Culverts in HEC-RAS 2025

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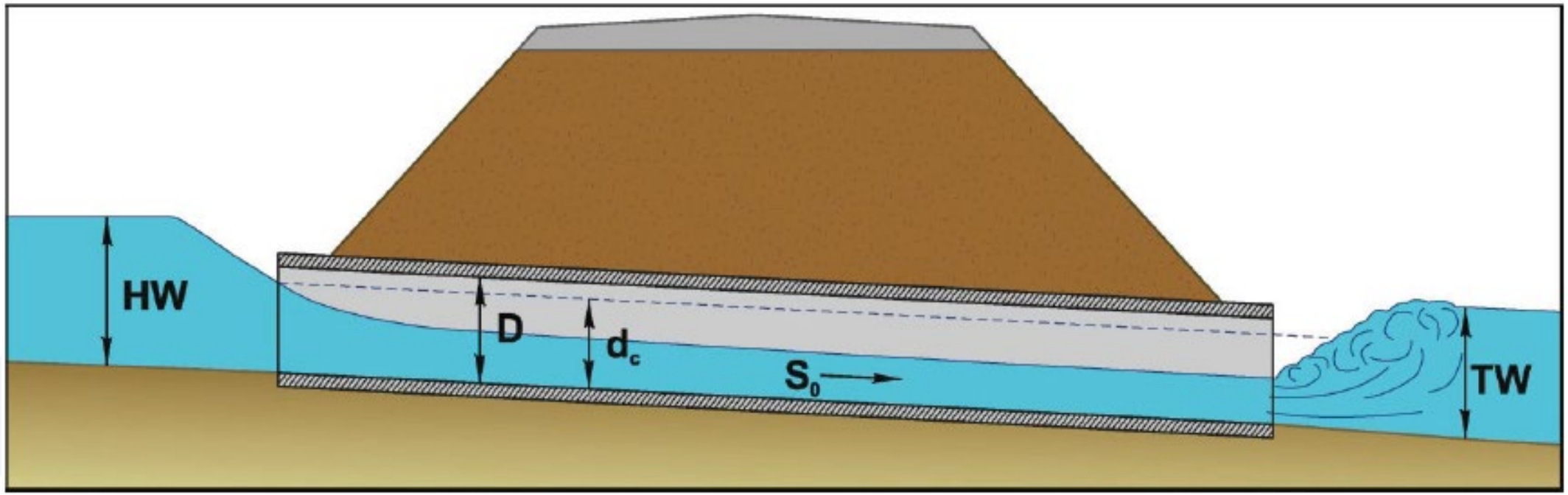
Outline

