JANUARY 24, 2017

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Twin Creeks: Technology and Tools BEFORE Regulation. Not because of…

KANSAS CITY MISSOURI

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Twin Creeks is a chance to do better for all on stormwater management needs.

I will show that:

1.) Technology is the Key and its abilities have exponentially grown.

2.) While Costs have dramatically declined in using Technology.

3.) Tech is key to reducing regulatory and procedural burdens on all.

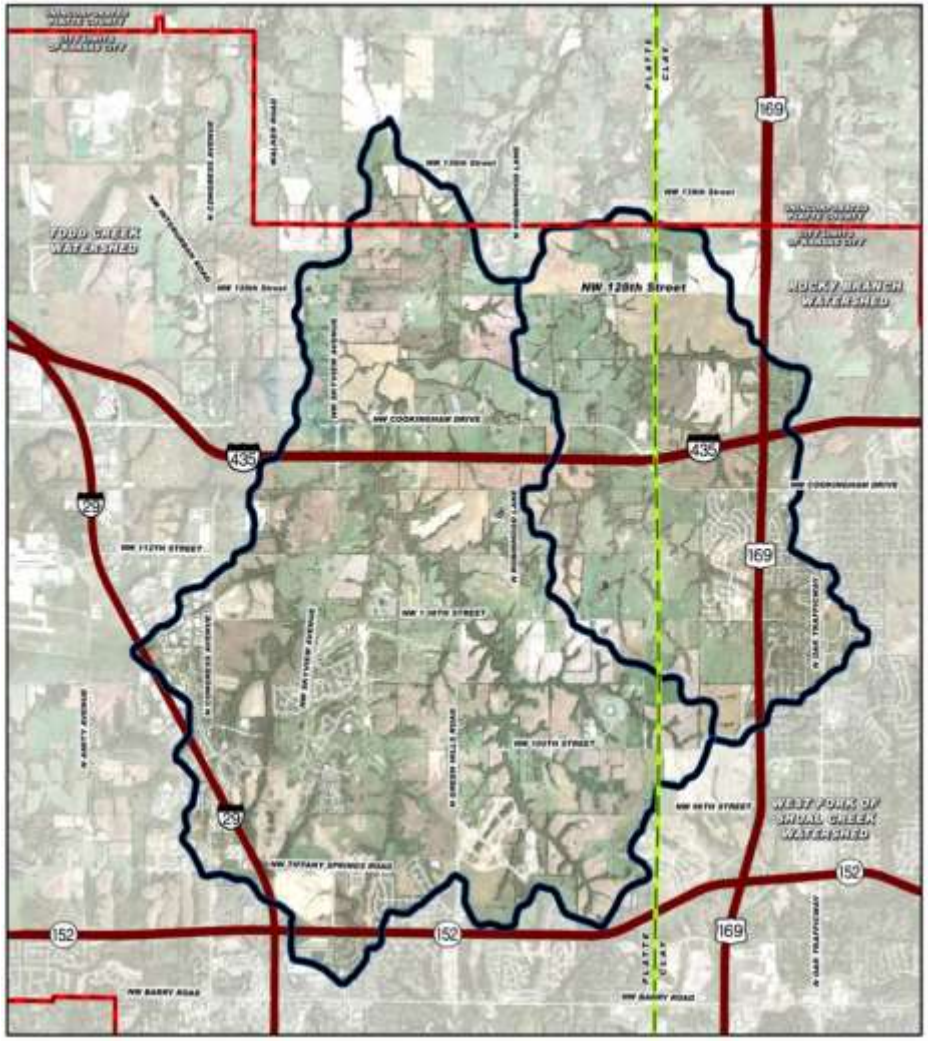
4.) I'll show types of tech tools and information we are building.

In: Hydrology, Hydraulics, Erosion/Meander, GIS is key to all

There is a Step 5.) that is not yet funded for Twin Creeks! It may be the hardest piece of all! Implementing it into process! No time for today!

History/Location: Twin Creeks (2nd & 1st Creeks)

- Just East of KCI in both Platte and Clay Counties in Missouri
- 31 square miles that flow north into Little Platte River
- First Cr is 10 & Second Cr 21 square miles
- 22 square miles is in Kansas City, MO
- Mostly rural, with urban development along the perimeter highways.



44.1 million in sewers & pump stations to two WWTP completed. Roads slow development now.

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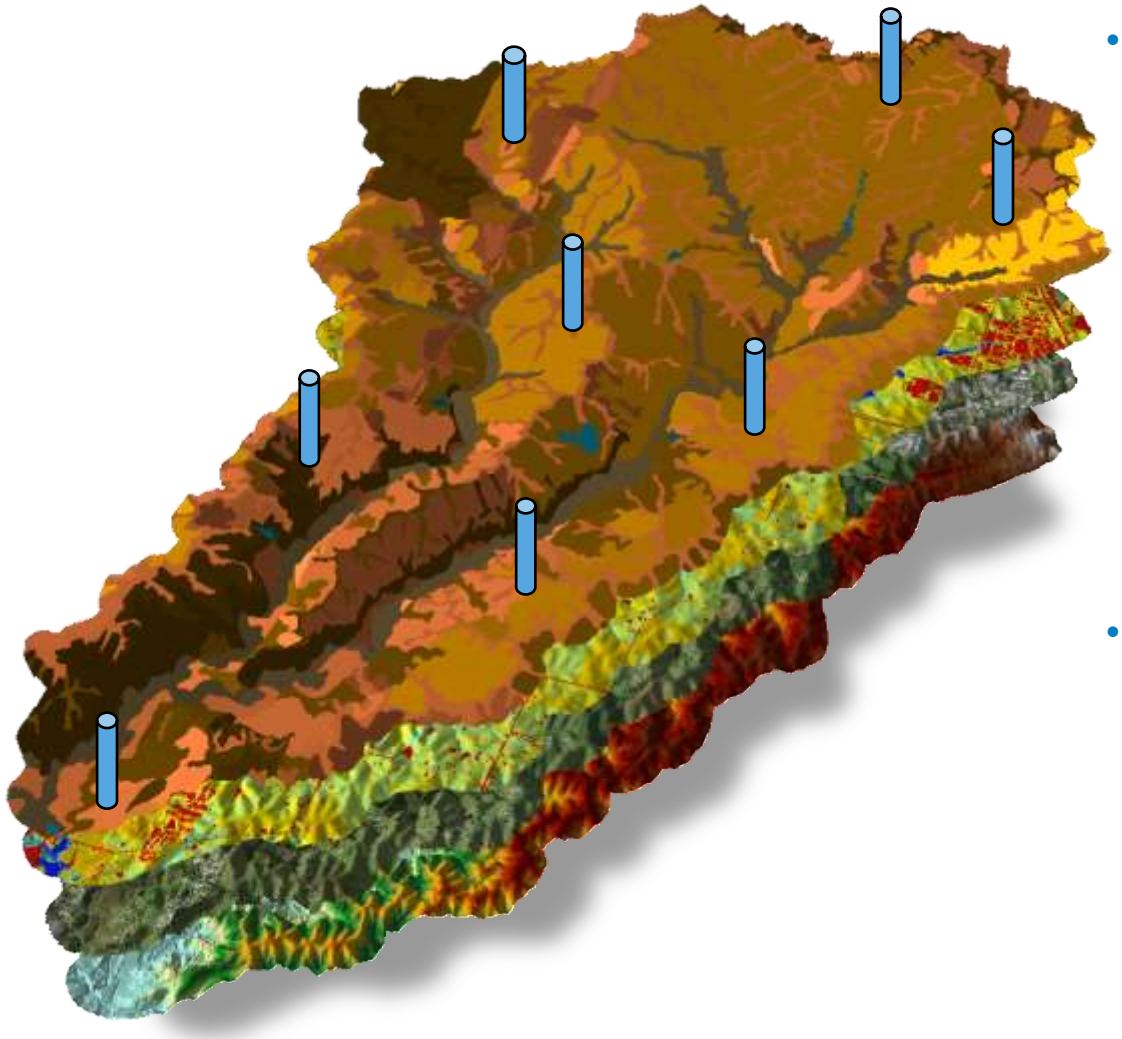
1.) The Technology of Input Data



- Utilized highest available quality data for assessment
  - LiDAR
  - Imagery
  - Landuse & Vegetation
  - Soil Distribution & Properties
  - Precipitation (Design Storms)
- Data formats and sources vary; can be converted to raster format. In essence, each one-square-meter includes the data listed

2.) Cost vs. technological benefits!

For **less than half** of the cost of KCMO's 2003 and 2005 watershed studies for First and Second Creeks we will gain:

LOMR of FEMA to accurately represent runoff, lowering flows significantly.

128 to 180 miles of Hec-Ras and SWMM modeling vs. the present 60.7 miles City, 30 miles of which is FEMA regulatory floodplain.

210 (or more) Hydraulic risk map products for those 128 to 180 miles

Flow paths with flow assigned to the 0.5 acre subbasin upstream of Hydraulics

We've found every as built or surveyed to 2008 LiDAR in the field.

Dozens of Hydrology Tools for Native, Existing and Future conditions that eliminate the need for existing micro and macro storm studies.

Erosion/Meander History & Erosion Hazard Assessment via the above tools

3.) We fail to use technology to drive regulation! Often the revers occurs! Procedure resists change!

#	Regulatory and Standard Practice Requirements	Type	Resource Document	Science
155	The stormwater management study for a development shall include an analysis of the existing downstream drainage systems to the point the development's land mass is less than 10% of the total watershed, unless waived by KCMO.	Peak	APWA 5600	VD Volume Discharge
157	For dry detention basins, the design shall allow for discharge of at least 80 percent of the detention storage volume within 24 hours after the peak or center of mass of the inflow has entered the detention basin.	Volume	APWA 5600	VD Volume Discharge
158	Draw down of a facility shall be completed within 72 hours of less when required for maintenance or inspection.	Volume	APWA 5600	VD Volume Discharge
163	The watershed plan manages runoff from all storms up to and including the 5-day event.	CRS Program	Series 400	VR Volume Retention
165	If flooding problem occur, runoff from the development shall be controlled by limiting the storm water release rates for the 1%, 10% and 100% storms to the predevelopment peak flow rates. Partial Volume Mitigation Effect	Peak	APWA 5600	VR Volume Retention
167	KCMO is a Class 9 Community which reduces flood insurance within the City limits by 5%.	Peak	https://www.kcwaterservices.org/crs/	
168	The use of the Rational Method for drainage areas greater than 5 acres is not appropraite.	Peak	APWA Supplement No. 2	VD Volume Discharge
169	SWMM is the prefered method for Drainage Masterplans.	Peak	APWA Supplement No. 2	NA
170	Small urban area, less that 10 acres of drainage shall use a 100-year, pre-existing discharge rate.	Peak	APWA Supplement No. 2	VD Volume Discharge
171	Large urban area, greater than 10 acres of drainage, shall use a peak discharge of the 100-year, pre-existing discharge rate, may be less if flooding is downstream.	Peak	APWA Supplement No. 2	VD Volume Discharge
172	For any development the City may impose prescribed discharge rates based on a Master Watershed study.	Peak	APWA Supplement No. 2	VD Volume Discharge
173	The maximum size for use in the Rational Method in a watershed is reduced from 200 acres to 5 acres.	Peak	APWA Supplement No. 1	VD Volume Discharge
174	The SCS curve numbers may be adjusted from a Type C, if the engineer can justify other soil types.	Peak	APWA Supplement No. 1	VD Volume Discharge
175	Q100 = 3cfs/ac; Q10 = 2cfs/ac; Q2 = 0.5 cfs/ac, Allowable Peak Discharge for new development	Peak	APWA 5600, 2011 Ver.	VD Volume Discharge

If you start by the Regulations & Process you can "die" by it. Steering through this regulatory forest does not get you where you need to be. 1.) Start with Technology's capabilities to help you identify your real core community storm needs. 2.) Use the needs and technology to reshape the regulations and process to be **simpler** and **directly linked to real storm water needs and goals.** Engineer solutions, not existing conditions.

