

# Culverts in HEC-RAS 2025

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US Army Corps  
of Engineers®



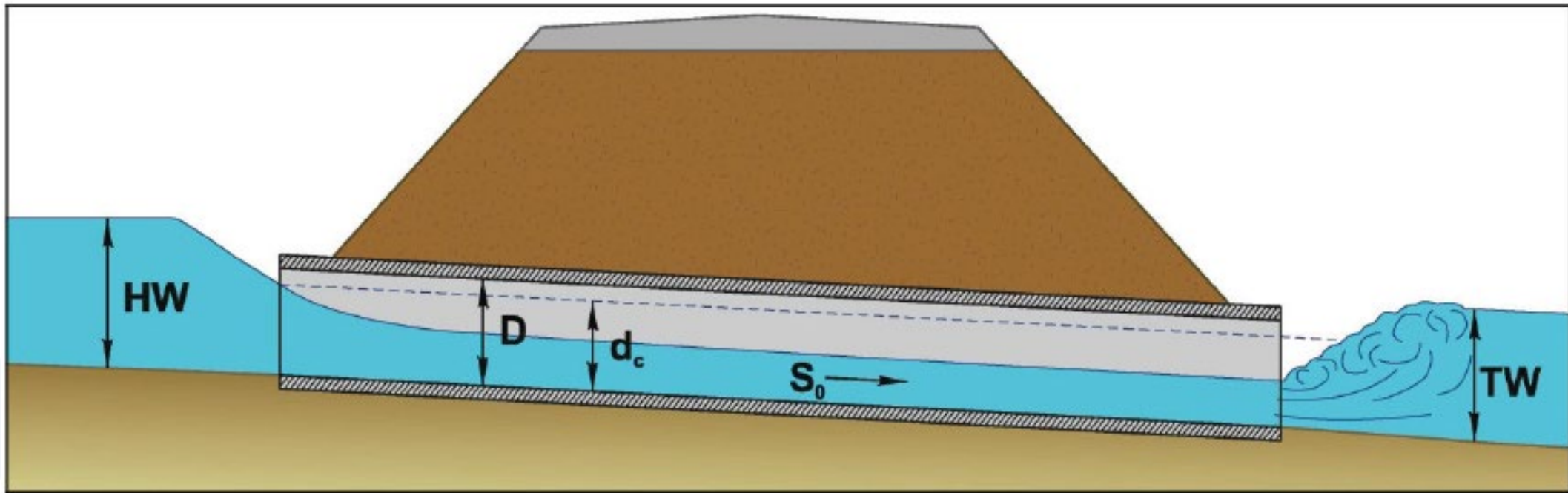
# Outline

- Culvert hydraulics refresher
- Entering culvert data in 2025
- Limitations and future advancements
- FAQs



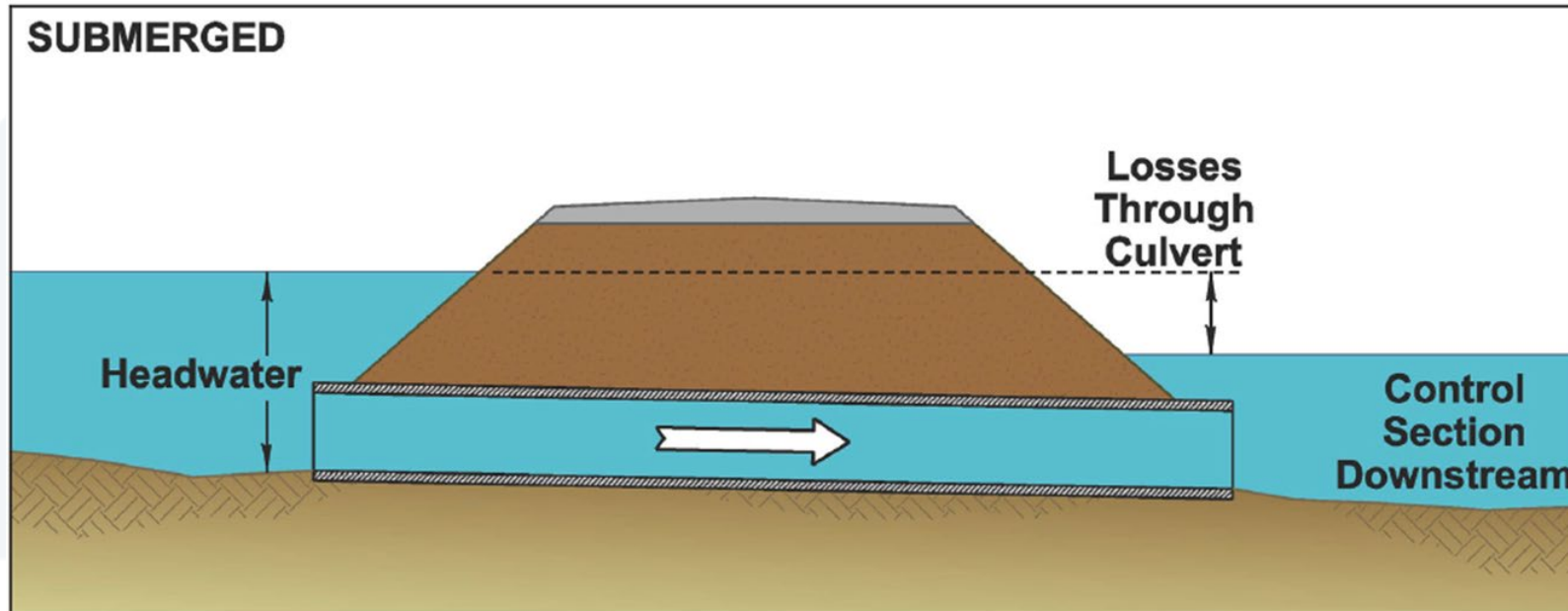
# Culvert Hydraulics Introduction

- RAS 2025 follows FHWA Hydraulic Design of Highway Culverts guidance for culvert computations
- Computations are mostly the same as RAS 6
- Inlet Control or Outlet Control condition



