Cite Your Sources

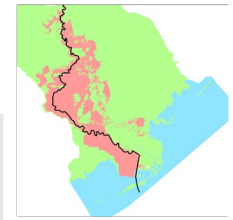
How to Handle Multiple Sources of Flood Risk

FREESE AND NICHOLS

The ability to simplify means to eliminate the unnecessary so that the necessary may speak.

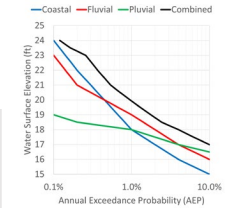
Hans Hofmann

Overview



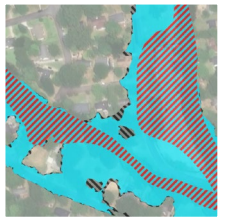
Controlling Event

Visualize multiple risk sources near the coast and determine which source caused the highest water surface elevations



Combined Probability

Quantify component sources of risk in an urban setting



Regulatory Mapping

Process “messy” 2D rain-on-mesh results for FEMA regulatory mapping

Controlling Event

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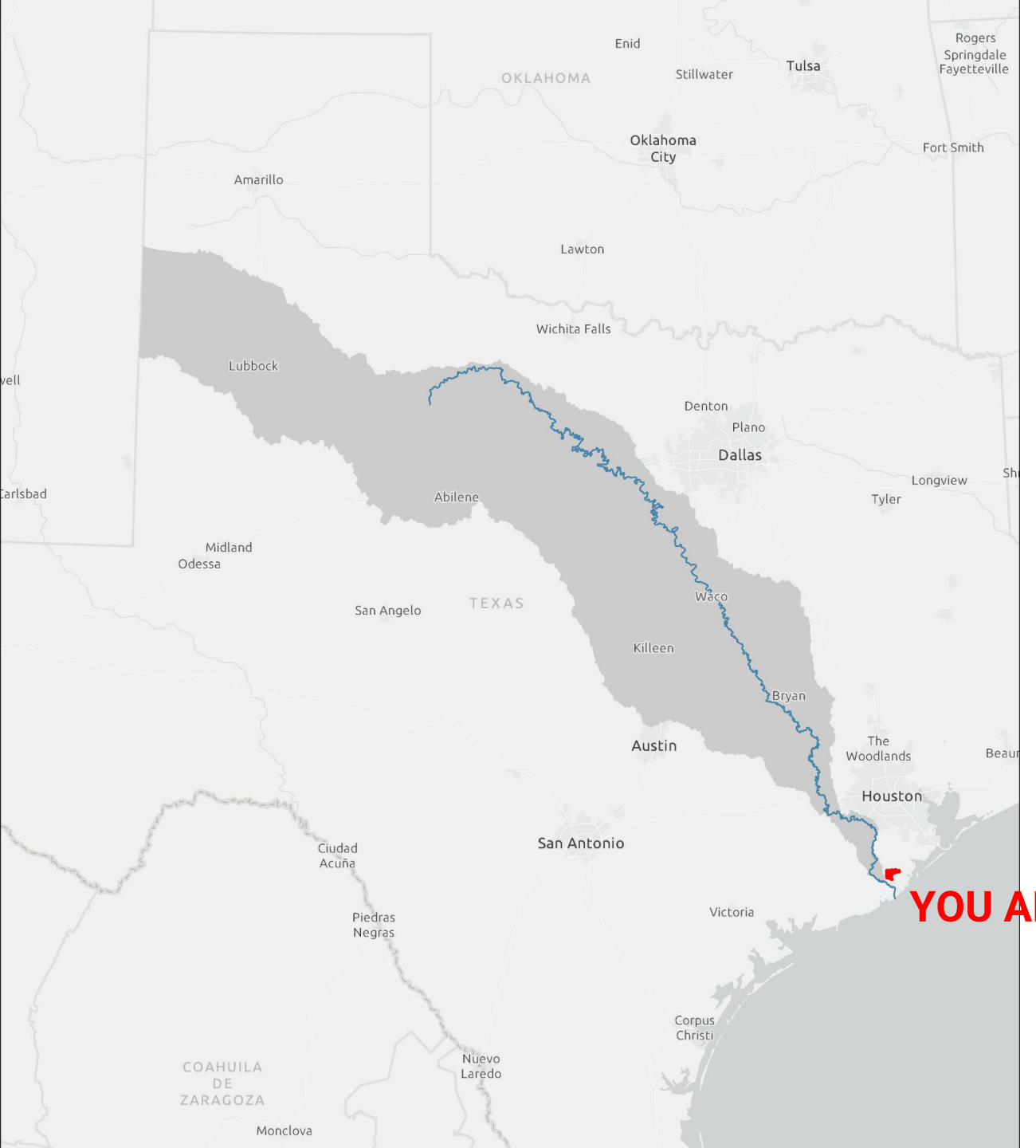
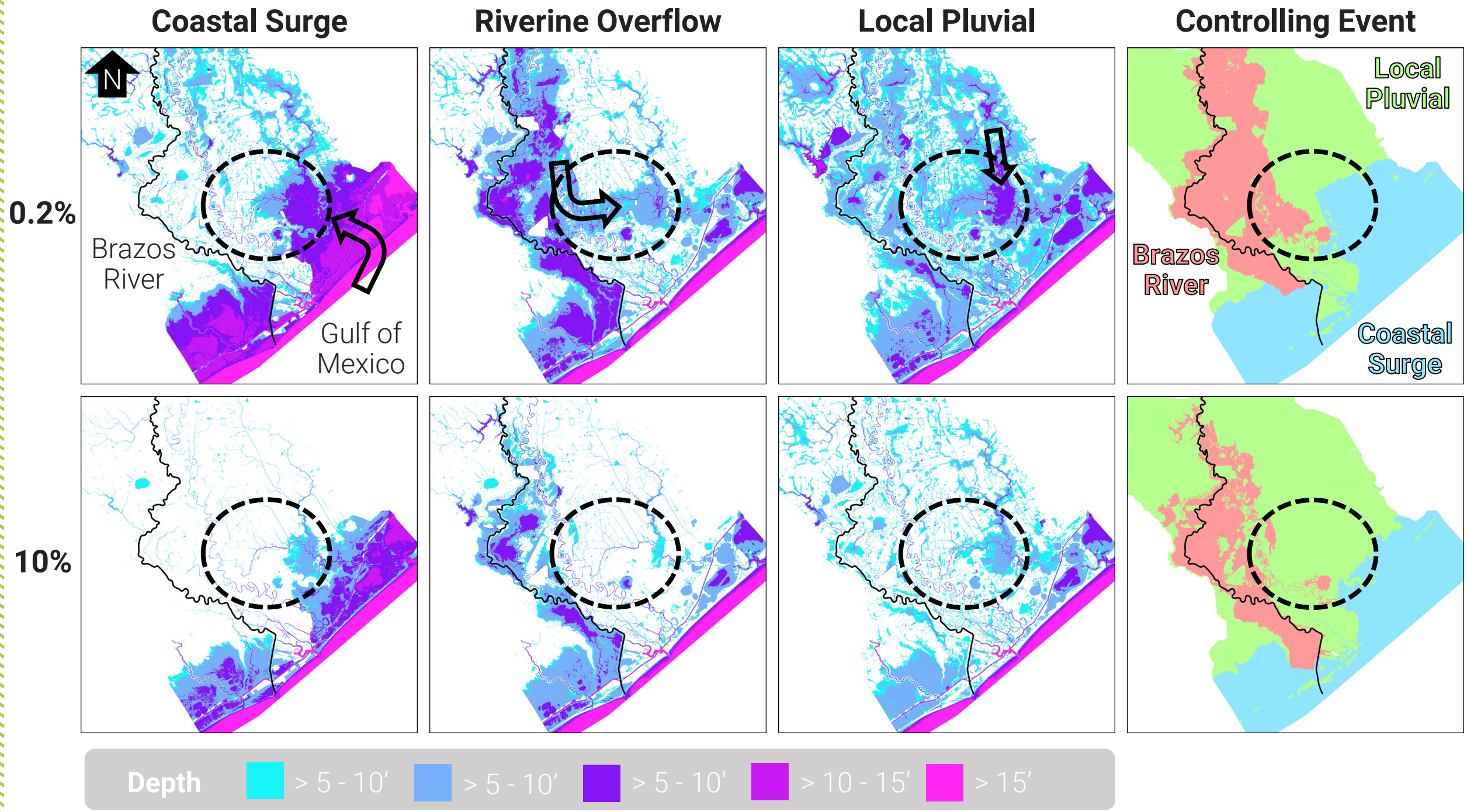
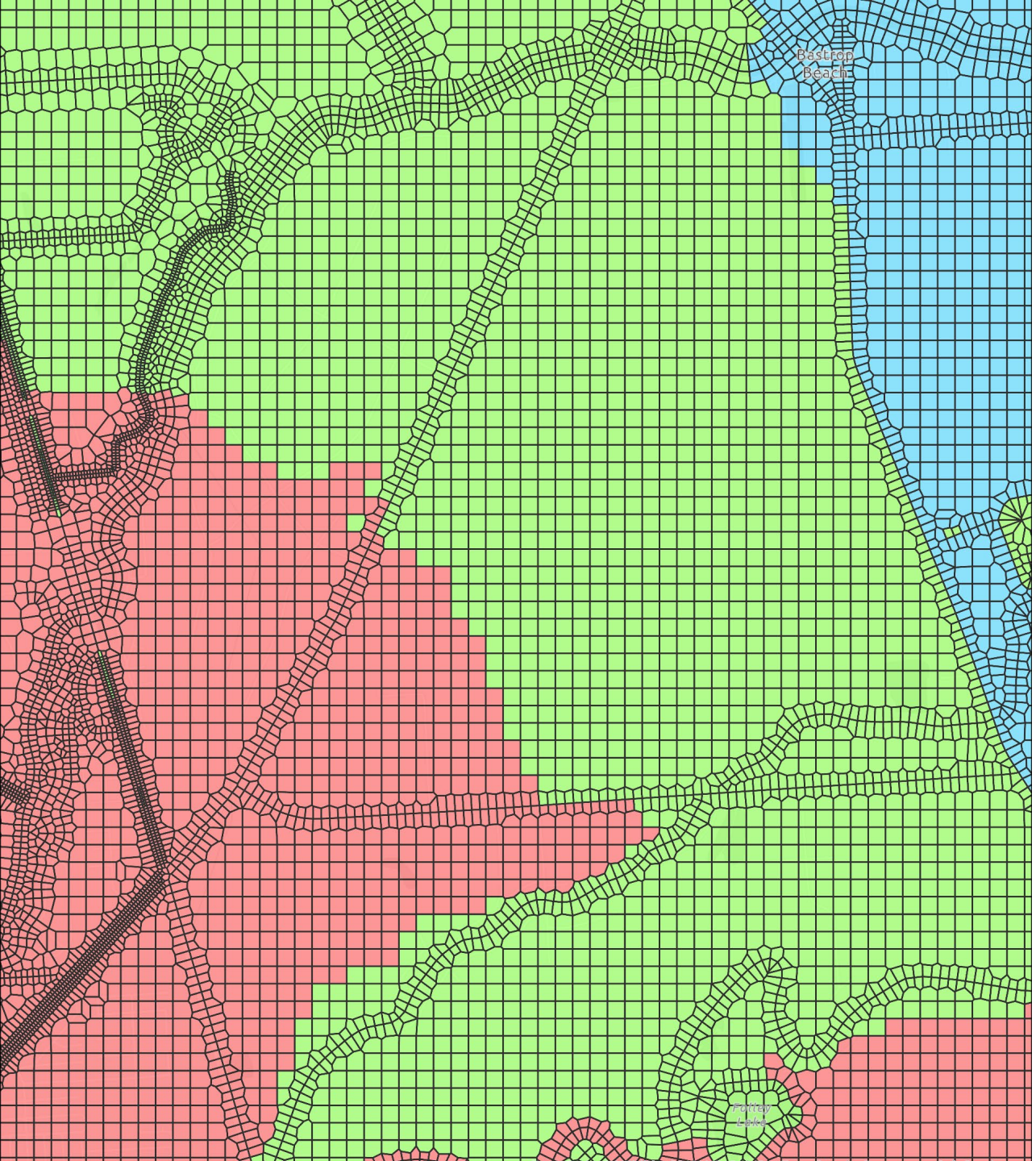


