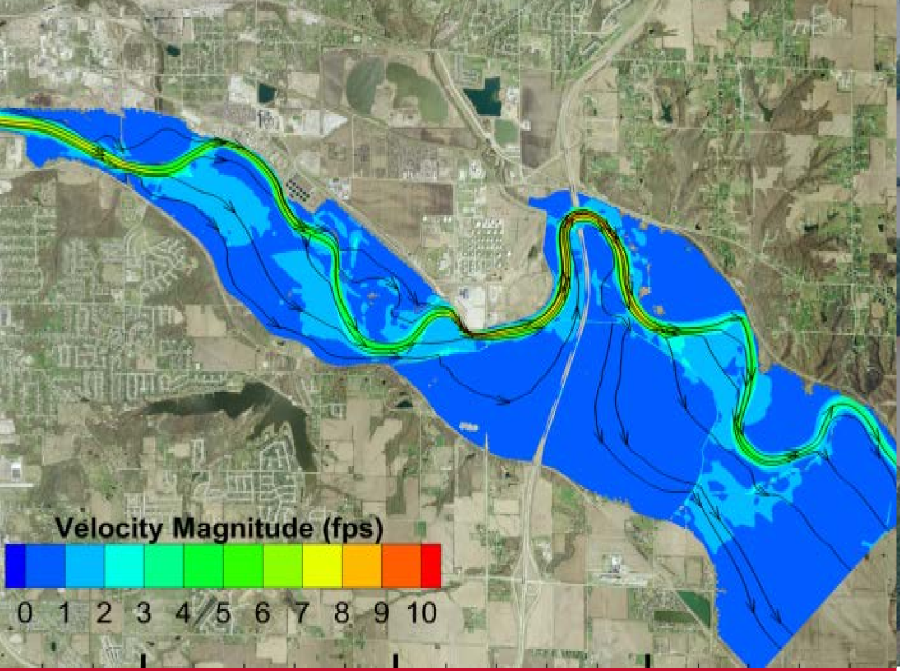
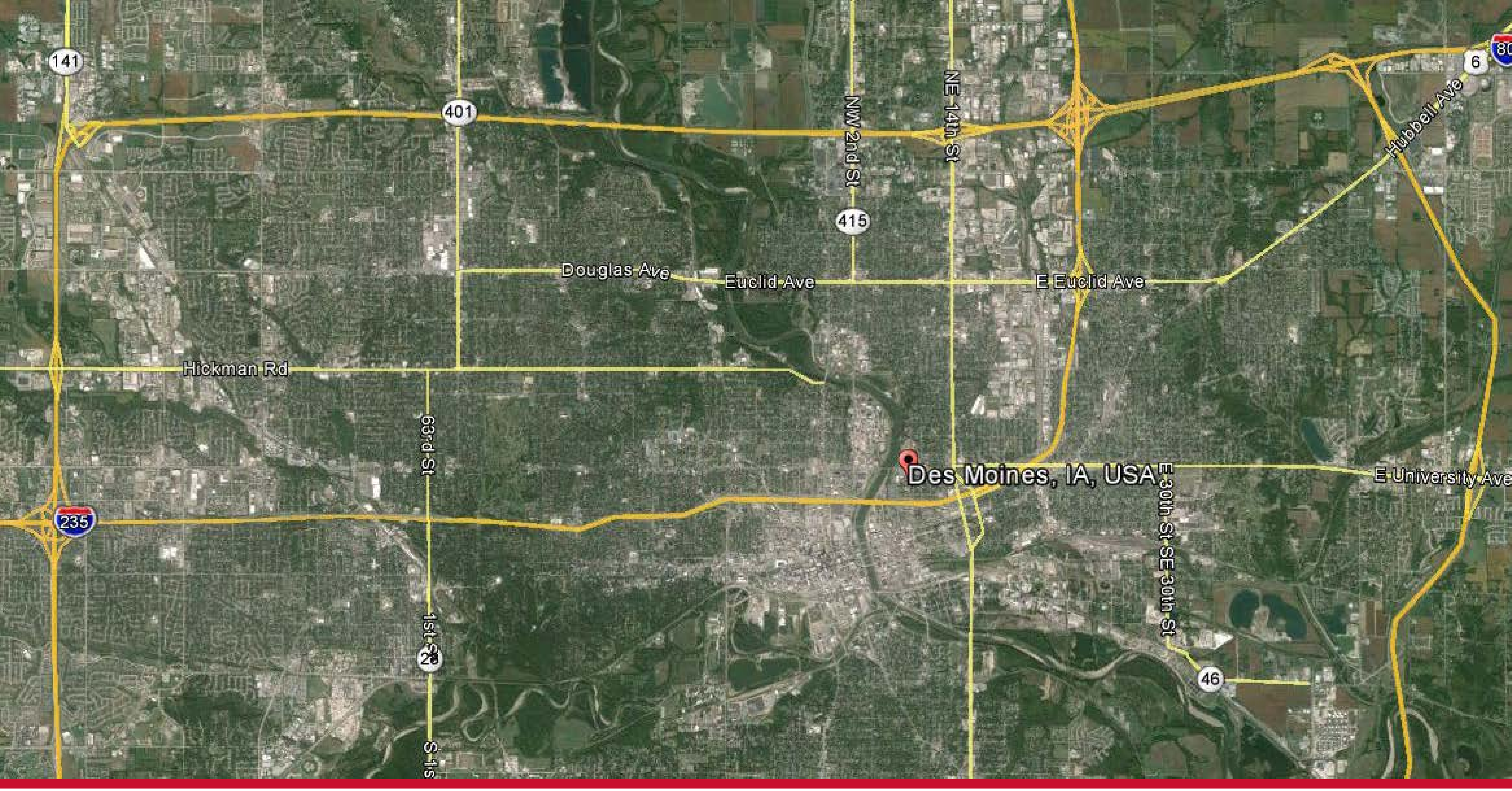
HDR



