

Going Beyond The Census Block for Hazus

Site Specific Loss Estimation Practices in FEMA



Harvard Gulch Area in Denver Colorado – 100 year flood losses



FEMA

Jesse Rozelle

Risk Analyst/Regional GIS Coordinator

FEMA Region 8/FEMA MOTF

Dave Kirkpatrick

Houston Engineering

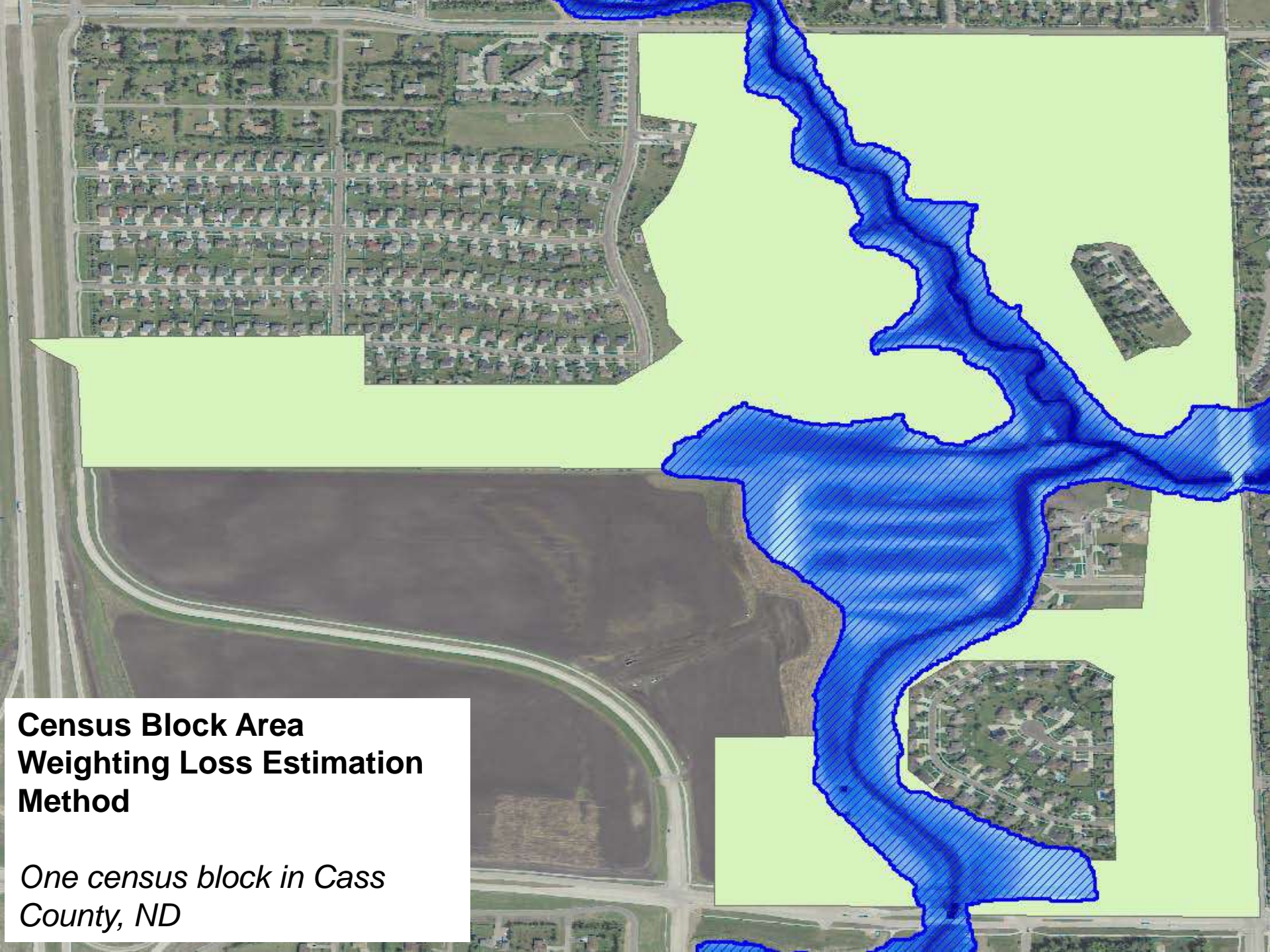
Benefits of Site Specific Loss Estimations

Pros

- Avoids Area Weighting Overestimation
- Ability to prioritize specific structures and neighborhoods for mitigation

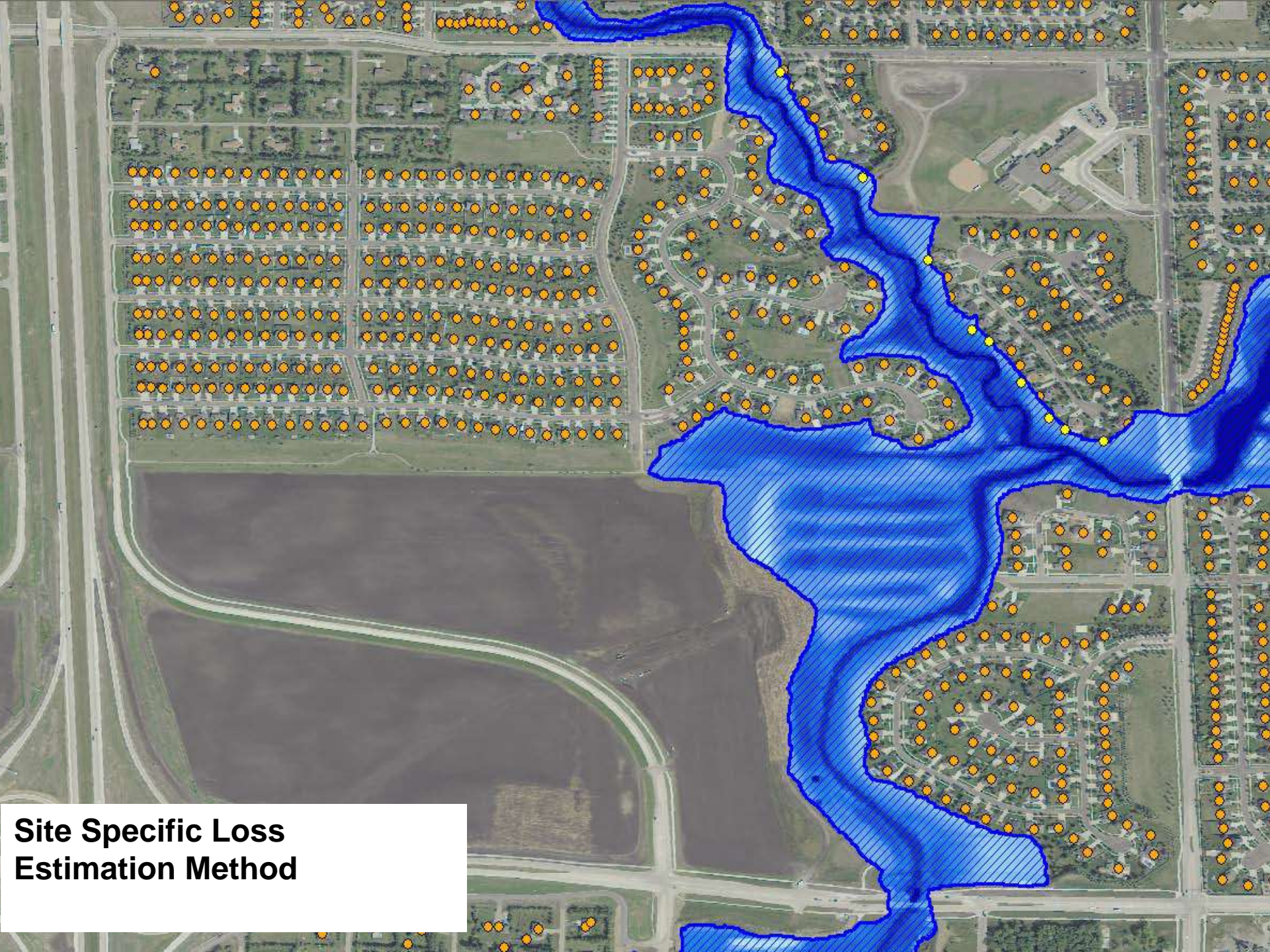
Cons

- Time/effort required to build inventories
- Data availability can be challenging



**Census Block Area
Weighting Loss Estimation
Method**

*One census block in Cass
County, ND*



**Site Specific Loss
Estimation Method**



Difference in Loss Estimates

Scenario	Flood Related Building Damage (buildings only) - Census Block Analysis	Flood Related Building Damage (buildings only) - Site Specific Analysis	Level I Area Weighting Approach Overestimation
2010 37 foot crest, closest to actual event	\$69,016,000	\$968,919	\$68,047,081
2010 37 foot crest, if flood protection measures had failed	\$81,561,000	\$2,835,323	\$78,725,677
2009 41 foot crest, closest to actual event	\$87,024,000	\$1,894,676	\$85,129,324
2009 41 foot crest, if flood protection measures had failed	\$374,937,000	\$232,863,548	\$142,073,452



FEMA

Inventory Prep

Summary of Hazus Minimum Required UDS Attributes:

