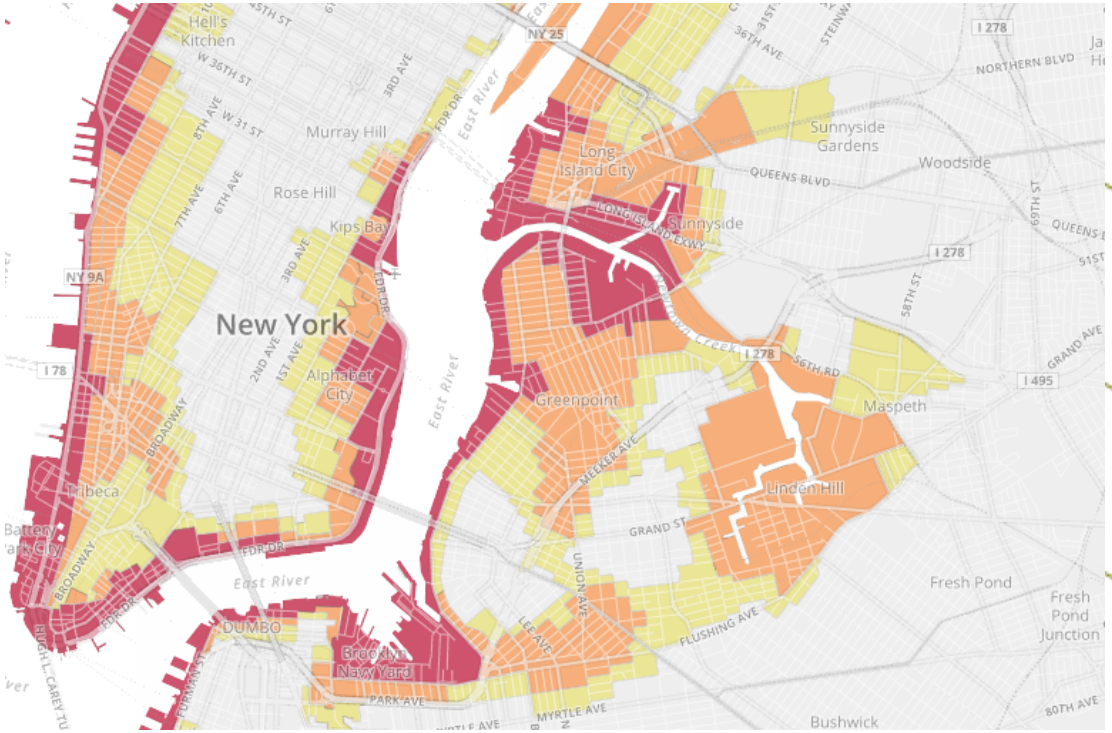
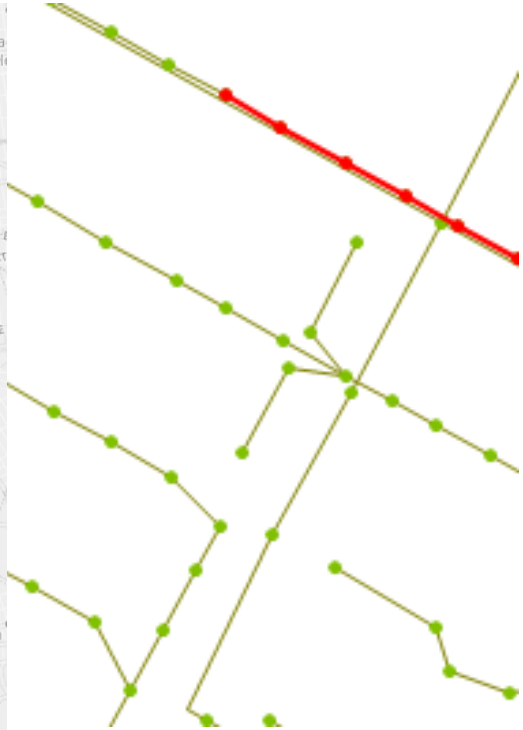
Hazen





Advanced 2D Hydraulic Modeling and LIDAR Integration for Coastal Resiliency Planning

