DELAWARE RIVER BASIN

INTERSTATE FLOOD MITIGATION TASK FORCE

ACTION AGENDA

JULY 2007

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Delaware River Basin Interstate Flood Mitigation Task Force
Action Agenda
Table of Contents

Appendices

Executive Summary

In September 2004, April 2005 and June 2006, three major floods caused devastation along the main stem Delaware River, repeatedly damaging property and disrupting tens of thousands of lives. These were the worst floods to occur on the main stem since the flood of record in 1955. The last occurrence of three main stem floods of comparable magnitude within so short a time span was the period from 1902 to 1904.[1]

Thankfully, during the 2004, 2005 and 2006 floods, advances in flood warning technology minimized loss of life. Nine deaths are attributed to these past three events; one was attributed to main stem flooding, whereas the remaining eight were attributed to tributary flooding.[2] Though tragic, this number compares favorably with the approximately 100 lives lost during the record event a half-century ago. However, encroachments by the built environment into the flood plain continue to create new threats – including the increased potential for property damage, personal injury or death, and an increased potential for harm to the riverine environment.

Over the past fifty years, businesses, industries, residences, roads, and utilities, including public and private water supply and wastewater facilities, have been constructed within the floodplain. One consequence is that our communities and built infrastructure are affected more than ever by floods. Another is that the environmental impacts of flooding are more serious than in the past. Flood waters infiltrate wastewater systems, introducing industrial waste and raw or partially treated sewage into waterways. In addition, debris and contaminants from the built environment are washed downstream, where they may not only cause additional damage to people and property, but potentially may settle on the river bottom and cause ecological harm for years to come. Development within the floodplain is accompanied by diminished vegetation, which leaves waterways more susceptible to stream bank erosion, particularly during floods. Severe erosion can convert a narrow, deep, clear and cold channel that is resistant to flooding, into a wide, shallow, turbid and warm one that is increasingly flood prone.

Reducing flood loss is a responsibility shared by federal, interstate, state, and local agencies throughout our region. Recognizing this, the governors of the four basin states – Delaware, New Jersey, New York and Pennsylvania – directed the executive director of the Delaware River Basin Commission, Carol Collier, to convene an interstate task force to develop a set of recommended measures for mitigating and alleviating flooding impacts along the Delaware and its tributaries. In their September 2006 letter to Ms. Collier, the governors wrote, "Individually, the Basin states can move forward with policies and regulations to reduce and mitigate the impacts of flooding, but we believe that through coordinated effort on a regional basis, we can do more to reduce flood loss within the Basin than we could accomplish acting separately, on our own. The Delaware River Basin Commission is the obvious vehicle for developing flood loss reduction and flood mitigation

[1] Serious floods along the main stem during this period occurred on March 2, 1902, October 11, 1903 and March 8, 1904. Flood stages on the main stem at Trenton during these events reached 23.6 feet (the 7th highest on record), 28.5 feet (3rd highest on record) and 30.6 feet (the highest ever), respectively. The 1904 event was caused by an ice jam at Trenton.

[2] Mortality data was obtained from the National Weather Service (NWS/NOAA) National Climatic Data Center (NCDC) Storm Event database.

plans that cannot be accomplished by any single state or local government but that require a holistic watershed approach. As much as any time since the Commission was created in 1961, now seems an appropriate moment for coordinated action through the DRBC."

The Delaware River Basin Interstate Flood Mitigation Task Force was assembled in October 2006. It is comprised of 31 members from a geographically diverse array of government agencies (legislative, executive, federal, state and local) and not-for-profit organizations. The group has identified a total of 45 consensus recommendations for a proactive, sustainable, and systematic approach to flood damage reduction. The recommendations are based upon a set of six guiding principles concerning floodplain restoration, floodplain protection, institutional and individual preparedness, local stormwater management and engineering standards, and the use of structural and non-structural measures. They are grouped within six priority management areas as follows:

- Reservoir operations: Included among the recommendations is a slate of actions for regulation and control of reservoir releases. The Task Force calls for an evaluation of reservoir spill and discharge mitigation programs along with development of a flood analysis model to evaluate alternative reservoir operating plans and to assess the downstream effect of reservoir voids of different magnitudes. These recommendations call for releases that would reduce the likelihood and volume of spills from some basin reservoirs during storm events to help mitigate flooding.
- Structural and non-structural measures: The Task Force calls on policy-makers to assign higher priority and allocate greater funding to the acquisition of property and elevation and/or flood-proofing of structures within the floodplain. It offers strong support for state dam safety programs and recommends improved maintenance of other flood control structures. An evaluation of mitigation measures basinwide by the U.S. Army Corps of Engineers is recommended, to include an analysis of the ecological, economic, long-term operation and maintenance, and social costs and benefits of all flood mitigation options.
- Stormwater management: The Task Force calls for minimizing stormwater runoff from new development and reducing runoff from existing development through the implementation of watershed stormwater management plans, long-term maintenance of stormwater infrastructure (including detention ponds, inlets, catch basins, outfalls and other devices), the use of non-structural stormwater management options, expanded incentives for achieving stormwater management objectives, stronger enforcement of stormwater management regulations, and the development of stream restoration and debris removal guidelines.
- Floodplain mapping: Because the Delaware River is an interstate waterway, coordination is needed for development of a seamless floodplain map that is consistent throughout the basin. The Task Force calls upon the states to coordinate flood study and mapping updates, incorporate existing and planned development and residual risk zones into new maps, and re-define and re-map the floodway along the main stem and its tributaries.
- Floodplain regulation: Currently, the regulations applicable to floodplain areas in the Delaware Basin vary widely. The Task Force urges that existing floodplain regulations be catalogued, evaluated and updated and that uniform regulation of floodplains within the basin be established. It further recommends that a

coordinated education, outreach and training program about floodplain protection and regulation be undertaken, that a flood hazard disclosure requirement be imposed, that a repetitive loss reduction strategy be adopted and that riparian zones be defined in accordance with uniform standards basinwide.

- Flood warning: The task force recommends that development of an advanced basinwide flood warning system proceed in a coordinated fashion. The existing system is comprised of flow gages, flash flood and flood forecasting, and education and outreach components. It is coordinated and funded by multiple organizations at the federal, state and local levels. The Task Force urges that the river gage network and its forecast points be evaluated, that rating tables be extended, that gages be flood hardened (i.e., able to withstand larger flood events), that flash flood forecasting be improved, that flood inundation maps be developed, that up-to-date Dam Emergency Action Plans be maintained, that a coordinated flood education and outreach program be developed and that a comprehensive program be undertaken to address coastal flooding.

During the public review phase of the draft recommendations, there was a broad based request for immediate action to mitigate future flooding impacts. To address this sense of urgency the Task Force has identified several core recommendations to enhance the basin's resiliency—its capacity to prepare for and recover from flooding. The following immediate actions are proposed:

- Establish areas of priority funding for acquisition, elevation, and flood proofing. *(Action S-6)*
- Develop an interoperable reservoir operating plan. *(Action R-2)*
- Develop and implement a consistent set of comprehensive floodplain regulations beyond minimum NFIP standards across the entire Delaware River Basin. *(Action FR-2)*
- Enable stormwater utilities – This approach benefits both water quality and quantity. In addition it reinforces the states' existing momentum for stormwater management and control of nonpoint source pollution. *(Action SM-2.3)*

The Interstate Flood Mitigation Task Force has concluded that no set of mitigation measures will entirely eliminate flooding along the Delaware River or its tributaries. However, the members believe that the combination of measures advocated in this report constitute a significant step in helping the Basin's increasingly vulnerable riverine and coastal communities to prepare for, respond to, and rebound from natural disasters.

An overview of the 45 recommendations is included as Table 1 of this document. Please note that these recommendations are not in any prioritized order, but instead are organized by priority management area. Assuming adequate resources are identified, an implementation matrix, included as Table 4 of this report, organizes the recommendations by anticipated implementation time frame.

Delaware River Basin Flood Mitigation Task Force
Table 1 - Recommendation Overview

Recommendation			Ongoing	Short-term (1-3 Years)	Long-term (4+ Years)	Resources Needed	Lead Agency
Reservoir Operations							
#1	R-1	Develop a Flood Analysis Modeling Tool	X			$$	DRBC
#2	R-2	Develop an Interoperable Reservoir Operating Plan		X		$$	DRBC
#3	R-3	Evaluate Discharge Mitigation Programs for Reservoirs	X			$	DRBC
#4	R-4	Evaluate Snowpack Based Storage Management	X			$	DRBC
#5	R-5	Publish Information on the Basin's Existing Major Impoundments		X		$	DRBC
#6	R-6	Evaluate Availability and Accuracy of Data		X		$	DRBC
Structural and Non-Structural Measures							
#7	S-1	Fund a Comprehensive Flood Mitigation Study of the Entire Delaware River Basin			X	$$$$ per state	USACE
#8	S-2	Prioritize the Completion of State and Local Hazard Mitigation Plans	X			$$$	State EMO's
#9	S-3	Ensure Financial Assistance for State, County and Municipal Flood Mitigation Projects	X			$$$$	State EMO's
#10	S-4	Provide Training for Local Officials to Maximize Use of Available Mitigation Funding		X		$$	DRBC
#11	S-5	Create Partnering Programs for Floodplain Acquisition		X		$$$$	State DEP's
#12	S-6	Establish Funding Priority Areas for Acquisition, Elevation, and Floodproofing		X		$$$	Basin States
#13	S-7	Maintenance of Flood Control Structures, excluding dams		X		$$$$	State DEP's
#14	S-8	Dam Safety Programs	X			$$$$	State Dam Agencies
#15	S-9	Evaluate and Coordinate Flood Mitigation Plans and Strategies	X			$$$	DRBC
Stormwater							
#16	SM-1	Develop Regional and Tributary-Based Watershed Stormwater Management Plans		X		$$ per 100sq. mi.	Basin States
#17	SM-2	Long-term Management of Stormwater Best Management Practices (BMPs) and Infrastructure	X			$ per municipality	Basin States
#18	SM-3	Non-Structural Stormwater Management for New and Redevelopment	X			$	Basin States
#19	SM-4	Enforcement of Existing Stormwater Standards and Regulations		X		$	Basin States
#20	SM-5	Provide and Promote Incentives to Reduce Stormwater Runoff from Existing Development		X		$-$$$$	Basin States
#21	SM-6	Develop and Maintain Precipitation and Streamflow Data	X			$	USGS/NWS
#22	SM-7	Stream Restoration and Debris Removal Guidelines		X		$	DRBC
#23	SM-8	Stormwater Management through Special Protection Waters Designation	X			$	DRBC

$ Key: $ = < $100,000 $$ = < $500,000 $$$ = < $1,000,000 $$$$ = > $1,000,000

Delaware River Basin Flood Mitigation Task Force
Table 1 - Recommendation Overview (Continued)

Recommendation			Ongoing	Short-term (1-3 Years)	Long-term (4+ Years)	Resources Needed	Lead Agency
Floodplain Mapping							
#24	FM-1	Coordinated Flood Study and Mapping Updates	X			$$$$	Basin States
#25	FM-2	Incorporate Existing and Future Planned Development and Residual Risk Zones into New Mapping			X	$$$$	Basin States
#26	FM-3	Redefine and Remap the Floodway along the Delaware River Main Stem and its Tributaries			X	$$$$	Basin States
Floodplain Regulations							
#27	FR-1	Catalog, Evaluate and Update Existing Floodplain Regulations in the Basin		X		$	DRBC
#28	FR-2	Develop a Coordinated Education, Outreach and Training Program		X		$	DRBC
#29	FR-3	Repetitive Loss Reduction Strategy for the Basin		X		$$	FEMA
#30	FR-4	Flood Hazard Disclosure Requirements		X		$	DRBC
#31	FR-5	Standardized Riparian Corridors			X	$	DRBC
Flood Warning							
#32	FW-1	Inventory and Evaluate Precipitation Observing Stations in the Basin		X		$	USGS
#33	FW-2	Evaluate River Gage Network		X		$	USGS
#34	FW-3	Extend Rating Tables		X		$	USGS
#35	FW-4	Flood Harden Gages at Key Forecast Locations			X	$$	USGS
#36	FW-5	Improve Flash Flood Forecasting			X	$$	NWS
#37	FW-6	Develop an Implementation Plan for the NWS Site Specific Model		X		$	NWS
#38	FW-7	Evaluate River Forecast Points		X		$	NWS
#39	FW-8	Provide River Forecasts with Confidence Level Information		X		$	NWS
#40	FW-9	Develop Flood Forecast Inundation Maps		X		$$	NWS
#41	FW-10	Maintain Up-to-Date High Hazard Dam Emergency Action Plan (EAP) Documents	X			$	DRBC
#42	FW-11	Establish a Coordinated Flood Warning Education and Outreach Program		X		$	DRBC
#43	FW-12	Develop a Flood Coordination Mechanism		X		$	DRBC/ Basin States
#44	FW-13	Ice Jam Monitoring and Communications Plan	X			$	State EMS
#45	FW-14	Coastal Flooding Impacts			X	$$$$	MACOORA

$ Key: $ = < $100,000 $$ = < $500,000 $$$ = < $1,000,000 $$$$ = > $1,000,000

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Thank you and acknowledgements:
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I. Authorization

The Delaware River Basin Interstate Flood Mitigation Task Force was formed in response to a September 21, 2006 letter to Delaware River Basin Commission (DRBC) Executive Director Carol R. Collier from Delaware Gov. Ruth Ann Minner, New Jersey Gov. Jon Corzine, New York Gov. George Pataki, and Pennsylvania Gov. Edward Rendell, who also serve as DRBC commissioners. At a public meeting on September 27, 2006, the Commission's federal representative and current Chair, Lt. Col. Gwen E. Baker of the U.S. Army Corps of Engineers, joined the state representatives in a vote unanimously approving formation of an interstate task force.

In their letter to Ms. Collier, the four governors explained their joint action as follows: "Individually, the Basin states can move forward with policies and regulations to reduce and mitigate the impacts of flooding, but we believe that through coordinated effort on a regional basis, we can do more to reduce flood loss within the Basin than we could accomplish acting separately, on our own. The Delaware River Basin Commission is the obvious vehicle for developing flood loss reduction and flood mitigation plans that cannot be accomplished by any single state or local government but that require a holistic watershed approach. As much as any time since the Commission was created in 1961, now seems an appropriate moment for coordinated action through the DRBC." The governors offered "the full cooperation of the state emergency management and environmental agencies in this effort" and ambitiously charged the Task Force to propose a preliminary action plan with recommendations by the close of 2006 "to enable implementation measures to be started as early as possible in 2007." (Appendix A)

II. Introduction

This report presents recommendations developed by the Interstate Flood Mitigation Task Force for reducing flood damage in the Delaware River Basin. Significant flood damage occurs annually in the basin. However, between September 2004 and June 2006, three major floods along the main stem Delaware River caused severe and repeated damage to thousands of structures and disrupted the lives of tens of thousands of people. The flooding was the worst since the record flood of 1955.

Because many floodplains are highly developed, floods cause damage to many facets of society; including business and residential properties, the transportation network, industry and utilities, which include public and private water supply and wastewater facilities. Furthermore, floods also present the potential for adverse environmental impacts by contaminating drinking water supplies, infiltrating sewer systems, and introducing raw or partially treated sewage into our waterways. Debris carried by floodwaters creates hazardous conditions for boaters, fishermen, and swimmers in and on the water. The loss of vegetation in the floodplain allows for increased erosion of public and private land and the loss of a healthy and natural floodplain degrades water quality as well as important ecosystems.

Each flood event has been analyzed by the National Weather Service, which has found that the flooding was primarily the result of unusually heavy rain and/or snowmelt, not only

during the events but in the days and months preceding the floods. During the most recent flood event in June 2006, rainfall totals at some locations in the western and northern portions of the basin totaled more than 15 inches over a seven-day period. Several factors contribute to flooding. Two key elements are rainfall intensity and duration. Intensity is the rate of rainfall, and duration is how long the rain lasts. Precipitation frequency tables developed by the National Oceanic and Atmospheric Administration determine the statistical probability for the combination of these two factors for the period of observed record in a specific area (NOAA Atlas 14). The probability of a 15" rainfall over a seven-day period in the Upper Delaware is a 1 in 700 chance in any given year. Large areas of the western and northern basin received over 10 inches of rain during the period – which is a 1 in 100 chance precipitation event. It should be noted a 100-year storm does not automatically produce a 100-year flood. This is because several factors, including topography, soil moisture and ground cover, independently influence the cause-and-effect relation between rainfall and streamflow. A 100-year rainfall event and a 100-year flood are completely different statistical accounts and cannot often be correlated.

While the primary cause of the flooding has been attributed to extreme precipitation events and pre-cursor conditions, other factors including, but not limited to, development, stormwater management, floodplain encroachment and reservoir management have been attributed by the public or larger scientific community as potential contributing and exacerbating factors.

The responsibilities for facilitating flood loss reduction are scattered across many federal, state, and local agencies and organizations in the Delaware River Basin. The responsibilities are far reaching; involving both planning and operational functions. Flood loss reduction functions are administered by numerous federal, state and local agencies. DRBC was formed, in part, to bring together various government and non-governmental stakeholders across jurisdictional boundaries for the shared interest of the watershed. One example of this is DRBC's Flood Advisory Committee (FAC) which was established in 1999. The committee has served to coordinate agencies efforts to improve the basin's flood warning system and mitigate flood losses. In addition, many good programs exist which depend on cooperation among agencies. Examples include the Federal Emergency Management Agency's Flood Mitigation Assistance (FMA) and Pre-Disaster Mitigation (PDM) programs which focus on providing mitigation assistance to State and local communities with the aim to reduce vulnerability *before* the next disaster threatens. Another example of cooperation among many parties and agencies is the Temporary Reservoir Release Spill Mitigation Program (Resolution 2006-18) recently established by the Delaware River Basin Commission.

Despite the administration of flood loss reduction programs aimed at preventative measures for damage reduction, flood losses still continue. Comprehensive and progressive action is needed to protect life, property and the natural waterways that support us all and to make the basin more flood resilient. Many agencies and organizations involved in flood loss reduction have expressed the desire to end the damage/personal loss/rebuild cycle that has been allowed to continue in the floodplains, but, through the task force process it was heard that strong measures and adequate funding are needed to end this cycle and ultimately reduce long-term flood damage costs.

The Delaware River Basin Interstate Flood Task Force convened on four occasions; October 25, 2006, November 11, 2006, December 6, 2006 and December 20, 2006. The Task Force is comprised of 31 members representing a broad array of governmental (both legislative and executive), and not-for-profit interests. In addition to the Task Force members, many more individuals participated in creation of this action plan through the formation of focus area work groups. The Task Force has identified a total of 45 recommendations to effectuate a more proactive, sustainable and systematic approach to flood damage reduction in the basin. These recommendations are divided into six (6) priority management areas as follows:

- Reservoir Operations;
- Structural and Non-Structural Measures;
- Stormwater Management;
- Floodplain Mapping;
- Floodplain Regulations; and
- Flood Warning

III. Background

Geographic Setting

The Delaware is the longest un-dammed river east of the Mississippi River, extending 330 miles from the Catskill Mountains of New York State to the mouth of the Delaware Bay where it meets the Atlantic Ocean. The river is fed by 216 substantial tributaries, the largest being the Schuylkill and Lehigh rivers in Pennsylvania.

Nearly 15 million people (approximately five percent of the nation's population) rely on the waters of the Delaware River Basin for drinking and industrial use, but the watershed drains only four-tenths of one percent of the total continental U.S. land area. The Catskill Mountain region provides a high quality source of water and NYC obtains nearly half of its municipal water supply from three Delaware Basin reservoirs--Cannonsville, Pepacton, and Neversink. The headwaters of the Delaware River form in New York State, Pennsylvania, New Jersey, and Delaware. Within the basin, the river supplies drinking water to much of the Philadelphia metropolitan area and major portions of New Jersey. In addition, water is diverted from the basin to both NYC and NJ. For the river's entire length, from its headwaters in New York to the Delaware Estuary and Bay, the Delaware also serves as an ecological and recreational resource. Over the past half century, as a result of the maintenance of lower basin minimum flows, cold-water fisheries have been established in the tailwaters of the East Branch Delaware, West Branch Delaware, and Neversink rivers and the upper main stem Delaware River, and most of the main stem upstream of Trenton, NJ has been designated by Congress as part of the federal Wild and Scenic Rivers system.

In all, the basin contains 13,539 square miles, draining parts of Pennsylvania (6,422 square miles or 50.3 percent of the basin's total land area); New Jersey (2,969 square miles, or 23.3%); New York (2,362 square miles, 18.5%); and Delaware (1,004 square miles, 7.9%).

The natural drainage area of the Delaware River Basin crosses many man-made boundaries in addition to the four state lines: 25 congressional districts, two Federal Emergency Management Agency (FEMA) regions, two Environmental Protection Agency (EPA) regions, five U.S. Geological Survey (USGS) offices, four Natural Resources Conservation Service (NRCS) state offices, two National Weather Service (NWS) local forecast offices, 42 counties, and 838 municipalities. Coordination of efforts is critical for effective flood loss reduction to occur within the basin.

Figure 1 depicts the watershed and major reservoirs of the Delaware River Basin. The reservoirs include the U.S. Army Corps of Engineers' five projects that were designed to maintain dedicated flood storage capacity, and other major reservoirs not specifically designed for flood control, including water supply reservoirs, hydropower reservoirs, and reservoirs used primarily for recreation. The U.S. Army Corps of Engineers' multi-purpose projects include Jadwin, Prompton, Beltzville, Blue Marsh and Francis E. Walter Reservoirs. The New York City water supply and flow augmentation reservoirs include Cannonsville, Pepacton and Neversink. The hydroelectric power generation reservoirs are the Mongaup System and Lake Wallenpaupack. Other major multipurpose reservoirs listed in Table 1 include Marsh Creek, Lake Nockamixon, and Merrill Creek.

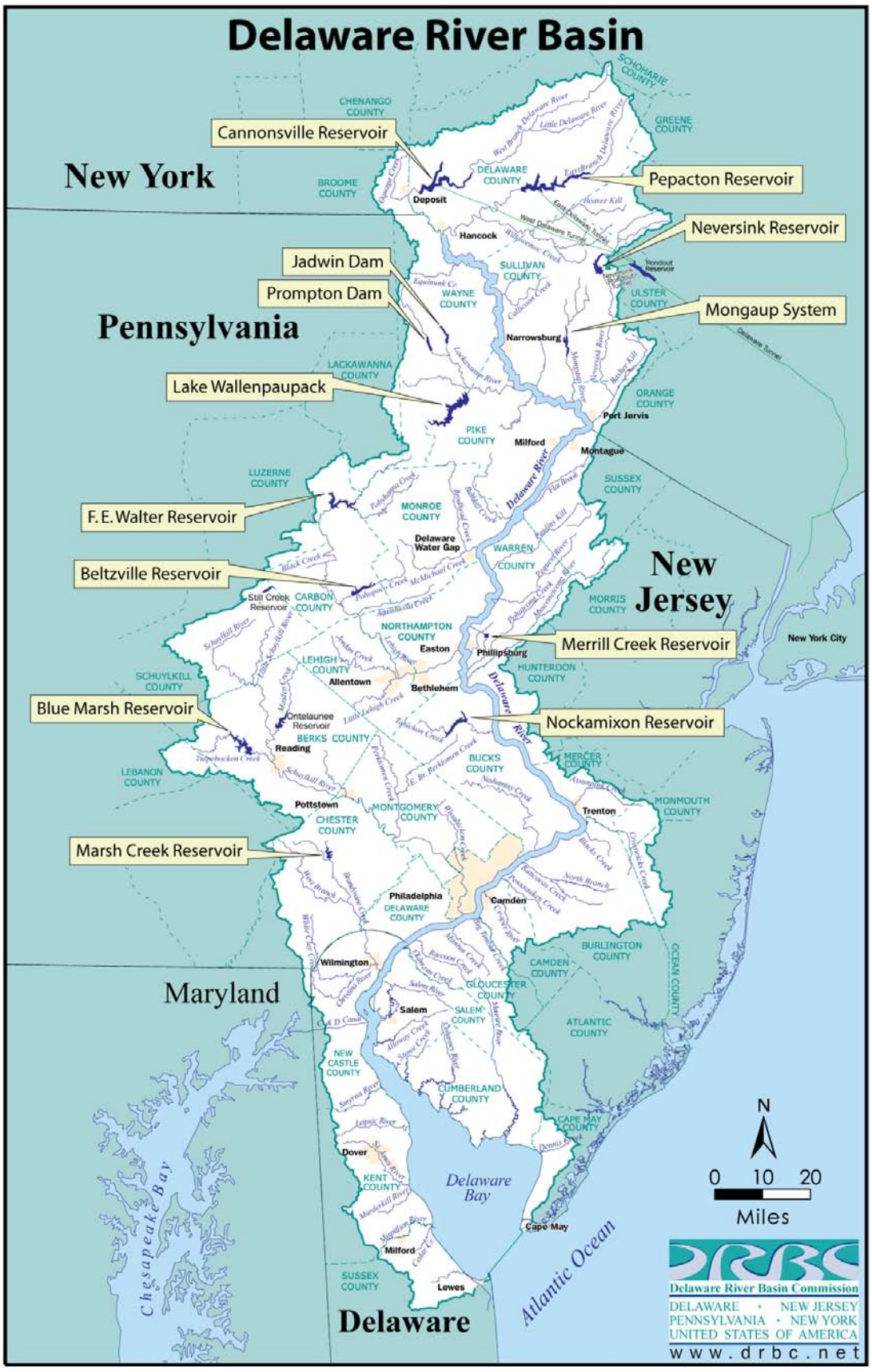


Figure 1. Map of the Delaware River Basin and Major Basin Reservoirs

Water Management in the Delaware River Basin

The waters of the Delaware River are apportioned through a 1954 U.S. Supreme Court Decree[3] and a federal-interstate compact enacted in 1961.[4] The compact created the Delaware River Basin Commission, an interstate and federal water resource agency with authority to regulate, plan and coordinate management of the water resources of the Delaware Basin. The Commission's members are the governors of the states of New York, New Jersey, Pennsylvania and Delaware and a federal member appointed by the President. Since 1997, the federal member has been the North Atlantic Division Commander of the U.S. Army Corps of Engineers, based in Brooklyn, New York.

In accordance with the Delaware River Basin Compact, the Commission has regulatory authority and responsibilities for planning and coordinating management of the Basin's water resources with respect both to water quality and water quantity. In the areas of reservoir operations and flow management, the Commission's authority is limited in that without the unanimous consent of the parties to the U.S. Supreme Court Decree of 1954, it may not "diminish or otherwise adversely affect the diversions, compensating releases, rights, conditions, [and] obligations" . . . contained in the Decree.[5] If the Decree Parties concur, however, they can act together through the Commission to modify the conditions of the Decree without returning to the Supreme Court. The parties to the 1954 Decree include the four basin states and the City of New York. For additional information about the Delaware River Basin Compact, the Commission and the Supreme Court Decree of 1954, see Appendix C.

The measures of certainty and flexibility afforded by the unique river basin management scheme created by the Decree and the Compact have provided the basis for more than four decades of joint watershed management by the basin states, the federal government and New York City, without further appeals to the court. Through the Commission, the parties have formally adjusted diversions and releases from New York City's Delaware system reservoirs more than a dozen times. Today, however, the parties face unprecedented challenges in the areas of flow management and allocation.

For nearly four-and-one-half decades after the Commission was created, the debate over allocation of water resources in the Delaware Basin revolved around ensuring an adequate supply of water for people and adequate in-stream flows for fish. Sustainable flows to meet ecological and recreational requirements became a vital objective, even though these uses were not contemplated by the Supreme Court when it apportioned the basin's waters 50 years ago. The advent of three successive main stem floods in 2004, 2005 and 2006 has rapidly transformed the flow management debate by adding flood mitigation to the mix of demands on limited water storage capacity.

[3] New Jersey v. New York, 347 U.S. 995 (1954).
[4] The Delaware River Basin Compact was enacted by concurring legislation of the states of Delaware, New York, New Jersey, and Pennsylvania and the federal government. *See* Pub. L. No. 87-328, 75 Stat. 688 (1961); Del. Code Ann. tit. 7, § 6501; N.J. Stat. Ann. §§ 32:11D-1 to 32:11D-110; N.Y. Envtl. Conserv. Law § 21-0701; Pa. State. Ann. § 815.101 ("Compact").
[5] Compact, § 3.3a

Flood Damage in the Delaware River Basin

Flooding affects all watersheds in the Delaware River Basin. However, flood damage potential is a function of human development in floodplains. The National Flood Insurance Program (NFIP), administered by the Federal Emergency Management Agency (FEMA), makes federally-backed flood insurance available in communities that adopt and enforce floodplain management ordinances in the effort to help reduce future flood losses. Through the collection of insurance premiums, the program effectively transfers the cost of flood loss reimbursement from tax payers to floodplain property owners. In addition to reimbursing flood victims for their losses, NFIP encourages development away from flood-prone areas and requires new and substantially improved structures to be constructed in a way that minimizes or prevents flood damage.

Unfortunately, flood insurance claims reflect only a fraction of the total cost of property damage caused by flooding. This is due in part to the fact that only a small percentage of property is insurable. For example, roads, bridges, public utilities and the natural environment cannot be insured. Further, many owners choose not to purchase the insurance because they are required to do so only if their property was purchased with federally-backed mortgages. In addition, flood insurance claims often occur in headwater areas, where property damage may result from stormwater flows as well as from stream flooding. Notwithstanding these limitations, insurance claims (since the NFIP's inception in the late 1970's) can provide a general picture of flood damage within the basin during the course of the flood insurance program.

Close to 20,000 flood insurance claim reimbursements have been awarded in the Delaware Basin since the late 1970s. The density of claims in certain areas reflects population density, the degree of development in floodplains, the number of policy holders, and flooding frequency.

Repeat flood insurance claims indicate areas where floodplain occupancy continues in spite of repeated inundation. Flood prone communities often find that available funds are not sufficient for either acquisition or elevation of residences and other buildings that are repeatedly flooded. As a means of illustrating the need for additional funding, DRBC staff has performed an analysis of properties within the basin that qualify as "repetitive loss"[6] and "severe repetitive loss"[7] properties. See Appendix D for the complete analysis. As an example of the severity of flooding in recent years, the number of repetitive loss properties in the basin prior to September 2004 was 209. Between September 2004 and February 2007, an additional 3,102 properties were added to this list. For total losses that occurred from the start of the NFIP program, January 1, 1978 through February 28, 2007, the NFIP made flood loss reimbursements totaling over $318 million on a total of 3,311 repetitive loss properties within the Delaware Basin.

[6] A property is considered a repetitive loss property by FEMA when there are 2 or more losses reported which were paid more than $1,000 for each loss. The 2 losses must be within 10 years of each other and be at least 10 days apart.

[7] A property is considered a severe repetitive loss property by FEMA either when there are at least 4 losses each exceeding $5000 or when there are 2 or more losses where the building payments exceed the property value.

In addition to the repetitive loss analysis, DRBC staff has prepared maps showing the locations and concentrations of individual flood insurance claims for each of the past three flood events -- September 2004, April 2005 and June 2006. The maps provide a look at the extent of damage from each event. These maps are provided in Appendix E.

Hydrologic Understanding of Severe Flooding Events

Three major floods have occurred on the Delaware River in the 22 months from September of 2004 through June of 2006. Although none were as devastating as the flood of 1955, collectively the three events comprised an unprecedented sequence of floods and accompanying property damage. Victims could somehow accept the September 2004 flood associated with Hurricane Ivan because it occurred almost exactly 50 years after the 1955 flood. It seemed to happen at exactly the right interval for a flood of its magnitude. The April 2005 flood was more difficult for people to accept, but after the June 2006 flood, there was little chance for the general public to make sense of what had happened. A basic explanation of the events is that each was the result of significant rainfall, not only during the event itself but in the preceding days and months. Each of the storms associated with these floods was unusual. However, the public now fears that because of floodplain encroachment, land development, reservoir management or other factors, flooding of this magnitude will be an annual occurrence into the future.

Two key contributors to flooding are rainfall intensity and duration. Rivers and streams may flood when prolonged rainfall over the course of several days, intense rainfall over a short period of time, or a debris or ice jam causes a river or stream to spill over its banks and inundate the surrounding area. Conditions prior to a rainfall event influence the amount of stormwater runoff into waterways. Thus, topography, soil conditions, and ground cover play very important roles. Dry soil accommodates greater infiltration of rainfall and reduces the amount of runoff entering streams. Conversely, soil that is saturated as a result of previous rains has a lower capacity for infiltration, and results in higher rates of surface water runoff. Since several factors independently influence the cause-and-effect relationship between rainfall and streamflow, a 100-year rainfall event and a 100-year flood are completely different statistical events and cannot often be correlated. Therefore, a 100-year storm does not automatically produce a 100-year flood.

The term “one-hundred-year flood” or base flood does not signify that such a flood occurs once every one hundred years. Rather, it means that there is a one in 100 (or one percent) chance that such a flood will occur in a given year. Two 100-year floods may occur one year apart or even one month apart, depending upon rainfall, snowmelt and soil conditions. A “20-year flood” is less destructive than a 100-year flood and is also more likely, with a one in 20 (or five percent) chance of occurring in any given year, whereas the catastrophic "500-year flood" has only a one in 500 (or 0.2 percent) chance of occurring in any given year.

The ability to predict the frequency of a particular event such as a flood depends on the length of the historical record. The period of recorded hydrologic data for the Delaware River is only about 100 years. As the historical record grows over time, however, the statistical probability of the current 100-year flood may well change. That is, the flood that we consider today to constitute the 100-year flood may over time and with more occurrences

become the 50-year flood. This statistical change can occur independent of changes in the landscape such as upland development and floodplain encroachment. It should be noted by the public and others that the 100-year *floodplain* is defined on the basis of the current hydrologic record and is only a reflection of statistical risk. The scientific community must continually update flood risk assessments and floodplain maps and communicate the associated risks to the general public.

IV. Flood Mitigation Action Plan

The Task Force has concluded that no one set of mitigation measures will eliminate flooding along the Delaware River, but the members believe that a combination of measures will improve the basin's resiliency – its capacity to prepare for and recover from flooding in the future. The Task Force recommendations in this report are informed by the following six guiding principles of floodplain management and have been divided into six priority management areas.

