Major Delaware River Flood
Early April 2005

Presented by

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Mission statement

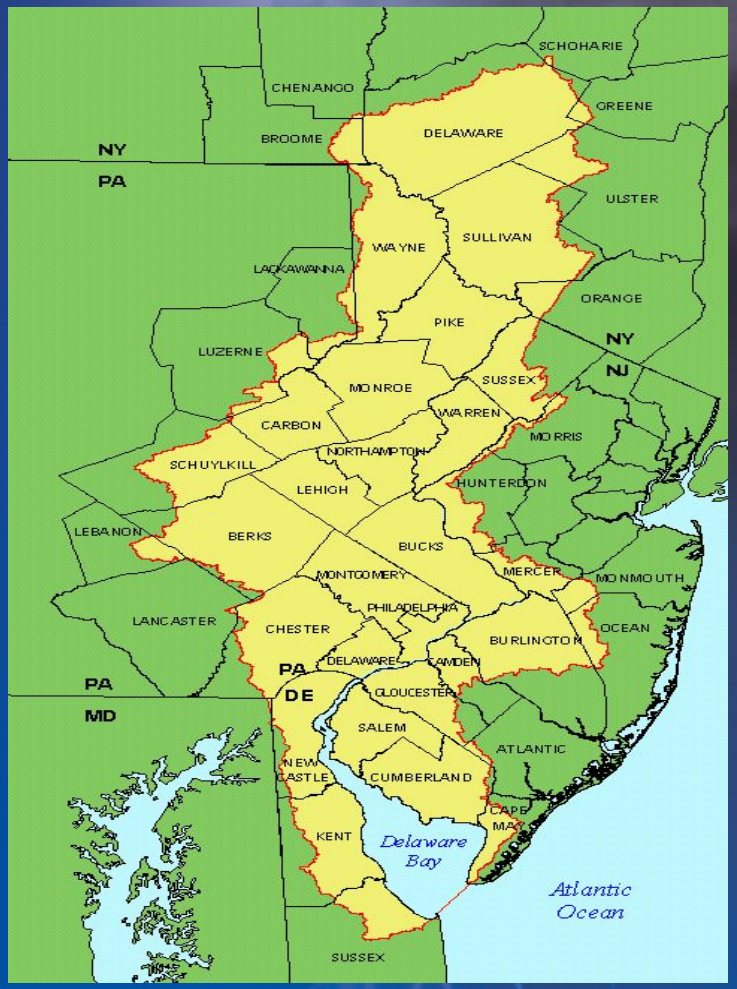
- "The **National Weather Service** (NWS) **provides** weather, **hydrologic**, and climate **forecasts and warnings** for the United States, its territories, adjacent waters and ocean areas, **for the protection of life and property** and the enhancement of the national economy. NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community."

Delaware River Basin

- Background:
- Longest un-dammed river east of the Mississippi
- Main stem 330 miles in length
- Drainage area - 13,539 square miles
- Includes PA, NY, NJ, and DE
- Provide 5% of the nations drinking water
- Provide NYC with 50% of it's drinking water
- Accessible within a short drive to 20% of the people living in the U.S.

Delaware River Basin

- Flood History:
  - ***Major Flooding recorded since 1839***
    - **Snowmelt: 1839, 1841, 1846, 1936, 1996**
    - **Severe Rainfall: 1850, 1862, 1942, 1975, 2005**
    - **Northeasters: 1869**
    - **Tropical Storms: 1933, 1938, 2001, 2004**
    - **Hurricanes: 1955, 1972, 1996, 1999**
    - **Averages about once every 8 years**



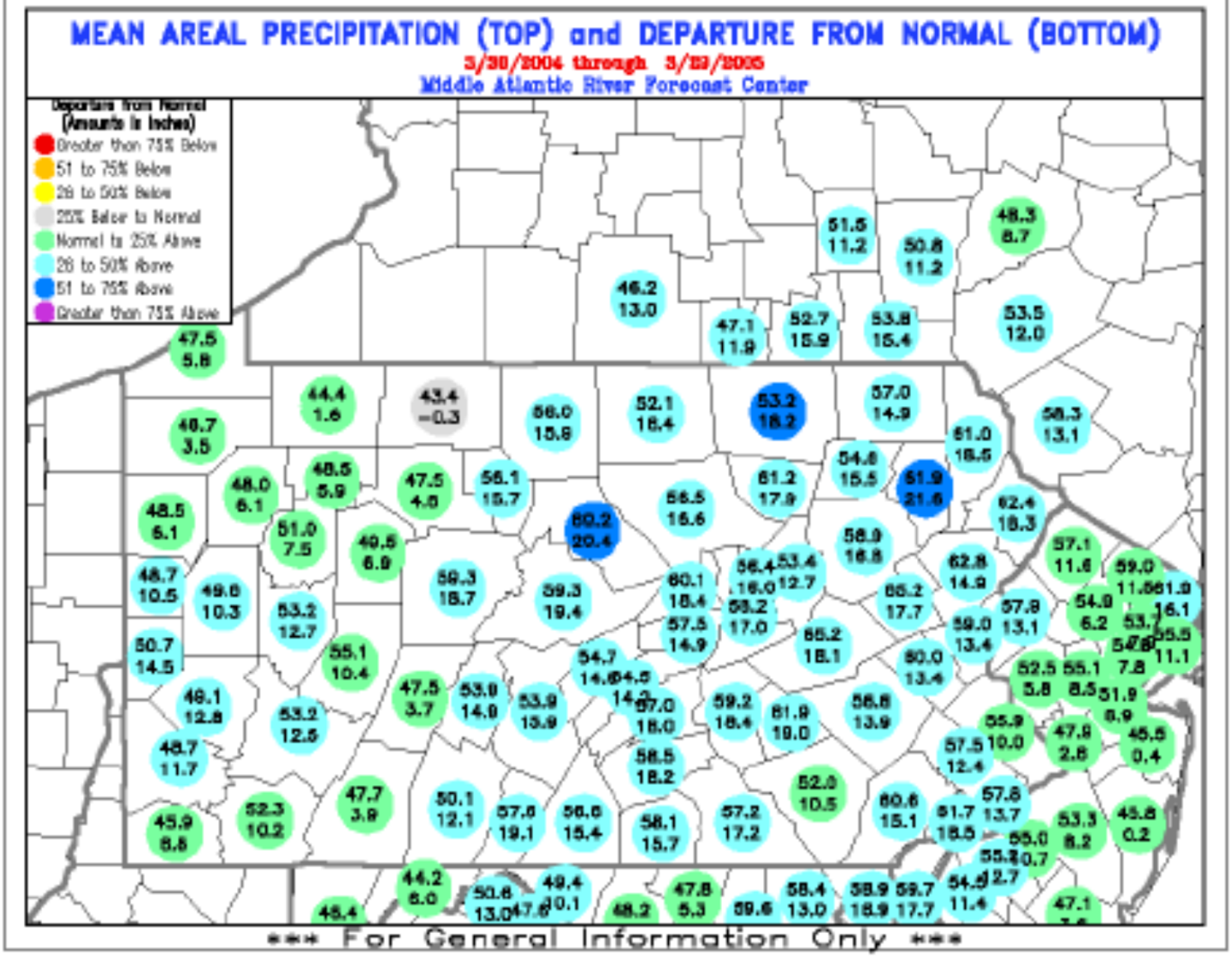
100 Year Flood (from USGS)

