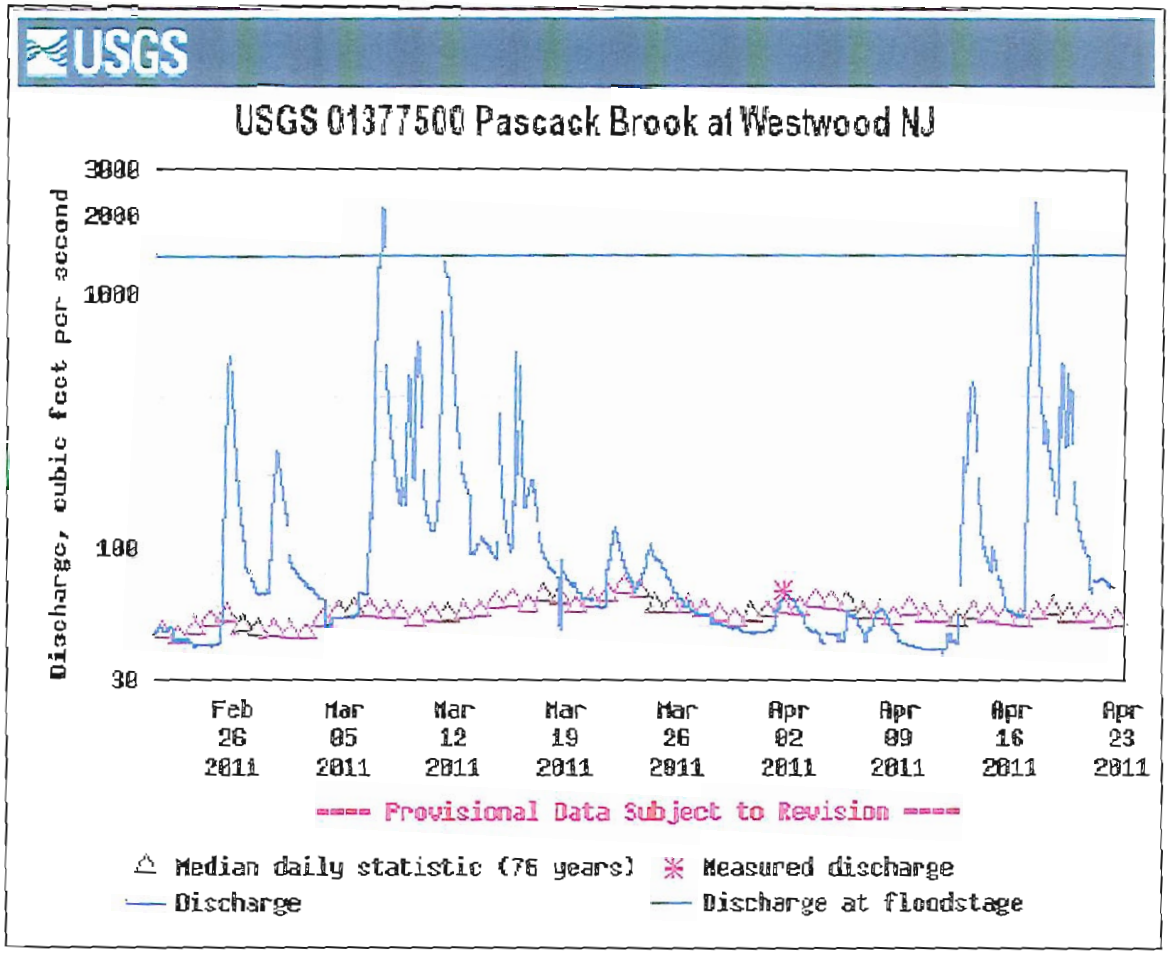
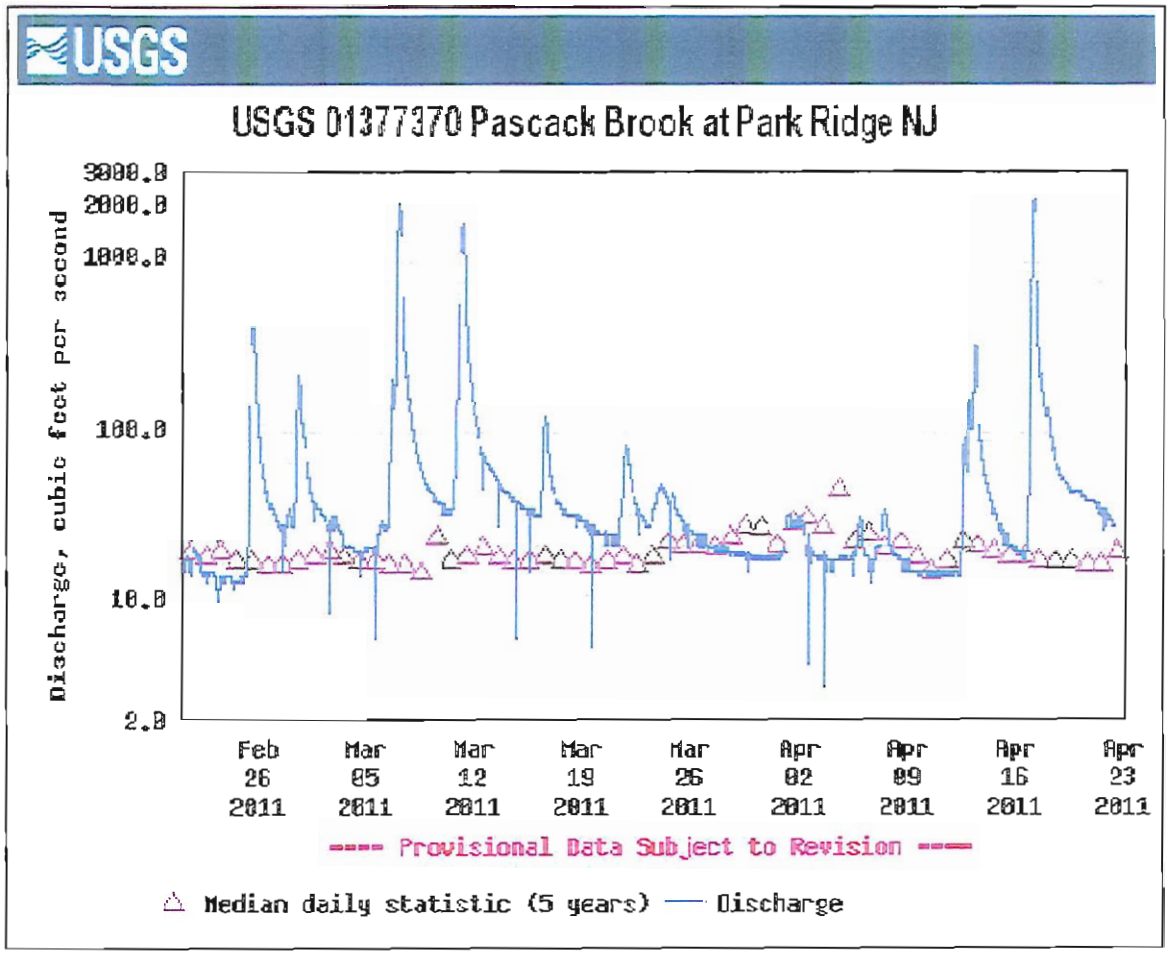
APPENDIX A

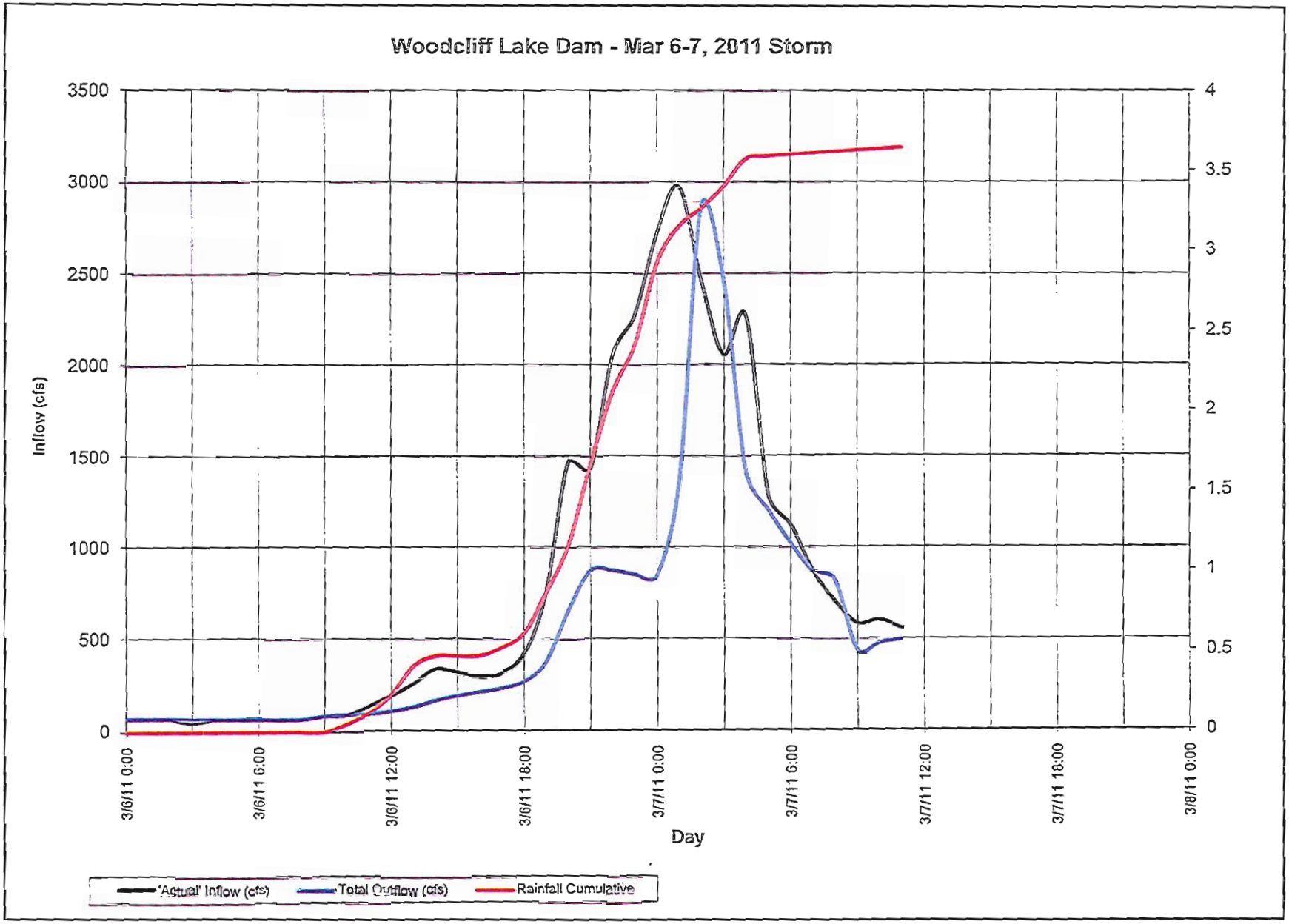
UNITED WATER PRESENTATION

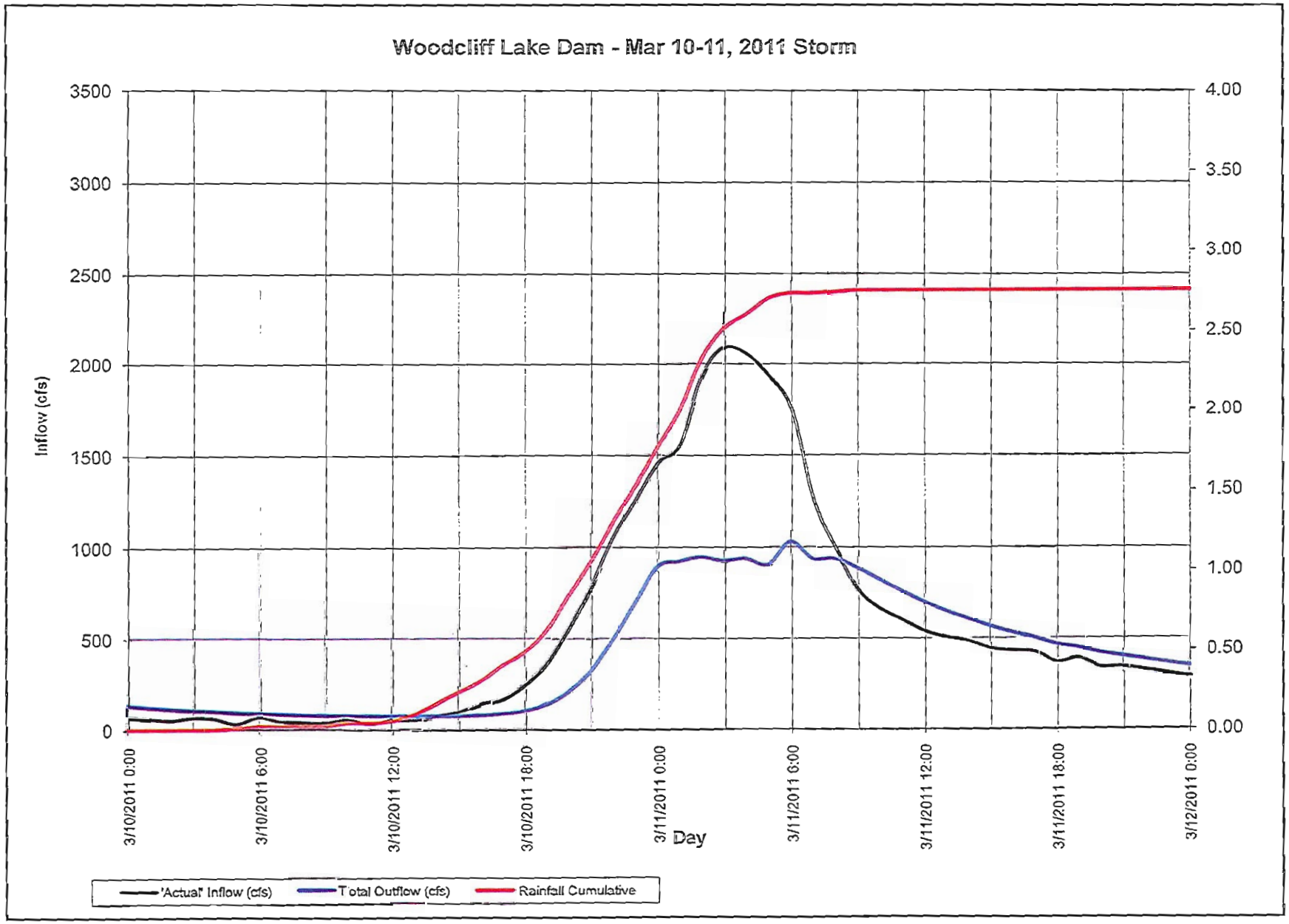
Hand Outs

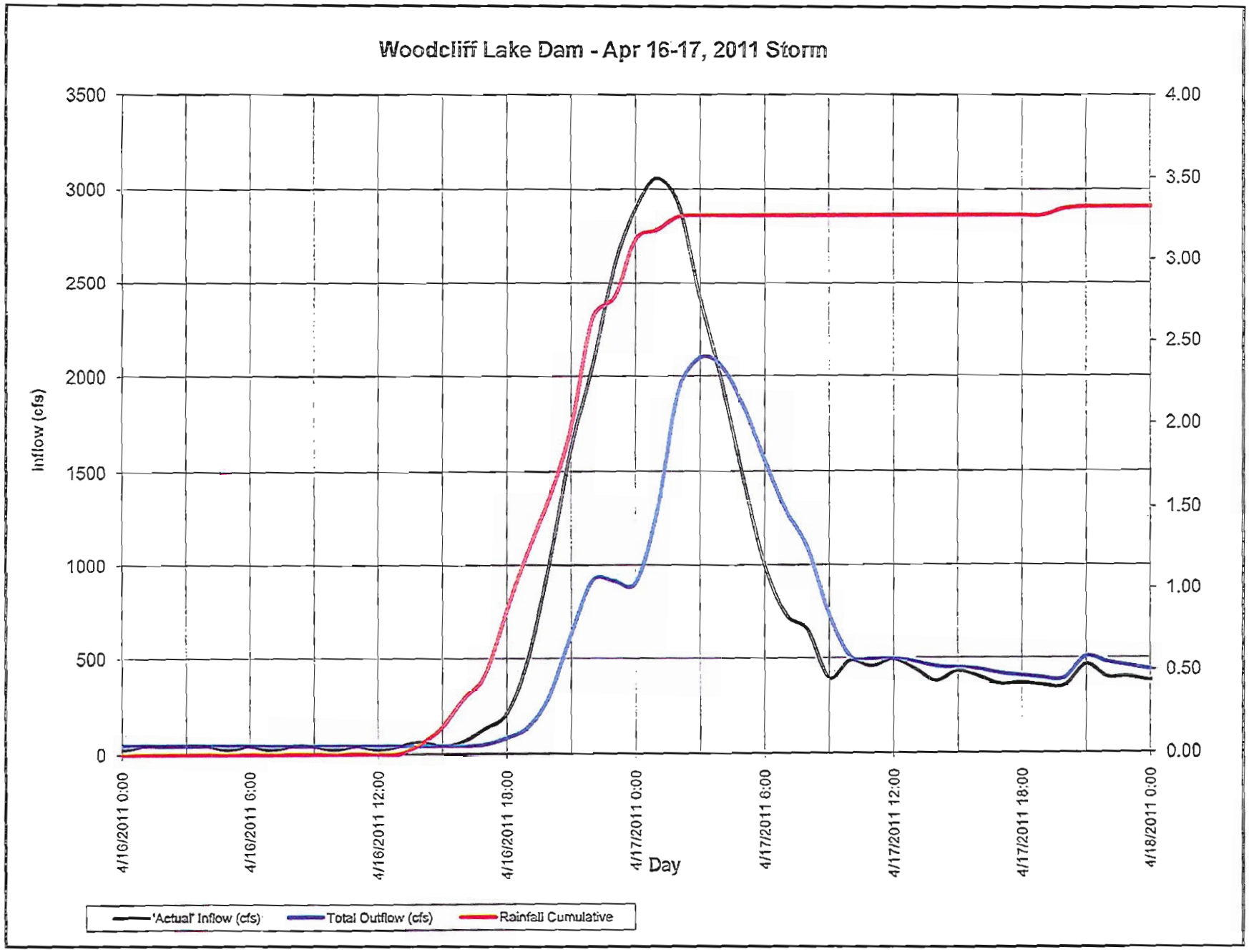
September 6th and 22nd, 2011

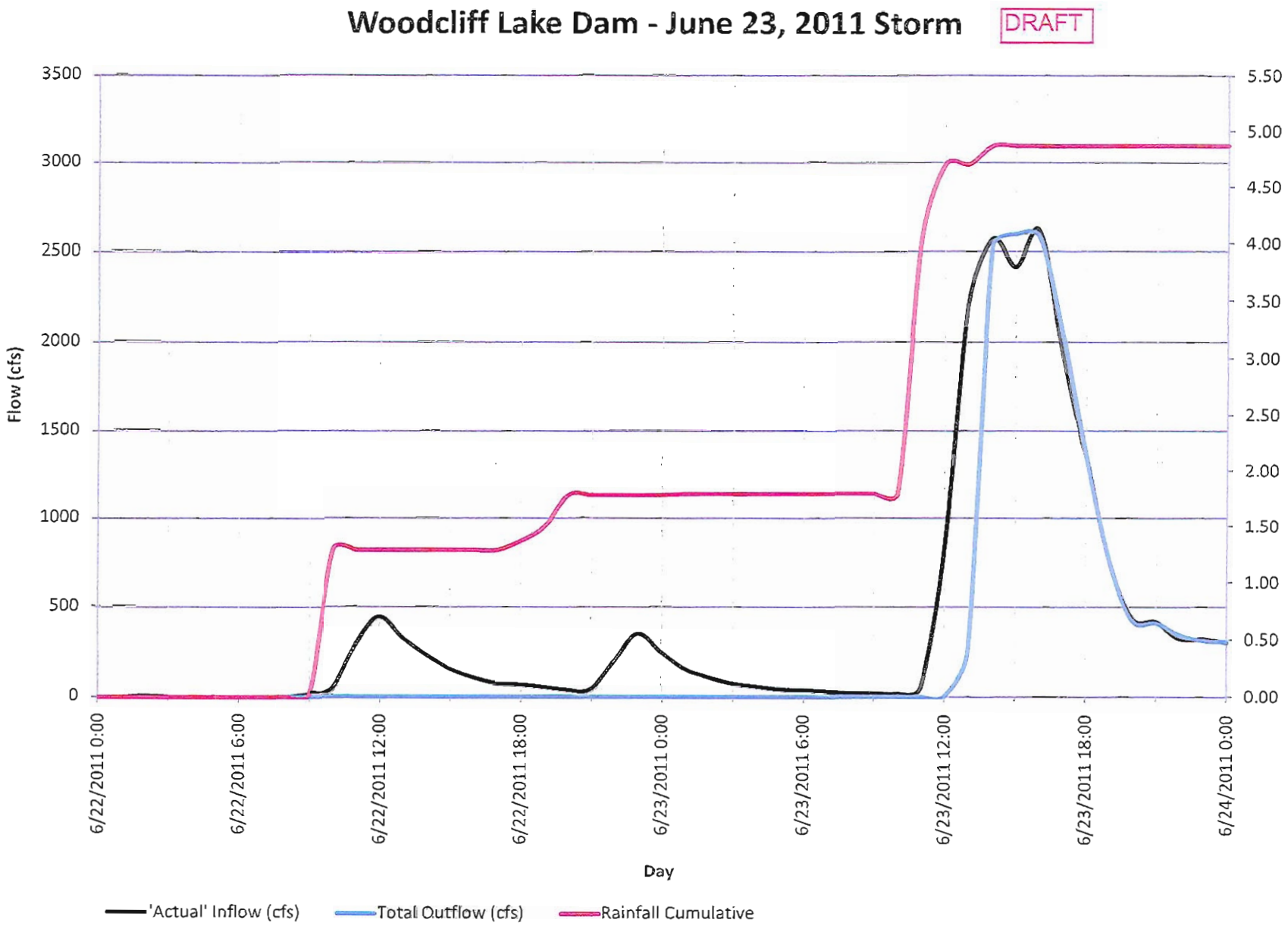

USGS
USGS 01377500 Pascack Brook at Westwood NJ
Discharge, cubic feet per second
3000
2000
1000
100
30
Feb 26 2011
Mar 05 2011
Mar 12 2011
Mar 19 2011
Mar 26 2011
Apr 02 2011
Apr 09 2011
Apr 16 2011
Apr 23 2011
---- Provisional Data Subject to Revision ----
Median daily statistic (76 years)
Measured discharge
Discharge
Discharge at floodstage


USGS
USGS 01377370 Pascack Brook at Park Ridge NJ
Discharge, cubic feet per second
3000.0
2000.0
1000.0
100.0
10.0
2.0
Feb 26 2011
Mar 05 2011
Mar 12 2011
Mar 19 2011
Mar 26 2011
Apr 02 2011
Apr 09 2011
Apr 16 2011
Apr 23 2011
---- Provisional Data Subject to Revision ----
Median daily statistic (5 years)
Discharge


Woodcliff Lake Dam - Mar 6-7, 2011 Storm
Inflow (cfs)
3500
3000
2500
2000
1500
1000
500
0
4
3.5
3
2.5
2
1.5
1
0.5
0
3/6/11 0:00
3/6/11 6:00
3/6/11 12:00
3/6/11 18:00
3/7/11 0:00
3/7/11 6:00
3/7/11 12:00
3/7/11 18:00
3/8/11 0:00
Day
'Actual' Inflow (cfs)
Total Outflow (cfs)
Rainfall Cumulative


Woodcliff Lake Dam - Mar 10-11, 2011 Storm
Inflow (cfs)
3500
3000
2500
2000
1500
1000
500
0
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
3/10/2011 0:00
3/10/2011 6:00
3/10/2011 12:00
3/10/2011 18:00
3/11/2011 0:00
3/11/2011 6:00
3/11/2011 12:00
3/11/2011 18:00
3/12/2011 0:00
Day
'Actual' Inflow (cfs)
Total Outflow (cfs)
Rainfall Cumulative

