



Two-Dimensional Floodplain Modeling in Downtown Baltimore

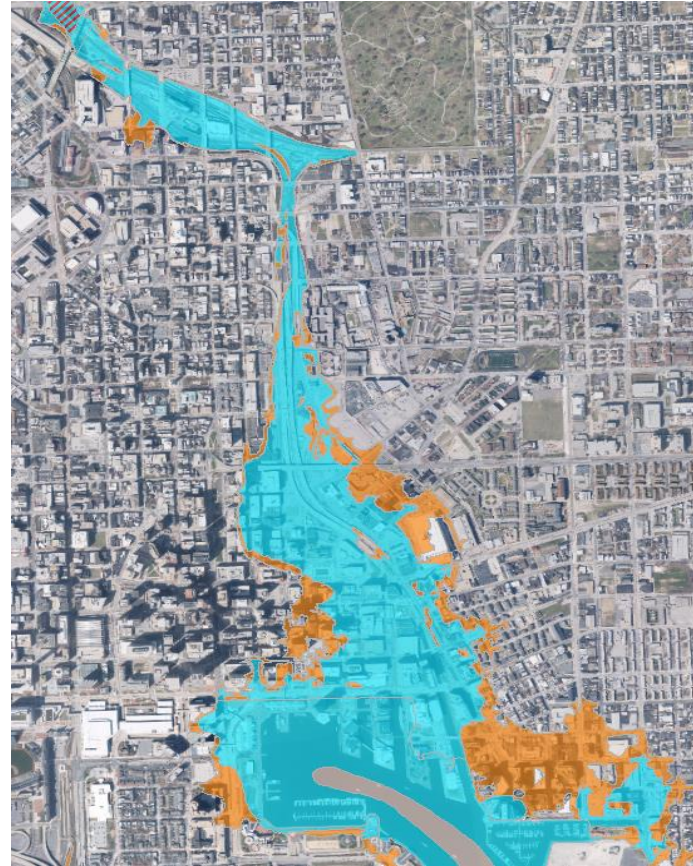
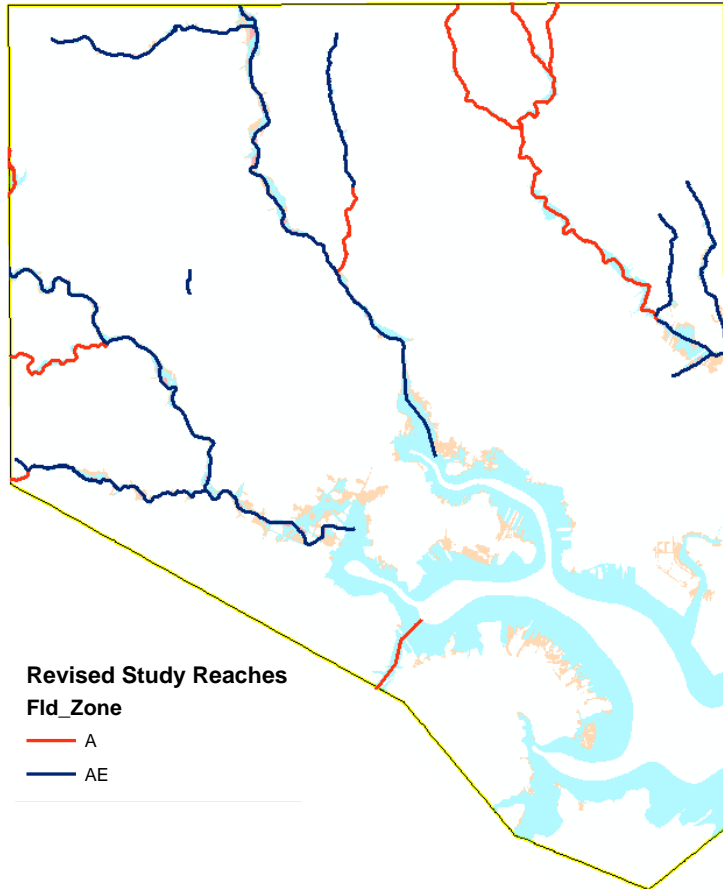
MAFSM – November 8th, 2018

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BALTIMORE CITY



BALTIMORE CITY FLOODING....

Baltimore city flooding from Wednesday night storm



Flooded streets and floating construction barrels after the Wednesday night downpour in Baltimore City. (Video by Jay Judge)