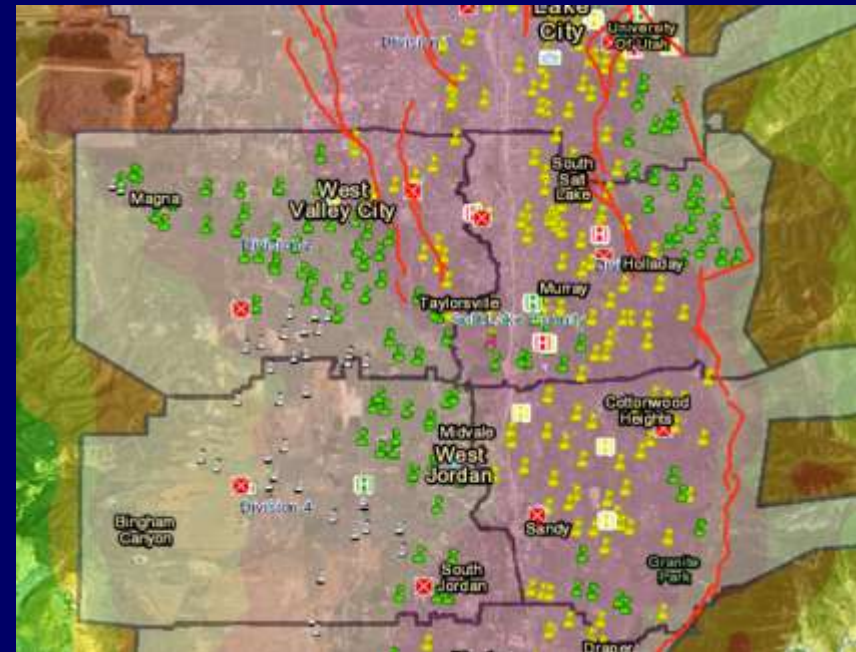
1. First Floor Height – Number in feet relative to FFE height above ground surface, field size integer
2. Building Value – Number in dollars, field size long Integer
3. Contents Value – Number in dollars, field size long Integer
4. Foundation Type – Text using foundation type IDs exactly as described in Table 3.11 of the Hazus Flood Technical Manual and shown above, field size 1
5. Occupancy – Text abbreviations exactly as described in Table 3.2 from the Flood Technical Manual, field size 5
6. Number of Stories – Number, field size byte



FEMA

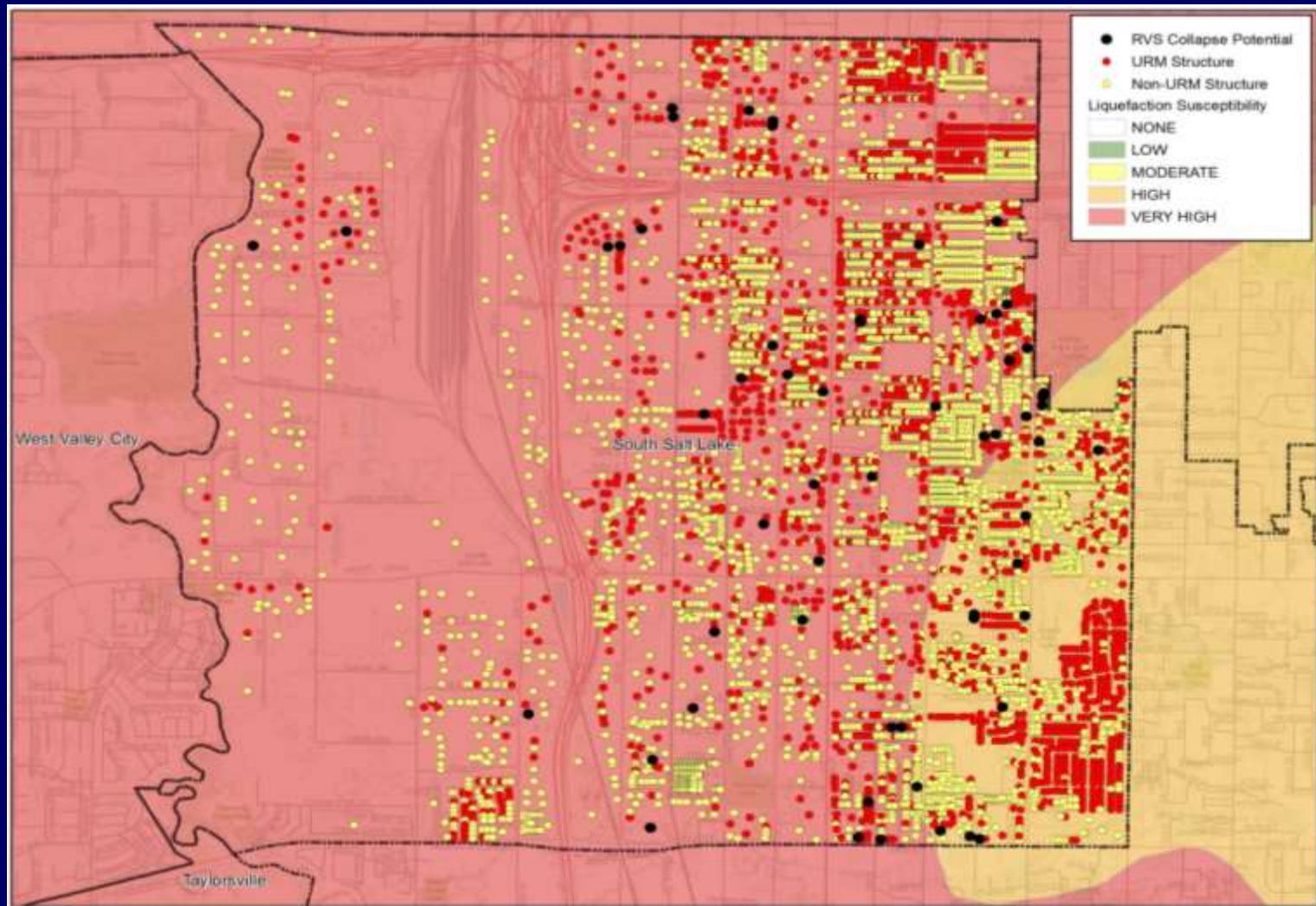
Preparedness Applications

Salt Lake City Catastrophic Earthquake Planning – Earthquake Site Specific Application



FEMA

Earthquake Vulnerability (M 7.0 Wasatch Scenario – Salt Lake City Segment)



FEMA

Response Applications – Fargo, ND





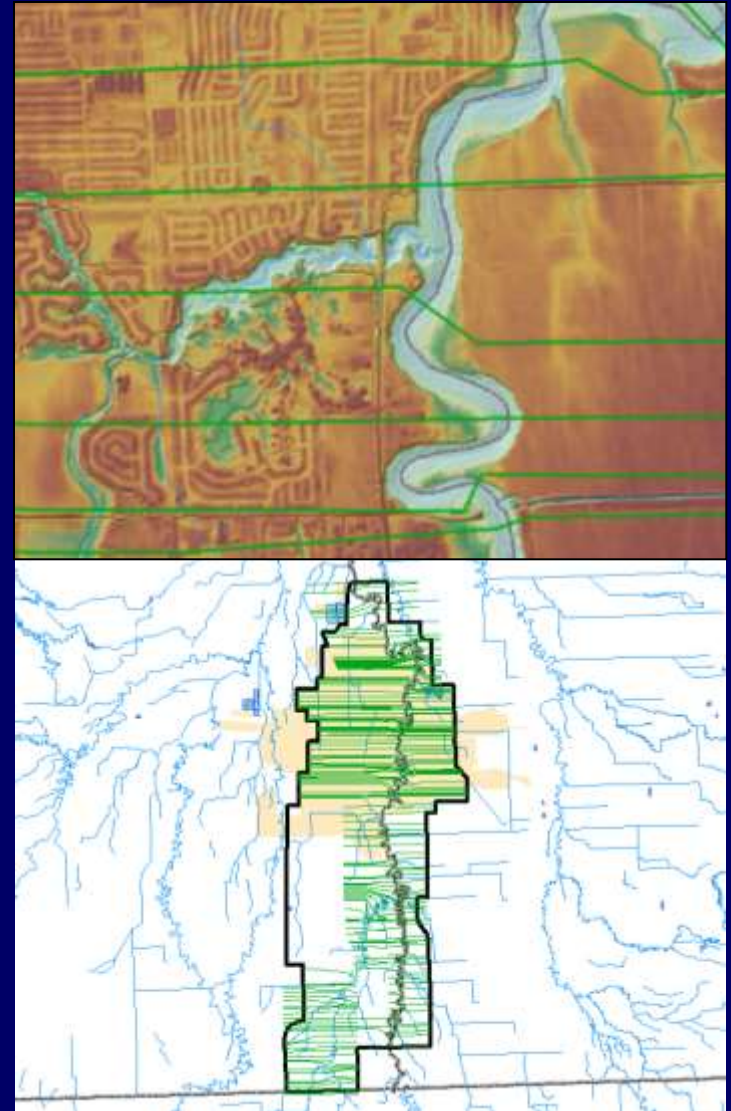
MOORHEAD

FARGO

2009 Spring Flood

Flood Inundation Polygons/User Created Flood Hazard – Houston Engineering, Fargo, ND.

