Not All Hazus Analyses are Created Equal: How to Get More Accurate Hazus-Estimated Flood Losses

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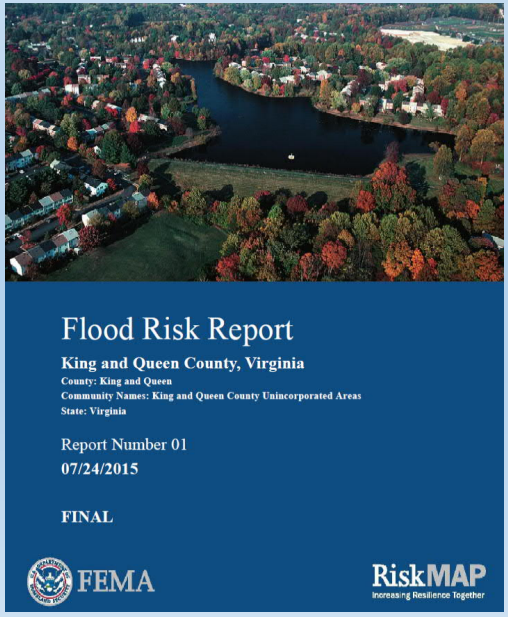
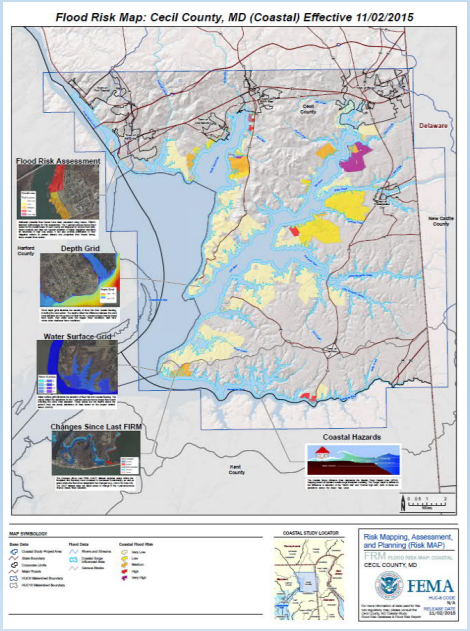
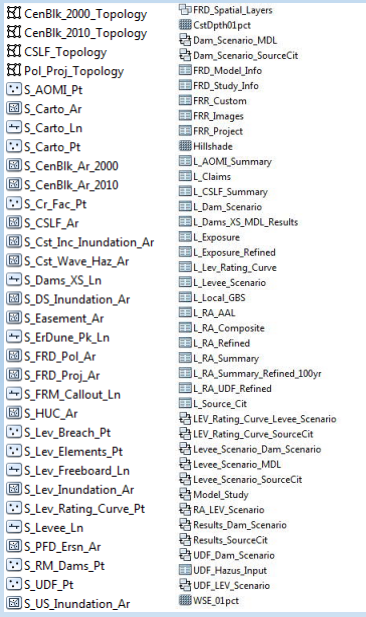
amec foster wheeler wood.

What is Hazus?

- Software program from FEMA used to estimate physical damage and socioeconomic impact of natural disasters
  - Requires ArcGIS
  - Flooding, Hurricanes, Earthquakes
- Used by communities for hazard mitigation, preparation, and response







Hazus Estimation for Flood Losses

Hazus provides users the option to perform different types of analyses:

- General Building Stock (GBS) - More generalized analysis, but easier to perform
  - Input data available for download from Hazus website
- User-Defined Facilities (UDF) – More detailed analysis, but requires additional data and time to put it in a Hazus-compliant format
  - Requires at least parcel/accessor data, but better results are possible if building footprints and detailed depth grids are included

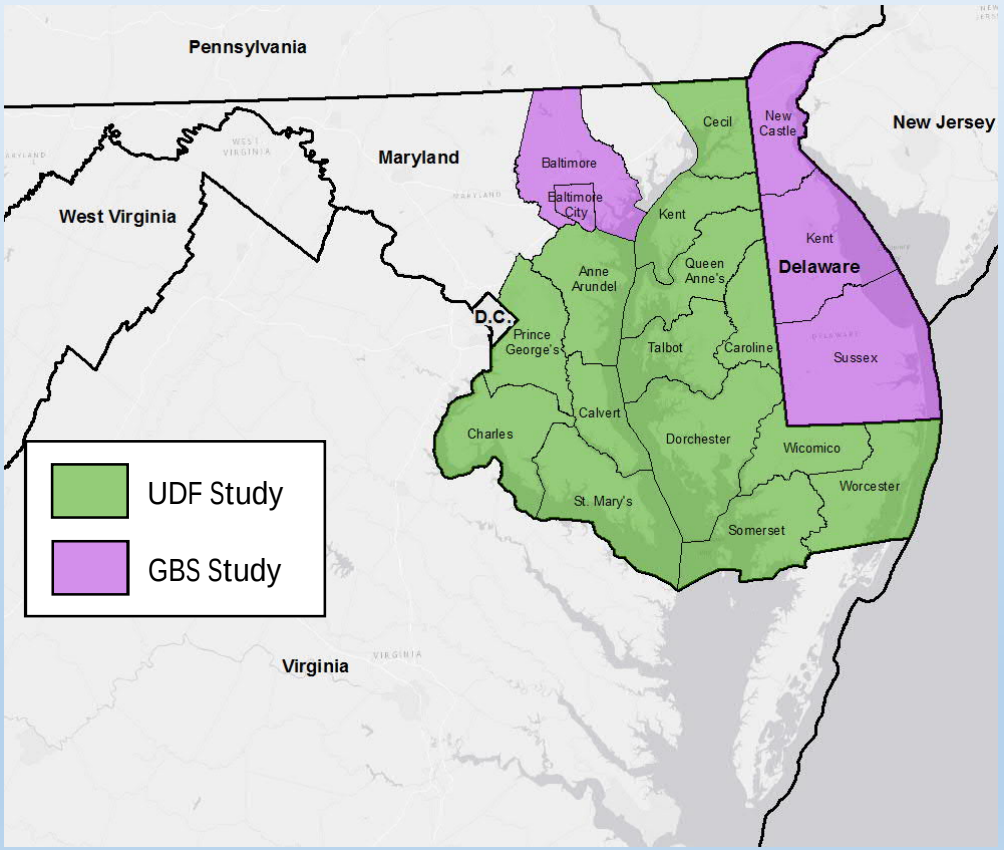
Amec Foster Wheeler Hazus Work Estimating Flood Losses

Completed Work:

