

NWS Flood Inundation Mapping Services

Ben Weiger

Chief, Hydrologic Services Branch, NWS Southern Region



*Bayou Vermillion River Conference
May 28, 2008
Lafayette, LA*

“Water Predictions for Life Decisions”

Presentation Outline

- Background and Impetus for Inundation Mapping Effort
- Inundation Map Features and Future Plans



NWS Forecast and Flood Categories



- For over 25 years, the NWS has utilized a **3-tier, impact based, flood severity** scale with the categories **minor**, **moderate**, and **major** flooding
- For each NWS river forecast location, flood stage and the stage associated with each of the NWS flood severity categories are established in cooperation with local public officials



NCC049-107-070200-
 /O.NEW.KMHX.FL.W.0001.010407T1300Z-000000T0000Z/
 /KINN7.1.ER.010407T1300Z.010412T0100Z.000000T0000Z.NO/
 200 PM EDT FRI APR 6 2001

THE NATIONAL WEATHER SERVICE IN NEWPORT HAS ISSUED A
FLOOD WARNING FOR NEUSE RIVER AT KINSTON

- FROM SATURDAY MORNING UNTIL FURTHER NOTICE
- AT 9 AM EDT FRIDAY THE STAGE WAS... 13.5 FEET
- **MINOR FLOODING IS FORECAST * FLOOD STAGE IS... 14.0 FEET**
- FORECAST...FLOOD STAGE WILL BE REACHED AT 900 AM SATURDAY. MAXIMUM STAGE WILL BE 15.0 FEET AT 900 PM EDT WEDNESDAY. THE RIVER MAY REMAIN ABOVE FLOOD STAGE FOR SEVERAL WEEKS. THE EXACT FLOOD DURATION IS DIFFICULT TO PREDICT DUE TO THE VERY SLOW RISE AND FALL TIMES FOR THIS RIVER.
- AT 14 FEET...WATER WILL BEGIN TO OVERFLOW INTO LOWLANDS ADJACENT TO THE NEUSE RIVER. \$\$

<http://www.weather.gov/ahps/>



Public Law No. 107-253

- **The Inland Flood Forecasting and Warning System Act of 2002, Pub. Law No. 107-253**

- ✓ **Championed by Representative Bob Etheridge (2nd District NC)**
- ✓ **Authorizes NOAA to conduct activities to improve inland flood forecasting, develop a new flood warning index, train and educate officials regarding improved forecasting techniques and the inland flood warning index**

PUBLIC LAW 107-253—OCT. 29, 2002 116 STAT. 1781

Public Law 107-253
107th Congress
An Act

To authorize the National Oceanic and Atmospheric Administration, through the United States Weather Research Program, to conduct research and development, training, and outreach activities relating to inland flood forecasting improvement, and for other purposes. Oct. 29, 2002
(H. R. 2400)

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, Inland Flood Forecasting and Warning System Act of 2002.
15 USC 5111 note.

SECTION 1. SHORT TITLE.
This Act may be cited as the "Inland Flood Forecasting and Warning System Act of 2002".

SEC. 2. AUTHORIZED ACTIVITIES. 15 USC 5111c.

The National Oceanic and Atmospheric Administration, through the United States Weather Research Program, shall—

- (1) improve the capability to accurately forecast inland flooding (including inland flooding influenced by coastal and ocean storms) through research and modeling;
- (2) develop, test, and deploy a new flood warning index that will give the public and emergency management officials fuller, clearer, and more accurate information about the risks and dangers posed by expected floods;
- (3) train emergency management officials, National Weather Service personnel, meteorologists, and others as appropriate regarding improved forecasting techniques for inland flooding, risk management techniques, and use of the inland flood warning index developed under paragraph (2);
- (4) conduct outreach and education activities for local meteorologists and the public regarding the dangers and risks associated with inland flooding and the use and understanding of the inland flood warning index developed under paragraph (2); and
- (5) assess, through research and analysis of previous trends, among other activities—
 - (A) the long-term trends in frequency and severity of inland flooding; and
 - (B) how shifts in climate, development, and erosion patterns might make certain regions vulnerable to more continual or escalating flood damage in the future.

SEC. 3. AUTHORIZATION OF APPROPRIATIONS. 15 USC 5111c.
note.

There are authorized to be appropriated to the National Oceanic and Atmospheric Administration for carrying out this Act \$1,250,000 for each of the fiscal years 2003 through 2005, of which \$100,000 for each fiscal year shall be available for competitive

NWS Partnered Surveys

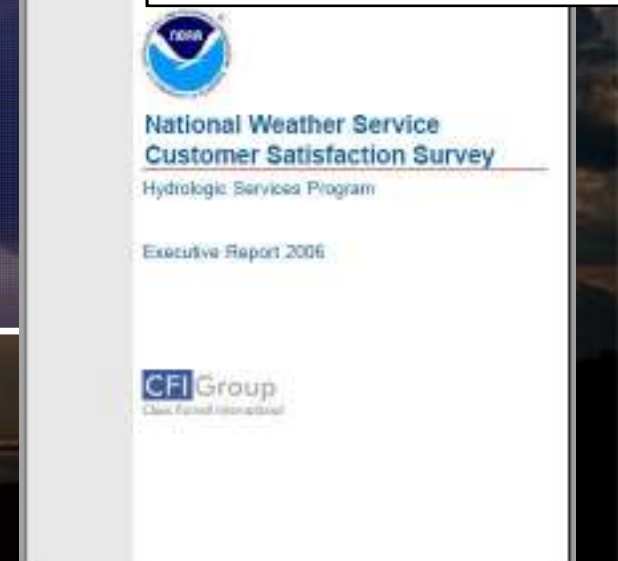
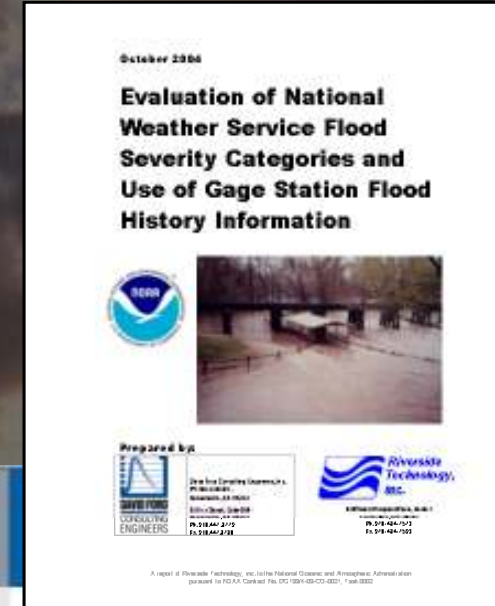


- **Since 2002, NWS has conducted extensive outreach to objectively determine whether our current flood severity index satisfies user needs**

- ✓ Partnered with Claes Fornell International (CFI) Group to survey users of NOAA's hydrologic information via the American Customer Satisfaction Index (ACSI)

- ✓ Partnered with David Ford Consulting Engineers, Inc to conduct a national survey of emergency managers