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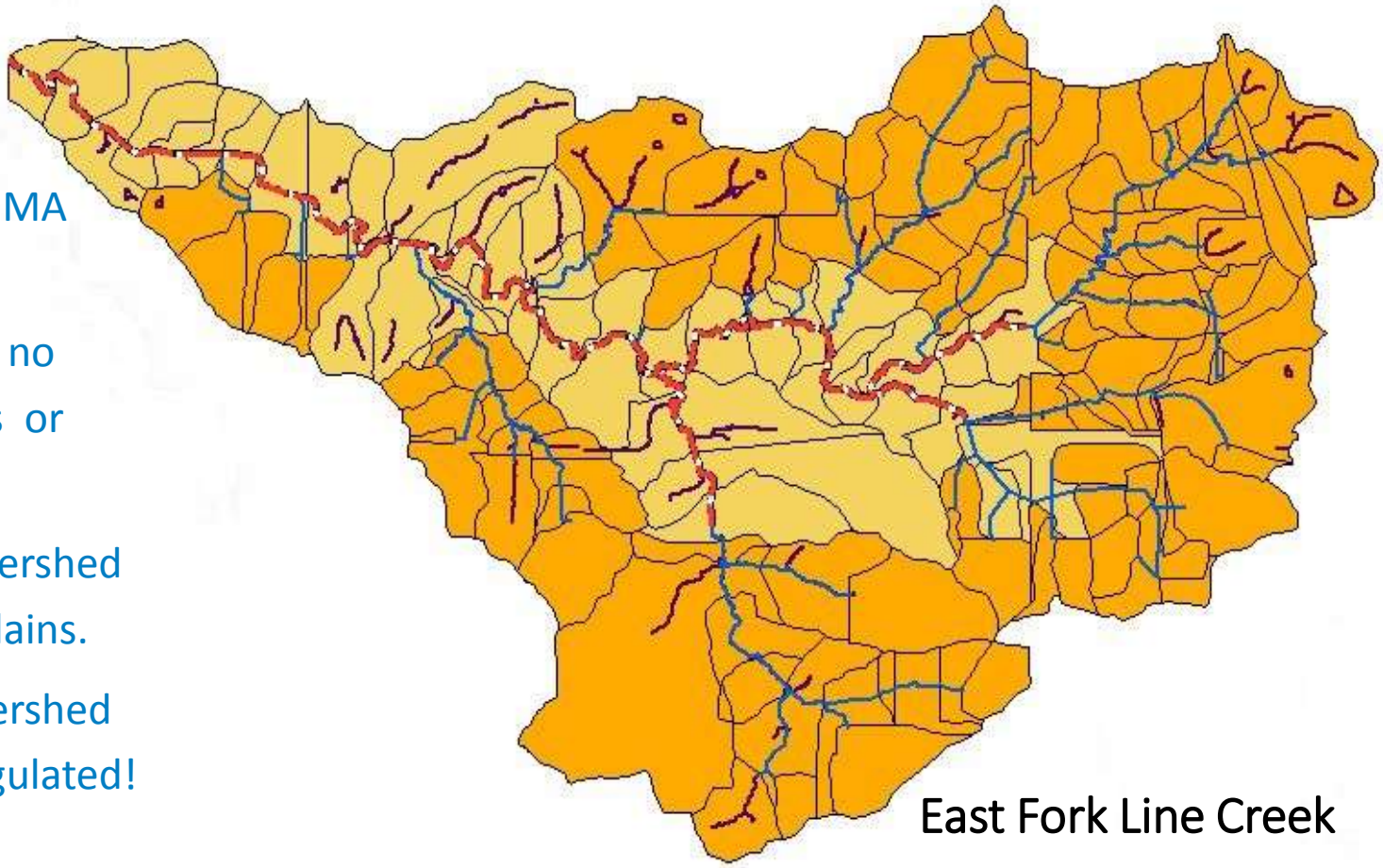
Let Tech simplify or eliminate some of these 175 regulatory requirements.

3.) There are 3 Regulatory Worlds! Federal to State to Local Regulations.

- Light Orange = FEMA floodplains
- Deep Orange has no FEMA floodplains or hydraulics.
- ~ 34% of this watershed has FEMA floodplains.
- ~66% of this watershed area is Locally regulated!

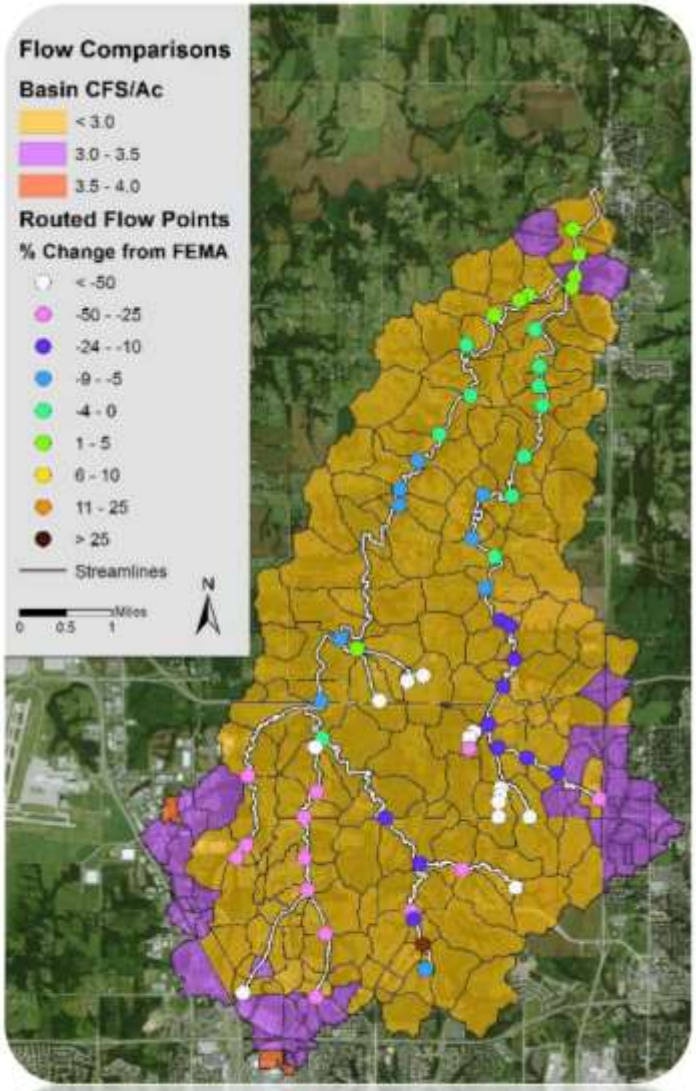


East Fork Line Creek

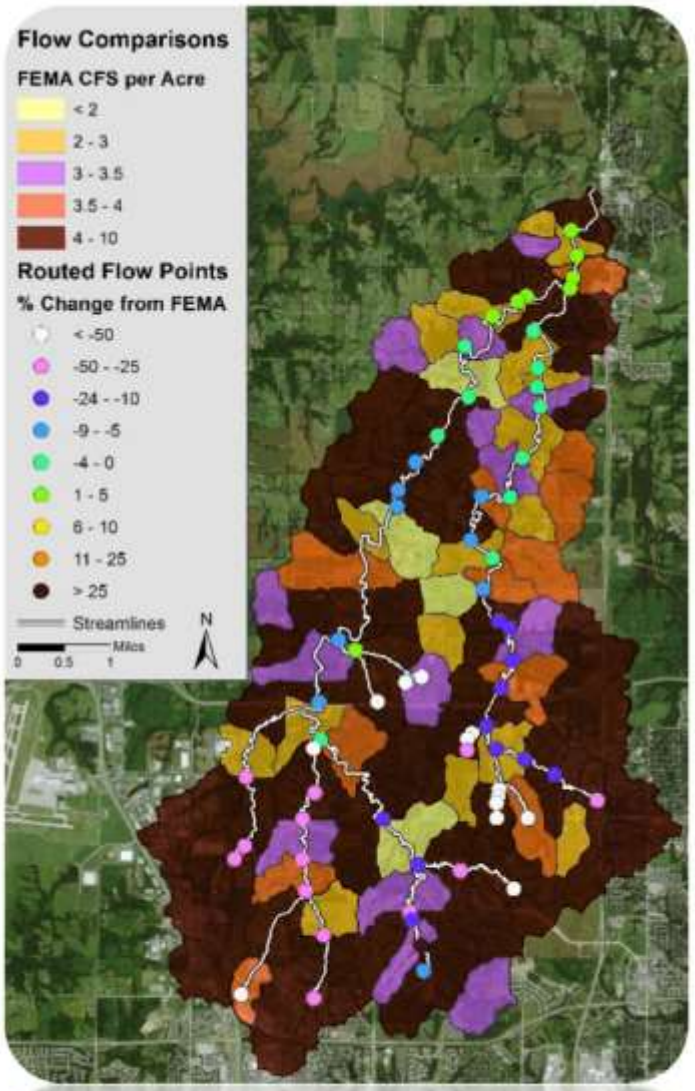
KCMO has ~ 210 sq. miles with only local regulations for stormwater management & ~ 109 sq. miles with partial Federal FEMA regulatory coverage.
Local Regulations usually calibrate to FEMA flows as the next slide will show.

3.) Local Flows vs. FEMA Flows

- FEMA flows are conservative due to the nature and age of regulatory modeling
- But local efforts often Calibrate to FEMA! This perpetuates older modeling methods!
- LOMR is needed & occurring to align local and federal.



Revised Local Flows



Pending FEMA Flows

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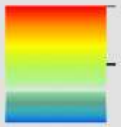
The Past will perpetuate without Technologies used to improve it!

