Approximate A Zone Mapping

Brian Chaille, P.E., CFM
IAFSM 2020 Annual Conference, March 11
The staff of the Coordinated Hazard Assessment and Mapping Program
which includes 18 Certified Floodplain Managers (CFM),
seven Professional Engineers (PE), and
seven Geographic Information Systems Professionals (GISP)

www.illinoisfloodmaps.org
We will cover…

• National Flood Insurance Program (NFIP)
• Floodplain Mapping
• Map Changes and Amendments
• Dealing with A Zones
• Establishing a Base Flood Elevation (BFE) in a Zone A Floodplain
• Looking Forward
National Flood Insurance Program (NFIP)
The largest inland system of rivers, lakes, and streams in the entire nation!

26,940 total miles of streams
19,080 miles (73%) are Zone A (The Yellow Lines)
Illinois is a VERY Wet State!

Floods are BY FAR the most common and the most costly disasters in Illinois.

Floors happen EVERY YEAR in Illinois.

Federal Disasters
1993 - 2020
National Flood Insurance Program

• NFIP is a voluntary program
• 88 of Illinois’ 102 counties & 890 communities are part of program (120 are not)
• FEMA makes flood insurance available along with disaster assistance and grants/loans
• Communities agree to adopt floodplain maps and floodplain management ordinance
1913 Ohio River Flood
1927 Mississippi River Flood
1930’s
TVA

Soil Conservation Service

Corps of Engineers
Floods are ‘Acts of God’ but flood losses are largely acts of man.

Gilbert F. White
(November 26, 1911 – October 5, 2006)

https://blog.predictiveheuristics.com/2013/12/05/predictions-in-the-future-white-or-black-swans/
The National Flood Insurance Act of 1968

NFIP and the Federal Insurance Administration under HUD

(FEMA 1979)
National Flood Insurance Program

- Goal of the NFIP is to reduce flood losses
- Program supported by 3 legs
National Flood Insurance Program

• Goal of the NFIP is to reduce flood losses
• Program supported by 3 legs
  • Floodplain Mapping
  • Floodplain Management
  • Flood Insurance
August 1968
Vietnam War is
90% of News
Chicago Hosts Democratic Convention and War Protests

Apollo 8
First Earth Rise
Frank Borman, Jim Lovell, William Anders
https://earthobservatory.nasa.gov/images/144427/all-of-you-on-the-good-earth
The Cold War

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Floodplain Mapping
NFIP Emergency Period and FHBM’s
Navier–Stokes Equations
3 – dimensional – unsteady

Coordinates: \((x, y, z)\)

Time: \(t\)

Pressure: \(p\)

Density: \(\rho\)

Stress: \(\tau\)

Heat Flux: \(q\)

Reynolds Number: \(Re\)

Prandtl Number: \(Pr\)

Velocity Components: \((u, v, w)\)

Total Energy: \(E_t\)

Continuity:
\[
\frac{\partial \rho}{\partial t} + \frac{\partial (\rho u)}{\partial x} + \frac{\partial (\rho v)}{\partial y} + \frac{\partial (\rho w)}{\partial z} = 0
\]

\(X\) – Momentum:
\[
\frac{\partial (\rho u)}{\partial t} + \frac{\partial (\rho u^2)}{\partial x} + \frac{\partial (\rho uv)}{\partial y} + \frac{\partial (\rho uw)}{\partial z} = - \frac{\partial p}{\partial x} + \frac{1}{Re_r} \left[ \frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{xz}}{\partial z} \right]
\]

\(Y\) – Momentum:
\[
\frac{\partial (\rho v)}{\partial t} + \frac{\partial (\rho uv)}{\partial x} + \frac{\partial (\rho v^2)}{\partial y} + \frac{\partial (\rho vw)}{\partial z} = - \frac{\partial p}{\partial y} + \frac{1}{Re_r} \left[ \frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \tau_{yy}}{\partial y} + \frac{\partial \tau_{yz}}{\partial z} \right]
\]

\(Z\) – Momentum:
\[
\frac{\partial (\rho w)}{\partial t} + \frac{\partial (\rho uw)}{\partial x} + \frac{\partial (\rho vw)}{\partial y} + \frac{\partial (\rho w^2)}{\partial z} = - \frac{\partial p}{\partial z} + \frac{1}{Re_r} \left[ \frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \frac{\partial \tau_{zz}}{\partial z} \right]
\]

