RiskMAP
Increasing Resilience Together

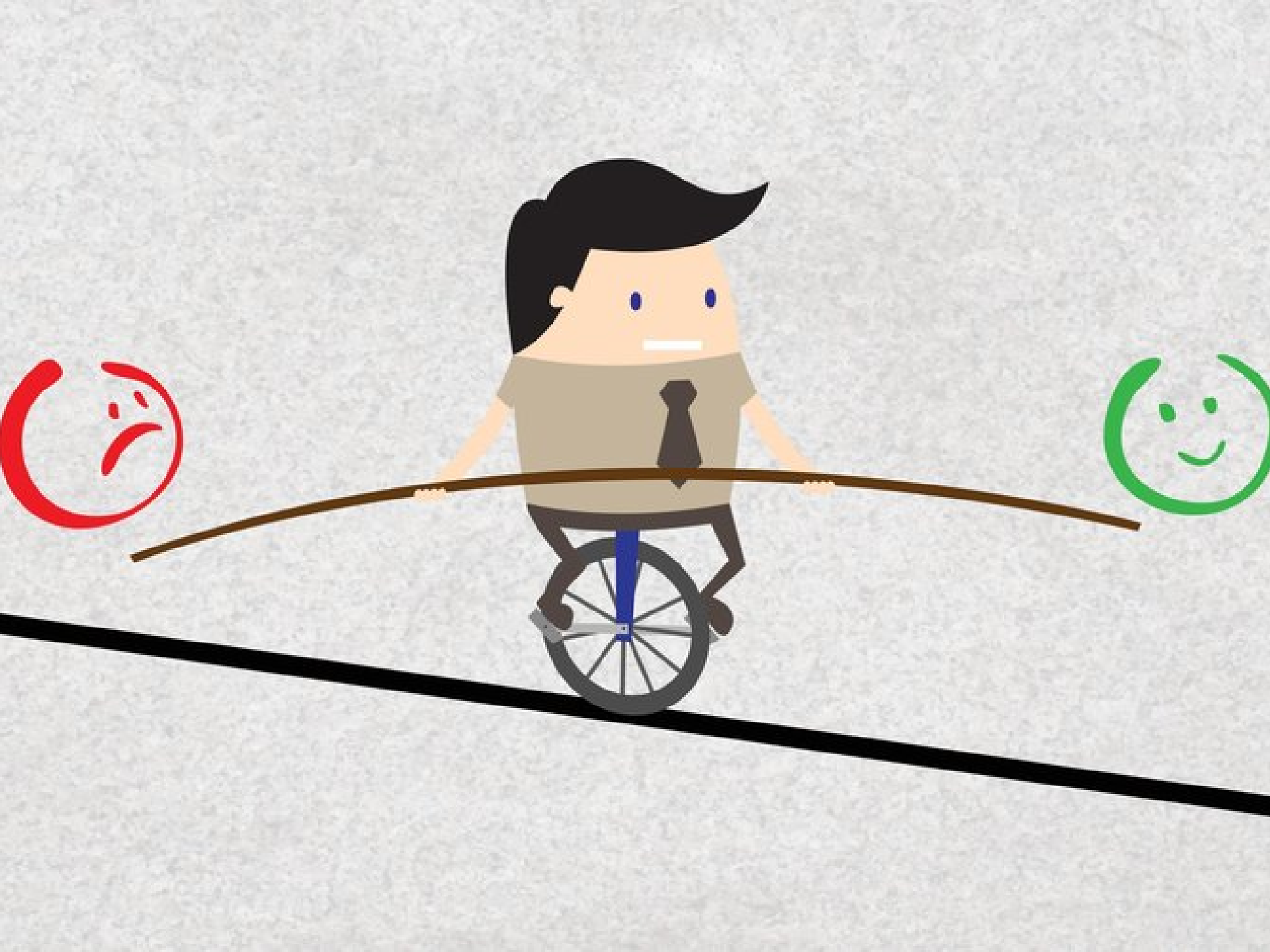
Hydrology & Hydraulics:

Opportunities for Communities to Reduce Flood Risks

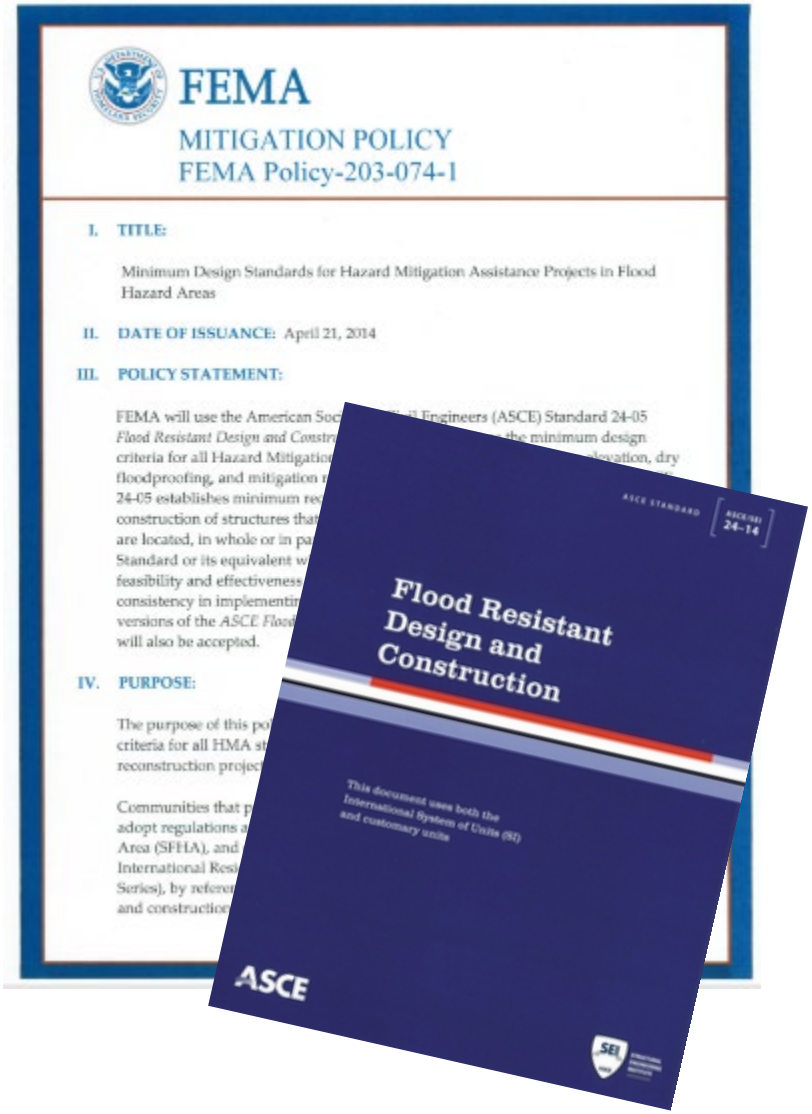
Alan Johnson, PE

FEMA

April 4, 2019



Flood Resistant Design & Construction
ASCE 24



In the Spring of 2014, FEMA adopted Policy-203-074-1, Minimum Design Standard for HMA Projects in Flood Hazard Areas, requiring the use of engineering design standards detailed in ASCE 24 Flood Resistant Design and Construction for mitigation reconstruction, structure elevation, and dry flood proofing projects funded by Hazard Mitigation Assistance (HMA) grant programs.

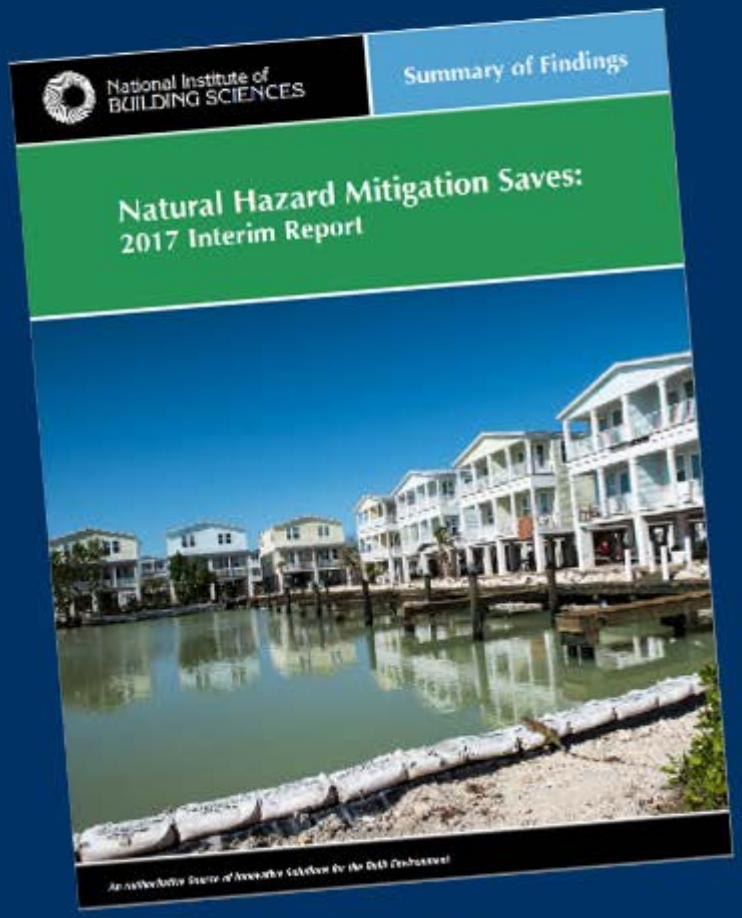
https://www.fema.gov/media-library/assets/documents/93727

ASCE 24 & the NFIP

- The provisions of ASCE 24 are consistent with NFIP performance requirements.
- ASCE 24 provisions meet or exceed NFIP regulations.
- Establishes new minimum requirements (*ASCE 24 is now the standard of practice*)
- In comparison with NFIP requirements, ASCE 24:
  1. Provides more specific requirements
  2. Incorporates the Coastal A Zone with foundation requirements
  3. Requires new construction and Substantial Improvement/Damage construction to incorporate freeboard
  4. Requires to dry floodproofing to consider human intervention requirements

National Mitigation Investment Strategy

Principals



1. Catalyze private and non-profit sector mitigation investments and innovation

2. Improve collaboration between the federal government and State, Local, Tribal and Territorial governments, respecting local expertise in mitigation investing

3. Make data- and risk-informed decisions that include lifetime costs and risks.

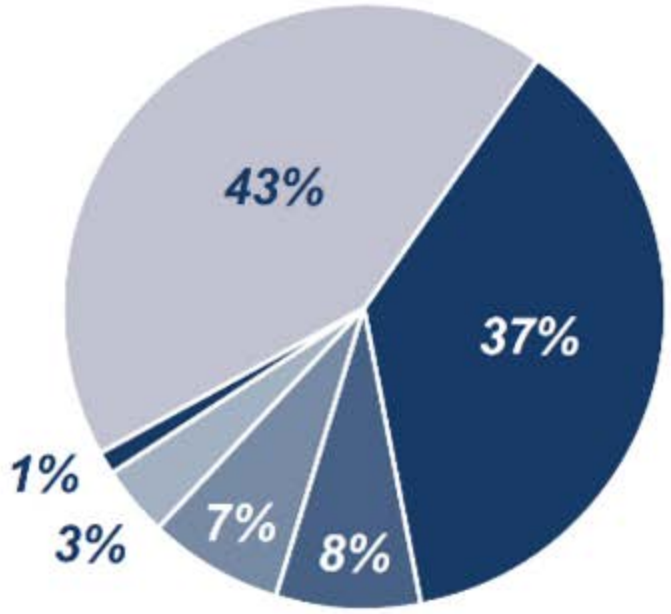
FEMA

Mitigation Saves
2017 Interim Report

National Institute for Building Science (NIBS)

National Benefit-Cost Ratio Per Peril *BCR numbers in this study have been rounded	Federally Funded	Beyond Code Requirements
Overall Hazard Benefit-Cost Ratio	**6:1**	**4:1**
Riverine Flood	7:1	5:1
Hurricane Surge	Too few grants	7:1
Wind	5:1	5:1
Earthquake	3:1	4:1
Wildland-Urban Interface Fire	3:1	4:1

Figure 1: Total costs and benefits of 23 years of federal mitigation grants.



