

2D Hydraulic Modeling User's Forum

# Automated Bridge and Culvert Meshing Tools in SMS

November 16, 2022



U.S. Department of Transportation  
**Federal Highway Administration**



Federal Highway Administration

**RESOURCE CENTER**

Office of Innovation Implementation

# Agenda

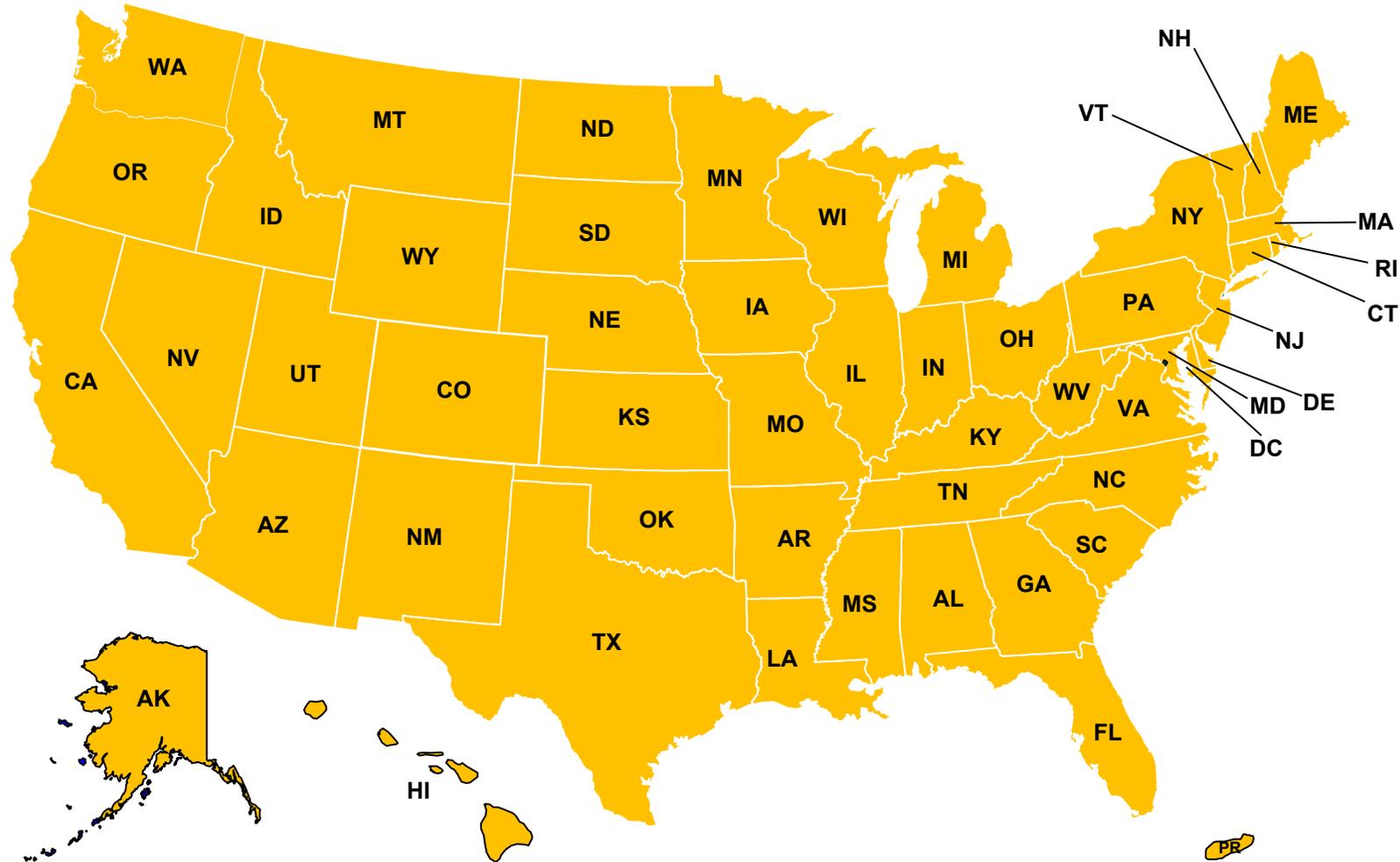
- Housekeeping stuff
- Training Opportunities
- Current Software Versions and Licensing
- Helpful Resources
- Overview of New Features in SMS 13.2
- Bridge and Culvert Meshing Tools
- Tips and Tricks

# Housekeeping

- Please post any questions in the Chat Pod
- PDF file of presentation slides (posted in the chat pod)
- PDH certificate (posted in chat pod)
- Recording link will be sent out tomorrow to all members of the 2D forum (with the slides and certificate)
- Participants may subscribe or unsubscribe using the link in the email
- 2D Hydraulic Modeling Forum participation

# 2D Hydraulic Modeling User's Forum Participation

 States participating in 2D Hydraulic Modeling Forum



# Training Opportunities

- In-person training (NHI [Course 135095](#))
  - 3-day course
  - Course materials recently updated
  - Scheduled Courses: Boise ID 11/28-12/1, Lakewood CO 12/6-12/8
- Virtual training available (NHI [Course 135095V](#))
  - 3-day course modified for 4-day online delivery
  - No currently scheduled sessions

# Training Opportunities (cont'd)

- Virtual Training (NHI [Course 135095A](#)) SRH-2D Model Data files, Diagnostics & Verifying 2D Model Results
  - Web-conference Training
  - Course materials recently updated
  - No currently scheduled sessions
- Virtual Training (NHI [Course 135095B](#)) Model Terrain Development with Various Data Sources
  - Web-conference Training
  - Course materials recently updated
  - No currently scheduled sessions

# Current Software Versions and Licensing

- SMS 13.1.24 (August 10, 2022) / SRH-3.3
- SMS 13.2.11 (October 18, 2022) / SRH-3.5
- Community license (free to all)
  - No license code needed
- Pro version free to all DOTs/FHWA and anyone whose role is to review models
  - License renewal / update required annually or with new computer
  - New security system requires a new license code
  - DOT/FHWA staff contact [scott.hogan@dot.gov](mailto:scott.hogan@dot.gov) or [laura.Girard@dot.gov](mailto:laura.Girard@dot.gov)
  - All others contact [support@Aquaveo.com](mailto:support@Aquaveo.com)

# Helpful Reference and Resources

Click links for information:

- [2D Hydraulic Modeling for Highways in the River Environment](#)
- [Training, Reference Documents, and Other Resources](#)
- [Step-by-step instructions \(SMS wiki\)](#)
- [Table of SRH-2D Errors and Solutions](#)
- [Tutorials and videos](#)
- [FHWA Bridge Scour Workshop](#)

# SRH-2D Modeling YouTube Videos

- [2D Hydraulic Modeling Videos \(2017\)](#)  
11 videos
- [2D Hydraulic Modeling Videos \(2020\)](#)  
6 videos
- [2D Sediment Transport Videos \(2022\)](#)  
6 videos **NEW!**

## Other FHWA Hydraulic Videos

- [Field Scoping Videos](#)  
5 videos
- [Open Channel Flow & Culvert Hydraulics](#)  
6 videos

Particle Size / Class / Gradations

A – Longest Axis  
B – Intermediate Axis  
C – Shortest Axis

### 2D Sediment Transport Modeling with SRH-2D

Federal Highway Administration USDOTFHWA  
6 videos · Last updated on Sep 29, 2022

Play all Shuffle

This video series is designed to provide guidance in the process of setting up and running a 2D sediment transport model with SRH-2D, developed by the US Bureau of Reclamation. The videos provide an overview of sediment transport modeling but also address the details of preparing, running, reviewing, and troubleshooting a model. Throughout the video demonstrations, the SMS user interface for SRH-2D is used to develop, execute, and review results for the 2D sediment transport analyses.