Energy:
\[
\frac{\partial (E_t)}{\partial t} + \frac{\partial (uE_t)}{\partial x} + \frac{\partial (vE_t)}{\partial y} + \frac{\partial (wE_t)}{\partial z} = - \frac{\partial (up)}{\partial x} - \frac{\partial (vp)}{\partial y} - \frac{\partial (wp)}{\partial z} - \frac{1}{Re_r Pr_r} \left[ \frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} + \frac{\partial q_z}{\partial z} \right]
\]

\[+ \frac{1}{Re_r} \left[ \frac{\partial}{\partial x} (u \tau_{xx} + v \tau_{xy} + w \tau_{xz}) + \frac{\partial}{\partial y} (u \tau_{xy} + v \tau_{yy} + w \tau_{yz}) + \frac{\partial}{\partial z} (u \tau_{xz} + v \tau_{yz} + w \tau_{zz}) \right] \]
Floodplain Mapping Requires Knowledge of Three Things

• Topography
  • Floodplain Geometry
    How high is the land?

• Hydrology
  • Flood Flow
    How much water?

• Hydraulics
  • Flood Height
    How deep is the water?
Floodplain Mapping

- Types of FEMA Maps

- Flood Hazard Boundary Maps (FHBM) – Very Old!
- Flood Boundary Floodway Maps (FBFM) – Old
- Flood Insurance Rate Maps (FIRM) – Less Old!
- Digital Flood Insurance Rate Maps (DFIRMs) – Nearly New!
- National Flood Hazard Layer (NFHL) – New-ish!
DFIRMs in Illinois
National Flood Insurance Program

• “100-Year” or Base Flood is the basis for the NFIP
  • Floodplain maps identify Base Floodplain
  • Floodplain Management regulations apply to areas located in Base Floodplain
  • Flood Insurance is required in Base Floodplain

• “100-Year Flood” = 1% Annual Chance Flood
Flood Zones

• 1% Annual Chance Flood is basis for the NFIP
  • 1% Annual Chance Flood is known as the “Base Flood”
  • 1% Annual Chance Flood Elevation is known as “Base Flood Elevation” or “BFE”
  • The floodplain delineation of the “Base Flood” is known as “Special Flood Hazard Areas” or “SFHA”

• Not all flood hazards are equal therefore floodplain maps have variety of Flood Zones
  • Each flood zone has unique regulatory requirements and flood insurance ratings
<table>
<thead>
<tr>
<th>Flood Zone</th>
<th>Floodplain Frequency</th>
<th>BFE or Depth Given?</th>
<th>Mandatory Flood Insurance Purchase Requirement?</th>
<th>Regulatory (requires permits)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone A</td>
<td>1% AC (100 Year)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone AE or A1-30</td>
<td>1% AC (100 Year)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone AO</td>
<td>1% AC (100 Year)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone AH</td>
<td>1% AC (100 Year)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone AR</td>
<td>1% AC (100 Year)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone A99</td>
<td>1% AC (100 Year)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone V</td>
<td>1% AC (100 Year)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone VE or V1-30</td>
<td>1% AC (100 Year)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Floodway</td>
<td>1% AC (100 Year)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone X (shaded) or Zone B</td>
<td>0.2% (500-Year); sometimes 1% less that 1’ depth</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Zone X (unshaded) or Zone C</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Zone D</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Flood Zone</td>
<td>Floodplain Frequency?</td>
<td>BFE or Depth Given?</td>
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<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone AE or A1-30</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone AO</td>
<td>1% AC (100 Year)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone AH</td>
<td>1% AC (100 Year)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone AR</td>
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<td>Yes</td>
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<td>Yes</td>
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<td>1% AC (100 Year)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone V</td>
<td>1% AC (100 Year)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone VE of V1-30</td>
<td>1% AC (100 Year)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Floodway</td>
<td>1% AC (100 Year)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Zone X (shaded) or Zone B</td>
<td>0.2% (500-Year);</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>sometimes 1% less</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>that 1' depth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zone X (unshaded) or Zone C</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Zone D</td>
<td>N/A</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
**KEY TO MAP**

- 500-Year Flood Boundary
- 100-Year Flood Boundary
- Zone Designations
- 100-Year Flood Boundary
- 500-Year Flood Boundary
- Base Flood Elevation Line With Elevation In Feet
- Base Flood Elevation in Feet Where Uniform Within Zone
- Elevation Reference Mark
- Zone D Boundary
- River Mile