Guiding Principles

1. **Preserve and Restore Floodplains Where Possible -** to recognize, preserve and restore the beneficial functions of floodplains for hazard reduction, water quality enhancement, wetland protection, wildlife habitat, riparian corridors, recreation, environmental relief, aesthetics and greenway areas.
2. **Be Prepared for Floods -** by developing advanced floodplain mapping, detailed risk assessments, enhanced early warning systems, multiple emergency notification measures, understandable response plans, workable recovery plans, and ongoing storm monitoring.
3. **Help People Protect Themselves from Flood Hazards -** through public interaction and involvement, available flood information, community outreach and education, self-help measures, flood proofing options, affordable flood insurance, and emergency preparedness.
4. **Prevent Adverse Impacts and Unwise Uses in the Floodplain -** through appropriate regulation and land use, open land preservation, acquisition of structures and relocation assistance programs, relocation of infrastructure (such as wastewater disposal plants), multi-objective planning, prohibiting unacceptable encroachments, and establishing ongoing maintenance practices that preserve and enhance environmental functions.
5. **Prevent Adverse Impacts from Development and Redevelopment** – by preparing tributary and regional stormwater management plans, adopting appropriate engineering standards into local ordinances, consistently administering and enforcing ordinances and providing long-term maintenance of facilities.
6. **Acknowledge the Values of Structural Flood Control Measures -** after a careful analysis of the ecological, economic, long-term operation and maintenance, and social costs and benefits of all mitigation options; identify those situations where a combination of structural solutions, structural modifications, and non-structural solutions is the most beneficial option.

Priority Management Areas:

In assessing the above guiding principles and in order to organize the following recommendations, the Task Force decided to divide the recommendations into six priority management areas. A focus area work group led by a committee chair was formed for each management area. Task Force members and contributors volunteered and worked within their work groups to form recommendations to then bring before the larger Task Force for review and approval. Discussions of the six priority management areas are as follows:

A. Reservoir Operations:

Three major main stem floods between September of 2004 and June of 2006 have focused attention on the potential management of the basin's major reservoirs for additional flood mitigation. The reservoirs include the Army Corps of Engineers' five projects that were designed to maintain dedicated flood storage capacity, and other major reservoirs not specifically designed for flood control, including water supply reservoirs, hydropower reservoirs, and reservoirs used primarily for recreation. There is a need to evaluate all of these reservoirs in order to develop plans to minimize their total discharge (spills plus releases) during flood conditions. On-line availability of rainfall forecasts and snowpack information from the National Weather Service are providing better information for release decisions prior to storm events, and probability of refill of reservoirs can be used as a basis for release programs aimed at limiting total discharge during flooding. Although, there are substantial hydraulic limitations on the controlled release capacity of most non-flood control reservoirs, forecast-based and variable release programs for the existing facilities can potentially contribute to flood crest reduction, particularly in reaches immediately downstream of reservoirs. Use of a comprehensive flood analysis model would allow for consideration of the cumulative effects of operations of all reservoirs on the main stem and would help promote coordinated operation and planning. These recommendations call for releases that would reduce the likelihood and volume of spills from some basin reservoirs during storm events to help mitigate flooding.

B. Structural and Non-structural Measures:

(Excerpted from Association of State Flood Plain Managers, No Adverse Impact Policy) "Flood damages in the United States continue to escalate. From the early 1900's to the year 2000, flood damages in the United States have increased six fold, approaching $6 billion annually. This occurred despite billions of dollars for structural flood control, and other structural and non-structural measures. We continue to intensify development within watersheds and floodplains, and do it in a manner where flood prone or marginally protected structures are suddenly prone to damages because of the actions of others in and around the floodplain.

Current national floodplain management standards allow for: floodwater to be diverted onto others; channel and overbank conveyance areas to be reduced; essential valley storage to be filled; or velocities changed with little or no regard as to how these changes impact others in the floodplain and watershed. The net result is that through our actions we are intensifying damage potentials in the nation's floodplains. This current course is one that is not equitable to those whose property is impacted, and is a course that has shown to not be economically sustainable."

Due to a host of economic, environmental, and political reasons, flood management has been historically moving away from large scale flood control projects and moving instead towards floodplain management and mitigation measures such as acquisition, elevation, floodplain regulation, and stormwater management. In some cases, though, after careful analysis of the ecological, economic, social, long-term operation, and maintenance costs and benefits, structural solutions such floodwalls, dams, engineered conveyances, and control structures may still be warranted. For the prevention of stream tributary flooding, small local flood control structures may be beneficial and should be investigated and analyzed. For example, backwater flooding along stream tributaries could be controlled and prevented through the use of flap gates, flood gates, tide gates, and pumping stations.

In advancing non-structural measures in the basin, multiple approaches are needed. Communities must be encouraged to complete and locally adopt their All-Hazards Mitigation Plans. The cost of mitigation projects identified in their respective hazard mitigation plans is often cost prohibitive for municipalities to fund individually. Greater funding is needed to help ensure that the local projects, such as acquisition, elevation, and flood proofing, can be implemented. Effective mitigation will require the cooperation and coordination of residents, elected officials, and all federal, state, and local agencies with flood mitigation responsibilities. Additionally, expansion of floodplain awareness and strengthened floodplain regulations basin-wide will allow for better planning and stricter protection of floodplains in the future.

C. Stormwater Management:

Historically stormwater management regulations have focused on addressing the peak rate of runoff from development and have not addressed water quality impacts, strived to avoid runoff through the use of low impact development strategies, or worked to minimize the volume of runoff through stormwater best management and infiltration practices. The result has been to actually exacerbate and create flooding conditions. Current regulatory regimes fail to provide the tools to successfully and comprehensively address stormwater runoff from existing development. But a number of new legal requirements, regulatory regimes, and models now exist to minimize and better address stormwater runoff from new development and from redevelopment. One such model is encouraging site/project design that incorporates low impact/non-structural stormwater management as a means to simulate natural drainage and infiltration functions.

In addition to managing stormwater runoff from future planned development, there are many good ways to reduce runoff from existing developments. Regional, tributary-based watershed stormwater management plans can provide a comprehensive and holistic approach to stormwater management by evaluating existing flooding problems, considering potential impacts from future land use practices, and identifying successful projects, programs, initiatives, ordinances, and regulatory regimes. When implemented, these plans could minimize the volume and peak rate of runoff while at the same time address water quality and other impacts associated with runoff from new and existing development. Successful planning efforts can provide necessary justification for tougher design requirements for new development and redevelopment and identify possible strategies for addressing existing development. However, little of the Delaware Basin Watershed is currently under approved stormwater management plans due to inadequate funding mechanisms.

D. Floodplain Mapping:

The mission of a successful floodplain mapping program is to provide public residents, emergency management personnel, insurance companies, design professionals, and State and local regulatory authorities accurate, up-to-date, and user-friendly floodplain maps.

FEMA develops and produces flood hazard data and maps in order to administer the National Flood Insurance Program (NFIP). The Delaware River Basin is comprised of two FEMA Regions, FEMA Region II and FEMA Region III. This requires the states and FEMA Regions to coordinate and confer on methodology and mapping specifics so that a seamless map can be created across state boundaries. For instance, agreement on discharges to the river and floodway standards must be made. The current minimum FEMA floodway standard allows for a 1.0' rise. Presently, the floodway of the main stem of the Delaware is mapped at a 1.0' rise because it is an interstate waterway. The NJ floodway standard for its other waterways is a more restrictive 0.2' rise.

Future hydrologic conditions are not typically taken into consideration during the development of floodplain maps used to identify flood-prone areas. As future development occurs, runoff from that development may increase flows in flood-prone areas downstream. In NJ, for example, State land use regulatory permits required by the NJDEP, the NJ Flood Hazard Area Maps are defined by the 100-year event plus a 25% increase in discharge. This 25% safety factor is incorporated to take into account future build-out. DE, PA, NY, and local communities within NJ currently use the 100-year flood event without any considerations for future build-out.

E. Floodplain Regulations:

Often, development in the floodplain has negative effects. These negative effects can include increased flood stages, increased velocities, increased flows, water pollution, and erosion and sedimentation. Development in the floodplain disturbs the naturally vegetated floodplain diminishing its flood absorption and protection capabilities, which in turn threatens to put people and emergency personnel in harms way in the event of a flood.

Current national floodplain management standards have two essential components. The first is to recognize the concept of a two-part floodplain, known as the floodway and the flood fringe. The floodway is the central portion of the floodplain, which is characterized by higher water velocities and greater depths of flow than the flood fringe. Since the floodway conveys the majority of flood flows, it should be left open to the passage of floodwaters wherever possible to avoid increases in flood elevations. The flood fringe comprises the outer areas of the floodplain on both sides of the floodway, and is characterized by lower flood depths and velocities than the floodway. The flood fringe also stores water during a flood. The preservation of flood storage is essential to ensuring that flood depths do not increase. The second component of floodplain management is the requirement that the lowest floor of buildings in the floodplain must be constructed at or above the level of the 1% chance flood (100-year flood) otherwise known as the base flood elevation (BFE).

Local communities are required to adopt and enforce at least the FEMA minimum standards for participation in the National Flood Insurance Program (NFIP). However, post-storm surveys have shown that FEMA compliant structures continue to sustain damages,

even when built properly. Constructing to slightly higher standards is a very cost-effective way to mitigate flood damages over the long term. For example, New York requires elevation in an unnumbered A Zone to three feet above the highest adjacent grade (two feet for ordinances/laws adopted before 1992), and New Jersey has established a floodway based on a 0.2 foot rise. Beyond minimum NFIP standards, there is no consistent set of floodplain regulations basinwide to uniformly manage development in the floodplain of the basin.

F. Flood Warning:

The river flood warning system in the Delaware River Basin is comprised of several elements and is coordinated and funded by numerous organizations at the federal, state, and local levels. Three main elements of the flood warning system include gaging, flood and flash flood forecasting, and education and outreach.

Effective flood warning is not possible without the collection and rapid transmission of precipitation and streamflow data. The maintenance of stream gages is critical to flood warning. The stream gaging program is operated by the U.S. Geological Survey, who also coordinates funding for the program. Most stream gages in the Delaware River Basin are cost shared through a cooperative funding program between the U.S. Geological Survey, U.S. Army Corps of Engineers, the Basin States of Delaware, New Jersey, Pennsylvania, and New York, the Delaware River Basin Commission, and some utilities and industries. Stream gages are especially important because they are used to reference flood height and to develop the stage-discharge or "rating" curve which relates predicted streamflow to flood stage elevation. The funding for the stream gages is an annual issue, and flood warning capabilities are reduced when gages are discontinued.

It is the responsibility of the National Weather Service (NWS) to provide flood forecasts and issue flood warnings. The NWS uses rainfall observations, streamflow and stage data, and computer modeling to forecast flood levels at river forecast points during storm events. NWS flood forecasts are then broadcast to state and county emergency offices and to the public over emergency management communications systems, NOAA Weather Radio, television and radio, and the Internet. State and county emergency managers relay the information to emergency personnel at the municipal level. Road closures, evacuation, and rescue actions are implemented at the local level. In addition to river flood warning, the NWS also issues flash flood warnings which are transmitted over NOAA Weather Wire to emergency managers and also placed on the Internet.

A key component of a successful flood warning system is communication with the public. Media plays an essential role in informing the public of flood forecasts, and the media needs to coordinate with the NWS and emergency managers to relay flood information. But, the public must also be aware of sources for flood-warning information and be capable of interpreting the flood message. Adequate lead time, knowledge of vulnerable property locations, and knowledge of the hazards associated with driving in flood waters, are minimum requirements for responding to a flood. The failure in any of these links in the warning system hinders flood warning.

The Task Force's flood warning recommendations focus on the components of the existing flood forecast and warning system in the basin. The system currently is supported by funding from a number of cooperating federal, state, and local agencies. The system has

three key major components; observing, forecasting, and warning. The recommendations listed identify deficiencies in the current warning system and areas where development and implementation of scientific and technical solutions can improve the timeliness and accuracy of the flood forecasts and warnings. User response to flood forecasts and warnings is critical to minimize the loss of life and property during flood events; therefore, education and outreach is also high priority.

Implementation of the recommendations will be based on funding and available resources; however there are a number of recommendations that require minimal or no funding and could be implemented at once.

V. Recommendations

A. Reservoir Operations

R-1: Develop a Flood Analysis Modeling Tool

R-2: Develop an Interoperable Reservoir Operating Plan

R-3: Evaluate Discharge Mitigation Programs for Reservoirs

R-4: Evaluate Snowpack Based Storage Management

R-5: Publish Information on the Basin's Existing Major Impoundments

R-6: Evaluate Availability and Accuracy of Data

Water Supply Reservoirs and Flood Protection: Lessons from Historical Data

With the devastating effects of the recent Delaware River floods, floodplain residents and elected officials are urging that year-round flood storage voids be maintained in water supply reservoirs. The three New York City (NYC) Delaware Basin reservoirs – Cannonsville, Pepacton, and Neversink – are receiving the most attention because they were full prior to each of these floods and uncontrolled spills formed a component of downstream floodwaters. As a result, some flood victims have concluded that the reservoirs caused the flooding and that without reservoir spills, their homes and businesses could be spared inundation in the future. The historical data support neither of these contentions and is offered below as background information.

As Table 2 shows, five of the ten highest main stem flood crests recorded at Trenton, N.J. occurred in 1902, 1903, 1904, 1936 and 1942 before the NYC reservoirs were constructed. The record flood of August 1955 along the main stem Delaware River occurred before the Cannonsville Dam was built. Although the Neversink and Pepacton reservoirs were both in place, neither reservoir spilled during the 1955 flood. None of the three NYC reservoirs spilled during the flood of 1996. Thus, seven of the ten worst main stem floods in the Delaware Basin recorded at Trenton over the past 100 years occurred in the absence of reservoirs or in the absence of spills. Although they might be helpful in reducing flood crests, year-round voids will not stop flooding along the main stem Delaware.

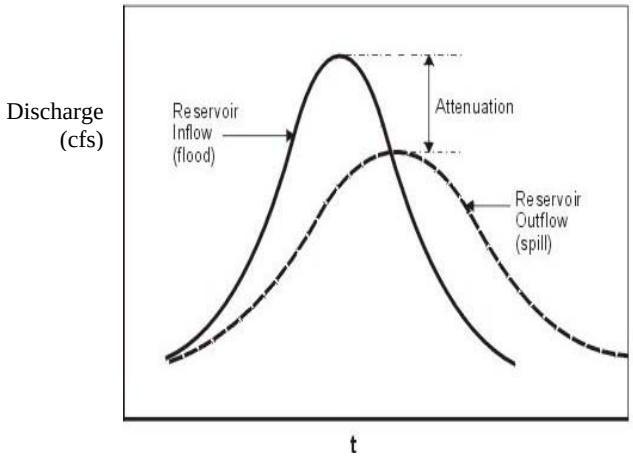
Table 2: Historic Flood Crests for the Delaware River at Trenton, N.J.

FLOOD RANK	*CREST STAGE (in Feet)*	*CREST DATE*	*NOTES*
1	30.60	3/8/1904	Ice Jam; NYC Reservoirs Not Built
2	28.60	8/20/1955	No spills; Cannonsville Not Built
3	28.50	10/11/1903	NYC Reservoirs Not Built
4	25.33	4/4/2005	Spills
5	25.09	6/29/2006	Spills
6	24.43	3/19/1936	NYC Reservoirs Not Built
7	23.60	3/2/1902	NYC Reservoirs Not Built
8	23.41	9/19/2004	Spills
9	22.20	1/20/1996	No Spills
10	21.12	5/24/1942	NYC Reservoirs Not Built

Despite the fact that flooding would still occur along the Delaware even if a year-round void program were implemented, reservoir management actions could reduce flood crests for a given flood. For this reason the Task Force has included reservoir management at water supply reservoirs as an element of this report, and there is sound justification for addressing all measures for reservoir management that that do not adversely impact water supplies.

Hydrologic theory and observed data show that even when they are full and spilling, reservoirs lower and delay the maximum flood discharges at dam sites when compared to natural undammed conditions. This is referred to as "attenuation". Attenuation is a function of reservoir storage as compared to runoff volumes, rainfall intensities, rainfall duration and spillway rating curves. One example from the flood of April 2005 is documented by the U.S. Geological Survey (USGS) in its publication, Flood of April 2-3, 2005, Neversink River Basin, New York[8]. USGS, which maintains flow gages throughout the basin, estimated that the peak rate of inflow to the city's Neversink Reservoir during the April 2005 event was 23,100 cubic feet per second (cfs). This estimate represents the rate of flow that would have occurred at the dam location if the dam had never been built. However, the actual peak discharge from the reservoir recorded by the USGS was a greatly reduced 12,300 cfs. By this measure, the dam nearly halved the rate of peak flow that would otherwise have moved downstream as a result of the storm. However, had a void existed in Neversink Reservoir prior to the storm, the reduction in peak flow would have been greater and resulted in lower downstream flood peaks. Although the reductions achieved miles downstream would be only slight, such measures merit careful consideration but must be weighed against the impact to water supply for New York, New Jersey and Pennsylvania.

Reservoir Attenuation:



From *"A Review of the Role of Dams in Flood Mitigation,"* a paper submitted to the World Commission on Dams in March 2000 by Peter Hawker.

[8] Suro, Thomas P., and Gary D. Firda. Flood of April 2-3, 2005, Neversink River Basin, New York. U.S. Geological Survey Open File Report 2006-1319. (2006).

Balancing the Needs for Flood Mitigation and Water Supply:

While some of the basin's multipurpose reservoirs, such as those owned and operated by the Corps of Engineers, maintain year round flood storage voids, such voids are not maintained by the basin's water supply reservoirs. On the contrary, water supply reservoirs fill during the winter and spring months of normal years. They are managed to reach full capacity in late spring in order to provide water supply storage for the coming year.

While recent management actions have been taken at the New York City reservoirs to increase releases during the summer and winter periods, the reservoirs continue to be managed to be full in the late spring. The following are several points that relate to and limit the potential for creating and maintaining year-round voids at these reservoirs:

1) The Supreme Court Decree of 1954 gives the City of New York the legal right to take an average of up to 800 mgd from the three reservoirs for water supply. Although historical diversions have been less than the full allocation, the City manages for the full storage condition in the late spring, in the event that all of the storage might be needed in a severe drought.

2) Storage in the three New York City reservoirs is shared with the other Delaware River Basin States. During dry periods, the states of Delaware, Pennsylvania, and New Jersey rely on storage in the NYC reservoirs to provide downstream releases to maintain flows in the main stem Delaware River and freshwater inflow to the Delaware Estuary. For example, during the month of August of 1999, an average of 73 percent of the flow at Montague, NJ, and 46 percent of the flow at Trenton, NJ was provided by releases from the NYC reservoirs. Some 2.5 million Pennsylvania and New Jersey residents obtain their drinking water from the Delaware River downstream of the Delaware Water Gap. During droughts, freshwater inflows from the reservoirs to the Delaware Estuary are needed to repel salt that might otherwise creep upstream through tidal action and threaten the water supply intakes of the City of Philadelphia and New Jersey American Water Company. In addition to public water supply, the releases are depended on for coldwater fishery maintenance and recreational boating.

3) Weather forecasting is not yet sufficiently advanced to furnish reliable drought predictions. Severe droughts can develop within a matter of months. By way of example, on May 1, 2001, NYC's Delaware Basin reservoirs were 100 percent full, holding approximately 271 billion gallons (bg) of water. In fact, the three reservoirs were spilling from April 13 through April 30, 2001. On December 15, 2001, less than eight months later, combined reservoir storage bottomed out at 63.348 bg, or only 23.4 percent of capacity, before slowly beginning to rebound. One frequently voiced request from flood victims is that a 20 percent year-round void be maintained in the NYC Delaware reservoir system. If a 20 percent (54 bg) void had been in effect in May 2001, the reservoirs would have entered the drought with approximately 217 bg of stored water rather than 271 bg. The system did not refill again until spring 2003. Table 3 lists the DRBC drought management periods since 1980. Periods are triggered by NYC reservoir storage levels.

Table 3: Dates of Drought as Determined by the DRBC Drought Management Plan (1980-Present)

ENTERED DROUGHT WATCH/WARNING/ EMERGENCY	*ENDED DROUGHT WATCH/WARNING/ EMERGENCY*	*NUMBER OF MONTHS OF DROUGHT MANAGEMENT*
10/17/1980	4/27/1982	18.5
11/13/1982	3/27/1983	4.5
11/9/1983	12/20/1983	1
1/23/1985	12/18/1985	11
1/16/1989	5/12/1989	4
9/13/1991	6/17/1992	9
9/21/1993	12/6/1993	2.5
9/15/1995	11/12/1995	2
10/27/1997	1/13/1998	2.5
12/14/1998	2/2/1999	1.5
10/29/2001	11/25/2002	13

4) Sufficient discharge capacity to maintain year-round voids in each of the three NYC Delaware Basin reservoirs is currently unavailable. Creating it would entail retrofitting the release works of these three reservoirs. Assuming the proposed voids could be maintained, NYC would need to evaluate whether its system could be managed under such constraints in a manner that would not jeopardize water supply, water quality, aggravate flood problems, or adversely affect the structural integrity of its dams.

A request has been made for a 20 percent year round-void through the re-allocation of approximately 54 billion gallons from water supply and low flow maintenance storage to flood control. Such a requested re-allocation of storage is the overriding issue associated with the year-round void question. Under the 1954 Supreme Court Decree, the year-round void issue is within the jurisdiction of the governors of the four basin states and the City of New York. The water policy implications of this issue may not be quickly or easily resolved. A major concern by Task Force members is that regardless of how this question is resolved, the Delaware River and its tributaries will continue to flood, and additional measures are needed to lower flood damages. It is in this context that the reservoir management recommendations and the other recommendations of this report are presented.

Recommendation R-1: Develop a Flood Analysis Modeling Tool

Finding: DRBC Resolution 2006-20 authorizes the Executive Director of the DRBC to accept funding for the development of a flood analysis model for the basin. While the commission already has an OASIS model capable of modeling reservoirs throughout the basin, the daily time step and other limitations of that model render it ineffective for complex modeling of storm events and associated reservoir operations. A more complex model, incorporating shorter time step operations and accounting for other factors contributing to hydrology in storm events, is needed to evaluate the potential for the basin's major reservoirs to be operated for flood mitigation.

The model is required for the DRBC staff to furnish the technical support that the Commission has directed the staff to provide for the development of flood mitigation plans for existing reservoirs. The model would enable the Commission to evaluate the feasibility of various reservoir operating alternatives and the effect of reservoir voids of different magnitudes on flooding at locations downstream from the reservoirs. Such a model would include representation of rainfall and snowmelt runoff, flow routing and reservoir hydraulics, and would calculate flow rates at all National Weather Service flood forecast points for any storm scenario. The model would allow evaluation of the effects of altering the existing structural conditions for major basin reservoirs for consideration as a potential flood mitigation measure to better accommodate forecast based operations. The model would also be useful as an educational tool for demonstrating the operations of reservoirs and basin flood hydrology. A graphical user interface would promote communication and understanding related to reservoir operations. Hydrologic models previously developed for the basin by the National Weather Service and U.S. Army Corps of Engineers would provide data and guidance for development and calibration of the new model.

Recommendation: DRBC should develop a flood analysis modeling tool as specified by resolution 2006-20. The initial version of the model should be able to evaluate the operations of all major Delaware basin impoundments. Later versions of the model could be developed to include possible future structures. The model should provide output in a form conducive to public education and outreach, and input data used for model comparisons by DRBC should be available to the public.

The model should allow the simulation of any storm scenario in 6-hour time steps and include pre-storm hydrologic conditions, including streamflow conditions, soil moisture, and snowmelt. The model should also include provisions for altering reservoir release rates prior to and during storm events. The model should provide for analyzing the effects of structural alterations of major basin reservoirs and should allow for evaluation of diversions, for other than water supply purposes, at those reservoirs. The main stem Delaware River and all non-tidal tributaries, especially those with major impoundments, should be included in the model. The model results should be made available on-line for use by interested parties.

Implementation: DRBC (Project Management), Contract with U.S. Geological Survey/ U.S. Army Corps of Engineers, NOAA-National Weather Service (advisory role)

Funding Mechanism: Funding has been committed by the Delaware River Basin States; $150,000 each from New Jersey, New York, and Pennsylvania; $50,000 from Delaware.

Estimated Cost: $500,000

Implementation Time Frame: 18 months from the date of contract

Recommendation R-2: Develop an Interoperable Reservoir Operating Plan that includes Potential Flood Mitigation by All Major Reservoirs

Finding: Three major main stem floods between September of 2004 and June of 2006 have focused attention on the potential management of the basin's major reservoirs for additional flood mitigation. The reservoirs include the U.S. Army Corps of Engineers' five projects that were designed to maintain dedicated flood storage capacity, and other major reservoirs not specifically designed for flood control, including water supply reservoirs, hydropower reservoirs, and reservoirs used primarily for recreation. There is a need to evaluate all of these reservoirs to develop plans in advance to minimize their total discharge (spills plus releases) during flood conditions. On-line availability of rainfall forecasts and snowpack information from the National Weather Service are providing better information for release decisions prior to storm events, and probability of refill of reservoirs can be used as a basis for release programs aimed at limiting total discharge during flooding. Although there are substantial hydraulic limitations on the controlled release capacity of most non-flood control reservoirs, forecast-based and variable release programs for the existing facilities can potentially contribute to flood crest reduction, particularly in downstream reaches near the reservoirs. Use of the flood analysis model described in Recommendation R-1 would allow consideration of the cumulative effects of operations at all reservoirs, and would promote coordinated operations.

The support of reservoir owners is essential for the successful development and implementation of flood operating plans. In addition, implementation of any flood operation plan that would affect water supply storage in the New York City Delaware Basin reservoirs would require unanimous agreement of the Parties to the 1954 Supreme Court Decree. To support negotiation of any agreements among the Parties, modeling with the DRBC's existing OASIS daily flow model and the proposed flood-analysis model described in Recommendation R-1 is required, to evaluate the potential effects of flood management proposals on the fundamental purpose of the reservoir.

The development and implementation of flood operating plans for reservoirs depends on the availability of high quality data and forecast information. Precipitation and runoff rates, snowpack conditions, and streamflow both upstream and downstream of reservoirs are needed to make operational decisions prior to and during flood events.

Recommendation: Develop a reservoir operation plan that includes potential flood mitigation by all major reservoirs located in the basin. Such a plan should not be expected to alleviate all future flooding, but could provide a measure of additional flood mitigation by means of seasonal or forecast based operations, including on tributary streams. The plan should consider opportunities for coordination of reservoir operations throughout the basin before and during flood events and assess data collection necessary for decision making

Implementation: DRBC, Decree Parties, U.S. Army Corps of Engineers, New York City, hydro-power companies, PADNRC (Nockamixon and Marsh Creek Reservoirs)

Funding Mechanism: Potential federal funds using DRBC flood model development funding as a local match.

Estimated Cost: Plan development will primarily require staff resources of DRBC, reservoir owners, and parties to the 1954 Supreme Court Decree, where applicable. A contract for services may be necessary depending on the number of model analyses required.

Implementation Time Frame: Three years

Recommendation R-3: Evaluate Discharge Mitigation Programs for Reservoirs

Finding: Discharge mitigation programs involve making controlled reservoir releases (through valves or gates) prior to storm events to minimize total discharge (uncontrolled flow over the spillway plus releases) during flood events. Spillways are a safety feature of all large dams and are required to prevent overtopping of the dam during severe flood events. Although large reservoirs, even when spilling, attenuate flows downstream, high total discharge rates can result in flooding immediately downstream of dams and contribute to the total flood flow further downstream. Programs designed to reduce total discharge rates offer some flood mitigation potential. Discharge mitigation programs may include maintenance of seasonal and snowpack based voids in water supply reservoirs to the extent that sufficient release capacity exists, and pre-storm releases based on potential runoff from forecast storm events. The capacity of a reservoir's outlet valves and piping (release works) is a critical limiting factor in the ability to lower reservoir levels and maintain voids, particularly for water supply reservoirs.

Discharge mitigation programs developed for individual reservoirs could be evaluated using the proposed flood analysis model described in Recommendation R-1, to determine their combined effects during various flood events, and could form the basis for a coordinated flood operation plan. Limited modeling performed by the National Weather Service has shown that relatively small reservoir voids can provide limited flood crest reduction in the reaches close to reservoirs. The continuing risk of flooding requires that evaluation of discharge mitigation measures, including adjustments to existing programs, not be delayed until after development of the flood analysis model.

DRBC Resolution 2006-18 approved a temporary discharge mitigation program for the New York City Delaware Basin reservoirs. As is true of any program that affects the diversions and releases from the New York City Delaware Basin Reservoirs established by the 1954 U.S. Supreme Court Decree, this discharge mitigation program, which could have potential impacts on water supply during subsequent dry periods, required the unanimous consent of the Parties to the Decree. The program provides increased release rates from the reservoirs when storage levels are above established thresholds during the fall and winter months. However, these releases are not large enough to prevent the reservoirs from filling during prolonged wet periods when runoff into the reservoirs exceeds the combined release and diversion rates. This program is temporary for the 2006/2007 winter season and is being re-evaluated in the Decree Party negotiations for a Flexible Flow Management Plan (FFMP)[9] for the basin's reservoirs. Under discussion are release and diversion capacities at these reservoirs. In addition, the official flood stages immediately downstream of the Cannonsville and Neversink reservoirs have been re-evaluated by the National Weather Service, and are being taken into account in the FFMP. There is a need to establish the maximum rate at which the reservoirs can be lowered prior to a storm event without causing flood problems downstream or adverse impacts on water supplies.

PPL is developing a snowpack and runoff based discharge mitigation program for implementation at Lake Wallenpaupack.

[9] Details on the Decree Parties' Flexible Flow Management Program can be found online at www.drbc.net.

Recommendation: Discharge mitigation programs should be evaluated, and both short term and long term programs should be considered for the reservoirs in the basin, while accounting for the fundamental purpose(s) of the reservoir storage (e.g. ecological, water supply, and hydropower uses). Potential release and diversion capabilities, as well as flood stages immediately downstream of dams, should be further evaluated to determine the maximum rate at which reservoirs can be lowered prior to a storm event or during an emergency, without adverse impacts on water supply, downstream flooding or structural integrity of the dams. Due to continuing risk of flooding, and the time requirement for development of the flood analysis model, evaluation of new discharge mitigation measures and consideration of adjustments to existing discharge mitigation programs should proceed in the short term using the best available information. Potentially feasible discharge mitigation programs should be submitted to the owners/operators of all major impoundments within the basin and, with respect to the New York City Delaware Basin Reservoirs to the Decree Parties for their consideration.

Implementation: City of New York, U.S. Army Corps of Engineers, hydro-power companies, PADCNR, DRBC, Decree Parties

Funding Mechanism: Existing budgets of individual dam owners, and state and federal agencies; possible NOAA grants.

Estimated Cost: Staff time, plus cost of monitoring and administration.

Implementation Time Frame: Beginning winter 2006/2007 and on-going. On February 20, 2007, the Commission posted for public comment a proposed Flexible Flow Management Plan (FFMP) incorporating a discharge management element that provides for increased releases (Table 1 in the FFMP) from the three New York City Delaware Basin Reservoirs when total system storage is above a discharge mitigation rule curve (Figure 1 in the FFMP). In order to establish maximum discharge rates (Table 2 in the FFMP), official flood stages downstream of the three reservoirs were updated by the National Weather Service in December 2006.

Recommendation R-4: Evaluate Snowpack Based Storage Management Programs for All Major Reservoirs

Finding: Snowpack based storage management is one type of discharge mitigation that has previously been implemented in the Delaware River Basin. Such programs are based on the concept that a percentage of the water equivalent in the snow pack on the watershed above a reservoir will eventually flow into the reservoir and can be counted as storage. During cold conditions, when snowpack is accumulating, freezing temperatures may reduce runoff rates into water supply reservoirs and allow the creation of voids over a period of time, depending on release capacities. In 2005, just prior to the late March/April flood event, a snowpack based void of approximately 11 billion gallons had been created in Pepacton Reservoir under a snowpack based storage management plan agreed to by the Parties to the 1954 Supreme Court Decree. Although the reservoir did fill and spill during the event, the void offered 11 billion gallons of storage capacity that would not otherwise have been available. Because a portion of the snowpack can be counted as storage, snowpack based programs pose less risk to water supply than other types of discharge mitigation programs. Snowpack water equivalence is monitored remotely by the National Weather Service and can be supplemented with field surveys or automated monitors. Frequent monitoring is required because snowpack can accumulate or disappear quickly; making it difficult to maintain representative voids due to limited release works capacity at water supply reservoirs. The temporary discharge mitigation program approved for the New York City Delaware Basin Reservoirs does not specify a snowpack related void, but counts 50 percent of the snowpack water equivalent as storage used for purposes of determining the release rates. PPL is developing a discharge mitigation program for Lake Wallenpaupack which accounts for both snowpack and forecast rainfall in determining potential runoff.

Snowpack based programs do not eliminate the need to also consider rainfall forecasts and are only one element of discharge mitigation programs for reservoirs.

Recommendation: Use of snowpack based storage management programs for all major reservoirs should be evaluated, while recognizing the limited seasonal availability and marginal risk reduction offered by this type of flood mitigation and the potential for increased risk to other water uses.

Implementation: City of New York, U.S. Army Corps of Engineers, hydro-power companies, PADCNR, DRBC, Decree Parties

Funding Mechanism: Existing budgets of individual dam owners and state and federal agencies; possible NOAA grants

Estimated Cost: Staff time, plus cost of monitoring and administration.

Implementation Time Frame: Beginning winter of 2006/2007 and on-going. Snow pack would be included in the determination of total system storage during the winter and early spring months.

Recommendation R-5: Publish Information on the Basin's Existing Major Impoundments

Finding: On-line information about basic physical features, storage uses, current storage amounts, inflow (runoff) and release rates, release capacity, diversion rates and diversion capacity is not available for all reservoirs. In the aftermath of the recent flooding, the observed data and hydrologic principles related to reservoir impacts during flooding, such as the attenuation effect on flood peaks and the percentage of drainage area impounded by reservoirs have often been challenged. There is a need for clear and consistent presentation of this information by public agencies and reservoir owners. The proposed flood analysis model described in Recommendation R-1 can be useful in displaying the combined effects of multiple reservoirs over a range of different storm events, and could be an educational tool for all interests. Additionally, there is need for clearer public information about discharge mitigation programs. Most recently, the discharge mitigation program approved by DRBC Resolution 2006-18 was erroneously reported in some newspapers as mandating a 20 percent void in the three New York City reservoirs. In reality, the program provides for greater releases when total storage is at 80 percent or greater of full storage capacity, but does not mandate a specific void. This has understandably led to confusion when the public has observed the subsequent refill of the reservoirs due to an extended period of high precipitation.

Recommendation: Publish and present information on the system uses and capabilities of the basin's existing major impoundments.

All information related to reservoir and dam facilities should be reviewed by reservoir owners prior to publication to assure that the information will not compromise the security of the facilities. The information should be presented at public workshops throughout the basin, and posted on the DRBC web site.

