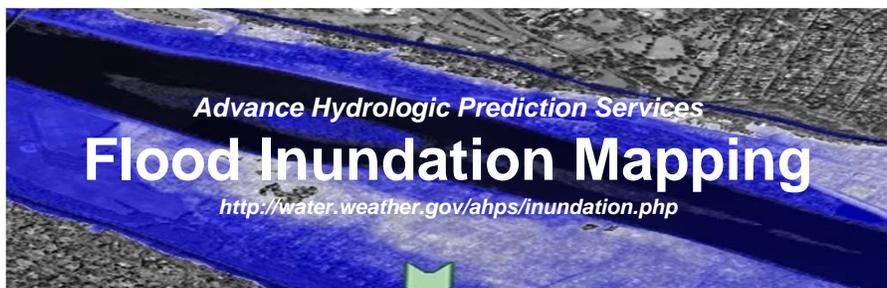




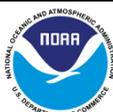
# Flood Warning User Forums Delaware River Basin



September 21<sup>st</sup> & 22<sup>nd</sup>, 2010



**Laurie G. Hogan**  
Hydrologic Services Division  
Eastern Region Headquarters  
NOAA's National Weather Service



## Advance Hydrologic Prediction Services Flood Inundation Mapping



- Overview
  - ✓ Locations available
  - ✓ Background Description
  - ✓ How the inundation libraries were created
- Strengths and Limitations
- Introduction to Interacting with the Maps
  - ✓ Tour of AHPS Web Pages
  - ✓ Downloads, Quick View of Maps in Google Earth
- Risk Mitigation Scenarios
- Future Plans



# Overview



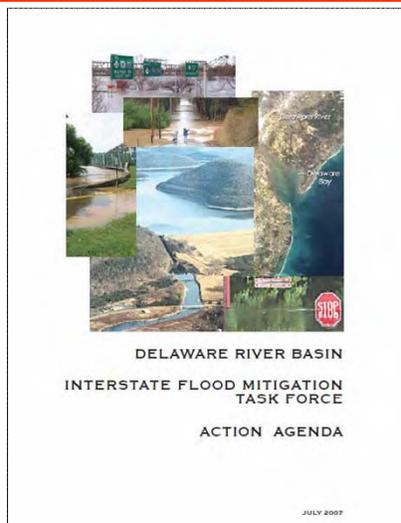
- AHPS Flood Inundation Maps are funded for 9 NWS River Forecast locations along the Delaware River main stem.
- 5 maps sets are now in AHPS:
  - ✓ Trenton
  - ✓ Lambertville/New Hope
  - ✓ Stockton
  - ✓ Frenchtown
  - ✓ Riegelsville
- Inundation maps provide information on the spatial extent and *estimated depth* of flood waters in the vicinity of NWS River Forecast locations.



# Background



- Recommendations FW-9 and FW-11 in the Task Force Action Agenda speak to the development of “Flood Inundation Mapping”.
- Funding (\$65K) secured by DRBC initiatives for NWS web contractor





## Inundation Map Creation



- U.S. Army Corps of Engineers, Philadelphia District developed inundation mapping for the Delaware River main stem from Trenton, NJ north to Port Jervis, NY.



NWS Quality Controlled and processed USACE model/GIS files to produce web ready inundation maps for 5 Delaware locations.

- 4 map libraries still in NWS QC process, TBD date for AHPS:

- ✓ Phillipsburg/Easton
- ✓ Belvidere
- ✓ Montague
- ✓ Port Jervis



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## AHPS Flood Inundation Mapping Strengths and Limitations



### Strengths:

- ✓ Available to public via the Internet at reasonably quick display speeds.
- ✓ Completely integrated with other NWS AHPS information
- ✓ Multiple formats for download

### Limitations:

- ✓ Zoom capability currently limited
- ✓ Only preset transportation layers, mapping overlays available.