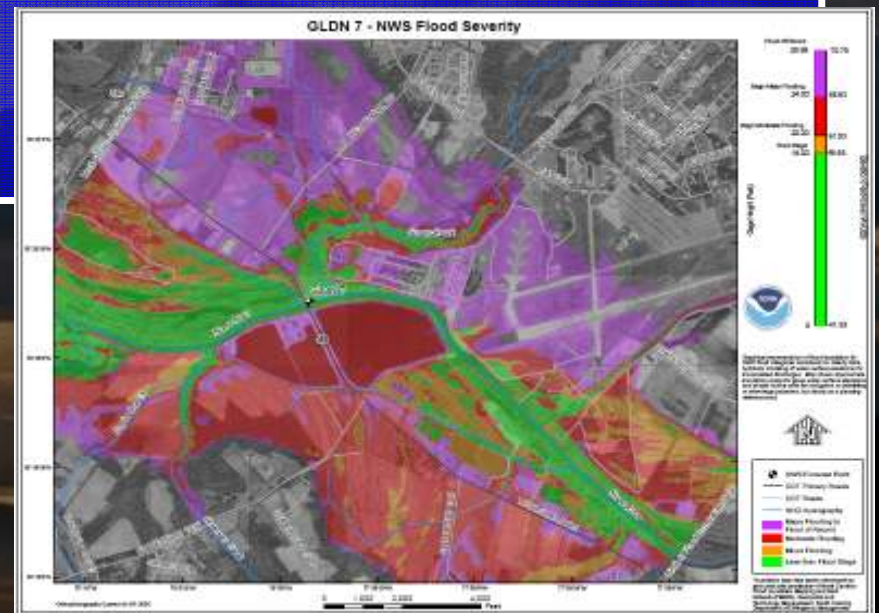
- ✓ Conducted additional local and regional user outreach



Enhancing the Communication of Flood Risk



- **Customers are telling us they....**
 - are familiar with NWS flood severity categories
 - find them useful
 - do not want changes to the existing flood severity indices
 - need communication of flood risk to be enhanced by use of **inundation graphics (maps)**



NWS Guidelines for Flood Mapping



- **NWS Flood Severity Inundation Mapping Standards and Methodologies**
- **Opportunities to Apply the Guidelines**

Methods and Standards for National Weather Service Flood Severity Inundation Maps

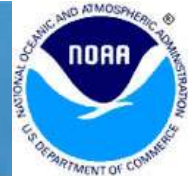
Submitted to:
National Oceanic & Atmospheric Administration
National Ocean Service
Coastal Services Center
2234 South Hobson Avenue
Charleston, SC

Submitted by:
Watershed Concepts
A Division of Hayes, Seny, Mattern, and Mattern
3333 Regency Parkway, suite 120
Cary, NC 27511

May 18, 2006

This report is the final deliverable for:
NWS Flood Severity Inundation Mapping Standards and Methodologies;
Contract # EA133C-05-CQ-1051 Task Order #2

Methods and Standards for NWS Flood Severity Inundation Maps



- Created for NWS by Watershed Concepts via EarthData International
- Minimum standards for mapping base topographic data
- Vertical Datums
- Hydraulic modeling methods
- Inundation map data standards
- Mapping methods
- Map scales and layout
- Consistent with FEMA DFIRM standards
- **Pilot mapping study (Goldsboro, NC)**

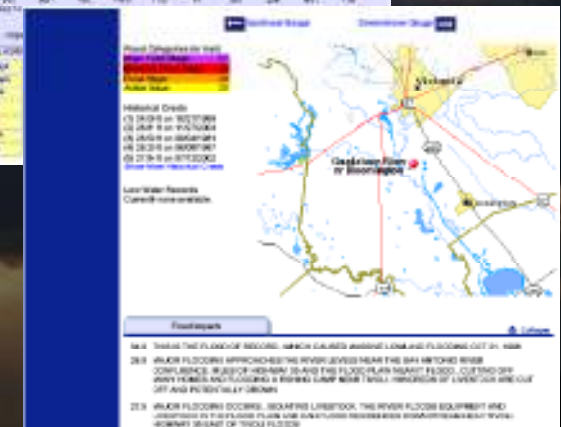
Table 3. Standards for developing Inundation Map Boundaries

Component	Minimum Standard	Preferred
Map Scale	1:12,000; 1:18,000; or 1:30,000	1:24,000 (1" = 2,000')
Map Base	Vector Data (Transportation and Hydrology Features)	Orthographic Imagery (USGS DOQQ or better)
Map Aesthetics (Line weights & colors, font size & appearance, labeling standards)	FEMA Guidelines & Specifications for Flood Hazard Mapping Features	FEMA Guidelines & Specifications for Flood Hazard Mapping Features

Advance Hydrologic Prediction Service



- Current Observations and Forecast Stages.
- Action Levels.
- Flood Stages for Major, Moderate, and Minor Categories.
- Historical Crests.
- Low Water Records.
- Flood Impacts at *particular* stages.