- Why Don't These Floods Happen Every 100 Years?
- The term "100-year flood" is misleading because it leads people to believe that it happens only once every 100 years. The truth is that an uncommonly big flood can happen any year. **There is a 1-in-100 chance that a flood this size will happen any year.**

100 Year Flood

- What Does It Take To Get One?
- Usually preceded by a wet period lasting months that “sets the stage” or an above normal snowpack.
- Often preceded a few days before by a “precursor flood event” that results in very wet soils and above normal river levels.
- Requires unusually heavy rain covering most of the river basin.

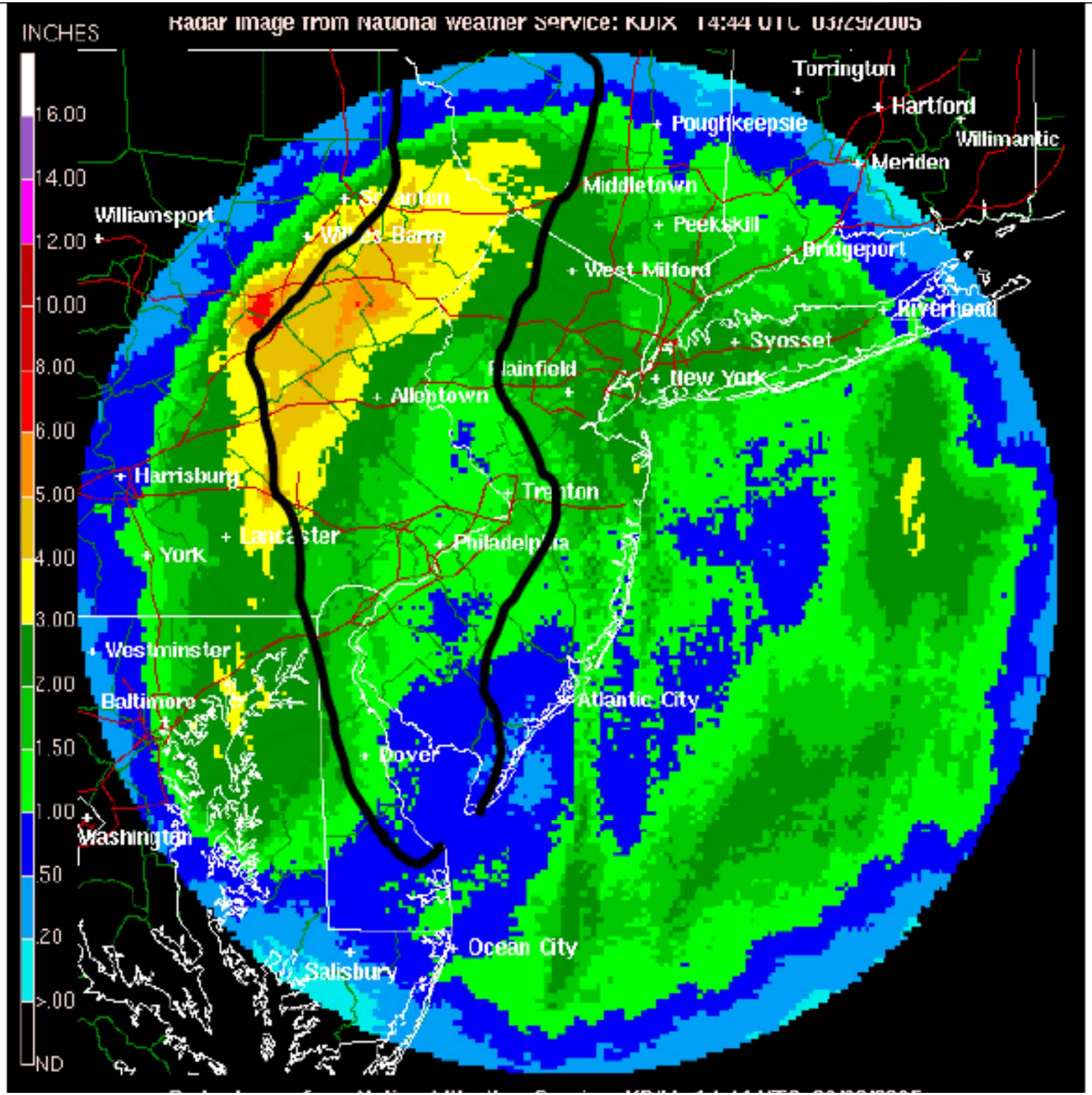
"Setting the Stage"
365 Day Precipitation Departures