Benefit: $157.9 billion

43% – Casualties & PTSD: $68.1

37% – Property: $58.1

8% – Additional living expenses & direct business interruption: $12.9

7% – Insurance: $10.5

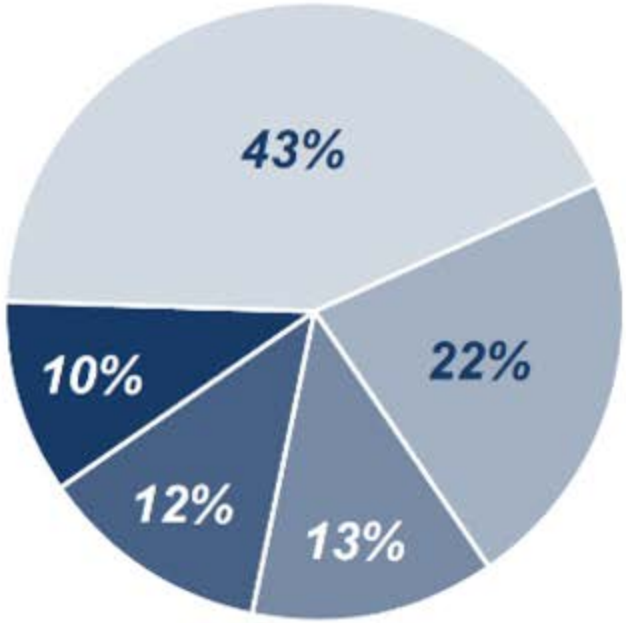
4% – Indirect business interruption: $6.3

1% – Loss of service: $2.0

billions 2016 USD

Cost: $27.4 billion

Figure 2: Costs & benefits of new design to exceed 2015 I-Code requirements.



Benefit: $15.5 billion

43% – Property: $6.7

22% – Additional living expenses & direct business interruption: $3.5

13% – Casualties & PTSD: $2.0

12% – Indirect business interruption: $1.8

10% – Insurance: $1.5

billions 2016 USD

Cost: $3.6 billion

Hazard Mitigation Assistance Program

HMA Program provides assistance for mitigation activities that reduce damage and protect life and property from future damages.

HMA Addendum (dated 2/27/2015) states: *"FEMA will use ASCE 24-14, or latest edition, or its equivalent as the minimum design criteria for all HMA-funded structure elevation, dry flood proofing, and mitigation reconstruction projects in flood hazard areas."*

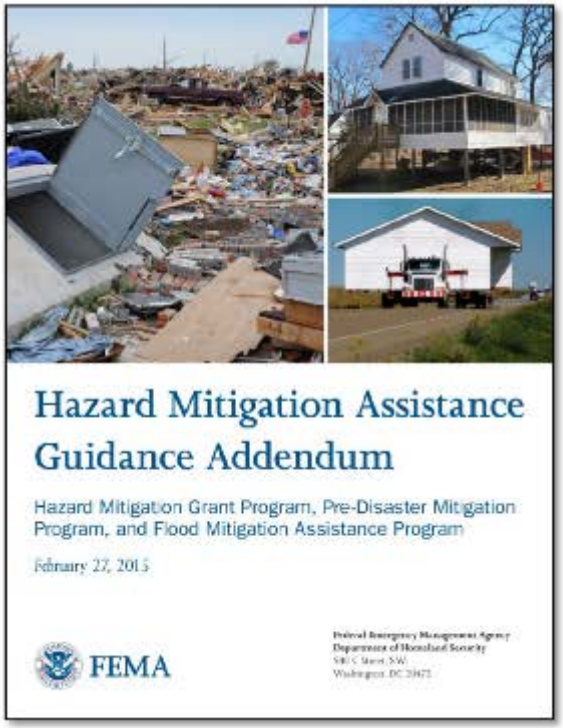
Detailed information on FEMA HMA Programs: https://www.fema.gov/hazard-mitigation-assistance

FEMA

HMA Grant Programs

- **Hazard Mitigation Grant Program (HMGP):** Provides grants to implement long-term hazard mitigation measures after a major disaster declaration in a given State.
- **Pre-Disaster Mitigation (PDM) Program:** Provides nationally competitive grants for hazard mitigation planning and implementing mitigation projects before a disaster event.
- **Flood Mitigation Assistance (FMA) Program:** Provides grants on an annual basis so that measures can be taken to reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program (NFIP).

Building Codes and Standards Directive



- As of September 6, 2016 - "FEMA will encourage and, to the extent permitted by law, require the integration and use of nationally recognized voluntary consensus-based building codes and standard consistently across FEMA programs."
- Policy applies to all FEMA offices and programs
  - Includes Public Assistance
- FEMA programs will adopt as appropriate regulations, policies, grant conditions, or other appropriate instruments, where legally permitted…

Guidance for Application of ASCE 24

- Different from the actual ASCE 24 Standard (You will need both for project oversight)
- Ensures that each project meets FEMA's HMA requirements which includes adhering to project-related design standards
- Supports integration of ASCE 24 as the minimum standard for flood-related HMA projects

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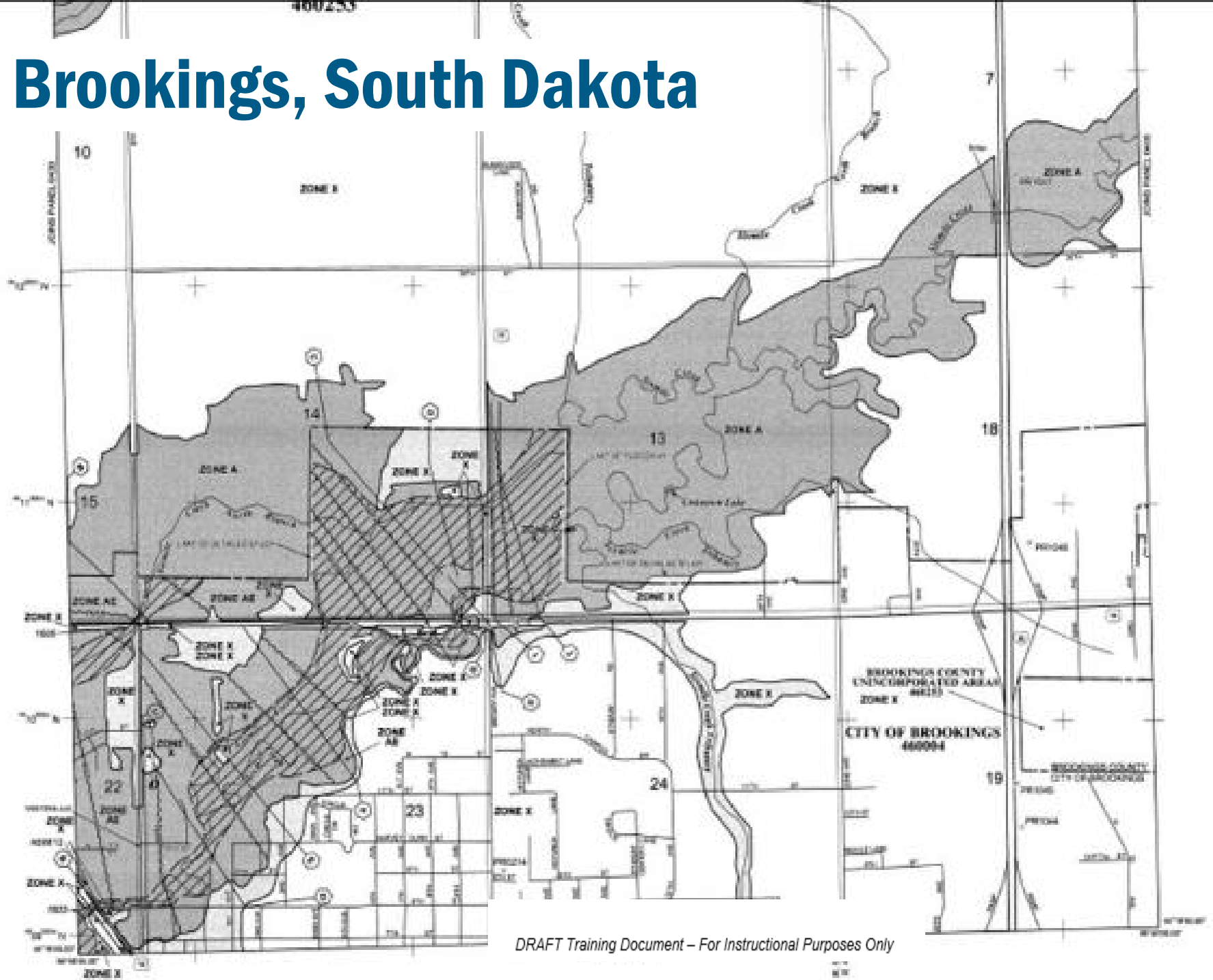
Applying Codes, Standards & Ordinances

HMA projects must comply with:

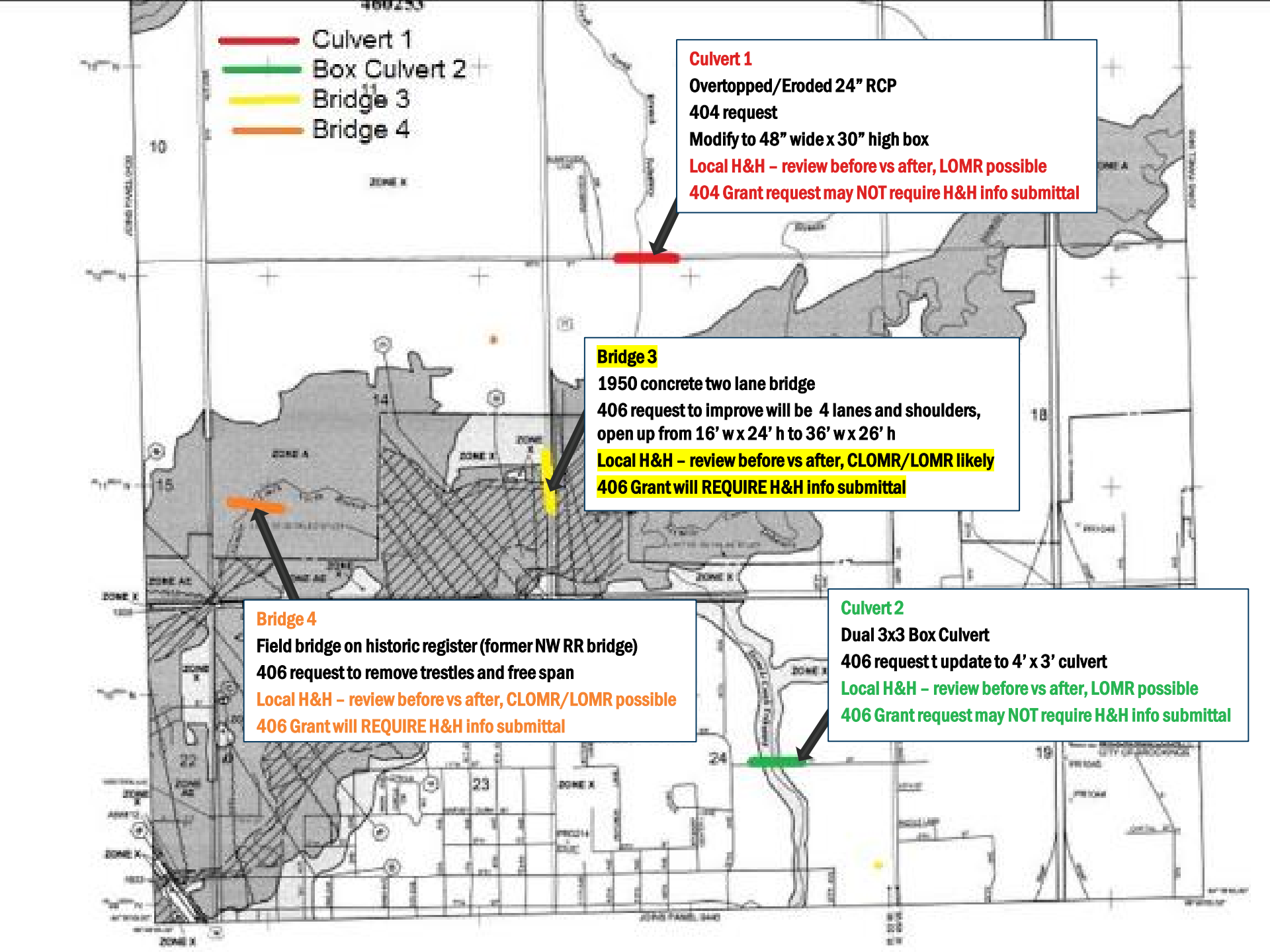
- State and local laws/ordinances
- Consensus standards referenced in the codes
- Federal laws, regulations, and statutes, and requirements within NFIP

Even if a project is technically feasible and cost effective, if implementing the project violates a Federal, State, or local ordinance, code, or requirement, the project will be ineligible for Federal assistance.