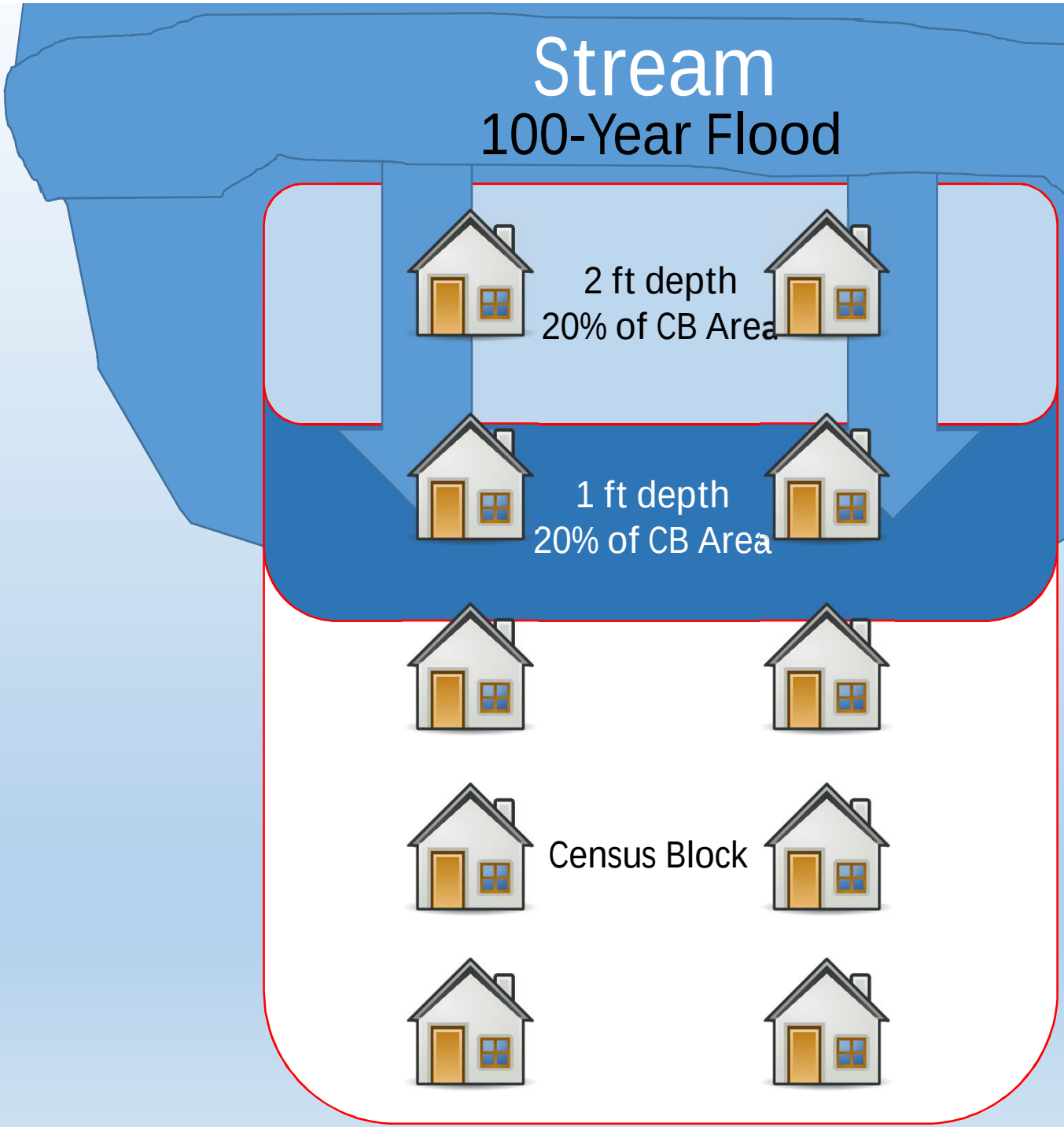
- Maryland:
  - GBS Studies (Coastal): Baltimore City, Baltimore County
  - UDF Studies (Coastal): Prince George's, Charles, St. Mary's, Calvert, Anne Arundel, Cecil, Kent, Queen Anne's, Talbot, Caroline, Dorchester, Wicomico, Somerset, Worcester Counties
- Delaware:
  - GBS Studies (Coastal): Kent, New Castle, Sussex Counties

In progress:

- UDF Studies for Riverine Areas in Maryland



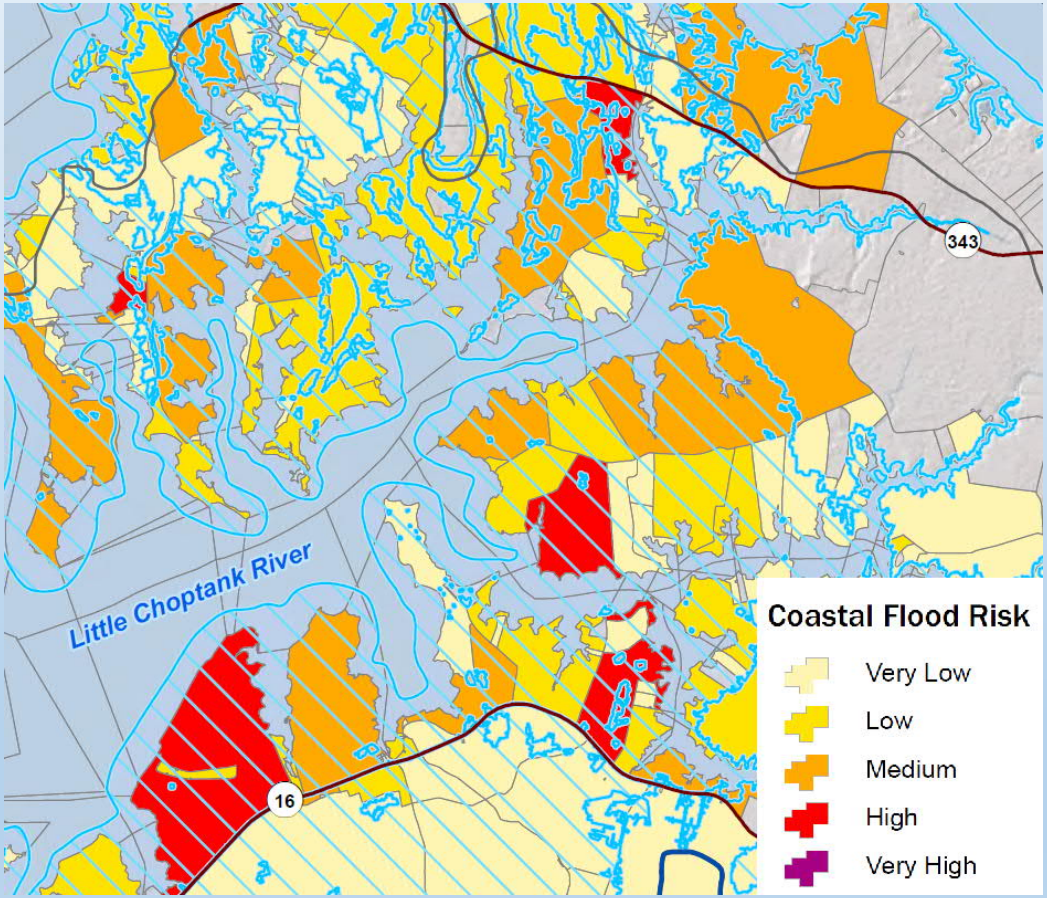
GBS Analyses Methodology



Type of Building	Count	Average Building Value
Single Family Residence (Residential)	10	$250,000
Townhome (Residential)	0	N/A
Retail (Commercial)	0	N/A
Light Industrial (Other)	0	N/A
School (Other)	0	N/A

