2D Hydraulic Modeling Webinar Series

November 13, 2025 Webinar

Webinar Title: Modeling Multiple Barrel 2D Culverts in SRH-2D/SMS

Summary of Questions and Answers from the Chat Pod.

Q: When embedment is considered, how does the embedment impact the flow calculations?

A: The embedment reduces the available conveyance area through the culvert.

Q: If we have a culvert invert, does this override the terrain elevation at this location (e.g., invert lower than terrain)?

A: Yes, the creation of a 2D culvert replaces any terrain data for the bottom of the barrels. If you have a roadway embankment or other terrain, it will override it.

Q: For a bottomless culvert where the terrain doubles as the culvert bottom, if the user were to be running an unsteady sediment transport model with these 2D culverts, would the culvert floor be able to update per time step to reflect the net erosion or sedimentation?

A: Yes, the sediment transport applies to the bottom of the culvert. You would need to define the bed conditions.

Q: So, it's not pipe/structure embedment, it like silt in the barrel.

A: The structure is embedded, but the invert is filled to the specified depth, leaving a laterally flat surface. The type of material would be based on the user specified Manning's n values for the bottom of the culvert.

Q: Would you recommend running a bridge as a 2d culvert that is "embedded" (instead of pressure arcs) to represent the channel bottom? Is there restrictions to the widths you can enter for culverts to represent a structure like this?

A: I would recommend using the terrain/elevations from a survey under a bridge if it is available.

Q: For clarification is 2D in these models longitudinal and transverse but not depth?

A: The 2D calculations compute longitudinal and lateral variations in velocity and depth. A depth averaged velocity is assumed.

Q: How about drop inlets? Large culvert tied to drop inlet/grate for flood mitigation.

A: A drop inlet is not 2D. This would typically be included in SRH-2D as a 1D structure.

Q: Guide Vanes?

A: It is possible to manually modify a mesh to represent features in the channel bed or culvert invert. However, since the flow over these structures is predominantly 3D, 2D results should not be relied on. However, based on experience the results from 2D analysis of weirs and other features can be very informative and qualitative.

Q: Yes, actually it would be great if drop inlets/drop structure culverts could be modeled in 2d in future updates

A: We will discuss this with the community and the Dr. Lai.

Q: Are there any model stability concerns for having 1D as well as 2D culverts together in a single model? Is it "best practice" to keep to all 1D or all 2D culverts for a given model?

A: No, there are no concerns about having both 1D and 2D culverts in a model.

Q: As I understand it, we are not supposed to combine a 1d model and a 2d model in the same mesh. i was told this may cause some errors no?

A: No such concern; you may mix them

Q: What are your thoughts on computing scour using 1D vs 2D culverts?

A: If you want to compute scour, 2D gives you more information. The 1D structure is just passing water.

Q: Did Scott say that 2D modeling is best to use when smaller culverts (i.e. less than 60") are flowing under pressure, or was it 1D (or HY8)?

A:1D for small culverts because the mesh elements in 2D become quite small

Q: I've also found that using 2D overtopping on skewed culverts often results in a lot of instability.

A: 2D overtopping creates a more complex interaction between the 1D and 2D flow zones, so it can be more sensitive. When you run into these issues, please reach out to us. We can offer suggestions and also take a closer look to see if there are other solutions.

Q: Would you use 2D for all supercritical flow in culverts?

A: You could, as 2D will represent both flow regimes well, but the 1D HY-8 approach also handles supercritical flow.

Q: How would the results differ if we used a 2d model for a small culvert rather than a 1d model?

A: If they are both done correctly, the results should be very similar for typical culvert crossings. The difference is that you get 2D output (point by point velocity and water level) for the 2D representation. For more complex hydraulic scenarios, (i.e. skew, flow around bends, lateral diversions, etc.) a 2D approach would be more representative.

Q: I've noticed that sometimes when using the 3D structure coverage for culverts, the culvert length generated in the coverage and 2D mesh doesn't match with my entered culvert length in the 3D Structures Coverage "Structure Properties". I usually run into this when working with culverts that are skewed to their roadway crossing. Just curious if this is a known issue.