Brookings, South Dakota



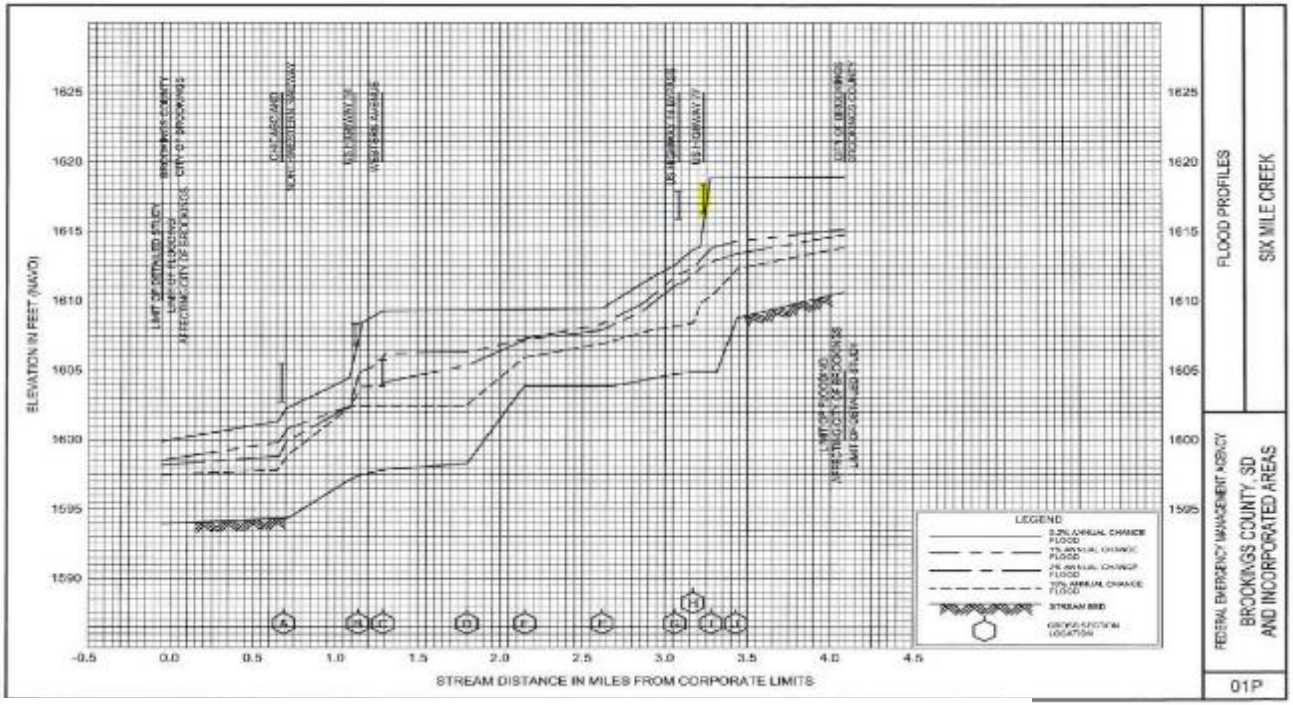
DRAFT Training Document – For Instructional Purposes Only


Culvert 1
Box Culvert 2
Bridge 3
Bridge 4
Culvert 1
Overtopped/Eroded 24" RCP
404 request
Modify to 48" wide x 30" high box
Local H&H – review before vs after, LOMR possible
404 Grant request may NOT require H&H info submittal
Bridge 3
1950 concrete two lane bridge
406 request to improve will be 4 lanes and shoulders, open up from 16' w x 24' h to 36' w x 26' h
Local H&H – review before vs after, CLOMR/LOMR likely
406 Grant will REQUIRE H&H info submittal
Bridge 4
Field bridge on historic register (former NW RR bridge)
406 request to remove trestles and free span
Local H&H – review before vs after, CLOMR/LOMR possible
406 Grant will REQUIRE H&H info submittal
Culvert 2
Dual 3x3 Box Culvert
406 request t update to 4' x 3' culvert
Local H&H – review before vs after, LOMR possible
406 Grant request may NOT require H&H info submittal

Materials for Reference/Use

Make decision from

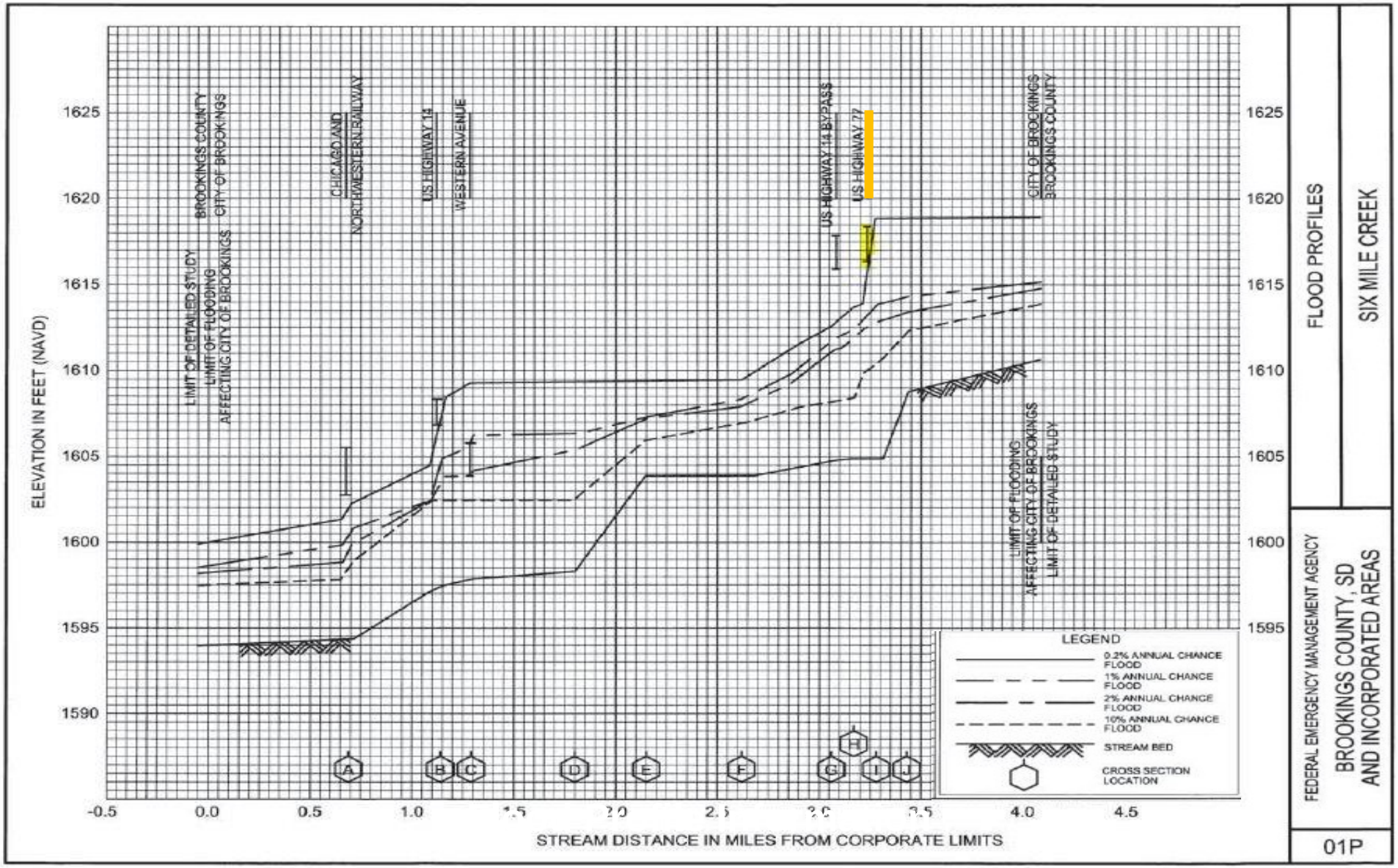
- **Flood Insurance Rate Map (FIRM)**
- **Flood Insurance Study (FIS) Text**
  - Flood Profile
  - Floodway Data Table
  - Summary of Discharges



FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
SIX MILE CREEK								
A	0.69	135	4,541	0.88	1,600.8	1,600.8	1,600.8	0.0
B	1.14	100	1,120	3.53	1,604.7	1,604.7	1,605.4	0.7
C	1.29	140	1,190	3.30	1,605.9	1,605.9	1,605.9	0.0
D	1.80	215	852	4.64	1,606.4	1,606.4	1,606.4	0.0
E	2.15	726	1,834	2.16	1,607.3	1,607.3	1,608.2	0.9
F	2.62	1270	3,420	1.15	1,608.3	1,608.3	1,608.9	0.6
G	3.06	1000	4,180	0.78	1,611.9	1,611.9	1,612.3	0.4
H	3.17	200	836	3.89	1,612.5	1,612.5	1,612.9	0.4
I	3.28	1600	6,824	1.09	1,613.8	1,613.8	1,613.8	0.0
J	3.43	1885	3,298	2.25	1,614.2	1,614.2	1,614.2	0.0

TABLE 2 – SUMMARY OF DISCHARGES

Flooding Source / Location	Drainage (Square Miles)	Peak Discharges (Cubic Feet per Second) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
SIX MILE CREEK (including SIX MILE CREEK NORTH BRANCH)					
Chicago and Northwestern Railroad	76	1,430	4,650	7,660	18,500



Questions

- Does this structure/crossing result a change/reduction in the Base Flood Elevation?
- What is the location (Cross-Section) of the structure in question?
- Why do I want to ask these questions?

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
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C	1.29	140	1,190	3.30	1,605.9	1,605.9	1,605.9	0.0
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E	2.15	726	1,834	2.15	1,607.3	1,607.3	1,608.2	0.9
F	2.62	1270	3,420	1.15	1,608.3	1,608.3	1,608.9	0.6
G	3.06	1000	4,180	0.78	1,611.9	1,611.9	1,612.3	0.4
H	3.17	200	836	3.89	1,612.5	1,612.5	1,612.9	0.4
I	3.28	1600	6,824	1.09	1,613.8	1,613.8	1,613.8	0.0
J	3.43	1885	3,298	2.25	1,614.2	1,614.2	1,614.2	0.0

Questions

Bridge 3 is located between cross-sections H and I

- What is the current cross-sectional area (1%) of the floodway near the bridge?
- What is the current recorded velocity (1%) of the floodway near the bridge?
- Is flow constrained by the current crossing/structure?
- Why do I want to ask these questions?