Implementation: Dam owners, DRBC, U.S. Army Corps of Engineers, NOAA, USGS

Funding Mechanism: Existing budgets of each implementing agency, possible FEMA grants for outreach, model development has been funded

Estimated Cost: Staff time

Implementation Time Frame: Starting immediately and on-going

Recommendation R-6: Evaluate Availability and Accuracy of Data

Finding: Recommendations R-1 thru R-5 depend on accurate hydrologic data. There is a need to determine the adequacy of data collection, both in the reservoir watersheds and downstream, for the purpose of developing and implementing plans to reduce reservoir discharge during flooding. Real time data for observed rainfall, streamflow, snowpack, antecedent soil moisture, and air temperature conditions provide information needed for runoff forecasting by the National Weather Service as well as information needed to make adjustments in operations. Accordingly, there is a need to coordinate the assessment of data collection for flood related reservoir operations with the assessments required for improvement of the basin-wide flood warning network. Because of the dependency of reservoir operations on rainfall/runoff forecasts, data required for the calibration and verification of the National Weather Service runoff forecasting models should also be considered in the assessment of data collection needs.

In addition to data collection, there is a need to maintain, update, and share data so it is available to users. The online data services provided by the National Weather Service and U.S. Geological Survey are highly developed for these purposes and could potentially be expanded to include additional data as monitoring is added to the collection network for the Delaware River Basin.

Developing discharge mitigation programs using storage other than flood control storage will involve assessing tradeoffs between the benefits provided by flood control voids and the costs accrued to the other reservoir purposes, including hydroelectric power, water supply, and recreational uses. Such assessments will, by necessity, need to move beyond the simple modeled analyses of stage (crest) reductions achievable through revised operations of the reservoirs, to evaluations of (i) potential reduction in flood damage (in dollar terms), and (ii) the impacts (both environmental and economic) on fisheries and other in-stream uses, water supply, reduction in power generation, and other reservoir uses. This will require the development of up-to-date stage-damage curves, to assess the former, and other up-to-date analytical tools, to assess the latter. These updated flood stage-damage curves and such other tools will need to be available, or developed, to fully assess various discharge mitigation plan options.

Recommendation: Evaluate the availability and adequacy of data necessary to implement recommendations R-1 thru R-5. Data collection should also be evaluated to ensure the most efficient means of data storage, updating, and sharing. Coordinate with the National Weather Service and U.S. Geological Survey in determining new data collection needs. Implementation of this recommendation should be coordinated with actions recommended in the Flood Warning portion of this Task Force Report.

Implementation: National Weather Service, U.S. Geological Survey, reservoir owners, DRBC

Funding Mechanism: Potential NOAA flood warning grants, Staff resources of National Weather Service, USGS, State DEP's, DRBC, reservoir owners

Estimated Cost: Staff resources required for evaluations, Costs for any new or upgraded streamflow, precipitation, or snowpack monitoring.

Implementation Time Frame: Could begin in 2007 in coordination with implementation of some flood warning recommendations.

B. Structural and Non-Structural Measures

S-1: Fund a Comprehensive Flood Mitigation Study of the Entire Delaware River Basin

S-2: Prioritize the Completion of State and Local Hazard Mitigation Plans

S-3: Ensure Financial Assistance for State, County and Municipal Mitigation Projects

S-4: Provide Training for Local Officials to Maximize Use of Available Mitigation Funding

S-5: Create Partnering Programs for Floodplain Acquisition

S-6: Establish Funding Priority Areas for Acquisition, Elevation, and Floodproofing

S-7: Maintenance of Flood Control Structures, excluding dams

S-8: Dam Safety Programs

S-9: Evaluate and Coordinate Flood Mitigation Plans and Strategies

Recommendation S-1: **Fund a Comprehensive Flood Mitigation Study of the Entire Delaware River Basin**

Finding: A comprehensive flood mitigation study of the Delaware River Basin has not been performed since the 1984 Delaware River Basin Report by the US Army Corp of Engineers. This report was authorized by Congress at the request of the Delaware River Basin Commission in response to the Tocks Island Dam deferment. Tocks Island was de-authorized by Congress in 1992. The study examined flood damage reduction alternatives for the section of the Delaware River from Burlington, NJ to Stroudsburg PA, the area that would have received flood protection from the Tocks Island Project. All practicable localized structural and non-structural flood damage reduction alternatives were investigated. This was the last comprehensive flood control study done on the main stem Delaware River.

Currently, there is a $3.9 million comprehensive effort underway to look at tidal and non-tidal flooding along the Delaware River in New Jersey. This effort is being sponsored by NJDEP.

Also ongoing is a federally funded $1 million effort by the Philadelphia District of the U.S. Army Corps of Engineers to study potential enhancements to the use and management of water resources in the Delaware River Basin. A subset of the objectives of this study relate to flood mitigation. They include an evaluation and update of storm frequency curves along the main stem Delaware, an assessment of national flood insurance claims data to identify areas of concentrated claims and structural inventories to be used in determining detailed flood vulnerability assessments.

Recommendation: The Governors of Delaware, New Jersey, New York, and Pennsylvania, as well as the respective state legislative delegation and congressional delegation should financially support a comprehensive basin-wide flood mitigation study to be performed by the U.S. Army Corps of Engineers. The study should include tidal and non-tidal reaches of the Delaware River and its tributaries. Structural and non-structural options for flood mitigation should be considered.

Implementation: U.S. Army Corps of Engineers, DRBC, Basin States

Funding Mechanism: Federal 50%, Non-Federal Sponsor 50%. The four Basin States should act in concert, led by DRBC, to jointly fund this study and act as the Non-Federal Sponsor.

Estimated Cost: $10 to $20 million

Implementation Time Frame: Feasibility Study duration is 3 to 5 years after receipt of initial Federal and Non-Federal funds.

Recommendation S-2: **Prioritize the Completion of State and Local Hazard Mitigation Plans**

Finding: The Disaster Mitigation Act of 2000 (DMA 2000) amends the Stafford Act and is the legislation designed to improve planning for, response to, and recovery from disasters by requiring state and local entities to have all hazard mitigation plans in place. The Federal Emergency Management Agency (FEMA) has issued guidelines for all hazard mitigation plans under DMA 2000 regulation. FEMA Mitigation programs require States and local governments to have approved all hazard mitigation plans to be eligible for all FEMA disaster mitigation funding. In order for a municipality to be eligible for cost-shared federal funds aimed at flood mitigation, either an approved flood and/or all hazards mitigation plan must be prepared.

All four basin states (Delaware, New Jersey, New York and Pennsylvania) have approved State Mitigation Plans. Pennsylvania has an approved Enhanced State Mitigation Plan. A State with a FEMA approved Enhanced State Mitigation Plan at the time of a disaster declaration is eligible to receive increased funds under the Hazard Mitigation Grant Program funding. The Enhanced State Mitigation Plan must demonstrate that a State has developed a comprehensive mitigation program, that the State effectively uses available mitigation funding, and that it is capable of managing the increased funding.

Recommendation S-2.1: Each municipality should create and maintain an approved all hazards mitigation plan. States should prioritize assistance to municipalities for the creation and maintenance of local Hazard Mitigation Plans to allow for access to FEMA mitigation project funding.

Recommendation S-2.2: Each Basin State should strive to obtain an Enhanced State Hazard Mitigation Plan status. In addition, each State should establish a process to address and prioritize NFIP repetitive and severe repetitive flood loss properties in their jurisdiction. Proper record keeping of all flood mitigation projects is necessary. The State Mitigation Units must receive adequate funding and personnel levels in order to carry out these tasks.

Implementation: State DEP's, State EMO's, DRBC, county and municipal governments

Recommendation S-3: **Ensure Financial Assistance for State, County and Municipal Flood Mitigation Projects**

Finding: The cost of mitigation projects identified in their respective hazard mitigation plans is often cost prohibitive for municipalities to fund individually. Some states already provide financial assistance for the non-federal share. Greater and continued federal and state financial assistance through grants and loans is needed to help ensure that the local projects can be implemented before the next flood occurs.

Recommendation S-3.1: To support the flood mitigation activities of federal agencies so that each agency's programs, knowledge and expertise are used to maximize public benefits, the basin states should provide funding of the non-federal share of State, county and/or municipal sponsored flood damage reduction projects in an equitable manner to projects assisted by all Federal agencies including but not limited to the Army Corps of Engineers, the Natural Resource Conservation Service, and Federal Emergency Management Agency.

Recommendation S-3.2: Beyond assisting with the non-federal share of project grants, each basin state should consider the creation of an on-going State funded hazard mitigation funding program. The intent of the State led program is to expand the "pot" of available mitigation funding so that more projects can be supported.

Implementation: State DEP's, State EMO's, DRBC, county and municipal governments

Recommendation S-4: **Provide Training for Local Officials to Maximize Use of Available Mitigation Funding**

Finding: Municipalities are not taking full advantage of the federal programs for acquisition and demolition of structures.

Recommendation: Through training and educational programs, encourage municipalities to make maximum use of federal and state funding for the acquisition of flood prone structures, demolition of these structures and conversion of the lands to naturally vegetative open space in perpetuity. There is a need for extensive training in various areas, such as responsibilities under the National Flood Insurance Program, developing Hazard Mitigation Plans and the application for flood mitigation grants. In addition, each County and Municipal Office of Emergency Management should consider assigning a "Mitigation Officer" to be the lead person to deal with all mitigation planning and implementation.

Implementation: DRBC, State DEP's, State EMO's, county and municipal governments

Recommendation S-5: **Create Partnering Programs for Floodplain Acquisition**

Finding: Through various open space and farmland preservation funding programs, a priority should be given to applications that are within floodplain areas. Often the land areas acquired under these programs will have restrictions that may limit their use for future flood mitigation projects that could potentially be identified in future flood mitigation plans.

Recommendation S-5.1: Through various open space and farmland preservation funding programs, a priority should be given to applications that are within floodplain areas. Programs such as Growing Greener in Pennsylvania and Green Acres/Blue Acres in New Jersey are important for providing required local matching funds in combination with federal FEMA funding.

Recommendation S-5.2: Encourage Basin States and the Federal government to provide funding for acquisition of developed and undeveloped property in the floodplain for purposes of floodplain protection and restoration and to partner with flood mitigation programs to address multiple purposes when appropriate.

Implementation: Federal Agencies, State Agencies, FEMA, DRBC, State DEP's, State EMO's, NYCDEP, PA DCNR, county and municipal governments

Recommendation S-6: **Establish Funding Priority Areas for Acquisition, Elevation, and Floodproofing**

Finding: As recently articulated by the Congressional Task Force on Natural and Beneficial Functions of the Floodplain, June 2002, floodplains "reduce flooding and limit flood-related damages through their floodwater conveyance and storage functions." As a result, protecting and restoring floodplain functions "will reduce flood losses" in addition to providing groundwater recharge, filtering sediment and contaminants, transporting nutrients, supporting habitats for a variety of sensitive living resources, providing open space that may be able to be used for multi-objective management (passive recreation, active recreation, buffers) and enhancing communities' quality of life.

Communities subject to increasing flood damages include both historic communities as well as recent development. Historic communities which have been colonized for centuries, such as Frenchtown, Lambertville, New Hope, Trenton, Yardley and others, play an important role in the history of our region and nation. New development has contributed to increasing flood damages by both placing new homes in harm's way and increasing flood flows and peaks for pre-existing communities. Floodplains will continue to flood.

Recommendation S-6.1: As recommended by the congressional task force, DRBC and states should focus available funds on implementation of natural, nonstructural solutions to reduce flood damages where practicable. Efforts should include prioritization of areas for acquisition, elevation and floodproofing of structure and/or basement utilities with emphasis in historic communities being placed on flood proofing and elevation and emphasis being placed on acquisition in all other communities.

Recommendation S-6.2: DRBC and the basin states should create a program that identifies and prioritizes individual projects within the watershed for flood-proofing, elevation or acquisition. The intent of this program would be to endorse and support prioritized projects by assisting with their funding applications so that more projects can receive cost-shared mitigation funding.

Recommendation S-6.3: The states, counties and local governments should make a concerted effort to purchase or otherwise preserve existing open space lands that are in the floodplain within the Delaware River Basin. Where necessary, these areas should be revegetated with native trees, shrubs and under story plants.

Implementation: DRBC, State agencies, county and municipal governments

Challenges: In Pennsylvania, legislation is needed to give DEP the authority to implement non-structural approaches.

Recommendation S-7: **Maintenance of Flood Control Structures, excluding dams**

Finding: Orphaned or abandoned, unmaintained flood control structures exist throughout the basin. Continued neglect of these structures could lead to catastrophic failure.

Recommendation S-7.1: Ensure adequate funding and mechanism to maintain existing flood control structures where it is demonstrated that their continuing operation provides an effective flood control measure. In evaluating flood control structures, ensure that long-term operation and maintenance costs are identified and included in all benefit/cost ratios so that the long-term functioning of the structures is not compromised.

Recommendation S-7.2: The basin states should provide adequate inspection and training of local officials, and when necessary enforcement, to ensure the integrity and maintenance of all basin flood control structures.

Recommendation S-7.3: All States have dam safety and inspection programs; however, no similar program exists for levees. An inventory to identify the nature, extent and impact of existing levees should be carried out in conjunction with Federal, State and local authorities.

Recommendation S-7.4: Legislation is needed to disband the "meadow companies" in southern New Jersey and find a responsible party to operate and maintain these levees.

Recommendation S-7.5: Owners of orphaned or abandoned, unmaintained flood control structures need to be determined and, when necessary, a mechanism must be established to transfer ownership to a new sponsor to assume maintenance responsibilities.

Implementation: State DEP's, State EMO's, county and municipal governments, DRBC

Recommendation S-8: Dam Safety Programs

Finding: Dam failures, either during dry weather or during flood events, have the potential to create catastrophic flooding in the Delaware River Basin. The basin states all have existing dam safety programs designed to require regular inspections of high hazard dams, as well as requiring dam owners to develop dam failure inundation maps and emergency action plans. Less than optimal inspection schedules, reporting and follow-ups, or inadequate response to inspection findings, have the potential to increase the threat of dam failures. In the extreme, the identification of conditions that threaten dam safety could lead to emergency drawdown of a reservoir to reduce such threats, as was recently the case at the Swinging Bridge dam on the Mongaup River.

Recommendation S-8.1: All owners of high hazard dams in the Basin should commit resources towards an appropriate inspection and maintenance program for their dams, including development of emergency action plans.

Recommendation S-8.2: Each basin state should have sufficient funding and resources for a strong dam safety inspection program, and to require repair of any inadequacies.

Recommendation S-8.3: Each basin state should support federal and/or state legislation providing funding for support of the National Dam Safety Program, state dam safety programs, and to assist with the cost of needed dam repairs and rehabilitation.

Implementation: dam owners, State dam safety agencies, FERC, State and Federal legislatures

Recommendation S-9: **Evaluate and Coordinate Flood Mitigation Plans and Strategies**

Finding: The Governors have pointed out that "The Delaware River Basin Commission is the obvious vehicle for developing flood loss reduction and flood mitigation plans that cannot be accomplished by any single state or local government but that requires a holistic watershed approach."

Recommendation S-9.1: With regard to flood mitigation and planning, the DRBC should evaluate, develop and implement policies based on recommendations of specialized focus groups including but not limited to:

- The Task Force On The Natural And Beneficial Functions Of The Floodplain, "The Natural & Beneficial Functions Of Floodplains, Reducing Flood Losses By Protecting And Restoring The Floodplain Environment, A Report For Congress", June 2002 (FEMA 409);
- The Association of Floodplain Managers (ASFPM), "National Flood Programs in Review 2000", http://www.floods.org/policy/natlpolicy.asp
- The Association of Floodplain Managers (ASFPM), No Adverse Impact (NAI) Floodplain Management, http://www.floods.org/NoAdverseImpact/whitepaper.asp,
- The Multihazard Mitigation Council, NATURAL HAZARD MITIGATION SAVES: An Independent Study to Assess the Future Savings from Mitigation Activities.

Recommendation S-9.2: The DRBC should conduct a comprehensive evaluation of flood loss and flood mitigation strategies that are currently being employed in the basin by all agencies at all levels of government to determine where enhancements to existing programs are necessary and where new ones should be created. The evaluation can examine the following: floodplain management and land use guidance and local enforcement, flood incident response for damage assessment, critical data collection, and technical assistance to local governments, flood insurance programs, and all-hazards mitigation planning efforts.

Recommendation S-9.3: The DRBC should create a model Flood Hazard Mitigation Plan for use by counties and municipalities in the Basin.

Implementation: DRBC

C. Stormwater

SM-1: Develop Regional and Tributary-Based Watershed Stormwater Management Plans

SM-2: Long-term Management of Stormwater BMPs and Infrastructure

SM-3: Non-Structural Stormwater Management for New and Redevelopment

SM-4: Enforcement of Existing Stormwater Standards and Regulations

SM-5: Provide and Promote Incentives to Reduce Stormwater Runoff from Existing Development

SM-6: Develop and Maintain Precipitation and Streamflow Data

SM-7: Create Stream Restoration and Debris Removal Guidelines

SM-8: Stormwater Management through Special Protection Waters Designation

Recommendation SM-1: **Develop and Implement Regional and Tributary-Based Stormwater Management Plans**

Finding: The purpose of stormwater management plans is to develop an understanding of existing stormwater issues, coordinate stormwater facility maintenance among those responsible for it, identify engineering standards to mitigate impacts from development and re-development and comprehensively plan for the future infrastructure. The States have provisions for the development of regional and tributary-based stormwater management plans. Yet, few regional or tributary-based stormwater management plans have been completed in the Basin due, in part, to inadequate state and local funding resources. Existing plans, developed before the implementation of the EPA Phase II stormwater rules[10], also need to be updated. Plans often include hydrologic and hydraulic modeling to identify problem areas, including those that flood, require maintenance, and need corrective action and retrofits. Once the stormwater system has been characterized through modeling and the planning process, actions that reduce flooding can be prioritized for implementation.

Recommendation SM-1.1: States should mandate and fund the development and adoption of regional and tributary-based watershed stormwater management plans in areas where appropriate. States and DRBC should prioritize the tributaries and main stem river areas that faired the worst during the past three floods for plan development. States should mandate an emphasis on volume reduction strategies, backflow prevention and use of stormwater best management practices and low impact development practices for new development, redevelopment and existing development to prevent future problems and address problems of the past.

Recommendation SM-1.2: Regional and tributary-based watershed stormwater management plans should assess the stormwater system with the most up to date hydrologic data available.[11] Hydraulic and hydrologic models of the tributary watershed should be developed.

Recommendation SM-1.3: Regional and tributary-based watershed plan developers should investigate and recommend remedial and retrofit opportunities for existing stormwater problems and local flood control[12] based on hydrologic and hydraulic analyses.

Recommendation SM-1.4: DRBC should consider the development of a Delaware River Basin-Based Stormwater Management Plan, which may include the development and implementation of basin-wide stormwater management requirements for new development, redevelopment, and for NPDES or other stormwater permits. The plans should emphasize the use of stormwater runoff prevention, low impact development, stormwater volume reduction and best management practices.

Implementation: States, DRBC, Counties, Municipalities, Stormwater Authorities

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[10] The intent of the rules is the protection of water quality but implementation has resulted in reductions in the amount of stormwater generated through the implementation of best management practices.

[11] Such as the National Oceanic and Atmospheric Administration "Precipitation-Frequency Atlas of the United States" Atlas 14, 2004.

[12] One opportunity might be extreme flood event diversion storage to further mitigate existing flooding above and beyond regulatory requirements. Flood flows would only be redirected during infrequent large events. Flows could be redirected to athletic fields, playgrounds, parklands, and other open spaces.

Funding Mechanism: State and Federal appropriations; Stormwater Authority user fees

Estimated Cost: $15 Million (one time minimum) for plans assuming half of the Basin still unstudied and approximately $200,000 per 100 square mile watershed. Costs uncertain for DRBC basin-wide stormwater management plan.

Implementation Time Frame: Immediate (Basin-wide planning within the next 5 years)

Recommendation SM-2: **Long-term Management of Stormwater Best Management Practices (BMPs) and Infrastructure**

Finding: Local governments are required to manage stormwater under the Federal Clean Water Act's National Pollution Discharge Elimination System (NPDES) permit system. Municipal separate storm sewer systems (MS4s) are required to develop and implement stormwater pollution prevention programs (SWPPP) to reduce the discharge of pollutants from their storm sewer system to the maximum extent practicable. Unfortunately, maintenance of existing stormwater infrastructure (detention ponds, inlets, catch basins, outfalls, conveyance facilities) is often inadequate due to lack of funding and dispersed responsibility (municipalities, counties, states, private land owners, and corporations). Without adequate maintenance, stormwater management facilities may not function properly and may contribute to flooding. Remedial projects such as culvert replacements or local flood control projects are also deferred or ignored due to lack of funding. A consistent and sufficient funding source for long-term maintenance of stormwater management facilities is needed. The responsibility for stormwater infrastructure management (capital planning and improvements, operations, maintenance, remedial actions, retrofits, and replacements) could be delegated to a regional entity (new or existing) to facilitate funding, consistency and accountability.

Recommendation SM-2.1: As an option for long-term maintenance of stormwater BMPs and infrastructure, each State should determine if statutory authority exists within its current regulatory framework for an entity (existing or new) to assume the responsibilities associated with the management of stormwater infrastructure (capital planning and improvements, operations, maintenance, remedial actions, retrofits, and replacements) on a regional or watershed basis. Specifically, statutes should allow the authority or entity to provide dedicated funding for planning and plan implementation (see SM-1), operations, maintenance, rehabilitation, and new facilities. State laws must allow the oversight entity all appropriate powers and liabilities necessary to execute the actions required to manage the stormwater system. Additional or new legislation, if needed, should be promulgated to allow and empower stormwater oversight entities. States should work with such entities to develop watershed-based or regional stormwater management plans.

Recommendation SM-2.2: States and municipalities should provide a sufficient, dedicated annual funding source to manage and maintain the stormwater conveyance system and associated structures, mitigate known problems, and plan for the future. FEMA should provide funding through the Hazard Mitigation Program to assist municipalities with remedial projects.

Recommendation SM-2.3: States should investigate the opportunities for existing entities, such as counties or wastewater utilities, or new entities, such as stormwater authorities, to facilitate and ensure stormwater management, maintenance and planning.

Implementation: State legislature, State Environmental Agencies, Counties, Municipalities

Funding Mechanism: Staff time (legislation), grants, appropriated funds

Estimated Cost: $40 Million for maintenance annually assuming approximately half of the basin's municipalities need funding or funding supplements of $100,000 per year. Remedial needs extensive but costs unknown.

Implementation Time Frame: Short-term (propose legislation); Long-term (assumption of responsibility or formation of authorities)

Recommendation SM-3: Non-structural Stormwater Management for New Development and Redevelopment

Finding: The use of nonstructural stormwater management strategies is widely recognized as beneficial in reducing the generation of stormwater onsite and the impact of stormwater from a site. Non-structural strategies may include, but are not limited to, requirements for the use of better site design, Low Impact Development (LID) and Green Technologies, limitations on impervious surfaces, clustering, changes to zoning densities, infiltration, stormwater reuse, onsite re-vegetation, vegetated buffers and habitat restoration projects. However, few states have mandated criteria requiring the use of non-structural stormwater management measures and developers have expressed uncertainty about their use.

Recommendation SM-3.1: States should require low impact development practices, non-structural stormwater management strategies, stormwater volume reduction and water quality enhancement for all new development and redevelopment draining into the Delaware River. Requirements for non-structural practices should be prescriptive such that all possibilities for use are exhausted before consideration of structural measures.[13]

Recommendation SM-3.2: States should develop and conduct a technical education program(s) about the use and implementation of non-structural stormwater management practices for land development professionals (regulators, reviewers, planners, architects, engineers, designers, and contractors).

Recommendation SM-3.3: States should develop and conduct an education program for the public, elected officials and decision makers to explain the benefits of non-structural approaches to stormwater management and how their use benefits the community and will lessen the impact of new development and redevelopment on existing flooding problems.

Recommendation SM-3.3: The DRBC should coordinate and craft a model ordinance that recognizes the existing efforts and approaches of the States.

Implementation: States, local and county ordinances, State permits, Stormwater Authority, DRBC

Funding Mechanism: Municipalities, Developers application fees; State, State permit fees should include not only the review of the particular application, but also the subsequent inspections by State staff.

Implementation Time Frame: Immediate

[13] As an example, see New Jersey's non-structural point system program at http://www.njstormwater.org/pdf/nsps_userguide2006013.pdf

Recommendation SM-4: Enforcement of Existing Stormwater Standards and Regulations

Finding: Each State has different engineering standards for stormwater management and soil and erosion control, which are applied through municipal ordinances. Municipalities may waive standards, require mitigation or accept cash in lieu of facilities as part of the give and take development approval process. Municipal enforcement of approved development plans is also inconsistent regarding construction inspection, correction of violations and requirements for as-built plans and earth disturbance thresholds. Stormwater flows to tributaries within watersheds, not political boundaries; therefore, one municipality's implementation of stormwater management requirements affects all other municipalities located downstream.

Recommendation SM-4.1: States should ensure compliance with existing state stormwater management laws and regulations at the municipal level. The preference would be to have unified stormwater management standards among all municipalities within the Delaware River Basin, but until such standards can be developed[14], more consistent implementation of existing regulations is needed.

Recommendation SM-4.2: To ensure long-term functionality of stormwater infrastructure, municipal separate storm sewer systems (MS4s) are required by permit to implement an inspection and maintenance program. Municipalities should ensure that stormwater infrastructure (both the conveyance system and contributing BMPs) undergo detailed inspections and that adequate maintenance is performed regularly for the protection of public safety.

Implementation: States, Municipalities; Delegated Entities (counties, conservation districts)

Funding Mechanism: Staff time; Review and inspection costs paid by developers applying for approvals.

Implementation Time Frame: Immediate

[14] Unification of stormwater management standards can be implemented through regional and tributary-based watershed planning (see SM-1).

Recommendation SM-5: Provide and Promote Incentives to Reduce Stormwater Runoff from Existing Development

Finding: Many regulations are in place to regulate the stormwater from new development and redevelopment. Such regulations will only lessen the impacts on flooding from new development and redevelopment through requirements of best management practices (BMPs). However, few regulations have the authority to mandate additional management of stormwater generated from existing development, which may be the most significant contributor to flooding. Retrofits to existing stormwater management systems and structures and land use management BMPs are rarely installed due to cost and/or availability of land. Land management practices include vegetated buffers[15] along streams, re-vegetation of large lawn areas[16], installation of porous pavement and redesigning detention basins to be infiltration basins, among others. These BMPs and retrofits may reduce flooding caused by stormwater runoff from existing developments, particularly more frequent, localized flooding.

Incentives are available to agricultural landowners through various programs for actions that will improve water quality, not quantity. Enrollment is limited to farms participating in specific programs with rigorous requirements. For incentives on existing development NYC DEP[17]with the Catskill Watershed Corporation has developed a stormwater retrofit program, which provides a 75% cost-share for the retrofitting of existing sites to treat stormwater runoff in the Catskill and Delaware (West of Hudson) watersheds. Over 35 projects have been completed for $3.9 million dollars, including a seeding program; installation of stormwater collection, conveyance and treatment structures in residential areas; and purchase of a truck-mounted "vac-all" for the maintenance of stormwater structures. However, in other areas of the Delaware River Basin, few incentives, if any, are available for retrofitting residential and commercial development with enhanced BMPs. Incentives and mechanisms are needed to provide for retrofit and remediation of poorly functioning stormwater management systems.

Recommendation SM-5.1: States should investigate and implement opportunities for reduction, control, infiltration and reuse of stormwater in existing development, including retrofits of onsite stormwater facilities and best management practices for existing developed sites. Such opportunities may include the preservation and/or installation of vegetated buffers along streams, replacement of large lawn areas with native grassland vegetation, vegetated rooftops, retrofitting detention basins for infiltration, re-routing parking lot and roof runoff from impervious areas and storm drains to pervious areas, and replacing older BMPs with more advanced technology.

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[15] Vegetative buffers absorb and hold stormwater, gradually releasing the water back to the stream over a longer period of time (than less vegetated areas), which helps regulate the flow and reduce downstream flooding during a storm.

[16] Large lawn areas, compacted during construction, essentially act as large impervious surfaces, doing little to infiltrate water or slow runoff velocity. Lawn areas can be replaced with low maintenance native warm season grasses, wildflowers, trees, and shrubs. The additional vegetation intercepts overland flow and may reduce the velocity with which stormwater enters the stormwater drainage system or stream channel.

[17] Refer to the following websites for details http://www.nyc.gov/html/dep/watershed/html/stormretro.html# and http://www.cwconline.org/programs/strm_wtr/strm_wtr.html. The New York City Watershed Memorandum of Agreement with New York State, EPA, and other groups mandated the program.

Recommendation SM-5.2: States should secure funding for incentive-based programs, similar to NYC DEP Stormwater Retrofit Programs and other agricultural incentive programs for retrofits of poorly functioning stormwater management systems and changes in land use practices.

Implementation: Federal, State, Local, Stormwater Authority

Funding Mechanism: State and Federal Grants, Low interest loans

Implementation Time Frame: Immediate

Recommendation SM-6: Develop and Maintain Precipitation and Streamflow Data

Finding: Accurate understanding of stormwater management (and flooding) issues is possible only with accurate precipitation and streamflow data throughout a watershed. Hydrologic relationships and standards are based on statistical analysis of recorded data to determine probabilities of occurrence. One-time or infrequent recording of data provides less than optimum statistical analyses. Further, stormwater management and flooding are based on relatively infrequent events typically thought of as 2-year, 10-year, 100-year or even higher return periods. Often misunderstood, these terms **do not** mean the intervals between like events. For example, two events (precipitation or flooding) that hydrologists consider statistically as 100-year events could occur in consecutive years or even multiple times in a single year. The facts are that our ability to classify extreme events is hampered by lack of long-term recording of precipitation and runoff data. Long-term, for these purposes, is data of a minimum of 100 years. With shorter periods of record, the hydrologic relationships shift with new events (such as three severe events on the Delaware River in three years serving to re-define a 100-year flood). Accurate definition of extreme events is critical for creating hydrologic analyses to support stormwater management planning and for accurate floodplain delineations and evaluation/design of flood control measures.

Recommendation SM-6.1: DRBC, USGS, NWS/NOAA and the States should maintain continuous precipitation, streamflow and tide gages throughout the Delaware River Basin to provide data needed to establish current statistical probabilities of severe events.

Recommendation SM-6.2: NOAA, NWS and USGS should provide bi-annual updates, plus non-routine updates after significant events, of the statistical precipitation and runoff evaluations at all gages to provide current estimates of design return period events for use in watershed modeling and planning studies.

Implementation: DRBC, USGS, NWS/NOAA, States

Funding Mechanism: Federal government with possible state and local cost-share.

Estimated Costs:
Continuous streamflow gage: $30,000 installation with $14,000 for Operation and Maintenance (O&M), per gage, annually
Precipitation gage: $1,600; O&M; $4,000 (new and more expensive equipment is expected to be the standard soon) per gage, annually.
Tidal gage: $8,500; O&M: $14,000 per gage, annually.

Implementation Time Frame: Immediate and on-going

Recommendation SM-7: Create Stream Restoration and Debris Removal Guidelines

Finding: Protecting healthy stream channels and maintaining functioning conveyance systems for the efficient movement of stormwater is an essential component of flood management. Obstructed drainage systems, culverts, bridge openings and stream channels may create backwater conditions and cause localized flooding. However, some types of natural woody debris in the stream channel provide flood reduction benefits, reduction of streamflow velocities, erosion protection, as well as food and habitat for aquatic life. Debris removal and/or conveyance maintenance may become necessary as the result of individual or accumulated flood events or be required in advance of storm events to minimize flooding. Communities have expressed concern, confusion and frustration about the permitting process and fees for this work. After the most recent major flooding events, some municipalities performing emergency repairs imparted significant ecological damage to the stream with the use of heavy equipment and uninformed practices. Debris removal or conveyance maintenance must consider and preserve the hydrologic, hydraulic and ecological function of the stream.

Recommendation SM-7.1: States should examine the current practices of debris removal and/or conveyance maintenance and the associated permitting processes. States need to develop guidelines, best management practices (BMPs) and categories of actions (general maintenance, pre-flood, emergency, and post-flood) and define which are allowed under each type of permitting program (emergency, by-rule, general, individual, other) and activities that are considered de minimis activities for which no permit is needed. States also should examine how each permit program (including fees) affects the timing and execution of the work. Office of Emergency Management (OEM) officials, public works officials, watershed groups and engineers with knowledge in hydrology, geomorphology, and natural channel design and other appropriate experts should be included in the development of the guidelines and evaluation of the permitting programs. States should develop educational programs to explain what actions are considered appropriate under different permit programs and BMPs.

Recommendation SM-7.2: States should develop a professional certification program in natural stream channel restoration and BMPs for public works officials, contractors, engineers and others and consider requiring oversight by a certified professional for all types of work within the stream.

Recommendation SM-7.3: States should require restoration of areas damaged by debris removal and conveyance maintenance, including access pathways.

Implementation: State environmental and natural resource agencies, DRBC, US Fish and Wildlife Service, National Park Service, Delaware Riverkeeper Network, NYCDEP, watershed groups, local OEM and public works officials

Funding Mechanism: Staff time; EPA grants for educational component

Implementation Time Frame: Immediate

Recommendation SM-8: Stormwater Management through Special Protection Waters Designation

Finding: The DRBC has designated the Lower Delaware River as interim Special Protection Waters. The Special Protection Waters designation protects the water quality of the Lower Delaware River and requires new and expanding facilities to create and implement nonpoint source pollution control plans, which must provide a reduction in polluted stormwater runoff through its implementation. Both water quality and water quantity benefits can be realized by stressing the use of best management practices (BMPs) that minimize the onsite generation of stormwater and infiltration strategies to reduce the runoff volume and peak rate.

Recommendation SM-8.1: DRBC should grant permanent Special Protection Waters designation to the Lower Delaware River.

Recommendation SM-8.2: When approving nonpoint source pollution control plans, DRBC should require the use of BMPs that minimize the generation of runoff, reduce runoff velocities, infiltrate stormwater and protect and restore water quality.

Recommendation SM-8.3: DRBC should develop a Special Protection Water guidance manual.

Implementation: DRBC, Delaware Riverkeeper Network

Funding Mechanism: Staff time; application fees

Implementation Time Frame: Immediate

D. Floodplain Mapping

FM-1: Coordinated Flood Study and Mapping Updates

FM-2: Incorporate Existing and Future Planned Development and Residual Risk Zones into New Mapping

FM-3: Redefine and Remap the Floodway along the Delaware River Main stem and its Tributaries

Recommendation FM-1: Coordinated Flood Study and Mapping Updates

Finding: Existing floodplain maps along the Delaware River are based on pre-1985 studies that may underestimate the current 100-year flood elevation, the floodways, and flood hazard areas. Along common stretches of river, current maps for New Jersey and New York are not consistent with those of Pennsylvania. New development could be proposed in flood prone areas that are not identified as floodplain on existing maps.