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

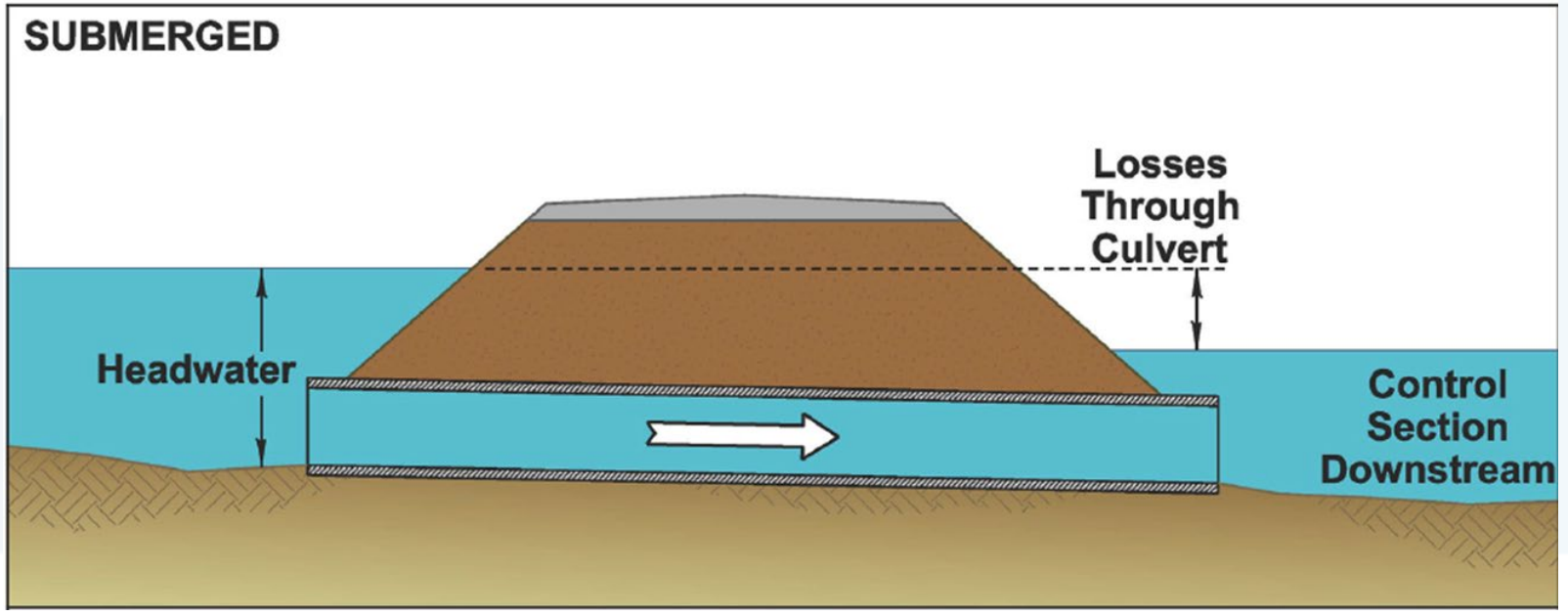
Culvert Hydraulics Introduction

- 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



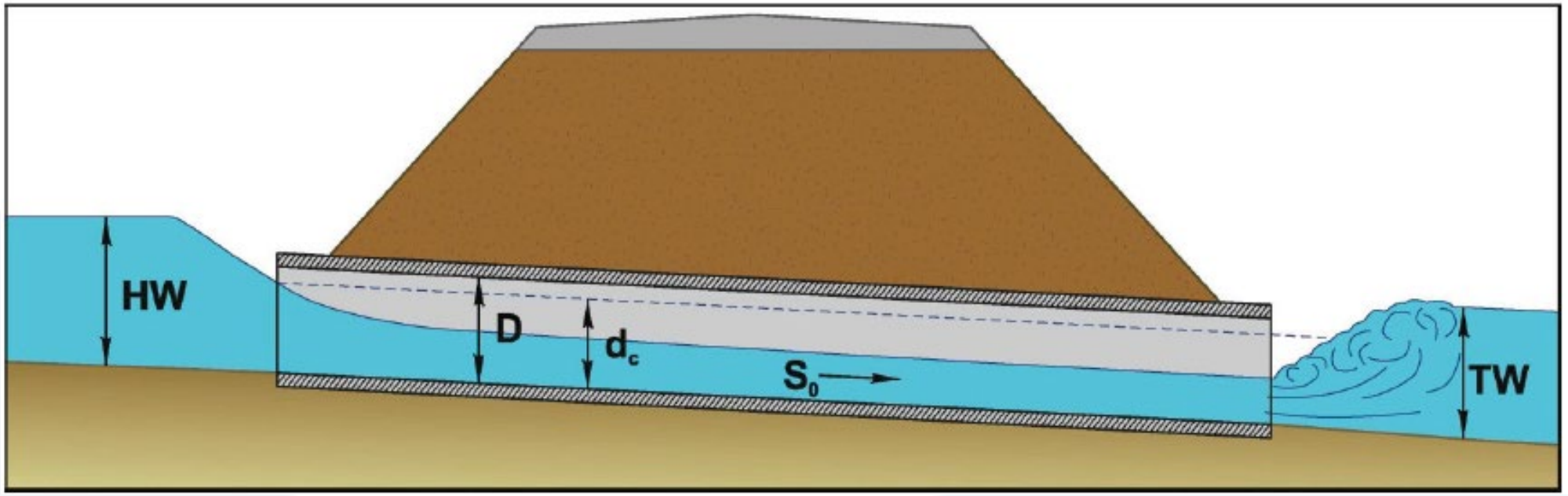
Outlet Control

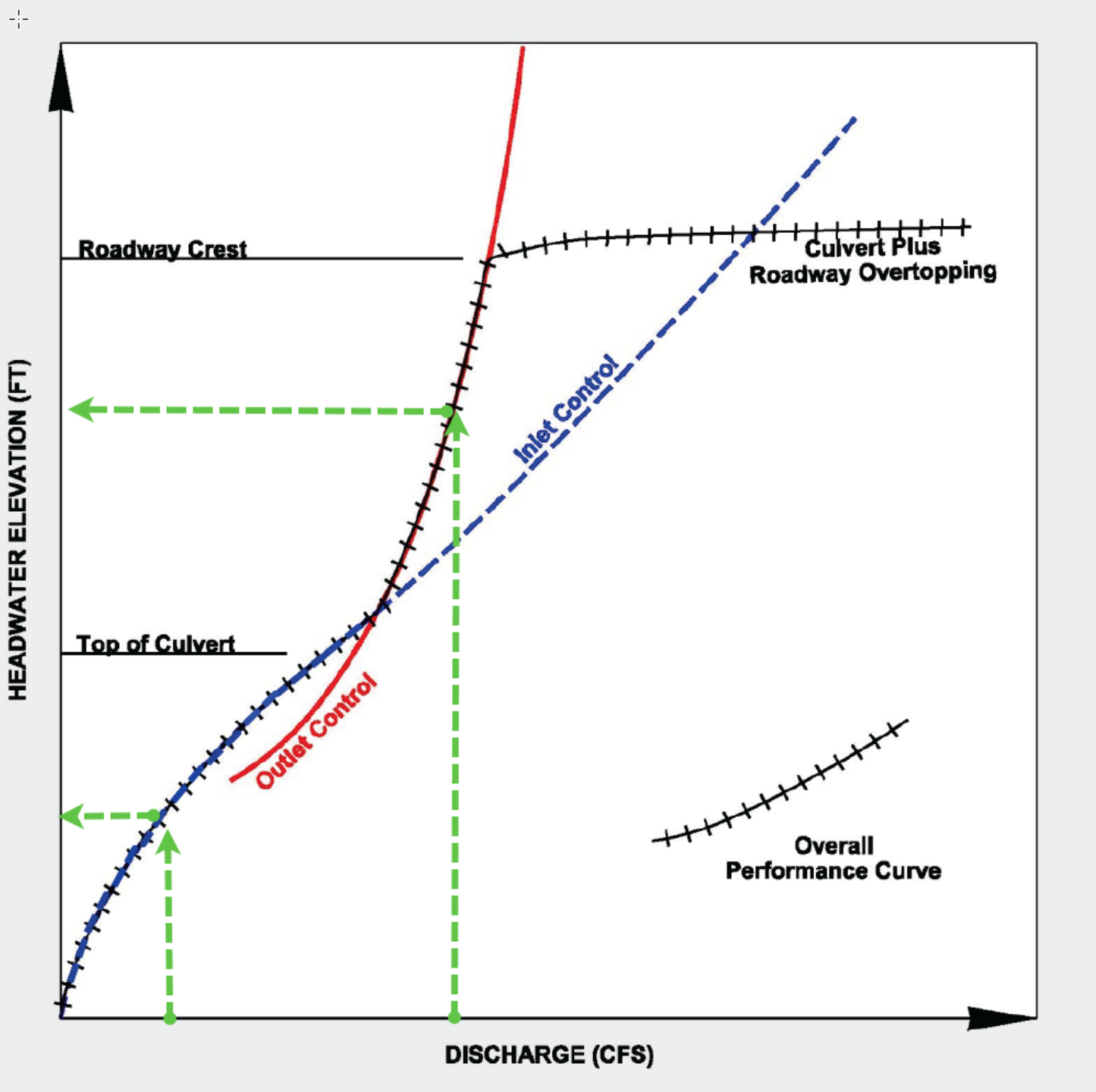
- Occurs when the flow capacity is limited by downstream conditions (high tailwater) or by the capacity of the barrel
- Flow is subcritical
- An energy balance is computed across the culvert
- Exit, entrance, and frictions losses are considered



