USGS Flood Inundation Mapping Program of Indiana

Presented by
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U.S. Geological Survey
Indiana Water Science Center

Presented to
Purdue Road School: 101st Transportation Conference and Expo
West Lafayette, Indiana
March 11, 2015
Indiana Silver Jackets

Federal and National Partners

Many Agencies

USGS

science for a changing world

FEMA

State, Local, and Educational Partners

One Solution

Indiana Silver Jackets

Be Risk Aware

One Solution

NRCS

USDA

US Department of Agriculture

ASFP

National Guard

US Department of Defense

NRCS

US Department of Agriculture

INDEP

Indiana Department of Environmental Management

IDEM

Indiana Geographic Information Council

DNR

Indiana Department of Natural Resources

Indiana Office of Community & Rural Affairs

Purdue University

IUPUI

The Polis Center
Funding for this Workshop Series

Cooperative Water Program
http://water.usgs.gov/coop/

http://www.in.gov/ocra/
Presentation Outline

Flood Inundation Mapping Program

- Introduction to USGS
- Terminology/Tools of USGS and NWS
- Flood Inundation Map Libraries
- Flood Response/Mitigation Tool
Presentation Outline

Flood Inundation Mapping Program

• Introduction to USGS
• Terminology/Tools of USGS and NWS
• Flood Inundation Map Libraries
• Flood Response/Mitigation Tool
Terms Important to Discussions of Flooding: **STAGE**

Height of water surface above a measuring level (Datum)
Terminology: **DISCHARGE**

- Volume of water
- Unit of time

- 4 cfs
- 600 cfs
What is a Streamgage?

- Remote device which provides streamflow, water level, water quality, and/or precipitation data.

- Streamflow is the volume of water that passes a point on a stream per unit of time (Discharge).

Spelling: Gauge vs. Gage.
Streamgage Fundamentals

- Water Level Sensors
  - Stilling Well
Other types of gages

- Water Level Sensors
  - Bubbler System
Other types of gages

- Water Level Sensors
  - Radar
Streamflow Gaging Stations
Discharge Measurements...

- Manned Boat
- Remote Boat
Streamgaging Fundamentals

• Discharge Measurements
  – Wading
  – Bridge
Rating Table

Discharge measured at all stages

Stage (ft)

Discharge (cfs)
Here is how to read a “rating table”.

<table>
<thead>
<tr>
<th>STATION NUMBER</th>
<th>Rating for Discharge (DCP) (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RATING ID: 41.0</td>
<td>TYPE: stage-discharge</td>
</tr>
<tr>
<td>EXPANSION: logarithmic</td>
<td></td>
</tr>
<tr>
<td>OFFSET: 0.00</td>
<td></td>
</tr>
</tbody>
</table>

**EXPANDED RATING TABLE**

<table>
<thead>
<tr>
<th>Gage height, feet</th>
<th>Discharge (cfs)</th>
<th>DIFF IN Q PER</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>.00</td>
<td>.01</td>
</tr>
<tr>
<td>.02</td>
<td>.03</td>
<td>.04</td>
</tr>
<tr>
<td>.03</td>
<td>.04</td>
<td>.05</td>
</tr>
<tr>
<td>.04</td>
<td>.05</td>
<td>.06</td>
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<tr>
<td>.05</td>
<td>.06</td>
<td>.07</td>
</tr>
<tr>
<td>0.30</td>
<td>1.8*</td>
<td>1.8</td>
</tr>
<tr>
<td>0.40</td>
<td>2.6</td>
<td>2.7</td>
</tr>
<tr>
<td>0.50</td>
<td>3.5*</td>
<td>3.6</td>
</tr>
<tr>
<td>0.60</td>
<td>5.1</td>
<td>5.2</td>
</tr>
<tr>
<td>0.70</td>
<td>7.0*</td>
<td>7.2</td>
</tr>
<tr>
<td>0.80</td>
<td>10.3*</td>
<td>10.7</td>
</tr>
<tr>
<td>0.90</td>
<td>15.3*</td>
<td>15.8</td>
</tr>
</tbody>
</table>

Gage Height = 0.62 feet
Discharge = 5.4 cubic feet per sec
USGS GOES near real-time Data Collection System

Field Station with Data Collection Platform (DCP)

Data Access and Processing System (DAPS), Wallops Island, VA and EROS Data Center in Sioux Falls, SD

National Water Information System (NWIS)
Welcome to the U.S. Geological Survey (USGS) Web page for the water resources of Indiana; this is your direct link to all kinds of water-resource information. Here you’ll find information on Indiana’s rivers and streams. You’ll also find information about ground water, water quality, and many other topics. The USGS operates the most extensive satellite network of streamgaging stations in the state, many of which form the backbone of flood-warning systems.