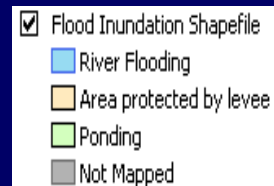
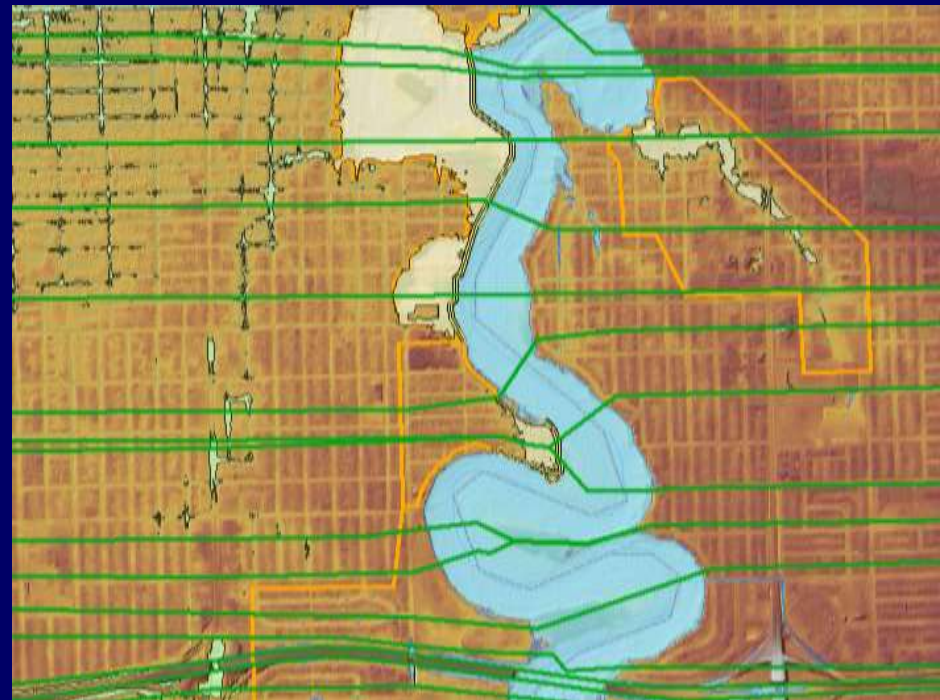
- Available Data Resources
 - LIDAR Data acquired by the City of Fargo and International Water Institute
 - FEMA FIS Hydraulic Models
 - Profiles tied to flood stage and intermediate stages interpolated
 - Permanent and temporary flood protection measures
 - Impact of emergency flood protection measures



FEMA

Flood Inundation Polygons

- Development of Flood Inundation Polygons
 - Water Surface interpolation developed using profile elevations and digital cross section locations
 - Water surface overlayed on ground terrain surface to create flood inundation depth grids
 - Depth grids converted to polygons for visual display



FEMA

Depth Grid

☒ depth_grd_pk

Depth (ft)

0.342864631 - 2.266922536
2.266922537 - 5.345415183
5.345415184 - 9.963154153
9.963154154 - 15.35051629
15.3505163 - 20.73787842
20.73787843 - 26.12524055
26.12524056 - 33.82147217