Comparing Approaches and Results of Independent 2D Hydraulic Modeling Efforts

US 65 2D Hydraulic Analysis
Iowa Department of Transportation

HDR



US-65 / HWY-5 Bypass at Des Moines River

Project Background and History

US-65 / HWY-5 Bypass at Des Moines River

Project Background and History | 1961 Aerial

US-65 / HWY-5 Bypass at Des Moines River

Project Background and History | 914 ft Bridges, Mid 1990's

US-65 / HWY-5 Bypass at Des Moines River

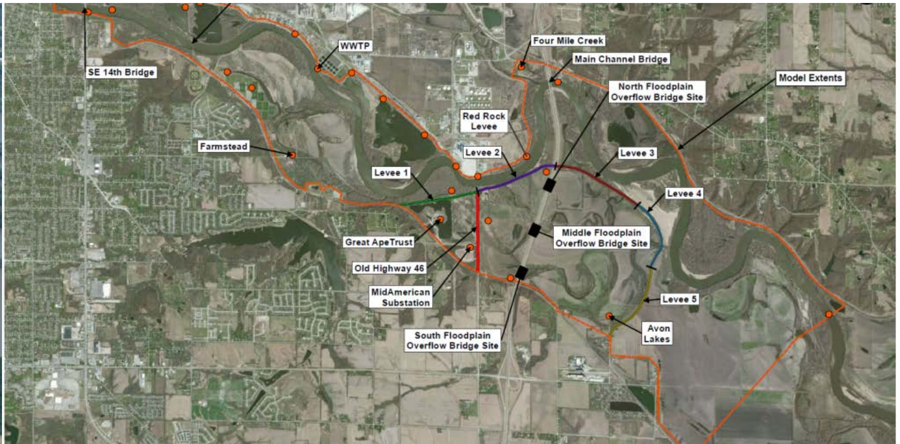
Project Background and History | 2008 Flood