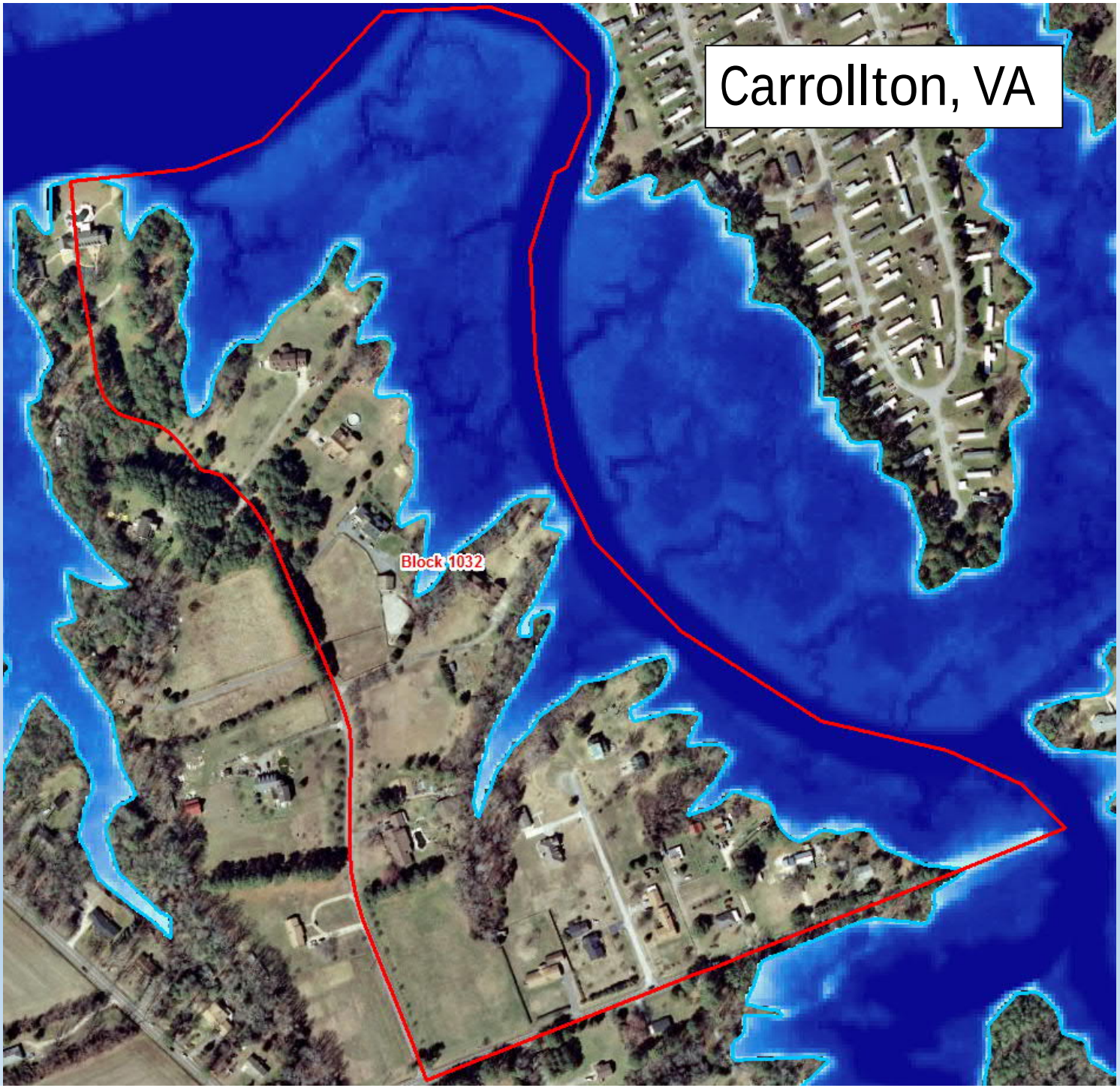
Hazus Flood Analysis

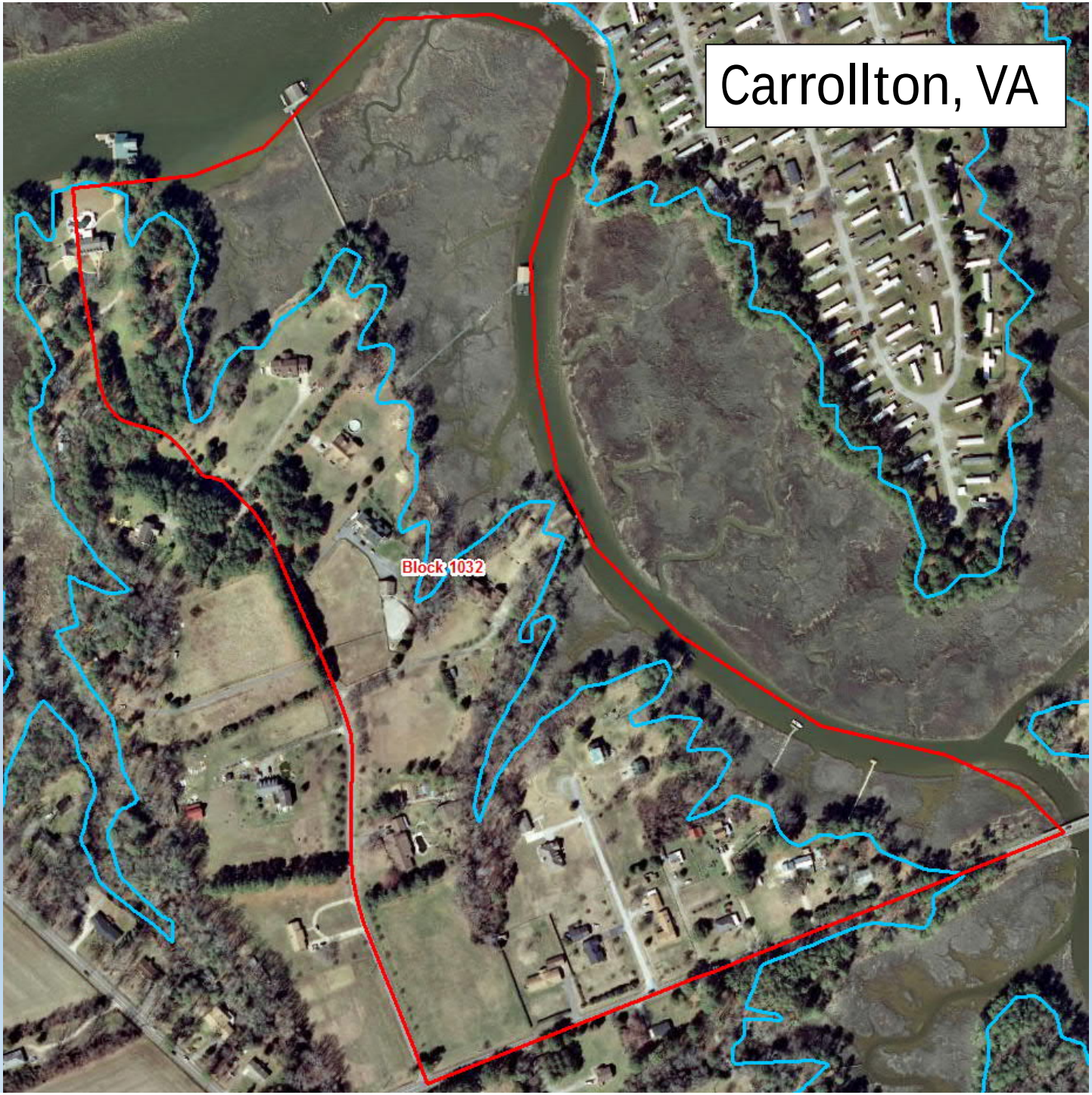
- General Building Stock (GBS) Studies
  - Estimate damage by Census Block
    - Area-level data
  - Damage estimated in percent and weighted by area of inundation at a given depth
  - Building and content losses estimated for residential, commercial, and other structures in the census block
  - Also losses estimated for business disruption



Census Block	Hazard	Return Period	Total Losses	Business Disruption	Building Loss Total	Content Loss Total
240037067003000	COAS	01pct	68,080,000	341,000	18,090,000	49649000
240037070011052	COAS	01pct	10,023,000	132,000	5,316,000	4575000
240037063004005	COAS	01pct	8,716,000	261,000	4,255,000	4200000
240037061011029	COAS	01pct	8,310,000	686,000	1,230,000	6394000
240037026023032	COAS	01pct	7,638,000	822,000	2,647,000	4169000
240037063001008	COAS	01pct	6,870,000	117,000	3,428,000	3325000
240037307001004	COAS	01pct	5,750,000	43,000	3,365,000	2342000
240037061011004	COAS	01pct	5,579,000	59,000	840,000	4680000

Census Block	Res Building Loss	Res Content Loss	Com Building Loss	Com Content Loss	Oth Building Loss	Oth Content Loss
240037067003000	17,943,000	49,230,000	110,000	189,000	37,000	230,000
240037070011052	4,777,000	2,864,000	184,000	496,000	355,000	1,215,000
240037063004005	3,247,000	1,986,000	141,000	392,000	867,000	1,822,000
240037061011029	111,000	218,000	822,000	3,982,000	297,000	2,194,000
240037026023032	15,000	9,000	2,630,000	4,154,000	2,000	6,000
240037063001008	2,777,000	1,711,000	615,000	1,341,000	36,000	273,000
240037307001004	3,175,000	1,896,000	121,000	345,000	69,000	101,000
240037061011004	388,000	1,011,000	14,000	46,000	438,000	3,623,000


Carrollton, VA
Block 1032


Carrollton, VA
Block 1032

Maryland Coastal Flood Loss Estimations (1%-Annual Chance) , 2010 AAL verses UDF

County	2010 AAL (GBS Study)	2015 UDF
Anne Arundel	$791,900,000	$86,200,000
Dorchester	$41,700,000	$37,100,000
Charles	$34,900,000	$9,300,000
Queen Anne's	$162,000,000	$21,800,000
Talbot	$87,100,000	$28,200,000
Somerset	$434,400,000	$88,500,000
Worcester	$629,800,000	$36,800,000

Hazus Flood Analysis

- User-Defined Facilities (UDF) Studies
  - Estimate damage to individual structures based on the flood depth at each UDF point
    - Each structure represented by a point in Hazus
    - Imported to the software as Latitude/Longitude coordinates with structure-specific information

