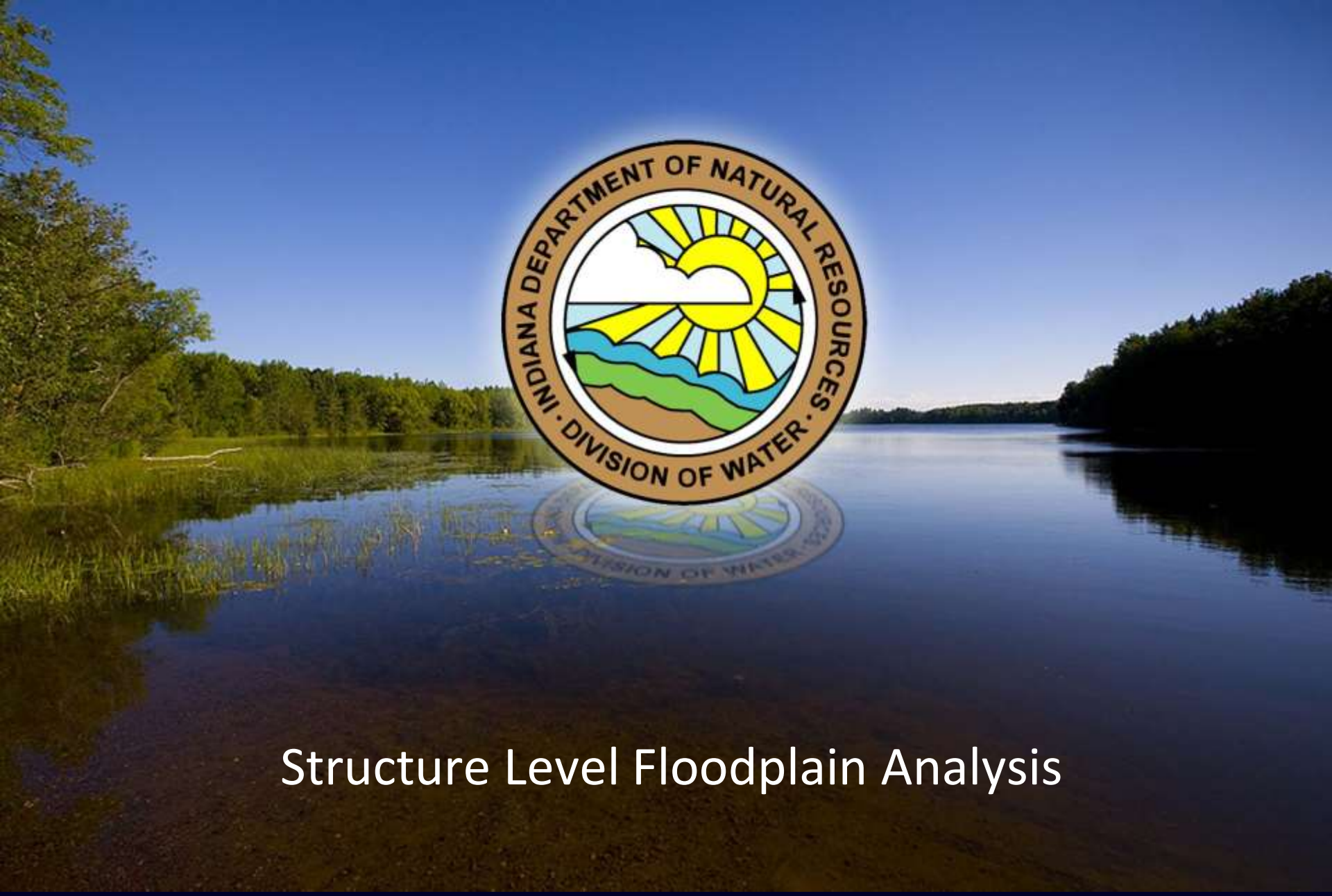


Structure Level Floodplain Analysis

David Knipe
Engineering Service Center

This presentation

- What is it? / Why do this?
- Data sources needed
- GIS analysis tools
- Results and future uses

Traditional Floodplain Mapping

- Floodplain polygon blob based on the 1% chance event “The Regulatory Floodplain”

The National Flood Insurance Program

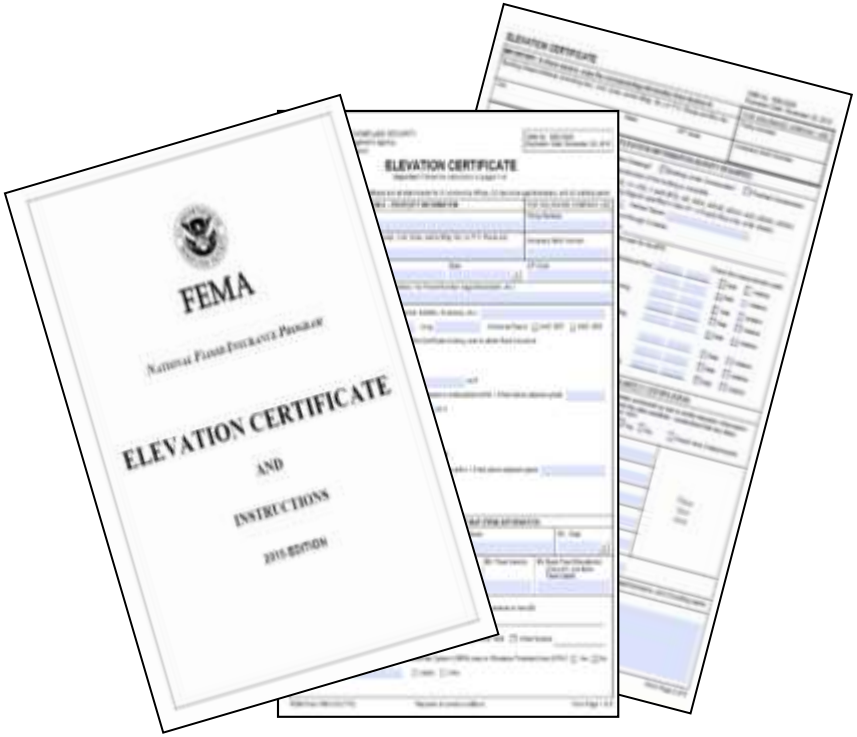
- Generally, structures that are located within the Special Flood Hazard Area and are financed by a federally regulated lender must have flood insurance coverage for the amount of the loan.
- Communities join the NFIP regulate development in floodplain areas – then flood insurance is available in that community

Letters of Map Amendment (LOMA)