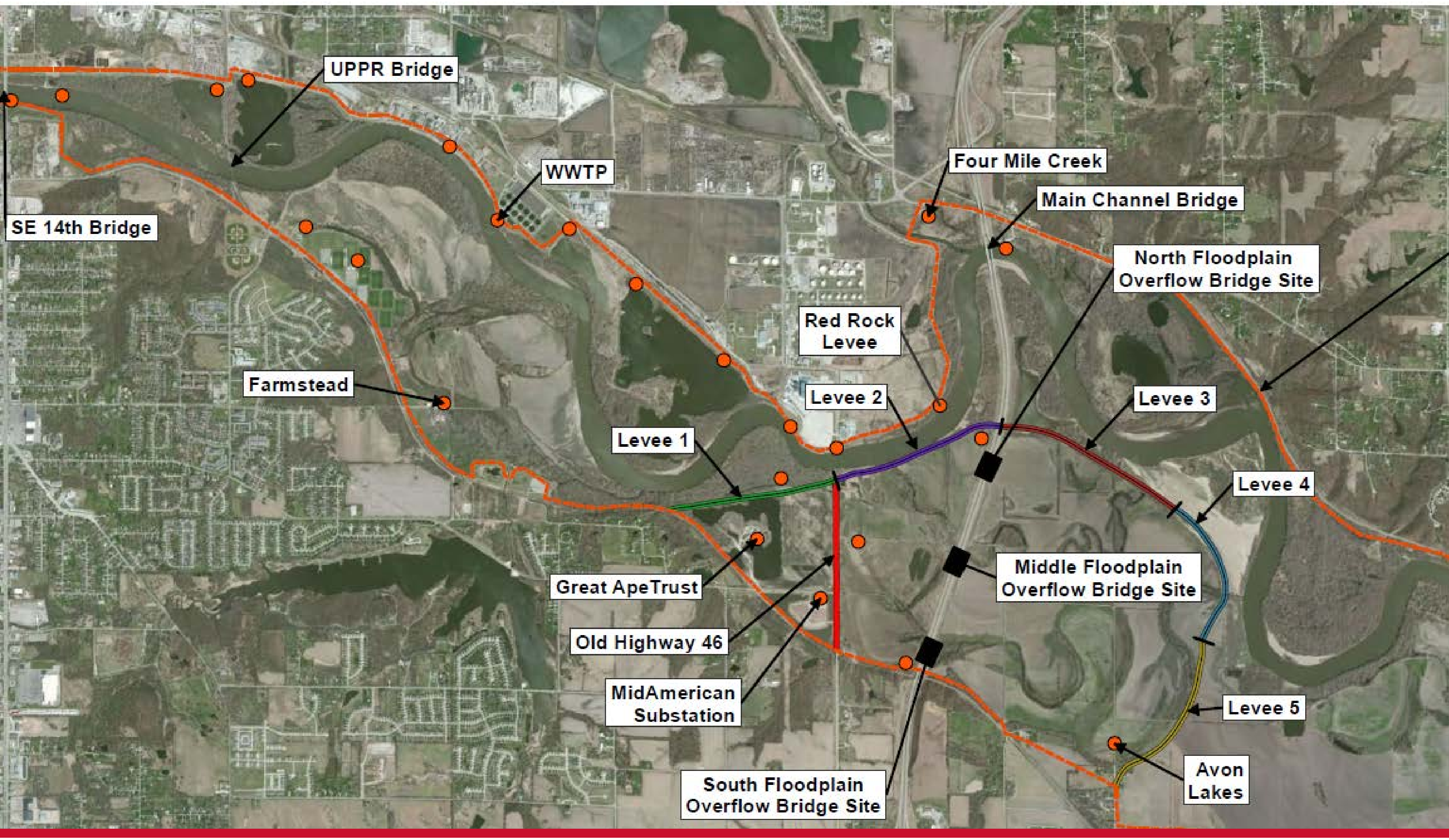
1993 Event vs 2008 Event

- 1993 Flood – 116,000 cfs
- 2008 Flood – 104,000 cfs
- HWMs were up to 3 ft higher during 2008
- Major Difference: US 65
- Iowa DOT wanted to investigate

Complex Hydraulic Issues

- USACE levee along left bank
- Right floodplain completely cut-off by road embankment. Pre-bypass floodplain carried significant flow (1993)
- Agricultural levee along right channel – overtopping at 25 year frequency
- Insurable structures upstream from Hwy 65 behind Agricultural levee system and near channel
- Channel transitions through multiple 90 degree bend as well as a 180 degree bend



