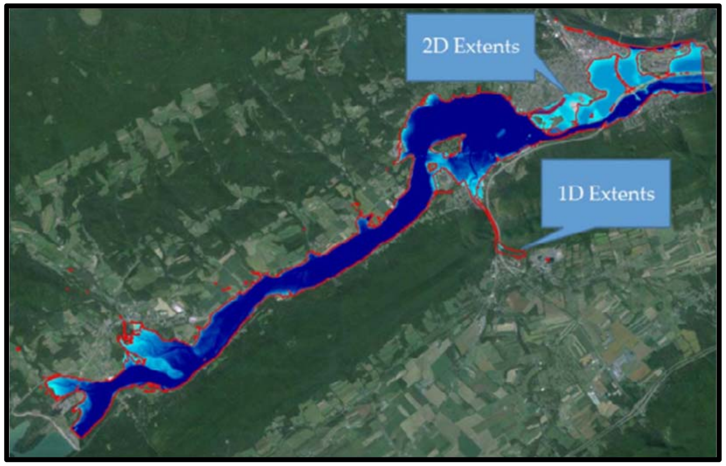
1D vs. 2D Modeling

Hydraulic Modeling Utilizing GeoHEC-RAS 2D



- 1D Advantages
  - Fewer geometric data are required
  - Shorter computational time
  - Channel flows computed more efficiently
  - Relatively smaller output files
- 2D Advantages
  - Flowpaths do not need to be predefined
  - Provides realistic depiction of flow throughout a system
  - Perform 1D and 2D modeling within the same unsteady flow model allows users to model larger river systems, 1D where appropriate (main river) and 2D modeling in areas that require a higher level of hydrodynamics
  - Flowpaths can change with flow depth
  - Cross-momentum of flow splits is accounted for (significant for roadway crossing systems)
  - Losses due to 2D effects (i.e. bends, flow separations, etc.) automatically included within computations
  - Floodplain storage is implicitly defined
  - Inputs and outputs can be defined spatially in GIS-type environments (better data continuity)
  - Does not require extraction of cross sections from survey data
  - Detailed Flood Mapping and Flood Animations – based on underlying terrain, each cell can be partially wet/dry reflected in the mapping and animations
  - Can provide results directly for mapping flood extents and inundation depths, velocities, and safety hazards

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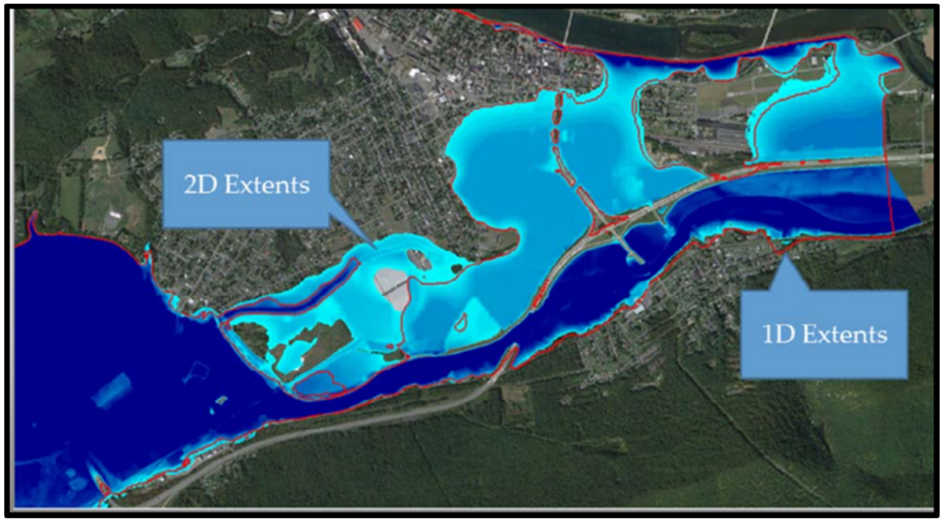
1D vs. 2D Modeling

Hydraulic Modeling Utilizing GeoHEC-RAS 2D

- When is 1D Okay
  - Locations where flow isn't required to spread (uni-directional flow)
  - Well-defined channel/overbank systems (defined valleys)
  - Simply-connected floodplains where flow in main channel is well connected to flow in the overbank and both are primarily uni-directional
  - When elevation data of only limited quality/quantity are available

- When is 2D Preferable
  - Anywhere flow is expected to spread
  - Urbanized Areas
  - Wide Floodplains
  - Downstream of Levee Breaks
  - Downstream of Upground Reservoir Breaks
  - Stream and Wetland Studies
  - Lake or Estuary Studies
  - Water Quality and Sediment Transport