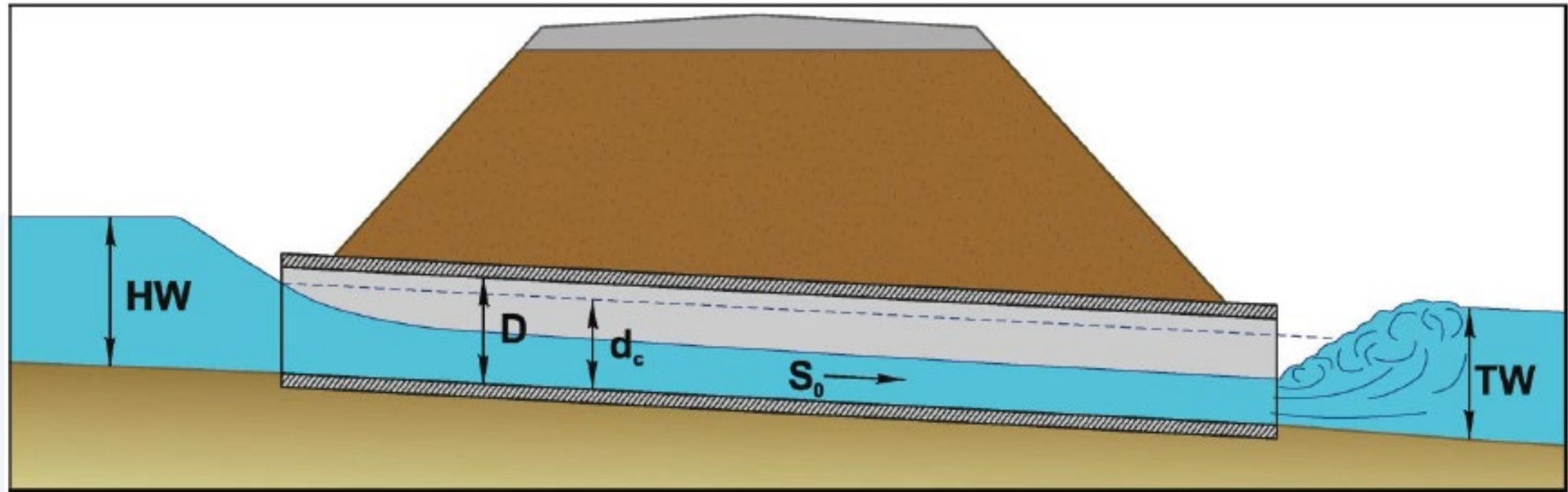
# Outlet Control

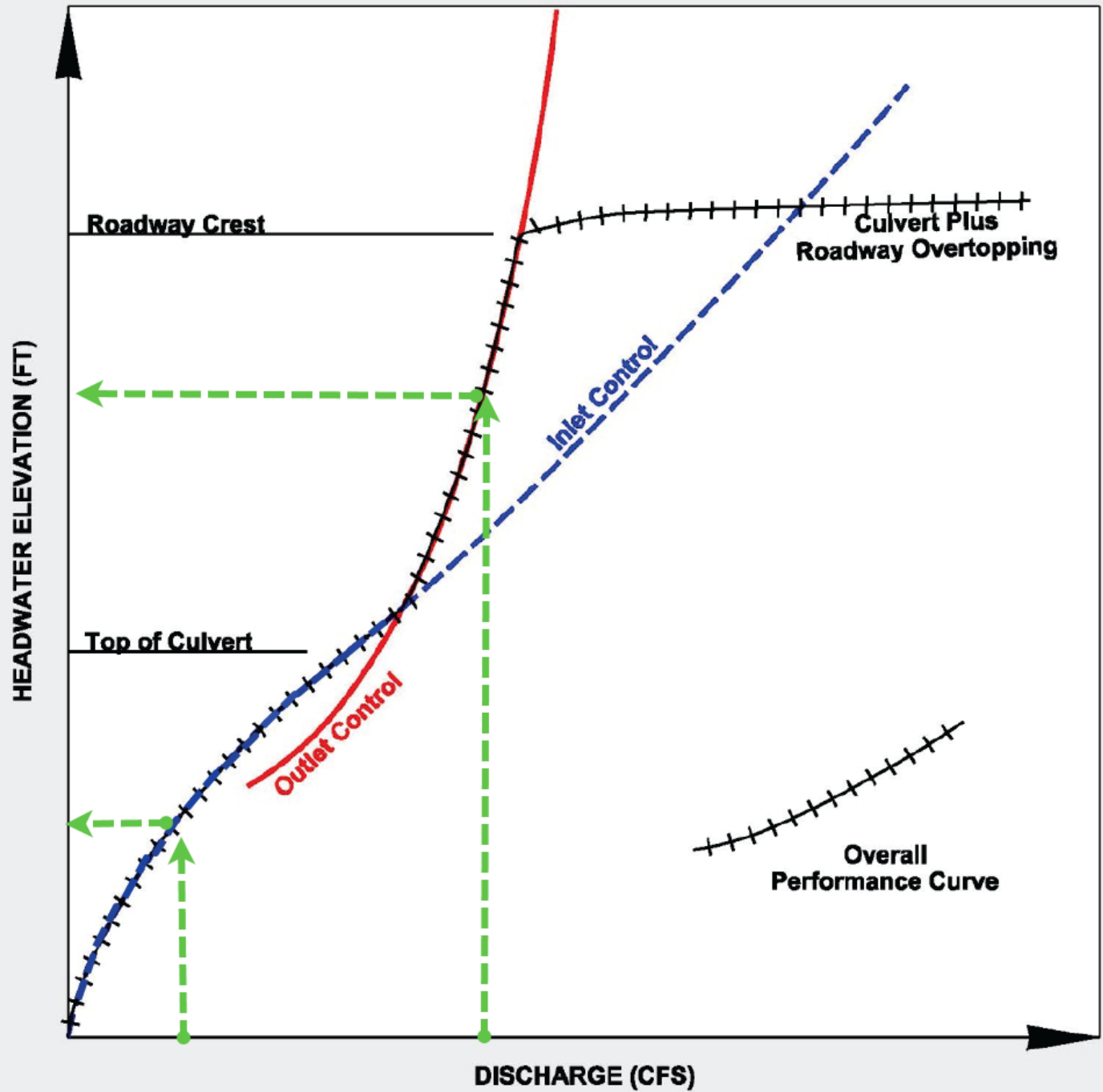
- Occurs when the flow capacity is limited by downstream conditions (high tailwater) or by the capacity of the barrel
- Flow is subcritical
- An energy balance is computed across the culvert
- Exit, entrance, and frictions losses are considered