Flood Inundation Shapefile

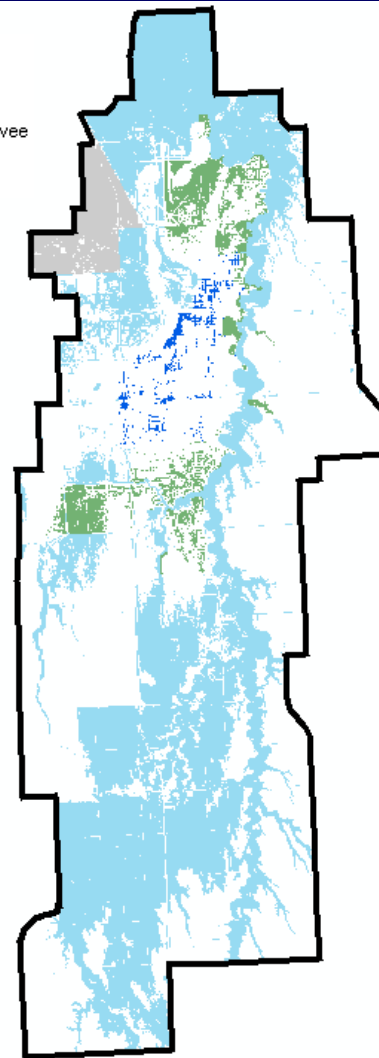
☒ inundation_pk

River Flooding

Ponding

Area protected by levee

Not Mapped



FEMA

Flood Inundation Polygons – 18 feet



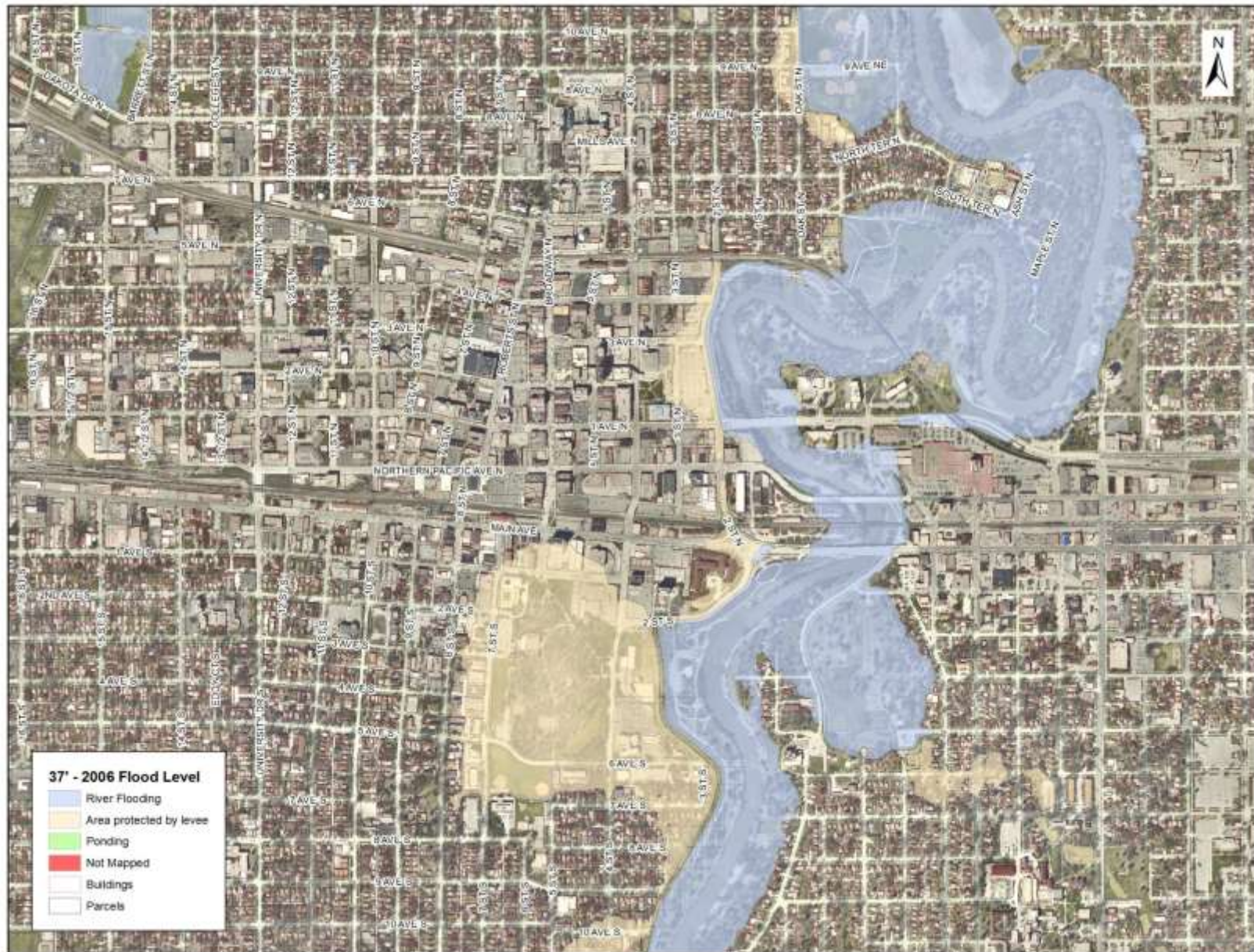
Flood Inundation Polygons – 25 feet



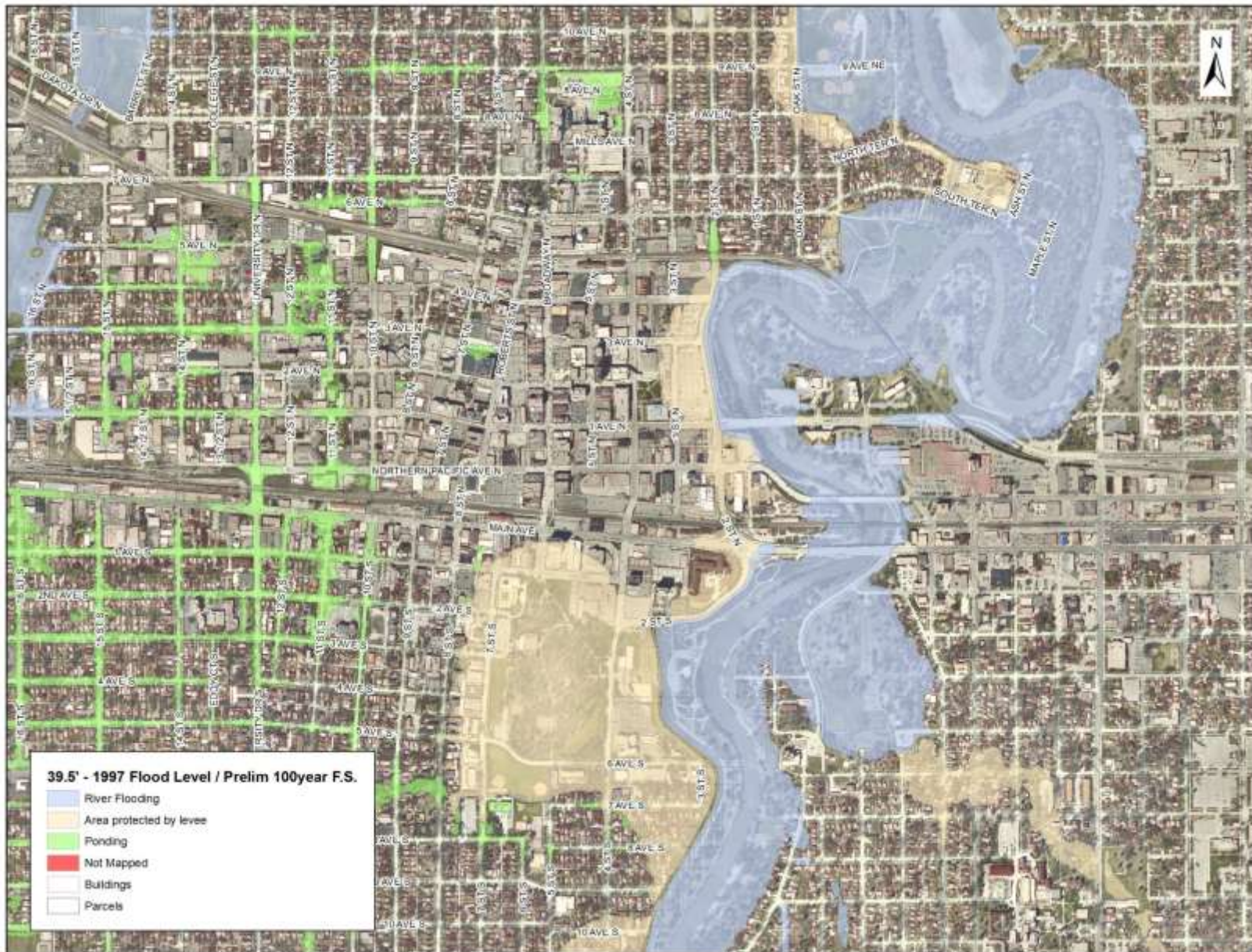
Flood Inundation Polygons – 30 feet



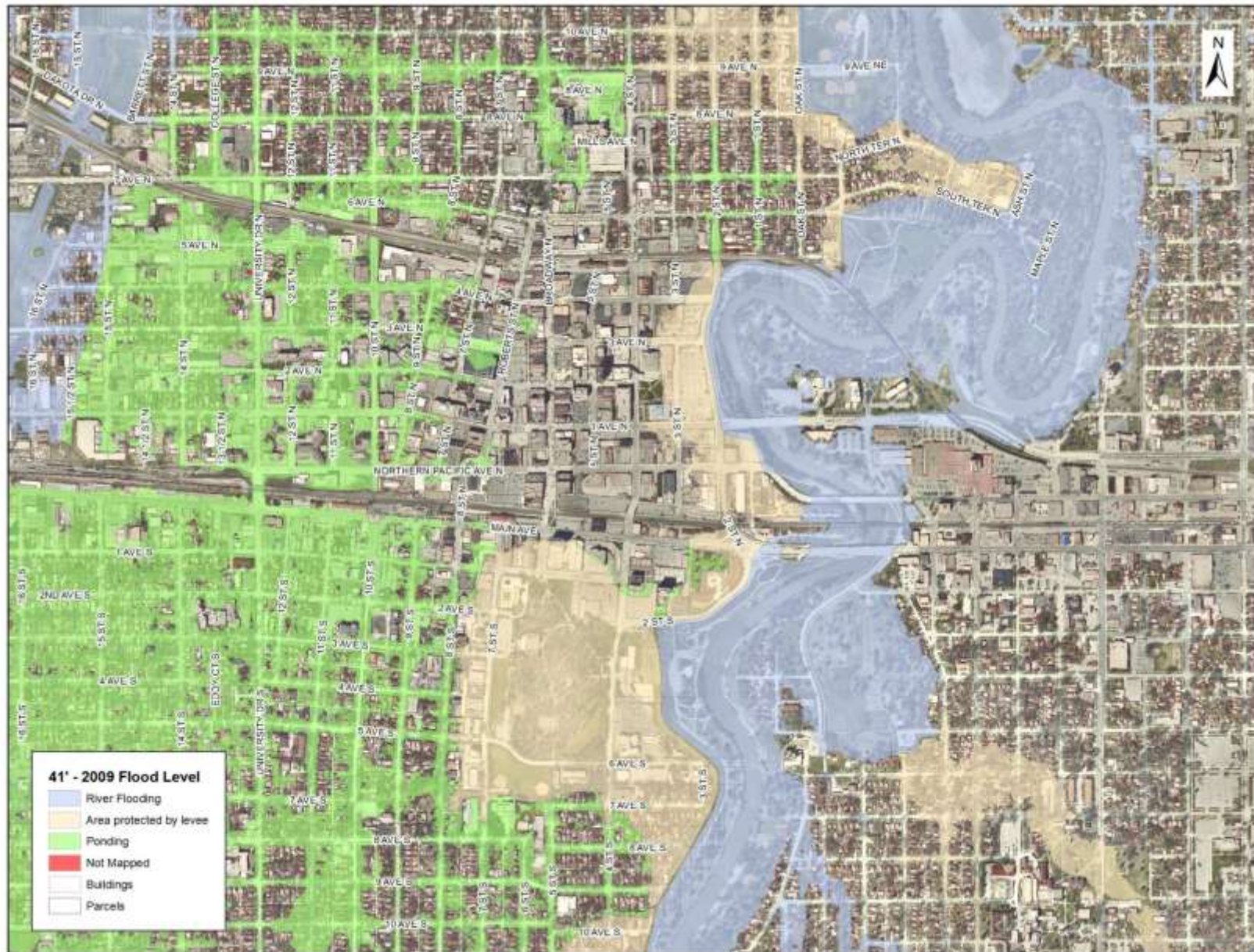
Flood Inundation Polygons – 37 feet



Flood Inundation Polygons – 39.5 feet



Flood Inundation Polygons – 41 feet



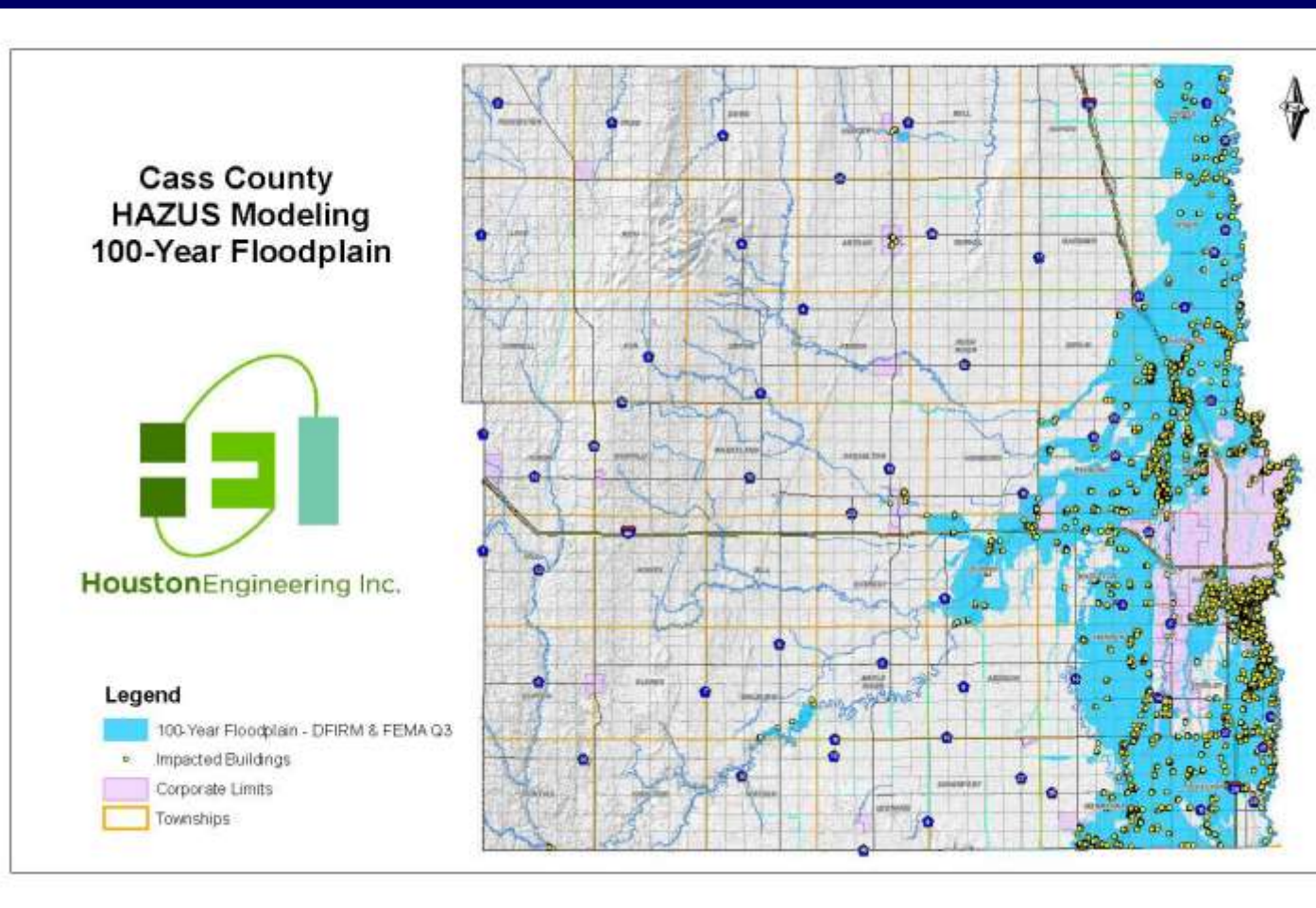
Flood Inundation Polygons

- Uses of Data
 - Identify areas at risk for potential flooding
 - Locate critical facilities
 - Identify areas that would be inundated by potential levee failures – Evacuation Planning
 - Inform residents of potential risk to property at forecasted flood stages
 - Assist City staff with establishing flood protection levels through the City – GPS link for water surface TINs tied to flood stage
 - Used by FEMA to determine damages and aid in mitigation planning