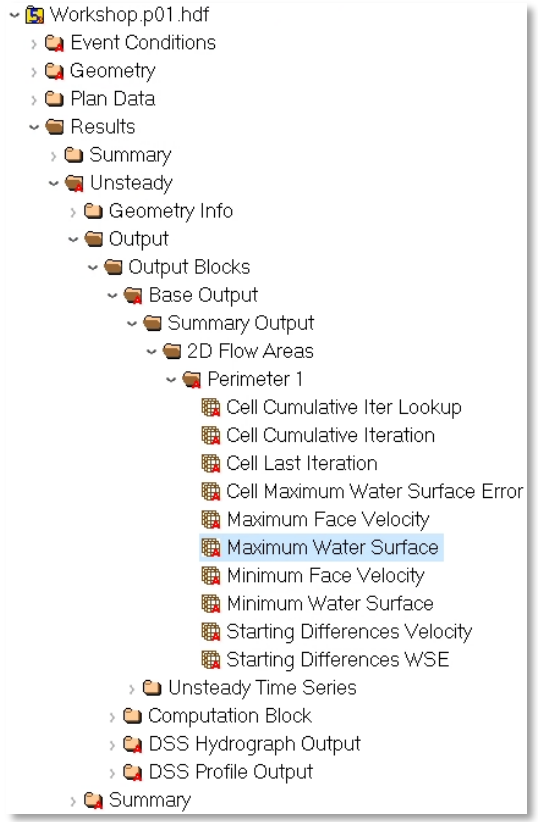
Coastal Complexities

- Ten miles from the coast with the potential for 5+ feet storm surge
- Lower Brazos River overflow per upstream drainage of 40,000 sqmi. (8,000 unregulated)
- Local pluvial risks with Atlas 14 500-yr, 24-hr total of 24 inches


Coastal Surge
Riverine Overflow
Local Pluvial
Controlling Event
0.2%
10%
N
Brazos River
Gulf of Mexico
Local Pluvial
Brazos River
Coastal Surge
Depth
> 5 - 10'
> 5 - 10'
> 5 - 10'
> 10 - 15'
> 15'



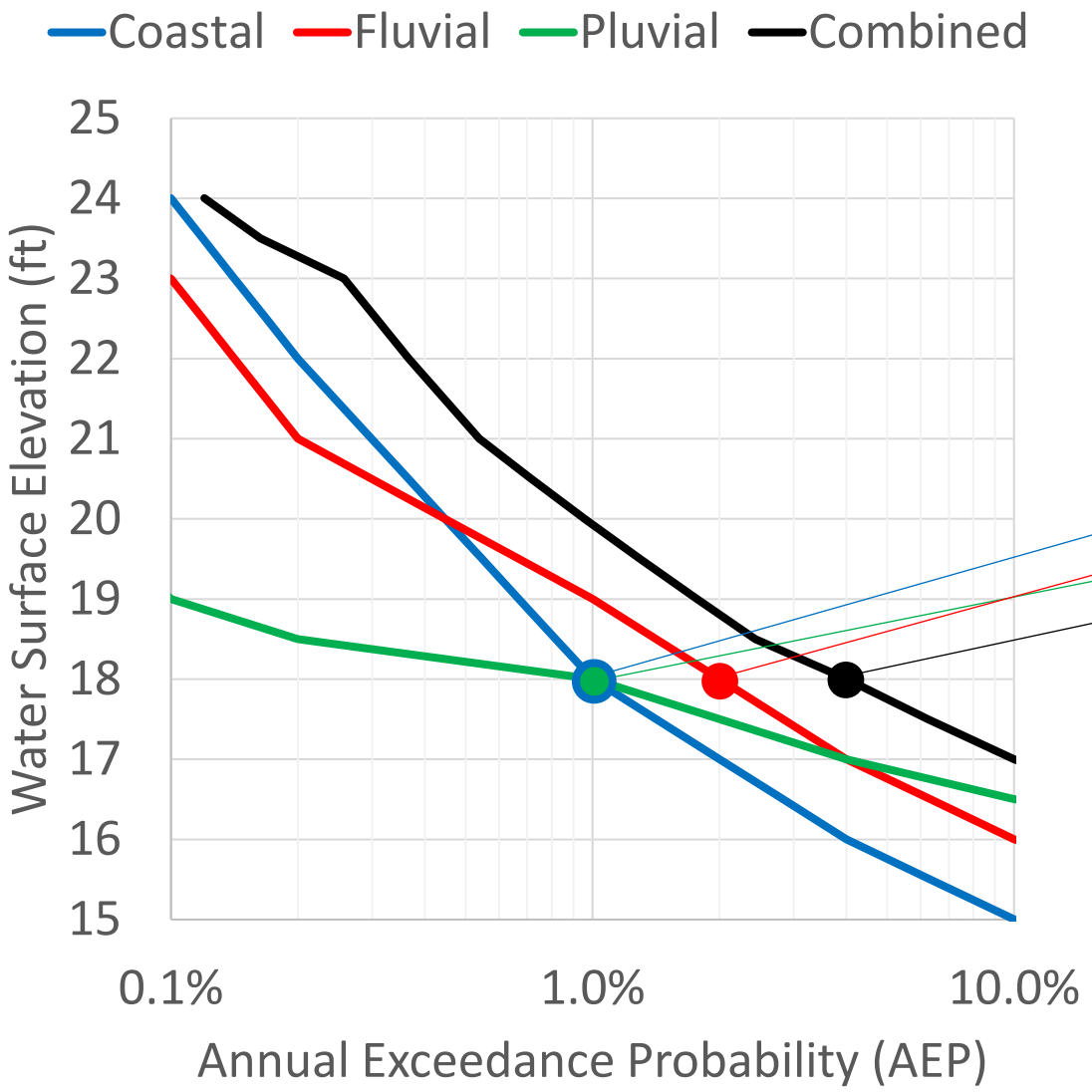
HDF Data Extraction



Combined Probability

Quantify component sources of risk in an urban setting

Combined Probability



Combined AEP for WSEL 18’

1% + 2% + 1% = 4%

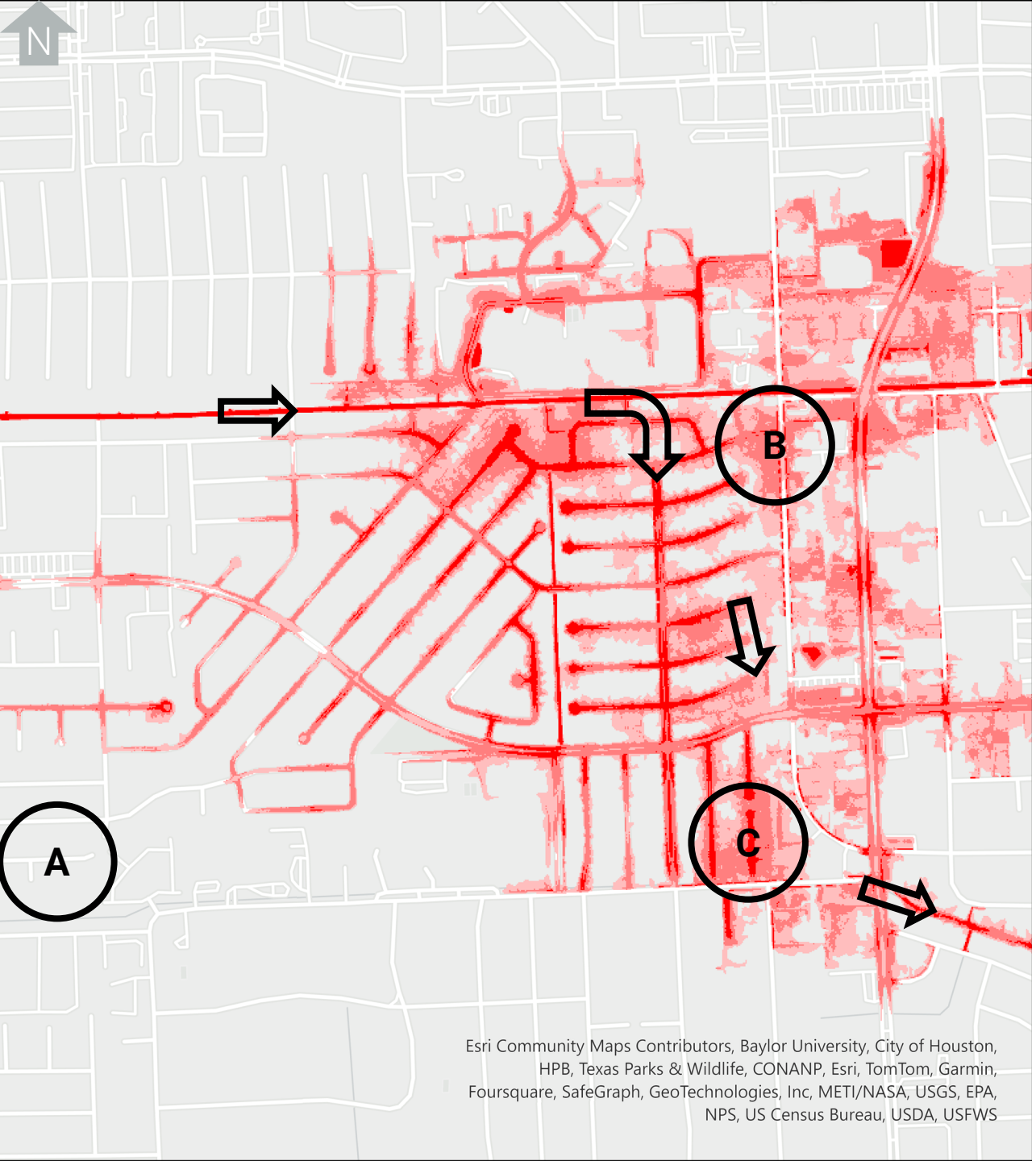
FEMA Coastal Flood Frequency and Extreme Value Analysis Guidance

4.6. Combined Effects: Surge Plus Riverine Runoff

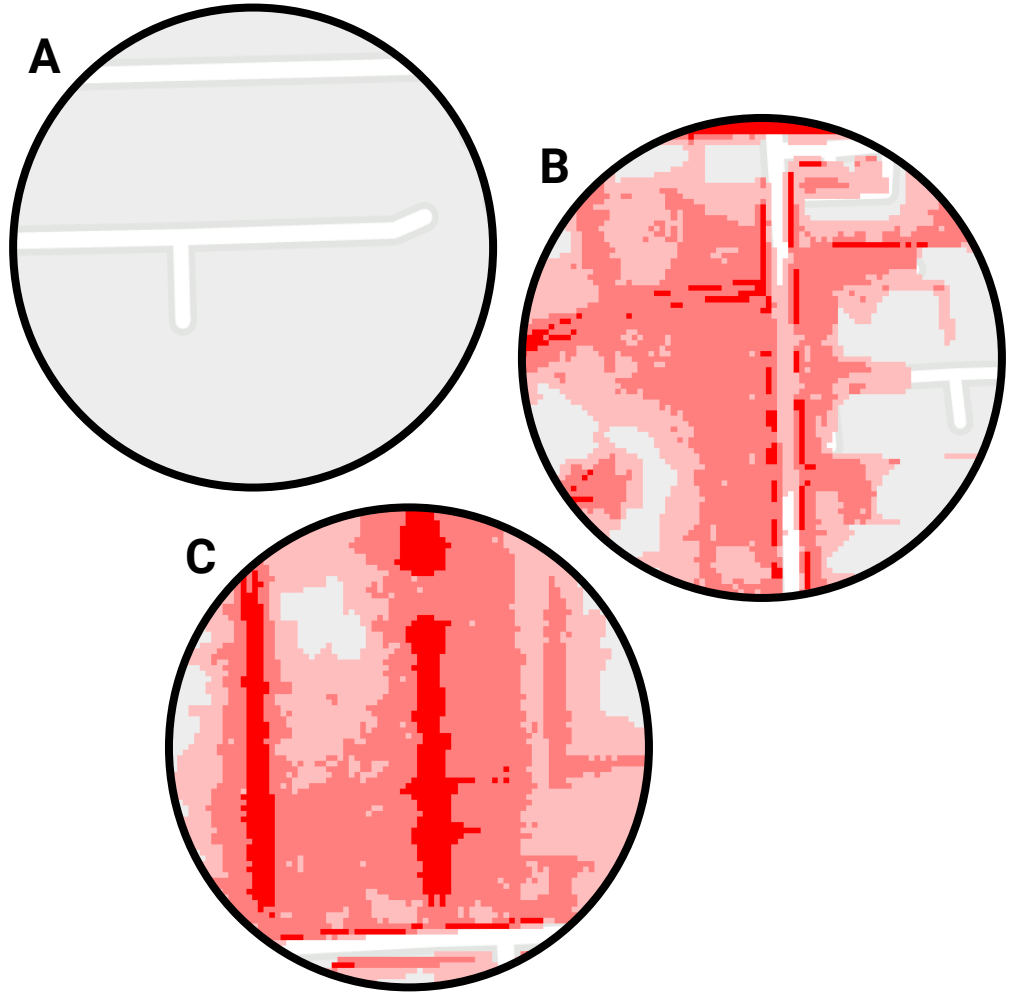
The simplest assumption is to assume that the extreme levels from coastal and riverine processes are physically independent and are not concurrent. This assumption is acceptable if storms that produce extreme rainfall and runoff are not the same as the storms that produce the greatest storm surge. Furthermore, if a single storm produces both large surge and large runoff, the runoff may be significantly delayed by the time required for overland flow, causing the runoff elevation to peak after the storm surge. When there are particular storms and locations for which these assumptions are not true, care should be taken to evaluate if they strongly influence the final statistics.