Basin Runoff

in Flow per Drainage Area



High: 5.0 cfs/ac

Low: 1.5 cfs/ac

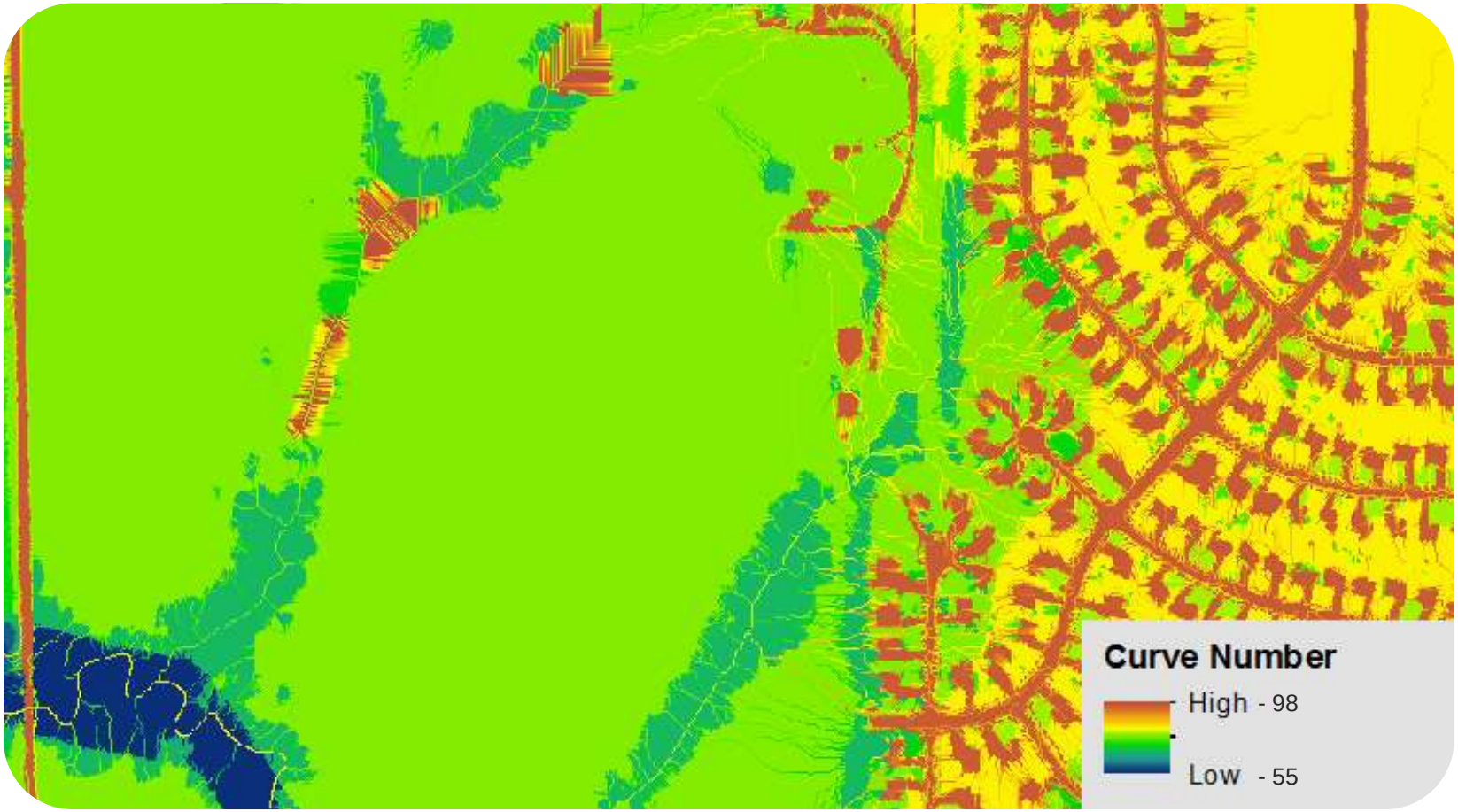
3.) Conclusions
& 4.) Tools

Existing
Conditions

Native
Conditions

Future
Conditions
(with no change
in regulations)

Hydrology, Curve Number, CN, per SCS & Rasters!



Weighted by Cumulative Drainage Area in this Case

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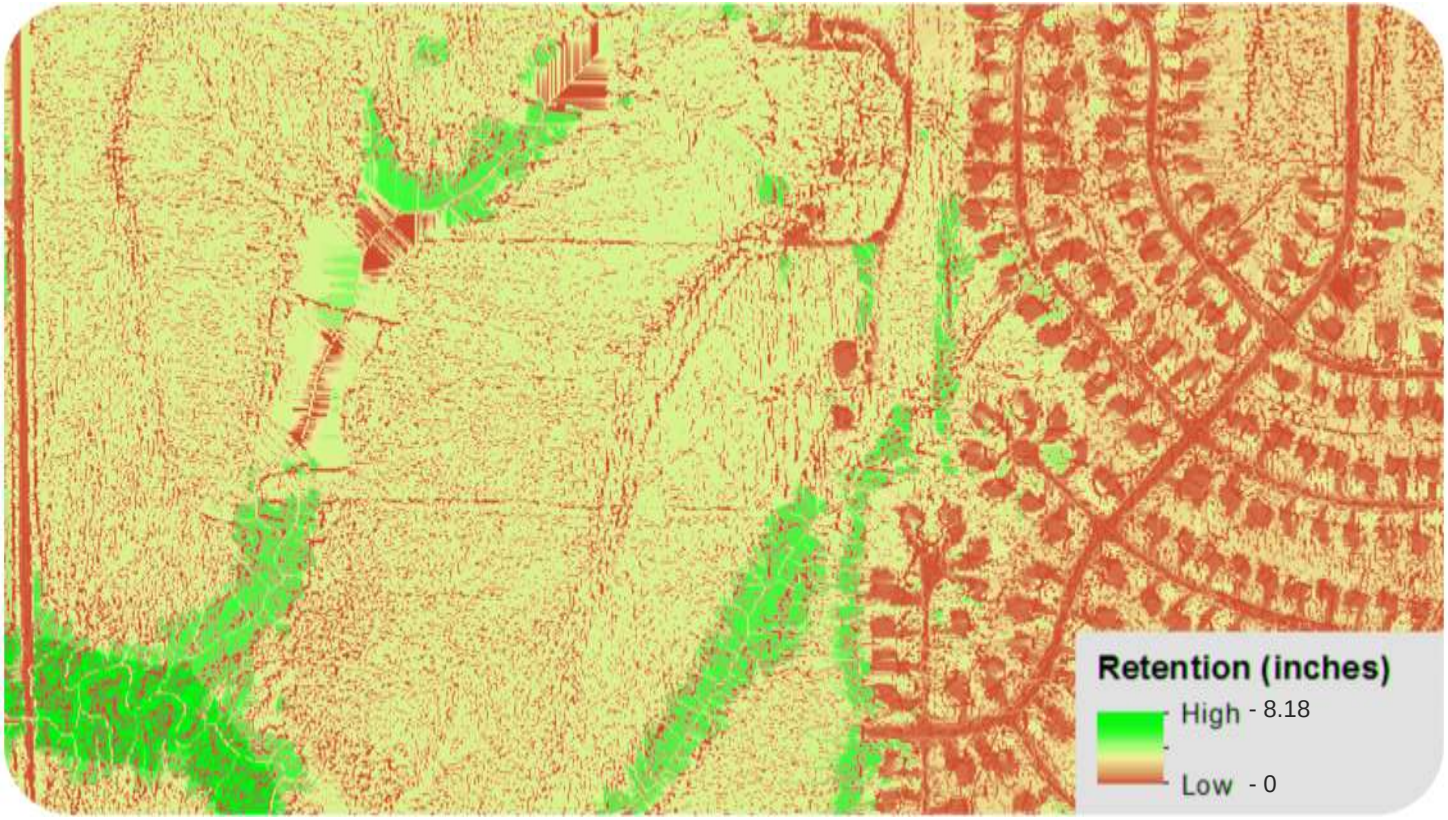
1 meter raster CN, from pervious, impervious, vegetation and soils. This shows Fair Vegetative conditions.

Potential Maximum Soil Retention (S)



- Developed from Curve Number: $S = \frac{1000}{CN} - 10$
- Weighted by Cumulative Drainage Area
- Used to Develop Initial Abstraction ($I_a = 0.2S$)

