Delaware River Basin Flood Analysis Model and Associated Studies
Analysis of Potential Flood Mitigation with Existing Reservoirs

Overview of Results and Next Steps
December 2009

FINDINGS

- Historical data and the Flood Analysis Model results do not support claims that spills from reservoirs are the root cause of flooding along the main stem Delaware River. Pervasive out-of-bank flooding would still have occurred even if none of the reservoirs spilled.
- Reservoir operations that result in larger pre-event voids may potentially reduce peak flood crests, but the amount of the reduction is highly dependent upon the characteristics of the storm event (precipitation intensity, duration and timing), river location (distance downstream from reservoir(s)) and the local topography and geomorphology. Dedicated pre-event voids will not eliminate flooding.
- Water supply simulations[1] indicate that neither ten nor twenty percent dedicated, year-round voids for flood storage can be constantly maintained in the NYC Delaware Basin reservoirs based upon historical inflow records and the physical constraints on controlled reservoir release rates.
- Water supply simulations also suggest that reservoir operating plans designed around maintaining a dedicated, year-round twenty percent void in the NYC reservoirs would reduce the reliable yield of the NYC Delaware Basin reservoirs by eight percent and double[2] the drought frequency based upon the historical inflow record, current demand rates, and the existing drought management plan. When the reservoirs operate under drought conditions, flow targets, release rates and diversions, are reduced with concomitant negative impacts on human and ecological uses of these water resources.
- Identified high damage locales and the structures in flood prone areas should be prioritized for structural and non-structural flood mitigation measures.

SUMMARY OF MODEL RESULTS AND ASSOCIATED STUDIES

The Delaware River Basin Flood Analysis Model, inundation mapping and structural surveys prepared by the Army Corps of Engineers (USACE) and water supply simulations with OASIS indicate that operational changes to reservoirs alone will not substantially reduce flooding similar to that experienced during the three major flooding events in September 2004, April 2005 and June 2006. Analysis of the three flooding events with the Delaware River Basin Flood Analysis Model and inspection of the inundation mapping prepared by the USACE demonstrate that pervasive out-of-bank flooding would have occurred regardless of the amount of dedicated pre-event voids in the upper basin reservoirs.

Of the thirteen reservoirs simulated, Prompton, Jadwin, F.E. Walter, Beltzville and Merrill Creek did not spill during any of the aforementioned events and thus can provide no further flood mitigation with additional pre-event void space. For the reservoirs that did spill, the model indicates that larger pre-event voids could have reduced flood crests but much of the main stem would have remained in National Weather Service (NWS) designated Moderate or Major flood stage. The amount of reduction in the flood crest that could potentially be achieved with pre-event voids is dependent upon the characteristics of the

[1] Performed with the OASIS model.
[2] Performed with the OASIS model. The drought frequency was calculated based on a maximum constant diversion of 600 mgd with reductions in the diversions, flow targets and releases, and drought exit criteria in accordance to the Flexible Flow Management Program.

storm event (path; precipitation intensity, duration and timing; antecedent soil saturation), proximity to the reservoir, and local topography and geomorphology of the stream channel.

Changes to the NYC Delaware Basin reservoir operations that would be required to achieve dedicated, year-round voids in the range of ten to twenty percent would result in measurable increased risks to water supply and instream aquatic life for varied flood mitigation benefits that cannot be guaranteed. The risks to water supply and instream aquatic life include reductions in diversions, flow targets and conservation releases for downstream flow augmentation and fisheries support. However, spill mitigation operations, where a seasonal, variable sized void is created to capture snowmelt and runoff, may effectuate some flood mitigation without unduly jeopardizing the regional water supply function of the NYC Delaware Basin reservoirs. Changes to the operations of other reservoirs to produce dedicated, year-round voids also would not guarantee flood mitigation benefits.

The Delaware River Basin Flood Analysis Model and inundation mapping by the U.S. Army Corps of Engineers demonstrate that continued development of the floodplains under most local land use and current flood plain regulations will allow future properties and inhabitants to be located in harms way, increasing the threat of damages to property and public health and safety. Although changes to the operations of the reservoirs to maintain dedicated, year-round voids for flood storage would potentially reduce flood crests, those operational changes would not achieve the desired outcome of averting flood damages in the future.