The NJDEP, PADCED and NYSDEC are currently working together with FEMA to complete a five-year digital map modernization program, based on countywide studies rather than municipal studies. The countywide studies insure more consistent information between municipalities and provide a digital environment that allows for easier revisions and updates.

In New Jersey, the NJDEP has set aside $1,000,000 to begin the preparation of new floodplain delineations and associated mapping for the main stem of the Delaware River along Mercer, Hunterdon, Warren and Sussex Counties. On May 16, 2006, the NJDEP executed a Cooperative Technical Partnership (CTP) agreement with FEMA in order to leverage state funding with the current federal Flood Map Modernization Program resources.

The NJDEP is also coordinating with USGS, USACE and FEMA on the development of updated hydrologic information for the Delaware River, which will be incorporated into the hydraulic modeling for the new mapping. Also, it is expected that current Light Detection and Ranging (LiDAR) information for Mercer, Hunterdon and Warren Counties will be used for this effort. This state of the art new mapping will be a valuable resource during times of emergency and for the regulation of land use along the floodplain area. The goal of this mapping effort is to more accurately define the limits of the flood hazard area and associated base flood elevation.

In New York, the NYSDEC in cooperation with FEMA and NYCDEP will soon begin county-wide DFIRM mapping, with full LiDAR, in the three New York counties that contain parts of the Delaware Basin: Delaware, Sullivan and Ulster Counties. A small portion of Broome County is also in the Delaware Basin, and that is scheduled for DFIRM mapping in 2007. Orange County is currently being remapped by FEMA as part of the Map Modernization plan. NYCDEP has committed itself to pay the full amount for detailed floodplain mapping within its West of Hudson watersheds, including headwater reaches and tributaries to the Pepacton, Cannonsville and Neversink Reservoirs.

FEMA is attempting to get final approval to develop Flood Advisory Maps for portions of the Delaware Basin in NY that experienced greater than 100-year anticipated flood flows in June 2006. FEMA has already completed Flood Advisory Maps for portions of the Neversink River and East Branch Delaware River as a result of the April 2005 floods. The Flood Advisory Map data will be incorporated into countywide DFIRMS.

In Pennsylvania, the Delaware Valley Regional Planning Commission (DVRPC) is currently preparing LiDAR data for various counties in PA that will be used by FEMA. The database revisions of the official FEMA Flood Insurance Rate Maps (FIRMs), which will primarily benefit Philadelphia and its surrounding counties, will more effectively display possible flood affected areas. DCNR is also gathering LiDAR data throughout parts of Pennsylvania

affected by Hurricane Ivan in 2004. FEMA contractors have identified and surveyed high water marks from the June 2006 flood throughout the Basin this past summer. FEMA will use this data to evaluate the accuracy of the current 100 year flood levels, and the actual updates of the various flood frequencies should it be necessary. FEMA and DCED are partnering with USGS to update flood-frequency data at streamgaging stations and peak-flow regression equations used in Pennsylvania. The results will be displayed on the internet using USGS StreamStats web application.

Recommendation: The NJDEP, PADEP, PADCED and NYSDEC in coordination with federal entities (e.g. FEMA, USGS, USACE), should develop new floodplain delineations and associated mapping for the main stem and significant tributaries of the Delaware River. The new study should include updated hydrology (i.e. updated flood frequencies), verification of stage discharge curves, LiDAR elevation data or topography within two-foot accuracy with finer resolution when required, state of the art hydraulic modeling and new delineations. Before initiating the study there should be concurrence on the methodology among DRBC, FEMA, NJDEP, NWS, PADEP, PADCED and NYSDEC.

The new delineations should be used to produce inundation maps for emergency management, be tied into NWS forecast locations where inundation forecasts are necessary and serve as basic input to FEMA's map modernization initiative. Taken together, the floodplain maps (verified by field inspection), inundation maps and modernized FIRM (flood insurance rate) maps should yield the most credible state of the art floodplain delineations that will support flood mitigation before, during and after flood events.

Implementation: NJDEP, PADEP, PADCED, NYSDEC, FEMA, USGS, NWS

Funding Mechanism: FEMA Map Modernization funds; NYC DEP funding for areas in the NYC water supply watersheds; NYSDEC; NJDEP, PADEP, PADCED, et al.

Estimated Cost: To Be Determined (NYS portion estimated at $10 million)

Implementation Time Frame: As soon as possible or could be coordinated with FEMA’s Map Modernization Program schedule.

Challenges: The assortment of mapping projects must be coordinated so that there is a consistent methodology and results.

FEMA Map Modernization funds are not sufficient. States must contribute funding and Congress must ensure that FEMA Map Modernization program continues to be fully funded.

Recommendation FM-2: Incorporate Existing and Future Planned Development and Residual Risk Zones into New Mapping

Finding: Future development is not typically taken into consideration during the development of floodplain maps to identify flood-prone areas. As future development occurs, runoff from that development may increase flows in flood-prone areas downstream. In NJ, for State land use regulatory permits required by the NJDEP, the NJ Flood Hazard Area Maps are defined by the 100-year event peak flow rate plus 25%. This 25% safety factor is incorporated to take into account future build-out. DE, PA, NY, and local communities within NJ currently use the 100-year event without any considerations for future build-out.

It is also important to consider that although an area may be located outside of the 100-year or the 100-year plus 25% floodplain, it does not completely rule out the possibility that the area may be susceptible to potential flooding impacts. For example, an area could be flooded by a larger event like the 500-year frequency event. In addition, an uncontrolled release of water during either a non-storm or storm event, like the catastrophic failure of an upstream dam or the breach of a levee, could result in significant flooding impacts beyond anticipated 100-year floods

Recommendation FM-2.1: Current and future planned development should be taken into consideration when preparing new floodplain maps for the main stem of the Delaware River and other streams and rivers within the Delaware Basin. Floodplain maps should include a residual risk factor of at least 25% to consider current and future planned development, to recognize possible variability's in hydrologic modeling, to consider temporary blockages to culverts and other hydraulic impediments that may exist from time to time, and to more accurately define flood risk. Updated flood-frequency data are needed in order to add the appropriate 25% to the appropriate base level of the 100-year flood flow.

Recommendation FM-2.2: Residual risk zones, including the 500-year floodplain and areas subject to levee or dam failures, should also be taken into consideration when preparing new floodplain maps for the main stem of the Delaware River and other streams and rivers within the Delaware Basin.

Implementation: NJDEP, PADEP, PADCED, PA Consortium, NYSDEC, FEMA

Funding Mechanism: Partial funding through FEMA Map Modernization

Estimated Cost: To Be Determined

Implementation Time Frame: As soon as possible or could be coordinated with FEMA's Map Modernization Program schedule.

Challenges: This would require an adjustment in floodplain map scoping for projects that are already funded and ongoing. Also, this cannot be implemented unless the local communities request it OR unless State law is changed to require it.

The vehicle that could be used to promote the benefits of this initiative to local communities is the Community Rating Systems (CRS). Under the CRS program, there is an incentive for communities to do more than just regulate construction to minimum National Flood Insurance Program (NFIP) standards. Residents of communities that adopt higher regulatory standards would be eligible to receive a reduction in their flood insurance premiums.

Homeland Security protocols and guidelines regarding the distribution of sensitive materials like dam and levee failure inundation maps need to be considered.

FEMA Map Modernization funds are not sufficient. States must contribute funding and Congress must ensure that the FEMA Map Modernization program continues to be fully funded.

Recommendation FM-3: Redefine and Remap the Floodway along the Delaware River Main stem and its Tributaries

Finding: The existing flood hazard area maps greatly underestimate the limit of the floodway along the main stem Delaware River and other waterways within the Delaware River Basin. The flood hazard area, or floodplain, is the area along a waterway that is expected to be or has been inundated by floodwaters. The floodway, which is the inner portion of the flood hazard area nearest the stream or river, is the most dangerous area that carries deeper flows and higher velocities during a flood. New construction is generally prohibited in floodways because it is unsafe and obstructs the passage of floodwaters. However, areas immediately adjacent to floodways where development is commonly allowed are often subject to flood depths and velocities similar to those of the floodway.

A regulatory floodway is defined as the channel of a river or other watercourse and portions of the floodplain adjoining the channel that must be reserved in order to carry and discharge the base (or 100-year) flood without cumulatively increasing the water surface elevation more than a designated height. The minimum FEMA floodway determination allows for a 1.0-ft rise. The current New Jersey State floodway standard, allows for a more conservative 0.2-ft. rise in flood depths. This more stringent, lower rise determination results in a larger regulatory floodway. Even though NJ has adopted this more stringent standard on its in-state waterways, the less stringent FEMA standard was used to delimit the floodway for the main stem of the Delaware River to avoid inconsistencies between different floodway criteria on the New Jersey and Pennsylvania sides of the river. Both Pennsylvania and New York allow a 1.0-ft rise floodway standard throughout the Delaware River Basin.

As a result, designated floodways are extremely narrow along the Delaware and new construction is sometimes improperly permitted in close proximity to streams and rivers simply because they are not currently demarcated as floodways. Communities must regulate development in these floodways to ensure that there are no increases in upstream flood elevations. Greater portions of communities would likely lie within mapped floodways if the 0.2-ft floodway standard were to be used. Adequately defining the floodway and regulating development in these floodways is one way to ensure flood loss reduction.

Recommendation FM-3.1: NJDEP, PADEP, PADCED and NYSDEC should evaluate their existing flood hazard maps in order to determine whether a more stringent standard should be used to define floodway boundaries throughout the Delaware River Basin. A comparison should be made between the current mapping protocol, which uses a 0.2-ft rise in flood depths in New Jersey and a 1.0-ft rise in both Pennsylvania and New York to delineate floodways, with floodway boundaries calculated using a 0.1-ft rise, which is more conservative and likely to expand floodway widths. Such a change could help to prevent new construction in close proximity to streams and rivers in many areas.

If the NJDEP, PADEP, PADCED and NYSDEC subsequently determine that re-mapping their floodways is necessary to ensure that the public is adequately protected from the hazards of new construction in areas prone to severe flooding, the States should then adopt a new floodway standard for flood hazard mapping throughout the Delaware Basin and revise the floodway maps accordingly.

Beyond remapping the floodway, communities and states can also choose to have more stringent regulations than the FEMA NFIP minimum standards within the current mapping constraints. One example is New Castle County, Delaware where their floodplain regulations state that no fill or residential construction is allowed in the floodplain. (National minimum regulations only dictate this type of constraint in the floodway.) This example of a more stringent floodplain regulation achieves a similar and even more stringent goal than redefining the current floodway.

Implementation: NJDEP, PADEP, PADCED or PA Consortium, NYSDEC, FEMA

Funding Mechanism: Partial funding through FEMA Map Modernization

Estimated Cost: To Be Determined

Implementation Time Frame: As soon as possible or could be coordinated with FEMA's Map Modernization Program schedule.

Challenges: The comparison should include main stem as well as upland streams. In upland areas, expansion of the floodway could encompass the entire floodplain. This will present a significant challenge to mountain communities in narrow valleys. Local communities outside of New Jersey would have to adopt the more conservative floodway standard into their local laws. (In NY and PA, local communities would need to request this OR State law would need to be changed to require this.)

The vehicle that could be used to promote the benefits of this initiative to local communities is the CRS. Under the CRS program, there is an incentive for communities to do more than just regulate construction to minimum NFIP standards. Residents of communities that adopt higher regulatory standards would be eligible to receive a reduction in their flood insurance premiums.

FEMA Map Modernization funds are not sufficient. States must contribute funding and Congress must ensure that the FEMA Map Modernization program continues to be fully funded.

E. Floodplain Regulations

FR-1: Catalog, Evaluate and Update Existing Floodplain Regulations in the Basin

FR-2: Develop a Coordinated Education, Outreach and Training Program

FR-3: Repetitive Loss Reduction Strategy for the Basin

FR-4: Flood Hazard Disclosure Requirements

FR-5: Standardized Riparian Corridors

Recommendation FR-1: Catalog, Evaluate and Update Existing Floodplain Regulations in the Basin

Finding: There is no consistent set of floodplain regulations basinwide to uniformly manage development within the floodplain areas of the basin. Currently, floodplain regulations vary widely from State to State and often from community to community. As a result, development may be occurring in the floodplain of one State or community that may be adversely affecting other States and communities. Development in the floodplain individually and cumulatively results in adverse impacts somewhere in the watershed. These adverse impacts can include increased flood stages, increased velocities, erosion and sedimentation, water quality degradation and habitat loss. In addition to these negative effects, development in the floodplain disturbs naturally vegetated riparian corridors and often threatens the safety of both residents and emergency personnel in the event of a flood.

For each community to participate in the National Flood Insurance Program (NFIP), it must adopt by ordinance the minimum Federal standards contained in the Flood Damage Prevention Ordinance. NFIP establishes the minimum level of protection from development that should be provided to floodplain areas. Local communities and states are encouraged to provide a greater level of protection than the NFIP minimum provides.

In determining suggested revisions to the floodplain regulations, the No Adverse Impact (NAI) concept for floodplain management should be evaluated and principles and means of implementation that follow the NAI concept should be proposed. The NAI approach was developed by the Association of State Floodplain Managers (ASFPM) and is defined as follows, "No Adverse Impact floodplain management is an approach which ensures that the actions of one property owner or a community do not adversely impact the properties and rights of other property owners." A few major principles of NAI that should be evaluated and considered for the Delaware River Basin include:

1) No Net Rise – New floodplain development must be designed so that it does not increase flood heights

2) Compensatory Storage – Any fill in the floodplain must be compensated by the provision of an equal volume of storage to replace what is lost. This reinforces the No Net Rise provision by preserving the ability of the floodplain to store water.

3) Minimum Flood Corridor – The purpose of the corridor, which applies to all mapped floodplains, is to provide a natural buffer which absorbs stormwater, stabilizes stream banks, filters pollutants, and protects aquatic life. The width of the buffer is established in proportion to the size of the stream channel.

4) Best Available Information – If mapping is available which exceeds FEMA's standards, or includes floodplain delineation for smaller steams not included on FEMA floodplain maps, such mapping is used to apply the floodplain regulations. This allows the use of more accurate and comprehensive mapping where available. One example of such mapping in the Delaware River Basin is the recent mapping completed for the Pennypack watershed in Montgomery County, PA. It should be noted that this detailed restudy required a certain level of resources.

All States and municipalities should be encouraged to adopt floodplain protection regulations and ordinances that surpass the NFIP minimum, embrace the no adverse impact approach of the ASFPM and, to the maximum extent possible, prevent future construction, fill or devegetation of the 100 year floodplain.

The Delaware River Basin Commission adopted Flood Plain Regulations on November 10, 1976. The regulations went into effect on January 1, 1977. The standards of floodplain use contained in these regulations apply to the non-tidal portions of the Delaware River and its tributaries. They were designed as minimum compliance standards to be followed by local units of government in the promulgation of flood plain regulation ordinances. The floodplain regulations are utilized by the Delaware River Basin Commission in reviewing certain categories of water-related projects pursuant to Section 3.8 of the Delaware River Basin Compact. This includes, but is not limited to, wastewater treatment plant effluents greater than 50,000 gpd and surface water withdrawals greater than 100,000 gpd. The regulations should be evaluated and updated in accordance with current floodplain management guidance.

Recommendation FR-1.1: Existing DRBC, State, county and local floodplain regulations should be cataloged and evaluated.

Recommendation FR-1.2: A consistent set of comprehensive floodplain regulations beyond minimum NFIP standards needs to be implemented across the entire Delaware River Basin, which responsibly reflects the conditions and needs of the various watershed regions within the basin. For example, there should be a consideration of how the regulations need to respond to the differing conditions of the headwaters, fluvial and bay areas, as well as, the upland, piedmont and estuary regions.

Specifically, these regulations should reflect and include, at a minimum, the following:

- A prohibition on new buildings in the floodway
- A restriction on the volume of flood storage that can be displaced in the flood fringe
- Standards for the lowest habitable floor of new buildings
- A mechanism to reasonably deal with repetitive loss structures
- A requirement to elevate new roadways where feasible
- A recognition of the importance of riparian corridors and measures to protect and restore natural vegetation and habitat in these areas

The establishment of a joint working group or basin legislator forum is needed to compose and implement a set of comprehensive basinwide floodplain regulations. Every effort should be made to encourage New Jersey, New York, Pennsylvania and Delaware to participate in the establishment and adoption of a set of consistent regulations within the Delaware River basin under the auspices of the Delaware River Basin Commission.

All implementation and enforcement is encouraged to remain under the existing framework whether State or local.

Recommendation FR-1.3: A model ordinance recommending more beneficial floodplain regulations should be developed for the communities of the basin with basinwide regulations and standards set. Examples of concepts to be contained in the model ordinance include

freeboard recommendations, compensatory storage, and a means for communities to determine the requirement for substantial improvement through a cumulative sum. There should be a cumulative loss count taking into consideration all payments made for a particular structure. Once the cumulative loss figure reaches over 50% the property must go on a high priority list for purchase and have greater access to funds for elevation and/or purchase with homes willing to accept a purchase being given a higher priority.

Recommendation FR-1.4: The Delaware River Basin Commission Floodplain Regulations need to be evaluated and updated based on current floodplain management guidance. The new regulations should apply to both freshwater and estuarine and saline waterways in the basin and should be applicable to all floodplain development.

Implementation: Basin states, State NFIP coordinators, FEMA, DRBC, county planning and engineering departments, municipalities, Delaware Riverkeeper Network, watershed groups, local code officials and local floodplain administrators

Challenges:
Each of the basin's 838 communities will need to be contacted to properly assess all existing floodplain management practices within the basin.

The implementation mechanism and resulting enforcement differs in each State.

Any change in the determination of the floodway would require remapping by FEMA.

Drafting the model ordinance will not be difficult once a comprehensive set of floodplain regulations is constructed for the basin, per recommendation FP-2 above. However it will take much longer for each of the basin's 838 communities to review and adopt these regulations. The process could take several years and there could be resistance in some communities.

Recommendation FR-2: Develop a Coordinated Education, Outreach and Training Program

Finding: Enforcement of floodplain regulations often occurs at the local level by local officials. Floodplain managers come from a variety of curricula and backgrounds. In small communities, floodplain managers are sometimes part-time employees. The role of these floodplain managers is expanding due to increases in disaster losses and the emphasis being placed upon mitigation to alleviate the cycle of damage-rebuild-damage. There is a need for a coordinated education, outreach and training program in the basin for floodplain managers, local planning and zoning boards, professionals and the public. Communities need to be armed with the proper knowledge to properly evaluate whether development is reasonably safe from flooding or will exacerbate local flooding conditions.

Recommendation: A coordinated education, outreach and training program needs to be developed in the basin for floodplain managers, local planning and zoning boards, professionals and the public. The expansion of floodplain awareness and strengthened floodplain regulations basinwide will allow for better planning and stricter protection of floodplains in the future.

The Certified Floodplain Managers (CFM) certification should be encouraged for all local floodplain managers and professionals. This national certification is supported by the Association of State Floodplain Managers (ASFPM) and lays the foundation for ensuring that highly qualified individuals are available to meet the challenge of breaking the damage cycle and stopping its negative drain on the nation's human, financial, and natural resources.

The local State chapters of ASFPM, the New Jersey Association of Floodplain Managers (NJAFM) and the New York State Floodplain and Stormwater Managers Association (NYSFSMA) are expected to be able to coordinate and help greatly with this task. Pennsylvania and Delaware are encouraged to consider implementing State chapters.

Implementation: FEMA, DCA, PADEP, PADCED, NJDEP, NYDEC, DRBC, ASFPM, NJAFM, NYSFSMA, DRN

Challenges: Given the large number of people that would necessarily be involved and impacted by such an effort, the coordination and funding of the program would likely be the biggest challenges.

Recommendation FR-3: Repetitive Loss Reduction Strategy for the Basin

Finding: There is a need for a repetitive loss reduction strategy to prioritize funding sources and areas in the basin. Many local communities and counties in the basin have scarce resources and are in need of technical assistance to prepare and prioritize applications for Federal funding; such as acquisition and elevation programs.

Recommendation: The Delaware River Basin should be a priority area for acquisition and elevation efforts. Consequently, a repetitive loss reduction strategy should be developed for the basin so that at-risk structures can successfully compete for funding sources. This strategy should include a well-rounded program that encourages, at a minimum, the following:

- The offer and acceptance of buyouts for repetitive loss properties
- Funding sufficient to provide fair market value for purchased properties
- Assistance in relocating flood victims into homes with affordable mortgage rates
- Adequate food-proofing of non-residential and historic structures, which cannot feasibly be purchased or elevated

Additionally, the State, county and local governments should make a concerted effort to better utilize the existing state funding sources for the purposes of purchasing, preserving and restoring flood prone lands in the Delaware River Basin. States should also encourage municipalities to make maximum use of federal funding (i.e. FEMA and NRCS) for the acquisition of flood prone structures, demolition of these structures and conversion of the lands to naturally vegetated open space by providing funding to assist with the non-Federal share of municipal sponsored mitigation projects funded by FEMA as part of the Hazard Mitigation Grant Program.

Efforts should include prioritization of areas for acquisition. Furthermore, historic communities should be targeted for flood proofing and elevation, while priority should be given to acquire and remove structures in non-historic communities. In cases where the Army Corps of Engineers has recommended and approved such measures, consideration should be given to the placement of structural measures, such as levees and flood retention walls, to protect non-commercial structures in non-historic communities.

States should also create and implement programs to remove highly vulnerable public works structures from the floodplain with a special emphasis on wastewater treatment plants that are routinely overwhelmed by floodwaters, and which discharge untreated or partially treated sewage into surface waters. As part of this program, all public works without a National Historic Register (NHR) listing that have experienced repetitive loss should be phased out by requiring removal from the floodplain upon substantial change, wherever feasible.

Implementation: FEMA Region II, FEMA Region III, DRBC, PEMA, NJOEM, SEMO, NRCS

Funding Mechanism: FEMA funding, NRCS Watershed Program funding
Challenges: Effective mitigation requires increased Federal and State funding as well as the cooperation and coordination of residents, elected officials and all Federal, State and local agencies with flood mitigation responsibilities.

Recommendation FR-4: Flood Hazard Disclosure Requirements

Finding: Property owners may first become aware they are living in a flood prone area either after they have experienced flooding or when a lender for a federally-insured mortgage company requires flood insurance. Although homeowners that require a federally-insured mortgage are required to prove they are not in a floodplain, other mechanisms need to be in place to alert those people buying homes without a mortgage and for those cases where no buildings yet exist onsite. Even for those homeowners who do have flood insurance, they may be unaware of the actual potential for flooding and actions that they can take to minimize damage.

Recommendation: The States should adopt flood hazard disclosure requirements for all real estate transactions. To the extent that a current property owner is aware of the flood history of a site, these facts should be made known in writing to any potential buyers of the property either by the property owner or the real estate licensee responsible for selling the property. Such notifications should be filed with the host municipality. The existence of permits or other documentation from the States, flood insurance records, easements onsite or tax records should be part of the disclosure requirements. Additionally, flood insurance companies should provide reminders to their policyholders, at the time of policy renewal, that they live in a flood prone area and include steps they can take to minimize loss.

Implementation: State Insurance Regulators

Challenges: Legislation required.

Recommendation FR-5: Standardized riparian corridors should be considered along all basin streams, rivers and estuary waters.

Finding: Healthy vegetation adjacent to surface waters is essential for maintaining bank stability, water quality protection, absorptive capacity of floodplain soils, reducing stream flow velocities and providing flood storage. The indiscriminate disturbance of such vegetation destabilizes the banks of channels and other surface waters, which leads to increased erosion and sedimentation that exacerbates the intensity and frequency of flooding. The loss of vegetation adjacent to surface waters also reduces filtration of stormwater runoff and thus degrades the quality of these waters. Such impacts adversely affect the health and habitat of fish and wildlife that depend upon clean surface waters and therefore disrupt the ecological balance that is necessary for life. Humans are ultimately affected by this imbalance, since clean water is essential for all life. Floodplains vegetated with native trees, shrubs and herbaceous plants help reduce flood volumes, velocities and peaks.

Recommendation: Standardized riparian corridors should be considered along all basin streams, rivers and estuary waters, the size of which appropriately reflects the relative gradient and natural resources of the watershed. A study to identify and prioritize certain riparian corridors throughout the basin that can provide areas for efficient floodplain restoration and increased floodplain storage should be performed.

Disturbance to existing vegetation within the corridors should be highly discouraged, while incentives should be developed to encourage revegetation and enhancement of previously disturbed areas with native trees, shrubs and herbaceous plants. Any subsequent regulatory guidelines that are developed for riparian corridors should also recognize that some intrusion into these areas is unavoidable and that preexisting land uses must be accommodated

Implementation: FEMA, DRBC, NFIP State coordinators, PADEP, NJDEP, NYSDEC, NRCS, municipalities, watershed groups

Challenges: Determining the appropriate width of the riparian corridor in various portions of the watershed could prove challenging. Furthermore there could be some local opposition to the institution of these corridors, since they necessarily limit the amount of near-stream development that can occur.

F. Flood Warning

Gaging

FW-1: Inventory and Evaluate Precipitation Observing Stations in the Basin

FW-2: Evaluate & Upgrade River Gage Network

FW-3: Extend Rating Tables

FW-4: Flood Harden Gages at Key Forecast Locations

Flash Flood and Flood Forecasting

FW-5: Improve Flash Flood Forecasting

FW-6: Develop an Implementation Plan for the NWS Site Specific Model

FW-7: Evaluate & Establish New River Forecast Points

FW-8: Provide River Forecasts with Confidence Level Information

FW-9: Develop Flood Forecast Inundation Maps

FW-10: Maintain Up-to-Date High Hazard Dam Emergency Action Plan (EAP) Documents

Education and Outreach

FW-11: Establish a Coordinated Flood Warning Education and Outreach Program

FW-12: Develop a Flood Coordination Mechanism

FW-13: Ice Jam Monitoring and Communications Plan

Coastal Flooding Impacts

FW-14: Coastal Flooding Impacts

Recommendation FW-1: Inventory and Evaluate Precipitation Observing Stations

Finding: There is no comprehensive inventory of precipitation observing stations available for the basin. An inventory and analysis of the observing stations is needed to determine improvements required to make the maximum use of existing precipitation observations to improve the delivery of flood warnings.

Recommendation FW-1.1: Develop a comprehensive inventory of precipitation observing station (automated and spotters) gages in the Delaware River Basin. The purpose of this inventory is to provide the information necessary to evaluate the existing precipitation network, maximize it for flood forecasting and identify areas for improvement.

Implementation: DRBC/NWS/USGS/NYCDEP

Estimated Cost: $20,000 One-time

Implementation Time Frame: Immediate

Recommendation FW-1.2: Precipitation gages not used by the NWS flood forecasting models need to be evaluated to determine if they should be added to the existing flash flood and river flood warning program in the Delaware River Basin. The evaluation should include an analysis of sub basins and the adequacy of the precipitation gages in each. The evaluation should determine:

- The location of additional gages required to improve the flood warning network relative to flood risk.
- The existing non-NWS gages that can be incorporated into the NWS network.
- The upgrades required to make existing non-NWS gages compatible with NWS requirements where the gages are to be added to the network

Upon completion of this evaluation, recommendations would be made on upgrades as well as locations and costs for additional new precipitation gages.

Implementation: DRBC, NWS, USGS

Estimated Cost: $30,000 One-time

Implementation Time Frame: Short Term

Recommendation FW-2: Evaluate & Upgrade River Gage Network

Finding: Several river gages in the basin do not meet the needs of the NWS flood forecast operations in the basin. For example, the West Branch Delaware River at Stilesville, NY, at the outlet of Cannonsville Reservoir, is not equipped with satellite telemetry for real time access.

Recommendation: The existing river gage network in the basin should be evaluated for locations and telemetry deficiencies (e.g. backup communications, reporting - frequency 4 hr to 1 hr, and rating curves). Evaluate the deficiencies and develop an implementation plan for upgrades based on flood forecasting requirements and user input. The 2002 "Recommendations to Address Flood Warning Deficiencies in the Delaware River Basin" report by DRBC provides some specific inventory information.

Implementation: NWS, DRBC, USGS

Implementation Time Frame: Immediate to long term

Challenges: Once the requirements are established the one time and recurring funding costs will be needed and support for these is required.

Recommendation FW-3: Extend Rating Tables

Finding: Rating tables (stage-discharge relationships) were exceeded at a number of forecast points in the Delaware River Basin during the floods of 2005 and 2006. On-the-fly straight line extrapolations used for the rating curves are known to be highly inaccurate. This makes it extremely challenging to forecast for points downstream since flow measured at these points is highly suspect.

Recommendation: Investigate having the USGS extend the rating curves for all forecast points to 125% of record flow.

Implementation: USGS, NWS

Implementation Time Frame: Short term

Recommendation FW-4: Flood Harden Gages at Key Forecast Locations

Finding: During the June 2006 flood, stream stages exceeded the design capacity of several stream gages at critical locations. The stream gage construction plans were designed based on existing flood-frequency analyses and installed considering constraints such as access, available land setting, and funding limits.

Recommendation: To preserve data transmission during critical periods, consideration should be given to flood harden gages at key forecast locations in the basin, including gage structure relocation or elevation of the existing structure. In order to flood-harden existing stream gages to withstand the 100-year or 200-year flood flow, an updated flood-frequency analysis must be performed at the gage of interest.

Implementation: USGS

Implementation Time Frame: Long term

Challenges: Funding

FLASH FLOOD AND FLOOD FORECASTING

Recommendation FW-5: Improve Flash Flood Forecasting

Finding: Much flood damage occurs in headwater basins, away from the major rivers. There is a need to develop better means for disseminating and delineating flood and flash flood warnings in headwater regions. Local, real-time monitoring equipment such as radio rain gages and Doppler radar technology, and related software are required to implement improved flash flood warning through high-resolution graphical displays.

As illustrated by flood insurance claims data, significant flood damage occurs in headwater areas where flood warning lead time is extremely short. In most cases, only a generalized warning for portions of a county can be issued.

Recommendation: Combine GIS and Doppler radar technology to improve small watershed flash flood forecasting.

Prototype graphical product distribution should be developed for urbanized portions of the Delaware River Basin. This will require work with the NWS, emergency managers, and potential local users to provide a product that is distributed in real time and quickly understood. This would provide local emergency managers with a real time image of where their resources should be concentrated to respond to the flooding. The work would be consistent with national NWS standards.

The initial phase of this work would involve a prototype application to several urban, county-sized sections of the Delaware River Basin that are prone to flash flooding, and would consist of the following:

- Addition of an automated flood warning system of rain gages, telemetry, and software to the existing precipitation network as necessary for verification of rainfall estimates.
- Work with NWS and county and local emergency officials to develop graphical products for distributing flash flood information.
- Provide software for distribution of graphical products.
- Educate local emergency officials and coordinate with media on the use of Doppler radar for estimating flooding potential and issuing warnings.

Implementation: NWS, DRBC, USGS

Estimated Cost: $510,000 One Time; $10,000 annual

Implementation Time Frame: Long term

Challenges: NWS baseline product requirements and development will define the implementation schedule

Recommendation FW-6: Develop an Implementation Plan for the NWS Site Specific Model

Finding: Flash flood forecasting produces warnings for a certain forecast area based on areal rainfall amounts. In the Delaware River Basin, there are headwaters and feeder streams that respond rapidly to excessive rainfall. It is very difficult to gain lead-time and provide specific point forecasts for these streams under this type of situation. A NWS site specific model could provide specific flash flood forecasts for a known location. Some of the Delaware forecast points that are on smaller rivers and headwater points respond in a flash-flood like manner.

Recommendation: Develop an implementation plan for the NWS site-specific model to improve warning timeliness and accuracy for areas susceptible to flash-flooding.

Implementation: NWS, DRBC

Estimated Cost: None

Implementation Time Frame: Short term

Recommendation FW-7: Evaluate and Establish New River Forecast Points

Finding: The gage height at which flooding begins (flood stage) is not representative of the level at which flooding occurs or has not been established for a number of the basin's stream gages.

Recommendation FW-7.1: Establish flood stages and impact statements for potential flood forecast points where gaging stations are equipped with real time telemetry. It is estimated that there are approximately 35 such gages distributed throughout the basin.

Implementation: NWS/DRBC

Estimated Cost: $ 70,000 One-time;$ 5,000 O&M

Implementation Time Frame: Long term

Recommendation FW-7.2: Evaluate and prioritize needs for establishment of new forecast points in basin. Determine need for upgrading existing stream gages or adding new gages. The evaluation should include an analysis of subbasins and the adequacy of the flood forecast points in each. Based on this evaluation, a determination should be made as to which existing stream gages, not now used as flood forecast points, should be upgraded for this purpose, and where additional gages are needed. This evaluation should also focus on funding mechanisms for the gages and the work load associated with the establishment of the new forecast point.

Implementation: NWS, DRBC, USGS

Estimated Cost: $30,000 One-time

Implementation Time Frame: Short term

Challenges: Criteria needs to be developed

Recommendation FW-8: Provide River forecasts with confidence level information

Finding: Many inquiries about forecasts ask for a confidence level and uncertainty of the NWS issued forecasts. Not everyone has access to information on the confidence in NWS forecasts. MARFC forecasters include ranges as comments in their forecast guidance, but these never reach most users.

Recommendation: Confidence level information should be added to river forecasts and displayed on the NWS AHPS web page. Bracketed forecasts based on uncertainty can be added in the short-run when needed.

A long-term goal is to establish short term (7-day) probabilistic forecasts at all river forecast points in the basin. It is necessary to develop and implement better techniques to incorporate ensemble and probabilistic precipitation forecasts and hydrologic model uncertainty into short-term probabilistic hydrologic forecasts.

Implementation: NWS

Implementation Time Frame: Short term, Long term

Recommendation FW-9: Develop Flood Forecast Inundation Maps

Finding: GIS based flood warning technology improvements have not been applied in the Delaware River Basin.

Recommendation: Develop a flood forecast inundation mapping prototype. The effectiveness of flood stage forecast mapping at the local user level should be demonstrated on a prototype basis in high risk basins. Flood inundation mapping would initially focus on high priority flood damage centers along the main stem Delaware and Schuylkill Rivers for prototype application. An objective of the mapping would be to provide representation of impact as a function of river stage wherever hydrologically applicable. Education of map users should be built into this program and usefulness of the products should be evaluated from the local perspective. This recommendation is consistent with the objectives represented in Recommendation FM-1.

Implementation: NWS, USGS, DRBC, USACE, FEMA

Implementation Time Frame: Long Term

Challenges: Access to Digital Elevation Models (DEM).

Recommendation FW-10: Maintain Up-to-Date High Hazard Dam Emergency Action Plan (EAP) Documents

Finding: Several large impoundment reservoirs and control structures which have the potential to cause severe flooding to the Delaware River in the event of a catastrophic dam breach failure are located within the Delaware River Basin. Many of these structures have Emergency Action Plans (EAP).

