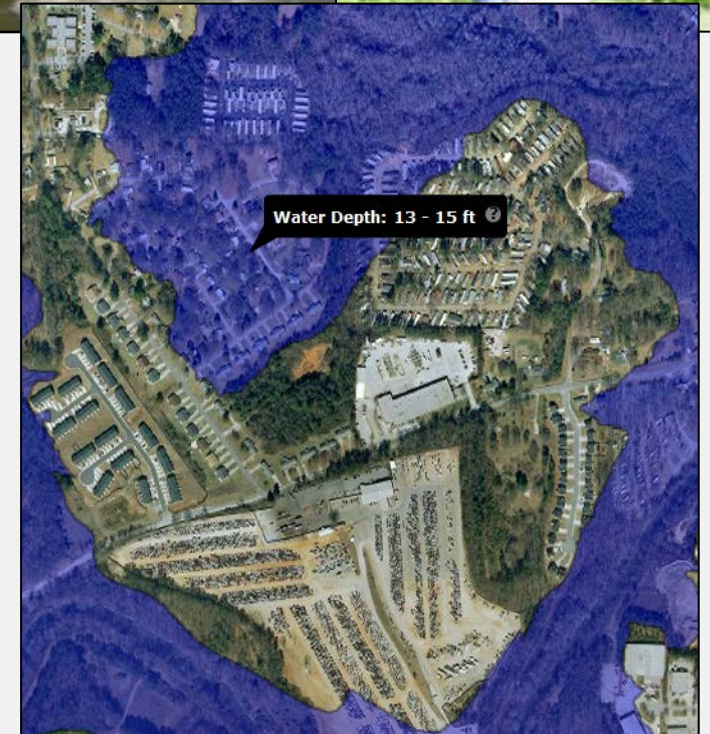




# USGS Flood Inundation Mapping Science

**Marie Pepler** Flood Inundation Mapping Coordinator

U.S. Department of the Interior  
U.S. Geological Survey



# USGS and NWS Data Networks

**USGS Current Water Data for the Nation**

**Daily Streamflow Conditions**  
Thursday, March 22, 2012 10:06:21

**Select a state from the map to access real-time data**

Current data typically are recorded at 15- to 60-minute intervals, stored onsite, and then transmitted to USGS offices every 1 to 4 hours, depending on the data relay technique used. Recording and transmission times may be more frequent during critical events. Data from current sites are relayed to USGS offices via satellite, telephone, and/or radio telemetry and are available for viewing within minutes of arrival.

All real-time data are **provisional and subject to revision**.

<a href="#">Build Current Conditions Table</a>	Show a custom current conditions summary table for one or more stations.
<a href="#">Build Time Series</a>	Show custom graphs or tables for a series of recent data for one or more stations.

**Explanation**

- High
- > 90th percentile
- 75th - 90th percentile
- 50th - 75th percentile
- 25th - 50th percentile
- 10th - 25th percentile
- < 10th percentile
- Low
- Not ranked

The colored dots on this map depict streamflow conditions as a percentile, which is computed from the period of record for the current day of the year. Only stations with at least 30 years of record are used. The grey circles indicate other stations that were not ranked in percentiles either because they have fewer than 30 years of record or because they report parameters other than streamflow. Some stations, for example, measure stage only.

**Over 8,100 USGS Gages reporting current stream conditions in NWIS**



**National Weather Service**

Home > River Observations

NWS has issued its annual Spring Flood Outlook. Details...

**4061 total gages**  
Show all locations in flood (70)

- 6 Gages: Major Flooding
- 17 Gages: Moderate Flooding
- 55 Gages: Minor Flooding
- 91 Gages: Near Flood Stage
- 4516 Gages: No Flooding
- 200 Gages: Observations older than 24 hours
- 23 Gages: Out of Service

Show all locations

Last map update: 03/22/12 at 04:51:44 pm EDT  
03/22/12 2:28:44 UTC

Disaster

**Hydrologic Resources**

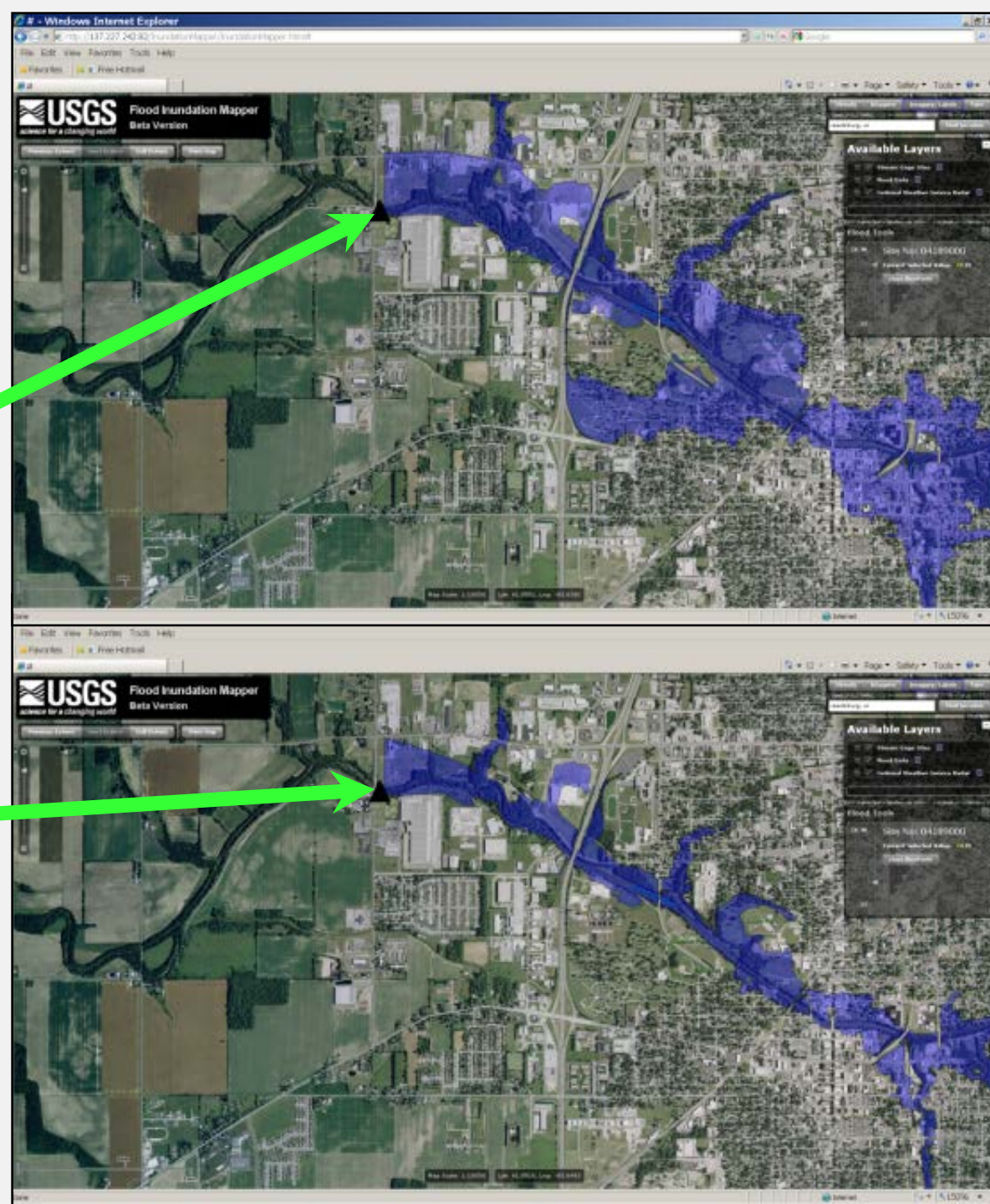
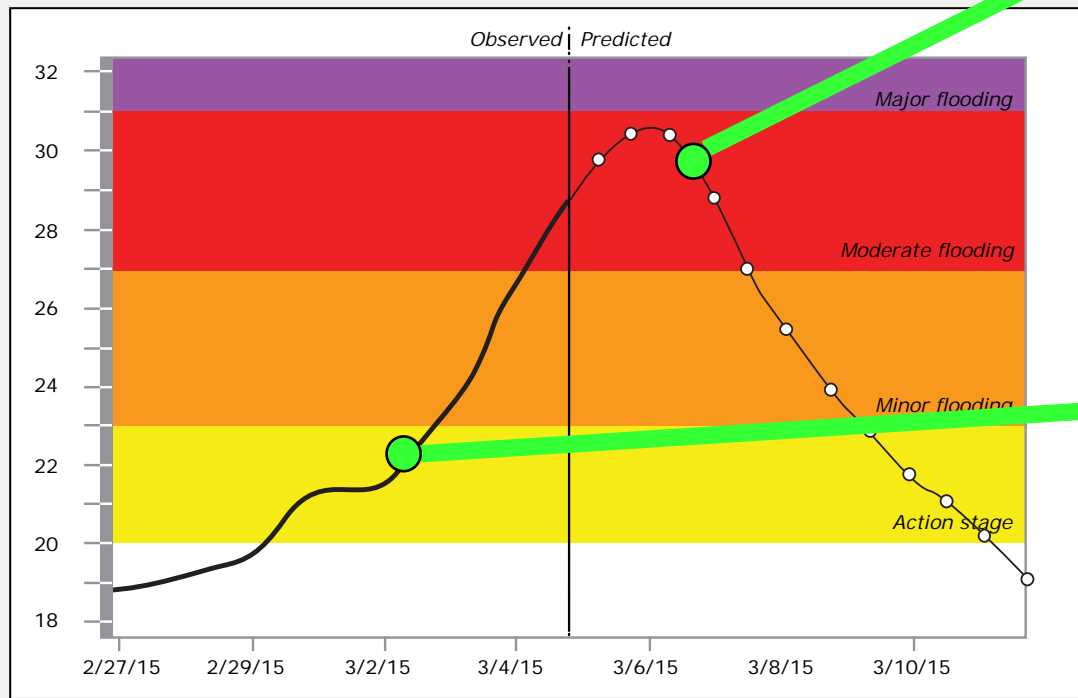
- ▶ River Forecast Centers
- ▶ About AHPs
- ▶ Publications
- ▶ AHPs Feedback
- ▶ AHPs RSS
- ▶ Automated Flood Warning Systems
- ▶ Hydro-meteorological Automated Data System
- ▶ Real-time Mapping Locations

**Additional Resources**

- ▶ National Significant River Flood Outlook
- ▶ U.S. Geological Survey Streamflow Information
- ▶ Snow Information
- ▶ NWS Precipitation and River Forecasting
- ▶ Water Resources Outlook
- ▶ Experimental Heavy Precipitation
- ▶ Guide to Hydrologic Information on the Web
- ▶ Precip Frequency/PMF

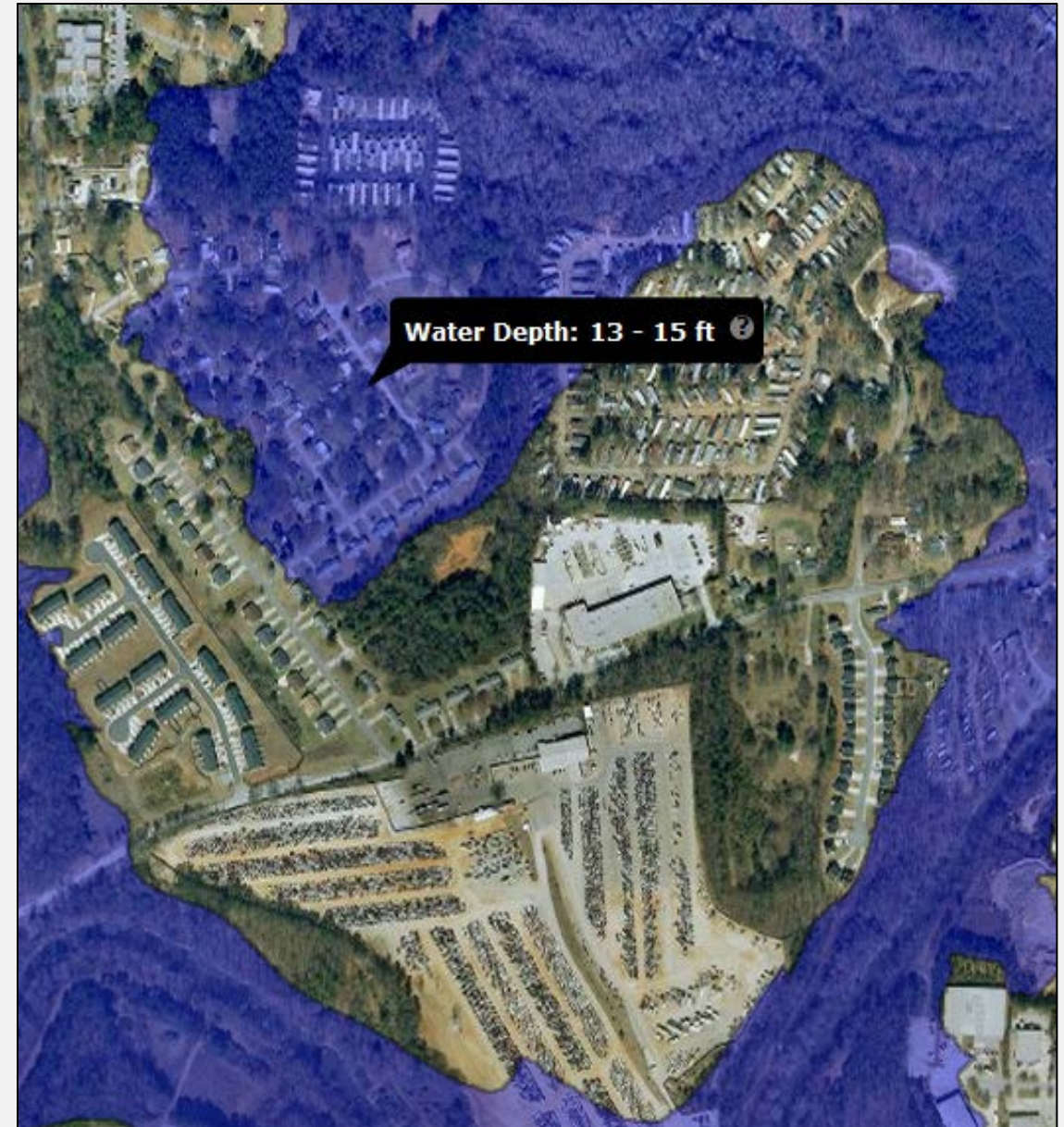
**Over 4,000 NWS Flood Forecast/Warning locations in AHPs**

# Flood Inundation Maps can translate a hydrograph into operational maps that communicate risk and consequences



# A Flood Inundation Map is:

- a map with a line where one side is wet and the other is dry under one defined situation.
  - Modeled,
  - Measured,
  - Or Both!