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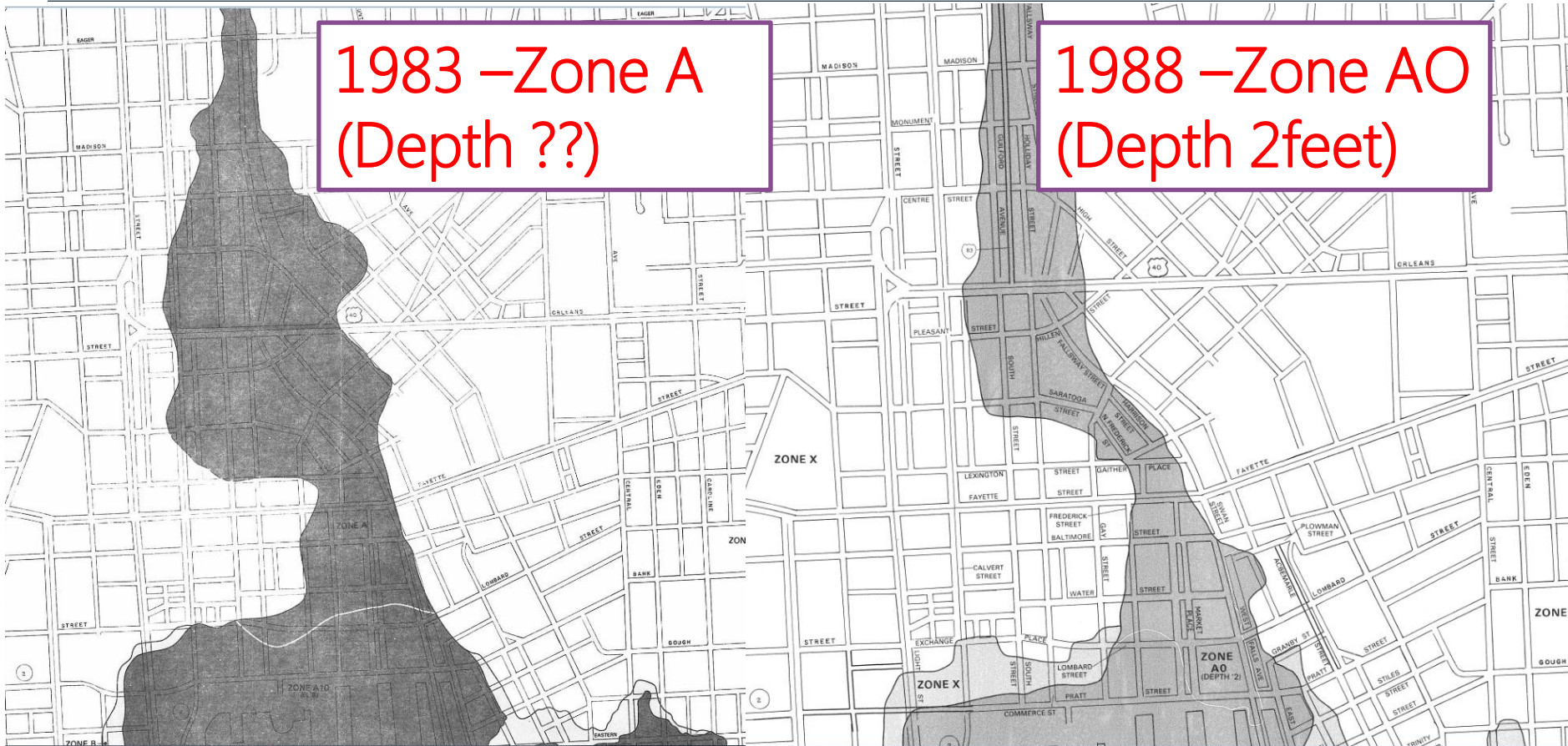


Flooding throughout the area with some businesses along the Jones Falls evacuated. (Kevin Richardson / Baltimore Sun video)