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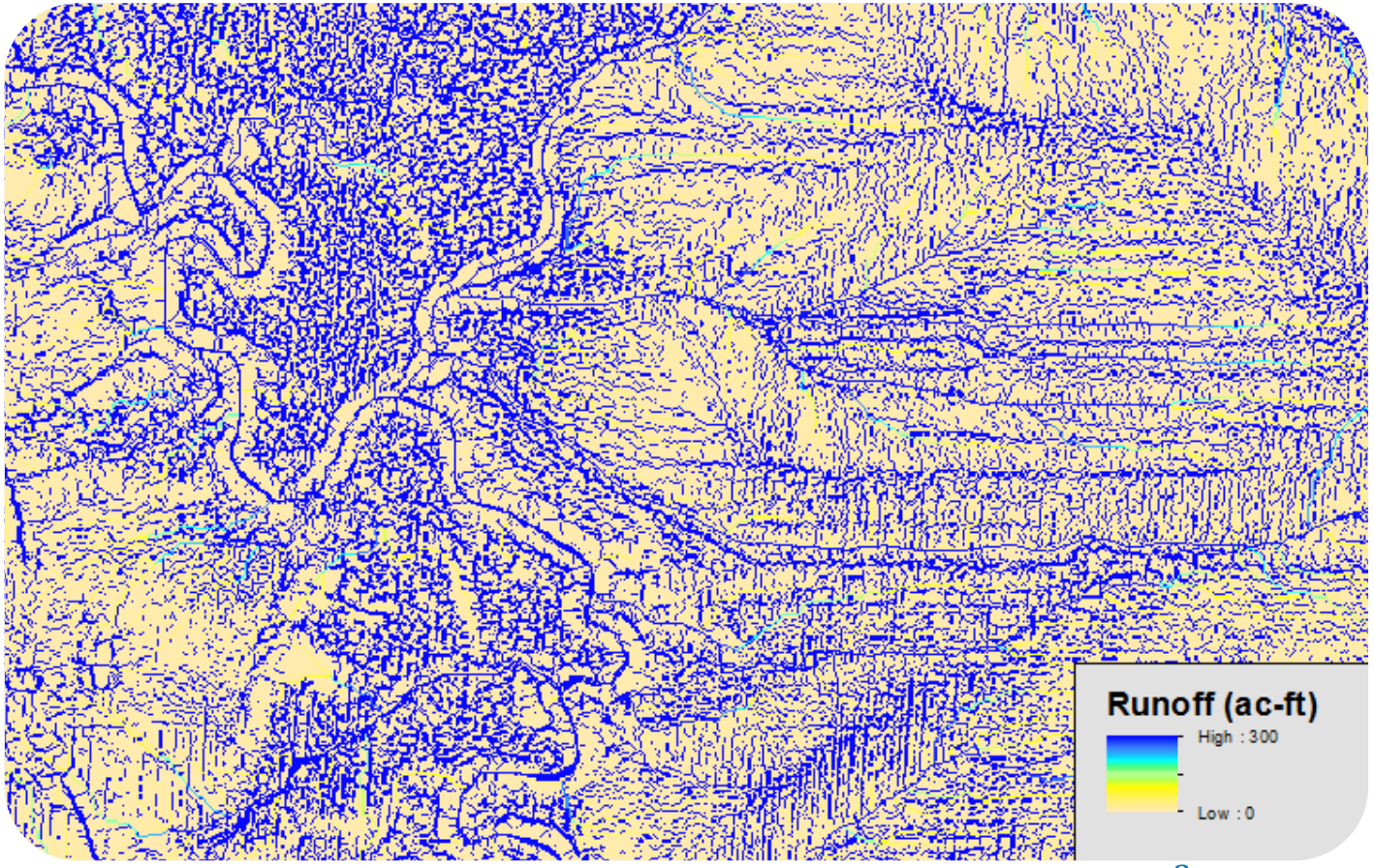
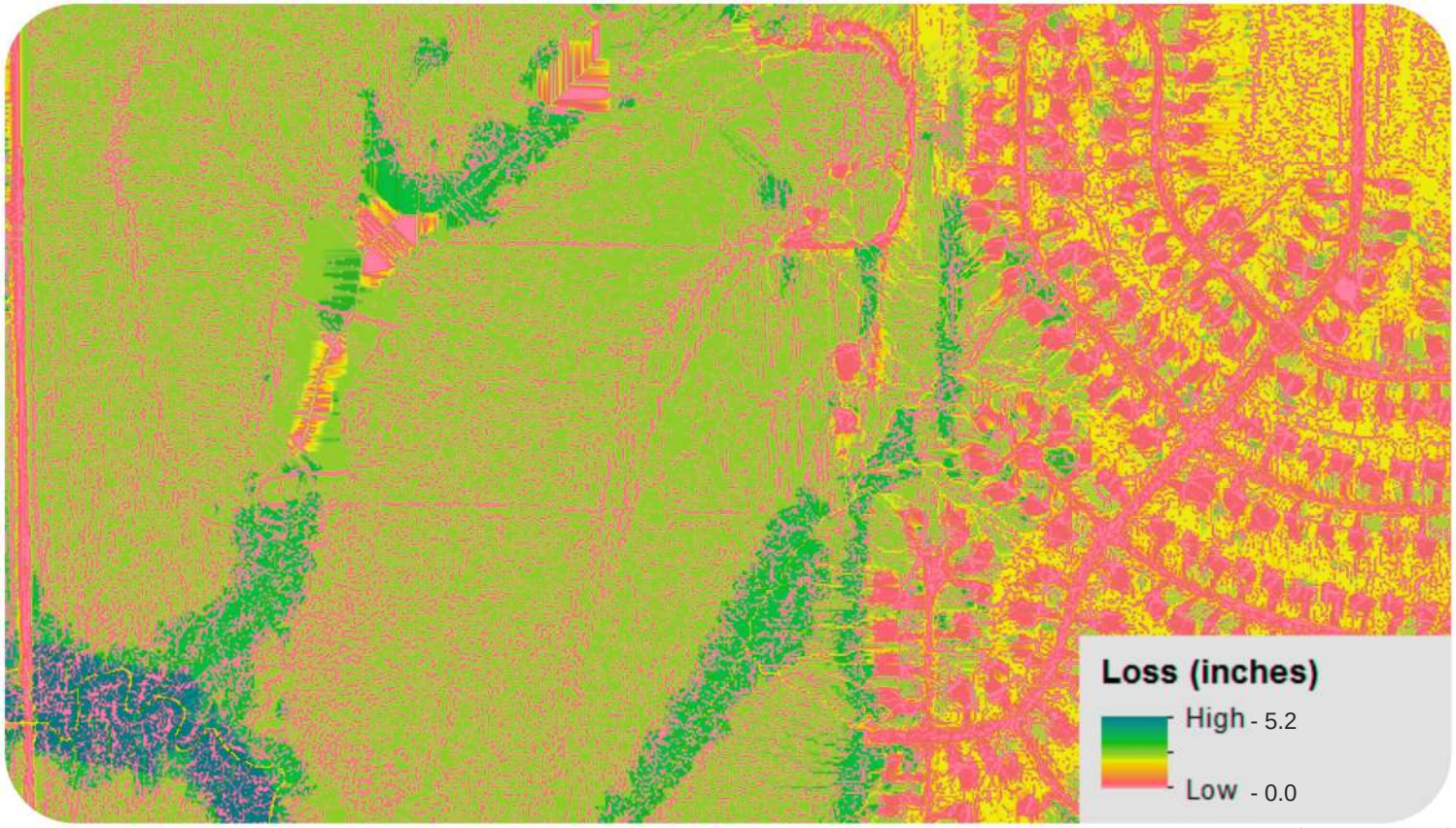
SCS Runoff



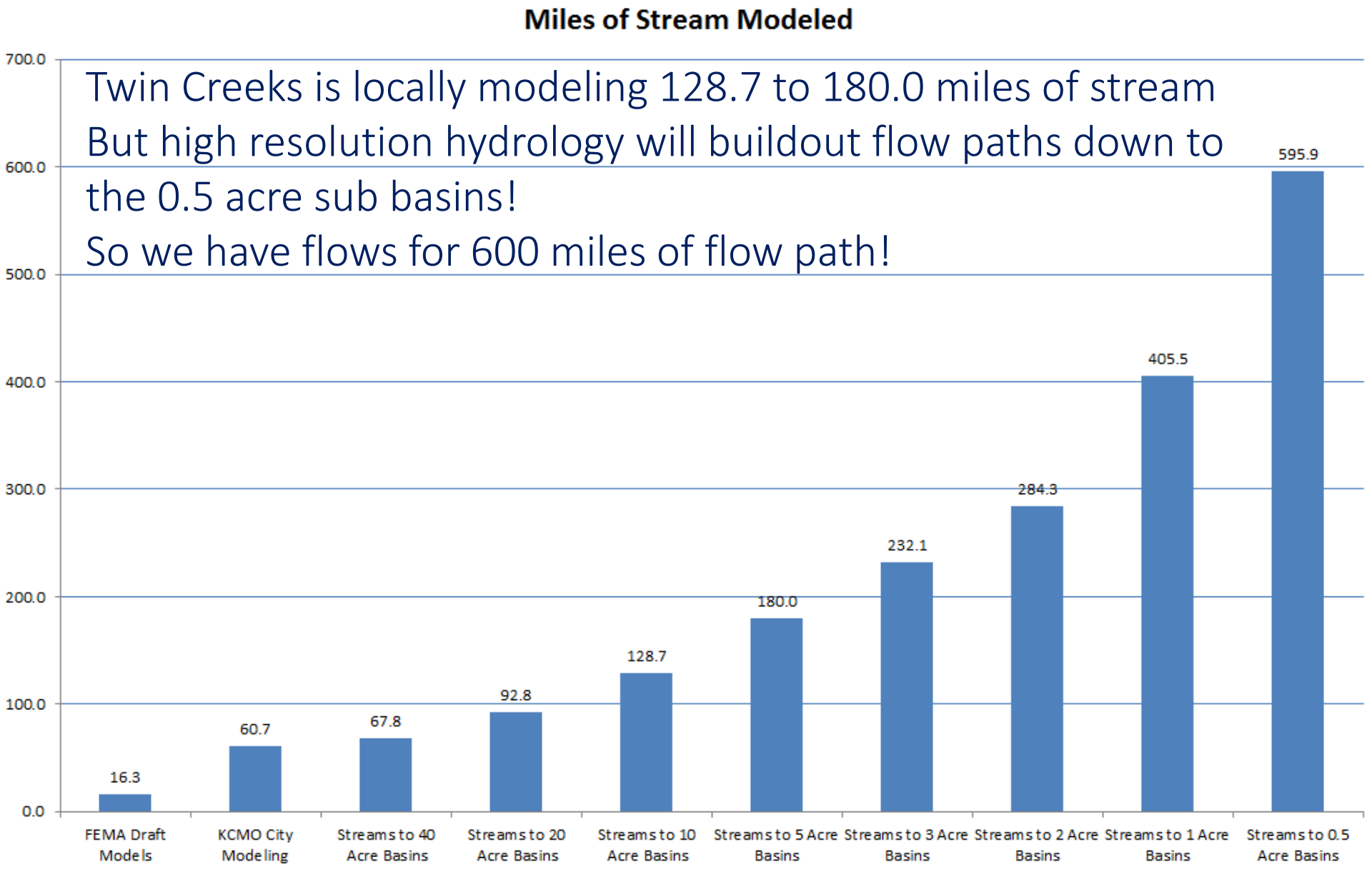
- Developed from SCS Methodology: $S = \frac{(P - 0.2S)^2}{P + 0.8S}$ for $P > I_a$
- Accumulated by Drainage Area

SCS Runoff Loss



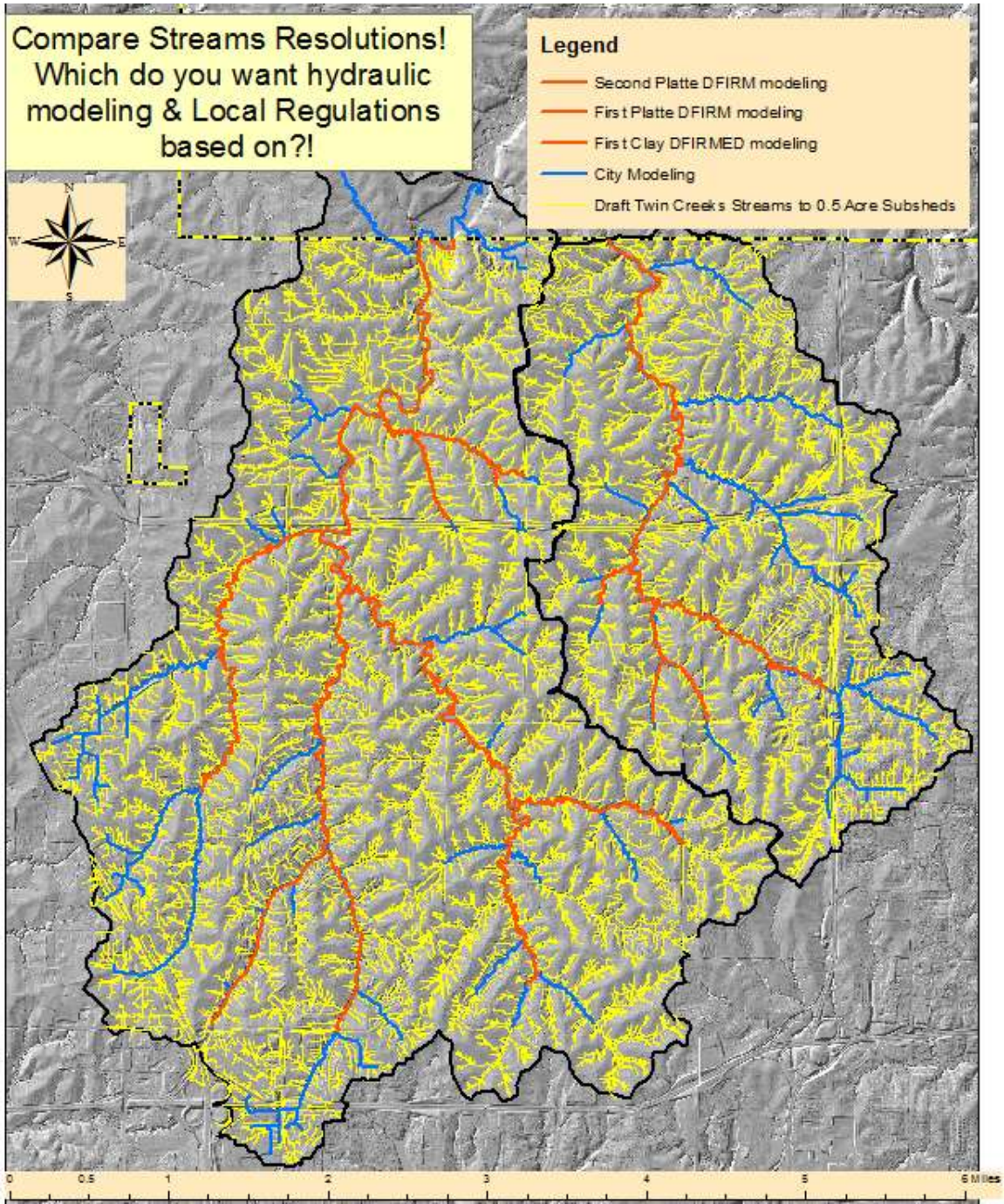
- Developed from SCS Methodology: $Loss = P - Q = P - \frac{(P - 0.2S)^2}{P + 0.8S}$
- Weighted by Cumulative Drainage Area
- Approximates Infiltration