# Inlet Control

- Occurs when the flow capacity of the entrance is less than the flow capacity of the barrel
- Flow is supercritical
- Flow capacity depends on the entrance geometry (Chart & Scale)





# RAS 7 Culverts Setup

**Inline Structure Data - Complete\_Geometry\_StorageAreas**

File View Options Help

River: **Bigheart Creek** Apply Data + [Camera]

Reach: **Reach1** River Sta.: **3715** Floodway Structu ↓ ↑

Upstream XS: **3871** Upstream channel length: **338.01 (ft)**

Description: **Charles Page Blvd Floodway Structure** ...

Pilot Flow: **0** Breach (plan data) ... Rules (unsteady data) ...

All Culverts: **No Flap Gates**

**Weir / Embankment** Tulsa\_WestTulsa\_Levees Plan: Complete\_May\_1984\_Event\_StorageAreas 3/22/2015

**Gate** H W

**Culvert**

**Outlet RC**

**Outlet TS**

**Legend**

- Ground
- Ineff
- Bank Sta

**Culvert Data Editor**

Culvert Group: **Culvert #1** ↓ ↑ [Reset] [Close] [Print]

Solution Criteria: **Computed Flow Control**

Shape: **Box** Span: **10** Rise: **10**

Chart #: **58- Rectangular concrete**

Scale #: **2 - Side tapered; More favorable edges**

Distance to Upstrm XS: **45**

Culvert Length: **190**

Entrance Loss Coeff: **0.5** ?

Exit Loss Coeff: **1** ?

Manning's n for Top: **0.012** ?

Manning's n for Bottom: **0.012**

Depth to use Bottom n: **0**

Depth Blocked: **0**

Upstream Invert Elev: **631**

Downstream Invert Elev: **630**

Use Momentum (GIS/2D only)

**Culvert Barrel Data**

Barrel Centerline Stations # Barrels : **5**

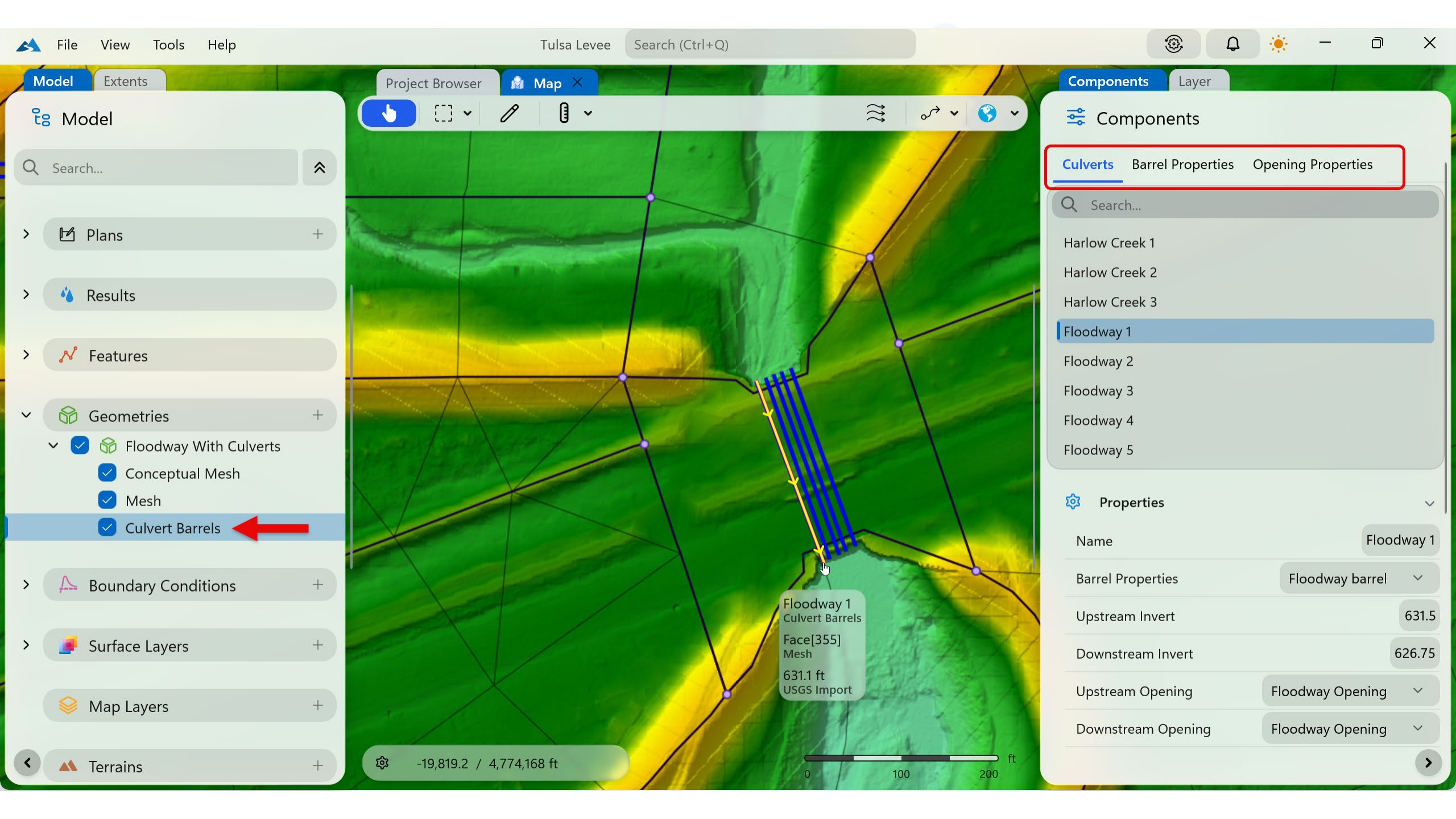
Barrel Name	US Sta	DS Sta
1 Barrel #1	117	117
2 Barrel #2	127.5	127.5
3 Barrel #3	138	138
4 Barrel #4	148.5	148.5
5 Barrel #5	159	159