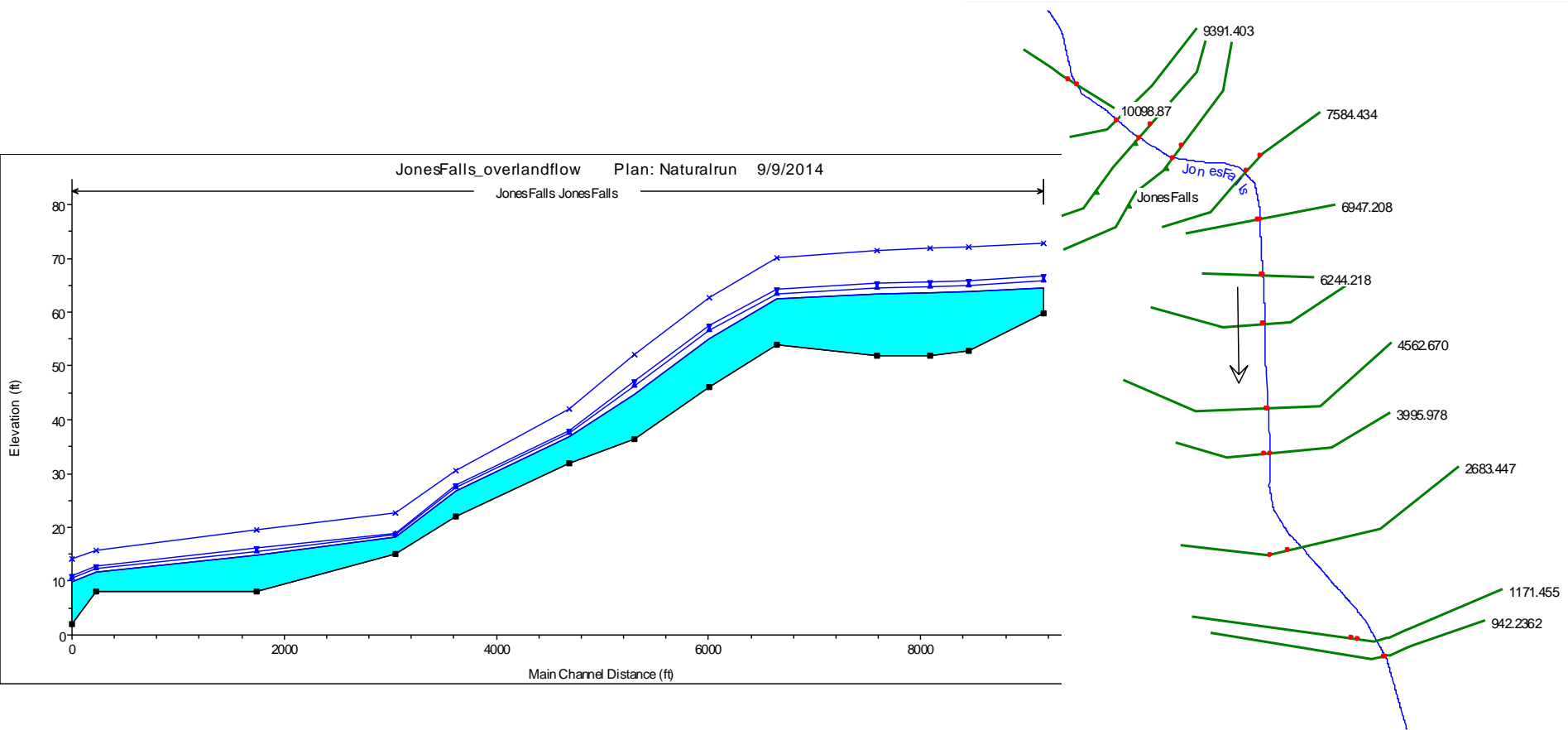
Effective Maps

1983 – Zone A
(Depth ??)

1988 – Zone AO
(Depth 2 feet)



Effective Modeling



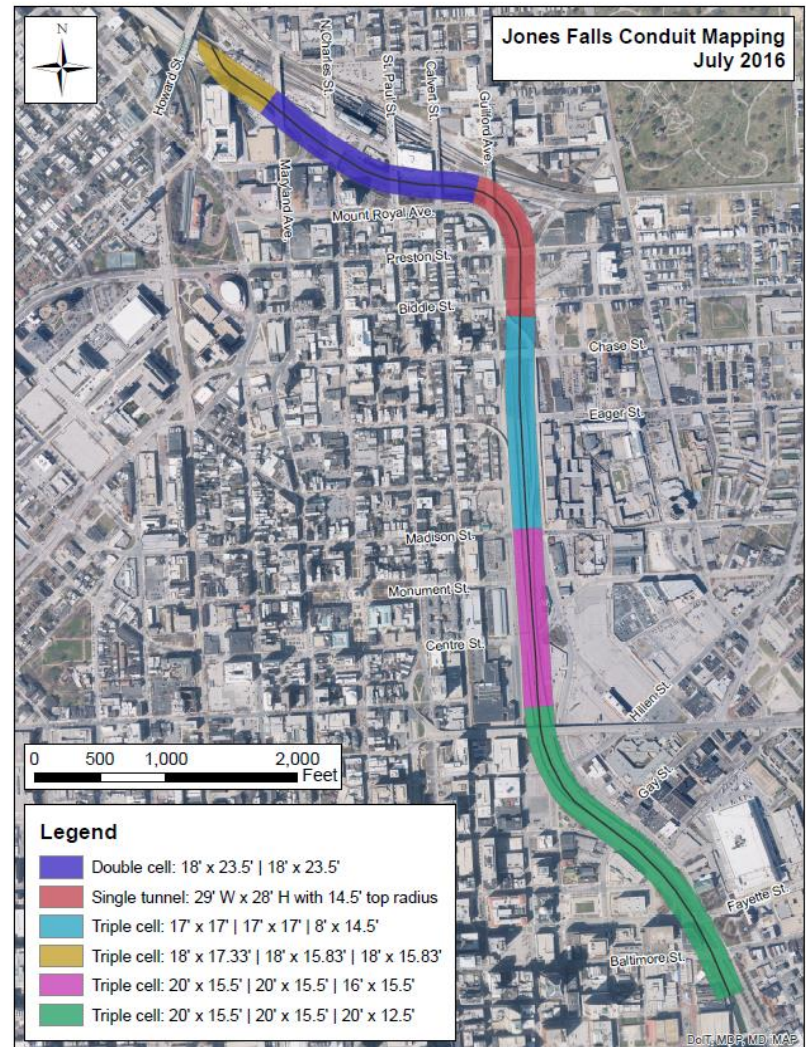
Preliminary H&H Analyses

- Effective Maps were not considered accurate hence need for better modeling of the downtown reach
- Recognized the limitations and worked with City DPW for gathering any available data
- Redefined the scope to do include more detailed / advanced modeling including a SWMM & 2D Overland Flow Analyses



