2D Stormwater Modeling Applications

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Company Background - About LAN

- Founded in 1935
- Full-service engineering, planning, and program management
- 21 offices nationwide
Agenda

2-Dimensional (2D) Stormwater Modeling

1. What is it
2. What’s Involved
3. General Applications
4. Example Projects
5. Michigan – local demonstration
Agenda

2-Dimensional (2D) Stormwater Modeling

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2D Stormwater Modeling

- Traditional “1-dimensional” modeling
  - Pipes, channels
  - 1 “direction” only
  - Limited surface flow

- 2-dimensional modeling
  - Pipes, channels
  - Multiple “directions”
  - Accurate surface flow
2D Stormwater Modeling

• 2D Stormwater Modeling:
  – A more accurate means to simulate stormwater runoff
2D Stormwater Modeling

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• New Approach
  – Available high resolution topography
  – Technological advances
2D Stormwater Modeling

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  - Technological advances

- Understanding the “Flood”
  - Traditional methods emphasize model the pipes
  - 2D Methods model the surface, or the “flood”
2D Stormwater Modeling
2D Stormwater Modeling

- Analysis Accuracy
2D Stormwater Modeling

- Analysis Accuracy
  - Improved understanding
2D Stormwater Modeling

• Analysis Accuracy
  - Improved understanding
  - Effective and efficient solutions
2D Stormwater Modeling

- Analysis Accuracy
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  - Effective and efficient solutions
  - Effective allocation of available funding
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• Communication Tool
  - Visual Simulation during Public Meetings
2D Stormwater Modeling

- Analysis Accuracy
  - Improved understanding
  - Effective and efficient solutions
  - Effective allocation of available funding
- Communication Tool
  - Visual Simulation during Public Meetings
- Benefit Determination
  - Funding assistance
2D Stormwater Modeling

• Analysis Accuracy
  - Improved understanding
  - Effective and efficient solutions
  - Effective allocation of available funding

• Communication Tool
  - Visual Simulation during Public Meetings

• Benefit Determination
  - Funding assistance

• Efficient and cost-effective
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2D Modeling – What’s Involved

Typical Analysis Inputs

• Aerial Topography – LiDAR – Essential

• Drainage Infrastructure
  – Pipes
  – Open Drains
  – Rivers

• Land Use
2D Modeling – What’s Involved

Hydrology - Traditional
– Rational Method
  • Delineate Drainage Area
  • Calculate Time of Concentration
  • Determine Intensity
  • Calculate Peak Flowrate
– Unit Hydrograph Methods
  • Rainfall Amount and Distribution
  • Loss Rates
  • Unit Hydrograph Methods
  • Develop Hydrographs
2D Modeling – What’s Involved

Hydrology – 2D Analysis

– Unit Hydrograph Methods

– Alternative 2D Approach
  • True simulation of rainfall/runoff
  • Rainfall applied directly to surface
  • Loss Rates applied prior to modeling
2D Modeling – What’s Involved

• Hydraulics
  – Sub-Surface (pipes)
    • Inlets
    • Size & Shape
    • Elevations

  – Surface
    • LiDAR
    • Roughness Zones
    • Topographic Adjustments

• Boundary Conditions
  • Hydrographs/Rainfall
  • Tailwater
## Model Comparison

<table>
<thead>
<tr>
<th>Method</th>
<th>Software</th>
<th>Advantages</th>
<th>Limitations</th>
</tr>
</thead>
</table>
| **Static or Steady State Analysis** | • StormCAD  
• HEC-RAS  
• Spreadsheets | • Ease of use  
• Standard product  
• Results reporting is simple and easy to interpret and evaluate  
• Limited data requirements | • Complex systems  
• No overland flow  
• Results reporting                                                                                                           |
| **Dynamic with 1-D Overland Sheetflow** | • SWMM  
• XP-SWMM  
• ICPR  
• InfoWorks  
• HEC-RAS | • Complex storm sewers  
• Pump stations and detention  
• Limited data requirements  
• 1-D overland flow | • Complex analysis – specialty  
• Limited overland flow  
• Limited results reporting                                                                                                           |
| **Dynamic with 2-D Overland Sheetflow** | • InfoWorks  
• XP-SWMM  
• SOBEK  
• MIKE Urban  
• HEC-RAS 5 | • Improved overland sheetflow  
• Improved storage accounting  
• Additional calibration options  
• Improved communications tools | • Complex analysis – specialty  
• Data requirements  
• Initial up-front cost                                                                                                           |
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2D Modeling Applications

• Problem Area specific studies

• Planning and Drainage Studies
  – Master Drainage Plans
  – System inventory and assessment
  – Problem identification and prioritization

• Support Design Level Project
2D Modeling Applications

• High-Level Rapid 2D Assessment
  – Initial problem evaluation
  – Planning tool
  – 90/10 rule: value/effort
  – Master plan applications
2D Modeling Applications

• High-Level Rapid 2D Assessment
  – How does it work
    • Leverage Available Data
      – LiDAR Data
      – GIS Information
    • Rainfall on Mesh
    • Regional Results Comparable With Detailed Studies
      – 90/10 Rule in Effect
Rapid 2D – San Antonio - Woodlawn

• High-Level Rapid 2D Analysis
  – Initial problem evaluation
  – Planning tool
  – 90/10 rule: value/effort
  – Master plan applications
2D Modeling Applications

- Complex Problem Evaluation
  - Combine traditional methods with cutting edge technology
  - Calibrated simulation
  - Confidence in solution
Complex Problem Evaluation

- Open channel, surface, and SS flow
# Problem Area Prioritization

## Problem Area Prioritization Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Flooded Structures</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>Impassable Intersections</td>
<td>4</td>
</tr>
<tr>
<td>C</td>
<td>Design Event Compliance</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>Extreme Event Compliance</td>
<td>3</td>
</tr>
<tr>
<td>E</td>
<td>Excessive Inundation Duration</td>
<td>2</td>
</tr>
<tr>
<td>F</td>
<td>Cross Block Flooding</td>
<td>1</td>
</tr>
</tbody>
</table>
Complex Problem Evaluation

Communication
• Confirmation of evaluation accuracy
• Effectiveness of solutions
2D Modeling Summary

• Relatively new approach
2D Modeling Summary

- Relatively new approach
- More accurate and comprehensive
2D Modeling Summary

- Relatively new approach
- More accurate and comprehensive
- Full understanding of complex flow
2D Modeling Summary

• Relatively new approach
• More accurate and comprehensive
• Full understanding of complex flow
• Planning tool
2D Modeling Summary

- Relatively new approach
- More accurate and comprehensive
- Full understanding of runoff
- Planning tool
- Design tool
2D Modeling Summary

- Relatively new approach
- More accurate and comprehensive
- Full understanding of complex flow
- Planning tool
- Design tool
- Communication tool
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2D Analysis and Lansing Region

- Flat topography – Overland flow important
- Intense short duration rainfall
- Mature developments

- Applications
  - Planning
  - Problem area evaluation
  - Design support
  - FEMA Map Evaluation
Webberville, MI
10-Year Flood Event
10-Year Flood Event
10-Year Existing vs Proposed Conditions - 11:45 am
10-Year Existing vs Proposed Conditions - Max Inundation
10-Year Existing vs Proposed Conditions
1:45 pm
Thank You

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