Holistic Urban 1D/2D Flood Modeling
About Today’s Presentation

- Please ask questions
- Recording of webinar available in 2 days
- PDH certificate emails will be sent around 1PM PDT
  ➢ Must be registered to qualify!
About Today’s Presenter

- John Howell
- 25 years experience in modeling and simulation
- Previously with Wallingford Software and Bentley Systems
It’s all about Risk
Important factors to consider in **Urban Flood Modeling**

- Use Accurate Surface Data
- Storage
- Hydrology
- Urban Hydrodynamics
- Dynamic Factors
- Results
What types of modeling do you have experience with? (select whatever is applicable)

- Basic hydrologic or hydraulic modeling
- Complex drainage studies
- NFIP Flood Mapping
- Rural and River Flood Mapping
- Urban Flood Modeling
Use Accurate Surface Data
True Depictions of the Surface

1D Catchment

Digital Terrain
Storage
2D Models are more accurate

1D Storage

2D Storage
Accurate Flow Analysis

1D Dual Drainage

2D Drainage
Dynamic 1D/2D Integration

The 1D model must pass flow to the 2D boundary at each time step based on 2D cell elevation.
2D Equations + 1D

- Solve the shallow water equations, including the acceleration, pressure, bottom slope, and friction slope terms
- $F_s, F_s U_s, F_s V_s$
- Shallow water equations are considered to provide a “full” mathematical representation of the physical processes controlling floodplain inundation
- Best characterization of overland flow

Hydrology
Rainfall Event

Designed

Measured
Urban Hydrodynamics
Halving the cell size increases run-time by a factor of four (4)
Multi-Domain Modeling
Multi-Domain Modeling
Buildings in the Floodplain
Why Model Buildings?
How do you typically represent buildings in your 2D models?

- Mannings Roughness?
- Block from Flow (inactive area)?
- Fill Area (Water can enter at a certain depth)?
- Layered (loss coefficient per layer)?
Buildings: Landuse Polygon

Very high Manning’s n value
Polygon boundary acts as vertical glass wall. Water ponds up outside of the wall and can’t enter to the polygon.
Water can enter the building once the depth is more than the fill depth.
Buildings: Layers
Dynamic Factors
Urban Floods – Dynamic Events

• Changing boundary conditions
• Changing flow regimes
• Interaction of multiple flow regimes
• Urban terrain must be considered
• Regulators/Inflatable Weirs to change flow in conduits
• Orifice area and discharge coefficient
• RTC to change weirs, pumps, conduits etc.
Dynamic 2D Elements

- Dynamic Elevation Shapes
- Head and Flow boundaries
Dynamic Elevation Shapes

- Elevation shapes can be polylines or polygons
- Triggers:
  - Simulation Time
  - Water Elevation
  - Water Elevation Difference
- Lower, Raise or alter vertex elevations
- Time to reach the change
Results You Can Use.
### Table E10 - Conduit Summary Statistics

Note: The peak flow may be less than the design flow and the conduit may still surcharge because of the downstream boundary conditions.

* denotes an open conduit that has been overtopped - this is a potential source of severe errors.

<table>
<thead>
<tr>
<th>Name</th>
<th>Time Min. (Hr.)</th>
<th>Time Min. (Min.)</th>
<th>Time Ratio of Maximum Water</th>
<th>Time Ratio of Maximum Design Vertical Computed of</th>
<th>Conduit Flow Velocity</th>
<th>Depth Flow Occurrence</th>
<th>Velocity Occurrence</th>
<th>Design Upstream Discharge</th>
<th>USGS</th>
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#### Diagram Description

- **Ocean**: Represents the boundary of the oceanic area.
- **River**: Indicates the flow direction and movement.
- **Water Levels**: Shows the level variations along the river flowpath.
<table>
<thead>
<tr>
<th>Conduit</th>
<th>Maximum Velocity Occurrence Design Upstream Denstr US DD</th>
<th>Name (cm)</th>
<th>(mm)</th>
<th>(mm)</th>
<th>(one)</th>
<th>Hr. Min.</th>
<th>Flow (m)</th>
<th>(m)</th>
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<td>50</td>
<td>1.2422</td>
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</tbody>
</table>
• Model outputs correlated in space and time
• Thematic rendering
• Direct export to GIS
• Can be animated
• Built in to platform
• xpviewer
Combined 2D Results

- Time to Inundation
- Duration of Inundation
- Time to peak Velocity
- Time to Peak Water Elevation
- Risk (Velocity x Depth)
Evacuation routes based on time to inundation
Special 2D polylines with elevation
Route cutoff values are user-defined
Routes are analyzed for cutoff by Depth, Velocity or VxD
• Built into the platform
• No file manipulation required
• Full control of display and thematics
• Full control of time series output
Video Case Study: Josephine County, Oregon with a detailed discussion of the 1D and 2D interaction across the entire study area.

xps.link/Josephine

Recorded 2D Modeling Series:
3-part series on cell sizes, structures and direct rainfall

xps.link/2dseries
Has this webinar been helpful? Can we provide more information? Would you like:

- A personalized demonstration of \texttt{xpswmm} and \texttt{xp2D}?
- A software evaluation of \texttt{xpswmm} and \texttt{xp2D}?
- A price quotation for our flood modeling software?
- Training options for flood modeling?
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- Write down this password - it will be required to print your certificate: storage
To Download Your Certificate

- In a couple of hours you will receive an email from ameducation@xpsolutions.com. Check your junk mail as it may go there.
- Click on the link in the email and follow the instructions. You will be presented with an optional opportunity to provide your feedback in a short survey, then to enter your name and password.
- If you go through the survey and don’t find where to download your PDH, you will also receive a confirmation email with a direct link.
Questions? Comments?

Thank you for joining this presentation,
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