The USGS provides current ("real-time") stream stage and streamflow, water-quality, ground-water levels, precipitation, and lake-stage for over 200 sites in Indiana.

Quick Link to Real-Time Data (Opens in new window)

Enter a USGS site number: 

View site list: SW | GW | WQ

Indiana Data Highlights

Recent Publications
## Current Streamflow Conditions — USGS Gages in Indiana

### Current Conditions for Indiana: Streamflow -- 225 site(s) found

#### PROVISIONAL DATA SUBJECT TO REVISION

**Customize table to display other current-condition parameters**

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Station Name</th>
<th>Date/Time</th>
<th>Gage Height, feet</th>
<th>Discharge, ft³/s</th>
<th>Long-term Median Flow 3/17</th>
<th>Temperature, Water, deg C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ohio River Basin</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03274050</td>
<td>Whiteriver River near Economy, IN</td>
<td>03/17 12:45 EST</td>
<td>3.48</td>
<td>5.1</td>
<td>12.0</td>
<td>--</td>
</tr>
<tr>
<td>03275000</td>
<td>White river near Alpine, IN</td>
<td>03/17 13:00 EST</td>
<td>7.66</td>
<td>659</td>
<td>766</td>
<td>--</td>
</tr>
<tr>
<td>03275600</td>
<td>East Fork White River at Abington, IN</td>
<td>03/17 12:45 EST</td>
<td>3.33</td>
<td>144</td>
<td>269</td>
<td>--</td>
</tr>
<tr>
<td>03276000</td>
<td>East Fork White River at Brookville, IN</td>
<td>03/17 13:00 EST</td>
<td>3.78</td>
<td>--</td>
<td>--</td>
<td>3.7</td>
</tr>
<tr>
<td>03276500</td>
<td>White River at Brookville, IN</td>
<td>03/17 12:45 EST</td>
<td>4.14</td>
<td>1,400</td>
<td>1,630</td>
<td>--</td>
</tr>
<tr>
<td>03291780</td>
<td>Indiana-Kentucky Creek near Canaan, IN</td>
<td>03/17 13:15 EST</td>
<td>3.25</td>
<td>20</td>
<td>26.0</td>
<td>--</td>
</tr>
<tr>
<td>03294000</td>
<td>Silver Creek near Sellersburg, IN</td>
<td>03/17 12:30 EST</td>
<td>5.28</td>
<td>139</td>
<td>282</td>
<td>--</td>
</tr>
<tr>
<td>03302220</td>
<td>Buck Creek near New Middletown, IN</td>
<td>03/17 13:15 EST</td>
<td>1.78</td>
<td>57</td>
<td>99.0</td>
<td>--</td>
</tr>
<tr>
<td>03302680</td>
<td>West Fork Blue River at Salem, IN</td>
<td>03/17 12:30 EST</td>
<td>3.48</td>
<td>18</td>
<td>20.0</td>
<td>--</td>
</tr>
<tr>
<td>03302800</td>
<td>Blue River at Fredericksburg, IN</td>
<td>03/17 12:30 EST</td>
<td>3.28</td>
<td>235</td>
<td>351</td>
<td>--</td>
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<tr>
<td>03302849</td>
<td>Whiskey Run at Marengo, IN</td>
<td>03/17 12:30 EST</td>
<td>1.90</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>03303000</td>
<td>Blue River near White Cloud, IN</td>
<td>03/17 13:15 EST</td>
<td>3.57</td>
<td>592</td>
<td>920</td>
<td>--</td>
</tr>
<tr>
<td>03303280</td>
<td>Ohio River at Cannelton Dam at Cannelton, IN</td>
<td>03/17 13:00 CDT</td>
<td>23.19</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>03303300</td>
<td>Middle Fork Anderson River at Brstow, IN</td>
<td>03/17 12:30 EST</td>
<td>6.55</td>
<td>31</td>
<td>62.0</td>
<td>--</td>
</tr>
<tr>
<td>03304300</td>
<td>Ohio River at Newburgh Lock and Dam, IN</td>
<td>03/17 13:00 CDT</td>
<td>27.51</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>03322000</td>
<td>Ohio River at Evansville, IN</td>
<td>03/17 13:00 CDT</td>
<td>25.05</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>03322011</td>
<td>Pigeon Creek near Fort Branch, IN</td>
<td>03/17 12:30 EST</td>
<td>1.92</td>
<td>--</td>
<td>19.0</td>
<td>--</td>
</tr>
<tr>
<td><strong>Upper Wabash River Basin</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>03322900</td>
<td>Wabash River at Linn Grove, IN</td>
<td>03/17 12:45 EST</td>
<td>6.58</td>
<td>1,010</td>
<td>474</td>
<td>--</td>
</tr>
<tr>
<td>03322985</td>
<td>Wabash River near Bluffton, IN</td>
<td>03/17 12:45 EST</td>
<td>7.29</td>
<td>1,340</td>
<td>919</td>
<td>--</td>
</tr>
<tr>
<td>03323500</td>
<td>Wabash River at Huntington, IN</td>
<td>03/17 13:00 EST</td>
<td>13.86</td>
<td>--</td>
<td>--</td>
<td>1.7</td>
</tr>
<tr>
<td>03323583</td>
<td>Eagle Marsh East near Fort Wayne, IN</td>
<td>03/17 12:30 EST</td>
<td>0.92</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>03323584</td>
<td>Eagle Marsh West near Fort Wayne, IN</td>
<td>03/17 12:30 EST</td>
<td>1.11</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>03323587</td>
<td>Graham McCulloch Ditch near Fort Wayne, IN</td>
<td>03/17 13:15 EST</td>
<td>6.36</td>
<td>--</td>
<td>1.5</td>
<td>--</td>
</tr>
<tr>
<td>03324000</td>
<td>Little River near Huntington, IN</td>
<td>03/17 13:00 EST</td>
<td>6.76</td>
<td>848</td>
<td>249</td>
<td>--</td>
</tr>
</tbody>
</table>
Observation – Current Stream Stage and Discharge