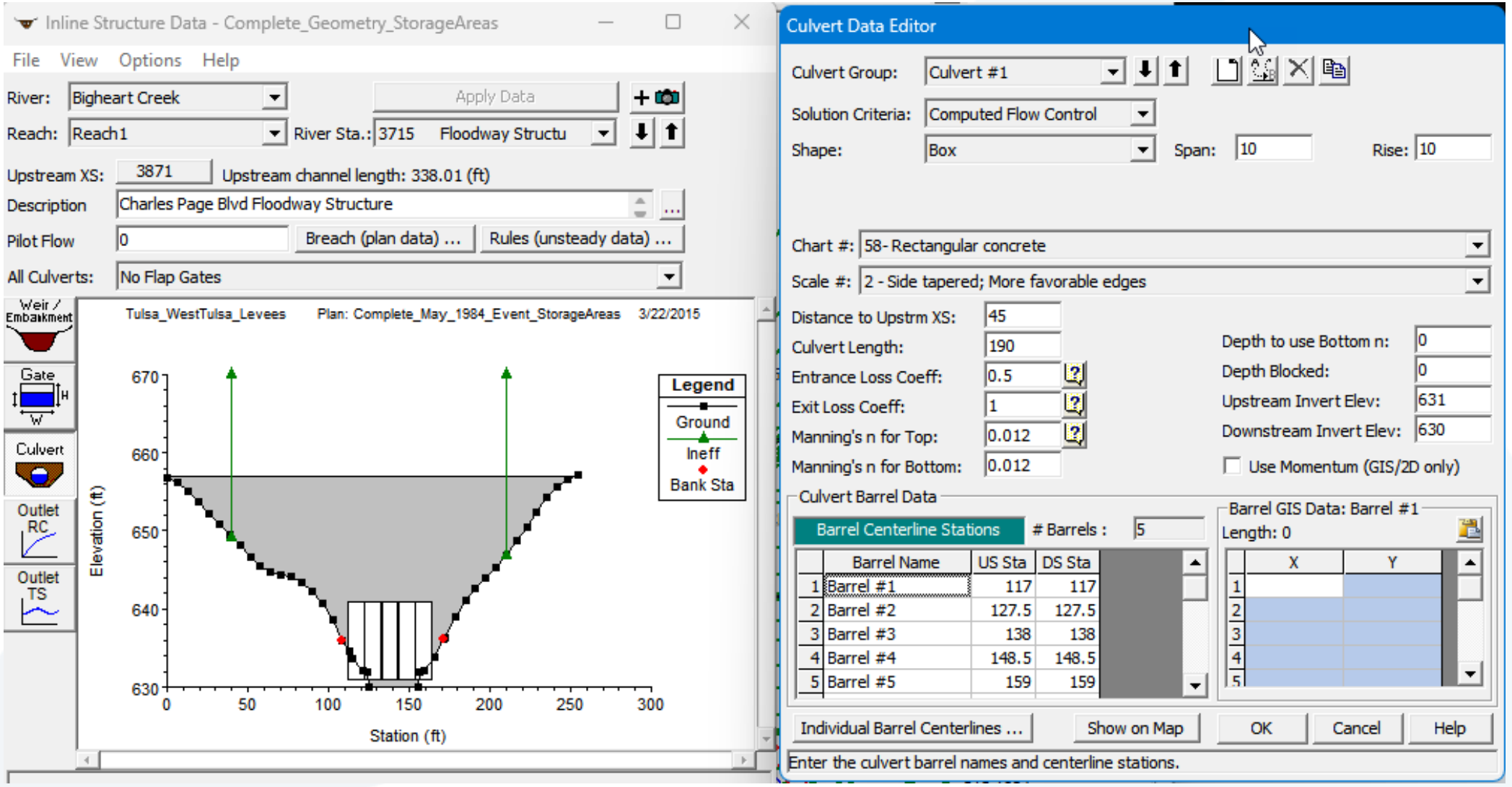
Inlet Control

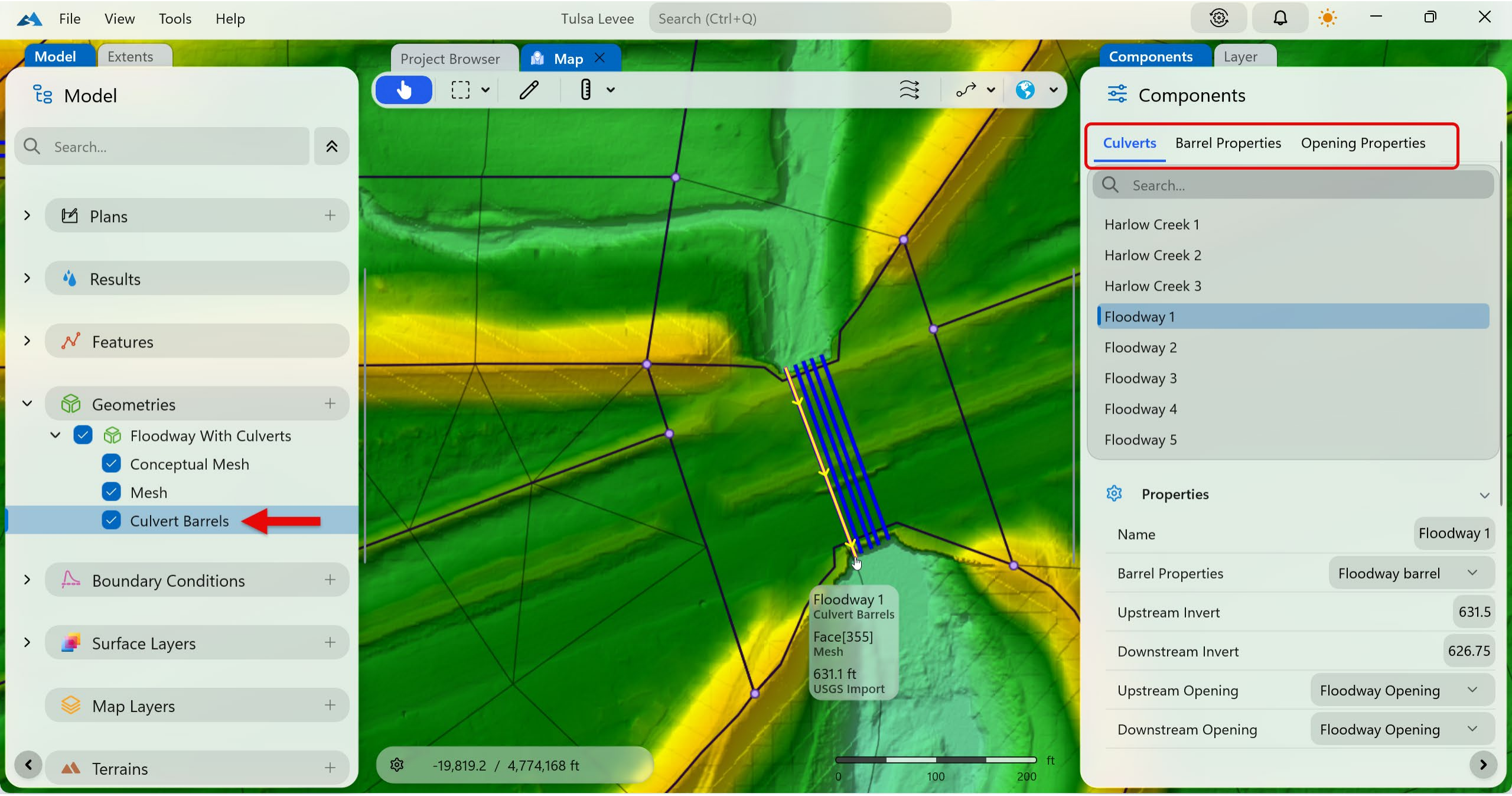
- Occurs when the flow capacity of the entrance is less than the flow capacity of the barrel
- Flow is supercritical
- Flow capacity depends on the entrance geometry (Chart & Scale)




Roadway Crest
Culvert Plus
Roadway Overtopping
Inlet Control
Top of Culvert
Outlet Control
Overall
Performance Curve
HEADWATER ELEVATION (FT)
DISCHARGE (CFS)

RAS 7 Culverts Setup

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Floodway With Culverts
Conceptual Mesh
Mesh
Culvert Barrels
Boundary Conditions
Surface Layers
Map Layers
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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