Storm No.1
Lower Basin
March 28-29, 2005

Doppler Rainfall Estimate

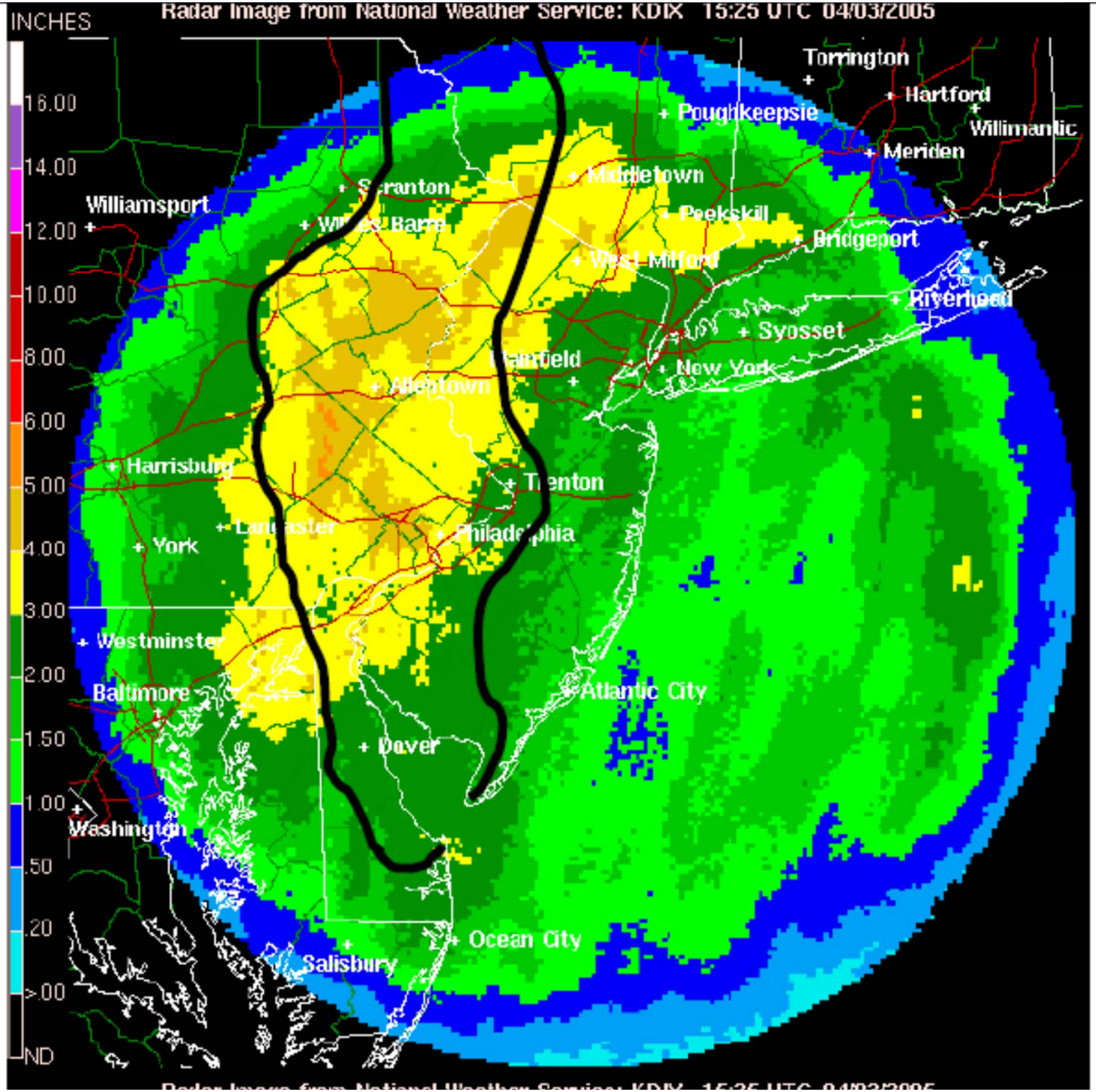
The first storm brought over two inches of rain to western and northern portions of the basin. Warm temperatures melted about half of the snowpack, which totaled over three inches water equivalent in some northern watersheds.



Storm No. 2
Lower Basin
April 2-3, 2005

Doppler Rainfall Estimate

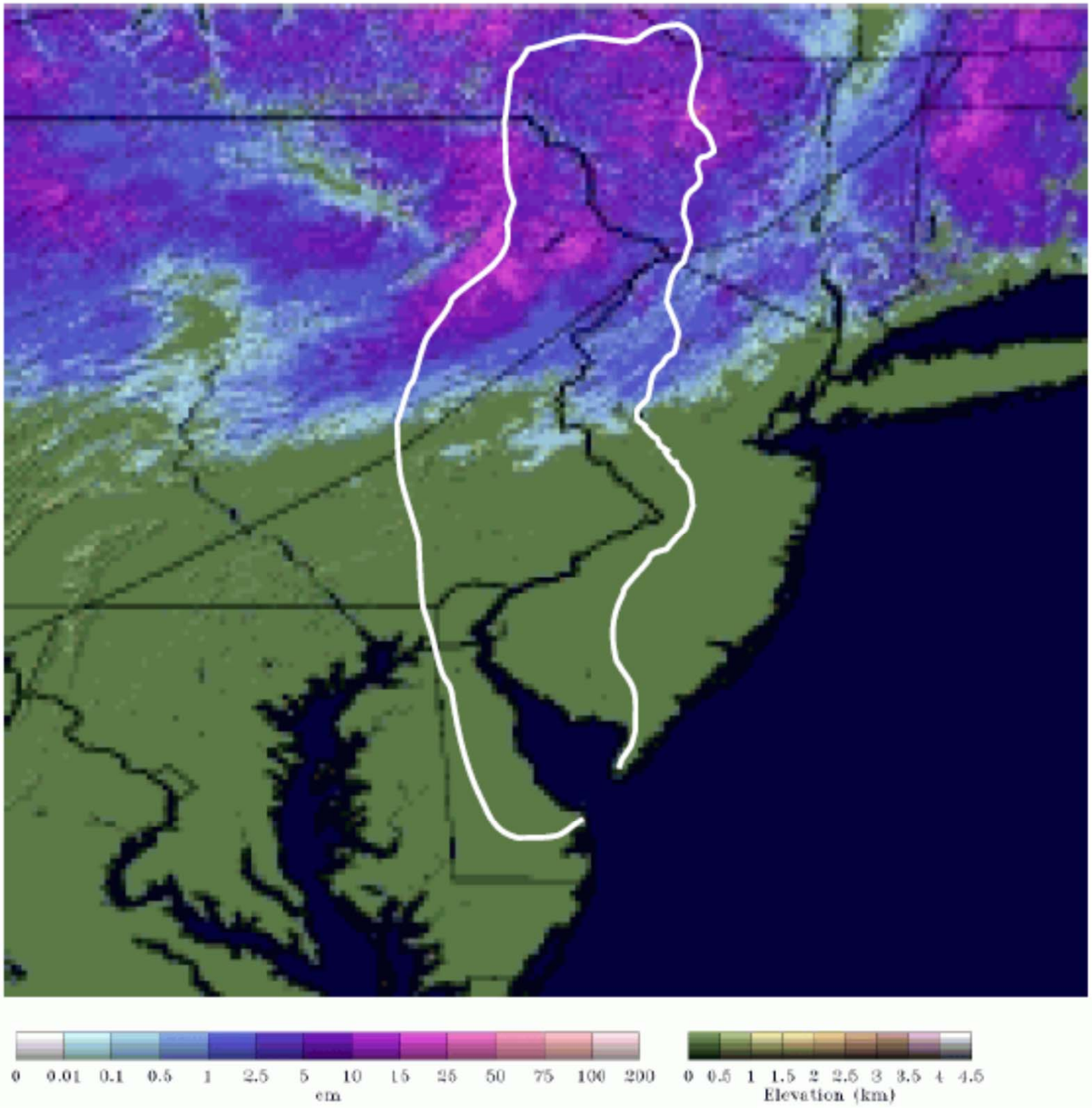
The second storm produced three- to five-inches of rain in the middle half of the basin, over two inches in the Catskill headwaters, and melted most of the remaining snow.