# FIM becomes a tool for flood...



- Preparedness
  - “What-if” scenarios
- Response
  - Tied to gage & forecast data
- Recovery
  - Damage assessment

- Mitigation & planning
  - Flood risk analyses
- Environmental & ecological assessments



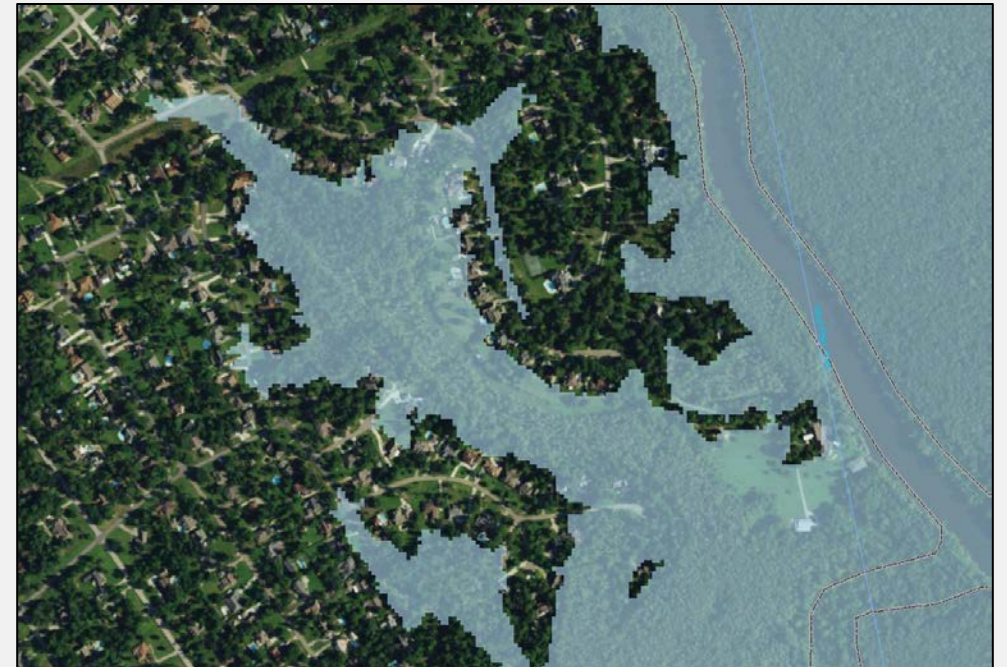
# Environmental Assessments and Support

- **Ecological studies of floodplains**
  - Such as frequency of inundation
- **Riparian habitat**
  - 7-day inundation areas
- **Hazardous substance spills**
  - Kalamazoo River Oil Spill



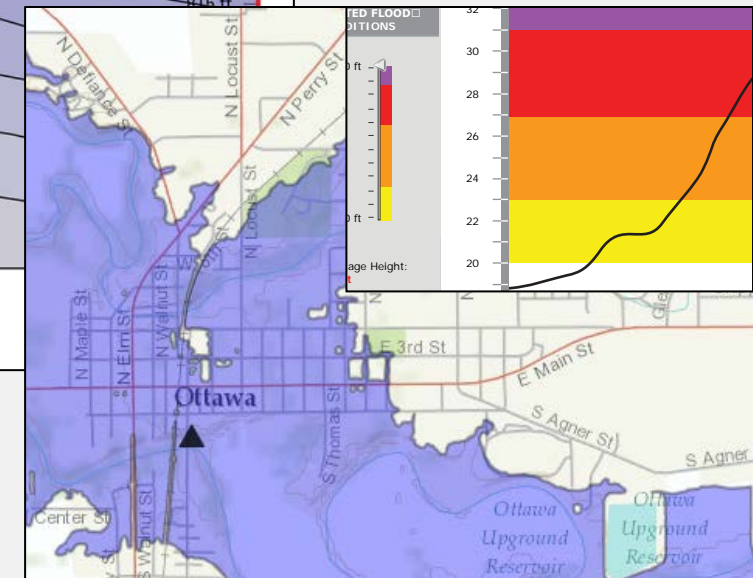
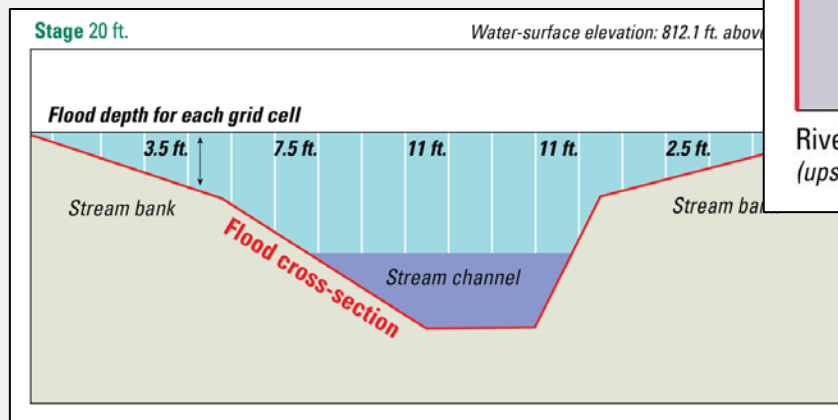
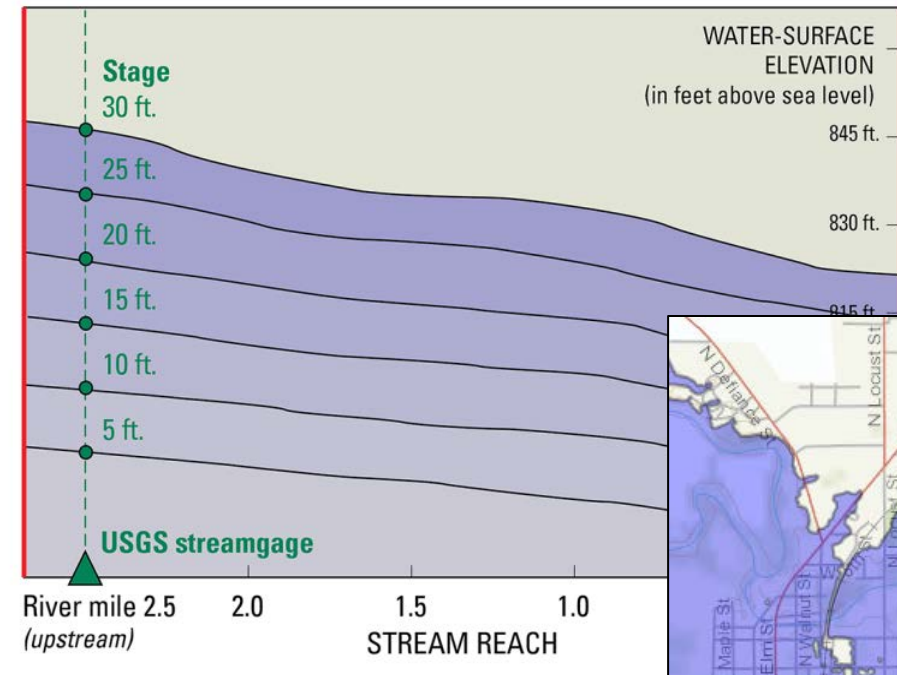
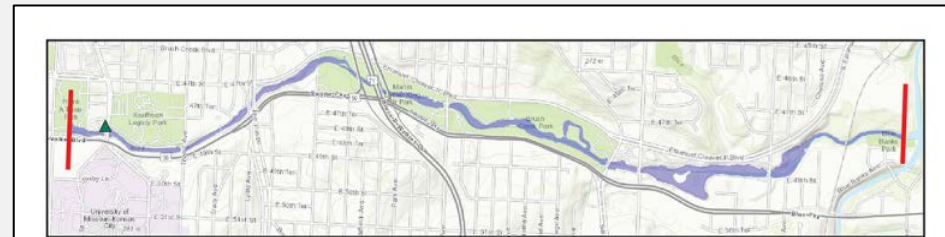
# Types of Flood Inundation Maps

- **Modeled Flood Inundation Map Libraries**
  - Probabilistic Flows (i.e. 1% chance flood)
  - Deterministic Flows
    - Stage Intervals (i.e. every 2 feet in stage)
    - Critical stages (i.e. Moderate and Major flood stages)
- **Flood Documentation Studies**
  - Measured
  - Interpolated from measurements
  - Remotely Sensed
    - Satellite
    - Aerial (manned or unmanned)



# Hydraulic Modeled Flood Inundation Map Libraries

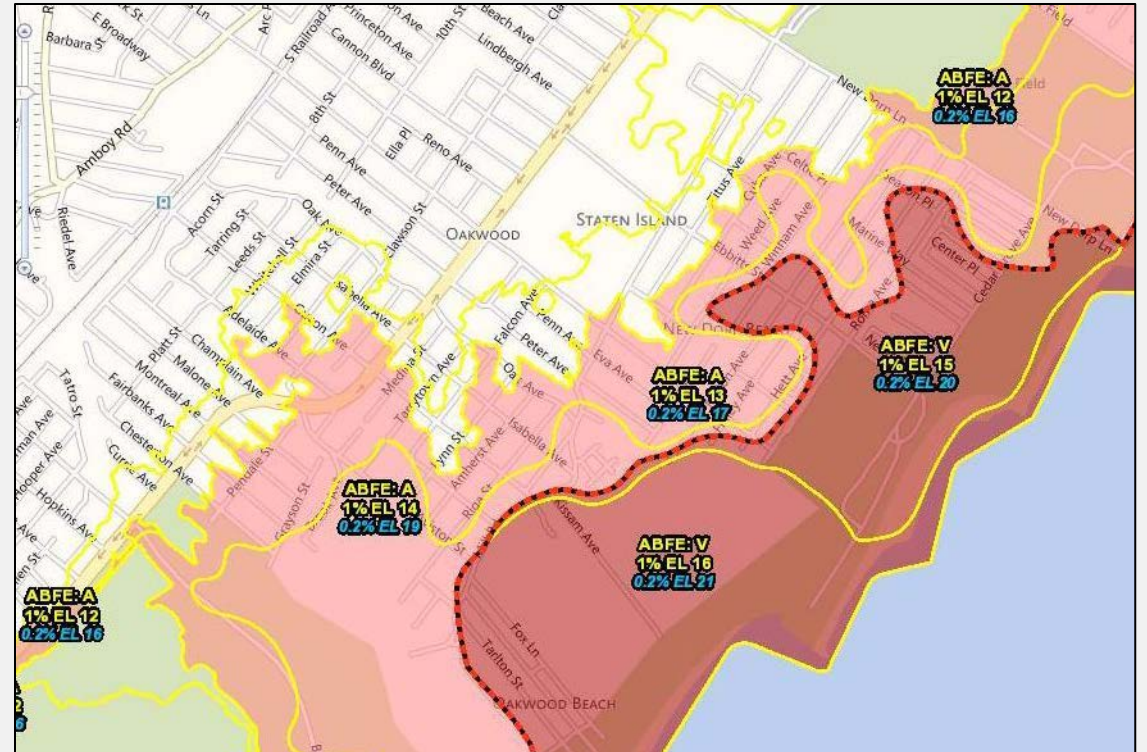
1. Stream Selection
2. Model Flood Heights
3. Delineate Flood Extents
4. Compute Flood Depths
5. Process Map Library



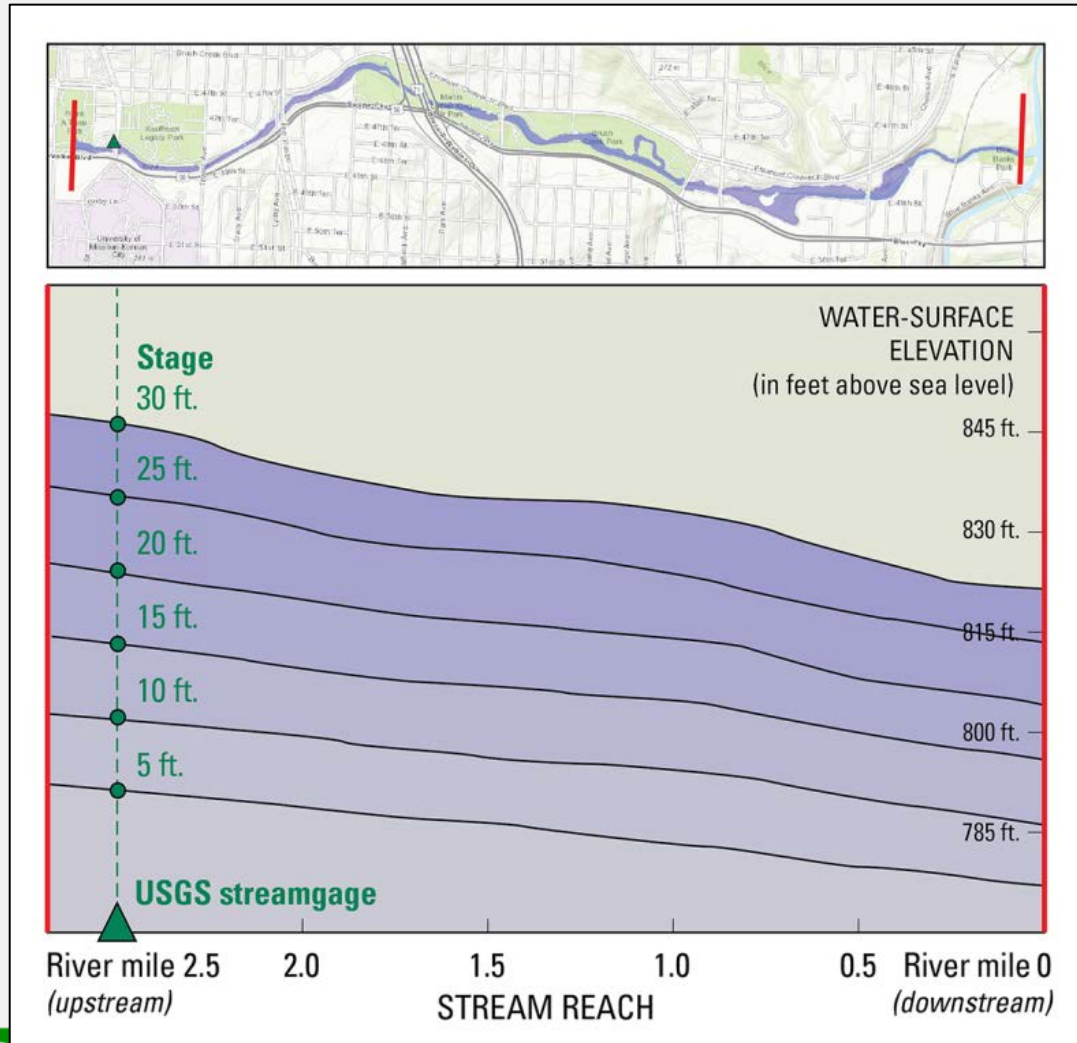


# Probabilistic Flood Inundation Map Libraries

- Most common example are FEMA's Flood Insurance Rate Maps (FIRM)
- Typically several are created
  - 20%, 10%, 5%, 1%, 0.2% Exceedance Probability Flows
- Same modeling method
- Different inputs and purpose