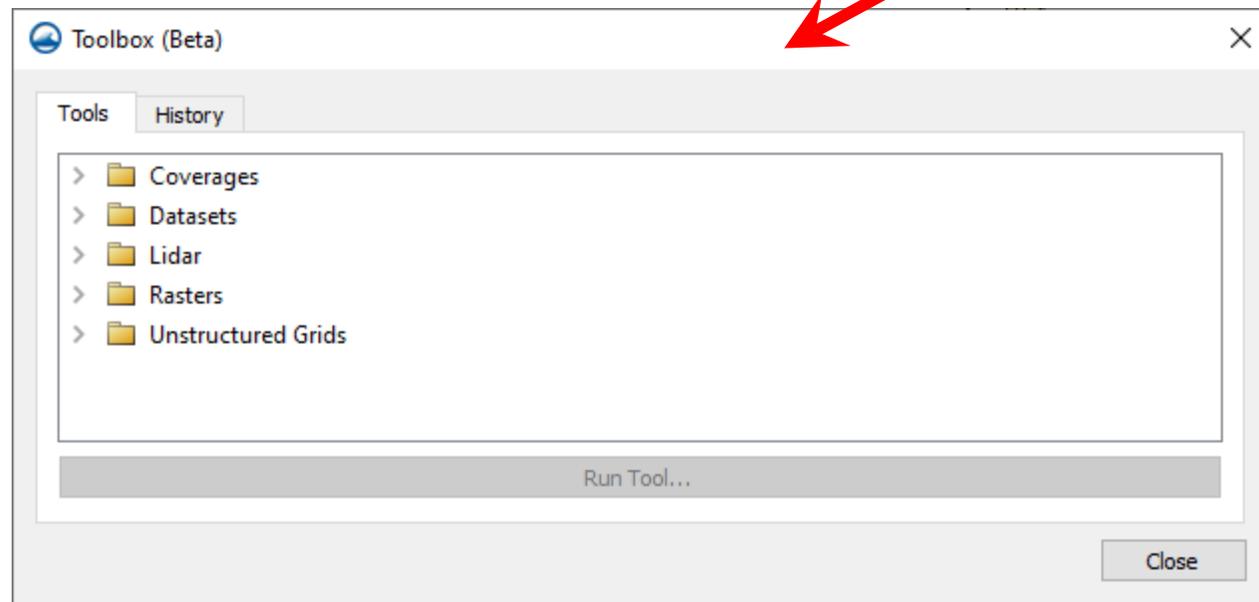
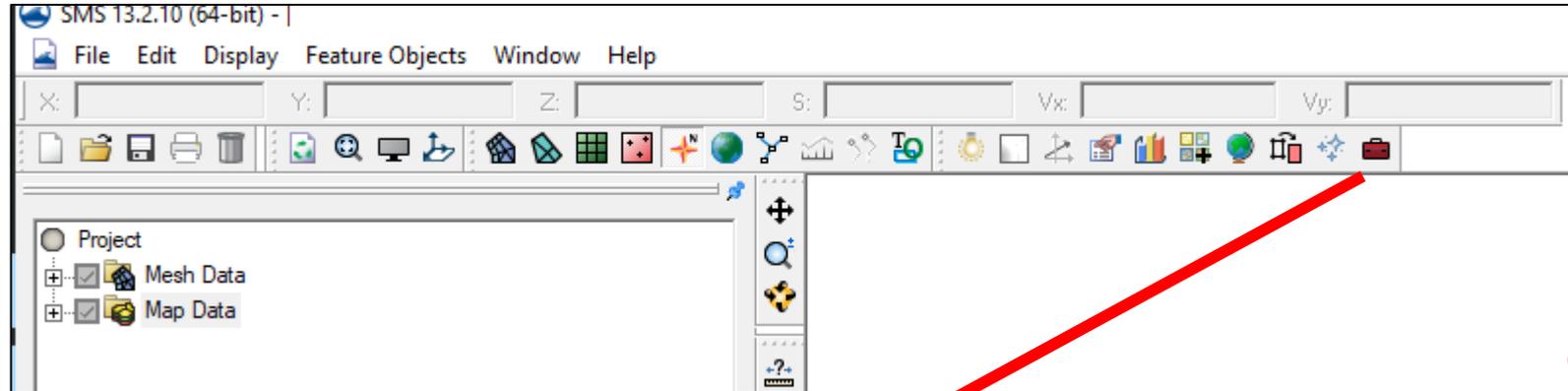
- Video 1 – Overview of Sediment Transport Modeling  
Federal Highway Administration USDOTFHWA  
14:45
- Video 2 – Converting a Hydraulic Model to a Sediment Model  
Federal Highway Administration USDOTFHWA  
20:27
- Video 3 – Sediment Parameters  
Federal Highway Administration USDOTFHWA  
12:48
- Video 4 – Executing a Sediment Model and Reviewing Results  
Federal Highway Administration USDOTFHWA  
14:36
- Video 5 – Sensitivity Analysis and Troubleshooting  
Federal Highway Administration USDOTFHWA  
27:06
- Video 6 – Cohesive Sediment Modeling  
Federal Highway Administration USDOTFHWA  
7:27

# Overview of SMS 13.2 New Features

- Toolbox
- Improved Data Portability
- Display Options
- Improved Map Coverage Features