An EAP is a document that contains information to be used by emergency management coordinators and personnel in the event of a sudden dam failure or the uncontrolled release of stored water. Dam inundation mapping is the key component of the EAP document since it clearly illustrates the extent and timing of potential downstream impacts during a dam breach or uncontrolled release of water event. The standard text of an EAP also includes emergency notification flowcharts; statement of purpose; project description; emergency detection, evaluation, and classification; general responsibilities; preparedness; plans for training, exercise, updating and posting; and approval and distribution information.

The dam owner is responsible for the preparation and maintenance of the EAP document. Regulatory authority in the Delaware River Basin over the dam owner's responsibilities may lie within several federal and state agencies including the Federal Energy Regulatory Commission (FERC), the NJDEP, the Pennsylvania Department of Environmental Protection (PA DEP), and the New York State Department of Environmental Conservation (NYSDEC).

Recommendation: The owners of dams located within the Delaware River Basin should prepare and maintain a current EAP document with associated up-to-date dam breach inundation mapping. The DRBC should coordinate and ensure that EAP documents for all large impoundments within the Delaware River Basin are shared between the states of New Jersey, Pennsylvania, and New York and available to at-risk communities for emergency management purposes.

Implementation: DRBC, Basin States, FERC

Implementation Time Frame: Long Term

EDUCATION AND OUTREACH

Recommendation FW-11: Establish a Coordinated Flood Warning Education and Outreach Program.

Finding: Local knowledge of the meaning of forecast flood stages needs to be improved in some portions of the basin. This effort must be achieved through work with local officials and the public.

Recommendation: A coordinated flood warning education and outreach program should be established for the Delaware River Basin. The program should include information on how the flood warning system works, how river flood warning and flash flood warning information can be obtained, and the importance of local knowledge of the meaning of flood stages. The program should include information about the multiple benefits of stream gages and the need to continuously fund the operation and maintenance of these gages. Encouraging and identifying potential cost sharing opportunities should be part of this effort.

The program should also focus on providing high-water historical information to impacted areas (e.g. public buildings and other highly visible locations)

The program should combine information prepared by the NWS, U.S. Army Corps of Engineers, and state and federal Emergency Management Agencies. Information on flood warning assistance opportunities for communities should be readily available. Press releases and conferences can be coordinated through the DRBC Public Information Office. Brochures would be distributed at meetings, public information sessions, and to middle and high school science teachers. Efforts would be made to work with local officials to provide improved knowledge of flood stages and interpretation of flood forecasts. The potential for a National Weather Service password protected site dedicated to emergency management personnel should be examined.

Implementation: NWS, DRBC, USGS, USACE

Estimated Cost: $50,000 annual

Implementation Time Frame: Short term, Long term. There is a potential opportunity for outreach to coincide each March during National Flood Awareness Week.

Recommendation FW-12: Develop a Flood Coordination Mechanism

Finding: The need for improved communications at all levels to the public before, during and after a flood event is an underlying need expressed by flood victims. During the last three floods on the Delaware River, flood victims sought information and were uncertain what agencies to turn to for flood information, including flood prevention and recovery.

Citizens and local emergency responders indicated a need for a single point of contact to provide upfront information and education to residents, local officials and local emergency responders on flood management and recovery. They also expressed a need for methods and materials to assist communities in these efforts.

Recommendation: A coordination mechanism should be developed to handle issues that arise between flood victims and other entities and manage the flow of information during and after the flood event and coordinate information between agencies.

Citizens should participate in the development of such plans and be made aware of management issues associated with flooding before, during and following a flood event. Additionally, the emergency management warning system at the local level could be improved by annually publicizing the plan, the role of the agencies involved and the role and responsibility of the public in following the plan.

As part of the communication plan, flood information methods and materials should be created for communities that would provide information on:

- State and federal regulations, model ordinances for local governments on land use planning to direct development away from flood prone areas;
- Flood prevention and preparedness literature for homeowners;
- Financial and insurance information and techniques to safeguard against flooding in the home;
- Explanation of confusing terminology such as 100 year flood;
- Contact numbers of relevant agencies, such as NJOEM, DRBC, NWS, FEMA, and USACE for citizens to obtain literature and information about flood prevention preparation and mitigation;
- Contacts for medical assistance and counseling services following flooding;
- Information on how to bring property into compliance with flood mitigation standards;
- Explanations of the differing requirements between federal, state and local regulators;
- Information on how long the process for recovery will take;
- Promote the NWS's StormReady program encouraging communities to receive StormReady designation; and
- Encourage communities to implement reverse 911 systems by providing documentation and program development guidelines.
- Advertise the importance of having NOAA Weather Radios (NWRs) available, particularly during potential weather-related power outages, since most are equipped with battery back-up capability. NOAA Weather Radio, a 24-hour radio broadcast by the NWS, has excellent radio coverage with 100% coverage along the Delaware River.

- Encourage the use of internet and RSS feeds (personal notification) for AHPS data.
- Implement reverse notification systems to help ensure timely evacuations during a flood event.

Implementation: NWS, DRBC, USACE, USGS, states

Implementation Time Frame: Short term, Long term

Recommendation FW-13: Ice Conditions Monitoring and Communications Plan

Finding: Ice jam flooding is a particular threat during rapid thaws or heavy rain events that follow a prolonged period of subfreezing temperatures. Ice jams caused record flood stages along on the Delaware River at Port Jervis, NY (1981) and Trenton, NJ (1904). Rapid rises in stage are an especially hazardous element of ice jam flooding. This may be caused by water backing up behind the ice jam, or by the breakup of ice jams upstream. During the 1981 ice jam flood at Port Jervis, NY and Matamoras, PA, both factors combined to cause a rise in stage of 14.5 feet in one hour. One death was attributed to the flooding and a total of 950 structures sustained damage amounting to $14.7 million (1981 dollars). Although some areas are more prone to ice jams than others due to factors such as channel geometry or obstructions such as bridge piers, the timing of ice jam flooding is very difficult to predict and warning time may be very short. Accordingly, monitoring of ice conditions, ice jams, and backwater conditions behind ice jams provides critical information if rapid thawing or heavy rain is forecast when heavy ice accumulations are in place.

During such conditions, teleconferences and other communication methods among state and county emergency management officials and the National Weather Service can provide for an exchange of information on ice conditions and provide contact information for reporting changing conditions or ice related problems. One example of such coordination was evident during the late winter of 2007 when the Pennsylvania Emergency Management Agency convened several such coordination sessions. It would be useful to expand this type of coordination activity to an interstate scale for the Main Stem Delaware River. In addition, it would be useful to enhance real time monitoring of ice conditions at bridges through the use of web cameras or local observers. The Delaware River Joint Toll Bridge Commission recently announced plans to install video and automated water level monitoring at bridges crossing the Delaware River. This would allow for increased ice conditions monitoring and flood monitoring potential in general. Further, the Ice Jam Information Clearinghouse, located on-line at http://www.crrel.usace.army.mil/icejams/, provides a centralized means of storing and retrieving ice jam data.

Recommendation: Expand ice conditions monitoring and coordination of information by:

1 Expanding ice jam emergency preparedness conferencing to the interstate level for coordination of briefings by the National Weather Service Binghamton and Mount Holly Offices;
2. Incorporating enhanced real time monitoring by the Delaware River Joint Toll Bridge Commission with data collection by the National Weather Service on ice conditions;
3. Working with the Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL) to ensure posting of all available ice jam information, and
4. Publicizing successful ice jam mitigation measures through the CRREL web site.

Implementation: State and County EMO's, Corps (CRREL), Delaware River Joint Toll Bridge Commission, National Weather Service, DRBC, National Park Service

Funding Mechanism: Bridge monitoring equipment to be funded by Joint Toll Bridge Commission. Agency staff time required for coordination with Corps of Engineers and teleconferences.

Implementation Time Frame: Start Winter 2007/2008

Recommendation FW-14: Coastal Flooding Impacts

Finding: Communities in the tidal reaches of the Delaware River and Bay are equally vulnerable to catastrophic flood events. The convergence of a major storm event with an incoming tide, or a Category 3, 4, or 5 Hurricane can create dramatic water level rises along both the main stem and the tidal portions of tributary streams. These major events can also have dramatic impact on sensitive coastal habitats such as wetlands that have become more exposed to harm as the result of increasing adjacent development and loss of tree cover and buffers. As waterfront and bayside living becomes more economically attractive the level of development has increased, subjecting more communities to the dangers of major storm events and storm surges.

Recommendation: Develop a comprehensive program for coastal communities and resources protection including:

- A model that takes into consideration the convergence of storm events, high flows from non-tidal stream and river reaches, storm events in nearby ocean and coastal regions and the Chesapeake Bay that dramatically impact storm events and surges in the Delaware Estuary and Bay.
- A flood warning system using the new model.
- Identification of high hazard areas and new floodplain mapping based on this model using conservative assumptions.
- DRBC regulations that prohibit development on the highly vulnerable river islands, floodways and floodplains.
- DRBC regulations requiring buffers along sensitive wetland, marsh and water ecosystems to provide buffering and needed protection from major storm events.

Implementation: DRBC, NOAA, USGS, USACE, DE, NJ, MACOORA

Implementation Time Frame: Long Term

Challenges: Existing fledgling efforts are sub-regional and must be pulled together (through pilot projects) into a regional coordinated system with integrated operations and management.

IV. Implementation Considerations

Implementation of this plan is critical and will require a commitment of funding and resources to reduce flood loss in the basin. The Task Force has identified some constraints that will affect implementation of the recommendations and which will require further analysis by the four governors, Task Force members and the public. These identified constraints are as follows:

a) Implementation time frame; identification of short-term actions

b) Staffing levels

c) Required legislation and/or regulation

d) Funding

e) Interstate coordination

f) Local support

In an effort to prioritize the recommendations contained in this report, the following immediate actions are proposed:

- Establish areas of priority funding for acquisition, elevation, and flood proofing. *(Action S-6)*
- Develop an interoperable reservoir operating plan. *(Action R-2)*
- Develop and implement a consistent set of comprehensive floodplain regulations beyond minimum NFIP standards across the entire Delaware River Basin. *(Action FR-2)*
- Enable stormwater utilities – this approach has water quality and quantity benefits and re-inforces the states' existing momentum for stormwater management and control of nonpoint source pollution; its time is *now*. *(Action SM-2.3)*

Notably, there was significant constructive tension among task force members as to the relative value of a "flood control" approach as compared to a "floodplain management" approach. The first four recommendations listed above fall into the latter category. The second encompasses both. The consensus of the task force is that aggressive implementation of a *floodplain management* strategy over the short term should be coupled with a methodical evaluation of *flood control* options over the long term. The task force members plan to meet annually commencing in late 2007, in order to monitor progress in implementing the action plan.

Table 4 is an implementation matrix which attempts to organize the recommendations by implementation time frame (on-going, short-term 1-3 years and long-term 3+ years) assuming adequate resources are identified.

Delaware River Basin Flood Mitigation Task Force
Table 4 - Recommendations by Implementation Time Frame

Recommendation		Lead Agency	Desired Result	Resources Needed
Ongoing Actions				
R-1	Develop a Flood Analysis Modeling Tool	DRBC	Prevention/ Public Education	$$
R-3	Evaluate Discharge Mitigation Programs for Reservoirs	DRBC	Prevention	$
R-4	Evaluate Snowpack Based Storage Management	DRBC	Prevention	$
S-2	Prioritize the Completion of State and Local Hazard Mitigation Plans	State EMO's	Prevention/ Public Education	$$$
S-3	Ensure Financial Assistance for State, County and Municipal Flood Mitigation Projects	State EMO's	Structural Projects	$$$$
S-8	Dam Safety Programs	State Dam Agencies	Emergency Services	$$$$
S-9	Evaluate and Coordinate Flood Mitigation Plans and Strategies	DRBC	Prevention/ Public Education	$$$
SM-2	Long-term Management of Stormwater Best Management Practices (BMPs) and Infrastructure	States	Prevention	$ per municipality
SM-3	Non-Structural Stormwater Management for New and Redevelopment	States	Prevention	$
SM-6	Develop and Maintain Precipitation and Streamflow Data	USGS/NWS	Emergency Services	$
SM-8	Stormwater Management through Special Protection Waters Designation	DRBC	Natural Resource Protection	$
FM-1	Coordinated Flood Study and Mapping Updates	Basin States	Prevention/ Public Education	$$$$
FW-10	Maintain Up-to-Date High Hazard Dam Emergency Action Plan (EAP) Documents	DRBC	Emergency Services	$
FW-13	Ice Jam Monitoring and Communications Plan	State EMS	Emergency Services	$
Short-term Actions (1-3 Years)				
R-2	Develop an Interoperable Reservoir Operating Plan	DRBC	Prevention	$$
R-5	Publish Information on the Basin's Existing Major Impoundments	DRBC	Emergency Services	$
R-6	Evaluate Availability and Accuracy of Data	DRBC	Emergency Services	$
S-4	Provide Training for Local Officials to Maximize Use of Available Mitigation Funding	DRBC	Education	$$
S-5	Create Partnering Programs for Floodplain Acquisition	State DEP's	Structural Projects	$$$$
S-6	Establish Funding Priority Areas for Acquisition, Elevation, and Floodproofing	Basin States	Structural Projects	$$$
S-7	Maintenance of Flood Control Structures, excluding dams	State DEP's	Emergency Services	$$$$
SM-1	Develop Regional and Tributary-Based Watershed Stormwater Management Plans	States	Prevention	$$ per 100sm
SM-4	Enforcement of Existing Stormwater Standards and Regulations	States	Prevention	$
SM-5	Provide and Promote Incentives to Reduce Stormwater Runoff from Existing Development	States	Prevention	$-$$$$
SM-7	Stream Restoration and Debris Removal Guidelines	DRBC	Natural Resource Protection	$

R=Reservoir Operations, S=Structural/Nonstructural, SM=Stormwater Management, FM=Flood Mapping, FR=Flood Regulations, FW=Flood Warning

$ Key: $ = < $100,000 $$ = < $500,000 $$$ = < $1,000,000 $$$$ = > $1,000,000

Delaware River Basin Flood Mitigation Task Force
Table 4 - Recommendations by Implementation Time Frame (Continued)

Recommendation		Lead Agency	Desired Result	Resources Needed
Short-term Actions (1-3 Years) (Continued)				
FR-1	Catalog, Evaluate and Update Existing Floodplain Regulations in the Basin	DRBC	Prevention/ Public Education	$
FR-2	Develop a Coordinated Education, Outreach and Training Program	DRBC	Public Education	$
FR-3	Repetitive Loss Reduction Strategy for the Basin	FEMA	Structural Projects	$$
FR-4	Flood Hazard Disclosure Requirements	DRBC	Prevention	$
FW-1	Inventory and Evaluate Precipitation Observing Stations in the Basin	USGS	Emergency Services	$
FW-2	Evaluate and Upgrade River Gage Network	USGS	Emergency Services	$
FW-3	Extend Rating Tables	USGS	Emergency Services	$
FW-6	Develop an Implementation Plan for the NWS Site Specific Model	NWS	Emergency Services	$
FW-7	Evaluate and Establish New River Forecast Points	NWS	Emergency Services	$
FW-8	Provide River Forecasts with Confidence Level Information	NWS	Emergency Services	$
FW-9	Develop Flood Forecast Inundation Maps	NWS	Emergency Services	$$
FW-11	Establish a Coordinated Flood Warning Education and Outreach Program	DRBC	Emergency Services	$
FW-12	Develop a Flood Coordination Mechanism	Basin States	Public Education	$
Long-term Actions (3+ Years)				
S-1	Fund a Comprehensive Flood Mitigation Study of the Entire Delaware River Basin	USACE	Structural Projects	$$$$ per State
FM-2	Incorporate Existing and Future Planned Development and Residual Risk Zones into New Mapping	Basin States	Prevention/ Public Education	$$$$
FM-3	Redefine and Remap the Floodway along the Delaware River Main Stem and its Tributaries	Basin States	Property Protection	$$$$
FR-5	Standardized Riparian Corridors	DRBC	Natural Resource Protection	$
FW-4	Flood Harden Gages at Key Forecast Locations	USGS	Emergency Services	$$
FW-5	Improve Flash Flood Forecasting	NWS	Emergency Services	$$
FW-14	Coastal Flooding Impacts	MACOORA	Emergency Services	$$$$

R=Reservoir Operations, S=Structural/Nonstructural, SM=Stormwater Management, FM=Flood Mapping, FR=Flood Regulations, FW=Flood Warning

$ Key: $ = < $100,000 $$ = < $500,000 $$$ = < $1,000,000 $$$$ = > $1,000,000

Definitions

100-Year Flood: The flood that has a 1 percent chance of being equaled or exceeded in any given year. It is also known as the Base Flood.

Flood Fringe (FEMA): That portion of the floodplain that lies beyond the floodway and serves as a temporary storage area for floodwaters during a flood. This section receives waters that are shallower and of lower velocities than those of the floodway.

Flood Level: An established gage height at a given location above which a rise in water surface level is defined as a flood for the corresponding river or stream reach. Flood level is usually set at a stage where the river or stream begins to overflow its banks and create a potential hazard to lives, property, or commerce. Flood level may equal or exceed bankfull stage but should rarely be less than bankfull stage.

Floodplain Management Regulations: Zoning ordinances, subdivision regulations, building codes, health regulations, special purpose ordinances (such as floodplain ordinance, grading ordinance, and erosion control ordinance), and other applications of the police power. The term describes such state or local regulations, in any combination thereof, which provides standards for the purpose of flood damage prevention and reduction.

Floodplain Management: The operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to, emergency preparedness plans, flood control works, and floodplain management regulations.

Floodplain: Any land area susceptible to being inundated by waters from any source.

Floodway: A regulatory floodway is defined as the channel of a river or other watercourse and portions of the floodplain adjoining the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height

Special Flood Hazard Area (SFHA): Darkly shaded area on a Flood Hazard Boundary Map (FHBM) or a Flood Insurance Rate Map (FIRM) that identifies an area that has a 1 percent chance of being flooded in any given year (100-year floodplain). Over a 30-year period, the life of most mortgages, there is at least a 26 percent chance that this area will be flooded. The FIRM identifies these shaded areas as FIRM Zones A, AO, AH, A1-A30, AE, A99, AR, AR/A, AR/AE, AR/A1- A30, AR/AH, AR/AO, V, V1-V30, and VE.

Acronyms

AHPS	Advanced Hydrologic Prediction Service
ASFPM	Association of State Floodplain Managers
BMP	Best Management Practice
CRS	Community Rating System
DCA	Department of Community Affairs
DFIRM	Digital Flood Insurance Rate Map
DCNR	Department of Conservation and Natural Resources
DRBC	Delaware River Basin Commission
DRN	Delaware Riverkeeper Network
DVRPC	Delaware Valley Regional Planning Commission
EAP	Emergency Action Plan
EMO	Emergency Management Office
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information System
GPD	Gallons per Day
MACOORA	Mid-Atlantic Coastal Ocean Observing Regional Association
NAI	No Adverse Impact
NFIP	National Flood Insurance Program
NHR	National Historic Register
NJAFM	New Jersey Association for Floodplain Management
NJDEP	New Jersey Department of Environmental Protection
NJOEM	New Jersey Office of Emergency Management
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
NYSDEC	New York State Department of Environmental Conservation
NYSFSMA	New York State Floodplain and Stormwater Managers Association
PADCED	Pennsylvania Department of Community and Economic Development
PADEP	Pennsylvania Department of Environmental Protection
PEMA	Pennsylvania Emergency Management Agency
SEMO	New York State Emergency Management Office
USACE	United States Army Corps of Engineers
USGS	U.S. Geological Survey

Appendix A

Governors' Letter

State of Delaware | State of New Jersey | State of New York | Commonwealth Pennsylvania

September 21, 2006

Carol R. Collier
Executive Director
Delaware River Basin Commission
25 State Police Drive
P.O. Box 7360
West Trenton, New Jersey 08628-0360

Dear Executive Director Collier:

The severe flooding this past June along the Delaware River highlighted our continued need to do more to protect our citizens' health, safety and welfare. Individually, the Basin states can move forward with policies and regulations to reduce and mitigate the impacts of flooding, but we believe that through coordinated effort on a regional basis, we can do more to reduce flood loss within the Basin than we could accomplish acting separately, on our own.

The Delaware River Basin Commission is the obvious vehicle for developing flood loss reduction and flood mitigation plans that cannot be accomplished by any single state or local government but that require a holistic watershed approach. As much as any time since the Commission was created in 1961, now seems an appropriate moment for coordinated action through the DRBC.

In our capacity as Commissioners, we hereby authorize and request that the DRBC staff the formation of an interstate task force to develop a set of recommended measures for alleviating and mitigating flooding impacts along the Delaware River and its tributaries. We ask that the Commission staff provide both coordination and technical support to this group. We direct that the measures to be evaluated by the task force include the development of a basin-wide flood management operating plan for the Basin's existing reservoirs. Such a plan would be a counterpart to the Commission's drought management plan. We seek task force recommendations for coordinated basin-wide flood mitigation and flood loss reduction initiatives.

Because any operational changes proposed must be backed by good scientific information, we also commit to immediately provide funding for the Flood Analysis Model for the Delaware Basin, that is needed to support this effort. We offer the full cooperation of the state emergency management and environmental agencies in this effort. Finally, we feel it is incumbent to the citizens we represent that a preliminary action plan with recommendations be completed by the end of the year to enable implementation measures to be started as early as possible in 2007.

We look forward to working with you and your staff to address this serious issue in a timely manner.

Sincerely,

Governor Ruth Ann Minner
Delaware

Governor Jon S. Corzine
New Jersey

Governor George E. Pataki
New York

Governor Edward G. Rendell
Pennsylvania

c: General Grisoli
Mayor Bloomberg

Appendix B

Public Comments and Response

- Overview of Action Plan Refinements in Response to Public Comment
- List of those who Submitted Written Comments
- Summary Written Comments – sorted by subject area[1]
- Verbal Public Comments received at the following Public Meetings:
  - Delhi, NY; February 8, 2007
  - Wilmington, DE; February 15, 2007
  - Ewing, NJ; February 20, 2007
  - Easton, Pa; February 27, 2007

1 A detailed summary of written comments sorted by commenter can be viewed at http://www.state.nj.us/drbc/Flood_Website/taskforce/Action-agenda_0707/comments.pdf

All Summaries prepared by DRBC Operations Staff, April 2007.

Delaware River Basin
Interstate Flood Mitigation Task Force

Overview of Action Plan Refinements in Response to Public Comment

Four public meetings attended by over 200 people were held in February 2007 in Delhi NY, Wilmington DE, Ewing NJ, and Easton PA. In addition, 60 written letters were submitted during the public comment period. A list of the 60 commenters and a summary of the comments compiled by staff is contained within Appendix B of the Task Force Report. The comments spanned all six management categories, addressed such general issues as prioritization, budget constraints, allocation of resources, and in some cases offered specific edits to action plans. While some of the comments were state or sub-basin specific, a short list of the high level themes which applied across the entire Basin is as follows:

- Reservoir Operations
- Governance
- Delivery of Government Services
- More Resources: Acquisition and Elevation
- Immediacy of the Problem
- Revisiting the Supreme Court Decree

The Task Force reviewed the staff comment summaries and met in March 2007 to provide direction to DRBC staff regarding changes to the report based on comments, form of public response, and transmittal logistics of final recommendations to Basin state governors. In brief, Task Force Members decided to make several changes to the final report based on the comments, but retain the basic recommendation architecture of the Public Review Draft Action Plan. Key changes involve adding a more detailed description concerning hydrologic conditions in the Basin that contribute to tributary and main stem flooding, the addition of a Reservoir Operations Findings Statement that very specifically addresses the issue of using water supply reservoirs for flood control, the addition of more specific implementation accountability for each of the actions, a new recommendation regarding the need for an ice jam monitoring and communication plan, and various corrections, edits and clarifications to the substance of specific recommendations based on commenter input. In addition, Appendix B has been added to the report to document the public participation process. Lastly, in lieu of prioritizing recommendations, an Implementation Matrix was developed to provide for a structured implementation process over the short and medium term timeframe.

Regarding the public perception of a cause and effect relationship between “spilling reservoirs” in the upper Basin and flood occurrence in the main stem river between Hancock NY and Trenton NJ, the Task Force concluded that flooding would still occur along the Delaware even if a year round void program were implemented. In brief, historic data indicate that flooding on the main stem Delaware River occurred before

New York City reservoirs were in place, and has occurred since construction when the reservoirs have not spilled. The basis for these finding can found in Section V of the final report.

They also determined that reservoir management actions that reduce flood crests for a given flood, even by an inch or two, have great meaning when it makes the difference between damaging or not damaging a home or structure. For this reason the Task Force included reservoir management at all major basin reservoirs as an element of the report and has advocated for addressing all measures for reservoir management that do not adversely affect water supplies. One measure under consideration by the parties to the Supreme Court Decree is establishment of a Flexible Flow Management Program, one component of which is a permanent "Discharge Mitigation Program". Another measure involves use of a flood analysis model to analyze the effects of structural alterations of major basin reservoirs, including evaluation of diversions, for other than water supply purposes, at those reservoirs.

Many commenters spoke to the need for more effective governance systems, including 1) more progressive flood plain regulations based on the latest digital floodplain mapping data; 2) better enforcement of existing floodplain management and stormwater management regulations; 3) improved linkage between regional stormwater and flood management plans; and 4) more attention to maintenance/clean out of conveyance structures.

Many commenters spoke to the need for a substantial increase in resources to effect positive flood mitigation outcomes. There was strong Task Force support for expediting, assisting and funding at adequate levels property acquisition and elevation.

Careful attention was paid to language corrections and action specific edits to make the document as accurate as possible. For example, representatives of the Association of REALTORS from New York, New Jersey and Pennsylvania alerted staff to the fact that the term REALTOR is a trademark that refers only to those real estate professionals who are members of the National Association of REALTORS.

All of the actions were re-evaluated to add more detail as to implementation accountability—ie., by specifying an action lead to facilitate tracking implementation progress.

Many commenters advocated for a more pro-active and immediate action agenda. In particular they indicated the multi-year studies and flood warning communication strategies were not sufficient to reduce the occurrence and magnitude of flooding in the future. To that end, the Task Force has taken a multi-pronged approach to reducing future flood risk. It has identified an array of on-going and short terms actions that will have collective effect of enhancing community flood resiliency. One Task Force Member characterized the approach as a "Ten Things to make the Basin 10% more Resilient Strategy". This strategy is captured in the Recommendation Overview Implementation Timeline.

A few commenters advocated a much stronger flood control approach and recommended a return to the Supreme Court to effect a new apportionment of upper Basin water storage to achieve a measure of flood control. As noted above, the Task Force has included reservoir management at water supply reservoirs as an element of the report and has advocated for addressing all measures for reservoir management that do not adversely affect water supplies. A brief *History of the Reservoirs Releases Program in the Upper Delaware River* Basin is provided as Appendix C to this report.

In summary, the Task Force has evaluated flood prevention and mitigation options over the past six months, considered public hearing testimony and written public comments, and continues to conclude that **no set of mitigation measure will entirely eliminate flooding along the Delaware River or its tributaries, and that a combination of measures will improve the basin's resiliency – its capacity to prepare for and recover from flooding—in the future.**

LIST OF THOSE WHO SUBMITTED WRITTEN COMMENTS
DELAWARE RIVER BASIN
INTERSTATE FLOOD MITIGATION TASK FORCE

	Commenter	Affiliation	Date
1	Willis W. Smith	Mayor, Village of Deposit	03/01/07
2	Dave Burd	Lambertville, Office of Emergency Management	03/08/07
3	James E. Eisel	Chairman, Delaware County Board of Supervisors	02/08/07
4	William J. Powell	Hunterdon County Emergency Management Coordinator	03/05/07
5	Charles H. Martin, James F. Cawley, Sandra A. Miller	Board of County Commissioners of Bucks County	02/28/07
6	Donna M. Lewis	Planning Director, County of Mercer	03/06/07
7	Michael W. Herbert	On behalf of Mercer County Board of Chosen Freeholders	03/07/07
8	John J. Bonacic	New York State Senator	02/08/07
9	Patrick J. Murphy	Congressman 8th District, Pa.	02/27/07
10	Joyce Andreoli	New Jersey Association of REALTORS	03/06/07
11	Derenda Updegrave	Pennsylvania Association of REALTORS	03/05/07
12	Charles Staro	New York Association of REALTORS	02/28/07
13	William Vogt	D.D.S and former Task Force Member	02/6/07
14	George Kelchner	President, Delaware Riverside Conservancy	02/05/07
15	Preston Luitweiler, P.E.	Aqua America	03/07/07
16	Robert F. Molzahn	Water Resources Association of the Delaware River Basin	02/27/07
17	Robin L. Dingle	Environmental Planning Consultants	03/07/07
18	Dr. Brent Blackwelder	Friends of the Earth	03/06/07
19	Jim Davis	Mill Rift Civic Association	02/28/07
20	Deborah Rousell, PhD.	Personal Comments and Letter from Trenton Island Civic Association	03/08/07
21	John Miller	New Jersey Association of Floodplain Managers (NJAFM)	03/03/07
22	Elizabeth George-Cherniara, Esq.	New Jersey Builders Association	03/13/07
23	Alicia Batko	Montague, N.J.	03/6/07
24	Lloyd Best, Jr.	Alpha, N.J.	02/26/07
25	Robert Castagna	Milford, N.J.	02/12/07
26	Philip Chase	Port Jervis, N.Y.; Town of Deerpark representative to the Upper Delaware Council	02/13/07
27	John D. Coffin	Flood Victim; Aberdeen, N.J., (Owns property in Wayne Co., Pa.)	02/6/07
28	James H. Cox	Flood Victim; Matamoras, Pa.	02/12/07
29	Barbara Curtis	Flood Victim	02/28/07

Individuals were identified as flood victims if they stated so in their comments.

LIST OF THOSE WHO SUBMITTED WRITTEN COMMENTS
DELAWARE RIVER BASIN
INTERSTATE FLOOD MITIGATION TASK FORCE

30	Kathy Davis		03/1/07
31	Harold Deal	Northampton County, Pa.	03/6/07
32	Robert Gavin	Bucks County, Pa.	03/7/07
33	Mina Hamilton	former President of the Delaware Valley Conservation Association	03/7/07
34	Douglas and Linda Hay	Flood Victims; Mill Rift, Pa.	02/13/07
35	Joan Homovich	Flood Victim; Downsville, NY	02/08/07
36	Joan Homovich	Flood Victim; Downsville, NY	03/5/07
37	Ronald Godshalk	Easton, Pa.	02/27/07
38	Uke Jackson	Delaware Water Gap, Pa.	02/24/07
39	William Kays		
40	J. Kennedy	Lower Mount Bethel, Pa.	02/28/07
41	David Laird II	Trenton, NJ	02/15/07
42	James and Doris MacPherson	Upper Mt. Bethel, Pa.	03/06/07
43	Thomas W. McBrien IV	Flood Victim; Upper Black Eddy, Pa.	03/06/07
44	John McVeigh		03/07/07
45	Sandy McNichol		03/07/07
46	Kelly Offerman	Flood Victim; Belvidere, NJ	03/07/07
47	Rita Ohman	Flood Victim; Equinunk, Pa.	02/15/07
48	Mike O'Hare	Flood Victim; Upper Black Eddy, Pa.	03/07/07
49	Kirk Pierson	Columbia, NJ	02/28/07
50	James Reuss	Flood Victim; Forks Township, Pa.	02/28/07
51	Edwin Rogusky	Catasauqua, Pa.	02/20/07
52	Ellen Sapienza	Flood Victim; Upper Black Eddy, Pa.	03/04/07
53	Nancy Shukaitis		03/07/07
54	Sheila Uris Stern	Flood Victim; Upper Black Eddy, Pa.	03/02/07
55	Karen and Wayne Tittle	Flood Victim; Upper Black Eddy, Pa.	03/02/07
56	Joan Van Gilson	Flood Victim; Island Section, Trenton, NJ	03/07/07
57	Barry Ziff	New Hope, Pa.	03/02/07
58	Michelle Kintner	Flood Victim; Minisink Hills, Pa.	02/22/07
59	Magoleath Berman	Morrisville, Pa.	02/23/07
60	Mary Lou Delahanty, Esq.	Lawrenceville, NJ	03/07/07

Individuals were identified as flood victims if they stated so in their comments.

Summary of Written Comments received by March 7, 2007, on the "Preliminary Action Plan Public Review Draft, January 2007" Issued by the Delaware River Basin Interstate Flood Mitigation Task Force

Comment ID	Comment
	General Support or Non-Support for the Plan
6, 15, 17, 19, 20, 21, 22, 27, 34, 52, 56	The Task Force did a commendable job of considering a broad range of recommendations.
6	Support was expressed for six priority management areas and holistic watershed approach.
9	The Preliminary Action Plan represents a strong step in the right direction, offering both long term and immediate solutions to be taken up by all levels of government.
24	To blame the flooding on the Upper Delaware Basin is a waste of money and time
22	Statements that development, stormwater management, and floodplain encroachment are potentially contributing and exacerbating factors for flood loss is not supported by data and are without merit.
13	There is nothing in the recommendations that would effectively create any meaningful flood control in the near future.
14	The Delaware Riverside Conservancy (DRC) and its membership refuse to take part in a flawed and inadequate process that fails to provide and/or recommend immediate and emergent flood relief.
	Prioritization
21	Due to limited state resources, the recommendations should be prioritized.
17, 42	The Task Force needs to emphasize & prioritize education, with a focus on stormwater management and protection/benefits of natural vegetation in the watershed.
20	Recommendations to immediately remedy obvious deficiencies are endorsed, if there is data and consensus to support the potential effectiveness of such measures. These include such measures such as funding mechanisms to elevate basement utilities in the Island Section of Trenton, and backflow prevention. These measures should be given priority for funding in addition to considering funding for longer term measures.
21	The report should place high priority on those measures which alleviate flood damage under existing conditions, and on measures which will both prevent flood damage under existing conditions and prevent increases in future flood damages.
53	A proven, public notification system of a dam break or any other pre-eminent danger should be No. 1 priority.
29	Most cost-effective recommendation is to strongly support, expedite, assist and fund at adequate levels property acquisition and elevation.
	Implementation
16, 20, 21, 22, 56, 58	Implementation of the report is critical and will require commitment and funding
27, 56, 58	Emphasizes the need to enact the recommendations quickly
31, 44	The best intended recommendations cannot be effective without the methods and the power to implement them.
38, 42, 59	It is vital to maintain the health of the river and its natural inhabitants.
	Coordination
5	Communications of the findings and recommendations of the Task Force report is critical to fostering public support, funding and political action.