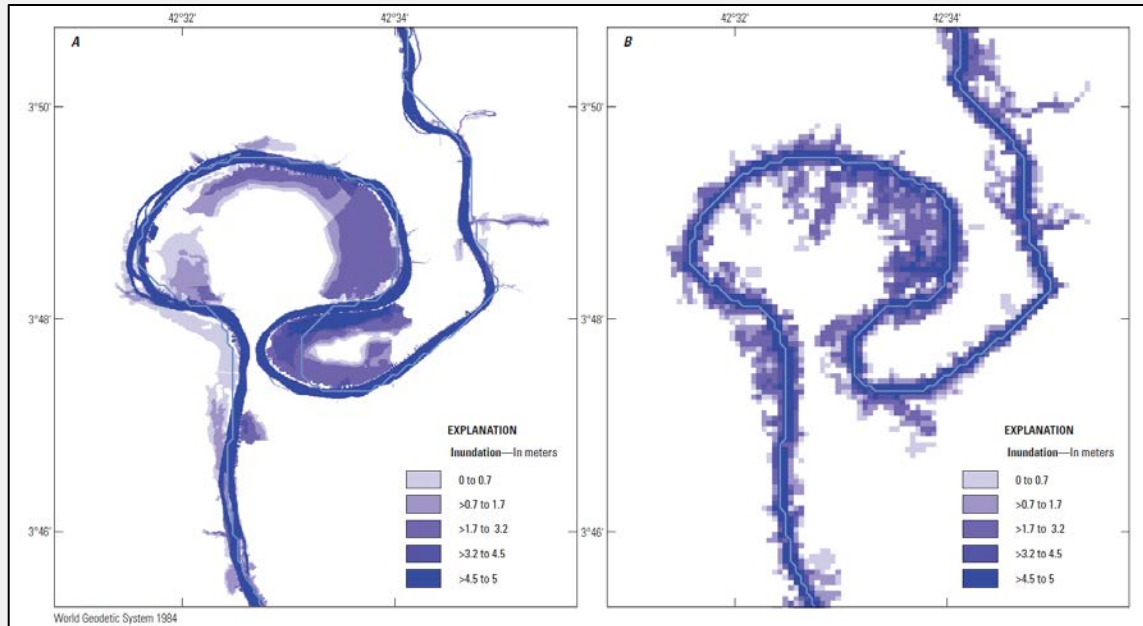


# Deterministic Flood Inundation Map Libraries



- Based on even “slices” of stage or flow
- Any hydraulic model (calibrated to a USGS gage rating curve)
- Presents a full range of maps
  - Usually ~15 maps
  - From bankfull to peak of record
- Robust as long as base conditions don't change

# GIS Modeled Flood Inundation Map Libraries



10-meter

90-meter

USGS GIS Flood Tool Sample Output



- Numerous methods are GIS only or have a loose hydrologic modeling component
- GISFlood Tool, HAND, Bathtub, etc.
- Can be flow, stage, or connectivity based
- Scale is critical for interpretation

# Creation of Flood Documentation Maps

1. Measure some aspect of the water level
  1. Streamgages or other sensors
  2. High-water marks
  3. Remote sensing
2. Connect the dots
  1. GIS model with elevation data
  2. Literally connect the dots
3. Delineate Flood Extents
4. Compute Flood Depths

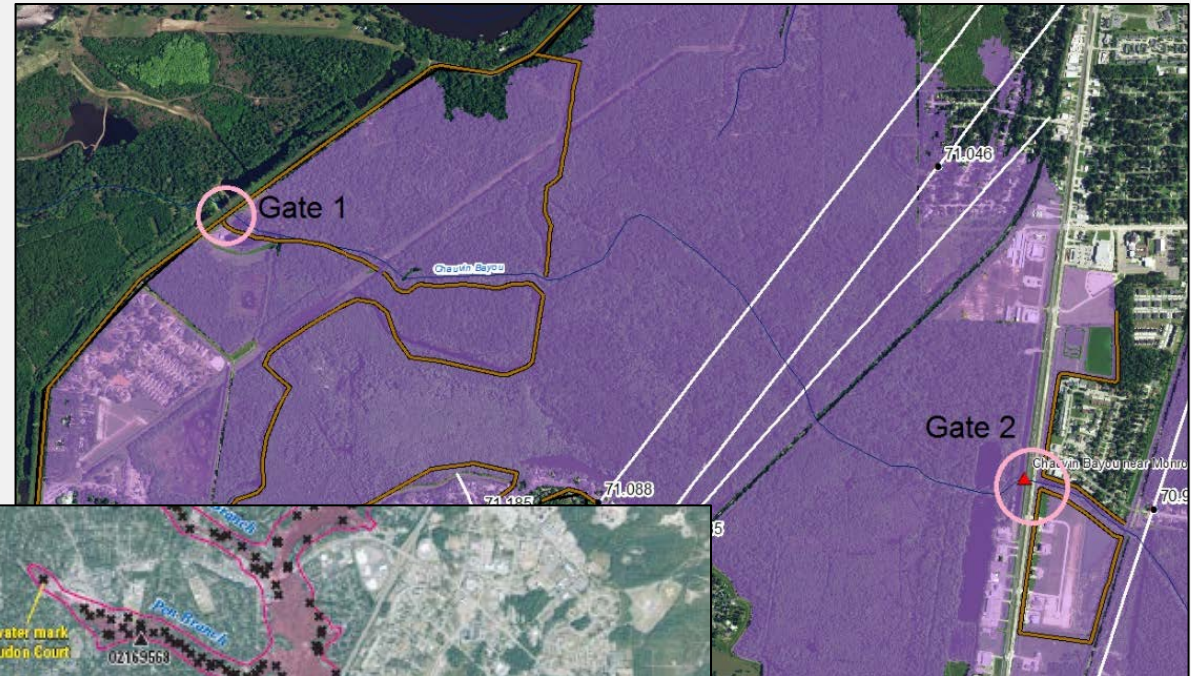


Cedar River, IA

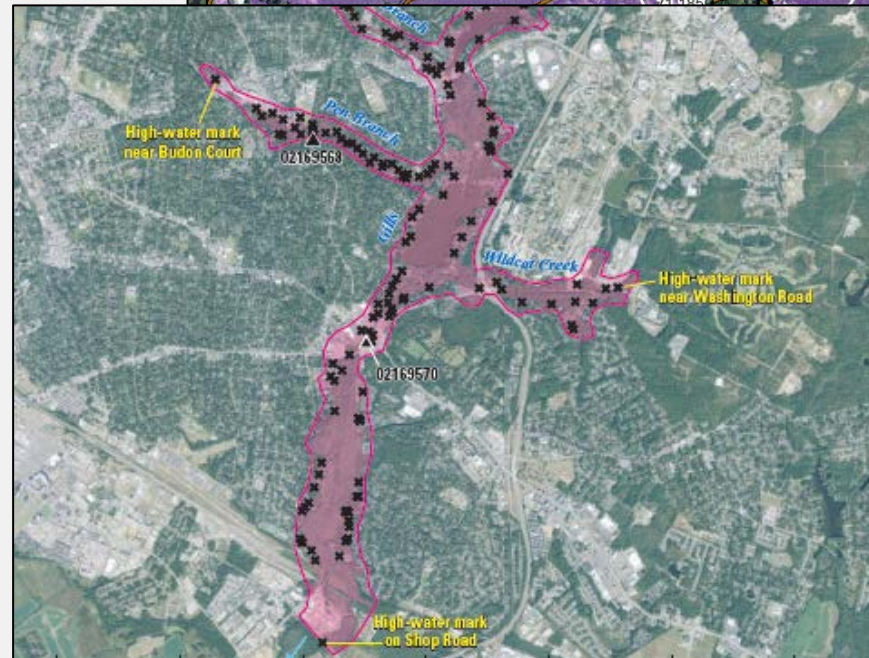


# High-Water-Mark Derived Flood Documentation Map

- Use the High-Water Mark information with the DEM to extend the marks out on the landscape
- Can be used for riverine or coastal flooded areas with some modifications



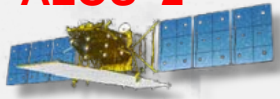
Working map view  
Ouachita River Complex, LA



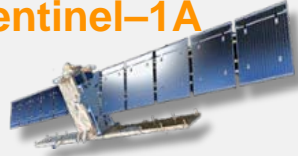
Published map view  
Columbia, SC

# Remote-Sensing Derived Flood Documentation Map

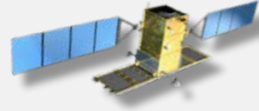
ALOS-2



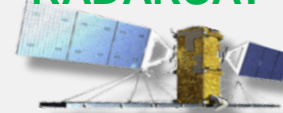
Sentinel-1A



COSMO-SkyMed



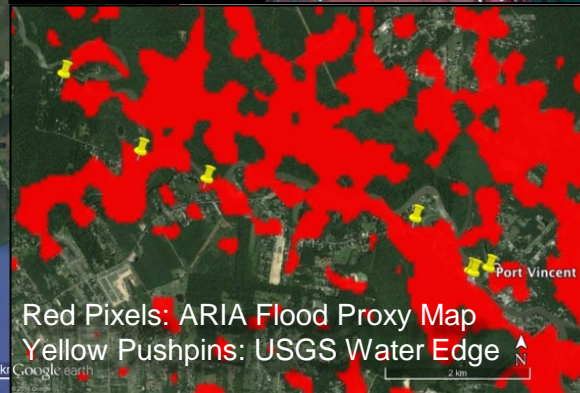
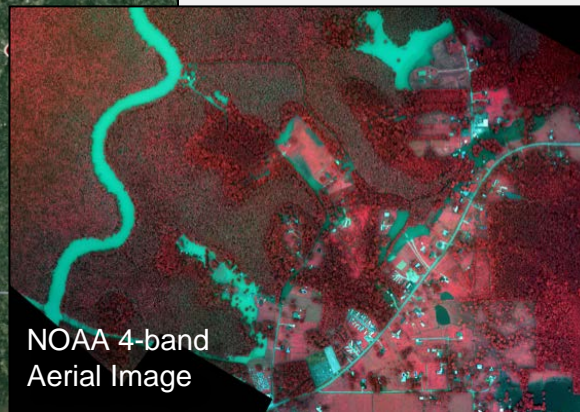
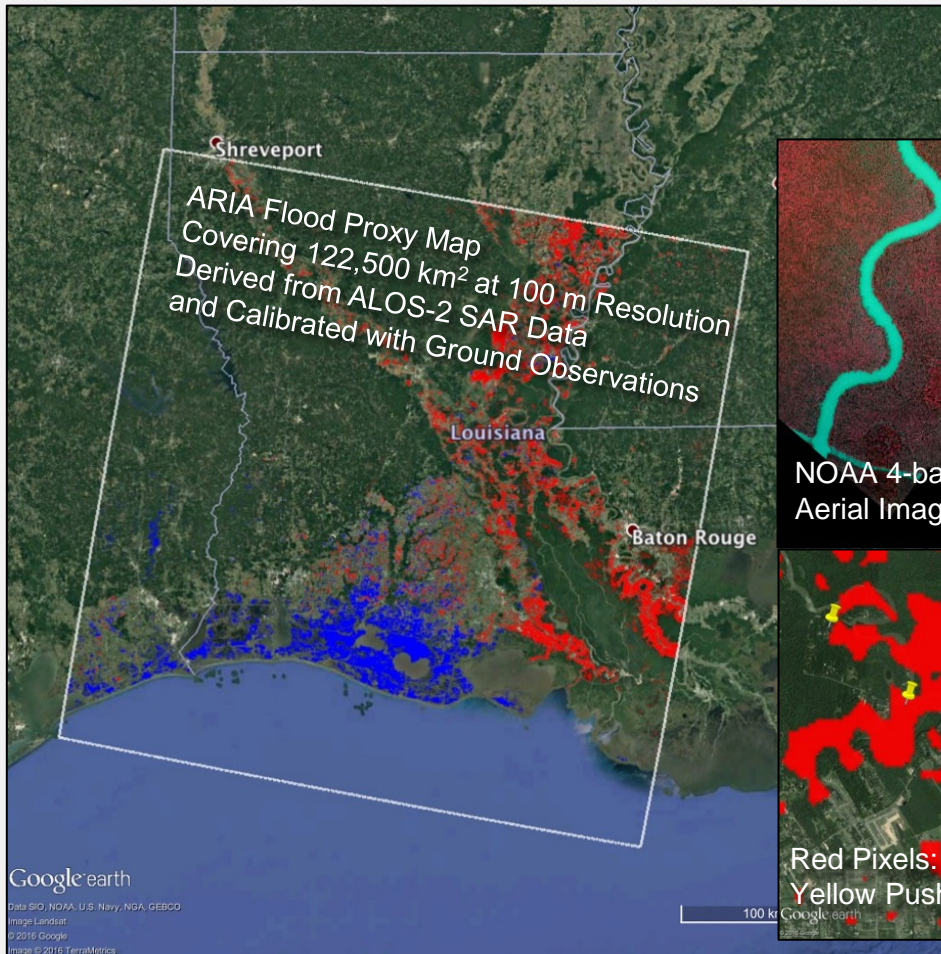
RADARSAT-2