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# Tour of AHPS Flood Inundation Mapping Web Site



## Inundation Mapping



<http://www.youtube.com/watch?v=RTmQGCKxgP4>

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# Delaware River AHPS Flood Inundation Maps



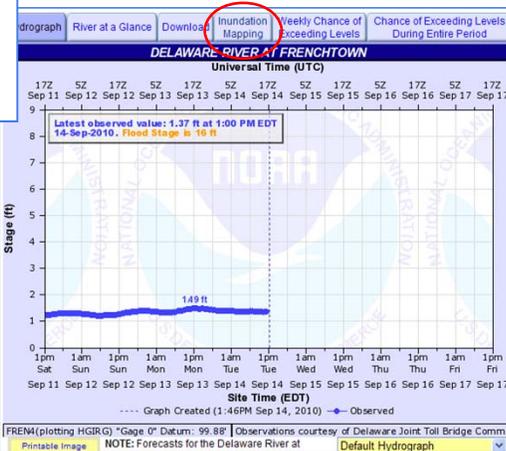
Navigate to the inundation maps using two methods:

- <http://water.weather.gov/ahps/inundation.php> (scroll down)

### Philadelphia/Mount Holly, NJ (PHI)

- FREN4 - Delaware River at Frenchtown (NJ)
- NHPP1 - Delaware River at New Hope-Lambertville Bridge (PA)
- RGLN4 - Delaware River at Riegelsville (NJ)
- STKN4 - Delaware River at Stockton (NJ)
- TREN4 - Delaware River at Trenton (NJ)

- Select the "Inundation Mapping" tab above the AHPS Hydrograph



--- Graph Created (1:46PM Sep 14, 2010) --- Observed



# Delaware River AHPS Flood Inundation Maps



## Standard View

**Trenton, NJ (TREM4)**

Data Type  
 Inundation Levels  
 Flood Categories  
 Current/Forecast

Inundation Levels	NAVD88	Stage
33.5	34.6	
32.9	33.9	
31.6	32.7	76.3 29.2
30.2	31.3	74.7 26.6
29.0	30.1	73.3 25.2
27.8	28.9	72.1 24.0
26.6	27.7	70.8 22.7
25.4	26.5	69.5 21.4
24.2	25.3	68.2 20.1
		66.7 18.6
<b>Major Flooding Begins</b>	<b>65.3</b>	<b>17.2</b>
23.5	24.6	
23.0	24.1	64.0 15.9
22.3	23.4	

**Moderate Flooding Begins**

21.5	22.6	63.1 15.0
21.1	22.2	62.3 14.2
20.4	21.5	61.4 13.3
19.7	20.8	
		60.5 12.4
		59.1 11.0
		58.1 10.0
		57.0 8.9
<b>Flooding Begins</b>	<b>60.5</b>	<b>12.4</b>
18.9	20.0	
17.5	18.6	
16.2	17.3	
14.9	16.0	
<b>13.7</b>	<b>14.8</b>	

**Delaware River at New Hope-Lambertville Bridge, PA (NHPP1)**

Data Type  
 Inundation Levels  
 Flood Categories  
 Current/Forecast

Inundation Levels	NAVD88	Stage
77.7	29.6	
76.3	28.2	
74.7	26.6	
73.3	25.2	
72.1	24.0	
70.8	22.7	
69.5	21.4	
68.2	20.1	
66.7	18.6	
<b>Major Flooding Begins</b>	<b>64.0</b>	<b>15.9</b>
63.1	15.0	
62.3	14.2	
61.4	13.3	
		60.5 12.4
		59.1 11.0
		58.1 10.0
		57.0 8.9
<b>Flooding Begins</b>	<b>60.5</b>	<b>12.4</b>
59.1	11.0	
58.1	10.0	
57.0	8.9	