UDF Points – Crisfield, Maryland

Still recovering from Sandy, Crisfield braces for next storm

WAMU, NOV 30, 2012

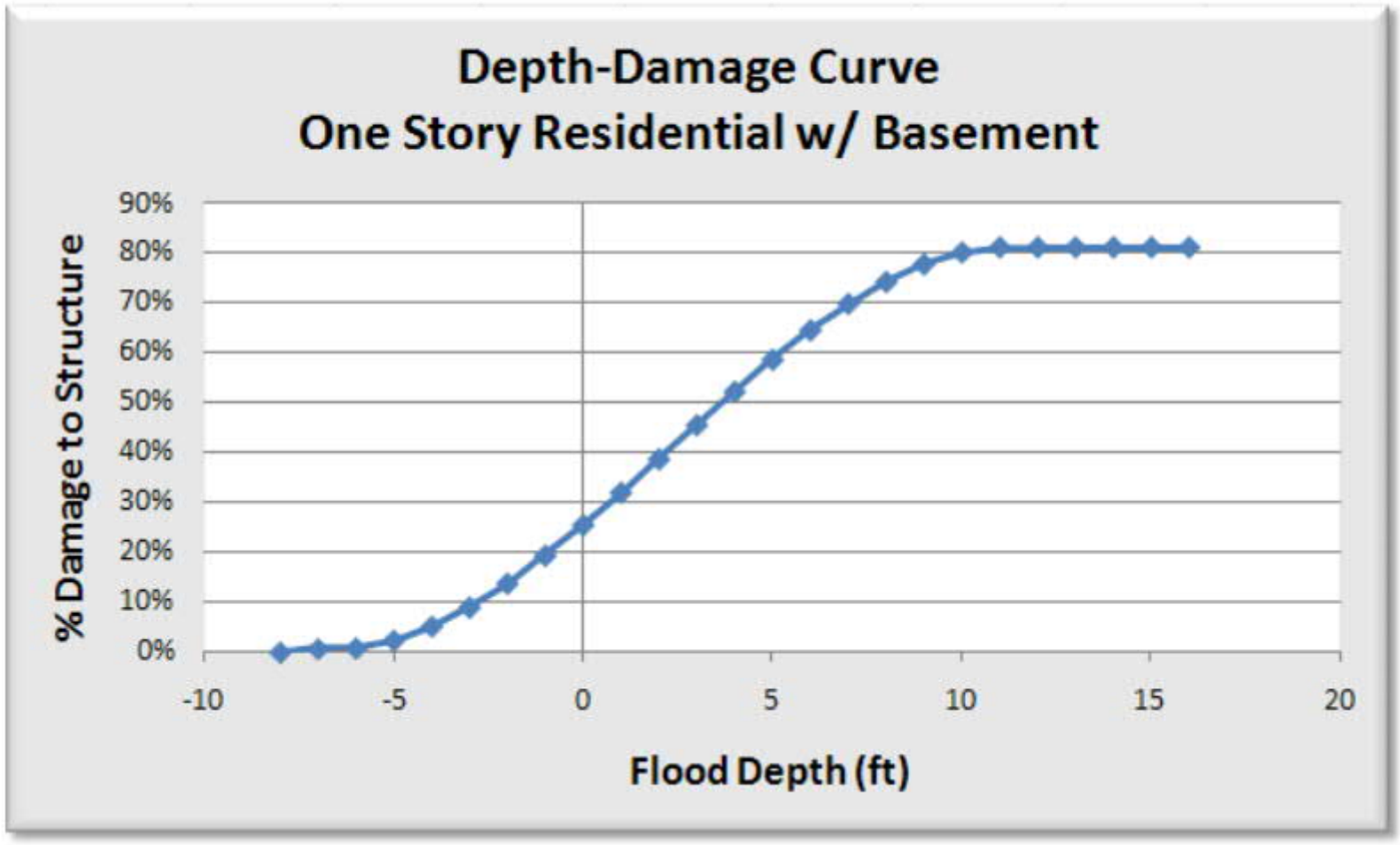
Effects Of Hurricane Sandy Linger In Small-Town Crisfield, Md.