TABLE 2 – SUMMARY OF DISCHARGES

Flooding Source / Location	Drainage (Square Miles)	Peak Discharges (Cubic Feet per Second) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
SIX MILE CREEK (including SIX MILE CREEK NORTH BRANCH)					
Chicago and Northwestern Railroad	76	1,430	4,650	7,660	18,500

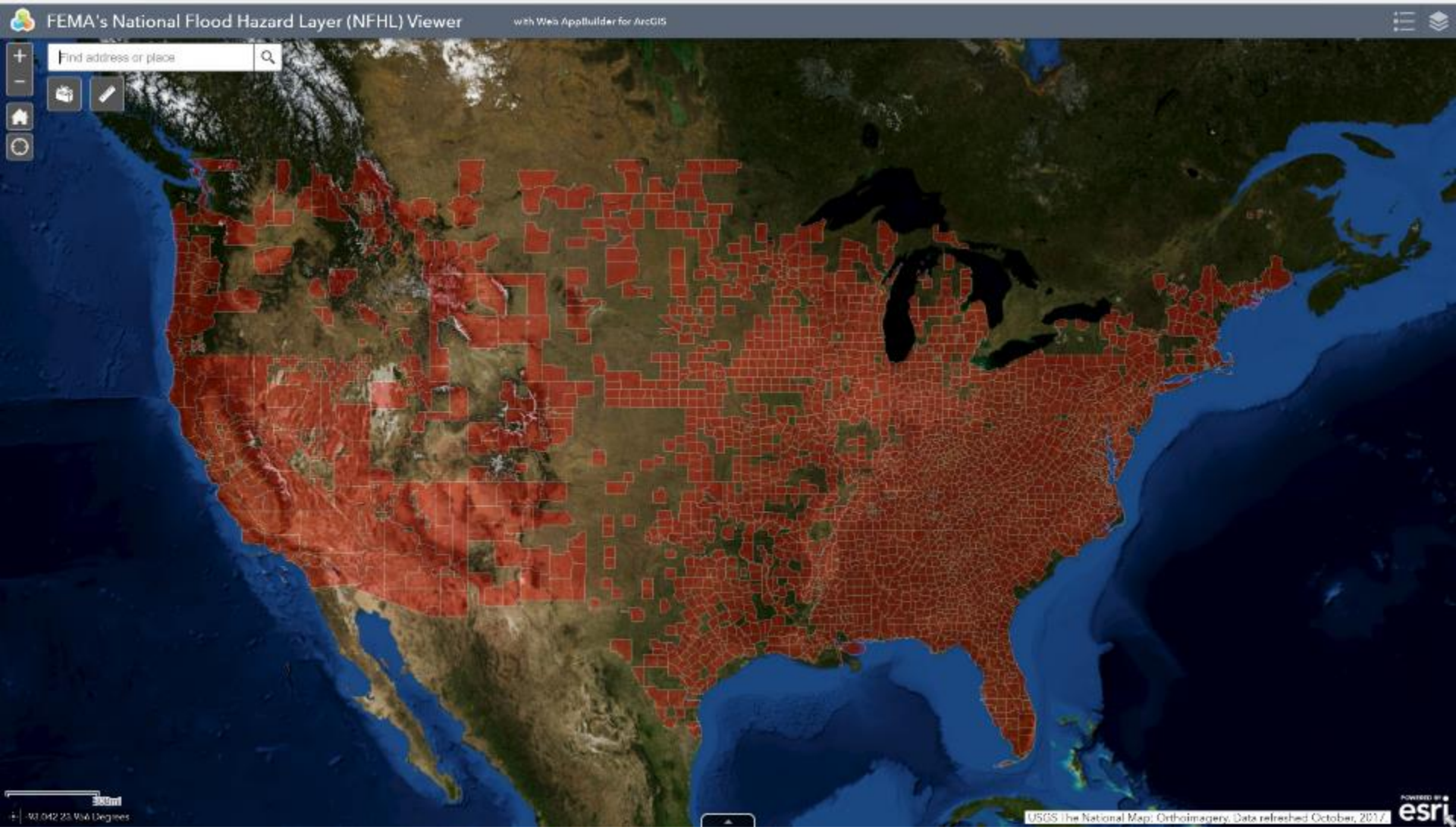
Questions

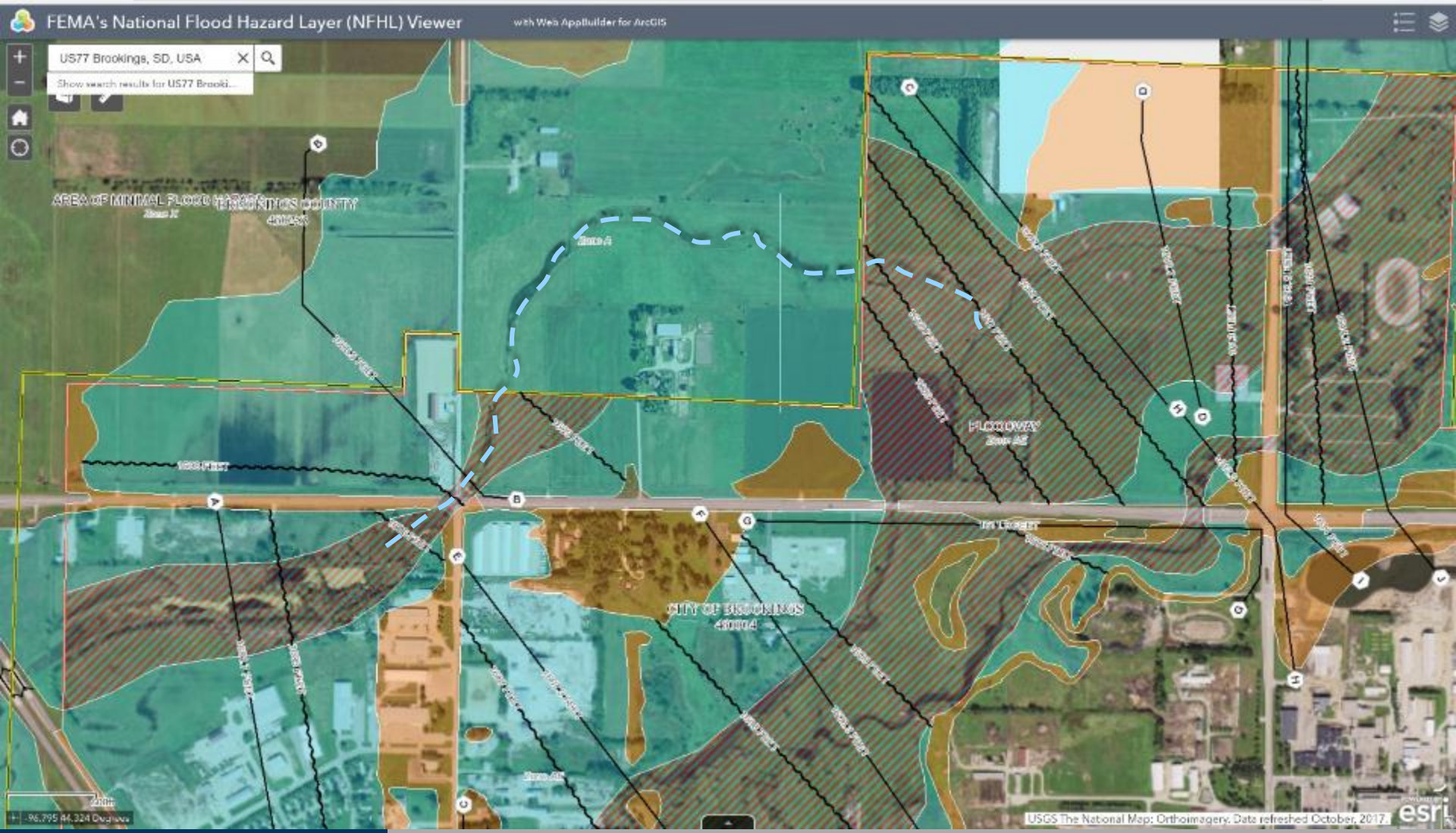
Bridge 3 is located at US 77 (Medary Avenue) ?

- **What is the current range of discharges at the location of Bridge 3?**
- **Why do I want to ask these questions?**

National Flood Hazard Layer – Portal

https://msc.fema.gov/nfhl





Questions

Does this flood area look familiar? (Hint: We were just looking at this)

- **Can you locate Bridge 3 on this image?**
- **Why does this floodplain look strange?**

Obtaining Flood Data & Modeling

To request technical (H&H models) from FEMA/NFIP:

FEMA FIS Technical Data Request

http://www.fema.gov/how-order-technical-administrative-support-data

MT-2 Forms also available online

CLOMRs and LOMRs submittal formatted data:

MT-2 Forms and Instructions

http://www.fema.gov/media-library/assets/documents/1343?id=1493

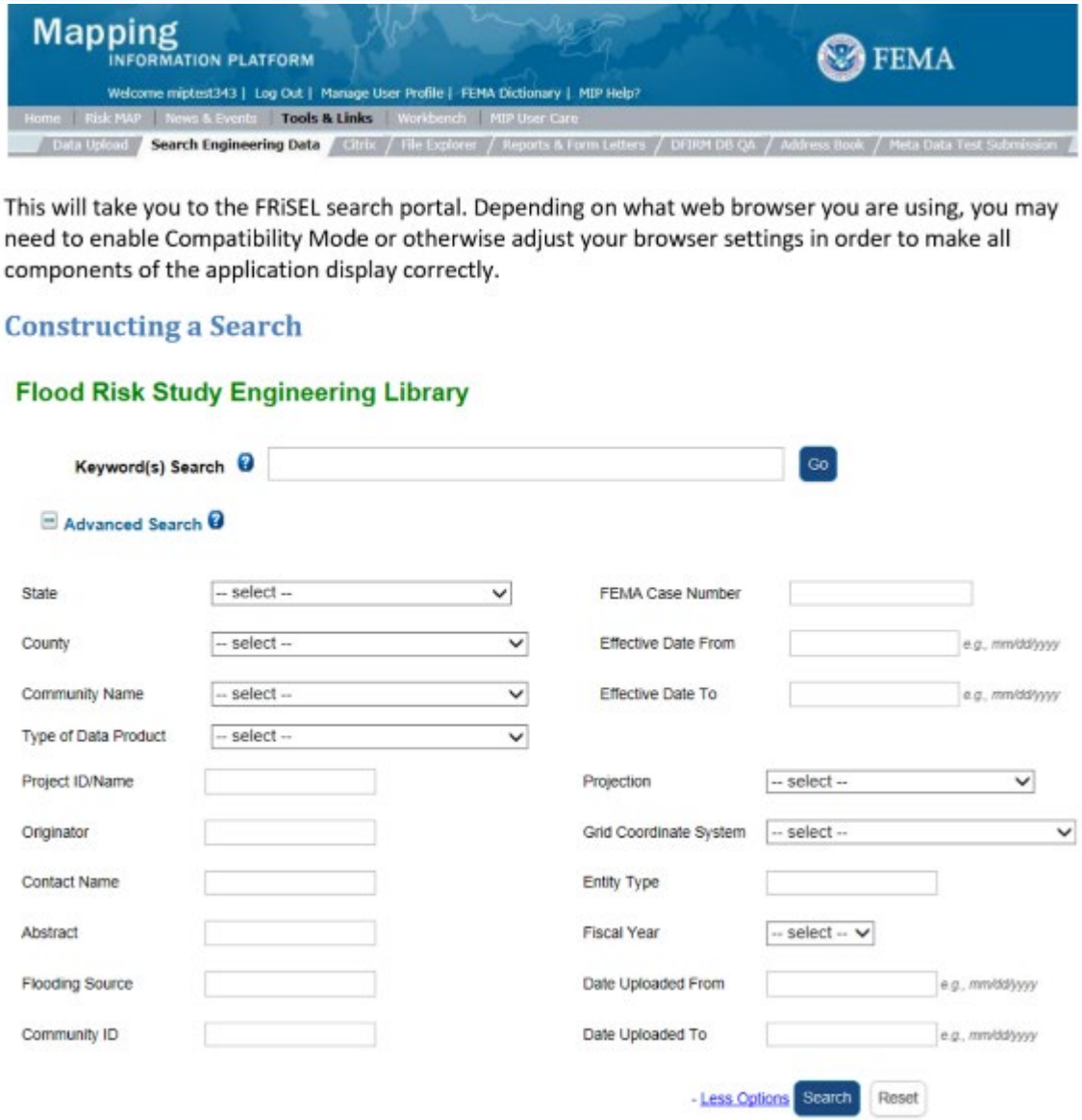
Note:

- Communities may request their own data at NO COST
- In some instances, those who can DEMONSTRATE that they will be performing a FEMA-funded project may also receive MSC data at no cost.
- Otherwise, there are fees for review of technical data for proposed projects.

