Using Integrated Catchment Modeling (ICM) Dynamic Analysis for Wildcat Branch

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Presentation Agenda
- Project Background
- Steady Modeling Approach
- Specific Areas of Concern
- ICM Model Construction
- Pros and Cons
- Comparison to HMS/RAS
- Flood Mitigation
- Questions

Project Location
Project Background

- Approx. 3.3 Sq. Miles
  - Wildcat 1.8 sq. mi.
  - Dunbar 1.5 sq. mi.
- Drains to Lake Arlington
- Primarily Residential
  - Single Family
  - Low Density Residential
  - Industrial
  - Parks and Institutional
- Several Areas with Frequent Flooding

Project Background

- FW Open Channel Studies
- FEMA Effective Zone AE
- Small Section of Zone A
- Established Floodway
- Study Intent
  - Update Floodplain and Floodway based on recent data
  - Evaluate Improvement Alternatives
  - Recommend CIP

Steady Modeling Approach

- Hydrologic Analysis (HEC-HMS)
  - Basin Delineation, Parameter Development
  - NRCS Loss and Unit Hydrograph Methods
  - Modified-Puls Routing
  - Flow Diversion
Steady Modeling Approach

- Hydraulic Modeling (HEC-RAS)
  - Section Layout Based on Assumed Flow Direction
  - Split Flow Optimization at Mt. Tabor
  - Roughness Values Based on Aerials and Field Observation
  - Structures Surveyed for Accuracy

Areas of Concern

- Overflow at Ramey Ave
- Overflow at Crenshaw
- Lateral Spill at Mt. Tabor
- Left Overbank Flow
- Flow Along Berry St.
- Flow Under IH-820E

Steady Modeling Limitations

- Flow in Multiple Directions
  - Parallel/Split Channels
- Overland Flow Challenges
- Volume and Detention
- Calculation Assumptions
  (Standard Step vs Dynamic)
- Mapping Assumptions

*Traditional drainage calculations require the engineer to make assumptions about these issues... these may be over-simplified, very conservative, or just plain wrong.*
Benefits of 2D Analysis

- **Hydrology** – Uses full hydrograph
  - Account for differences in timing
  - Evaluate surface flow patterns accurately
- **Hydraulics** – Realistic 1D/2D interaction
  - Complex overland flow directions
  - Break over from one stream to another
  - Storage in low-lying areas and impoundments
  - Split flow situations and relief channels
- **Look at the system as a whole**
  - Gain a better understanding of flow patterns for HMS/RAS
  - Optimize the solutions to reduce project costs

InfoWorks ICM Model

- **Integrated Catchment Modeling** – Combines Urban Storm Sewer and Riverine Flow in 1D/2D Hydrodynamic Model
- **Capabilities** – Closed Conduit and Overland Interaction
  - 1D Storm Sewer
  - 1D Stream Channels
  - 2D Overland Flow
  - Hydrology

ICM Model Construction

- **Ground Model Import**
- **Construct River Reaches**
- **Add Flow Information**
- **Add Roughness Polygons**
- **Add Voids**
- **Add Breaklines**
- **Generate 2D Mesh**
- **Add Bridges/Culverts**
- **Run/Troubleshoot**

*Dynamic River Modeling is an Iterative Process... Fix, Run, Crash, Repeat*
Modeling Misconceptions

- If the Model Runs Then It is Good
- Check and Re-Check
  - Volume Balance
  - Stability
- Engineering Judgment
  - Do the Results Make Sense?
- It is a Black Box (Don’t Know How It Gets the Answer)
- Run Hand Calculations
- Runs the Same Calculations as RAS/HMS

InfoWorks ICM Cons

- Inputting Bridge/Structure is not User Friendly
- Bridge Opening Shapes are Somewhat Complicated, Especially Custom
- Supposed to Look Like RAS, but Still Quite Different
- Bridge Entrance/Exit for Bridge Routine
- River Reaches are One Feature, Not Cross Sections
  - Stability Issues Difficult to Pinpoint Within a Reach
- Bank lines can get complicated when splitting river reaches because they are separate features from the reach and must be split as well
- Inflows Applied at Nodes, Not Sections (Objects)

InfoWorks ICM Pros

- Wide Range of Capabilities
  - Integrated Storm Sewer, Rivers, Open Channel, Overland
- RAS Import Capabilities
- Connecting River and Mesh is Easier than in IWRS
- Cut XS and Banklines Directly from Terrain
- Better Editing Tools than SD/RS, Undo Function, Snap, etc.
- 3D Viewing
Data and Model Organization

- Version Control (for Building Model)
- History of Committed Changes
- Branch from the History
- Scenarios (for What-if's)
  - Allow Testing of Different Scenarios Without Creating a New Version
  - Re-integrate the Scenarios Back into the Base Version or Delete
- Transportable Database
  - Submitting a Model is Streamlined
  - One Single File for Entire Model
    - Multiple Alternatives, Multiple Runs, Results, etc.

ICM Model Results

- Flow Rates Similar at Most Locations
- Inflow Hydrographs
- Hydraulic Routing
- WSEL Generally Lower
- Routing Differences
- Assumptions about timing
- Differentiated in Inundation Areas
- Overland Flow Patterns
- Standard Step vs. 2D Flow

<table>
<thead>
<tr>
<th>Location</th>
<th>RCS 100-yr Flow (cfs)</th>
<th>ICM 100-yr Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramey</td>
<td>2370</td>
<td>2389</td>
</tr>
<tr>
<td>City of Village Creek, Sr</td>
<td>2859</td>
<td>2838</td>
</tr>
<tr>
<td>City of Wales</td>
<td>2996</td>
<td>2974</td>
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<tr>
<td>ICM 200</td>
<td>3335</td>
<td>2796</td>
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</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>RCS 100-yr WSEL (ft)</th>
<th>ICM 100-yr WSEL (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U/S of Ramey</td>
<td>628.1</td>
<td>628.0</td>
</tr>
<tr>
<td>At the Mt. Tabor Overflow</td>
<td>615.8</td>
<td>615.5</td>
</tr>
<tr>
<td>U/S of Village Creek Dr</td>
<td>607.3</td>
<td>605.9</td>
</tr>
<tr>
<td>U/S of Dillard St</td>
<td>598.0</td>
<td>596.3</td>
</tr>
<tr>
<td>U/S of IH-820</td>
<td>575.5</td>
<td>574.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>RCS Location (In Channel)</th>
<th>ICM Location (In Channel)</th>
<th>RCS Location (Overland Areas)</th>
<th>ICM Location (Overland Areas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramey</td>
<td>618.3</td>
<td>618.2</td>
<td>616.7</td>
<td>616.8</td>
</tr>
<tr>
<td>Mt. Tabor Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Berry St near Dillard Ave</td>
<td>598.0</td>
<td>596.3</td>
<td>598.0</td>
<td>598.0</td>
</tr>
</tbody>
</table>
ICM Results - Areas of Concern

- Overflow at Ramey Ave
- Overflow at Crenshaw
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Mapping Changes

- Mapping is based on the intersection of a water surface TIN or Grid with the terrain.
- Top widths must match so not much flexibility
- Used shallow flooding to identify flood prone areas outside the “floodplain”
Flood Mitigation

- Improvement Alternative Evaluation
- Channel Improvements
- Detention Facilities
- Structure Improvements

- Improve Future Development?
  - Mt. Tabor Site
  - Linear Parks
  - Model Expansion (SD)
  - Area Redevelopment

Questions?