Flood Frequency and Extreme Value Analysis, Guidance Document 76 18

https://www.fema.gov/sites/default/files/documents/Coastal_Flood_Frequency_and_Extreme_Value_Analysis_Guidance_Nov_2023.pdf

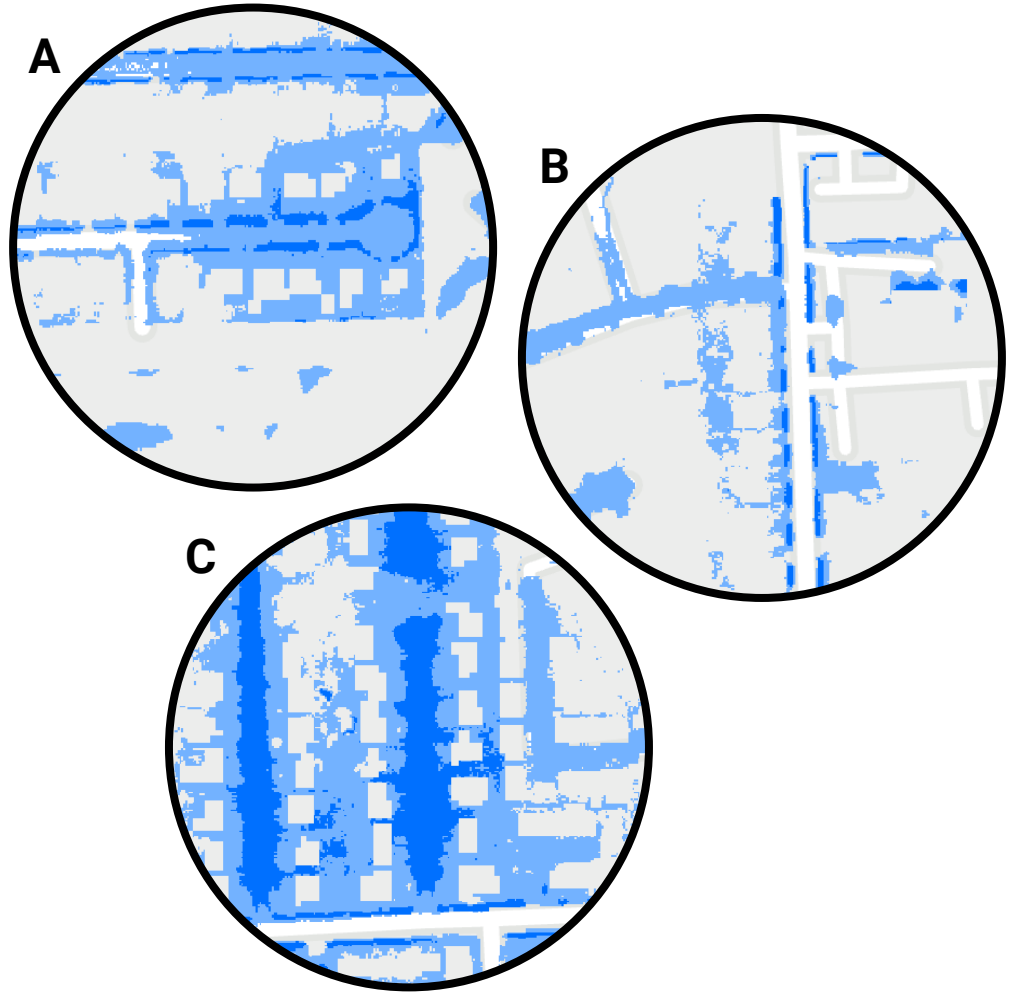


Fluvial Risk

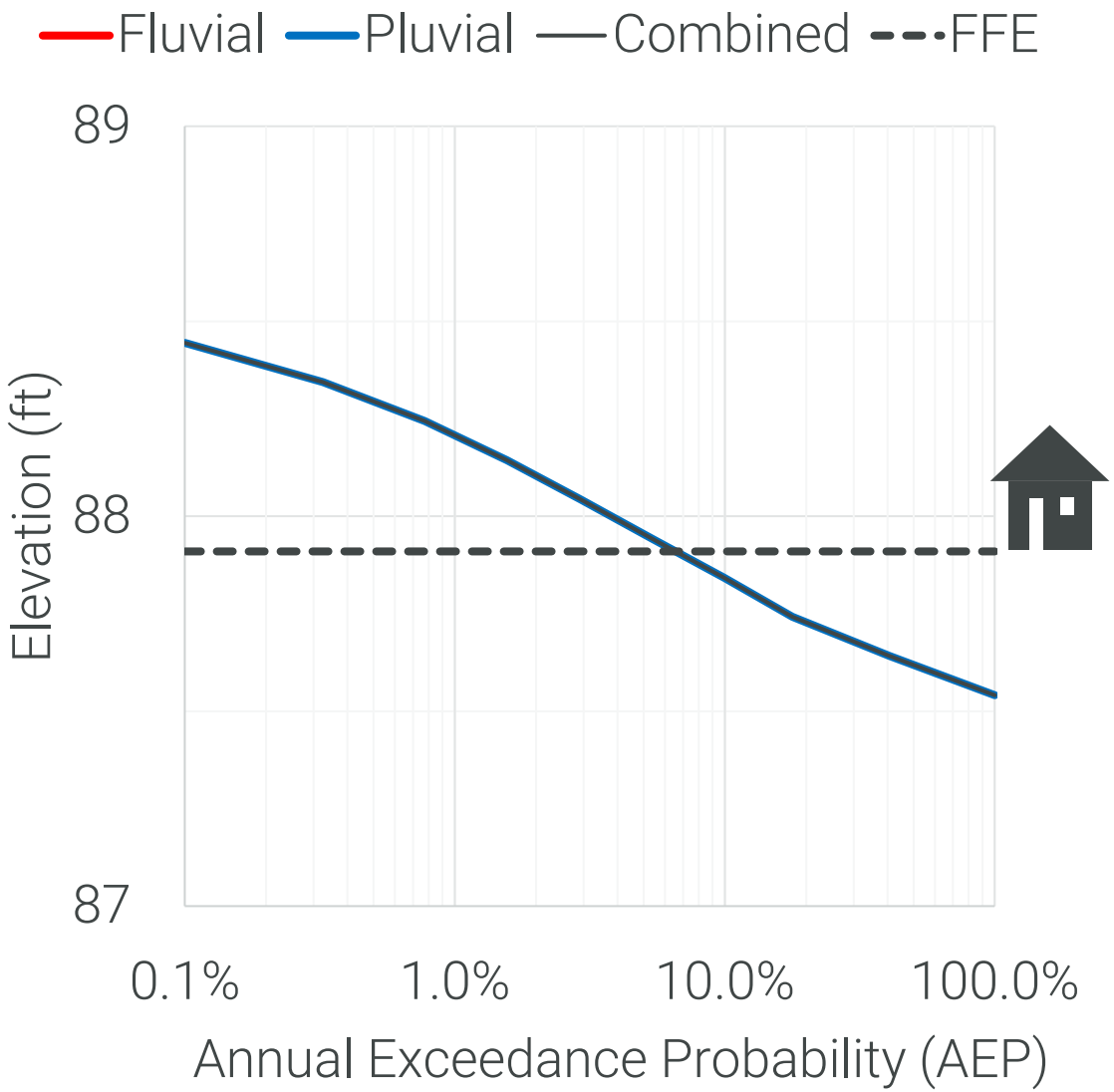


Depth < 6” 6” – 18” > 18”

Pluvial Risk



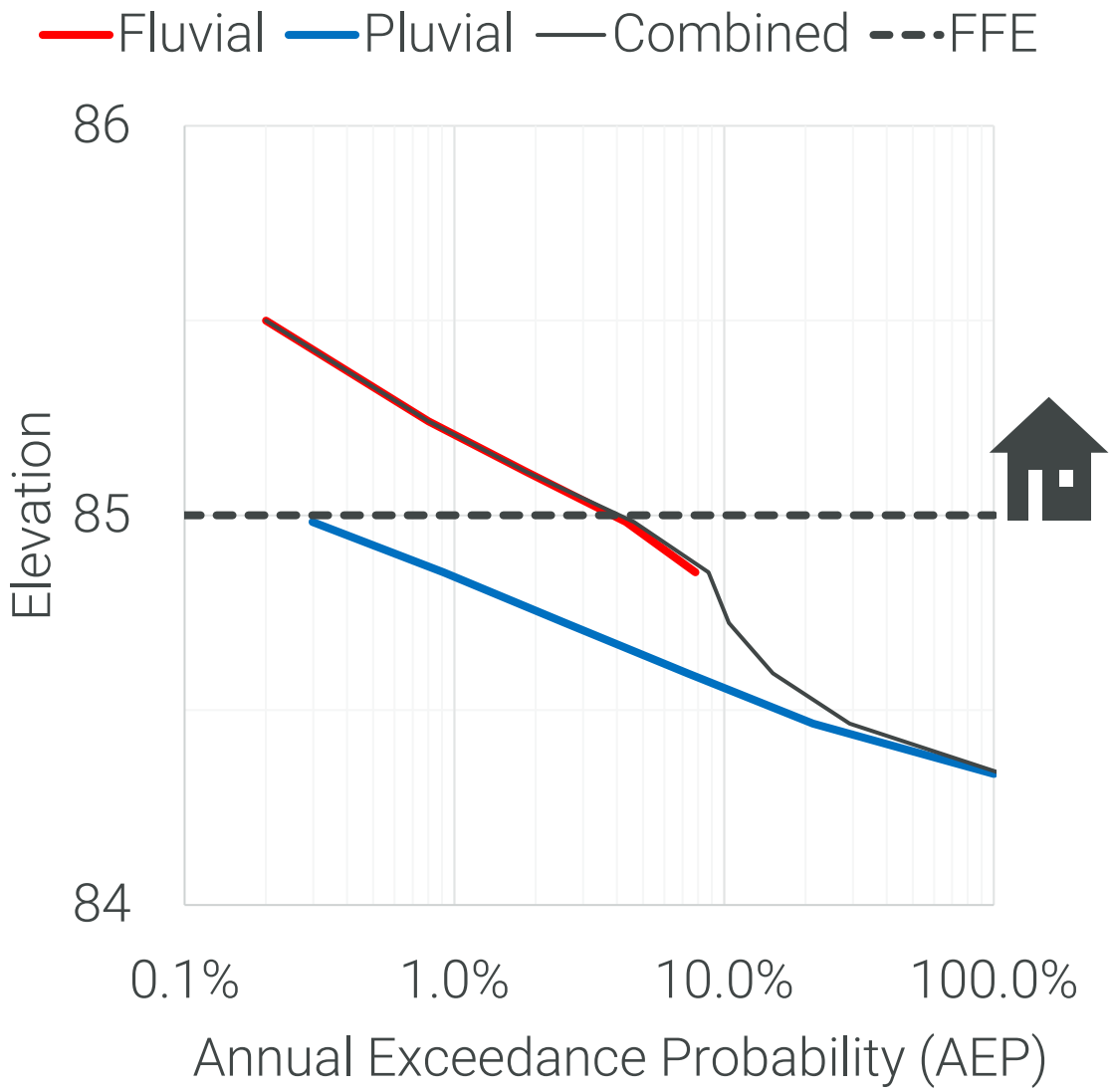
Depth < 6” 6” – 18” > 18”



Combined Risk Location A

Combined AEP for Elev. 87.9’