**EXPLANATION OF ZONE DESIGNATIONS**

<table>
<thead>
<tr>
<th>ZONE</th>
<th>EXPLANATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Areas of 100-year flood; base flood elevations and flood hazard factors not determined.</td>
</tr>
<tr>
<td>A0</td>
<td>Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined.</td>
</tr>
<tr>
<td>AH</td>
<td>Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined.</td>
</tr>
<tr>
<td>A1-A30</td>
<td>Areas of 100-year flood; base flood elevations and flood hazard factors determined.</td>
</tr>
<tr>
<td>A99</td>
<td>Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined.</td>
</tr>
<tr>
<td>B</td>
<td>Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading)</td>
</tr>
<tr>
<td>C</td>
<td>Areas of minimal flooding. (No shading)</td>
</tr>
<tr>
<td>D</td>
<td>Areas of undetermined, but possible, flood hazards.</td>
</tr>
<tr>
<td>V</td>
<td>Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined.</td>
</tr>
<tr>
<td>V1-V30</td>
<td>Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined.</td>
</tr>
</tbody>
</table>
Accessing Floodplain Maps

• FEMA Map Services Center – www.msc.fema.gov

• Effective Maps
• Historic Maps
• Flood Insurance Studies (FIS)
• Letters of Map Change (LOMCs)
• DFIRM Database

FEMA Flood Map Service Center: Welcome!

Looking for a Flood Map?

Enter an address, a place, or longitude/latitude coordinates:

Looking for more than just a current flood map?
Visit Search All Products to access the full range of flood risk products for your community.

About Flood Map Service Center

The FEMA Flood Map Service Center (MSC) is the official public source for flood hazard information produced in support of the National Flood Insurance Program (NFIP). Use the MSC to find your official flood map, access a range of other flood hazard products, and take advantage of tools for better understanding flood risk.

FEMA flood maps are continually updated through a variety of processes. Effective Information that you download or print from this site may change or become superseded by new maps over time. For additional Information, please see the Flood Hazard Mapping Updates Overview Fact Sheet.
Accessing Floodplain Maps

• National Flood Hazard Layer (NFHL) - https://www.fema.gov/national-flood-hazard-layer-nfhl
• Online Interactive Map of All DFIRM data
• Can be loaded into Google Earth
• Displays LOMCs
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Dealing with A Zones
Dealing with A Zones
Dealing with A Zones
Dealing with A Zones
Approximate A Zones

- Approximate A Zones do not have BFEs
- Minimum Requirement of the NFIP: Permits
  - Permits must require that the lowest floor of all new construction be built above the BFE; necessitates the estimation of a BFE
  - “Reasonably safe from flooding”
  - Good examples of > 50 lot or 5 acre BFE determination rule.
- CFR 60.3
Resources

• Subdivision Design and Flood Hazard Areas (PAS 584)
  https://www.fema.gov/media-library/assets/documents/126942

• Understanding and Managing Flood Risk: A Guide for Elected Officials
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Establishing a Base Flood Elevation (BFE) in a Zone A Floodplain
FEMA - “Managing Floodplain Development in Approximate Zone A Areas: A Guide for Obtaining and Developing Base (100-Year) Flood Elevations”

“Before computational methods are used...

- existing floodplain studies or computations
  - IDOT and Local Bridge Plans and Bridge Hydraulic Studies
  - FEMA, USACE, NRCS, ISWS, USGS ...

First: "Steal it!"

HOW EFFORTLESSLY I STEAL THIS MAN
Second: “Let FEMA do it!”

• FEMA Cares!
• If your client has more time than money
• If the structures are so high above the river that it’s obvious that the flood risk is low
• You and your client don’t mind being rejected the first time
• You don’t mind your name or company’s name not being on the application
Third: “Learn Hydrology and Hydraulics”

- Stream Stats
- Use available topographic data for cross-section
- Survey channel profile
- Normal Depth Calculation
StreamStats
https://streamstats.usgs.gov/ss/

StreamStats Report
Region ID: IL
Workspace ID: IL2020114014010784090
Clicked Point (Latitude, Longitude): 46.3538, -88.31347
Time: 2020-01-10 19:49:27 -0600

Basin Characteristics

<table>
<thead>
<tr>
<th>Parameter Code</th>
<th>Parameter Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRNAREA</td>
<td>Area that drains to a point on a stream</td>
<td>214.18</td>
<td>square miles</td>
</tr>
<tr>
<td>CSL10.85</td>
<td>Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known</td>
<td>5.424</td>
<td>feet per mile</td>
</tr>
<tr>
<td>SOILPERM</td>
<td>Average Soil Permeability</td>
<td>1.149</td>
<td>inches per hour</td>
</tr>
<tr>
<td>ILR63</td>
<td>Indicator variable for IL region 3, enter 1 if site is in region 3 else 0</td>
<td>1</td>
<td>dimensionless</td>
</tr>
<tr>
<td>URBThe2010</td>
<td>Fraction of drainage area that is in urban classes 7 to 10 from Theobald 2010</td>
<td>0.016</td>
<td>dimensionless</td>
</tr>
</tbody>
</table>