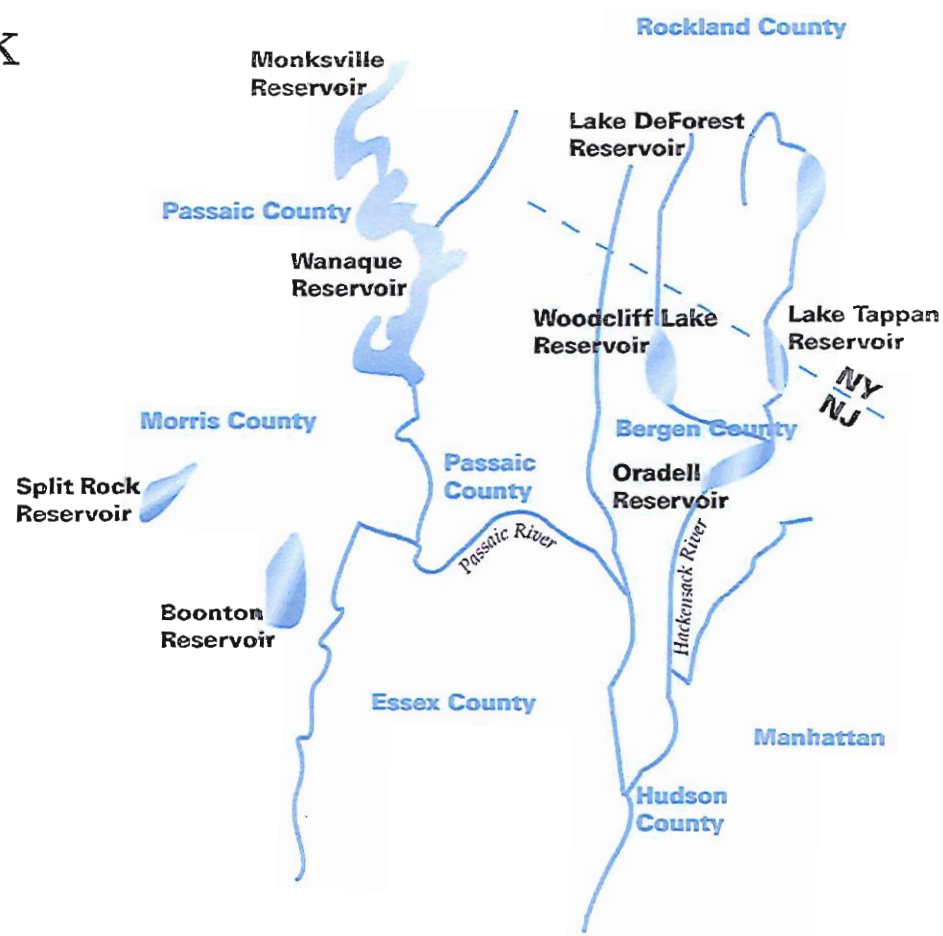

Woodcliff Lake Dam - Apr 16-17, 2011 Storm
Inflow (cfs)
3500
3000
2500
2000
1500
1000
500
0
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
4/16/2011 0:00
4/16/2011 6:00
4/16/2011 12:00
4/16/2011 18:00
4/17/2011 0:00
4/17/2011 6:00
4/17/2011 12:00
4/17/2011 18:00
4/18/2011 0:00
Day
'Actual' Inflow (cfs)
Total Outflow (cfs)
Rainfall Cumulative


Woodcliff Lake Dam - June 23, 2011 Storm
DRAFT
Flow (cfs)
3500
3000
2500
2000
1500
1000
500
0
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
6/22/2011 0:00
6/22/2011 6:00
6/22/2011 12:00
6/22/2011 18:00
6/23/2011 0:00
6/23/2011 6:00
6/23/2011 12:00
6/23/2011 18:00
6/24/2011 0:00
Day
'Actual' Inflow (cfs)
Total Outflow (cfs)
Rainfall Cumulative

Effects of the Woodcliff Lake Dam

OVERVIEW OF UNITED WATER WATER SUPPLY SYSTEM

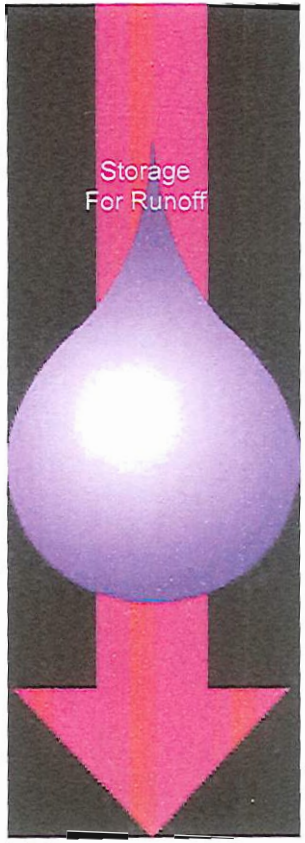
- 4 Reservoir Hackensack River Basin System
- 50% owner with NJDWSC for the Wanaque South Project
- Operations for Jersey City



WATER SUPPLY

- UWNJ serves a population of approximately 800,000 in 60 municipalities in Bergen and Hudson Counties
- UWNJ supplies 9 communities with wholesale water to support their systems
- Haworth Water Treatment Plant pumps an average of 115 million gallons per day with peak day of 190 MGD

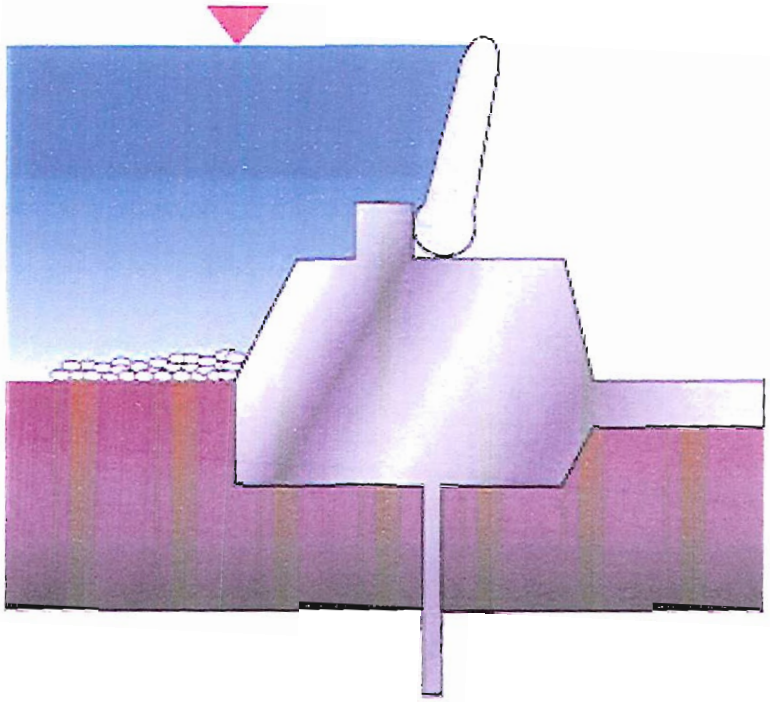
Competing Needs



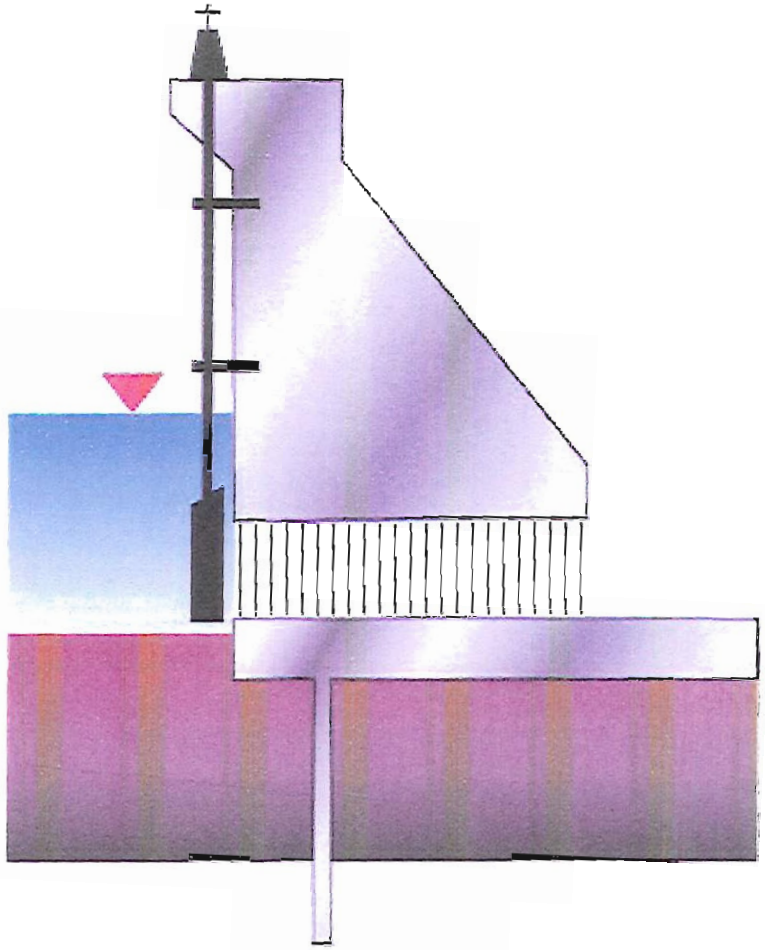
State-wide > 4 Million

Water Supply and Flood Attenuation
are mutually exclusive competing purposes

DAM DESIGNS ARE DIFFERENT

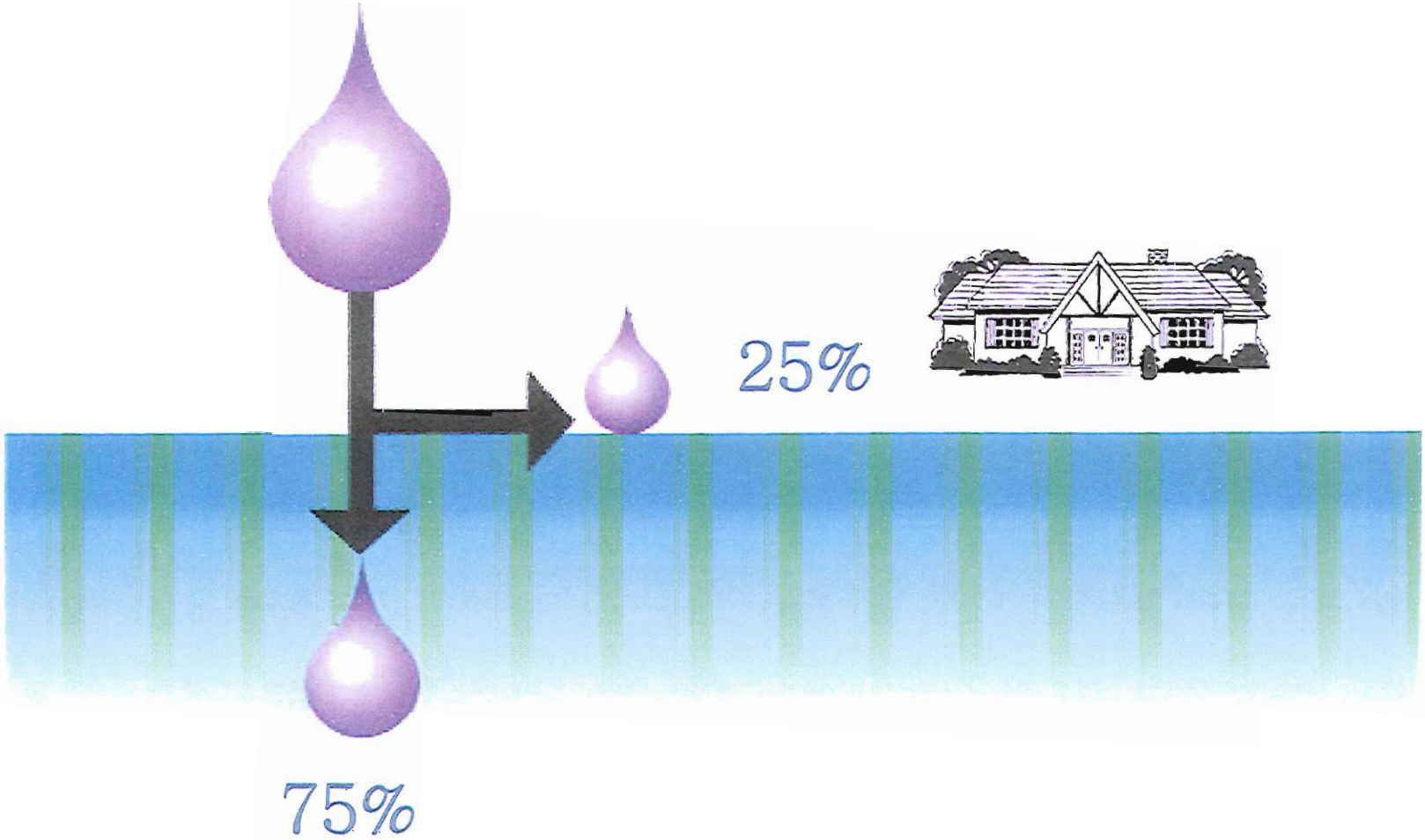


Water Supply

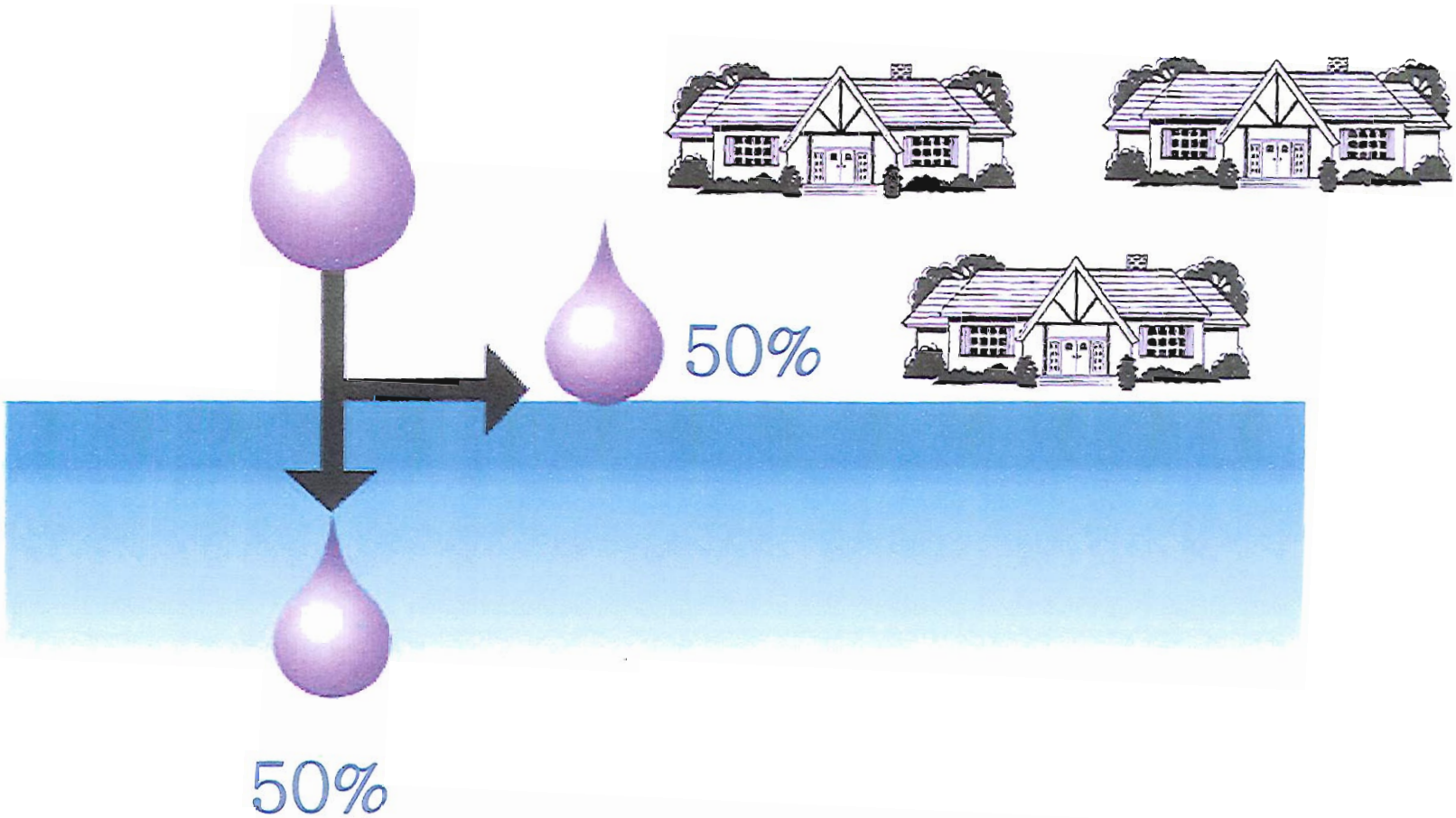


Flood Control

1960's RUNOFF

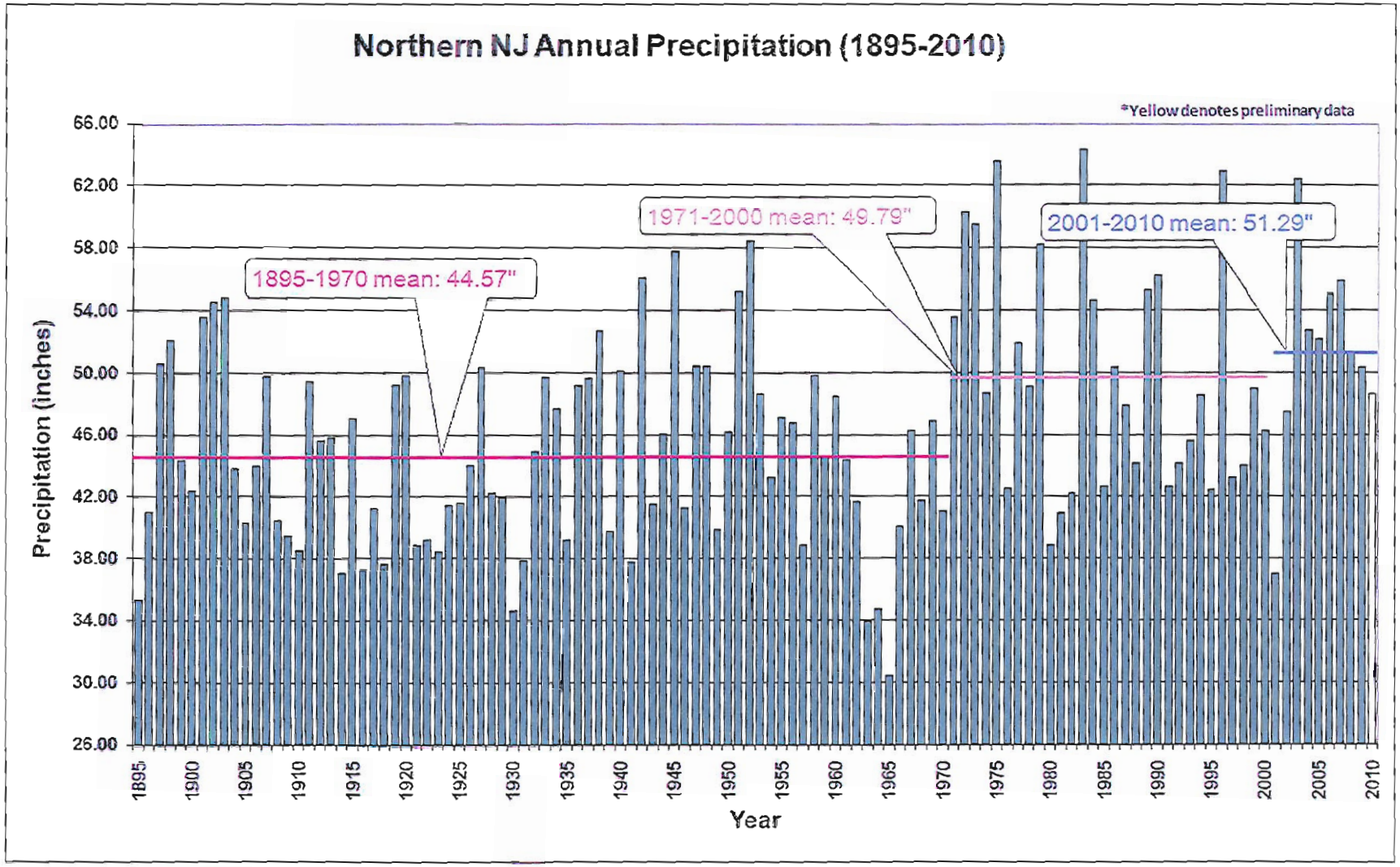


RUNOFF TODAY



- 100% increase in runoff

Northern NJ Annual Precipitation
Source : Rutgers University Web Site



Hurricane Irene, August 2011 Peak Flow Comparison

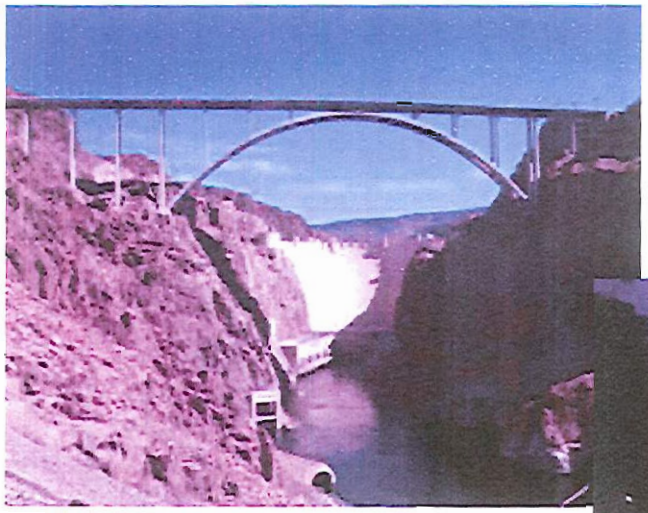
Dam Name	Hazard Potential	Watershed Area, Square Miles	Reservoir Capacity, Million Gallons	Sep 1999 Tropical Storm Floyd Peak Flow		April 2007 Nor'easter Peak Flow		August 2011 Hurricane Irene Peak Flow	
	Class*			CFS	MGD	CFS	MGD	CFS	MGD
Oradell	High	113	3,500	9,760	6,309	11,600	7,498	10,520	6,800
Tappan	High	49	3,850	2,070	1,338	4,620	2,986	4,660	3,012
Woodcliff	High	19	850	9,630	6,225	3,260	2,107	4,630	2,993

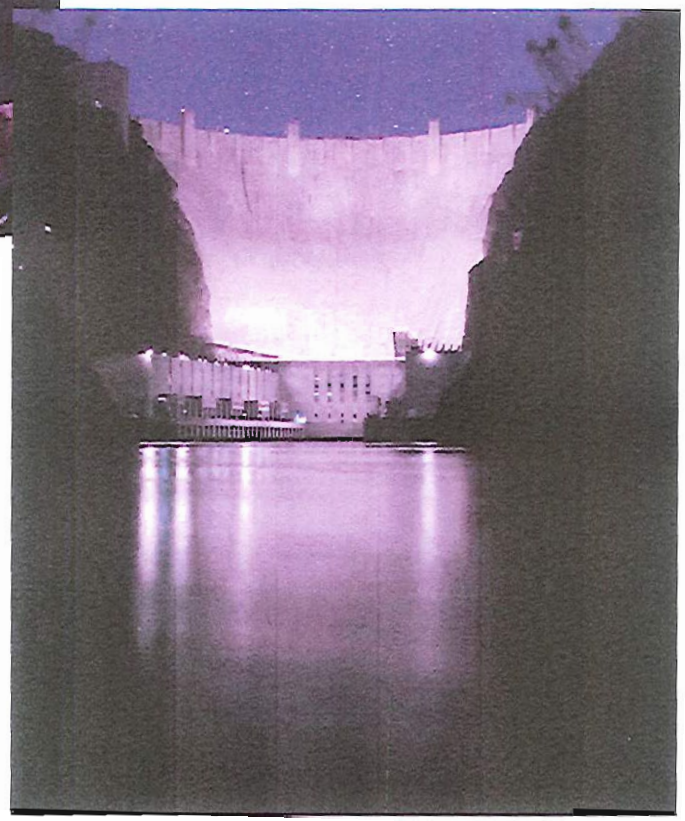
* Hazard Potential Class of "High" means there is the potential for the loss of a life

WATER SUPPLY IS A VITAL RESOURCE

- The health, safety, and economic well being of the people we serve depends on adequate water supply
- This must not be diminished by reducing the available water stored in our reservoirs