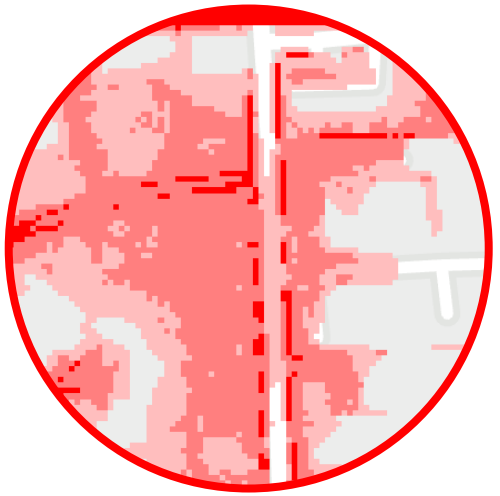
0% + **6%** = **6%**



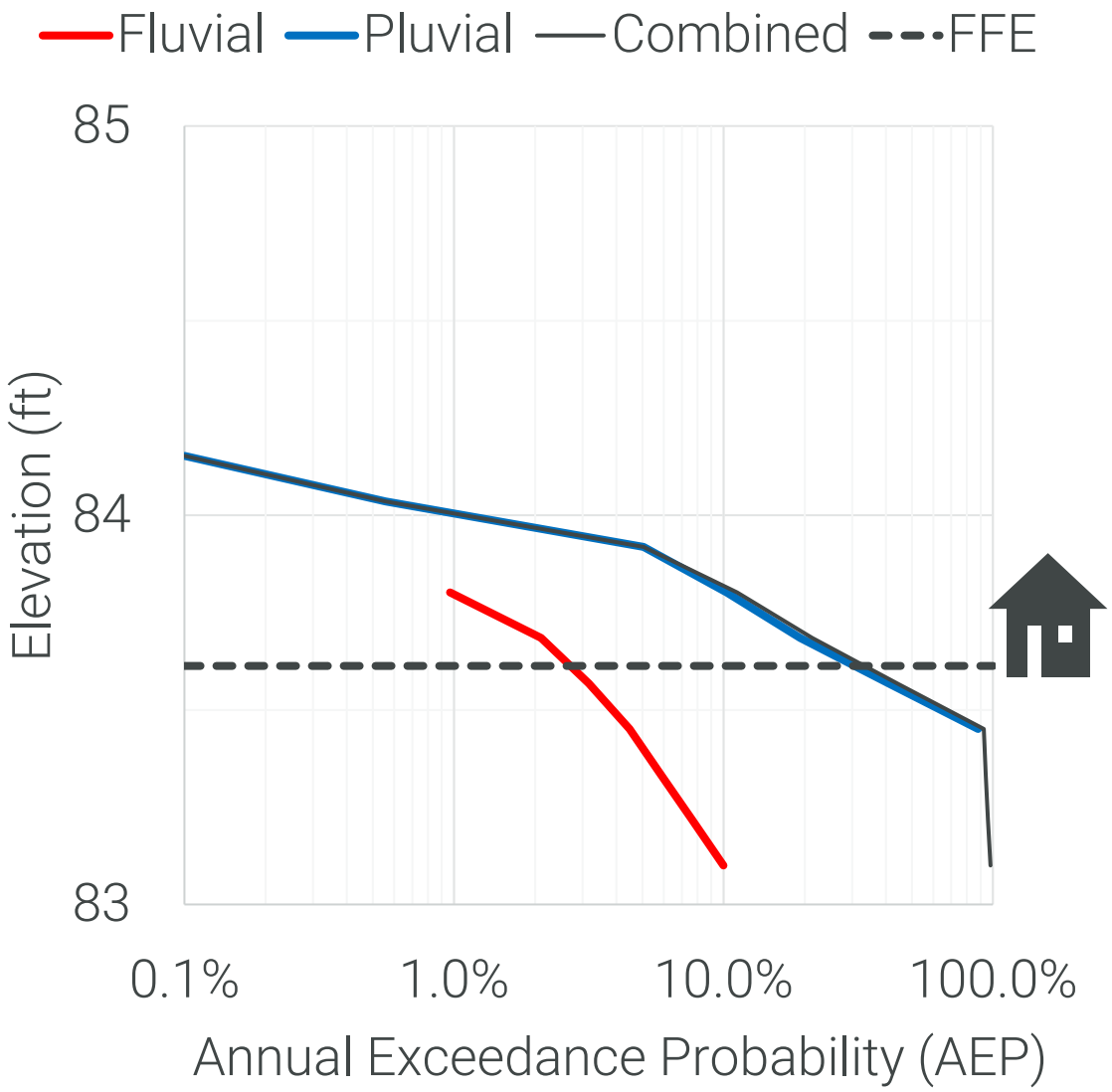
Combined Risk Location B

Combined AEP for Elev. 85’

4% + **0.3%** = **4.3%**

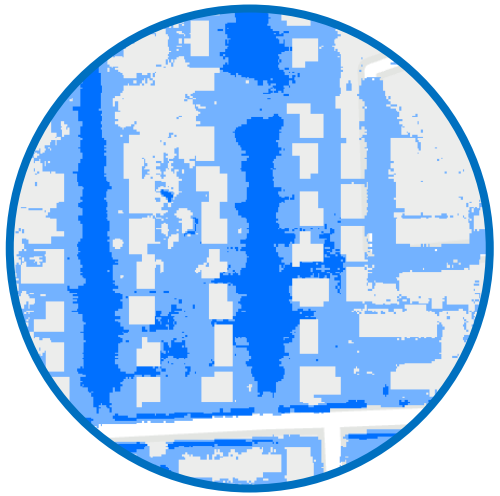


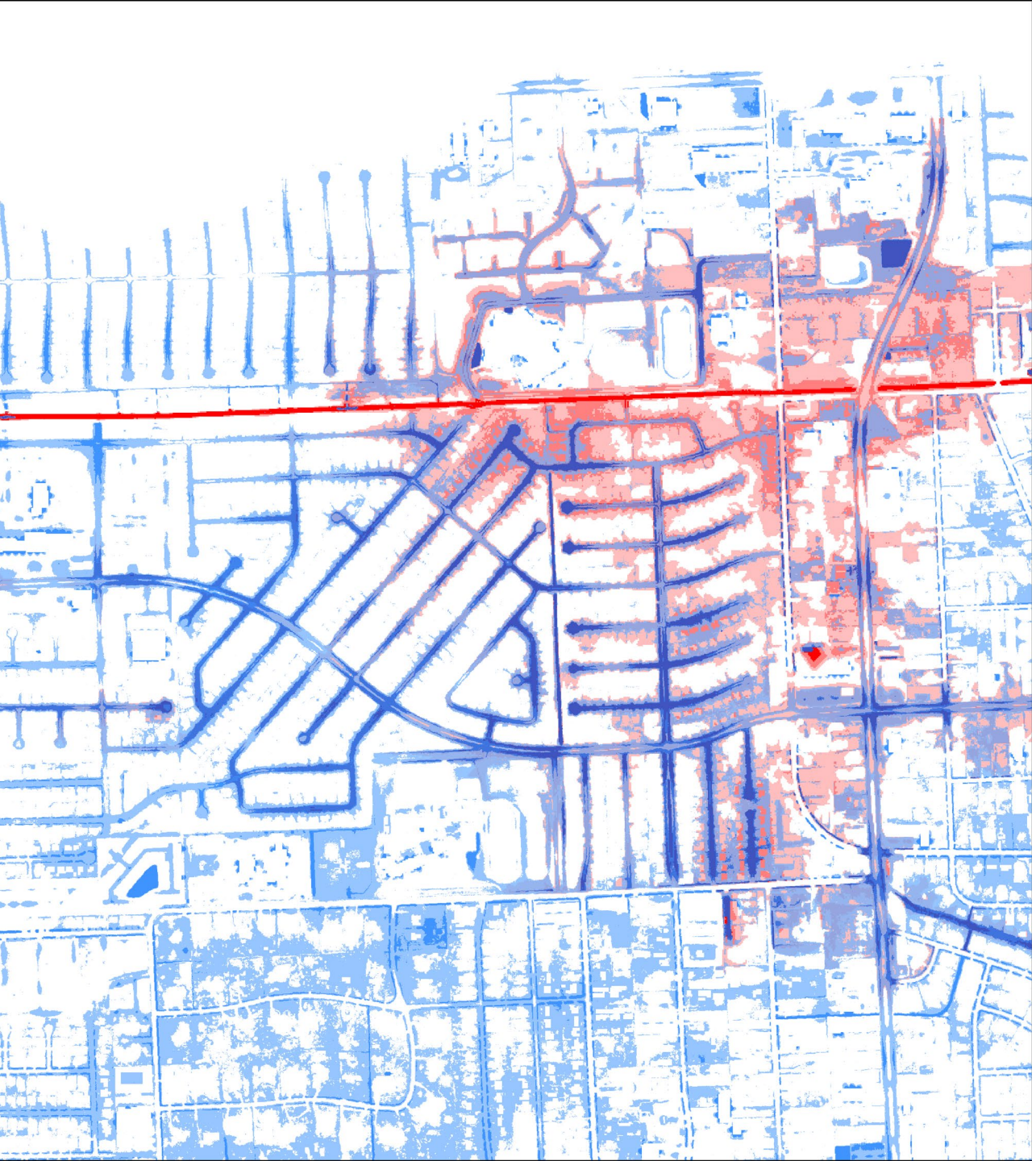
Combined Risk Location C



Combined AEP for Elev. 83.6’

3% + **30%** = **33%**



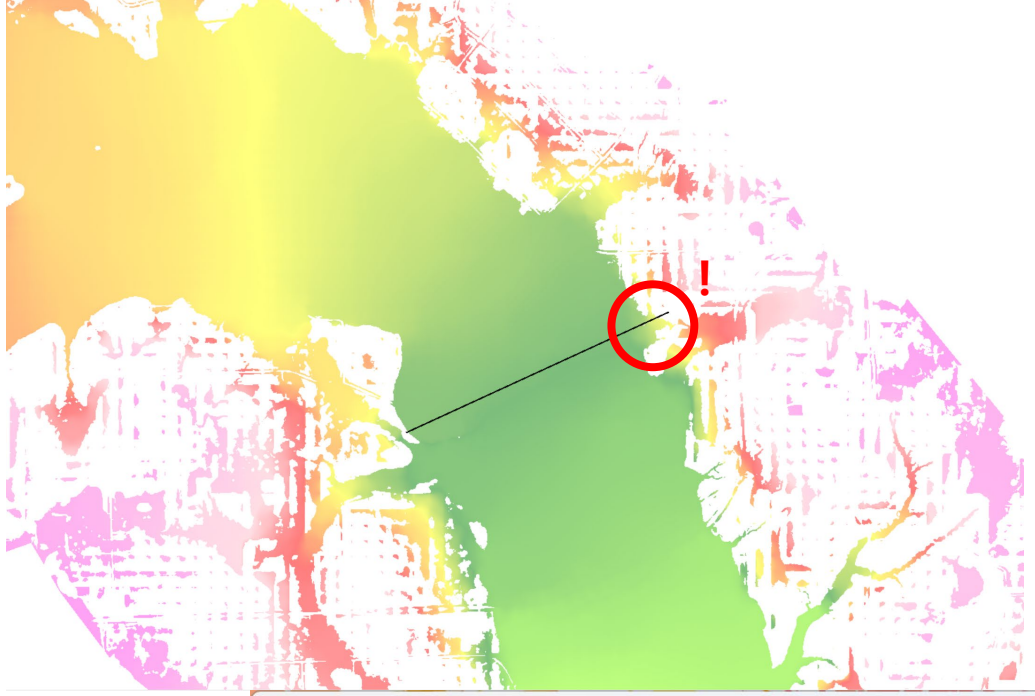


Risk Communication

- Distinguish between each source to frame expectations for project benefits
- Emphasize residual risk; one project (usually) does not fix it all