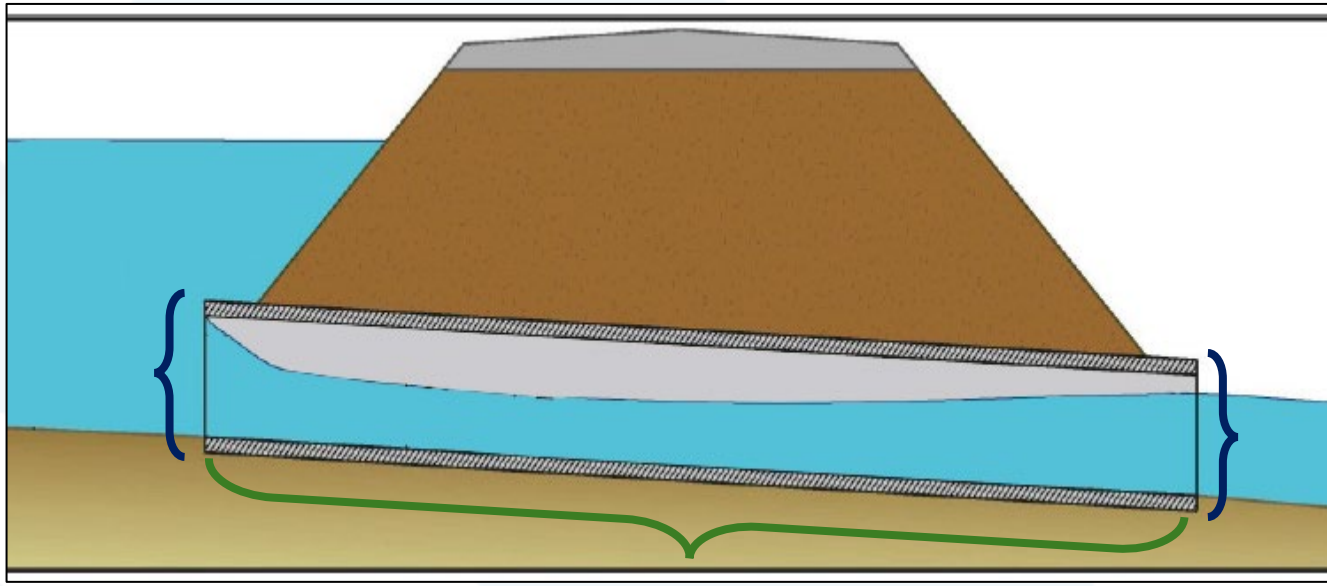
- Design philosophy: geospatial first, flexibility, reusability

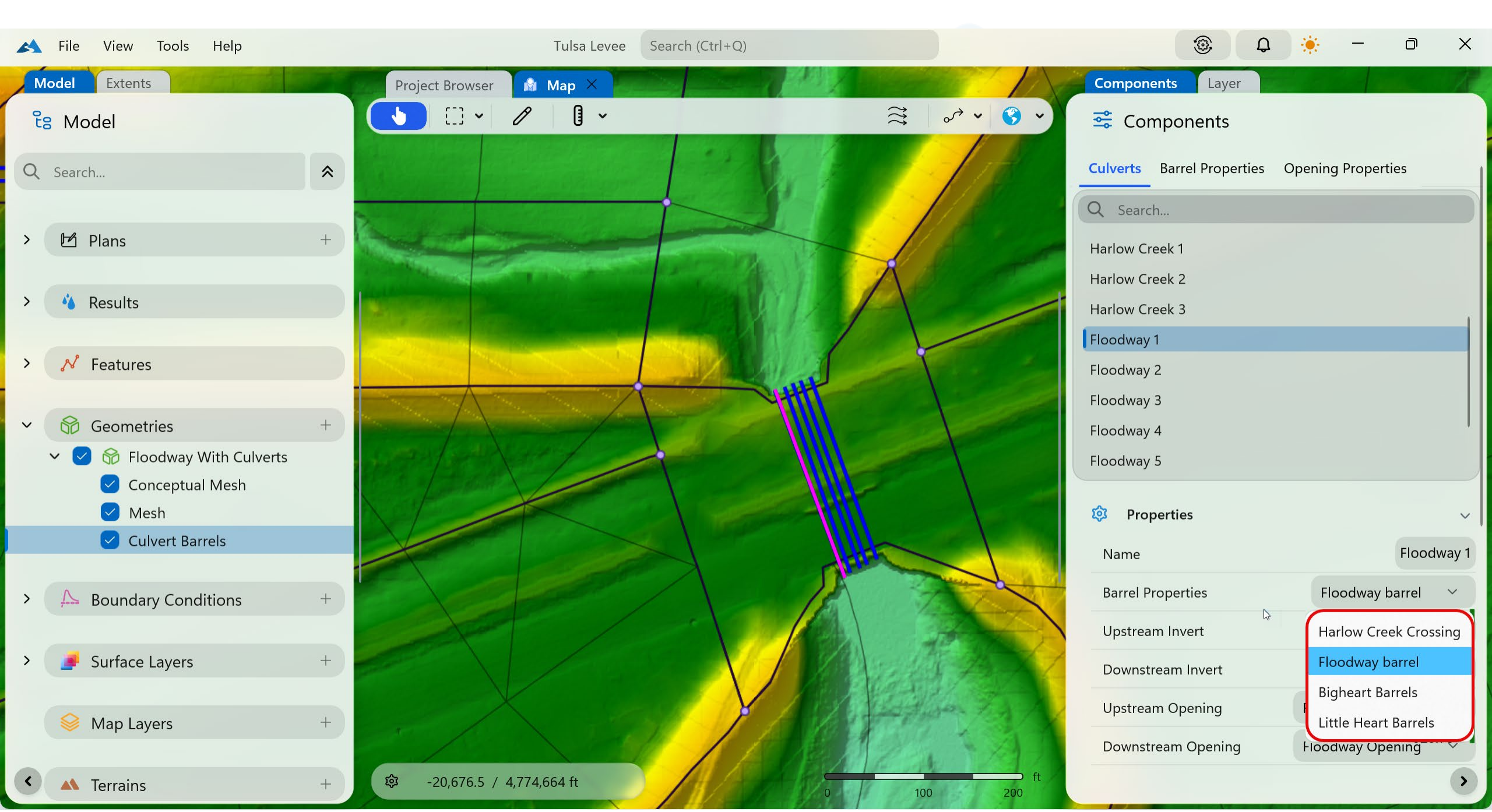
- Individual Culvert Barrels are drawn in the map
  - US to DS
  - Culverts are not attached to a ‘structure’
  - Culverts are not tied to a ‘Culvert Group’