IMPORTANT WATER MANAGEMENT CONSIDERATIONS

- Persons living in a flood hazard area (100-year floodplain) have a high level of risk for experiencing flooding regardless of the presence of flood damage reduction structures. [3]
- Relying on operational changes to existing reservoirs for flood mitigation will provide a false sense of security to people and structures currently located in or proposed to be located in flood prone areas.
- Seven of the ten worst main stem floods reported for the Delaware River at Trenton, NJ during the past one-hundred and ten years occurred prior to the construction of many of the reservoirs or in the absence of spills from reservoirs in the upper basin.
- Approximately 9 million people get their drinking water from the NYC Delaware Basin Reservoirs and 2.5 million persons use drinking water withdrawn from the main stem Delaware River downstream of the Delaware Water Gap.
- Population data indicate that approximately 13,150 persons[4] live in the 100-year floodplain[5] of the main stem Delaware River between Hancock, NY and Trenton, NJ.
- Since the inception of the National Flood Insurance Program, approximately $237 million dollars in claims have been paid to 2,210 repetitive and severe repetitive loss properties in the Delaware River Basin.[6]

[3] For example, the Lehigh River is protected by two Army Corps of Engineers flood damage reduction reservoirs (F.E. Walter and Beltzville) and still has experienced flood crests characterized as Moderate at some of its NWS forecast points.
[4] Based upon U.S. Census Block Centroid Populations, which are the smallest geographic entities within a county for which the Census Bureau tabulates population, dated 2000 and updated in 2004.
[5] FEMA Q3 delineation augmented with information from PADEP for Pike and Wayne Counties.
[6] Values tabulated based on closed claims as of November 30, 2008. The amount does not include uninsured flood damage or properties that have been acquired and razed.

NEXT STEPS

The results of the Delaware River Basin Flood Analysis Model and associated studies support the conclusion of the Interstate Flood Mitigation Task Force: *No one set of measures will eliminate flooding along the Delaware River, rather the Task Force Members recommended a combination of measures to improve the basin's resiliency—its capacity to prepare for and recover from flooding in the future.*

The Commission will continue to pursue implementation of recommendations in all six Task Force priority management areas. Task Force members recommended adhering to specific guiding principles in framing out a multi-year Flood Mitigation Action Plan:

- Preserve and restore floodplains where possible
- Be prepared for floods
- Help people protect themselves from flood hazards
- Prevent adverse impacts and unwise uses in floodplains
- Prevent adverse impacts from development and redevelopment
- Acknowledge the value of structural flood control measures

Below is an outline of intended Commission activities for flood damage mitigation. It should be noted that although flooding is pervasive throughout the basin, many mitigation measures will require action at the local level.

A. Reservoir Operations

- Continue to work with reservoir operators to evolve Spill Mitigation Program(s) to "shift spilled water to managed water."
- Continue to explore the use of National Weather Service Advanced Hydrologic Prediction Service (NWS/AHPS) forecasts to estimate quantities of water that potentially could be managed for downstream uses rather than spilled.

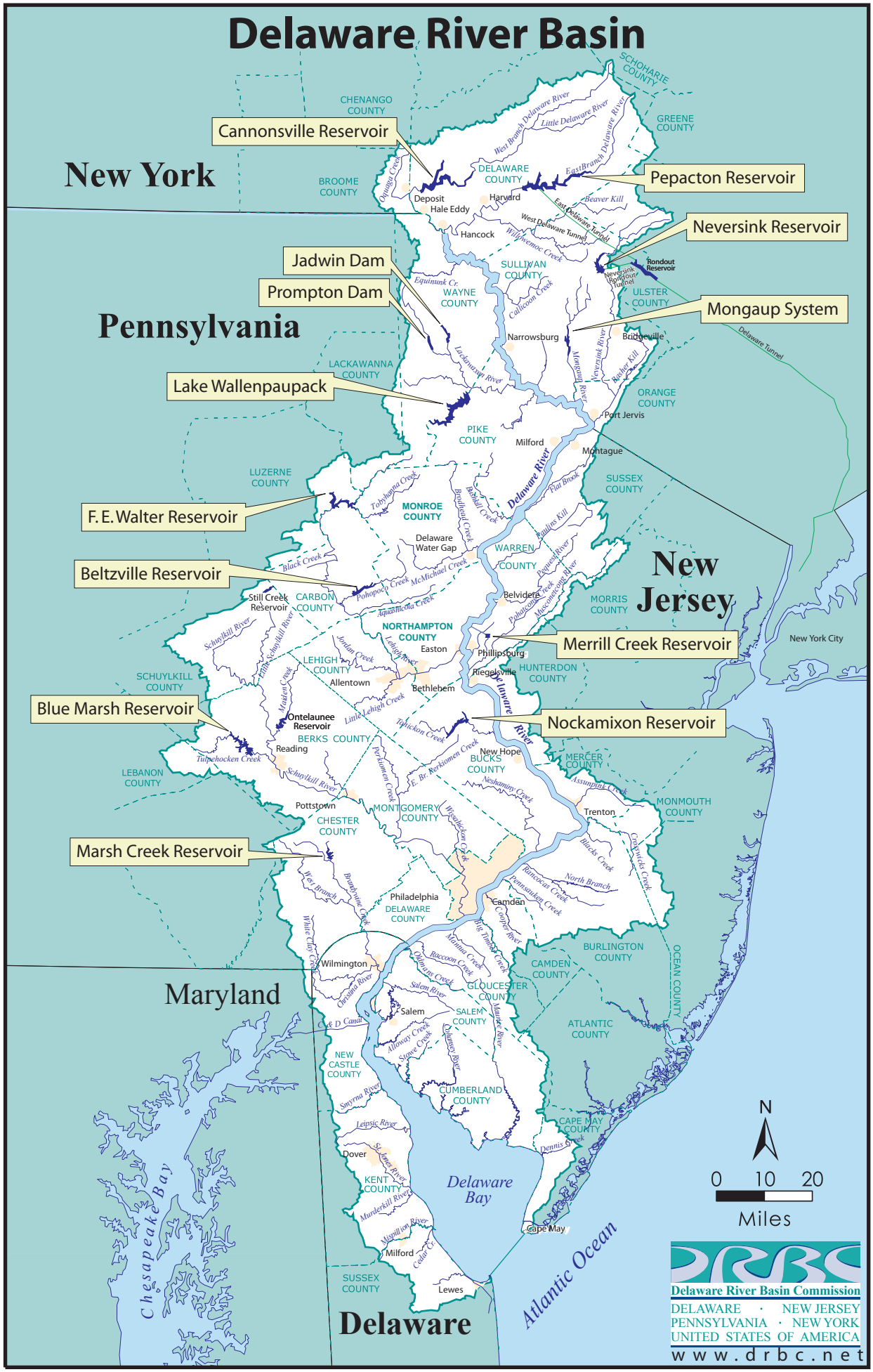
B. Continue Implementing Non-Reservoir Related Task Force Recommendations