Summary of Written Comments received by March 7, 2007, on the "Preliminary Action Plan Public Review Draft, January 2007" Issued by the Delaware River Basin Interstate Flood Mitigation Task Force

Comment ID	Comment
16	There should be a continuing open dialogue with all stakeholders in the basin and balancing of interests in developing implementation strategies for flood loss reduction.
20	All communities should have representation during the prioritization of recommendations and the funding allocation process.
56	Going forward, announcements, notices and flyers regarding meetings and discussions are needed to keep residents advised.
1	DRBC should provide clear information to downstream communities regarding reservoir release schedules contemplated as part of future plans for "Flexible Flow Management."
31	Task Force should continue to work closely with environmental organizations like the Delaware Riverkeeper Network.
17	Flood management practices need to be adopted in tributaries because local actions have cumulative benefits.
	Composition
20, 60	Neither Trenton nor Mercer County was represented on the Task Force
22	There are no members of the regulated community on the Task Force
21	On page 3, it is not clear if private business was represented on the Task Force.
6	Better representation of scientists, policy-makers, and lay people are needed to effectively implement the policies of the Plan.
	Document Clarity
21	On page 8, the reference to the frequency for a 10 inch rainfall should be clarified.
27	Explain Supreme Court Decree in report, list Decree members; possibly include the Decree as an Appendix
27	Better explain the impact on the definition of the floodway of a 0.2 foot rise in depth vs. a 1.0 foot rise in depth; recommends providing an example or a graphic.
35	The report needs to mention DRBC Resolution 2006-18
	Requested Document Additions
21	Identification of areas of greatest risk, ranking of mitigation strategies, and specific funding sources should be considered for inclusion in the document.
21	On page 9, a map should be added to show the drainage for each of the four basin states.
21	On page 10, it would be valuable to know the percentage of floodplain properties where flood insurance has actually been purchased.
21	On page 10, there is a need for a policy on prioritizing repetitive loss areas
21	On page 13, SM –Strengthening regulations must be backed by education to land use decision bodies.
2	Add the following language to page 12, B. Structural and Non-structural Measures to advocate consistency between the Interstate Task Force Report and the NJ Task Force Report, "*Small local flood control that may be beneficial for prevention of stream tributary flooding should be investigated. Backwater flooding along the stream tributaries could be controlled and prevented through the use of flap gates, flood gates, tide gates and pumping stations." Also modify language under SM-1.1 as noted below.*
22	The Task Force's recognition of the need for flexibility (as evidenced in FR-5: Riparian Corridors) should be adopted as a core principal of its report.
16	It must be acknowledged that we cannot completely control all natural events.

Summary of Written Comments received by March 7, 2007, on the "Preliminary Action Plan Public Review Draft, January 2007" Issued by the Delaware River Basin Interstate Flood Mitigation Task Force

Comment ID	Comment
	Reservoir Operations
General:	
43, 60	DRBC and the states must make flood prevention a primary mission with regard to the management of reservoirs.
28, 50, 55, 57, 60	It is likely that overfilling the reservoirs and reservoir management had a significant impact on the three recent floods. What effect do reservoirs have on the flood levels? Any study needs to be expedited.
14	Understand the need for comprehensive studies regarding the reservoirs and the basin as a whole, but studies are not required or necessitated for immediate and substantial relief in the form of reservoir voids and proper reservoir management. A simple calculation regarding drainage areas and percentages evidences the potential of the reservoirs to provide substantial and significant reductions in downstream flooding damage and devastation.
14	The current management and operations of the reservoirs is reckless, dangerous, and maintained at levels which represent extreme indifference to the lives, safety and property of all of those downstream.
3, 8, 23, 25, 28, 30, 32, 34, 35, 36, 43, 45, 47, 48, 49, 50, 52, 54, 55, 57, 58	The reservoirs must have a permanent year-round void for flood mitigation.
26, 29, 31, 48, 52	The 1954 Supreme Court Decree should be revisited.
9	The DRBC should pursue every avenue possible to bring the parties to the 1954 Supreme Court Decree together for a more permanent agreement before the current reservoir operation agreement ends on May 21, 2007.
29, 31, 49	More diversions to the Hudson via the aqueduct should be made in the event of a flood.
26, 47	New York City should be prohibited from selling Delaware water to new customers in the Hudson watershed.
25, 26, 31, 47, 50, 53	New York City should seek a water supply from the Hudson in order to lessen its reliance on the Cannonsville, Pepacton and Neversink. This additional supply would allow for a void for flood management without endangering the NYC water supply.
26	The federal government should fund the cost of a filtration plant and pump system in order to allow NYC to take 325mgd from the Hudson. (In 1951, NYC's own "Little Hoover Commission" claimed that 325mgd could be taken from the Hudson above Poughkeepsie)
57	Siltation in the reservoirs must be addressed. This would create a greater storage capacity to allow for greater voids.
34	Commended PPL's discharge mitigation program for Lake Wallenpaupack and said Mongaup and other watershed pools should do the same.
Specific	
21	**R-1:** A basin wide model that includes real time data for decision support should be pursued, and should be GIS based and coupled with flood inundation mapping.
21	**R-1:** A six hour time step for the flood analysis model is questioned as being too long.
5	**R-1:** Such analysis is helpful tool to explain causes of flooding to the public
22	**R-1 and R-2**: A high priority should be given to developing a flood analysis model and the procurement of hydrologic data. All

Summary of Written Comments received by March 7, 2007, on the "Preliminary Action Plan Public Review Draft, January 2007" Issued by the Delaware River Basin Interstate Flood Mitigation Task Force

Comment ID	Comment
	available forecasting technology should be used to better inform release decisions and to reduce total discharge from reservoirs during flood conditions.
5, 19, 29, 31, 49, 60	**R-2:** Emphasize need for coordinated releases, better reservoir management and the development of a reservoir operations plan.
31	**R-3:** Spill mitigation should take into account real-time weather conditions and actual rainfall.
15, 16	**R-3:** Spill mitigation programs should not adversely impact uses for which the reservoirs were created
22	**R-3 and R-4:** Discharge mitigation programs and snowpack based storage management are supported.
19, 34	**R-4:** Why is the arbitrary number 50 percent used in the water equivalent snowpack calculation. Won't a greater percentage reach the reservoir? Why not use 100% snowpack water equivalent estimate instead of 50% when determining releases.
19	**R-5:** Support this recommendation. It is crucial that data pertaining to reservoir storage be made more readily available to the public.
22	**R-6:** DRBC should ensure accurate reporting of data and conditions for all the basin's reservoirs and dams. DRBC should use services offered by the National Weather Service and USGS to provide relevant data on-line for the public.
	Structural and Non-Structural
General:	
29, 38, 49, 53	Supports non-structural solutions, acquisition and converting floodplains to open space, rather than large engineering projects.
29, 32, 49	Support building another reservoir specific for recreation and flood control.
43, 52	The size of the reservoirs should not be increased.
48	Investigate the possibility of increasing the size of the reservoirs
50, 51	Advocate a Main Stem Dam
18, 23, 31, 33, 42, 52, 53, 59	Oppose Main Stem Dam; A main stream dam is not the answer and will not stop flooding. Opposition to further expenditure of tax dollars.
29, 39, 49	Obstructions in the river should be cleared so as to not prevent flow during high water events. Examples include widening the river, removing all trees and vegetation from river islands and some banks is necessary, removing some islands completely, removing unused bridges, dredging silt, and "any S curves be cut straight through". Such a move would require coordination between the three states.
31	Oppose channelization, dredging, removing trees from islands and shorelines and removing entire islands to expedite flow during periods of heavy runoff.
21	The Task Force should note that flood mitigation projects require proper record keeping. A centralized GIS data base may assist with future planning and help focus mitigation dollars.
Specific	
29, 33	**S-1:** Support ACOE study, A re-analysis of appropriate flood control and flood mitigation methods is warranted.
31	**S-1:** Oppose the ACOE study (an unencumbered flood study up and down the river that would allow them to create their own plans

Summary of Written Comments received by March 7, 2007, on the "Preliminary Action Plan Public Review Draft, January 2007" Issued by the Delaware River Basin Interstate Flood Mitigation Task Force

Comment ID	Comment
	to mitigate future flooding.)
21	**S-1:** DRBC participation Corps of Engineers evaluation of basin-wide mitigation strategies is encouraged.
40	**S-2:** Municipalities should be required to do hazard mitigation plan. Residents have no control if municipalities decide not to participate in or create a plan leaving the municipality ineligible for funding. Wants policymakers to put strict enforcement on agencies to help with mitigation and compliance.
4	**S-2:** All-Hazard Mitigation Plan: Federal legislators need to review and possibly modify the DMA-2000 to ease municipal requirements for development of All-Hazards Mitigation Plans. State Mitigation Units need to be better staffed. States should develop a funding source to assist municipalities in hiring planning consultants. States should consider deploying Mitigation Unit employees to lead regional planning processes.
6	**S-2:** Supportive of companion process to the Task Force, involving a NJ four county approach to developing a Multi-Jurisdictional Flood Mitigation Plan, as a first step toward a regional All-Hazards Plan.
5, 47	**S-3:** Greater and continued federal funding for acquisition and elevation is needed.
21	**S-4:** There is a need for extensive training in various areas such as responsibilities under the National Flood Insurance Program, developing Hazard Mitigation Plans, and application for flood mitigation grants.
4	**S-4:** Each County and Municipal Office of Emergency Management should have a "Mitigation Officer". This person would be on the Local Emergency Planning Council (LEPC) and be the lead person to deal with all mitigation issues.
4	**S-4:** Citizens should be encouraged to join Community Emergency Response Teams (CERT). CERT teams could help support municipal mitigation actions.
60	**S-5:** Recommending property acquisition as a flood mitigation solution further victimizes residents who cannot control the decision to keep reservoirs at 100 percent capacity.
21	**S-5:** Mention should be made that Growing Greener in PA and Green Acres/Blue Acres in New Jersey are important for local matches to FEMA funds, which require local matching funds.
46	**S-5, S-6.2 & FR-3:** Will counties/communities that have severe rep loss properties be prioritized for funding? What is the timeframe that funding will become available? Funding is dependant on each municipality having a mitigation plan in place, can DRBC help expedite this?
5, 31	**S-6 & FR-3:** Support emphasis on floodproofing and elevation in historic communities and acquisition of floodplain properties elsewhere.
22, 31, 38	**S-6:** A process is needed to insure that property acquisition is appropriate and justified. Don't use eminent domain for acquisitions but do so with incentives and fair market buyouts.
20, 60	**S-6:** Trenton should be included in the report with other communities mentioned for historic significance. Insert Trenton on page 33, paragraph 2, line 3.
20	**S-6.1:** Elevation of basement utilities needs to be mentioned as an effective means of flood proofing. Insert the phrase "of structure and or basement utilities" into page 33, paragraph 3, sentence 2.
21	**S-7.3:** A levee safety and inspection plan is supported.
22	**S-8:** A funding mechanism is needed to support private dam owners and government in dam inspection and maintenance activity

Summary of Written Comments received by March 7, 2007, on the "Preliminary Action Plan Public Review Draft, January 2007" Issued by the Delaware River Basin Interstate Flood Mitigation Task Force

Comment ID	Comment
	when they cannot afford it.
21	**S-8:** Dam safety enforcement is not adequately addressed in the action plan.
34	**S-8:** Supportive of dam safety inspections.
Specific problem/ location:	
23	Mashipacong Island ice flow channel needs to be cleared of debris that has collected from the last three floods.
56	Morrisville, PA has a retaining wall, why doesn't the Trenton Island Section have one?
57	Pipelines should be constructed along highways to carry floodwaters to deep abandoned coal mines; turbines for electricity generation, irrigation or geothermal are presented as possible end uses for the water.
1	Mitigation needs to be done with the huge gravel bar underneath the Route 17 overpass that crosses the Delaware River. Minor flooding at this location could impact the Airport Road area and Wastewater Treatment Plan improvements.
41	There seems to be a bias to flooding north of the Trenton railroad bridge, there is also a flood problem south of the bridge in the Broad Street Park neighborhood.
49	Consider completion of a flood control reservoir in upstate NY started by the Army Corps of Engineers in the 50s/60s and equip with water control features.
17	Cost benefit and ecological analysis should be conducted to evaluate wing dam removal and replacement where these structures raise flood levels.
31	Remove low head dams on tributaries to restore natural riparian areas and prevent flood waters from backing up, for example those on the Pequest in Belvidere, N.J. Also, remove abandoned structures in floodplain and on islands.
56	Can the National Guard be sent to sandbag the Island section of Trenton in times of need?
	Stormwater Management
General:	
5, 34, 59	Endorse proactive stormwater and waterway corridor management.
24, 49, 59	Support low impact development practices and non-structural stormwater management strategies
44	Development of upriver municipalities is partially to blame for these flood events, planning has been inadequate in upriver regions.
5, 27, 40	Stormwater enforcement is a problem in Pennsylvania. Help identify ways to require municipalities to enforce and implement their stormwater management ordinances. Under Pennsylvania law, stormwater requirements can be waived by the elected officials.
41, 57	Existing retention basins and culverts are in need or restoration and maintenance. Retention basins should be revaluated for size.
Specific:	
6	**SM-1:** Stormwater Management Plans and Ordinances need to integrated with local and regional flood management plans.
17, 21	**SM-1:** Regional stormwater management plans must be promoted and enforced at the local level.
2, 20, 21, 41, 56	**SM 1.1:** Consider rewording to allow for structural measures such as backflow preventers where they are the proper mitigation solution. Insert the phrases "and main stem river areas" and "backflow prevention" and "existing development" into page 38, paragraph 2, sentence 3.
21	**SM-2:** The EPA Clean Water Act generation of the MS4 permit system under NPDES should be mentioned.

Summary of Written Comments received by March 7, 2007, on the "Preliminary Action Plan Public Review Draft, January 2007" Issued by the Delaware River Basin Interstate Flood Mitigation Task Force

Comment ID	Comment
21	**SM-3:** The DRBC should work at the State/County level to implement ordinance changes
17	**SM 3:** Supportive of Low Impact Development; Future designs of bridges and culverts should minimize concentrated flows and promote natural channel stability.
21	**SM 4.1:** The phrase "more consistent implementation" could be replaced by "thoughtful enforcement" of existing standards.
21	**SM 4.2:** Include a note on the inspection requirements under the MS4, NPDES Phase II regulations.
21	**SM-5:** DRBC should review how smart growth and stormwater requirements can be addressed for re-development. Requirements for flood mitigation retrofits should be strengthened.
21	**SM-5:** Consider adding the USDA-NRCS programs as means of reducing stormwater runoff from existing development.
21	**SM-5.1:** Consider providing BMPs to older sites without stormwater control when retrofit is feasible.
21	**SM 6.1:** Data maintained by the DRBC, USGS, NWS/NOAA and the States should be made available to the public in a coordinated manner.
21, 47	**SM-7:** Address the need for streamlined and consistent permitting between the states specific to maintenance cleanouts. State land use policies and regulations make river/creek/ditch clean-out (necessary due to erosion) rather costly (engineering and permitting)
17	**SM-7:** Stream restoration guidelines should be developed that include measures to mitigate existing flooding and prevent future degradation of water quality and stream habitat resulting from flood induced erosion and sedimentation.
22	**SM-7:** Some of the statements related to channel clearing and permitting seem at odds with the flood mitigation purpose of the report or appear out of context.
25, 28, 56	**SM-7:** Erosion is a serious concern and financial relief is needed for riverbank restoration (invasive species - Japanese hops mentioned as a concern)
	Floodplain Mapping
General:	
6	Better communication is needed between the counties, FEMA and NJDEP as part of the floodplain map update process.
21	Adding dam failure inundation limits to Flood Insurance Rate Maps is supported.
4	Flood Hazard Maps-Once completed, make maps available on-line to emergency managers.
40	The flood maps along the river are inaccurate.
17	Floodplain mapping needs to extend to the headwaters of the tributaries.
53	Revise floodplain mapping based on the last three floods, take El/Nino/Global Warming effect into account
22	Compensation must be provided to those property owners who are prevented from using their property.
Specific:	
21	**FM-2:** The Task Force should consider the Report entitled "Reducing Flood Losses – Is the 1 percent Chance Flood Standard Sufficient" – The report of the 2004 Assembly of the Gilbert F. White National Flood Policy Forum.
21	**FM-2.2:** Agree that areas subject to levee or dam failures should be taken into consideration when preparing new floodplain maps.
22	**FM-2:** It is unclear why a 25 percent safety factor is necessary if the area is already built out.

Summary of Written Comments received by March 7, 2007, on the "Preliminary Action Plan Public Review Draft, January 2007" Issued by the Delaware River Basin Interstate Flood Mitigation Task Force

Comment ID	Comment
22	**FM-2:** There are not technical reports that support the 25 percent safety factor for the 100 year flow rate. Without this documentation, it is arbitrary.
22	**FM-2:** If the 'no net fill' restriction is imposed, it is unnecessary to apply the 25 percent safety factor.
22	**FM-2:** Potential flooding impacts from existing development should be controlled by retro-fitting existing conditions, not by curtailing future development.
21	**FM-3:** The Task Force is encouraged to view documents provided by the ASFPM on this subject.
22	**FM-3:** The cited 0.1 ft allowable rise standard appears to be directed at preventing development rather than at mitigating flooding. Analysis and documentation is needed to justify this rather than the New Jersey standard of 0.2 ft. rise or the FEMA standard of 1 ft rise.
	Floodplain Regulations
General:	
31, 34, 44, 49	Support a prohibition of new construction in the floodplain
5	Floodplain regulations in the basin need to be upgraded.
53	New floodplain building codes are needed after redelineation of floodplains
23, 31, 40, 49, 53	Existing floodplain regulations need to be enforced. There is a failure to enforce at the federal, state and local level.
29	Pennsylvania is recognized as being a development-friendly state, the state should take steps to reverse that.
25	Consider the long-term financial impact to riverside towns of more restrictive building codes (loss of ratables)
Specific:	
22	**FR-1:** The Task Force should encourage adoption of uniform, region-wide standards administered by state or county and not municipal entities.
22	**FR-1:** If floodplain protection requirements are adopted to prevent future construction, fill, or devegetation, then the Task Force should emphasize that compensation must be made to property owners by the respective governments.
21	**FR-1:** #4, The plan should recognize the resources required for producing the level of detail in the Pennypack Creek floodplain restudy.
22	**FR-2:** The certification of all local floodplain managers and local officials is supported.
22	**FR-3:** Rather than financing repeated reconstruction as under the Flood Insurance Program, better access to mitigation monies would enable communities to acquire flood prone properties.
22	**FR-3:** All flood prone structures should be required to carry flood insurance.
31	**FR-3:** Remove roads, waste water facilities, and public infrastructure that sustain repeated damage from flooding.
10, 11	**FR-4:** The term REALTOR® is a registered mark from NAR and may only be used by members of the association. The term "real estate licensee" is the more general term and should be used for purposes of this report.
10, 11, 12	**FR-4:** Such a significant disclosure obligation of "permits or other documentation from the states, flood insurance records, easements onsite or tax records" on a real estate licensee for information that is not within the personal knowledge of the licensee without extensive investigation is unreasonable and could unfairly place the licensee in jeopardy of legal or administrative prosecution.

Summary of Written Comments received by March 7, 2007, on the "Preliminary Action Plan Public Review Draft, January 2007" Issued by the Delaware River Basin Interstate Flood Mitigation Task Force

Comment ID	Comment
10, 11, 12	**FR-4:** Object that real estate licensees should become responsible for certain property condition disclosures that appropriately should only apply to the seller. We suggest that any final recommendation limit property condition disclosure obligations to sellers only. The onus is on the seller only to make these disclosures prior to a buyer being bound by a contract of sale.
11	**FR-4:** The requirement for a municipality to store individual property flood history would place a liability on the municipality. Why should a municipality store this information and what would it be used for?
22	**FR-4:** Support flood hazard disclosure requirements
21	**SM-7 or FR:** Address the need for streamlined and consistent permitting between the states specific to maintenance cleanouts. State land use policies and regulations make river/creek/ditch clean-out (necessary due to erosion) rather costly (engineering and permitting).
	Flood Warning
General:	
4, 22, 29, 31	Support and recognize the need for improved gaging, forecasting, and warning systems
22	DRBC should invest in tools that provide real time warnings and images for emergency management personnel.
4	The National Weather Service should develop a password protected site dedicated to emergency management personnel.
4	Support 6 hours frequency forecasting updates
Specific:	
36	**FW-2:** USGS gages immediately downstream of Cannonsville and Pepacton (Stilesville #01425000, Downsville #0141700) need telemetry for real-time access.
4	**FW-2:** Request for Hunterdon County forecast point.
22	**FW-2:** Additional financial sources should be sought to support the operation and maintenance of gages.
21	**FW-2:** Supports flash flood forecasting tool for the headwaters.
4, 21, 53	**FW-10:** Dam failure inundation mapping should be more readily available. Adding dam failure inundation limits to Flood Insurance Rate Maps is supported.
4	**FW-10:** All dam/levee emergency action plans should follow a standardized format to facilitate use by Emergency Management Officials. The plans should be available in electronic format and should be included into the EPI-Net system so that they are available on a protected on-line source.

DELAWARE RIVER BASIN FLOOD MITIGATION TASK FORCE
PUBLIC MEETING #1

Thursday, February 8, 2007
Sen. Charles D. Cook County Office Building
Delhi, N.Y.

(60 people in attendance)

Summary of Public Comments:

Tina Molé, representative of N.Y. State Senator John Bonacic
Delhi, NY; (A collection of 6 newspaper articles was distributed)
A statement prepared by Senator Bonacic was read. Senator Bonacic supports the needed studies and analysis mentioned in the task force document, but he urges that until these studies are completed and the results implemented, lowering the NYC reservoirs and creating sizable voids should be a first priority. He maintains that current reservoir levels, according to NYCDEP, are 15% above average. He suggests that there is no need for reservoir levels to be so far above average and he proposes that the reservoirs should be lowered immediately and the average levels of the reservoirs should be maintained.

James Eisel, Supervisor of Delaware County, N.Y. and Task Force Member
Mr. Eisel stressed that one of his main concerns is reservoir operations and that the current temporary spill mitigation program needs to become permanent. He believes this program, along with snowpack monitoring and releases, may have the ability to contain 50-60% of rainfall events that would otherwise cause flooding conditions.

Gerard Behrens
Downsville, NY
NYC reservoir levels need to be adjusted to account for rainfall and lowered to average levels.

Sam Rowe, Town of Hancock Supervisor, Delaware County, N.Y.
Hancock, NY
Attention was brought to recommendations S-3 through S-6:
S-3 Ensure Financial Assistance for State, County and Municipal Flood Mitigation Projects
S-4 Provide Training for Local Officials to Maximize Use of Available Mitigation Funding
S-5 Create Partnering Programs for Floodplain Acquisition
S-6 Establish Funding Priority Areas for Acquisition, Elevation, and Floodproofing
In regards to Hazard Mitigation Grant Program (HMGP) funding, following a disaster a certain percentage of all disaster funding is made available to the state for mitigation purposes. This pot of money is usually distributed from FEMA to the state and then is dispersed to all counties. During the June 2006 flood, the mitigation dollars were directed only to affected counties. Directing mitigation dollars to affected counties only should be continued in the future.
Delaware County has applied to FEMA for acquisition funds but has never been awarded any funds. Hancock has applied for acquisition funds and was denied. Small N.Y. towns are not able to meet the necessary qualifying requirements set by FEMA. The qualifying requirements should be revisited and help with prioritizing the applications is necessary.

Regarding recommendation SM-7 (Create Stream Restoration and Debris Removal Guidelines), because the area is mountainous and conditions vary from other areas in the basin, the township would like to be involved in and kept aware of the development of any such guidelines.
HMGP funding recently made available to N.Y. requires a 25% local match. A lot of the work that would qualify for funding has already been done through FEMA. Current FEMA bank armorization using riprap, however, is causing incision of the stream bed and eroding private property. A better, long-term solution than the FEMA riprap should be found.
Use of Natural Resource Conservation Service (NRCS) Emergency Watershed Protection funding is limited because it can only be used near a roadway and it cannot touch private property. Instead, funding should be made available to repair/restore a damaged stream on a watershed basis, not only near a roadway.

Robert H. Homovich, Supervisor of the Town of Colchester, Delaware County, N.Y.
Downsville, NY
N.Y. towns cannot afford unfunded mandates. Town ordinances have been reviewed and they seem to work as is. Now, new FEMA mapping using recent high water marks has put the whole valley in the floodplain. The floodplain ordinance for the town did not anticipate and was not designed for this change. Now, with the change in floodplain and floodway, what does this do to the local economy? To real estate values? To the tax base? To flood insurance rates of existing residents who are now told they are in the floodway? Will banks still hold the mortgages of existing residents? The town would like answers to these questions. If towns are going to be asked to regulate, it must be something that the towns can live with.
Years have gone by with no stream maintenance. The river channels need to be maintained and have a planned maintenance schedule in order to clear out debris. Right now, Colchester has six miles of trash, trailers, uprooted trees, etc. He cannot get any funding from agencies for debris removal.
Reservoir operation plans that are operated in a realistic and flexible manner are needed. Stormwater management will bankrupt towns; funding must be provided.

Joan Homovich
Downsville, NY
Ms. Homovich lives one mile downstream from Pepacton. Nine events have flooded her home. She offered the following thoughts:
Recommendation R-3 (Evaluate Discharge Mitigation Programs for Reservoirs): She believes planning takes too long. Something should be done now.
Recommendation R-2 (Develop an Interoperable Reservoir Operating Plan): She is concerned about the implementation time of three years.
DRBC Resolution 2006-18 (Interim Spill Mitigation Plan): Needs to be evaluated now. Release rates need to be increased and revaluated, especially for Pepacton at the L2 level. Why does Pepacton have the smallest release capacity of the program? An evaluation of flood thresholds immediately below Cannonsville and Neversink was recently performed by the National Weather Service. As a result, the maximum combined spill and release flow rate for each of these reservoirs is being reevaluated. Why was the flood threshold not reevaluated for Pepacton?
Recommendation FW-7 (Evaluate River Forecast Points): In the recent USGS report on the April 2005 event in the Neversink River Basin, gages 01417000 (East Branch at Downsville) and 01425000 (West Branch at Stilesville) are listed. Why aren't these gages available online with real-time data? These should be prioritized for updates.

Jim Serio, Delaware River Foundation
Hancock, NY
The adaptive release policy for the NYC reservoirs is needed and goes a long-way in the short-term. The policy will be released in March at DRBC's Regulatory Flow Advisory Committee meeting. The adaptive policy will look at what is coming into the reservoirs to convert uncontrolled spills into controlled releases. In order to create any substantial voids in anticipation of hurricane season, the program must begin in summer.
Habitat and recreation need to be highlighted in the report. Yes, we need to mitigate floods, but doing so also provides and maintains better habitat which in turn creates and sustains recreation, including fisheries.
More downstream water supply is already being addressed at the FE Walter Dam with the new current flow management plan allowing the pool elevation to be maintained at 65 feet.

Stanley Woodford, Supervisor, Town of Deposit, N.Y.
Deposit, NY
Regarding the flexible flow program and DRBC Resolution 2006-18, Mr. Woodford would like to see the reservoirs lowered to 80%.
He also would like to know if there is a way to dredge the rivers without hurting the fish.

David Jones, Kittatinny Canoes
Dingmans Ferry, PA
Kittatinny Canoes cannot afford another flood. $0.5 million was lost in the last flood and in addition revenues have been lost. Controlling the reservoirs is a short-term solution. NYC needs to release water in the summer to create voids and control flow.
The June flood created an artificial floodplain. His buildings were built higher than the 100-year flood levels and yet they were inundated this past flood. He is concerned about changes in the floodplain and the damage caused by erosion. In considering any regulations, land owner rights must be evaluated and just compensation provided for any imposed economic burden.

Ken Pyle
Delhi, NY
Mr. Pyle, a 30-year Delhi resident, is concerned with future development and believes all future development should wait and take into account new studies and delineations of the floodplain and floodway. He is concerned that when development is allowed in the floodplain, the allowed fill will displace water elsewhere and exacerbate future flooding conditions downstream. Local towns need development, but they need safe development.

Antonio Scielzi
Delhi, NY
FEMA will only pay for riprap in repairing stream beds. This does not solve the problem and is only temporary. The riprap placed at one bridge has already moved. A longer-term solution should be sought and the funding should be expanded to cover large stone and slate.

Elaine O'Neil, Delaware Riverside Conservancy (DRC)
Belvidere, NJ
The temporary spill mitigation plan, Resolution DRBC 2006-18, does not take into account rainfall. A plan needs to be put in place that is flexible and adaptive. Release rates need to be increased.

The Delaware Riverside Conservancy was originally a member of the task force, but it has withdrawn its name from the report because there are no short-term recommendations and the recommendations suggested by DRC (including mandated reservoir voids and retrofitting the NYC outlet works) were not accepted into the report.

Bob Mackey, NJ resident
NYC has an arrogant attitude and greater releases should be made.

Edward (Skip) Garlits, PA resident
A main stem flood flow control structure at Walpack Bend in the Delaware Water Gap and a reservoir along the Flat Brook would provide for the water supply needs of downstream users (N.J. & Pa.) during droughts. This creation of a new water supply may allow the decree parties to agree to greater voids in the NYC reservoirs.

DELAWARE RIVER BASIN FLOOD MITIGATION TASK FORCE
PUBLIC MEETING #2

Thursday, February 15, 2007
Carvel State Office Building
820 North French Street, Wilmington, Del.

(5 people in attendance)

Summary of Public Comments:

No comments were made.

DELAWARE RIVER BASIN FLOOD MITIGATION TASK FORCE
PUBLIC MEETING #3

Tuesday, February 20, 2007
William Antheil Elementary School,
339 Ewingville Road, Ewing, N.J.

(75 people in attendance)

Summary of Public Comments:

Bill Kearney, Co-president Island Civic Association
Trenton, NJ
A statement signed by 101 community members of the Island section of Trenton was read. The association appreciated the report and hopes that the commitment to study the problem carries through to a commitment to implement a solution to the problem. The association appreciates that many of the recommendations need appropriate research, studies and planning and it endorses the data driven process. But, there are some obvious community- or organization-specific deficiencies that could be prioritized and committed to now. Prioritization is an important next step, along with subsequent identification of projects and allocation of appropriate funding.

In the Island section of Trenton, most of the community experiences basement flooding primarily caused by backwater flooding. Insurance only allows replacement of utilities (furnace, electrical, etc.) to be returned to the basement. The community needs grants or available funding in order to raise these utilities to an upper floor. This would allow for a solution and prevent loss of these utilities during the next event.

In addition, the community needs retrofitting of storm sewers in order to prevent backwater flow into the neighborhood. Following the April 2005 event, a passive elbow joint was installed that worked effectively to prevent damage during the June 2006 event. Active backflow prevention devices as opposed to passive would be even better for the community.

Elaine O'Neil, Delaware Riverside Conservancy
Belvidere, NJ
She said the Delaware Riverside Conservancy was a Task Force member, but withdrew from the process because their recommendations were ignored by the task force since New York City would not agree to them. She went on to say their recommendations included retrofitting release works, 20%-30% voids, and using shaft #6 to take additional water out of the reservoirs. The temporary spill release program does not take into account rainfall. While the releases to date through the program (142 BG) are impressive, it is worthless compared to what is still retained in the reservoirs (combined 89%). The program is designed to allow the reservoirs to be 100% full at the start of June and won't be in effect during hurricane season. She questions the "neighborliness" of New York City.

Barry Ziff
New Hope, PA
Stream restoration was addressed in the report. What about reservoir restoration? The silting issue/problem needs to be addressed to determine if storage is being lost. He read an article

reporting that per capita water consumption is down; if this is true, does New York City need as much reservoir storage for its drinking water?

Kurt Weirich, American Red Cross Director of Emergency Services
Princeton, NJ
He commends DRBC on the report and its recommendations. He strongly supports mitigation and elevation programs. He all too often has responded to floods on the Delaware and would like this cycle of repetitive floods to end. The only way to end this cycle is to have comprehensive, properly funded mitigation plans that continue to be implemented. Stream gaging along with modeling, prediction and warning are very important. These tools make it easier for residents and emergency management personnel to understand the forecasted event and respond appropriately. He added that these tools should be made more easily accessible to the public and more data should be made available to first responders. He advocates flood insurance and flood mitigation opportunities. A public education and awareness campaign is critical for residents and communities to appropriately respond to flood events and plan for the future.

Joe Bair
Trenton, NJ
He lives across the street from the Island section and believes that reservoir levels will not go down until there is a drought. He noted the high level of anxiety due to current high reservoir levels and expressed concern about a future ice jam. Residents need better information regarding elevation of appliances. It is very hard to figure out how high they should be elevated. Future LIDAR and accompanying digital flood maps will help, but they need the information now. Sewage infiltration, which impacted his property, should be addressed. Sewer vents need to be protected from flood waters with collars. He had a specific inquiry about the New Jersey Governor's Flood Mitigation report and will follow up directly with John Moyle.

Jim McManimon, Ewing Twp Administrator
Ewing, NJ
Stormwater backflow preventors are needed to protect Ewing Township, too. There are 69 outfalls between Trenton and Ewing. Many of the outfalls along Route 29 are owned by the State of N.J. In one section of Ewing Twp. in the vicinity of Wilburtha Road, 500 homeowners and apartment residents go without power in the event of a flood. The power company has estimated that it would cost $150,000 to relocate the grid.

Comments by the audience: Medina Consultants, working for N.J. Department of Transportation, is looking at all outfalls currently along Route 29. Yardley, Pa. also has a problem with backflooding due to storm drains.

Doug Gravier, Lambertville, N.J. Resident
Grants or insurance are needed to help pay for the elevation of utilities or help defray the costs of disconnecting/re-connecting utility service. Elevation of utilities can cost between $10,000-$15,000. This is a short-term solution that many will be able to take advantage of. He's not expecting that all costs can be covered, just some of them.
He plans to set up a Yahoo User Group ("Yahoo @ Delaware River Flooding" or something like that) so all meeting attendees can coordinate and work together.

Jay McLaughlin, Waste Management
Morrisville, PA He coordinates disaster response for Waste Mgmt. from Sullivan County, N.Y. down to Trenton, N.J. He warns that there is a depression setting in around river towns. We need a more proactive approach to flood mitigation, not just improved flood warning. The report makes it sound like we are surrendering. We are losing the serenity of living in a river town and the government owes us more.

Gail Pedrick
New Hope, PA
She witnessed the 1955 flood (a one day flood), the 2004 flood (a one day flood), the 2005 flood (a two day flood), and the 2006 flood (a three day flood). The reservoirs need to be lowered! These recent events were lengthened by the reservoirs. She referred to a lawsuit against New York City for mismanagement of the reservoirs and is concerned that silt buildup is weakening the dams which would be catastrophic if they would fail. Flooded residents should have had a seat on the task force. Regarding a potential ice jam, she is concerned about the potential buildup and would like to know what will be done in the event of an ice jam. She remembers the 1996 jam up in Milford, PA when she was given only three hours to remove belongings from her home and is worried that a similar scenario could occur. She believes dynamite was used in the past to break up ice.