**Delaware River at Stockton, NJ (STKN4)**

Data Type  
 Inundation Levels  
 Flood Categories  
 Current/Forecast

**Flood Stage Categories**

Major Flood  
 Moderate Flood  
 Minor Flood  
 Near Flood

Allow Overlapping Flood Category Layers

**Why Missing Categories?**

**Inundation Feedback**

Inundation in partnership with

**Delaware River at Frenchtown, NJ (FREN4)**

Data Type  
 Inundation Levels  
 Flood Categories  
 Current/Forecast

**Flood Stage Categories**

Major Flood  
 Moderate Flood  
 Minor Flood  
 Near Flood

Allow Overlapping Flood Category Layers

**Why Missing Categories?**

**Inundation Feedback**

Inundation in partnership with

View all valid statements/warnings

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: 9 at 17:30 UTC 09/14



# Delaware River AHPS Flood Inundation Maps



## Detailed View

**Frenchtown, NJ (FREN4)**

Data Type  
 Inundation Levels  
 Flood Categories  
 Current/Forecast

Inundation Levels	NAVD88	Stage
188.3	44.0	
188.1	41.8	
186.1	40.8	
183.4	38.1	
182.2	37.1	
<b>160.6</b>	<b>36.3</b>	
159.2	34.9	
157.7	32.4	
156.3	32.0	
155.8	31.2	
		127.7 28.7
		126.7 27.7
		125.7 26.7
		124.7 25.7
		123.7 24.7
		122.7 23.7
		122.1 23.1
		121.1 22.1
		120.4 21.4
		119.7 20.7
<b>Major Flooding Begins</b>	<b>118.9</b>	<b>19.9</b>
118.3	19.3	
<b>117.6</b>	<b>18.6</b>	
		76.8 23.7
		76.0 22.9
		74.6 21.5
		73.9 20.8
<b>Moderate Flooding Begins</b>	<b>72.5</b>	<b>19.4</b>
71.8	18.7	
		71.1 18.0
<b>Flooding Begins</b>	<b>71.1</b>	<b>18.0</b>
113.8	14.8	

**Delaware River at Stockton, NJ (STKN4)**

Data Type  
 Inundation Levels  
 Flood Categories  
 Current/Forecast

Inundation Levels	NAVD88	Stage
88.5	35.4	
87.2	34.1	
86.1	33.0	
85.0	31.9	
83.9	30.8	
82.7	29.6	
81.5	28.4	
80.9	27.8	
80.2	27.1	
79.0	25.9	
78.3	25.2	
<b>Major Flooding Begins</b>	<b>77.6</b>	<b>24.5</b>
76.8	23.7	
76.0	22.9	
74.6	21.5	
73.9	20.8	
<b>Moderate Flooding Begins</b>	<b>72.5</b>	<b>19.4</b>
71.8	18.7	
		71.1 18.0
<b>Flooding Begins</b>	<b>71.1</b>	<b>18.0</b>
60.5	12.4	
59.1	11.0	
58.1	10.0	
57.0	8.9	

**Delaware River at New Hope-Lambertville Bridge, PA (NHPP1)**

Data Type  
 Inundation Levels  
 Flood Categories  
 Current/Forecast

Inundation Levels	NAVD88	Stage
77.7	29.6	
76.3	28.2	
74.7	26.6	
73.3	25.2	
72.1	24.0	
70.8	22.7	
69.5	21.4	
68.2	20.1	
66.7	18.6	
65.3	17.2	
<b>Major Flooding Begins</b>	<b>64.0</b>	<b>15.9</b>
63.1	15.0	
62.3	14.2	
61.4	13.3	
		60.5 12.4
		59.1 11.0
		58.1 10.0
		57.0 8.9
<b>Flooding Begins</b>	<b>60.5</b>	<b>12.4</b>
59.1	11.0	
58.1	10.0	
57.0	8.9	

**Delaware River at Trenton, NJ (TREM4)**

Data Type  
 Inundation Levels  
 Flood Categories  
 Current/Forecast

Inundation Levels	NAVD88	Stage
33.5	34.6	
32.9	33.9	
31.6	32.7	76.3 29.2
30.2	31.3	74.7 26.6
29.0	30.1	73.3 25.2
27.8	28.9	72.1 24.0
26.6	27.7	70.8 22.7
25.4	26.5	69.5 21.4
24.2	25.3	68.2 20.1
		66.7 18.6
<b>Major Flooding Begins</b>	<b>64.0</b>	<b>15.9</b>
63.1	15.0	
62.3	14.2	
61.4	13.3	
		60.5 12.4
		59.1 11.0
		58.1 10.0
		57.0 8.9
<b>Flooding Begins</b>	<b>60.5</b>	<b>12.4</b>
59.1	11.0	
58.1	10.0	
57.0	8.9	