Twin Creeks stream flow paths are critical starting points



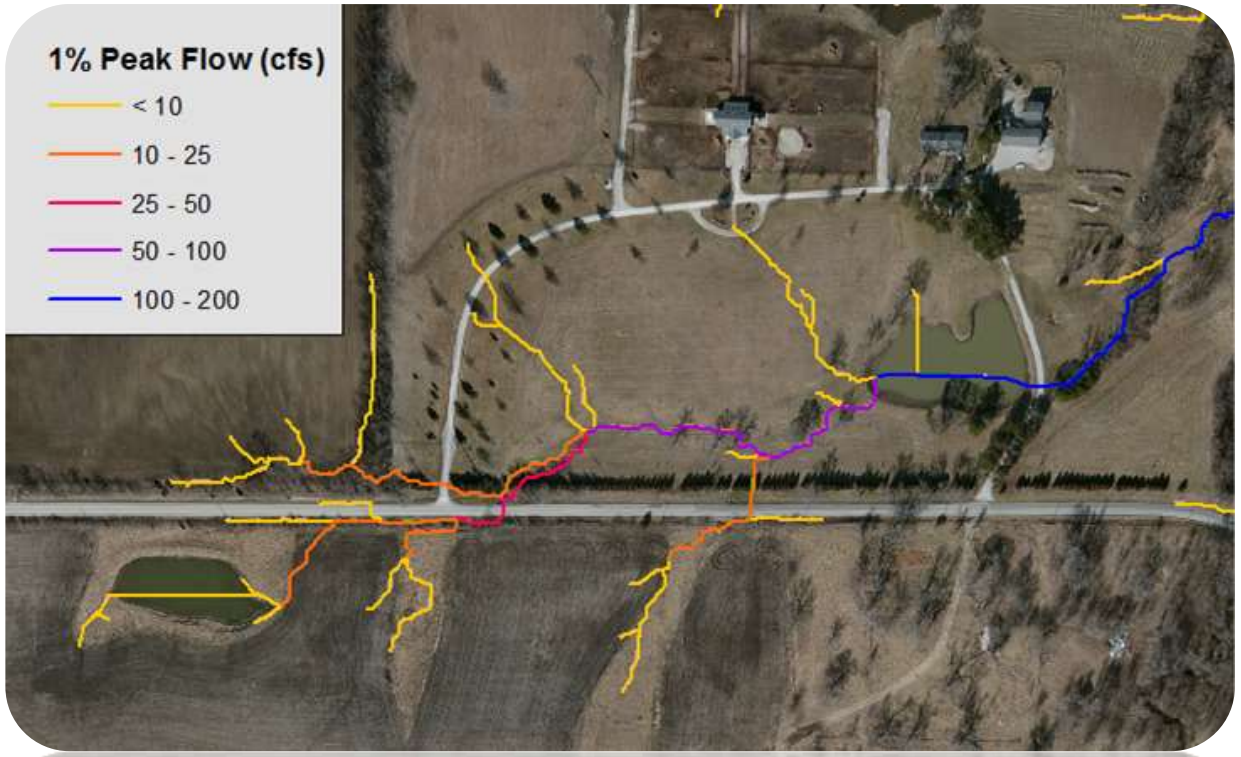
Flow Path to 0.5 Acre sub basins

- Red = FEMA Regulatory (30 miles A & AE Zones)
- Blue = City modeled Hydraulics
- Yellow = Flow paths previously not modelled to the 0.5 acre subsheds.



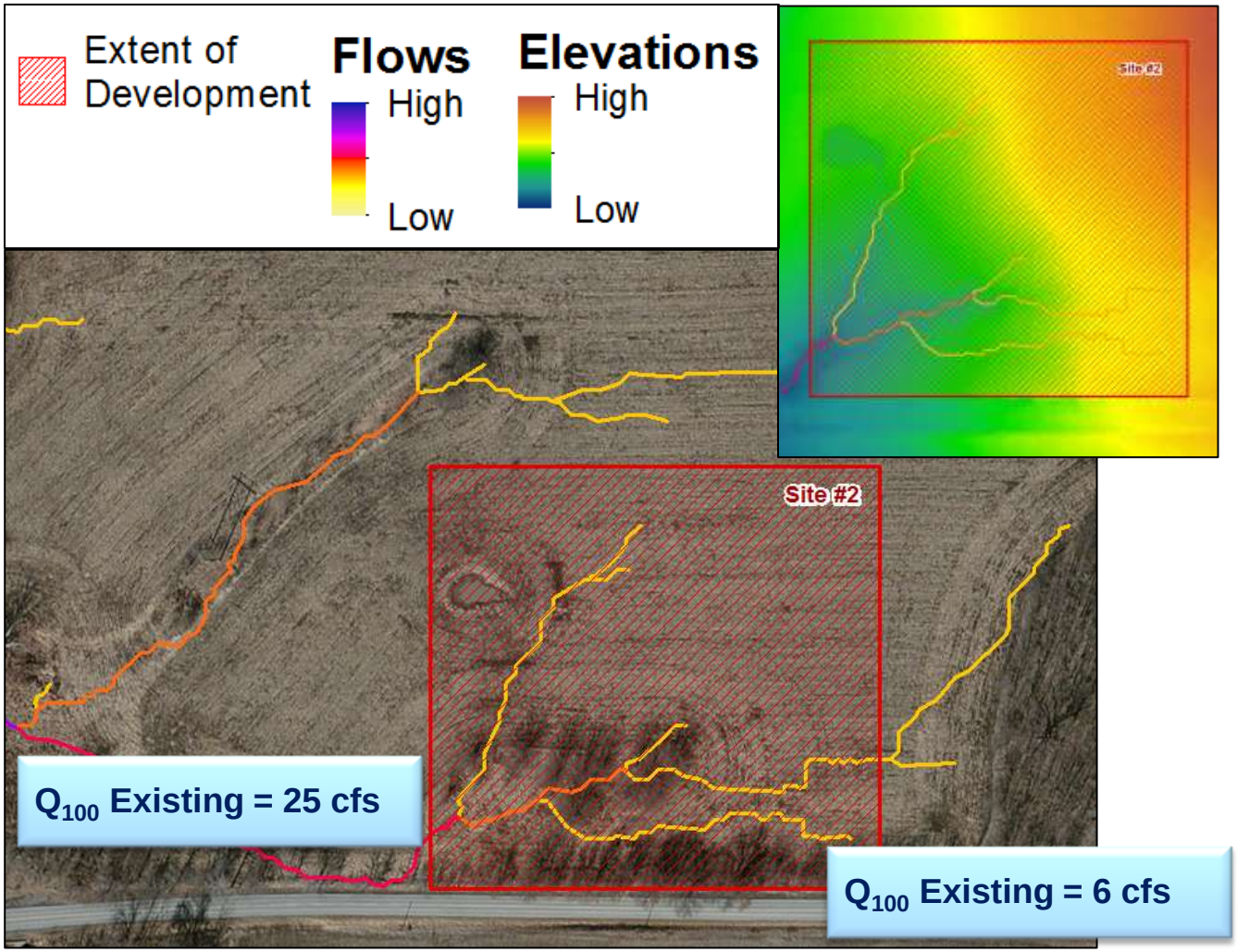
Gridded Flow Distribution

- Up to drainage area of one-half acre
- Utilizes SCS methodology based on flow regime
- Land use and contributing drainage area are accounted for
- If you have half acre lots, you have flows for each lot on average.



Hypothetical Development Site #2

- Pre-Development inflows and outflows are Provided: 6cfs entering and 25cfs leaving site
- Inflows assist with site development
- Post-Development flows leaving site must meet regulatory requirements
- Plans developed by developer dictate the CN value, which is applied to obtain necessary storage of site



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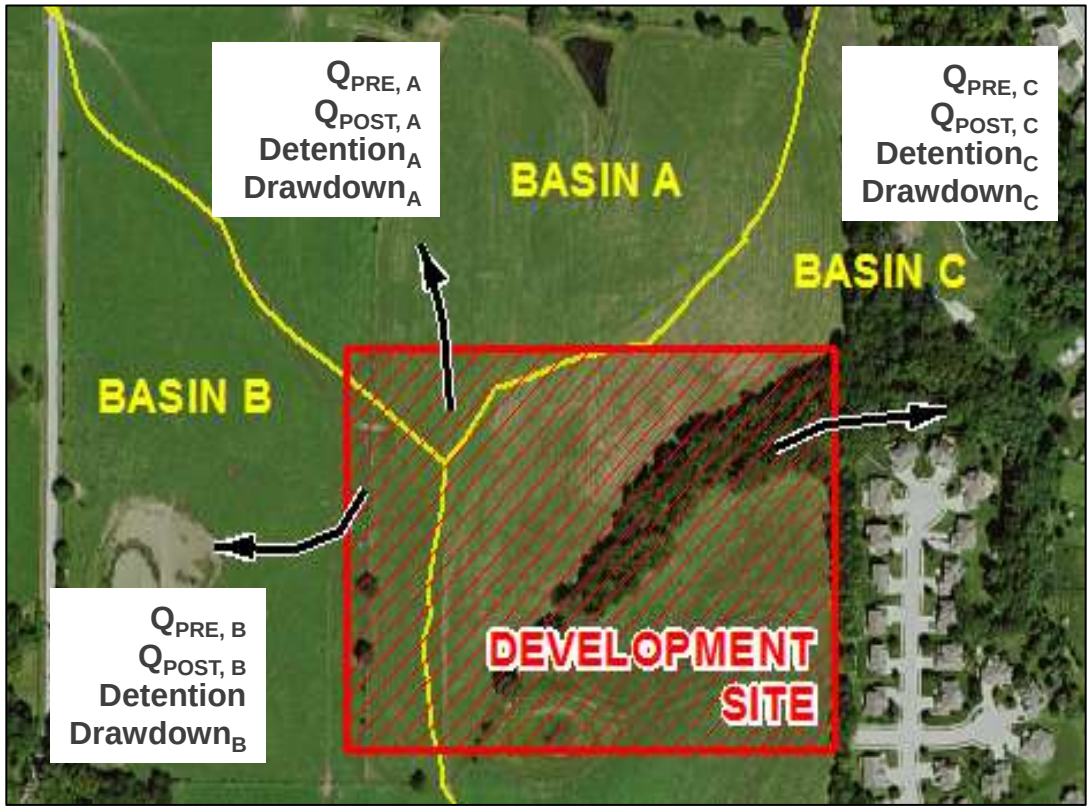
Example Development Site & Tools



- Developer Provides extent of Development
- Pre-Development Flows are Provided
- Post-Development Flows, Detention, and Drawdown Times are Provided

"Detention" is only one way to solve. One can use the entire site plan to slow, reduce and lengthen the time and reduce the flow, thus reducing any detention.