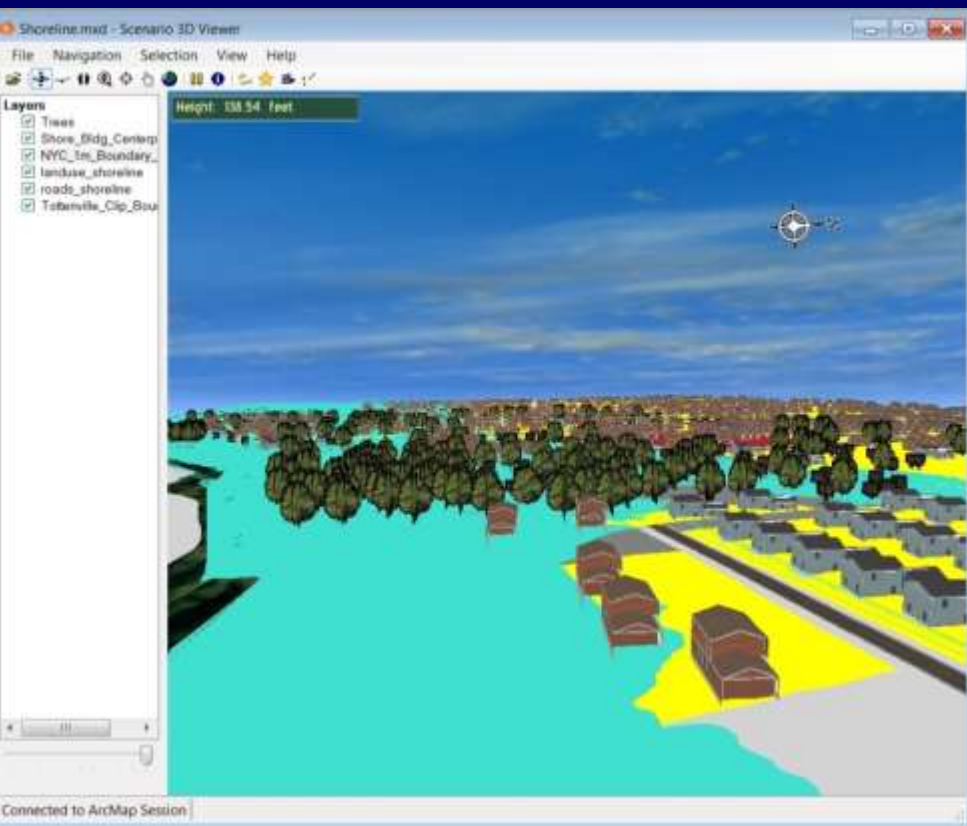
FEMA

- Response ready site specific building inventory
- Hazard mitigation planning uses



FEMA

Recovery Applications



Hurricane Sandy
Hazus/CommunityViz Integration
- In Progress



FEMA

Mitigation Scenarios

Four mitigation scenarios for each of the three hazard scenarios are prepared based on:

1. Removal of basements within current effective 100 year flood zone (17K in NYC)
2. Removal of basements within preliminary work maps 100 year flood zone (41K in NYC)
3. Increasing first floor elevations to the current effective 100 year flood elevation
4. Increasing first floor elevations to the preliminary work map 100 year flood elevation



FEMA

Observed Impacts: Staten Island Summary

- Based on High Resolution (3ft) FEMA MOTF Sandy Inundation Depth Grid: <http://fema-data.esri.com/GISData/MOTF/>
- Exposure summaries available on FEMA GeoPlatform: <http://bit.ly/12HU0eq>

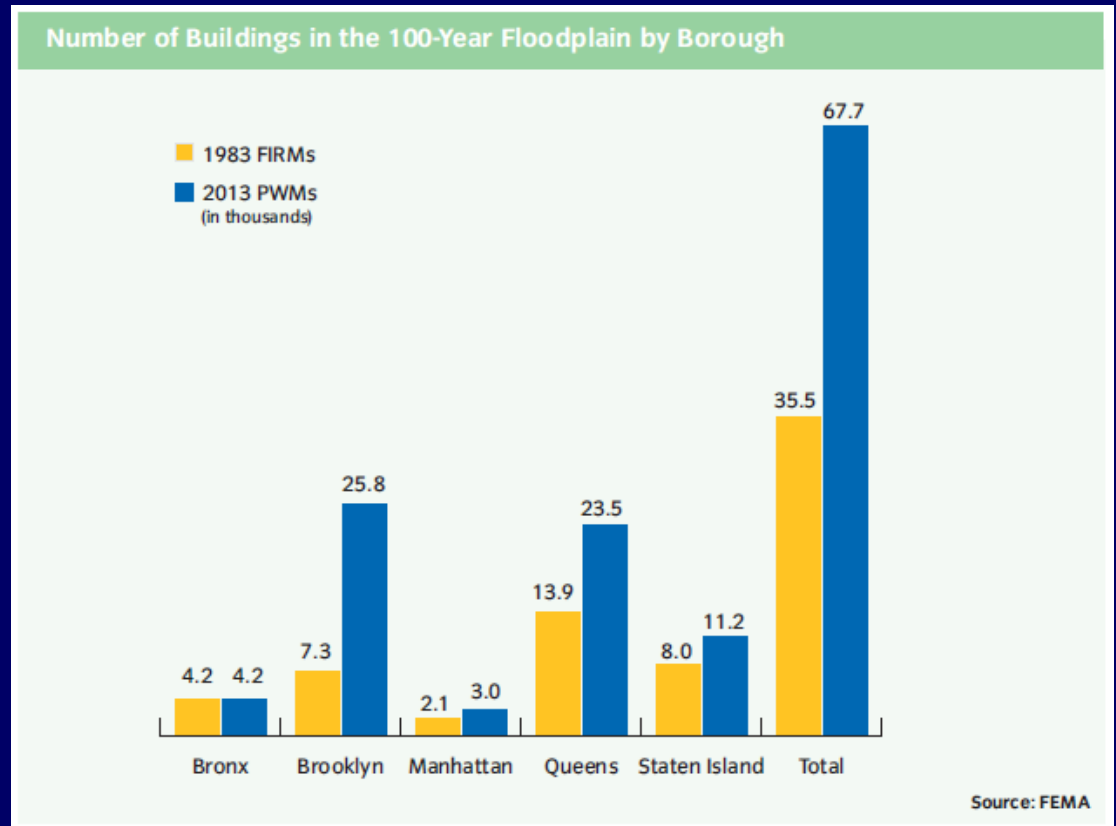
FEMA-MOTF Impact Summary for Staten Island	
Total Population	468,730
Total Households	165,516
Exposed Population	51,497
Exposed Households	18,119
Damaged IA Households	11,948
NFIP Inudated Policies	4,040
IA Affected Households	2,687
IA Minor Households	3,962
IA Major Households	5,215
IA Destroyed Households	84
Total IA \$ Loss	\$ 170,266,270
IA Affected Buildings	2,154
IA Minor Buildings	2,501
IA Major Buildings	3,910
IA Destroyed Buildings	71



FEMA

Buildings Exposure Increases

- Increase floodplain exposure (1983-2013)



FEMA

Inventory Preparation

- Converting over 200 MapPluto BldgClass to 33 Hazus Occupancy Types
- Assumptions regarding mixed use occupancies—assigned based on exposed floor occupancy

New York City Inventory by Hazus-MH Occupancy Based on MapPluto BldgClass

Occupancy	Building Count	Occupancy	Building Count
COM1	25,347	IND2	10,518
COM10	494	IND3	80
COM3	6,170	REL1	6,680
COM4	7,039	RES1	322,674
COM5	573	RES2	2,952
COM6	738	RES3A	270,987
COM7	754	RES3B	114,069
COM8	3,951	RES3C	58,434
COM9	162	RES3D	17,041
EDU1	3,543	RES3F	1,628
EDU2	706	RES4	721
GOV1	3,434	RES5	1,154
GOV2	483	RES6	408
IND1	2,356	Total	863,096



FEMA

Foundation Data

BsmtCode	CountOfOccupancy	
1 (Full Basement Above Grade)	153,564	18%
2 (Full Basement Below Grade)	497,800	58%
3 (Partial Basement Above Grade)	1,232	0%
4 (Partial Basement Below Grade)	4,331	1%
5 (Unknown assumptions based on 1983 FIRM SFHA)	143,915	17%
N (None/No Basement)	62,254	7%
	863,096	100%

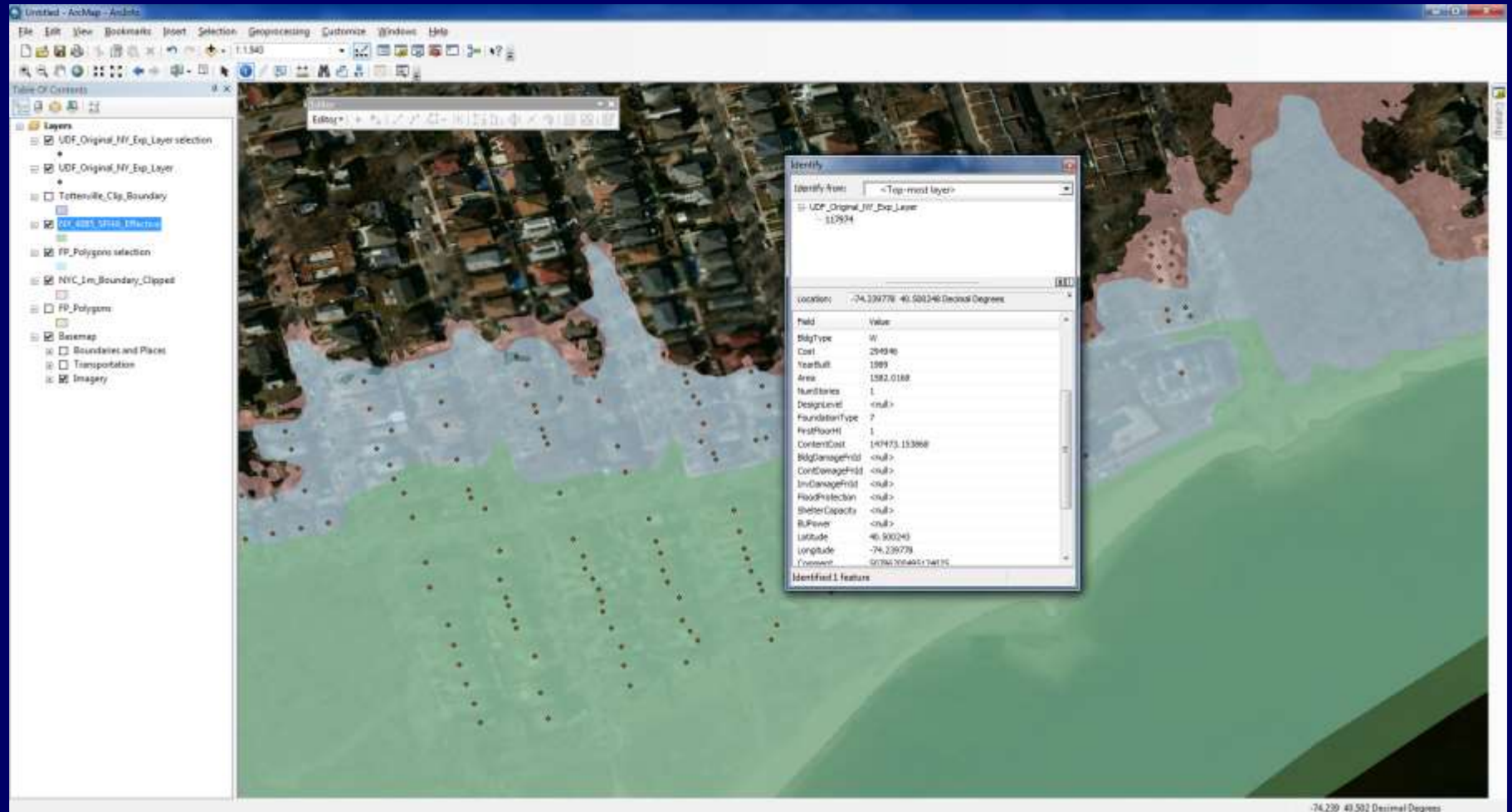
NYC Building Count Exposure	
Basements In Current Effective (1983) SFHA	16,473
Basements In PWM SFHA (2013)	41,290
Basements In Sandy Final Inundation	49,609