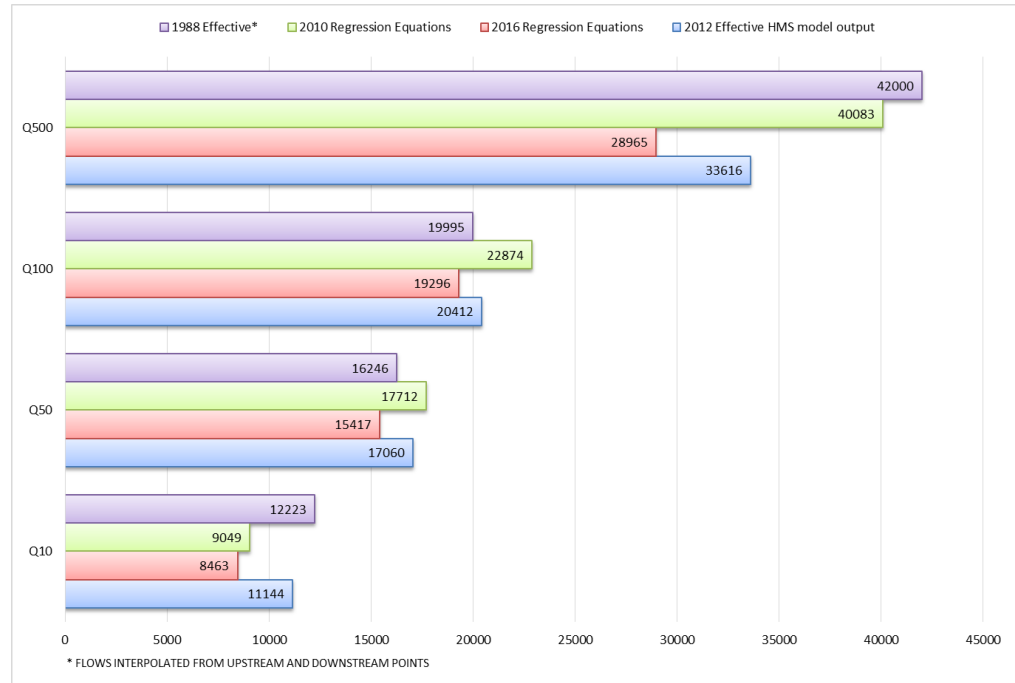
H&H Analyses

- Underground Tunnel System / Complex Stormwater system handled by PC-SWMM
 - As-builts dated 1911 thru 1955
 - Not all Stormwater network available for accounting losses in system
- Overland Flow analysis performed using HEC-RAS 5.0 (Two-Dimensional) Modeling
 - 2D analysis for complex flow patterns thru alleyways and street network
 - Lateral flow and tidal mapping conditions at inner harbor



Hydrology

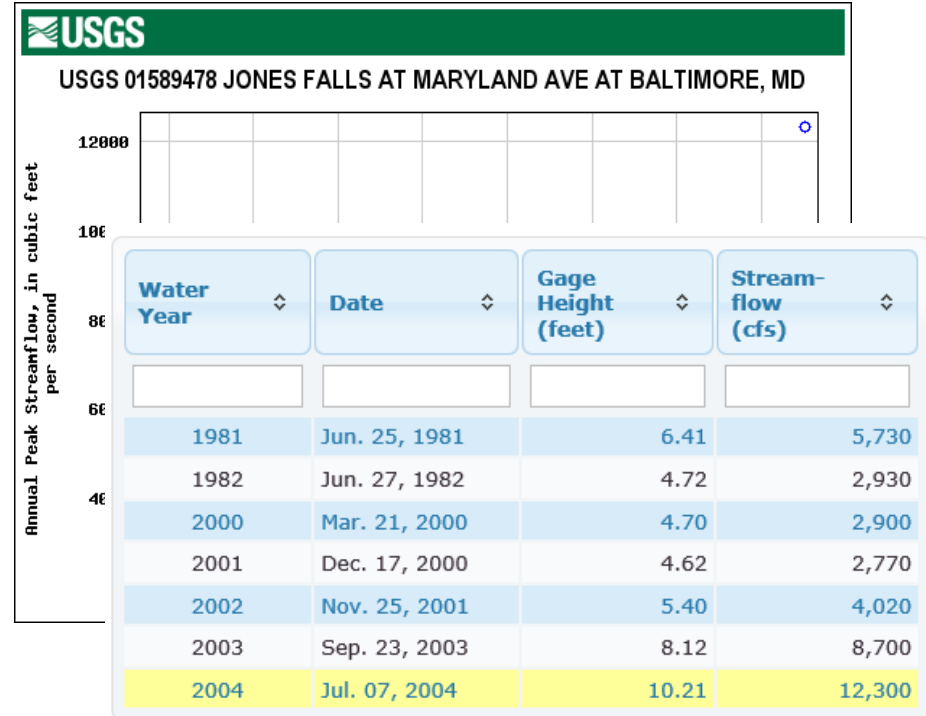
- PC-SWMM / HEC-RAS 2D Analysis Discharge Selection...
- Peak Discharge comparison analysis performed
 - 1988 Effective Discharges vs. 2010 Regression Equations vs. 2012 Effective Discharges vs. 2016 Regression Equations
 - 1% annual chance event – 2016 regression based peak discharges compared close to Historic 1988 Effective Discharges