- The NFIP Regulations require that the lowest ground (natural grade) touching the structure be **equal to or higher than the BFE for a LOMA removal**
- A LOMA for a property / structure is a removal from the SFHA, and therefore the mandatory insurance requirement is waived (but insurance is still available!!!)
- Still, it's binary – in or out of the floodplain, based on elevation

The Elevation Certificate

- Administrative tool of the NFIP
- Required to rate post-FIRM and some pre-FIRM buildings for flood insurance
- Used by communities to determine compliance with local floodplain management ordinances
- Required for an application for a LOMA.
- Summary of elevations at a structure, compared with the base flood elevations
- Must be filled out and stamped by a surveyor (common) or an engineer or architect (not-common)

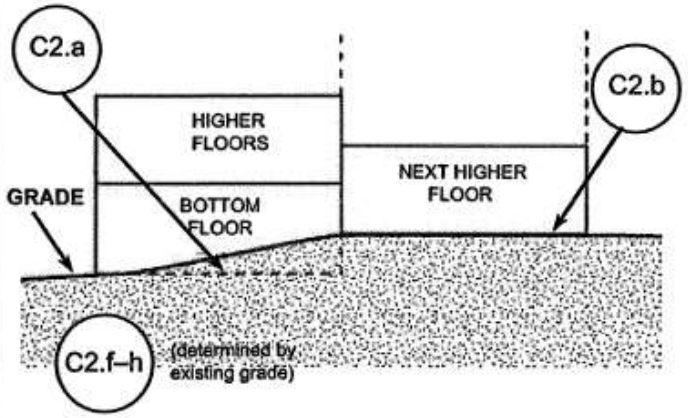


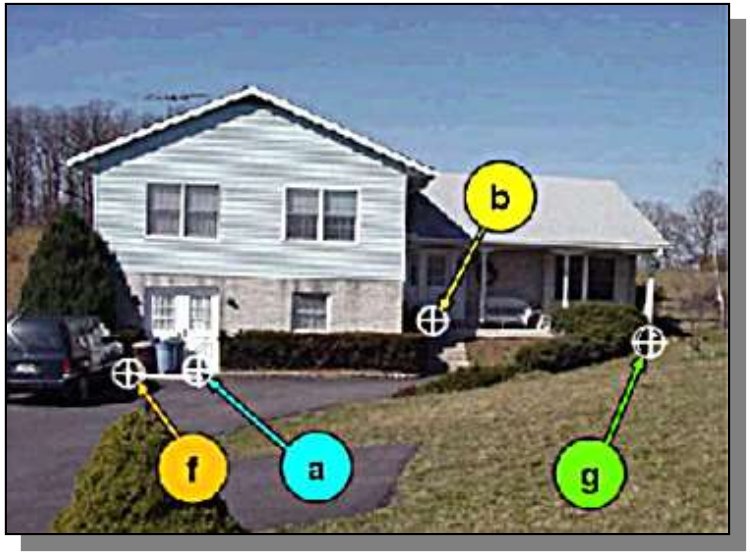
The Elevation Certificate

DIAGRAM 3

All split-level buildings that are slab-on-grade, either detached or row type (e.g., townhouses); with or without attached garage.

Distinguishing Feature – The bottom floor (excluding garage) is at or above ground level (grade) on at least 1 side.*





Section C – Building Elevation Information (survey required)

ELEVATION CERTIFICATE

OMB No. 1660-0008
Expiration Date: November 30, 2018

IMPORTANT: In these spaces, copy the corresponding information from Section A.			FOR INSURANCE COMPANY USE
Building Street Address (including Apt., Unit, Suite, and/or Bldg. No.) or P.O. Route and Box No.			Policy Number:
City	State	ZIP Code	Company NAIC Number

SECTION C – BUILDING ELEVATION INFORMATION (SURVEY REQUIRED)

C1. Building elevations are based on: ☐ Construction Drawings* ☐ Building Under Construction* ☐ Finished Construction

*A new Elevation Certificate will be required when construction of the building is complete.

C2. Elevations – Zones A1–A30, AE, AH, A (with BFE), VE, V1–V30, V (with BFE), AR, AR/A, AR/AE, AR/A1–A30, AR/AH, AR/AO. Complete Items C2.a–h below according to the building diagram specified in Item A7. In Puerto Rico only, enter meters.

Benchmark Utilized: _____ Vertical Datum: _____

Indicate elevation datum used for the elevations in items a) through h) below.

☐ NGVD 1929 ☐ NAVD 1988 ☐ Other/Source: _____

Datum used for building elevations must be the same as that used for the BFE.

		Check the measurement used.	
a) Top of bottom floor (including basement, crawlspace, or enclosure floor)	_____ . _____	☐ feet	☐ meters
b) Top of the next higher floor	_____ . _____	☐ feet	☐ meters
c) Bottom of the lowest horizontal structural member (V Zones only)	_____ . _____	☐ feet	☐ meters
d) Attached garage (top of slab)	_____ . _____	☐ feet	☐ meters
e) Lowest elevation of machinery or equipment servicing the building (Describe type of equipment and location in Comments)	_____ . _____	☐ feet	☐ meters
f) Lowest adjacent (finished) grade next to building (LAG)	_____ . _____	☐ feet	☐ meters
g) Highest adjacent (finished) grade next to building (HAG)	_____ . _____	☐ feet	☐ meters
h) Lowest adjacent grade at lowest elevation of deck or stairs, including structural support	_____ . _____	☐ feet	☐ meters

Elevation Certificate Section C

- Section C should be completed if the building is located in any of Zones A1-A30, AE, AH, A (with BFE), or AR.
- C1. Must indicate whether elevations are based on construction drawings, a building under construction, or finished construction.
- Item C2. A field survey is required for Items C2. a-h. Most control networks will assign a unique identifier for each benchmark.