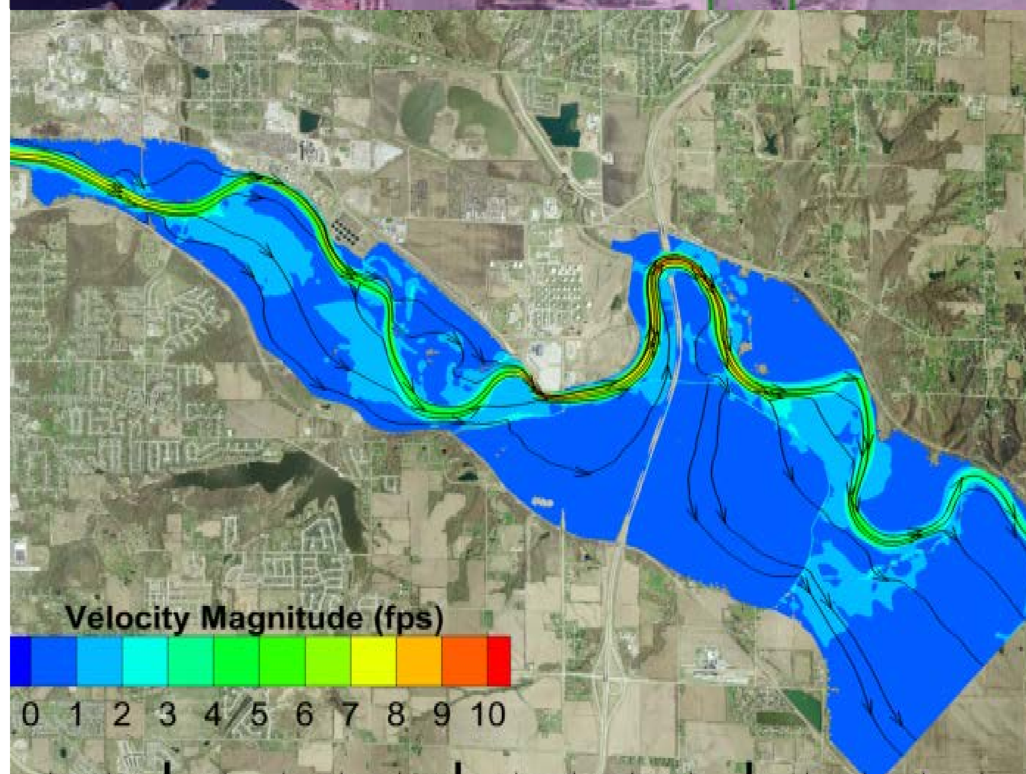


US-65 Hydraulic Investigation

Study Area Overview

Hydraulic Analysis Tools

- 1D HEC RAS Model
  - Widely accepted – predicts average velocity in cross section and water surface elevation
  - Very challenging to accurately incorporate, ineffective flow areas, losses from channel bends, levee overtopping
- 2D Models
  - Predicts depth-averaged two-dimensional velocity and water surface elevation
  - Bathymetry, terrain, surface roughness incorporated into computational mesh
  - Solution at every cell
- Iowa DOT decided to use a 2D model for analysis and mitigation design
- Comparison to independent 2D model effort (HDR)



Iowa DOT- TUFLOW

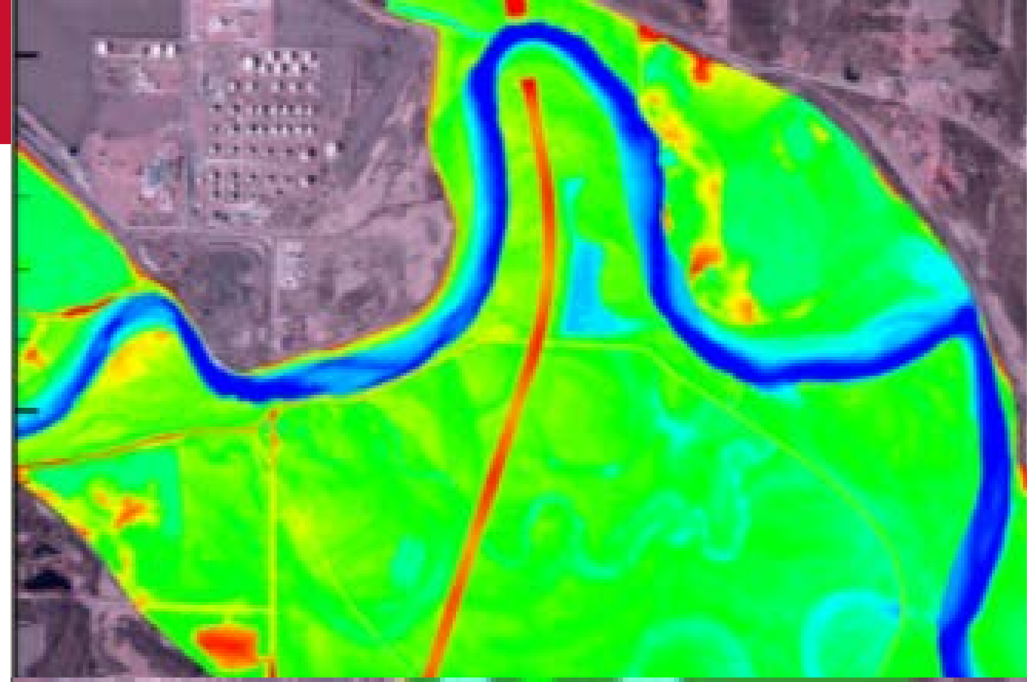
- Structured, Rectangular mesh
- 1D/2D elements
- Finite Difference
- Internal boundary conditions
- Proprietary software

HDR- SRH 2.0

- Unstructured, boundary-fitted mesh
- 2D elements
- Finite Volume
- Piers/structures can be explicitly represented
- Non-proprietary software (BOR)

