Flood Warning Improvement Recommendations for the Delaware River Basin

Delaware River Basin Flood Task Force Action Plan

Prepared by NOAA/National Weather Service – Eastern Division
In Cooperation With
The United States Geological Survey
and the
Delaware River Basin Commission

Delaware River Basin Interstate Flood Mitigation Task Force Report
July 2007

Contains 45 recommendations on preparing, responding to,
and recovering from flooding

14 recommendation focus on river forecasting and flood warning

Recommendations Addressed

FW 1.1 - Develop a Comprehensive Inventory of Precipitation Observing Stations in the Delaware River Basin

FW 2 - Evaluate and Upgrade River Gage Network

FW 7.2 - Evaluate the Need for New Forecast Points in the Basin

Interstate Task Force Recommendations

FW-1.1	Inventory and Evaluation of NWS Precipitation Observing Network (NWS) – Complete - (FY08 Funding)
FW -1.2	Evaluate non NWS used gages for inclusion into above network (NWS) – Targeted for any FY09 grant funding.
FW-2	Evaluation of Stream Gaging Network (NWS) - Complete (FY08 Funding)
FW-3	Extend Rating Tables - Begun (USGS) - FY10 grant funding will enable continuation and expansion of effort.
FW-4	Flood Harden Gages (USGS) - Begun with FY08 funding. FY09 grant funding will enable continuation of effort.
FW-5	Improve Flash Flood Forecasting – NWS Binghamton continuing to develop and test procedures for finer delineation of flood and flash flood warnings. Targeted to continue with FY09 funding.

Interstate Task Force Recommendations (cont.)

FW-7.1 Establish flood stages and impacts for potential flood forecast points equipped with real time telemetry. Targeted with FY09 grant funding.

FW-7.2 Evaluate the need for new forecast points and upgraded services at existing forecast points. Complete - (FY08 funding)

FW - 9 Develop Flood Inundation Maps - 9 sites targeted with FY08 funding. Awaiting libraries for 8 locations. Work on first site (Trenton) undergoing process evaluation.

FW-10 High Hazard Dam Emergency Action Plan Documentation (DRBC). Targeted with FY09 grant funds.

FW-11 Education and Outreach Program (DRBC). Targeted with FY09 grant funding.

FW-13 Ice Condition Monitoring and Communications Plan. Continuing with FY09 funding.

Summary of Gages and Major Gaging Networks Located in Basin (FW 1.1)