A Comparison with Hoover Dam





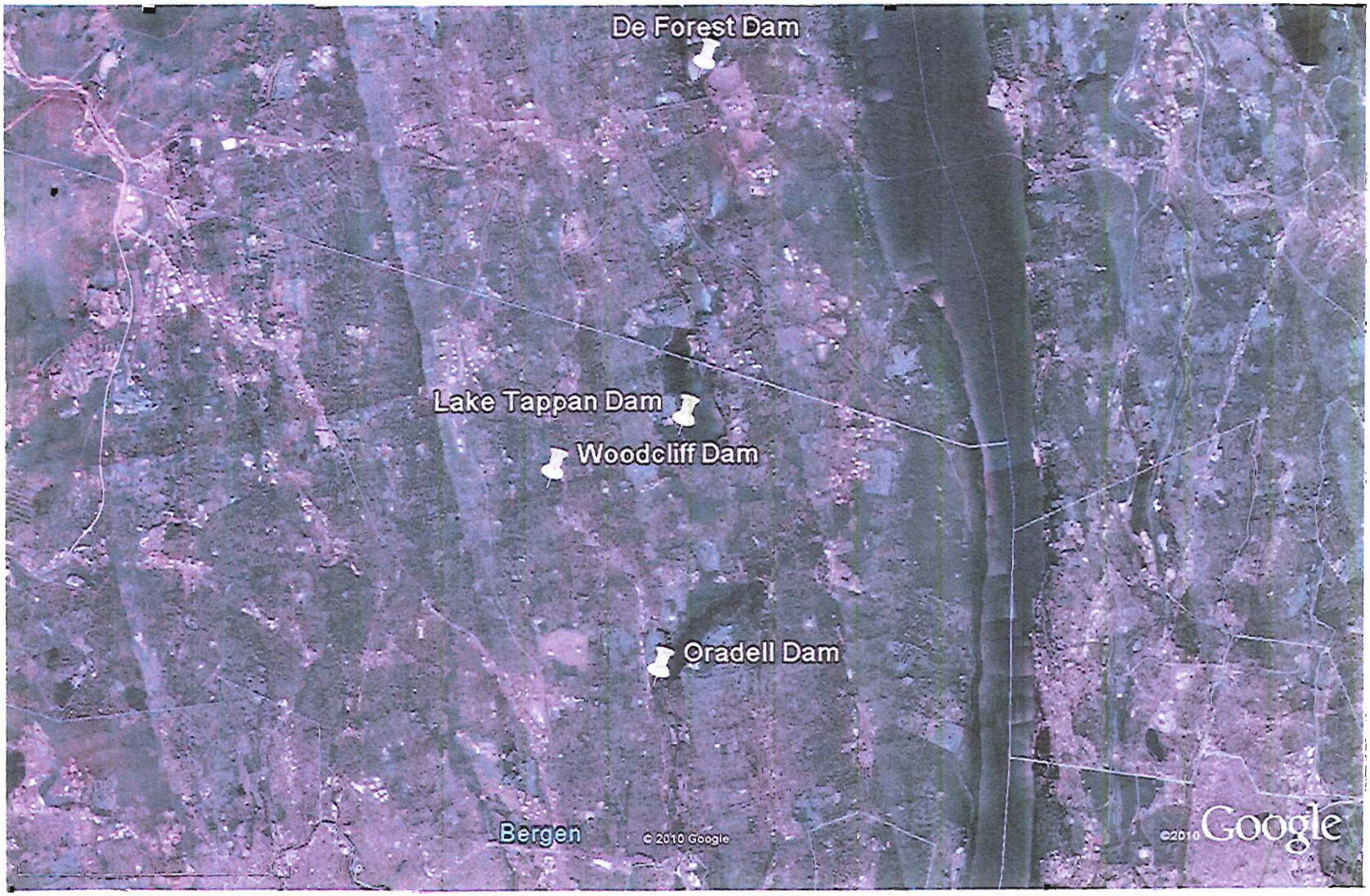
Hoover Dam

Length:	1,224 ft
	379 m
Height:	726.4 ft
	221.4 m
Capacity:	28,537,000 acre-feet
	35.2 km^3

DeForest Lake Dam

Length:	1,330 ft
	405 m
Height:	35 ft
	10.7m
Capacity:	18,100 acre-feet
	0.02 km^3

Dams on Hackensack River, New Jersey

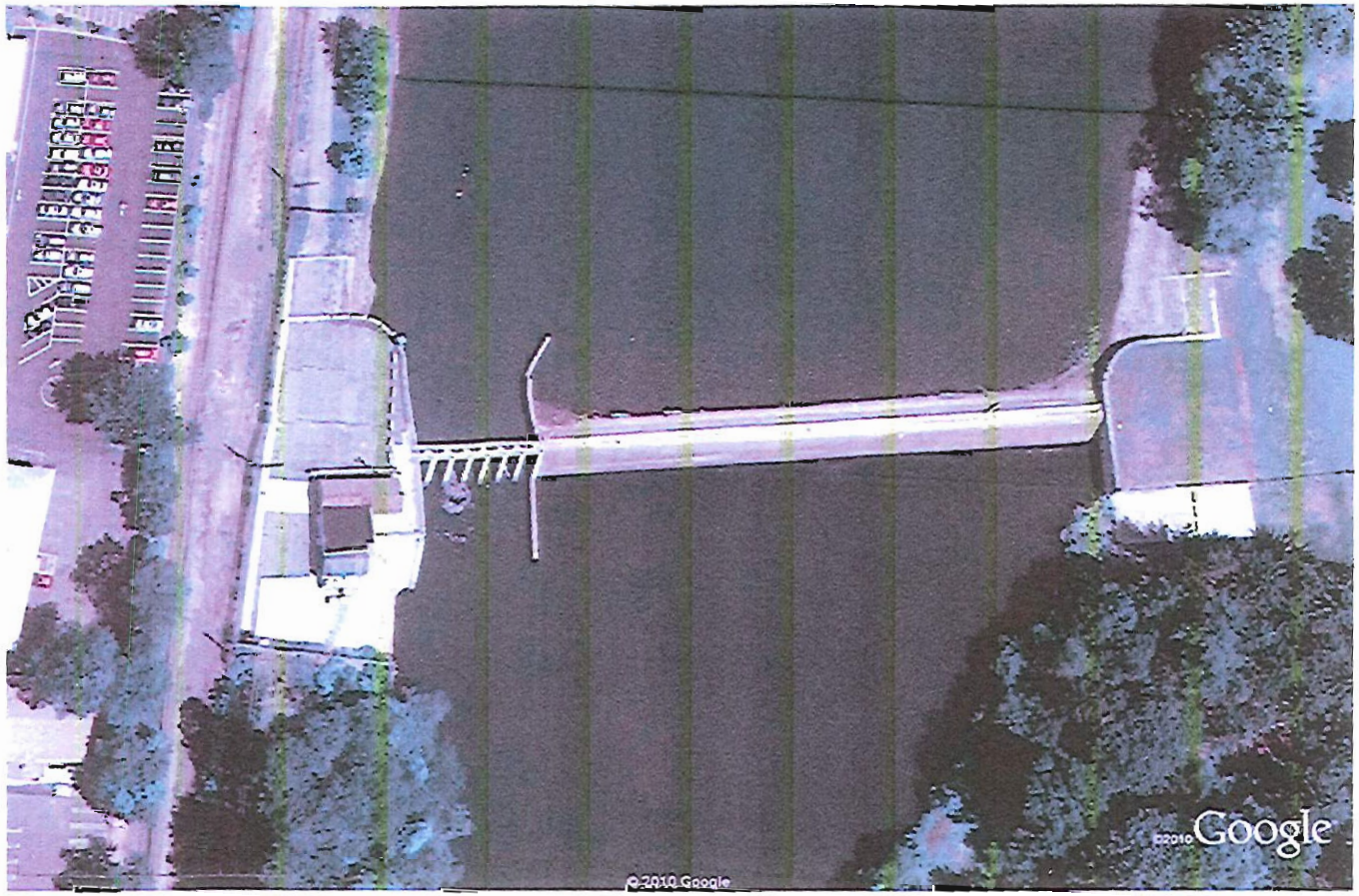


Owned Water Supply Dams
Hackensack River System

Dam Name	Hazard Potential Class *	Watershed Area Square Miles	Reservoir Capacity Million Gallons	Height Feet	Year Built	Last Major Upgrades	Regulatory Agency
Oradell	High	113	3,500	25	1923	2005 $2.0 M	NJDEP
Tappan	High	49	3,850	34	1966	2006 $0.25 M	NJDEP
Woodcliff	High	19	850	35	1905 1984	2001	NJDEP
DeForest	High	26.6	5,900	35	1954	2001/2006	NYSDEC

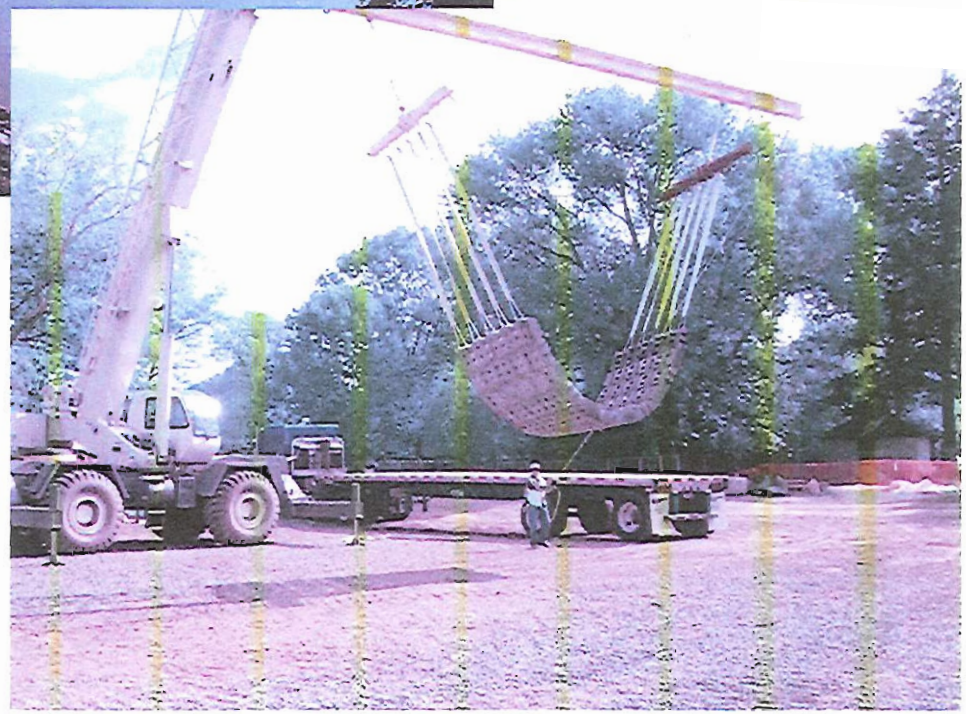
* Hazard Potential Class of "High" means there is the potential for the loss of a life

Oradell Dam



- Constructed in 1923
- Southernmost Dam on the Hackensack River
- Intake to the Haworth WTP
- Concrete Dam, Reverse Ambursen
- 7 Sluice Gates

Overtopping Protection and New Sluice Gate Actuators added in 2005



Response to Dam Emergencies

United Water Dams have comprehensive Dam Emergency Action Plans (EAP)

- Action Plans are designed to meet criteria set by the individual State's office of Dam Safety
- Action Plans are reviewed and updated annually.
- Regular drills are conducted with outside agencies

- Security
  - Dam Vulnerability Assessments
  - Dam Remediation and Recovery Plans

Why Dam Emergency Action Plans?

- "Establish procedures to

  protect life and property

  in the areas that might be affected by a failure of the dam(s) or an uncontrolled release of water"

Exercises and Drills

- Tabletop Exercises are conducted regularly
- Include outside agencies (police, OEM, etc.) from local, county and state.
- Include informational sessions in addition to a drill scenario.

Preparations for Hurricane Irene

- **Inspections: Post-Earthquake , Pre-Hurricane**
- **Standby Generators started and power transferred before storm**
- **Emergency Action Plan (EAP) was reviewed in detail**
- **Wed Aug 24, UWNJ in contact with NJDEP regarding preparations**
  - NJDEP BDSFC authorizes voluntary 1 foot lowering for all dam owners
- **Thu Aug 25, Governor Christie issues State of Emergency**
- **Releases require coordination between the four reservoirs on the Hackensack River and Pascack Brook**
- **Fri Aug 26, UWNJ met with County and Municipal officials in preparation**

During Hurricane Irene

- Operations and Engineering Team on site continuously 24/7 for the duration of the event
- Water supplied to customers at all times during the event
- High water quality maintained with the 2009 addition of the Dissolved Air Flotation system at Haworth
- Notifications and Alerts made to all Agencies and Emergency Responders
- 9 Billion Gallons Runoff due to 7+ Inches of Rain in less than 18 hours

THE SOLUTION

- **Better land use and zoning regulation**
- **Restoration of the natural brook and stream channels**
- **Blue acre funding to purchase vulnerable homes in the flood zone to recover natural flood plains**
  - Move the people who flood more frequently out of harms way
- **Diligently protect our flood plains to remain undeveloped as the natural, permanent solution to attenuate flooding**
- **Increase state spending for flood control management**

Blue Acres

Elevate and/or relocate flood-pron

Acquire (and either demolish or re
the property to open space

Retrofit and structural improvemer
flooding, earthquakes, and other h

Planning grants to develop Flood a

Develop or improve warning syste

Localized (minor) flood control proj
facilities such as

L11-11-040

Allowable Mitigation Projects

Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters.

Allowable or "fundable" FEMA projects under the Hazard Mitigation Grant Program (HMGP) and the Pre-Disaster Mitigation Grant Program (PDM) can address all natural hazards issues while the Flood Mitigation Assistance Program (FMA), the Repetitive Flood Claims Program (RFC) and the Severe Repetitive Loss Grant \Program (SRL) address flood issues.

Allowable Mitigation Projects	FEMA HMA Programs				
	HMGP	FMA	PDM	RFC	SRL
Elevate and/or relocate flood-prone homes or businesses	✓	✓	✓	✓	✓
Acquire (and either demolish or relocate) flood-prone homes from willing owners and return the property to open space	✓	✓	✓	✓	✓
Retrofit and structural improvements to buildings to minimize damage from high winds, flooding, earthquakes, and other hazards	✓	✓	✓		
Planning grants to develop Flood and All Hazard Mitigation Plans	✓	✓	✓		
Develop or improve warning systems	✓				
Localized (minor) flood control projects that are designed specifically to protect critical facilities such as • installation of culverts and floodgates • construction of retention and detention basins • upgrade culverts to bridges	✓	✓	✓	✓	✓
Protective measures for utilities	✓		✓		
Community-wide or system-wide storm water management projects	✓		✓		
Dry floodproofing measures for non-residential properties		✓		✓	✓
Construct safe rooms inside schools and other buildings in tornado prone areas	✓		✓		
Sand fencing and vegetation management for natural dune restoration, wildfire control, landslide or snow avalanche		✓	✓		
Beach nourishment		✓			
Hydrologic and hydraulic, engineering and drainage studies when part of a larger project			✓		

** All applications are subject to individual review and approval. Program guidance is available on the FEMA.gov website.*

For more information Contact: New Jersey Office of Emergency Management, Division of State Police
P. O. Box 7068, West Trenton, NJ 08628-0068

SFC Robert Little, State Hazard Mitigation Officer

Telephone: (609) 963-6963 Fax: (609) 530-3649 Email: Little.robert@ow.njsp.org

We remember this… Lake Tappan 1981

What our water supply reservoirs should look like…

Questions and Answers
Additional Comments

MAKING THE PLANET SUSTAINABLE IS THE BEST JOB ON EARTH

APPENDIX B

FEMA Flood Discharge Table
And Flood Profiles
For Pascack Brook

United Water
Cross Section Location Map
And HEC-RAS Summary Tables

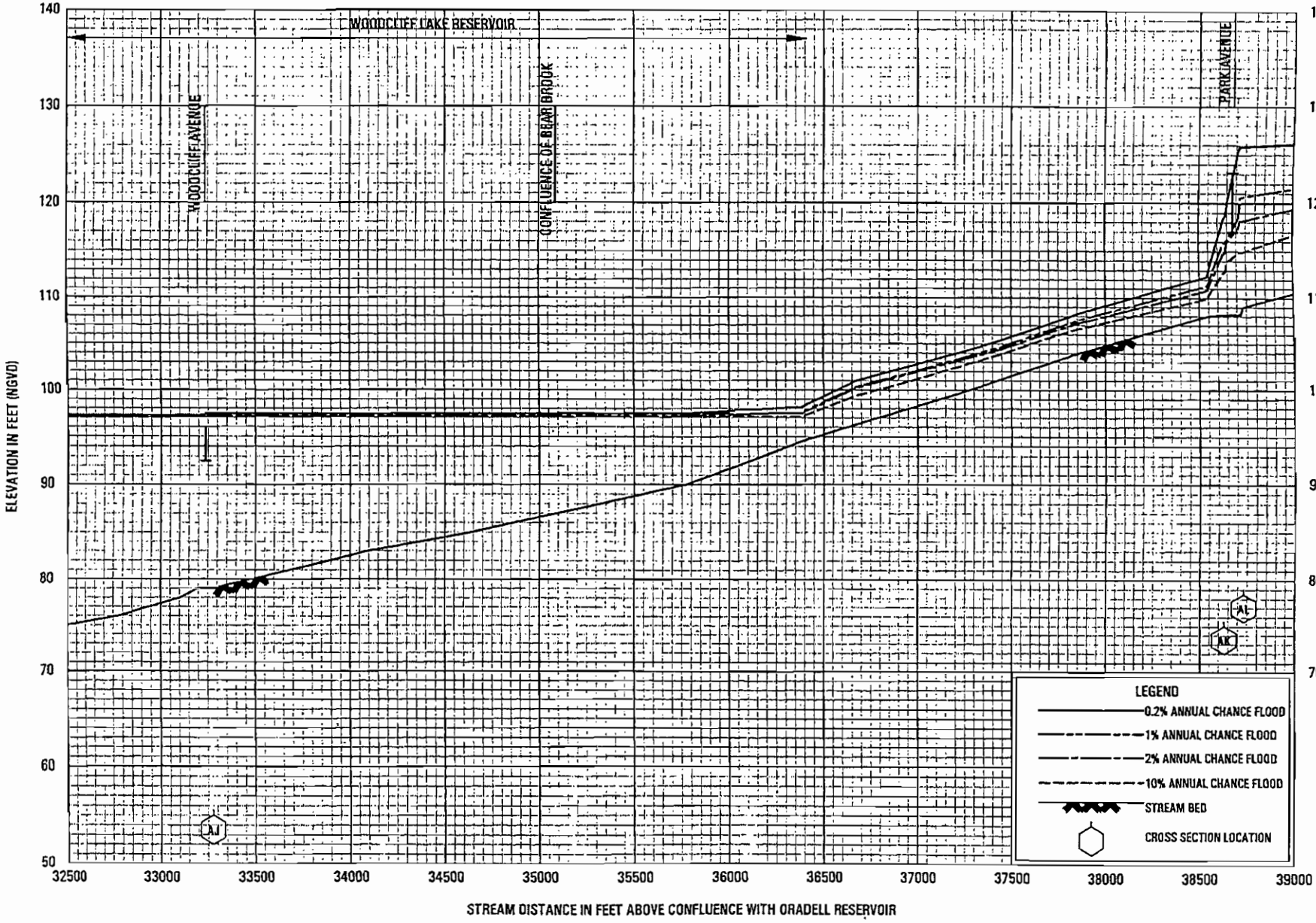
TABLE 9 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
NORWOOD BROOK					
At confluence with Oradell Reservoir	1.90	243/926[1]	406	499/2,002[1]	753
Upstream of CONRAIL bridge	1.60	215/858[1]	360	444/1,750[1]	671
OOST VAL BROOK					
At confluence with East Branch Saddle River	3.63	*	*	839	1,200
OVERPECK CREEK					
At confluence with Hackensack River	17.30	1,810	2,240	2,665	4,000
Upstream of confluence of Teaneck Creek	12.00	1,635	2,030	2,390	3,500
Upstream of confluence of Flat Rock Brook	8.40	1,215	1,520	1,775	2,700
Upstream of confluence of Tributary to Overpeck Creek	5.70	760	1,090	1,200	1,600
Upstream of confluence of Metzlers Creek	3.00	530	750	830	1,100
TRIBUTARY TO OVERPECK CREEK					
At confluence with Overpeck Creek	1.00	275	445	545	810
PASCACK BROOK					
Downstream limit of Study	**	1,780	3,370	4,400	7,330
At USGS gage No. 01377500 (Westwood)	29.60	1,890	3,560	4,540	7,740
Confluence of Musquapsink Brook	**	1,580	3,000	3,940	6,570
At Woodcliff Lake Reservoir Spillway	19.40	1,440	2,740	3,610	6,050
Upstream end of Woodcliff Lake	**	1,720	3,250	4,280	7,160
Approximately 1,800 feet Upstream of Grand Avenue	**	1,730	3,270	4,320	7,250

*Data not available
**Drainage area unknown
[1]Discharge determined using Special Report No. 38/Discharge calculated considering interbasin flow transfer

TABLE 11 - SUMMARY OF ROUGHNESS COEFFICIENTS - continued

Stream	Channel "n"	Overbank "n"
Hackensack River By-pass	0.030	0.060
Haunsmans Ditch	0.030	0.060
Henderson Brook	0.035-0.045	0.050-0.080
Herring Brook	0.025-0.033	0.035-0.080
Hillsdale Brook	0.024-0.045	0.030-0.080
Hirschfeld Brook	0.025	0.200
Hirschfeld Brook Tributary	0.025	0.200
Ho-Ho-Kus Brook	0.018-0.060	0.050-0.100
Ho-Ho-Kus Brook Tributary	0.030-0.035	0.080-0.100
Holdrum Brook	0.035-0.045	0.060-0.100
Jordan Brook	0.035-0.045	0.050-0.080
Kips Brook	0.030	0.050-0.070
Kroner's Brook	0.040	0.050-0.080
Laurel Brook	0.040	0.090
Losen Slofe	0.028	0.070-0.090
Mahwah River	0.040	0.080
Mannings Brook	0.022-0.030	0.040-0.060
Masonicus Brook	0.015-0.050	0.015-0.100
Metzlers Creek	0.015-0.100	0.020-0.180
Mill Brook	0.030-0.045	0.050-0.080
Muddy Creek	0.030-0.040	0.070-0.090
Musquapsink Brook	0.020-0.046	0.043-0.130
Musquapsink Brook By-pass	0.040	0.070
Norwood Brook	0.020-0.030	0.015-0.020
Oost Val Brook	0.030-0.040	0.040-0.090
Overpeck Creek	0.020-0.180	0.050-0.100
Tributary to Overpeck Creek	0.033	0.060-0.080
Pascack Brook	0.012-0.046	0.070
Passaic River	0.035-0.045	0.050-0.080
Pleasant Brook	0.030-0.045	0.060-0.070
Pleasant Brook Tributary	0.015-0.060	0.015-0.070
Pine Brook	0.040	0.070
Ramapo River	0.035-0.100	0.060-0.500
Tributary 1 to Ramapo River	0.025-0.060	0.040-0.100
Tributary 2 to Ramapo River	0.030-0.080	0.080-0.200
Ramsey Brook	0.035-0.045	0.060-0.100
Reservoir Brook	0.040	0.070
Rivervale Brook	0.030	0.075
Saddle Brook	0.035	0.060-0.100
Saddle River	0.018-0.045	0.015-0.140
Sparkill Brook	0.030-0.050	0.030-0.050
Sparkill Creek	0.030-0.050	0.030-0.050
Sparrow Bush Brook	0.036-0.070	0.060-0.080
Sprout Brook	0.030-0.050	0.020-0.120
Stateline Brook	0.045	0.080



