Pompton Lakes Dam – Downstream Effects of the Floodgate Facility

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Overview
Overview
Prior to the construction of the floodgate facility

- Frequent flooding occurred at the upper end of Pompton Lake near Oakland, NJ
- Water backed up during high river flow
Overview – Current Conditions

How the Floodgate Facility works:
• Maximum flood reduction to U-S residences
• Does not increase D-S flooding
• Customized computer system automatically operates the gates
Overview – Current Conditions

• The Pompton Lake Dam provides a 40-YR level of flood protection

• The project consisted of:
  – Installing 2 floodgates at Pompton Dam
  – Widening & Deepening of approximately 1 mile of the Ramapo River upstream of the Lake
Overview – Current Conditions

• The Governor’s Passaic River Basin Flood Advisory Commission
  – Recommended an independent study of the gate operation after several downstream flood events

• NJDEP
  – Retained the services of AECOM to evaluate the operational impacts of the Pompton Lakes Dam Floodgate Facility

• Goal
  – Develop calibrated hydrologic & hydraulic models to ascertain the downstream effects from the operation of the floodgate facility
Hydrologic Modeling

• Pompton River Drainage Basin
  – 354 mi² of runoff drains to the D/S reach of Pompton basin
  – 3 major rivers: Pequannock, Wanaque, & Ramapo Rivers

• Goal: develop inflow hydrographs for unsteady HEC-RAS model in Pompton River down to Jackson Avenue Bridge
Hydrologic Modeling

- HEC-HMS ver. 3.5
  - Existing HMS model
  - Four calibration events
    March 12-14, 2010
    March 6-9, 2011
    March 9-13, 2011
    Hurricane Irene (August 27-29, 2011)
  - Frequency events
    2-, 10-, 25-, 40-, 50-, 100-, 500-yr
Storm Precipitation Analysis System (SPAS)

- Radar rainfall data processed as 1km x 1km grids at 5-min intervals for four calibration storms
  - SPAS used by Applied Weather Associates (AWA). NEXRAD data acquired from Weather Decisions Technologies

- Utilizes:
  - Real-time rain gauge observations.
  - High resolution NEXRAD radar data
  - DEM basemap
Storm Precipitation Analysis System (SPAS)

- Traditional methods not representative:
  - Thiessen Polygon
  - Inverse Distance Square

- Average Recurrence Interval (ARI)
  - ARI analysis provided for each calibration storm
  - Hurricane Irene (2011) - >1000 year event

- Each of the 64 HMS subbains was assigned with 5-min rainfall time series
Storm Precipitation Analysis System (SPAS)

March 10-14, 2010

SPAS 1221 Total Storm Rainfall (48-hours)
March 12, 2010 (2100 UTC) to March 14, 2010 (2100 UTC)

- Total Storm Rainfall (inches):
  - 3-3.25
  - 3.25-3.5
  - 3.5-3.75
  - 3.75-4
  - 4-4.25
  - 4.25-4.5
  - 4.5-4.75
  - 4.75-5
  - 5-5.25
  - 5.25-5.75
  - 5.75-6

- Average Rainfall: 4.2" 
- Maximum Rainfall: 5.8" 
- Minimum Rainfall: 3.1"

August 27-29, 2011

SPAS 1222 Total Storm Rainfall (31-hours)
March 6, 2011 (0600 UTC) to March 7, 2011 (1300 UTC)

- Total Storm Rainfall (inches):
  - 2.75-3
  - 3-3.25
  - 3.25-3.5
  - 3.5-3.75
  - 3.75-4
  - 4-4.25
  - 4.25-4.5
  - 4.5-4.75

- Average Rainfall: 3.8" 
- Maximum Rainfall: 4.6" 
- Minimum Rainfall: 3.1"
Hydrologic Modeling – Calibration/Validation

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Terrain & Survey

- LiDAR collected by NGA
- As-Built data acquired for the Pompton Dam
Hydraulic Modeling

HEC-RAS ver. 4.1.0

- Goal: Develop calibrated hydraulic model to ascertain the downstream effects from the operation of the floodgate facility
- Unsteady flow model used to determine the D/S effects of the Floodgate Facility
- Gate operation coded to mirror the USACE operational rule curve
Hydraulic Modeling – USACE Rule Curve

- Operated to maintain a set pool elevation in Pompton Lake
  - Set pool elevations defined as a function of the gate opening and lake level
  - Set pool elevations vary from 201.37 ft at a gate opening of 0.0 ft to 201.40 ft (NAVD 88) at openings ≥ 4.5 ft
Gate operation is a function of the difference between the lake elevation and the set point elevation:

- If the lake level is more than 0.25 ft above the set point, the gates are opened 0.25 ft.
- If the lake level is more than 0.50 ft above the set point, the gates are opened 0.50 ft.
- If the lake level is more than 1.0 ft above the set point, the gates are opened 1.0 ft.
- Similarly, if the lake level is more than 0.25 ft below the set point, the gates are closed 0.25 ft....and so on.
• Rule curve exceptions
  – If the lake level is falling, then the gates would not be opened
  – If the lake level is rising, then the gates would not be closed
  – These exceptions minimize lake level oscillations