NEWEA Annual Conference
January 22, 2018

NEW ENGLAND WATER ENVIRONMENT ASSOCIATION
NEWEA
WORKING FOR WATER QUALITY

Outline

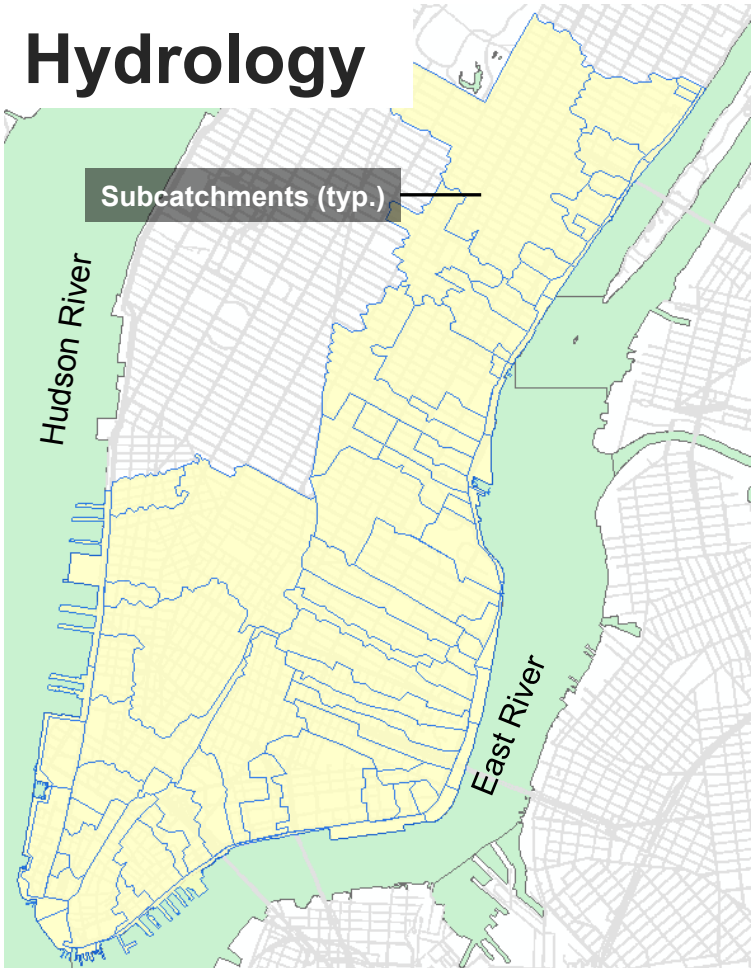
- Need for Coastal Storm Modeling
- InfoWorks ICM Modeling
  - 1-Dimensional
  - 2-Dimensional
- Application of Modeling Approach
- Questions

Coastal Storm Risks

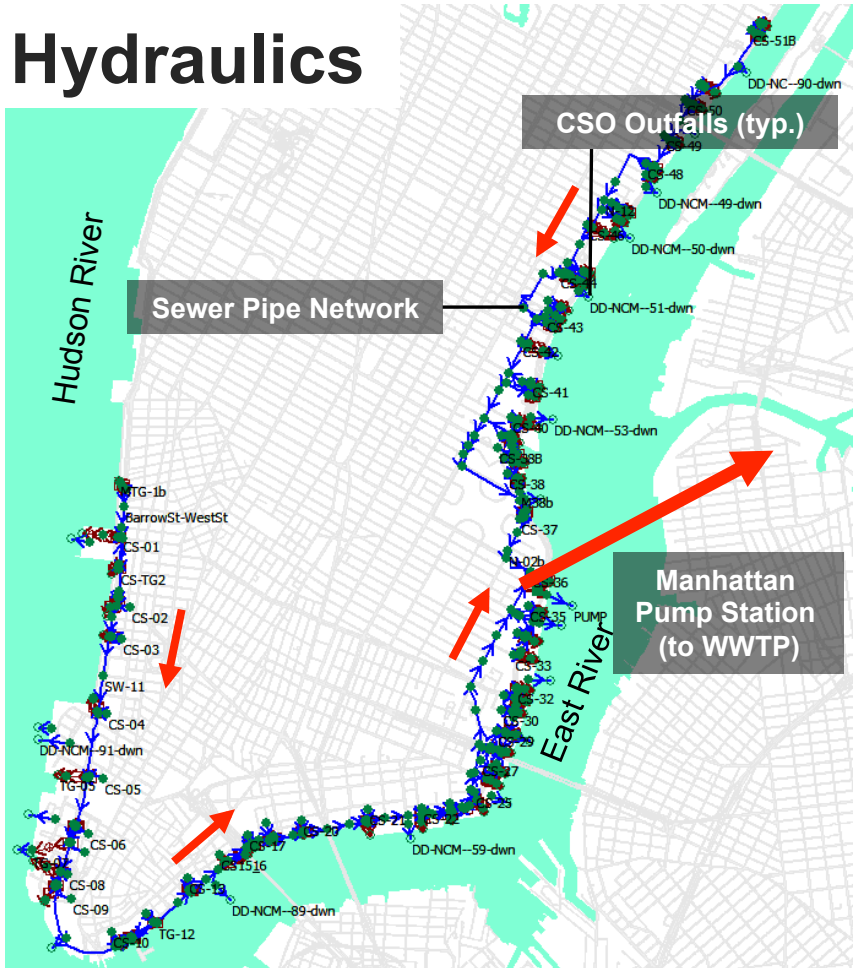
- Sea level rise and storm surge events present risks to vulnerable coastal infrastructure and residential populations
- Combined sewer infrastructure, like in NYC, is uniquely vulnerable during a storm surge event where flooding is compounded with wet weather flows
- Modeling helps municipalities assess and address their coastal storm risk