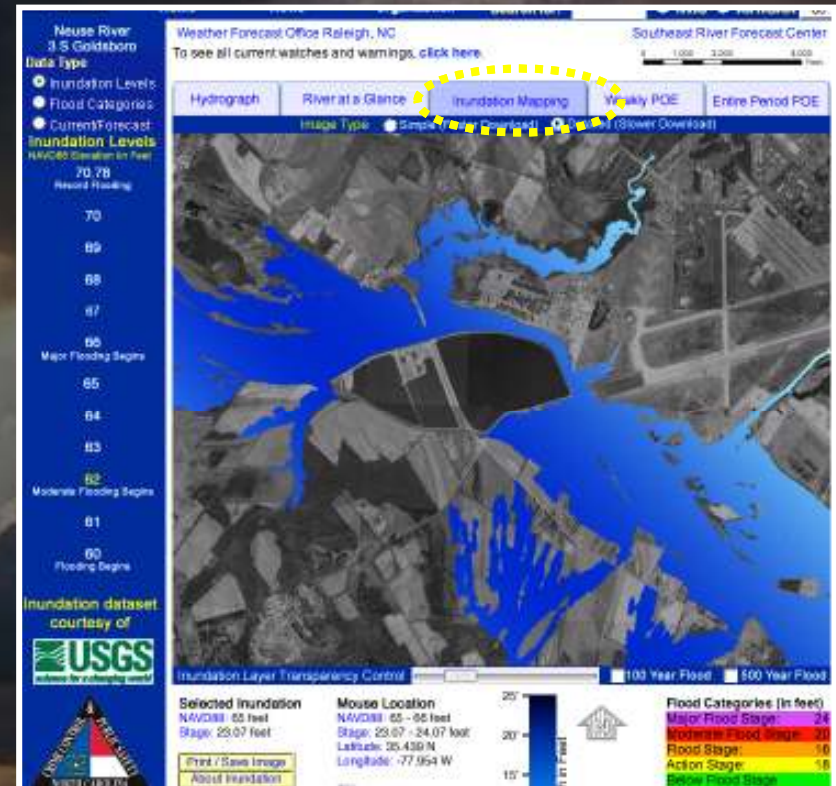


AHPS Flood Inundation



Current Flood Inundation Mapping Partners

- FEMA
- USGS
- NOAA
- ... and state/local communities

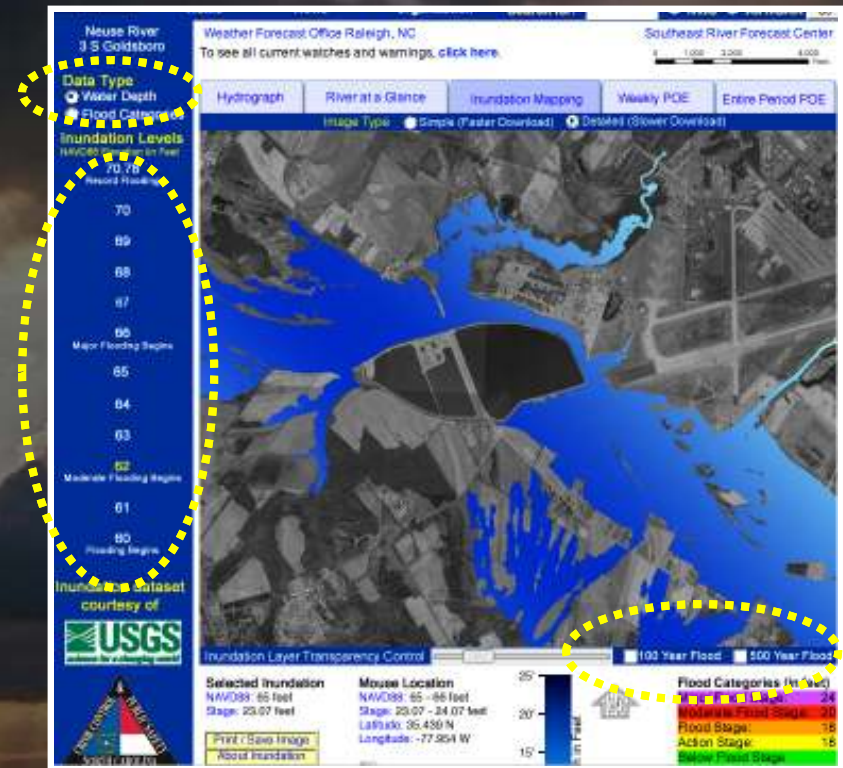


AHPS Flood Inundation Products



Inundation Maps for

- Inundation Levels - Pre-set increments from action levels to flooding.
- Flood Categories: (Major, Moderate, Minor)
- FEMA DFIRM intervals.



AHPS Flood Inundation Maps



Inundation Map Overlay

- superimposed on aerial images,
- merged onto graphical maps, or
- exported to multiple formats (including shapefiles, kmz).



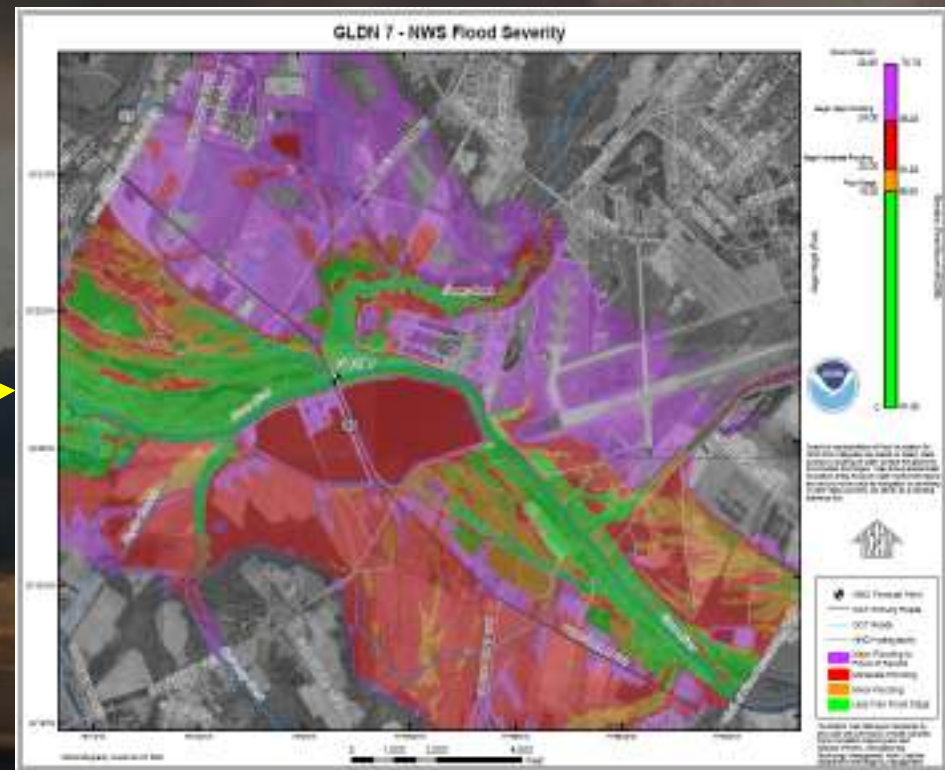
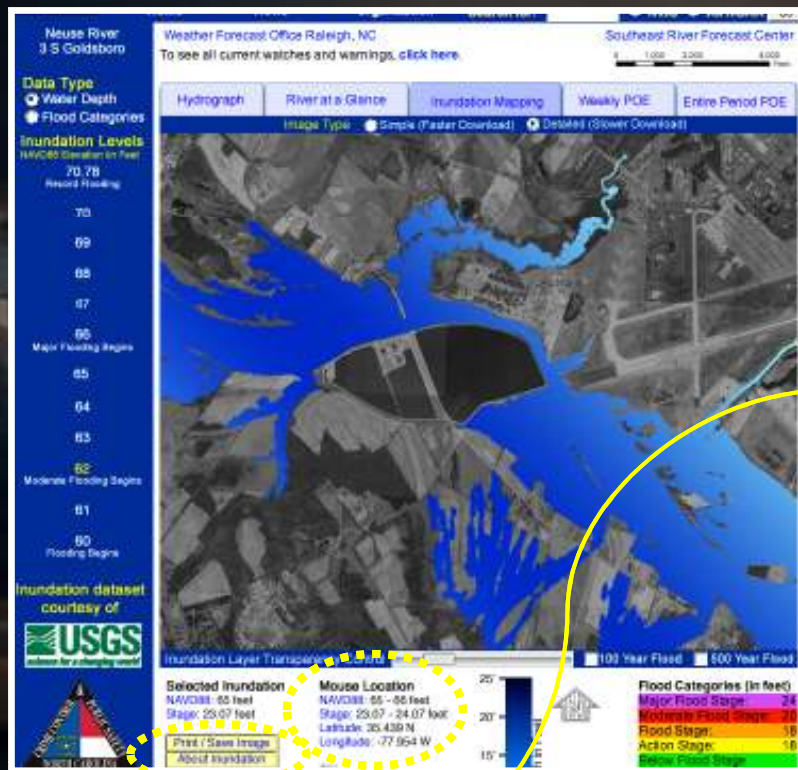
AHPS Flood Inundation Features



Interactive displays

- water depth
- latitude/longitude coordinates.