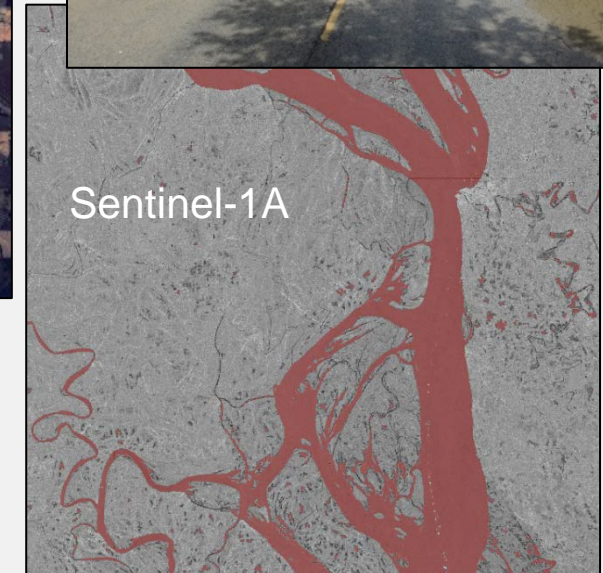
NOAA



USGS



Landsat

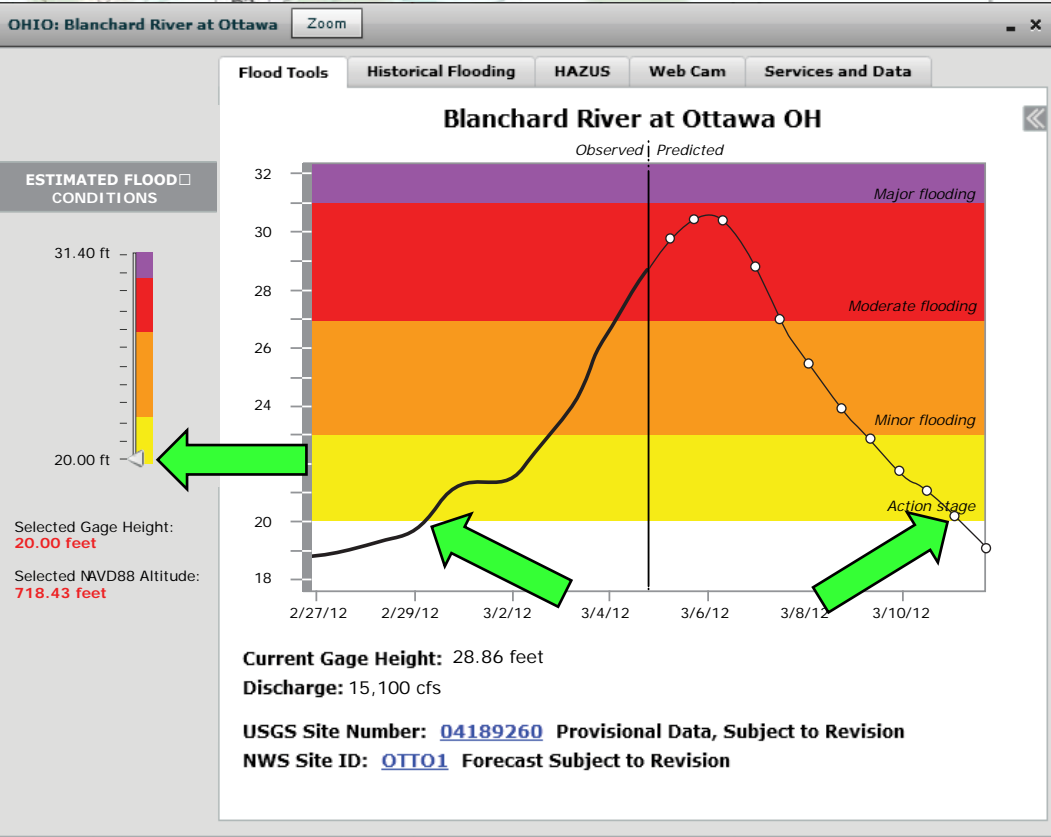
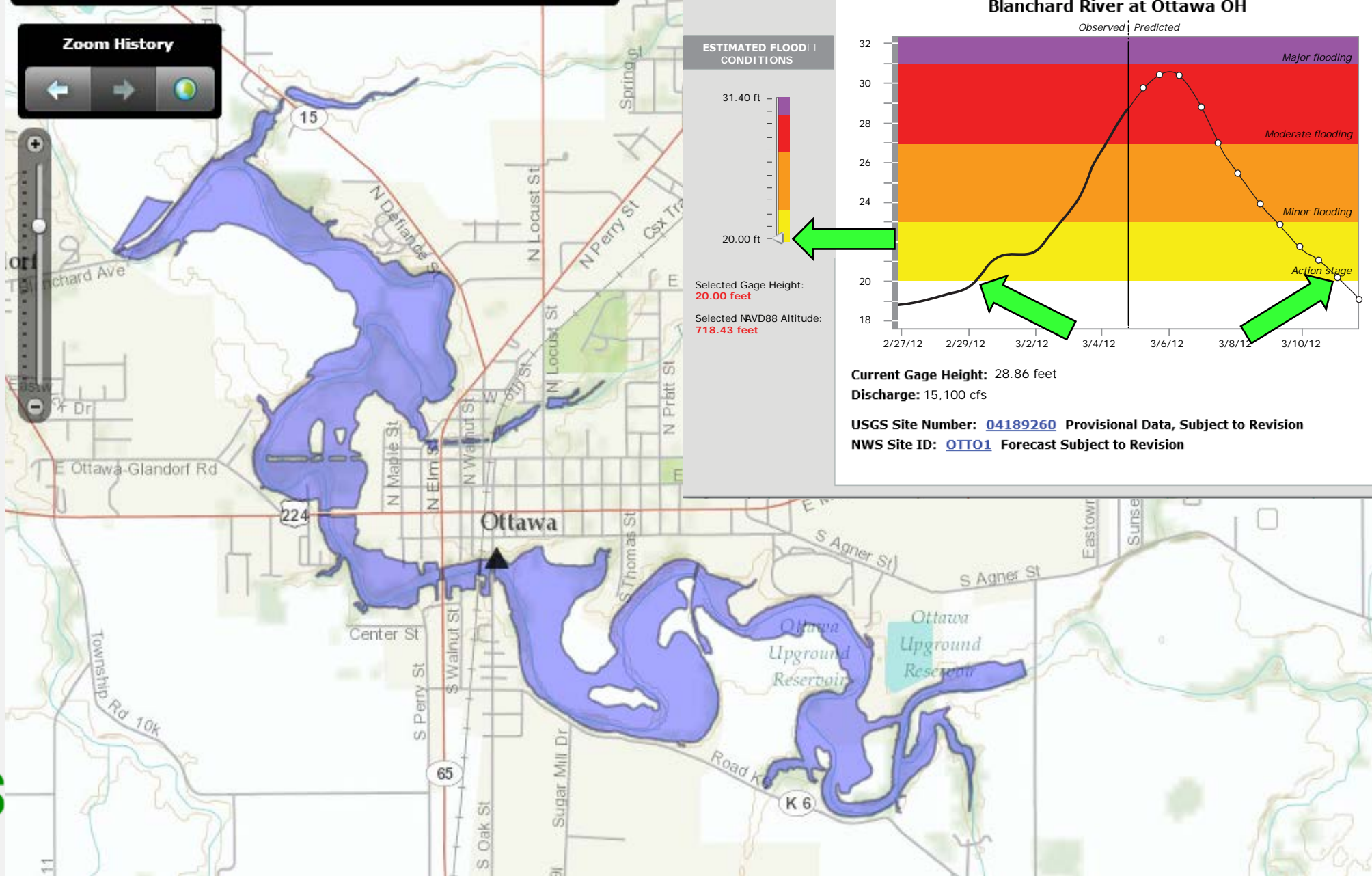
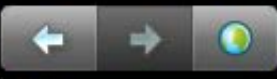


Sentinel-1A

# USGS FIM Research

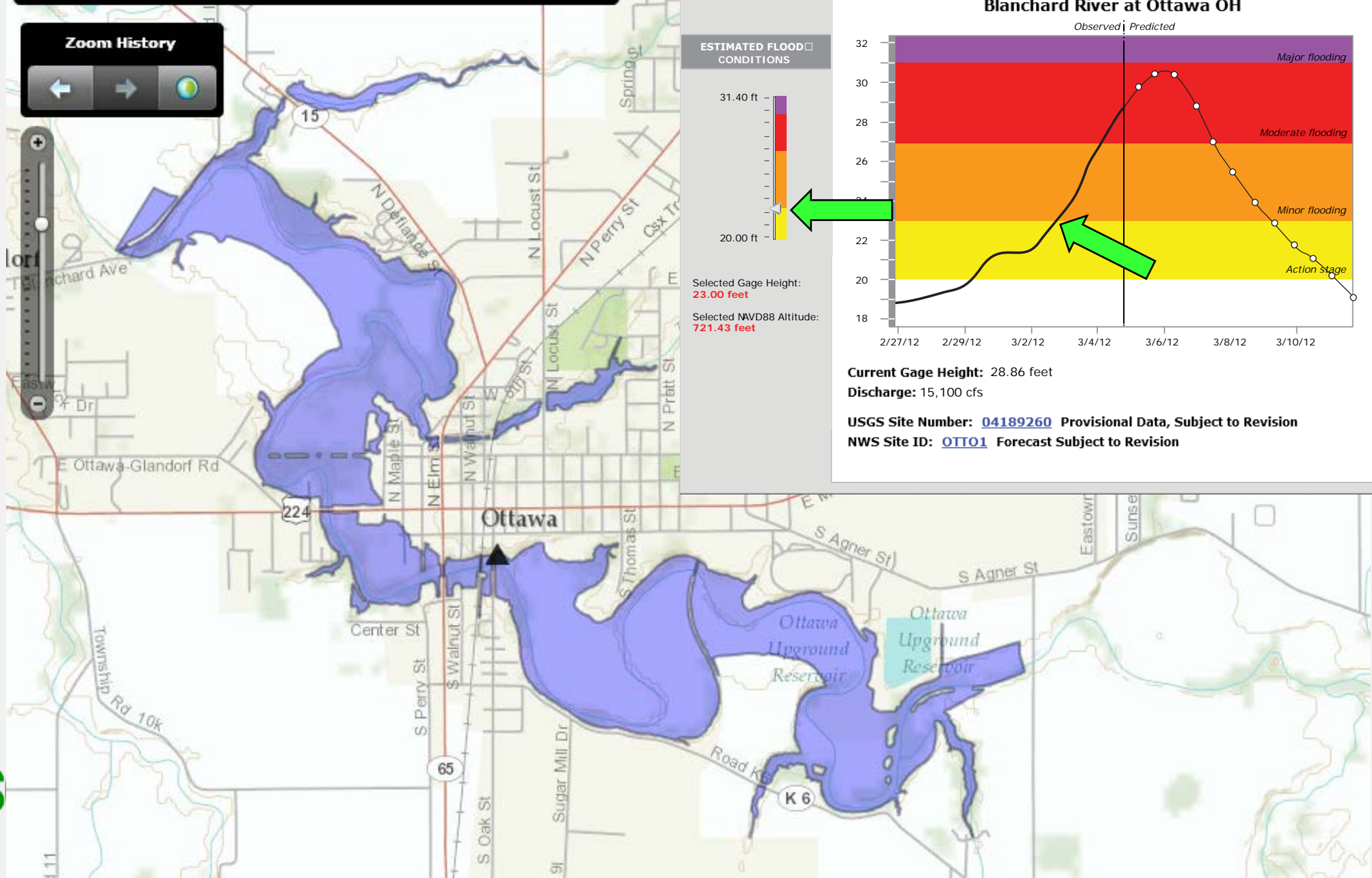
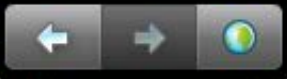
- **FIM Library Lifecycle**
  - When should maps be reexamined?
  - Under what conditions should they be removed?
- **Expand RapidFIM testing**
  - Develop standards for comparing FIM methods
    - Possibly F-Score (working with NWS LMRFC on this)
- **Communicating more varied quality of FIM libraries (uncertainty computations and display)**

### Zoom History





Zoom History



OHIO: Blanchard River at Ottawa Zoom

Flood Tools | Historical Flooding | HAZUS | Web Cam | Services and Data

### Blanchard River at Ottawa OH

Observed | Predicted

**ESTIMATED FLOOD CONDITIONS**

31.40 ft

20.00 ft

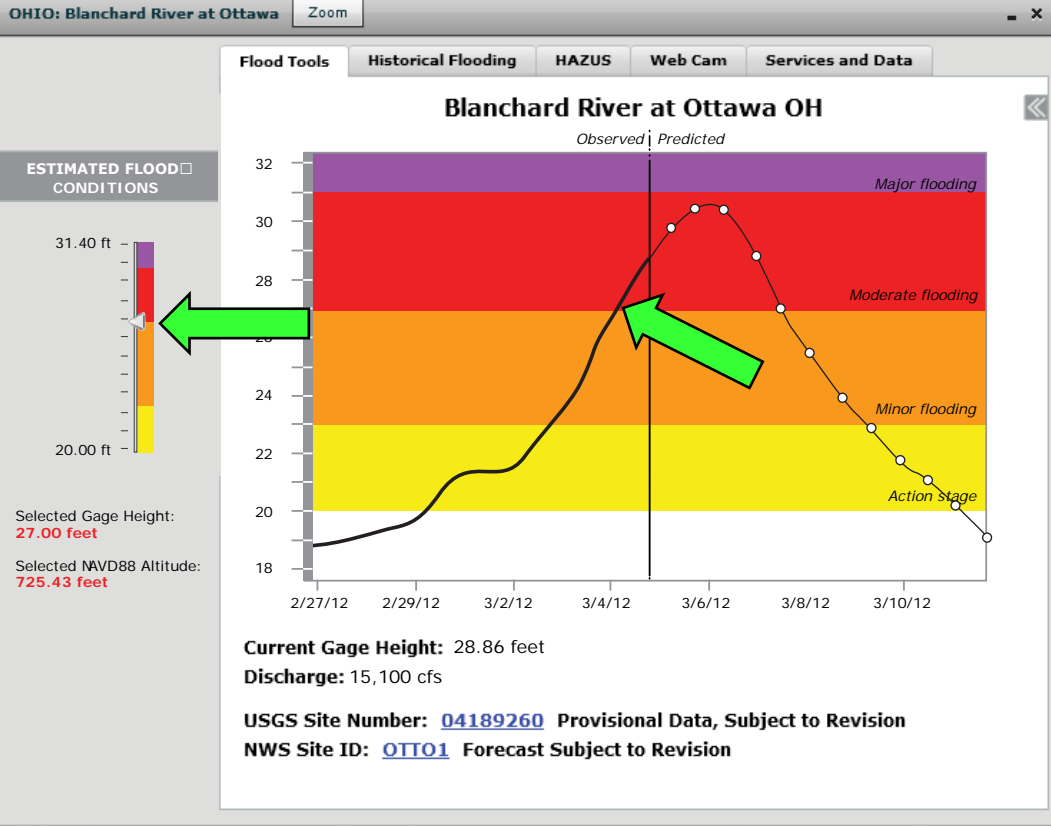
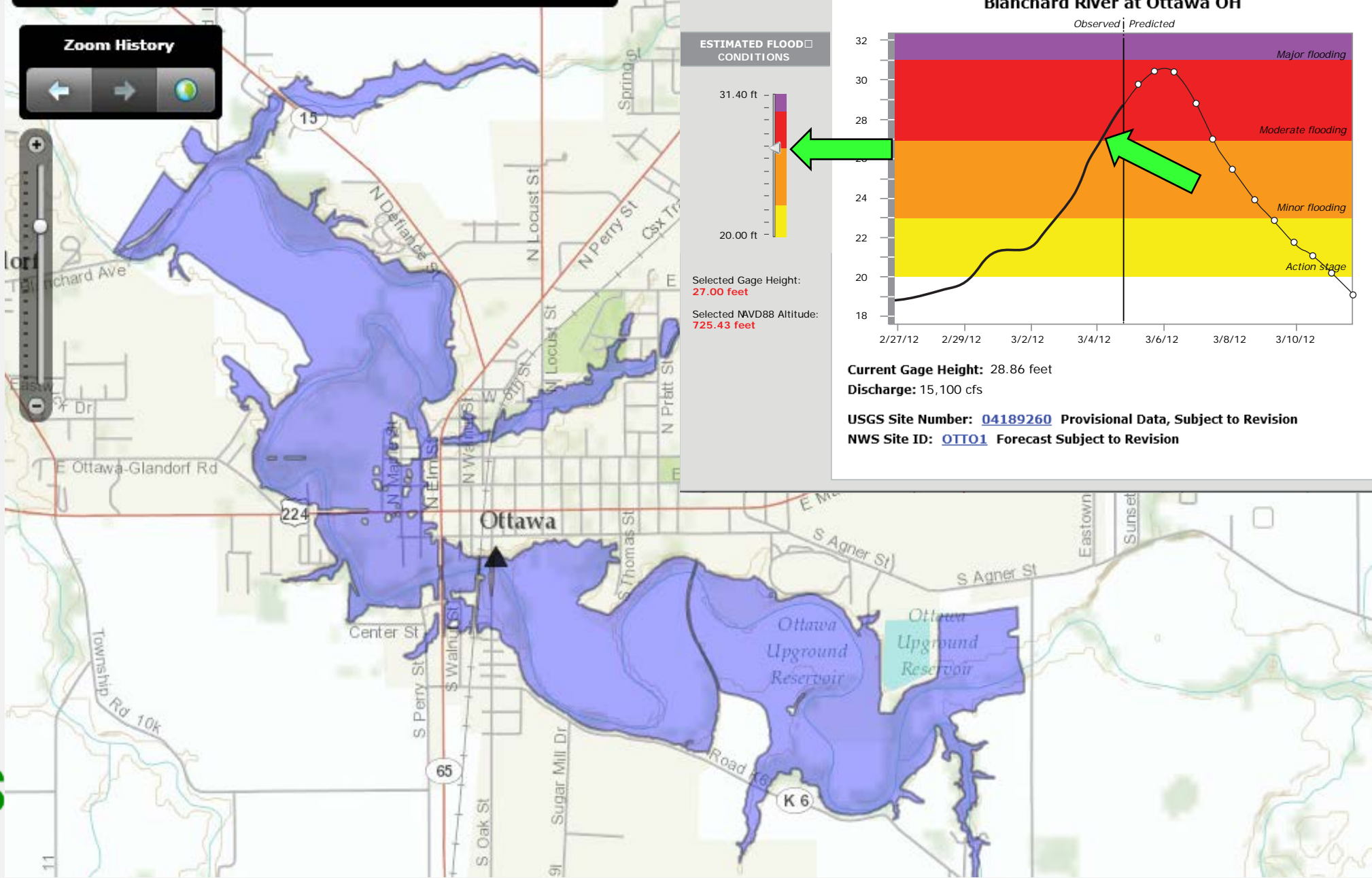
Selected Gage Height: **23.00 feet**