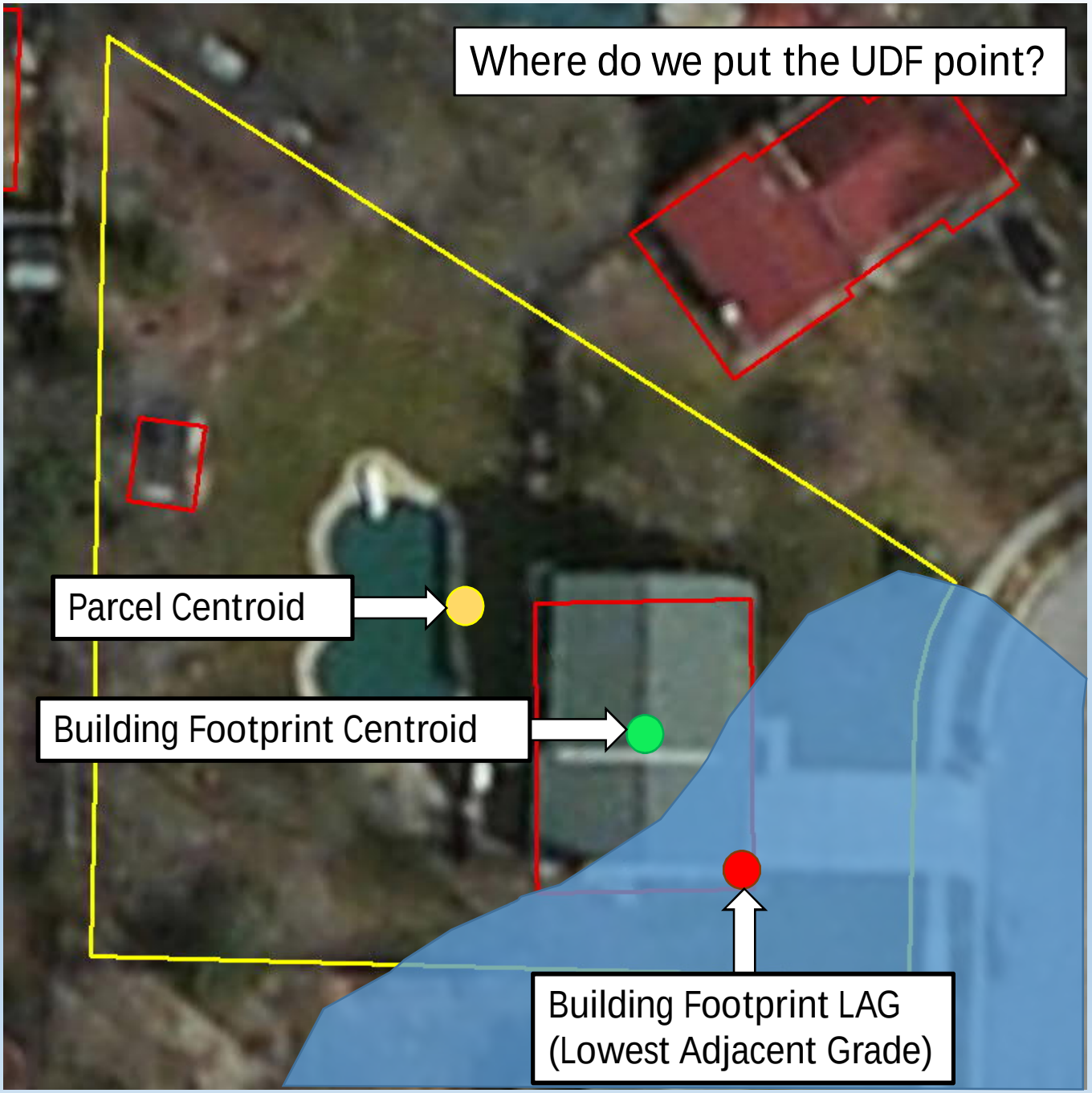
UDF Points – Crisfield, Maryland

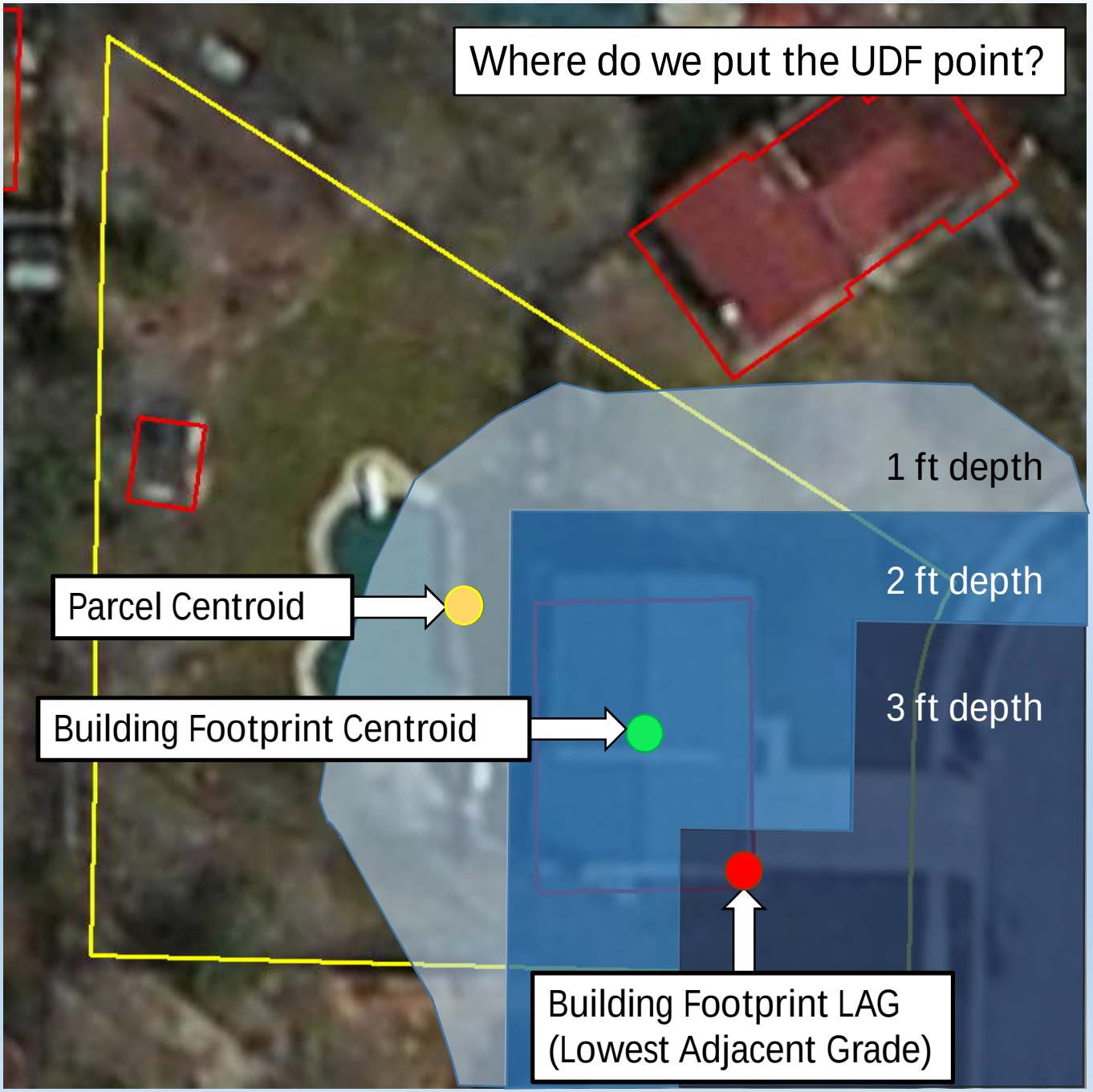
Required Information for UDF Analysis

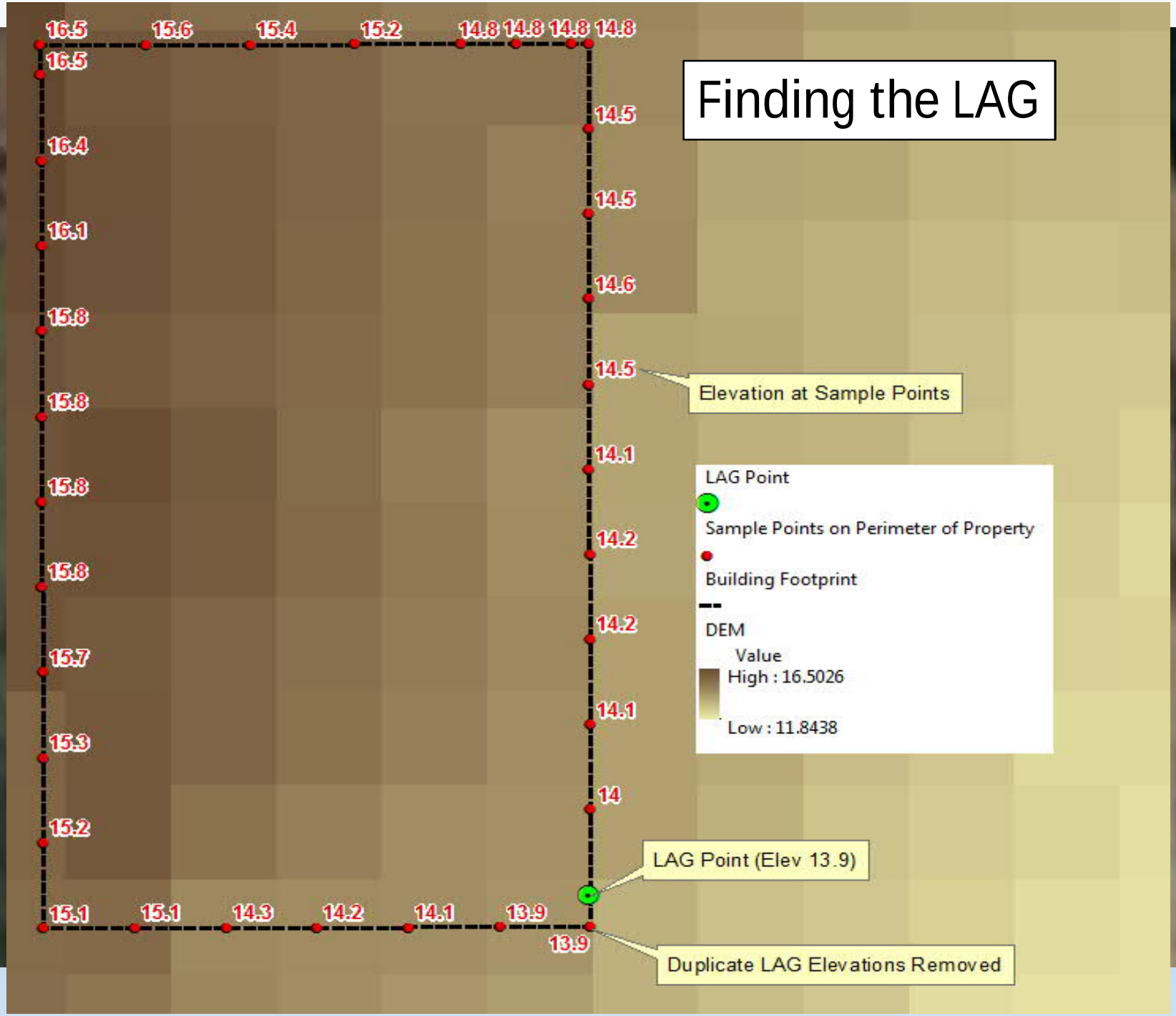
Attribute	Description
Building Type	Residential, commercial, other
Building Cost	Assessed value of building
Foundation Type	e.g. pile, slab on grade, crawl space, basement
First Floor Height	Height of first floor of building above ground
Building Type	Materials used to construct building (e.g. wood, concrete, masonry)
Year Built	Year that structure was built
Number of Stories	
Latitude/Longitude	Location of UDF point
Building Size	Area of structure in square feet