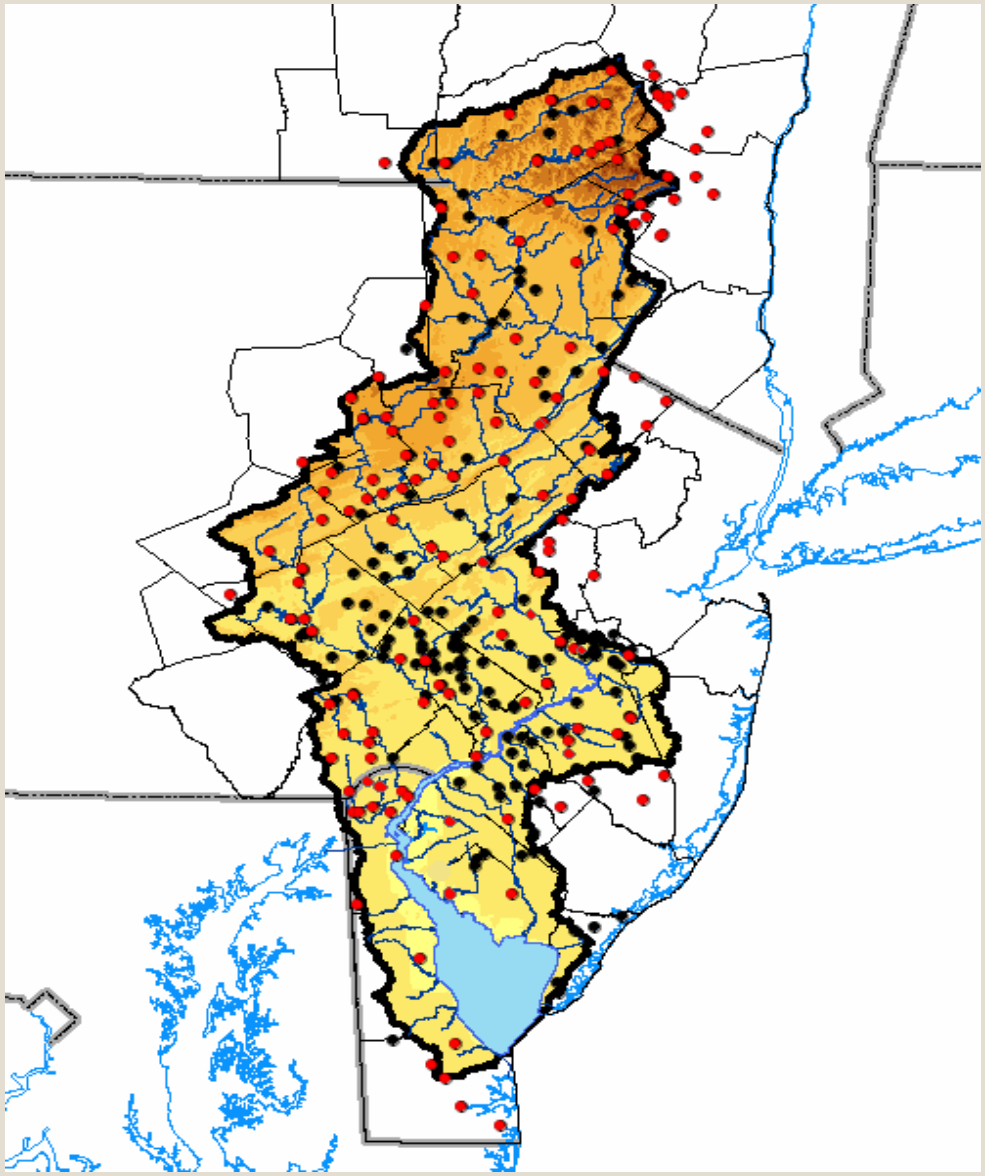
Precipitation

Automated Surface Observing Systems (ASOS) – 37
Integrated Flood Observing and Warning System (IFLOWS) – 59
NWS Cooperative Observer Program – 38
Community Collaborative Rain, Hail and Snow Network (COCORAHS) – 117
United State Geological Survey – 32
US Army Corps of Engineers - 7
Delaware Environmental Observing System (DEOS) - 7
New York City DEP - 38

Automated Snow Pillow Monitors - 2

Location of All Precipitation Gages Used by the National Weather Service

- Hourly Reporting Station
- Daily Reporting Station



Data Source: National Weather Service

Stream Gages (FW 2)