Barrel GIS Data: Barrel #1 Length: **0** [Reset]

X	Y
1	
2	
3	
4	
5	

Individual Barrel Centerlines ... Show on Map OK Cancel Help

Enter the culvert barrel names and centerline stations.



**Model** Extents

Model

Search...

- Plans
- Results
- Features
- Geometries
  - Floodway With Culverts
    - Conceptual Mesh
    - Mesh
    - Culvert Barrels**
- Boundary Conditions
- Surface Layers
- Map Layers
- Terrains

Project Browser Map

Hand Select Lasso Edit Measure

Waves Path Earth

**Components** Layer

Components

Culverts Barrel Properties Opening Properties

Search...

- Harlow Creek 1
- Harlow Creek 2
- Harlow Creek 3
- Floodway 1**
- Floodway 2
- Floodway 3
- Floodway 4
- Floodway 5

Properties

Name	Floodway 1
Barrel Properties	Floodway barrel
Upstream Invert	631.5
Downstream Invert	626.75
Upstream Opening	Floodway Opening
Downstream Opening	Floodway Opening

Floodway 1  
Culvert Barrels  
Face[355]  
Mesh  
631.1 ft  
USGS Import

-19,819.2 / 4,774,168 ft

0 100 200 ft

# Entering Culverts in 2025

- Design philosophy: geospatial first, flexibility, reusability
- Individual Culvert Barrels are drawn in the map
  - US to DS
  - Culverts are not attached to a 'structure'
  - Culverts are not tied to a 'Culvert Group'
- Culvert properties are shared among culvert barrels
  - Barrel Properties
  - Opening Properties

