Improvements to HEC -RAS Floodplain Elevations and Design of Hydraulic Improvements for Flood Relief

using EPA SWMM v5:Case Study from the Allen Creek in Ann Arbor, MI.

Presented by: Nathan D. Zgnilec

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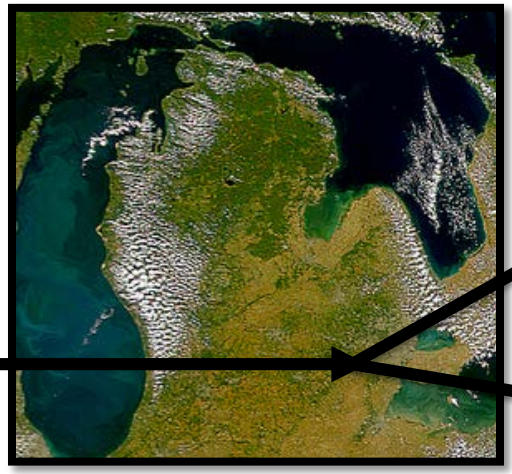
Project Location

Ann Arbor, MI

- 120,000 population
  - 5th largest in MI
- University of Michigan

Allen Creek Watershed

- 5.65 square miles
- ~12 miles in length
- ~50% impervious



Allen Creek
Connectivity and Enclosure

Majority enclosed, up to 100 -years old

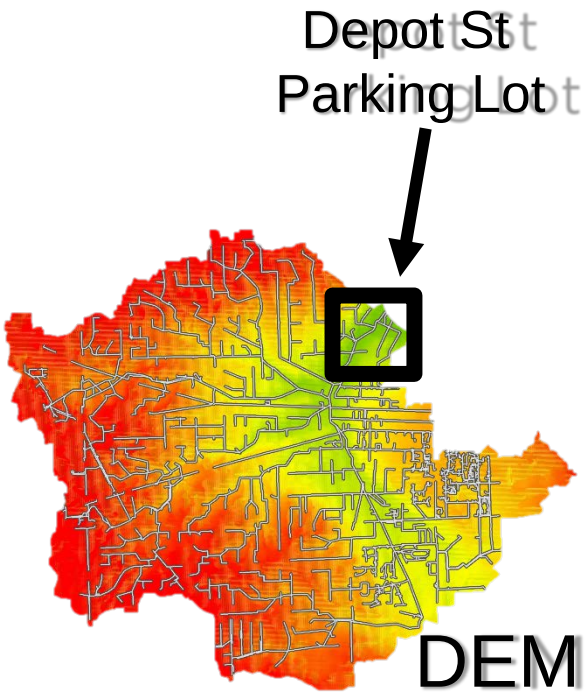
Outlet Capacity = 1,200 cfs

- 50 -year storm

Experiences most severe flooding in City

enclosure

outlet



DEM

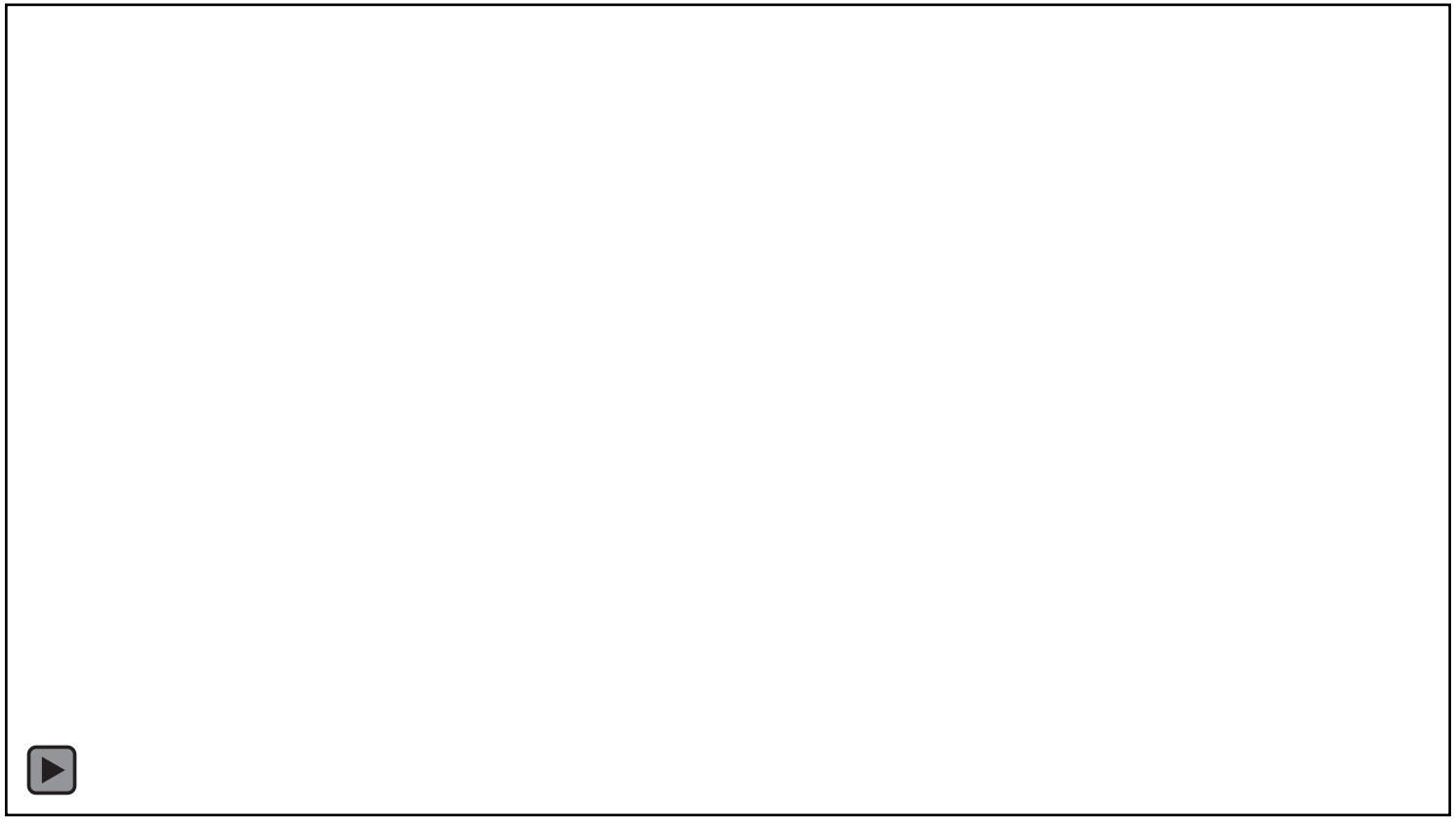
Depot St Parking Lot