Printable images

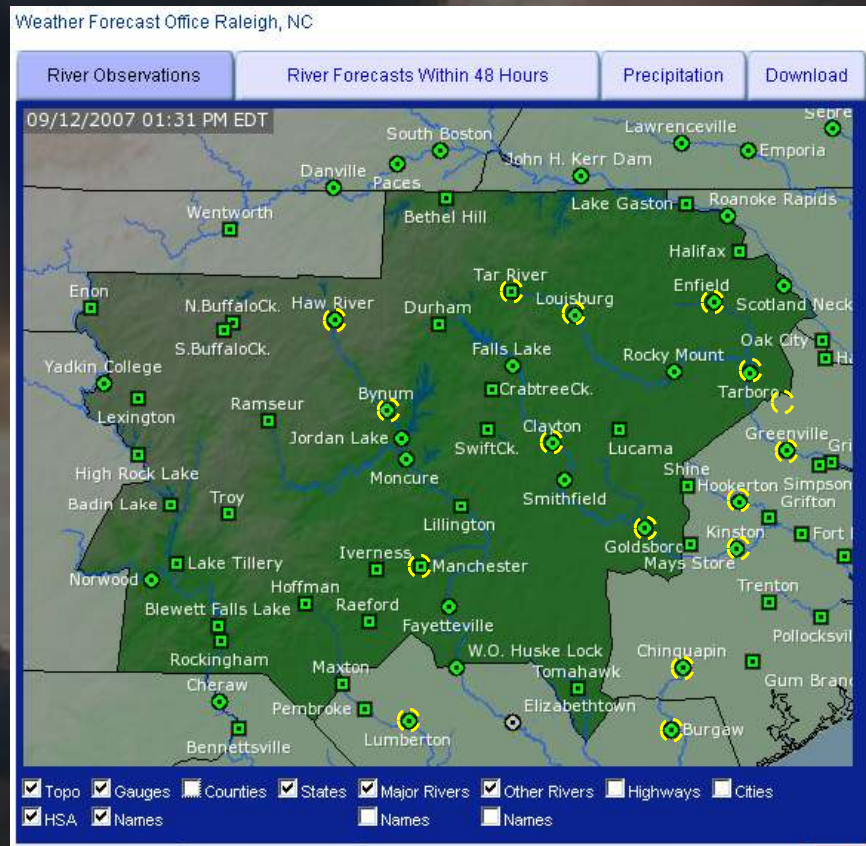


First Wave



October 2007

- 17 Sites near Raleigh North Carolina.
- These sites are within the following watersheds: *Cape Fear, Contentnea, Fishing, Haw, Neuse, Roanoke, and Tar.*



• Note: Roanoke River at Williamston is not depicted.

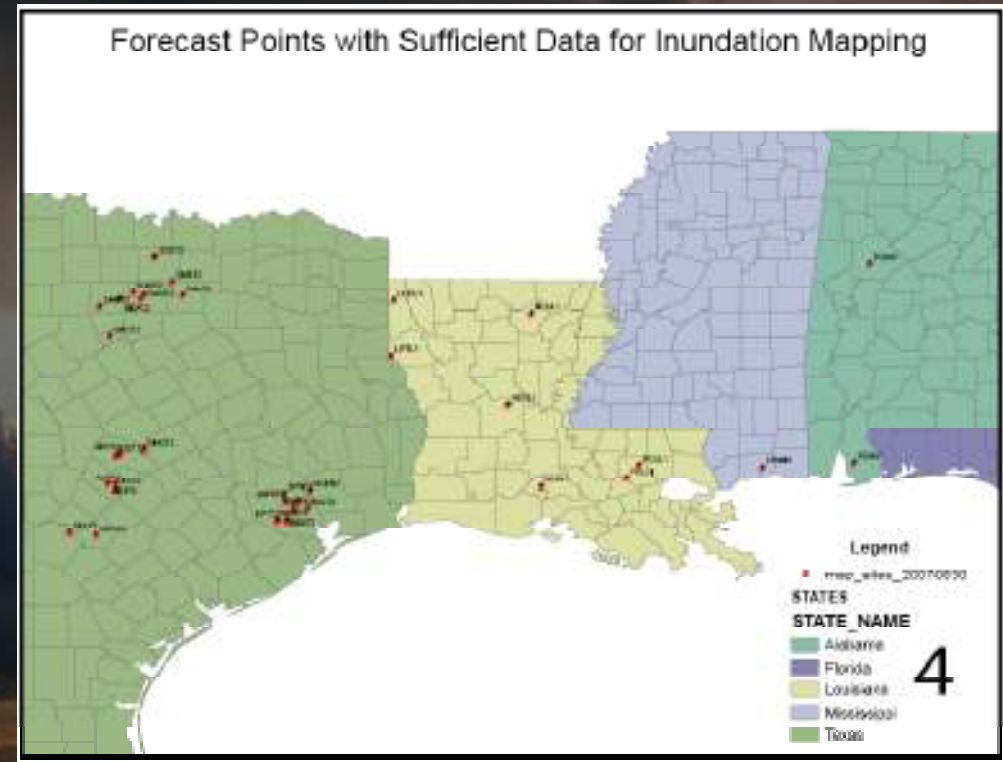
<http://www.weather.gov/ahps/inundation.php>

Second Wave



Summer/Fall 2008

- Up to 35 Sites in the Gulf Coast states have been scoped out.
- These sites are within :
Texas, Louisiana, Mississippi, and Alabama.
- **LA sites**
 - ***Red R./Alexandria***
 - ***Tickfaw R./Holden***
 - ***Sabine R./Logansport***
 - ***Ouachita R./Monroe***
 - ***Amite R./Port Vincent***
 - ***Biloxi R./Lyman***



NWS/FEMA Partnership



NFIP

- Regulatory/legal implications
- Objective analysis
- Historical stream flow statistics
- Hydrologic and hydraulic analysis
- Steady state conditions
- GIS techniques for mapping
- Relies on accurate elevation data
- Values given at multiple cross sections along river reach