InfoWorks Modeling

Hydrology



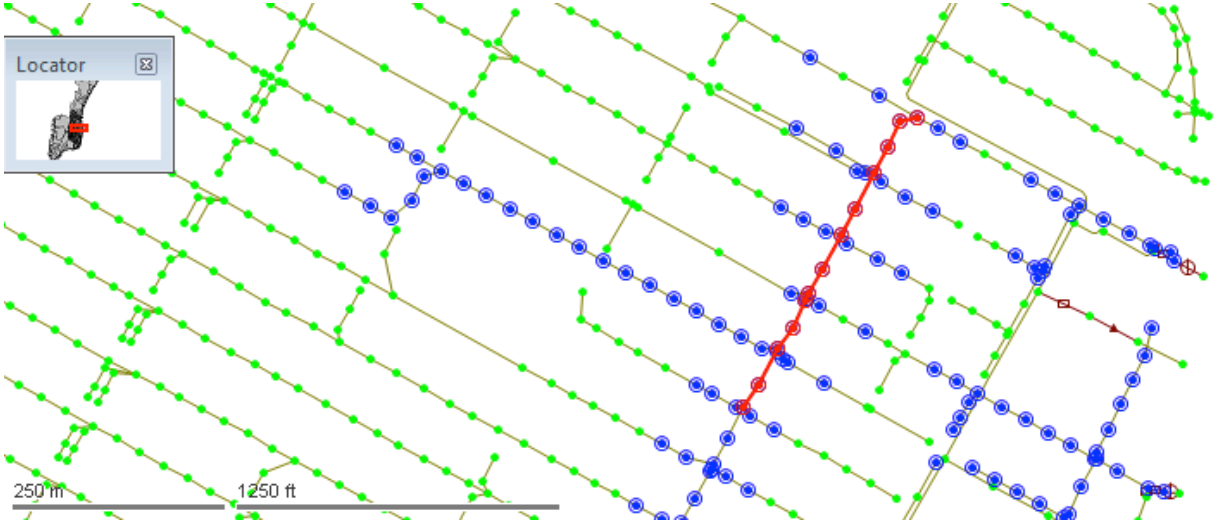
Hydraulics



InfoWorks ICM Modeling

- Standard 1D models can simulate:
  - Flows, levels, etc. in pipe network
  - Manhole location and volume of flooding
- 2D models add the capability to simulate:
  - Where the floodwater will move to, over the land, and around obstacles (buildings, etc.)
  - Simulate water re-entering the system at a downgradient location
  - Predict the flow, velocity, depth of the floodwater

InfoWorks Modeling – 1D

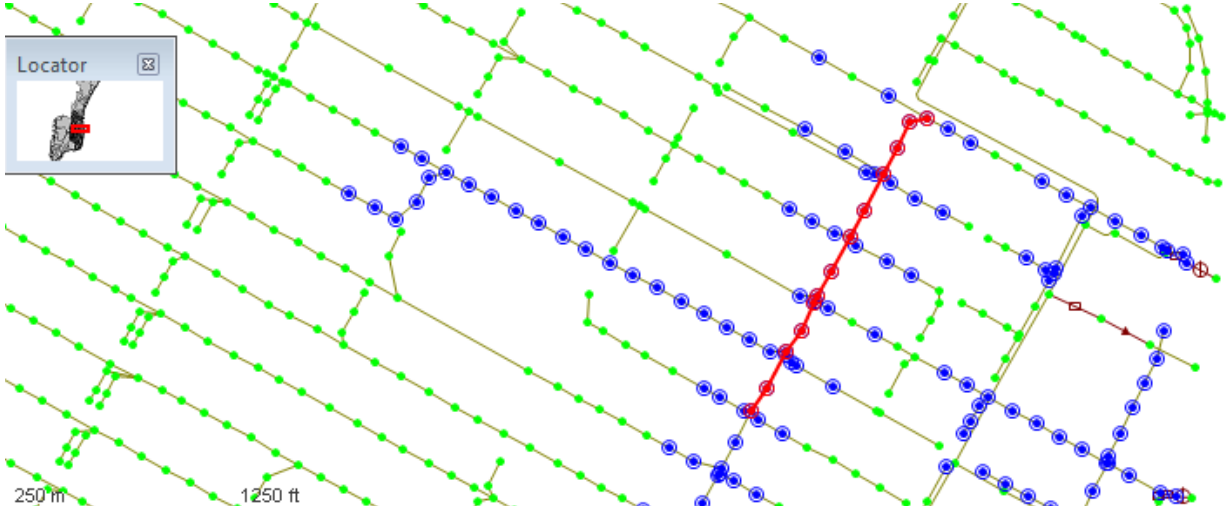


KEY

- Sewer of interest
- Predicted flooding at manholes

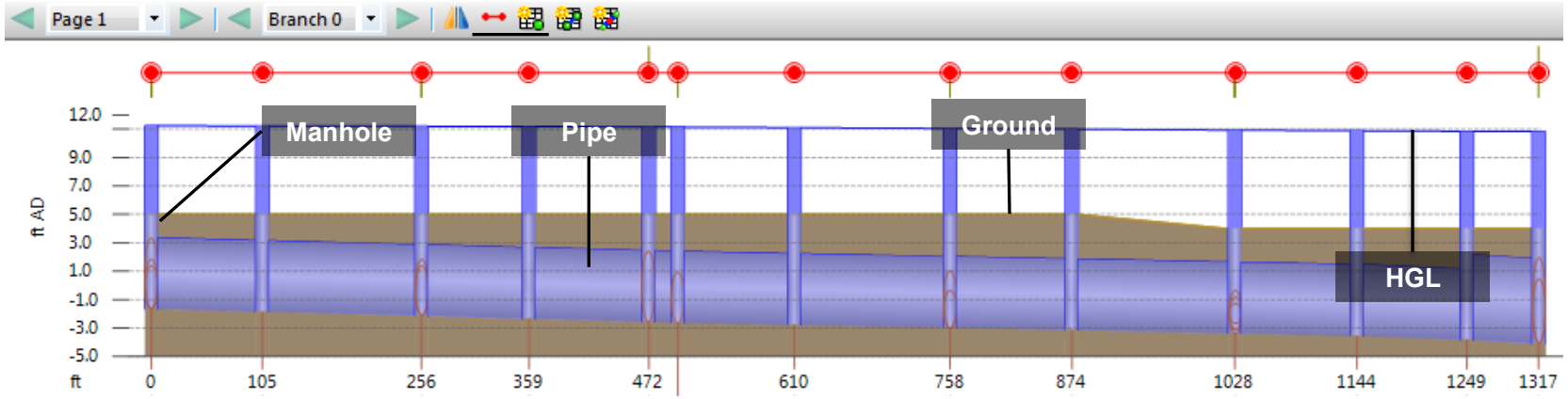
- Flooding can be predicted only at a manhole
  - Volume is conserved but water contained in vicinity of manhole
- No information on where water spreads
  - No ability to simulate water traveling overland and re-entering elsewhere in system