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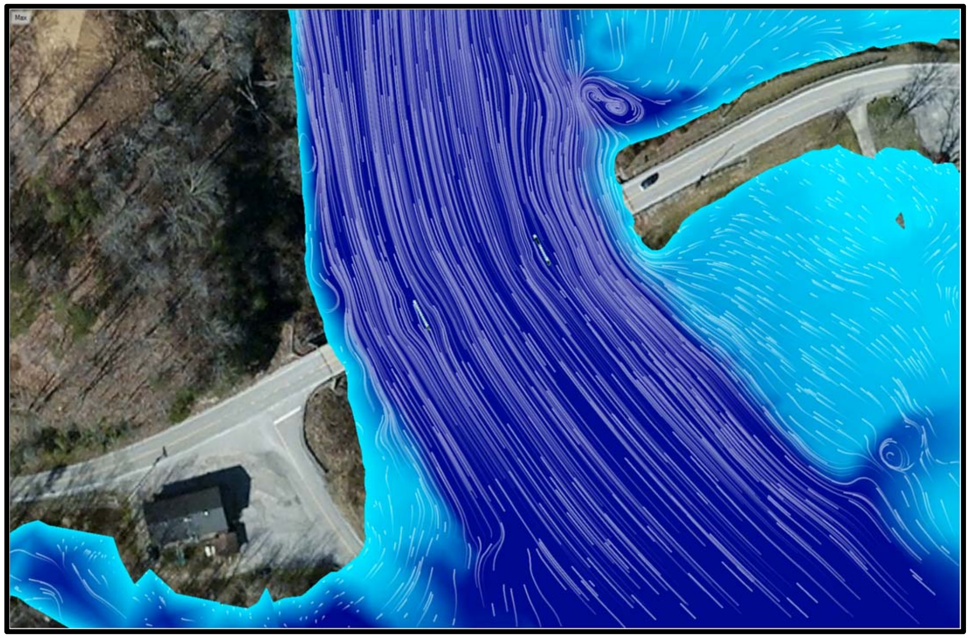
1D vs. 2D Modeling

Hydraulic Modeling Utilizing GeoHEC-RAS 2D

- 1D or 2D?
  - What is the length-to-width ratio of the project area? (> or < 3:1?)
  - Does the project have features that force flow to rapidly contract or expand?
  - Does the project have any features that redirect flow significantly (i.e. buildings)?
  - What kind of output animations are needed to convey the results to the stakeholders?



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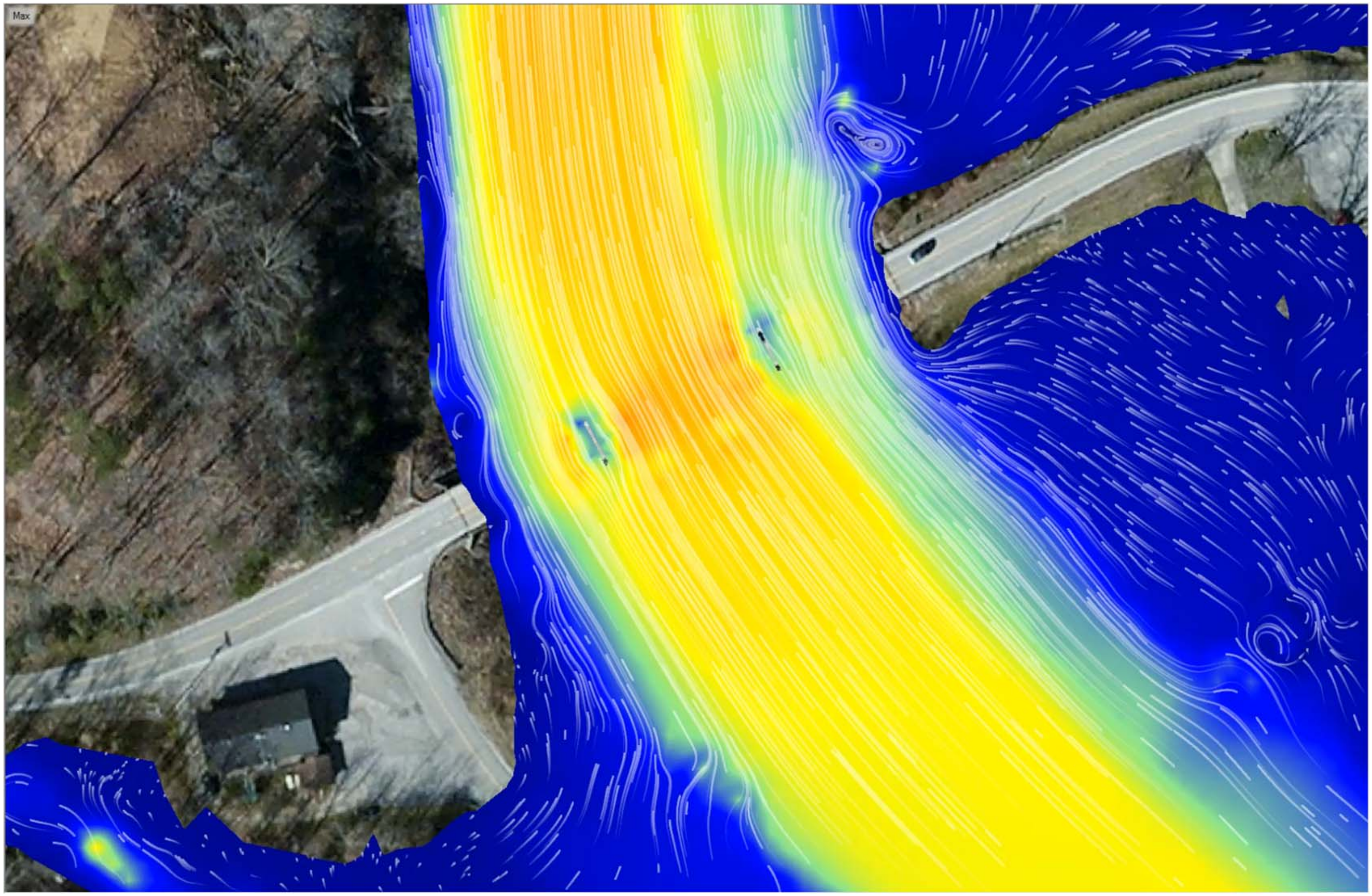
1D vs. 2D Modeling