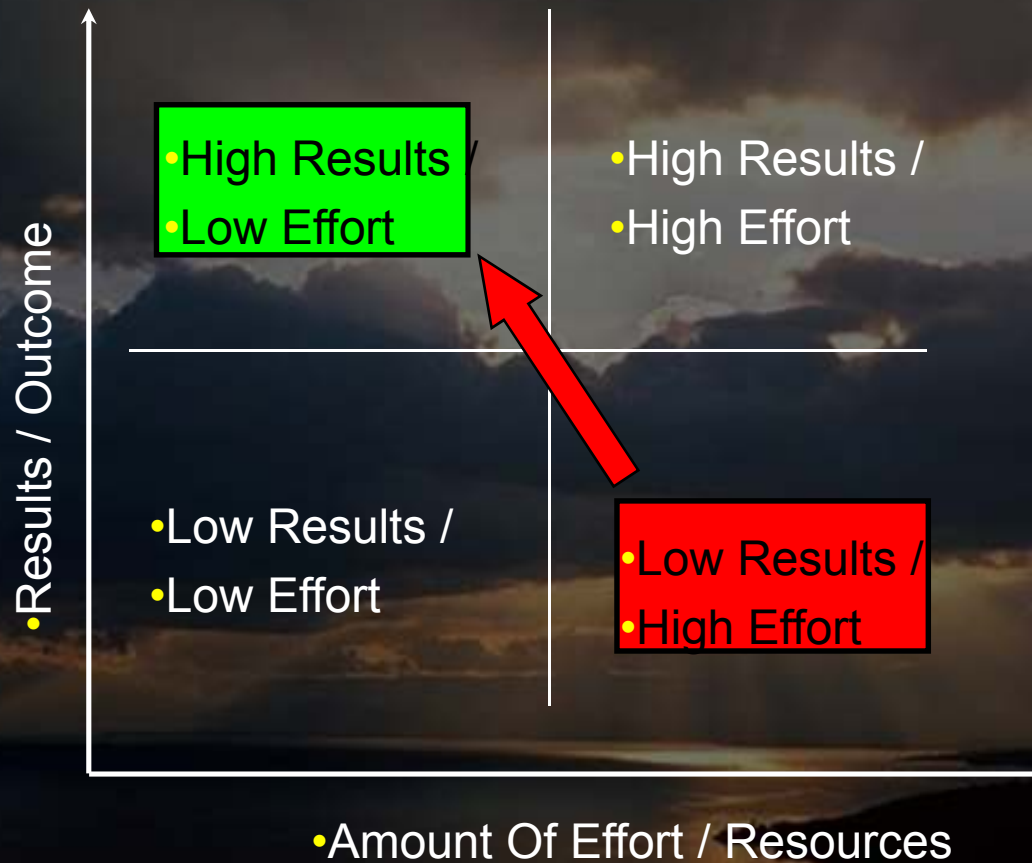
NWS Flood Warning Program

- Alert public of potential threats to life and property
- Subjective analysis based on historical impacts and coordination with local EMA
- One forecast value given at flood forecast point only
- Traditionally not mapped
- No regulatory/legal implications
- Used for evacuation and road/bridge closure decisions

Future of Flood Mapping – Where We Want to Be?



- Flood Severity Mapping for forecast points
- Map Libraries to show flood impacts for range of river stages
- Collaborate with FEMA Map Modernization
- GOAL – Larger # of Forecast Points Mapped

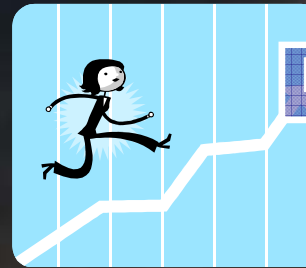


“Water Predictions for Life Decisions”

Partnering to Reduce Costs and Improve Efficiency



Costs go down



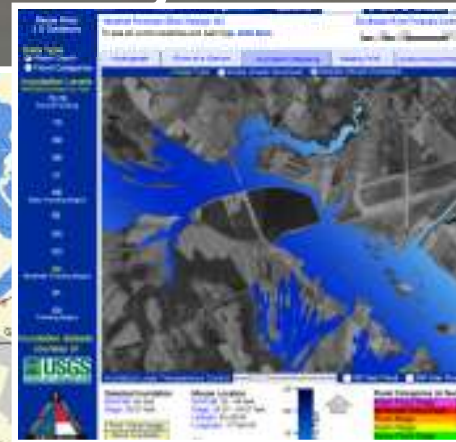
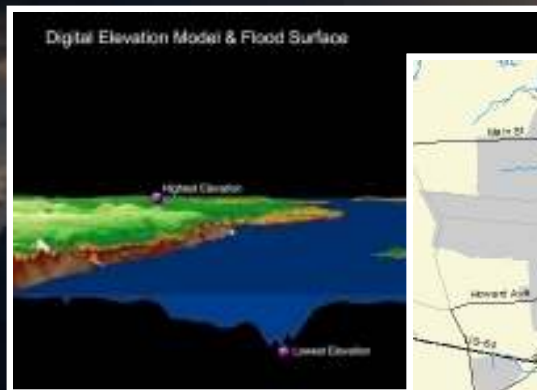
Efficiency goes up

- Cost per county average for updating FIS and maps: **~300 - 400 K**
- Additional cost to complete one inundation map library as part of the FIS: **5 – 6 K (~2% cost increase)**
- Cost doubles and time increases if inundation map library is created after FIS is completed: **11 - 12K**
- Developing inundation libraries in conjunction with FIS yields significant user benefit for small incremental cost.

Next Wave??



- FEMA Map Modernization activities
- Partnering with other state/federal agencies and the private sector to develop map libraries
- Coastal Areas and Dynamic Modeling

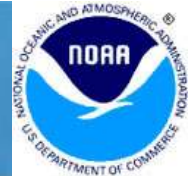


Mapping Process - Page One

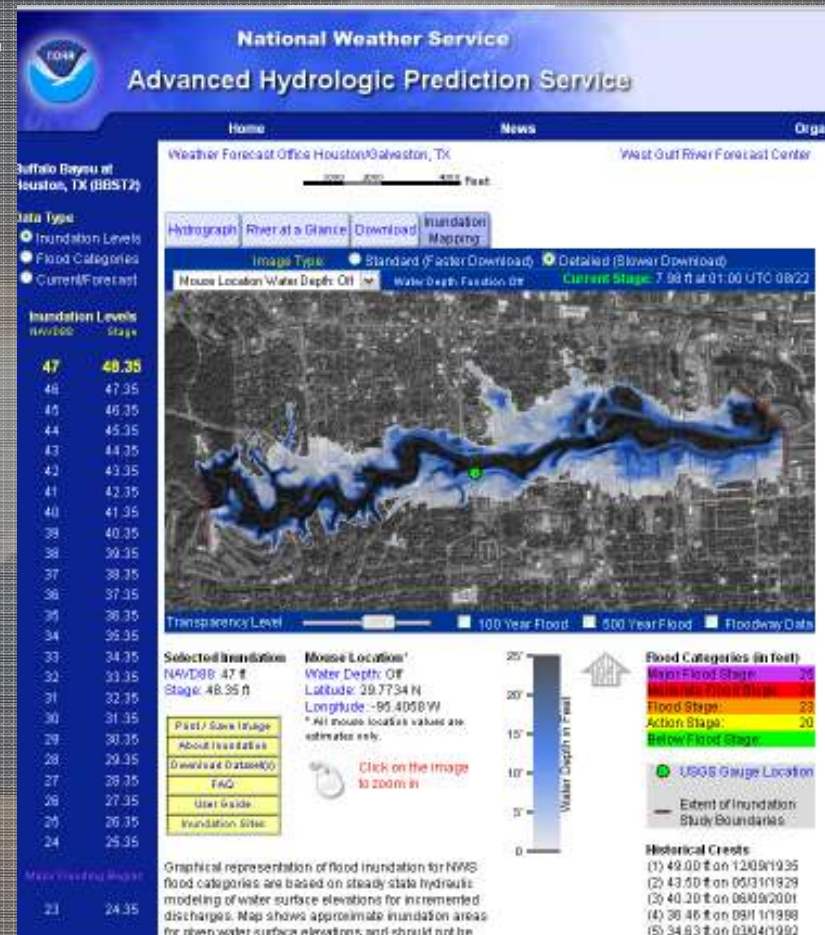


- Identify available existing topographic/engineering data from completed FIS and confirm with forecast points
- Identify ongoing or beginning FEMA FIS and confirm with forecast points
- If data exists but no study, collect topographic and engineering data via RMCs and work with partners to fund detail study.
- If the study is completed, get access to completed model data and topographic from participating community or CTP, work with partners to fund detail study.
- Obtain USGS or other rating curve used at the forecast point gages.
- QA LIDAR / Topographic data

Mapping Process – Page Two



- Examine current hydraulic model to see where it can be truncated (inflows, tribs, backwater effects)
- Determine the mapping stage interval (every foot, 2ft, 4ft, etc)
- Develop flows that will match rating curve stage for the mapping intervals at the gage and input hydraulic model (trial and error)
- Develop flood profiles for the mapping intervals with model and export to GIS...from flood stage to predetermined high flow (major flooding, or flood of record)
- Ensure local observations and flood categories are referencing the correct datum, or when the USGS plans to update datum.