InfoWorks Modeling – 1D



KEY

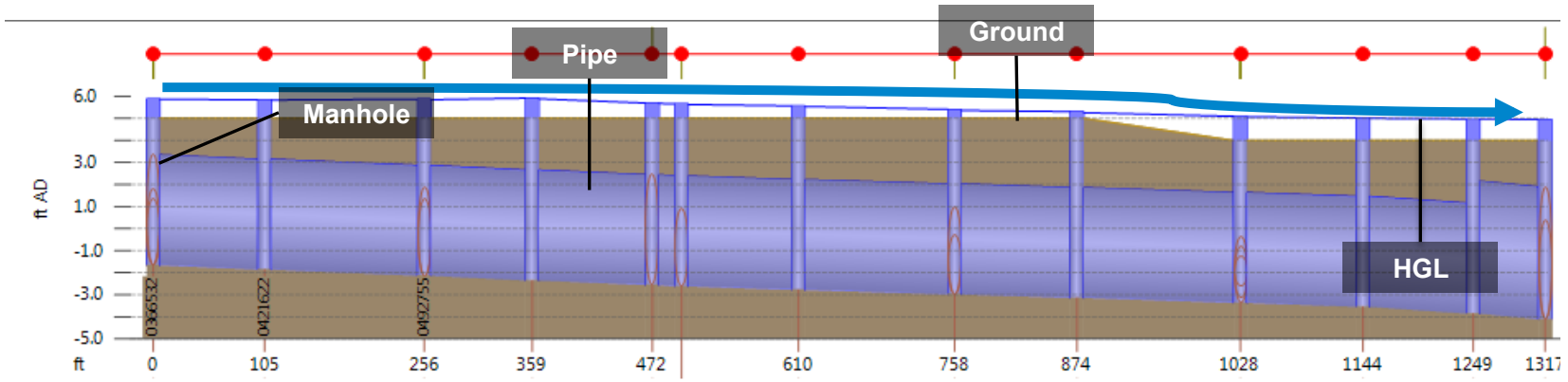
- Sewer profile shown
- Predicted flooding at manholes



InfoWorks ICM Modeling – 2D

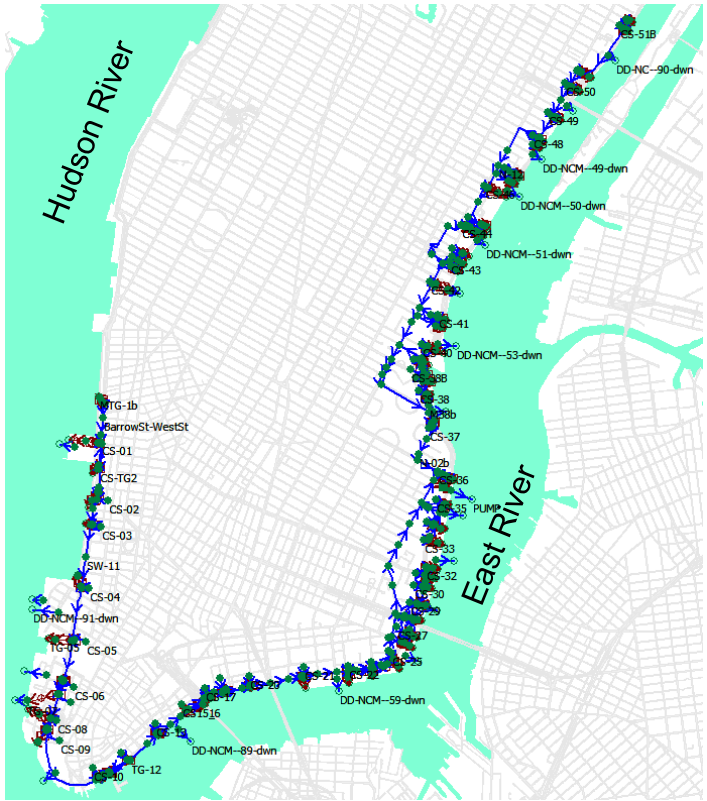
- Flooding can be predicted anywhere within 2D model extents
- Water spreads along ground based on topography
  - Water can travel overland and re-enter elsewhere in system