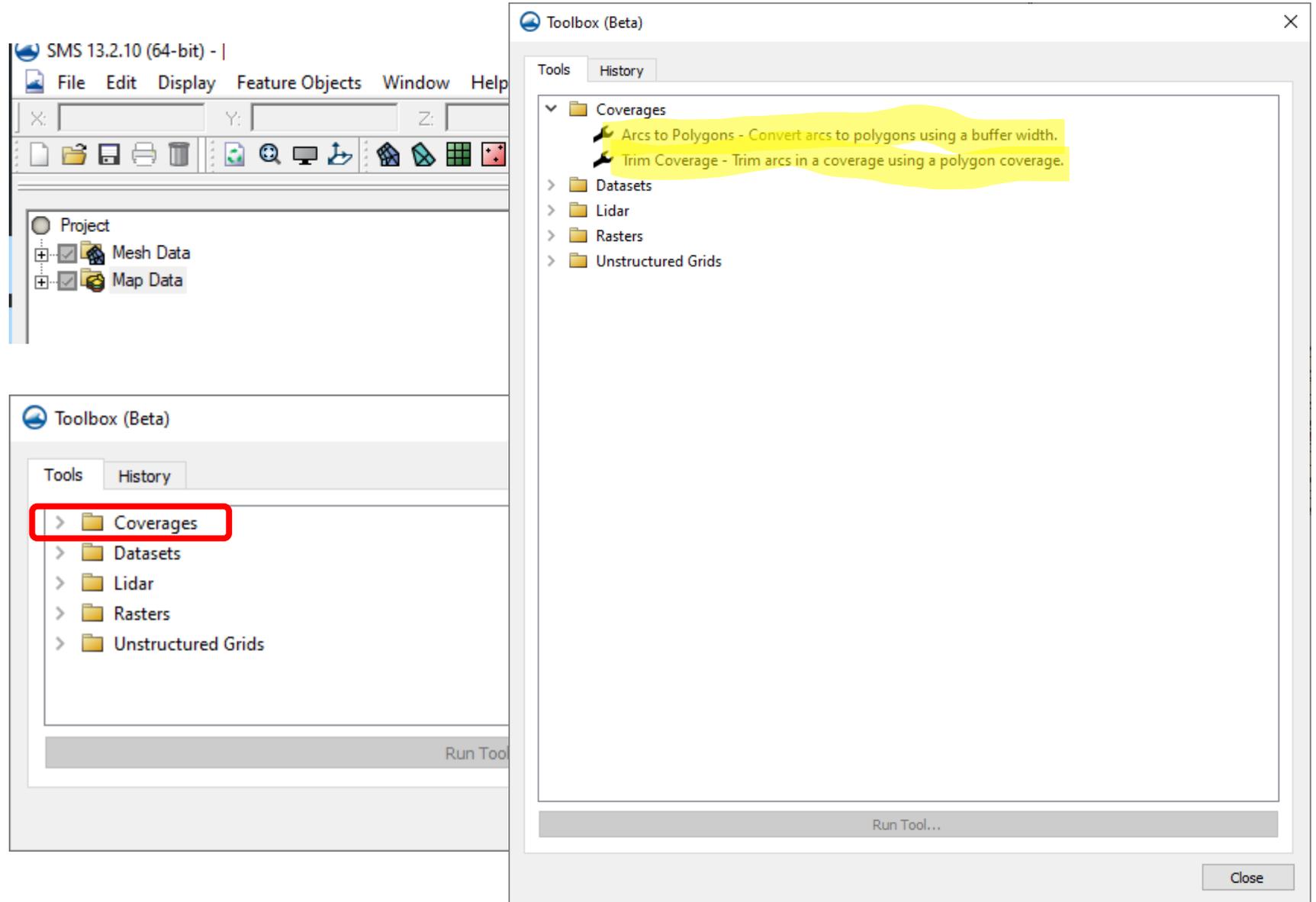
# Overview of SMS 13.2 New Features

- [Toolbox \(Toolbox Tutorial\)](#)



# Overview of SMS 13.2 New Features

- Toolbox



# Overview of SMS 13.2 New Features

- Toolbox

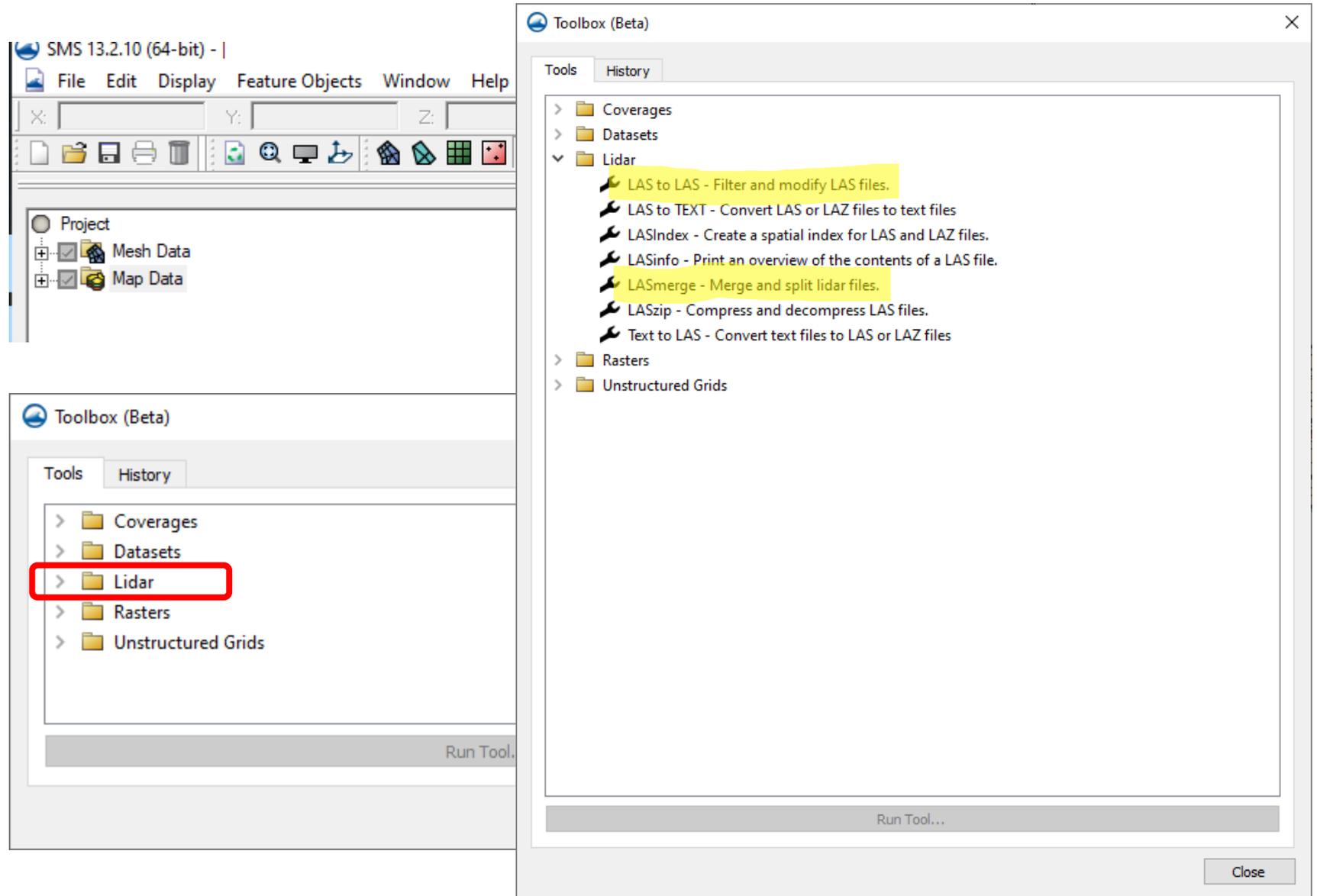
The screenshot shows the SMS 13.2.10 (64-bit) software interface. The main window displays a project with Mesh Data and Map Data. The Toolbox (Beta) window is open, showing a list of tools under the 'Datasets' folder. The 'Compare Datasets' and 'Landuse Raster to Mannings N' tools are highlighted in yellow.

**Toolbox (Beta) Tools:**

- Coverages
- Datasets
  - Advective Courant Number - Compute the advective courant number dataset.
  - Advective Timestep - Compute the advective timestep dataset.
  - Angle Convention - Convert between angle conventions.
  - Canopy Coefficient - Compute a canopy coefficient from a landuse raster.
  - Chezy Friction - Compute Chezy friction from a landuse raster.
  - Compare Datasets - Compare two datasets.**
  - Convert Cell Dataset to Point Dataset - Convert a cell dataset to a point dataset.
  - Convert Point Dataset to Cell Dataset - Convert a point dataset to a cell dataset.
  - Directional Roughness - Convert a land use raster (NLCD, C-CAP, etc) to a directional rough...
  - Filter Dataset Values - Assign dataset values based on conditionals.
  - Geometry Gradient - Compute geometry gradient data sets.
  - Gravity Waves Courant Number - Compute the gravity wave courant number dataset.
  - Gravity Waves Timestep - Compute the gravity wave timestep dataset.
  - Landuse Raster to Mannings N - Convert an landuse raster (NLCD, C-CAP, etc) to a Manning...**
  - Map Activity - Builds a dataset with values from one dataset and activity from another.
  - Merge Datasets - Merge two transient datasets.
  - Point Spacing - Calculate point spacing for a grid.
  - Primitive Weighting - Compute the primitive weighting coefficient.
  - Quadratic Friction - Compute quadratic friction from a landuse raster.
  - Sample Timesteps - Create a dataset with sampled time steps from another dataset.
  - Scalar to Vector - Convert scalar to vector dataset.
  - Smooth Datasets - Smooth a data set by limiting slope or area.
  - Smooth Datasets by Neighbor - Smooth a dataset by averaging nodal neighbors.
  - Time Derivative - Calculate the time derivative of a transient dataset.
  - Vector to Scalar - Convert vector to scalar dataset.
- Lidar
- Rasters
- Unstructured Grids