# RAS Culvert Data Components

- Culvert

1. Feature Line (Location)

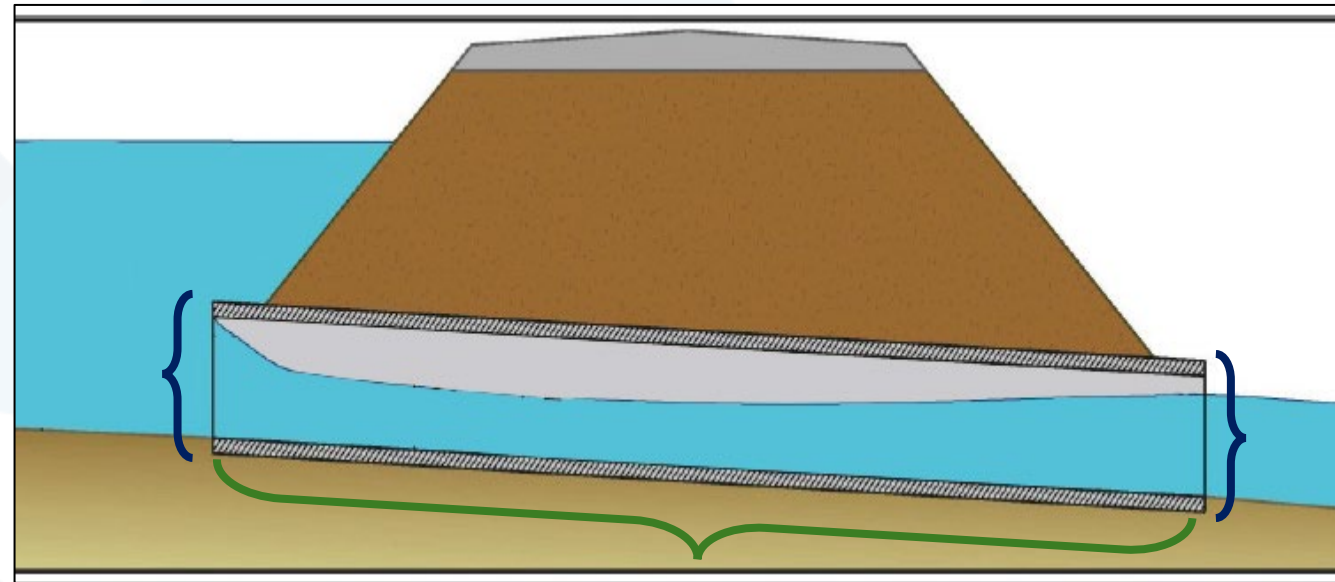
2. US / DS Inverts

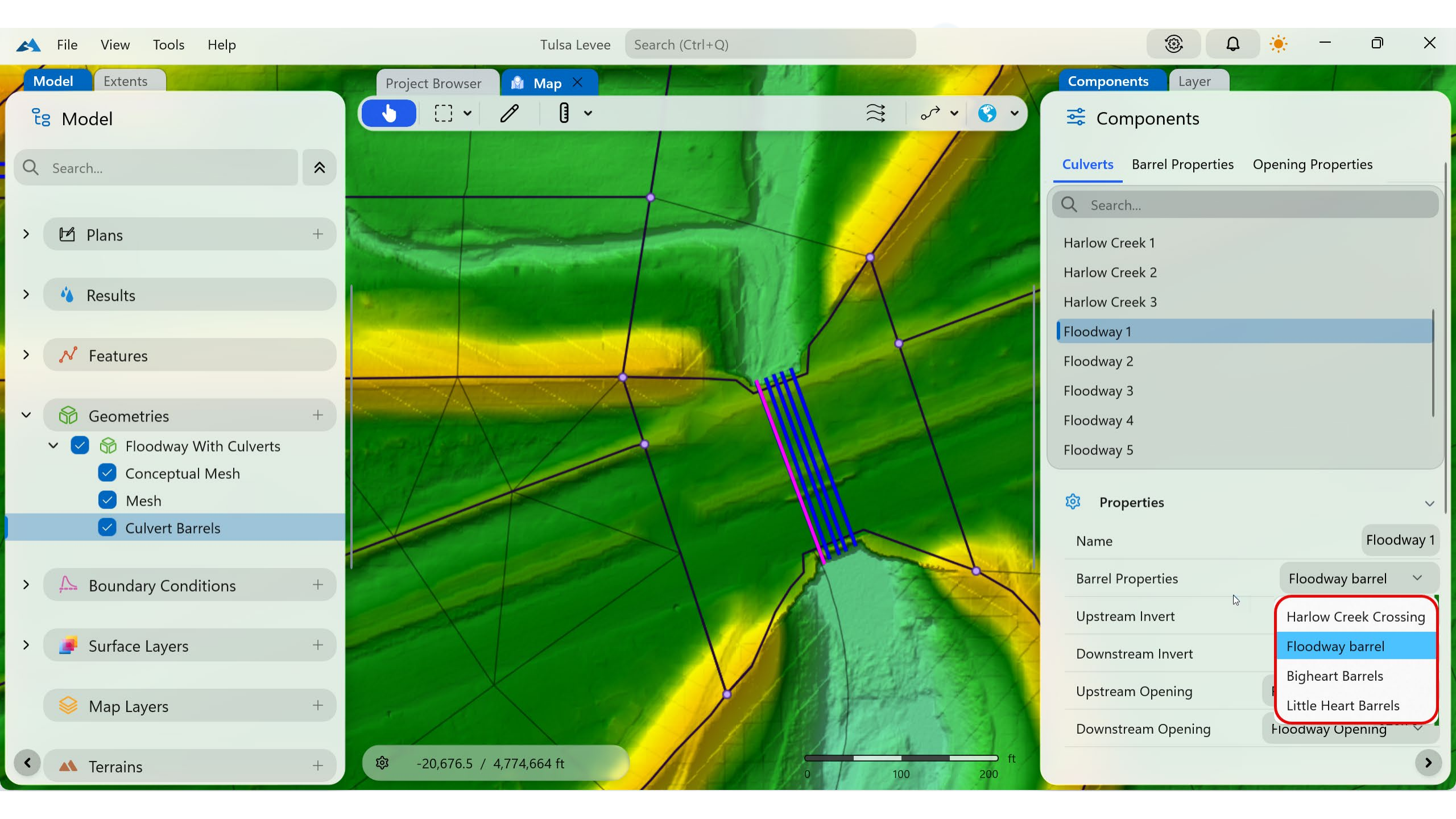
3. Barrel Properties

- Rise
- Span
- Shape
- N Values
- Depth blocked

4. Opening Properties (US/DS)

- Entrance K
- Exit K
- Inlet Configuration





**Model** Extents

Project Browser **Map** X

Model

Search...

- Plans +
- Results
- Features
- Geometries +
  - Floodway With Culverts
    - Conceptual Mesh
    - Mesh
    - Culvert Barrels
- Boundary Conditions +
- Surface Layers +
- Map Layers +
- Terrains +

Project Browser **Map** X

Hand Select Lasso Erase Measure Undo Redo Refresh

**Components** Layer

Components

Culverts Barrel Properties Opening Properties

Search...

- Harlow Creek 1
- Harlow Creek 2
- Harlow Creek 3
- Floodway 1
- Floodway 2
- Floodway 3
- Floodway 4
- Floodway 5

Properties Floodway 1

Barrel Properties Floodway barrel

- Harlow Creek Crossing
- Floodway barrel
- Bigheart Barrels
- Little Heart Barrels

Upstream Invert

Downstream Invert

Upstream Opening

Downstream Opening Floodway Opening

-20,676.5 / 4,774,664 ft



# Barrel Properties

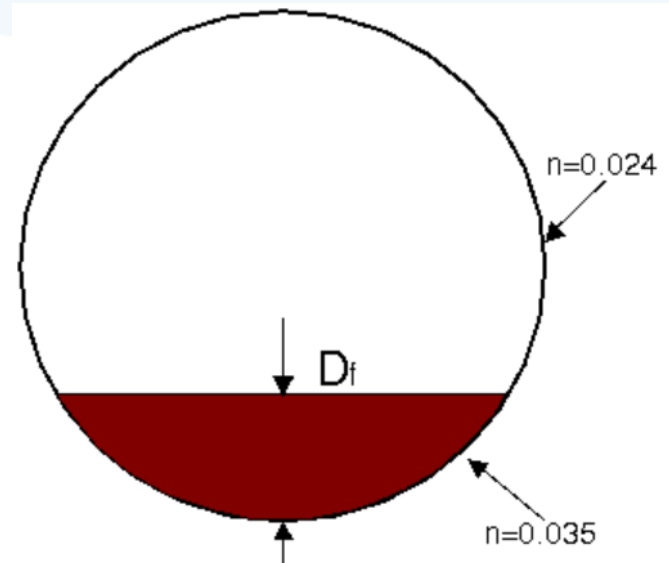
- Rise, Span
- Shape
  - Circle
  - Box
  - Ellipse
- n Values
  - n value
  - Bottom n
  - Bottom n Depth
- Depth blocked