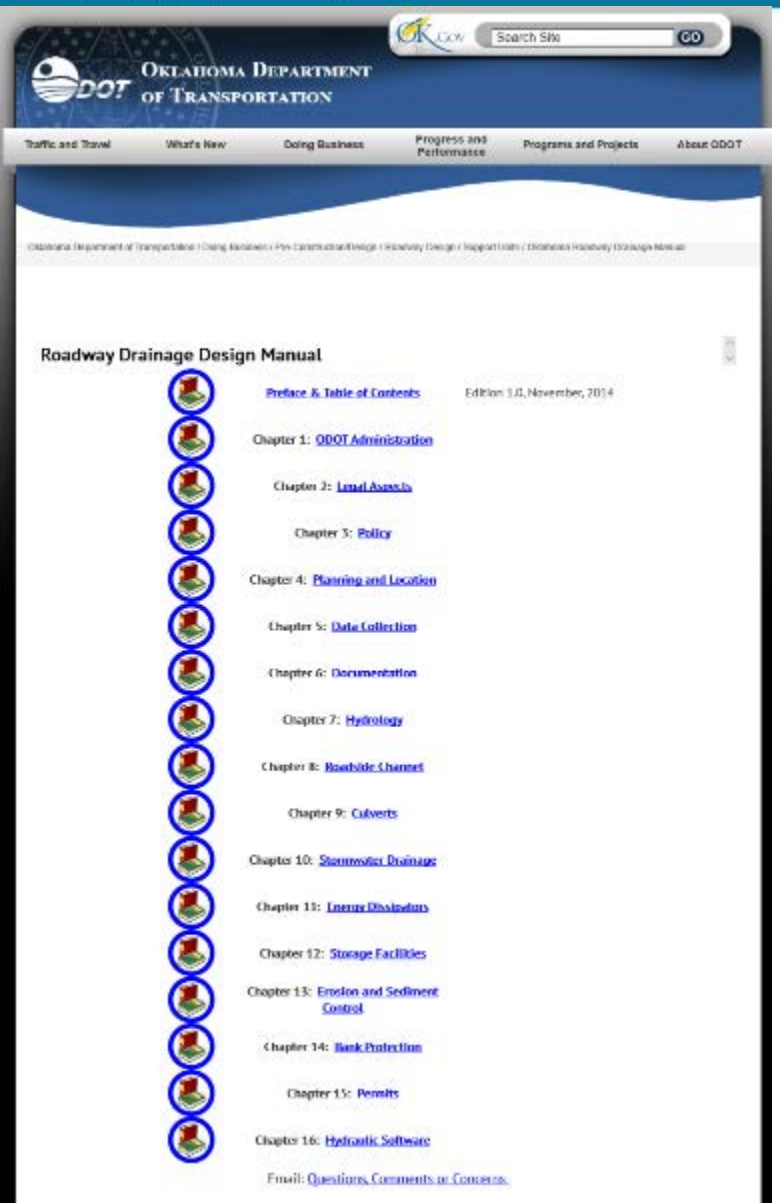
https://hazards.fema.gov

- Online search portal providing public access to data created to support FEMA flood risk map projects and FIRM updates, at NO COST to the user.
- Step by Step directions available in the FRiSEL User Guide

https://hazards.fema.gov/femaportal/wps/PA_MIPSearchEngine/help/Flood%20Risk%20Study%20Engineering%20Library%20User%20Guide.pdf

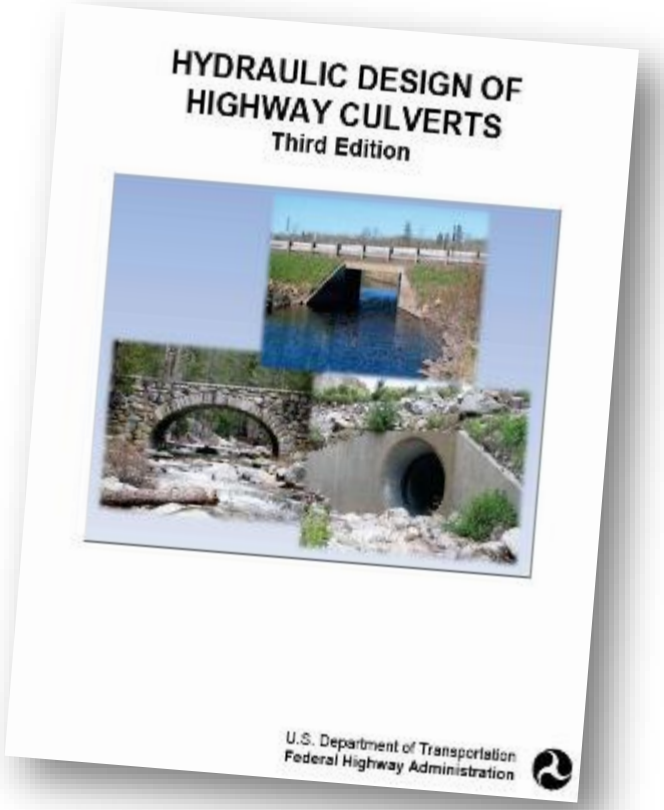


Culvert Design Resources



- **ODOT ROADWAY DRAINAGE MANUAL**

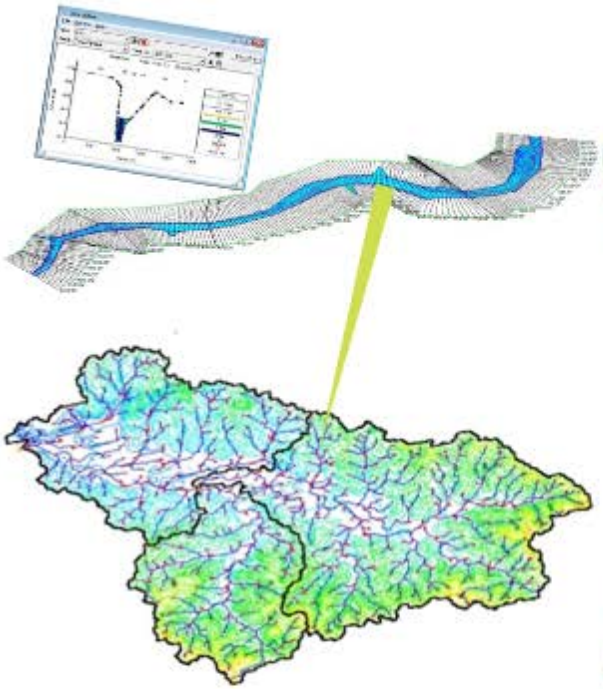
- **FHWA DESIGN OF CULVERTS**



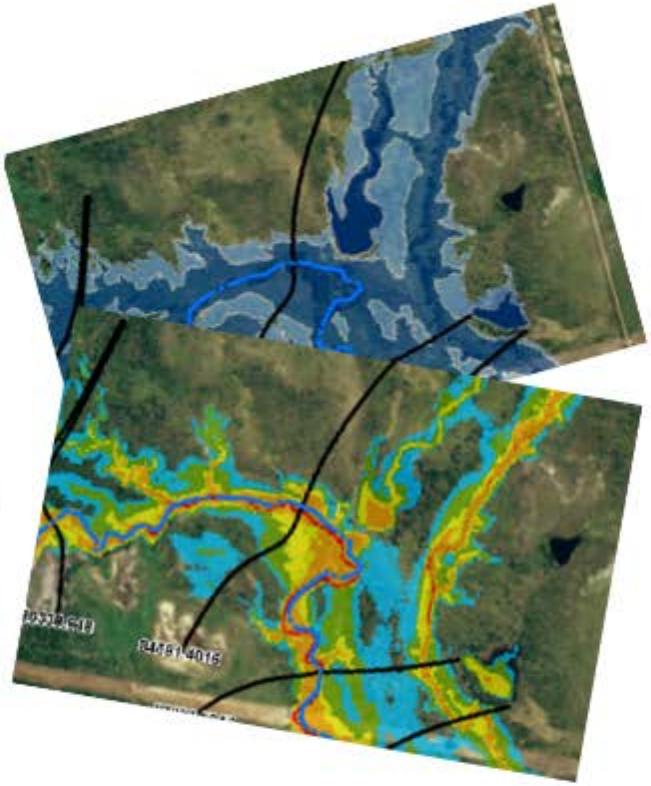
Questions

- **Various culverts within the Zone A floodplain. Most Zone A models don’t always include structure information**
- **Do these damaged culverts require an H&H analysis?**
  - For Local review/submittal?
  - For post-disaster grant request?

Base Level Engineering



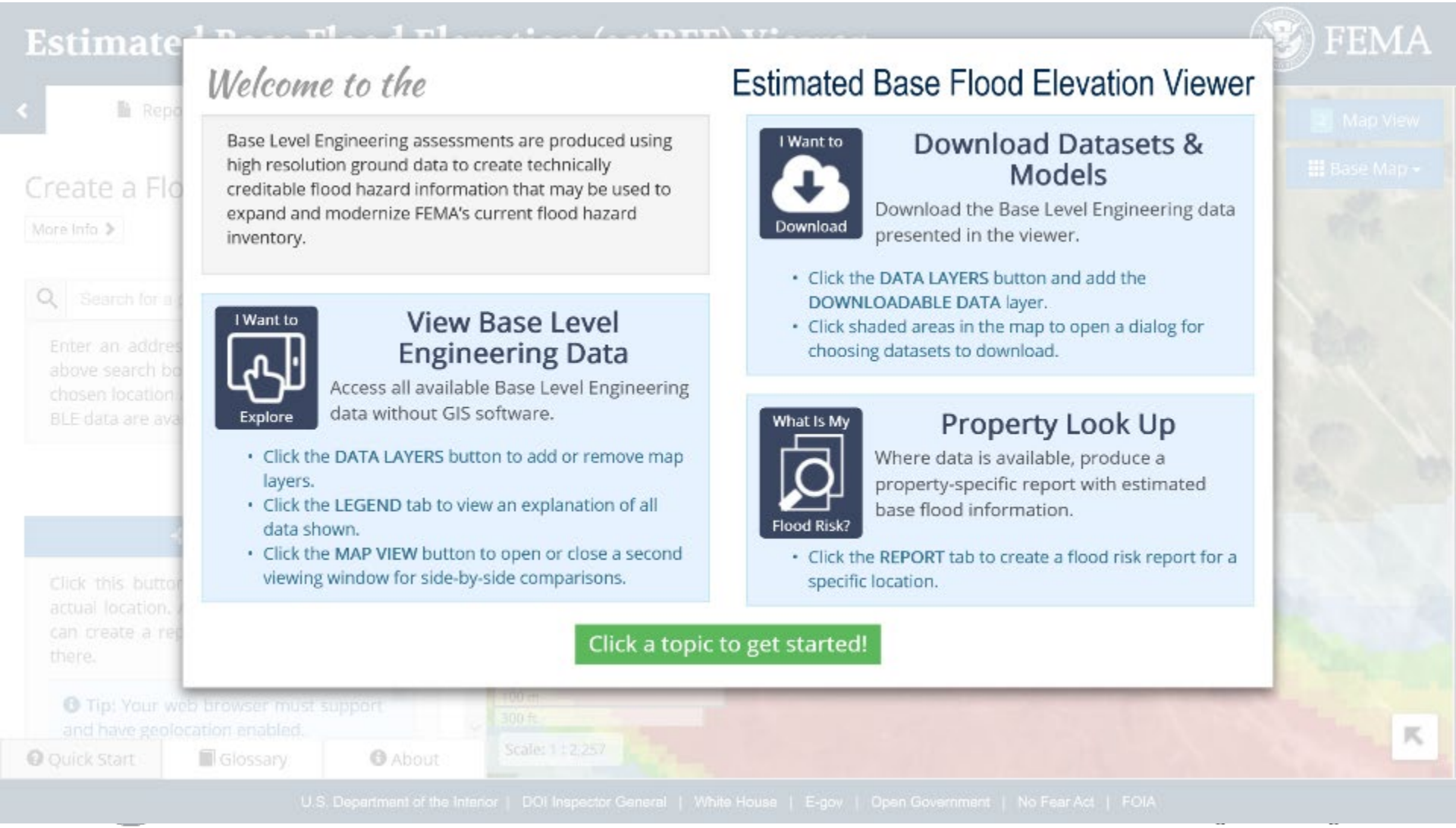
Credible and expandable engineering analysis and modeling for FEMA, State, communities and developers.