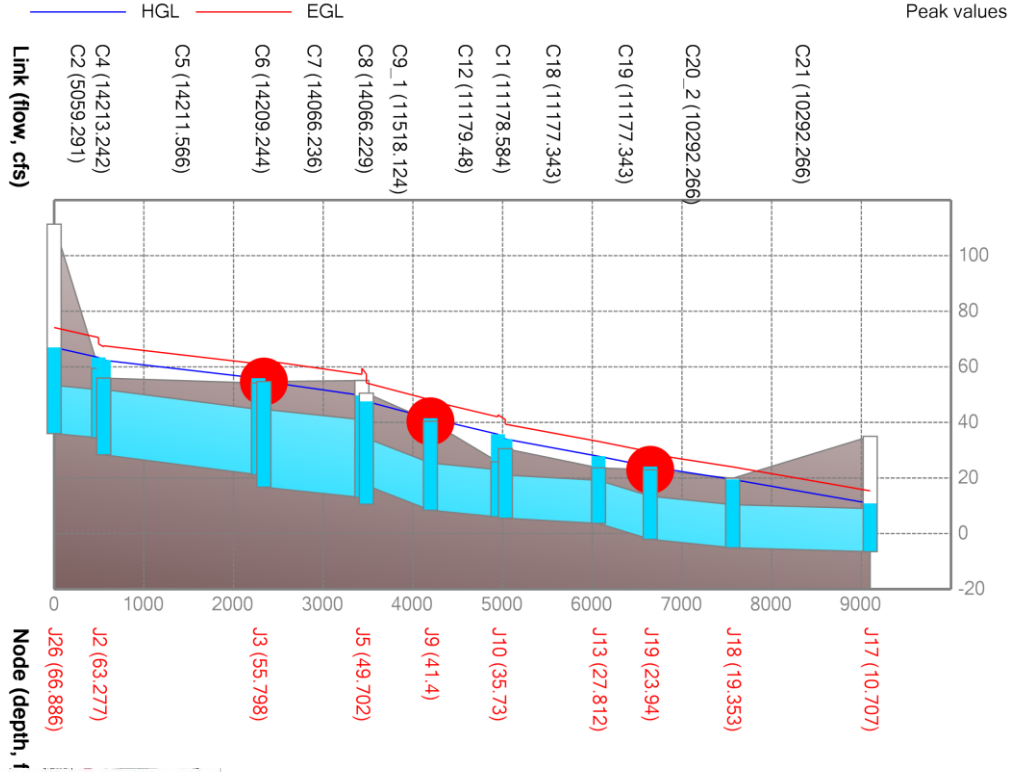
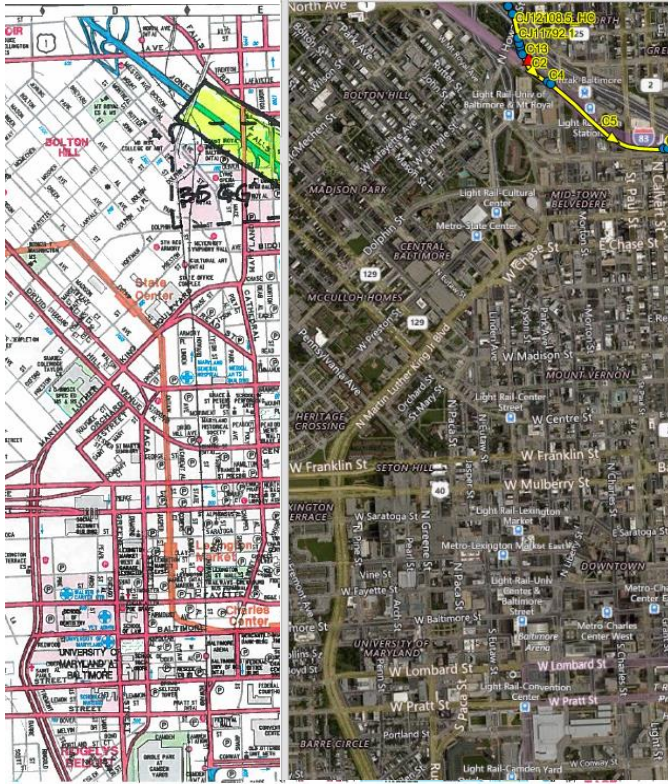
Hydrology Cont.

USGS Gage located just at entrance of Tunnel System

- July 2004 event close to 4% annual chance recurrence interval peak flow
- Not enough gage data for calibration purposes
- Gage Height from 2004 event used to compare modeling results as applicable