Staten Island Basement Exposure in 1983 SFHA	
	3,994
Basement Area (sqft)	5,873,179
Basement Replacement Value (\$)	\$ 617,619,314
Basement Content Replacement Value (\$)	\$ 527,692,906
Staten Island Basement Exposure in 2013 SFHA	
	6,905
Basement Area (sqft)	10,556,644
Basement Replacement Value (\$)	\$ 1,161,910,116
Basement Content Replacement Value (\$)	\$ 1,032,599,061



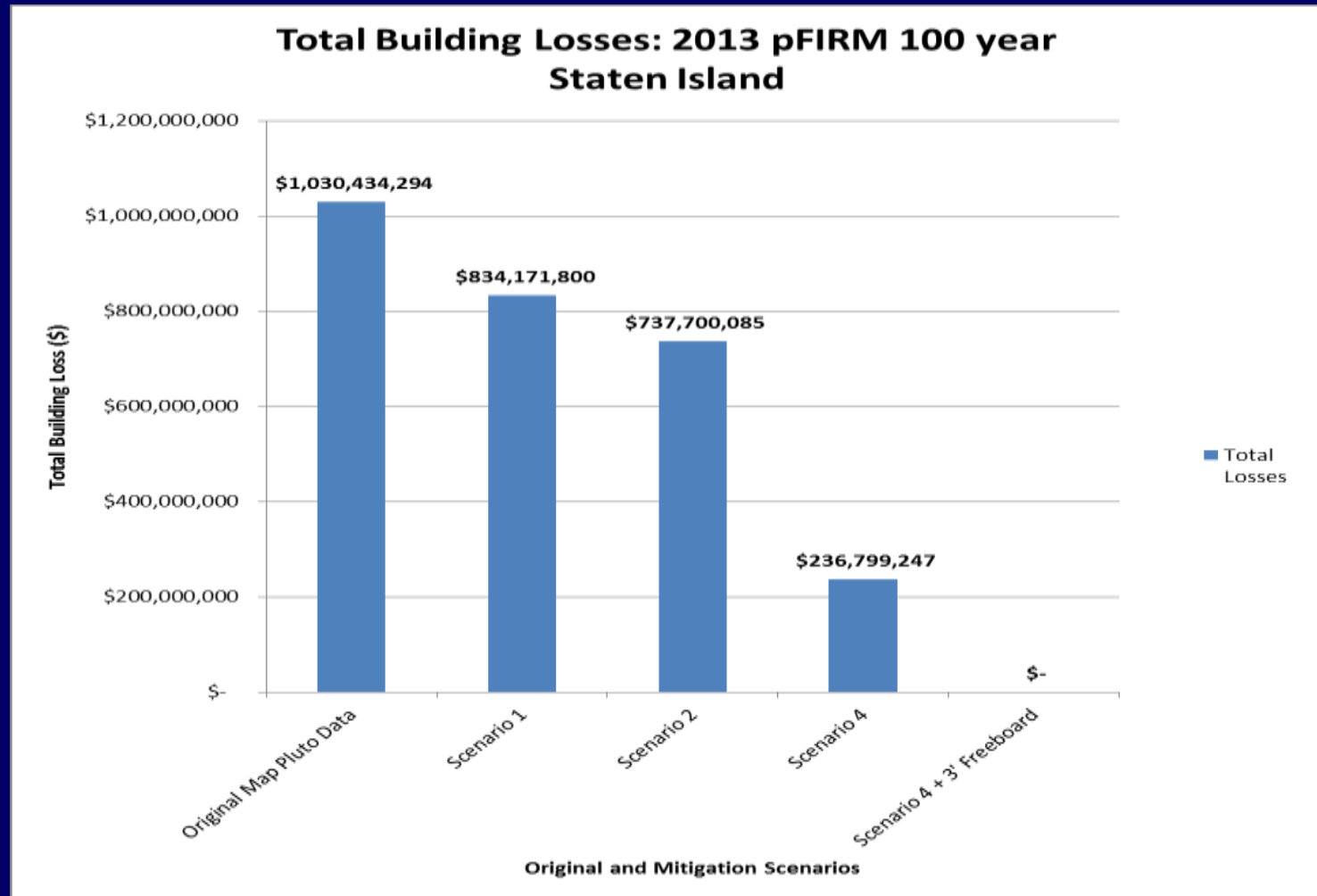
FEMA

Tottenville



FEMA

Preliminary pFIRM 2013 SFHA Scenario Losses- Staten Island All Buildings



FEMA

Preliminary pFIRM 2013 SFHA Scenario Losses-Staten Island All Buildings

Preliminary Staten Island Building Flood Scenario Losses based on 2013 pFIRM 100 year Event	Building Loss	Content Loss	Inventory Loss	Total Loss	Damaged Buildings	Average Total Damage per Building	Percent Loss Reduction over Original
Original Map Pluto Data	\$ 405,826,747	\$ 493,031,398	\$ 131,576,149	\$ 1,030,434,294	8,628	\$ 119,429	0%
Scenario 1-removal of basements in 1983 SFHA	\$ 322,309,593	\$ 413,859,556	\$ 98,002,651	\$ 834,171,800	8,396	\$ 99,353	19%
Scenario 2-removal of basements in 2013 SFHA	\$ 282,991,001	\$ 363,682,259	\$ 91,026,825	\$ 737,700,085	7,670	\$ 96,180	28%
Scenario 4-no basements and first floor elevations to 2013 BFEs	\$ 143,764,887	\$ 83,542,425	\$ 9,491,935	\$ 236,799,247	7,570	\$ 31,281	77%
Scenario 6-no basements and first floor elevations with 3 feet of freeboard over 2013 BFEs	\$ -	\$ -	\$ -	\$ -	-	\$ -	100%



FEMA

Preliminary pFIRM 2013 SFHA Scenario Losses-Staten Island Residential Buildings

Preliminary Staten Island Building Flood Scenario Losses based on 2013 pFIRM 100 year Event	Single-Family Residential Building Loss	Single-Family Residential Content Loss	Total Loss	Damaged Single- Family Residential	Average Total Damage per Single-Family Home	Percent Loss Reduction over Original
Original Map Pluto Data	\$ 225,181,059	\$ 105,138,610	\$ 330,319,669	5,959	\$ 55,432	0%
Scenario 1-removal of basements in 1983 SFHA	\$ 181,891,100	\$ 102,511,841	\$ 284,402,942	5,816	\$ 48,900	14%
Scenario 2-removal of basements in 2013 SFHA	\$ 164,898,403	\$ 95,659,906	\$ 260,558,309	5,254	\$ 49,592	21%
Scenario 4-no basements and first floor elevations to 2013 BFEs	\$ 103,320,593	\$ 38,472,823	\$ 141,793,416	5,249	\$ 27,013	57%
Scenario 6-no basements and first floor elevations with 3 feet of freeboard over 2013 BFEs	\$ -	\$ -	\$ -	-	\$ -	100%



FEMA

Potential Premium Savings

PREMIUM AT 4 FEET BELOW
BASE FLOOD ELEVATION

\$9,500/year



PREMIUM AT
BASE FLOOD ELEVATION

\$1,410/year



PREMIUM AT 3 FEET ABOVE
BASE FLOOD ELEVATION

\$427/year



Rates per FEMA flood insurance manual, October 1, 2012, for a \$250,000 building coverage policy (does not include contents) on a single-family structure located in a high to moderate risk zone.

- Based on elevation, limitations to premium reduction for dry and wet flood proofing mitigation strategies



FEMA

Discussion Items

Improve Sandy calibration: NFIP and City loss data

Improve first floor height averages by foundation type by geographies or boroughs?

Assumptions for benchmark years? Building code changes? Tagging and year-built relationships?

Missing or default year built attributes (6,000, fewer in SFHA). Historic orthoimagery imagery available (CityMap).

Improve content valuations for basements exposure of high and mid rises.