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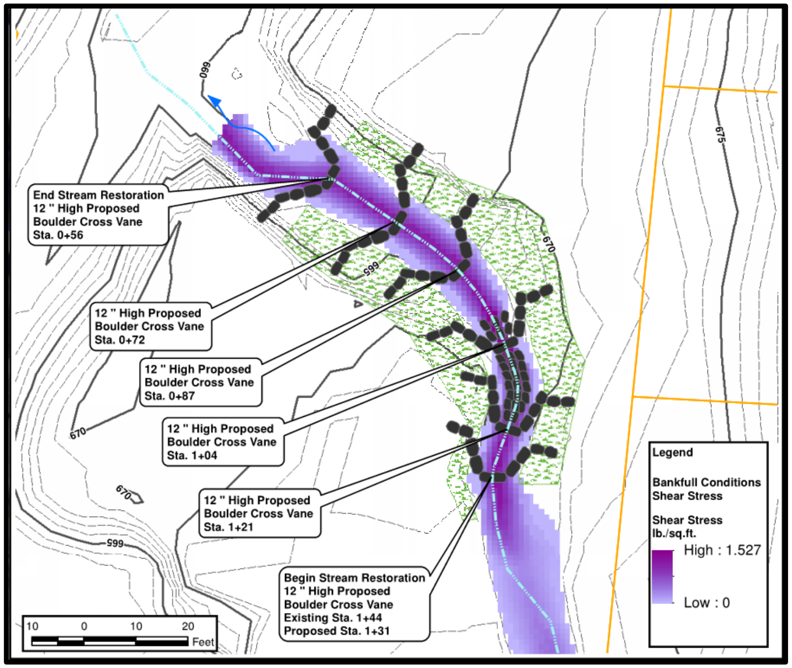
1D vs. 2D Modeling

Sustainable Restoration Approach Hydraulic Modeling

- Floodplain Management & Permitting
- HEC-RAS 1D – Flood Impact Analysis
- HEC-RAS 2D – Stream Restoration Design
  - In-Stream Structure Modeling (3D Objects)
  - Near Bank Shear Stress Management
  - Floodplain Connectivity
  - Stream and Wetland Complex Modeling
  - Velocity Particle Tracing
  - Depth Grid Mapping



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1D vs. 2D Modeling

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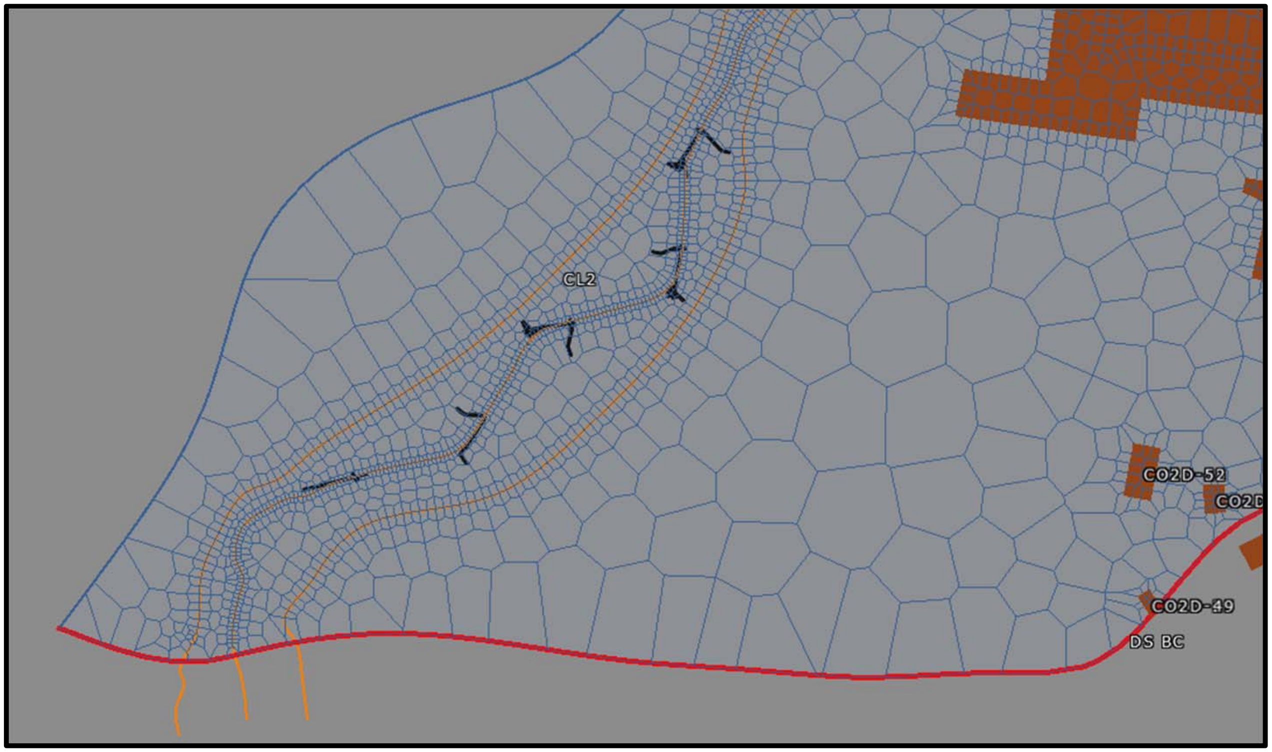
Sustainable Restoration Approach Hydraulic Modeling