A: This is a known issue for skewed culverts. Watch for updates. The current tool is projecting a perpendicular offset from the embankment arc when determining culvert length. So, when skewed, the offsets are incorrect. For now, I (Scott) have been adjusting the culvert length according to the skew angle to get the correct applied length for now.

Q: May be outside the scope of this discussion, but what are the differences between a 3D bridge and the Pressure Boundary condition?

A: The pressure boundary condition assumes a constant horizonal elevation along the bridge, so bridge slope or arch scenarios where not represented well.

Q: It would be great to also have the option to stamp the terrain in 3D Bridges.

A: This feature is currently being considered.

Q: I'm a little confused about the "assign properties to individual arcs" button, can you please repeat that part?

A: By default, SMS finds the longest arc and assumes that is the center line of the embankment. From that it assigns the role of each of the other arcs. If that is not the case, you can specify the roles of each arc explicitly.

Q: For 3D culverts, can you elaborate on the relationship between the structure properties specified and the elevations in the 2D mesh itself? I.e., which values are used for SRH-2D calculations, and which are used only for UGrid or 2D mesh generation?

A: The tool has multiple outputs. The first is a mesh that represents the terrain through the structure. This is either the bottom half of the culverts, or the terrain under a bridge. The second is a 3D structure that enables pressure flow. The last is a coverage that can be incorporated into the mesh generator coverage to make sure your mesh is consistent.

Q: I find myself a bit confused since historically, we used BCs arcs in combination with the bridge footprint tool.

A: The previous BC arcs were used to define the limits of the pressure flow but also assumed a horizontal bridge. The 3D bridge generated by the tool now represents the variable elevation across a bridge.

Q: Does it only works with straight culvert or can they have curves?

A: Currently limited to straight.

Q: Can this all be done on the free version?

A: Yes

Q: How to model a culvert with in internal drop?

A: The 3D structures tool does not accommodate vertical drops, but the mesh could be edited, once generated, to represent a drop. Keep in mind that a 2D model does not represent vertical velocity. It generally provides a reasonable result, but carefully consider the assumptions.

Q: So, it's an option that you'd use if you have multiple arcs representing different culverts along the stream right?

A: If you have multiple culverts along a stream, you would create a separate 3D Structure coverage for each one.

Q: How would you incorporate an apron slab? Would that be modeled in the 3D structure tool?

A: Yes, and appurtenant features up and downstream of the culvert should be represented in the terrain.

Q: I've found it is helpful to define your 3D structure footprint/parameters and copy into the mesh generator coverage before spending significant time on your domain mesh generator, it is much easier to get everything to line up

A: That is a great point and recommended best practice.

Q: Can hydrograph be created from WMS for 2D- culvert?

A: Absolutely. SRH-2D Boundary conditions accommodate hydrographs.

Q: Could you model different opening sizes by creating multiple 3D structures side by side?

A: Yes, but this is currently challenging. Parallel structures could be defined, but the width of the mesh generated for a structure does currently not accommodate others in proximity. However, it is doable with some mesh editing. This will be a consideration for future developments.

Q: So, if you accidentally move a node, how do you fix it?

A: Multiple options: 1- snap it back using the footprint coverage. 2- if the discrepancy is not too large, SMS will try to seam it together. 3- delete the footprint arcs and recopy them from the footprint coverage.

Q: When you say don't move nodes or vertices in the 3D structure culvert footprint - does that also include not changing vertices to nodes in the footprint? For example, connecting other arcs in your mesh generator coverage to the footprint polygon?

A: Great question. It is ok to change the vertices to node in the footprint.

Q: Is there a way to figure out how much flow is going through the structure cross section area during the model run?

A: Yes, that is computed as part of the 3D structure plot.

Q: For a bridge I understand it uses the terrain provided. Say your survey/terrain includes points/elevations representing the piers of the bridge. Don't those have to be flattened out in the terrain before going through with the Bridge 3D structure method?