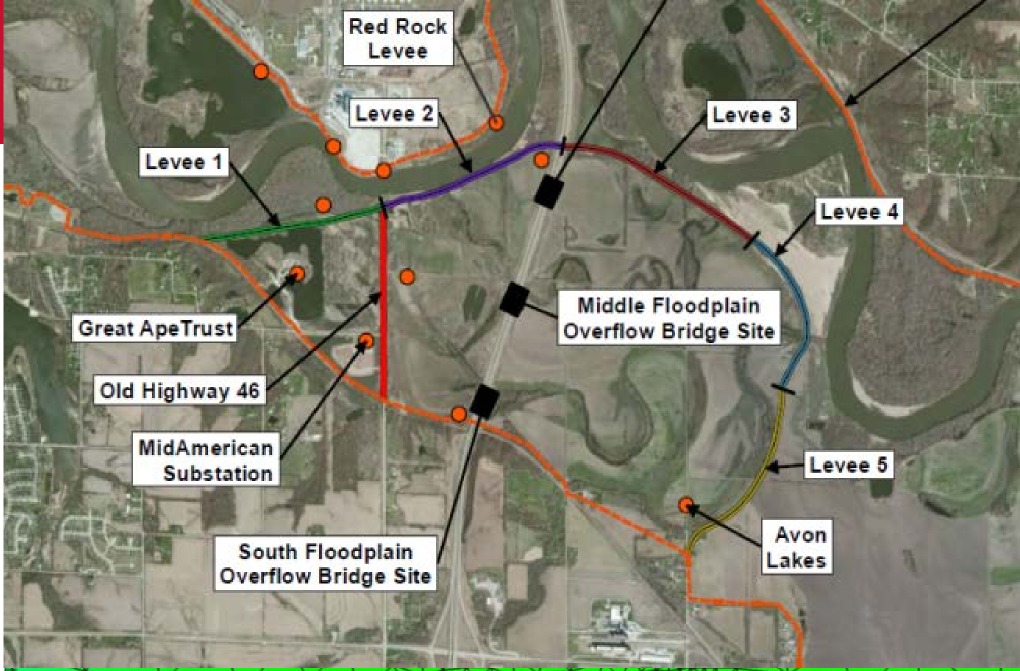
Model Development Similarities

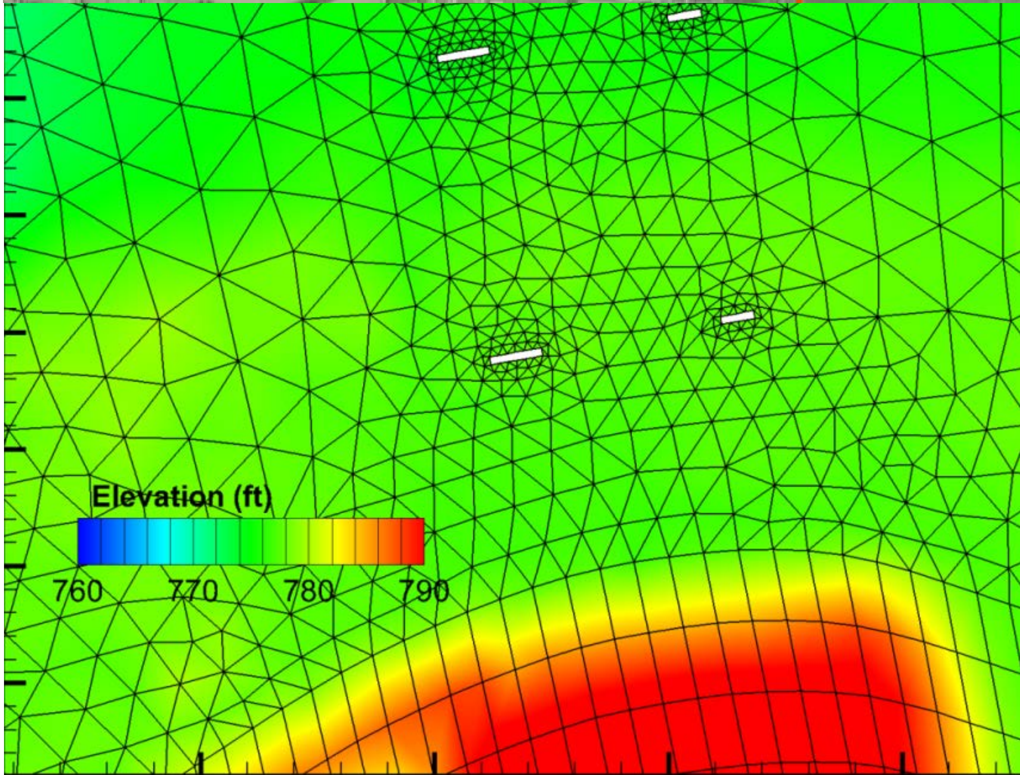
- Same digital terrain models
- Land use coverage
- Model Extent
- Inflow Boundary
- Downstream Boundary