USGS Real Time Stream Discharge – 166

Stage Only Stream Gages – 6

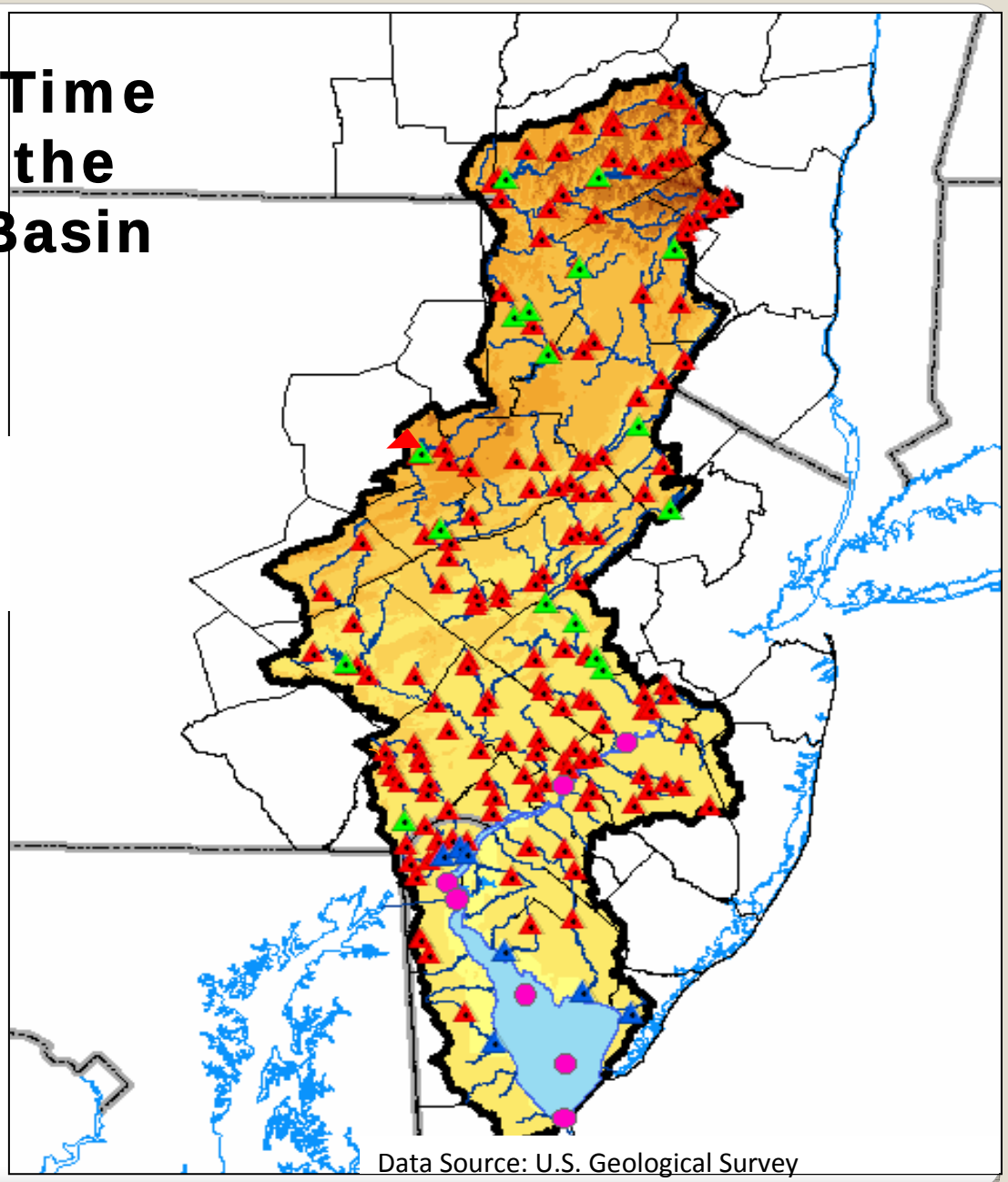
Lake Level – 10

Tide Gages – 14

- USGS Station Identification Number
- Station Name
- NOAA Handbook 5 ID Code
- State
- County
- Stream Name
- Latitude
- Longitude
- Gage Datum
- Datum Reference
- Drainage Area at Station
- Indication whether site is a Flood Forecast Point (Yes or No) Type of Flood Forecast Point (River or Site Specific)
- Flood Stage if known
- URL Address for Real Time Information from USGS
- URL for NOAA AHPS Real Time Information (If a flood forecast point)
- Type of Telemetry
- Type of Gage (Discharge or Stage)
- Reporting Interval (1-Hour, or 4-Hour)
- Period of Record
- Number of Years of Record
- Funding Source