2D Computational Mesh Optimization Tool (Adaptive Mesh)



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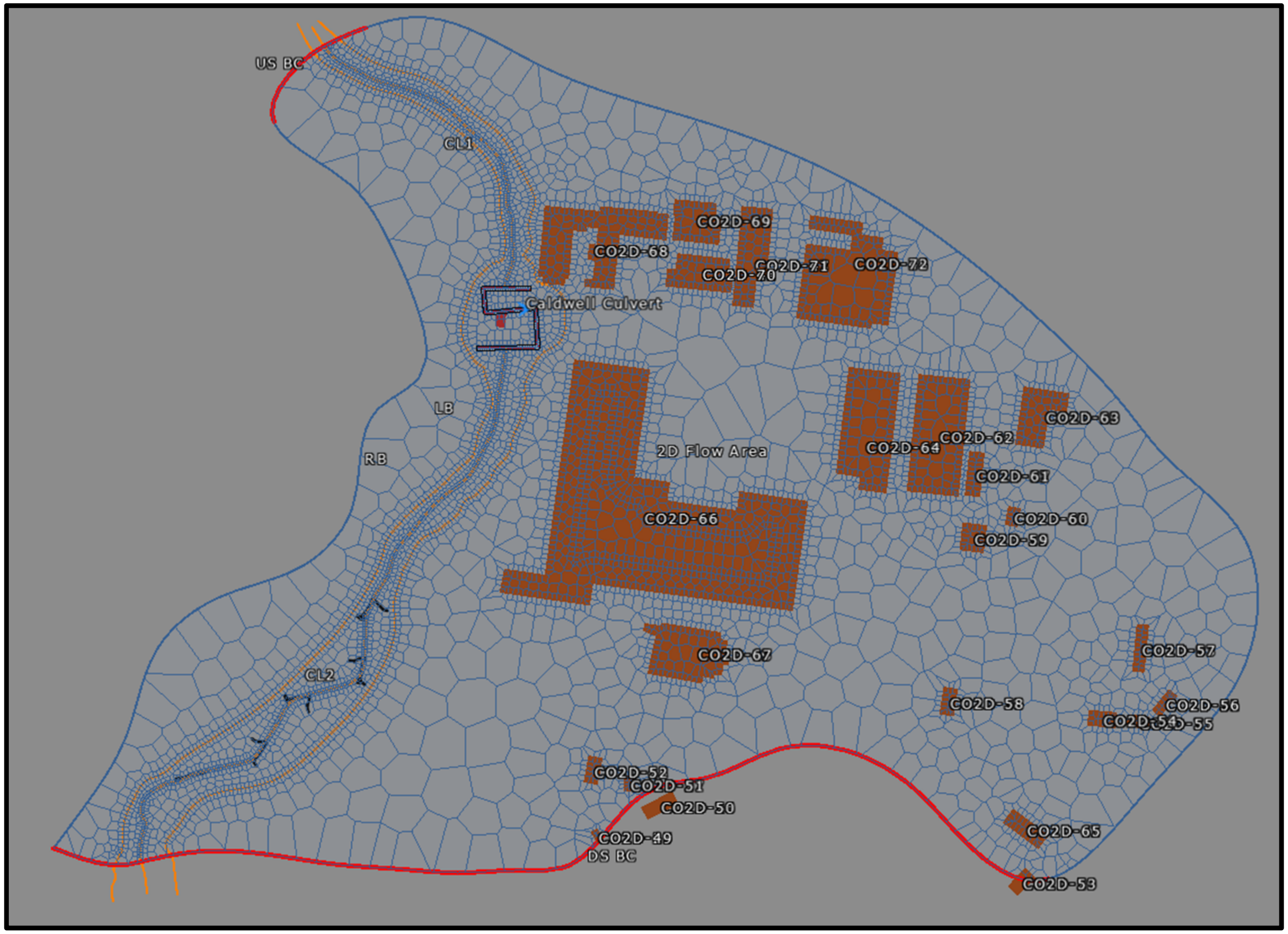
1D vs. 2D Modeling



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1D vs. 2D Modeling

Hydraulic Modeling Utilizing GeoHEC-RAS 2D

“All models are wrong, but some are useful.”