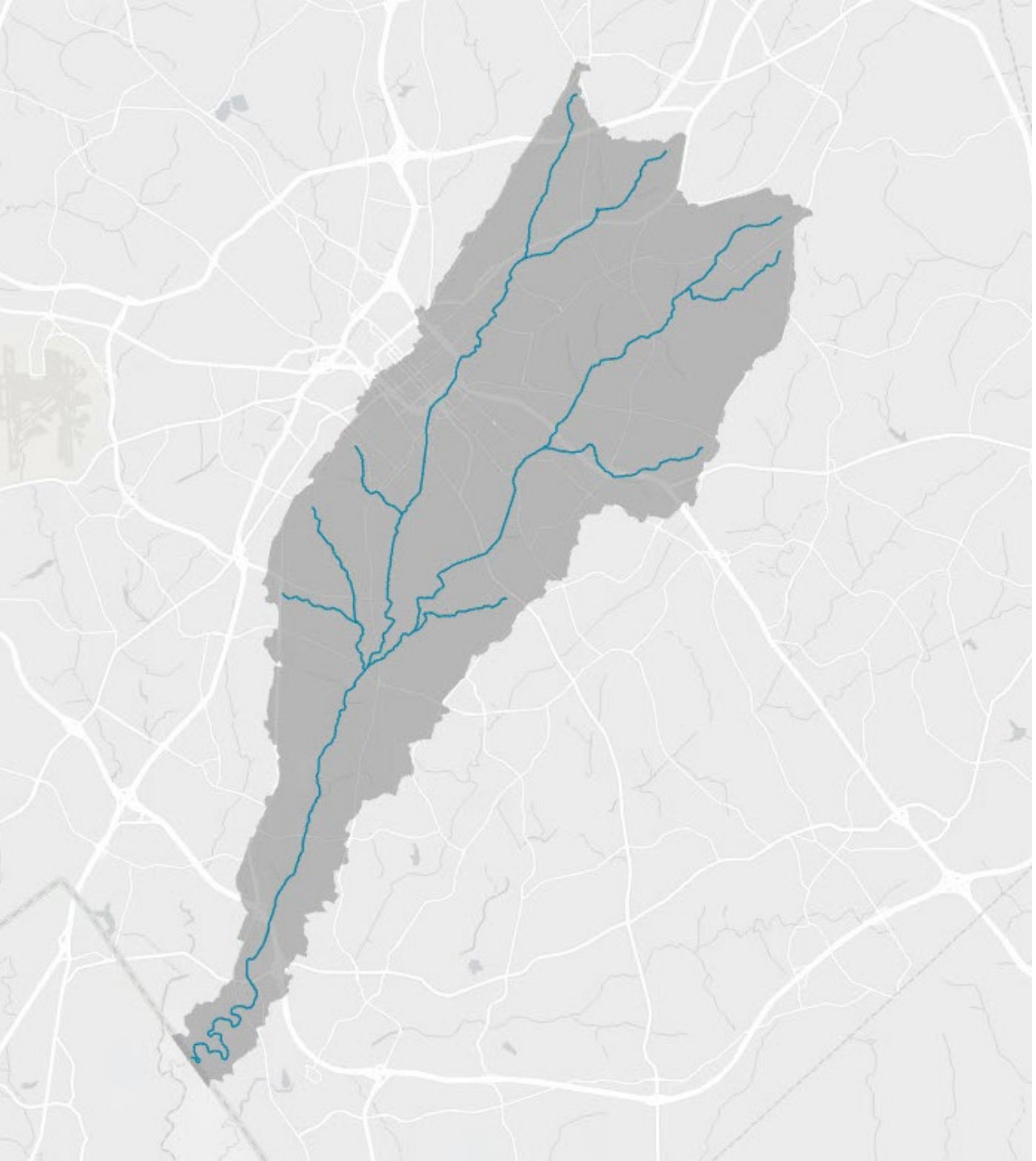
Regulatory Mapping

Process “messy” 2D rain-on-mesh results for FEMA regulatory mapping



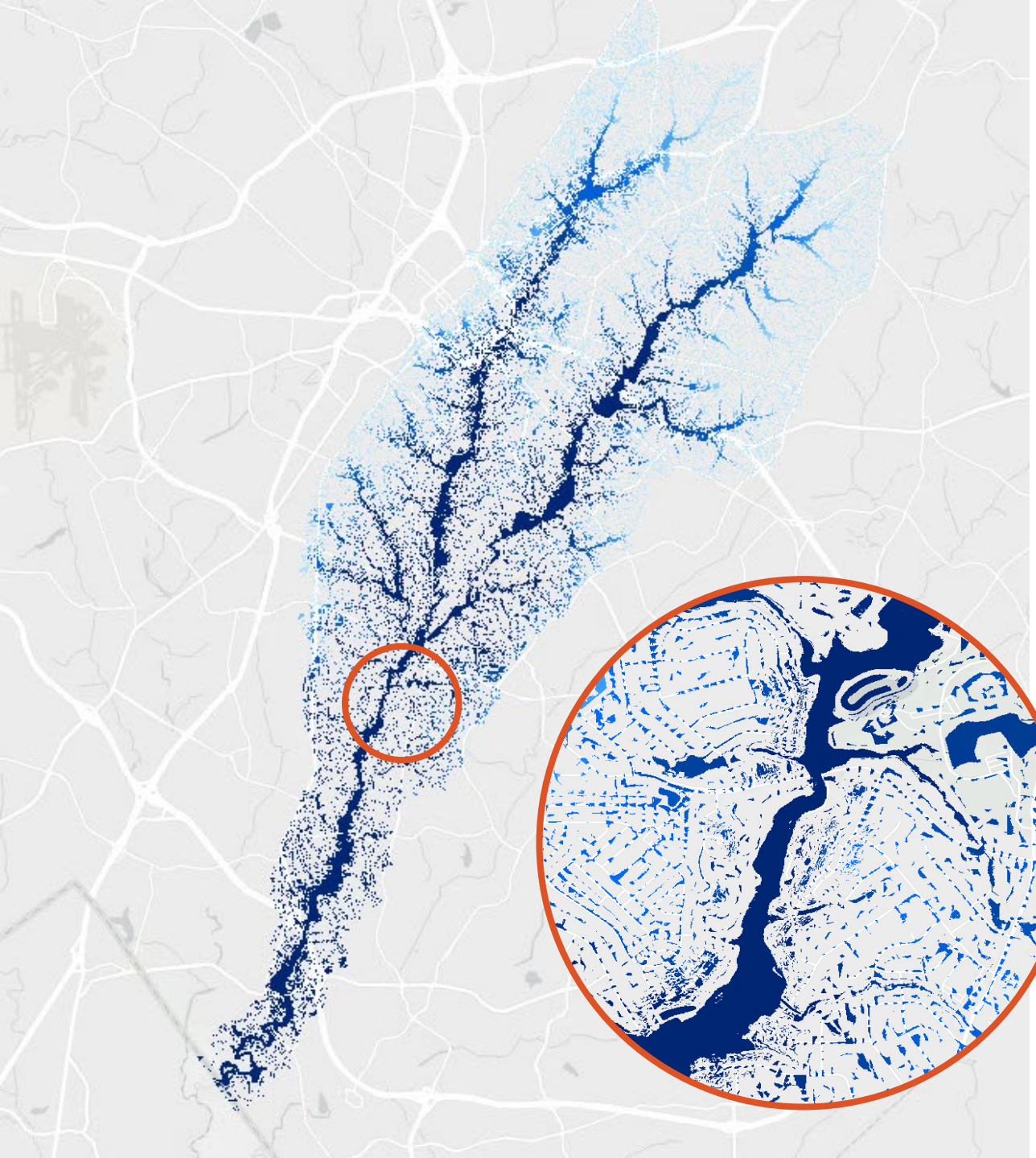
FEMA Guidelines and Standards

- SID 112 "… all floodplain boundaries … shall pass the Floodplain Boundary Standard."
- SID 628 "… all raster datasets align with the underlying model information used to develop the associated regulatory products …"



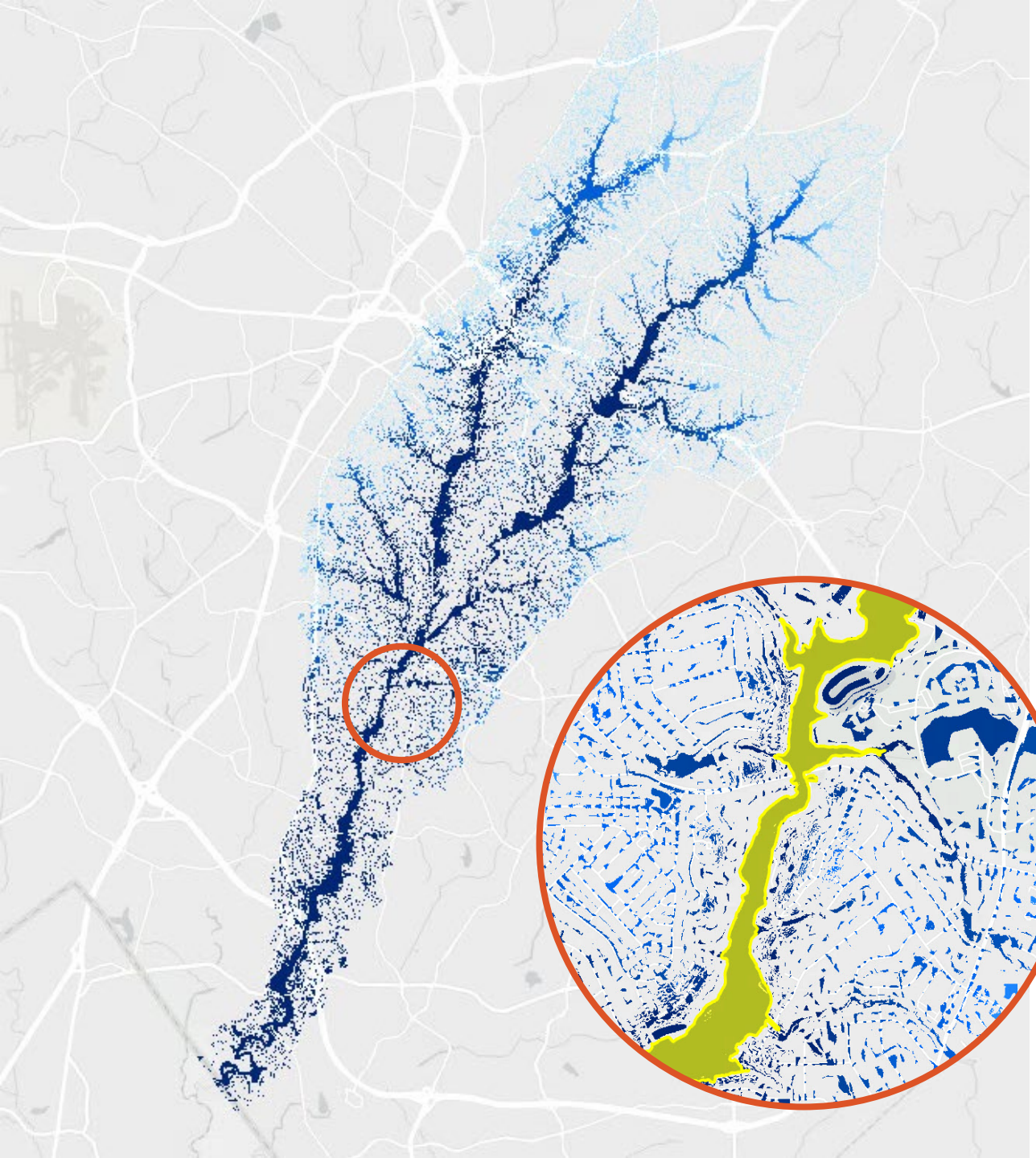
Background

- Pilot study of 3 basins
- Once methodologies are determined they will be applied to a larger area
- Results need to be easily re-produced
- Minimize manual effort to maximize budget



Raw Results

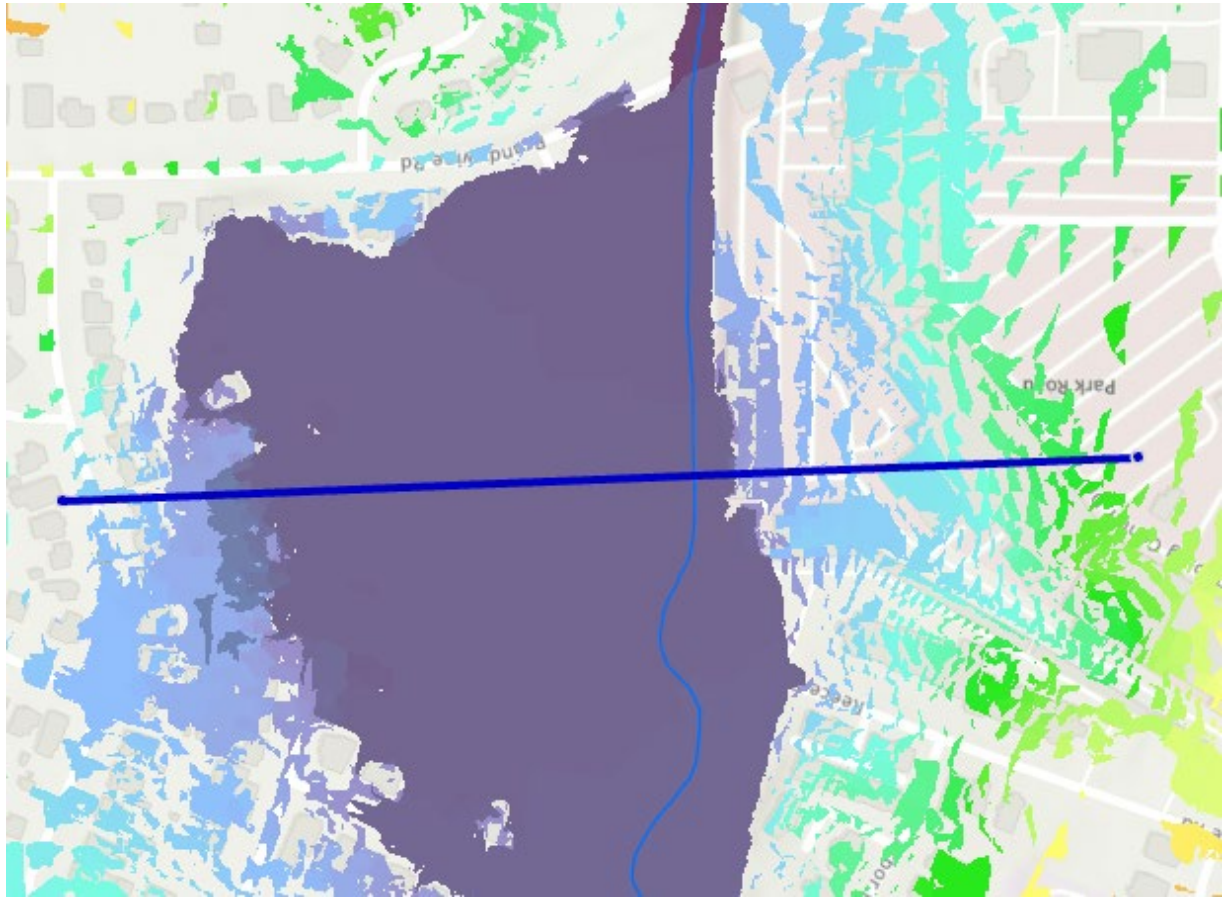
- 2D ROM results produce lots of detail
- Detail is valuable, but not always useful