Components Layer

Components

Culverts Barrel Properties Opening Properties

	Name	Rise	Span	Shape	n Value	n Value (B	Depth n V	Depth Blocked
0	Harlow Creek Crossing	6	25	Ellipse	0.02		0	0
1	Floodway barrel	10	10	Box	0.02		0	0
2	Bigheart Barrels	15	15	Circle	0.02		0	0
3	Little Heart Barrels	8	8	Circle	0.025	0.035	1	1
4								



# Opening Properties

## Outlet Control

- K Entrance
- K Exit

## Inlet Control

- Inlet Configuration



Components Layer

Components

Culverts Barrel Properties **Opening Properties**

	Name	K Entrance	K Exit	Inlet Configuration
0	Harlow Entrance	0.5	0.5	BoxCulvert_FlaredWingwalls30to75
1	Floodway Opening	0.5	0.6	BoxCulvert_FlaredWingwalls30to75
2	Big Heart Creek Entrance	0.5	0.8	BoxCulvert_FlaredWingwalls30to75
3	Little Heart Creek Entrance	0.9	0.6	CorrugatedMetalPipeCulvert_ProjectingFromFill
4		0	0	ConcretePipeCulvert_SquareEdgeWithHeadwall
5		+		

# Culverts – Table View

File View Tools Help Tulsa Levee Search (Ctrl+Q)

Model Extents Project Browser Map Culverts

Model

Search...

- Plans
- Results
- Features
- Geometries
  - Floodway With Culverts
    - Conceptual Mesh
    - Mesh
    - Culvert Barrels
- Boundary Condition
- Surface Layers
- Map Layers

Zoom To

- Tools
- Tables
  - Open Culverts Table
- Copy
- Export

Culverts

	Name	Barrel Properties	Upstream Invert	Downstream Invert	Upstream Opening	Downstream Opening
8	Floodway 1	Floodway barrel	631.5	626.75	Floodway Opening	Floodway Opening
9	Floodway 2	Floodway barrel	631.5	626.75	Floodway Opening	Floodway Opening
10	Floodway 3	Floodway barrel	631.5	626.75	Floodway Opening	Floodway Opening
11	Floodway 4		631.5	626.75	Floodway Opening	Floodway Opening
12	Floodway 5	Harlow Creek Crossing	631.5	626.75	Floodway Opening	Floodway Opening
13	West Trib 1	Floodway barrel	642.5	640.9	Little Heart Creek Entarncce	Little Heart Creek Entarncce
14	West Trib 2	Bigheart Barrels	634.8	633.9	Big Heart Creek Entrance	Big Heart Creek Entrance