NFIP in summary

- Floodplain designation is based on a binary in / out determination
- Property owners fight this – with LOMA's to get out of insurance requirements
- But a LOMA doesn't change anything physically

LiDAR for LOMA's(2017)

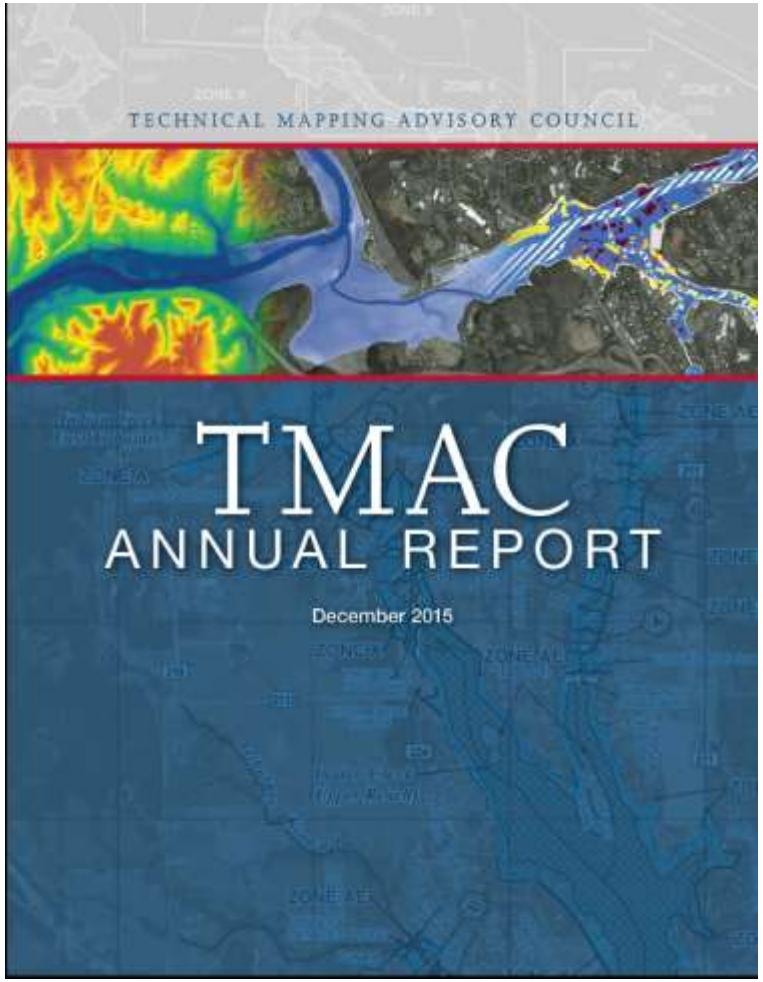
- **Risk Map Standard 199 (proposed):**

LOMC submittals must include certifications by a licensed professional authorized to certify the data under state law, except when LiDAR is provided to satisfy the lowest adjacent grade (LAG) requirements for LOMA's.

SID #	Primary Keyword	Implementation	Original Standard	Revised/New Standard
199	Letter of Map Change (LOMC)	Effective immediately	LOMC submittals must include certifications by a licensed professional authorized to certify the data under state law.	LOMC submittals must include certifications by a licensed professional authorized to certify the data under state law, except when LiDAR is provided to satisfy the lowest adjacent grade (LAG) requirements for LOMAs.

TMAC Recommendations (2015)

- **Recommendation 14**: FEMA, and its mapping partners including the private sector, should transition to a flood risk assessment focus that is structure specific. Where data are available, FEMA and its partners should contribute information and expertise consistent with their interests, capabilities, and resources towards this new focus.



Structure Specific Risk Assessment

- Not binary – a more nuanced method for determining risk at a structure
- Based on a series of flood profiles, not just on the 1% (or regulatory) profile
- Can be expressed in a number of ways (AAL, flood risk rating)

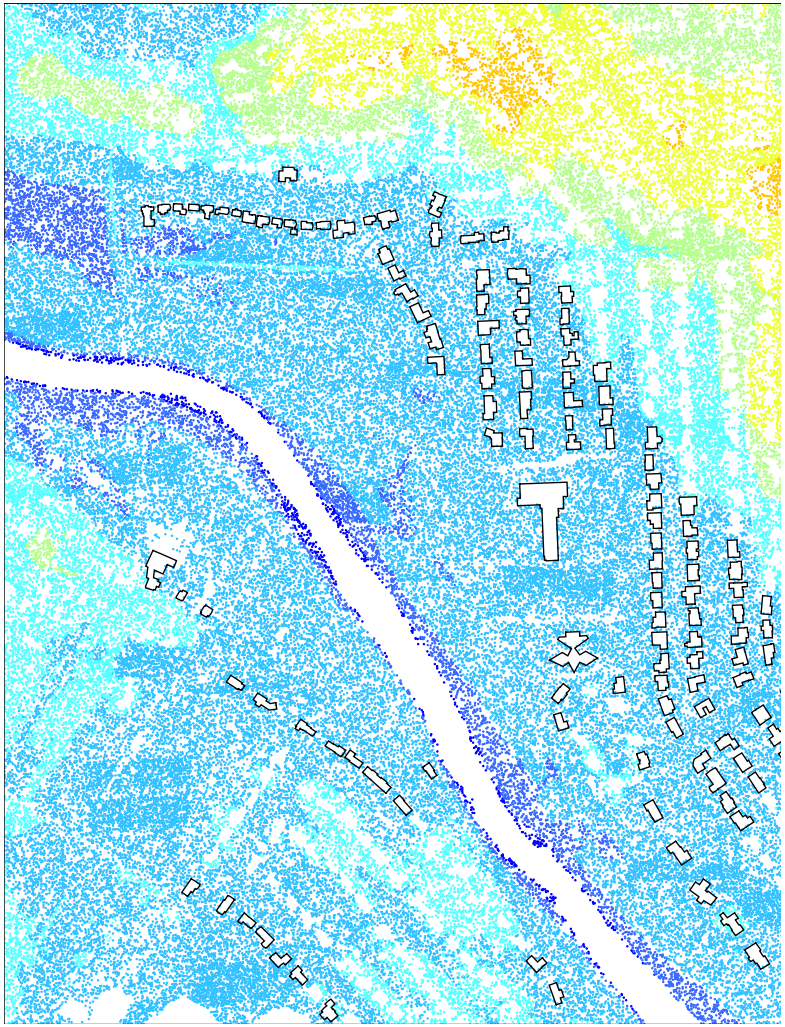
What do you need to do this?

- Hydraulic Floodplain study (with multiple profiles)
- Replacement Costs (for AAL and cost-based evaluations)
- Elevation Certificate

But what if you don't have an EC for a structure?????