Peak-Flow Statistics:

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban 2 Year Peak Flood</td>
<td>3890</td>
<td>ft³/s</td>
</tr>
<tr>
<td>Urban 5 Year Peak Flood</td>
<td>6860</td>
<td>ft³/s</td>
</tr>
<tr>
<td>Urban 10 Year Peak Flood</td>
<td>9640</td>
<td>ft³/s</td>
</tr>
<tr>
<td>Urban 25 Year Peak Flood</td>
<td>11990</td>
<td>ft³/s</td>
</tr>
<tr>
<td>Urban 50 Year Peak Flood</td>
<td>14200</td>
<td>ft³/s</td>
</tr>
<tr>
<td>Urban 100 Year Peak Flood</td>
<td>16400</td>
<td>ft³/s</td>
</tr>
<tr>
<td>Urban 500 Year Peak Flood</td>
<td>21800</td>
<td>ft³/s</td>
</tr>
</tbody>
</table>

Peak-Flow Statistics Citations:

(http://pubs.usgs.gov/sir/2016-1104/pdf)
Illinois GIS Clearinghouse Height Modernization
https://clearinghouse.isgs.illinois.edu/data/elevation/illinois-height-modernization-ilhmp-lidar-data

Interpolate Line
Profile Graph
Survey Channel Profile
Normal Depth Calculation

Instructions: Select variable to solve, adjust slider bars, click on graph to modify the cross section. CSV cross section data can be loaded in the input box below. This online calculator is for demonstration and educational purposes only.

Solve For:
Water Surface (normal depth)

Slope: 0.00005 (ft/ft)

WSE: 714.62 (ft)

Channel Manning n: 0.035

Flow: 16400 (ft³/s)

Select HEC-RAS Geometry: Choose File

Flow Area: 11612.0 (ft²)
Wetted Perimeter: 1140.5 (ft)
Max Depth: 16.49 (ft)
Average Velocity: 1.41 (ft/s)
Top Width: 1138.49 (ft)
Iterations: 682
Froude Number: 0.08

Load HEC-RAS Data
Normal Depth Conclusion

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Parameter Change</th>
<th>BFE Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel Depth</td>
<td>- 8 ft.</td>
<td>- 0.8 ft.</td>
</tr>
<tr>
<td>Roughness Manning’s “n”</td>
<td>+ 0.01</td>
<td>+ 1.4 ft.</td>
</tr>
<tr>
<td>Slope</td>
<td>- 0.00005 ft./ft.</td>
<td>+ 2.0 ft.</td>
</tr>
</tbody>
</table>

- Most Conservative: 716.3 ft.
- Most Optimistic: 711.9 ft.
- Difference 4.4 ft.
Fourth: “Get Lucky!”

- Find Model Backed Zone A Elevations
Model Backed Zone A Elevations
Model Backed Zone A Elevations

Expression

Write the expression in the language of the selected parser.  

\[
\text{[STREAM_STN]} \& \text{"ROUND([WSEL_REG],2)}
\]
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Looking Forward
DFIRMs in Illinois

- Ford and Warren counties have new Preliminary DFIRMs
- Large portions of Randolph, Cook and Kane counties have new Preliminary DFIRMs based on new studies
- Large portions of Lake, McHenry, White and Alexander have new studies in progress
- Peoria, Effingham, Clay, Madison, St. Clair, Monroe, Macoupin, McDonough, Bond, and McHenry are funded for new studies
FEMA Model Backed A Zones

- [http://illinoisfloodmaps.org/dfd.aspx](http://illinoisfloodmaps.org/dfd.aspx)
- [Model being Developed](#)
- [Model backed](#)
- [Not Yet Model Backed](#)

- **Model Backed**
  - Still Approximate
  - “Option B” Base Level Engineering
    - No Bridges or Structures, but cross sections are placed appropriately for structure modeling
    - Cross-sections are auto-placed and hand adjusted
    - Single Channel Manning’s “n”, overbanks from Land Use Land Cover
    - No channel bathymetry

---

[Diagram of Illinois State Flood Zones]
Precipitation

Figure 3 Statewide average annual precipitation for Illinois from 1895 to 2017. The green line shows the year-to-year variability. The blue line is a linear trend showing an increase of 4.14 inches over the past century. Source: NOAA NCEI, 2018.
Precipitation

- TP-40 (1961)
ILLINOIS

Illinois State Water Survey

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