- 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

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Harlow Creek 1
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Harlow Creek 3
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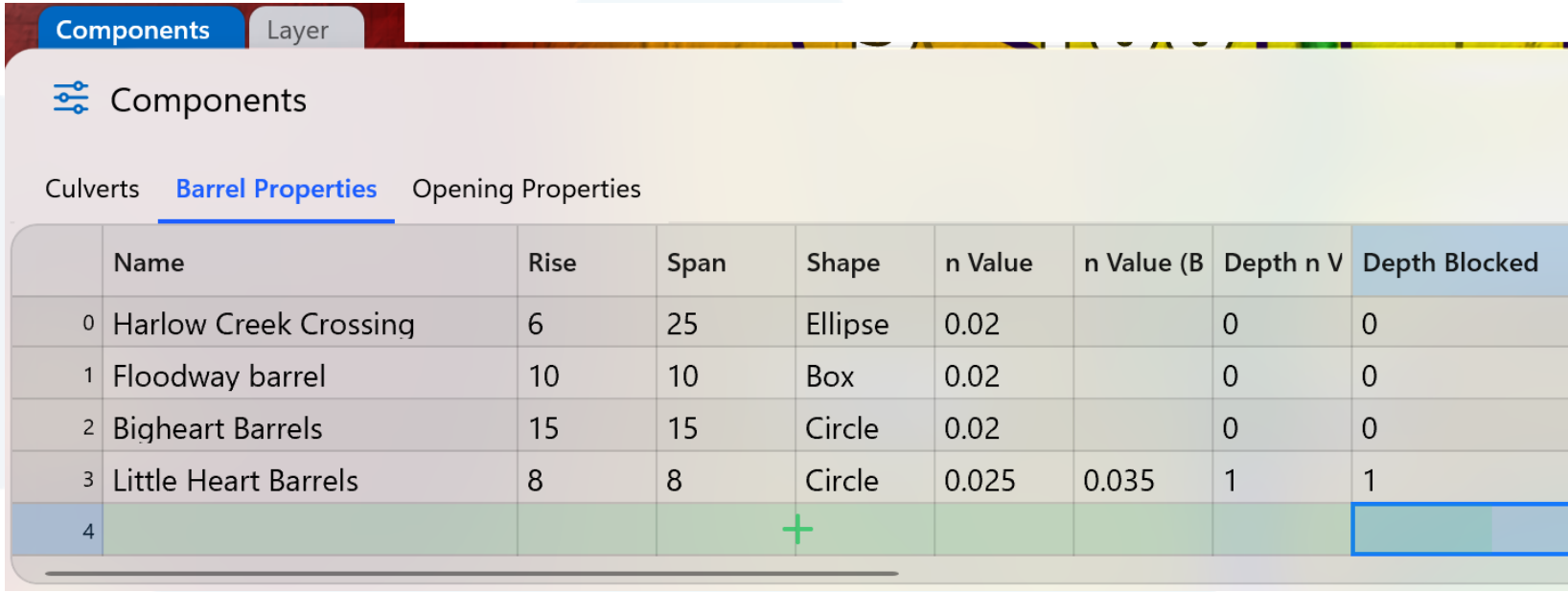
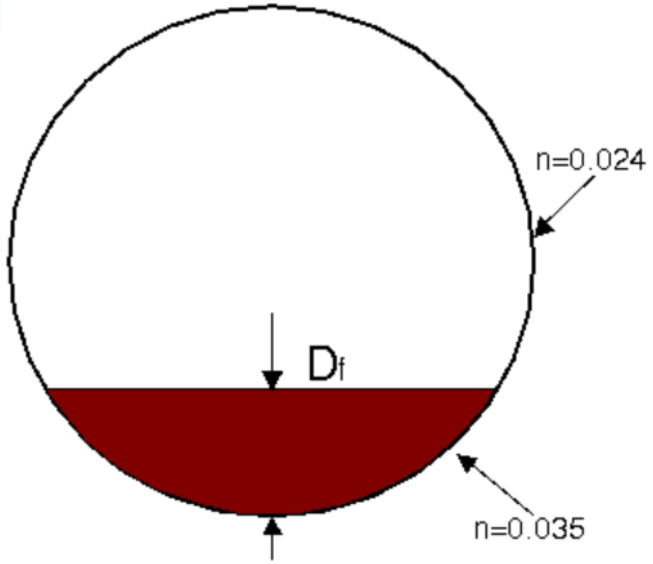
Floodway 2
Floodway 3
Floodway 4
Floodway 5
Properties
Name
Floodway 1
Barrel Properties
Floodway barrel
Upstream Invert
Downstream Invert
Upstream Opening
Downstream Opening
Floodway Opening
Harlow Creek Crossing
Floodway barrel
Bigheart Barrels
Little Heart Barrels
-20,676.5 / 4,774,664 ft
0
100
200
ft