FLOOD PROFILES

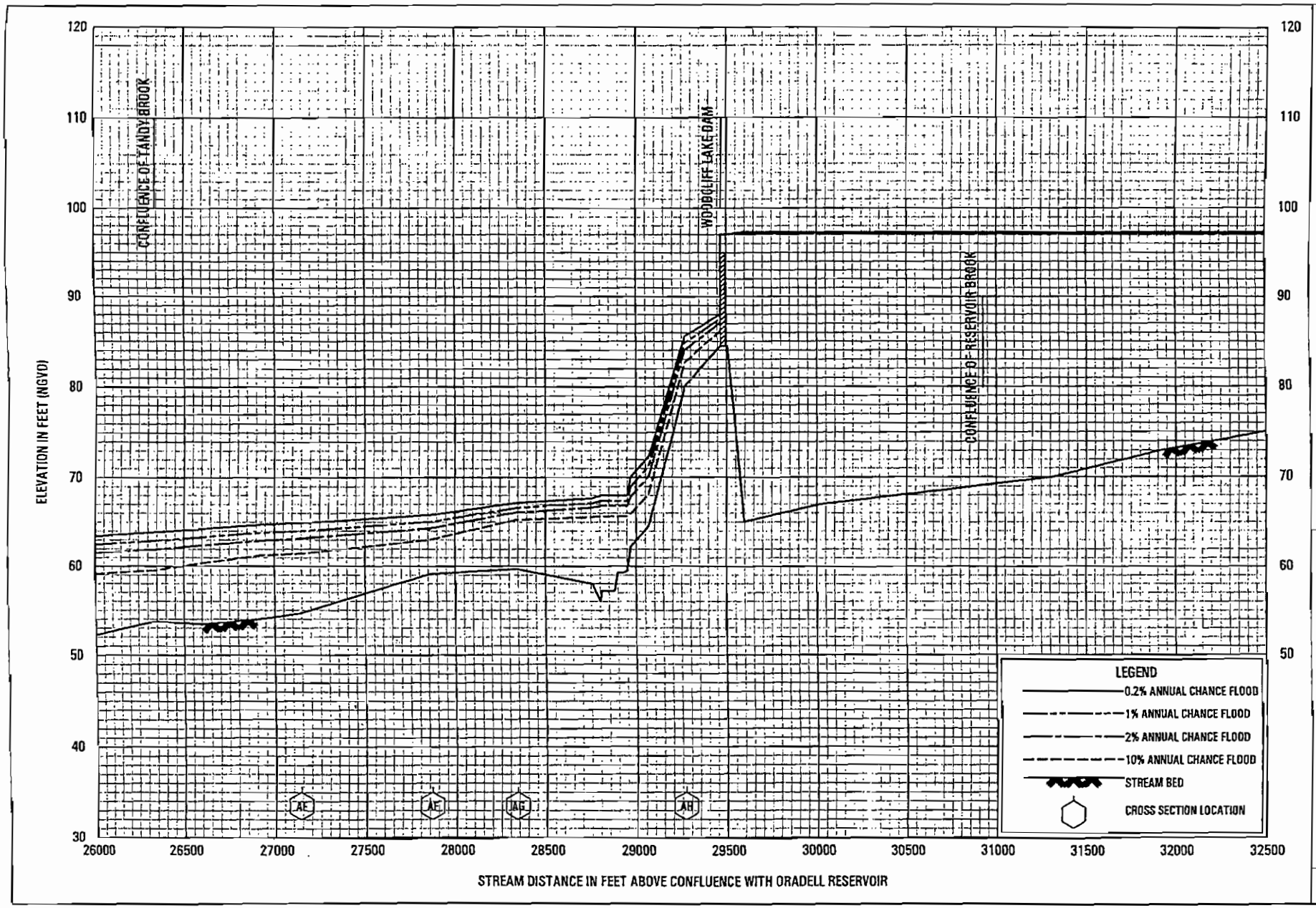
PASCACK BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERGEN COUNTY, NJ

(ALL JURISDICTIONS)

226P



FLOOD PROFILES

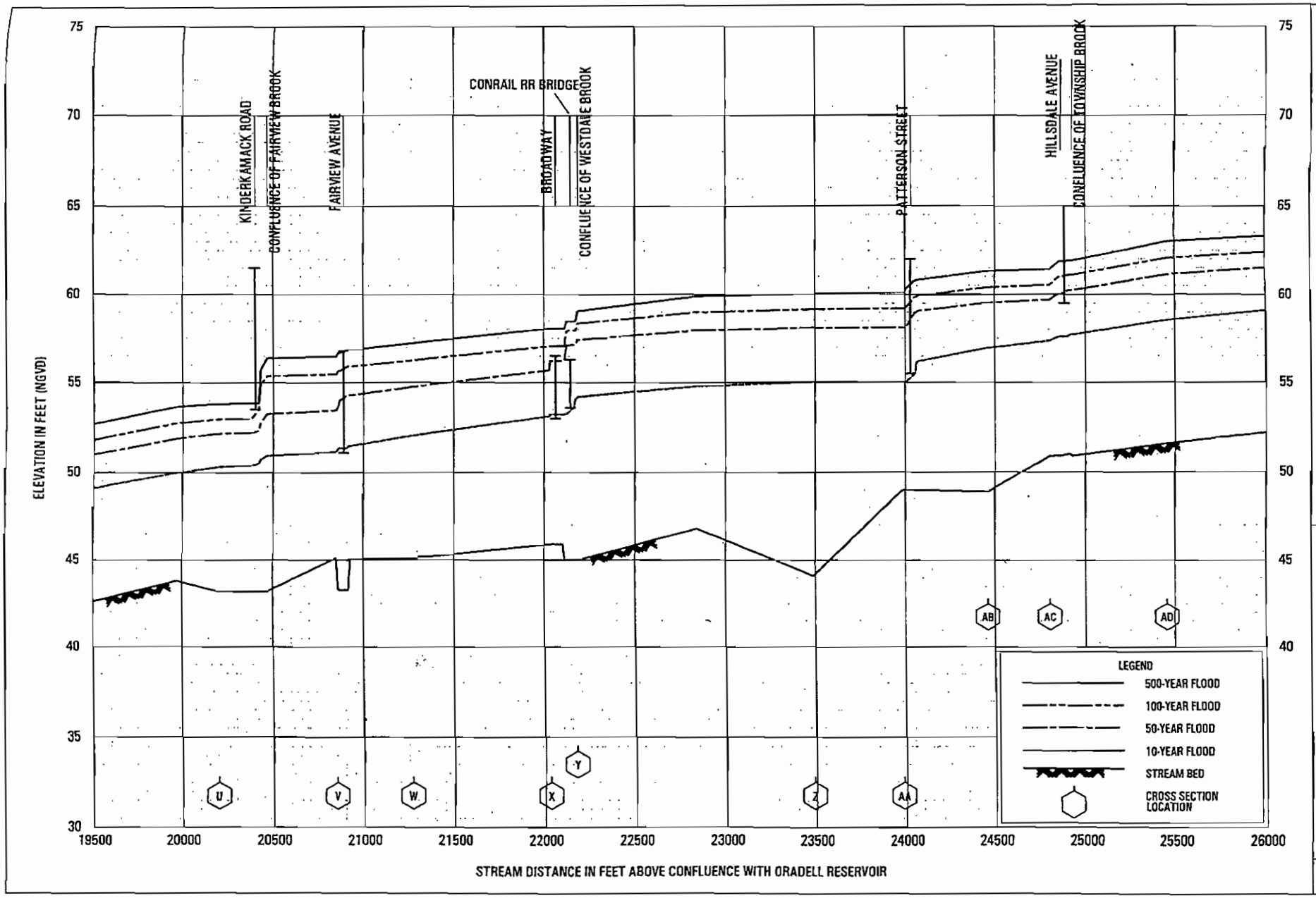
PASCACK BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERGEN COUNTY, NJ

(ALL JURISDICTIONS)

225P



FLOOD PROFILES

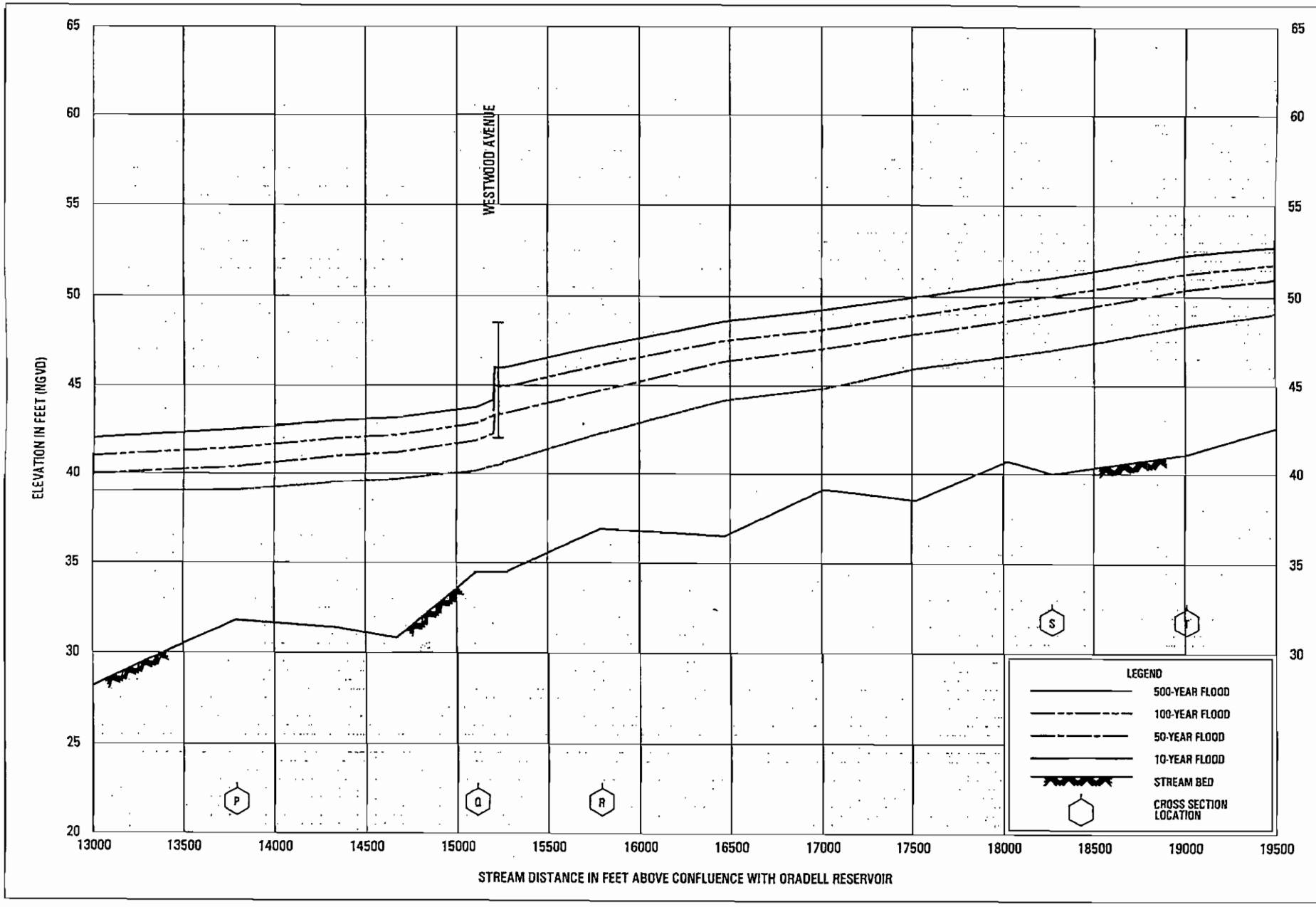
PASCACK BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERGEN COUNTY, NJ

(ALL JURISDICTIONS)

224P



FLOOD PROFILES

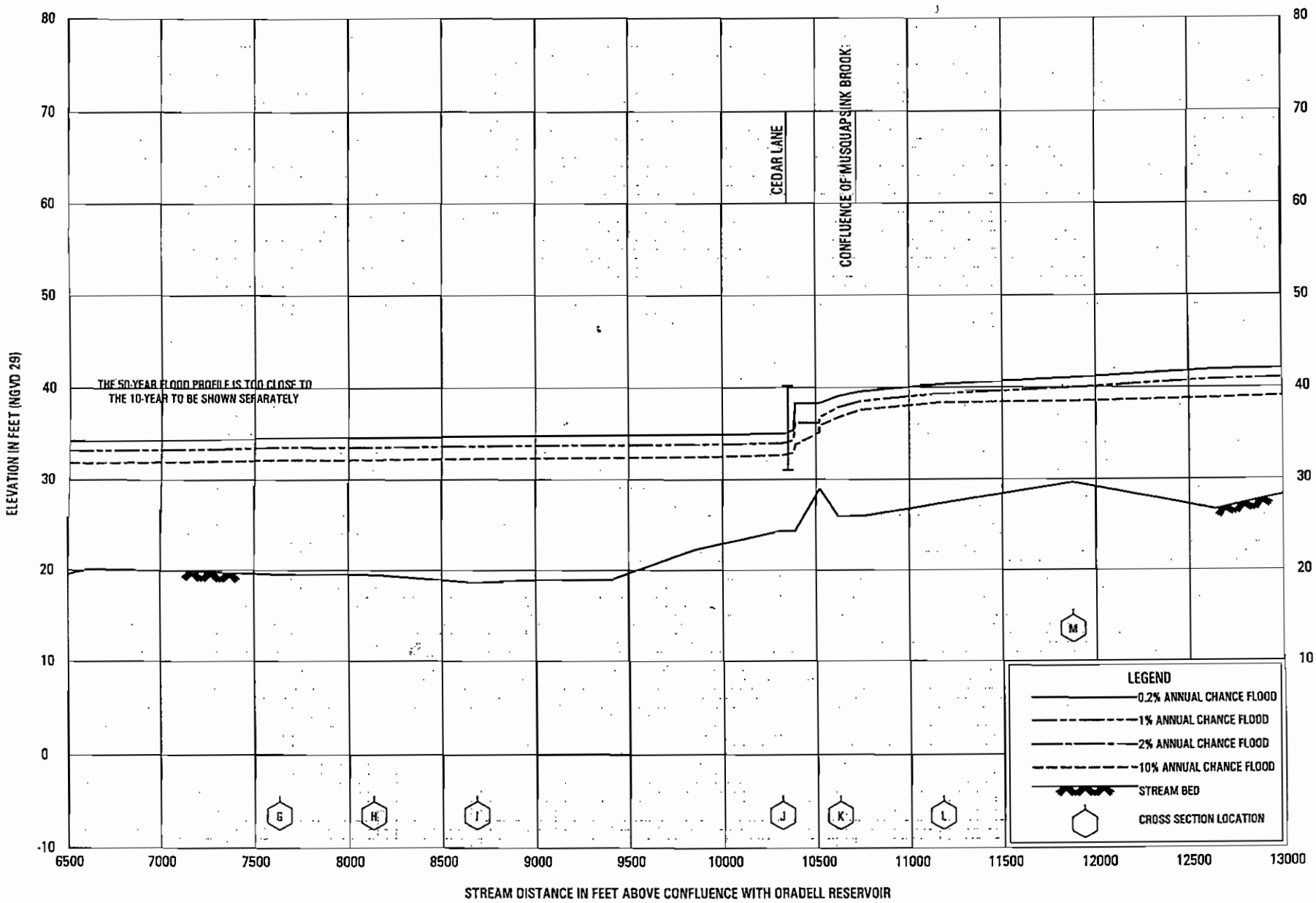
PASCACK BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERGEN COUNTY, NJ

(ALL JURISDICTIONS)

223P



FLOOD PROFILES

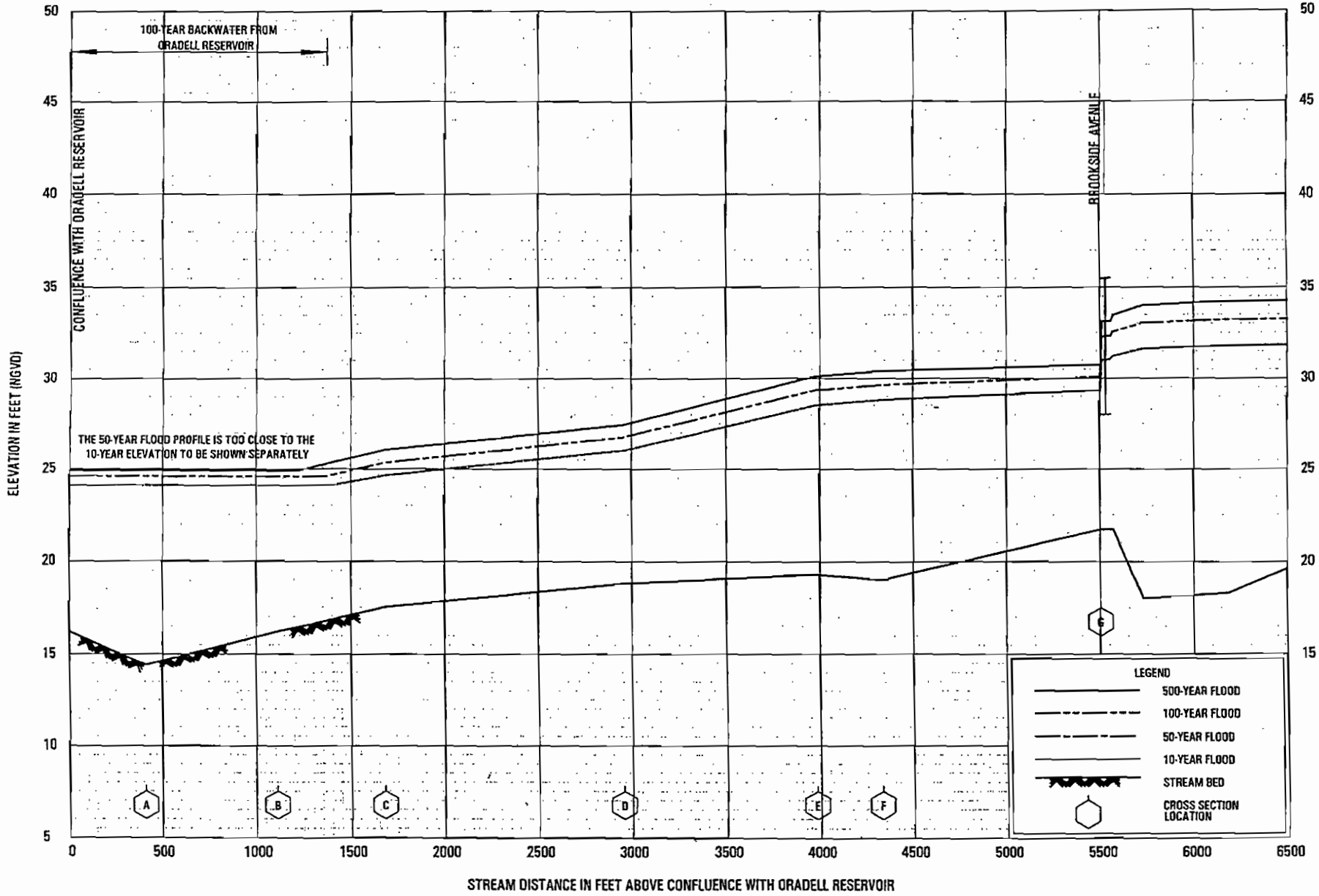
PASCACK BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERGEN COUNTY, NJ

(ALL JURISDICTIONS)

222P



FLOOD PROFILES

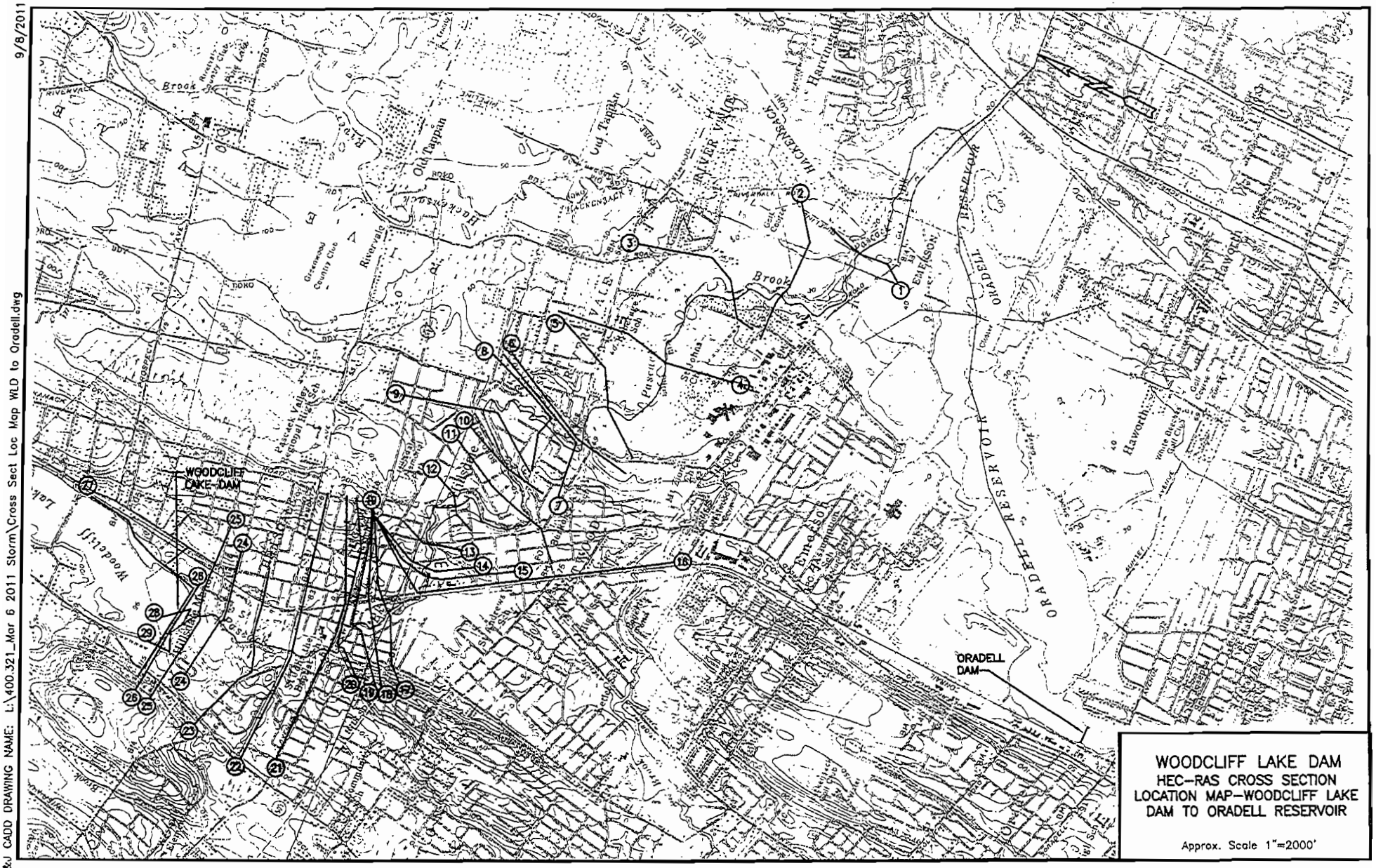
PASCACK BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BERGEN COUNTY, NJ

(ALL JURISDICTIONS)

221P



WOODCLIFF LAKE DAM
HEC-RAS CROSS SECTION
LOCATION MAP-WOODCLIFF LAKE
DAM TO ORADELL RESERVOIR

Approx. Scale 1"=2000'

BS&J CADD DRAWING NAME: L:\400.321_Mar 6 2011 Storm\Cross Sect Loc Map WLD to Oradell.dwg 9/8/2011

BUCK, SEIFERT & JOST, INC.