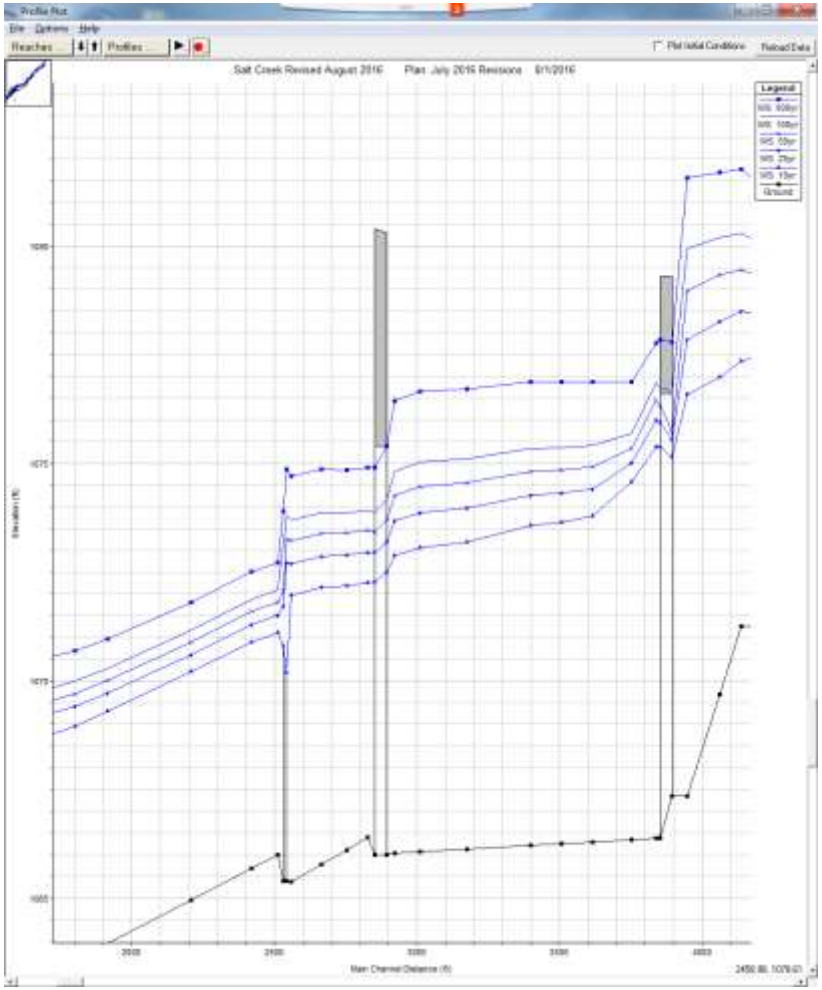
Using the LiDAR point cloud

- Trying to estimate the Lowest Adjacent Grade to a structure
- Use Ground “Last Return” points
- Use building outlines as a buffer



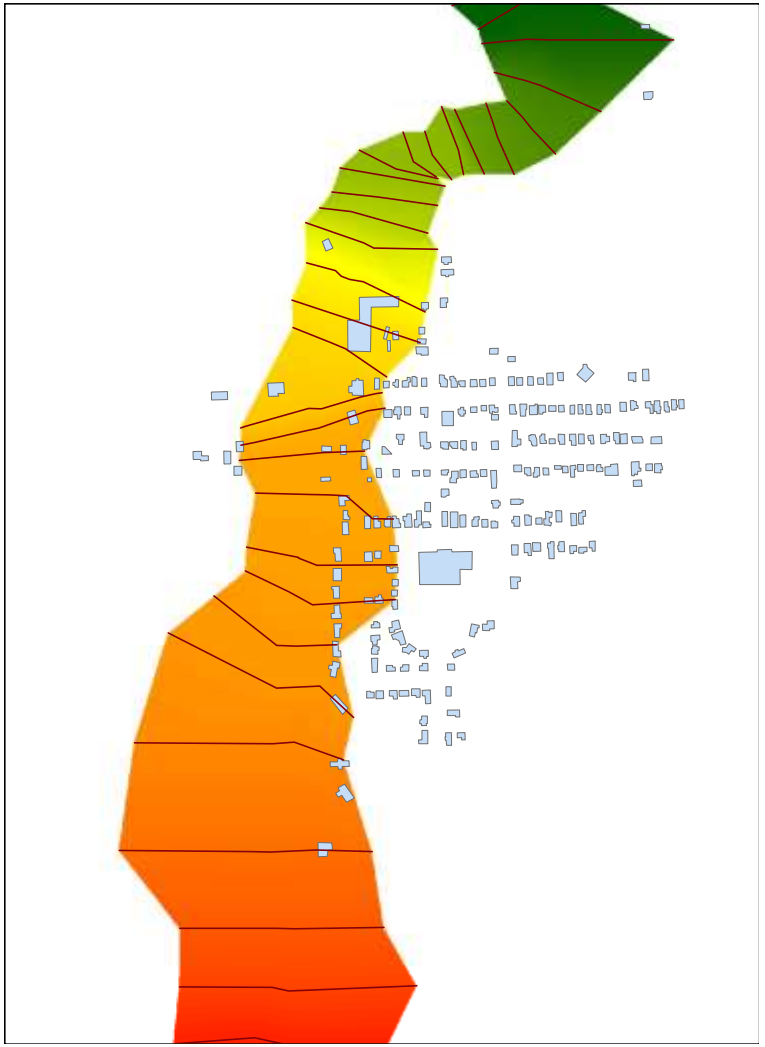
The Analysis

- Using Traditional Floodplain Analysis
- 5 “Risk MAP” profiles (10%, 4%, 2%, 1%, 0.2%)