InfoWorks ICM Modeling – 2D

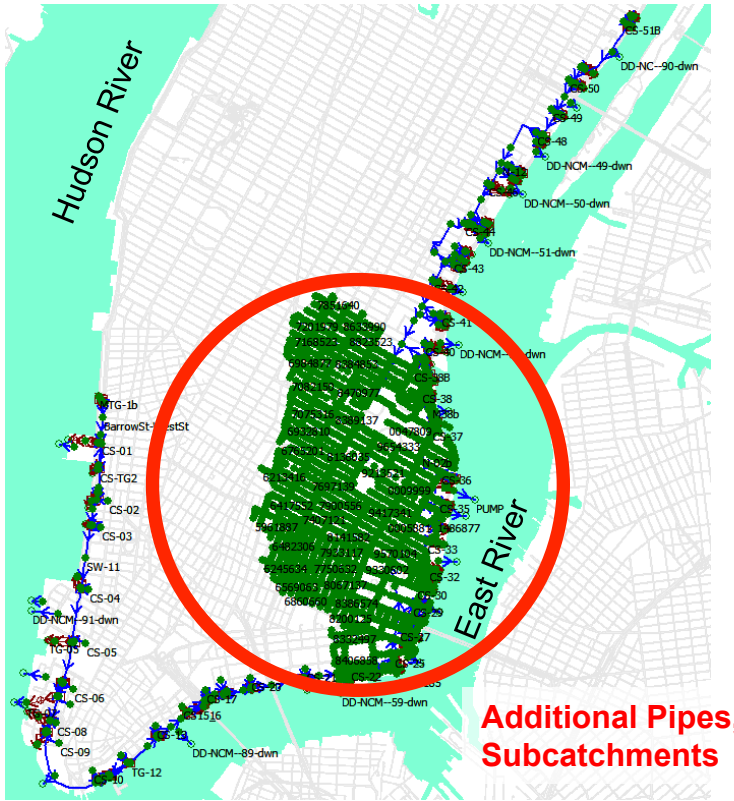


2D Modeling – Key Inputs

Detailed Sewer Network within 2D Study Area



Original Model



Additional Pipes, MHs, Subcatchments

Updated Model

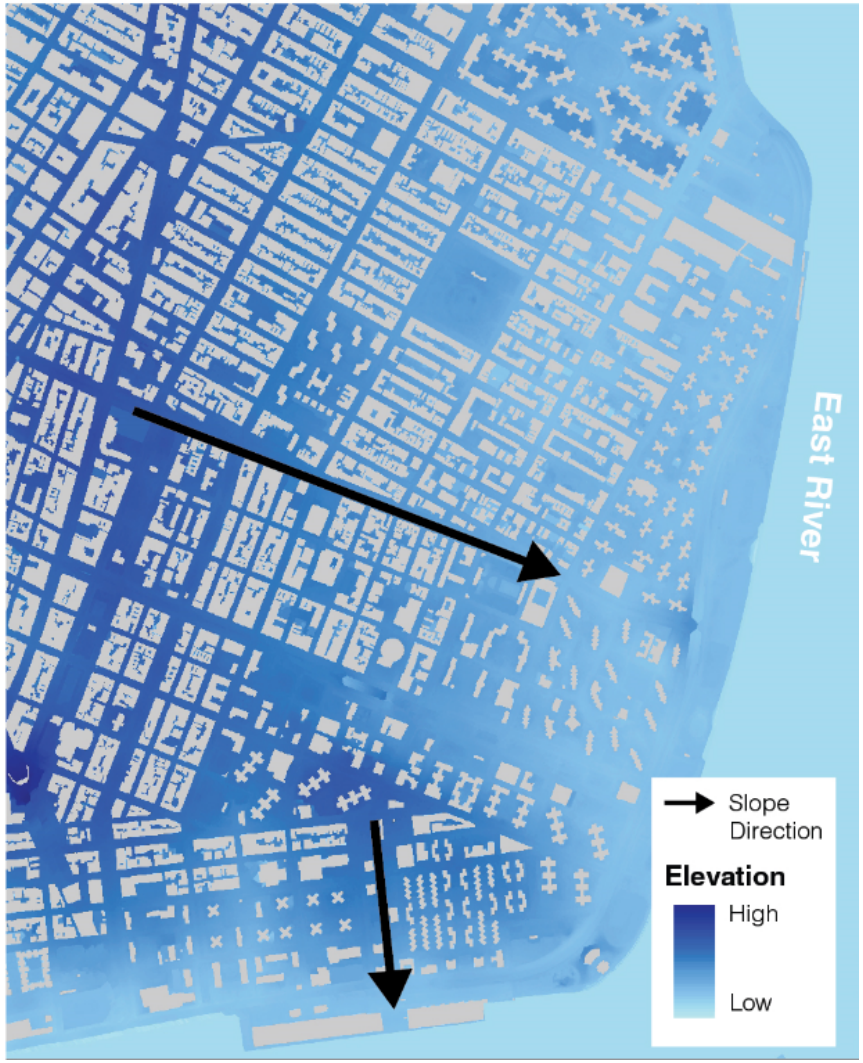
2D Modeling – Key Inputs

Detailed Sewer Network within 2D Study Area

Updated Model

2D Modeling – Key Inputs

- Topography Data
  - LIDAR
  - 1 ft x 1 ft resolution
  - Critical for 2D modeling