Serves as relief when downstream enclosure surcharges

Frequently floods

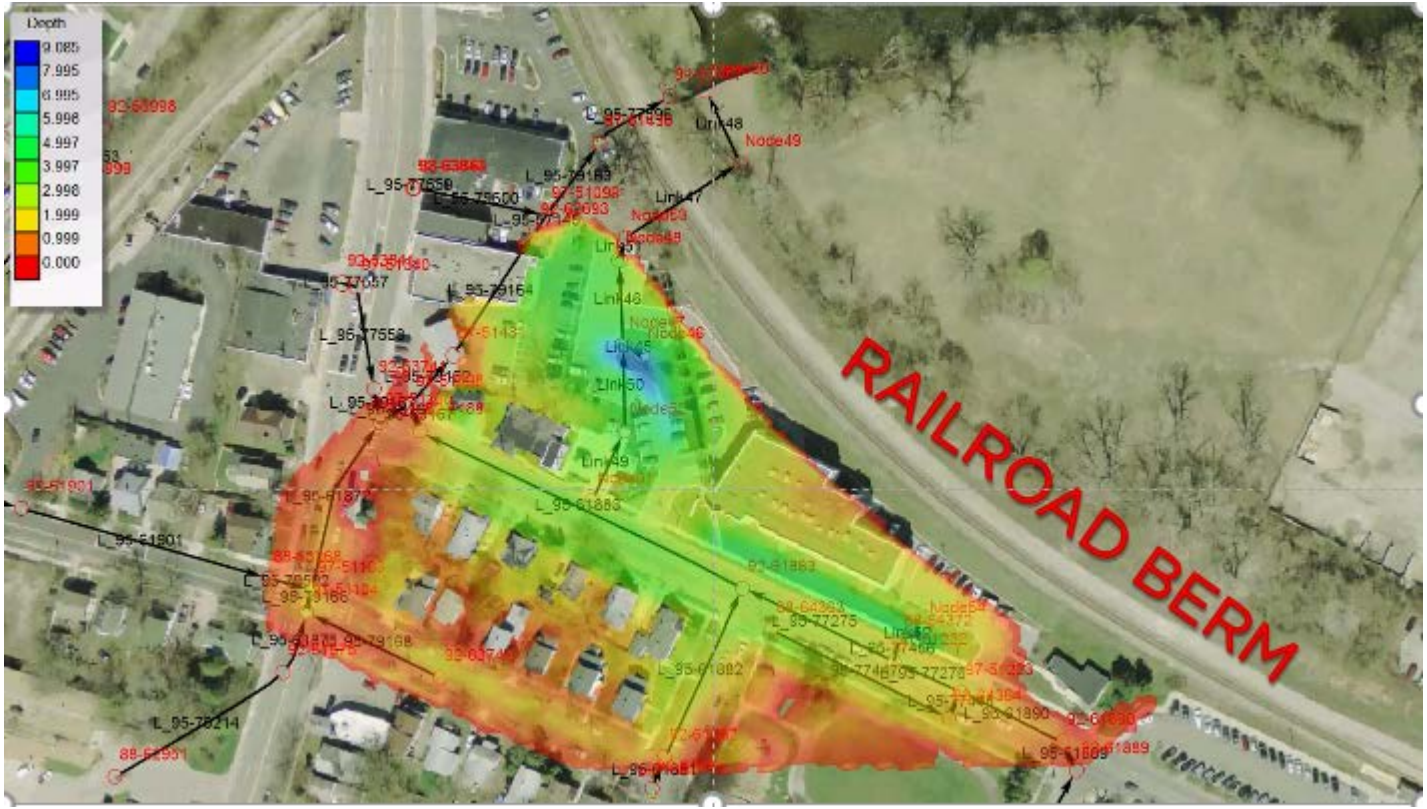
Railroad berm acts as floodwall

Model: 10 -feet of flooding during 100 -year storm



100-year Storm Event

Modeled Flooding at Depot St. Parking Lot



100-year Storm Event

Modeled Flooding at Depot St. Parking Lot

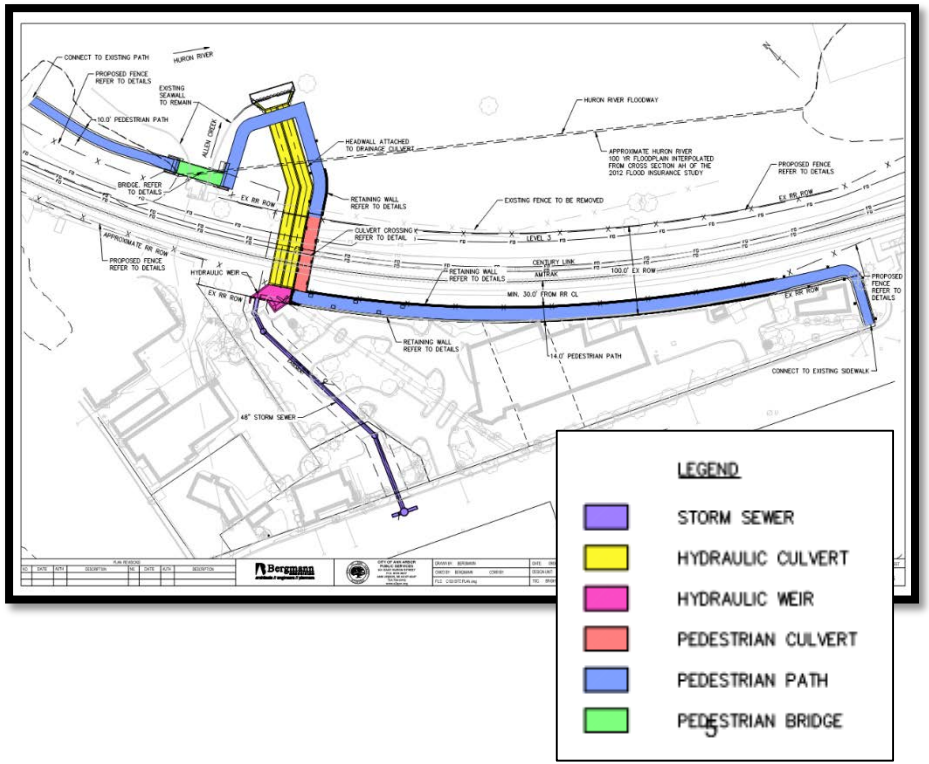
Hydraulic Improvements for Flood Control