# Overview of SMS 13.2 New Features

- Toolbox



# Overview of SMS 13.2 New Features

- Toolbox

SMS 13.2.10 (64-bit) - |

File Edit Display Feature Objects Window Help

X: Y: Z:

Project

- Mesh Data
- Map Data

Toolbox (Beta)

Tools History

- Coverages
- Datasets
- Lidar
- Rasters**
  - Blend Raster to Edges - Blend the secondary raster into the edges of the primary raster.
  - Bounds to Polygon - Generate a coverage with an exterior polygon for the active region of the i...
  - Clip Raster from Elevations - Clip a raster where the raster elevations are above or below an elev...
  - Dataset to Raster - Convert dataset values into a raster.
  - Edit Elevations - Edit a rasters elevations from the Z values of point and arcs in a coverage.
  - Extend Raster - Extend a raster to the extent of polygons in a coverage, writing out a new raster.
  - Fill Nodata - Fill nodata values in a raster, creating a new raster.
  - Interpolate Priority Rasters - Interpolate multiple rasters to a UGrid with priority.
  - Merge Elevation Rasters - Merge two elevation rasters with priority.
  - Nodata to Polygon - Generate a coverage with polygons for the active region of the input raster.
  - Raster Difference - Tool to calculate the difference between two rasters, writing out a new raster.
  - Raster to Grid - Tool to create a grid from a raster, using every pixel in the raster.
  - Trim Raster - Trim a raster to the extent of polygons in a coverage, writing out a new raster.
  - WSE Dataset Raster - Tool to make a WSE (water surface elevation) raster from a dataset.
- Unstructured Grids

Run Tool...

Close

# Overview of SMS 13.2 New Features

- Toolbox

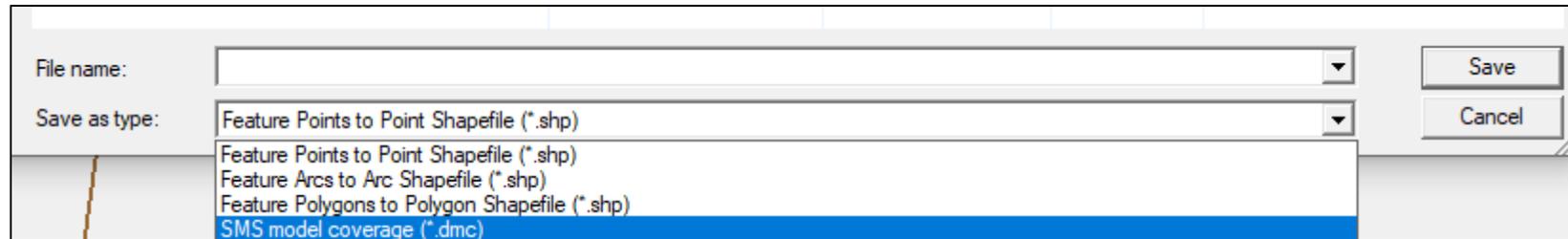
The screenshot shows the SMS 13.2.10 (64-bit) software interface. The main window displays a project with Mesh Data and Map Data. The Toolbox (Beta) window is open, showing a list of tools under the 'Unstructured Grids' category. Several tools are highlighted in yellow, including 'Create Bridge Footprint', 'Merge UGrids', and 'Map Activity to UGrid'.

**Toolbox (Beta) Tools:**

- Coverages
- Datasets
- Lidar
- Rasters
- Unstructured Grids
  - Convert 3D Data to 2D Data - Convert 3D UGrid data set to 2D UGrid and data sets.
  - Convert Mesh/Scatter/Cartesian Grid to UGrid - Convert geometry to a UGrid.
  - Convert to 2D Mesh - Convert 2D UGrid and data sets to Mesh 2D module.
  - Convert to Voronoi UGrid - Convert a UGrid to a Voronoi UGrid.
  - Create Bridge Footprint - Tool to create a UGrid or coverage for a bridge.**
  - Extrude to 3D UGrid - Extrude a 2D UGrid into a new 3D UGrid.
  - Import UGrid Points - Import points and data sets from a csv file.
  - Interpolate to UGrid - Interpolate from a UGrid data set to a UGrid.
  - Map Activity to UGrid - Map activity from a coverage to a UGrid.**
  - Merge UGrids - Merge two UGrids.**
  - Smooth UGrid - Smooth a UGrid.

# Overview of SMS 13.2 New Features

- Toolbox
- Improved Data Portability
  - SRH-2D coverages can be transferred between projects

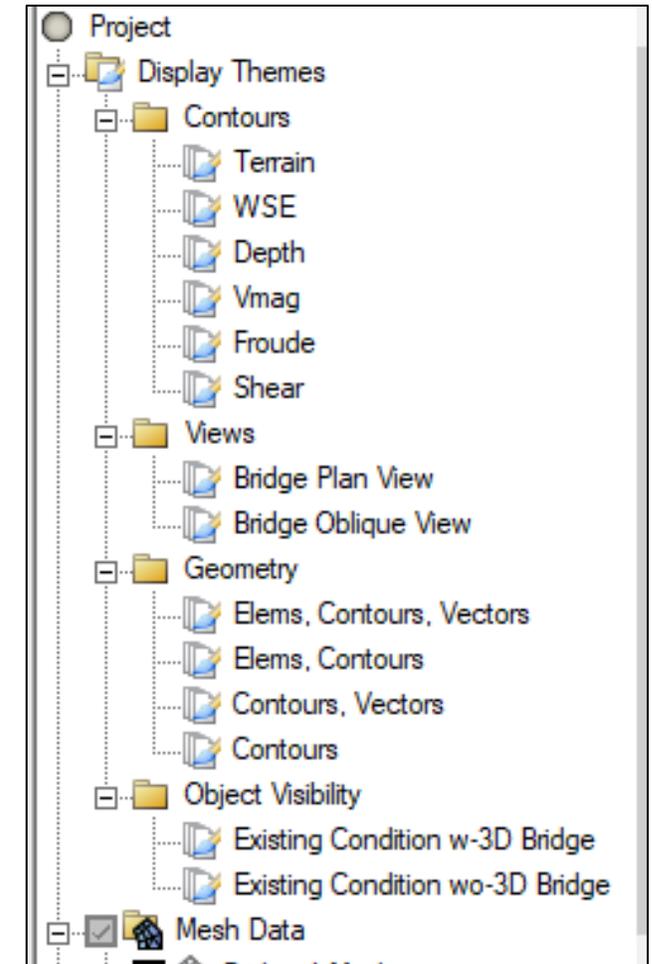
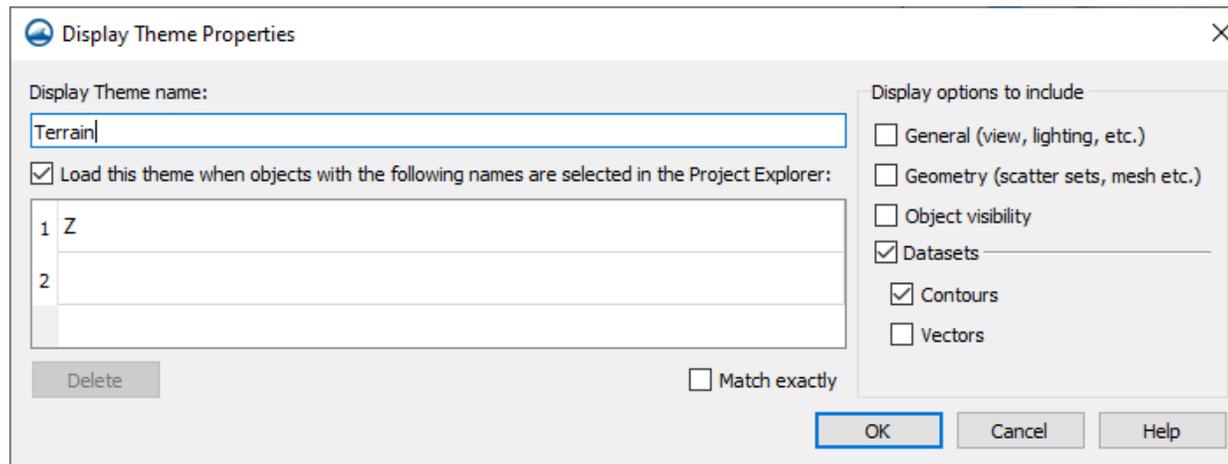