SEPT 2011

HEC-RAS Plan: Plan 63 River: Pascack Brook Reach: WCL Dam

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
WCL Dam	27	500 cfs	0.00	89.00	89.02	89.02	89.02	0.000000	0.00	1.42		0.00
WCL Dam	27	1000 cfs	0.00	89.00	89.02	89.02	89.02	0.000000	0.00	1.42		0.00
WCL Dam	27	1500 cfs	0.00	89.00	89.02	89.02	89.02	0.000000	0.00	1.42		0.00
WCL Dam	27	2000 cfs	0.00	89.00	89.02	89.02	89.02	0.000000	0.00	1.42		0.00
WCL Dam	26	500 cfs	0.00	89.00	89.02	89.02	89.02	0.000000	0.00	1.42		0.00
WCL Dam	26	1000 cfs	0.00	89.00	89.02	89.02	89.02	0.000000	0.00	1.42		0.00
WCL Dam	26	1500 cfs	0.00	89.00	89.02	89.02	89.02	0.000000	0.00	1.42		0.00
WCL Dam	26	2000 cfs	0.00	89.00	89.02	89.02	89.02	0.000000	0.00	1.42		0.00

HEC-RAS Plan: Plan 63 River: Pascack Brook Reach: Gated Spillway

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Gated Spillway	29	500 cfs	500.00	89.00	89.77	89.77	90.16	0.003653	4.99	100.15	130.00	1.00
Gated Spillway	29	1000 cfs	1000.00	89.00	90.22	90.22	90.84	0.003189	6.31	158.55	130.00	1.01
Gated Spillway	29	1500 cfs	1500.00	89.00	90.60	90.60	91.41	0.002933	7.22	207.83	130.00	1.01
Gated Spillway	29	2000 cfs	2000.00	89.00	90.94	90.94	91.92	0.002771	7.94	251.76	130.00	1.01
Gated Spillway	28	500 cfs	500.00	66.00	66.39	67.74	83.83	0.416310	33.52	14.92	38.50	9.49
Gated Spillway	28	1000 cfs	1000.00	66.00	66.75	68.76	85.26	0.186806	34.52	28.97	38.50	7.01
Gated Spillway	28	1500 cfs	1500.00	66.00	67.11	69.62	86.25	0.117815	35.11	42.72	38.50	5.87
Gated Spillway	28	2000 cfs	2000.00	66.00	67.46	70.38	87.04	0.085267	35.50	56.33	38.50	5.17

HEC-RAS Plan: Plan 63 River: Pascack Brook Reach: Pascack Brook

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Pascack Brook	25	500 cfs	500.00	60.00	62.31	61.57	62.64	0.003257	4.58	109.05	51.56	0.56
Pascack Brook	25	1000 cfs	1000.00	60.00	63.52	62.47	64.03	0.003164	5.74	174.35	57.25	0.58
Pascack Brook	25	1500 cfs	1500.00	60.00	64.46	63.21	65.12	0.003216	6.48	231.36	63.92	0.60
Pascack Brook	25	2000 cfs	2000.00	60.00	65.09	63.87	65.29	0.001365	4.51	926.50	733.94	0.40
Pascack Brook	24	500 cfs	500.00	58.00	60.53	59.74	60.84	0.003049	4.47	111.76	52.49	0.54
Pascack Brook	24	1000 cfs	1000.00	58.00	61.57	60.65	62.11	0.003576	5.90	169.60	59.11	0.61
Pascack Brook	24	1500 cfs	1500.00	58.00	62.18	61.39	62.98	0.004384	7.20	225.32	177.14	0.70
Pascack Brook	24	2000 cfs	2000.00	58.00	62.65	62.46	63.59	0.004528	7.99	323.56	238.91	0.72
Pascack Brook	23	500 cfs	500.00	56.00	58.81	57.45	58.93	0.001235	2.83	194.46	122.01	0.35
Pascack Brook	23	1000 cfs	1000.00	56.00	59.99	58.35	60.14	0.001136	3.18	372.24	178.21	0.34
Pascack Brook	23	1500 cfs	1500.00	56.00	60.74	58.97	60.92	0.001047	3.60	527.68	239.75	0.34
Pascack Brook	23	2000 cfs	2000.00	56.00	61.33	59.44	61.53	0.001011	3.93	683.71	288.74	0.35
Pascack Brook	22	500 cfs	500.00	54.00	57.05	55.96	57.29	0.002575	3.94	126.80	63.72	0.49
Pascack Brook	22	1000 cfs	1000.00	54.00	58.58	57.03	58.83	0.001606	4.06	261.24	140.83	0.42
Pascack Brook	22	1500 cfs	1500.00	54.00	59.36	57.74	59.67	0.001504	4.59	401.59	218.99	0.42
Pascack Brook	22	2000 cfs	2000.00	54.00	59.88	58.30	60.24	0.001578	5.12	527.80	270.65	0.44
Pascack Brook	21	500 cfs	500.00	52.00	55.82	53.70	55.94	0.000789	2.76	181.05	62.90	0.29
Pascack Brook	21	1000 cfs	1000.00	52.00	57.06	54.71	57.24	0.001544	3.43	291.67	122.80	0.39
Pascack Brook	21	1500 cfs	1500.00	52.00	57.78	55.49	58.01	0.001832	3.80	394.66	162.44	0.43
Pascack Brook	21	2000 cfs	2000.00	52.00	58.29	56.34	58.55	0.001826	4.13	499.95	246.19	0.44
Pascack Brook	20	500 cfs	500.00	51.42	55.18	53.68	55.36	0.002661	3.43	145.88	92.35	0.48
Pascack Brook	20	1000 cfs	1000.00	51.42	56.14	55.12	56.37	0.002586	3.86	275.75	273.53	0.49
Pascack Brook	20	1500 cfs	1500.00	51.42	56.67	55.72	56.94	0.002246	4.24	433.44	312.74	0.48
Pascack Brook	20	2000 cfs	2000.00	51.42	57.12	56.27	57.40	0.002053	4.52	578.55	344.90	0.47
Pascack Brook	19	500 cfs	500.00	50.71	54.06		54.30	0.001543	3.90	134.96	154.54	0.40
Pascack Brook	19	1000 cfs	1000.00	50.71	55.09		55.38	0.001553	4.76	349.47	265.12	0.42
Pascack Brook	19	1500 cfs	1500.00	50.71	55.50		55.90	0.002063	5.86	467.42	309.53	0.49
Pascack Brook	19	2000 cfs	2000.00	50.71	55.72		56.28	0.002782	7.03	539.79	333.87	0.58
Pascack Brook	18	500 cfs	500.00	50.00	53.09	51.90	53.29	0.002359	3.64	137.47	73.14	0.47
Pascack Brook	18	1000 cfs	1000.00	50.00	54.14	52.98	54.42	0.002411	4.27	279.82	473.27	0.49
Pascack Brook	18	1500 cfs	1500.00	50.00	54.62	53.66	54.89	0.002149	4.56	551.65	667.12	0.48
Pascack Brook	18	2000 cfs	2000.00	50.00	55.11	54.55	55.31	0.001545	4.29	922.45	864.06	0.42
Pascack Brook	17	500 cfs	500.00	48.89	51.03	50.61	51.48	0.005457	5.40	92.60	50.88	0.71
Pascack Brook	17	1000 cfs	1000.00	48.89	52.45	51.54	52.96	0.003264	5.76	192.83	154.55	0.59

HEC-RAS Plan: Plan 63 River: Pascack Brook Reach: Pascack Brook (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Pascack Brook	17	1500 cfs	1500.00	48.89	53.90	52.50	54.13	0.001117	4.40	647.14	469.41	0.37
Pascack Brook	17	2000 cfs	2000.00	48.89	54.78	53.27	54.87	0.000526	3.41	1606.55	1239.55	0.26
Pascack Brook	16	500 cfs	500.00	46.73	49.79	48.05	49.89	0.000673	2.51	199.24	70.58	0.26
Pascack Brook	16	1000 cfs	1000.00	46.73	51.51	48.77	51.66	0.000585	3.09	324.09	74.65	0.26
Pascack Brook	16	1500 cfs	1500.00	46.73	52.84	49.36	53.00	0.000510	3.34	629.87	530.61	0.25
Pascack Brook	16	2000 cfs	2000.00	46.73	53.55	49.89	53.70	0.000464	3.39	1067.33	689.35	0.24
Pascack Brook	15	500 cfs	500.00	45.17	49.18	47.45	49.40	0.001290	3.72	134.25	41.49	0.36
Pascack Brook	15	1000 cfs	1000.00	45.17	50.80	48.52	51.11	0.001330	4.65	282.76	292.34	0.39
Pascack Brook	15	1500 cfs	1500.00	45.17	52.13	49.39	52.21	0.000633	2.92	1140.13	831.03	0.26
Pascack Brook	15	2000 cfs	2000.00	45.17	52.92	51.38	52.95	0.000350	2.24	1812.61	870.62	0.20
Pascack Brook	14	500 cfs	500.00	44.56	48.35	47.06	48.71	0.002403	4.78	104.52	35.68	0.49
Pascack Brook	14	1000 cfs	1000.00	44.56	49.52	48.32	50.18	0.003921	6.53	153.03	47.54	0.64
Pascack Brook	14	1500 cfs	1500.00	44.56	50.35	49.42	51.26	0.004803	7.66	195.94	56.08	0.72
Pascack Brook	14	2000 cfs	2000.00	44.56	51.02	50.23	52.14	0.005336	8.47	236.26	63.06	0.77
Pascack Brook	13	500 cfs	500.00	44.46	47.65	46.35	47.75	0.000892	2.49	200.83	89.83	0.29
Pascack Brook	13	1000 cfs	1000.00	44.46	48.74	46.96	48.91	0.000990	3.33	300.64	93.48	0.33
Pascack Brook	13	1500 cfs	1500.00	44.46	49.46	47.46	49.71	0.001177	4.07	368.47	95.89	0.37
Pascack Brook	13	2000 cfs	2000.00	44.46	50.04	47.91	50.38	0.001347	4.71	424.46	97.82	0.40
Pascack Brook	12	500 cfs	500.00	42.00	45.92		46.13	0.001369	3.75	148.13	104.65	0.38
Pascack Brook	12	1000 cfs	1000.00	42.00	47.12		47.33	0.001189	4.14	411.10	283.86	0.37
Pascack Brook	12	1500 cfs	1500.00	42.00	47.65		47.89	0.001338	4.77	564.99	305.85	0.40
Pascack Brook	12	2000 cfs	2000.00	42.00	48.02		48.31	0.001522	5.37	688.22	365.25	0.43
Pascack Brook	11	500 cfs	500.00	39.00	42.12	40.88	42.39	0.001941	4.18	119.66	42.73	0.44
Pascack Brook	11	1000 cfs	1000.00	39.00	43.21	41.88	43.69	0.002538	5.71	237.04	283.81	0.52
Pascack Brook	11	1500 cfs	1500.00	39.00	43.80	43.51	44.29	0.002570	6.21	423.82	338.56	0.53
Pascack Brook	11	2000 cfs	2000.00	39.00	44.25	43.94	44.71	0.002481	6.47	575.55	342.80	0.53
Pascack Brook	10	500 cfs	500.00	35.00	36.50	36.46	37.07	0.011341	6.08	82.23	66.07	0.96
Pascack Brook	10	1000 cfs	1000.00	35.00	37.40	37.19	38.15	0.007820	6.97	143.52	70.82	0.86
Pascack Brook	10	1500 cfs	1500.00	35.00	38.02	37.78	39.00	0.007527	7.95	188.79	74.14	0.88
Pascack Brook	10	2000 cfs	2000.00	35.00	38.57	38.31	39.74	0.007276	8.68	230.39	77.06	0.88
Pascack Brook	9	500 cfs	500.00	31.00	35.18		35.22	0.000362	1.61	310.18	138.34	0.19
Pascack Brook	9	1000 cfs	1000.00	31.00	36.52		36.57	0.000284	1.81	648.19	332.70	0.18
Pascack Brook	9	1500 cfs	1500.00	31.00	37.38		37.43	0.000253	2.00	944.96	362.35	0.18
Pascack Brook	9	2000 cfs	2000.00	31.00	38.08		38.14	0.000240	2.17	1203.10	375.70	0.17

HEC-RAS Plan: Plan 63 River: Pascack Brook Reach: Pascack Brook (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Pascack Brook	8	500 cfs	500.00	30.00	34.42	31.62	34.48	0.000285	1.81	275.67	84.85	0.18
Pascack Brook	8	1000 cfs	1000.00	30.00	35.58	32.38	35.68	0.000514	2.60	385.15	107.80	0.24
Pascack Brook	8	1500 cfs	1500.00	30.00	36.31	33.01	36.47	0.000725	3.19	470.56	125.57	0.29
Pascack Brook	8	2000 cfs	2000.00	30.00	36.93	33.59	37.13	0.000877	3.62	552.23	141.60	0.32
Pascack Brook	7	500 cfs	500.00	29.50	32.96	32.96	33.60	0.009471	6.52	87.10	80.69	0.90
Pascack Brook	7	1000 cfs	1000.00	29.50	34.29	33.78	34.69	0.003446	5.67	277.34	229.68	0.60
Pascack Brook	7	1500 cfs	1500.00	29.50	35.25	34.35	35.51	0.001840	5.04	512.96	254.11	0.46
Pascack Brook	7	2000 cfs	2000.00	29.50	35.95	34.84	36.18	0.001446	5.00	693.53	265.26	0.42
Pascack Brook	6	500 cfs	500.00	28.76	32.20	31.02	32.39	0.001473	3.52	146.38	64.09	0.39
Pascack Brook	6	1000 cfs	1000.00	28.76	33.00	31.83	33.42	0.002273	5.25	209.13	92.64	0.51
Pascack Brook	6	1500 cfs	1500.00	28.76	33.57	32.52	34.21	0.002885	6.57	267.44	111.98	0.59
Pascack Brook	6	2000 cfs	2000.00	28.76	34.12	33.19	34.91	0.003080	7.41	337.82	143.67	0.62
Pascack Brook	5	500 cfs	500.00	26.00	27.72	27.72	28.30	0.012619	6.08	82.17	71.61	1.00
Pascack Brook	5	1000 cfs	1000.00	26.00	28.90	28.42	29.43	0.005055	5.87	170.45	78.64	0.70
Pascack Brook	5	1500 cfs	1500.00	26.00	29.99	28.98	30.51	0.003125	5.78	259.64	85.16	0.58
Pascack Brook	5	2000 cfs	2000.00	26.00	30.89	29.48	31.43	0.002489	5.90	338.92	90.56	0.54
Pascack Brook	4	500 cfs	500.00	20.85	25.44	22.96	25.51	0.000332	2.22	256.78	84.18	0.20
Pascack Brook	4	1000 cfs	1000.00	20.85	27.13	23.77	27.25	0.000362	2.95	412.24	100.22	0.22
Pascack Brook	4	1500 cfs	1500.00	20.85	28.19	24.43	28.36	0.000422	3.58	551.27	173.80	0.25
Pascack Brook	4	2000 cfs	2000.00	20.85	28.95	25.01	29.18	0.000506	4.21	725.35	300.36	0.27
Pascack Brook	3	500 cfs	500.00	19.50	24.10	21.89	24.26	0.000702	3.45	184.66	60.04	0.29
Pascack Brook	3	1000 cfs	1000.00	19.50	25.45	23.02	25.76	0.000989	4.92	296.57	183.91	0.37
Pascack Brook	3	1500 cfs	1500.00	19.50	26.29	23.90	26.66	0.001122	5.74	529.60	380.96	0.40
Pascack Brook	3	2000 cfs	2000.00	19.50	26.95	24.66	27.32	0.001102	6.08	874.67	642.56	0.40
Pascack Brook	2	500 cfs	500.00	18.99	23.41	21.45	23.48	0.000433	2.33	279.52	111.54	0.22
Pascack Brook	2	1000 cfs	1000.00	18.99	24.55	22.16	24.67	0.000565	3.23	532.79	281.74	0.27
Pascack Brook	2	1500 cfs	1500.00	18.99	25.21	22.74	25.36	0.000647	3.78	740.80	333.09	0.29
Pascack Brook	2	2000 cfs	2000.00	18.99	25.74	23.22	25.91	0.000697	4.18	923.76	362.83	0.31
Pascack Brook	1	500 cfs	500.00	18.00	21.67	20.19	21.74	0.000801	2.10	238.51	130.05	0.27
Pascack Brook	1	1000 cfs	1000.00	18.00	22.58	20.89	22.68	0.000800	2.60	457.29	336.48	0.29
Pascack Brook	1	1500 cfs	1500.00	18.00	23.14	21.39	23.27	0.000801	2.97	647.67	343.70	0.30
Pascack Brook	1	2000 cfs	2000.00	18.00	23.61	21.80	23.75	0.000801	3.26	810.03	349.73	0.30

APPENDIX C

ARMY CORPS OF ENGINEERS
SEPTEMBER 1977
PASCACK BROOK FLOOD CONTROL STUDY

HACKENSACK RIVER BASIN, NEW YORK AND NEW JERSEY

PASCACK BROOK FLOOD CONTROL FEASIBILITY STUDY

STAGE II

U.S. ARMY CORPS OF ENGINEERS · NEW YORK DISTRICT ·

September 1977

HACKENSACK RIVER BASIN, NEW YORK AND NEW JERSEY

PASCACK BROOK FLOOD CONTROL FEASIBILITY STUDY

STAGE II

A. GENERAL

This investigation was conducted in order to determine the feasibility of flood protection along Pascack Brook and its tributaries, Muddy Creek, Mill Brook, Bear Brook and Echo Glen Brook.

Pascack Brook is a major tributary of the Hackensack River. It flows in a generally southerly direction from its source in Rockland County. The Brook enters New Jersey at Montvale and ends at its confluence with the Hackensack River in Harrington Park at the upstream end of the Oradell Reservoir.

B. FLOOD DAMAGES

The study area consists of residential, commercial, industrial and public development. Flood damage estimates were based on a field survey conducted by MSR Engineers in July and August of 1975. Tropical storm "Doria", which occurred in August 1971, was used as the reference flood. Total damages at stage, which occurred in the Pascack Brook Basin within the study limits as a result of the August 1971 storm, are estimated at $2,400,000. The total damages at stage which would result from a flood three feet higher than "Doria" were estimated at $13,100,000.

Areas experiencing major flood damages in the basin as a result of "Doria" include: the Westwood-Hillsdale area in the lower reaches of Pascack Brook which sustained $1,100,000 in

damages, the Village of Spring Valley near the upstream limit of the study area which sustained $450,000 in damages, and Pearl River along Muddy Creek which sustained $175,000 in damages. Damages along Bear Brook and Mill Brook amounted to $200,000 and $275,000, respectively. It was determined that these damages were insignificant to warrant further investigation since the majority of the damage was the result of a bridge that collapsed and was subsequently replaced. All damage estimates are based on January 1977 price levels.

C. THE FLOOD PLAIN

The flood plain is relatively steep in most reaches which accounts for the very small increase in land area and structures affected between "Doria" and the 100-year flood; the 100-year flood and the 200-year flood; and the 200-year flood and the Standard Project Flood. However, in the downstream reach of Pascack Brook near Oradell Reservoir there is a significant increase in land area between the 200-year flood and the Standard Project Flood, but very little increase in structural damage due to the limited development. There are a total of 1,600 acres of land and 1,200 structures up to and including the limits of the Standard Project Flood. Similar data for Doria, the 100-year flood, and the 200-year flood, including a flood plain map, are shown in Attachment 1.

D. HYDROLOGY

The hydrologic data was developed by the Corps of Engineers. The major basis for the analysis was the development of a peak discharge versus frequency curve using the Pearson Type III distribution with log transformation of the flood peaks, at the Pascack Brook at Westwood stream gage, located 2.3 miles upstream from the mouth, with a drainage area of 29.6 square miles. There were 42 years of flood data and the developed statistical parameters were mean=2.903, standard deviation=0.269 with a skew coefficient of 0.25. The expected probability adjustment was made in the computation of the final frequency curve. The actual unit hydrograph at the gage was derived through analysis of the August 1971 and May 1968 flood hydrographs using the HEC-I - Flood Hydrograph Optimization procedures. The unit hydrograph Clark parameters Tc and R were translated to points above the gage by using a drainage area to the 0.25 ratio, on the basis of hydraulic similarity along the stream. Synthetic unit hydrographs were developed at the upstream points of concern, and the peak discharge versus frequency relations were developed by proportioning on the basis of the unit hydrograph peaks. The final peak discharge versus frequency curves and summary are presented in Attachment 2. The Standard Project Flood was developed at all locations by using an index rainfall of 10.5 inches and infiltration losses of 0.1 inch per hour.

E. HYDRAULICS AND DESIGN CRITERIA

Backwater computations were obtained with the aid of the HEC-2 computer program developed by the Army Corps of Engineers Hydrologic Engineering Center. Cross sections were coded at regular intervals and special attention was paid to structures, such as bridges and dams, which may alter profile characteristics. Flood marks were obtained from public officials and local residents living near the streams studied. These were used to match the flood stages that existed during Hurricane Doria in August of 1971.

The starting condition at the Oradell Reservoir for the Doria flood was obtained from records of the Hackensack Water Company. A rating curve was developed for the Oradell Dam and used for starting conditions for the 100-year, 200-year, and SPF backwater calculations. At Pascack Brook's confluence points with the tributaries studied, rating curves were developed and computer runs were made using the peak of Pascack Brook with the coincidental flow of its tributary, and the coincidental flow of Pascack with the peak of the tributary. In all cases the worst condition was plotted on the profile.

The rating curves and the flow lines for existing and improved conditions for the various reaches investigated along Pascack Brook and Muddy Creek are provided in Attachment 3. All channel excavation alternates were designed with sides sloping two feet horizontal to one foot vertical and with a minimum of two feet of freeboard. Channels have sides and bottom consisting of natural earth unless high velocities necessitate the use of rip-rap to prevent erosion.

Levee and wall schemes were designed with three feet of freeboard with levees having a top width of eight feet and sides sloping 2-1/2 feet horizontal to one foot vertical. Reinforced concrete walls were utilized only when space limitations prohibited the use of levees.

F. PLAN FORMULATION

Alternative flood control measures investigated included non-structural plans, channel excavation, levees and flood walls, combinations of both levees and walls with channel excavation, a diversion pipe along Muddy Creek and the removal of Woodcliff Lake Dam. Pascack Brook was divided into five (5) reaches and Muddy Creek was divided into three (3) reaches as indicated on Attachment 4. After inspecting the site and completing and evaluating the damage survey, it was determined that flooding along Hill Brook, Bear Brook, and Echo Glen Brook was not severe enough to justify a Federal interest in providing flood control measures. The banks along these tributaries are high and the channel bottoms are very steep. An initial economic evaluation indicated that non-structural flood protection for all reaches along Pascack Brook and Muddy Creek were justified. However, an alternative of this nature would be highly impractical and socially unacceptable in a developed urban setting such as the communities to be protected in the study area. Structural protection for Reaches 1, 3 and 4 along Pascack Brook and Reaches 1 and 3 along Muddy Creek were eliminated from further consideration because the estimated costs of flood protection would provide a highly unfavorable B/C Ratio.

Low Level flood control measures, such as minor clearing and snagging, were investigated. It was determined that such measures would only protect against flooding from frequent storms, when damages are lightest or non-existent. Benefits would be correspondingly low, yielding extremely unfavorable Benefit/Cost Ratios.

Schematic layouts of the structural alternatives investigated and data concerning non-structural alternatives are included in Attachment 5.

G. REAL ESTATE

Preliminary real estate costs were estimated by contacting real estate agencies in the study and adjoining area to determine the cost of similar property on the market for sale and to review recent property sale transactions in the vicinity. The real estate estimates as indicated below are considered realistic based on the location and type of property required.

1. Permanent Easement - $20,000/acre
2. Temporary Easement - $ 2,000/acre

H. DESCRIPTION AND FIRST COST OF SCHEMES FURTHER CONSIDERED

1. Reach 2 of Pascack Brook begins at Woodcliff Lake Dam and flows through Westwood and Hillsdale ending at Cedar Lane. Damages sustained from past floods were primarily residential and commercial with the area encompassing Lyons Avenue and the area surrounding Broadway, Hillsdale Avenue and Yeler Way, the most severely damaged.

The 100-year design channel improvement for this reach would consist of dropping the existing stream invert four to five feet and providing a channel top width ranging from 70 to 90 feet. In order to accommodate the larger channel, five bridges would have to be replaced including Brookside Avenue, Broadway, Paterson Street, Hillsdale Avenue and Erie Lackawanna Railroad. Channel excavation would begin downstream from Cedar Lane and end at the Woodcliff Lake Dam. This plan would have total first cost of $5,833,000. The 200-year design channel excavation would have the same invert as the 100-year design; the only difference being the channel top width would vary from 90 to 110 feet. The Fairview Avenue Bridge would be replaced in addition to the five bridges mentioned for the 100-year channel excavation. The total first cost for this plan would be $7,040,000.

The 100-year wall and levee improvement would provide protection with walls up to nine feet in height and levees up to ten feet in height. Interior drainage requires the use of pumping stations to accommodate runoff from 426 acres behind the proposed structures. The first cost for this plan is estimated to be $8,890,000.

2. Reach 5 of Pascack Brook begins at Lake Suzanne and flows through Spring Valley down to Lawrence Street. Past floods have caused mostly residential damages. Properties

adjacent to Pascack Brook from Lake Suzanne down to the New Jersey and New York Railroad and the area surrounding Memorial Park have been damaged severely in the past from flooding.

Channel improvement for this reach would lower the existing stream invert four to five feet from Dutch Lane to Main Street and from Onderdonk's Pond to the spillway at Lake Suzanne. The top width would average fifty feet in the downstream area and forty feet in the upstream section making it necessary to replace eight (8) bridges. The total first cost for a 100-year design channel improvement would be $3,732,000.

The 100-year wall and levee plan consists of reinforced concrete walls up to eight feet high and levees up to ten feet high. The majority of interior drainage would be pumped, the only possible exception is the utilization of a ponding area at Memorial Park. The first cost for this alternate is $8,637,000.

3. Reach 2 of Muddy Creek is the final area within the study limits having sufficient damages to warrant further investigation. It begins at the crossing of Route 304, flows through Pearl River and ends at the New York-New Jersey State line. Damages are restricted to areas immediately adjacent to Muddy Creek and are mostly commercial.

The pipe diversion would divert water under a storm flow into a 72" x 113" elliptical reinforced concrete pipe at the intersection of Muddy Creek and Route 304. The pipe would be

placed adjacent to Route 304 and would discharge back into Muddy Creek downstream of the damage areas. It would have a capacity of 460 cfs and for a 100-year storm would reduce the channel flow to an allowable amount. The total first cost would be $1,257,000.

The 100-year channel improvement for Reach 2 of Muddy Creek would consist of lowering the existing invert by three to four feet and widening a channel to a top width of 36 to 40 feet. It would be necessary to replace four (4) bridges, including Washington Avenue, West Central Avenue, Jefferson Avenue and a private road. The total first cost would be $1,333,000.