Model Development Differences

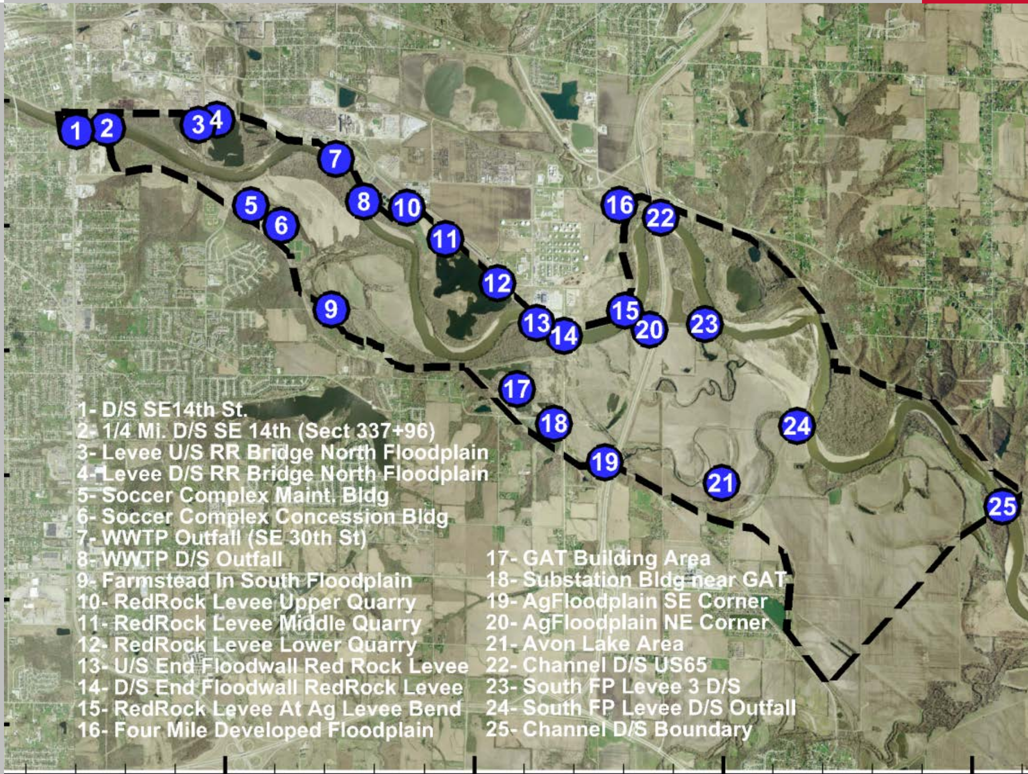
- Levee and embankment overtopping
- Hydraulic controls
- Losses at bridges and piers
- Slight differences in Manning's roughness
- Structured vs. unstructured mesh





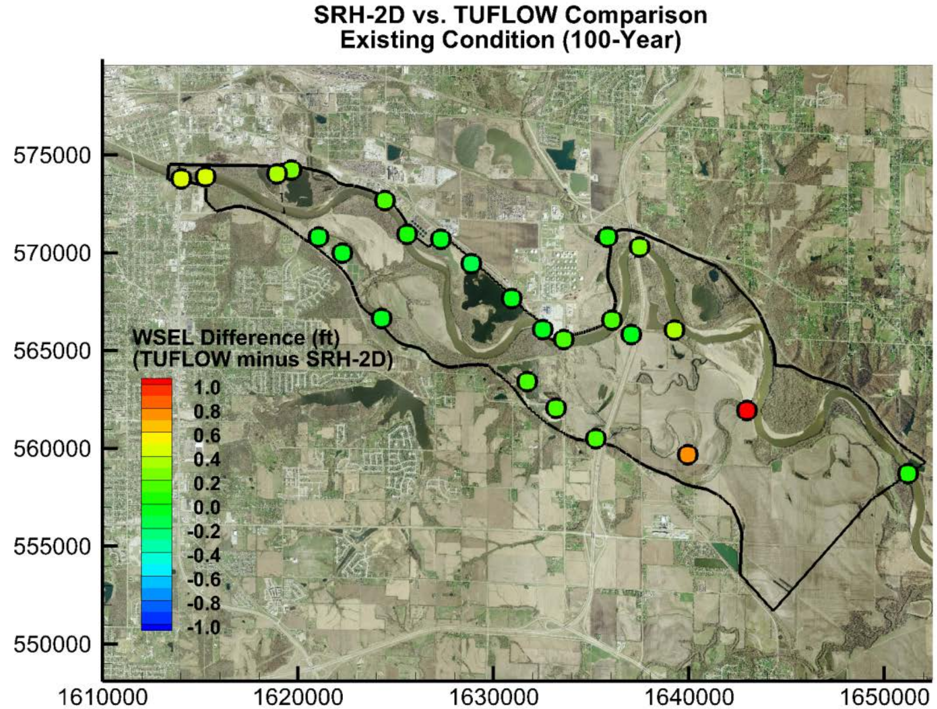
Model Comparisons

- 25 point comparisons
- 4 flow rates,100-year to 500-year events
- 8 geometric configurations (pre-bypass, post-bypass, 6 mitigation alternatives)