Data assisting the estimation of flood extents, water surface elevations and flood depths

May be adopted as Best Available Information (BAI) by communities & inform development decisions.

www.infrm.us/estBFE



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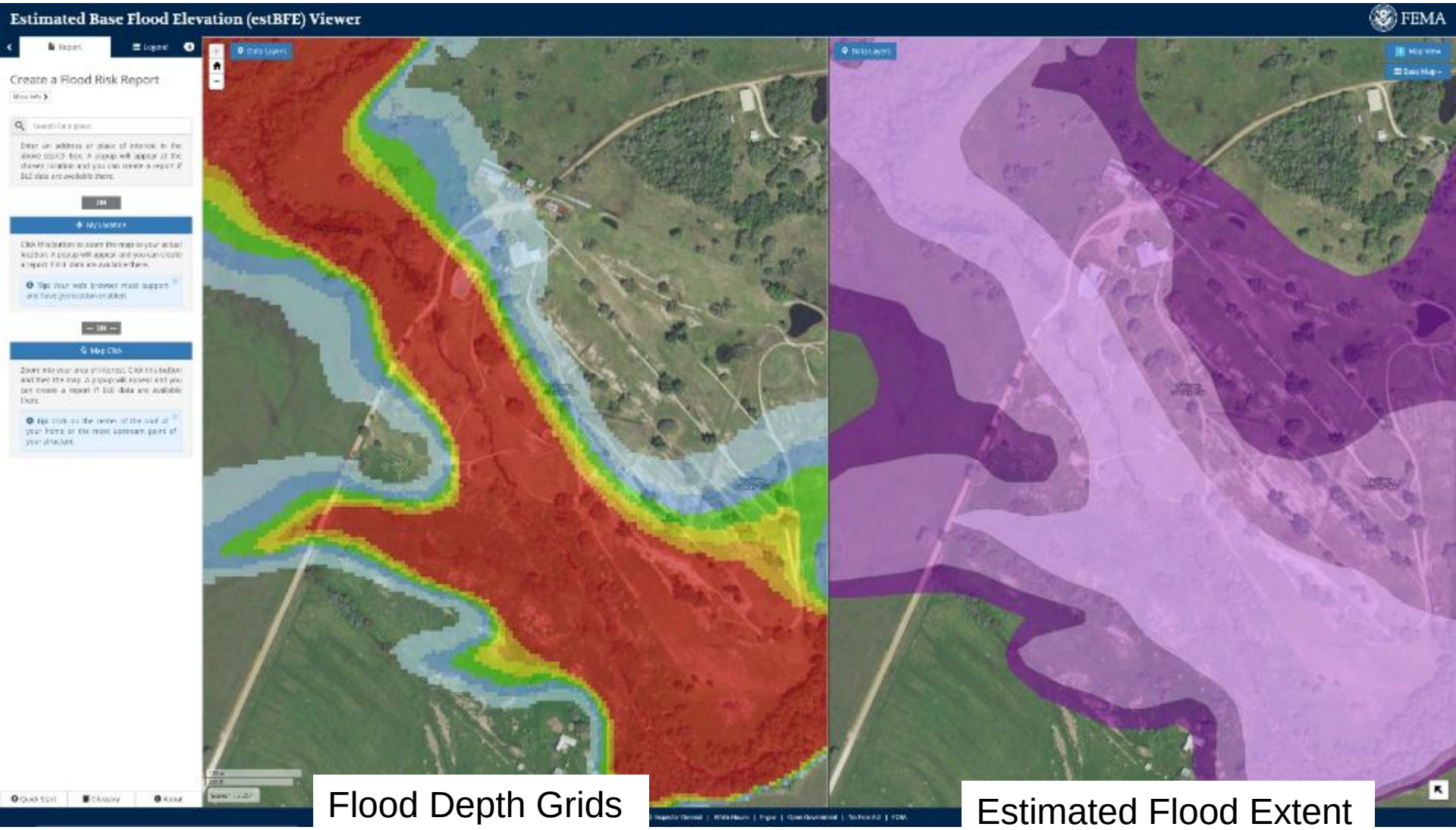
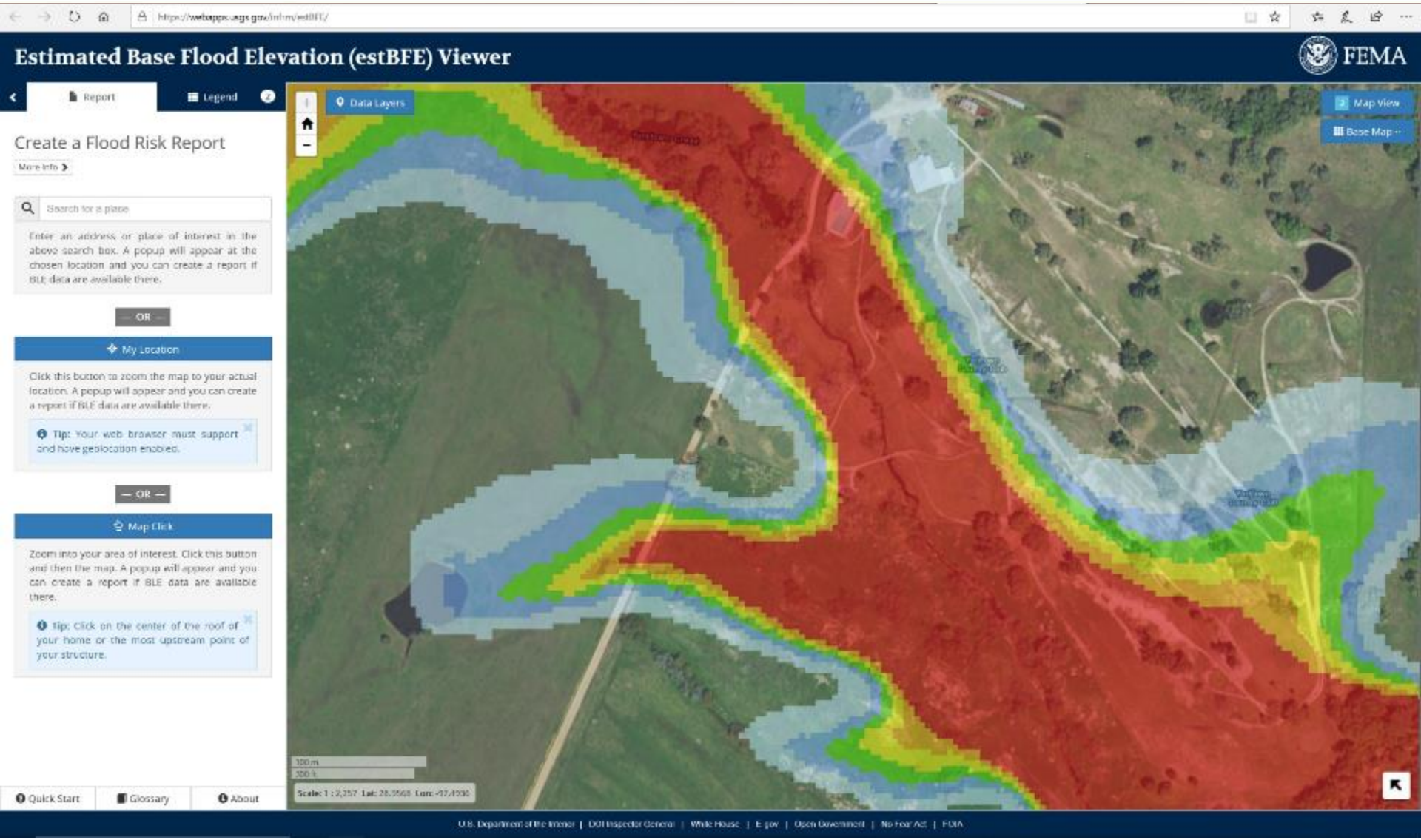