Snowpack Water Equivalent

March 27, 2005

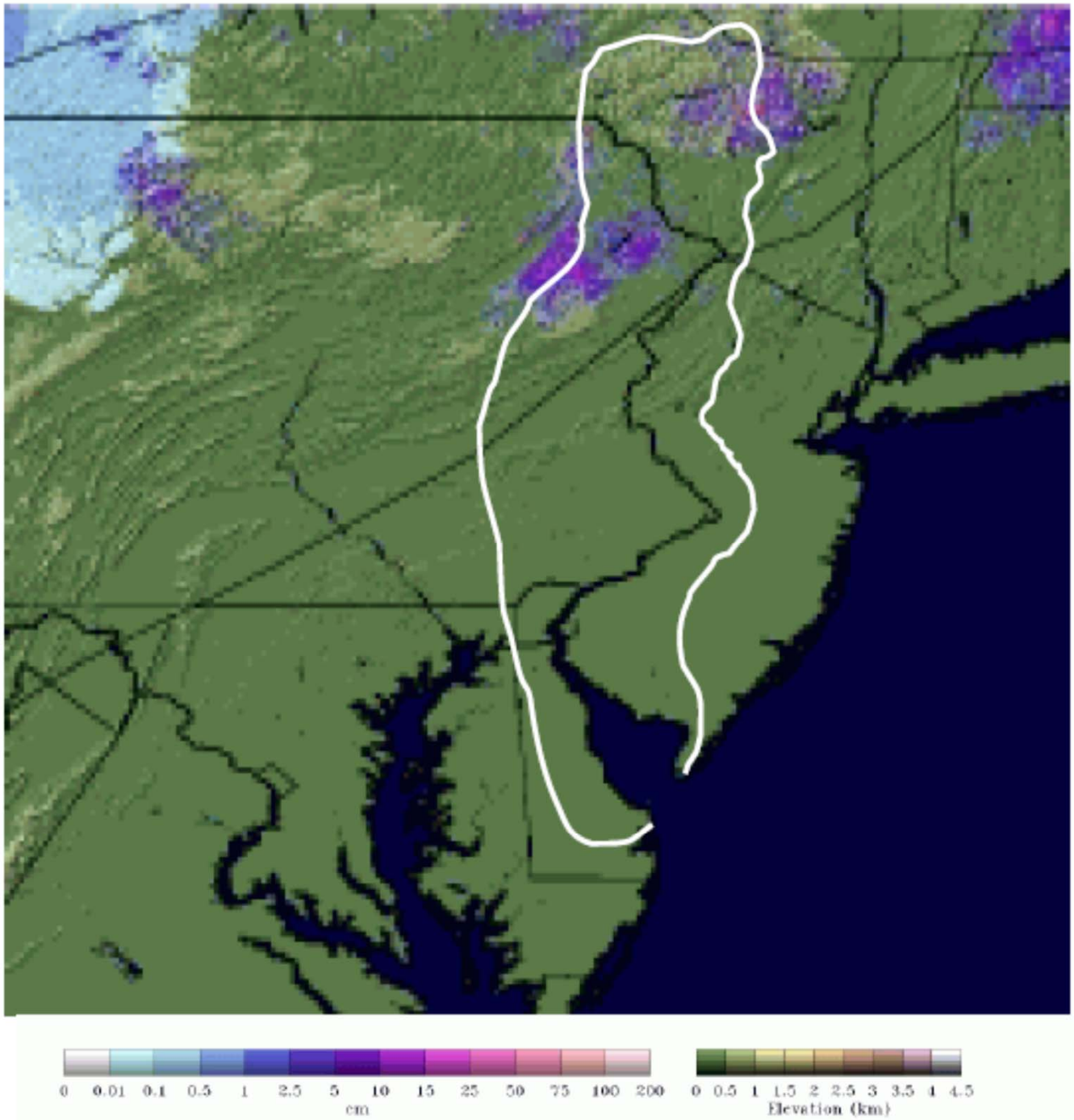
Prior to the first storm, some watersheds in the upper Delaware basin had in excess of three inches water equivalent in the snowpack.



Snowpack Water Equivalent

April 3, 2005

By the end of the second storm, most of the snowpack had melted.



Spring Flood of April 3-4, 2005

Two early spring rainstorms - the first on March 28-29 and a second on April 2-3, 2005 - combined with snowmelt to cause major flooding in the Delaware River Basin. Along the main stem of the Delaware River, the flood crests exceeded those reached in Tropical Storm Ivan only six and a half months earlier, and again caused evacuations, bridge and road closures, and extensive damage.

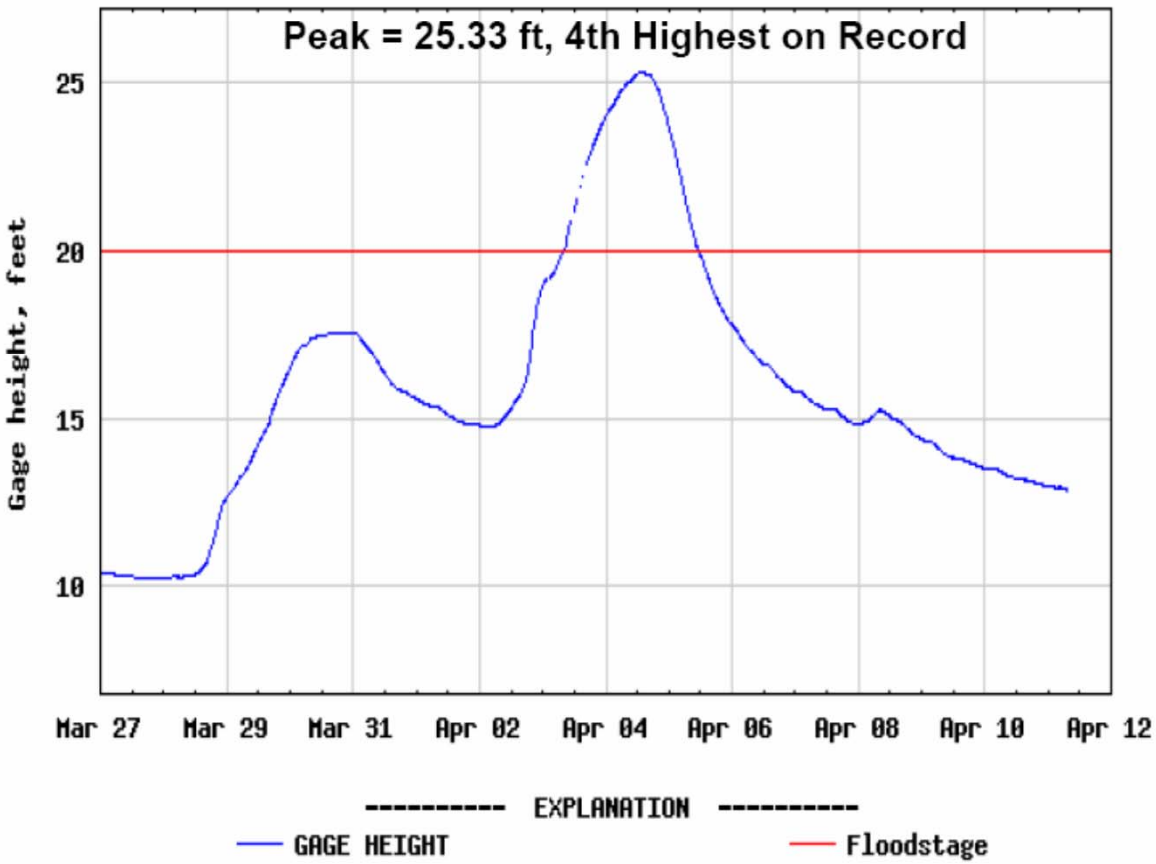
Delaware Canal at Yardley, Pa. – one half mile upstream of Afton Avenue Bridge – 8:30 am, April 4, 2005
Canal bank overtopped by Delaware River. River stage at U.S. Geological Survey (USGS) Trenton gage = 25 ft.