Location of Real Time Stream Gages in the Delaware River Basin

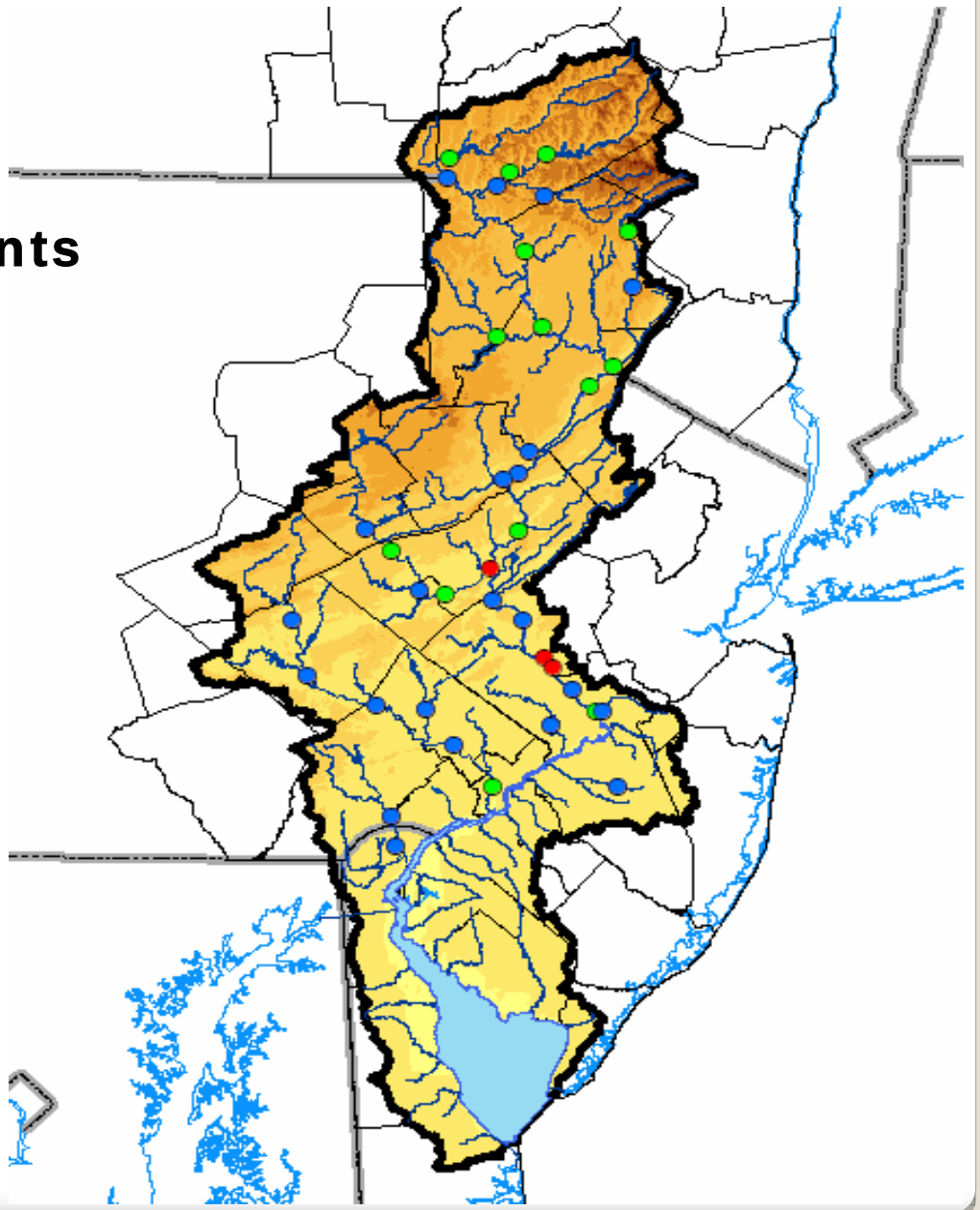
- Real Time Flow
- Real Time Stage or Lake Level
- Auto Tide (USGS)
- Auto Tide (NOS)



Data Source: U.S. Geological Survey

River Flood Forecast Points in the Delaware River Basin as of June 2009

- Crest Only Point
- Flood Only Point
- Daily Point



Four Groups of 44 Separate Improvements and Recommendations Identified

Precipitation Network Improvements (FW 1.1)

Stream Gaging Network Improvements (FW 2)

Forecast Point Recommendations (FW 7.2)