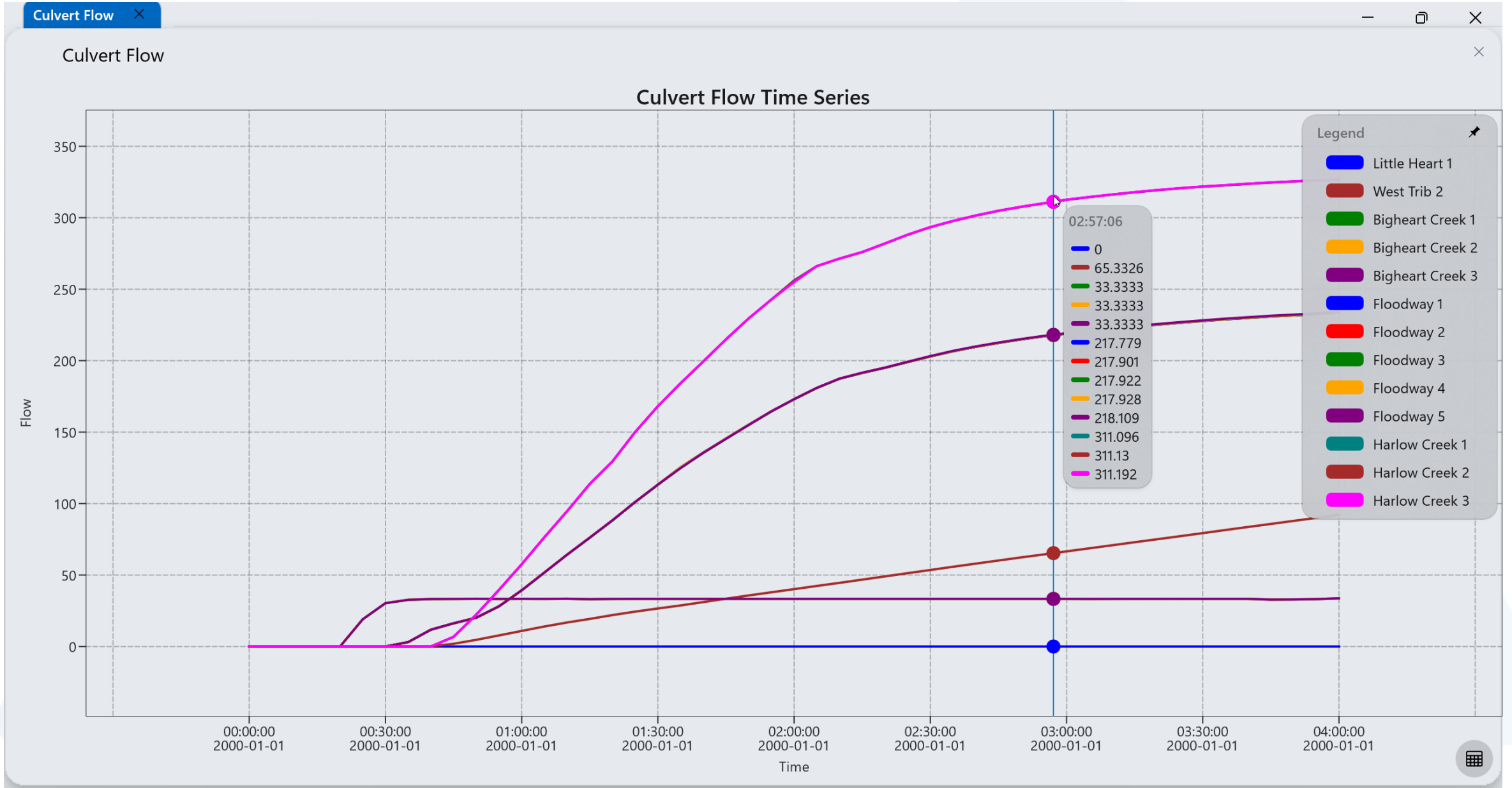
Little Heart Barrels

# Culvert Output

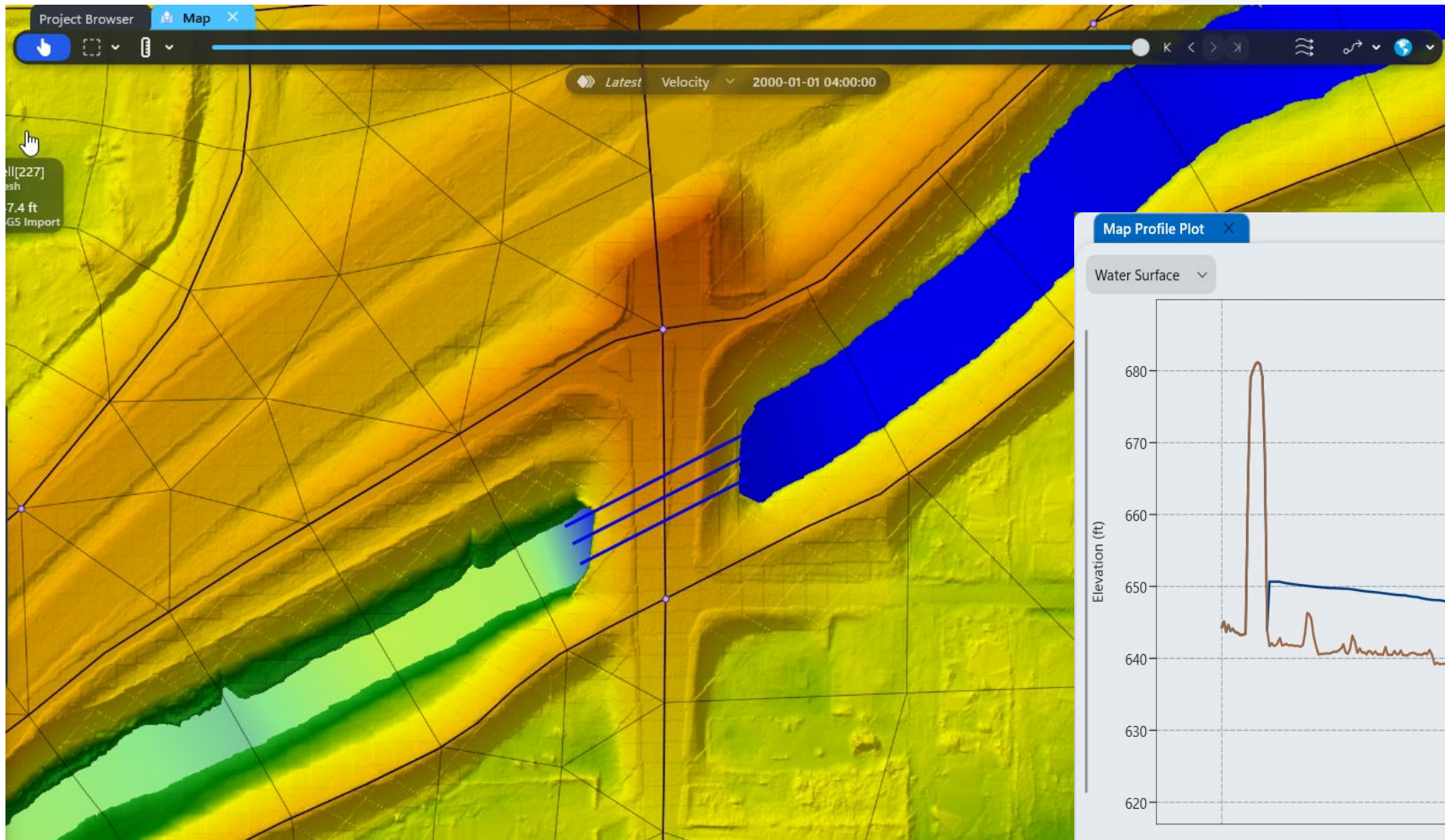
The screenshot displays a software interface for a hydrological model. The main window shows a 3D topographic map with a culvert structure highlighted in purple. The interface is divided into several panels:

- Model Panel (Left):** Contains a search bar and a tree view of model components. The 'Culvert Barrels' option is checked and highlighted with a red box.
- Components Panel (Right):** Lists various culvert components such as 'Little Heart 2', 'Bigheart Creek 1', 'Bigheart Creek 2', 'Bigheart Creek 3', 'Harlow Creek 1', 'Harlow Creek 2', 'Harlow Creek 3', and 'Floodway 1'. Below the list is a 'Properties' section with fields for 'Name', 'Barrel Properties', 'Upstream Invert', 'Downstream Invert', 'Upstream Opening', and 'Downstream Opening'.
- Map Area (Center):** Shows a 3D topographic map with a culvert structure highlighted in purple. A context menu is open over the map, with the 'Plot Flow Time Series' option highlighted by a red box.
- Top Bar:** Includes a menu bar (File, View, Tools, Help), a search bar (Search (Ctrl+Q)), and window controls.
- Bottom Bar:** Shows a scale bar (0 to 200 ft) and a coordinate display (-19,144.9 / 4,775,760 ft).