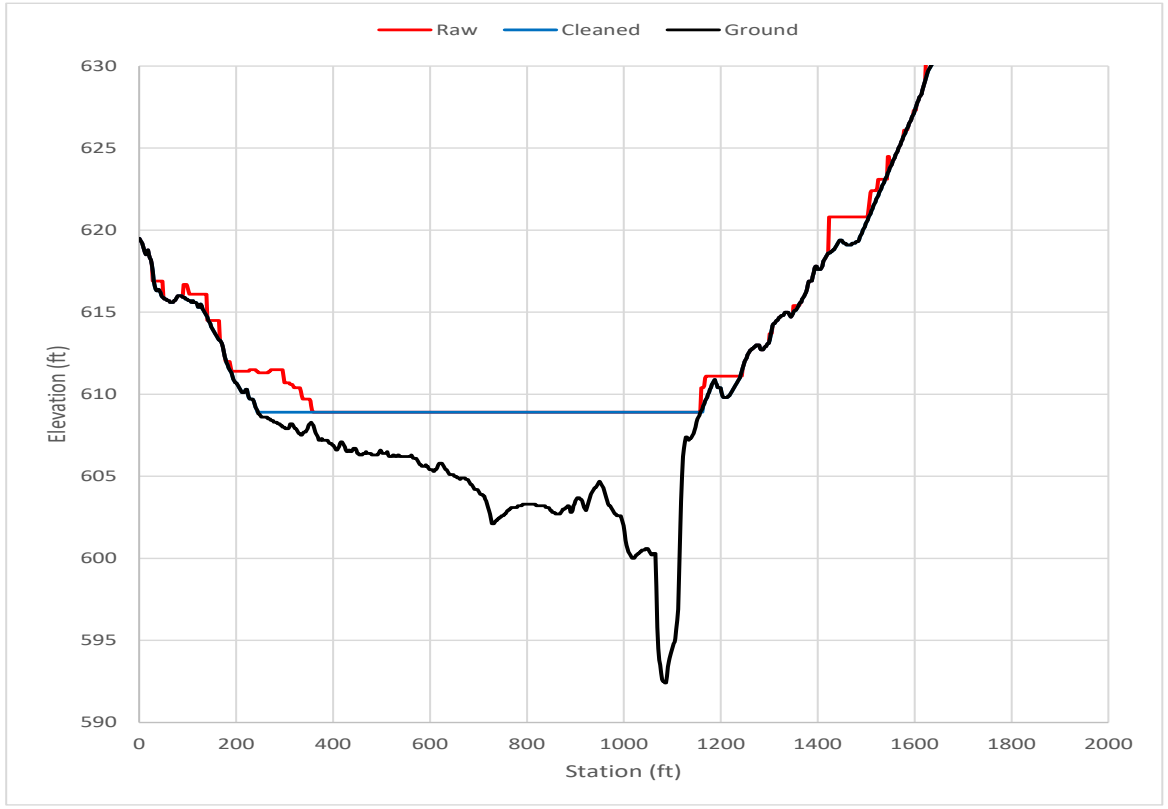


Raw Results

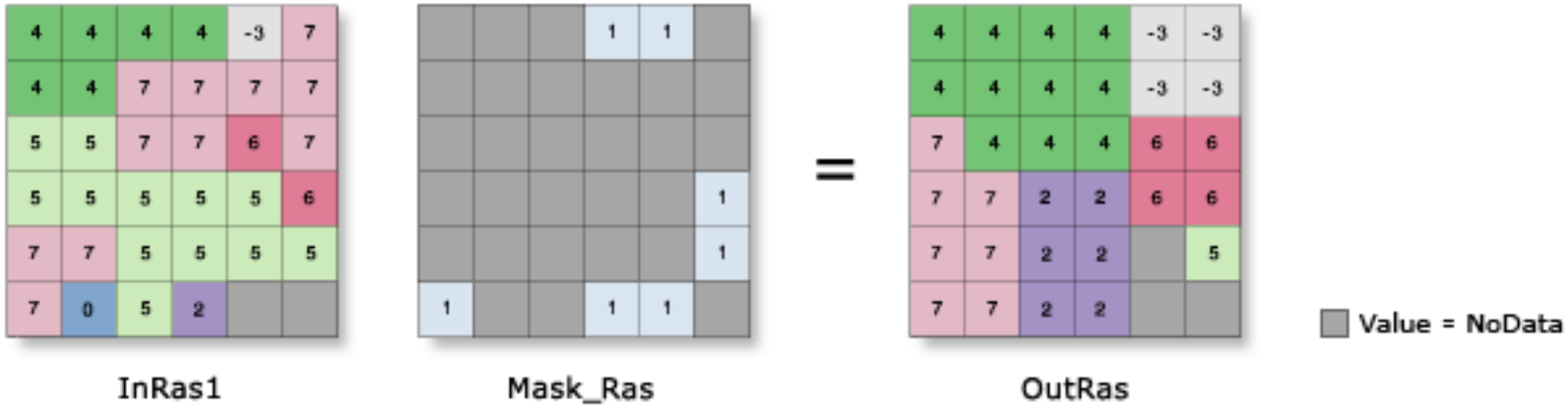
- 2D ROM results produce lots of detail
- Detail is valuable, but not always useful
- How do we parse out rasters by their flooding source?

Raw Results

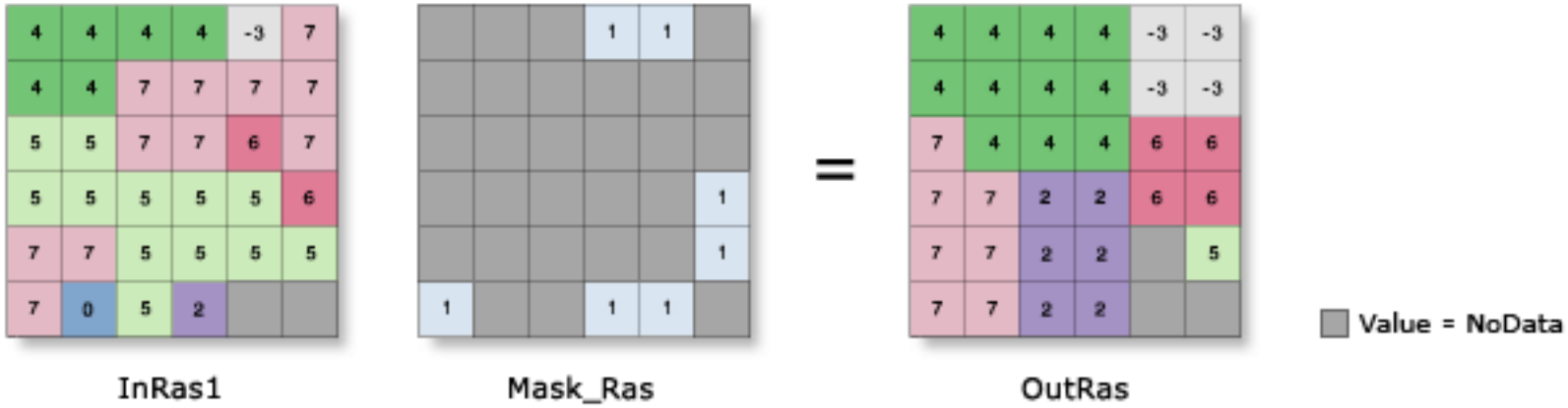


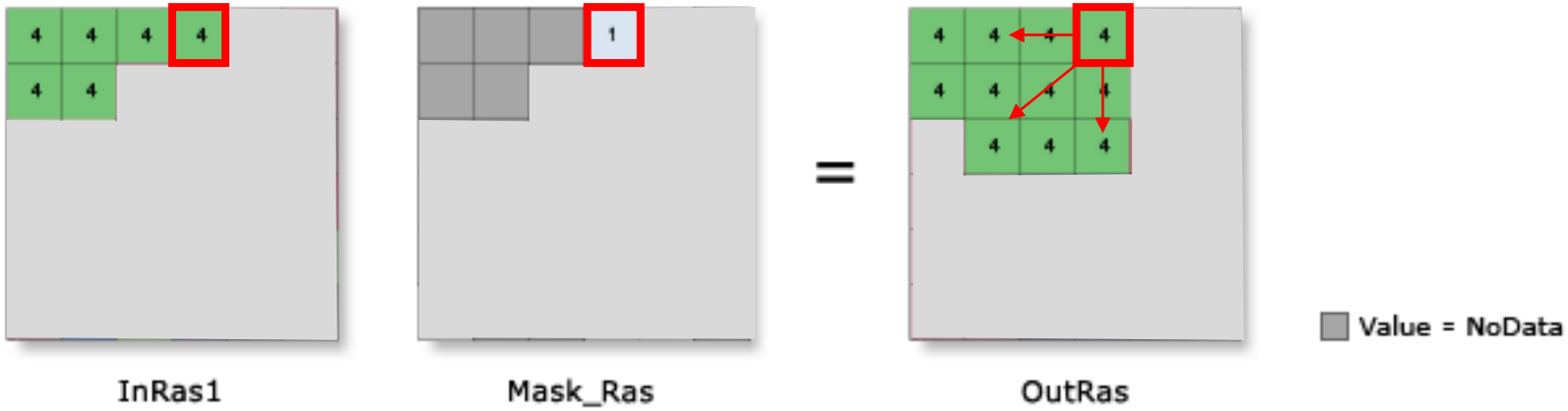

Raw
Cleaned
Ground
630
625
620
615
610
605
600
595
590
Elevation (ft)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Station (ft)