-George E. P. Box

“For every complex problem there is an answer that is clear, simple, and wrong.”

-H.L. Mencken

Representative Projects

UNT to Moock Road Pipeline Repair & Stream Restoration
- City of Southgate, Campbell County, KY

20" NG Pipeline, 0.1 Sq. Mi. Drainage Area, 2,500 lf Stream Restoration, Headwater Stream

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Representative Projects

UNT to Moock Road Pipeline Repair & Stream Restoration
- Upstream Pipeline Crossing

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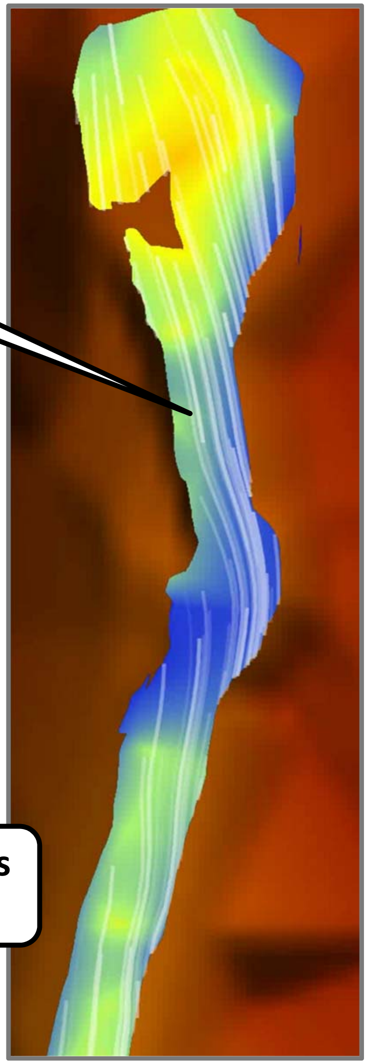
Project Models



Representative Projects

UNT to Moock Road Pipeline Repair & Stream Restoration
- Downstream Pipeline Crossing

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Representative Projects

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UNT to Moock Road Pipeline Repair & Stream Restoration
- Downstream Pipeline Crossing

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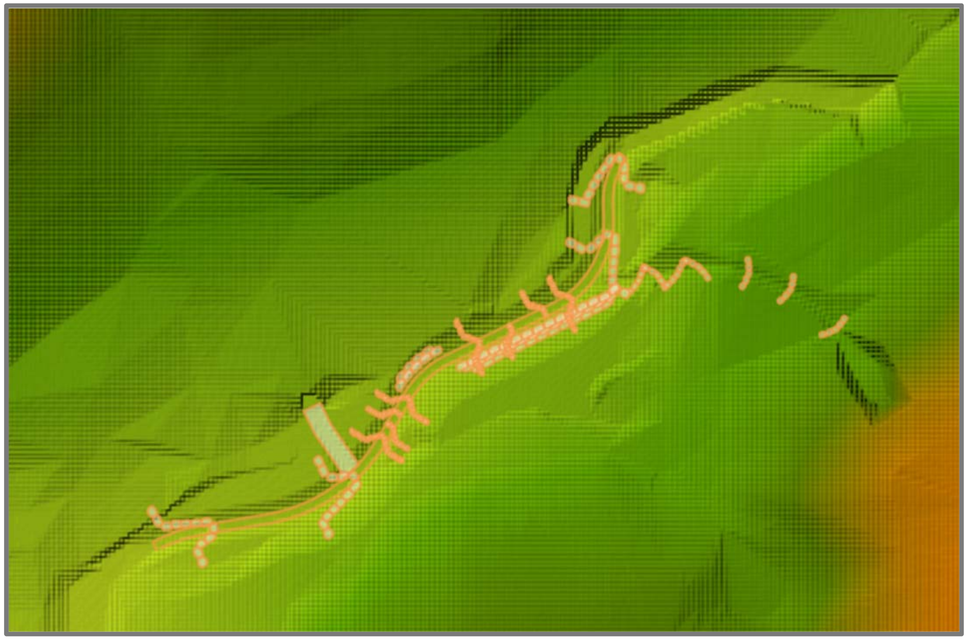
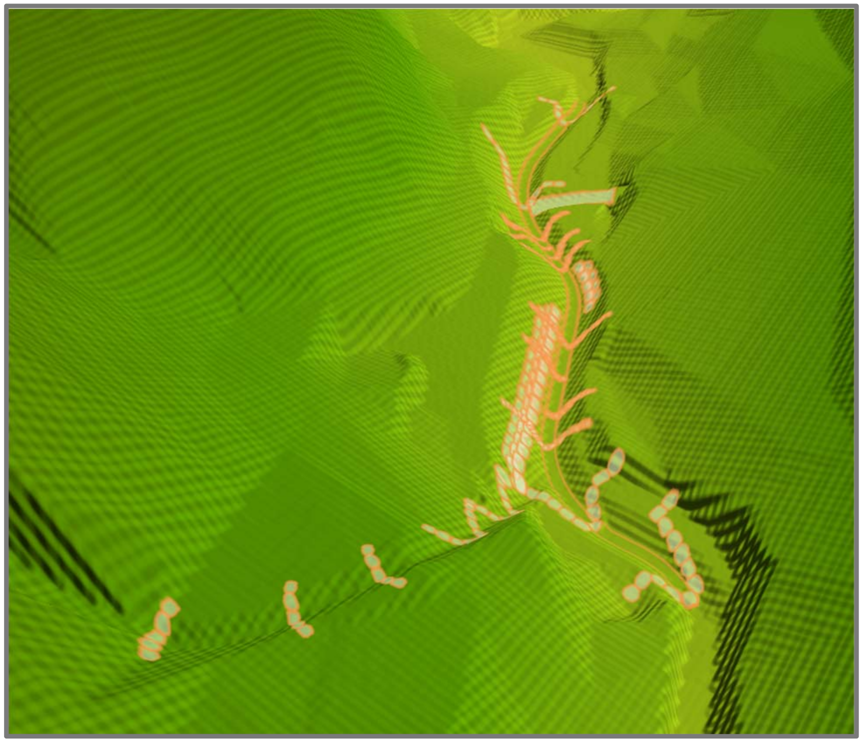
Representative Projects