**Red Flag Warning**

View all valid statements/warnings

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: 8.17 at 18:15 UTC 09/14

Mouse Location Water Depth: Off Water Depth Function Off

Selected Inundation: NAVD88: 19.7 ft Stage: 20.8 ft

Mouse Location: Water Depth: Off Latitude: 40.2384 N Longitude: -74.7921 W

Flood Categories (in feet):  
 River Flood Stage: 25  
 Moderate Flood Stage: 23  
 Flood Stage: 20  
 Action Stage: 15  
 Below Flood Stage: 15

USGS Gauge Location  
 Extent of Inundation



# Delaware River AHPS Flood Inundation Maps



User Guide available (.pdf file)

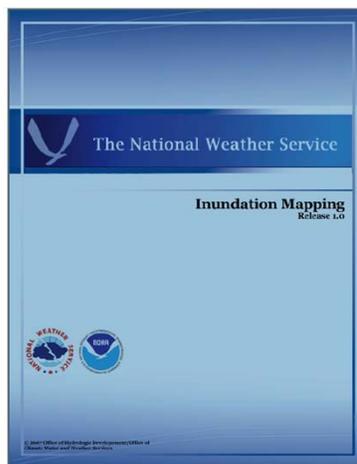
Transparency Level

21.5  
20.8  
**Begins**  
20.0  
18.6  
17.3  
16.0  
14.8

**Selected Inundation**  
NAVD88: 23.0 ft  
Stage: 24.1 ft

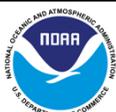
Print / Save Image  
About Inundation  
**Download Dataset(s)**  
FAQ  
User Guide  
Inundation Sites

Mouse  
Latitud  
Longit.  
\* All mo  
estimate



Graphical representation of flood categories are based on:

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# AHPS Flood Inundation Maps Downloads



National Weather Service  
Advanced Hydrologic Prediction Service

Weather Forecast Office Philadelphia, PA (PHO), NJ

Hydrograph River at a Gauge Downloads Inundation Weekly Chance of Exceeding Levels Chance of Exceeding Levels During Entire Period

**Downloads for Delaware River at Trenton (TREN4)**

Hydrographs:

- Default Hydrograph (18K)
- Scale to Flood Categories (20K)

RSS Feeds:

- RSS files for TREN4

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:

- Ice at the Trenton Gauge

Inundation Shapefiles:

- TREN4 Shapefile File (7,907K - Last Updated 8/9/2010 10:01 am)
- TREN4 K00Z File (2,999K - Last Updated 8/9/2010 10:01 am)

Inundation Images:

- TREN4 Images File (10,327K - Last Updated 8/9/2010 10:01 am)

Custom to Area Map

esri  
ArcReader  
Free ArcGIS Desktop Viewer

GRASS: Download

Download World Wind Java SDK

Download Google Earth 5

<http://www.esri.com/software/arcgis/arcreader/index.htm> <http://grass.fbk.eu/index.php> <http://worldwind.arc.nasa.gov/java/> [Maps.google.com/earth/view](http://Maps.google.com/earth/view)



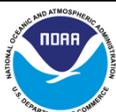
# AHPS Flood Inundation Maps Using Downloads – 4 steps