Flooding along the Delaware River – April 4, 2005

USGS

USGS 01463500 DELAWARE RIVER AT TRENTON NJ

6 Historical Peaks:
.6 ft on 03/08/1904
.60 ft on 08/20/1955
.50 ft on 10/11/1903
.33 ft on 04/04/2005
.43 ft on 03/19/1936
.39 ft on 09/19/2004



Provisional Data Subject to Revision

How could I have known a flood was coming?

- **Outlook statement issued on Wednesday, March 30th stating flooding was possible.**
- **Flood Watch issued on Thursday, March 31st**
  - ***Updated on Friday, April 1st for potential major flooding.***
- **First flood warning issued at 346 PM Saturday, April 2nd for major river flooding along Delaware River.**
  - ***River crested at Trenton on Monday April 4th***

Three days before

YDROLOGIC OUTLOOK

ATIONAL WEATHER SERVICE MOUNT HOLLY NJ

00 PM EST WED MAR 30 2005

NOTHER ROUND OF HEAVY RAIN IS POSSIBLE FRIDAY NIGHT INTO SATURDAY...

ERE IS STILL SOME UNCERTAINTY AS TO THE EXACT AMOUNT OF RAINFALL THAT WILL OCCUR ACROSS THE REGION. AT THIS TIME...IT APPEARS THAT 1 INCH OF RAINFALL IS POSSIBLE WITH AMOUNTS AS HIGH AS 2 INCHES...DEPENDING ON THE TRACK AND STRENGTH OF THE LOW.

ANY LOCATIONS RECEIVED BETWEEN 1 AND 2 INCHES OF RAIN EARLIER THIS WEEK AND ANY NEW RAINFALL WILL INCREASE THE FLOOD THREAT.

MEROUS STREAMS AND CREEKS EXPERIENCED FLOODING WITH THE PAST SYSTEM AND WHILE MOST CREEKS AND STREAMS ARE CRESTING OR ALREADY FALLING...THEY WILL REMAIN HIGH THROUGH THE END OF THE WEEK.

AY TUNED TO NOAA WEATHER RADIO OR OTHER LOCAL MEDIA FOR FURTHER UPDATES ON THIS DEVELOPING SITUATION. IT IS POSSIBLE THAT A FLOOD WATCH MAY BE iSSUED AT A LATER TIME.

Two days before

FLOOD WATCH

NATIONAL WEATHER SERVICE MOUNT HOLLY NJ

252 PM EST THU MAR 31 2005

.FLOOD WATCH IN EFFECT FROM FRIDAY EVENING TO SUNDAY MORNING...

RAINFALL AMOUNTS IN EXCESS OF TWO INCHES ARE POSSIBLE FRIDAY NIGHT INTO SATURDAY OVER AT LEAST PORTIONS OF EASTERN PENNSYLVANIA, NORTHERN, CENTRAL AND SOUTHWESTERN NEW JERSEY, NORTHERN DELAWARE AND FAR NORTHEASTERN MARYLAND. THOSE AMOUNTS WOULD CAUSE WIDESPREAD FLOODING

OF MANY OF THE AREA'S STREAMS, WITH SOME STREAMS NOT HAVING MUCH TIME TO RECOVER FROM LAST IONDAY'S RAINS BEFORE RISING AGAIN. IF YOU LIVE IN A LOCATION THAT IS PRONE TO FLOODING, PAY PECIAL ATTENTION TO SUBSEQUENT WEATHER FCRECASTS. IN ADDITION TO STREAM FLOODING, THERE IAY WELL BE URBAN AND POOR DRAINAGE FLOODING DURING TIMES OF THE HEAVIEST RAINFALL. THE ATIONAL WEATHER SERVICE WILL CONTINUE TO MONITOR THIS SITUATION, AND ADDITIONAL STATEMENTS ND WARNINGS WILL BE ISSUED IF NEEDED.