- Example Site: Development is Located on Basin Divide Between Three Basins

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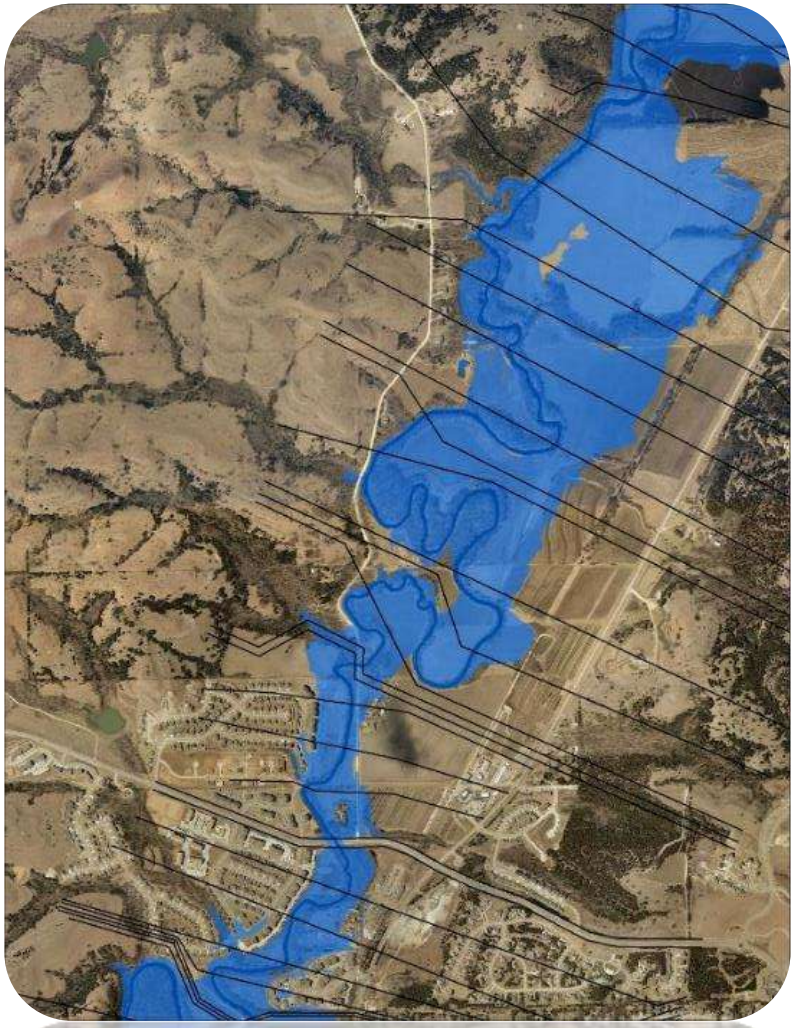
Hydraulic Modeling

- Performed Up To Drainage Area of Five to Ten Acres
- Utilizes HEC-RAS Modeling
- Cross Sections Cut on LiDAR above City modeling.
- Floodplains and Other Products Developed
- Floodplains by Storm Event
    - 500-year, 100-year, 50-year, 25-year, 10-year, 5-year, 2-year



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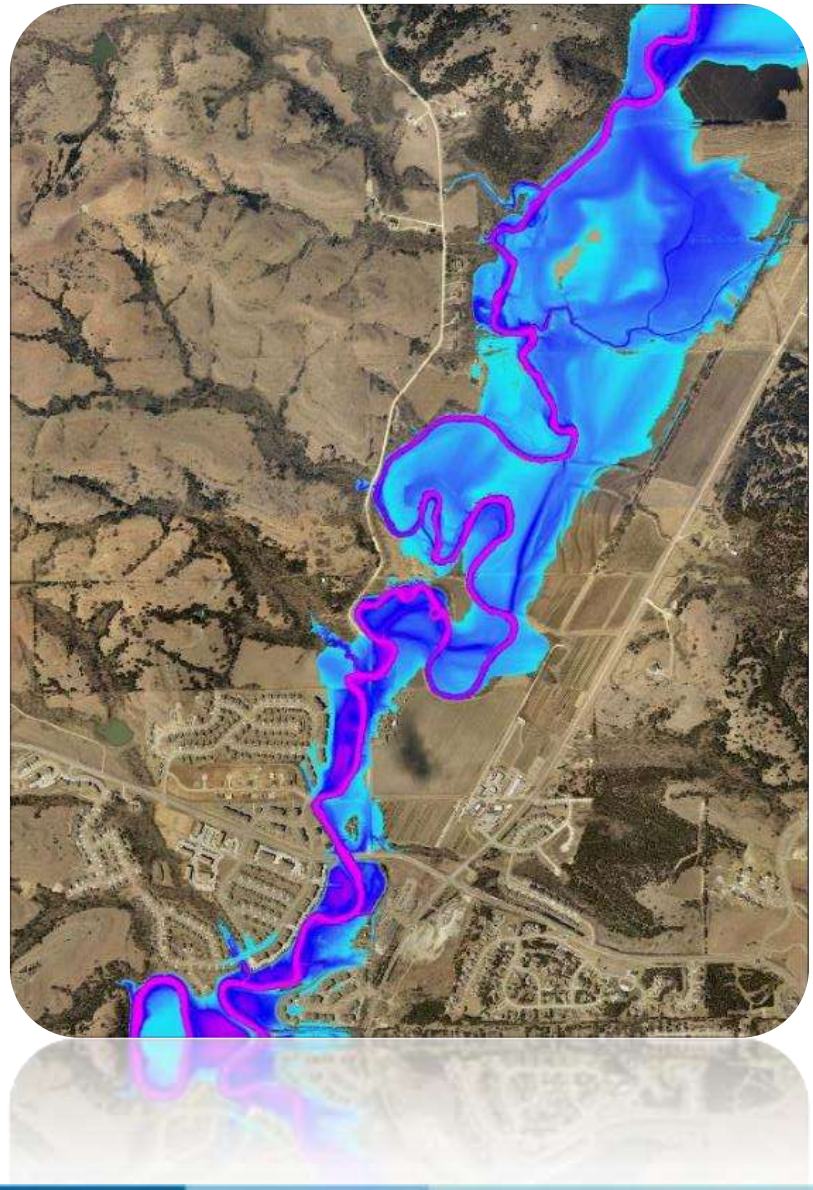
HEC-RAS Derived Products: WSEL, Depth, & Volume Grids

- Water Surface Elevation Grids from HEC-RAS – 1 meter Terrain raster = Depth Grids. Always get both!
- Depth of Flooding by Storm Event
  - 500-year, 100-year, 50-year, 25-year, 10-year, 5-year, 2-year
- Areas within deeper flood depths are at higher risk than those outside in shallower depths
- Depth across the floodplain area also represents volume of the water within floodplain
- = Raster Area * Depth



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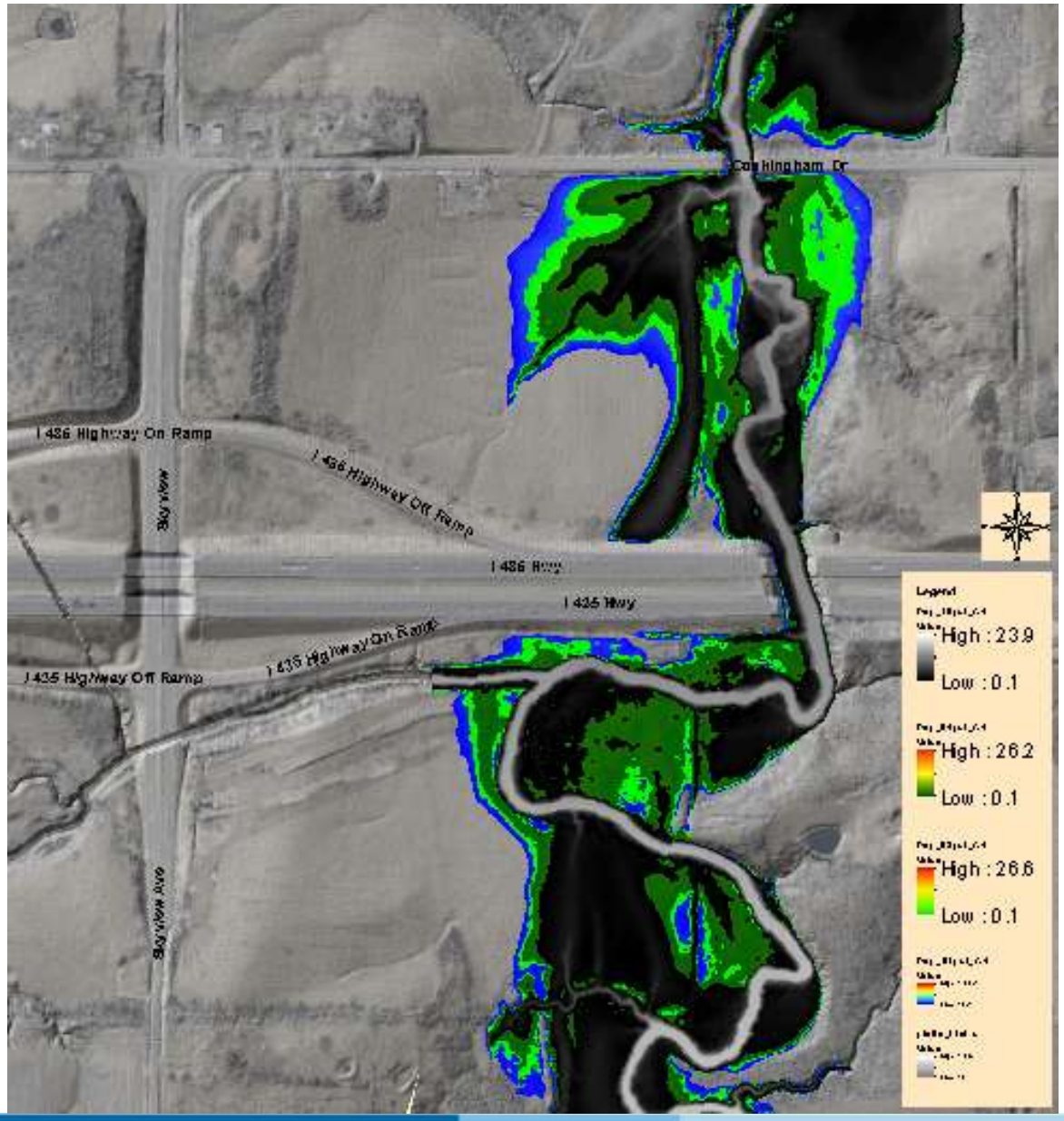
Range of Severities

Here you see four storm event severities from 10% to 1%

We'll provide these for Native, existing and future conditions.