Nibble Background



Nibble Background





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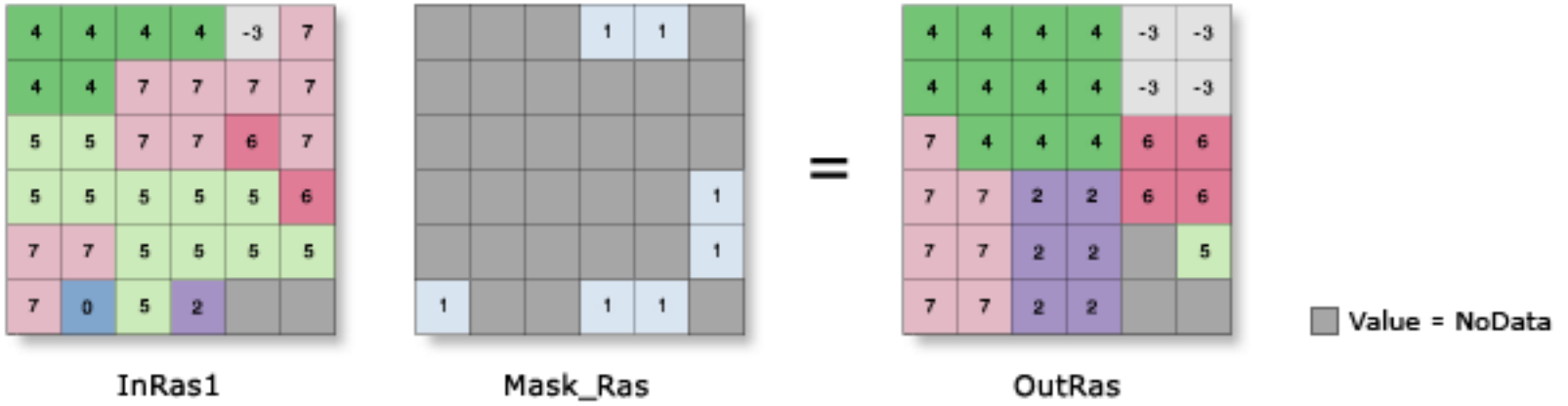
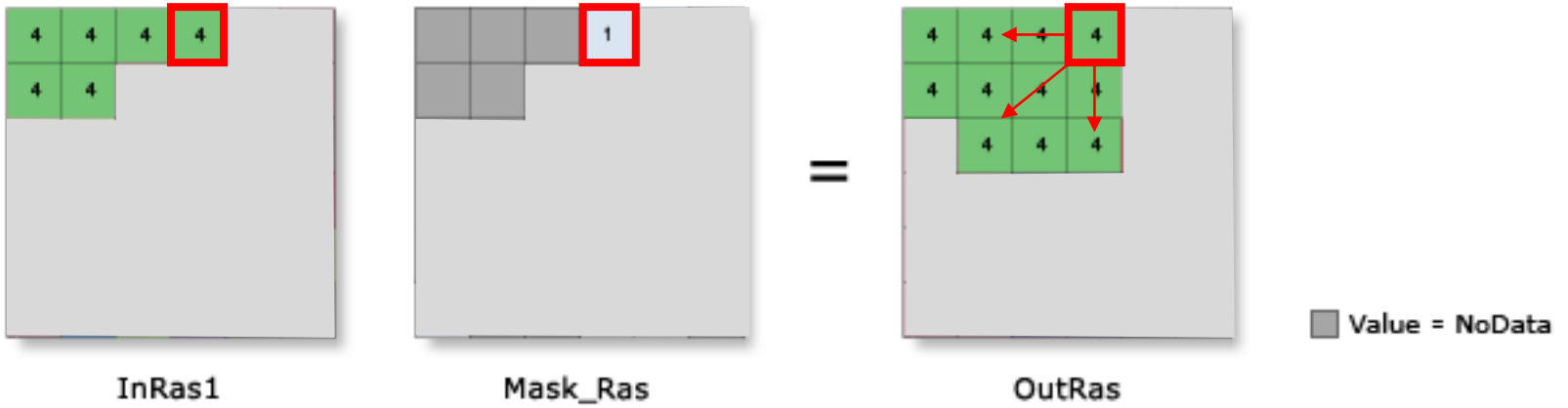
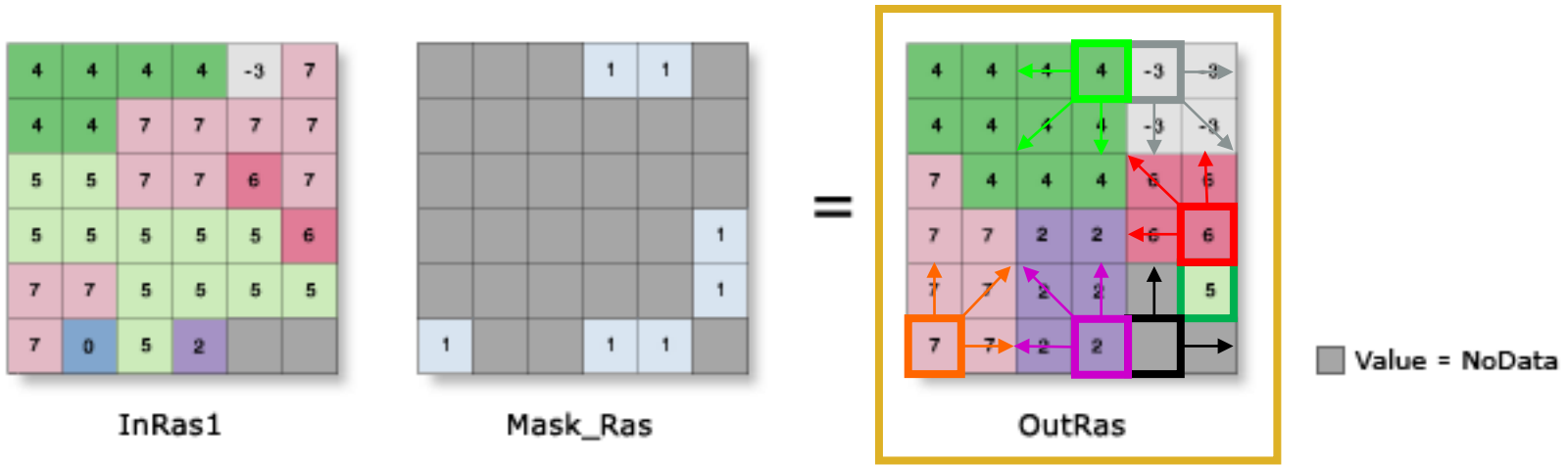
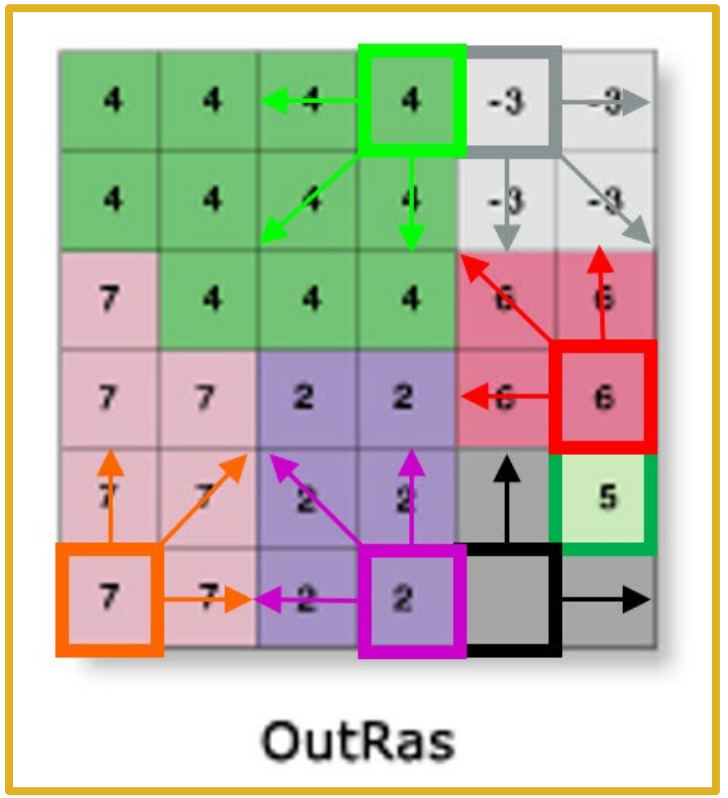






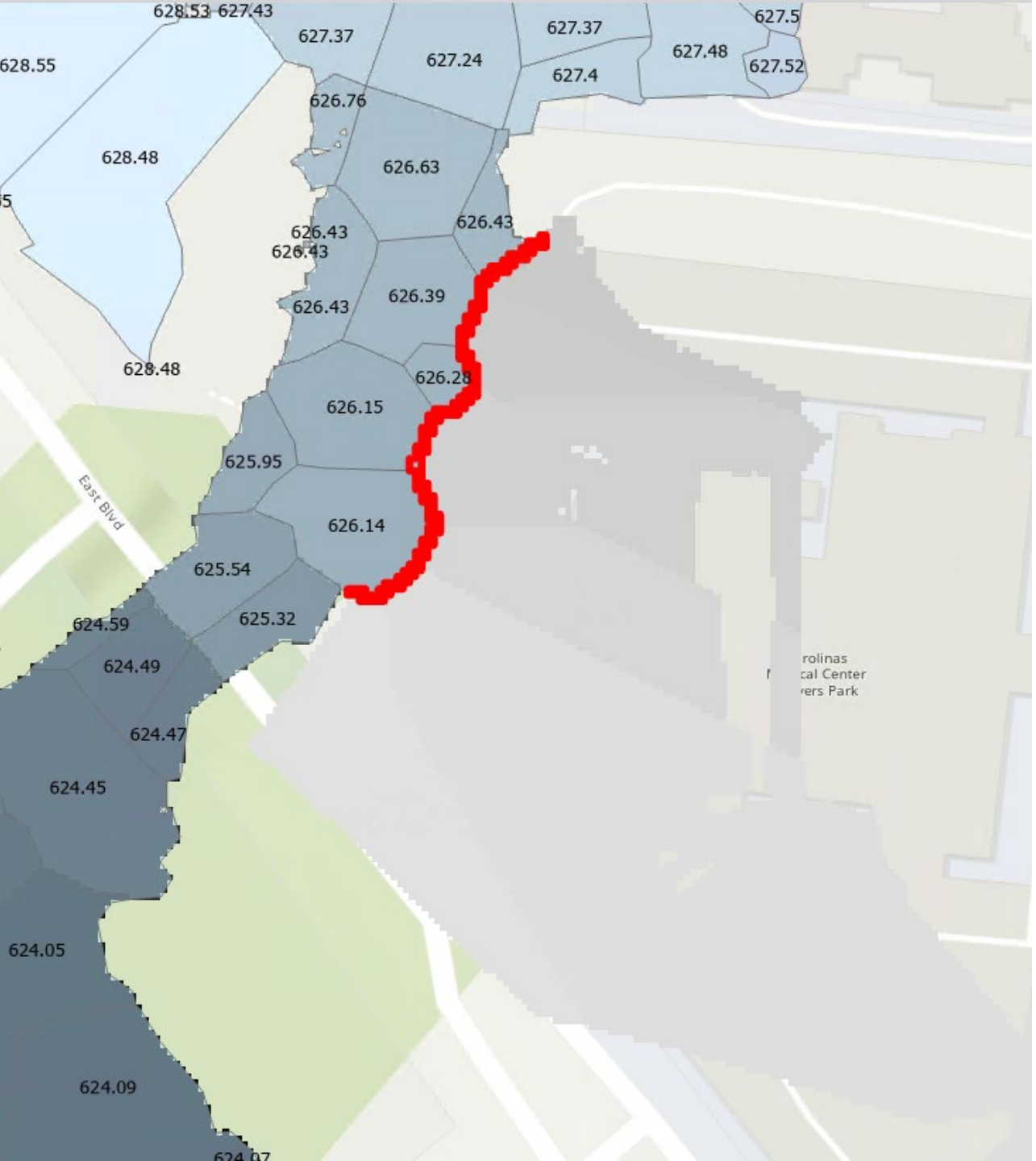


Nibble Challenges

- Need a mask that does not include pluvial flooding
- Final rasters still need to align with the underlying model
- Minimize manual clean-up

Nibble Challenges

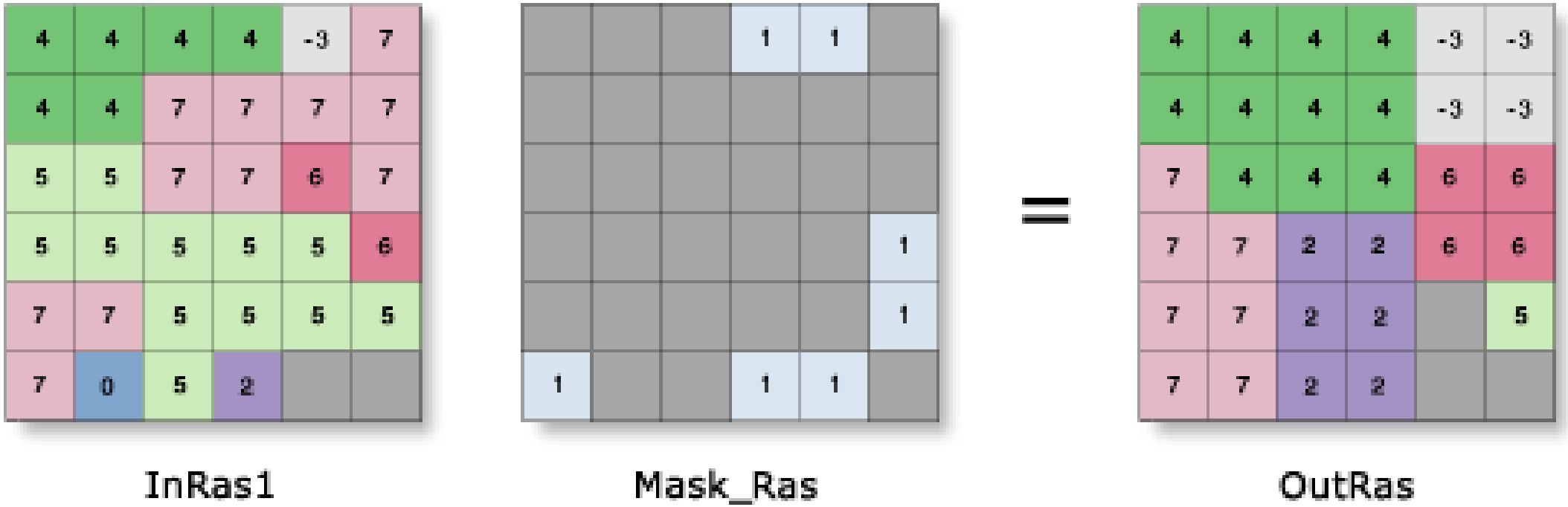
- Difficult to identify mask areas to filter out
- Searched for areas where there was >1’ elevation change



Nibble Challenges

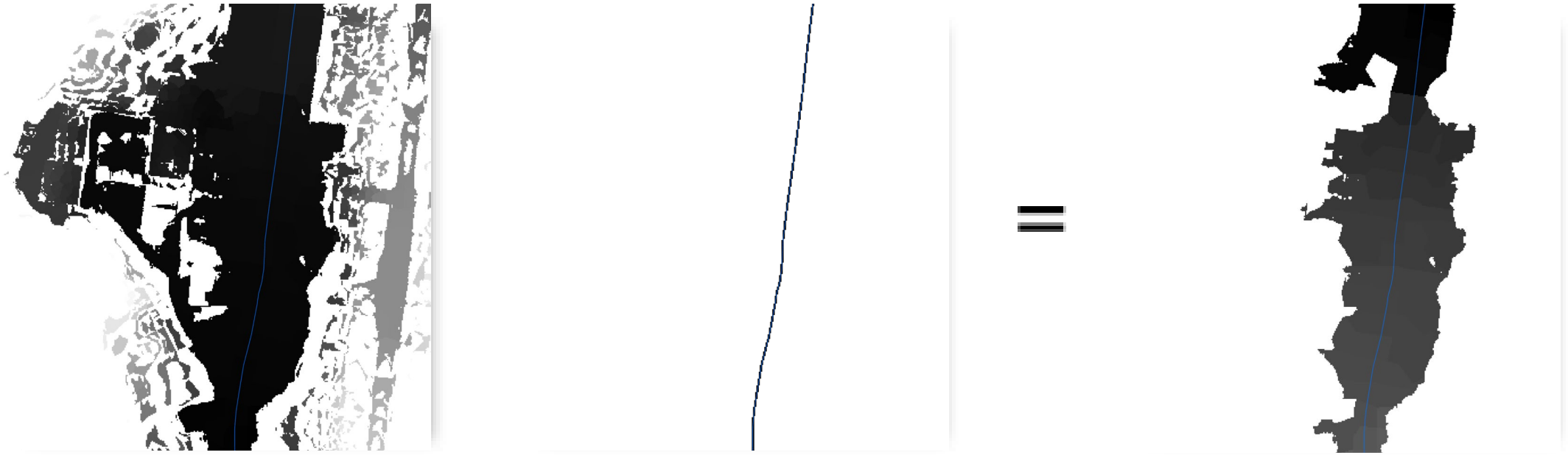
- Difficult to identify mask areas to filter out
- Searched for areas where there was >1’ elevation change
- Lots of effort
- Not consistent