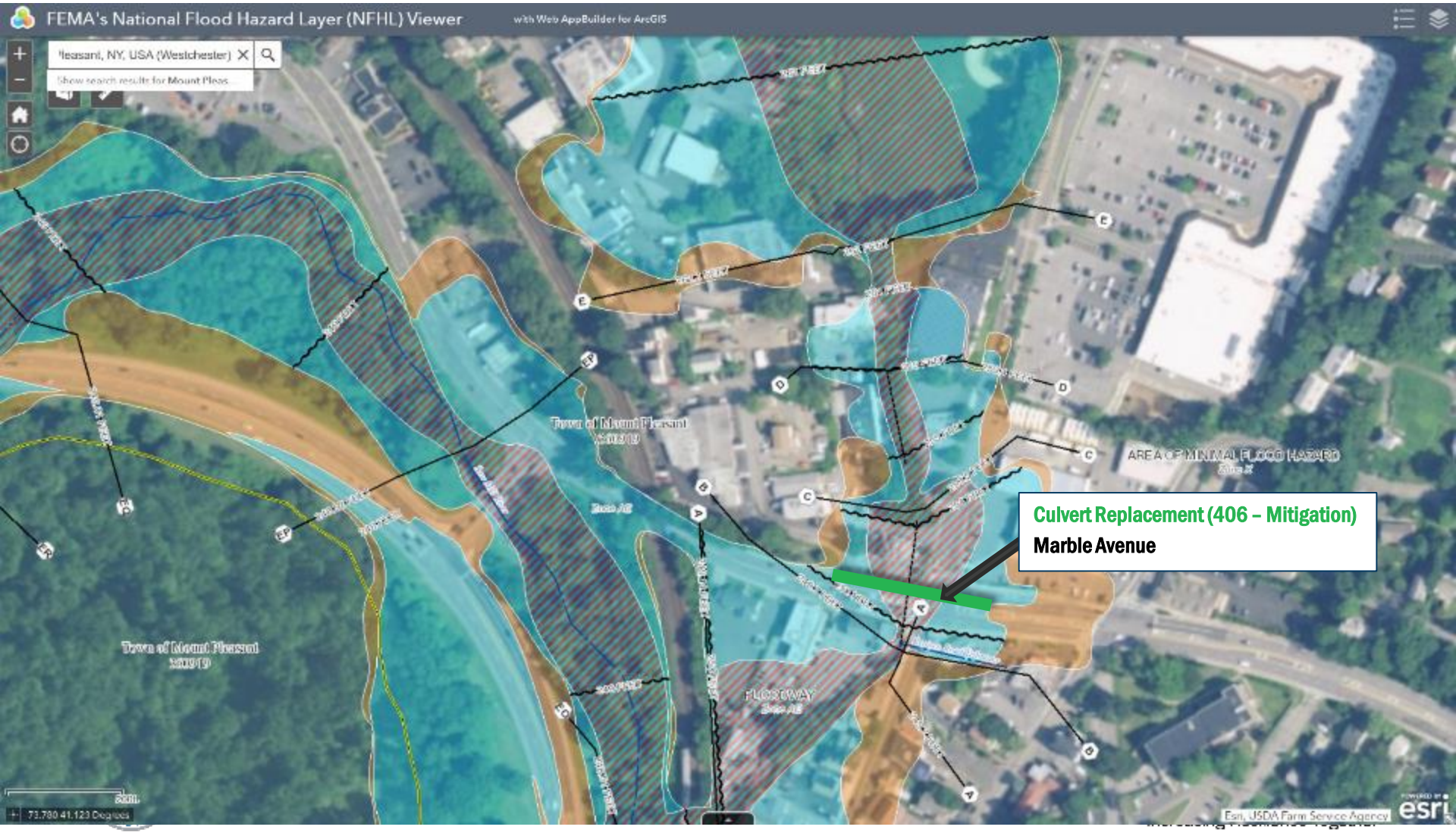
Flood Depth Grids

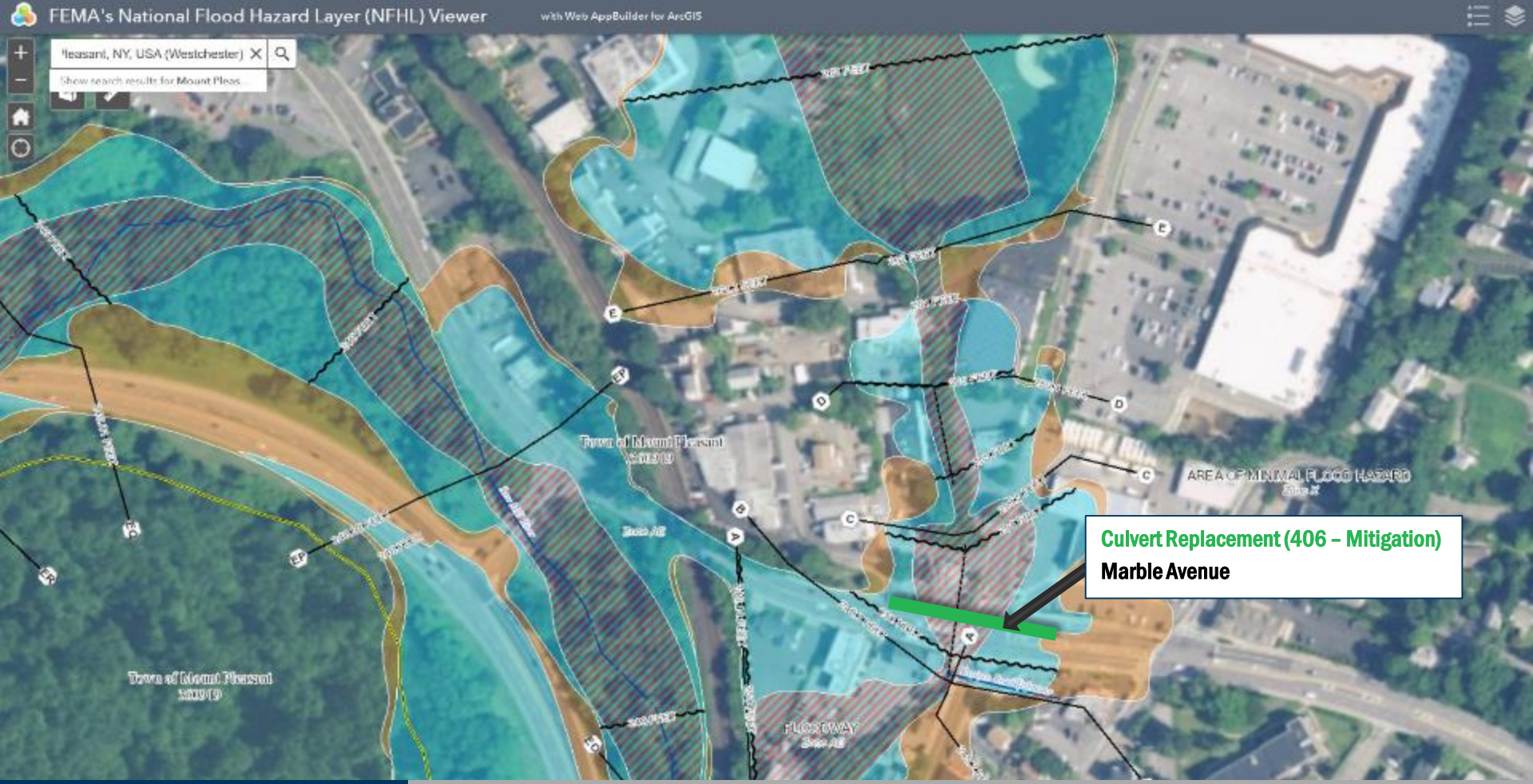
Estimated Flood Extent – 10%, 1% and 0.2%

www.infrm.us/estBFE



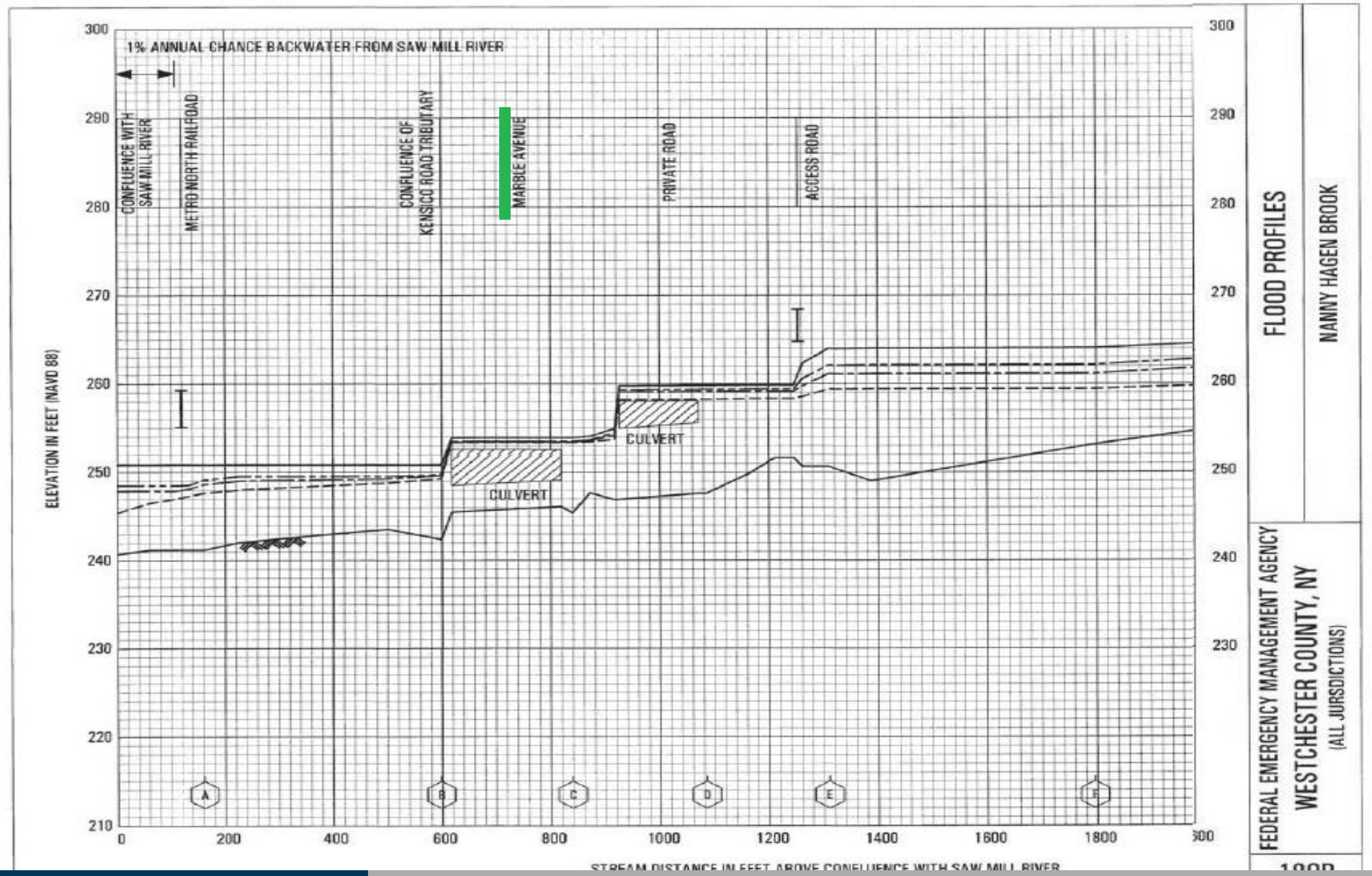
Town of Mount Pleasant, New York





Questions

- Applicant wants to increase this 42” CMP culvert to a 72” concrete box culvert using HMGP.
- Does increasing the culvert size provide a flood benefit?
- Can the applicant be funded under HMGP?
- Is an H & H study needed to justify BCA?
- Any other concerns?