UNT to Moock Road Pipeline Repair & Stream Restoration
- Downstream Pipeline Crossing





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Project Models

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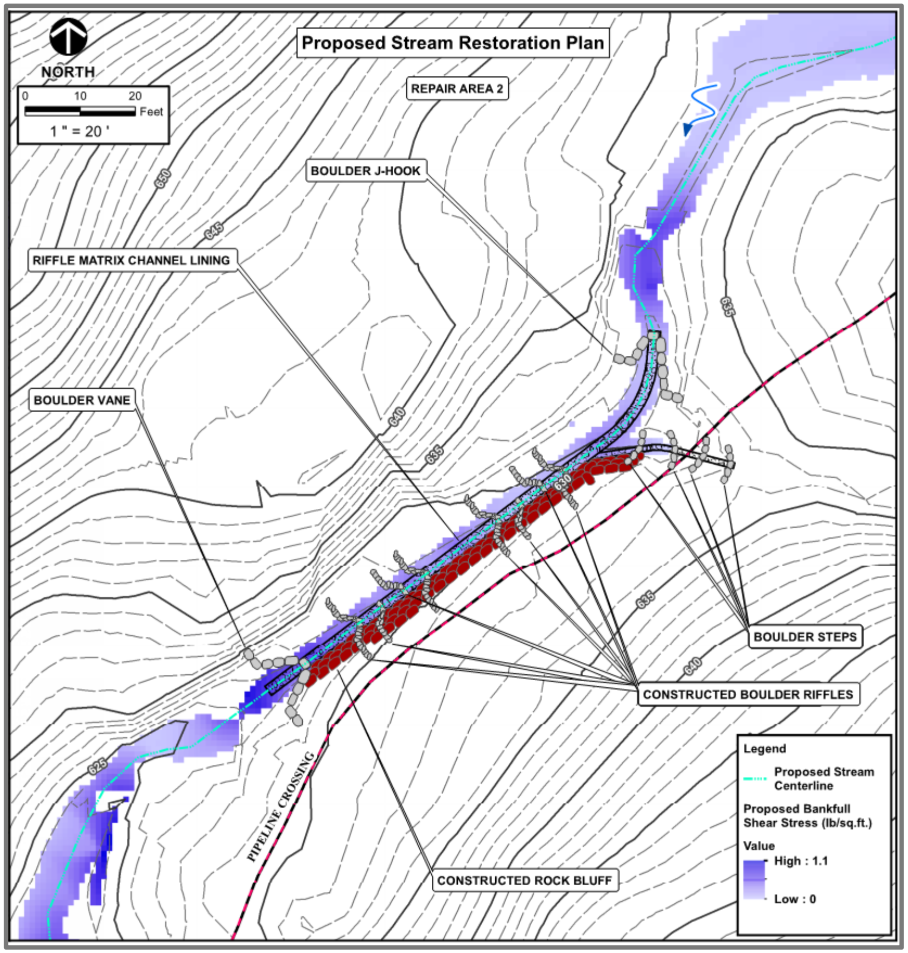