Approach Overview



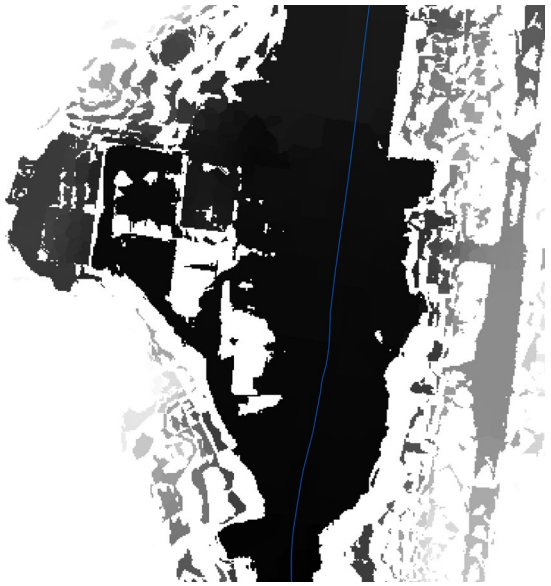
Approach Overview

- Use the centerline to pull elevation values from the WSEL
- Nibble outwards in series using the extent of the previous results



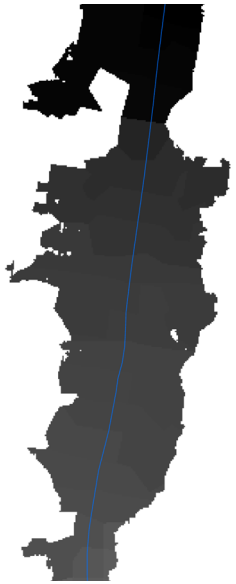
Steps

0. Inputs



1. Centerline WSELs

2. Nibble 1/10’

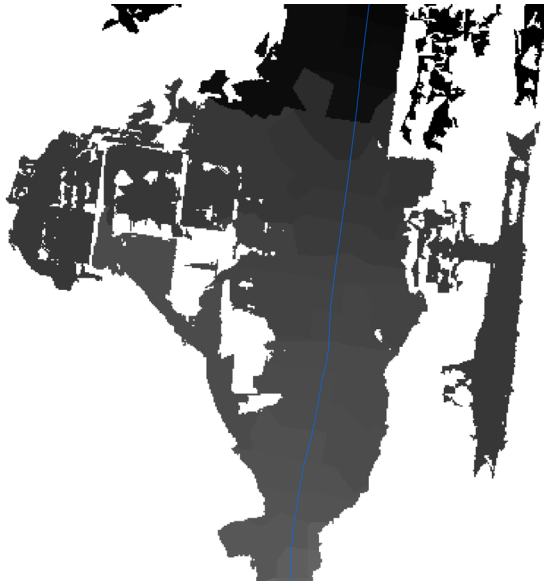


3. Nibble 2/10’

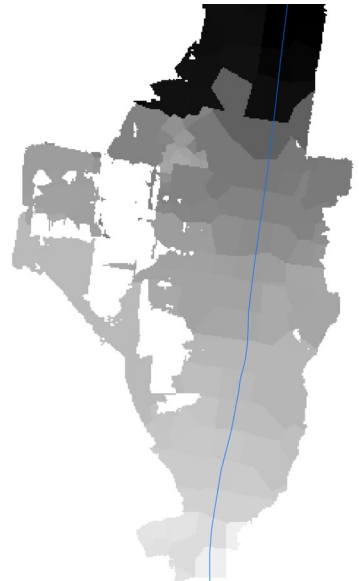
4. Nibble 1/2'

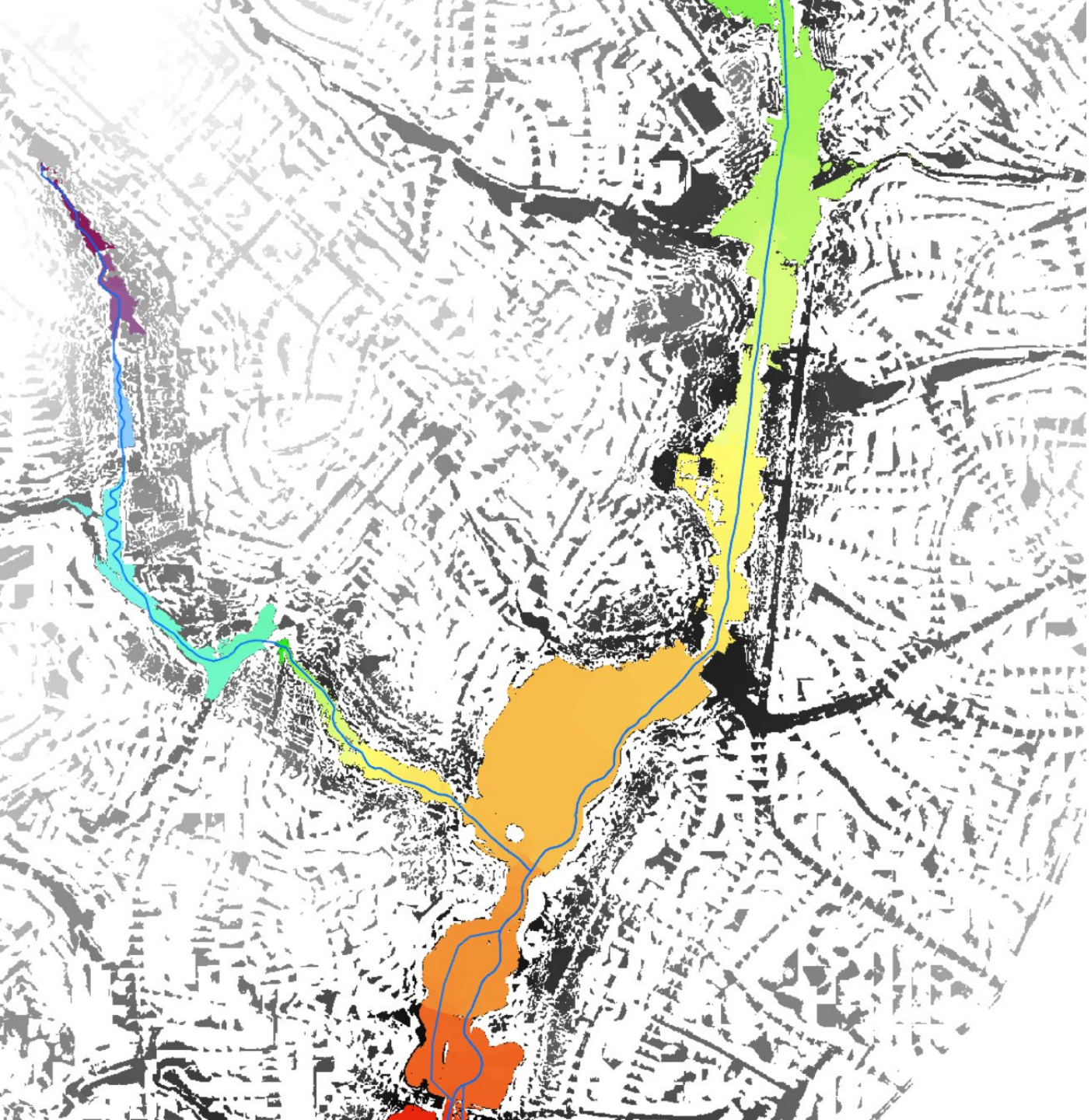
5. Nibble 1’

6. Nibble Underground



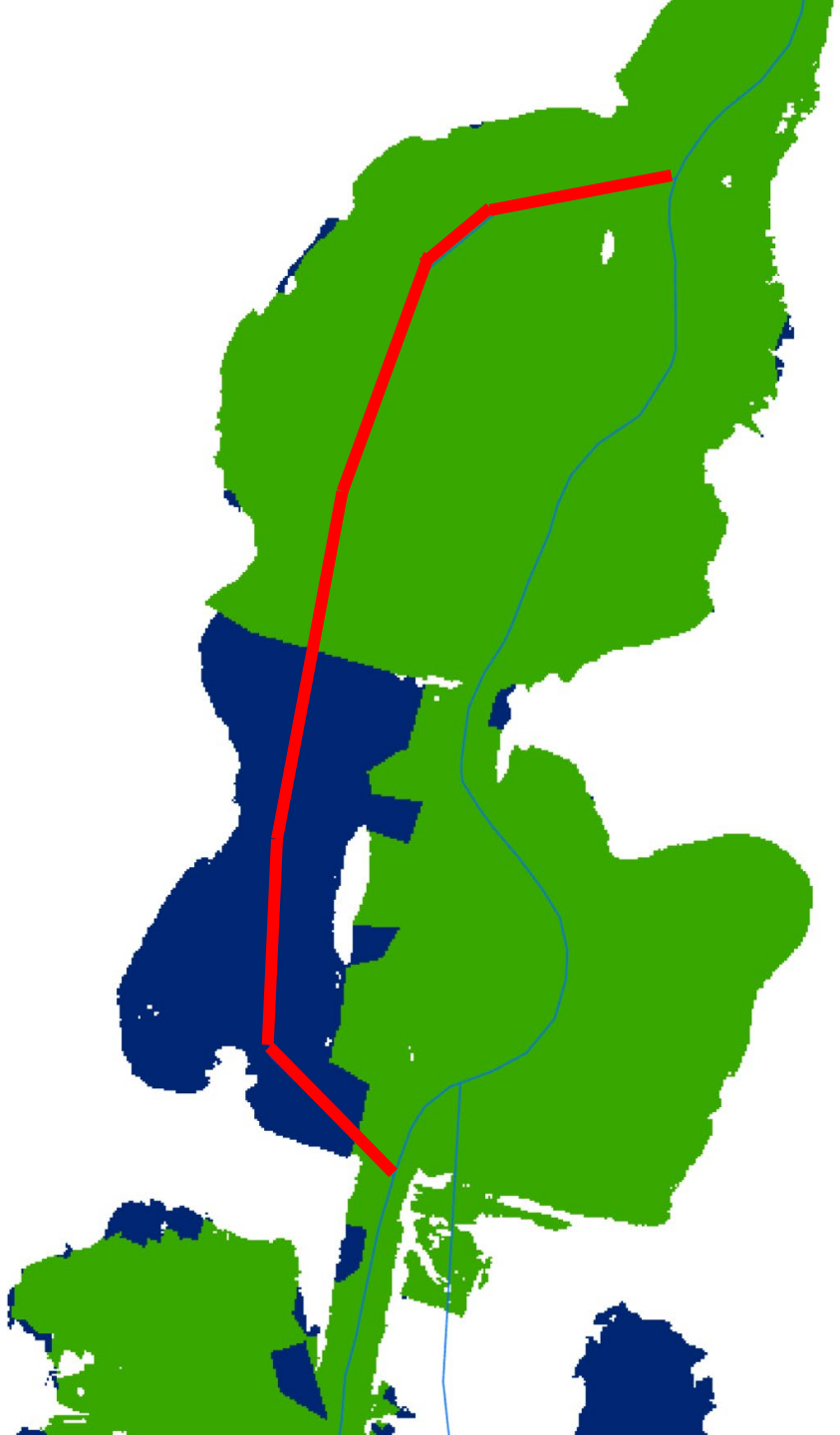
7. Reconcile to Ground





Results

- Eliminates results from pluvial sources and unstudied tributaries
- Eliminates “cupping” effects from raw RAS Mapper outputs
- Ensures consistency between rasters, regulatory floodplains, profiles, and BFEs
- Leverages readily available GIS tools

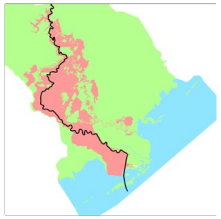


QC

Raster differences compared to raw raster output highlight where secondary profiles needed

WSEL Diff < -0.1’ < 0.1’ > 0.1’

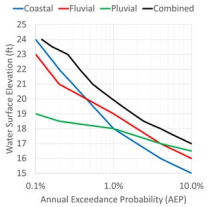
Conclusions



Controlling Event

Visualize the primary source of flooding to aid risk communication and alternative identification

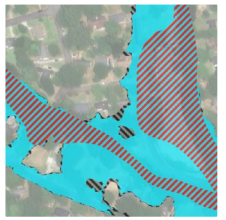
Leverage raw HDF output using Python



Combined Probability

Quantify each source to frame project benefits and emphasize residual risk

Leverage existing FEMA framework



Regulatory Mapping

Process “messy” 2D rain-on-mesh results for FEMA regulatory mapping

Leverage ArcGIS Nibble tool with constraints

Thank you

Mark Pauls
mark.pauls@freese.com

Rob Wood
robert.wood@freese.com

FREESE AND NICHOLS