24 hours before

- BULLETIN
- FLOOD WARNING
- NATIONAL WEATHER SERVICE MT HOLLY NJ
- 346 PM EST SAT APR 02 2005

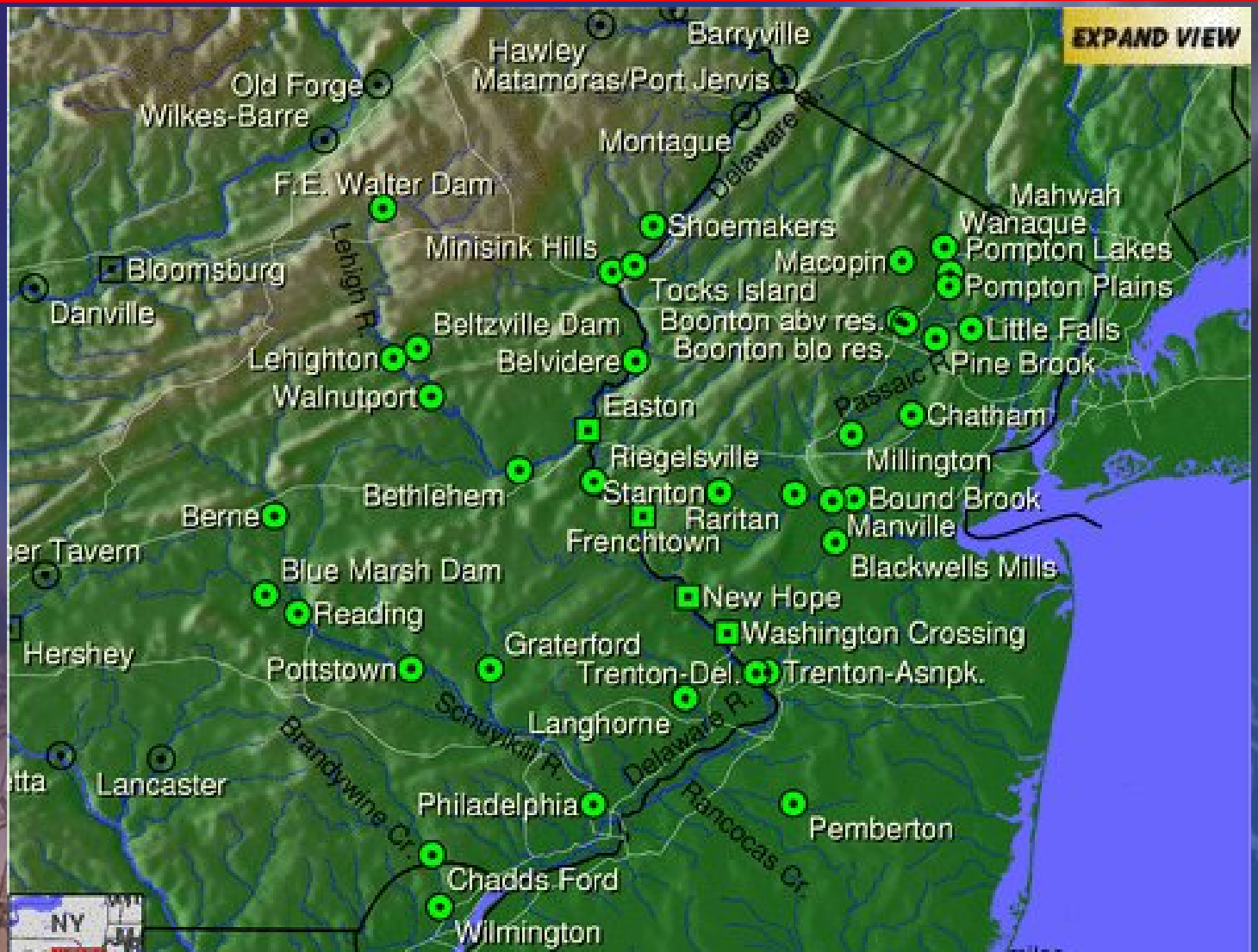
...THE NATIONAL WEATHER SERVICE HAS ISSUED A FLOOD WARNING FOR...THE DELAWARE RIVER AT TOCKS ISLAND...BELVIDERE...EASTON PHILLIPSBURG BRIDGE...RIEGELSVILLE...FRENCHTOWN...STOCKTON...NEW HOPE BRIDGE... WASHINGTON CROSSING...TRENTON.

- **...MAJOR FLOODING IS FORECAST FOR THE DELAWARE RIVER...**

* TRENTON ON THE DELAWARE RIVER...

FOR THE DELAWARE RIVER AT TRENTON THE LATEST STAGE WAS 15.6 FEET RISING AT 3PM SATURDAY. THE DELAWARE RIVER AT TRENTON IS FORECAST TO RISE ABOVE FLOOD STAGE BY TOMORROW LATE MORNING AND CONTINUE TO RISE TO NEAR 24.2 FEET BY EARLY MONDAY MORNING.
AT 22.0 FEET, WATER BEGINS ENTERING PARKING GARAGE AT STATE CAPITOL BUILDING.
THIS CREST COMPARES TO A PREVIOUS FLOOD CREST OF 22.2 FEET ON JAN 21 1996.

AHPS – Mt. Holly service area



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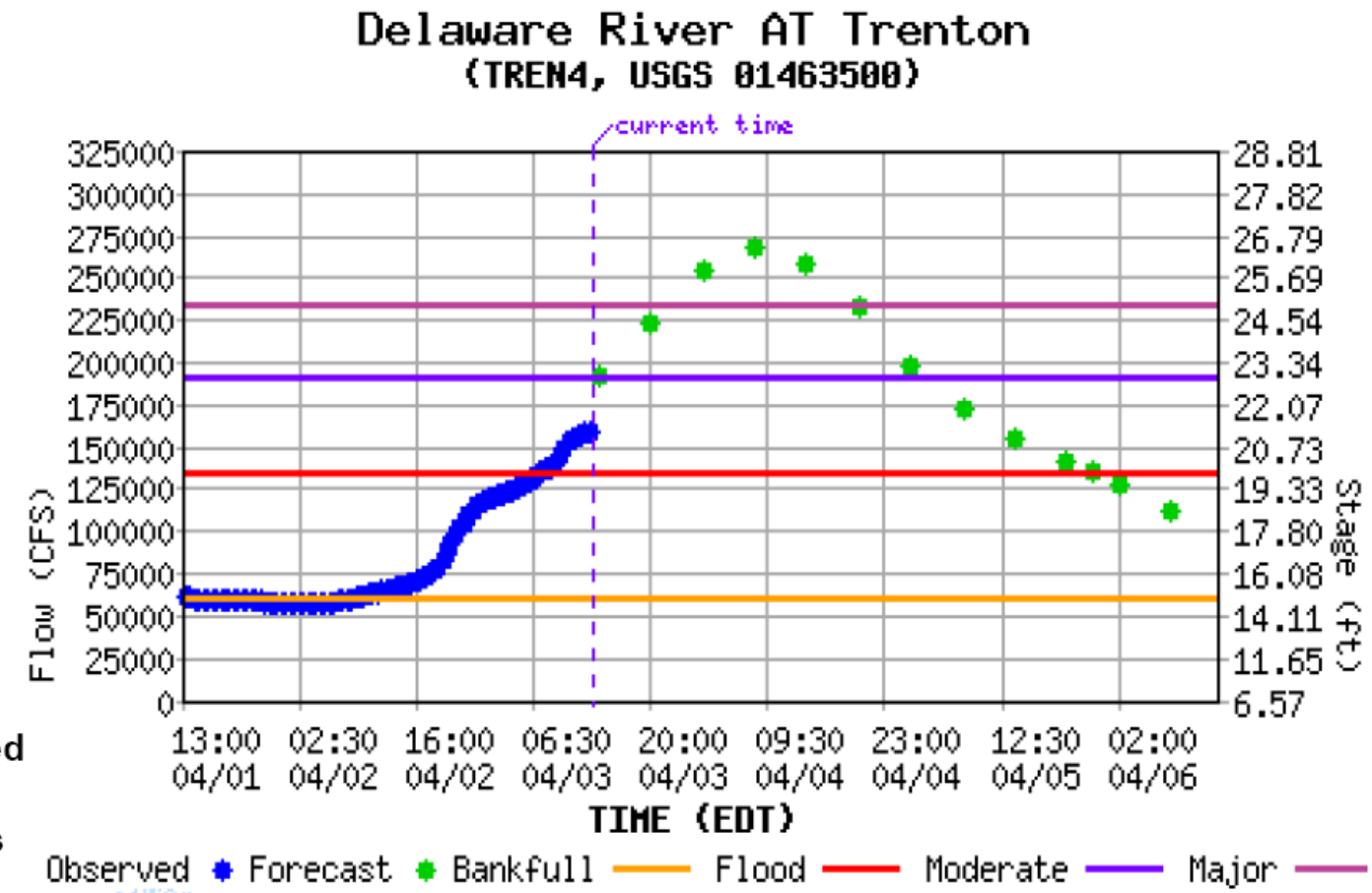