General

Figure D-1: Recommended Flood Forecast Improvements
Upper Delaware River Basin

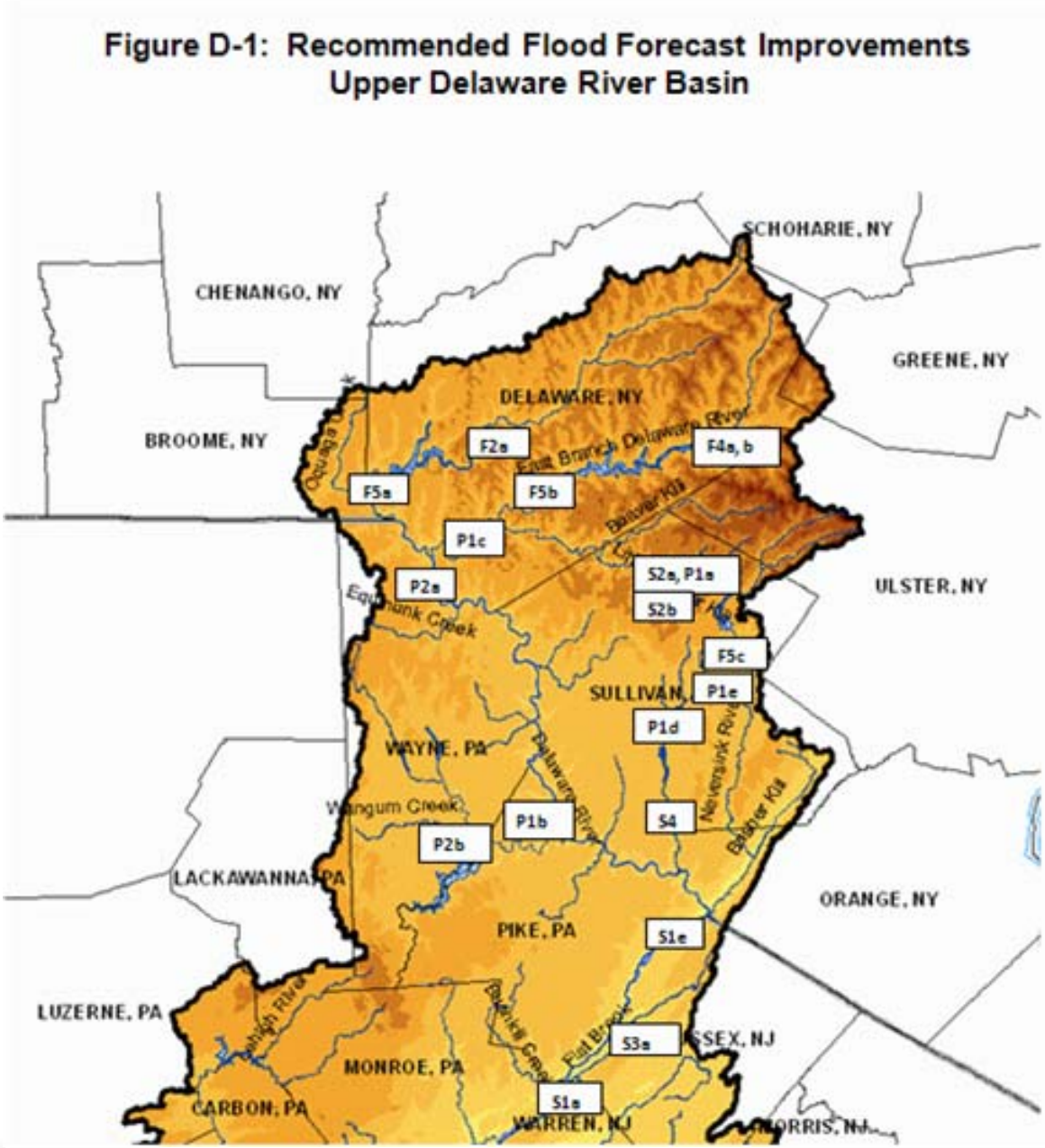
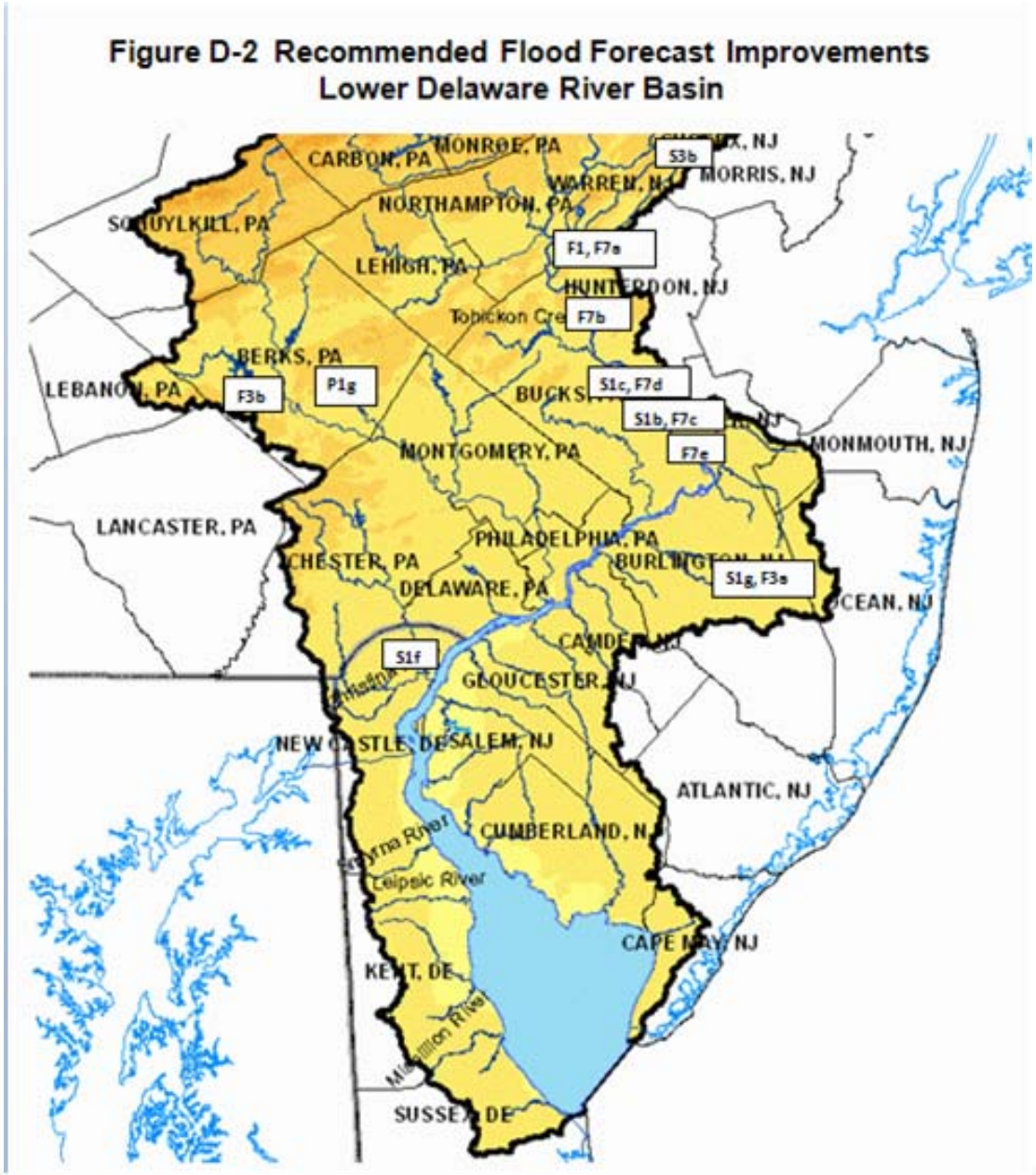