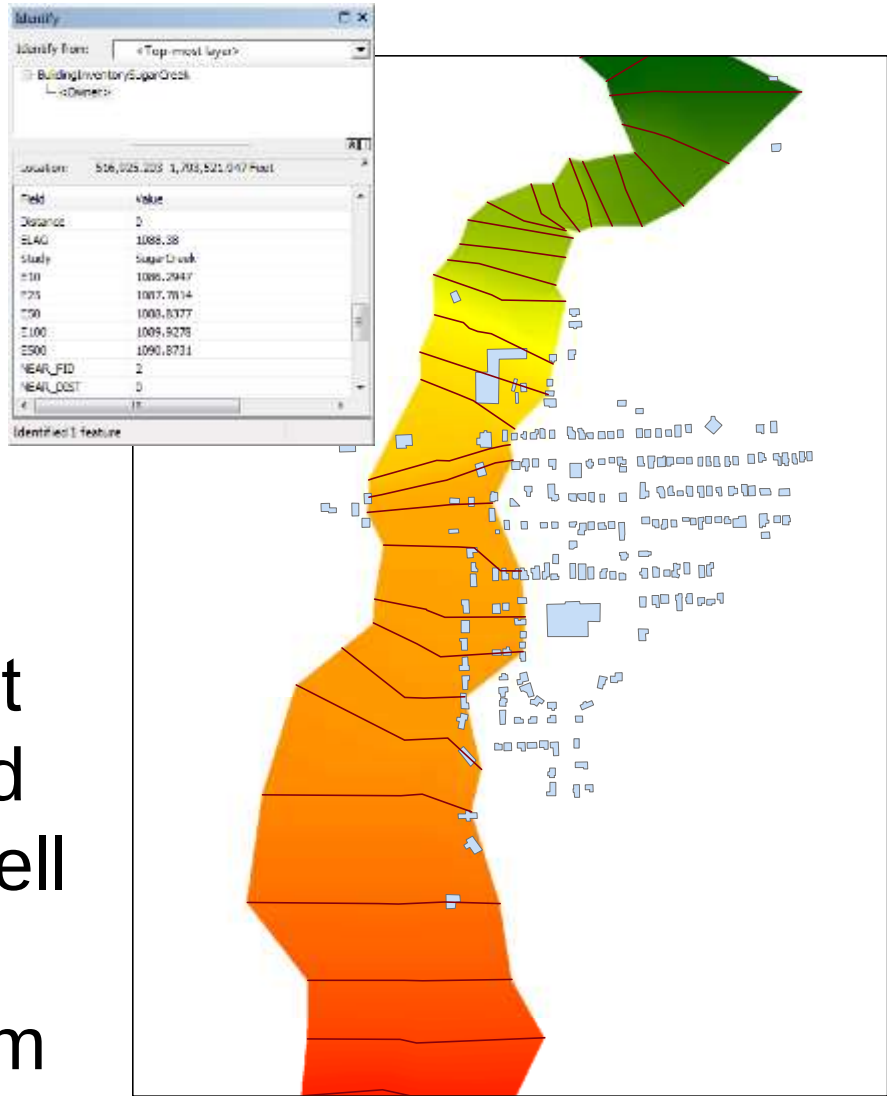
The Analysis

- Create Water Surface Grids from hydraulic model
- Clip grid to cross section limits



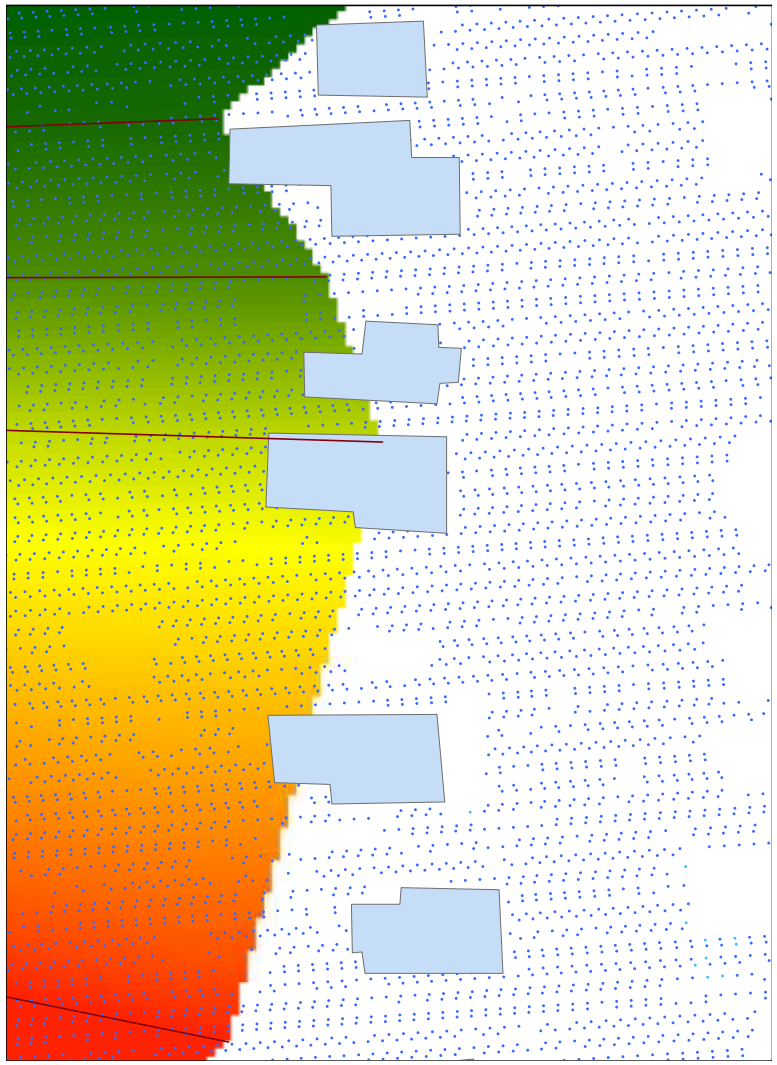
The Analysis

- If building outline intersects – interpolate values (use highest)
- If building outline doesn't intersect – find nearest grid cell
- Attribute 5 elevations from 5 profiles