Selected NAVD88 Altitude: **721.43 feet**

**Current Gage Height:** 28.86 feet  
**Discharge:** 15,100 cfs

**USGS Site Number:** [04189260](#) **Provisional Data, Subject to Revision**  
**NWS Site ID:** [OTTO1](#) **Forecast Subject to Revision**

**Zoom History**



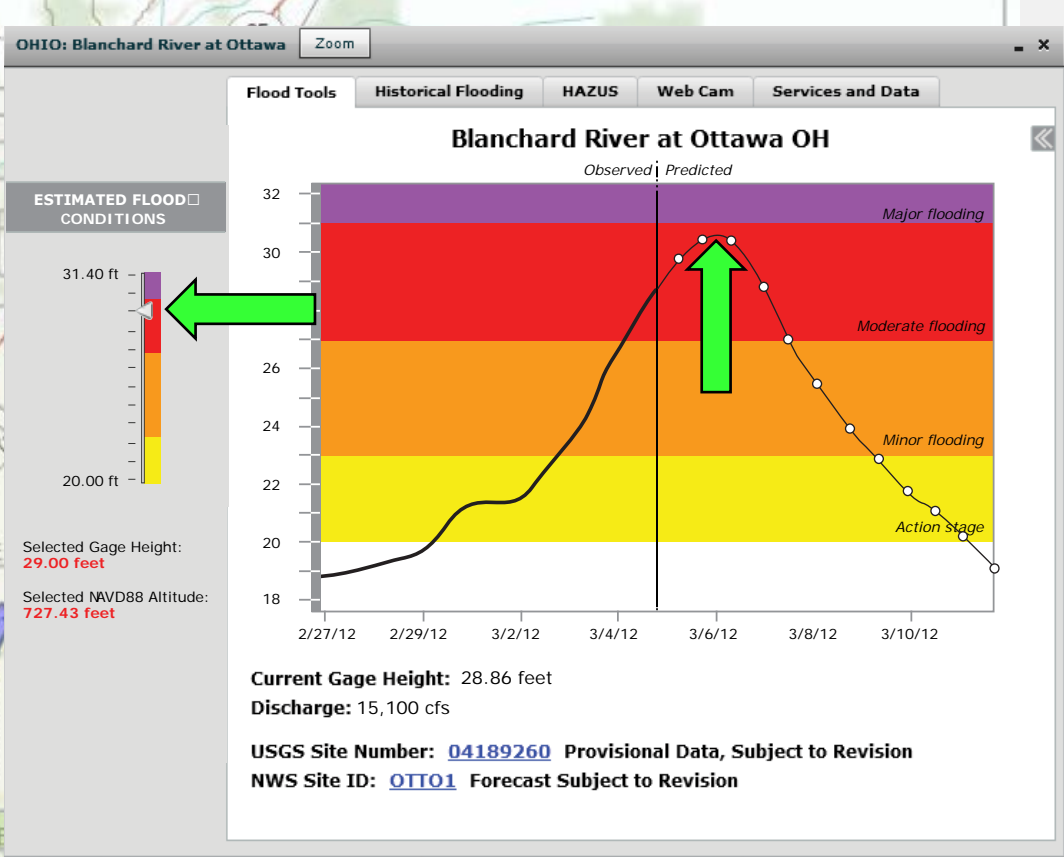
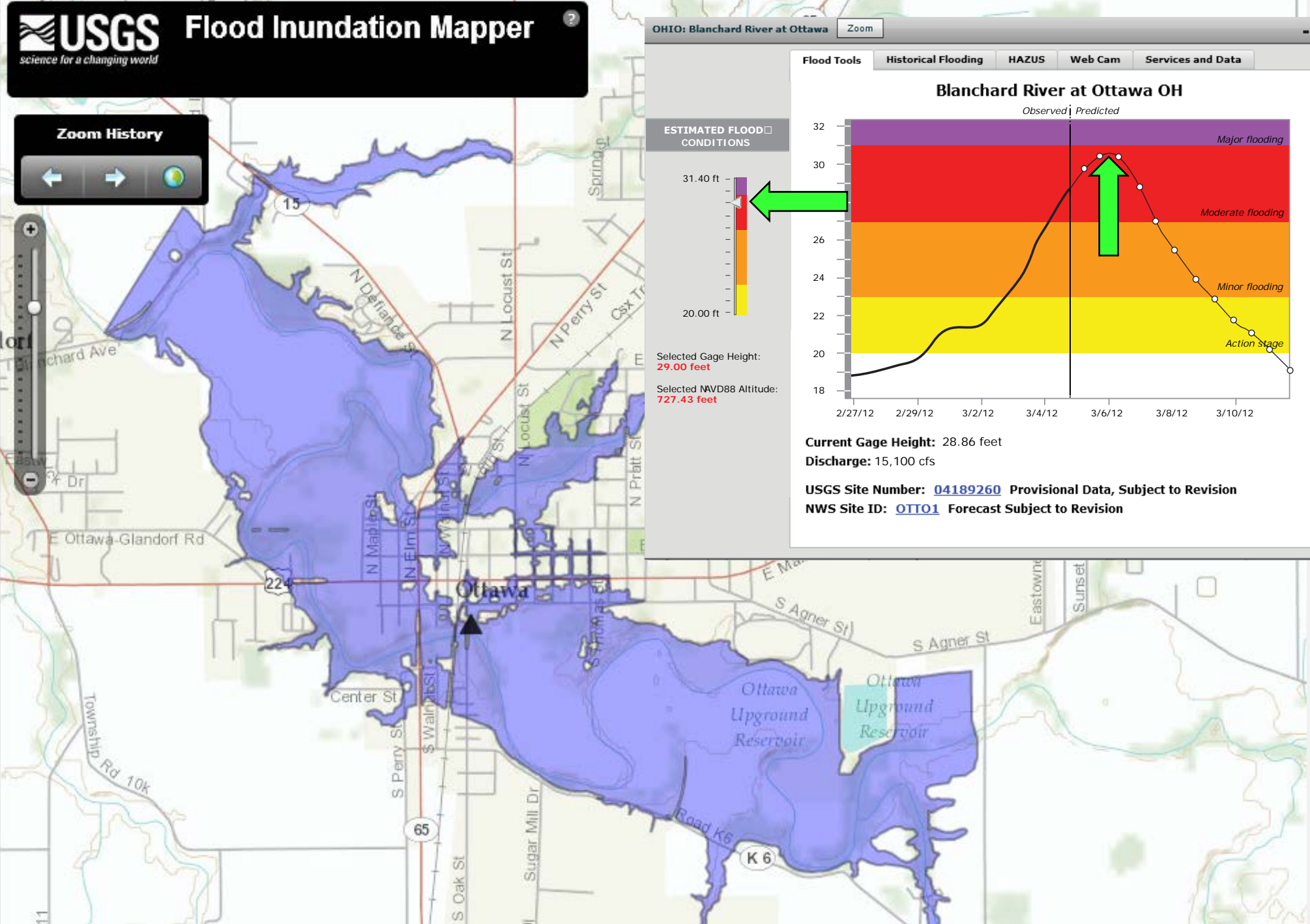
**Zoom History**

← → 🌐

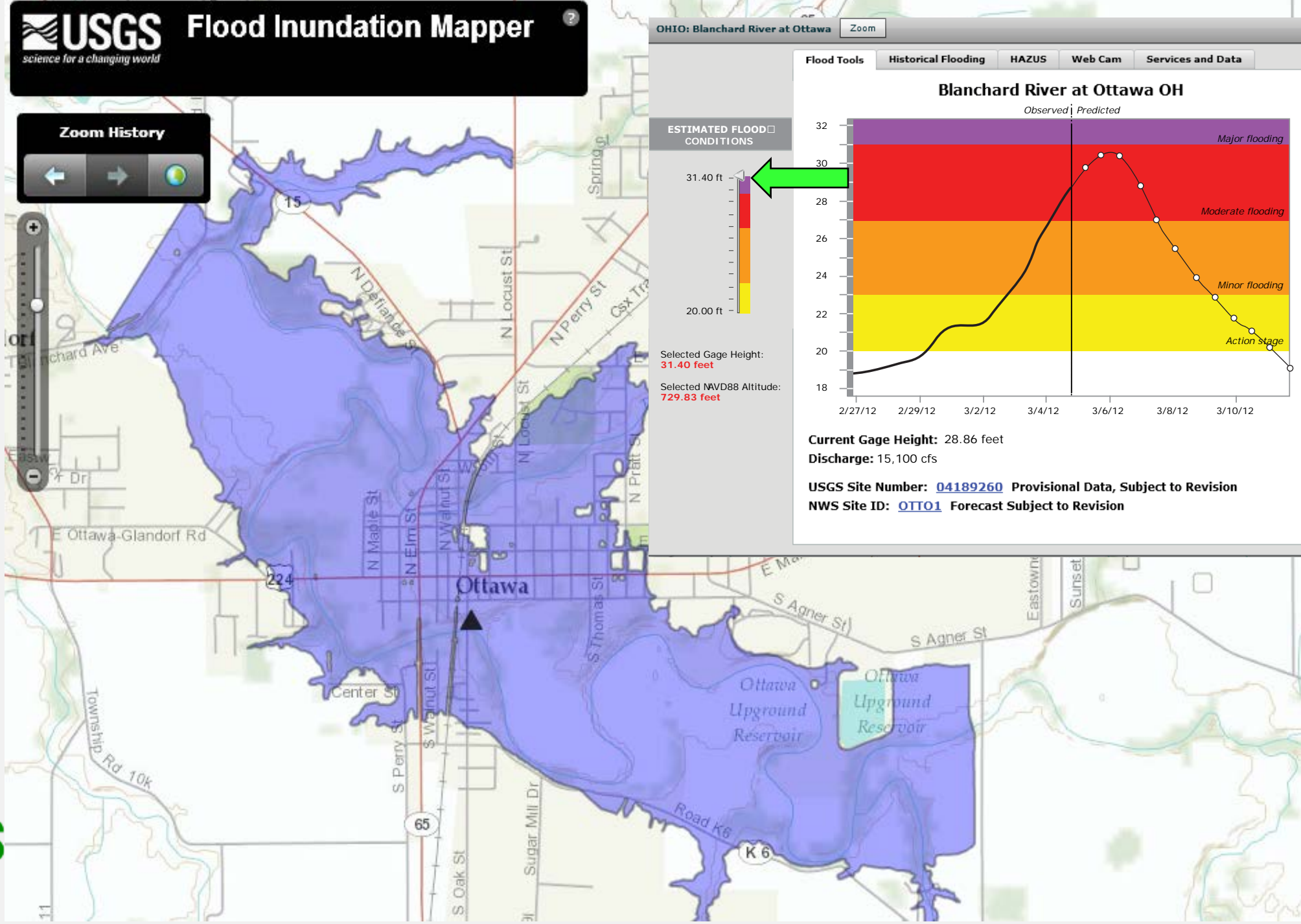
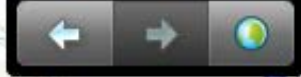
+

0

-



Zoom History



OHIO: Blanchard River at Ottawa

Zoom

Flood Tools | Historical Flooding | HAZUS | Web Cam | Services and Data

**Blanchard River at Ottawa OH**

Observed | Predicted

ESTIMATED FLOOD CONDITIONS

31.40 ft

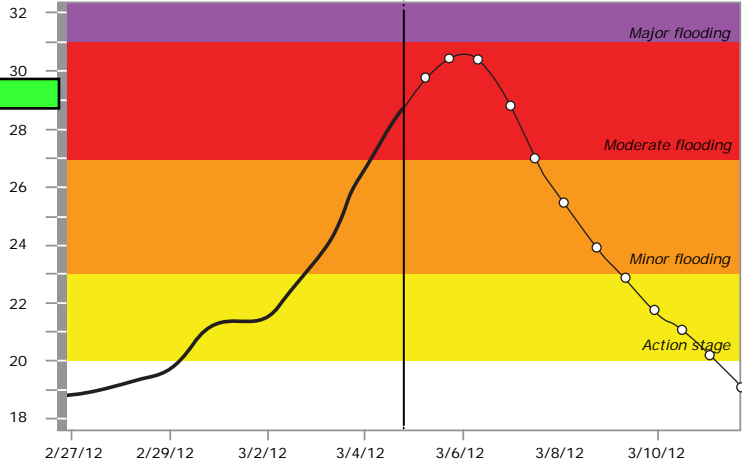
20.00 ft

Selected Gage Height:

31.40 feet

Selected NAVD88 Altitude:

729.83 feet



**Current Gage Height:** 28.86 feet

**Discharge:** 15,100 cfs

**USGS Site Number:** [04189260](#) **Provisional Data, Subject to Revision**

**NWS Site ID:** [OTTO1](#) **Forecast Subject to Revision**

# Contact Information



**Marie C. Peppler**

USGS Office of Surface Water

[mpeppler@usgs.gov](mailto:mpeppler@usgs.gov)

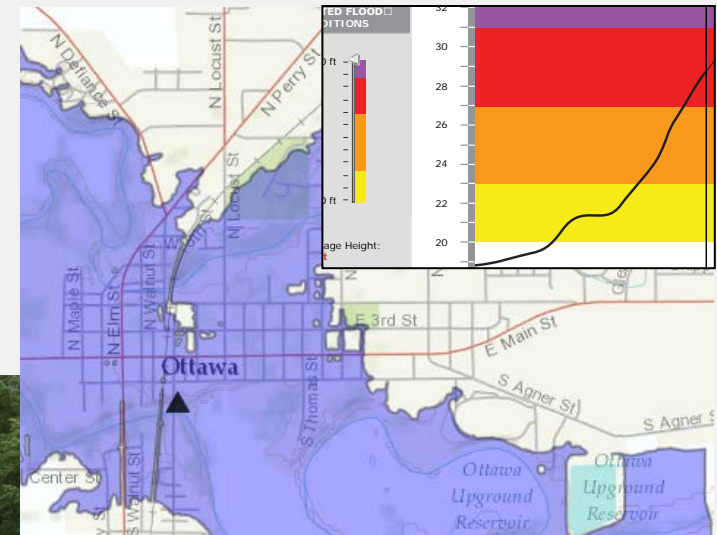
703.648.5314

[http://water.usgs.gov/osw/flood\\_inundation/](http://water.usgs.gov/osw/flood_inundation/)