Real-time gage data: 120 days old up through current
User-Defined Plot — up to 120 days

USGS 03351000 WHITE RIVER NEAR NORA, IN

Gage height, feet


Provisional Data Subject to Revision

- Gage height
- Measured gage height
- Floodstage
WaterWatch: Current Streamflow

WaterWatch: Flood
Water Now

• No computer available?

• On demand service with no subscriptions

• Any text-capable phone

Water Now

• Send text to:
  waternow@usgs.gov

• Text body should have station number

• Can query more specific information with more complicated gages
Water Alert

- Provides alerts via text or email
- No limit on the number set up
- Daily updates or real-time.
- All basic parameters available for SW, GW, QW, and Precipitation

http://water.usgs.gov/wateralert
## Current Conditions for Indiana: Streamflow -- 225 site(s) found

**PROVISIONAL DATA SUBJECT TO REVISION**

<table>
<thead>
<tr>
<th>Station Number</th>
<th>Station Name</th>
<th>Date/Time</th>
<th>Gage Height, feet</th>
<th>Discharge, ft³/s</th>
<th>Long-term Median Flow, 2/20</th>
<th>Temperature, Water, deg C</th>
</tr>
</thead>
<tbody>
<tr>
<td>03274650</td>
<td>WHITEWATER RIVER NEAR ECONOMY, IN</td>
<td>02/20 08:45 EST</td>
<td>4.04</td>
<td>30</td>
<td>8.50</td>
<td>--</td>
</tr>
<tr>
<td>03275000</td>
<td>WHITEWATER RIVER NEAR ALPINE, IN</td>
<td>02/20 09:00 EST</td>
<td>8.50</td>
<td>1,210</td>
<td>495</td>
<td>--</td>
</tr>
<tr>
<td>03275600</td>
<td>EAST FORK WHITEWATER RIVER AT ALEXINGTON, IN</td>
<td>02/20 08:45 EST</td>
<td>4.68</td>
<td>697</td>
<td>187</td>
<td>--</td>
</tr>
<tr>
<td>03275600</td>
<td>EAST FORK WHITEWATER RIVER AT BROOKVILLE, IN</td>
<td>02/20 09:00 EST</td>
<td>4.37</td>
<td>--</td>
<td>2.2</td>
<td>--</td>
</tr>
<tr>
<td>03275600</td>
<td>WHITEWATER RIVER AT BROOKVILLE, IN</td>
<td>02/20 08:45 EST</td>
<td>5.41</td>
<td>3,620</td>
<td>1,220</td>
<td>--</td>
</tr>
<tr>
<td>03291780</td>
<td>INDIAN-KENTUCK CREEK NEAR CANAAN, IN</td>
<td>02/20 09:15 EST</td>
<td>4.15</td>
<td>129</td>
<td>29.0</td>
<td>--</td>
</tr>
<tr>
<td>03291400</td>
<td>SILVER CREEK NEAR SELLERSBURG, IN</td>
<td>02/20 08:30 EST</td>
<td>9.56</td>
<td>1,170</td>
<td>172</td>
<td>--</td>
</tr>
</tbody>
</table>