- Project file organization changes

Name	Date modified	Type	Size
1Dvs2DCulvert132_data	11/10/2022 2:48 PM	File folder	
1Dvs2DCulvert132_models	11/10/2022 3:00 PM	File folder	
1Dvs2DCulvert132.sms	11/10/2022 2:47 PM	SMS File	1,454 KB

# Overview of SMS 13.2 New Features

- Toolbox
- Improved Data Portability
- Display Options
  - [Display Themes \(Tutorial\)](#)
  - New contour label display options (one label per contour option)



# Overview of SMS 13.2 New Features

- Toolbox
- Improved Data Portability
- Display Options
- New/Improved Map Coverage Options
  - [Cross section processing tools](#) (interpolate, trim, etc.)
  - CAD type operations ([specify arc length, trim/extend arc](#))
    - Special functions (h, v, and d keys)



# Automated Bridge and Culvert Meshing in SMS

## *Create Bridge Footprint Tool*

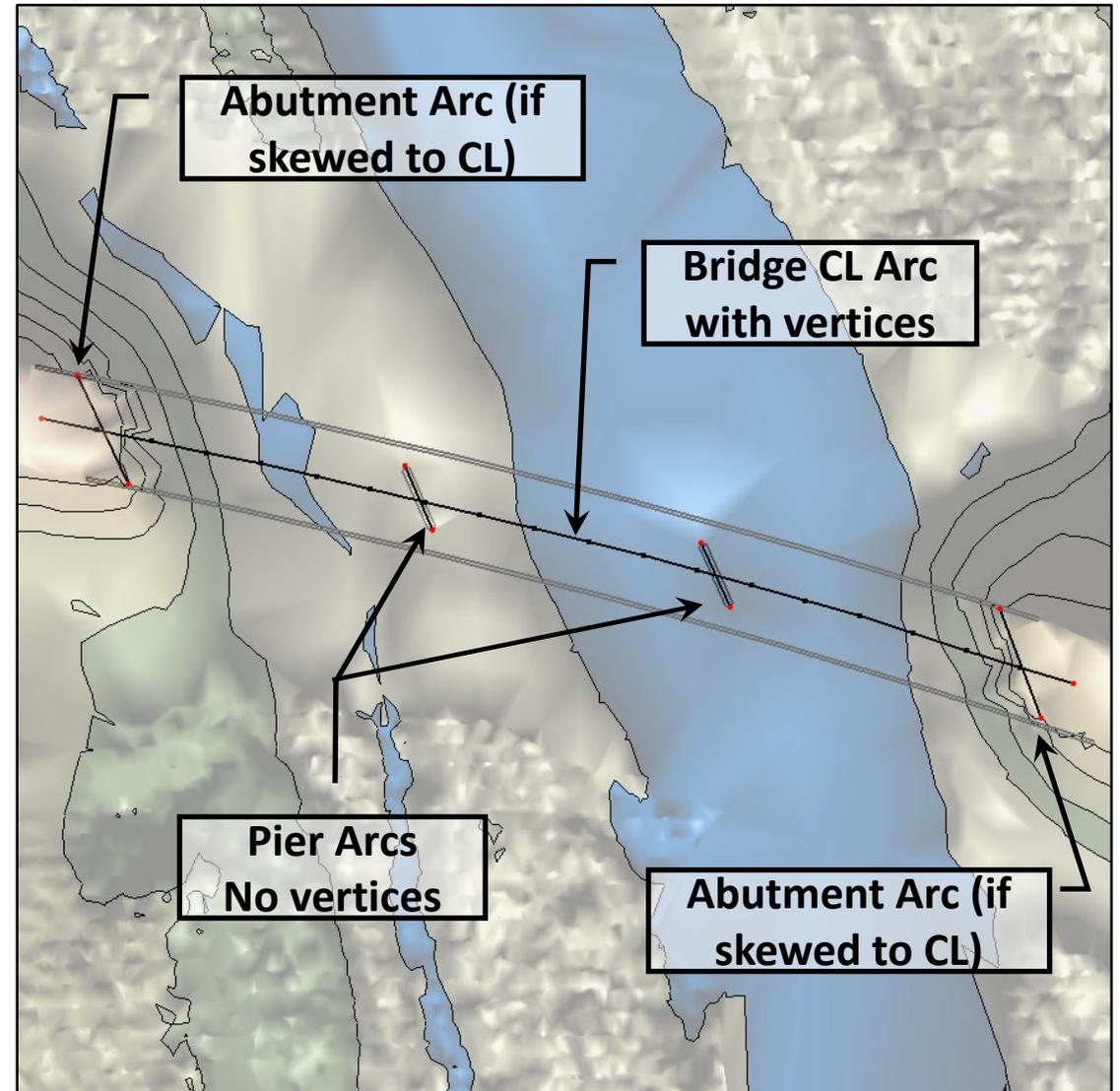
- Various pier shapes
- Wall piers or cylindrical piers (Pier group)
- Multiple piers (with different alignments)
- Skewed piers
- Skewed abutments
- Box culverts
- Cylindrical culverts (*coming in SMS 13.3*)

*Note: This tool and the following steps are beta versions and will continue to be streamlined in future versions of SMS.*