For many critical parameters.

Information on call!



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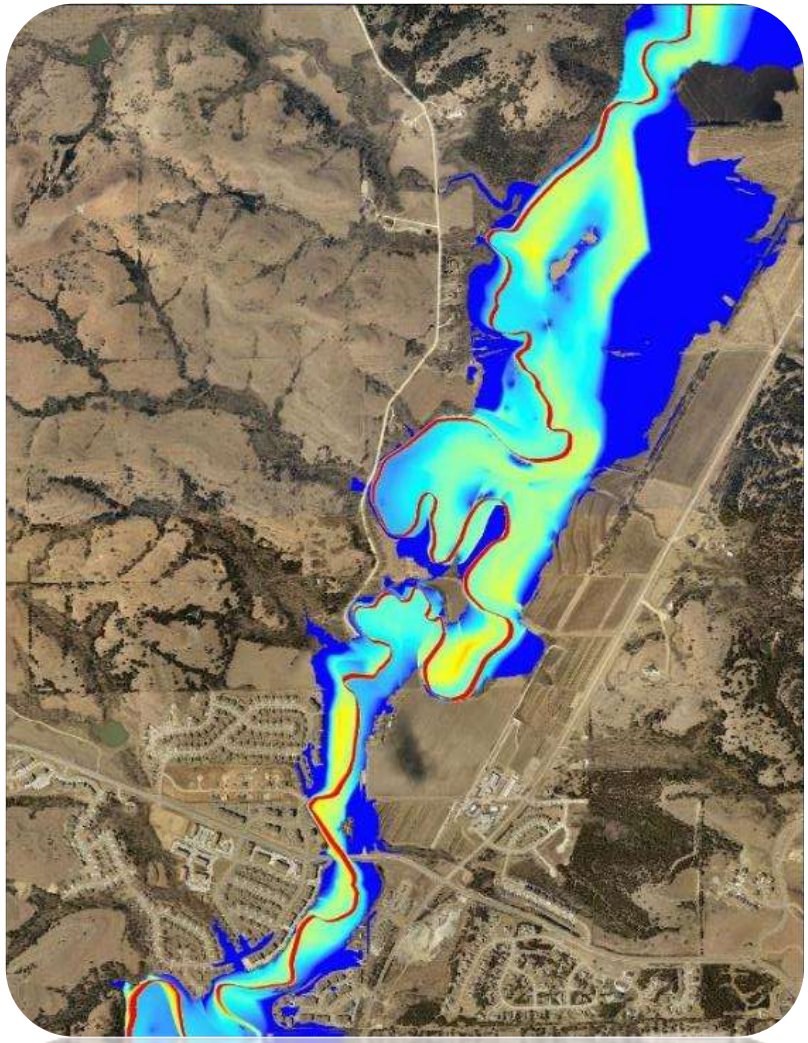
HEC-RAS Derived Products: Velocity & Shear Stress Grids

- Highest Velocities Typically Occur within the Channel, while Overbank Velocities are Typically Lower
- Water Velocity Depends on Storm Events
  - 500-year, 100-year, 50-year, 25-year, 10-year, 5-year, 2-year,
- Shear Stress is Directly Dependent on Water Velocity
- Areas near higher velocities and shear stress are at higher risk than those outside in shallower depths
- City can create Flood Severity Thresholds



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Stream Erosion & Meander Hazards

Johnson County identified 63 locations on Indian Creek with 3.5 million in mitigation needs.

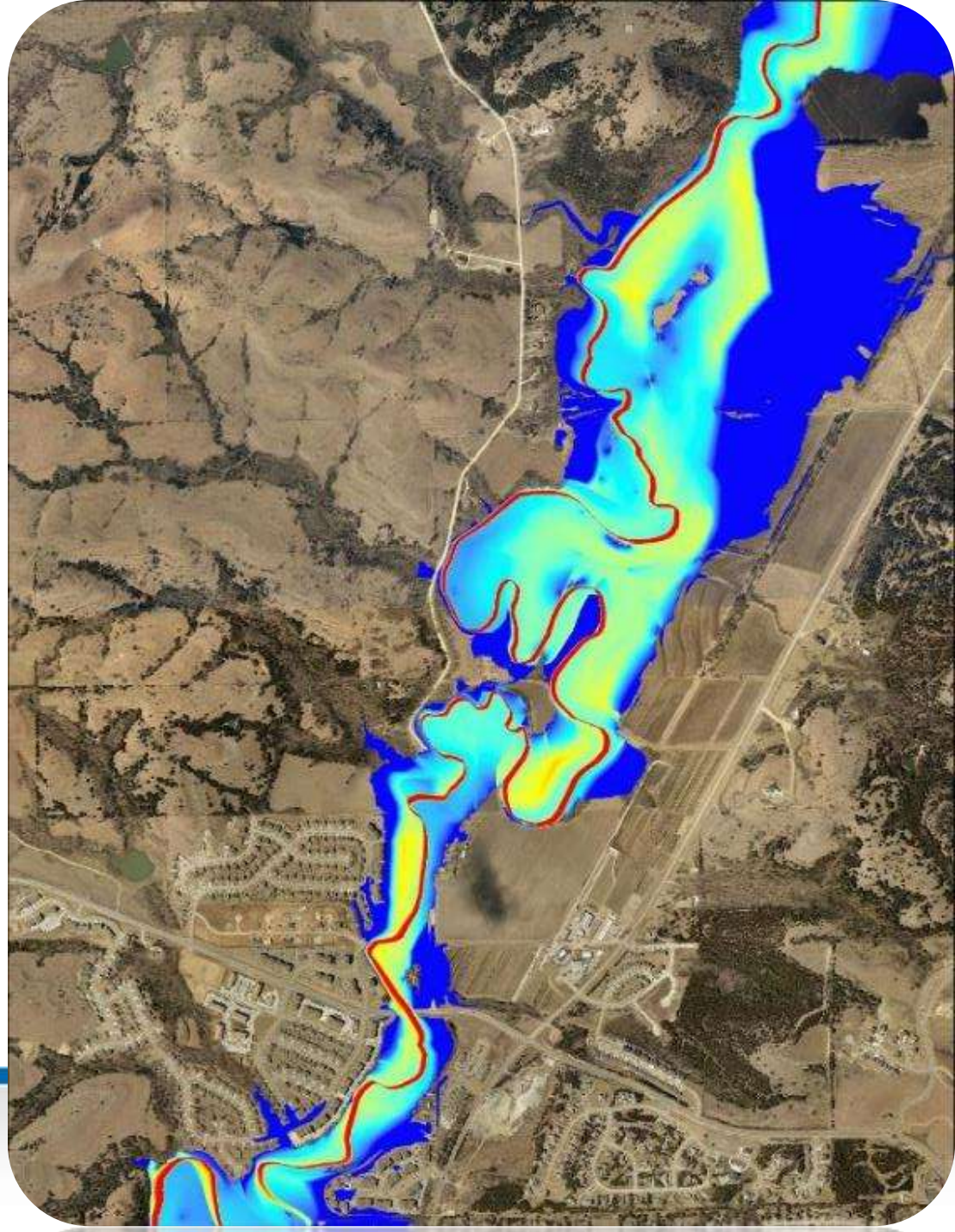
If you wait it will cost you more. 3.5 becomes 10 to 20 million with time!

Extrapolating to KCMO the above is, Best Case 25 million, worst case, 143 million.
A stable stream is still changing. Urban streams are rarely stable.

We need to plan for stream change to avoid these costs in our rural areas where this is still possible!

Stream Erosion Hazard Zones

- A Science-Based Methodology will Consider Relevant Parameters (Ground Slope, Velocity, etc.)
- Other modeling parameters within Hec-Ras.
- Erosion Hazard Zones



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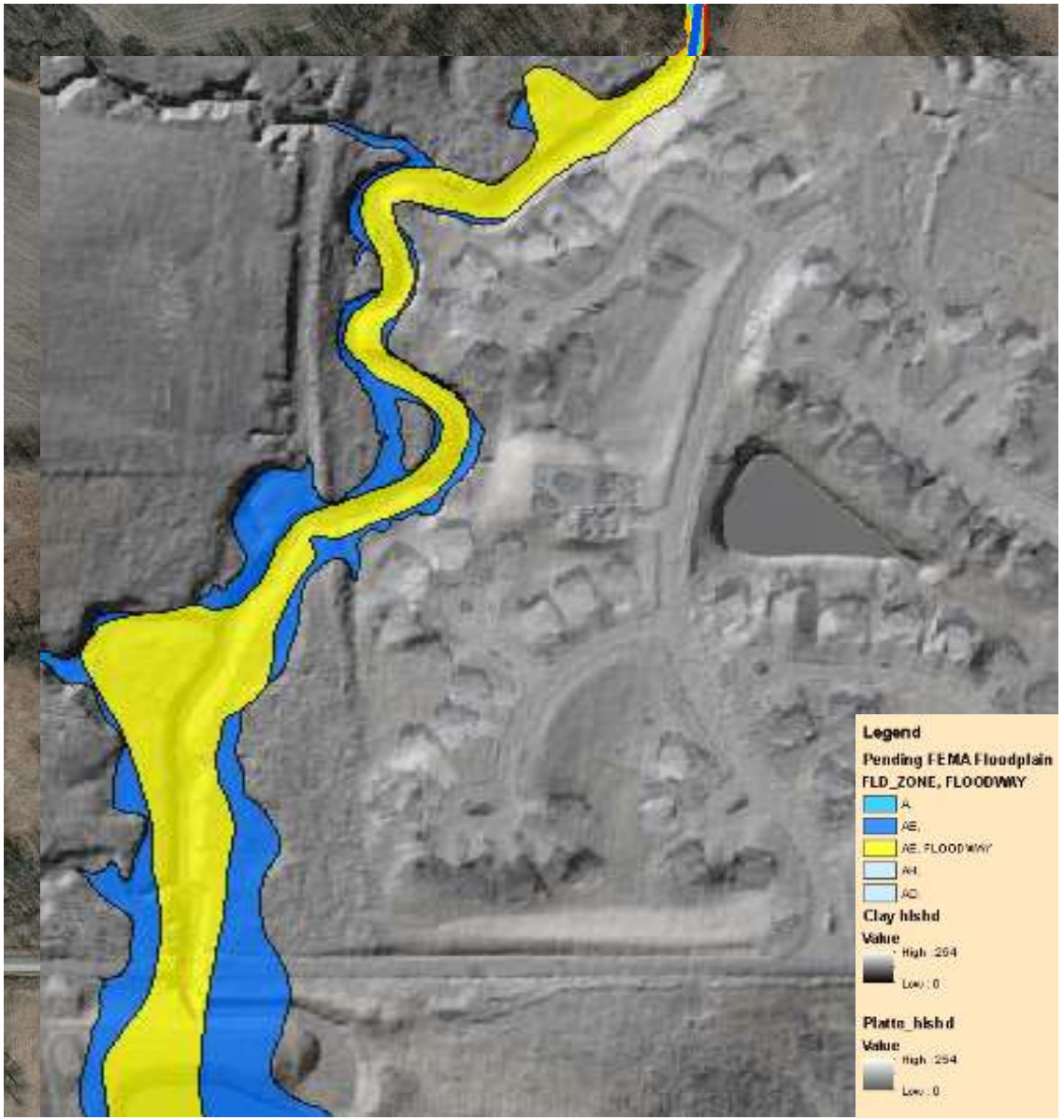
Our Setbacks & buffers need to consider erosion and meander