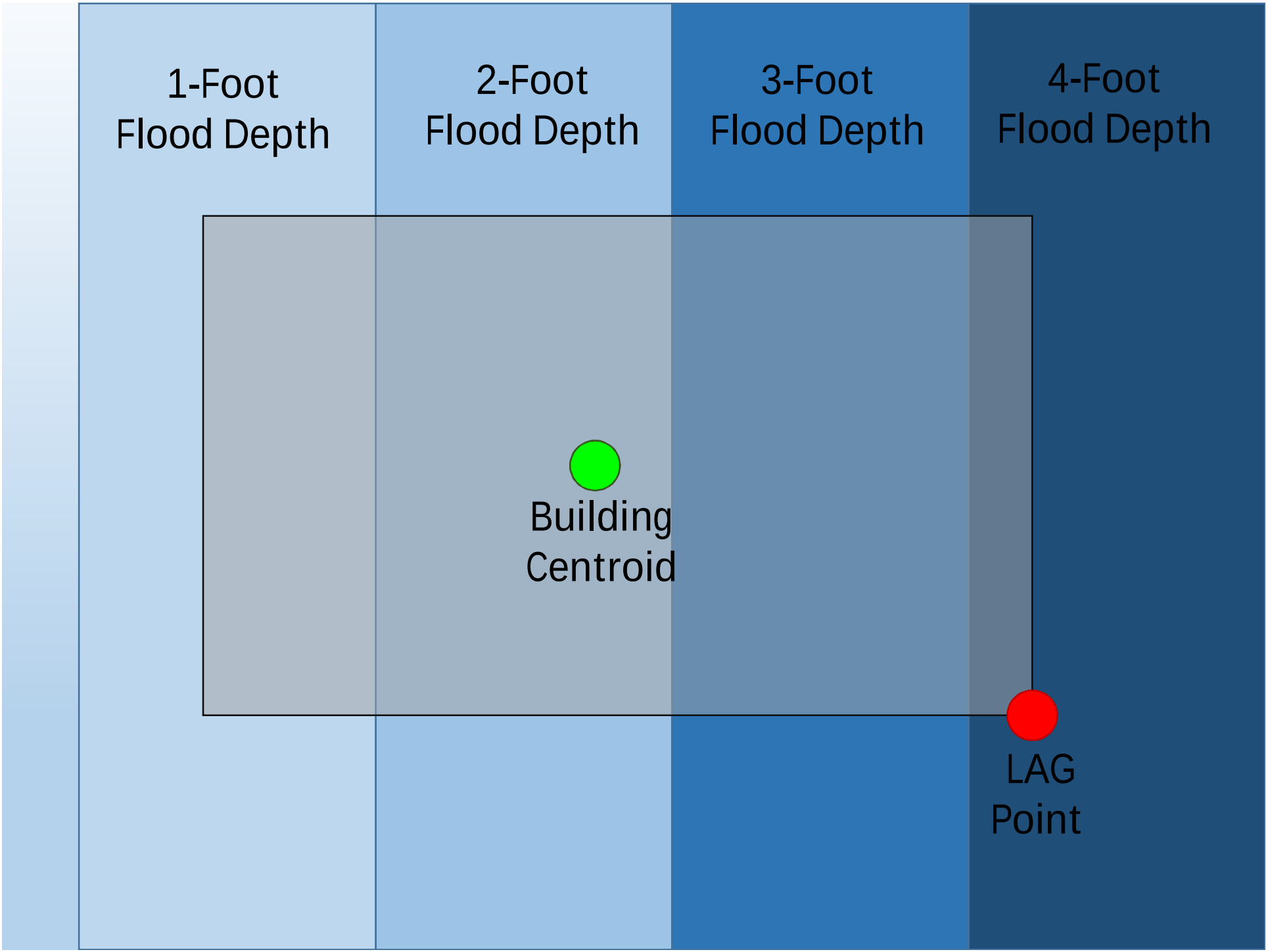
Figure 9: Example depth-damage relationship:
United States Army Corps of Engineers, *Economic Guidance Memo #04-01*, October 2003