Detailed estimates of first costs for the alternatives previously discussed for Reaches 2 and 5 along Pascack Brook and 2 along Muddy Creek are presented in Attachment 6. All estimates were prepared using January 1977 price levels, 25% for contingencies, 15% for engineering and design and 10% for supervision and administration. Composite maps showing typical channel, and levee and wall plans for Pascack Brook and Muddy Creek are presented in Attachment 7.

I. ECONOMICS

The economics pertinent to the alternatives investigated are discussed in the following paragraphs.

1. Annual Damages. The average annual damages were developed based on the Frequency Curves in Attachment 2, the Rating Curves in Attachment 3, and the Stage-Damage Curves in Attachment 8. The annual damages under both existing and improved conditions were calculated by computer.

The average annual damage program used was developed by the Army Corps of Engineers Hydrologic Engineering Center. Basically, the computer program inputs three curves; the stage-damage curve, the stage-discharge curve, and the discharge-frequency curve. It combines these curves to develop a frequency-damage curve, and then integrates this to find the average annual damages. This calculation was done for each bank of each reach for existing conditions and for each scheme of improvement investigated.

The study area was broken up into five (5) reaches along Pascack Brook and three (3) reaches along Muddy Creek. Each reach was further broken down by left and right banks. The average annual damages along Pascack Brook and Muddy Creek are presented on the computer print-out sheets included as Attachment 9.

2. Annual Benefits. The average annual benefits that would accrue as a result of providing flood protection along Pascack Brook and Muddy Creek in the reaches selected for further investigation are discussed in the following paragraphs.

a. Flood Reduction Benefits. Flood reduction benefits were separated into the categories of residential, commercial, industrial, and public and include physical damages to lands and structural development, the loss of business income, wages, and salaries, the inconvenience of traffic delays, and the costs for emergency operations, clean-up, and restoration. Benefits as a result of reduced flood damages under existing conditions were developed by computer and projected for future conditions of development, allowing for growth in residential contents by using an affluence factor. The affluence factor, the benefits under existing conditions for each alternative, and benefits under future conditions for each alternative are presented in Attachment 10.

b. Advance Replacement of Bridges. The various alternatives investigated would require the reconstruction of certain bridges in the study area. Since the replacement of these structures as a project cost is actually extending the life of these structures with a reduction of annual maintenance costs, the net reduction is considered a benefit. Attachment 11 shows benefits attributed to the advanced replacement of bridges calculated for the Bogert Mill Road Bridge for the 100-year channel excavation alternative along Pascack Brook. This calculation is typical and was used to determine the advanced replacement benefits for other bridges which would be replaced under the various other alternatives as indicated in the table in Attachment 11.

c. Unemployment Benefits. The State of New York reported in its publication, "Employment Trends", dated August 1977 that in all areas of the State unemployment was equal to or greater than 6 percent in June of 1977 and that the construction industry was sluggish. In addition, the State of New Jersey reported in its publication, "Economic Indicator", dated 30 June 1977 that all areas of New Jersey had unemployment rates equal to or greater than 6.9 percent in May of 1977 and that construction employment was in a depressed period. On this basis, unemployment benefits are included because of the high rates of unemployment in the area and the availability of construction labor. Unemployment benefits, which would result from the construction of the various flood control alternatives, were determined in accordance with current guidelines and are presented in Attachment 12.

3. Annual Costs. Annual costs were based on a 6-3/8% interest rate and a 100-year amortization period. It was considered that construction of either alternative could be completed within two years and therefore interest during construction was not included in the annual costs. Operation and maintenance and major replacement costs were added to the annualized capital costs.

All estimates are based on January 1977 price levels. Detailed breakdowns of annual costs for the alternative plans are presented in Attachment 13.

4. Benefit-Cost Ratio. The benefit-cost ratios for all alternatives considered are presented in Attachment 14.

J. ENVIRONMENTAL

The environmental concerns relative to the flood control measures investigated in this study are discussed in detail in Attachment 15.

K. PUBLIC INVOLVEMENT

An initial public meeting was held in Westwood, New Jersey on 30 April 1975 at which time local interests were given the opportunity to express their concerns and to identify water resource problems in the entire Hackensack River Basin. The input obtained from this meeting aided in the preparation of the Plan of Study and identified communities along Pascack Brook and tributaries as having the worse flood problem in the Hackensack River Basin. Therefore study efforts were concentrated in the Pascack Brook Basin. Other informal meetings are planned with the flood problem communities in the basin to review the alternatives considered in Stage II investigation prior to conducting the Formulation Stage Public Meeting.

L. COORDINATION

Federal, State and local governments as well as interested groups and organizations were advised of this study's initiation and were requested to furnish the Corps with any available data which would assist in conducting this investigation. Prior to holding a Plan Formulation Public Meeting, the flood

control measures which were investigated during this Stage II study will be coordinated with local officials of the various flood problem communities. Feasible alternatives considered have been forwarded to the U.S. Department of Interior, Fish and Wildlife Service for their review and and their input in the form of planning aid letters. The purpose of these letters is to provide data which will make the alternatives acceptable from a Fish and Wildlife standpoint.

M. CONCLUSION AND RECOMMENDATION

Based on the findings of this Stage II report, it has been determined that there is a Federal interest to provide flood control measures along Pascack Brook in the Hackensack River Basin at Westwood and Hillsdale, New Jersey. The feasible alternative, consisting of channel excavation, would provide flood protection against a 100-year storm and would reduce flood damages that would result from storms greater than the 100-year design flood. The first cost of this alternative is $5,883,000 and the annual cost is $378,000. The annual benefits are $394,000 which provide a benefit-cost ratio of 1.04. On this basis, it is recommended that a Stage III investigation be initiated to further study the flood problem and to develop flood control measures in more detail.

CLARK H. BENN
Colonel, Corps of Engineers
District Engineer

APPENDIX D

ENGINEERING DATA
FOR
WOODCLIFF LAKE RESERVOIR
AND
ORADELL RESERVOIR

United Water New Jersey
Woodcliff Lake Dam

Engineering Data

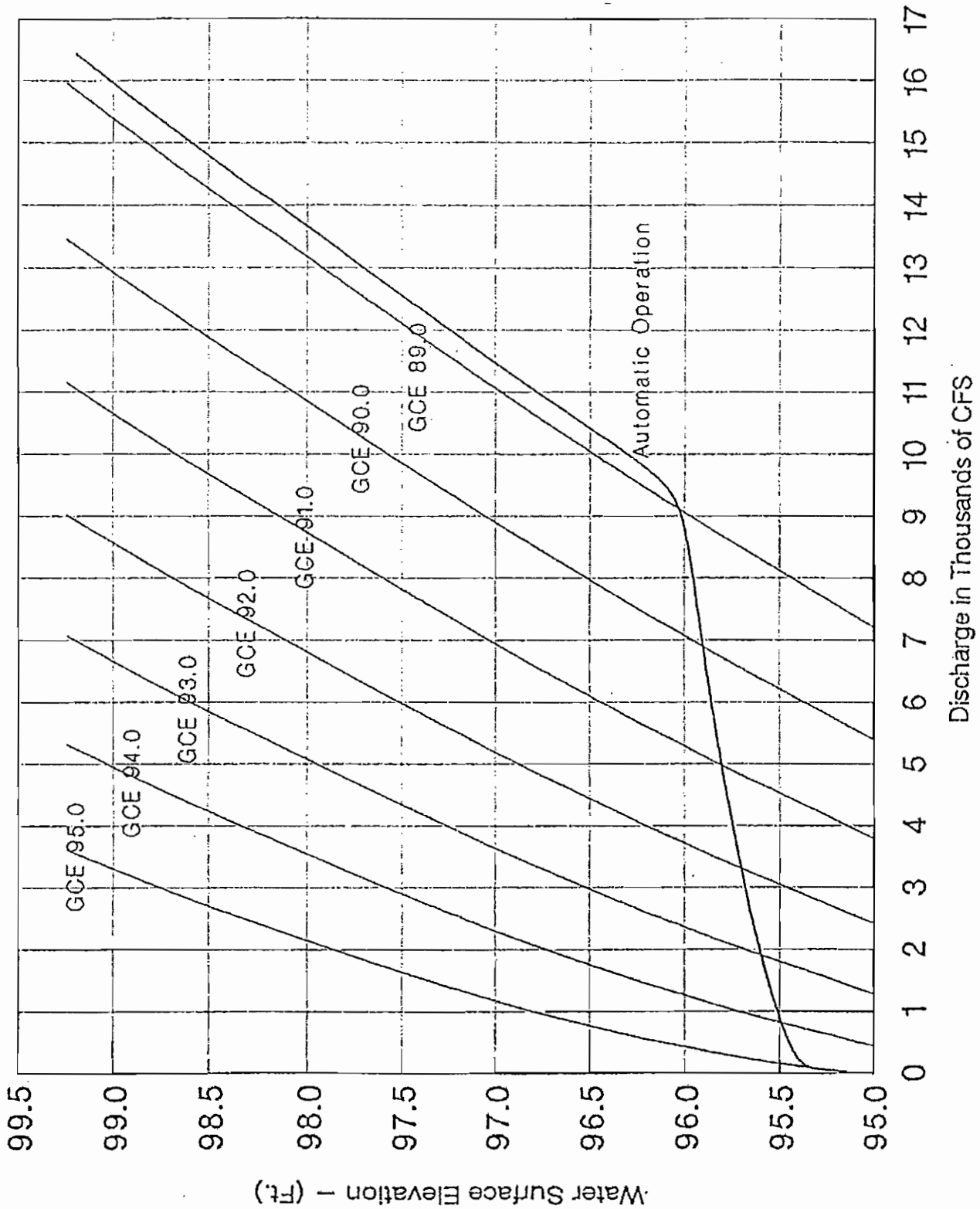
Stream:	Pascack Brook, a tributary of the Hackensack River
Drainage Area for Dam:	19.4 square miles
Maximum Flood at Dam:	7,000 cfs, (4,500 MGD±) September 16, 1999
Spillway Design Flood:	13,760 cfs, SDF
Year of Dam Construction :	1903, modified 1984
Dam Type:	Earth Embankment, with Concrete Spillway and Stilling Basin
Length of Dam:	1500 feet
Top Width of Dam:	24 feet
Side Slopes:	2 on 1 Upstream, 2-1/2 on 1 Downstream
Core Wall:	Concrete, on sheet piling
Elevations:	100.00 Top of Dam, 95.00 Top of Bascule Gates, 89.00 Spillway Crest, 65.00 Centerline of 24" Outlet Pipe
Reservoir Capacity:	2,673 Acre-feet at Elevation 95.00
Reservoir Area:	173 Acres at Elevation 95.00
Spillway Gates:	Two, each 65 ft. long and 6 ft. high
Gate Control:	Automatic, oil-operated, computerized
Standby Power:	Diesel-driven Generator
Outlet Pipe:	24" Stainless Steel, in 48" Carrier Pipe
Outlet Control:	Two 24" Ball Valves (Centerline Elev. 63.85±)

Winter Mode Sep 1 → Apr 30
top of gates set to
El 91.0
1.5 ft over gates

Figure No. 3
Woodcliff Lake Dam
Reservoir Storage

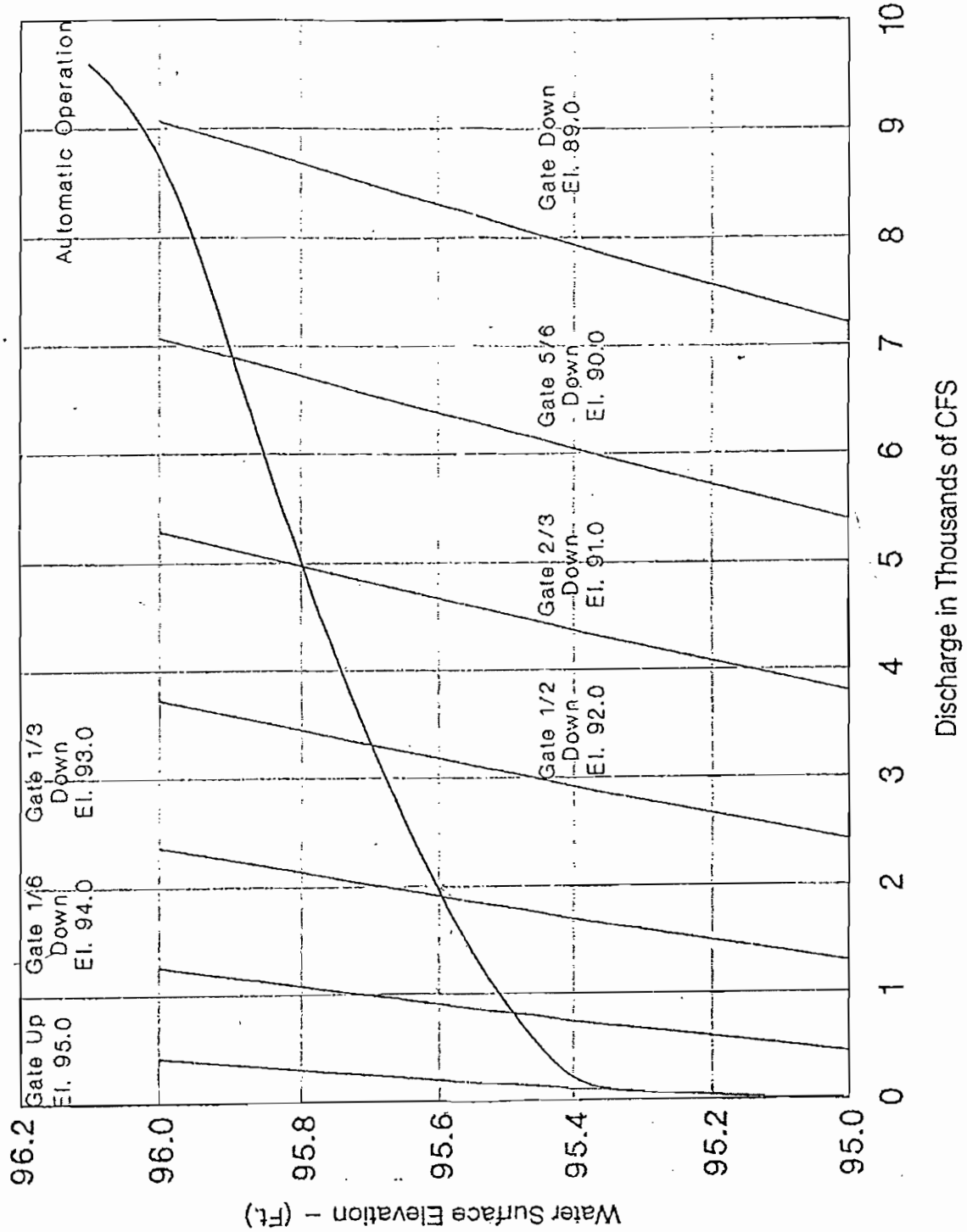
Water Surface Elev. (Ft.)	Reservoir Storage Volume (MG)	Reservoir Storage Volume (Acre-Ft)
67.87	2.1	6.6
68	2.1	6.4
68.5	2.3	7.0
69	3.1	9.5
69.5	4.5	13.8
70	6.6	20.1
70.5	9.2	28.3
71	12.5	38.5
71.5	16.5	50.6
72	21.1	64.7
72.5	26.3	80.8
73	32.2	98.9
73.5	38.8	119.0
74	46.0	141.1
74.5	53.8	165.2
75	62.4	191.4
75.5	71.5	219.5
76	81.4	249.7
76.5	91.9	281.9
77	103.0	316.1
77.5	114.8	352.3
78	127.2	390.5
78.5	140.3	430.6
79	154.0	472.7
79.5	168.4	516.8
80	183.4	562.8
80.5	199.0	610.7
81	215.2	660.5
81.5	232.1	712.1
82	249.5	765.6
82.5	267.5	820.9
83	286.1	878.0
83.5	305.3	936.9
84	325.0	997.4
84.5	345.3	1,059.7
85	366.1	1,123.6
85.5	387.5	1,189.1
86	409.3	1,256.2
86.5	431.7	1,324.8
87	454.5	1,394.8
87.5	477.8	1,466.4
88	501.6	1,539.3
88.5	525.8	1,613.5
89	550.4	1,689.0
89.5	575.4	1,765.8

Water Surface Elev. (Ft.)	Reservoir Storage Volume (MG)	Reservoir Storage Volume (Acre-Ft)
90	600.8	1,843.7
90.5	626.5	1,922.7
91	652.6	2,002.8
91.5	679.0	2,083.9
92	705.8	2,165.9
92.5	732.8	2,248.8
93	760.0	2,332.5
93.5	787.5	2,416.9
94	815.3	2,501.9
94.5	843.2	2,587.6
95	871.2	2,673.7
95.5	899.5	2,760.3
96	927.8	2,847.2
96.5	956.2	2,934.4
97	984.7	3,021.8
97.5	1,013.2	3,109.3
98	1,041.7	3,196.8
98.5	1,070.2	3,284.2
99	1,098.6	3,371.5
99.5	1,127.0	3,458.5
100	1,155.2	3,545.2
100.5	1,183.3	3,631.4
101	1,211.2	3,717.0
101.5	1,238.9	3,802.0
102	1,266.4	3,886.3
102.5	1,293.5	3,969.7
103	1,320.4	4,052.1
103.5	1,346.9	4,133.5
104	1,373.0	4,213.7
104.5	1,398.7	4,292.6
105	1,424.0	4,370.0
105.5	1,448.8	4,446.0
106	1,473.0	4,520.4
106.5	1,496.6	4,592.9
107	1,519.7	4,663.6
107.5	1,542.0	4,732.3
108	1,563.7	4,798.9
108.5	1,584.7	4,863.2
109	1,604.9	4,925.1
109.5	1,624.2	4,984.5
110	1,642.7	5,041.3



Curves indicate flow over both gates, for different sustained gate crest elevations, or Automatic Operation of the gates.
See Note on Figure No. 2B for discharge formula used.
GCE = Gate Crest Elevation

Figure No. 2A
Woodcliff Lake Dam
Bascule Gate Discharge Rating Curve



Prepared By: Buck, Seifert & Jost, Inc.
November 1993

Gates lower automatically for WSE between 95.5 feet and 96.0 feet
Discharge = C*L*h ^3/2 3.2<C<3.95, L = L(eff), h = WSE – GCE

L = 65 ft × 2 gates = 130 ft

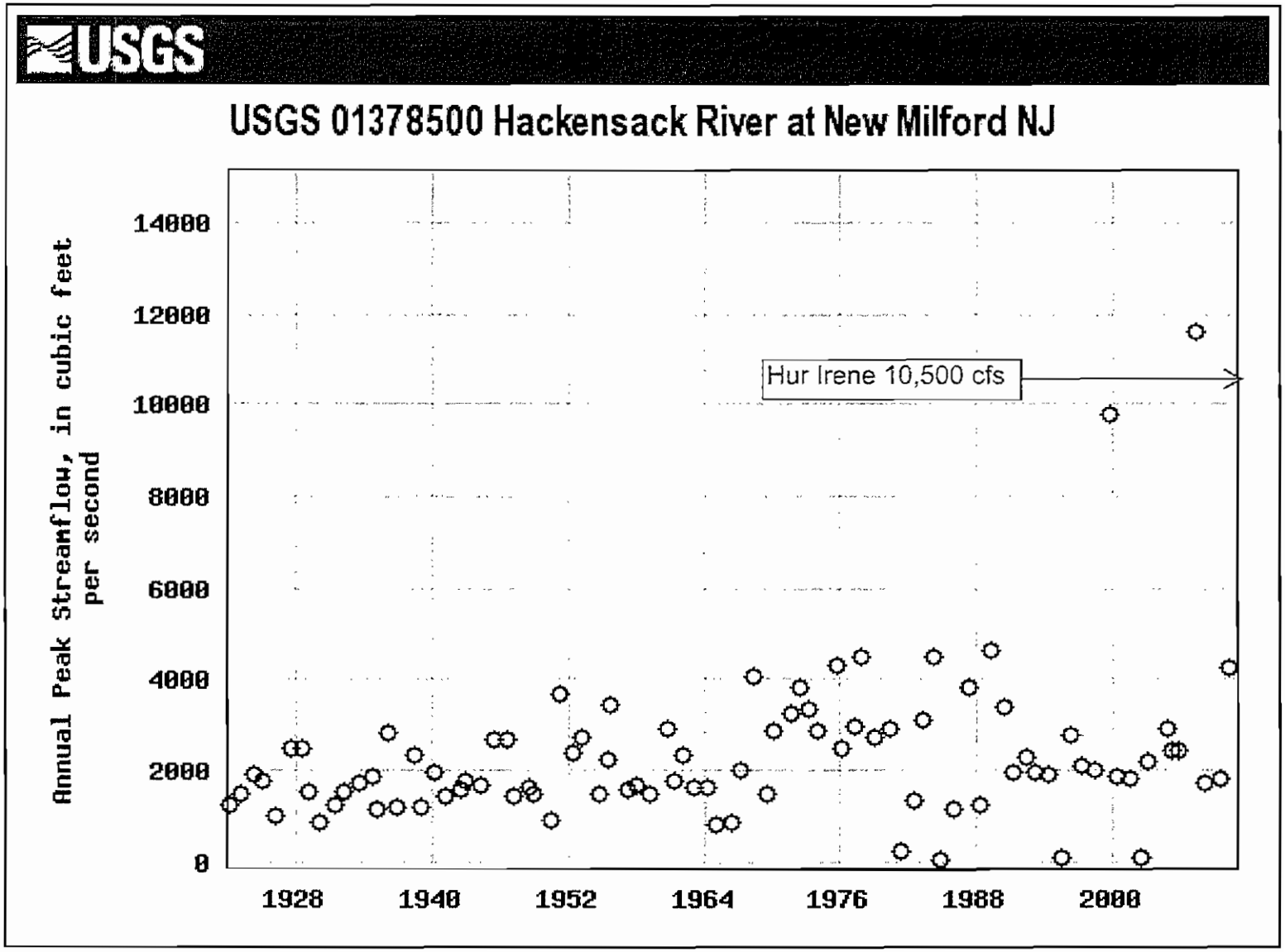
Curves indicate flow over both gates, for different sustained gate crest elevations, or Automatic Operation of the gates.
GCE = Gate Crest Elevation

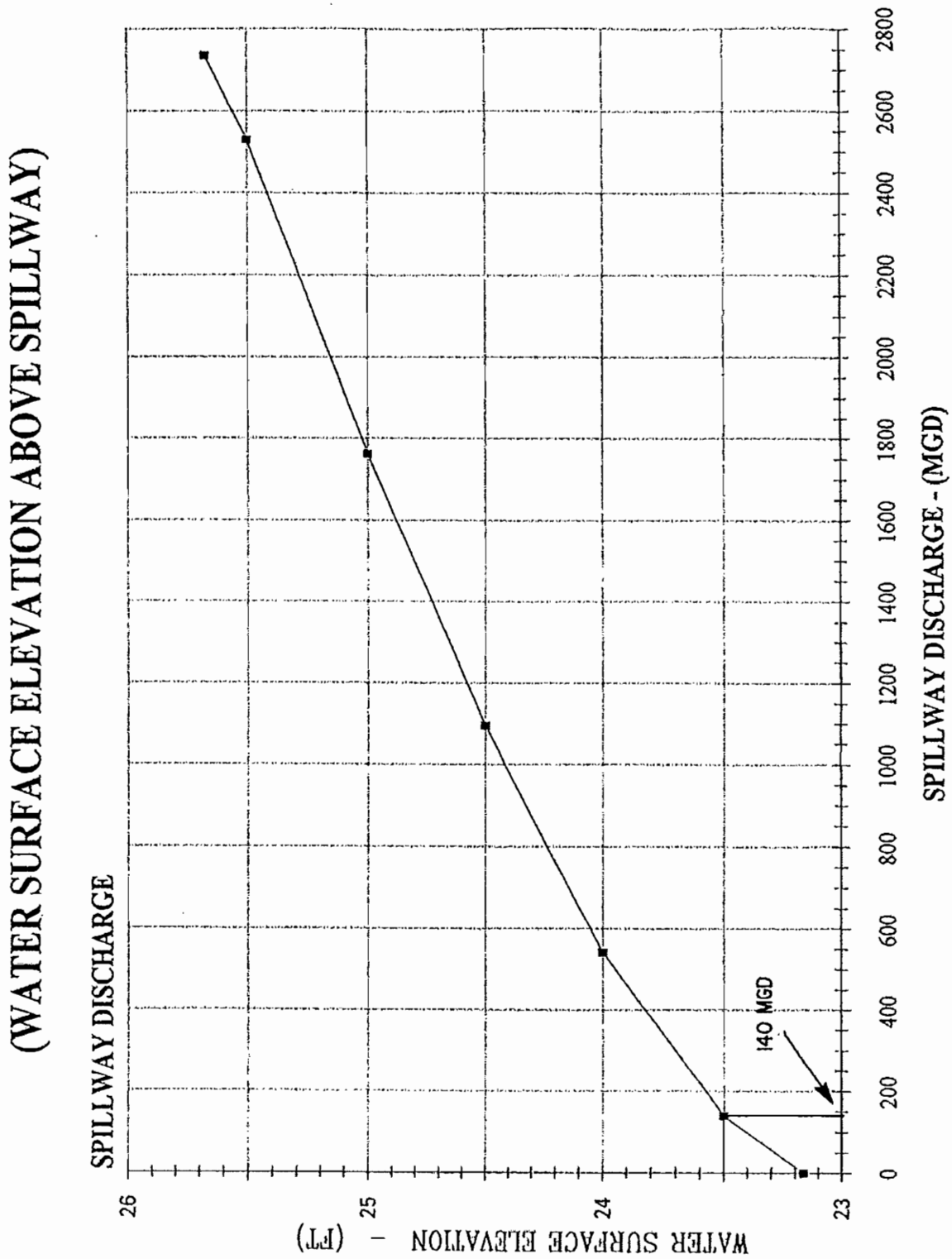
Figure No. 2B
Woodcliff Lake Dam
Bascule Gate Discharge Rating Curve