Figure D-2 Recommended Flood Forecast Improvements
Lower Delaware River Basin



Index of Recommended Flood Forecast Improvements for the Delaware River Basin

Precipitation Gages

P1a	New precipitation gage – Willowemoc Watershed in the Livingston Manor, NY vicinity
P1b	New precipitation gage – Delaware River above Lackawaxen River near Barryville, PA
P1c	New precipitation gage – Delaware River at Fishs Eddy, NY
P1d	New precipitation gage – Mongaup River at Mongaup Valley, NY
P1e	New precipitation gage – Neversink River at Bridgeville, NY
P1f	New Precipitation gage – Neshaminy Creek at Rushland or Penns Park. PA
P1g	New Precipitation gage – Manatawny Creek near Spangsville, PA
P2a	Automated Snow Monitor – Equinunk vicinity, PA
P2b	Automated Snow Monitor – Hawley vicinity, PA

Stream Gages

S1a	Extend and maintain rating curve – Delaware River at Tocks Island/Delaware Water Gap
S1b	Extend and maintain rating curve – Delaware River at New Hope/Lambertville, NJ
S1c	Extend and maintain rating curve – Delaware River at Stockton, NJ
S1d	Extend and maintain rating curve – Delaware River at Reigelsville, NJ
S1e	Extend and maintain rating curve – Delaware River at Montague, NJ
S1f	Extend and maintain rating curve – Brandywine Creek at Wilmington, DE
S1g	Extend and maintain rating curve – North Branch Rancocas Creek at Pemberton, NJ
S2a	Install new stream gage – Willowemoc Creek near Livingston Manor, NY
S2b	Install new stream gage – Little Beaver Kill near Livingston Manor, NY
S3a	Flood hardening – Flat Brook, NJ
S3b	Flood hardening – Musconetcong River at outlet to Lake Hopatcong, NJ
S4	Re-activate stream gage on Mongaup river downstream of Rio Reservoir

Flood Forecast Points

F1	Convert from crest only to flood only forecast point – Delaware River at Easton/Phillipsburg
F2a	Establish a River Flood Forecast Point - West Branch Delaware River at Walton, NY
F2b	Establish a River Flood Forecast Point - Neversink River at Goddefroy, NY
F3a	Extend forecasting from 48 to 72 hours – North Branch Rancocas Ck. At Pemberton, NJ
F3b	Extend forecasting from 48 to 72 hours – Schuylkill River at Reading, PA
F4a	Establish site specific flood forecast point - East Branch Delaware River at Margarettville, NY
F4b	Establish site specific flood forecast point – Dry Brook at Arkville, NY

Table D-1: Index of Recommended Flood Forecast Improvements for the Delaware River Basin

Flood Forecast Points (Continued)

F5a	Evaluate Stage vs. Flood Impact - West Branch Delaware upstream of Hale Eddy
F5b	Evaluate Stage vs. Flood Impact - East Branch Delaware upstream of Harvard
F5c	Evaluate Stage vs. Flood Impact – Neversink River upstream of Bridgeville
F6	Develop Implementation Plan for SSHP. Include small watersheds throughout the basin in the evaluation
F7a	Evaluate for probability forecasting – Delaware River at Easton/Phillipsburg
F7b	Evaluate for probability forecasting – Delaware River at Frenchtown
F7c	Evaluate for probability forecasting – Delaware River at New Hope/Lambertville
F7d	Evaluate for probability forecasting – Delaware River at Stockton, NJ
F7e	Evaluate for probability forecasting – Delaware River at Washington's Crossing, PA

General Recommendations

G1	Update and maintain the gage and flood forecast point inventories and GIS on an annual basis.
G2	Develop public information documenting steps and considerations for establishing flood forecast points.
G3	Expand ice observation network
G4	Continue work to increase stream gage reporting frequency from 4 hours to 1 hour. Maintain existing telephone capabilities.
G5	Continue work to extend forecast to 72 hours for all river flood forecast points.
G6	Continue development of probability based ensemble forecasting.
G7	Continue development of distributed hydrologic modeling for application to small streams.

Precipitation Network

- 7 new observing sites recommended to improve real time watershed monitoring
- 2 new snow pillows/automated snow water equivalent monitors for snowmelt modeling

Stream Gage Network

- Develop and maintain full rating curves at 7 high priority forecast sites to improve forecast accuracy
- New stream gages at 2 locations
- Flood harden 2 high priority sites to improve reliability during floods
- Reactivate gage downstream of Rio Reservoir to improve main stem forecasts

Forecast Point Recommendations

Seven recommendations impacting 15 sites including:

- Forecast frequency upgrades
- 2 new river forecast points
- Extending forecasts from 48 to 72 hours at 2 sites
- Develop site specific forecasts for fast responding locations
- Additional flood impact documentation at three sites
- Evaluating the development of probability forecasts at 5 sites

General Recommendations

- Yearly update of gage inventory

- Development of public information brochure or web page on considerations and steps in establishing flood warning points and warning services

- Continue building on existing ice jam reporting network

- Increase reporting frequency of stream gages that report greater than once an hour

- Examine increasing forecasts to 72 hours at all forecast points

- Continue development of probability based forecasts for water resource management

- Continue development and advances in distributed hydrologic modeling to provide capacity to issue flood forecasts for small fast responding basins

What Has Been Accomplished?