# Flow Time Series



# Culvert Momentum



# Limitations and Future Advancements

## Short Term

- Culverts only work with shallow water CPU Solver
  - Diffusion wave and GPU are in development
- More results visualization
- Add Weirs

## Medium Term

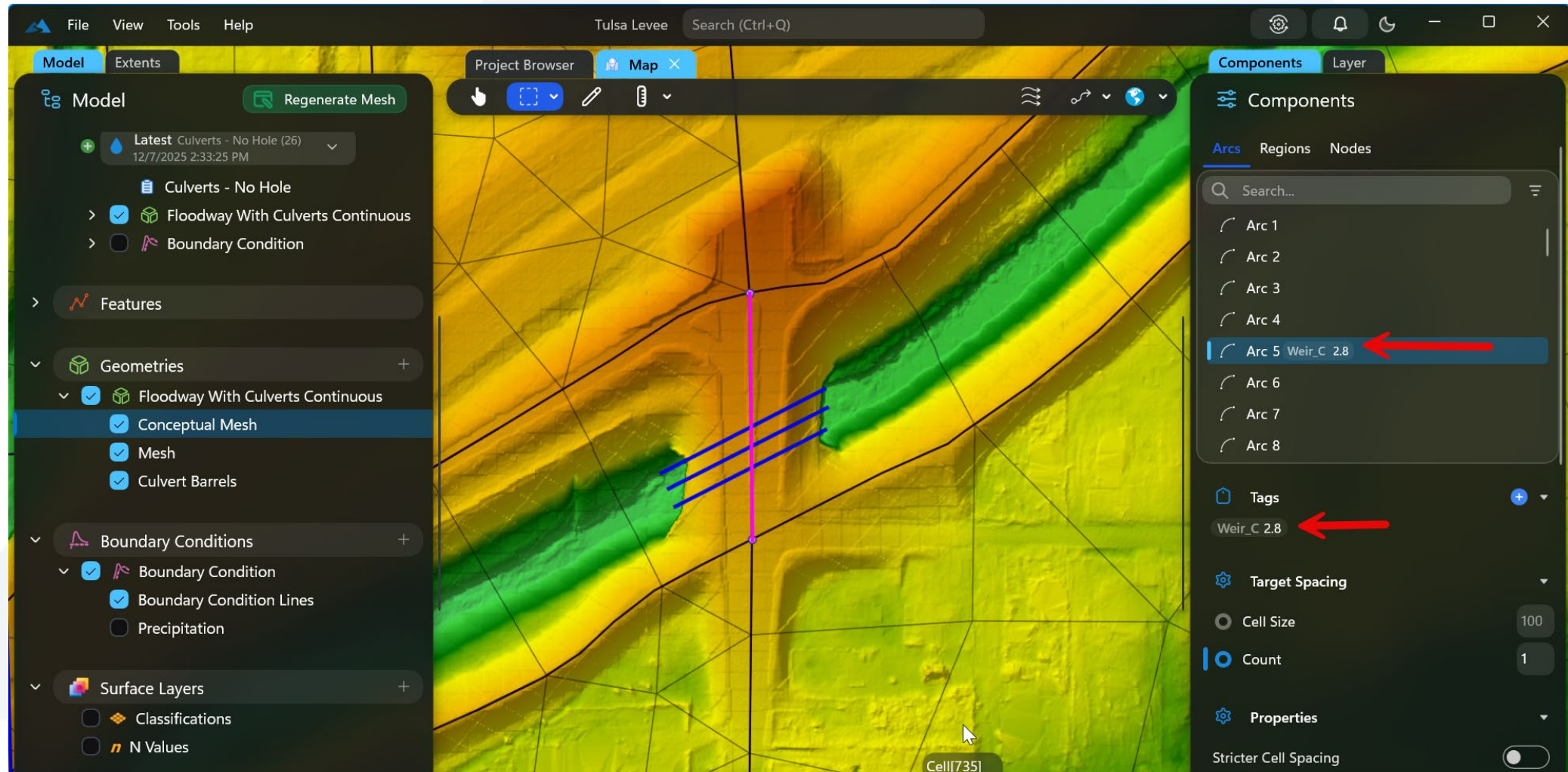
- Inlet Property Cleanup
- Output grouping

## Long Term Vision

- Culverts look more like pipe networks
  - Variable slopes and shapes, junctions, bends, etc.

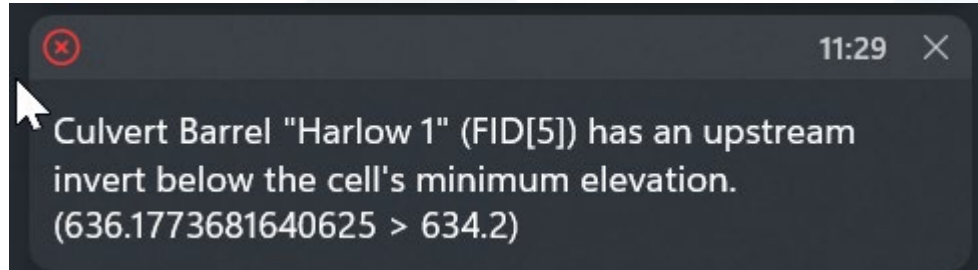
# Coming Soon... Weirs in 2025

- Initial implementation
  - Simply set weir coefficient as tag or arc property



# FAQs

- Why am I getting the culvert invert error? My terrain is clearly below my culvert.



- The terrain minimum is not necessarily the cell minimum
  - Or...you have US / DS parameters mixed
- 
- Does the direction of my culvert line matter?
    - Computationally, no
    - But for sanity sake, absolutely

# Questions