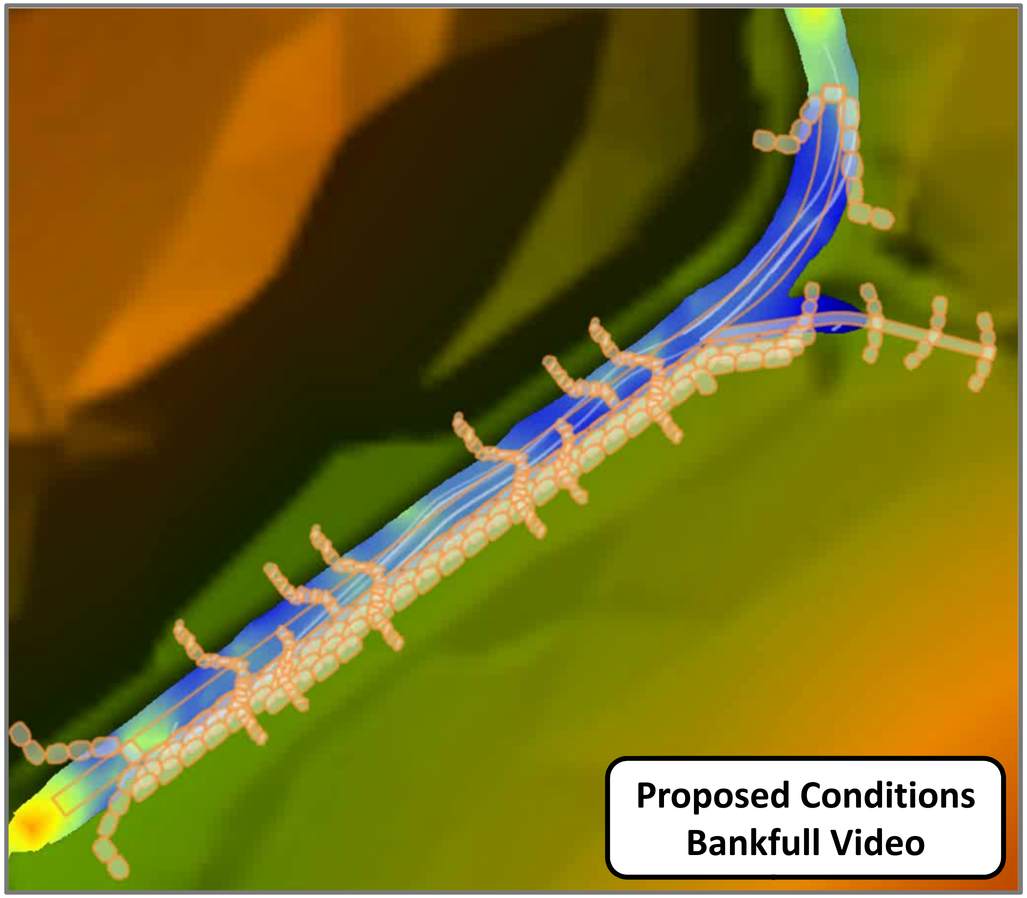

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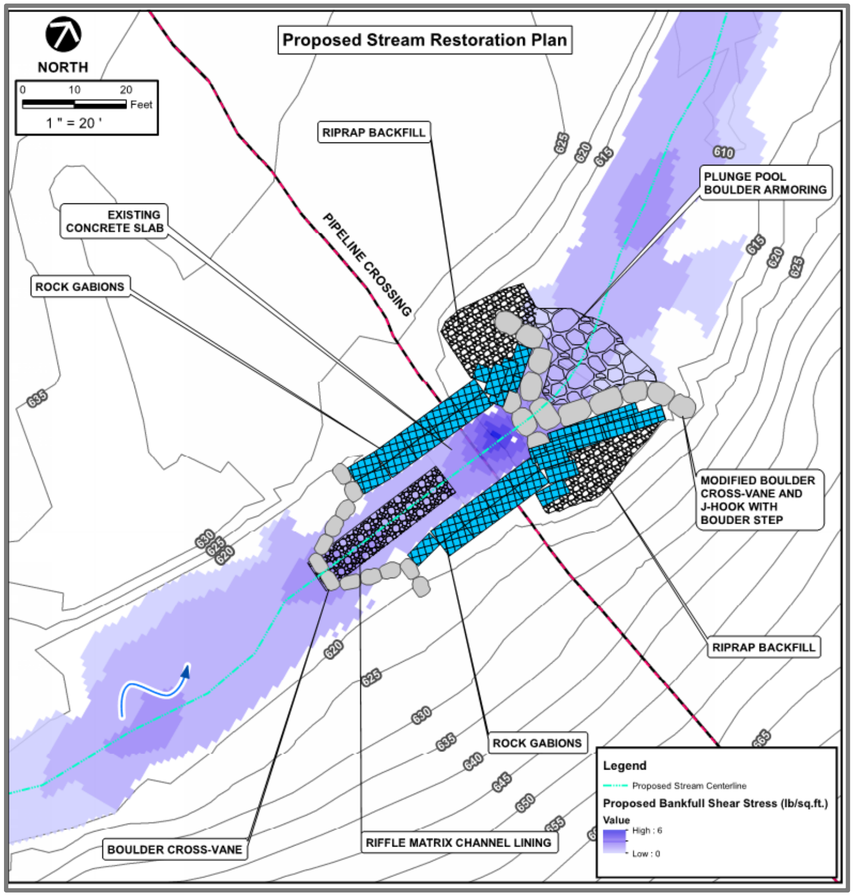
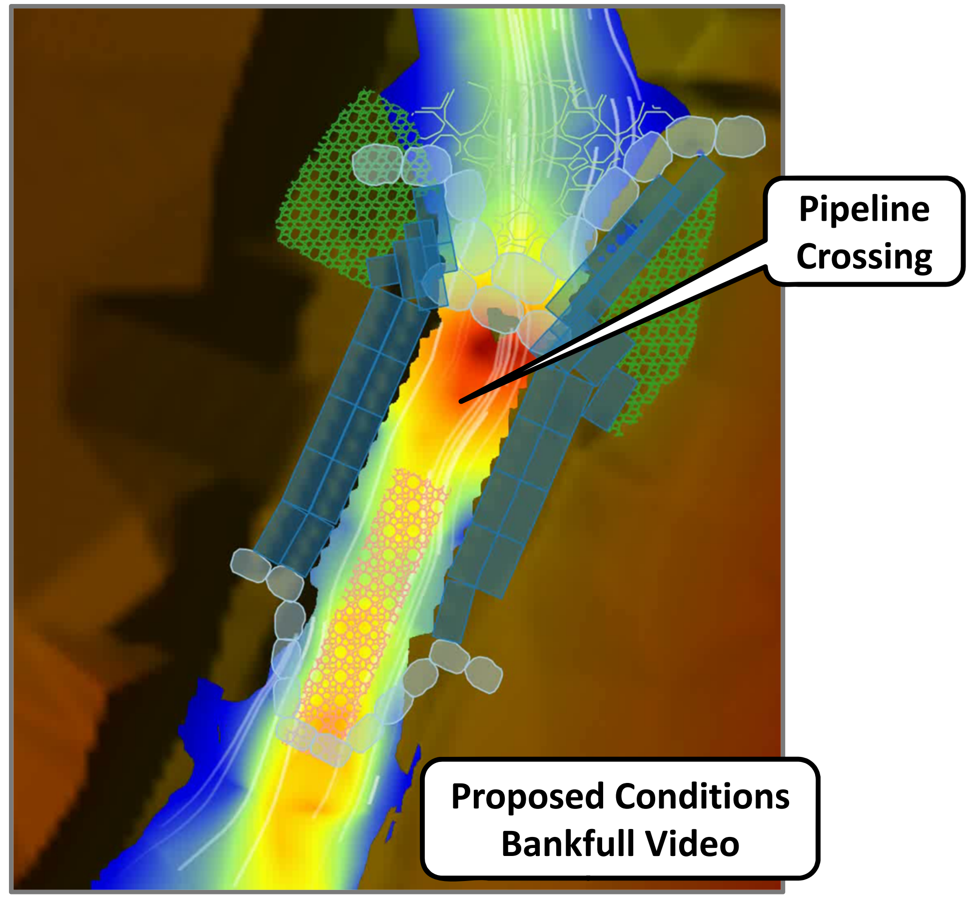
Project Approach





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Representative Projects