Mapping Process – Page Three



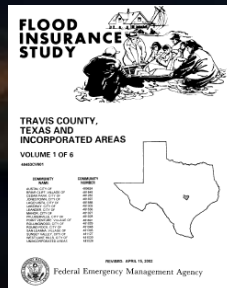
- Map in GIS using tools such as WISE or HEC-GEORAS and develop shapefiles for flood depth grids and inundation polygons
- Deliver depth grid files and polygon layers (ASCII grid files, shapefiles, geodatabases)
- Collect existing aerial photograph data (higher resolution and more recent the better)
- All deliverables (mapping and aerials) given to Orion for implementation on the web.
- Orion uses flood depth grids to do the depth scroll over calculations and builds web (beta version)
- QA/QC done using internal beta test site
- Changes are incorporated and updated then final is pushed out to AHPS sites....



NOAA/NWS Flood Inundation Map Library Guidelines - Status



- FEMA Guidelines are specific to the development of DFIRMs (Digital Flood Insurance Rate Maps).
- Limitations to the DFIRM and Regulatory Recurrence Levels.
- Specify acceptable FEMA standards for NOAA/NWS Flood Inundation Mapping Guidelines.
- Target goal for 3rd Quarter FY08.
- Incorporate methodologies particular H&H aspects.
- Define the components of a “Technical Data Book”.
- Methods and Allowable Assumptions to produce inundation map library.
- Extend Appendix C of FEMA Flood Hazard Mapping Program(Basic Review, Detailed Review) to Map Libraries.



$$S_f = S_0 - \frac{\partial y}{\partial x} + \frac{V}{g} \frac{\partial V}{\partial x} - \frac{1}{g} \frac{\partial V}{\partial t}$$



“Water Predictions for Life Decisions”

Enhance NOAA/NWS Guidelines for Flood Inundation Map Libraries



- **NWS Flood Severity Inundation Mapping Standards and Methodologies** (*May 2006*)
- **Statement of Work – National Weather Service Data Inventory and Flood Severity Inundation Map Libraries** (*July 2006*) needs to incorporate Lessons Learned
- **Spell out the deliverables for development of AHPS Flood Inundation Graphics.**
- **Document the process of producing the Flood Depth Grids.**
- **Updated guidelines will be available in the summer/fall time frame.**

Methods and Standards for National Weather Service Flood Severity Inundation Maps

Submitted to:
National Oceanic & Atmospheric Administration
National Ocean Service
Coastal Services Center
2234 South Hobson Avenue
Charleston, SC

Submitted by:
Watershed Concepts
A Division of Hayes, Seny, Mattem, and Mattem
3333 Regency Parkway, suite 120
Cary, NC 27511

May 18, 2006

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Partnering and Customer Requirements for Inundation Mapping



- **Marketing the Program to Partners.**
- **Develop Awareness of USGS, COE, FEMA, local programs.**
- **Inventory of existing information, DEMs, detailed FIRMs and studies, aerial photography.**
- **Find Funding Source and its Availability.**



“Water Predictions for Life Decisions”

•Summary



- For NWS river forecast locations.....
 - Enhance the communication of flood risk by a developing a library of inundation maps and linking them with observed/forecast river stages
 - Each library will include flood inundation maps for NWS flood category levels and FEMA flood frequency events



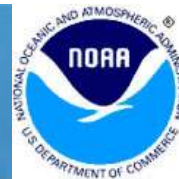
“Water Predictions for Life Decisions”

NWS Hydrometeorological Web Pages



- **NWS web pages**
 - www.srh.weather.gov (regional HQ web page)
 - www.weather.gov/ahps (AHPS web page)
 - www.srh.noaa.gov/ridge/ (radar data)
 - water.weather.gov/ (precipitation analysis)
 - www.srh.noaa.gov/precipitation_analysis_hourly.php (experimental hourly precipitation estimates)

“Water Predictions for Life Decisions”



Questions?

Contact Information

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Victor Hom

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**National Flood Mapping Program
Manager**

victor.hom@noaa.gov

“Water Predictions for Life Decisions”

Data Type

- Inundation Levels
- Flood Categories
- Current/Forecast

Inundation Levels

NAVD88 Stage

53	43.7
52	42.7
51	41.7
50	40.7
49	39.7
48	38.7
47	37.7
46	36.7
45	35.7
44	34.7
43	33.7
42	32.7