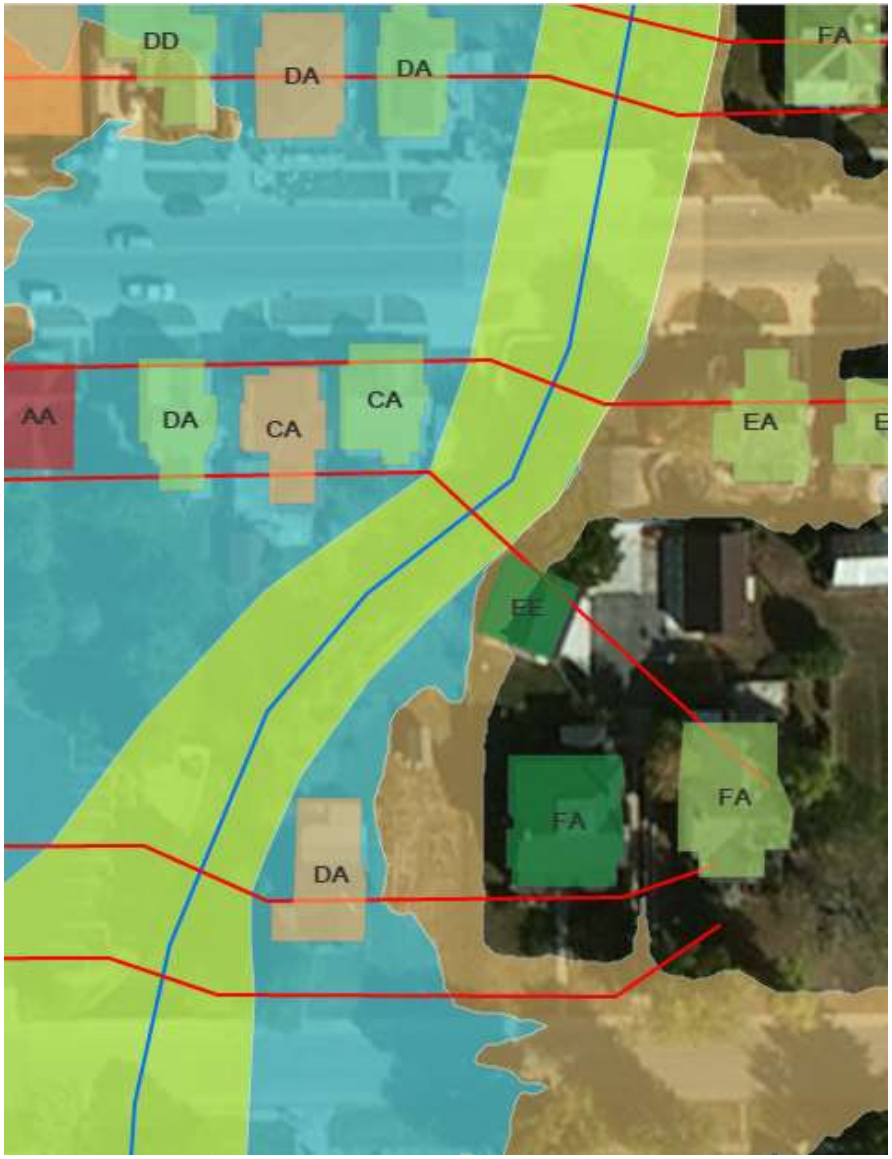
Estimated Lowest Adjacent Grade

- LiDAR point cloud “Bare Earth” or “Last Return”
- Buffer building outlines by .25 feet – find lowest point value in that buffer
- Move out .25 feet if nothing found



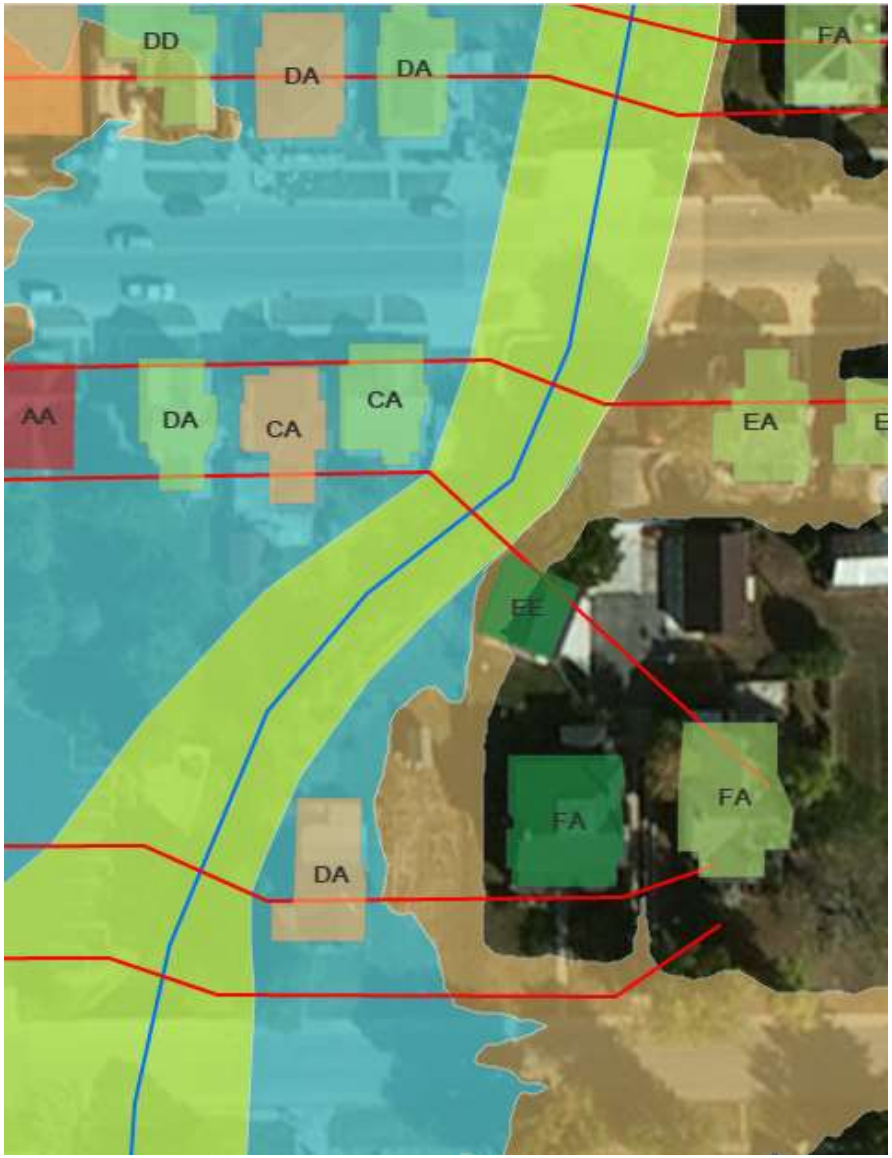
Flood Risk Rating

- First Letter based on ELAG only
- A < 10%
- B between 10% and 4%
- C between 4% and 2%
- D between 2% and 1%
- E between 1% and 0.2%
- F > 0.2%