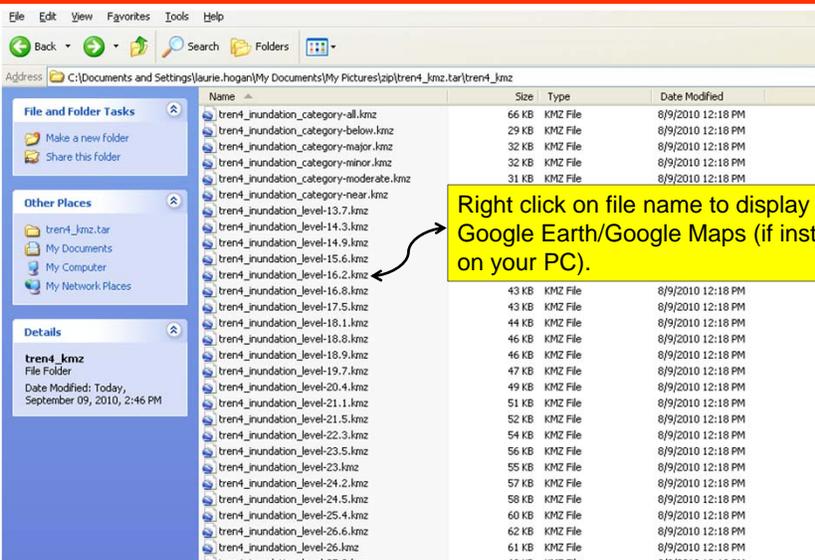
1. Left click on file name
2. Accept Disclaimer
3. Save the file
  - File is zipped to speed transfer to your PC
4. Unzip file
  - 7-zip software will handle this zip format (FREE)



• <http://www.7-zip.org/>

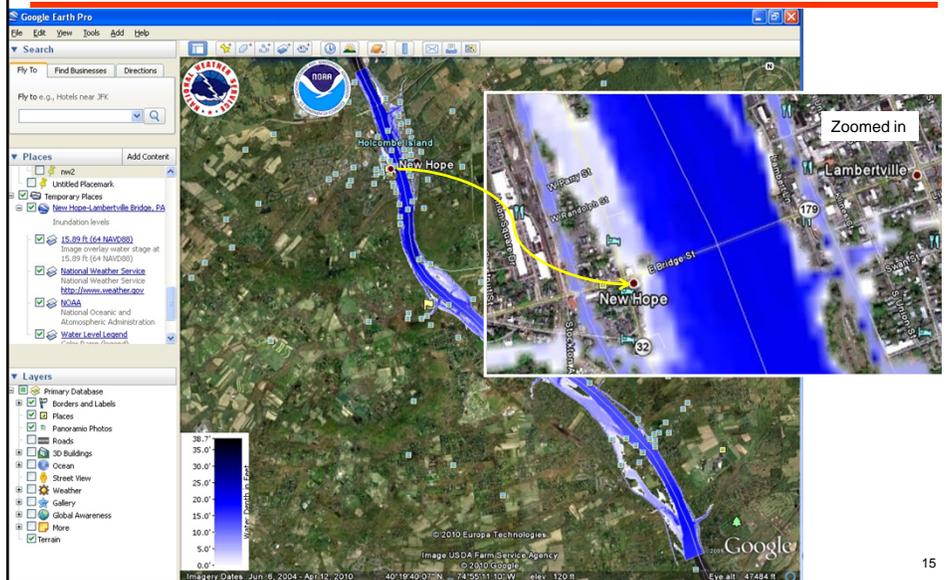


# Extracted Files - Ready To Go!





## Google Earth Inundation Depiction Stage 15.9 ft at New Hope



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## Scenario: Road Closure Decisions



Task: Identify locations that will require road closure in the next 2-4 hours.

Q. What NWS forecast point inundation map covers my area of concern?

Q. When does the hydrograph forecast flooding; what categories are forecast?

*Record assessment for future use.*

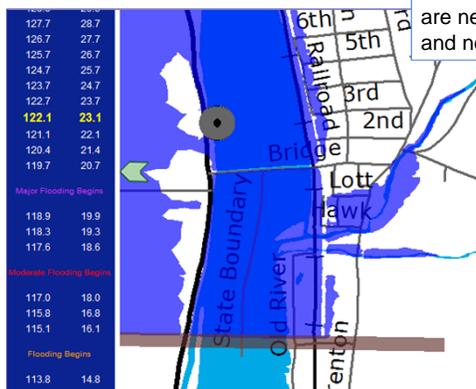
16



# AHPS Standard View Road Closures



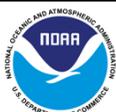
Location: Frenchtown, NJ



When the NWS forecasts Major Flooding, plans are needed for road closures along Railroad Ave. and near Hawk St. in Frenchtown, NJ.