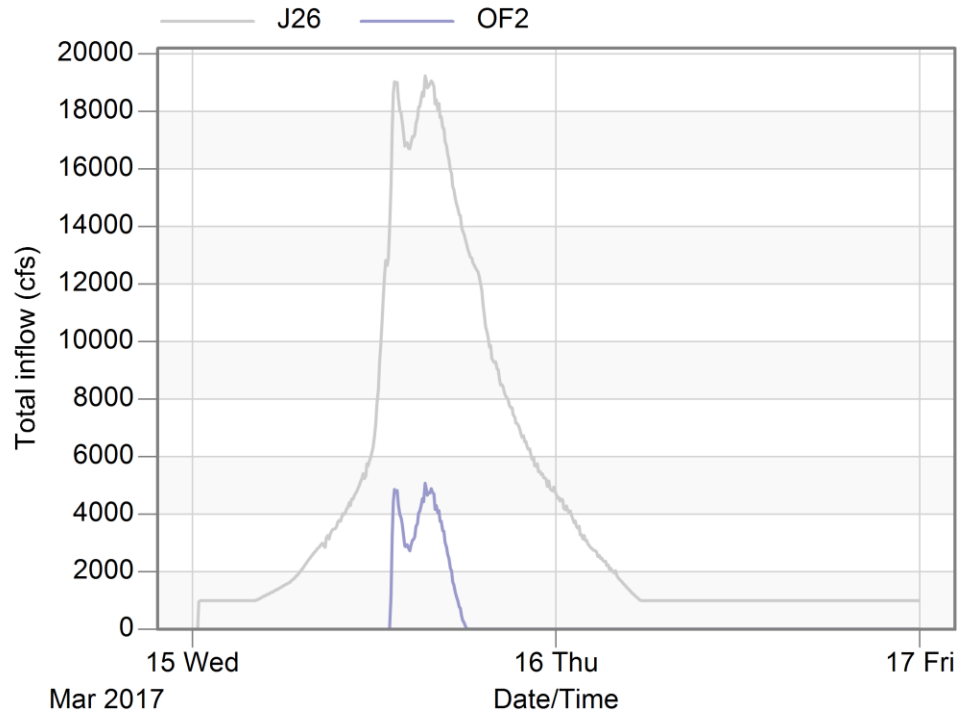
SWMM Analysis



Overtopping Discharges

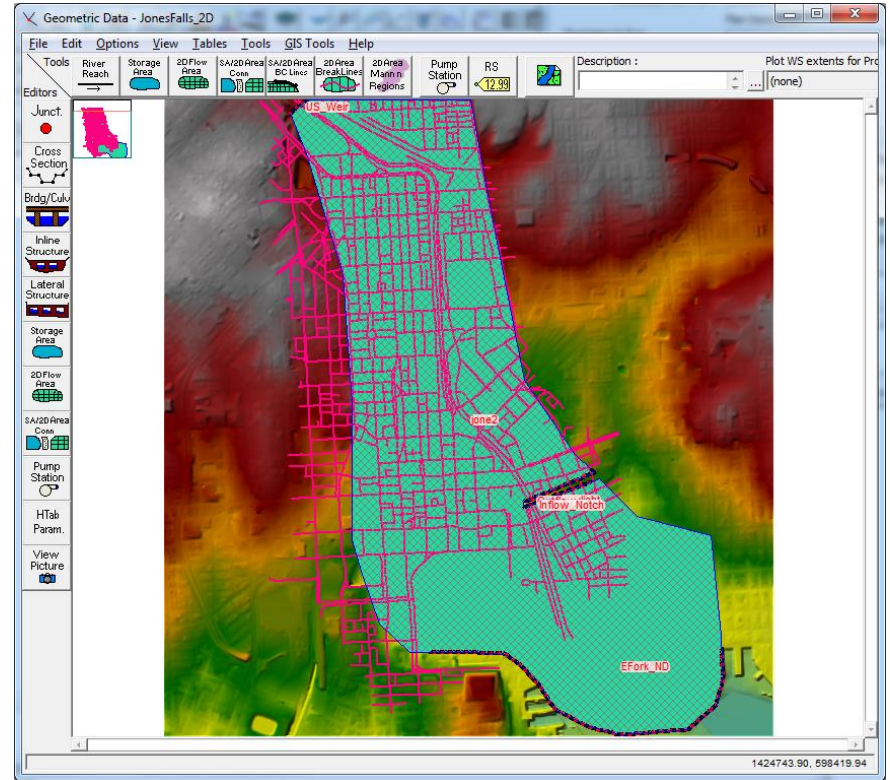
1% annual chance recurrence interval peak discharge distribution – based on PC-SWMM analysis

- $Q_{\text{peak}} \sim 19,300$ cfs
- $Q_{\text{system}} \sim 14,300$ cfs
- $Q_{\text{overland}} \sim 5,000$ cfs



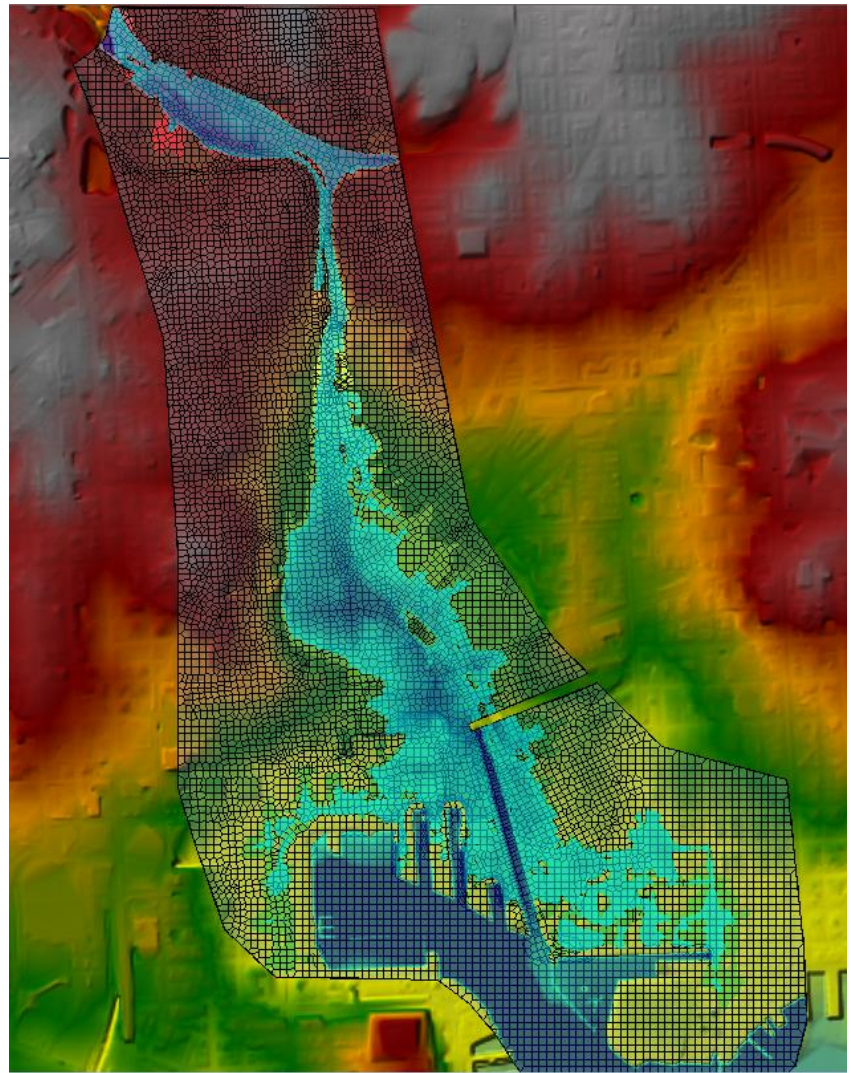
HEC-RAS 2D

- RAS 5.0.3 used with couple limitations
- Downstream Boundary Conditions
- Bathymetry Burned in Terrain
- Base Data Refinements