- Focus efforts on natural, non-structural solutions that reduce susceptibility to flooding, while preserving the flexibility to use more traditional structural approaches where appropriate.
- Continue to improve and upgrade the Flood Warning System
- Facilitate Education and Outreach Programs for Emergency Management Officials

C. Implement New Non-Reservoir Related Measures

- Strengthen Floodplain Management
- Create a Riparian Corridor Integrity Trust Fund to preserve and protect the floodplain along lines of NJ Blue Acres Fund
- Develop a Stormwater Retrofit Program along the lines of the Catskill Watershed Corporation http://www.cwconline.org/programs/strm_wtr/strm_wtr.html

D. Continue to explore opportunities for additional multi-purpose storage facilities


Delaware River Basin
New York
Pennsylvania
New Jersey
Maryland
Delaware
Cannonsville Reservoir
Pepacton Reservoir
Neversink Reservoir
Jadwin Dam
Prompton Dam
Mongaup System
Lake Wallenpaupack
F. E. Walter Reservoir
Beltzville Reservoir
Merrill Creek Reservoir
Blue Marsh Reservoir
Nockamixon Reservoir
Marsh Creek Reservoir
Delaware River
Delaware Bay
Chesapeake Bay
Atlantic Ocean
Delaware Tunnel
West Delaware Tunnel
East Delaware Tunnel
Rondout Reservoir
Neversink Rondout Tunnel
Still Creek Reservoir
Ontelaunee Reservoir
SCHOHARIE COUNTY
CHENANGO COUNTY
GREENE COUNTY
BROOME COUNTY
DELAWARE COUNTY
SULLIVAN COUNTY
WAYNE COUNTY
ULSTER COUNTY
ORANGE COUNTY
LACKAWANNA COUNTY
PIKE COUNTY
LUZERNE COUNTY
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WARREN COUNTY
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HUNTERDON COUNTY
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CHESTER COUNTY
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Bethlehem
New Hope
Trenton
New York City
Reading
Pottstown
Philadelphia
Camden
Wilmington
Salem
Dover
Milford
Lewes
Cape May
West Branch Delaware River
Little Delaware River
East Branch Delaware River
Beaver Kill
Willowemoc Creek
Equinunk Cr.
Calicoon Creek
Lackawaxen River
Mongaup River
Neversink River
Rocher Kill
Tobyhanna Creek
Broadhead Creek
Bushkill Creek
Flat Brook
Paulins Kill
Pequest River
Pohatcong Creek
Musconetcong River
Black Creek
McMichael Creek
Pohopoco Creek
Aquashicola Creek
Schuylkill River
Jordan Creek
Lehigh River
Little Lehigh Creek
Tohickon Creek
Perkiomen Creek
E. Br. Perkiomen Creek
Neshaminy Creek
Assunpink Creek
Tulpehocken Creek
Maiden Creek
Wyomissing Creek
Crosswicks Creek
Blacks Creek
Rancocas Creek
North Branch
Pennsauken Creek
Big Timber Creek
Cooper River
Mantua Creek
Raccoon Creek
Oldmans Creek
Salem River
Alloway Creek
Stowe Creek
Cohansey River
Maurice River
Cohansey River
Delaware Bay and River
Chesapeake & Delaware Canal
Leipsic River
St. Jones River
Murderkill River
Mispillion River
Cedar Cr.
Dennis Creek
White Clay Creek
Brandywine Creek
West Branch
Christina River
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