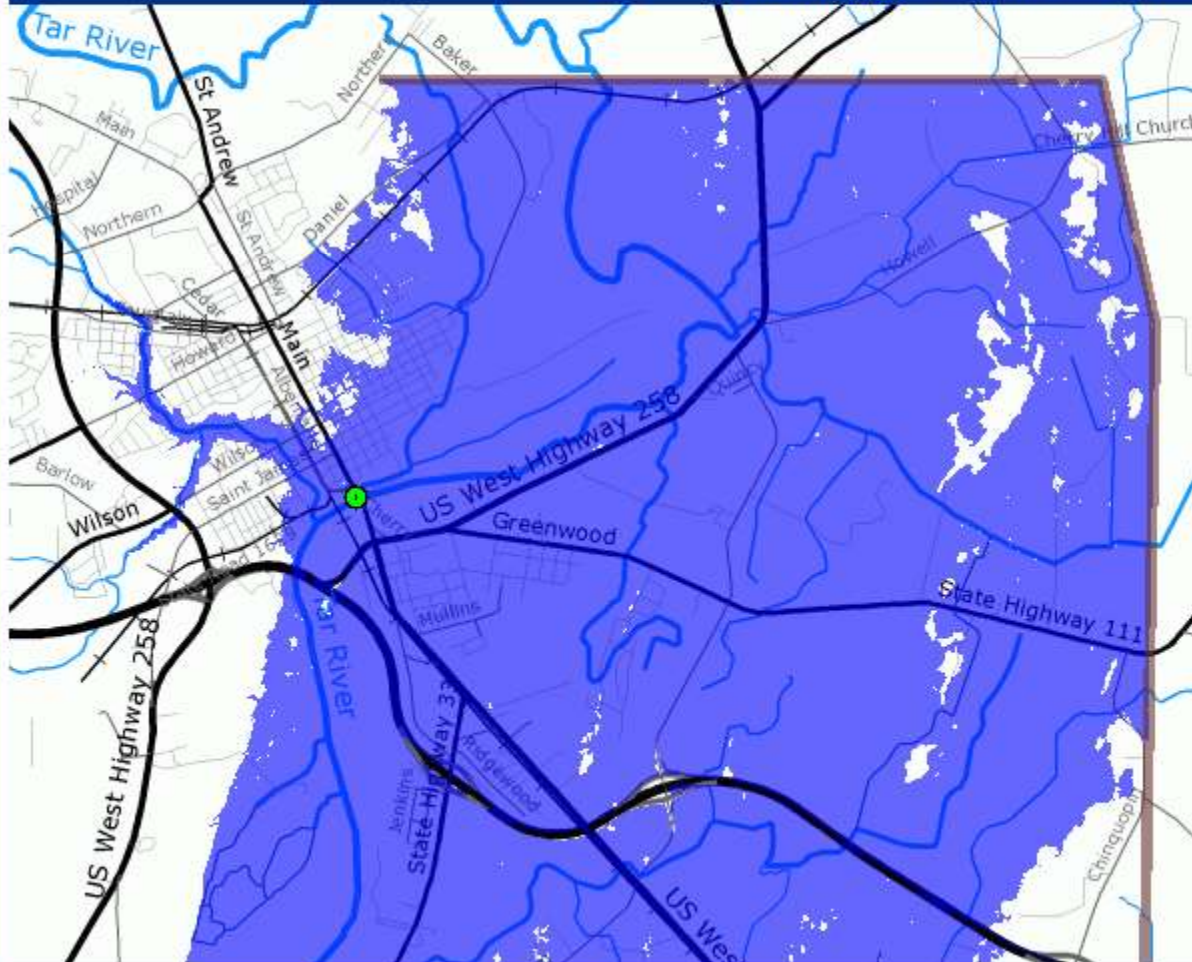
Major Flooding Begins

41	31.7
40	30.7
39	29.7
38	28.7
37	27.7
36	26.7
35	25.7
34	24.7

Hydrograph River at a Glance Download Inundation Mapping Weekly Chance of Exceeding Levels Chance of Exceeding Levels During Entire Period

Image Type: Standard (Faster Download) Detailed (Slower Download)

Current Stage: 1.23 ft at 16:15 UTC 11/30



- Inundation Levels
- Flood Categories
- Current/Forecast

Hydrograph River at a Glance Download Inundation Mapping Weekly Chance of Exceeding Levels Chance of Exceeding Levels During Entire Period

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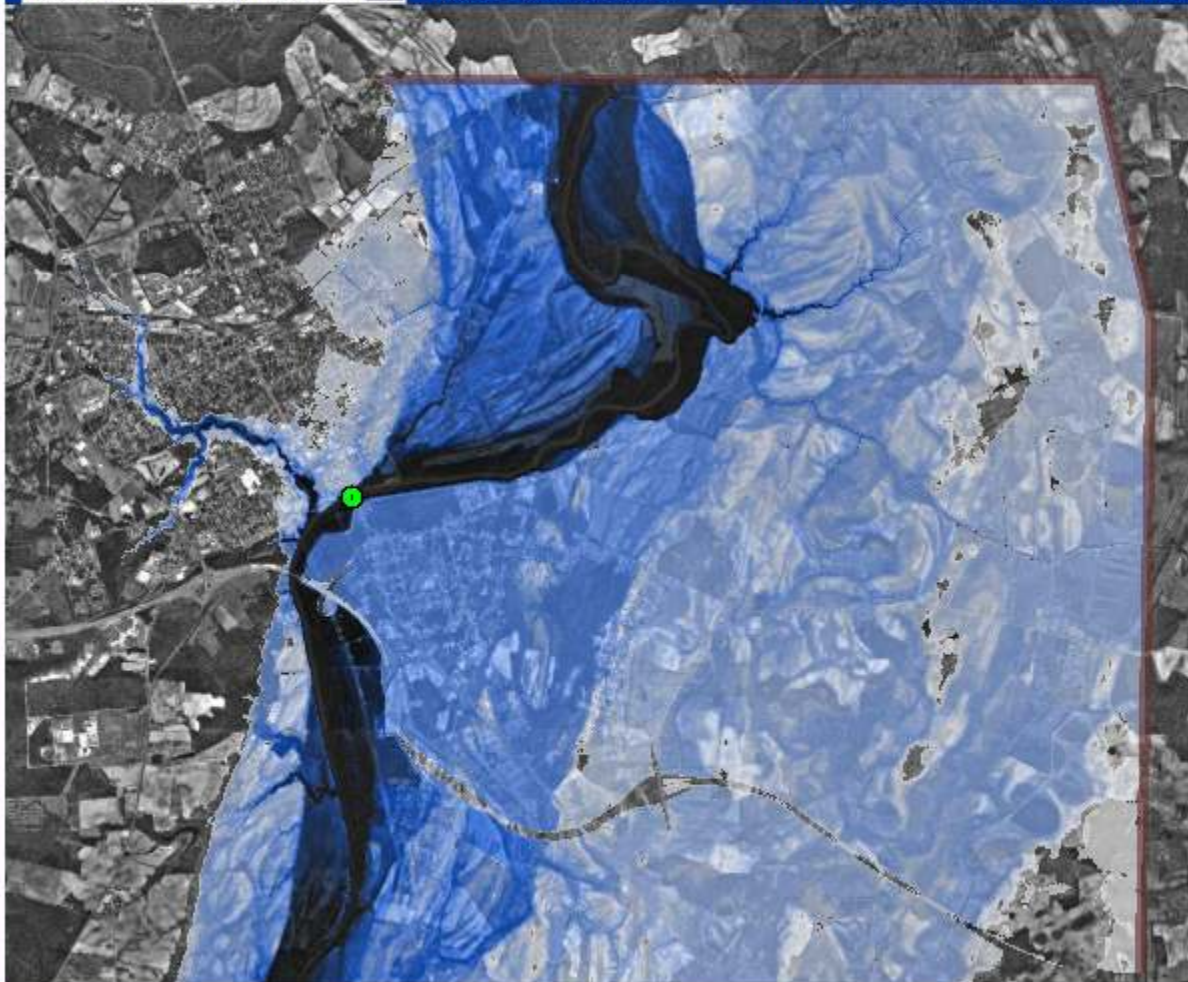
Mouse Location Water Depth: Off Water Depth Function Off **Current Stage: 1.23 ft at 16:15 UTC 11/30**

Inundation Levels
NAVD88 Stage

53	43.7
52	42.7
51	41.7
50	40.7
49	39.7
48	38.7
47	37.7
46	36.7
45	35.7
44	34.7
43	33.7
42	32.7

Major Flooding Begins

41	31.7
40	30.7
39	29.7
38	28.7
37	27.7
36	26.7
35	25.7
34	24.7



39	29.7
38	28.7
37	27.7
36	26.7
35	25.7
34	24.7
Moderate Flooding Begins	
33	23.7
32	22.7
31	21.7
30	20.7
29	19.7




Transparency Level 100 Year Flood 500 Year Flood Floodway Data

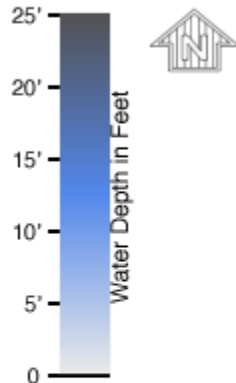
Flooding Begins	
28	18.7

Selected Inundation
 NAVD88: 53 ft
 Stage: 43.70 ft

- [Print / Save Image](#)
- [About Inundation](#)
- [Download Dataset\(s\)](#)
- [FAQ](#)
- [User Guide](#)
- [Inundation Sites](#)




Mouse Location*
 Water Depth: Off
 Latitude: 35.9062 N
 Longitude: -77.4492 W
 * All mouse location values are estimates only.