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Construction Time-Lapse Video

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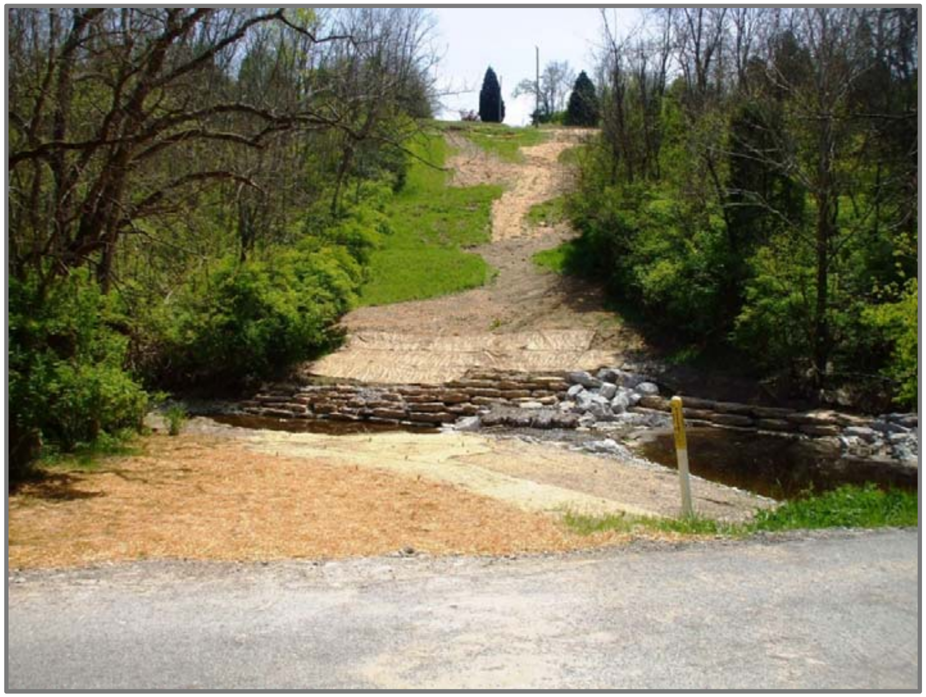
Summary

If you build it… it will come…



Thank You
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