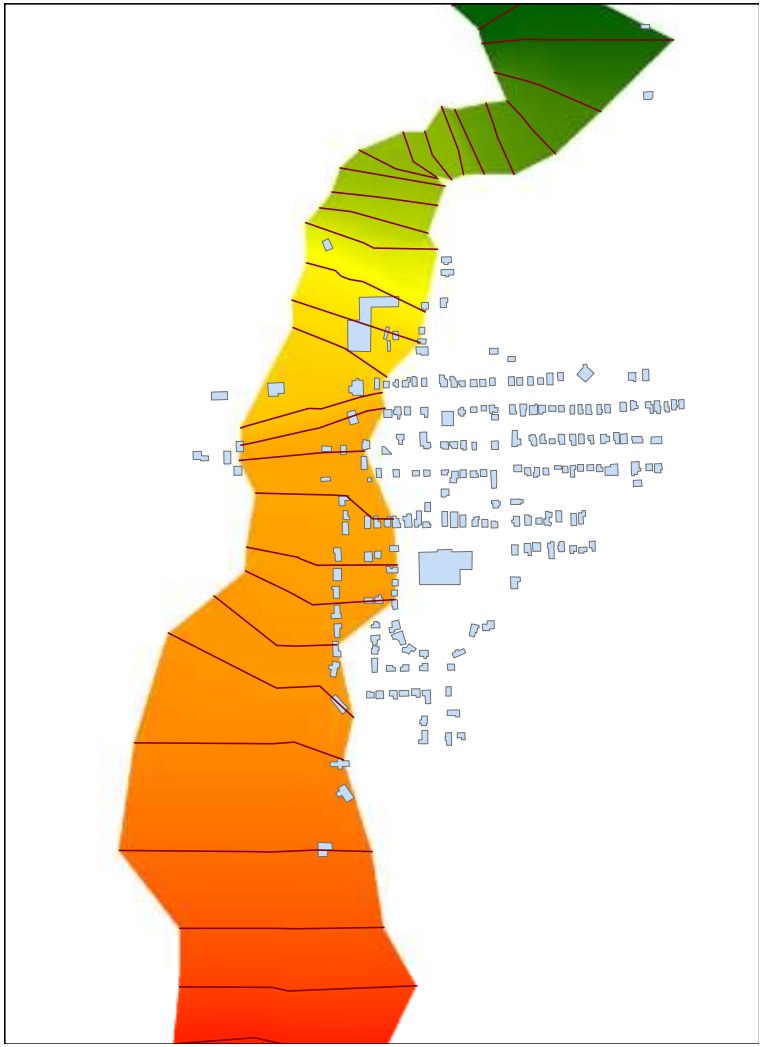
Flood Risk Rating

- Second Letter based on ELAG and foundation type
- Slab = ELAG
- Crawl = ELAG – 3’
- Basement = ELAG – 8’
- Letter grades then as before

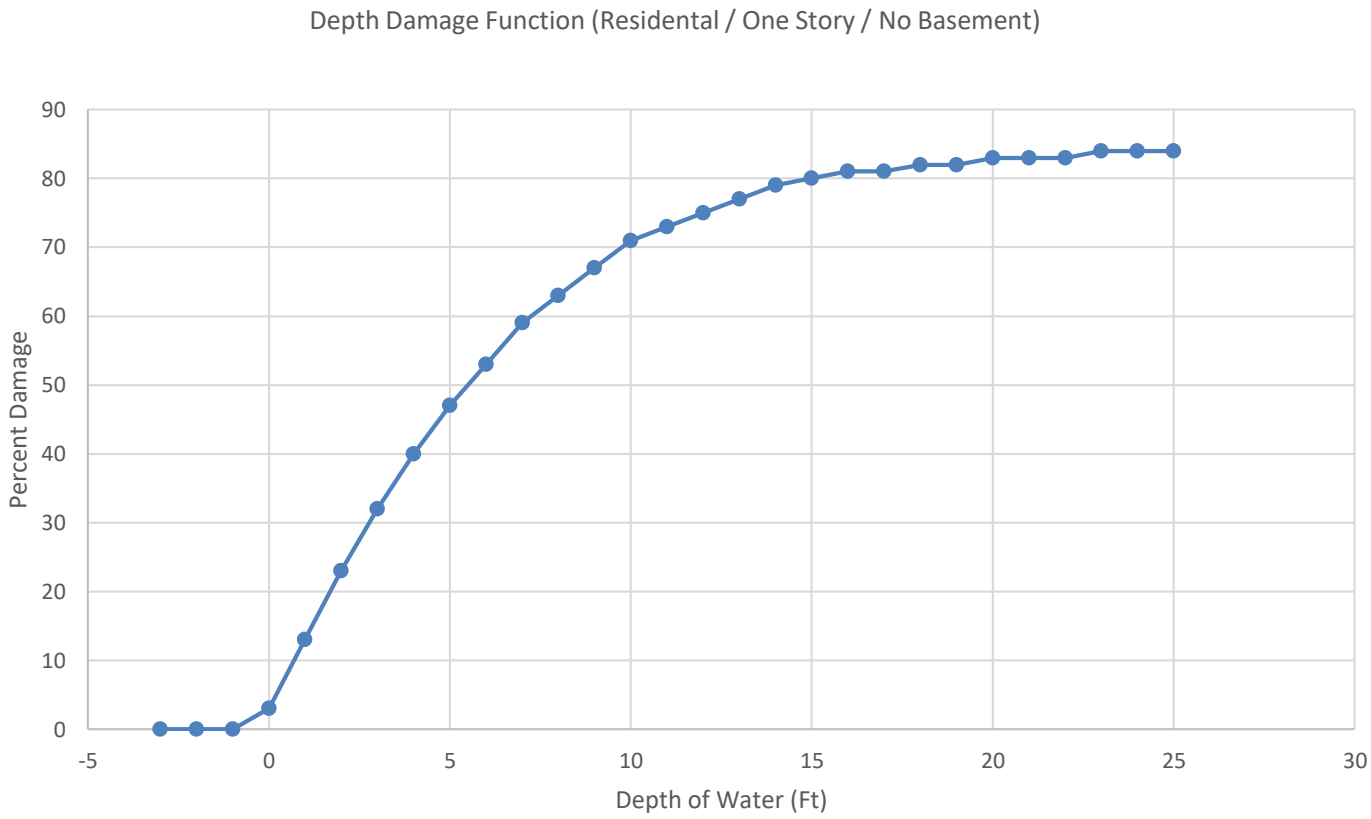


Average Annualized Loss Calculation

- Building Information from IDLGF data
- Replacement and Content replacement cost estimated from IDLGF
- Depth / Damage curves from Hazus / FEMA / USACE

