DAM BREACH ANALYSIS WITH HEC-RAS 5.0 2D,
IMPROVEMENTS TO ACCURACY, HAZARD DATA OUTPUTS AND EFFICIENCY, CASE EXAMPLES

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June 2016
Outline

• Background
• HEC-RAS 5.0 2-D Approach
• RAS Mapper Enhancements
• Geometry Window Changes
• Dam Breach Modeling
Background

- Previous dam breach software used 1-D approach
- HEC-RAS 5.0 includes 2-D capabilities
- 2-D modeling is better suited to dam breach simulation
- Public domain software
HEC-RAS 2-D Approach

- Implicit finite volume solution
  - Solves either diffusion wave or full 2-D St. Venant equations
  - Breaches should be modeled using full momentum solution
- Utilizes structured or un-structured grids
- Grid cell faces represented as cross sections
- Grid cell areas modeled using elevation-volume tables, rather than a flat or sloped plane
- Captures sub-grid detail when performing calculations and mapping results
Most 2D Models Simplify the Terrain
Grid Cell Representation

Cell Faces
Extracted from Terrain
Sub-Grid Level Detail
Geometry Window Changes

• Can display terrain, land use, aerial photos and online data
• Dam breach parameter calculator
• Grid creation and modification tools
  – 2-D breakline tool
• Land use modification tool
Breach Parameter Calculator

![Breach Parameter Calculator GUI]

- **Input Data**
  - Top of Dam Elevation (ft): 8031
  - Breach Bottom Elevation (ft): 8000
  - Pool Elevation at Failure (ft): 5031
  - Pool Volume at Failure (acre-ft): 298500
  - Failure mode: Overtopping
  - Dam Crest Width (ft): 44
  - Slope of US Dam Face 21 (H:V): 3
  - Earth Fill Type: Non-Homogeneous or Rockfill
  - Slope of OS Dam Face 22 (H:V): 2

- **Xu Zheng (and Von Thun)**
  - Dam Type: Dam with core wall
  - Dam Erodibility: Medium

- **Method**
  - M disco et al: 538, 0.5, 3.87
  - F roechl (1995): 701, 1.4, 1.91
  - F roechl (2000): 521, 1, 1.53
  - Von Thun & Gillette: 642, 0.5, 1.66
  - Xu & Zheng: 832, 0.65, 3.60

*Note: The breach development time from the Xu Zheng equation includes more of the initial erosion period and post erosion than what is used in the HEC-RAS breach formation time.*
RAS Mapper Enhancements

• Utility used to manage inputs and outputs
• Can create interpolation surfaces from 1D HEC-RAS cross sections to correct terrains or represent changes
• Can create composite terrains
• Able to display animated results
• Includes particle tracing options
• Results can be output in multiple formats
RAS Mapper
Land Use Type
2-D Rectilinear Grid
2-D Grid w/Breaklines
Cell Size Along Breaklines
Terrain Correction
Proposed Terrain Development
Inundation Animation
Particle Tracing
Dam Breach Modeling Approach

• Consider how up and downstream areas will be represented
  – 1-D cross sections, storage area, 2-D flow area
• Terrain used is crucial
  – Raw LiDAR data may have problems
• Breakline development is very important
• Boundary conditions need to be properly defined
Dam Breach Benchmark Model
Results Comparison

• HEC-RAS 5.0 compared to InfoWorks
  – InfoWorks: Finite volume model, automated flexible triangular mesh
  – HEC-RAS: Finite volume solution, grid cells can have up to 8 faces

• Breach hydrograph used for InfoWorks developed externally

• HEC-RAS 5.0 results based on full 2-D simulation

• Inundation areas very similar
2-D Results Comparison
2-D Results (Close-up)
Conclusion

• 2-D modeling can improve dam breach results, while reducing effort required
• Can model reservoir and downstream inundation area as 2-D regions
• Terrain development/modification is critical
• Grid refinement is necessary to correctly represent hydraulic features
QUESTIONS?