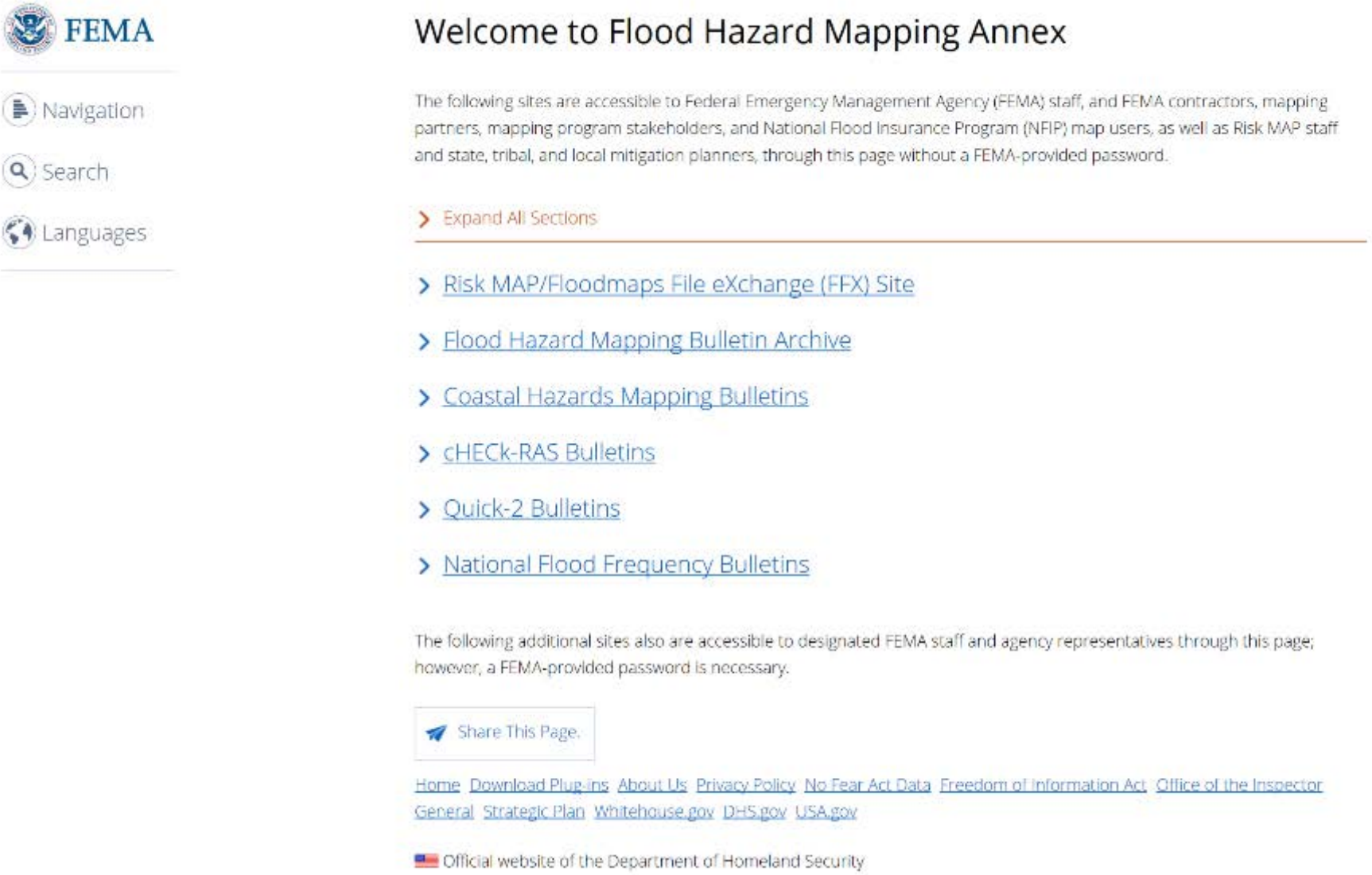


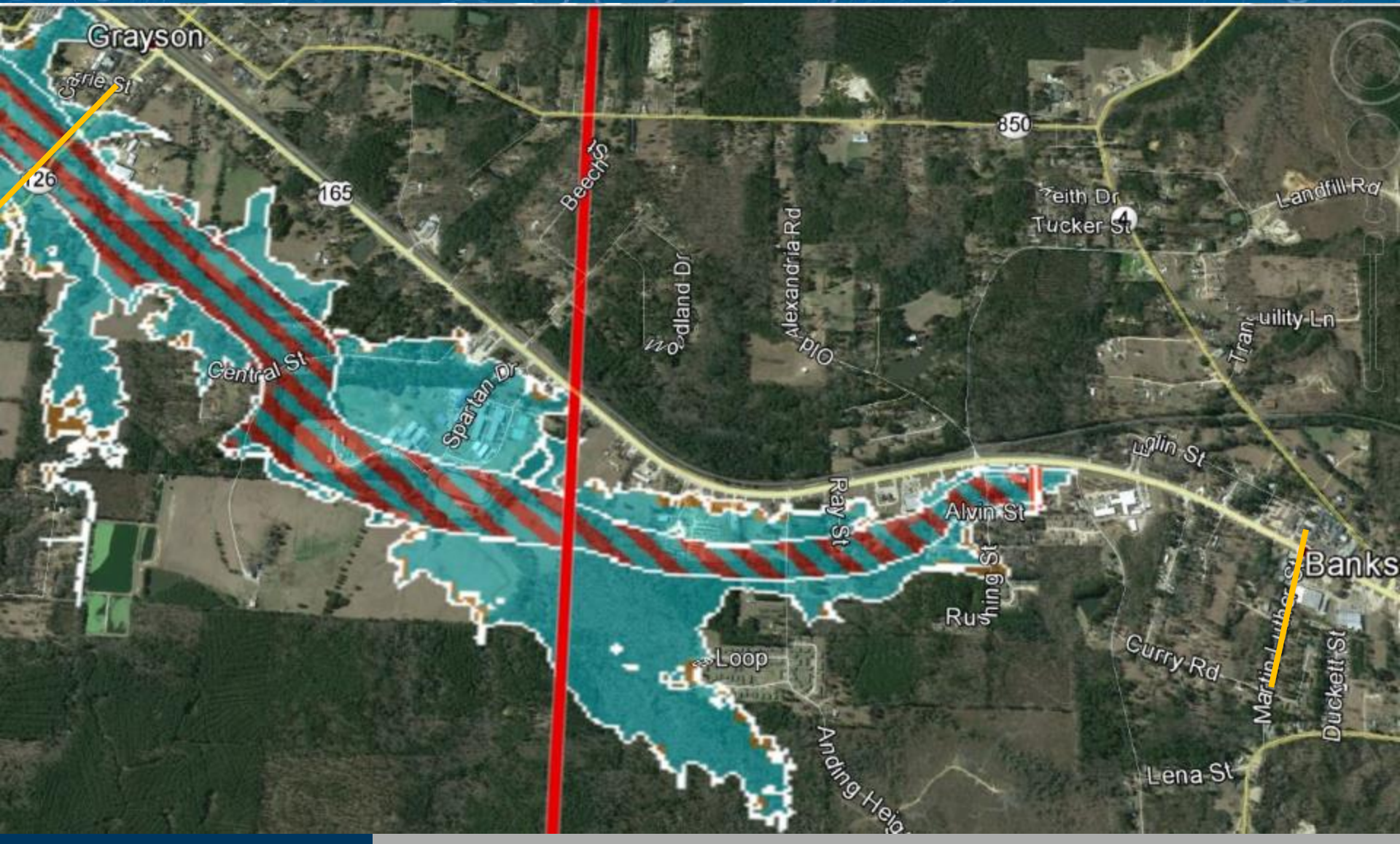
Questions

Floodway exists in the proposed project area.

- **Culvert appears overtopped during all flood profiles depicted (10% thru 0.2%)**
- **Larger culvert will pass more water, will this cause problems downstream?**

http://www.floodmaps.fema.gov/





Questions

Project suggests channelization from US Hwy 126 (DS) to MLK St (US)

- **Potential Issues?**
- **Original Hydraulic Model from 1976. How can community match this modeling?**

FEMA Hydraulic Modeling Considerations

Duplicate Effective

- Models may be requested from the Map Service Center
- Also check with local floodplain administrator to locate modeling
- Submittal requires duplication of the current effective modeling

Corrected Effective

- Requestors may alter/modify and make corrections to the duplicate effective.
- Changes may include: n-values altered, stream length updates
- Suggested that one model for each set of changes is made
- Physical changes (cross-section updates and or bridge/culvert additions should NOT be included

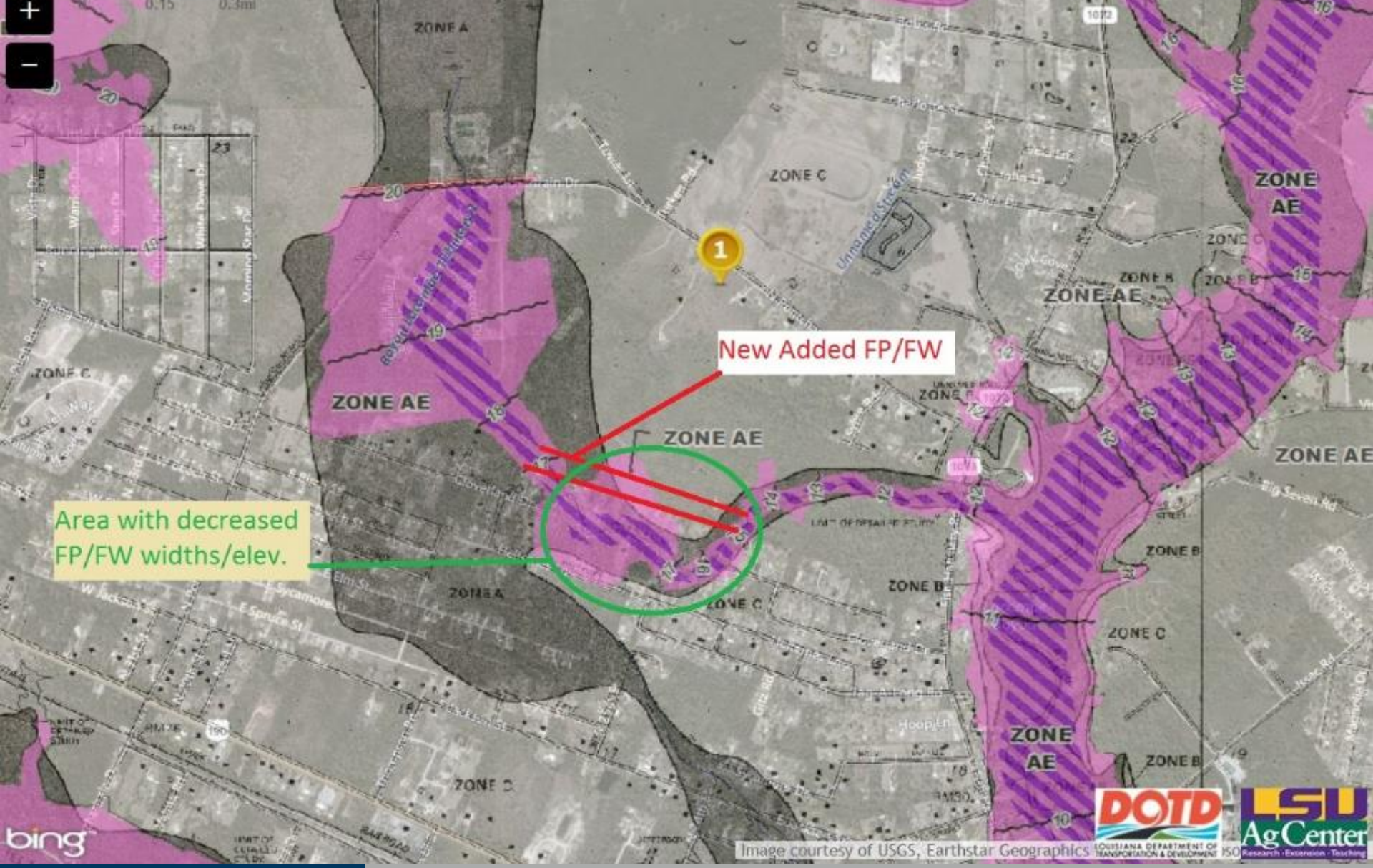
Existing Conditions

- AKA pre-project conditions model
- Add new cross-sections (for fill placement, suggest minimum include one at start, one at end and one intermediate)
- Add structures that currently exist
- Update hydrology, if necessary
- For quicker review – it is suggested that one model for each set of changes is made

Proposed Conditions

- Add proposed project conditions
- Alter cross-sections to mimic proposed earthwork/channelization
- Alter structure geometry in modeling to show proposed bridge/culvert

- Review effects of project **Pre-Project versus Proposed Project** and determine effect of project on BFEs (is CLOMR needed?)
- Zone A or AE, no floodway → increases greater than 1.0 should require CLOMR
- Any (0.00ft) change in Zone AE with floodway requires CLOMR
- **All projects require LOMRs**



Questions

Mitigation project proposed would create secondary channel and divert flood flow

- **Review of submitted modeling indicates project would cause an increase in BFEs**
- **What other options are available, if any?**

Pre-Adopt Increased Risk

- **44CFR65.12**
  - Allows community via CLOMR, then LOMR process to pre-adopt risk.
  - No Insurable structures can be added.
  - All adversely impacted owners notified, and approved of change.
  - .
- **Once CLOMR approved, community provides FEMA copy of FP ordinance adopting increased risk.**
- **Ready to construct as proposed.**

Additional Resources

- Guidance for Applying ASCE 24 Engineering Standards to HMA Flood Retrofitting and Reconstruction Projects (2013)
- Highlights of ASCE 24-14 Flood Resistant Design and Construction (2015)
- Highlights of ASCE 24-05 Flood Resistant Design and Construction (2010)
- FEMA P-312 – Homeowner's Guide to Retrofitting (2014)
- FEMA P-259, Engineering Principles and Practices of Retrofitting Floodprone Residential Structures, 3rd Edition (2012)
- FEMA P-936 – Floodproofing Non-Residential Buildings (2013)
- FEMA NFIP Technical Bulletins

Questions?

FEMA