# Automated Bridge and Culvert Meshing in SMS

## *Steps to generate a bridge mesh*

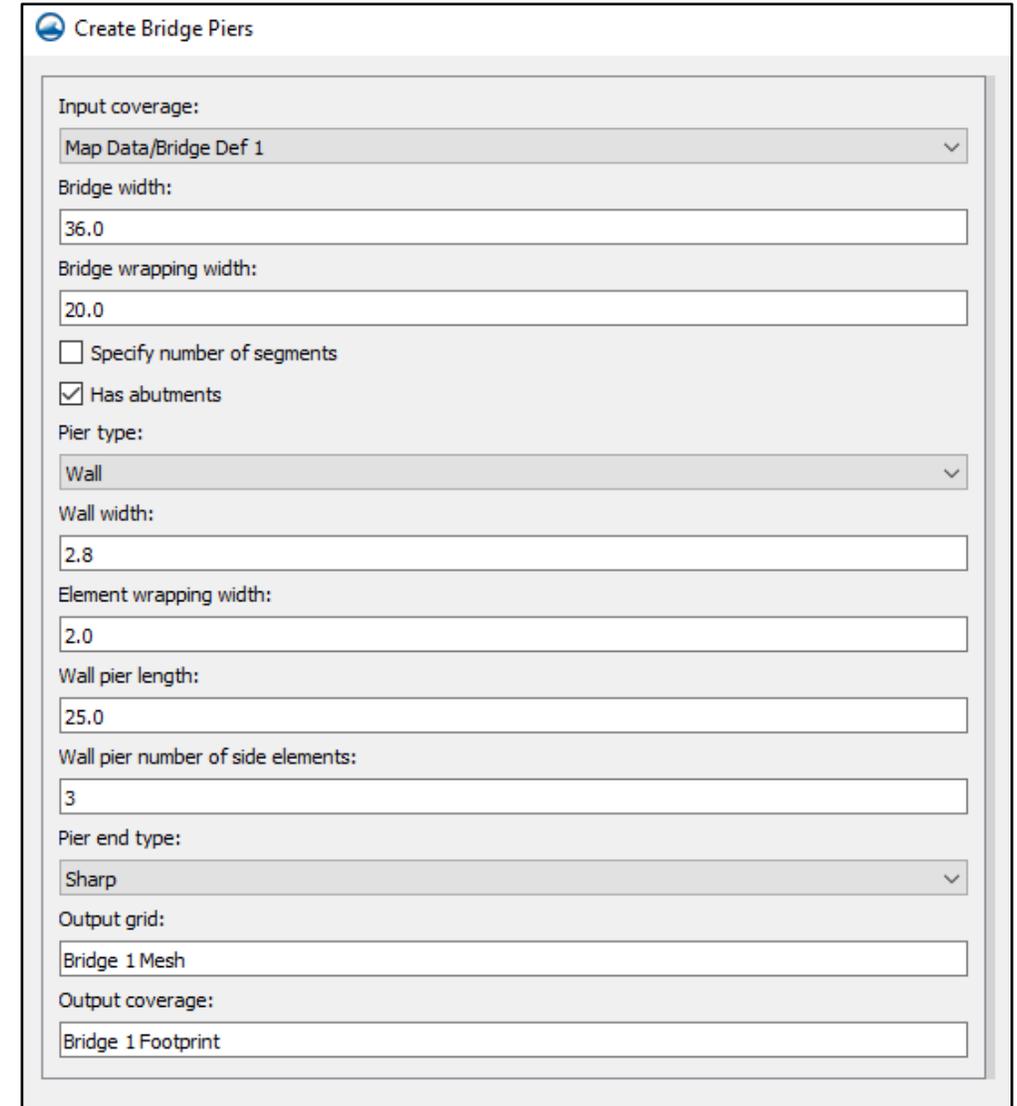
1. Create a new coverage (Area Property type) named Bridge Def (or similar)
2. Draw the bridge centerline arc with vertices that represent the desired number of elements
3. Draw arcs to represent pier location and alignment
4. Draw arcs for abutments if they are skewed to the bridge centerline



# Automated Bridge and Culvert Meshing in SMS

## *Steps to generate a bridge mesh*

5. Run **Create Bridge Footprint**  
(Toolbox – Unstructured Grids)
6. Enter bridge and pier geometry and mesh preferences
7. Generate the bridge mesh and footprint
8. Interpolate terrain elevations to the bridge mesh



The screenshot shows the 'Create Bridge Piers' dialog box with the following settings:

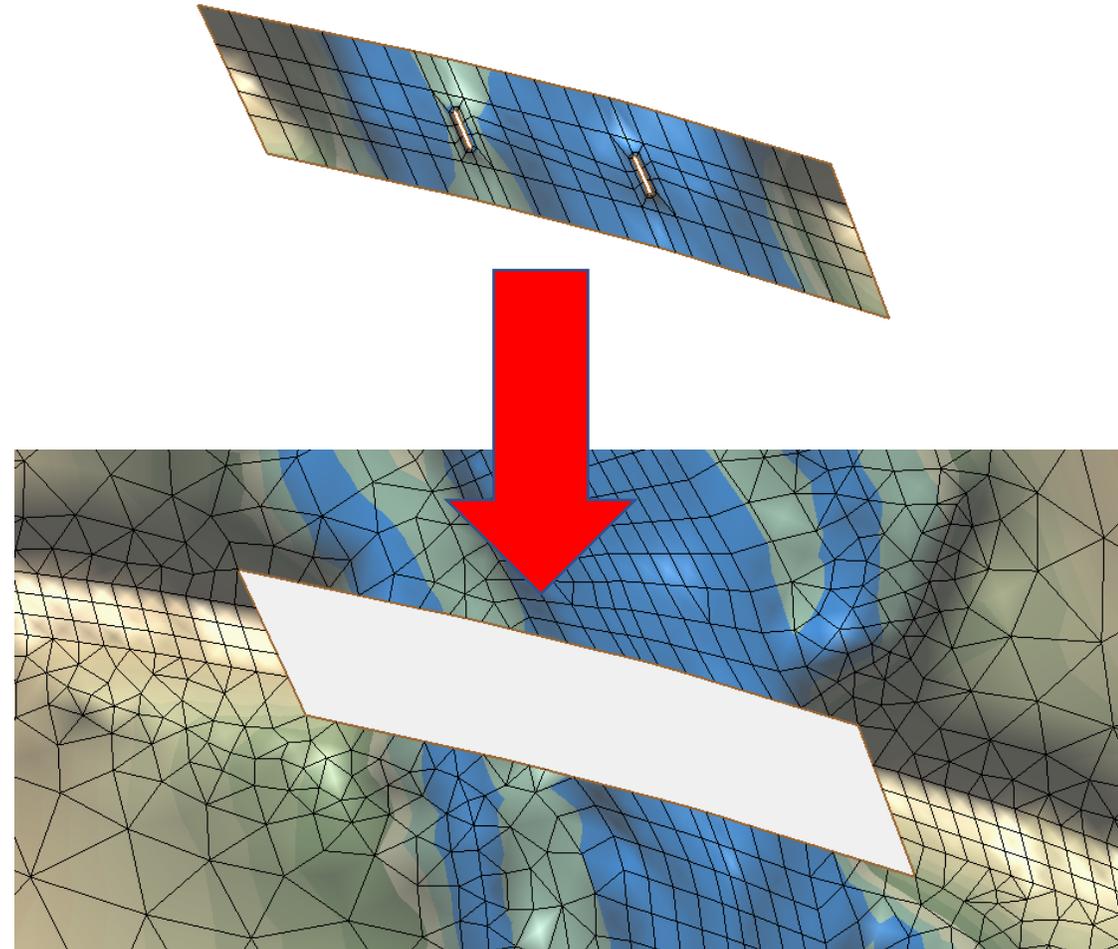
- Input coverage: Map Data/Bridge Def 1
- Bridge width: 36.0
- Bridge wrapping width: 20.0
- Specify number of segments
- Has abutments
- Pier type: Wall
- Wall width: 2.8
- Element wrapping width: 2.0
- Wall pier length: 25.0
- Wall pier number of side elements: 3
- Pier end type: Sharp
- Output grid: Bridge 1 Mesh
- Output coverage: Bridge 1 Footprint

# Automated Bridge and Culvert Meshing in SMS

## *Steps to generate a bridge mesh*

9. Copy the footprint into the full mesh generator coverage
10. Generate the full mesh with a hole for the bridge mesh
11. Use the Merge UGrids Tool to merge the bridge mesh and full mesh