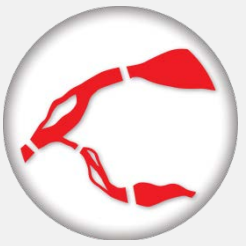


# General Steps for Creation of a Modeled Flood Inundation Map Library using a Hydraulic Model

1. Stream Selection
2. Model Flood Heights
3. Delineate Flood Extents
4. Compute Flood Depths
5. Process Map Library

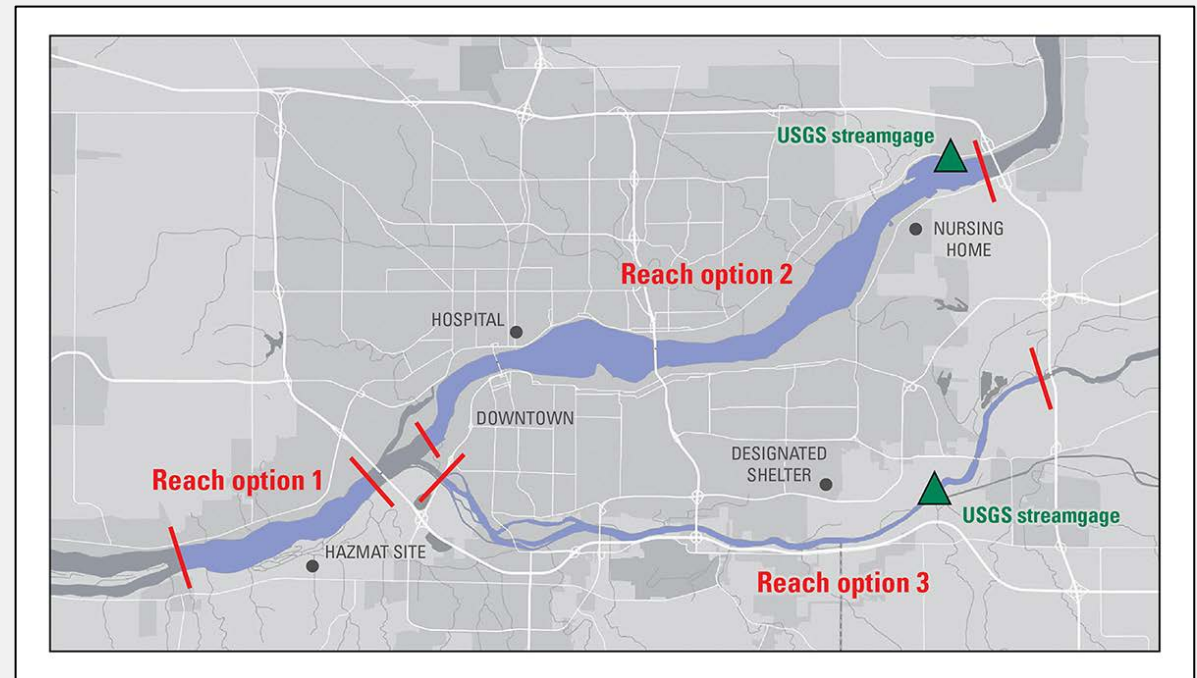


# 1. Stream Selection



- Streamflow information
- Flood Forecast information
- Elevation data availability
  - Topography
  - Bathymetry
  - Structural surveys

- Flood Impact Locations
  - Critical infrastructure
  - Routes of egress
  - Populations

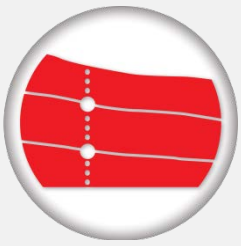


# Gather Data

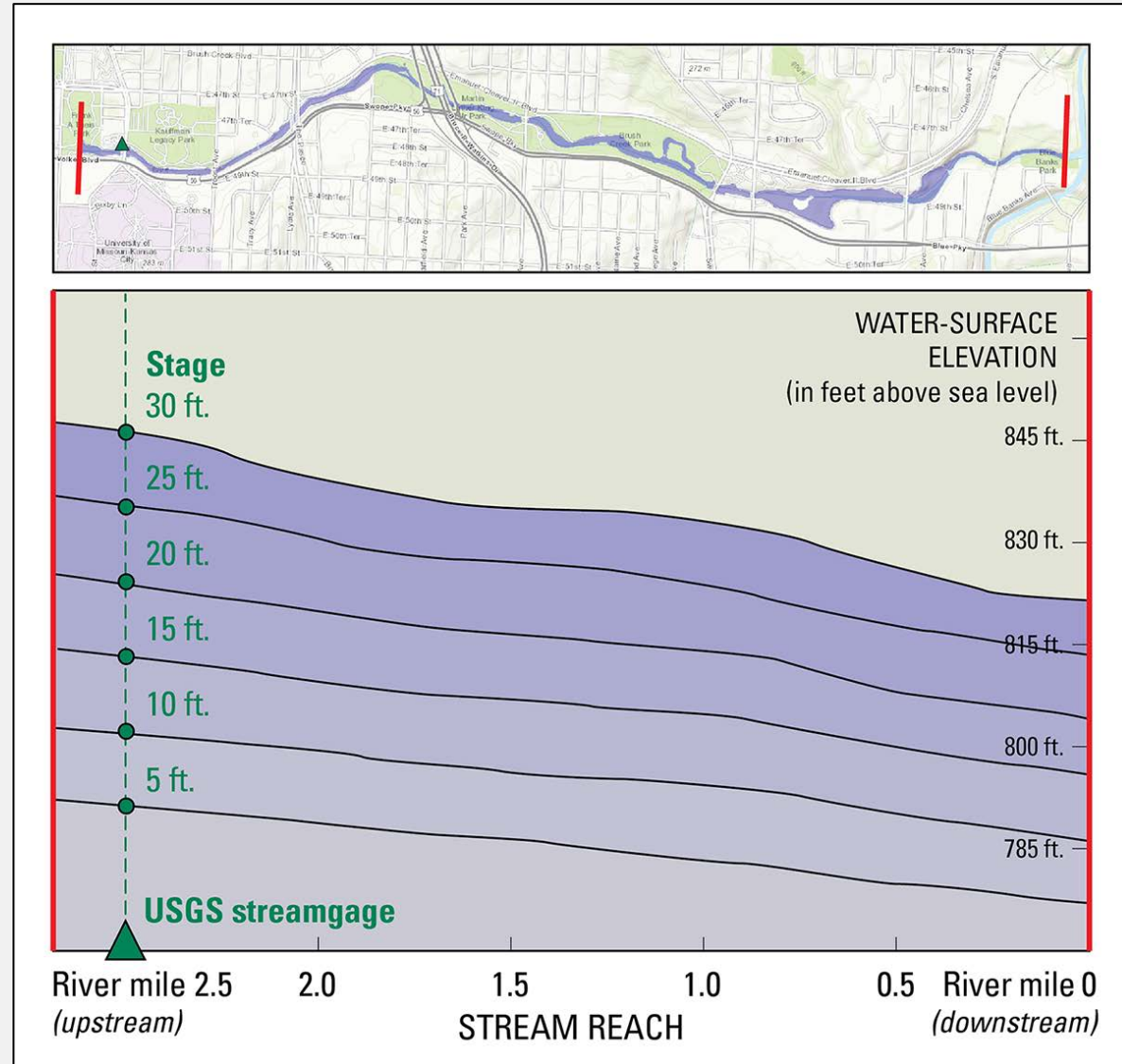
- **Real-time streamflow information from a gage within the selected reach**
  - **Historical flood levels at that gage**
  - **Current and historical rating curves at that gage**
- **Short-term probabilistic forecasts at that gage**
- **High-resolution elevation data (dictates the quality of the maps more than any other factor)**
- **Existing hydraulic models (if available and recent)**



# 2. Model Flood Heights



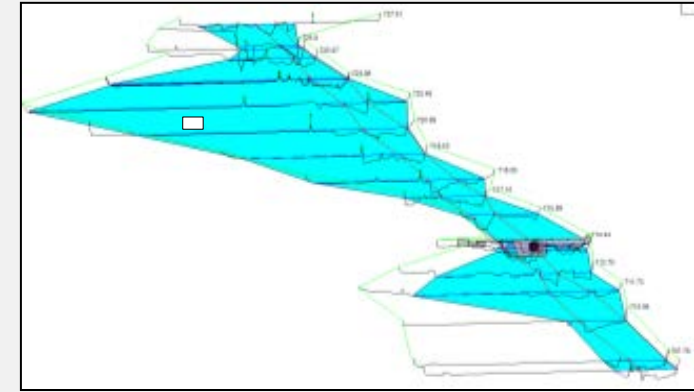
- Hydraulic model calibrated to a USGS gage rating curve
- Rating curve extensions possible
- Can be any generally accepted appropriate model



# Hydraulic Modeling details

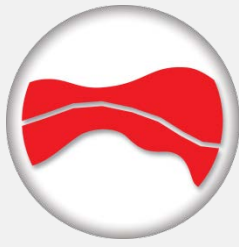
## 2. Hydraulic Modeling

- Calibrate model to streamgage record and current land cover
  - Well developed rating curves are crucial
- Any appropriate model is accepted
  - USACE HEC-RAS is common
  - Model must be peer-reviewed and documented



- Modeled flood scenarios are chosen to reflect local conditions (bridge conditions, levees, temporary structures, etc.)
- In highly complex flow situations, a 2D model might be warranted

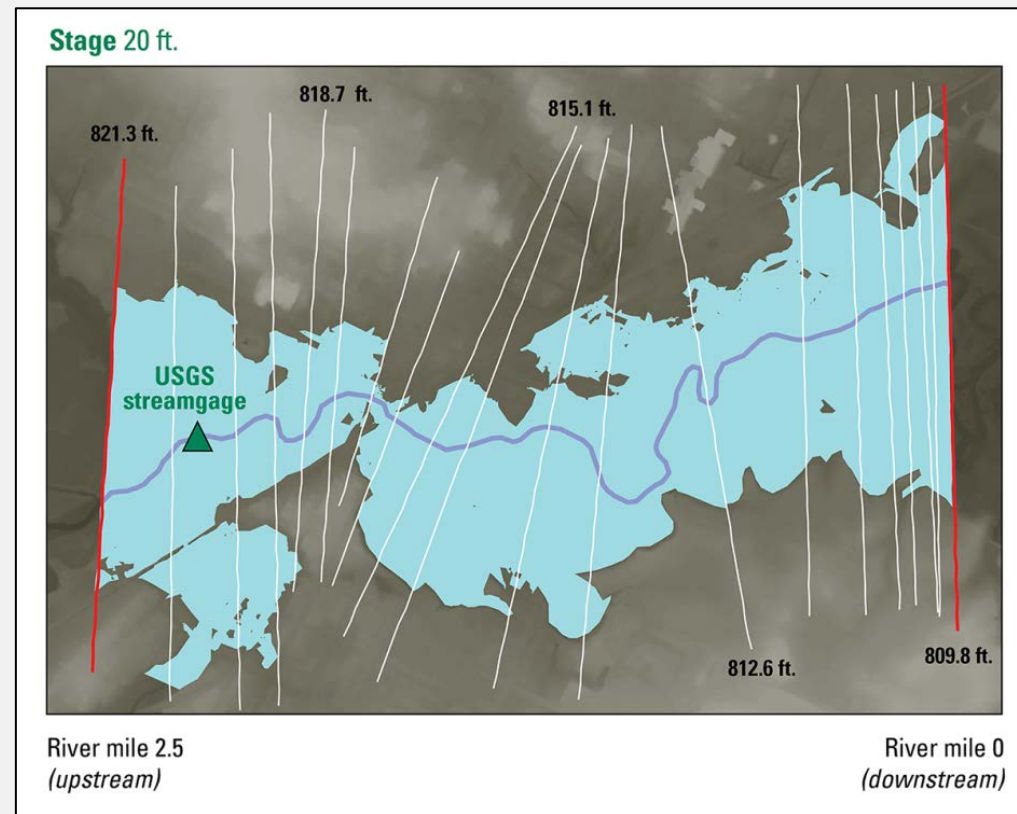
# 3. Delineate Flood Extents



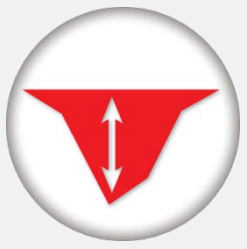
## Geospatial Processing

- Create TIN models using cross sections and the modeled water surface profile
- Intersect the TIN with the DEM to generate predicted inundated areas depth grids
- Clean up and QA data

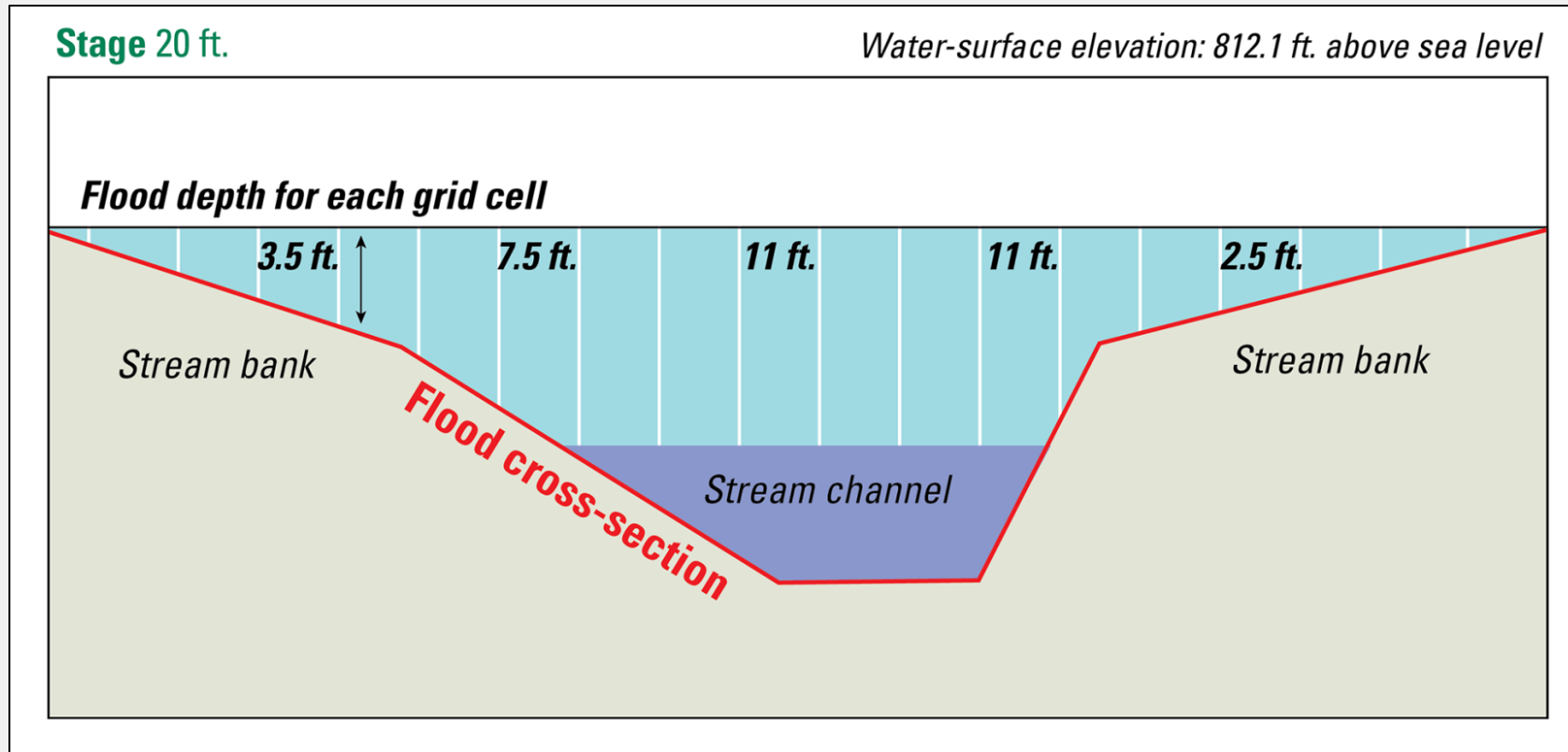
- Repeat for all modeled water surface profiles to generate a library of maps