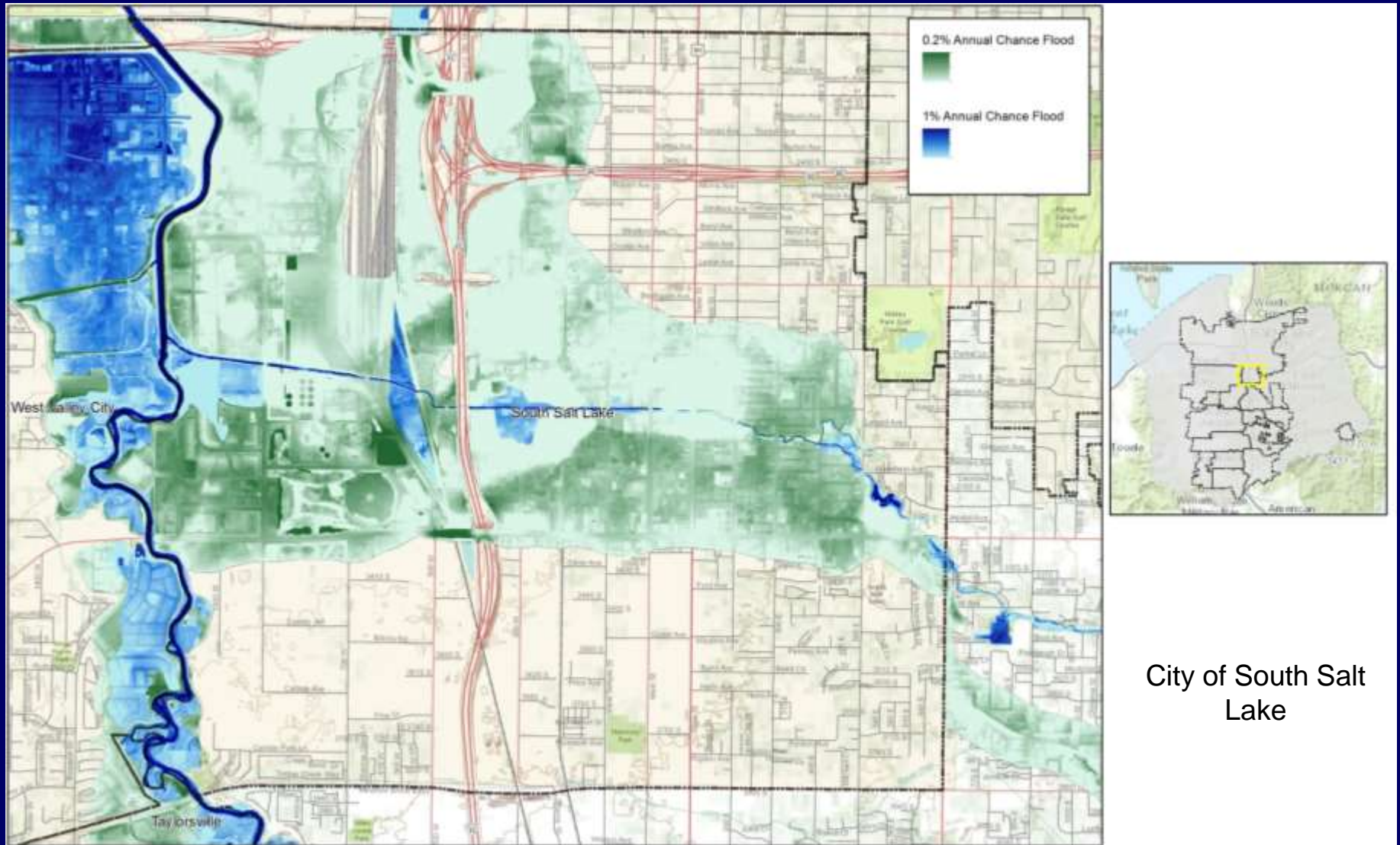
Mitigation scenarios—implemented based on Sandy damage (tagging, reconstruction permitting)?

Exposure areas? Depth damage methodology limitations for medium and high rise.

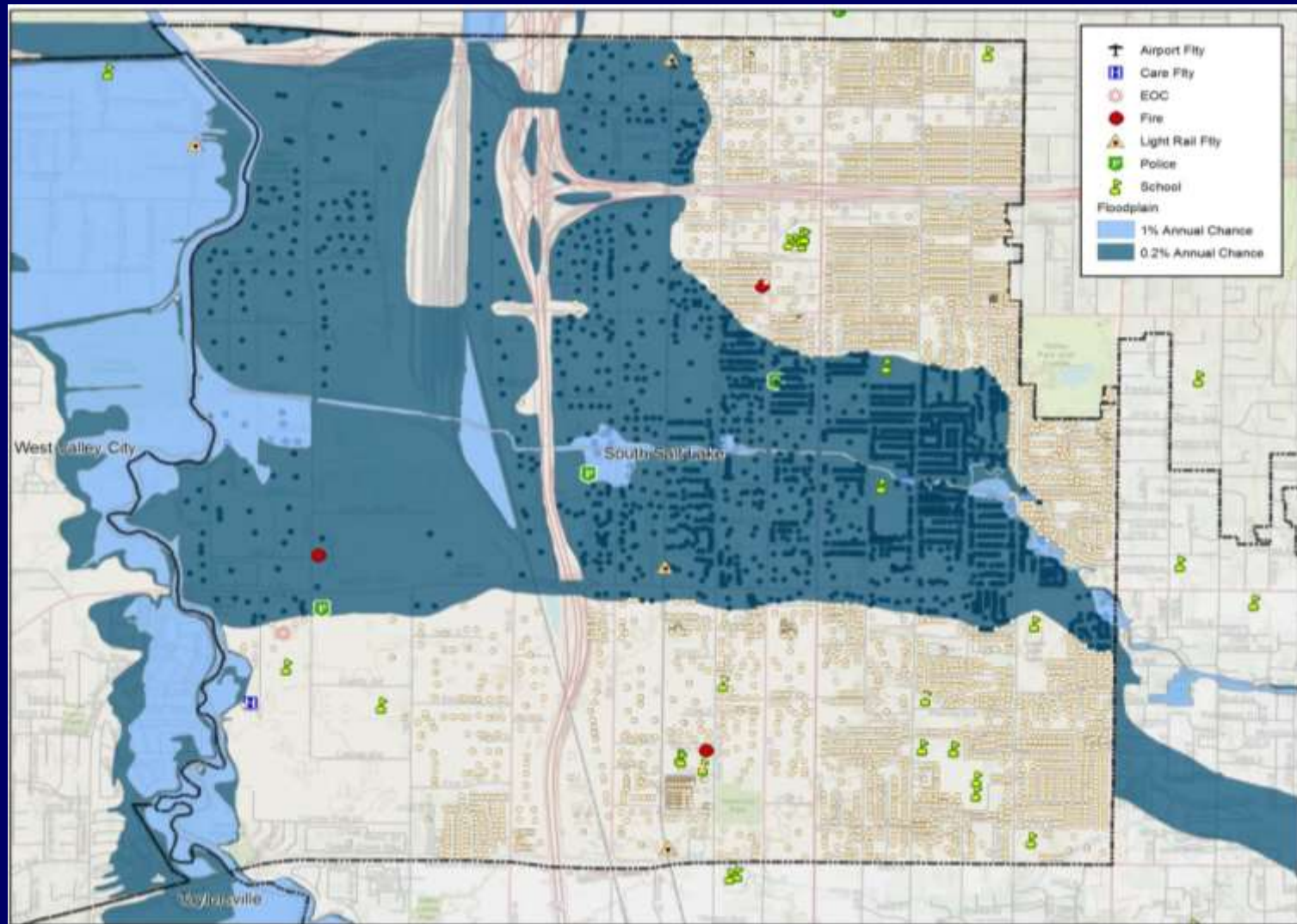


FEMA

Mitigation Applications – Denver/SLC Flood Risk Assessment for RiskMap/Hazard Mitigation Planning