Barrel Properties

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



	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								



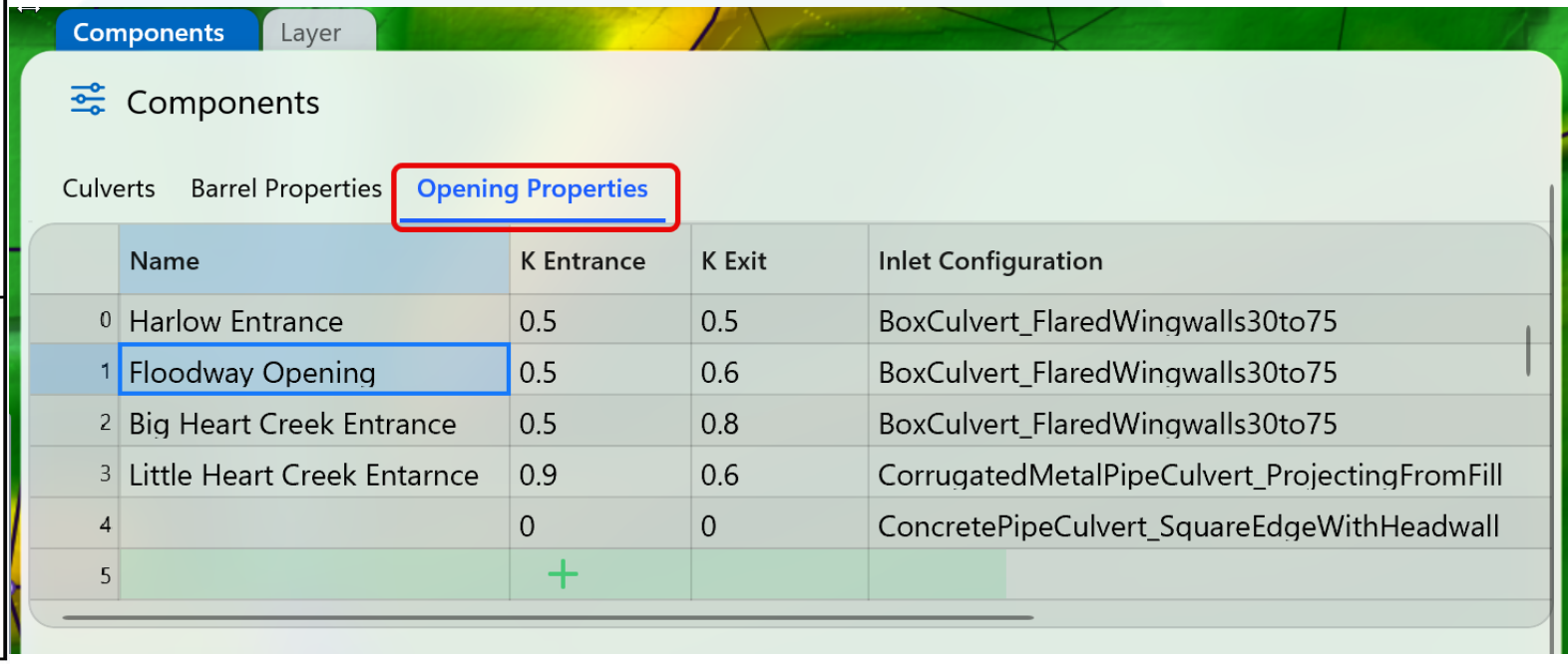
Opening Properties

Outlet Control

- KEntrance
- KExit

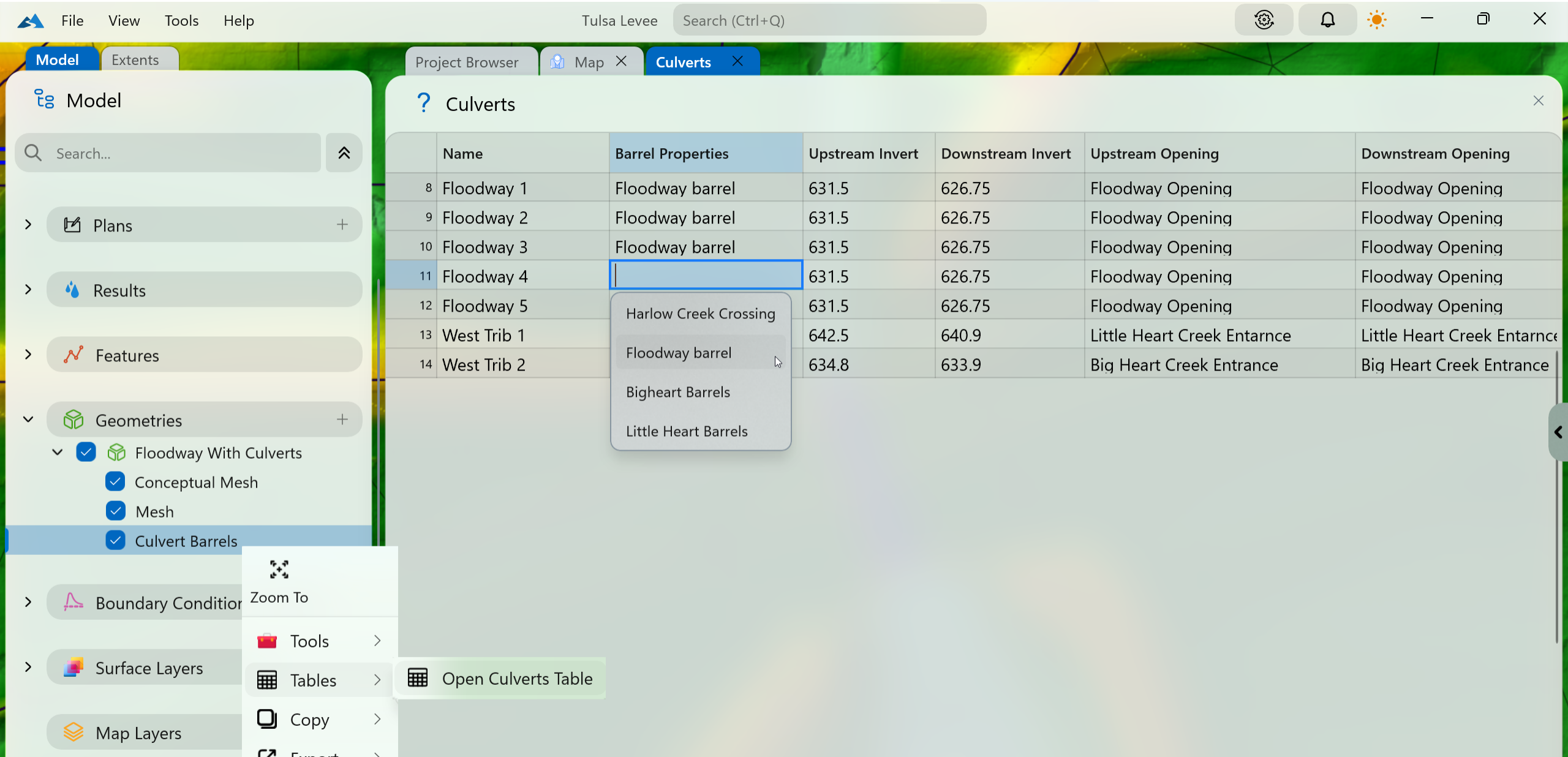
Inlet Control

- Inlet Configuration

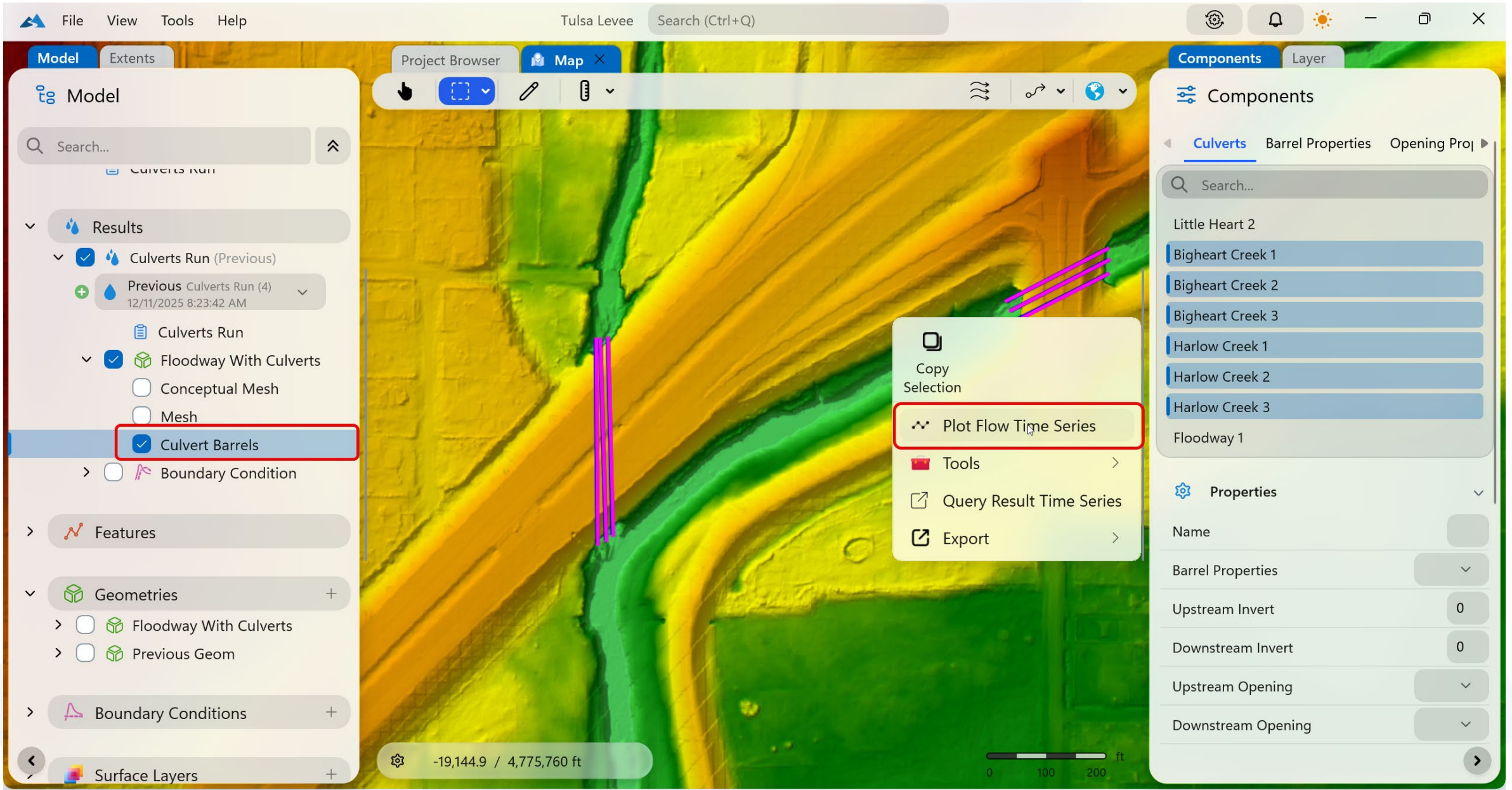


	Name	K Entrance	K Exit	Inlet Configuration
0	Harlow Entrance	0.5	0.5	BoxCulvert_FlaredWingwalls30to75
1	Floodway Opening	0.5	0.6	BoxCulvert_FlaredWingwalls30to75
2	Big Heart Creek Entrance	0.5	0.8	BoxCulvert_FlaredWingwalls30to75
3	Little Heart Creek Entarnce	0.9	0.6	CorrugatedMetalPipeCulvert_ProjectingFromFill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