### Gage height, feet

**Most recent instantaneous value:** 18.80 04-10-2014 13:00 EST

Add up to 2 more sites and "Gage height, feet"

Enter up to 2 site numbers separated by a comma. A site number consists of 8 to 15 digits.

**Subscribe here**

Create presentation-quality / stand-alone graph. Subscribe to WaterAlert P00065 DD002 43

**Share this graph | Facebook | Twitter | Email**
Select Stage Thresholds: NWS AHPS

Flood Categories (in feet):
- Major Flood Stage: 26
- Moderate Flood Stage: 24
- Flood Stage: 14
- Action Stage: 9

Historical Crests
1. 38.00 ft on 04/01/1950
2. 31.15 ft on 03/27/1913
3. 30.50 ft on 05/20/1943
4. 28.00 ft on 03/19/1928
5. 27.70 ft on 02/19/1883
6. 27.58 ft on 01/16/1950
7. 27.60 ft on 06/16/1950
8. 27.40 ft on 04/22/2013
9. 27.30 ft on 01/19/2005
10. 27.10 ft on 01/08/1993

Low Water Records
1. -2.00 ft on 02/26/1982
2. -3.50 ft on 02/21/1986
3. -0.50 ft on 05/29/1994
4. -0.50 ft on 07/23/1956
5. -0.80 ft on 08/24/1941

If you notice any errors in the below information, please contact our Webmaster

31. West Terre Haute is severely threatened. Water at the top of levees. During windy conditions, overtopping will occur. Pumping will not keep up with water seepage. Tayonville (Dresser) is totally destroyed. Industrial and commercial area from US 40 to Interstate 70 floods extensively. Extensive flooding along Lost Creek may threaten residential and commercial areas in Northern Terre Haute. US 40 and US 150 are overtopped.

30. Record to near record flood is in progress. Water at the edge of US 160 and US 50. Old Paris Road closed west of US 150. Situation serious in Toad Hop and Dresser. Industrial and commercial areas along east bank of Wabash River from US 40 to I-70 floods. Flood waters are at the top of levee protecting Tayonville. Extensive flooding along Lost Creek possibly threatens residential and commercial areas in northern Terre Haute. Sandbagging of Terre Haute Treatment Plant is necessary.

29. Sandbagging necessary at the Terre Haute Water Treatment Plant. Flood waters will begin to enter the Water Treatment Plant at 29.5 feet. Residential and commercial areas affected in Terre Haute and the West Terre Haute areas. Tayonville (Dresser) is very extensively flooded. Toad Hop should evacuate. Water near US 150 and US 40...
• Flood stage provided at many gages

• Can specify >, <, inside, or outside a range of your choosing
Efforts are underway to make StreamStats operational for many states, with a long-term goal of national coverage. Work needed to implement StreamStats is generally done by the USGS in cooperation with various state and local agencies. The map below indicates states where StreamStats has been implemented, and where work on implementation is currently underway. Green states have fully implemented StreamStats applications, orange states have been completed and are in testing internally, and blue states are undergoing implementation. Users may access the implemented state applications by selecting the state of interest on the map below, or by selecting the name of the state from the list above.
StreamStats: Choice of two maps