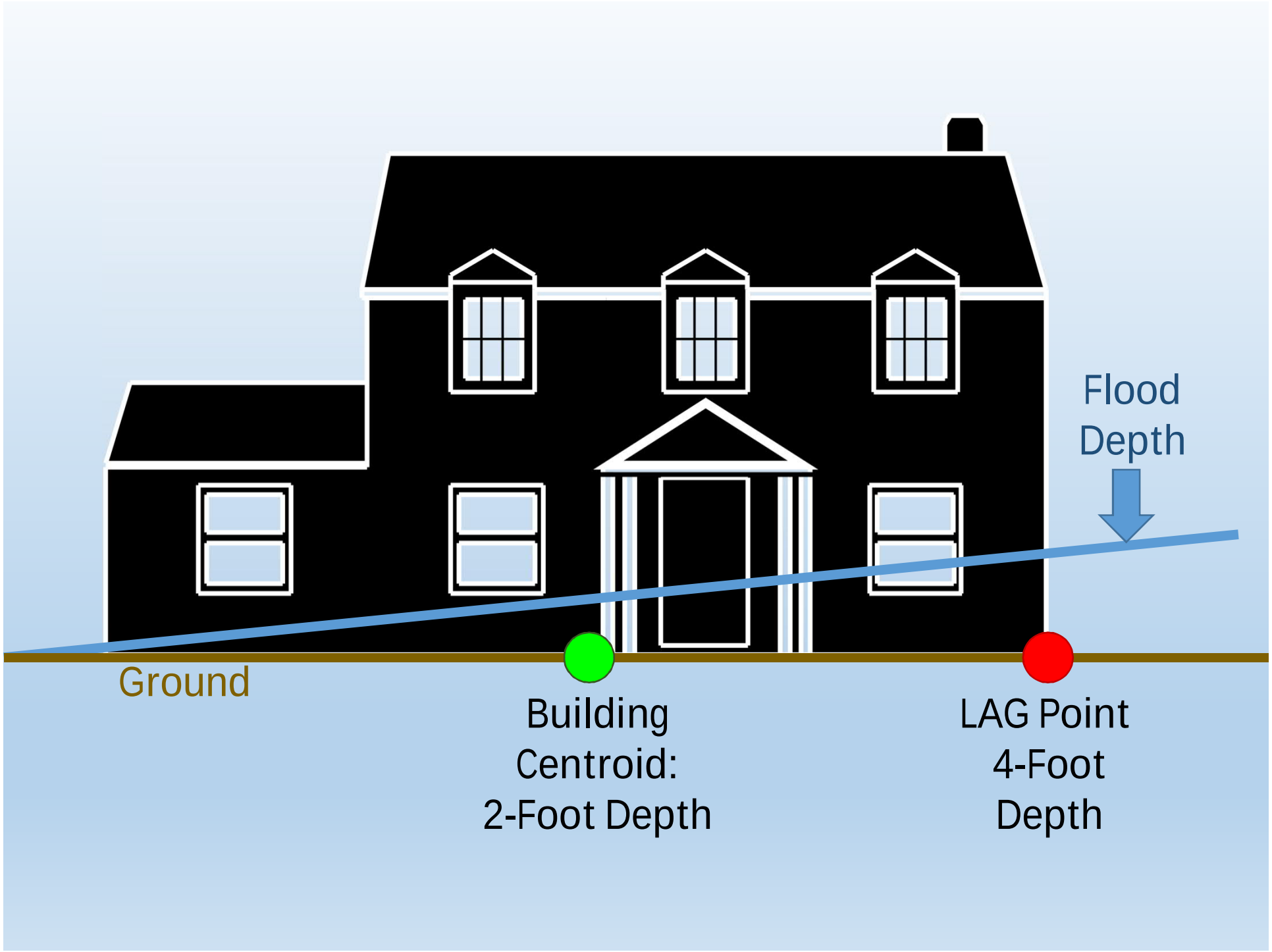


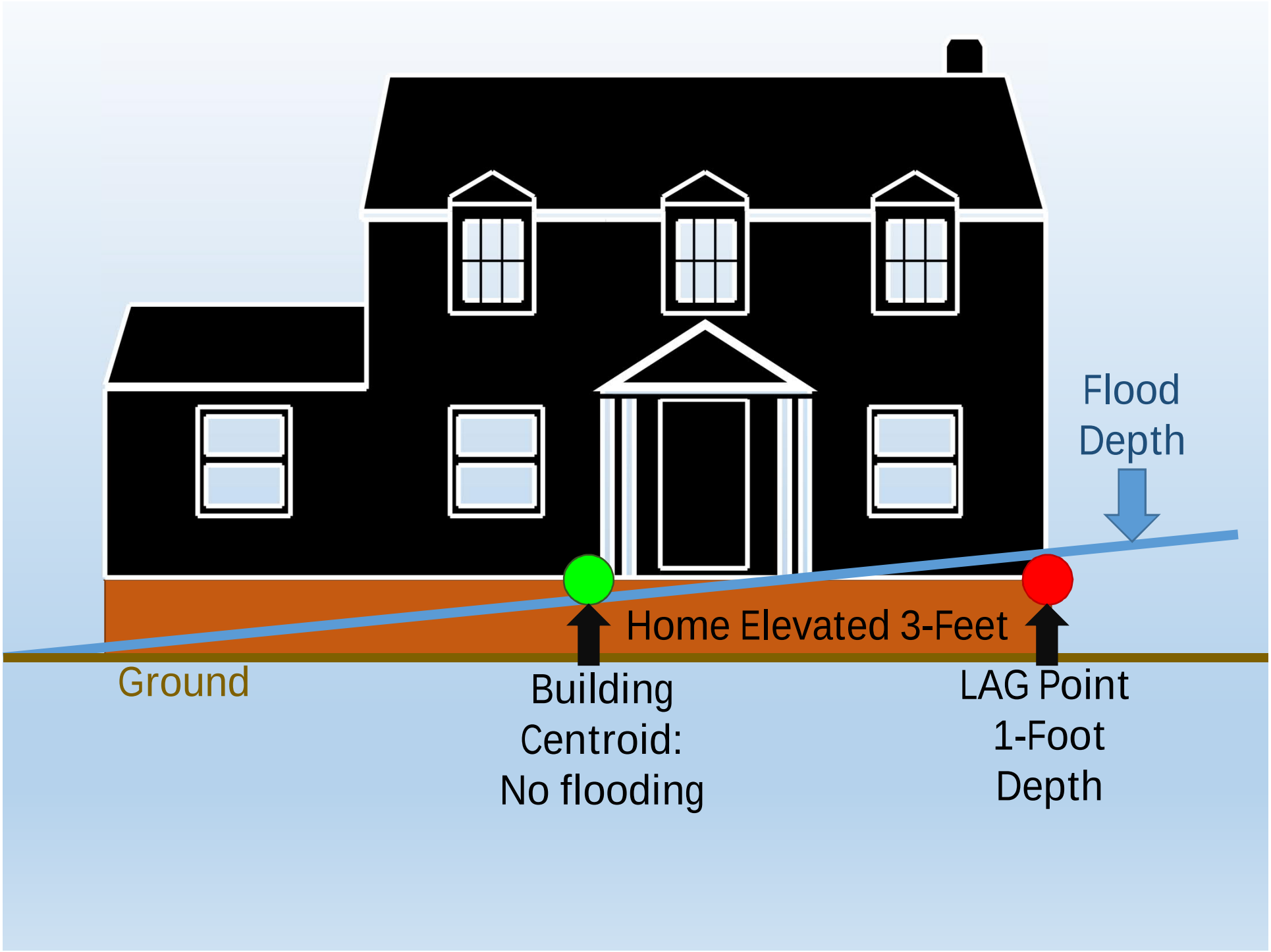

Where do we put the UDF point?
Parcel Centroid
Building Footprint Centroid
Building Footprint LAG
(Lowest Adjacent Grade)


Where do we put the UDF point?
1 ft depth
2 ft depth
3 ft depth
Parcel Centroid
Building Footprint Centroid
Building Footprint LAG
(Lowest Adjacent Grade)


Finding the LAG
16.5
15.6
15.4
15.2
14.8
14.8
14.8
14.8
16.5
14.5
16.4
14.5
16.1
14.6
15.8
14.5
Elevation at Sample Points
15.8
14.1
15.8
14.2
15.8
14.2
15.7
14.1
15.3
14
15.2
LAG Point (Elev 13.9)
15.1
15.1
14.3
14.2
14.1
13.9
13.9
Duplicate LAG Elevations Removed
LAG Point
Sample Points on Perimeter of Property
Building Footprint
DEM
Value
High : 16.5026
Low : 11.8438

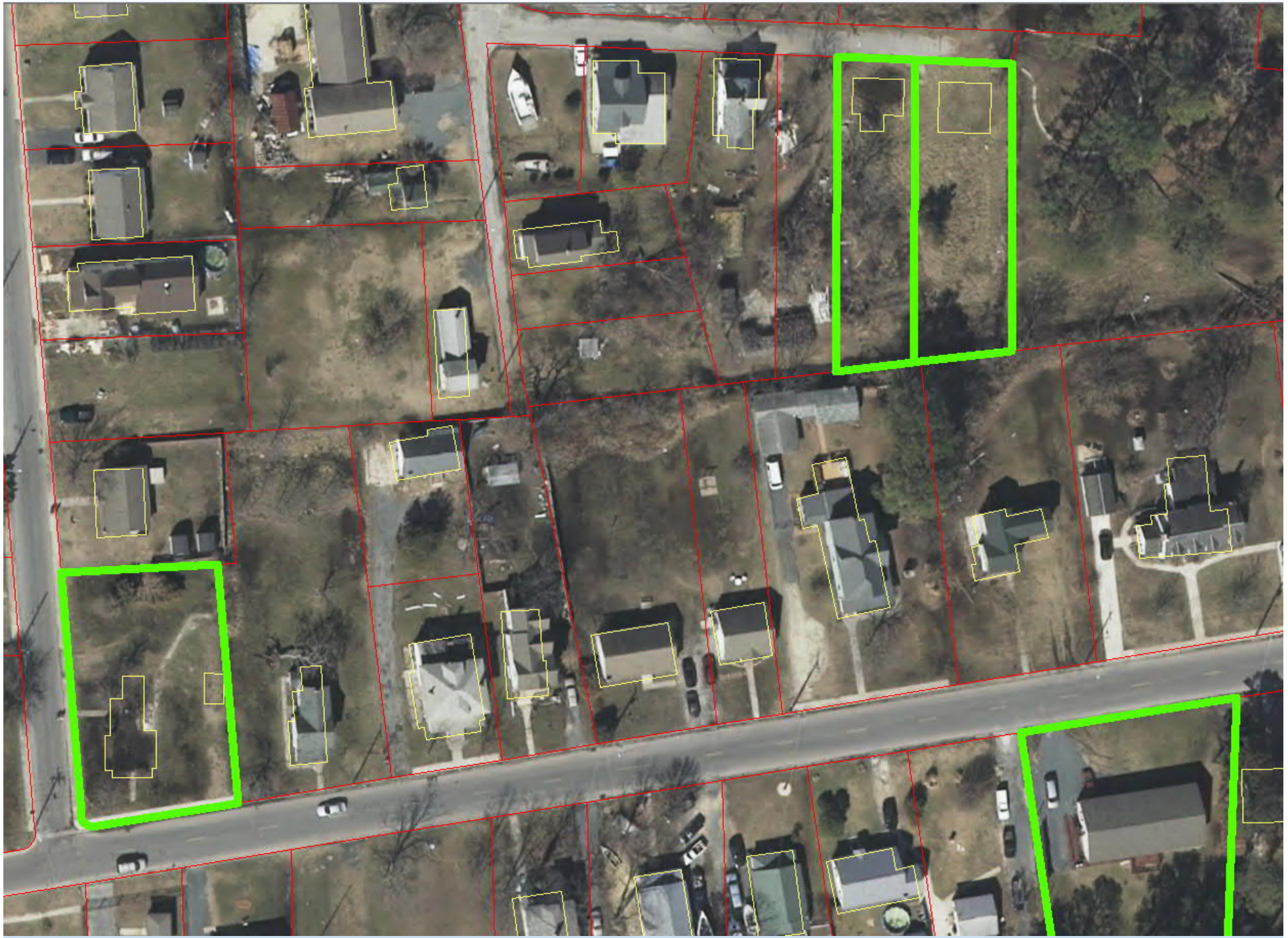

1-Foot
Flood Depth
2-Foot
Flood Depth
3-Foot
Flood Depth
4-Foot
Flood Depth
Building
Centroid
LAG
Point


Flood
Depth
Ground
Building
Centroid:
2-Foot Depth
LAG Point
4-Foot
Depth


Flood
Depth
Home Elevated 3-Feet
Ground
Building
Centroid:
No flooding
LAG Point
1-Foot
Depth

Adjustments to the UDF Points

- Attribution of missing data
- Adjusting point based on imagery if building footprints are erroneous
- Determining where to place UDF point if multiple buildings are on parcel
  - Identifying main building
- Adjusting UDF points and attributes in unusual circumstances
  - Mixed-use buildings
  - Multi-story condominiums