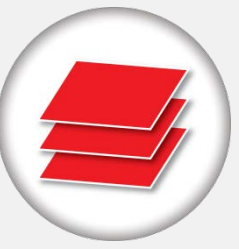
# 4. Compute Flood Depths



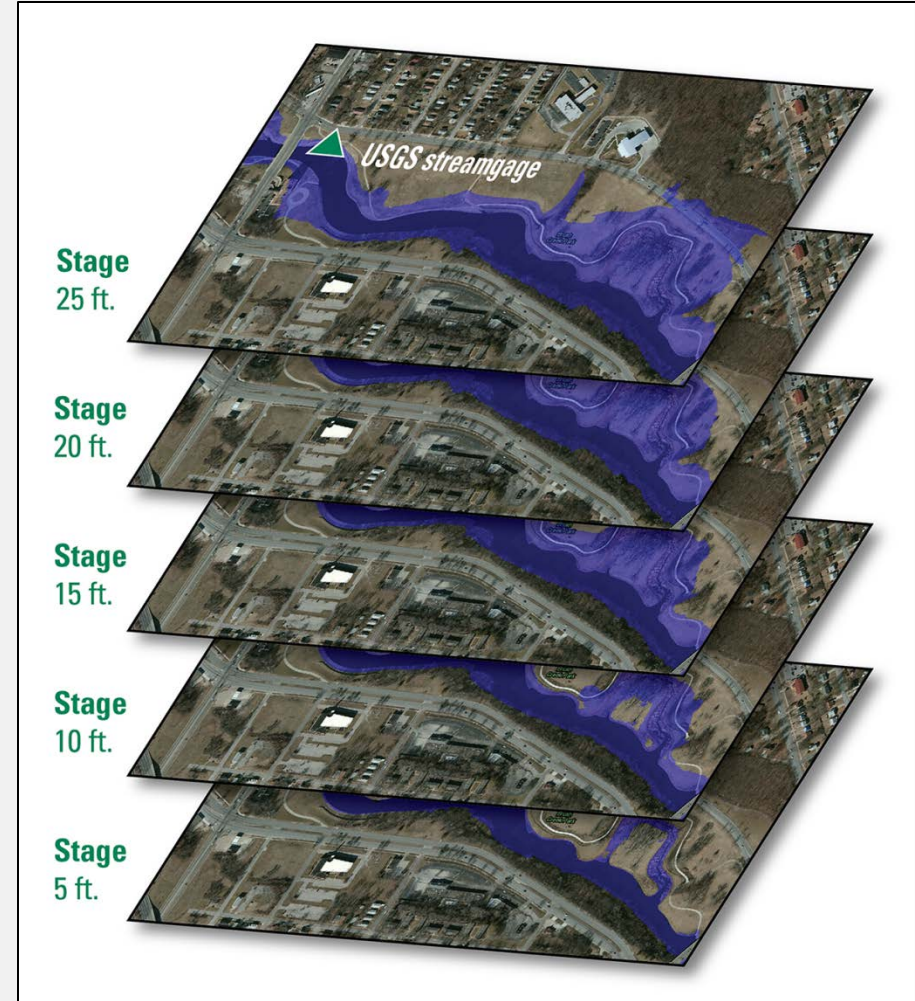
- Flood extents are processed with the topographic data to produce estimated depths across the floodplain



# 5. Process Map Library



- The hydraulic model, flood extents and flood depths are peer reviewed and documented
- Maps are overlaid onto city maps to aid in planning and response



# Peer-Reviewed Documentation

## ■ Required:

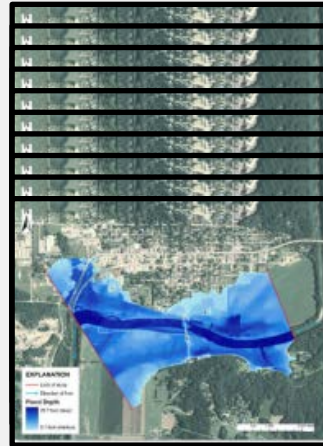
- **Uncertainty and Use Limitations**
- **Study area and scope**
- **Hydrologic data**
- **Hydraulic model calibration and performance**
- **Accuracy assessment**
- **Metadata**

## ■ Recommended:

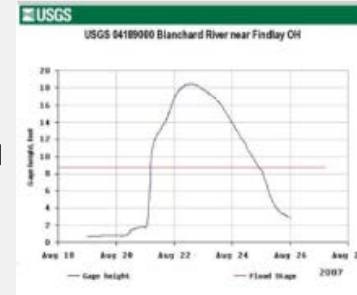
- **Technical Summary Notebook of the hydraulic model**
- **Project QA/QC checklist completed by the project team**
- **Published to a public website**

# FIM Mapper – more than just maps

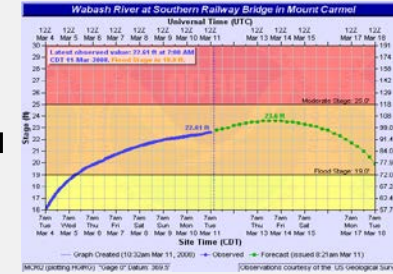
Turns the modeled map data into an operational tool by combining data together with tools that enhance the utility and don't require any Modeling or GIS software or skills



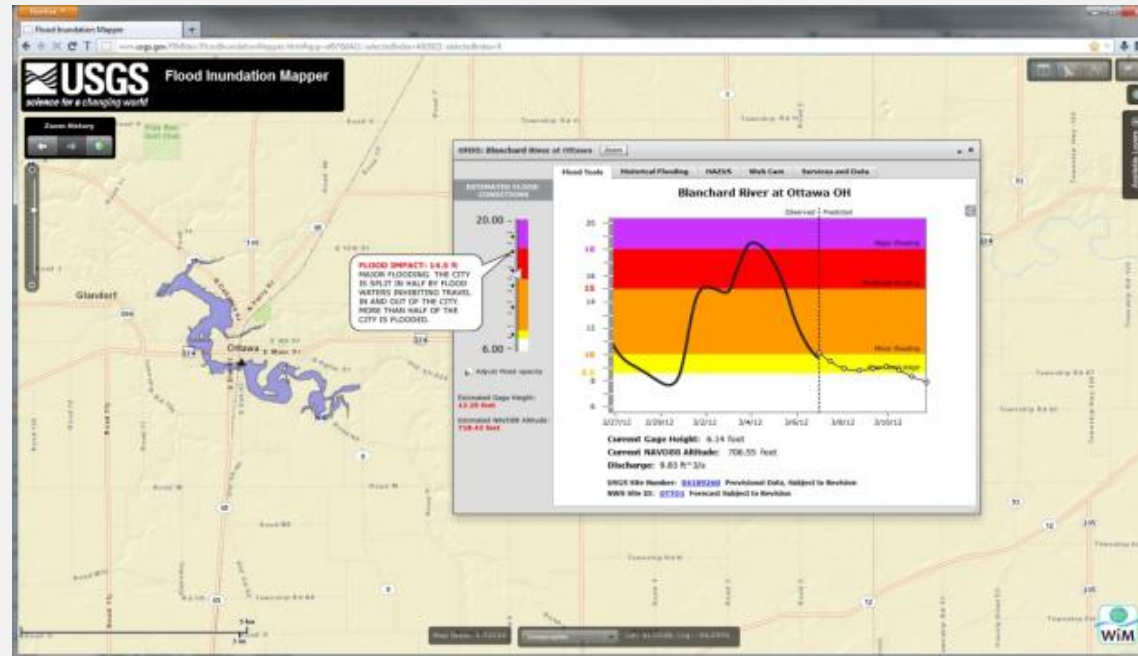
Flood Library



USGS Real-time streamgauge



NWS Flood Forecast



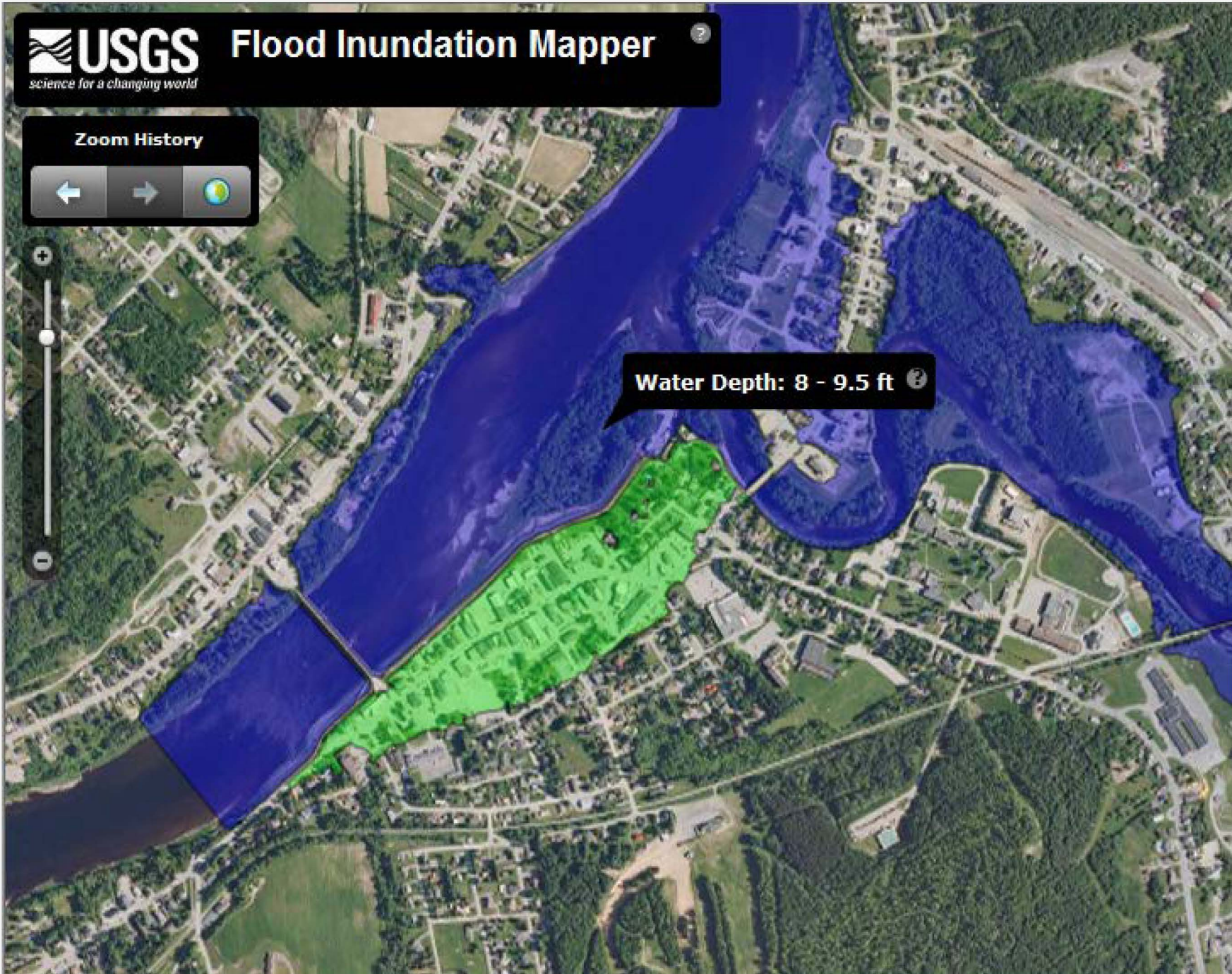


# Flood Inundation Mapper

Zoom History



Water Depth: 8 - 9.5 ft





http://wim.usgs.gov/FDOI/ - Windows Internet Explorer

http://wim.usgs.gov/FDOI/#app=cfb2888d0-selectedIndex=1&lib=1-selectedIndex=0&oa=2-selectedIndex=0

usgs.gov

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# USGS Flood Inundation Mapper

Basemaps

Zoom History

Estimated Flood Conditions

34.00

17.00

Adjust flood opacity

Selected Gage Height: 24.00 feet

Selected NAVD88 Altitude: 641.25 feet

IOWA: Iowa River at Iowa City

Flood Tools Historical Flooding HAZUS Web Cam Services and Data

Top 10 Annual Flood Peaks Annual Flood Peaks

### Top 10 Annual Flood Peaks for Iowa River at Iowa City

Gage Height: 24.10'  
Date: 1851-06-00

Date	Approximate Gage Height (feet)
1851-06-00	24.10
1973-05-01	22.5
1973-04-09	22.0
1982-06-15	21.5
1991-06-13	21.0
1993-08-10	20.5
2008-06-15	28.0

Click on an historical flood to see the estimated extent. Due to changes in the channel and urbanization over time, these areas are only an estimate using 2010 modeled conditions. These numbers are provided for historical context only and are not reviewed inundation areas for the selected flood height.

\*Please visit the [USGS NWIS Flood Peaks Page](#) for more information on flagged peaks and the full flood peak record.

Map Scale: 1:72224 Geographic Left: -91.6675, Top: 41.2800

100%



http://wim.usgs.gov/FIMI/ - Windows Internet Explorer

http://wim.usgs.gov/FIMI/#app=cfb21888d-selectedIndex=1&bb=1-selectedIndex=0&lea=3-selectedIndex=1

usgs.gov

Google Search

TSA Amazon Internal ORder WIM SP Conversion Calendar Weather IPDS Employee Express Flood GLO USGS Flood Inundation USGS Pub Wisconsin View Dendrochronology Bayfield Co.

# USGS Flood Inundation Mapper

Basemaps

Zoom History

IOWA: Iowa River at Iowa City

Flood Tools Historical Flooding HAZUS Web Cam Services and Data

Top 10 Annual Flood Peaks Annual Flood Peaks

## Annual Flood Peaks for Iowa River at Iowa City

Estimated Flood Conditions

34.00

17.00

Adjust flood spacity

Selected Gage Height: 19.50 feet  
Selected NAVD88 Altitude: 636.70 feet

Click on an historical flood to see the estimated extent. Due to changes in the channel and urbanization over time, these areas are only an estimate using 2010 modeled conditions. These numbers are provided for historical context only and are not reviewed inundation areas for the selected flood height.

\*Please visit the [USGS NWIS Flood Peaks Page](#) for more information on flagged peaks and the full flood peak record.

Map Scale: 1:72224

Compass

Lat: 41.6988, Lng: -91.3817

National Weather Service | METI/NASA, DeLorme, NAVTEQ, USGS, Esri, EPA, USDA, TomT...