Latest: 21.29 ft 160306 CFS (117% of flood flow) [13:15 04/03]
Max: 21.29ft (160306 CFS) Max Fcst: 26.50ft (268391 CFS)
Min: 14.75ft (57748 CFS) Min Fcst: 18.60ft (112754 CFS)
Forecast data shown are guidance only
See your local NWS for the official river forecast

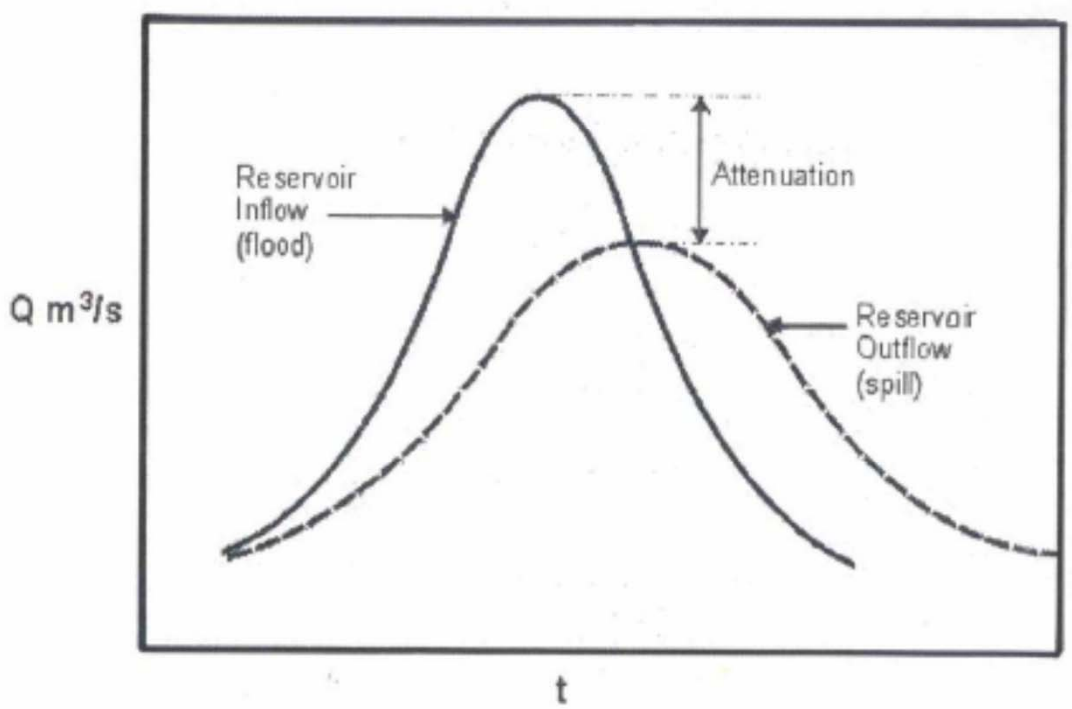
Tabular Data

Urban legend – Reservoirs caused flooding

- **FACT: Because of the heavy rainfall and previously wet conditions, many reservoirs were full (or nearly so) and 'spilled' water during this event.**
- **Even though they spilled water, they helped lessen the effects of the flooding**
  - ***How can this be true?***