Goal

- General reduction in the depth and duration of flooding
- Decrease 100 -year flood depth by 5 feet

Solution

- Flood relief culverts through railroad berm



Allen Creek FEMA Floodplain

Last defined in 2012, using HEC -RAS model

2012 HEC -RAS model

- Steady -state surface flow model

Did not adequately account for

- dynamic routing
- increase flow through the pressurized enclosure
- surface storage

Resulted in

- underestimated flow capacity of enclosure
- artificially high floodplain elevations

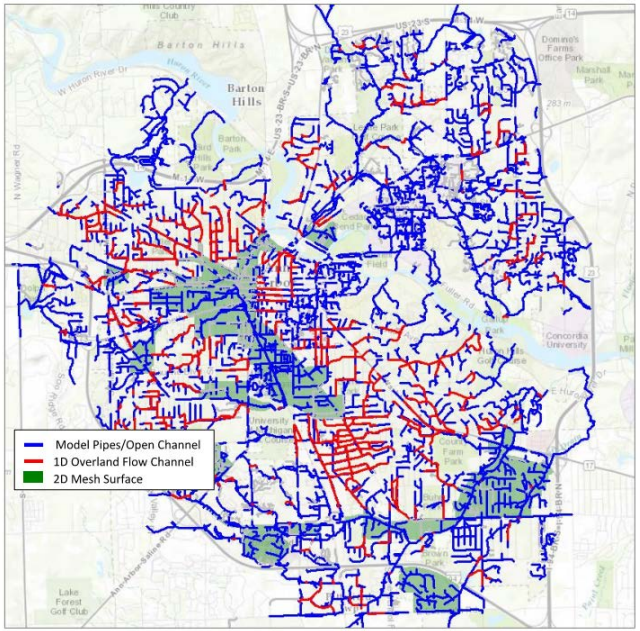
FEMA

Federal Emergency Management Agency

City of Ann Arbor Stormwater Management Model - 2015

- InfoSWMM model
- Accounts for City's entire stormwater conveyance system
  - 500 subcatchments
  - +4,000 links
  - +100 raingages
- Calibrated and validated using collected flow and rainfall data

Figure 1-1 – Stormwater System Components



Source: City of Ann Arbor Stormwater Model Calibration and Analysis Project, Final Report, CDM Smith 2015

1. Existing Conditions Floodplain

Comparison of 100 -year floodplains

- HEC-RAS – Effective Model
- SWMM – Duplicate Effective Model

Focused on predicted water surface elevations

- SWMM model was up to 1.5 feet lower than HEC -RAS
- HEC-RAS was known to over predict flooding -> overestimated floodplain elevations