Indiana

StreamStats for Indiana incorporates regression equations for estimating peak-flow frequency statistics at the 10-, 25-, 50-, 100-, 200-, and 500-year recurrence intervals (equivalent to the 10-, 4-, 2-, 1-, 0.5-, and 0.2-percent annual exceedance probabilities, respectively) for unregulated streams throughout Indiana, and equations for estimating bankfull-channel dimensions of width, mean depth, and cross-sectional area for non-urban wadeable streams in the three largest physiographic regions of Indiana. These equations are implemented by use of two separate interactive map applications: one which provides the peak-flow estimates, and the other which provides the bankfull-channel-dimension estimates. The separate applications were necessary because flood-frequency estimates for many stream reaches in Indiana have been coordinated by the Indiana Department of Natural Resources, the Natural Resources Conservation Service, the U.S. Army Corps of Engineers, and the USGS. That is, these agencies have agreed on flood-frequency values for selected stream reaches for use in water-resources investigations and planning activities. Custom programming that was required to deliver the coordinated flood-frequency values precludes delivery of bankfull-channel-dimension estimates in the same output. Links to the separate applications are provided below. Users of the interactive map for estimating peak-flow statistics who select points along the coordinated stream reaches will be provided with the coordinated discharges instead of flow estimates obtained from regression equations. More information about coordinated discharges can be found here.

Interactive Map for Estimating Peak-Flow Statistics

Interactive Map for Estimating Bankfull-Channel Dimensions

Note that regression equations are developed using streamflow statistics and basin characteristics for USGS-operated streamgages. The equations are applicable with known accuracy when they are applied at locations with basin characteristics that are within the ranges of the basin characteristics for the streamgages used to develop the equations. Estimates for user-selected sites with basin characteristics that are outside of those for the streamgages used to develop the equations are extrapolated. These extrapolated estimates should be used with caution, as their associated errors are unknown and may be large. StreamStats outputs provide the ranges of applicability for each basin characteristic that is used as an explanatory variable in the regression equations, and warnings when those ranges
Site-selection Map
## Basin Characteristics Report

**Date:** Fri Sep 21 2012 10:43:23 Mountain Daylight Time

**NAD27 Latitude:** 39.7783 (39 46 42)  
**NAD27 Longitude:** -86.2506 (-86 15 02)  
**NAD83 Latitude:** 39.7783 (39 46 42)  
**NAD83 Longitude:** -86.2506 (-86 15 02)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel 10-85 slope in feet per mile</td>
<td>7.49</td>
</tr>
<tr>
<td>Contributing drainage area in square miles.</td>
<td>173.884</td>
</tr>
<tr>
<td>Region number</td>
<td>1008</td>
</tr>
<tr>
<td>Percent of area covered by water and wetland</td>
<td>2.14</td>
</tr>
<tr>
<td>Total drainage area in square miles</td>
<td>173.884</td>
</tr>
<tr>
<td>Percent of area covered by urban land cover</td>
<td>5.93</td>
</tr>
</tbody>
</table>
Streamstats Ungaged Site Report

Date: Fri Sep 21 2012 10:49:10 Mountain Daylight Time
Site Location: Indiana
NAD27 Latitude: 39.7912 (39 47 28)
NAD27 Longitude: -86.2681 (-86 16 05)
NAD83 Latitude: 39.7913 (39 47 29)
NAD83 Longitude: -86.2681 (-86 16 05)
Drainage Area: 2.558 mi²

Peak Flow Basin Characteristics
Region number=1008
100% Region 4 Peak Flow (2.56 mi²)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Regression Equation Valid Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contributing Drainage Area (square miles)</td>
<td>2.56</td>
<td>Min 0.31 Max 2444</td>
</tr>
<tr>
<td>Stream Slope 10 and 85 Method (feet per mi)</td>
<td>17.7</td>
<td>Min 2.7 Max 48.7</td>
</tr>
<tr>
<td>Percent Urban (percent)</td>
<td>64.3</td>
<td>Min 0</td>
</tr>
</tbody>
</table>

Peak Flow Streamflow Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Flow (ft³/s)</th>
<th>Standard Error (percent)</th>
<th>Equivalent years of record</th>
<th>90-Percent Prediction Interval</th>
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</thead>
<tbody>
<tr>
<td>PK10</td>
<td>664</td>
<td>23</td>
<td>7.7</td>
<td>Minimum 404 Maximum 1090</td>
</tr>
<tr>
<td>PK25</td>
<td>842</td>
<td>23</td>
<td>11</td>
<td>Minimum 551 Maximum 1290</td>
</tr>
<tr>
<td>PK50</td>
<td>974</td>
<td>22</td>
<td>13</td>
<td>Minimum 635 Maximum 1490</td>
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<tr>
<td>PK100</td>
<td>1100</td>
<td>22</td>
<td>15</td>
<td>Minimum 713 Maximum 1700</td>
</tr>
<tr>
<td>PK200</td>
<td>1230</td>
<td>23</td>
<td>17</td>
<td>Minimum 788 Maximum 1920</td>
</tr>
<tr>
<td>PK500</td>
<td>1400</td>
<td>24</td>
<td>18</td>
<td>Minimum 881 Maximum 2220</td>
</tr>
</tbody>
</table>
Can we anticipate flooding?