eservoir Attenuation

- **Reservoirs provide attenuation even when full.**

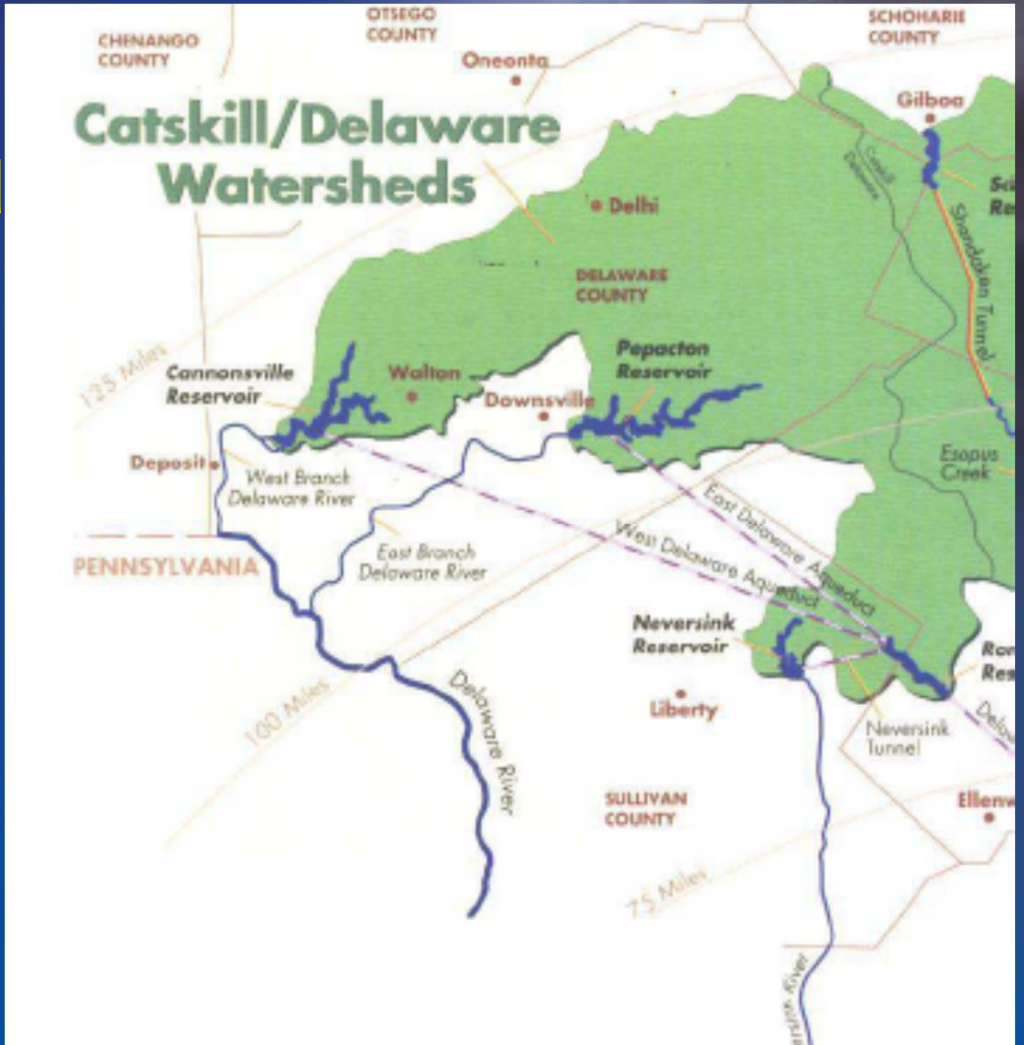


From " *A Review of the Role of Dams in Flood Mitigation*", a paper submitted to the World Commission on Dams

Model simulation

Asked to provide a rough estimate of the impact on flood crests due to the existence of the following four reservoirs….

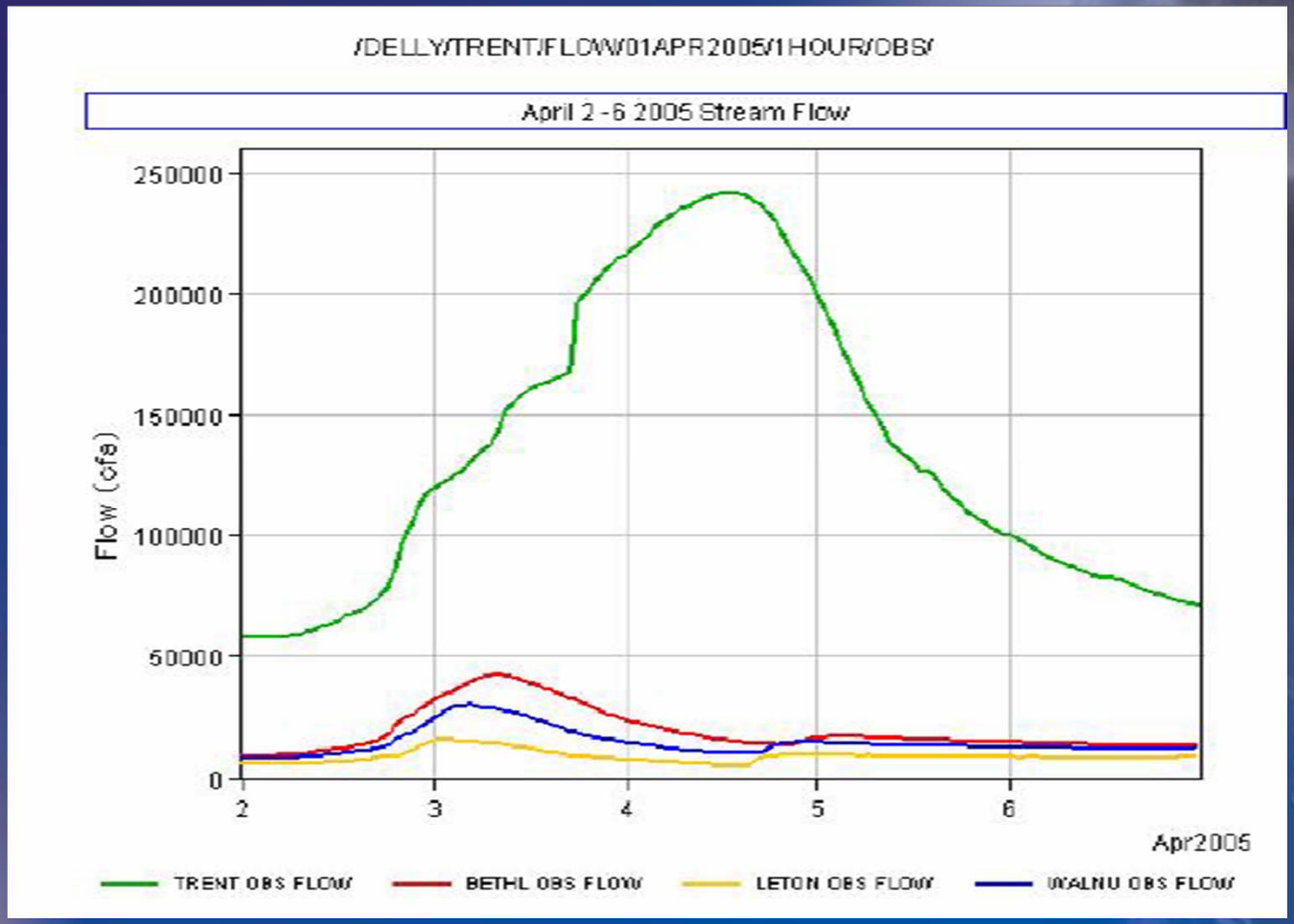
- ***Cannonsville***
- ***Pepacton***
- ***Neversink***
- ***Wallenpaupack***



Model Simulation Results

- **For this event, our simulations indicate that even though these dams spilled, crest levels would probably have been higher if the four dams did not exist.**
- ***– Lower Delaware…0.5 to 1.5 foot higher crests without dams***
- ***– Upper Delaware…1.0 to 2.5 foot higher crests without dams***

Reality –
Reservoirs help minimize floods



ee that tiny curve upward on the bottom three lines on pril 4th – that was the water release from FE Walter

Urban Legend #2

- Excessive urbanization and land development caused the major river flooding in September 2004 and April 2005 along the Delaware River
- There is an interesting meteorological angle to this…
- But first, let's go to the satellite imagery
  - *Courtesy of maps.google.com*

Search Help

Why did it flood on April 3-4, 2005?

- **The stage was set by heavy rainfall on March 28 and 29th**
  - ***Afterward, streams were running high, reservoirs were full.***
- **More very heavy rainfall occurred on April 2nd and 3rd**
  - ***There was extensive snowmelt over northern portions of the Delaware River basin***
  - ***Vegetation was still dormant***
  - ***Ground was either saturated or still frozen (north); so it sort of behaved like pavement***

Contact information

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Cell 609-320-7205

Internet website

- ***Weather.gov/phi***
  - **Mt. Holly weather office web page; we average over a million web hits a day, come join the crowd.**
- ***Weather.gov/ahps***
  - **Advanced Hydrologic Prediction System web page**

NOAA Weather radio

The End