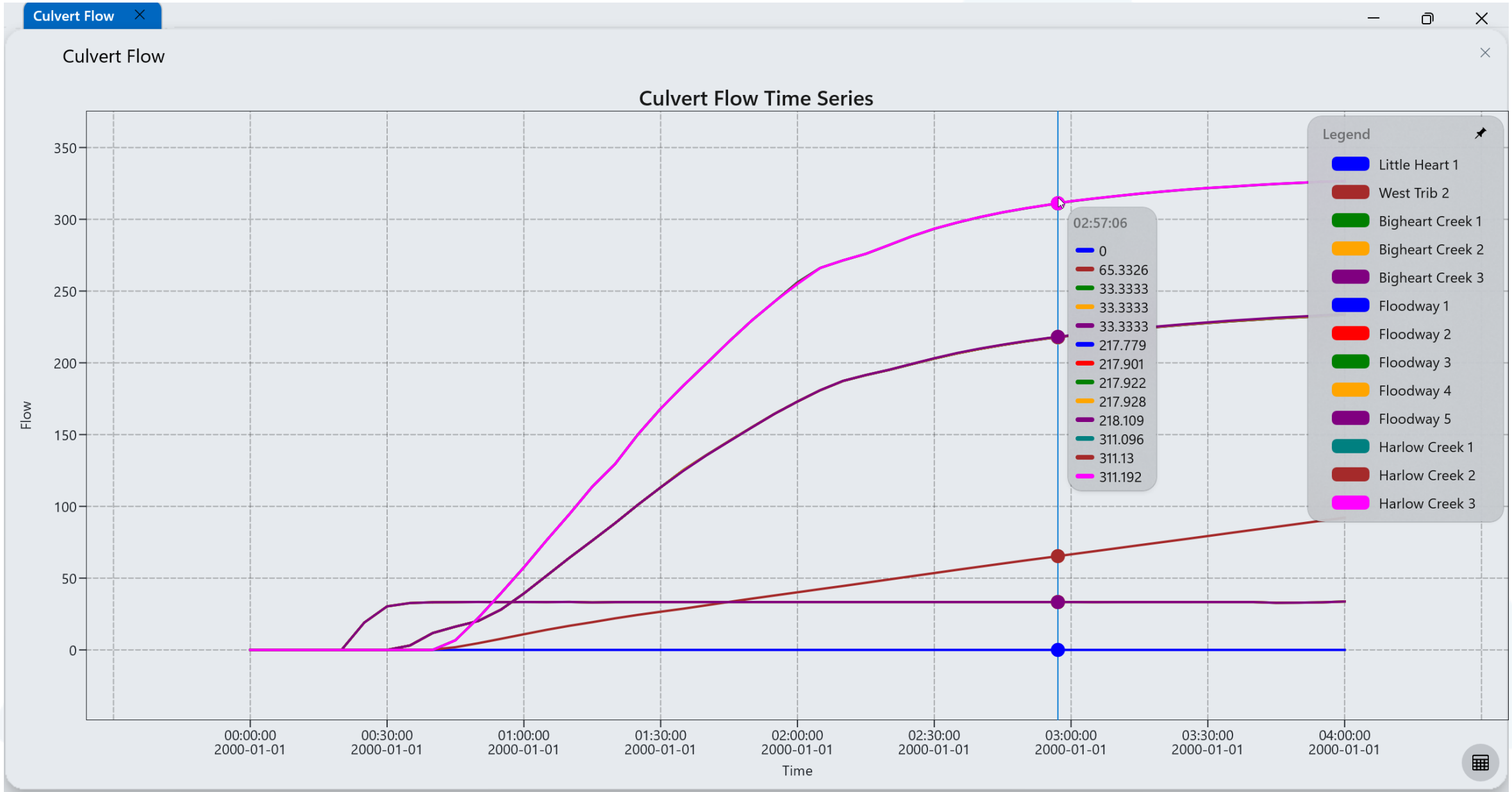
Culverts – Table View



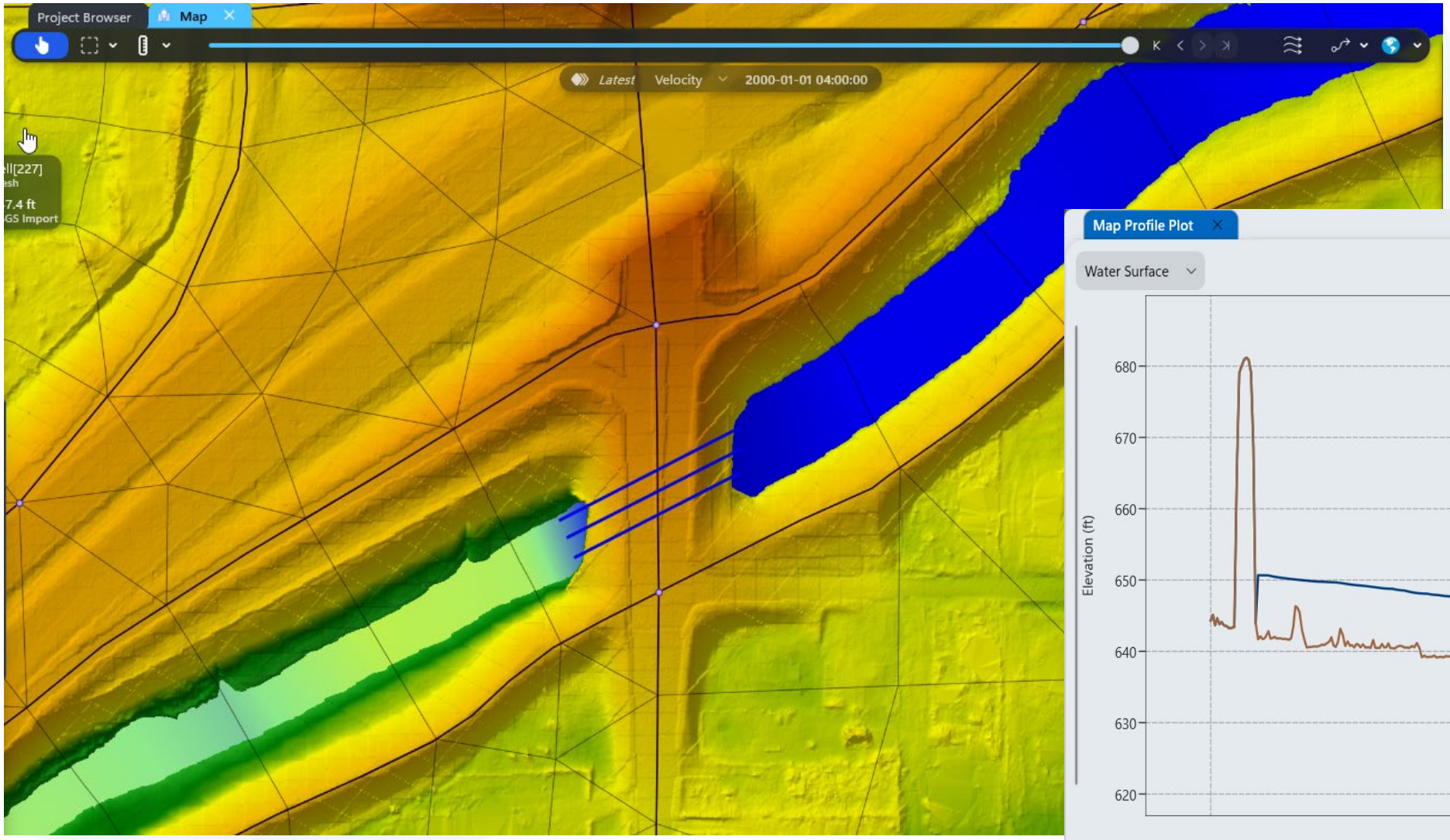
Culvert Output



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

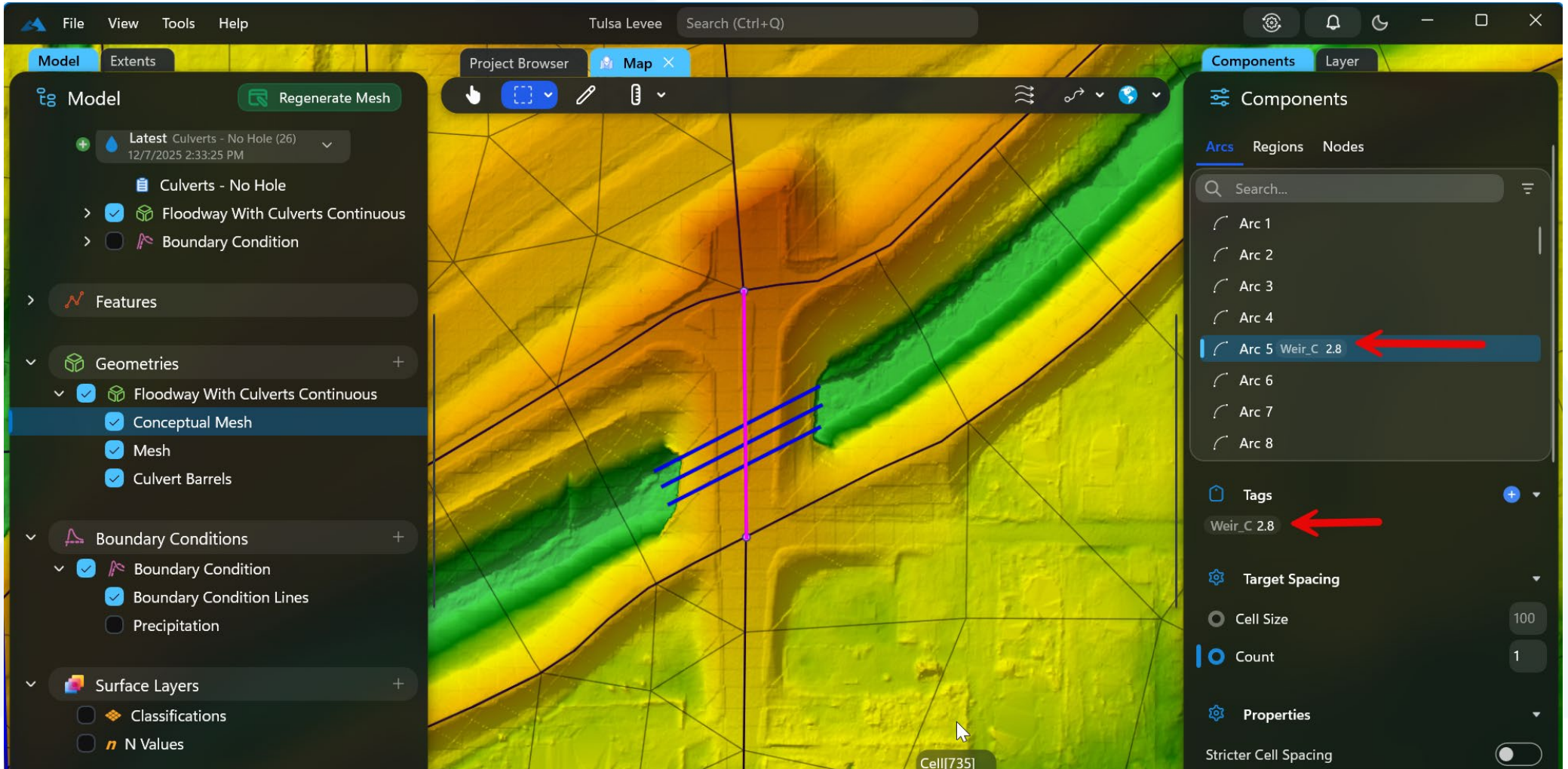
- Inlet Property Cleanup
- Output grouping

Long Term Vision

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

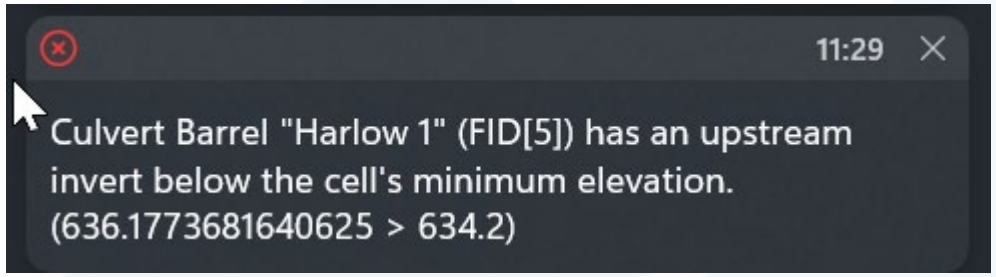
Coming Soon…Weirs in 2025

- 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