Quantitative Precipitation Forecasts

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Days 1-2</th>
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</thead>
<tbody>
<tr>
<td>Day 2</td>
<td>Days 1-3</td>
</tr>
<tr>
<td>Day 3</td>
<td>Days 4-5 and Days 6-7</td>
</tr>
</tbody>
</table>

5- and 7-day Totals

Loop of All 6-hourly or 24-hourly Forecasts for Days 1-3
View 12-Hour QPFs for Days 1-3

NOAA: QPF

http://www.hpc.ncep.noaa.gov/qpf/qpf2.shtml
Snow Cover Maps

http://www.nohrsc.noaa.gov/nsa/
NOAA Flood-outlook Maps

NATIONAL WEATHER SERVICE

Significant River Flood Outlook

Click a region on the national map below to access more detailed RFC data.

View the River Flood Outlook for Alaska

http://www.hpc.ncep.noaa.gov/nationalfloodoutlook/
The Advanced Hydrologic Prediction Service (AHPS) provides new information and products provided through the infusion of new science and technology. This service improves flood warnings and water resource forecasts to meet diverse and changing customer needs. Additional information on the AHPS Service program may be obtained through the "Additional Links" on the left menu of this page.

Quarterly Status Report

(Click here to download PDF viewer from Adobe.com)

Main Link Categories:
Home | NWS
AHPS: National River Conditions

- Observed stage
- Flood forecast points
- Collocated with USGS gages

http://water.weather.gov/ahps/
AHPS: Zoom to area of interest
AHPS: Hydrograph for Wabash River at Mount Carmel

Reliability of the Forecast: Based on current and forecast river, weather and reservoir conditions

NOTE: Forecasts for the Wabash River at Mount Carmel are issued routinely year-round.
AHPS: Flood Impacts and Historical Crests

**Flood Categories (in feet)**

- Major Flood Stage: 25
- Moderate Flood Stage: 19
- Flood Stage: 11
- Action Stage: 11

**Historical Crests**

1. 34.02 ft on 05/08/2011
2. 33.35 ft on 01/13/2005
3. 33.24 ft on 06/14/2009
4. 35.90 ft on 09/30/1913
5. 33.35 ft on 06/17/2002
6. 31.75 ft on 01/27/1991
7. 30.89 ft on 06/12/1996
8. 35.42 ft on 08/20/1996
9. 30.43 ft on 06/23/1990
10. 30.37 ft on 11/22/1986

**Low Water Records**

1. 1.00 ft on 10/05/1940
2. 2.00 ft on 09/27/1941
3. 2.00 ft on 10/02/1954
4. 2.00 ft on 12/31/1963
5. 2.02 ft on 09/09/2012

**Gauge Location**

Latitude/Longitude Disclaimer: The gauge location shown in the above map is the approximate location based on the latitude/longitude coordinates provided by the NWS by the gauge owner.

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If you notice any errors in the below information, please contact our Webmaster

36. An unbelievable flood. Water 4 feet above May 2011 flood. Levee at Mt. Carmel overtopped. Great flood destruction in both Indiana and Illinois affecting major power plants, residential and business areas. Indiana State Road 64 and nearby railroad flooded. Possible flooding to 1-84.

36. Princeton Newspaper article during early May 2011 stated that the top of the Mt. Carmel, Illinois levee was 36 feet. A flood of this magnitude...assuming that levee Unit #5 failed in western Gibson County...would rival March 1913 and cause widespread flood destruction.