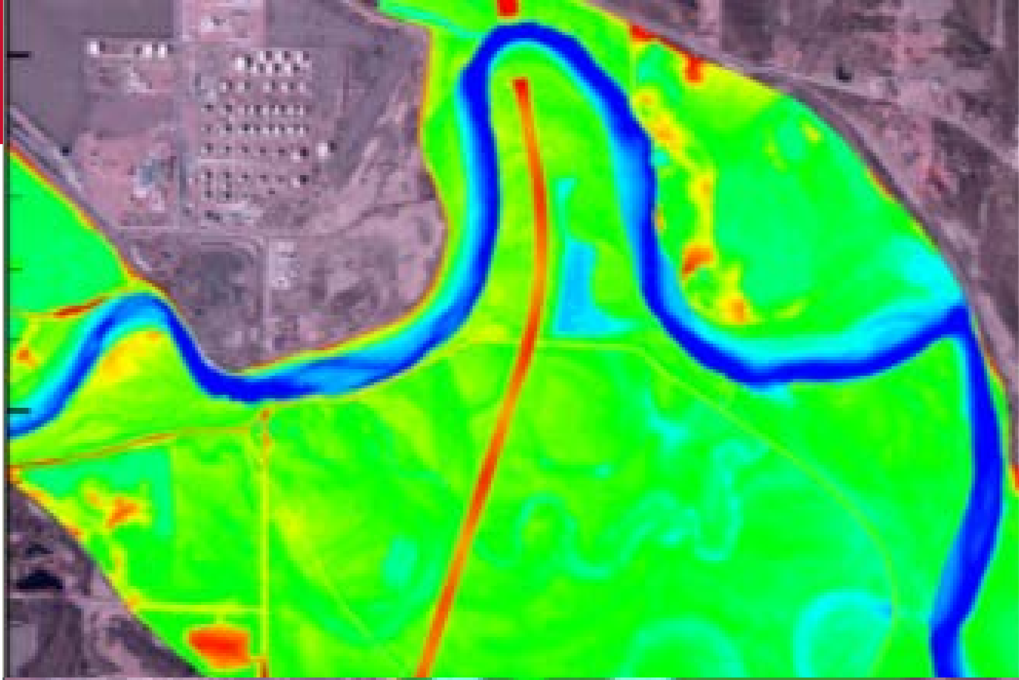
Preliminary Comparisons

- 76% of all points compared within 0.5 ft
- 12 locations within 0.5ft for all simulations
- TUFLOW higher than SRH-2D at 80% of sampled points



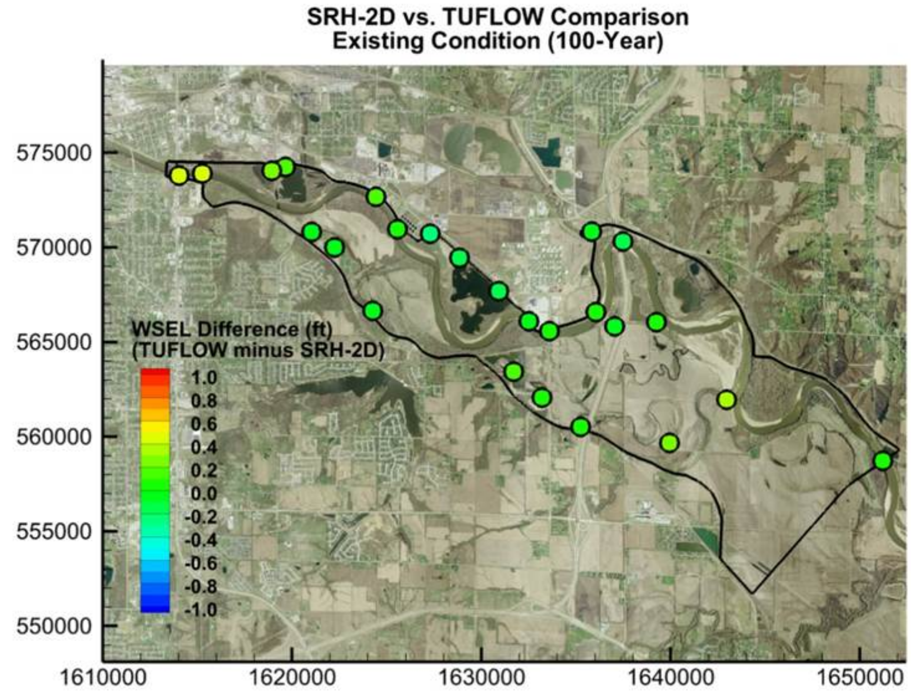
Modifications made to SRH-2D Model

- Manning's roughness coefficient were increased to the same coefficients used in TUFLOW model
- Minor changes to mesh to represent levees and embankments better
- Localized improvements to spatial representation of roughness