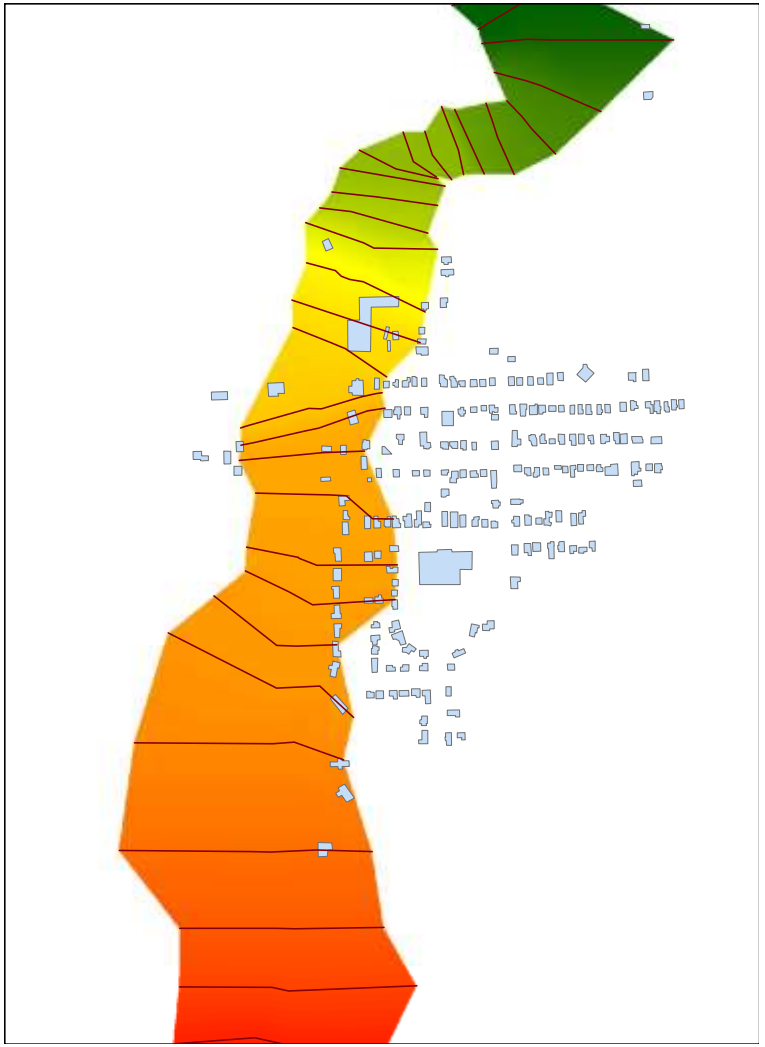


Depth Damage Functions



Average Annualized Loss Calculation

- Sum of amount of damage multiplied by return interval
- For 5 profiles:
- $D_{10} * .1 + D_{25} * .04 + D_{50} * .02 + D_{100} * .01 + D_{500} * .002$

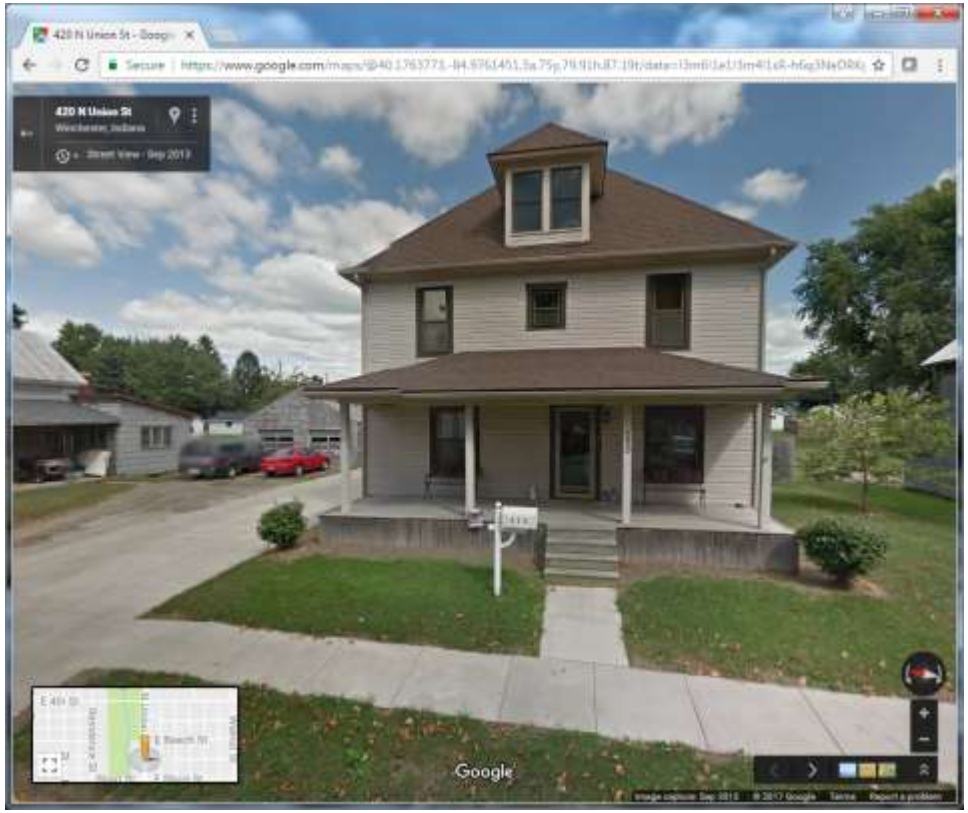


Salt Creek / Sugar Creek in Winchester

[link to AGOL map]

Issues to consider

- Ground truthing with EC's
- Does ELAG = true first floor
- Privacy Act Issues



544 Main Street

LAG:

LiDAR 1093.7
EC 1093.73

- Lowest Adjacent Grade (LAG) to the structure (to the nearest 0.1 foot or meter) 1093.7 ft. (m) S.E. corner
- Elevation of the lowest grade on the property; or within metes and bounds area (to the nearest 0.1 foot or meter) 1093.7 ft. (m)
- Indicate the datum (if different from NGVD 29 or NAVD 88 attach datum conversion) ☐ NGVD 29 ☒ NAVD 88 ☐ Other (add attachment)
- Has FEMA identified this area as subject to land subsidence or uplift? ☒ No ☐ Yes (provide date of current releveling):

544 Main Street

135 Clem Street

LAG:

LiDAR 1094.89
EC 1092.43

a) Top of bottom floor (including basement, crawlspace, or enclosure floor)	1089.21	☒ feet	☐ meters
b) Top of the next higher floor	1097.01	☒ feet	☐ meters
c) Bottom of the lowest horizontal structural member (V Zones only)	_____._____	☐ feet	☐ meters
d) Attached garage (top of slab)	_____._____	☐ feet	☐ meters
e) Lowest elevation of machinery or equipment servicing the building (Describe type of equipment and location in Comments)	1094.70	☒ feet	☐ meters
f) Lowest adjacent (finished) grade next to building (LAG)	1092.43	☒ feet	☐ meters
g) Highest adjacent (finished) grade next to building (HAG)	1094.70	☒ feet	☐ meters
h) Lowest adjacent grade at lowest elevation of deck or stairs, including structural support	_____._____	☐ feet	☐ meters

135 Clem Street