36. Flood waters threaten Gibson Generating Station located in Gibson County Indiana just across the river from Mt. Carmel. In June 2006...it was the third largest power plant in the nation according to the Indianapolis Star. Its generated power went to 79 Indiana counties including the Indianapolis area. Wabash River is at a record level...about one foot above the January 2005 flood and the local levees in the East Mount Carmel, Indiana area. Levee Unit #6 overtopped. A serious flood is in progress.
NWS Precipitation Data

NOAA's Weather and Climate Toolkit

Introduction

NOAA's Weather and Climate Toolkit (WCT) is free, platform independent software distributed from NOAA's National Climatic Data Center (NCDC). The WCT allows the visualization and data export of weather and climate data, including Radar, Satellite, and Model data. The WCT also provides access to weather/climate web services provided from NCDC and other organizations.

The WCT provides tools for background maps, animations and basic filtering. The export of images and movies is provided in multiple formats. The data export feature supports conversion of data to a variety of common formats including KMZ, Shapefile, Well-Known Text, GeoTIFF, ESRI Grid and Gridded NetCDF. These data export features promote the interoperability of weather and climate information with various scientific communities and common software packages such as ArcGIS, Google Earth, MatLAB, QGIS, R and many more. Advanced data export support for Google Earth enables the 2-D and 3D export of rendered data and timeslides.

Current data types supported:

- CF-compliant Gridded NetCDF
- Generic CF-compliant Irregularly-Spaced/Unlinear Gridded NetCDF/HDF
- GRIB1, GRIB2, GMI, GEMPAK, HDF (CF-compliant) and more gridded formats
- GOES Satellite AREA Files
- NEXRAD Radar Data (Level-II and Level-III)
- U.S. Drought Monitor Service (from the National Drought Mitigation Center (NDMC))
- OPeNDAP support for Gridded Datasets

Download / Launch

New Features / FAQ / Tutorials

NOAA's Climate.gov created an article and video introduction to the Weather and Climate Toolkit. If you are a first time user, please check out this video for more information on the Toolkit's capabilities.

http://www.ncdc.noaa.gov/wct/
Presentation Outline

Flood Inundation Mapping Program

• Introduction to USGS
• Terminology/Tools of USGS and NWS
• Flood Inundation Map Libraries
• Flood Response/Mitigation Tool
Inaccessible Roadways

https://www.youtube.com/watch?v=eTV7_mGN6jY
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 show 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...
Indiana Flood Inundation Mapping Program

Cooperators and Partners
• OCRA
• INDOT
• City of Indianapolis
• City of Fort Wayne
• Indiana Homeland Security (IDHS)
• IDNR, Division of Water
• USGS
• National Weather Service
• US Army Corps of Engineers
• Purdue University
• Private sector engineering firm
Over 8,000 USGS Gages reporting current stream conditions in NWIS

Over 4,000 NWS Flood Forecast/Warning locations in AHPS
Flood Inundation Maps translate a hydrograph into operational maps that communicate risk and consequences.
FIM Libraries (cont’d)

- Designed to
  - Communicate flood risk
  - Support cost-effective decisions
  - Protect lives and property
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 Aspects

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

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

![Map of stream options](image-url)
2. Model Flood Heights

- Hydraulic model calibrated to a USGS gage rating curve
- Rating curve extensions possible
- Can be any generally accepted appropriate model
3. Delineate Flood Extents

- Water-surface profiles are combined with a high-resolution digital elevation model
- Area of probable inundation for that flow profile
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.

USGS
FIM Mapper – more than just maps

http://water.usgs.gov/osw/flood_inundation/
FIM Libraries (cont’d)

Include Hi-Res maps, reports, GIS layers, & online mapper
Flood-Inundation Mapper Examples
Data Requirements

• Channel cross-sections

• Bridge geometry and photos

• Benchmark Elevation Checks
Small Stream Applications

Shallow water can alter field collection techniques
Mid-size Stream Applications

Jon boat to navigate some shallow conditions
Large Stream Applications

Little canopy cover and ample water depth both simplify data collection.
Interactive Web Mapping Application: The Core of FIM Program
FIM Mapper

Able to map historic flood conditions.

Coming soon – HAZUS loss estimation data for all IN FIM libraries.
http://wim.usgs.gov/FIMI/
Presentation Outline

Flood Inundation Mapping Program

• Introduction to USGS
• Terminology/Tools of USGS and NWS
• Flood Inundation Map Libraries
• Flood Response/Mitigation Tool
Flood Event Scenario

- **HEADS UP** – Understanding flood potential
- **WARNING** – Flood event detection
- **RESPONSE** – Situational awareness during floods
- **RECOVERY** – Data and information for recovery
- **PLANNING AND PREPARDNESS** – Resources for making your community more resilient to flood hazards
Putting it all together

Heads Up – NWS QPF, Flood outlook, flood watch, streamflows from WaterWatch

Planning and Preparedness – the Flood Response Plan

Event Detection – USGS WaterAlert from gage, NWS flood warning

Recovery – historic precipitation and gage data, flood inundation Mapper

Response – NWS flood forecasts, current USGS gage data, flood inundation Mapper

Putting it all together
What is a flood response plan (FRP)?