2D Modeling – Key Inputs

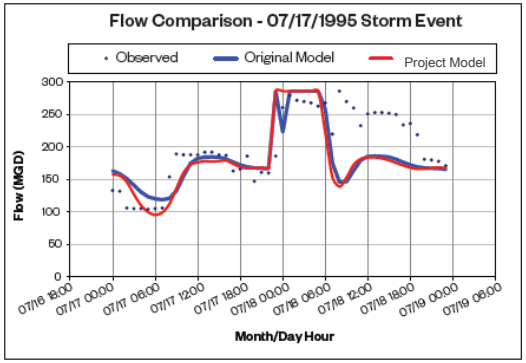
Buildings and 2D Surface

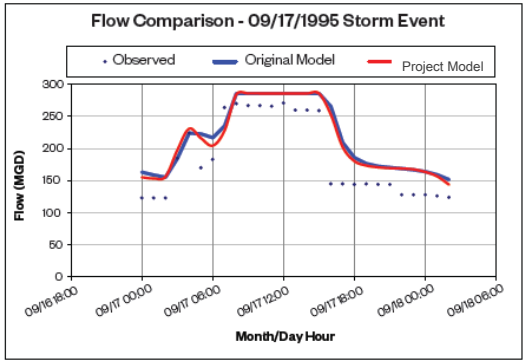
Buildings

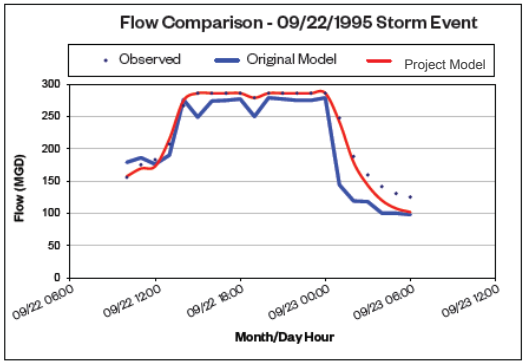
Microtopography

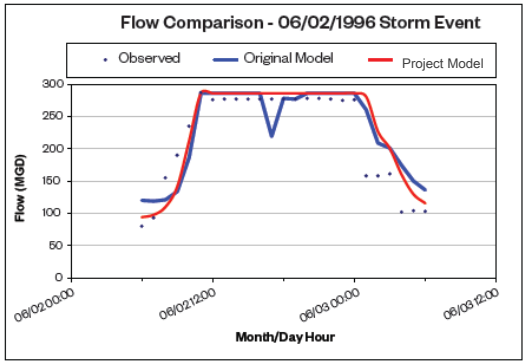
Model Validation

- Validate to historical data to confirm model predictions
- Helps identify errors
- Enhances confidence









2D Modeling Approach

Establishing a Project Baseline

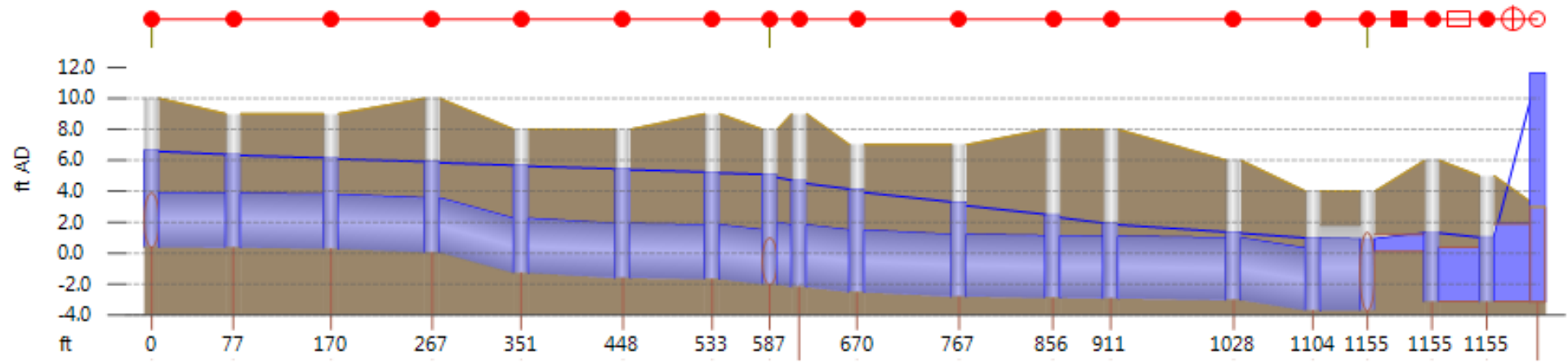
- Establish project boundary
- Model existing hydraulics under design rainfall conditions
    - Establish baseline sewer HGLs for regular tide and storm surge conditions

1

Establish Baseline Condition:
Model existing sewer conditions for design rainfall event at mean high tide

2

Determine Sewer Hydraulics under Surge Conditions:
Model post-flood protection sewer conditions for design storm with surge