- Here we see stream change and meander from 1964 to 2014 by orthos.
- City Stream Buffer is based on the 1% regulatory FEMA floodplain + 75 feet.
- Not enough!
- The meander will win!
- We are not Identifying our Risks with modern Tech!



Twin Creeks Technology Benefits Conclusion

- We will have correct, accurate & precise starting geospatial data, models & tools.
- Locate more risk and avoid it or resolve it.
- Correct and align FEMA and local flows, lowering flows and floodplains.
- Determining erosive and meander hazards and add to lowered flood hazards.
- Protect stream corridors and associated natural resources

- Provide geospatial data to all for the most benefits with least practical cost.

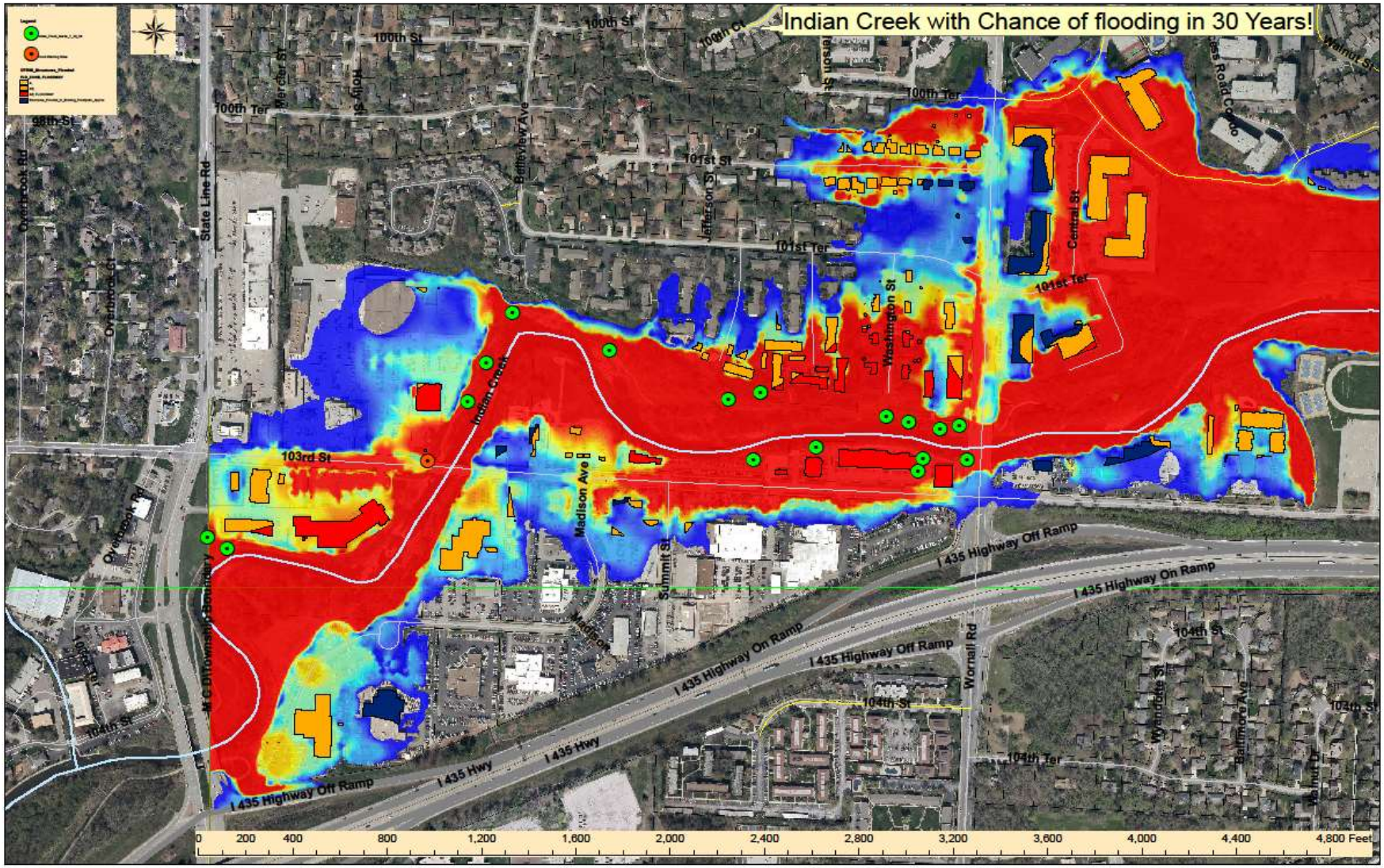
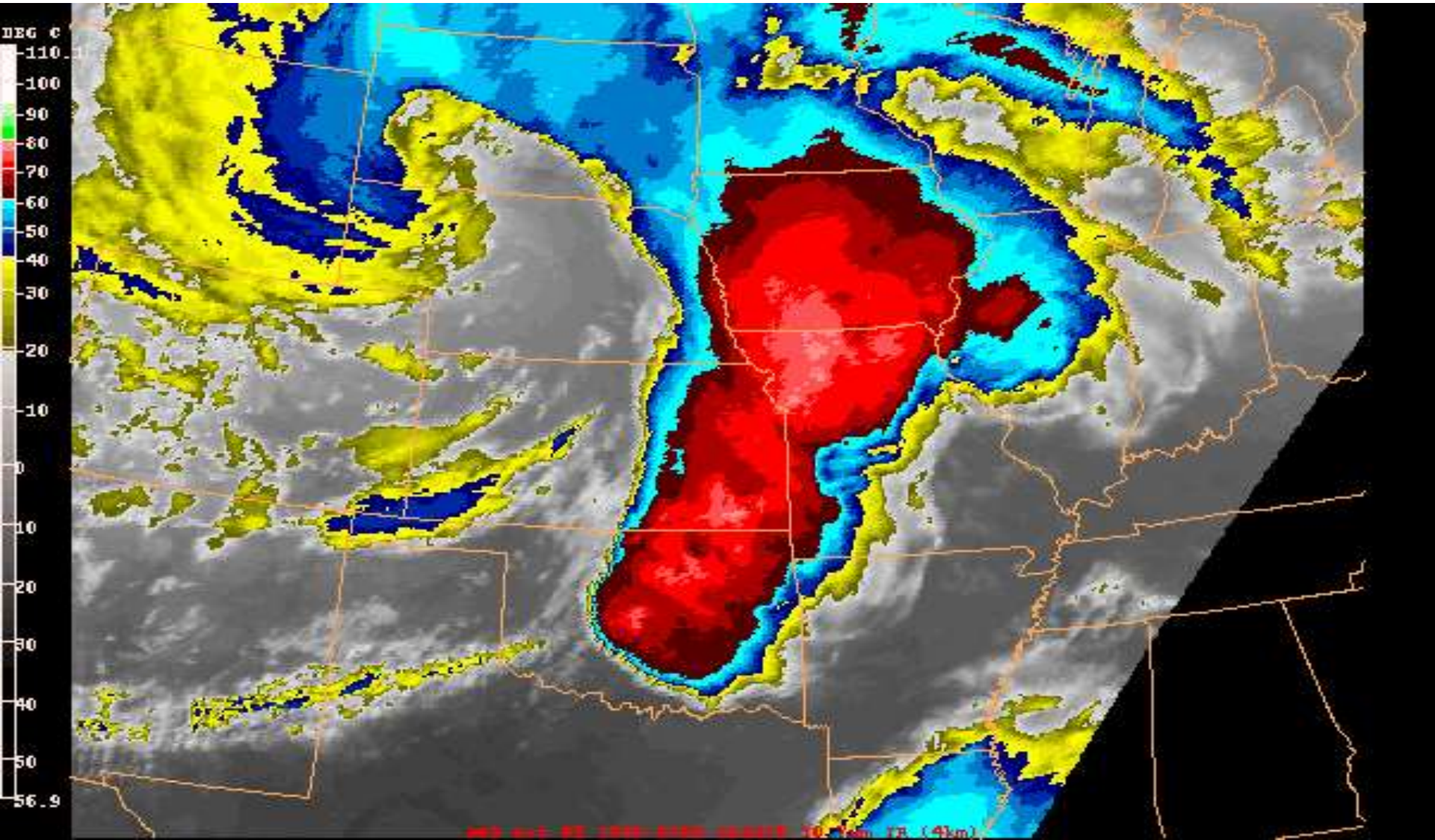
- Avoid one-size-fits-all requirements / avoid excessive regulation

- Reduce the engineering that needs to be done for development on the project level, while better targeting, showing and sharing stormwater risks and needs.

- Use this information to focus on solutions.

- Protect development and owners, reduce regulation and review time

QUESTIONS !!


Indian Creek with Chance of flooding in 30 Years!
100th St
100th Ter
98th St
State Line Rd
Overbrook Rd
Overbrook St
Mercier St
Holly St
Bellevieu Ave
Jefferson St
Nelson St
Central St
Washington St
Indian Creek
103rd St
Madison Ave
Summit St
Wornall Rd
104th St
104th Ter
I 435 Highway Off Ramp
I 435 Highway On Ramp
I 435 Hwy
0 200 400 800 1,200 1,600 2,000 2,400 2,800 3,200 3,600 4,000 4,400 4,800 Feet

Oct. 4, 1998 4.5 inches of rain in 70 minutes!