UDF Point Placement Case Study-
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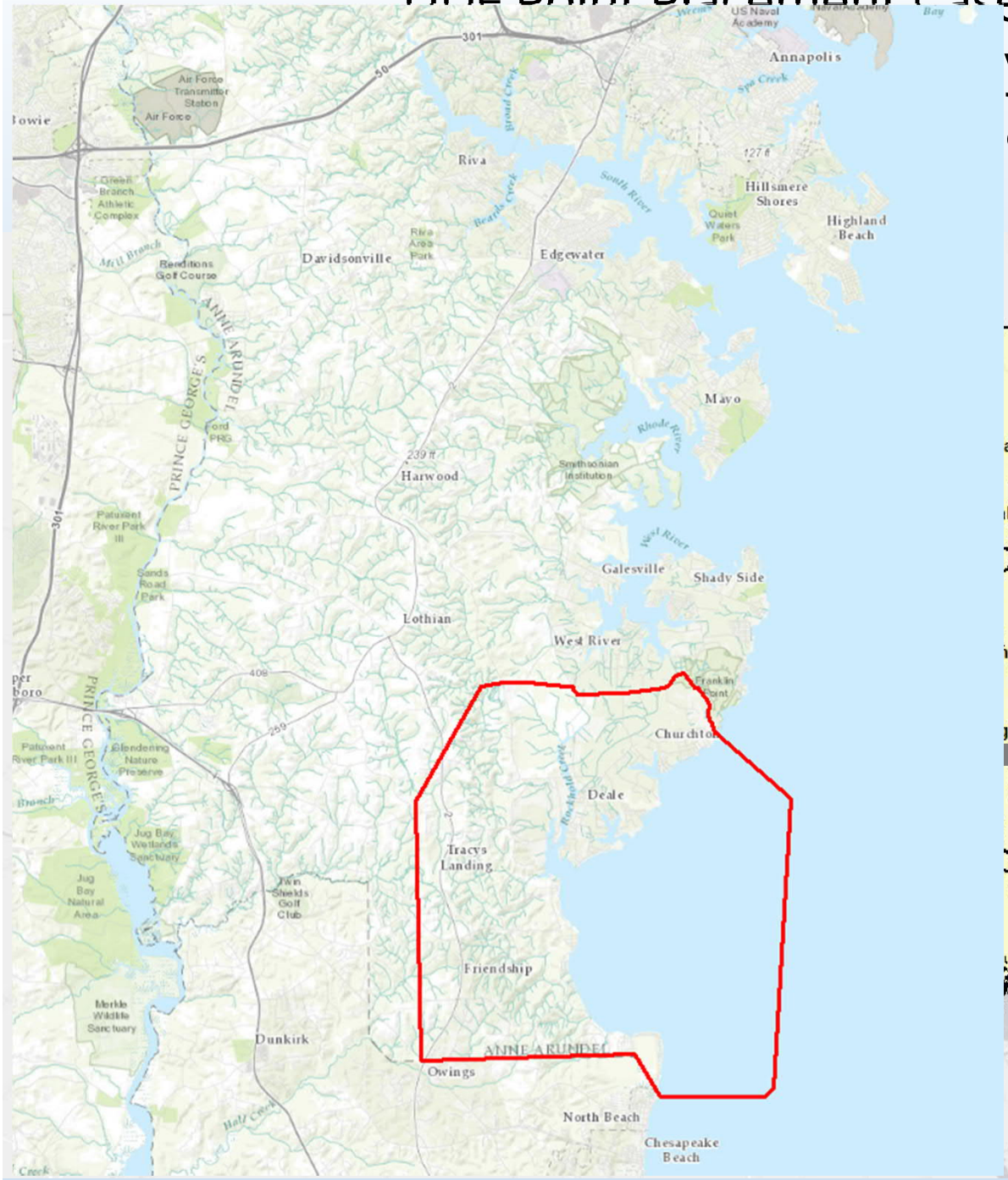
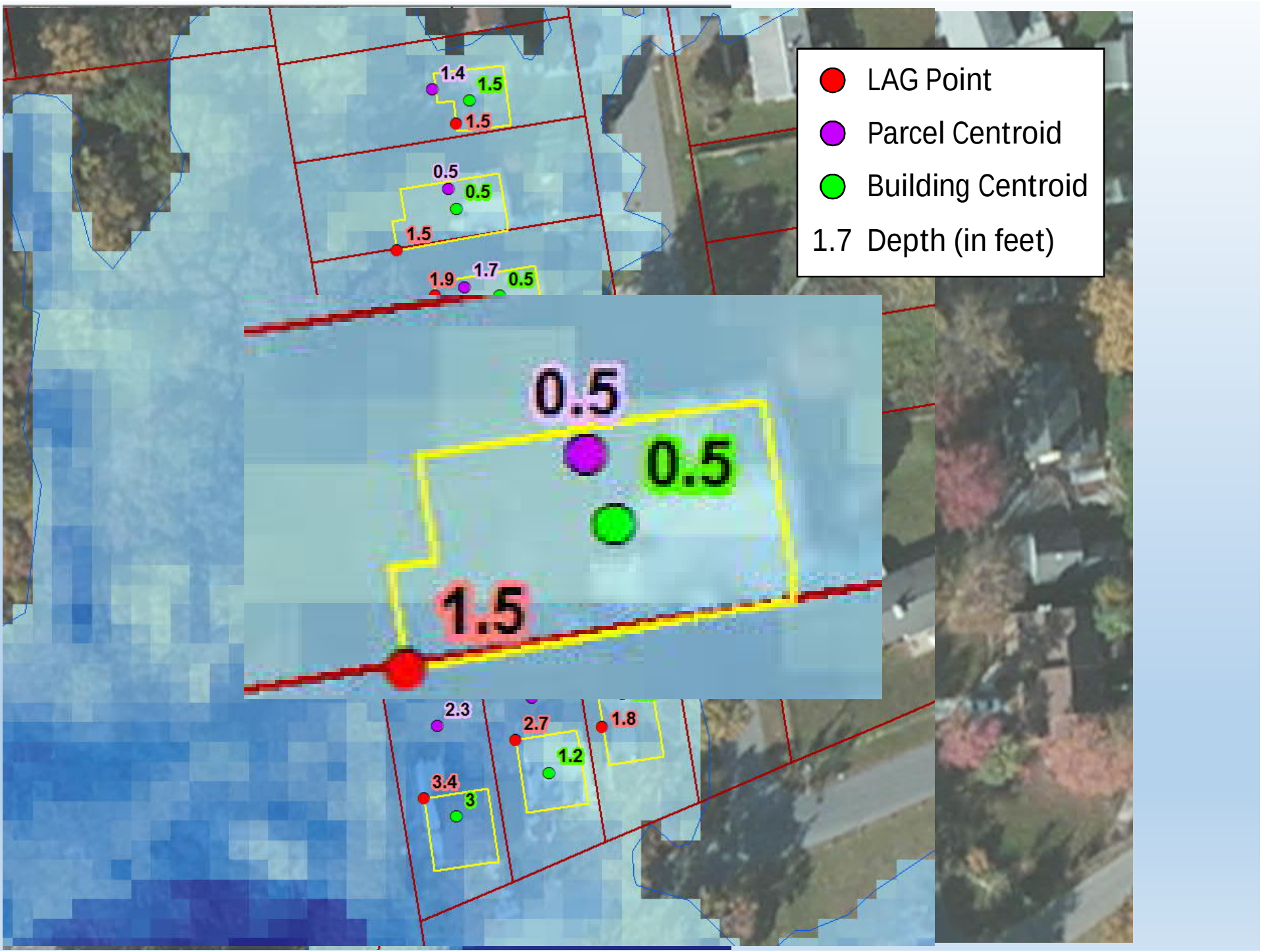
arcel Centroids, and




LAG Point
Parcel Centroid
Building Centroid
1.7 Depth (in feet)
1.4
1.5
1.5
0.5
0.5
1.5
1.9
1.7
0.5
0.5
0.5
1.5
2.3
2.7
1.8
1.2
3.4
3

UDF Flood Estimates: Southern Anne Arundel County Study Area

	LAG Points	Building Centroids	Parcel Centroids
Number of UDF Points in Coastal Floodplain	343	195	240
Average Depth at UDF Point	1.7 feet	1.3 feet	1.5 feet
Total Losses	$10,100,000	$6,800,000	$7,400,0000

2010 AAL Loss Estimate for Study Area (GBS): $55,278,000

Summary of Results

- When compared to UDF studies, GBS studies tend to overestimate flood losses in Hazus
  - In many cases these differences can be extremely large
- Flood losses for UDF studies may be better estimated in Hazus by placing the UDF points on the lowest adjacent grade (LAG) of the main building
  - Method captures more buildings and higher flood depths in floodplain when compared to parcel or building centroids
  - Some manual adjustment of points is usually necessary to achieve the most accurate loss estimates