100%



**USGS Flood Inundation Mapper**  
science for a changing world

Zoom History

Estimated Flood Conditions

34.00  
17.00

Adjust flood opacity

Selected Gage Height: **28.50 feet**  
 Selected NAVD88 Altitude: **645.70 feet**

Map Scale: 1:72224  
 Geographic  
 Lat: 41.6659, Long: -91.5069

**IQWA: Iowa River at Iowa City**

Flood Tools Historical Flooding HAZUS Web Cam Services and Data

Quick Assessment **Loss by Census Block**

**Study Region: iow4**  
**Scenario: Stage 28.50**

**Regional Statistics**

Area (square Miles)	614
Number of Census Blocks	2423
Number of Buildings	
Residential	33029
Total	36732
Number of People in the Region (x1)	111006
Building Exposure (\$ Millions)	
Residential	6197309
Total	8911981

**Scenario Results**

**Shelter Requirements**

Displaced Population (# Households)	1118
Short Term Shelter (# People)	3230

**Economic Loss**

Residential Property (Capital Stock) Losses (\$ Millions)	18
Total Property (Capital Stock) Losses (\$ Millions)	54
Business Interruptions (Income) Losses (\$ Millions)	1



# USGS Flood Inundation Mapper

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Zoom History

10th St  
25th St  
1st Ave  
5th St  
3rd St  
University of Iowa  
Flakbina Golf Course  
Melrose Ave  
W Benton St  
Mason Trk  
1st Ave  
W Park Rd  
Davenport St  
E Market St  
E Jefferson St  
E College St  
S Dodge St  
Highland Ave  
Sycamore St  
W Park Rd  
Tenth St  
W 1st St  
W 2nd St  
W 3rd St  
W 4th St  
W 5th St  
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W 43rd St  
W 44th St  
W 45th St  
W 46th St  
W 47th St  
W 48th St  
W 49th St  
W 50th St

Estimated Flood Conditions

34.00  
17.00

Adjust Road opacity

Selected Gage Height: 28.50 feet  
Selected NAVD88 Altitude: 643.70 feet

Map Scale: 1:72224  
Geographic  
Lat: 41.7049, Lng: -91.5790

Available Layers

Quick Assessment Loss by Census Block

View layer on map:

- HAZUS Loss Data by Census Block

HAZUS Loss Data by Census Block

Debris Generation  
Finish Tons

- Finish Tons 1-18
- Finish Tons 19-52
- Finish Tons 53-117
- Finish Tons 118-289
- Finish Tons 289-887

Map Scale: 1:72224  
Geographic  
Lat: 41.7049, Lng: -91.5790

OSGS  
WIM



# USGS Flood Inundation Mapper

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DH10: Blanchard River at Ottawa

Flood Tools | Historical Flooding | HAZUS | Web Cam | Services and Data

### Sign up for WaterAlert for this site

Water information texted directly to you... simply subscribe to [WaterAlert!](#)

### Project Contacts for more information

Maps created by [USGS Ohio Water Science Center](#)

### Data Downloads

[Download Data](#)

### References

[Download Report](#)

Estimated Flood Conditions

31.40 -  
20.00 -

Adjust flood opacity

Selected Gage Height: **28.00 feet**  
Selected NAVD88 Altitude: **726.43 feet**



# WaterAlert form

Site number, sent by mapper

The screenshot shows the USGS WaterAlert Subscription Form. At the top left is the USGS logo with the tagline "science for a changing world". To the right of the logo is a navigation menu with "USGS Home", "Contact USGS", and "Search USGS". Below the logo is a blue header bar with "USGS WaterAlert" and "[ version 1.3 ]". The main title is "Subscription Form".

The form is divided into several sections:

- Site Info:** Site Number: 04182000; Agency: USGS; Transaction ID: mw3Kc.
- Send Notification To:** A link "about this...". Radio buttons for "My mobile phone" (selected) and "My email address". A text input field containing "608-239-2702" and a dropdown menu showing "AT&T".
- Notification Frequency:** A link "about this...". Radio buttons for "Hourly" and "Daily" (selected).
- Parameter:** undefined (undefined).
- Threshold Condition:** Real-time value is: Greater than  ft.

At the bottom, there is a checkbox "I have read and acknowledge the [Provisional Data Statement](#) and [Disclaimer](#)." and three buttons: "Submit", "Reset", and "Cancel".

Three green arrows point to specific fields: one to the Site Number, one to the mobile phone number, and one to the threshold level input field.

Personal info

Threshold level, selected by mapper

\*Email address is required for a one-time confirmation. Shortly after you submit this form, you will receive an email to which you must reply, without altering, in order to activate this SMS subscription.

## Flood-Inundation Map for the Wabash River at Terre Haute, Indiana at the U.S. Geological Survey Streamgage Number 03341500

### UNCERTAINTY AND USE LIMITATIONS

Although the flood-inundation maps represent the boundaries of inundated areas with a distinct line, some uncertainty is associated with these maps. The flood boundaries shown were estimated based on gage heights at selected USGS streamgages. Water-surface elevations along the stream reaches were estimated by steady-state hydraulic modeling, assuming unobstructed flow and using discharges and hydrologic conditions anticipated at the USGS streamgage(s). The hydraulic model reflects the land-cover characteristics of any bridge, dam, levee, or other hydraulic structure existing in 2012. Unique meteorological factors (timing and distribution of precipitation) may cause actual discharges along the modeled reach to vary from assumed conditions during a flood and lead to deviations in the water-surface elevations and inundation boundaries shown. Additional areas may be flooded due to unanticipated backwater from major tributaries along the main stem or from localized debris or ice jams.

### STUDY AREA

The city of Terre Haute, Indiana (Ind.), is in central Vigo County and is the county seat of government. The Wabash River forms the western boundary of the corporate limits of Terre Haute. The drainage area is 12,263 square miles at the Terre Haute streamgage. The Wabash River had instances of severe flooding in 1913, 1943, 1950, 1958, 1959, and 2005.

### PURPOSE AND SCOPE

The purpose of this report is to describe the development of a series of estimated flood-inundation maps for a 6.3-mile reach of the Wabash River near Terre Haute, Ind., and to make these maps available to emergency workers and the public by way of the USGS Flood Inundation Mapping Science Web site at [http://water.usgs.gov/osw/flood\\_inundation/](http://water.usgs.gov/osw/flood_inundation/).

### MAP SOURCES

Detailed source data for this map series can be found in "Flood-inundation maps for the Wabash River at Terre Haute, Indiana (2013)" at: <http://pubs.usgs.gov/sim/3232/>

Suggested citation:  
Lombard, P.J., 2013. Flood-inundation maps for the Wabash River at Terre Haute, Indiana. U.S. Geological Survey Scientific Investigations Map 3232, 22 sheets, 7-p. pamphlet

### HYDROLOGIC DATA

The study area hydrologic network consists of one streamgage, Wabash River at Terre Haute (station number 03341500) that has been operated by the USGS continuously since 1927, although the actual streamgage location was moved in 1985. Water level (stage) is measured continuously and continuous records of streamflow are computed at this streamgage. Steady-flow data consisted of flow regime, boundary conditions, and peak discharge information, the latter obtained from field measurements and the stage-discharge relation that was developed by the USGS at the Wabash River at Terre Haute streamgage.

### HYDRAULIC MODEL

The hydraulic model was calibrated to the most current stage-discharge relation at the Wabash River at Terre Haute streamgage. Model calibration was accomplished by adjusting Manning's n values until the results of the hydraulic computations closely agreed with the known flood discharge and stage values. Differences between measured and simulated water levels for specified flows were equal to or less than 0.1 foot (ft).

### WATER-SURFACE PROFILES

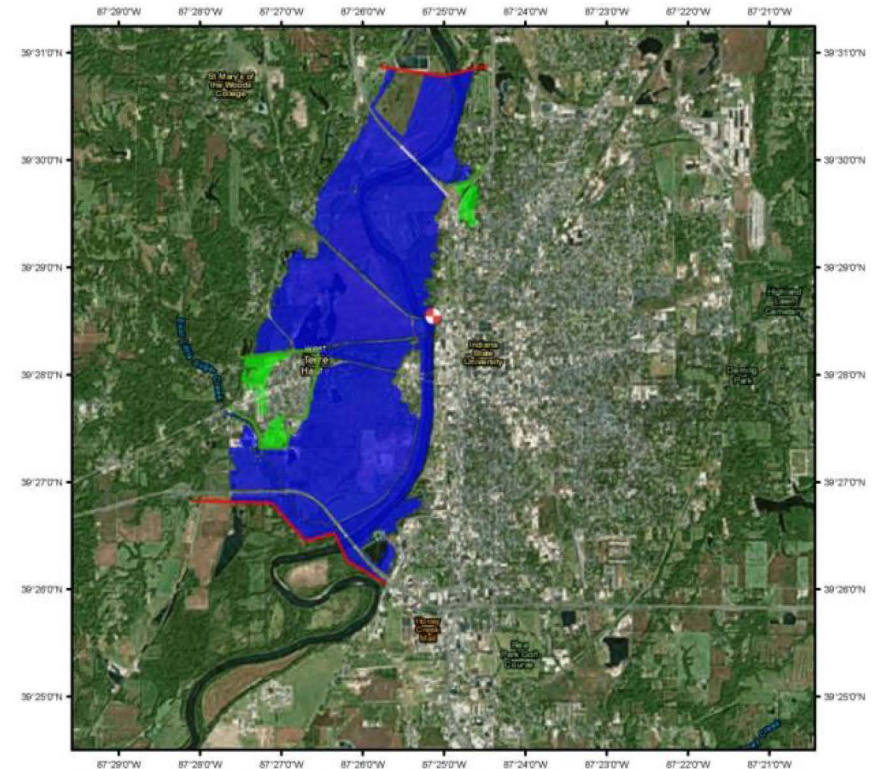
Profiles were developed for a total of 22 stages at 1-ft intervals between and including 9 ft (action stage) and 30 ft (flood of record) as referenced to the Wabash River at Terre Haute streamgage (station number 03341500). Discharges corresponding to the various stages were obtained from the most current stage-discharge relation (rating 55.1) at the streamgage. The streamgage is near the midpoint of the 6-mile reach.

### FLOOD-INUNDATION MAPS

The inundation maps were created in a geographic information system (GIS) by combining the water-surface profiles and digital elevation model (DEM) data. The DEM data were derived from light detection and ranging (LIDAR) data that had a horizontal accuracy of 1.02 ft and a vertical accuracy of 0.37 ft.

### DISCLAIMER

The flood maps should not be used for navigation, regulatory, permitting, or other legal purposes. The United States Geological Survey (USGS) provides these maps as a quick reference and emergency planning tool but assumes no legal liability or responsibility for any direct, indirect, incidental, consequential, special, or exemplary damages or lost profit resulting from the use or misuse of this information.



Flood-Inundation Map for the Wabash River at Terre Haute, Indiana at the U.S. Geological Survey Streamgage Number 03341500

Map corresponding to a Gage Height of 23.00 feet and an Elevation of 468.40 feet (NAVD 88)



### EXPLANATION

- Flood-inundation area
- Area of uncertainty due to levee (where applicable)
- Levee
- Study area boundary
- USGS streamgage and NWS forecast site (if applicable)

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-Planet, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aergrid, IGN, IGP, swisstopo, and the GIS User Community  
Sources: Esri, DeLorme, USGS, NPS

### LOCATION



# Website Resources

- Outline of FIM Science and library development processes
  - Toolbox
- Information Sheet
  - Two page pdf
- Mapper
- Training

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**USGS Flood Inundation Mapping Science**

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## Flood Inundation Mapping (FIM) Program

Floods are the leading cause of natural-disaster losses in the United States. More than 75 percent of declared Federal disasters are related to floods, and annual flood losses average about \$7.82 billion with 94 fatalities per year. Although the amount of fatalities has declined due to improved early warning systems, economic losses have continued to rise with increased urbanization in flood-hazard areas. The **USGS Flood Inundation Mapping (FIM) Program** helps communities protect lives and property by providing tools and information to help them understand their local flood risks and make cost-effective mitigation decisions.

The **USGS Flood Inundation Mapping Program** has two main functions:

- 1) Partner with local communities to assist with the development and validation of flood inundation map libraries.**  
A flood inundation map library is a set of maps that shows where flooding may occur over a range of water levels in the community's local stream or river. The USGS works with communities to identify an appropriate stream section, gather the necessary data to model where flooding will likely occur, and verify that the maps produced are scientifically sound. To learn more about the scientific process of developing a map library, visit the [FIM Science section](#).

Inundation maps can be used for:

- *Preparedness* - "What-if" scenarios
- *Timely Response* - tied to real-time gage and forecast information
- *Recovery* - damage assessment
- *Mitigation and Planning* - flood risk analyses
- *Environmental and Ecological Assessments* - wetlands identification, hazardous spill cleanup

To help communities create a flood inundation map library, the USGS created the FIM Toolbox, which contains development resources and contact information.

- 2) Provide online access to flood inundation maps along with real-time streamflow data, flood forecasts, and potential loss estimates.**  
Once a community's map library is complete, it is uploaded to the USGS FIM Mapper, an online public mapping application. The FIM Mapper allows users to explore the full set of inundation maps that shows where flooding would occur given a selected stream condition. Users can also access historical flood information and potential loss estimates based on the severity of the flood. The FIM Mapper helps communities visualize potential flooding scenarios, identify areas and resources that may be at risk, and enhance their local response effort during a flooding event.

The USGS works with the National Weather Service, the U.S. Army Corps of Engineers, and the Federal Emergency Management Agency to connect communities with federal flood-related

### Flood Inundation Mapper

Visit the [Flood Inundation Mapper](#) to explore flood inundation maps, streamflow conditions, flood forecasts, potential loss estimates, and more...

### FIM Toolbox

Visit the [FIM Toolbox](#) to learn more about developing a flood inundation map library for your community.

### Download

Download the [FIM Information Sheet](#) to share information about the flood libraries and the FIM Program with others.



# Surface Water Tech Memorandum 2015.03

## USGS Flood-Inundation Map Development and Documentation Standards

- At a USGS gage
- Starts with NWS guidelines but with 10 exceptions/additions
- Documentation
- Peer-review



United States Department of the Interior  
U.S. GEOLOGICAL SURVEY  
Reston, Virginia 20192

In Reply Refer To:  
Mail Stop 415

February 9, 2015

OFFICE OF SURFACE WATER TECHNICAL MEMORANDUM 2015.03

**SUBJECT:** USGS Flood-Inundation Map Development and Documentation Standards

### Introduction and Purpose

The U.S. Geological Survey (USGS) is a leader in flood-inundation modeling and mapping. Flood-inundation maps (FIMs) show inundation extent, and in some cases inundation depth, for a wide range of streamflows and are distinguished from Federal Emergency



# Surface Water Tech Memorandum 2015.04

- **USGS Furnished Flood-Inundation Map Policy**
- **First approved in Idaho, Dec, 2015**
- **At a USGS gage**
- **Meets USGS Requirements**
- **Work with local USGS Water Science Center**



United States Department of the Interior  
U.S. GEOLOGICAL SURVEY  
Reston, Virginia 20192

In Reply Refer To:  
Mail Stop 415

February 9, 2015

OFFICE OF SURFACE WATER TECHNICAL MEMORANDUM 2015.04

SUBJECT: USGS Furnished Flood-Inundation Map Policy

#### Introduction and Purpose

The U.S. Geological Survey (USGS) is partnering through the Integrated Water Research Science and Services (IWRSS) consortium with the National Weather Service and the U.S. Army