2. Evaluation of Proposed Hydraulic Improvements

Objective

- reduce flooding from 778.1 to 773, or lower

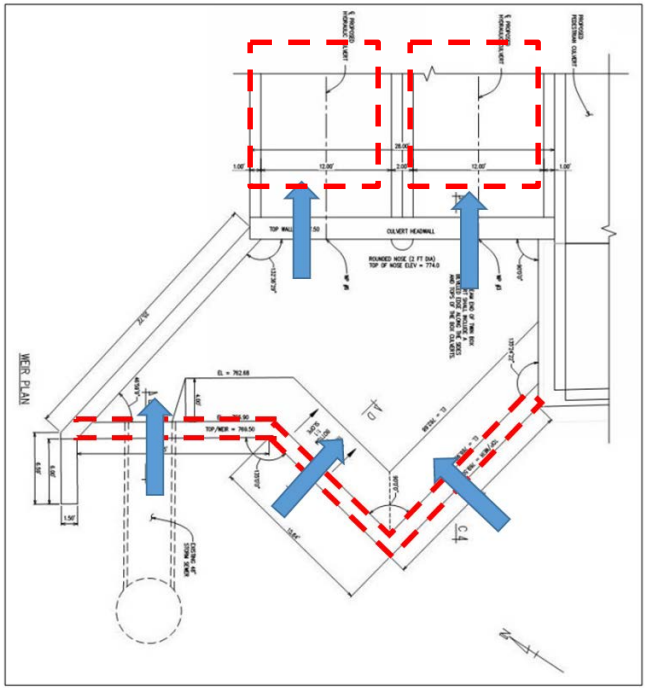
Solution

- allow surcharged flows to exit through relief culverts running below railroad berm