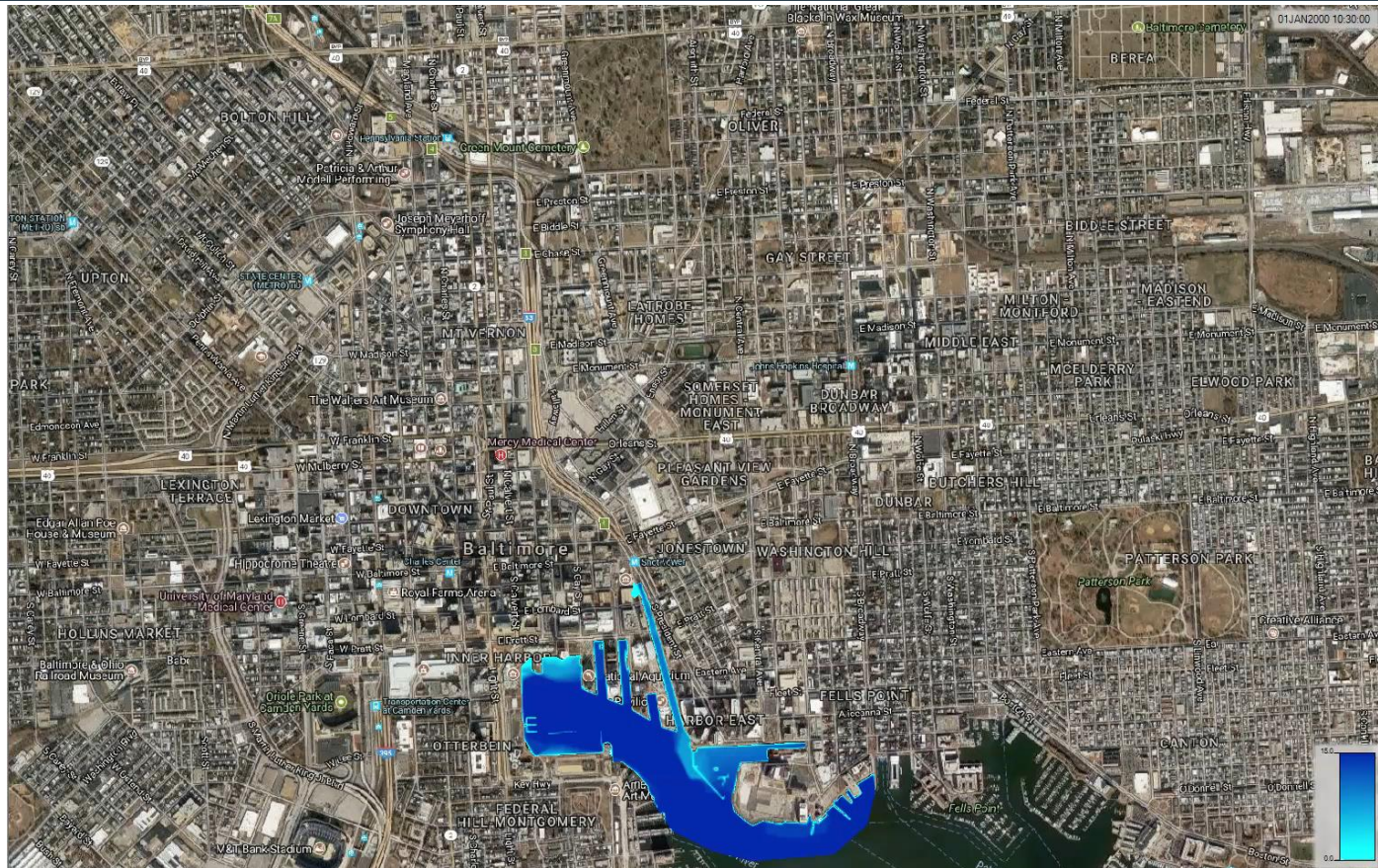


RAS 2D Cont.