Mary Lou Delahanty, Glen Afton Civic Association, Trenton
Trenton, NJ
She applauds the study, but we need measures that can be implemented now. One such measure is the creation of a void in the NYC reservoirs. The current spill mitigation program expires May 31 and it needs to continue beyond that date. Concern was expressed about working relationships with NYC and the possibility of going back to the U.S. Supreme Court was suggested. The possibility of building more reservoirs was raised.

Nancy McKeen, Glen Afton Civic Association, Trenton
Trenton, NJ
Acquisition and open space are seen as white surrender flags. The report makes it seem as if we are giving up. She is upset that Trenton is dismissed from being a historic community.
We need more proaction (like the Trenton plan), not reaction as this plan seems to be. There are outfalls that can be addressed. In fact, one check valve was installed in the Sanhickon system for $100,000 by NJDOT. More outfalls need to be addressed and more grants made available.
Why were no flooded residents/citizens from Trenton asked to participate on the Task Force? Why was DOT not on the task force? Why wasn't flooding on smaller streams, like the Assunpink Creek, specifically addressed?

David Laird II
Trenton, NJ
He is concerned with Spring Lake and its designed function as an extended detention basin. He also has concerns about culverts placed in the wrong places and nonpoint source pollution as well as the D&R Canal and its flood gates system.

Lucy Walter, Mercer County Freeholder
Congressman Holt held a meeting for flooded residents back on August 14, 2006. At that meeting, DRBC was one of the speakers present. At that meeting, Freeholder Walter expressed her desire for Mercer County involvement; reverse 911, etc. She is disappointed that Mercer

County was not included as a Task Force member and that they should have been part of the process. She feels that Hunterdon and Warren counties had ample representation and that Mercer was ignored. The N.J. Association of Counties would have been a good task force member, too. We need a multi-jurisdictional approach with county governments being a key player. A seemless system across county boundaries is needed for immediate emergency response.

Deborah Roussell, Island Civic Association
Trenton, NJ
The Island section needs better efforts to add backflow prevention devices and to retrofit storm sewers. One was recently retrofitted, which is positive but cost $100,000. This is 1 out of the needed 69. Also, the Island section needs help to move up utilities out of basements. This study and report are positive, but the work cannot be forgotten 10-15 years down the road if there is a period of no flooding; we need to be diligent in working towards implementation. Pressure must be put on elected officials.

Jolene Cooper
Resident of the Byram section of Kingwood, Hunterdon County, NJ
The Byram section of Kingwood has been repetitively flooded. It is a small (approximately 40 homes), but committed community. Funding and grants for elevation of homes is desired. FEMA continues to spend dollars for mitigation, but dollars committed to elevating homes falls short. She is concerned about a lack of funding to implement measures. She believes that is why so much attention is focused on reservoir management since those are actions that can be done relatively quickly without requiring a lot of money.
Silt levels in the reservoirs should be addressed prior to considering raising the reservoirs. More voids in the reservoirs are important. Even if they only create an additional inch downstream, that inch is important to the downstream residents.

Unidentified Person
A look should be taken at how development in the Lehigh River Valley impacts flooding. Land development, impervious cover, and zoning decisions all have an impact on runoff, which exacerbates flooding.

Assemblywoman Marcia Karrow, N.J. State Legislature (District 23) and Task Force Member
She represents 16 flooded communities in Hunterdon and Warren counties. She emphasized recommendation S-1, Fund a Comprehensive Flood Mitigation Study of the Entire Delaware River. This recommendation would allow the Army Corps of Engineers to study all structural and non-structural solutions to flooding. N.J. has already made a commitment to the Army Corps for a limited portion of the study. All four governors would need to provide funding for this unfettered study.

DELAWARE RIVER BASIN FLOOD MITIGATION TASK FORCE
PUBLIC MEETING #4

Tuesday, February 27, 2007
Hugel Science Center, Lafayette College
Easton, Pa.

(100+ people in attendance)

Summary of Public Comments:

Doug Platz, Office of Congressman Patrick Murphy (8th District-Pa.)
Congressman Murphy said in a prepared statement that flooding is changing the current landscape and that the task force's report is a strong step in the right direction. The congressman is eager to be of assistance with the report's implementation. He is concerned over the operations of the NYC reservoirs and recommends that the current temporary spill mitigation program be extended through the current flood season. He urges the decree parties to come up with an agreement prior to the May 31 expiration date.

Phil Chase, Upper Delaware Council
Port Jervis, NY
A prepared statement was read. He noted that he previously worked on efforts to stop Tocks Island Dam. He warned that NYC has always wanted to avoid the costs of filtration and pumping that would be necessary to take water from the Hudson. Other towns, such as Hyde Park and Poughkeepsie, drink Hudson water and NYC could, too, if the city would pay an estimated $8 billion for a filtration plant. NYC has put millions into purchasing farmland and building new sewer plants in the headwaters of Cannonsville. He referred to the 1951 "Little Hoover Commission" which was comprised of experts from around the nation hired by NYC. He said this commission recommended that Cannonsville should not be built, that all drinking water should be filtered, and that the city's water tunnels should be fixed. In addition, this panel found that it is possible to pump 325 million gallons per day (MGD) from the Hudson. He stated that this should be done in order to allow for voids in the NYC Delaware Basin reservoirs. He also warned that when the Delaware Aqueduct is closed for maintenance in the next few years, none of the allowed 800 MGD diversion to NYC will be made. It is possible that the Catskills Aqueduct will close down for maintenance in the future and then the full diversion of 800 MGD to NYC out of the Delaware reservoirs can be expected. If 325 MGD is taken from the Hudson, the allowed NYC diversion of 800 MGD is decreased, which creates the possibility of a 70-100 billion gallon void.

DRBC does not have the authority to do what needs to be done due to NYC's veto power as a decree party. He said there is a need to return to the U.S. Supreme Court to take back the 800 MGD diversion from NYC and believes NYC should be stopped from selling water to other out-of-basin customers.

William Kays
Warren County resident
To reduce floods, the flow in the Delaware should be expedited to the Atlantic Ocean.. Inflows to the river should be controlled, but also trees and vegetation should be removed from river

islands in a controlled manner, some of the river islands should be removed and the S curve in the Delaware should be straightened or else a canal should be put through it.

Diane Tharp, Delaware Riverside Conservancy Member
Minisink Hills, PA
NYC reservoirs and Lake Wallenpaupack need to have adequate and coordinated spill mitigation plans. There needs to be a permanent year-round provision to keep a void for flood mitigation purposes in all reservoirs. Increased releases are necessary in order to account for times of increased inflow (runoff) to the reservoirs. A spill mitigation program will not work unless it takes into account rainfall. In addition, it is not prudent for NYC to create additional storage in its basin reservoirs. She is concerned that a newspaper investigation showed that reservoir inspection reports were falsified.

JoAnn Kennedy
Martins Creek, PA
There is a severe failure of adequate enforcement of floodplain and stormwater regulations at the federal, state and local level, and confusion over who should be doing the enforcement. Hazard mitigation plans have not been completed by her township in a timely fashion, so residents have lost funding assistance opportunities Floodplain maps are inadequate. Development is continuing. Strict enforcement of programs already in place is needed at all levels of government and all agencies must coordinate their efforts.

Robert Belstra
Blairstown, NJ
Mr. Belstra owns a farm in Hope Township along the Beaver Brook, a quick response stream. In June, the private bridge spanning the river was washed away. FEMA directed him to contact the Farmers Home Administration for a loan. Why isn't more aid being given to homeowners?

The NYC reservoirs should have greater releases before flood events. Channelization is a good idea. Is there another site for a dam like Tocks Island that could be used since that location did not work out? (He said a dam also would help with hydropower generation).

George Kelchner, Delaware Riverside Conservancy President
Phillipsburg, NJ
Over the past six years, the NYC population has increased by 9% but water consumption has decreased by 450 million gallons. Why does NYC need so much water? Prior to both the September 2004 and April 2005 flood events, NYC was not making any diversions. He understands the reason is because the city did not want to aggravate conditions at Rondout Reservoir. If need be, let's modify Rondout and get Shaft #6 working in order to divert more water from the reservoirs to the Hudson. He later added that he thought the floods were manmade, not natural.

Jeff Russo, Delaware Riverside Conservancy Attorney
He is an attorney representing a nonprofit with hundreds of residents. One formal objection he made was over the approach, ideals and focus of the task force since he believes public comments were not procedurally taken into consideration. He also formally objected to the subjectivity of that evening's powerpoint presentation regarding the reservoirs and the timing of the proposed Flexible Flow Management Plan now under consideration. He believes that this was done to taint the public.

Kathy Davis, Delaware Riverside Conservancy Member
Bangor, PA
The report has some merit, but it is not good or quick enough. Short-term actions are needed. The Supreme Court decree must be revisited because NYC is arrogant. She noted that nine lives were already lost and future floods will kill more people.

Mark Klouda, Delaware Riverside Conservancy Member
Columbia, NJ
He questioned why there were no flooded residents on the task force.

Robert Tailor
Lower Mt. Bethel Township, PA
Should penalties, in addition to the removal of flood insurance, be attached to lack of appropriate enforcement? Most local governments do not know how to adequately enforce their floodplain management ordinances. Local officials need training and licensing.
Lack of appropriate local control was evident after the recent PPL fly ash spill. The township allowed PADEP to lead operations and he does not believe township interests were protected.
Lake Wallenpaupack needs to release water prior to the river cresting. During one of the floods, PPL released water at 3 a.m., the worst possible time. He said this increased water levels at this house by nine feet. Coordination and action plans need to be in place to avoid this occurrence in the future.

Mel Kaplan
Bushkill, PA
He has been an emergency management volunteer for 30 years. Those who do not learn from past experiences are doomed to repeat them. He warned of the event in the Susquehanna Basin about 35 years ago when an earthen dam was overwhelmed and floodwaters inundated Wilkes-Barre and Harrisburg. Dredging of tributaries used to be common place in the late 1960s. Today, dredging is no longer done and the channels have filled with rock. The flood plain maps have to be wrong if dredging hasn't occurred since they were drawn.

Mary Shafer, Author of "Devastation on the Delaware," Local Weather Communicator for Nockamixon Township, PA
Ferndale, PA
Four things affect flooding: nature, communication, technology and human behavior. Some circumstances we do not have much direct control over, including shifting climatic conditions and NYC reservoir levels. But one thing we do have direct control over is our own behavior. For the larger decisions, people need to affect local politics – show up at township meetings and make sure to vote in your local elections.

Rivers flood, floods cannot be stopped, and floodplains are a necessary part of a "living" river. Perhaps the Supreme Court decree should be revisited, but people who live in the floodplain must accept the risks associated with living in the floodplain. She mentioned that there is a dichotomy between those who live "on the river" vs. those who live "with the river." "With the river" residents believe that floods are a "beauty tax" that you must accept in order to live with the beauty of the river all other days of the year. "On the river" residents believe that the river and government owe them something. The reality is that people should be helped to move out of the floodplains and that future development needs to be restricted from the floodplains.

Robert Johnson, Easton Citizen Action Group
Easton, PA
We need to stop development in the floodplain! In downtown Easton, a "Riverwalk" project is planned 20 yards from the river on a vacant property that was inundated by the June 2006 flood to a height of eight feet. Government needs to make a conscious decision not to allow developers to continue to build in the floodplain. These are obstructions during future floods and should not be allowed. We need a moratorium on development in the floodplains.

Someone else in the audience added that better federal/state/regional enforcement of regulations already in place is needed.

Elizabeth Weaver, Friends of the Delaware Canal Board Member
Easton, PA
The preservation and restoration work needed for the flood-damaged Delaware Canal is estimated to be $31 million dollars (cost share: 25% state and 75% federal/FEMA). The canal is a national historic landmark and the work will be completed between Easton, PA and Bristol, PA. She does not believe these costs are included in the task force documents and poster displays.

Edward (Skip) Garlits, PA Resident, Task Force Contributor
A main stem flood flow control structure at Walpack Bend in the Delaware Water Gap (controlling 74% of the drainage between the Delaware Water Gap National Recreation Area and Trenton) and a reservoir along the Flat Brook would provide for the water supply needs of downstream users in NJ & PA during droughts. If built, they may allow the decree parties to agree to greater voids in the NYC reservoirs in order to protect homes and infrastructure downstream. He believes we have to move towards structural measures for flood loss reduction.

Craig Gillhouse
Belvidere, NJ
He said development along the Brodhead Creek in the Poconos needs to be considered. He believes that creek discharged more than the Lehigh River during one of the floods. Development in the Poconos and lack of dredging on the rivers are exacerbating flooding.

Elaine O'Neil, Delaware Riverside Conservancy Member
Belvidere, NJ
She said the Delaware Riverside Conservancy was a task force member, but withdrew from the process because their recommendations were ignored by the task force since NYC would not agree to them. A problem with the task force is that everything was decided by consensus. She went on to say their recommendations included retrofitting release works, 20%-30% voids, and using shaft #6 to take additional water out of the reservoirs. The temporary spill release program does not take into account rainfall; what matters is the amount of water stored in the reservoirs, not the amount of water released under the program. The recurrent theme is that we need voids to reduce flooding and we need to look at using shaft #6 to release water into the Hudson. NYC needs to step up and be socially responsible. She would like DRBC to go back to the Supreme Court because the decree is outdated. She is not an advocate of a main stem dam since it would put more control in the hands of the government and she does not believe that such a long-term, government solution will benefit homeowners like her along the river.

Assemblywoman Marcia Karrow, N.J. State Legislature (District 23) and Task Force Member

She represents 16 flooded communities in Hunterdon and Warren counties. She emphasized recommendation S-1, Fund a Comprehensive Flood Mitigation Study of the Entire Delaware River. This recommendation would allow the Army Corps of Engineers to study all structural and non-structural solutions to flooding. N.J. has already made a commitment to the Army Corps for a limited portion of the study. All four governors would need to provide funding for this unfettered study.

She noted that the Delaware Riverside Conservancy recently sent a letter to Governor Corzine requesting that the Supreme Court decree be revisited. She noted that her office will track and follow any action that occurs as a result of that request. She believes it needs to be added as a recommendation by the task force.

Appendix C

History of Flood Management and Reservoir Release Decisions in the Delaware Basin

- History of Flood Management Decisions on the Main Stem Delaware River
- History of Reservoir Release Decisions in the Upper Delaware
- Supreme Court of the United States, Amended Decree, State of New Jersey v. State of New York and City of New York, June 7, 1954.

History of Flood Management Decisions on the Main Stem Delaware River

Large structural projects were the flood protection measure of choice in the early and mid 20th Century, and the first Delaware River Basin Commission (DRBC) Comprehensive Plan included a large dam on the Delaware River at Tock's Island. Such a large dam and its dedicated flood storage capacity would have significantly reduced, though not eliminated, flooding on the middle and lower main stem. The 1975 decision by the DRBC to defer the Tocks Island Dam decision, the Scenic River designation of the main stem Delaware, and Congressional de-authorization of the Tock's Island project, left the middle and lower river without the flood control once envisioned in the original Comprehensive Plan of the DRBC.

Due to a host of economic, environmental and political reasons, the national trend in flood management moved away from large scale flood control projects and instead towards floodplain management and mitigating measures such as acquisition, elevation, floodplain regulations, and stormwater management. In addition, while spill mitigation programs at existing water supply reservoirs may provide some reduction in flood crests along tributary streams, they cannot be depended upon to produce the major reductions in flood peaks sought by property owners along the middle and lower Delaware. The following is a brief summary of past studies and plans that speak to flood management in the Basin.

Level B Study

The DRBC's 1981 Level B Study was a comprehensive water resources planning study funded by the U.S. Water Resources Council and the DRBC after the Tocks Island decision. In considering main stem flood potential, the study looked at the flood control provided by the four Corps of Engineer reservoirs upstream of Trenton, NJ. These reservoirs (F.E. Walter, Beltzville, Jadwin, and Prompton) provide 68 billion gallons of dedicated flood storage capacity and are designed and managed to maintain this capacity. They are located on tributaries and control less than 10 percent of the drainage area of the Delaware River above Trenton. The Level B Study noted that in a repetition of the 1955 flood, these facilities, which were built after 1955, would have reduced the flood level at Trenton by 1.3 feet. In other words, the crest at Trenton would have been reduced from 28.6 feet to 27.3 feet – still 7.3 feet above flood stage.

In further addressing main stem flood potential, the Level B Study cited an analysis performed by the National Weather Service after record flooding from Hurricane Agnes in the Susquehanna River Basin in 1972. This analysis modeled the Hurricane as if it had been centered over the Delaware River Basin, and calculated a flood crest of 31 ft at Trenton – 11 feet above flood stage and 2.4 feet higher than the record flood of 1955. The Preferred Plan of the Level B Study did not recommend any additional flood control dams other than those previously constructed in the Delaware River Basin. The study noted that non-structural flood mitigation measures such as flood warning and emergency

preparedness, floodplain property acquisition, floodplain management, flood insurance, and stormwater management, should be given more consideration than in the past.

1984 Delaware River Basin Study by the Corps of Engineers

The 1984 Corps study was authorized by Congress through a recommendation from the House Committee on Public Works and Transportation, after the DRBC expressed interest in the development of a flood damage reduction program for main stem communities in the absence of the Tocks Island Dam. The study included a detailed analysis of flood damage potential along the main stem of the Delaware River below Tocks Island. The study reviewed existing flood control projects, developed updated flood hydrology, identified major damage centers, developed estimated annual flood damages based on a flood risk assessment, and evaluated both structural and non-structural flood protection measures. All forms of impoundments and impoundment sites were reviewed for controlling flood waters on the main stem. The impoundments were screened using a set of seven criteria listed on pages 63 and 70 of the study report. These criteria are summarized below:

1) Projects were to be located above the City of Trenton, New Jersey.
2) Projects were to have a minimum of 20,000 acre-ft (6.52 billion gallons) of available flood control storage – either run of river or pumped storage.
3) Projects could not be located on Federal or state-designated scenic rivers or protected areas, nor on the main stem of the Delaware River.
4) Projects which were Part of the Level B Comprehensive Plan, and are designated for water supply, were considered unavailable to provide flood protection unless they had additional capacity to add-on flood control.
5) Projects could not require "extensive" relocation of major roads, railways, or structures which made them "obviously" economically infeasible.
6) Sites previously eliminated or deferred for environmental, social or cultural reasons were automatically eliminated.
7) Projects could not be economically feasible as a single flood control project if they were already infeasible as a flood control component of a multipurpose project.

All but two of several hundred potential impoundments were eliminated from consideration using these criteria, and the two remaining sites were eliminated due to either high cost or their small impact on main stem flooding. The study presents, on pages 66-69, a complete list of the impoundment sites meeting the 20,000 acre-ft criterion. Also eliminated were 30 local levee/floodwall measures for riverside communities in Monroe, Northampton, Hunterdon, Warren, Mercer, Bucks, and Burlington Counties. A three level screening process based on cost vs. annual average damages of the protected community was used and eliminated all the structures from further consideration. The study located 12 out of 58 riverside communities where local non-structural flood protection measures were economically justified. The individual structures identified for application of protection measures accounted for only 2 percent of the 12,000 total floodplain structures in the study area. At the time, interest at the local

level in sponsoring further studies of non-structural protective measures was extremely limited. Nearly 30 years had passed without a major main stem flood.

2004 Water Resources Plan for the Delaware River Basin

A resolution adopting a new Water Resources Plan for the Delaware River Basin was signed by the four basin governors and the federal commissioner in September of 2004. The purpose of the plan was to provide a uniform framework for addressing water resources issues in the basin. It stressed the interrelatedness of water resource issues and the need for considering all aspects of water resources in decision-making. The formulation of the plan was based on recommendations of a Watershed Advisory Council, representing a spectrum of private, public, and non-profit interests, and the recommendations of DRBC advisory committees. The plan is comprised of five Key Result Areas, the second of which is Waterway Corridor Management. Flood loss reduction is included primarily in this category, although Key Result Area No. 3 – Linking Land and Water Resource Management includes storm water management. Page 31 of the plan lists the three goals for Waterway Corridor Management. These are:

2.1 Prevent or minimize flood-induced loss of life and property, and protect floodplain ecology.
2.2 Enhance water-based recreation in the river and tributaries.
2.3 Protect and restore healthy and biologically diverse riparian and aquatic ecosystems.

In its description of the major components of flood loss reduction, the plan lists assessment of flood hazards, pre and post disaster mitigation strategies, linking flood control with storm water management, minimizing ecological impacts of floods, enhancement of flood forecasting, and public education on the natural functions of floodplains, risks of development in the floodplain, and the need for hazard mitigation plans. While the plan does not prescribe new dams, it recognizes the flood control benefits provided by existing structures. The plan includes a matrix of goals and objectives, and includes two objectives for Goal 2.1. These are:

2.1.A Upgrade and modernize flood warning and forecasting capabilities.
2.1.B Characterize flood damage risks; prioritize and implement actions to reduce risks and losses, and address human induced ecological impacts of hydromodification.

The plan lists on-line availability of Advanced Hydrologic Prediction Service products, compliance with the Disaster Mitigation Act of 2000 and restoration of hydrologically impaired waterways as desired outcomes for the two objectives. The recent flooding has resulted in the initiation of several studies aimed at characterizing flood damage risk and identifying actions to reduce flood losses. These studies, combined with the recommendations of the Task Force provide an opportunity to complete the work plan to address Goal 2.1 and its two objectives, and determine the extent to which large new structural control measures on the main stem Delaware River will play a part.

New Jersey Governor's Task Force Report

After the floods of September 2004 and April 2005, New Jersey Acting Governor Richard Codey established the Delaware River Flood Mitigation Task Force. On August 22, 2006, Governor Jon Corzine released the final report of the Flood Mitigation Task Force which includes 37 recommendations directed at flood loss reduction. The recommendations are detailed and consistent with Goal 2.1 of the Delaware River Basin Water Resources Plan. However, the report goes further than the basin plan in its implications for large main stem structural projects. The Executive Summary introduces the major findings of the report with the statement that "The floodplains should be expected to flood," and follows this with the finding that "No set of measures, alone or in combination, will stop or eliminate flooding in the Delaware River Floodplain." The report does not rule out structural solutions for flood control, and encourages studies of their viability, but states that "Any study should focus on local nonstructural and structural measures, and should not revisit the federal and state policy and funding decisions that terminated the proposed Tocks Island dam project."

Post Flood Direction by DRBC Commissioners

Since the June 2006 flood, the DRBC commissioners have met in public sessions concerning flood issues. DRBC staff have also participated in hearings and briefings related to the causes of the flooding. The major concern voiced by riverside citizens has been the need for more flood control. Many riverside property owners believe that changes to management of existing water supply reservoirs could significantly lower flood levels along the main stem, and that reservoir spills and upstream development are largely responsible for the spate of recent flooding. The commissioners have responded by establishing this Task Force, providing funding for the development of a flood analysis model for the basin's reservoirs, and approving a temporary spill mitigation program for the three New York City Delaware Basin reservoirs. Consensus among the commissioners is that spill mitigation will not achieve major flood control along the main stem, and that a comprehensive program is needed to address flood loss reduction.

History of Reservoir Release Decisions in the Upper Delaware

The Delaware River Basin Commission (DRBC), a federal-interstate compact agency, was formed in 1961 by the signatories to the Delaware River Basin Compact -- Delaware, New Jersey, New York, Pennsylvania, and the United States -- to provide for cooperative management of the water resources of the Basin. There are five Commissioners: the Governors of the four basin states and a federal representative appointed by the president (Ref. 1). The DRBC has regulatory, as well as management, planning and resource development authorities.

The compact establishing the DRBC provided the Commission with the authority, in accordance with the doctrine of equitable apportionment, to allocate the waters of the basin to and among the States that are signatory to the DRBC compact and to and among their political subdivisions, and to impose conditions, obligations and release requirements related thereto, all subject to certain conditions and limitations. A key limitation is that the Commission may not, without the unanimous consent of the parties to the 1954 Supreme Court decree[a], diminish or otherwise adversely affect the diversions, compensating releases, rights, conditions, obligations and provisions for the administration thereof contained in the decree (Ref. 1). The Decree Party representatives are the governors of the four basin states and the mayor of New York City.

Supreme Court Decree

On May 4, 1931, the U. S. Supreme Court issued a decree authorizing New York City (NYC) to divert an average of up to 440 million gallons of water per day (mgd) from two reservoirs it proposed to construct in the Delaware River Basin (the basin) for its water supply system in the Hudson River Basin (Ref. 2). This decree temporarily settled the case of the New Jersey v. New York, 283 U.S. 336 (1931), and resolved an interstate dispute over NYC's diversion of water from the basin. The decree also required NYC to release sufficient water from its Delaware Basin reservoirs to maintain flow targets in the Delaware River at Port Jervis, NY and Trenton, NJ.

The 1931 decree was superseded by an amended decree issued by the Supreme Court on June 7, 1954 in the same matter, 347 U.S. 995 (1954) (Ref. 2) (hereinafter, “the Decree”). This second adjudication arose when NYC sought to increase its diversion upon construction of a proposed third reservoir within the Delaware Basin. The amended decree increased NYC's allowable diversion to an average of 800 mgd from the three Delaware Basin reservoirs, on condition that NYC release sufficient water from the reservoirs to maintain a minimum basic flow of 1,750 cubic feet per second (cfs) in the Delaware River at Montague, NJ. In addition, the Decree authorized New Jersey to continue its existing diversion of up to an average of 100 mgd from the basin without providing compensating releases. The Decree designated the Chief Hydraulic Engineer of the U.S. Geological Survey (USGS) or that official's designee as the Delaware River Master (River Master) (Ref. 3). The River Master's duties include ensuring that the provisions of the Decree are carried out (Ref. 4).

Two-Part Governance of Delaware River Flows – DRBC and the Decree Parties

The 1954 Decree did not constitute a permanent apportionment of the waters of the basin. Rather, the Decree expressly provided that the parties could apply to the court for further action or relief at any time (Ref. 3). The Decree also provided that the diversions it allowed would not constitute prior appropriations or confer any superiority of right with respect to use of the Delaware's waters (Ref. 3). The uncertainty as to diversion rights and release requirements in the long term created an incentive for the parties to exert greater collective control over apportionment of the river's flow. They did so through the Delaware River Basin Compact, which provides that "[e]ach of the signatory states and their respective political subdivisions . . . in recognition of reciprocal benefits, hereby waives and relinquishes for the duration of this compact any right, privilege or power it may have to apply for any modification of the terms of the decree . . . which would increase or decrease the diversions authorized or increase or decrease the releases required thereunder . . . .(Ref. 1). The initial term of the compact is 100 years. As noted above, without the unanimous consent of the parties to the Decree, the compact gives the Commission no authority to "diminish or otherwise adversely affect the diversions, compensating releases, rights, conditions, [and] obligations" . . . contained in the Decree. If the Decree Parties concur, however, they can act together through the Commission to modify the conditions established by the Court.

Over time, the Commission has identified areas where a departure from strict application of the terms of the decree can assist in the conservation of the basin's water and other resources. The Commission has supported Decree Party negotiations leading to a series of understandings codified in Commission regulations that are aimed at protecting public health and welfare during times of drought and enhancing the basin's fisheries. The most significant of these are a set of consensus recommendations contained in the Decree Parties' "Good Faith Recommendations" for interstate water management of 1982 (Ref. 6). A subset of these Good Faith recommendations became the subjects of Commission Resolutions Nos. 83-13, 84-7, and 88-22 (Revised), establishing regulations codified at Sections 2.5.3 through 2.5.6 of the DRBC Water Code. These rules are generally known as the "reservoir drought operating plans" (Ref. 7). The measures incorporated in these resolutions were prompted by a record drought in the 1960s and were made to conserve storage and continue to provide flow augmentation during periods of drought or extended dry weather. The drought operating plans, which consist of phased reductions in diversions and releases based upon reservoir storage curves, have been invoked numerous times since their adoption in the early 1980s.

Additional understandings among the Decree Parties have been established through DRBC regulation in the form of a docket and subsequent docket revisions. Docket D-77-20 CP and amendments thereto (Ref. 8) primarily concern protection and enhancement of the cold-water fisheries below the three NYC Delaware Basin reservoirs (the "tailwater fisheries"). Through a series of experimental programs approved in the form of dockets, the Commission and the Decree Parties have attempted to improve the tailwater fisheries, while recognizing the diversions to New York City (NYC) and New Jersey and the Montague flow target, all prescribed by the Decree, as well as the constraints imposed by limited reservoir storage, particularly during drought.

Recent Negotiations

The parties to the 1954 U.S. Supreme Court Decree are in the process of developing a Flexible Flow Management Plan (FFMP) for managing Delaware River Basin impoundments, including the NYC water supply reservoirs, for multiple objectives. These objectives include water supply, which encompasses the need to control salt concentrations near major urban intakes in the upper reaches of the Delaware Estuary; ecological flows; and flood mitigation. One component of the FFMP is a permanent "Discharge Mitigation Program." This program currently is undergoing revision in response to comments submitted during the recent public comment period on the FFMP.

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[a] The Compact also states that DRBC, after consultation with the River Master, may by unanimous consent of its members declare a state of emergency resulting from a drought or catastrophe and may authorize and direct an increase or decrease in any diversion permitted or releases required by the Decree, in such manner and for such limited time as may be necessary to meet such emergency condition. Compact § 3.3(a).

References

1. Delaware River Basin Commission, Delaware River Basin Compact, Section 3.3, Paragraph a, October 27, 1961.
2. Supreme Court of the United States, Delaware Diversion Case, State of New Jersey v. State of New York and City of New York, Opinion of Justice Holmes, May 4, 1931.
3. Supreme Court of the United States, Amended Decree, State of New Jersey v. State of New York and City of New York, June 7, 1954.
4. U.S. Geological Survey, Office of the Delaware River Master, Internet web site, http://wwwrvares.er.usgs.gov/orh/nrwww/public/odrm.
5. U.S. Geological Survey, Report of the River Master of the Delaware River, U.S. Geological Survey Open File Report, Filed Annually from 1955 to Present.
6. States of Delaware, New Jersey, New York, and Pennsylvania, and New York City, Interstate Water Management Recommendations of the Parties to the U.S. Supreme Court Decree of 1954 to the Delaware River Basin Commission Pursuant to Commission Resolution 78-20.
7. Delaware River Basin Commission, Delaware River Basin Water Code, December 1996.
8. Delaware River Basin Commission, Docket D-77-20 CP, May 1977; Docket D-77-20 CP (Revised), November 1983; Docket D-77-20 CP (Revision 2), June 1993; Docket D-77-20 CP (Revision 3), February 1997; and Docket D-77-20 CP (Revision 4), April 1999.

Office of the Delaware River Master

SUPREME COURT OF THE UNITED STATES

No. 5, ORIGINAL.--OCTOBER TERM, 1950.

State of New Jersey, Complainant,

v.

State of New York and City of New York, Defendants,
Commonwealth of Pennsylvania and State of Delaware, Intervenors.

AMENDED DECREE

[June 7, 1954.]

The Court, having considered the amended petition of the City of New York, joined by the State of New York, to which is appended the consent of the State of New Jersey, the answer filed by the State of New Jersey seeking affirmative relief and the answers filed by the Commonwealth of Pennsylvania and the State of Delaware, the evidence and exhibits adduced by the parties, the report of Kurt F. Pantzer, Esquire, Special Master, and statements from all the parties addressed to the Court expressing the intention of the parties not to file exceptions or objections to the report, and being fully advised in the premises, now enters the following order:

I. REPORT OF SPECIAL MASTER APPROVED. The "Report of the Special Master Recommending Amended Decree," filed May 27, 1954, is in all respects approved and confirmed.

II. 1931 DECREE SUPERSEDED. The decree of this Court entered May 25, 1931 (283 U.S. 805) is modified and amended as hereinafter provided and, upon the entry of this amended decree, the provisions of the decree of May 25, 1931, shall be of no further force and effect.

III. DIVERSIONS BY THE CITY OF NEW YORK ENJOINED EXCEPT AS HEREIN AUTHORIZED The State and City of New York are enjoined from diverting water from the Delaware River or its tributaries except to the extent herein authorized and upon the terms and conditions herein provided.

A. *Authorized Diversions.*

1. *440 M. G. D.* The City of New York may divert from the Delaware River watershed to its water supply system the equivalent of 440 million gallons daily (m. g. d.) until the City completes and places in operation its reservoir presently under construction on the East Branch of the Delaware River.

2. *490 M. G. D.* After the completion and commencement of operation of the East Branch reservoir, the City may divert the equivalent of 490 m. g. d. until the completion of its proposed dam and reservoir at Cannonsville on the West Branch of the Delaware River, provided, however, that in the event of an abnormal or unforeseeable interruption of its facilities, the City may divert in excess of the equivalent of 490 m. g. d. to meet its emergency requirements, but in no event shall such diversion impair the obligation of the City to make the releases hereinafter specified.

3. *800 M. G. D.* After the completion of the Cannonsville reservoir, the City may divert the equivalent of 800 m. g. d.

4. *Computation of Diversion.* At no time during any twelve-month period, commencing June 1, shall the aggregate total quantity diverted, divided by the number of days elapsed since the preceding May 31, exceed the applicable permitted rate of diversion.

B. *Conditions and Obligations Imposed in Connection With Diversions and Releases by City.* The diversions and releases by the City of New York from the Delaware River shall be made under the supervision and direction of the River Master, hereinafter appointed, and shall be subject to the following conditions and obligations:

1. *Compensating Releases--The Montague Formula.* The City shall release water from its reservoirs as follows:

(a) Until the East Branch reservoir is completed and placed in operation, on the day following each day in which the average flow in the Delaware River falls short of 0.50 cubic feet per second per square mile (c. s. m.), either at Montague, New Jersey (below the mouth of the Neversink River), or at Trenton, New Jersey (0.50 c. s. m. being equivalent to a flow of 1740 cubic feet per second (c. f. s.) at Montague and 3400 c. f. s. at Trenton), the City shall release water from the Neversink reservoir at an average of 0.66 c. s. m. or 61.38 c. f. s.

(b) Upon the completion and placing in operation of the Neversink and East Branch reservoirs, the City shall release water from one or more of its storage reservoirs in the upper Delaware watershed. Such releases shall be in quantities designed to maintain a minimum basic rate of flow at the gaging station of the United States Geological Survey (U. S. G. S.) at Montague of 1525 c. f. s. (985.6 m. g. d.) until the Cannonsville project is completed and its reservoir first filled to the extent that 50 billion gallons above the lowest outlet are available for diversion and release, and of 1750 c. f. s. (1131.1 m. g. d.) thereafter. Compliance by the City with directions of the River Master with respect to such releases shall be considered full compliance with the requirements of this subsection (b).