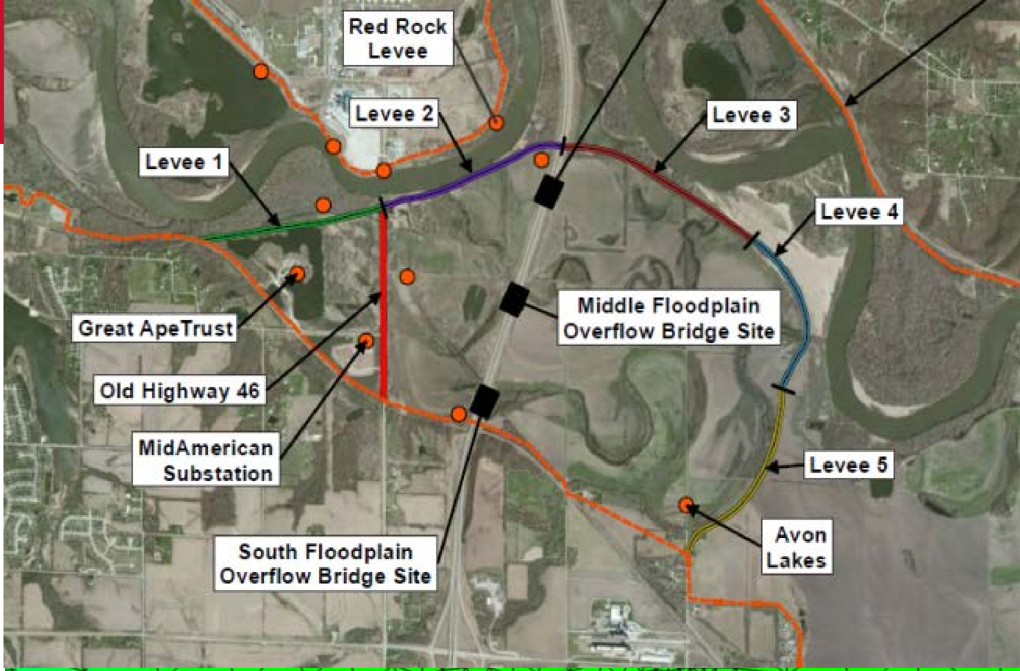
Improved Comparisons

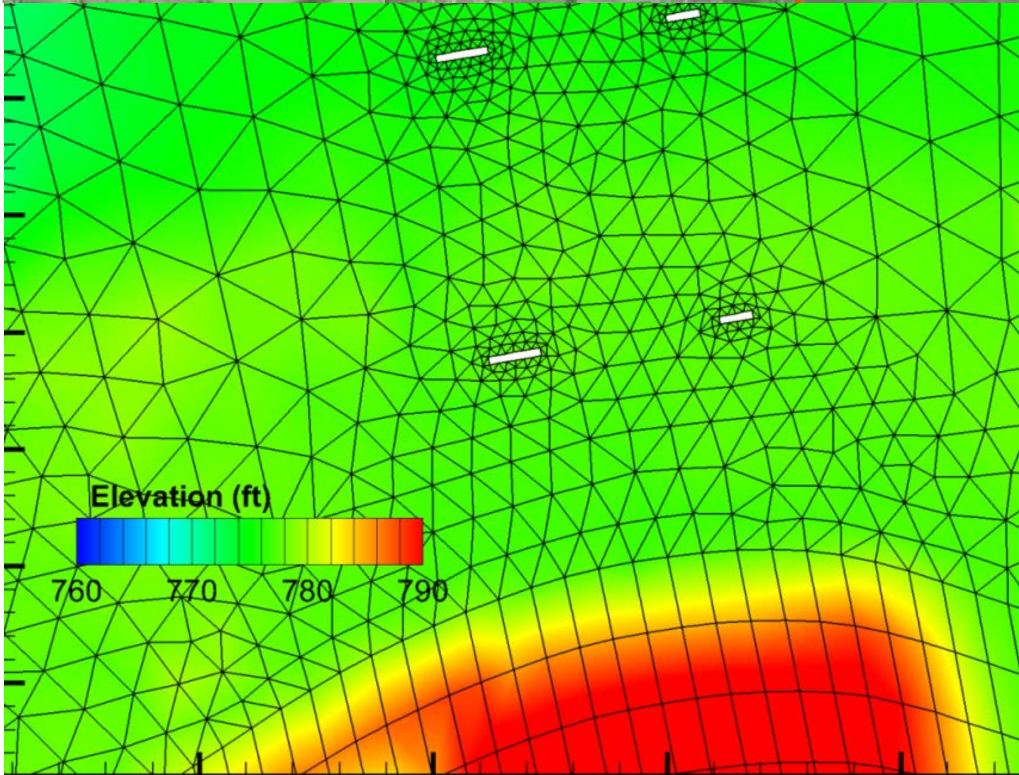
- 91% of all points compared within 0.5 ft (compared to 76% before modifications)
- TUFLOW higher than SRH-2D at 76% of sampled points
- Best comparisons in immediate vicinity of US-65
- Some difference still exist, but models agree suitably to confirm design decisions



Remaining Differences

- Numerical schemes (finite difference vs finite volume)
- Geometric representation of hydraulic controls
- Ability to represent flow blockages (piers, buildings)
- Spatial representation of roughness





Conclusions

- Similar results in both models
- Logical differences between two models- could be reconciled
- Predicted impacts/mitigation performances were similar
- Importance of geometry, roughness, boundary conditions
- Model comparison documents expected range of variation between different computational methods