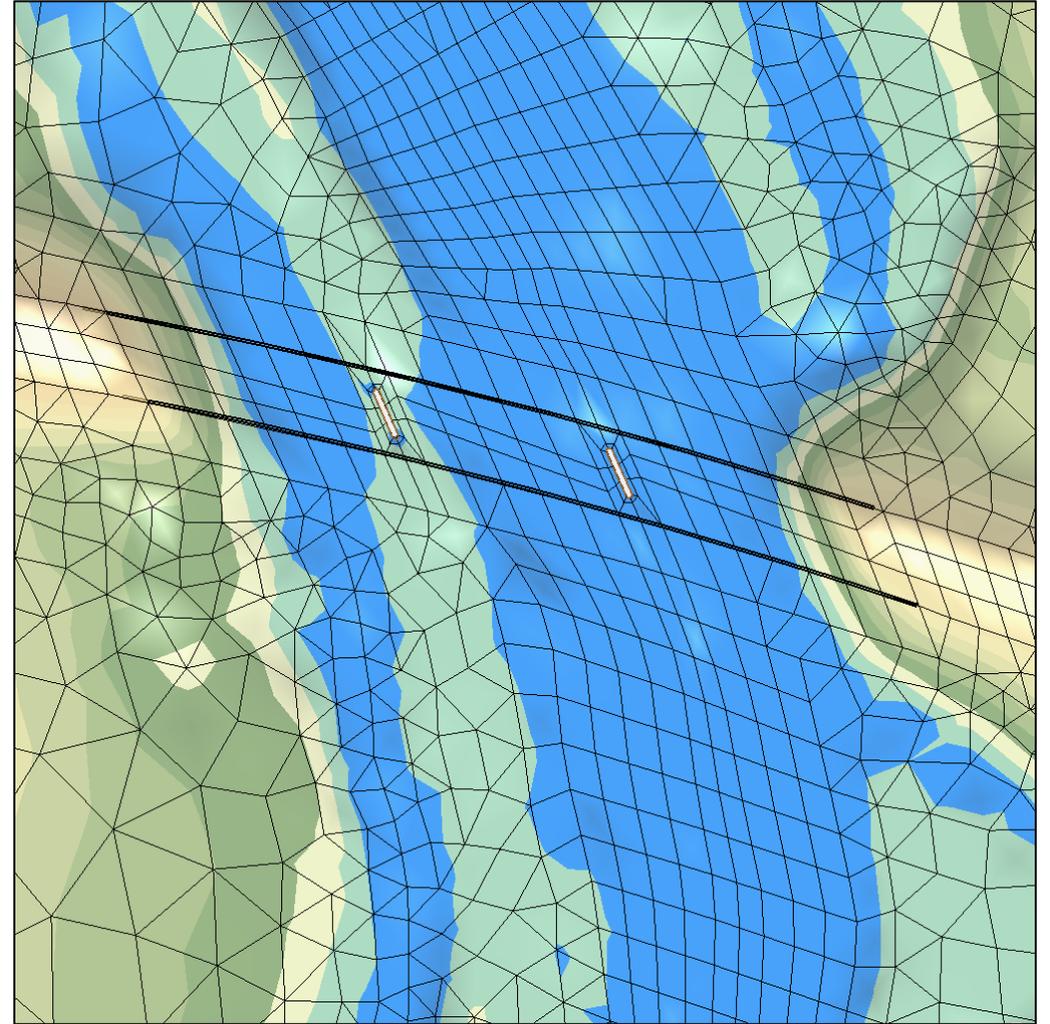
It's time for a demo

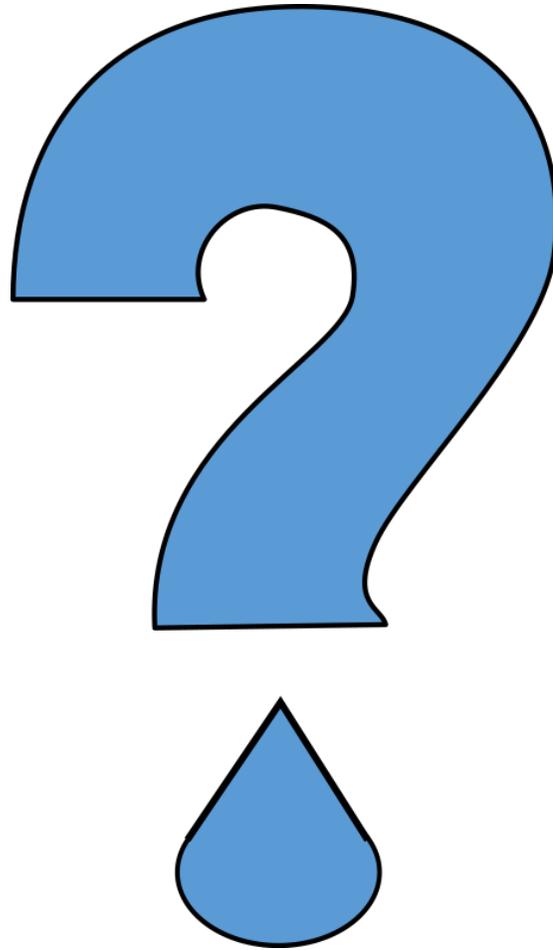


# Automated Bridge and Culvert Meshing in SMS

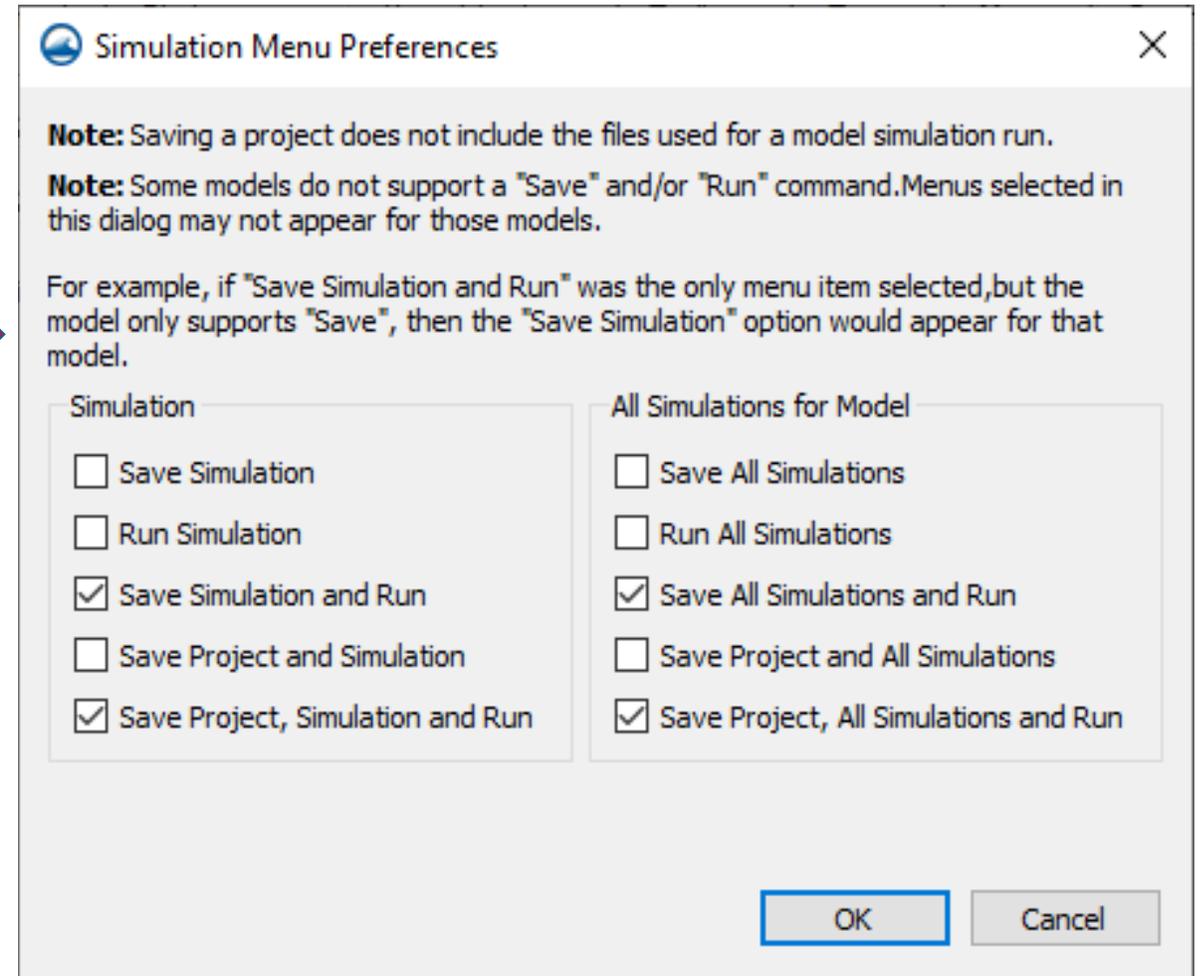
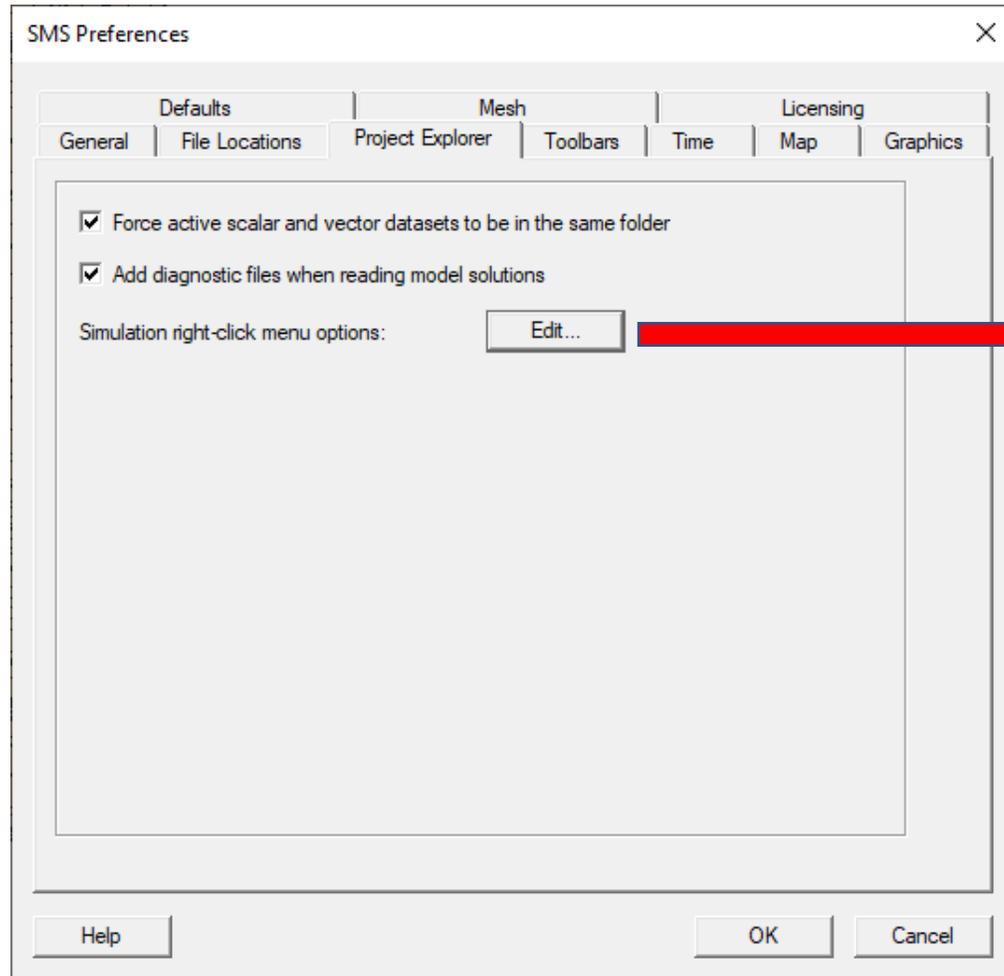
## *Additional notes:*

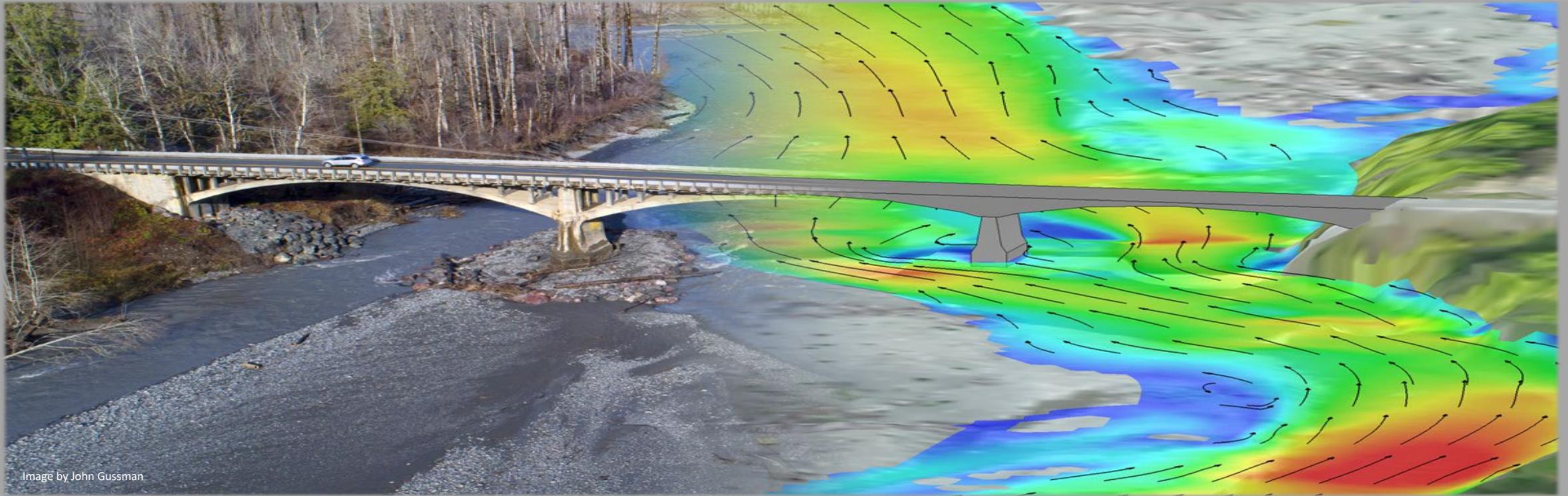
1. Create a new coverage for each bridge
2. Generate all bridge meshes and merge with main mesh one at a time
3. Review mesh quality around bridge meshes to check for issues
4. Report any problems





# Tips and Tricks - Simulation Execution Options





***THANK YOU!***

***Please contact us with any questions***

**Scott Hogan**

FHWA Resource Center

[Scott.hogan@dot.gov](mailto:Scott.hogan@dot.gov)

(720) 575-6026

**Laura Girard**

FHWA Resource Center

[laura.girard@dot.gov](mailto:laura.girard@dot.gov)

(970) 217-3894