United Water New Jersey
Oradell Reservoir Dam

Engineering Data

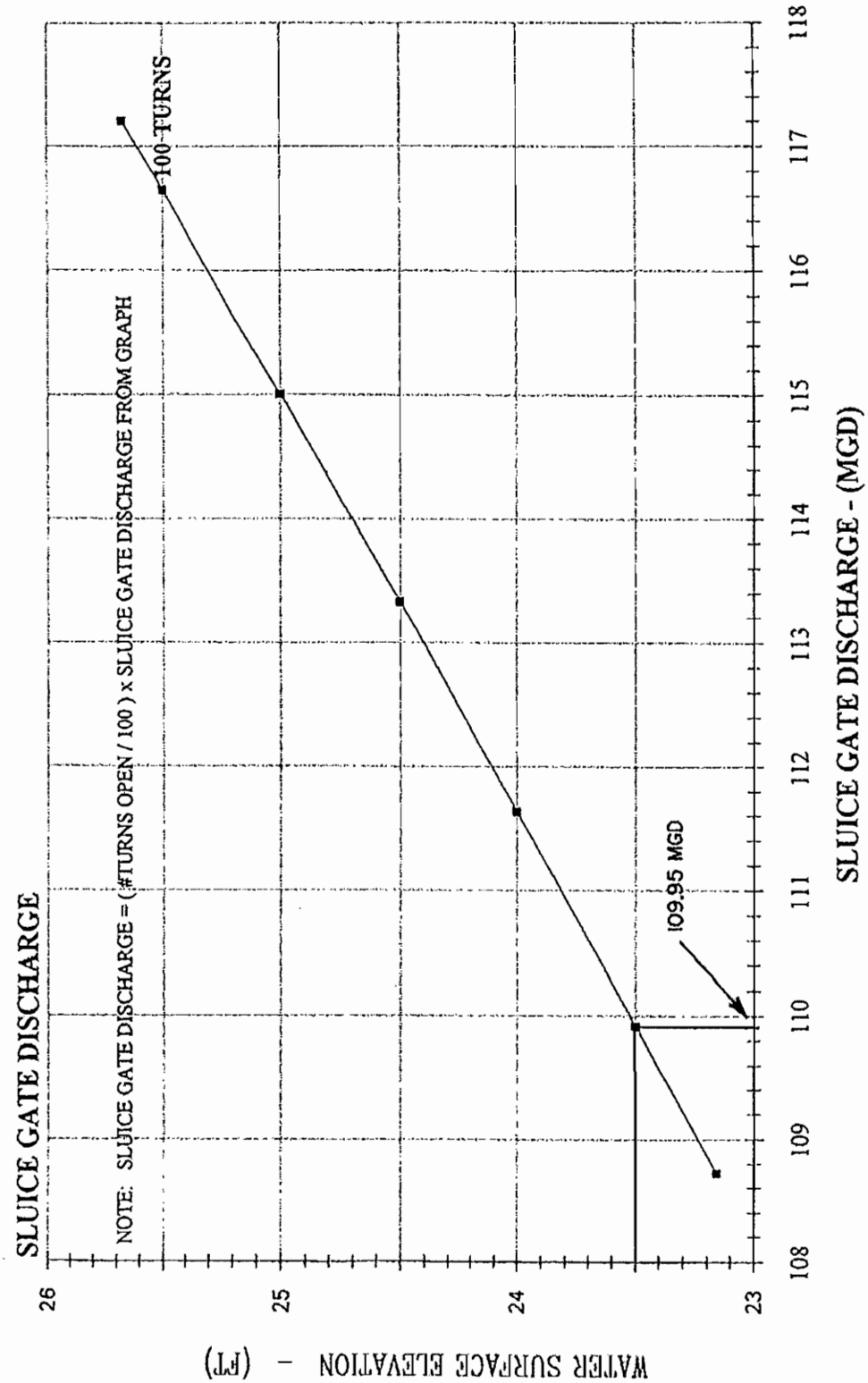
Stream:	Hackensack River
Drainage Area for Dam:	112 square miles +/-
Maximum Flood at Dam:	8,000 cfs, (5,000 MGD+/-) September 17, 1999 ← Refer to following for Peak Stream Flow at USGS New Milford
Spillway Design Flood:	22,500 cfs, SDF
Year of Dam Construction :	1923, modified 1965
Dam Type:	Reverse Ambursen, with Concrete Spillway and Sluiceway
Length of Dam:	402 feet
Top Width of Dam:	Varies
Side Slopes:	N/A
Core Wall:	Concrete envelope on piles and sheet piling with earth fill
Elevations:	25.7 Top of Sluiceway Operating Slab 23.16 Spillway Crest, 7.16 Toe of Dam 2.67 Sluice Gate(s) Invert
Reservoir Capacity:	10,740 Acre-feet at Elevation 23.16
Reservoir Area:	796 Acres at Elevation 23.16
Outlet Pipe:	Sluice Gates (7 gates)
Outlet Control:	Sluice Gates Operators
Sluiceway Gates:	Seven Sluice Gates, each seven (7') feet wide by nine (9') feet high
Gate Control:	All gates – motor-operated, locally and at SCADA
Standby Power:	All gates – Emergency stand-by Generator located in Storage Building and Local Control Station (LCS)


USGS
USGS 01378500 Hackensack River at New Milford NJ
Annual Peak Streamflow, in cubic feet per second
14000
12000
10000
8000
6000
4000
2000
0
1928
1940
1952
1964
1976
1988
2000
Hur Irene 10,500 cfs



See Note on Figure No. 2B for Total Discharge Computation

Figure No. 2A
Oradell Reservoir Dam
Spillway Discharge Rating Curve



Total Sluice Gate Discharge Calculation:
Q(cfs) = 0.72 x (Total number of turns for all gates) / 864 x 9 x 7 x (2 x 32.2 x (Reservoir elev. – Tail water Elev.)) ^(0.5)
Q(mgd) = Q(cfs) x 0.6463

Sample: for reservoir elev. 23.5, with 250 total turns from all gates, and tail water elev. 9;
Sluice Gate Discharge = 0.72 x 250 / 864 x 9 x 7x (2 x 32.2 x (23.5 – 9))^(0.5) = 401 cfs = 259 mgd
Spillway Discharge (from chart on page 6) = 140 mgd
Total Discharge = 259 mgd + 140 mgd = 399 mgd

Total discharge = spillway discharge + sluice gate discharge*

*Computed sluice gate discharge shown in graph is maximum possible with tail water elev. 7±. For sluice gate discharge at other tail water elevations see formula next to graph.

Figure No. 2B
Oradell Reservoir Dam
Sluice Gate Discharge Rating Curve

Figure No. 3
Oradell Reservoir Dam
Reservoir Storage

Water Surface Elev. (Ft.)	Reservoir Storage Volume (MG)	Reservoir Storage Volume (Acre-Ft)
4.3	0	0.0
5	52	160.1
5.5	95	292.9
6	143	440.0
6.5	196	600.7
7	252	774.6
7.5	313	960.9
8	378	1,159.3
8.5	446	1,368.9
9	518	1,589.4
9.5	593	1,820.1
10	671	2,060.5
10.5	753	2,309.9
11	837	2,568.0
11.5	924	2,834.3
12	1,013	3,108.1
12.5	1,104	3,389.2
13	1,198	3,677.1
13.5	1,294	3,971.4
14	1,392	4,271.7
14.5	1,492	4,577.8
15	1,593	4,889.5
15.5	1,697	5,206.4
16	1,801	5,528.4
16.5	1,908	5,855.5
17	2,016	6,187.6
17.5	2,126	6,524.6
18	2,238	6,866.6
18.5	2,351	7,213.8
19	2,466	7,566.4
19.5	2,582	7,924.6
20	2,701	8,288.7
20.5	2,822	8,659.2
21	2,945	9,036.6
21.5	3,070	9,421.4
22	3,198	9,814.3
22.5	3,329	10,216.0
23	3,463	10,627.5

Water Surface Elev. (Ft.)	Reservoir Storage Volume (MG)	Reservoir Storage Volume (Acre-Ft)
23.5	3,601	11,049.6
24	3,742	11,483.4
24.5	3,887	11,929.9
25	4,038	12,390.6
25.5	4,193	12,866.6
26	4,353	13,359.4
26.5	4,520	13,870.7
27	4,693	14,402.0
27.5	4,873	14,955.3
28	5,061	15,532.4
28.5	5,258	16,135.4
29	5,463	16,766.4
29.5	5,679	17,427.8
30	5,905	18,122.0
30.5	6,143	18,851.6
31	6,393	19,619.3
31.5	6,657	20,428.0
32	6,934	21,280.7
32.5	7,228	22,180.5
33	7,537	23,130.8
33.5	7,864	24,135.0
34	8,210	25,196.8
34.5	8,576	26,319.9
35	8,964	27,508.3
35.5	9,374	28,766.1
36	9,807	30,097.6
36.5	10,267	31,507.2
37	10,753	32,999.7
37.5	11,268	34,579.8
38	11,813	36,252.6
38.5	12,390	38,023.1
39	13,001	39,896.9
39.5	13,647	41,879.4
40	14,330	43,976.5

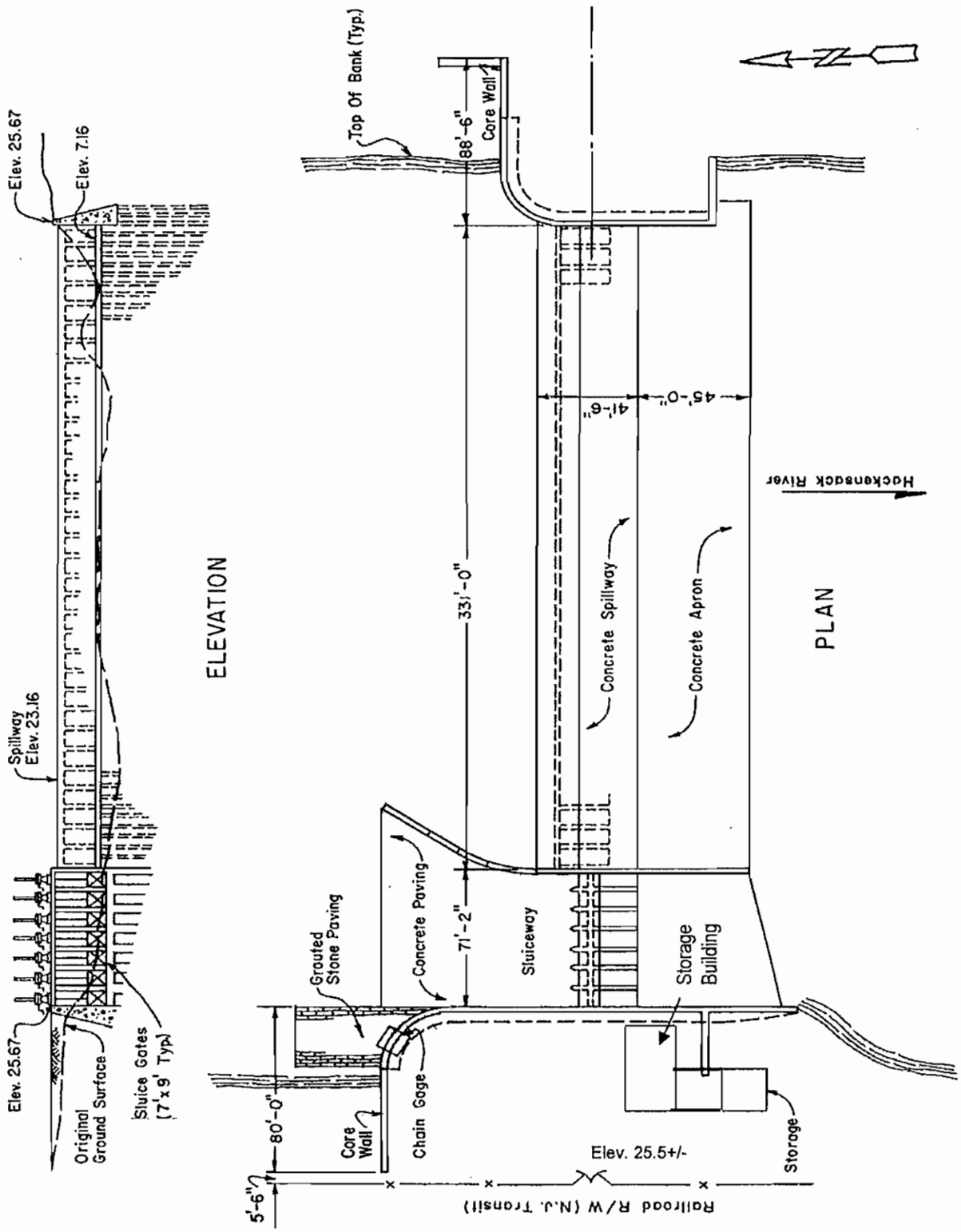
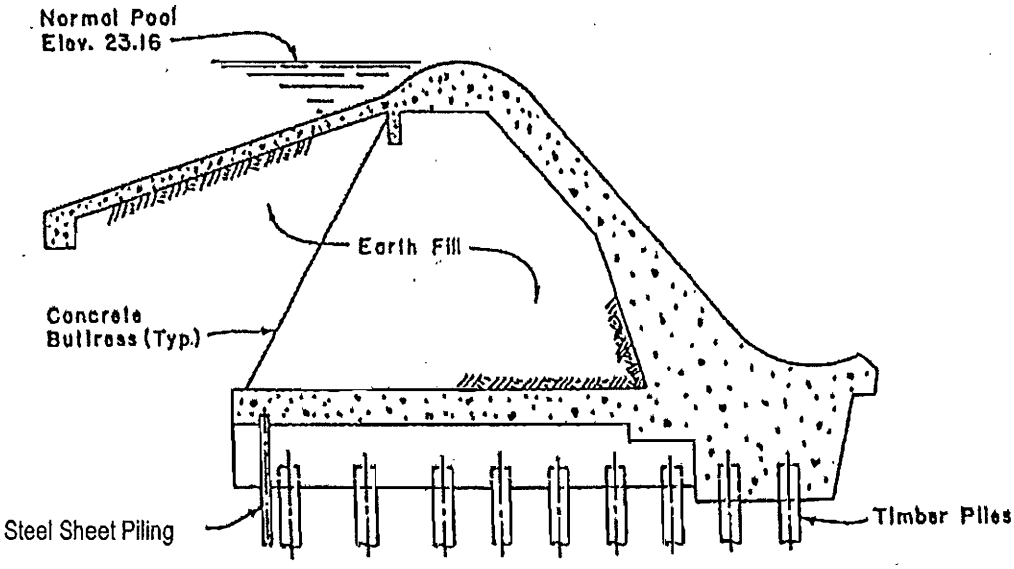
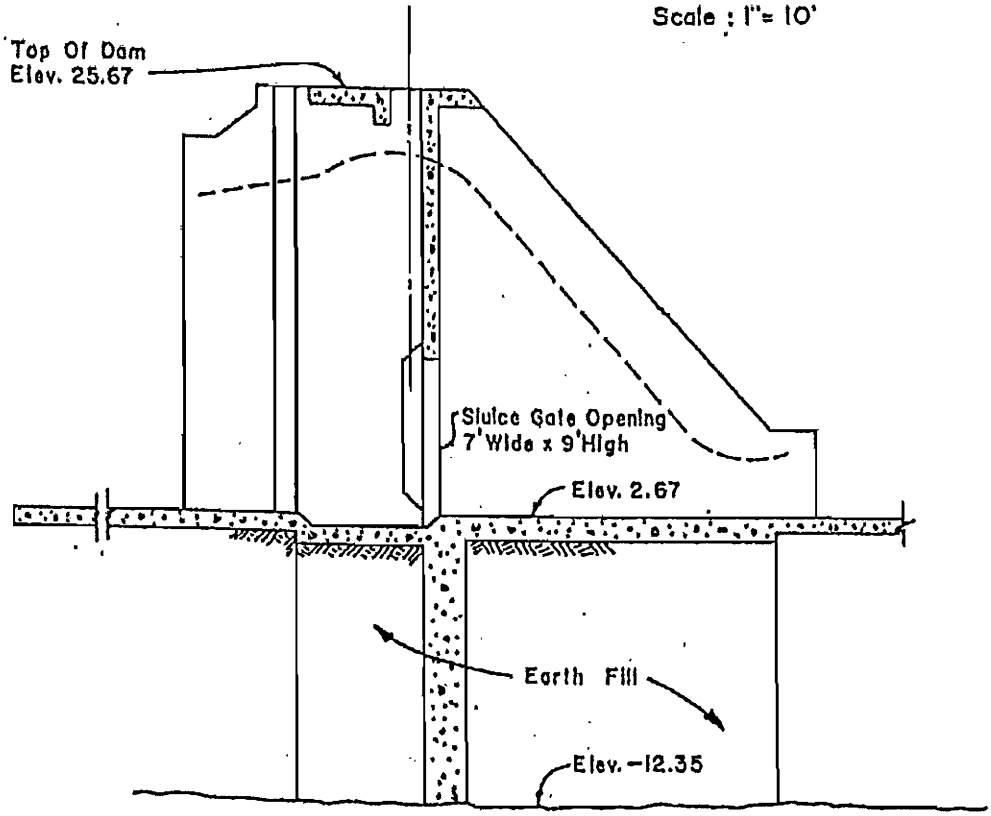


Figure No. 4
Oradell Reservoir Dam
Plan and Elevation
Scale: NONE



SPILLWAY SECTION
Scale : 1"= 10'



SLUICEWAY SECTION
Scale : 1"= 10'

Figure No. 5
Oradell Reservoir Dam
Spillway and Sluiceway Sections
Scale: AS SHOWN

APPENDIX E

NJDEP
WATER ALLOCATION PERMIT
FOR
WOODCLIFF LAKE RESERVOIR

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

State of New Jersey

Department of Environmental Protection

Mail Code 401-03
DIVISION OF WATER SUPPLY
WATER SUPPLY PERMITTING
BUREAU OF WATER ALLOCATION
P.O. BOX 420
TRENTON, NEW JERSEY 08625-0420
TEL.# 609-292-2957
FAX.# 609-633-1495

BOB MARTIN
Commissioner

March 3, 2011

United Water NJ
700 Kinderkamack Road
Oradell, NJ 07649
Attn: Emad Sidhom

Dear Mr. Sidhom:

Re: Water Allocation Permit - Modification
Program Interest ID: 5082X
Activity No. WAP080003

Enclosed is a permit issued pursuant to the Water Supply Management Act, N.J.S.A. 58:1A-1 et seq. This permit becomes effective on April 1, 2011 and is to divert water from two wells and two intakes in the following Municipalities and Counties:

MUNICIPALITY	COUNTY
Emerson Boro	Bergen
Haworth Boro	Bergen
Hillsdale Boro	Bergen
New Milford Boro	Bergen
Old Tappan Boro	Bergen
Oradell Boro	Bergen
River Vale Twp.	Bergen

5082X is your Program Interest ID and WAP080003 is your Permit Activity Number, and will appear on all forms and correspondence from the Bureau of Water Allocation. Reference your Program Interest ID and Activity No. in all correspondence.

Be advised that as you are responsible for complying with the terms and conditions of the enclosed permit you should review them thoroughly. Failure to comply with any or all of the terms and conditions could result in penalties and/or revocation of the permit.

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Printed on Recycled Paper and Recyclable

Within 20 calendar days following your receipt of this permit you may submit a request for an adjudicatory hearing to contest the conditions of this permit. Regulations regarding the format and requirements for requesting an adjudicatory hearing may be found in N.J.A.C. 7:19-2.13.

To request a hearing, the permittee must complete the enclosed Tracking Form and supply all the information specified in Part III of the Tracking Form. A copy of the completed, signed and dated Tracking Form, together with all of the information required by Part III of the Tracking Form, including attachments where specified, must be submitted to:

1. Janis Hoagland, Director
New Jersey Department of Environmental Protection
Office of Legal Affairs
P.O. Box 402
Trenton, New Jersey 08625

2. Diane E. Zalaskus, P.E., Bureau Chief
New Jersey Department of Environmental Protection
Mail Code 401-03
Division of Water Supply
Bureau of Water Allocation
P.O. Box 420
Trenton, New Jersey 08625-0420

Very truly yours,

Diane E. Zalaskus

Diane E. Zalaskus, P.E.
Bureau Chief
Bureau of Water Allocation

Enclosure

CERTIFIED MAIL NO. 7008 1140 0000 1261 7901

c: Bureau of Water Allocation
Northern Bureau of Water Compliance & Enforcement Element
Robert Hudgins, BWA

State of New Jersey
Department of Environmental Protection
Bureau of Water Allocation
PO Box 426, Trenton, New Jersey 08625-0426

Water Allocation Permit

The New Jersey Department of Environmental Protection grants this permit* in accordance with your application, attachments accompanying same application, and applicable laws and regulations. This permit is also subject to further conditions and stipulations enumerated in the supporting documents.

Program Interest ID: 5082X **Permit Number:** WAP080003	**Issuance Date:** 03/03/2011	**Effective Date:** 04/01/2011	**Expiration Date:** 03/31/2031

Name and Address of Applicant UNITED WATER NJ 700 Kinderkamack Road Oradell, NJ 07649	**Location of Activity/Facility** Haworth Boro Bergen	
	Type of Permit Water Allocation Permit - Modification	**Statute(s)** N.J.S.A. 58:1A-1

This permit grants permission to divert water from the approved sources in the attached permit inventory, in the following municipalities, for the following water uses:

MUNICIPALITY	COUNTY
Emerson Boro	Bergen
Haworth Boro	Bergen
Hillsdale Boro	Bergen
New Milford Boro	Bergen
Old Tappan Boro	Bergen
Oradell Boro	Bergen
River Vale Twp	Bergen

Water Uses: Public Community Supply

This permit is subject to the attached Conditions.