• Normal conditions
  – The gates remain closed and all outflow passes over the fixed spillway

• Operation
  – Every 15 minutes the lake level and stream flow gauges are checked and the gates are operated automatically.
Hydraulics - Calibration

• Multiple sources were utilized for calibration
  – USGS Gages Rating Curves
  – High water marks collected by the USGS after Hurricane Irene
  – High water marks collected by the USACE after Hurricane Irene
  – High water marks from the USGS Water Watch website http://waterwatch.usgs.gov/
Hydraulic - Calibration

• Minimal hydraulic calibration was necessary
  – The level of effort on calibrating the HEC-HMS model yielded desirable flows

• Minimal changes to the Manning’s n-values were made
  – Important to keep the values within a realistic range for this stream
Hydraulic – Calibration (Hurricane Irene)
Results – Operation of the Pompton Lake Dam Floodgate facility

• How did this affect areas downstream of the Pompton Lake Dam?

• What role did the flood gates play in the flooding?

• Did lowering the lake by 3 ft prior to Hurricane Irene help?
Results – Operation of the Pompton Lake Dam Floodgate facility

• As the lake level rises, the rule curve manages the opening of the gates to release floodwater, regulating the lake level

Upstream water levels would have been ~6 ft higher during Hurricane Irene w/o the gates

Pompton Lake Dam – Downstream Effects of the Floodgate Facility
Results – Operation of the Pompton Lake Dam Floodgate facility

Does the gate operation increase the downstream flooding?

Where does the water that used to flood Oakland (the community upstream of the dam) go?

<table>
<thead>
<tr>
<th>Hydrograph Pre-Gate Condition (ac-ft)</th>
<th>Current Condition (ac-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Volume</td>
<td></td>
</tr>
<tr>
<td></td>
<td>56,776</td>
</tr>
<tr>
<td></td>
<td>56,962</td>
</tr>
<tr>
<td></td>
<td>The difference is 186 (ac-ft) or 0.3%</td>
</tr>
<tr>
<td>Rising Limb of Hydrograph</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17,062</td>
</tr>
<tr>
<td></td>
<td>19,820</td>
</tr>
<tr>
<td></td>
<td>The difference is 2,758 (ac-ft) – The Current Condition having more water on the Rising Limb of the Hydrograph</td>
</tr>
<tr>
<td>Recession Limb of Hydrograph</td>
<td></td>
</tr>
<tr>
<td></td>
<td>39,714</td>
</tr>
<tr>
<td></td>
<td>37,142</td>
</tr>
<tr>
<td></td>
<td>The difference is 2,572 (ac-ft) – The Pre-Gate Condition having more water on the Recession Limb of the Hydrograph</td>
</tr>
</tbody>
</table>

Results – Operation of the Pompton Lake Dam Floodgate facility

- Flow arrives at the Hamburg TPK slightly sooner
- Peak Flows remain the same
- Flows recede earlier now
Results – Operation of the Pompton Lake Dam Floodgate facility

Dawes Highway

Hamburg Turnpike

Pompton Lake Dam

Peak WSEs are the same

Gate begins to function

Pre Gate WSEs
Current Condition WSEs
Results – Operation of the Pompton Lake Dam Floodgate facility

• In summary
  – With the gates in place, the water rose quicker downstream of the dam and receded faster
  – The total volume of water is nearly identical
Percent Chance of Flooding Downstream of Dam

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Percent Chance of Flooding Downstream of Dam

% Annual Chance
- 0.2 - 1% (500-yr)
- 1 - 2% (100-yr)
- 2 - 2.5% (50-yr)
- 2.5 - 4% (40-yr)
- 4 - 10% (25-yr)
- 10 - 50% (10-yr)
- 50%+ (2-yr)

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Percent Chance of Flooding Downstream of Dam

Pompton Lake Dam –
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Results – Operation of the Pompton Lake Dam Floodgate facility (Alternative Analysis)

- Did lowering the Pompton Lake Reservoir by 3.0 ft in advance help?
  - Model ran with gates in automatic operation per rule curve
  - 3 events analyzed
    1. Hurricane Irene
    2. March 12-14, 2010
    3. Simulated event of smaller magnitude
Results – Operation of the Pompton Lake Dam Floodgate facility (Alternative Analysis)

• Conclusion
  - Lowering the Pompton Lake Reservoir prior to flooding will not have any significant reduction in downstream flooding
  - Not enough storage volume in the reservoir

Identical Peaks WSEs

Just upstream of Hamburg Turnpike

Legend
- Flow - Irene
- Flow - Irene - Lake -3'

Date
- 31 Aug 2011
- 01 Sep 2011

Flow
- 2400
- 1200
- 0

Identical Peaks WSEs
Additional information

• Only a small portion of the different events analyzed and the results have been presented here.

• A more detailed report on the downstream effects can be found here:

  http://dng.northjersey.com/media_server/tr/2012/04/12dam/NJDEPPomptonLakeDamFlooddateOperationStudyFINAL.pdf
Thank You

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