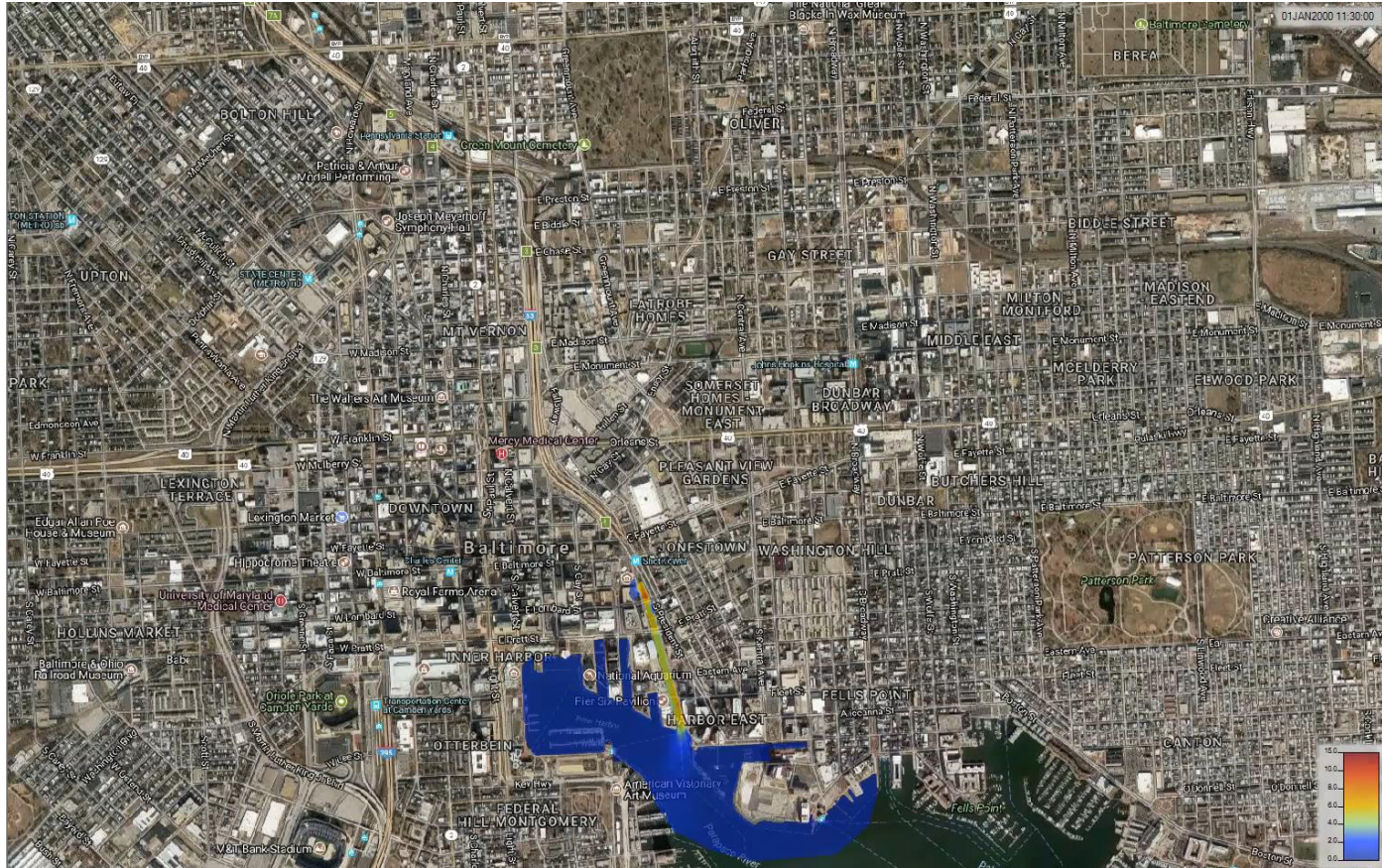
- 2D analysis limited to overland flow area
- Improved analysis in several geometric conditions
 - Split flows
 - Urbanized areas – dense building footprint
- Used breaklines to refine grid for alleyways and streets acting as corridor for flood conveyance



Animation



Animation



Conclusions

- Is it possible?
- What's missing??

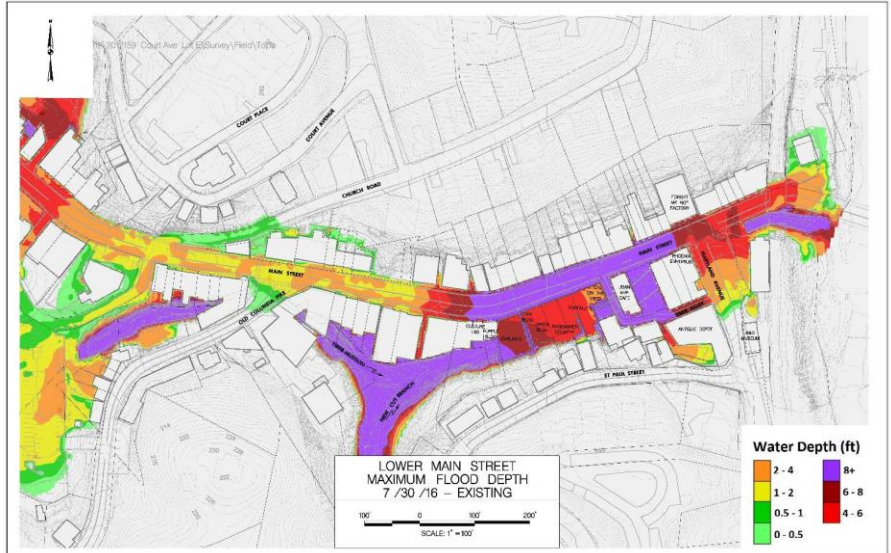


The Ellicott City Flood Mitigation Plan, August 23, 2018

E. Infrastructure Improvements

The strategy to expand the floodplain will be combined with the execution of several floodwater retention facilities that have been in process, as well as several conveyance improvements. These include:

- Hudson 7 Retention Facility (identified in H and H Analysis): 13 acre-ft of storage in the US 29/40 Interchange
- Quaker Mill Retention Facility: 10 acre-ft of storage along Rogers Avenue
- 8600 Main Street Culvert Expansion (identified in the H and H Analysis): Significantly increasing the capacity of the culvert.



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