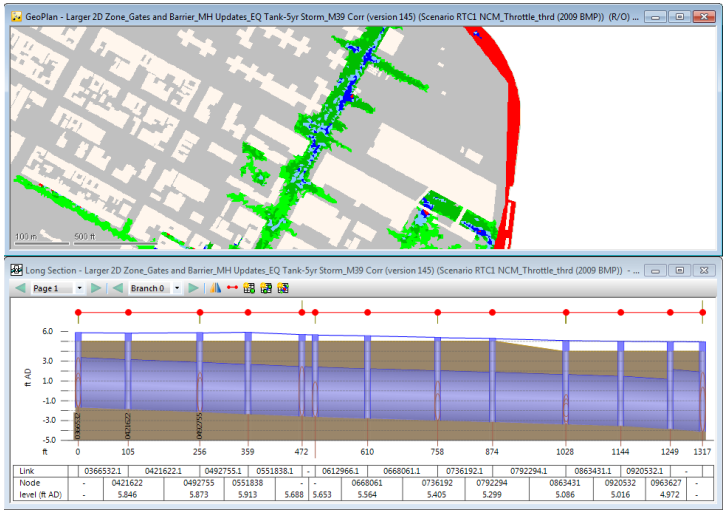
2D Modeling Approach

Establishing a Project Baseline

- Add proposed floodwalls to remove surge-induced flooding
  - Compare modeled HGL to established baseline conditions
  - Use LIDAR to determine surface expression of HGL
- Determine rainwater-induced flood risk

1 **Establish Baseline Condition:**
Model existing sewer conditions for design rainfall event at mean high tide

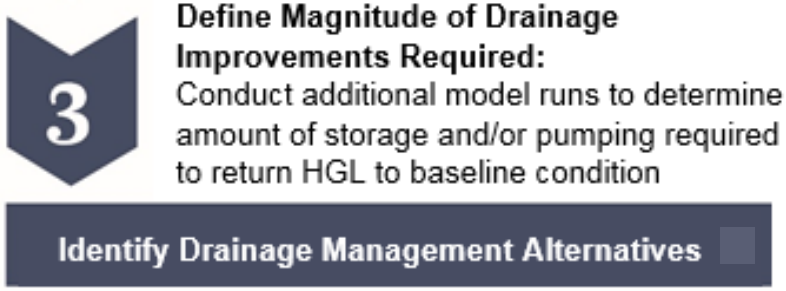
2 **Determine Sewer Hydraulics under Surge Conditions:**
Model post-flood protection sewer conditions for design storm with surge



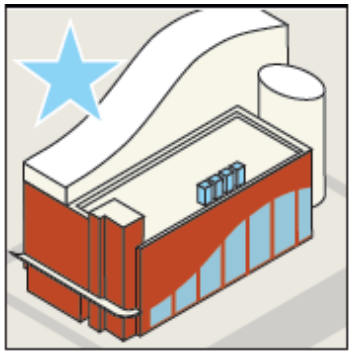
2D Modeling Approach

Identifying Drainage Improvements

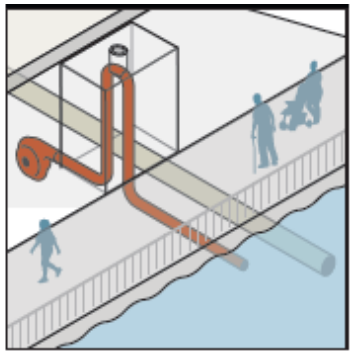
- Determine drainage management requirements
  - Aim to achieve baseline HGL
- Model the improvements
  - Evaluate alternatives and compare strategies