Precipitation and stream gage inventories completed and current as of June 2009

Several of the larger more general Interstate 2007 Report recommendations broken down into smaller location specific addressable tasks for action

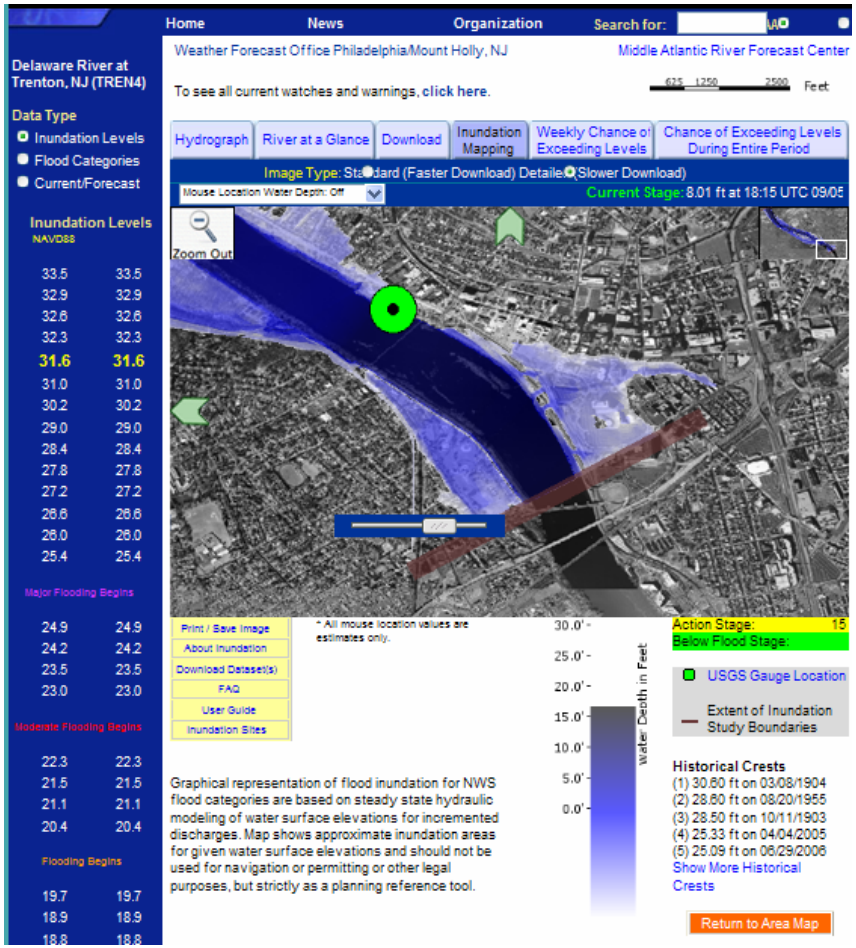
Some of tasks recently addressed:

- Crest only to flood only forecasts at 4 locations
- New forecast point at Walton NY
- AHPS probability forecasts added to 4 of 5 recommended sites
- Increase in stream gage DCP reporting frequency to one hour at all NJ basin sites
- River forecasts extended from 48 to 72 hours at 9 forecast points.

Delaware River

Select the points:

- [ ] All
- [ ] at Callicoon
- [ ] at Barryville
- [x] at Matamoras/Port Jervis
- [x] at Montague
- [ ] at Tocks Island
- [x] at Belvidere
- [x] at Easton
- [x] at Riegelsville
- [x] at Frenchtown
- [x] at Stockton
- [x] at New Hope-Lambertville Bridge
- [ ] at Washington Crossing
- [x] at Trenton
- [ ] at Pier 12 Philadelphia



Trenton on Development Site