- Pre-scripted actions
- Establishes lines of communication (names, #s, order)
- Pre-scripted resources (e.g. press notifications)
- Links to available flood information (gages & forecast points)

Benefits of FRP include:

- Preserves institutional knowledge
- Might provide Comm. Rating System credit for NFIP
- Protects life and property
City of Columbus—2008 flooding
- Columbus Flood Response & Evacuation Plan (FREP) is a Stand-alone Appendix to a larger, more comprehensive Flood Risk Management Plan (FRMP)

- The City of Columbus Flood Risk Management Plan is organized around the “Emergency Life Cycle” framework.

- The Plan recognizes that future flood events will occur and provides a road map to help the community function more efficiently as they
  - Respond to flooding when it occurs,
  - Recover from flood events,
  - Pursue avenues to mitigate the community’s vulnerability to present and future condition flood risks, and
  - Improve overall preparedness for flood events
FRP Elements

Preliminary Pages

Sec 1 - Event Detection and Level Determination

Sec 2 - Communication

Sec 3 - Actions

Sec 4 - Termination and Follow-Up

Appendices
To view up to date rainfall 12 & 6-hour forecasts:
3. www.crh.noaa.gov/ind/
4. Select “Forecast Graphics” tab
5. Mouse over the table to change the forecast information
6. “QPF” shows precipitation in 6-hr increments and “Next Image” shows 3-days of QPF data

For 48-hour rainfall forecasts:
2. Select the “Forecast Precipitation” tab

Precipitation Forecasts
Closed when Flatrock gage is at 19 ft.
Putting it all together

Heads Up – NWS QPF, Flood outlook, flood watch, streamflows from WaterWatch

Planning and Preparedness – the Flood Response Plan

Event Detection – USGS WaterAlert from gage, NWS flood warning

Recovery – historic precipitation and gage data, flood inundation Mapper

Response – NWS flood forecasts, current USGS gage data, flood inundation Mapper
Flood Inundation Mapper

Blanchard River at Ottawa OH

Estimated Flood Conditions

- Observed
- Predicted

Selected Gage Height: 20.00 feet
Selected NAVD88 Altitude: 738.43 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
USGS Flood Inundation Mapper

IOWA: Iowa River at Iowa City

Top 10 Annual Flood Peaks for Iowa River at Iowa City

Estimated Flood Conditions

Selected Gage Height: 24.00 feet
Selected NAVD88 Altitude: 641.30 feet

Gage Height: 24.10 feet
Date: 1851-06-06

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.*
**USGS WaterAlert form**

**Site Info:**
- Site Number: 04182000
- Agency: USGS
- Transaction ID: mw3Kc

**Send Notification To:**
- My mobile phone: 608-239-2702
- My email address: 

**Notification Frequency:**
- Hourly
- Daily

**Parameter:**
- undefined (undefined)

**Threshold Condition:**
- Real-time value is: Greater than 12.00 ft

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- I have read and acknowledge the [Provisional Data Statement](#) and [Disclaimer](#).

- [Submit](#)  [Reset](#)  [Cancel](#)

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*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 values at some USGS streamgages. Water-surface elevations along the stream center were estimated by steady-state hydraulic modeling, assuming uniform flow and using discharge and hydrologic conditions anticipated at the USGS streamgages. The hydraulic model reflects the land cover characteristics of any bridge, dam, levee, or other hydraulic structure existing in 2012. Unique meteorological factors (flow and downstream outflow and precipitation) may cause actual discharges along the modeled reach to vary from assumed conditions during a flood and to deviations in the water-surface elevations and inundation boundary 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 incorporated limits of Terre Haute. The drainage area is 12, 303 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/woflood_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/3361/22 sheets, 1 pdf pamphlet.

Suggested citation:

HYDROLOGIC DATA

The study area hydrologic network consists of three streamgages, 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) data 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 33 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 curve) 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.