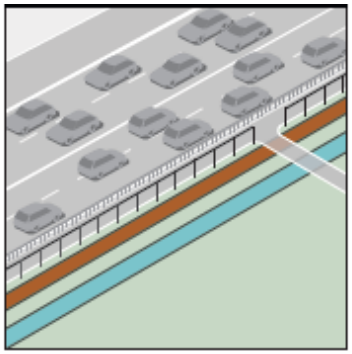
Leveraging existing facilities



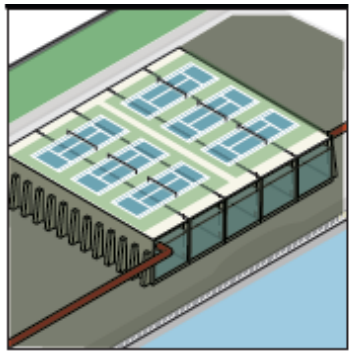
Pumping



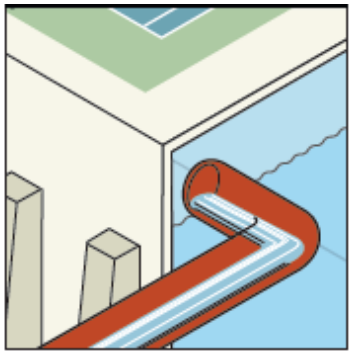
Additional Conveyance Capacity



Storage



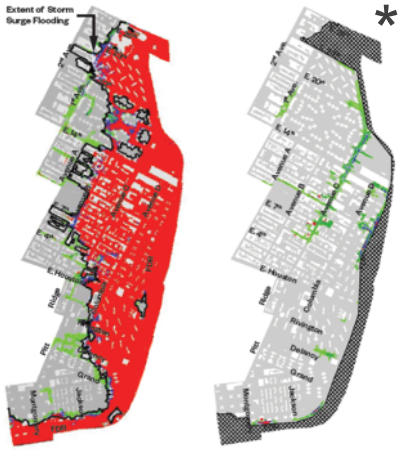
Conveyance to Storage



2D Modeling Approach

Evaluating Project Performance

Design Storm Evaluation



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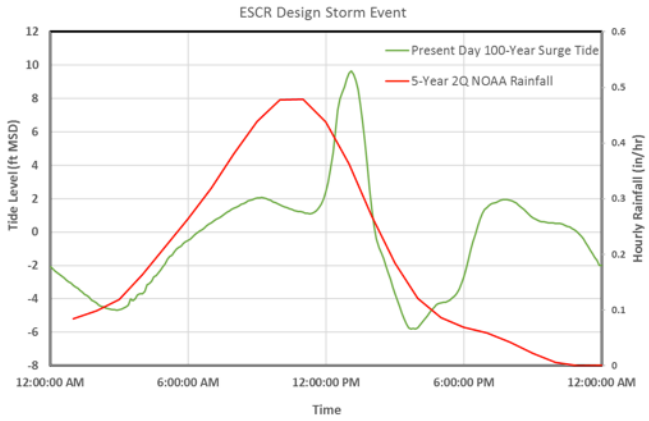
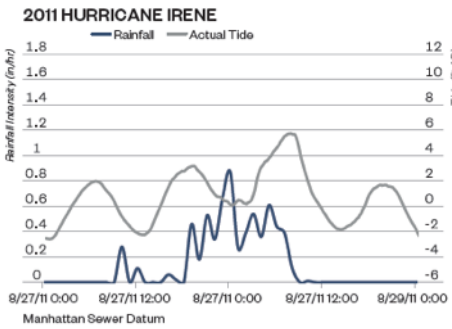
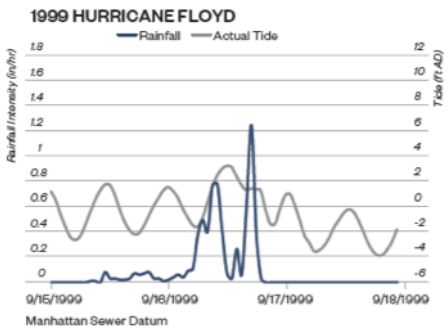


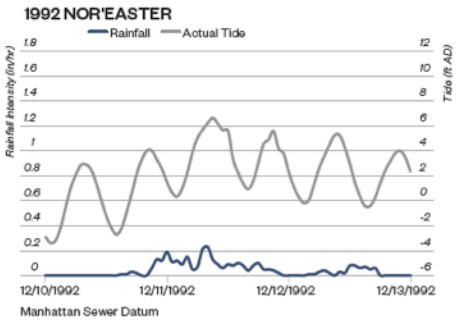
4 **Evaluate Performance (Design Storm):** Model performance of drainage alternatives for design storm event and refine as needed

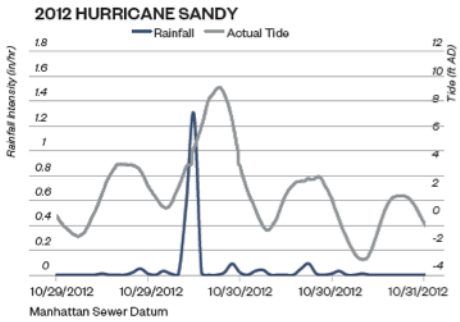
5 **Evaluate Performance (Actual Storms):** Model performance of drainage alternatives for actual storm events (e.g., Hurricane Sandy, Hurricane Irene, etc.)

Actual Storm Evaluation









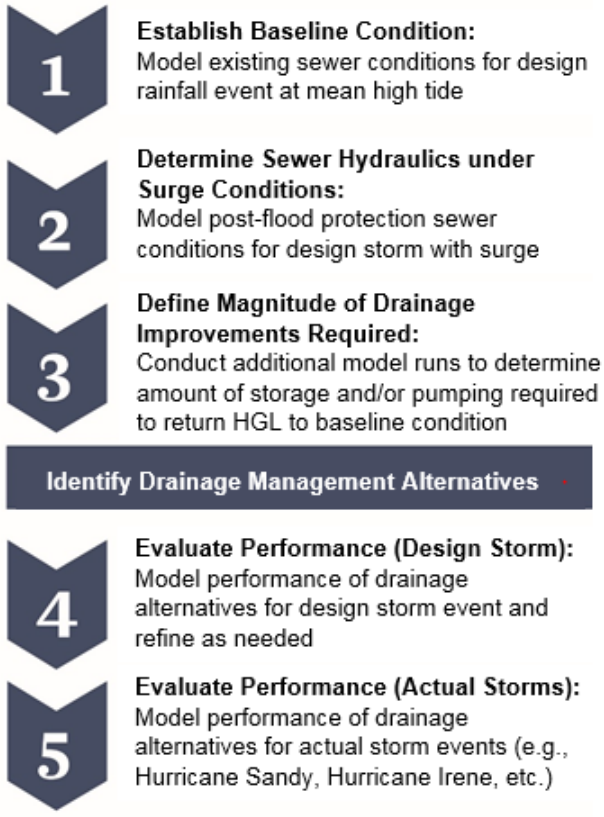
* Modeling performed in conjunction with AKRF-KSE JV, DDC, ORR, and DEP

2D Modeling Approach

Summary

Verified modeled approach informs project design

- Storage volumes
- Pumping rates
- Conveyance capacities and flow
- Operations



Conclusion

- Benefits of 2D modeling
  - Account for potential sewer and overland flow paths for coastal storm surge modeling applications
  - Quantify predicted flooding depths, extents, and flow rates
  - Determine source of flooding in vulnerable areas and identify ground surface and sewer features that pose limitations
  - Develop and model drainage solutions to lessen flood risk
  - Improved ability to communicate modeling results

Acknowledgments

Questions?

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