2. Evaluation of Proposed Hydraulic Improvements

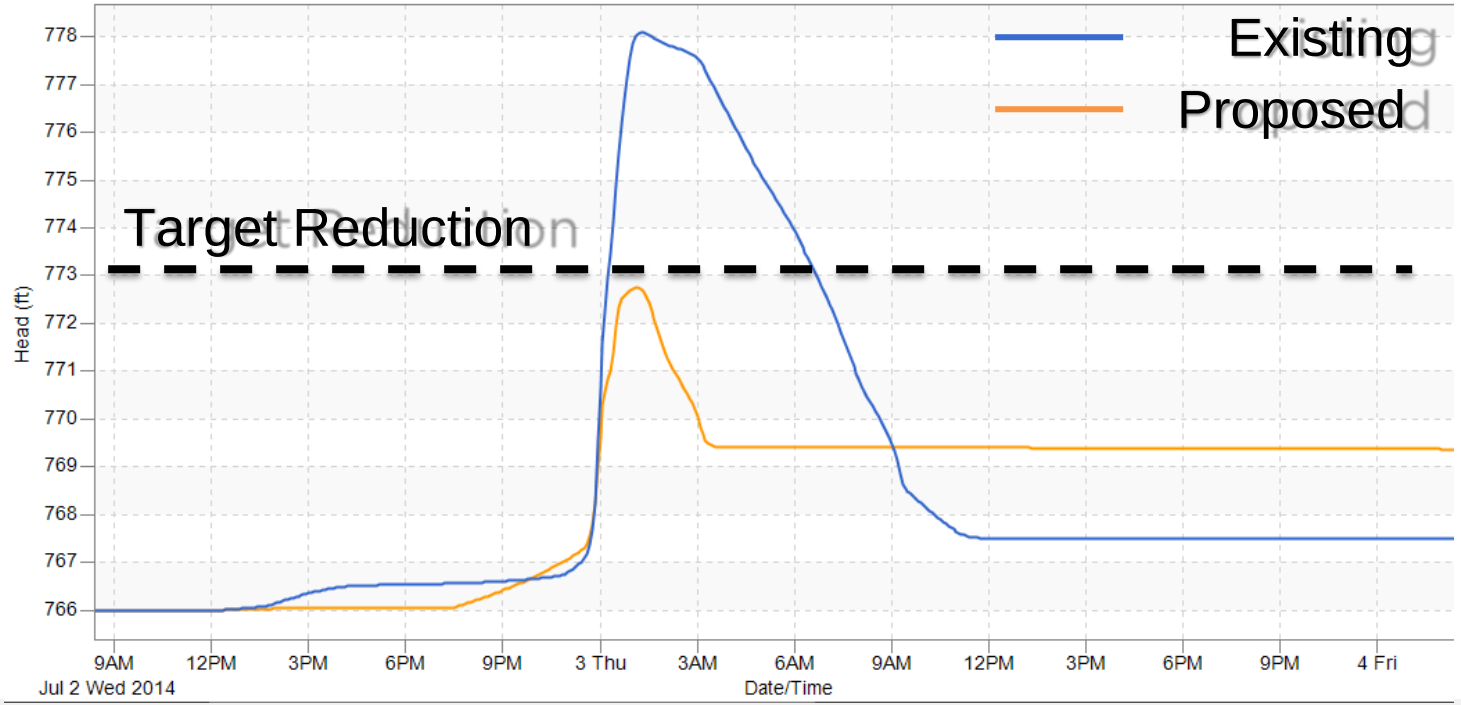
Weir – 50 feet long

Twin Box Culverts - 212 feet of 7’x12’



2. Evaluation of Proposed Hydraulic Improvements

Depot St. Parking Lot - WSL



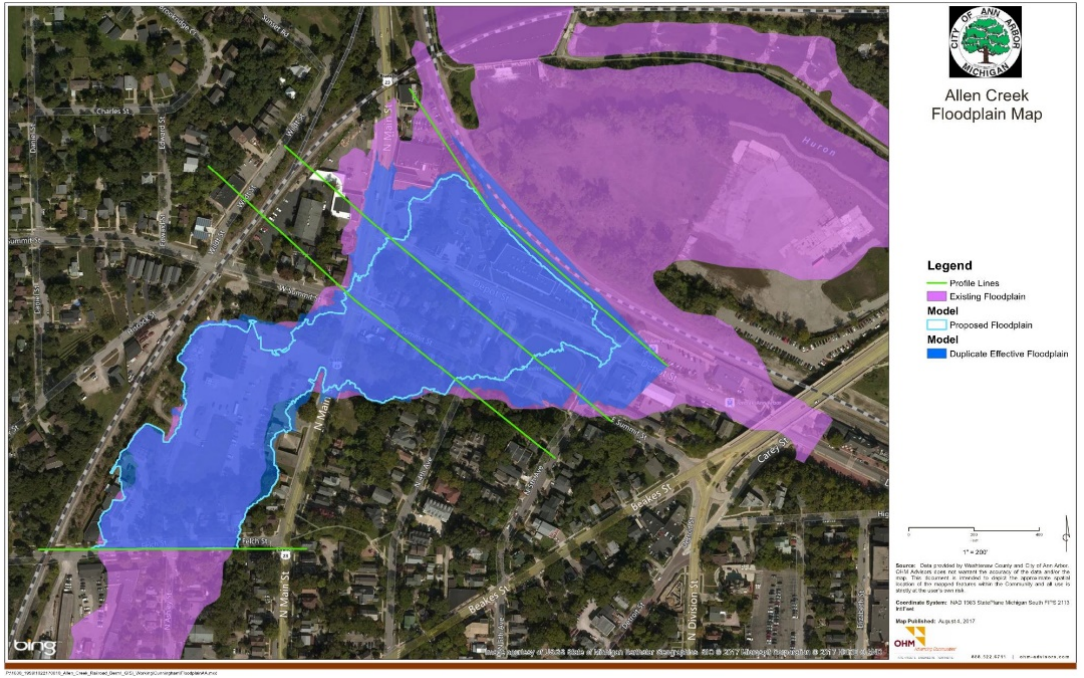
3. Revised Floodplain

Depot Street Parking Lot

- Reduced base flood elevation to 772.7 feet

Upstream Boundary

- Maintained existing floodplain elevation



4. FEMA CLOMR Application

- Successfully received CLOMR from FEMA based on SWMM model
  - Submitted in advance of project construction
  - Necessary because proposed improvements result in modification to the existing floodplain

- After project completion
  - Apply for LOMR

Design Renderings

Lessons Learned

- HEC-RAS is not always the most appropriate tool for floodplain mapping
- In an urban environment, like the Allen Creek, SWMM is better suited to model multiple dynamics
- Would not have been able to make design decisions in HEC RASs like we did in SWMM -
- Using a different modeling method resulted in additional scrutiny from FEMA

Thank You