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# Scenario: Critical Facility Risk Assessment

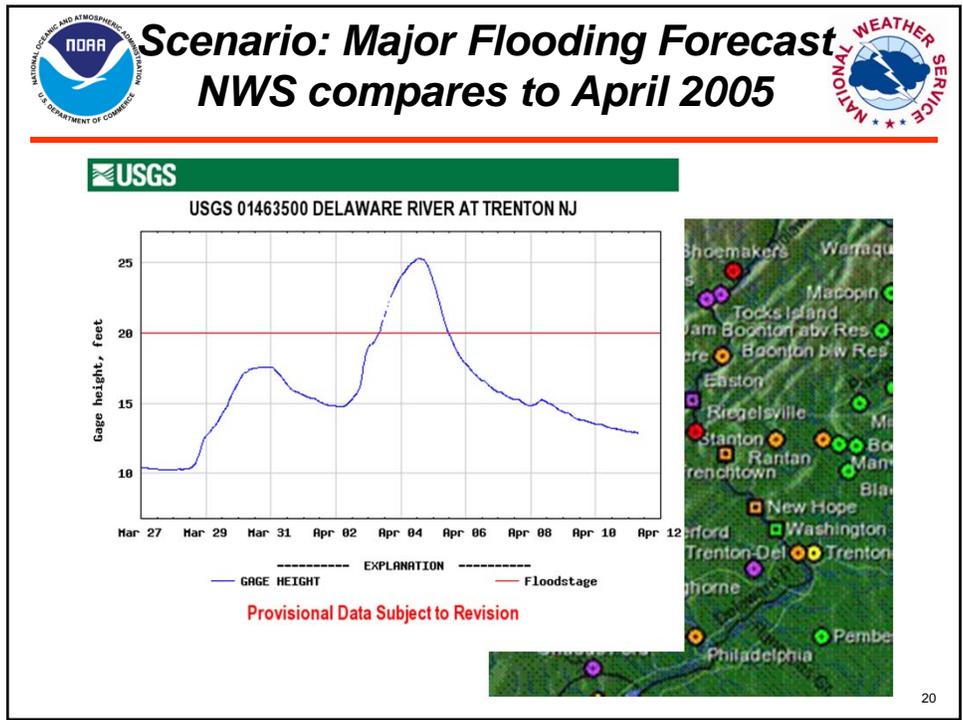
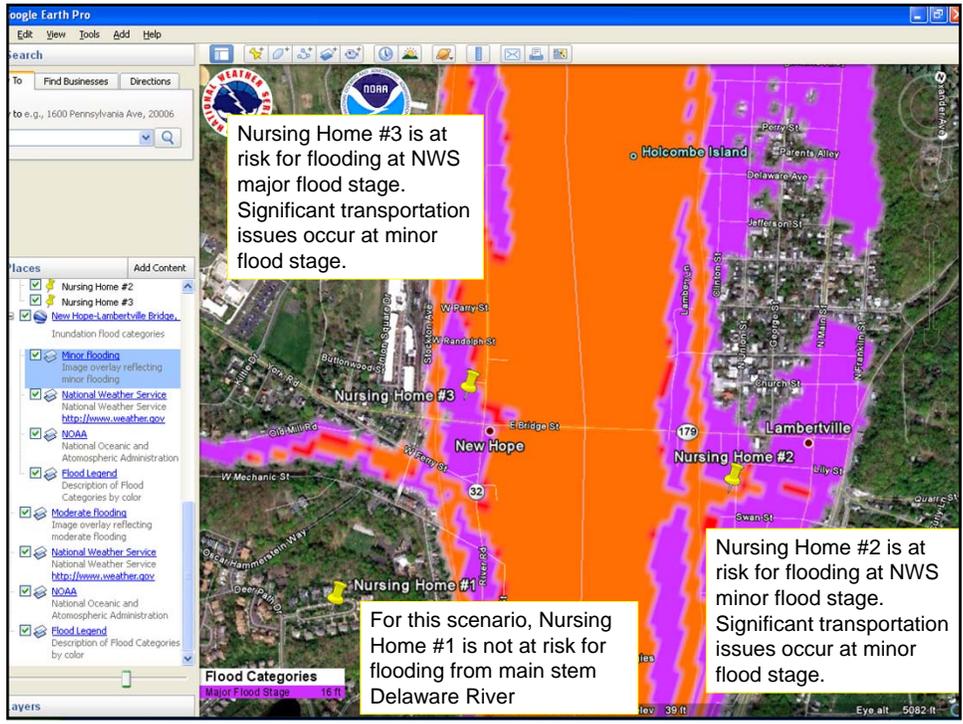