A: Yes. The terrain under the bridge comes from the DEM or TIN. The surface used in SMS for SRH-2D should not include pier elevations. Piers are represented as holes in the mesh.

Q: So is there still a need to set the mesh type to the 2d/Ugrid mesh for the footprint polygon in the mesh generator?

A: The mesh type is set to the 2D/UGrid type and the name of the 2D structure mesh is selected.

Q: Is the automatically generated monitoring line at the center of the structure? Is it still beneficial to have monitoring lines before and after the structure or does this eliminate that need?

A: Generally, the one line should be sufficient, but it is also helpful to have a monitoring point located a short distance upstream of the structure to help note any stability issues.

Q: Can you re-explain how to add the arcs for a skewed structure?

A: You define one arc for the embankment. You define another arc for the alignment of the culvert.

Q: What about "entrance loss coefficients" in culverts using SMS?

A: Much of the contraction losses are computed in the 2D calculations, however, the actual loss associated with different edge configurations (i.e. square edge, beveled edge, etc.) are not explicitly added in the 2D calcs. As noted during the presentation though, the loss coefficients for the edge were derived under still pool (zero velocity head) conditions, and are more applicable when a 1D HY-8 approach is used. In bridge modeling, we don't account for the configuration of the leading bridge edge, as it would be a negligible effect in the overall headloss. In cases where that the inlet configuration is a consideration in the design, a 1D model approach is recommended for that analysis .

Q: In case of overtopping, are the same mesh cells used to calculate flow in the culverts and over the culverts?

A: The overtopping is computed as 1D flow.

Q: A tool that updates the mesh when the structure is edited w/o having to go through all steps to manually remake the mesh

A: That is a good idea. We will consider this in future development.

Q: Is there a proximity limit for adjacent structures example rail and highway so that your generated culvert surface/mesh doesn't overlap?

A: There is not a specified limit, but overlap can be a problem. The 3D Structure Bridge allows the user to turn off the up or downstream wrapping elements, which can be helpful when things get tight.

Q: When a mesh is assigned with a terrain, do you need to exclude the polygon of the structure_coverage, because 2D/Ugrid has already included the terrain?

A: In the polygon with the structure, the 2D/Ugrid is assigned INSTEAD of a terrain source.

Q:I see the monitor line created at the center of culvert includes the Q. Can average velocity also show at the monitor line?

A: Yes, the monitor line also reports average velocity.

Q: Can you elaborate on back water flow?

A: Not exactly sure about the context of this question but a couple concepts may help address it: 1) the flow through culverts can be influenced/controlled by the tailwater (backwater?) and this is part of the 2D computations, 2) backflow, or reverse flow, can be calculated in culverts (i.e. tidal conditions).

Q: What does it mean if the new monitor line created is unstable but the rest previously made are stable?

A: The monitor line itself cannot cause an instability, but by adding a monitoring line you may detect an instability that was not noticed previously.

Q:Not related to modeling 3D structures: Is there ever a chance y'all might set up a message board-style forum? I seem to recall there used to be one and it was taken down a few years ago. I think something like that could be a useful resource.

A: Aquaveo had to take it down because of bots. If enough people are interested we may be able to bring it back

Q: Any consideration by Aquaveo for future 2D to 3D modeling? Getting ahead of the coming 3D hydraulic modeling?

A: It is under the future plan :)

Q: When setting the invert roughness in the materials coverage, all that is needed is a polygon that traces the edge of the culvert itself (where the 1D weir flow area is applied)?

A: Correct. But there is no need to trace each individual culvert. A single polygon can be used to represent the group of culverts.

Q: So does this "select elevation raster" button do the same thing as going into the mesh generator, selecting the footprint bounding polygon, and assigning the ugrid mesh type to the polygon?

A: No. The 'Select elevation raster' is used to assign elevations to the element nodes in the wrapping later around the mesh, to ensure a smooth connection with the main mesh.