(c) At the commencement of the calendar year following the completion and placing in operation of the Neversink and East Branch reservoirs and of each calendar year thereafter, the City of New York shall estimate and report to the River Master the anticipated consumption of water during such year to be provided for by the City from all its sources of supply. The City shall, as

hereinafter provided, release in the aggregate from all its storage reservoirs in the upper Delaware watershed, in addition to the quantity of water required to be released for the purpose of maintaining the then applicable minimum basic rate of flow as hereinabove provided, a quantity of water equal to 83 per cent of the amount by which the estimated consumption during such year is less than the City's estimate of the continuous safe yield during such year of all its sources obtainable without pumping. In any such year the City's estimate of anticipated consumption shall not exceed by more than 7 1/4 billions gallons the actual consumption in any previous calendar year; and its safe yield in any such year, obtainable without pumping, shall be estimated at not less than 1355 m. g. d. after the Neversink and East Branch reservoirs are put into operation; and at not less than 1665 m. g. d. after the Cannonsville reservoir is put into operation. If, at any time after the completion of the Cannonsville reservoir and prior to the year 1993, the continuous net safe yield for water supply of all of the City's sources of water supply, obtainable without pumping, is increased by the development of additional sources, such greater safe yield shall be used in determining the excess releases.

(d) The City of New York shall release the excess quantity provided for in subsection (c) at rates designed to release the entire quantity in 120 days. Commencing with the fifteenth day of June each year, the excess releases shall continue for as long a period, but not later than the following March 15, as such additional quantity will permit. Such period is hereafter referred to as the "seasonal period." The excess quantity required to be released in any seasonal period shall in no event exceed 70 billion gallons. In releasing the excess quantity specified for any seasonal period, the City shall not be required to maintain a flow at Montague greater than the applicable minimum basic rate plus the excess quantity divided by 120 days, or in any event greater than 2650 c. f. s., nor to release at rates exceeding the capacity of its release works. The City shall in each seasonal period continue its excess releases until March 15 or until the aggregate quantity of the flow at Montague in excess of the basic rate or in excess of such higher rates as are not the result of the City's prior releases, is equal to the total specified excess quantity.

(e) The terms and conditions provided in subsections (b), (c) and (d) hereof shall continue to be applicable in all respects in the event that the U. S. G. S. gaging station at Montague shall be relocated at a point below the confluence of the Neversink River with the Delaware River.

2. *Minimum Capacity of Release Works at Reservoirs of City.* In constructing the Cannonsville reservoir, the City shall install release works of such capacity as will provide a minimum aggregate release capacity from all its reservoirs in the Delaware River watershed of not less than 1600 c. f. s. under conditions of maximum reservoir depletion.

3. *Releases to be Continued in Spite of Interference.* In the event that any works hereafter constructed by public or private interests in the watershed of the Delaware River outside of the State of New York shall prevent the proper operation of the U. S. G. S. gaging station at Montague or interfere with the effective operation of the above release requirements by diverting water past the station or by intercepting the natural flow and storing it in reservoirs with an aggregate storage capacity in excess of 25 billion gallons, the City of New York shall continue to make the releases above specified which would be required in the absence of such interference, and appropriate gaging stations shall be established for that purpose.

4. *Inspection Permitted.* The States of New Jersey and Delaware and the

Commonwealth of Pennsylvania, through accredited representatives, and the River Master, shall at all reasonable times have the right to inspect the dams, reservoirs and other works constructed by the City of New York, to inspect the diversion areas and the inflow, outflow and diverted flow of such areas, to inspect the meters and other apparatus installed by the City of New York and to inspect all records pertaining to inflow, outflow and diverted flow.

IV. TREATMENT OF PORT JERVIS SEWAGE. The effluent from the sewage treatment plant at the City of Port Jervis, New York, shall be treated so as to effect a reduction of 85 per cent in the organic impurities and shall be treated with a chemical germicide, or otherwise, so that the *E. coli* originally present in the sewage shall be reduced by 90 per cent. Untreated industrial waste from plants in the City of Port Jervis shall not be allowed to enter the Delaware and Neversink Rivers. The treatment of such industrial wastes shall be such as to render the effluent practically free from suspended matter and nonputrescent. The treatment of both sewage and industrial waste shall be maintained so long as any diversion is made from the Delaware River or its tributaries.

V. DIVERSIONS BY NEW JERSEY AUTHORIZED UNDER SPECIFIED CONDITIONS.

A. *Authorized Diversions.* The State of New Jersey may divert outside the Delaware River watershed, from the Delaware River or its tributaries in New Jersey, without compensating releases, the equivalent of 100 m. g. d., if the State shall not, prior to July 1, 1955, repeal Chapter 443 of the New Jersey Laws of 1953, and if, when the Commonwealth of Pennsylvania accepts the conditions as specified in Section 19 of that Chapter, the State of New Jersey shall join with the Commonwealth of Pennsylvania in requesting the consent of Congress to the agreement embodied in Chapter 443 of the New Jersey Laws of 1953 and an Act of the Commonwealth of Pennsylvania accepting the conditions of such New Jersey Act.

B. *Conditions and Obligations Imposed in Connection with Diversions by New Jersey.* The diversions by New Jersey from the Delaware River shall be made under the supervision of the River Master and shall be subject to the following conditions and obligations:

1. Until the State of New Jersey builds and utilizes one or more reservoirs to store waters of the Delaware River or its tributaries for the purpose of diverting the same to another watershed, the State may divert not to exceed 100 m. g. d. as a monthly average, with the diversion on any day not to exceed 120 million gallons.

2. If and when the State of New Jersey has built and is utilizing one or more reservoirs to store waters of the Delaware River or its tributaries for the purpose of diversion to another watershed, it may withdraw water from the Delaware River or its tributaries into such impounding reservoirs without limitation except during the months of July, August, September and October of any year, when not more than 100 m. g. d. as a monthly average and not more than 120 million gallons in any day shall be withdrawn.

3. Regardless of whether the State of New Jersey builds and utilizes storage reservoirs for diversion, its total diversion for use outside of the Delaware River watershed without compensating releases shall not exceed an average of 100 m. g. d. during any calendar year.

VI. EXISTING USES NOT AFFECTED BY AMENDED DECREE. The parties to this proceeding shall have the right to continue all existing uses of the waters of

the Delaware River and its tributaries, not involving a diversion outside the Delaware River watershed, in the manner and at the locations presently exercised by municipalities or other governmental agencies, industries or persons in the Delaware River watershed in the States of New York, New Jersey and Delaware and the Commonwealth of Pennsylvania.

VII. RIVER MASTER.

A. *Designation.* Subject to the concurrence of the Director of the U. S. Geological Survey, the Chief Hydraulic Engineer of the U. S. Geological Survey, or such other engineer of the U. S. Geological Survey as shall at any time be designated by the Chief Hydraulic Engineer, is hereby designated as River Master.

B. *Duties.* The River Master shall either in person or through his assistants possess, exercise and perform the following duties and functions:

1. *General Duties.*

(a) Administer the provisions of this decree relating to yields, diversions and releases so as to have the provisions of this decree carried out with the greatest possible accuracy;

(b) Conserve the waters in the river, its tributaries and in any reservoirs maintained in the Delaware River watershed by the City of New York or any which may hereafter be developed by any of the other parties hereto;

(c) Compile and correlate all available data on the water needs of the parties hereto;

(d) Check and correlate the pertinent stream flow gagings on the Delaware River and its tributaries;

(e) Observe, record and study the effect of developments on the Delaware River and its tributaries upon water supply and other necessary, proper and desirable uses; and

(f) Make periodic reports to this Court, not less frequently than annually, and send copies thereof to the Governors of Delaware, New Jersey, New York and Pennsylvania, and to the Mayor of the City of New York.

2. *Specific Duties with Respect to the Montague Release Formula.* In connection with the releases of water which the City of New York is required to make under Par. III-B-1 (b) of this decree, the River Master, in co-operation with the City of New York, shall, by appropriate observation and estimates, perform the following duties:

(a) Determine the average times of transit of the flow between the release works of the several reservoirs of the City and Montague and between the release works of other storage reservoirs in the watershed and Montague;

(b) Make a daily computation of what the average flow observed on the previous day at Montague would have been, except for that portion previously contributed by releases of the City or as affected by the contributing or withholding of water at other storage reservoirs, for the purpose of computing the volume of water that would have had to be released in order to have maintained precisely the basic rate on that day;

(c) Take account of all changes that can be anticipated in the flow from that

portion of the watershed above Montague not under the City's control and allow for the same by making an appropriate adjustment in the computed volume of the daily release; and

(d) After taking into consideration (a), (b) and (c), direct the making of adjusted daily releases designed to maintain the flow at Montague at the applicable minimum basic rate.

C. *Distribution of Costs.* The compensation of, and the costs and expenses incurred by, the River Master shall be borne equally by the State of Delaware, State of New Jersey, Commonwealth of Pennsylvania, and the City of New York.

D. *Replacement.* In the event that for any reason the Chief Hydraulic Engineer of the U. S. G. S. or his designee cannot act as River Master, this Court will, on motion of any party, appoint a River Master and fix his compensation.

VIII. NO PRIOR APPROPRIATION NOR APPORTIONMENT. No diversion herein allowed shall constitute a prior appropriation of the waters of the Delaware River or confer any superiority of right upon any party hereto in respect of the use of those waters. Nothing contained in this decree shall be deemed to constitute an apportionment of the waters of the Delaware River among the parties hereto.

IX. DECREE WITHOUT PREJUDICE TO THE UNITED STATES. This decree is without prejudice to the United States. It is subject to the paramount authority of Congress in respect to commerce on navigable waters of the United States; and it is subject to the powers of the Secretary of the Army and Chief of Engineers of the United States Army in respect to commerce on navigable waters of the United States.

X. RETENTION OF JURISDICTION; NO ESTOPPEL. Any of the parties hereto, complainant, defendants or interveners, may apply at the foot of this decree for other or further action or relief, and this Court retains jurisdiction of the suit for the purpose of any order or direction or modification of this decree, or any supplemental decree that it may deem at any time to be proper in relation to the subject matter in controversy. The fact that a party to this cause has not filed exceptions to the report of the Special Master or to the provisions of this decree shall not estop such party at any time in the future from applying for a modification of the provisions of this decree, notwithstanding any action taken by any party under the terms of this decree.

XI. COSTS OF THIS PROCEEDING. The costs of this proceeding shall be paid by the parties in the following proportions: State of New Jersey, 26 2/3 per cent, City of New York, 26 2/3 per cent, State of New York, 10 per cent, Commonwealth of Pennsylvania, 26 2/3 per cent, and State of Delaware, 10 per-cent.

Appendix D
-Draft, Subject to Change-

Analysis of Repetitive and Severe Repetitive Loss Properties in the Delaware River Basin

Prepared by DRBC Operations Staff
April 2007

Full report can be viewed online at: http://www.state.nj.us/drbc/Flood_Website/floodclaims_home.htm

Analysis of the National Flood Insurance Program (NFIP) Claims in the Delaware River Basin

Repetitive and Severe Repetitive Loss Properties

(data as of 02/28/07)

Total Repetitive Loss Properties: 3,311; $318 Million in Property Claims
Total Severe Repetitive Loss Properties: 486; $113 Million in Property Claims

Top Ten Counties in the Basin with the Highest Number of Designated Loss Properties:

County	Repetitive Loss Properties	Total Payouts for Repetitive Loss Properties
Bucks, PA	775	$90,637,232
Montgomery, PA	485	$54,050,375
Mercer, NJ	242	$13,688,747
Northampton, PA	239	$29,780,422
Warren, NJ	225	$24,543,943
Delaware, PA	178	$10,886,267
Hunterdon, NJ	166	$13,583,940
Chester, PA	130	$8,380,068
New Castle, DE	105	$24,624,300
Lehigh, PA	95	$5,524,623

County	Severe Repetitive Loss Properties	Total Payouts for Severe Repetitive Loss Properties
Bucks, PA	151	$37,843,028
Montgomery, PA	90	$18,693,894
Warren, NJ	60	$12,091,315
Northampton, PA	48	$9,254,592
Chester, PA	14	$3,603,757
Lehigh, PA	14	$2,351,387
Hunterdon, NJ	13	$3,297,321
Delaware, PA	12	$1,512,009
Sullivan, NY	12	$1,913,673
Mercer, NJ	12	$5,407,347

Top Ten Municipalities in the Basin with Highest Number of Designated Loss Properties:

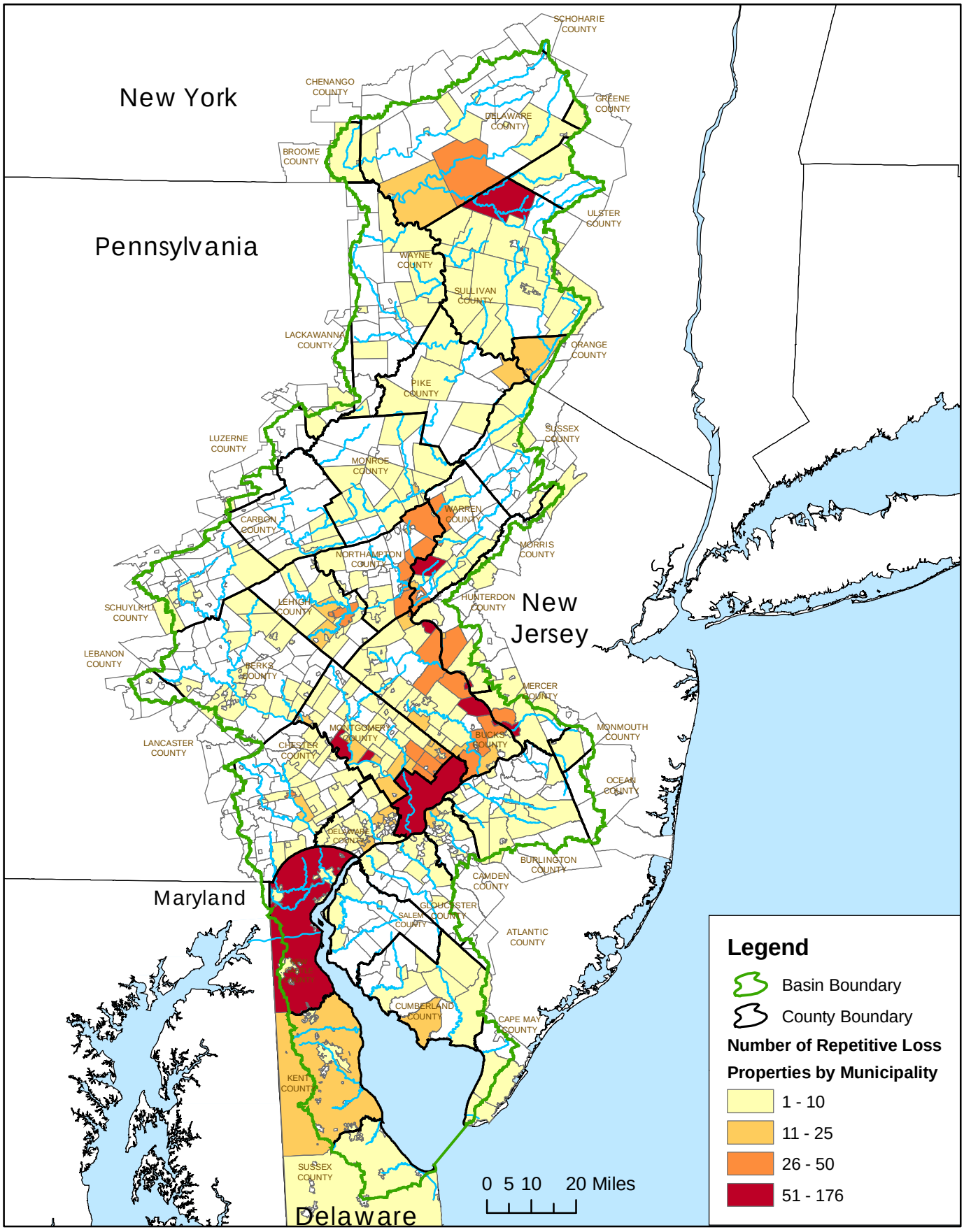
Municipality	Repetitive Loss Properties	Total Payouts for Repetitive Loss Properties
Trenton, NJ	176	$11,459,971
Yardley, PA	170	$19,282,322
Philadelphia, PA	95	$7,471,828
New Castle, DE	86	$18,101,486
Harmony, NJ	76	$11,095,956
West Norriton, PA	76	$7,493,477
New Hope, PA	71	$10,208,886
Upper Makefield, PA	66	$10,682,761
Lambertville, NJ	64	$3,348,860
Bridgeton, PA	59	$6,048,814

Municipality	Severe Repetitive Loss Properties	Total Payouts for Severe Repetitive Loss Properties
Yardley, PA	46	$11,206,158
West Norriton, PA	34	$5,580,246
Harmony, NJ	29	$5,878,462
Upper Makefield, PA	21	$5,872,833
Plumstead, PA	13	$3,513,572
Forks, PA	12	$2,858,239
Middletown, PA	12	$1,578,207
Allentown, PA	11	$1,685,403
Rockland, NY	10	$1,760,483
Solebury, PA	10	$4,436,010

Notes:

1. A property is considered a repetitive loss property by FEMA when there are 2 or more losses reported which were paid more than $1,000 for each loss. The 2 losses must be within 10 years of each other and be at least 10 days apart.
2. A property is considered a severe repetitive loss property by FEMA either when there are at least 4 losses each exceeding $5000 or when there are 2 or more losses where the building payments exceed the property value.
3. Claims were mapped and summaries compiled using Lat/Long coordinate points provided by FEMA. On occasion, the Lat/Long location does not match the FEMA assigned community name for specific claims.
4. Information was compiled by DRBC staff, April 2007. A complete analysis table is available online at http://www.state.nj.us/drbc/Flood_Website/floodclaims_home.htm
5. This analysis does not capture uninsured flood damage.

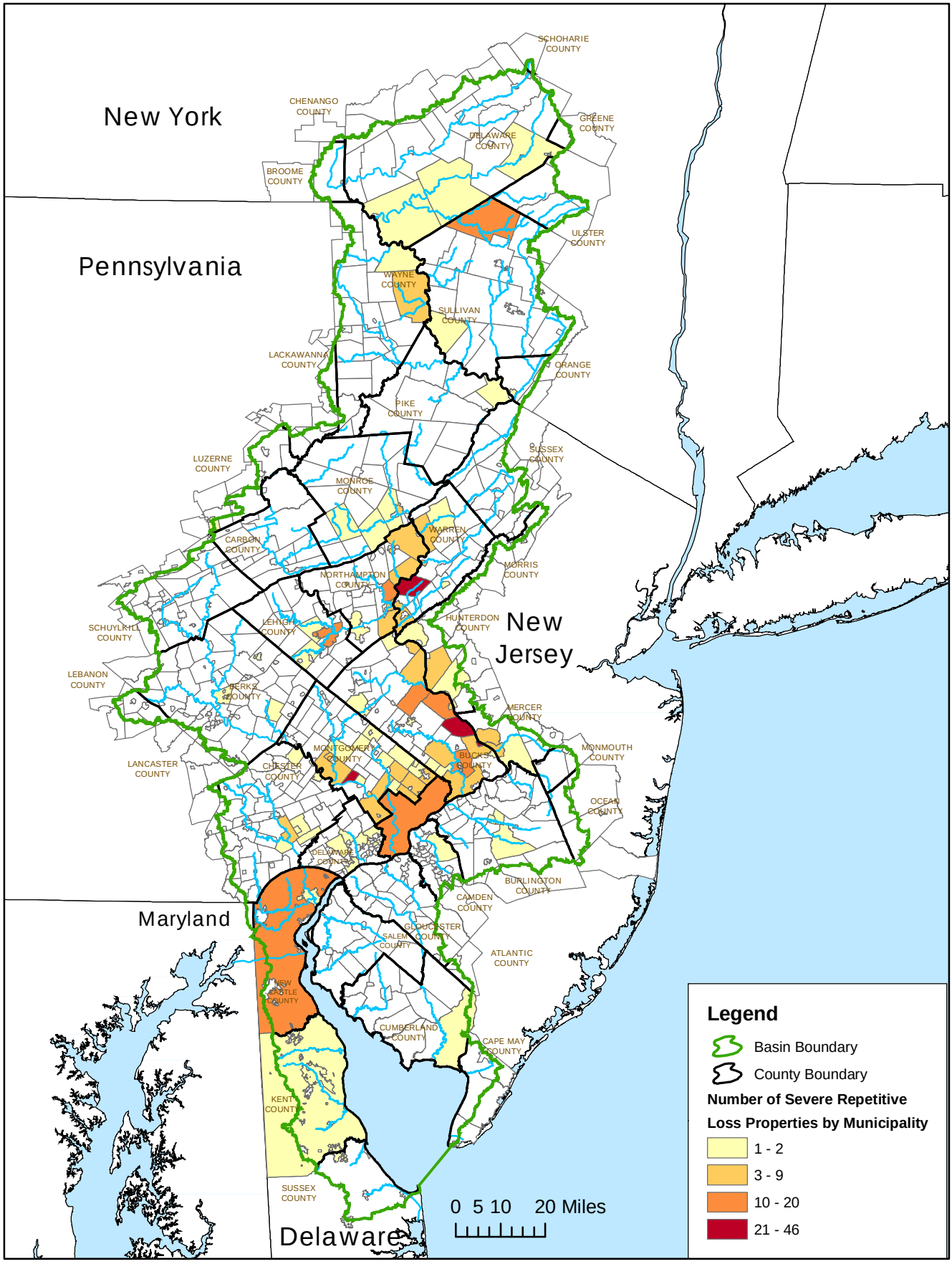
Repetitive Loss Properties in the Delaware River Basin



Source: Federal Emergency Management Agency (FEMA). A property is considered a repetitive loss property when there are 2 or more losses reported which were paid more than $1,000 for each loss. The 2 losses must be within 10 years of each other and be at least 10 days apart. Losses from 01/01/1978 - 02/28/07 that are closed are considered.

Prepared by Delaware River Basin Commission Staff, April 2007.

Severe Repetitive Loss Properties in the Delaware River Basin



Source: Federal Emergency Management Agency (FEMA). A property is considered a severe repetitive loss property either when there are at least 4 losses each exceeding $5000 or when there are 2 or more losses where the building payments exceed the property value. Losses from 01/01/1978 - 02/28/07 that are closed are considered.

Prepared by Delaware River Basin Commission Staff, April 2007.

Appendix E
-Draft, Subject to Change-

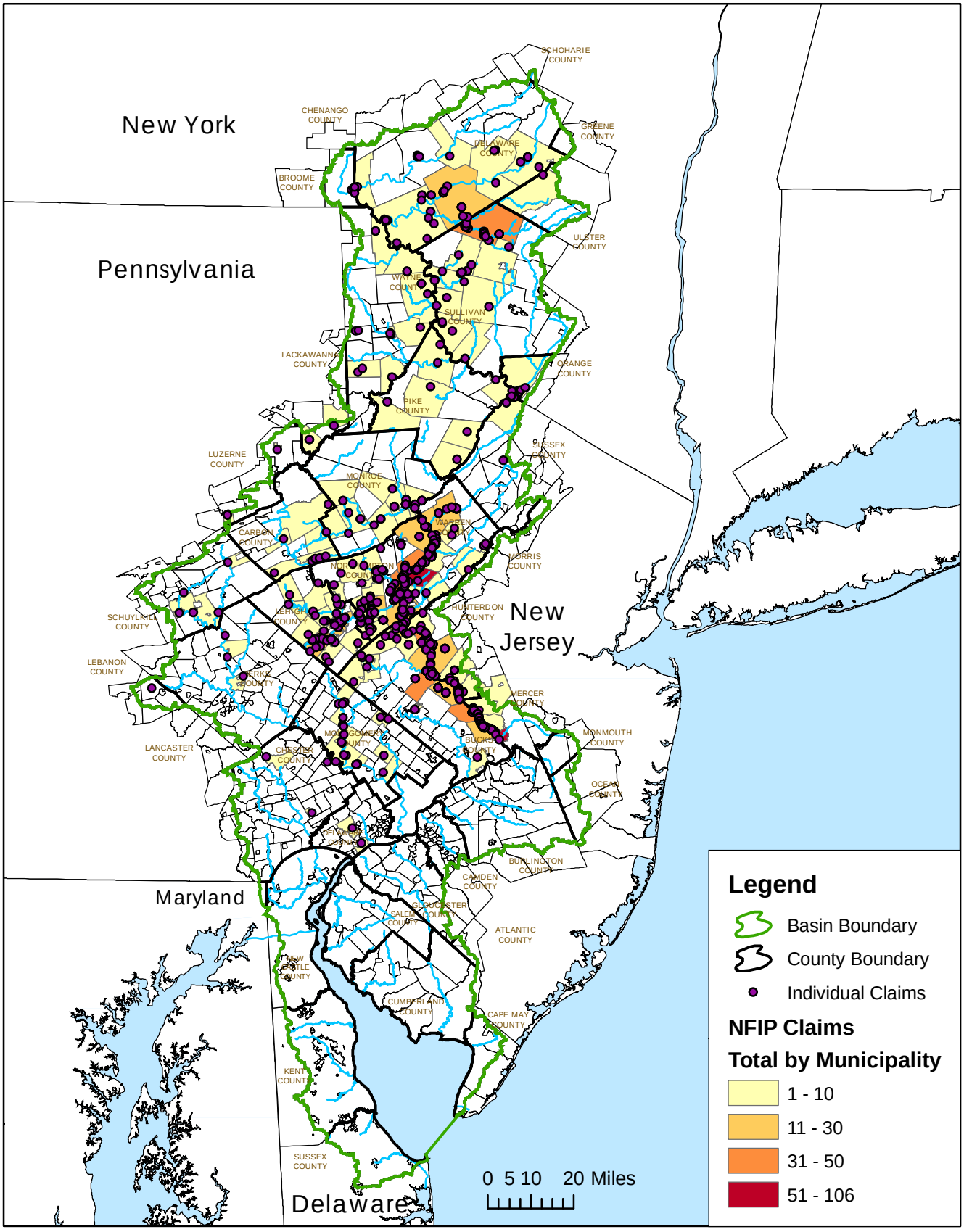
Analysis of Flood Insurance Claims in the Delaware River Basin

September 2004, Ivan
-
April 2005 Flood
-
June 2006 Flood

Prepared by DRBC Operations Staff
April 2007

Full report can be viewed online at: http://www.state.nj.us/drbc/Flood_Website/floodclaims_home.htm

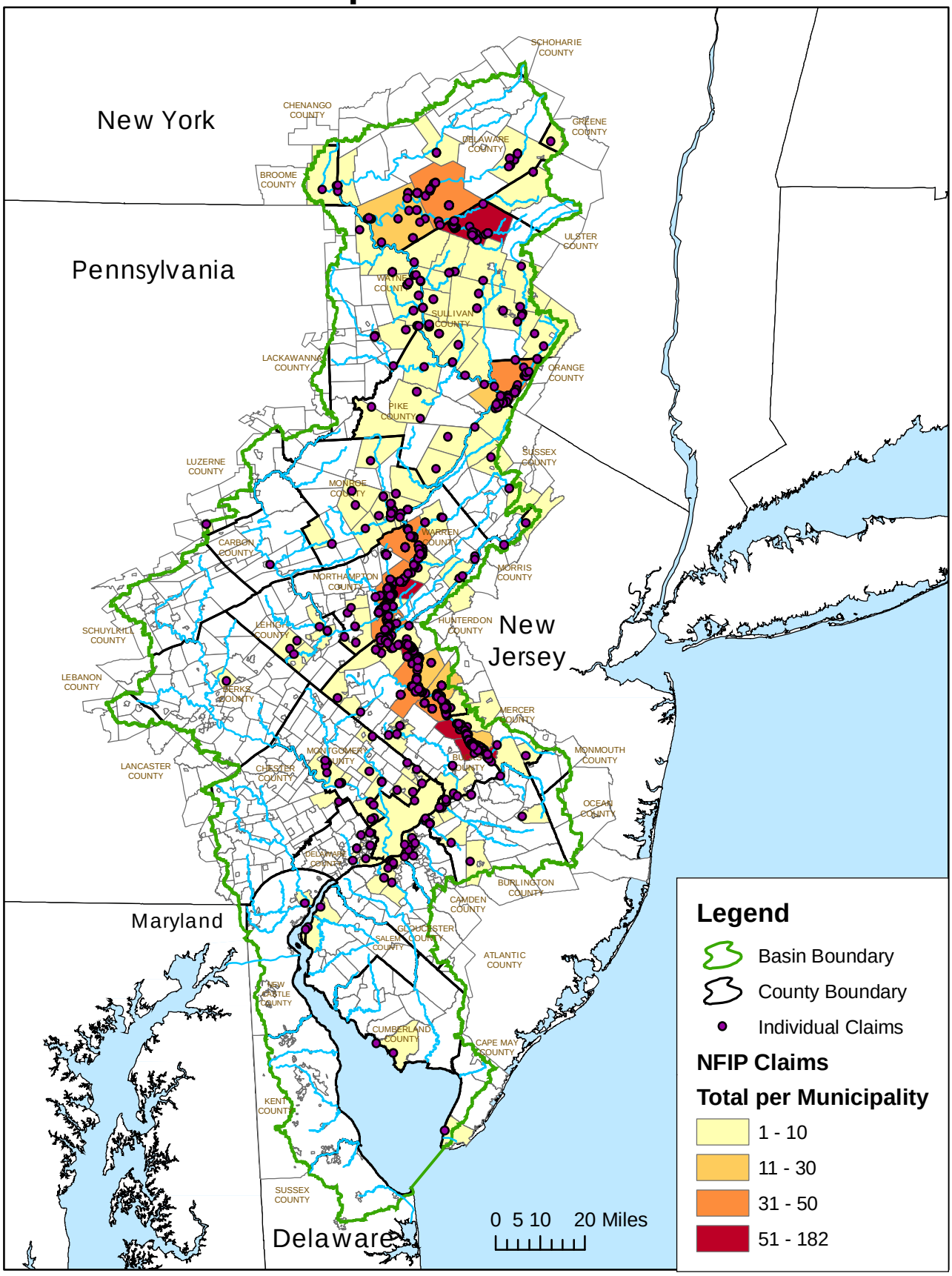
National Flood Insurance Claims in the Delaware River Basin (by Municipality) September 2004 Event - Ivan



Source: Federal Emergency Management Agency (FEMA). Claims represented include all National Flood Insurance Program (NFIP) closed claims as of 02/28/07 for dates of loss listed 9/17/04 - 9/20/04.

Prepared by Delaware River Basin Commission Staff, April 2007.

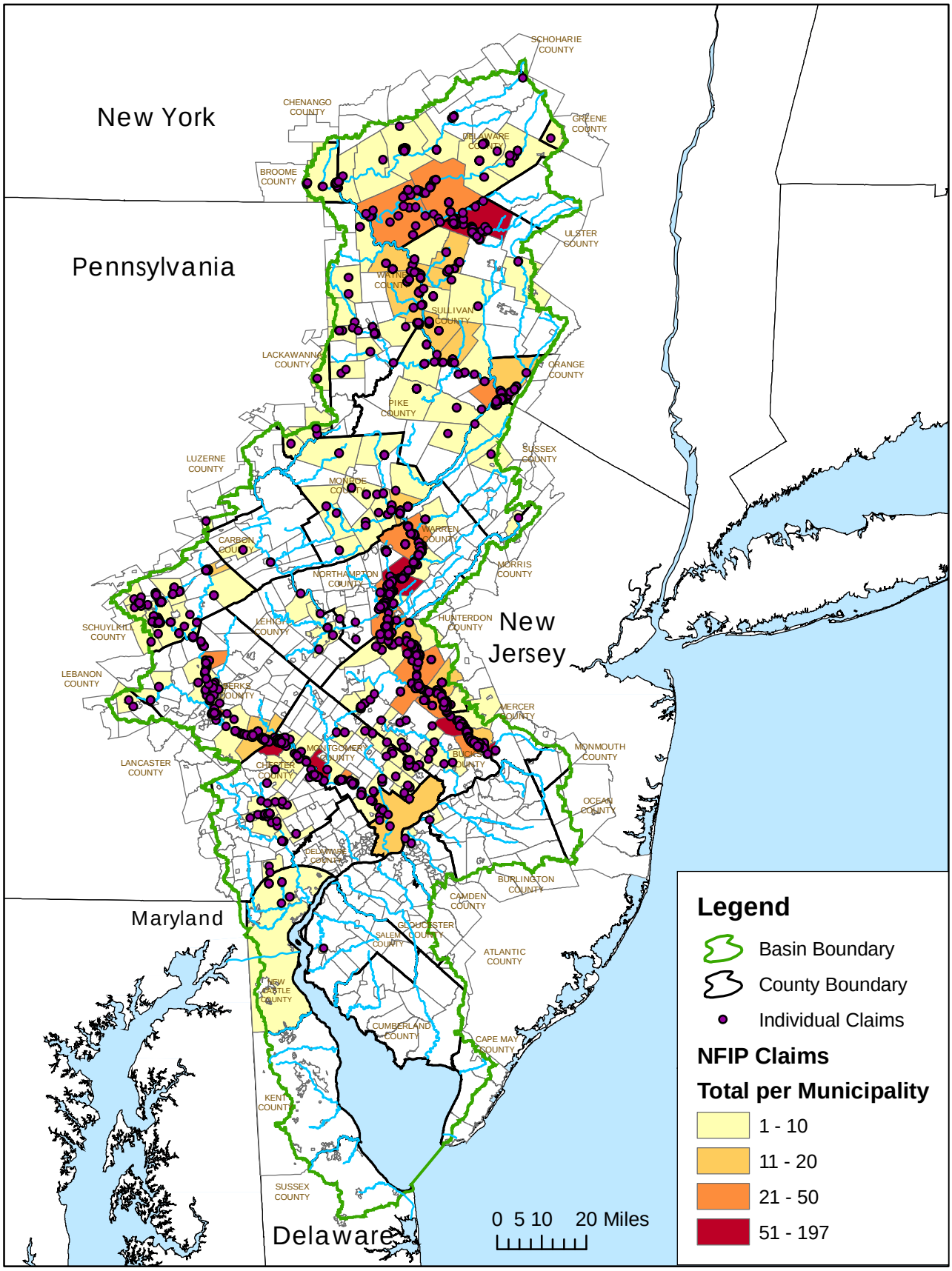
National Flood Insurance Claims in the Delaware River Basin (by Municipality) April 2005 Event



Source: Federal Emergency Management Agency (FEMA). Claims represented include all National Flood Insurance Program (NFIP) closed claims as of 02/28/07 for dates of loss listed 4/2/05 - 4/5/05.

Prepared by Delaware River Basin Commission Staff, April 2007.

National Flood Insurance Claims in the Delaware River Basin (by Municipality) June 2006 Event



Source: Federal Emergency Management Agency (FEMA). Claims represented include all National Flood Insurance Program (NFIP) closed claims as of 02/28/07 for dates of loss listed 6/26/06 - 6/30/06.

Prepared by Delaware River Basin Commission Staff, April 2007.