Task: Identifying nursing homes at risk for flooding in the New Hope/Lambertville area.

- Q. Where are the nursing homes?
- Q. What would minor flooding vs. major flooding look like in the vicinity of the nursing homes?
- Q. How many persons are in each facility?
- Q. If evacuations are needed, what lead time is needed for numbers/types of individuals to relocate?
- Q. What transportation routes would be available?

*Record assessment for future use.*

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## Scenario: Evacuation Decisions



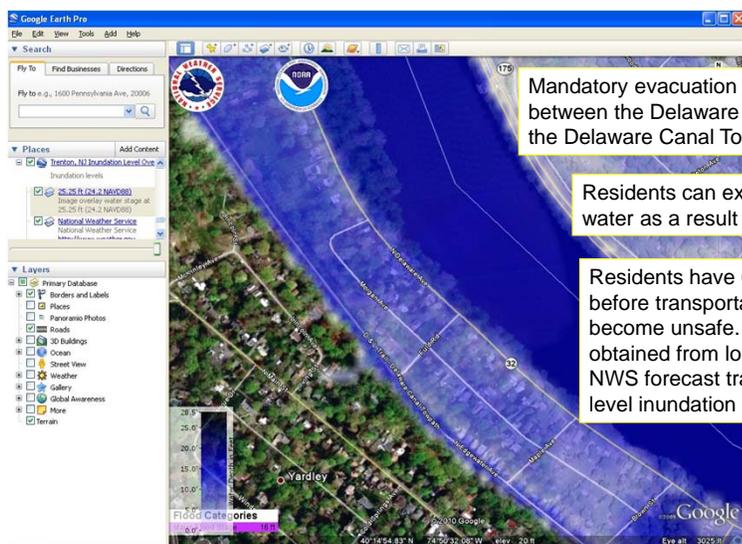
Task: Identifying neighborhoods for mandatory evacuation. Municipality: Yardley, PA

- Q. Where is inundation expected during the major flooding that is forecast?
- Q. What is the expected water depth?
- Q. What transportation routes remain dry?
- Q. How can we easily identify and communicate areas requiring evacuation?
- Q. When do we need the people to be out of the risk area?



## Google Earth Depiction

Major Flood Stage Forecast at Trenton Gage Location  
Inundation Map covers Yardley, PA



Mandatory evacuation for areas, between the Delaware River and the Delaware Canal Towpath.

Residents can expect 4-6 feet of water as a result of the flooding.

Residents have 6-8 hours before transportation routes become unsafe. (This could be obtained from looking at the NWS forecast trace and lower level inundation maps).



## AHPS Flood Inundation Mapping



- Summary
  - ✓ 5 Delaware River Locations now available
  - ✓ Last 4 Delaware River locations available late 2010/early 2011
  - ✓ Inundation maps are available in web browsers - fully integrated with other AHPS information
  - ✓ Downloads, Utilization of Maps in a wide variety of software applications
- Risk Mitigation Scenarios
  - ✓ NWS assistance available
- Future Plans

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## AHPS Flood Inundation Mapping



Thank you for spending your time with us today.

### Acknowledgement:

The NWS AHPS Flooding Inundation Maps were made possible by the partnership efforts of the USACE-Philadelphia District, DRBC, and the USGS. The NWS greatly appreciates the contributions of all parties in this effort!!

Contact information of the presenter: [laurie.hogan@noaa.gov](mailto:laurie.hogan@noaa.gov)



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