 Click on the image to zoom in



Flood Categories (in feet)

Major Flood Stage:	32
Moderate Flood Stage:	24
Flood Stage:	19
Action Stage:	19
Below Flood Stage:	

-  USGS Gauge Location
-  Extent of Inundation
-  Study Boundaries

- Historical Crests**
- (1) 41.51 ft on 09/19/1999
 - (2) 34.00 ft on 07/27/1919
 - (3) 33.50 ft on 10/04/1924
 - (4) 31.77 ft on 08/20/1940
 - (5) 30.20 ft on 09/24/1928
- [Show More Historical Crests](#)

Inundation Feedback

Inundation in partnership with



Graphical representation of flood inundation for NWS flood categories are based on steady state hydraulic modeling of water surface elevations for incremented discharges. Map shows approximate inundation areas for given water surface elevations and should not be used for navigation or permitting or other legal purposes, but strictly as a planning reference tool.

Our Partners

Feedback/Questions
Provide Feedback
Ask Questions



- [Location Map for TARN7](#) (15k)

Weekly Chance of Exceeding Levels Images:

- [Stage](#) (appr. 15k)
- [Flow](#) (appr. 15k)
- [Volume](#) (appr. 15k)

Chance of Exceeding Levels During Entire Period Images:

- [Stage](#) (appr. 15k)
- [Flow](#) (appr. 15k)

Photos:

- [Gauge Site](#)

Inundation Shapefiles:

- [TARN7 Shapefile File](#) (22,645k - Last Updated 11/30/2007 12:47 am)

Inundation KMZ Files:

- [TARN7 KMZ File](#) (31,225k - Last Updated 11/30/2007 12:44 am)

Inundation Images:

- [TARN7 Images File](#) (12,450k - Last Updated 11/30/2007 12:39 am)

[Return to Area Map](#)

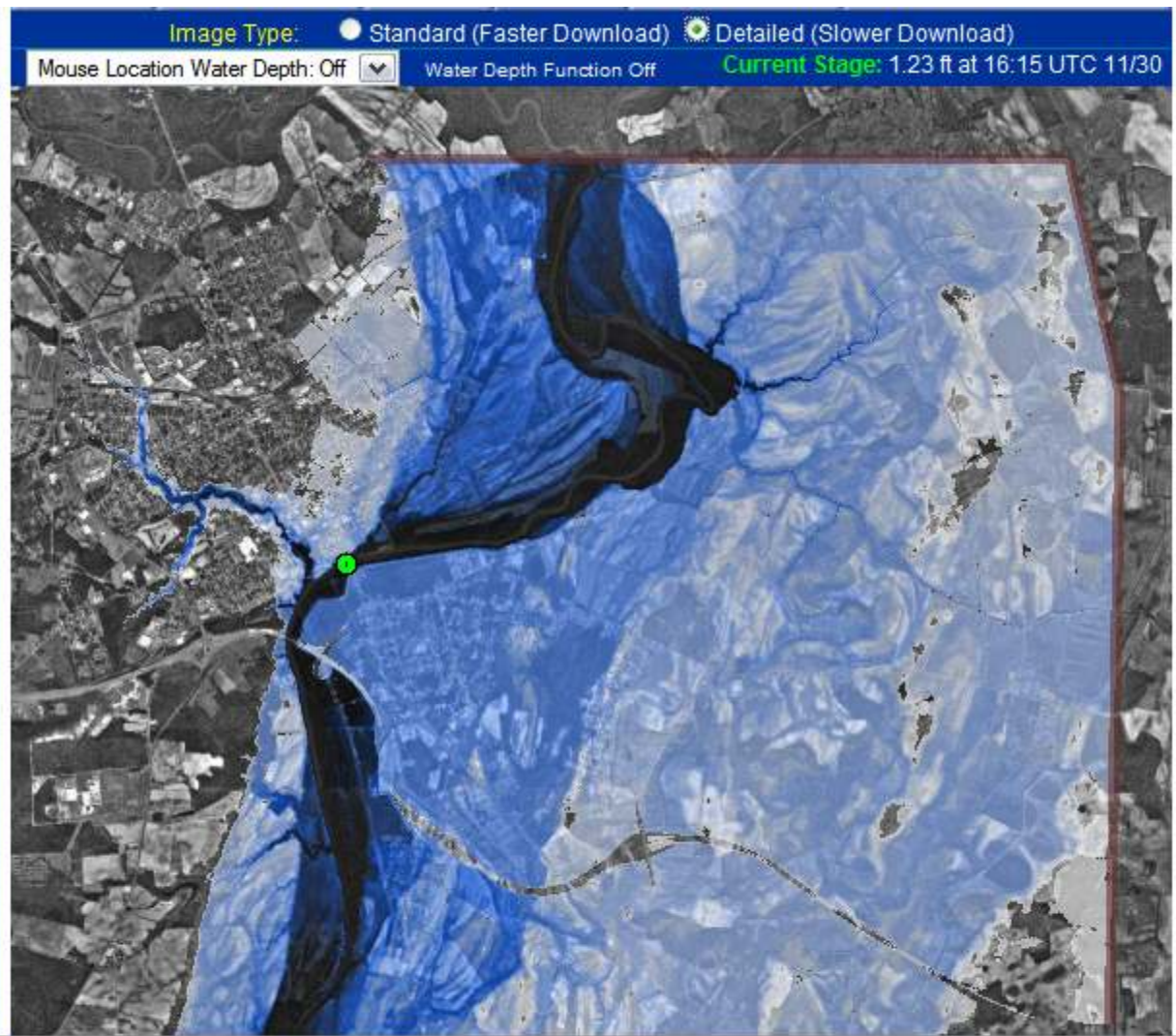
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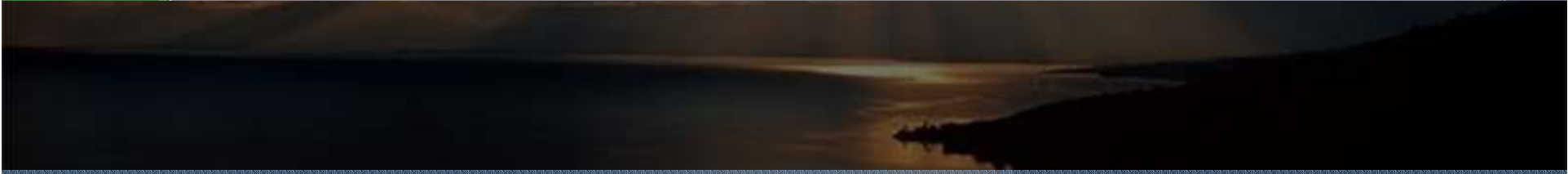
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Done

Windows taskbar showing the Start button and open applications: twdb1204_bw.ppt... and Advanced Hydrolo...



“Water Predictions for Life Decisions”