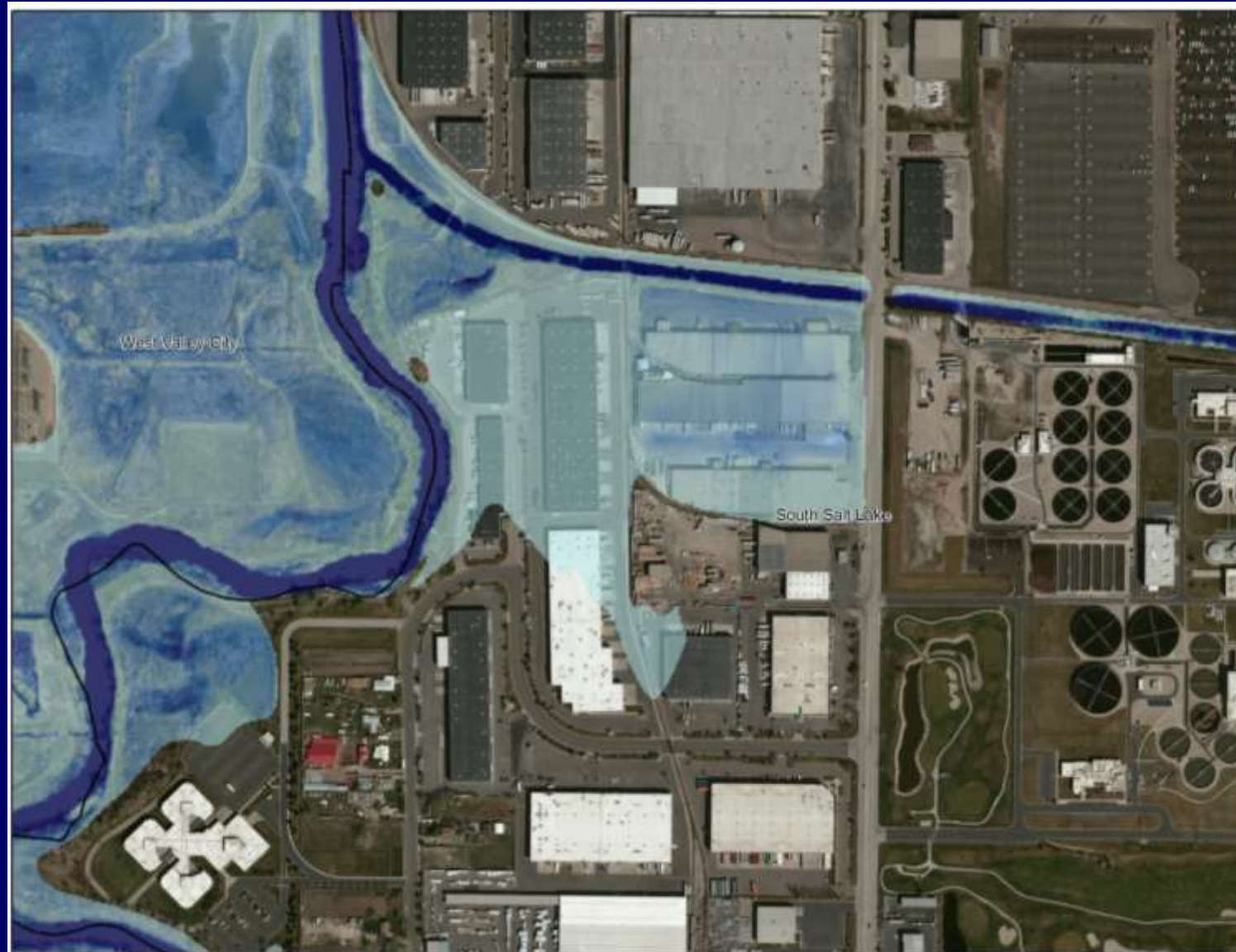


Flood Vulnerability (City of South Salt Lake)



FEMA

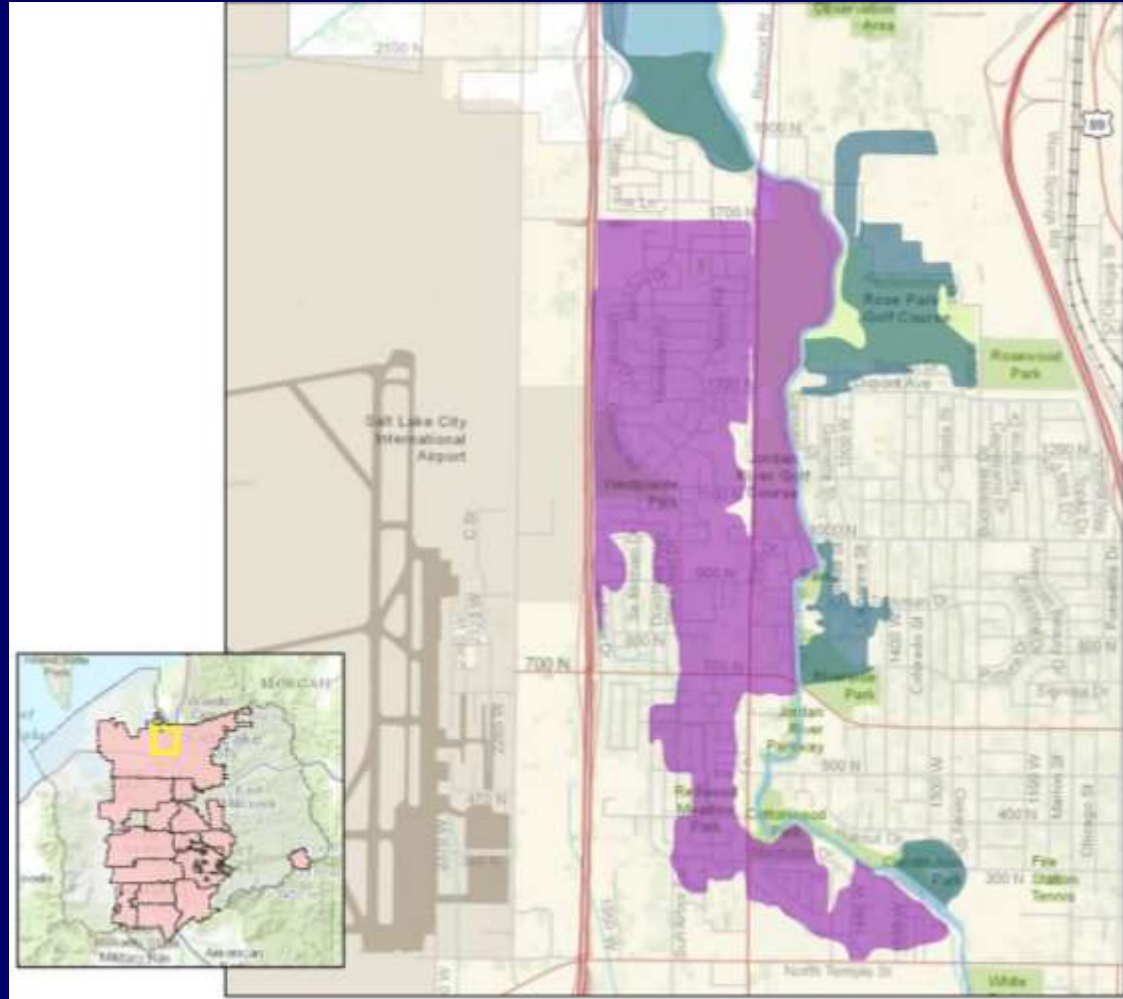
Flood Vulnerability (City of South Salt Lake)



Flood Vulnerability (X Protected by Levee)

X Protected by Levee Zone

- Exposure:
 - 1,668 structures
 - \$410,638,150 building & contents value
- Hazus Site-Specific Building Loss:
 - Normal Duration - \$17,892,355
 - Long Duration - \$28,604,916



FEMA

Flood Vulnerability

(City of South Salt Lake)

- City of South Salt Lake Structure Count in flood zones
- Hazus 1% Annual Chance Total Loss: \$4,713,084 →
 - 0.09% loss ratio
- Hazus 0.2% Annual Chance Total Loss: \$196,799,441
 - 3.63% loss ratio
- Critical Facilities in Flood Zones with depths
 - 1% Annual Chance Flood
 - Granite School District Police Station: 0.1 ft depth
 - 0.2% Annual Chance Flood
 - South Salt Lake Fire Department: 6.0ft depth
 - Mill Creek Light Rail Station: 0.3ft depth
 - Central Pointe Light Rail Station: 0.2ft depth
 - South Salt Lake Police Department: 0.1ft depth
 - Salt Lake County Sheriff's Office: 0.1ft depth
 - Granite Park Jr. High School: 1.7ft depth
 - Granger School: 0.1ft depth

Structure Counts			
1% Annual Chance		0.2% Annual Chance	
Residential	22	Residential	1,078
Commercial	34	Commercial	1,064
Industrial	10	Industrial	233



FEMA

Flood Hazard (Denver, CO)

- Previous Occurrences
 - Most damaging - June 1965 on South Platte, over \$2.7B in damage
 - May 2007 - S. Platte rose 3 feet in one hour, death of 2-year old on Lakewood Gulch.

Location: Limited
Strength: Moderate
Probability: Very Likely
Significance: Medium



Year	Location	Deaths	Damages
1864	Cherry Creek	0	\$7,365,830
1912	Cherry Creek	2	\$164,152,791
1965*	South Platte	8	\$2,735,879,850
1973*	South Platte	10	\$531,392,047

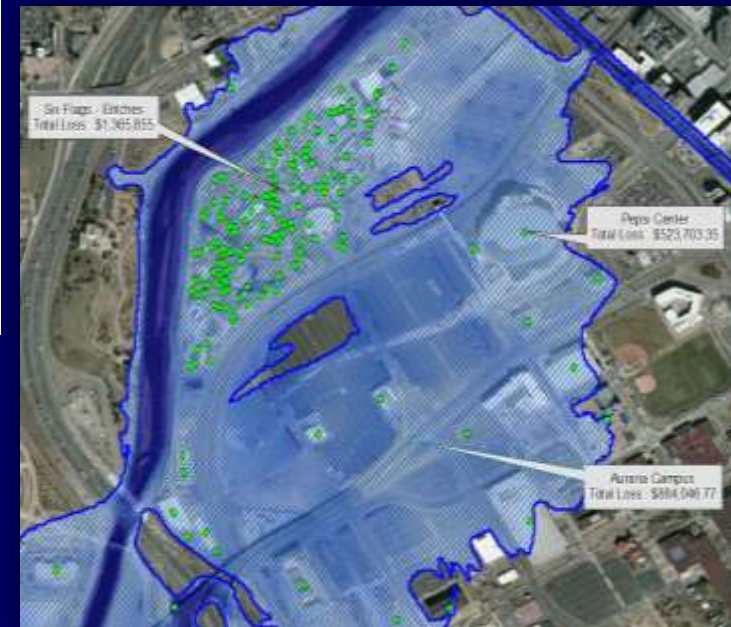


Flood Risk Analysis

	Pre LOMC*		Post LOMC*	
City and County of Denver	1 % Annual Flood	0.2 % Annual Flood	1 % Annual Flood	0.2 % Annual Flood
Structure Count	1,846	4,906	1,468	4,826
Building and Contents Value	\$2,031M	\$4,248M	\$1,451M	\$4,007M
Total Loss	\$153M	N/A	\$79M	\$616M
Loss Ratio	0.075	N/A	0.054	0.040

All values in Millions of Dollars

*LOMC – South Platte River - Lower Lakewood Gulch Mitigation Project



FEMA

Flood Vulnerability

Impacts	Capabilities
<ul style="list-style-type: none">-Population-Built Environment-Economy	<ul style="list-style-type: none">-Planning/Regulatory-Admin/Technical-Financial-Education/Outreach
	<ul style="list-style-type: none">• Participate in NFIP and CRS• Denver Urban Drainage and Flood Control District project prioritization

Questions?

Jesse.rozelle@fema.dhs.gov

FEMA-MOTF@fema.dhs.gov



FEMA