Approved by the authority of:
Bob Martin, Commissioner
Department of Environmental Protection

Diane E. Zalaskus 3/3/11

Diane E. Zalaskus, P.E., Bureau Chief
Bureau of Water Allocation

Date

** Permit means Certification, Approval, Registration, Equivalency, etc.*

UNITED WATER NJ
5082X
Water Allocation Permit: WAP080003

Permit Inventory

Water Diversion Sources – Water may be diverted under this permit from the following sources:

Source Designation (Well Permit No. or Intake No.)	Description	Subject Item ID
INTAKE 1	ORADELL RESERVOIR (CORRECTED)	WSIN0000075794
INTAKE 2	HIRSCHFIELD BROOK	WSIN0000075795
RIVERVALE C.C.	LAKE TAPPAN	WSIN0000137093
EMERSON GOLF CLUB	ORADELL RESERVOIR	WSIN0000137094
2300004135	EMERSON WELL 11	WSWL0000064352
2300004815	HAWORTH WELL 24RW	WSWL0000064378

United Water NJ Reservoir System:

Source Designation	Source Description	Subject Item ID
LAKE TAPPAN	HACKENSACK RIVER (ON-STREAM)	WSYT0000867812
WOODCLIFF LAKE	PASCACK BROOK (ON-STREAM)	WSYT0000867813
LAKE DEFOREST	HACKENSACK RIVER (ON-STREAM)	WSYT0000867814
ORADELL RESERVOIR	HACKENSACK RIVER (ON-STREAM)	WSYT0000867815

Group Subject Items – The following items are grouped sources for the purpose of setting permit requirements outlined in this document:

Group Designation	Group Description	Group Subject Item ID	Group Members
UNITED WATER NJ	5111 WA PERMIT – ALL DIVERSION SOURCES	WSWA0000075793	SURFACE WATER SOURCE, ORADELL RESERVOIR INTAKE (WARG077759)
			PASSAIC FORMATION AQUIFER SOURCES, WELLS EMERSON 11 & HAWORTH 24RW (WARG867821)
			INTAKE 2, HIRSCHFIELD BROOK (WSIN075795)
			RIVERVALE C.C., LAKE TAPPAN (WSIN137093)
			EMERSON GOLF CLUB, ORADELL RESERVOIR (WSIN137094)
CONJUNCTIVE USE SOURCES	WELLS AND HIRSCHFIELD BROOK INTAKE	WARG0000077757	PASSAIC FORMATION AQUIFER SOURCES, WELLS EMERSON 11 & HAWORTH 24RW (WARG867821)
			INTAKE 2, HIRSCHFIELD BROOK (WSIN075795)
SURFACE WATER SOURCE	ORADELL RESERVOIR INTAKE	WARG0000077759	INTAKE 1, ORADELL RESERVOIR (CORRECTED) (WSIN075794)

UNITED WATER NJ
5082X
Water Allocation Permit: WAP080003

Group Subject Items – The following items are grouped sources for the purpose of setting permit requirements outlined in this document:

Group Designation	Group Description	Group Subject Item ID	Group Members
PASSAIC FORMATION AQUIFER SOURCES	WELLS EMERSON 11 & HAWORTH 24RW	WARG0000867821	2300004135, EMERSON WELL 11 (WSWL064352)
			2300004815, HAWORTH WELL 24RW (WSWL064378)
UNITED WATER NJ RESERVOIR SYSTEM	ORADELL, LAKE TAPPAN, WOODCLIFF LAKE & LAKE DEFOREST RESERVOIRS	WSYG0000867816	LAKE TAPPAN, HACKENSACK RIVER (ON-STREAM) (WSYT867812)
			WOODCLIFF LAKE, PASCACK BROOK (ON-STREAM) (WSYT867813)
			LAKE DEFOREST, HACKENSACK RIVER (ON-STREAM) (WSYT867814)
			ORADELL RESERVOIR, HACKENSACK RIVER (ON-STREAM) (WSYT867815)

UNITED WATER NJ
5082X

Water Allocation Permit : WAP080003

Permit Requirements

Limit Requirements

The following limits apply and are the maximum permitted allocation:

Final Permit Phase

Subject Item	Parameter	Limit
UNITED WATER NJ, 5111 WA PERMIT - ALL DIVERSION SOURCES (WSWA75793)	Water Diverted	<= 4860 Million Gallons Per Month. [N.J.A.C. 7:19- 2]
		<= 43070 Million Gallons Per Year. [N.J.A.C. 7:19- 2]
CONJUNCTIVE USE SOURCES, WELLS AND HIRSCHFIELD BROOK INTAKE (WARG77757)	Water Diverted	<= 730 Million Gallons Per Year. [N.J.A.C. 7:19- 2]
PASSAIC FORMATION AQUIFER SOURCES, WELLS EMERSON 11 & HAWORTH 24RW (WARG867821)	Maximum Diversion Rate	<= 330 Gallons Per Minute. [N.J.A.C. 7:19- 2]
	Water Diverted	<= 14 Million Gallons Per Month. [N.J.A.C. 7:19- 2]
INTAKE 1, ORADELL RESERVOIR (CORRECTED) (WSIN75794)	Maximum Diversion Rate	<= 154000 Gallons Per Minute. [N.J.A.C. 7:19- 2]
INTAKE 2, HIRSCHFIELD BROOK (WSIN75795)	Water Diverted	<= 210.7 Million Gallons Per Month. [N.J.A.C. 7:19- 2]
2300004815, HAWORTH WELL 24RW (WSWL64378)	Maximum Diversion Rate	<= 160 Gallons Per Minute. [N.J.A.C. 7:19- 2]
	Water Diverted	<= 7.14 Million Gallons Per Month. [N.J.A.C. 7:19- 2]

Other Limit Requirements

Final Permit Phase

Subject Item	Parameter	Limit
INTAKE 1, ORADELL RESERVOIR (CORRECTED) (WSIN75794)	Rated Pump Capacity	<= 167000 Gallons Per Minute. [N.J.A.C. 7:19- 2]
INTAKE 2, HIRSCHFIELD BROOK (WSIN75795)	Rated Pump Capacity	<= 4720 Gallons Per Minute. [N.J.A.C. 7:19- 2]
2300004135, EMERSON WELL 11 (WSWL64352)	Rated Pump Capacity	<= 170 Gallons Per Minute. [N.J.A.C. 7:19- 2]
2300004815, HAWORTH WELL 24RW (WSWL64378)	Rated Pump Capacity	<= 160 Gallons Per Minute. [N.J.A.C. 7:19- 2]

Other Limit Requirements

Final Permit Phase

Subject Item	Parameter	Limit
LAKE TAPPAN, HACKENSACK RIVER (ON-STREAM) (WSYT867812)	Passing Flow	The permittee shall not allow the minimum passing flow of the Hackensack River below the Lake Tappan dam to be < 19.2 cubic feet per second . The releases from Lake Tappan, except during natural spillage, shall not exceed the sum of 35.6 cfs (23 mgd) plus the Lake Deforest Reservoir release with the following exceptions: a. The maximum release from Lake Tappan can be increased up to 52 mgd plus the Lake Deforest release at times when the percent of storage in Lake Tappan exceeds that of the Oradell Reservoir by 10% or more. b. The maximum release from Lake Tappan can be increased up to 52 mgd plus the Lake Deforest release at times when the Oradell Reservoir is below 45% of its capacity regardless of Lake Tappan storage. The minimum release of 19.2 cfs (12.4 mgd) can be altered as below: a. If Lake Tappan is below 10% of its capacity, the release from Lake Tappan shall not exceed the Lake Deforest release. b. If Oradell Reservoir is spilling or near spilling (i.e., above 95 % of capacity), no minimum release from Lake Tappan is required. c. If Lake Tappan is below 70% of its capacity and Oradell Reservoir is above 70 % of its capacity, no minimum release from Lake Tappan is required. [N.J.A.C. 7:19- 2]
ORADELL RESERVOIR, HACKENSACK RIVER (ON-STREAM) (WSYT867815)	Passing Flow	The permittee shall not allow the passing flow of the Hackensack River as measured at USGS gage station number 01378500 at New Milford (below Oradell Reservoir) to be < 12.9 cubic feet per second on a daily average. [N.J.A.C. 7:19- 2]

Monitoring Requirements

Final Permit Phase

Subject Item	Requirement	Frequency	Monitored Parameter	Monitoring Method
2300004135, EMERSON WELL 11 (WSWL64352)	Static water levels for each well indicated shall be monitored. [N.J.A.C. 7:19- 2]	Each Month	Static Water Level	Airline, Tape, or Gage
2300004815, HAWORTH WELL 24RW (WSWL64378)				
INTAKE 2, HIRSCHFIELD BROOK (WSIN75795)	The monthly diversion from each source indicated shall be monitored. [N.J.A.C. 7:19- 2]	Each Month	Water Diverted	Meter

Monitoring Requirements

Final Permit Phase

Subject Item	Requirement	Frequency	Monitored Parameter	Monitoring Method
RIVERVALE C.C., LAKE TAPPAN (WSIN137093)	The monthly diversion from each source indicated shall be monitored. [N.J.A.C. 7:19- 2]	Each Month	Water Diverted	Meter
EMERSON GOLF CLUB, ORADELL RESERVOIR (WSIN137094)				
2300004135, EMERSON WELL 11 (WSWL64352)				
2300004815, HAWORTH WELL 24RW (WSWL64378)				
INTAKE 1, ORADELL RESERVOIR (CORRECTED) (WSIN75794)	The monthly diversion from Oradell Reservoir shall be monitored. The metered diversion from the Oradell Reservoir intake shall then be corrected by subtracting the water diverted under permits 5084, 5088, 5107, 5094, 5274, 2225P, Hirschfield Brook, well Emerson 11 and well Haworth 24RW placed into Oradell Reservoir each month. The total CORRECTED monthly diversion must be recorded and reported as water diverted. (Note: If the supplementing diversion exceeds or is equal to the storage pond diversion, the pond diversion should be reported as zero.) [N.J.A.C. 7:19- 2]	Each Month	Water Diverted	Meter

Record Keeping Requirements

Final Permit Phase

Subject Item	Requirement	Frequency	Monitored Parameter	Record Keeping Method
UNITED WATER NJ, 5111 WA PERMIT - ALL DIVERSION SOURCES (WSWA75793)	A log book of month end meter readings for each diversion source shall be maintained on site. [N.J.A.C. 7:19- 2]	Each Month	Meter Reading	Log Book

Submittal/Action Requirements

Final Permit Phase

Applicable Subject Items	Submittal/Action Type	Requirement
INTAKE 1, ORADELL RESERVOIR (CORRECTED) (WSIN75794)	Submit Public Quarterly Report	The required monitoring results shall be recorded on the form provided by the Department. The completed form shall be submitted within 30 days after the end of each quarter. [N.J.A.C. 7:19- 2]

Submittal/Action Requirements

Final Permit Phase

Applicable Subject Items	Submittal/Action Type	Requirement
INTAKE 2, HIRSCHFIELD BROOK (WSIN75795)	Submit Public Quarterly Report	The required monitoring results shall be recorded on the form provided by the Department. The completed form shall be submitted within 30 days after the end of each quarter. [N.J.A.C. 7:19- 2]
RIVERVALE C.C., LAKE TAPPAN (WSIN137093)		
EMERSON GOLF CLUB, ORADELL RESERVOIR (WSIN137094)		
2300004135, EMERSON WELL 11 (WSWL64352)		
2300004815, HAWORTH WELL 24RW (WSWL64378)		
UNITED WATER NJ, 5111 WA PERMIT - ALL DIVERSION SOURCES (WSWA75793)	Submit Proposal/Plan	The permittee shall submit a Water Supply System Plan (WSSP) that addresses system capacity and diversion source issues and details future planned upgrades or additions to the water system to enable the permittee to fully utilize its allocations and meet long-term water demands. The WSSP shall identify viable water supply options and propose an implementation schedule for the selected alternative(s) to meet UWNJ's current and future demand projections. A complete WSSP shall be submitted to the Department within 120 days of the effective date of the permit . The WSSP shall at a minimum consider and provide an implementation schedule for one or more of the following alternatives: 1. Any planned redevelopment of wells to restore lost capacity; 2. Potential additional diversion sources; 3. Potential water intake upgrades/improvements; 4. Potential transmission main improvements; 5. Evaluation/upgrade of interconnections to remove hydraulic limitations; 6. Reducing the amount of unaccounted-for-water; 7. Contracting for additional supply; 8. More stringent conservation measures. [N.J.A.C. 7:19- 2]
UNITED WATER NJ, 5111 WA PERMIT - ALL DIVERSION SOURCES (WSWA75793)	Submit Water Conservation and Drought Management Plan	The permittee shall continue to implement, to the satisfaction of the Department, a water conservation and drought management program. The program shall encourage water conservation in all types of use within the area served by the permittee, including actions taken pursuant to this program and the impact thereof. The plan should specificially address how the permittee will reduce the unaccounted for water to 15% or less within 5 years. Submit according to the following schedule: An update to the water conservation and drought management plan shall be submitted on or before January 31, 2012 and every other year thereafter. [N.J.A.C. 7:19- 2]
UNITED WATER NJ, 5111 WA PERMIT - ALL DIVERSION SOURCES (WSWA75793)	Submit Renewal Application	A renewal application shall be submitted three months prior to the expiration date. [N.J.A.C. 7:19- 2]

Text Requirements

All Phases

UNITED WATER NJ, 5111 WA PERMIT - ALL DIVERSION SOURCES (WSWA75793)

1. For the purposes of calculating the excess diversion fee for the Hackensack River, the Department shall use the real-time provisional data as reported by the United States Geological Survey. [N.J.A.C. 7:19- 4]
2. Whenever the total storage of Oradell Reservoir, Woodcliff Lake, Lake Tappan and Lake DeForest is less then 15% above the NJ Department of Environmental Protection drought warning curve, the permittee shall divert its full share of the Wanaque South Project allocation. [N.J.A.C. 7:19- 2]
3. The total monthly and annual allocation shall include the corrected Oradell Reservoir diversion under permit 5111; water pumped into the reservoir from the Saddle River as permitted under Water Allocation Permit 5107; water pumped from Wanaque South project as permitted under Water Allocation Permits 5094 and 5274 that is delivered to UWNJ; water diverted from Sparkill Creek and Lafayette Street wells under Permit 5084 and other raw water wells discharging into tributaries reaching Oradell Reservoir permitted under Allocation Permits 5088 and 2225P, the diversion from Emerson and Haworth wells and Hirschfield Brook, and the diversion from Emerson Golf Club and Rivervale Country Club. The total water diverted under the above referenced Water Allocation Permits shall be reported under activity WAX090001 or superseding document. [N.J.A.C. 7:19- 2]
4. Water may be diverted under this modified permit for public supply and golf course irrigation. However, water shall not be used to serve non-potable consumptive purposes for new projects that are greater than 50 percent non-potable and greater than 50 percent consumptive where, as determined by the Department, alternate water sources including but not limited to reclaimed water for beneficial reuse are feasible to serve the non-potable consumptive needs of the project. [N.J.A.C. 7:19- 2]
5. Water may be diverted under this permit only from the approved diversion sources at the maximum rates specified. [N.J.A.C. 7:19- 1]
6. A major modification of this permit may be required in order to request the approval of any additional diversion sources or an increase in the pumping capacity. [N.J.A.C. 7:19- 2]
7. All diversion sources shall be metered with a totalizing flow meter. [N.J.A.C. 7:19- 2]
8. At a minimum, each diversion source flow meter shall be calibrated at least once every five years. [N.J.A.C. 7:19- 2]
9. Each flow meter shall be calibrated to within five percent accuracy. [N.J.A.C. 7:19- 2]
10. All wells shall be equipped with a metal tag showing the well permit numbers (source designation) as listed in the allocation permit inventory or have the well permit numbers painted on the casings. [N.J.A.C. 7:19- 2]
11. The pumping equipment capacity shall not be increased without prior approval from the Bureau of Water Allocation. [N.J.A.C. 7:19- 1]
12. Any well not intended for use shall be decommissioned in accordance with N.J.A.C. 7:9D-3.1 et seq. [N.J.A.C. 7:9D-3]
13. Static water level shall be measured and reported as depth to water, in feet, from ground surface. [N.J.A.C. 7:19- 2]
14. All new services shall be metered in accordance with all applicable laws, regulations or codes including, but not limited to, the Water Supply Management Act. [N.J.A.C. 7:19- 6]
15. All existing services shall be metered. [N.J.A.C. 7:19- 6]
16. Water charges for each service connection shall be based in part on metered usage. [N.J.A.C. 7:19- 6]
17. The monthly quantity of water transferred and delivered to/received from interconnections shall be reported as part of the water system monitoring on separate forms provided by the Department. [N.J.A.C. 7:19- 2]
18. The Department may modify, suspend or terminate this permit, after due process, for violations of permit conditions, N.J.S.A. 58:1A-1, N.J.A.C. 7:19-1 et seq., any orders issued by the Department, or when in the public interest. [N.J.A.C. 7:19- 2]

Text Requirements

All Phases

UNITED WATER NJ, 5111 WA PERMIT - ALL DIVERSION SOURCES (WSWA75793)

19. The permittee shall investigate to the Department's satisfaction complaints by users of wells or surface water supplies within the zone of influence of its diversion to determine what impact the diversion has had on such wells or surface water supplies. A report on these investigations shall be forwarded to the Bureau of Water Allocation. Any well or surface water supply which becomes damaged, dry, has reduced capacity, reduced water quality or is otherwise rendered unusable as a water source as a result of the permittee's diversions shall be repaired or replaced at the expense of the permittee. Work shall be in accordance with all State, County and Municipal construction standards for potable water. After reviewing all applicable investigational reports the Department of Environmental Protection will make the final determination regarding the validity of such complaints, the scope or sufficiency of such investigations, and will determine how to resolve any problems resulting from the diversion. [N.J.A.C. 7:19- 2]
20. This permit is issued for a limited period, and is not subject to automatic renewal. [N.J.A.C. 7:19- 2]
21. The permittee is subject to such fees as may be prescribed by the regulations. [N.J.A.C. 7:19- 3]
22. The permittee shall have the right to apply at any time for modification of this permit by submission of the appropriate application forms. [N.J.A.C. 7:19- 2]
23. The permittee may informally discuss the terms and conditions of this permit at any time with the Bureau of Water Allocation. [N.J.A.C. 7:19- 2]
24. The permittee shall obtain approval from the Bureau of Water Systems and Well Permitting before using the diversion for public water supply. [N.J.A.C. 7:19- 2]
25. In addition to the specific management requirements cited above, and when so directed by the Department, the permittee shall comply with applicable portions of the Water Supply Management Rules (N.J.A.C. 7:19-6 et seq. and N.J.A.C. 7:19-8 et seq.) to include the determination of dependable yield; unaccounted-for water; rehabilitation; system pressure and storage; interconnections; and operation of interconnections. [N.J.A.C. 7:19- 6]
26. If the permittee violates any condition of this permit, the permittee is subject to administrative penalties up to $25,000 per day per offense. [N.J.S.A. 58:1A-16]
27. The issuance of this permit shall not be deemed to affect in any way action by the Department of Environmental Protection of the State of New Jersey on any future application. [N.J.A.C. 7:19- 2]
28. No change in plans or specifications shall be made except with the prior written permission of the Department of Environmental Protection of the State of New Jersey. [N.J.A.C. 7:19- 2]
29. The granting of this permit shall not be construed to in any way affect the title or ownership of property, and shall not make the Department of Environmental Protection or the State a party in any suit or question of ownership of property. [N.J.A.C. 7:19- 2]
30. This permit does not waive the obtaining of Federal or other State or local government consent when necessary. This permit is not valid and no work shall be undertaken until such time as all other required approvals and permits have been obtained. [N.J.A.C. 7:19- 2]
31. A copy of this permit shall be kept at the facility site, and shall be exhibited upon request of any person. [N.J.A.C. 7:19- 2]
32. The Department has the right to enter and inspect any site, building, or equipment, or any portion thereof, owned or operated by the permittee, at any time, in order to ascertain compliance or noncompliance with N.J.S.A. 58:1A-1 et seq., 58:4A-4.1 et seq., 58:12A-1 et seq., these rules, or any other agreement or order issued or entered into pursuant thereto. Such right shall include, but not be limited to, the right to require the testing of any equipment at the facility, to sketch or photograph any portion of the site, building or equipment, to copy or photograph any document or records necessary to determine such compliance or noncompliance, and to interview any employees or representative of the owner, operator, or permittee. Such right shall be absolute and shall not be conditioned upon any action by the Department, except the presentation of appropriate credentials as requested and compliance with appropriate standard safety procedures. [N.J.A.C. 7:19- 2]
33. This permit may be transferred, with the consent of the Department, but only for the identical use of the waters. [N.J.A.C. 7:19- 2]
34. If the authorized diversion privileges are not currently diverted, subject to contract, or reasonably required for a demonstrated future need, they shall revert back to the State upon renewal or modification of the permit. [N.J.A.C. 7:19- 2]
35. The permittee shall protect each source from vandalism, tampering, and contamination at all times. [N.J.A.C. 7:19- 2]

Text Requirements

All Phases

UNITED WATER NJ, 5111 WA PERMIT - ALL DIVERSION SOURCES (WSWA75793)

36. This permit shall expire as indicated on the permit approval cover page. [N.J.A.C. 7:19- 2]

2/15/2011

STAFF REPORT

In the matter of

United Water New Jersey

Application No. 5111 to modify permit to divert water from Oradell Reservoir, Hirschfield Brook and two wells in Haworth, Emerson, and New Milford Boroughs, Bergen County

In compliance with the provisions of N.J.S.A. 58:1A-1 et seq., United Water New Jersey, 700 Kinderkamack Road, Oradell, New Jersey 07649, filed an application with the Department of Environmental Protection on July 25, 2008 to divert a maximum of 5,517 million gallons of water during any month (mgm), not to exceed 50,735 million gallons during any year, at a maximum rate of 154,000 gallons per minute from existing Wells Emerson11 and Haworth 24RW; 478 and 403 feet deep completed in the Passaic Formation, and from Oradell Reservoir and Hirschfield Brook.

The application request represents an increase of 657 mgm and 7,665 mgy above the existing overall allocation of 4,860 mgm and 43,070 mgy and a request to increase the maximum passing flow release requirement below Lake Tappan from 23 mgd, plus the volume of the Lake Deforest release, to a maximum release of 60 mgd plus any additional release from Lake Deforest beyond the normal 9.75 mgd. The allocation increase was to come from a separate increase of 15 mgd due solely to UWNJ's 17.5 mgd share of the proposed 35 mgd increase in safe yield of the Wanaque South Project and an additional 6-7 mgd by increasing the maximum release requirement from Lake Tappan for a total safe yield increase of 21 mgd.

UWNJ withdrew their request to increase the monthly and annual allocations in a letter dated April 7, 2010. UWNJ wishes to continue to pursue the requested increase in the maximum release requirement for Lake Tappan. UWNJ claims the current requirements limiting the releases from Lake Tappan cause the storage level in Oradell Reservoir to become dangerously low while leaving ample usable storage in Lake Tappan. Without additional releases from Lake Tappan in excess of the release limits, the only way to maintain the level in Oradell Reservoir is to pump water from the Wanaque South Project, which at times is not sufficient to maintain the required water level.

Diversion is for the purpose of public community water supply and serves the following communities: Alpine, Bergenfield, Bogota, Carlstadt, Cliffside Park, Closter, Cresskill, Demarest, Dumont, East Rutherford, Edgewater, Emerson, Englewood, Englewood Cliffs, Fair Lawn, Fairview, Fort Lee, Franklin Lakes, Hackensack, Hasbrouck Heights, Haworth, Hillsdale, Leonia, Little Ferry, Lodi, Maywood, Montvale, Moonachie, New Milford, Northvale, Norwood, Old Tappan, Oradell, Palisades Park, Paramus, Ridgefield, Ridgefield Park, River Edge, River Vale, Rochelle Park, Rockleigh, Rutherford, Saddle Brook, South Hackensack, Teaneck, Tenafly, Teterboro, Upper Saddle River, Wallington, Washington Township, Westwood, Woodcliff Lake, Wood-Ridge, Guttenberg, Hoboken, North Bergen, Secaucus, Union City, Weehawken and West New York.

Public notice was required due to the request to change the rules governing releases from Lake Tappan.

No requests for a hearing were filed upon the notice published on December 24, 2010 in The Record.

Background/Findings of Fact

1. Water is requested to be diverted under this modified permit for public community supply from the following sources at the maximum rates specified below:

Groundwater

Well Permit No.	Well Name or Designation	Pump Capacity (gpm)	Depth (feet)	Aquifer
2300004135	Emerson 11	170	478	Passaic Formation
2300004815	Haworth 24RW	160	403	Passaic Formation

Surface Water

Intake No.	Source	Maximum Diversion Rate (gpm)	Pump Capacity (gpm)
Intake 1	Hackensack River (Oradell Reservoir)	164,000	154,000
Intake 2	Hirschfield Brook	4,720	4,720

2. This application request is for a renewal of an allocation granted by the following:

Permit No.	Date Issued	Source of Water	Diversion Amount
5111	3/30/1997	Hackensack River, Hirschfield Brook, Wells 11 & 24RW	118 mgd
5111	10/20/1983	Hackensack River, Hirschfield Brook, Wells 11 & 24RW	118 mgd
P-1223	12/16/1981	Haworth 24RW Well	7 mgm
1257	8/19/1965	Emerson 11 Well	0.23 mgd
1239	5/20/1965	Hackensack River	92 mgd
1217	1/21/1965	Hirschfield Brook	2 mgd
239	8/4/1926	Hackensack River	0.5 mgd

The applicant maintains the following permits:

Sources	Allocation MGM	MGY
5081 (5 wells)	53.7	644
5082 (2 wells)	62	
5084 (2 wells and 1 intake)	110	
5088 (4 wells)	39.06	394
5094 (1 intake)	3,875	
5107 (3 wells and 1 intake)	1,574.1	
5111 (2 wells and 4 intakes)	4,860	43,070*
5274 (1 intake)	775	
2225P (4 wells)	16	111

* Includes water pumped under Permit Nos. 5107, 5094, 5084, 5088, 5274 and 2225P.

3. The following information is available for the applicant's diversion sources:

Well No.:	Emerson 11	Haworth 24RW
Well Permit No.:	2300004135	2300004815
Date Constructed:	3/1965	10/1966
Depth (feet):	478	403
Pump Capacity (gpm):	170	160
Site Elevation:	35	21
Static Water Level:		
Date (when constructed):	3/24/1965	10/18/1966
Level (feet):	0	4
Date (recent):	3/30/2007	10/2/2007
Level (feet):	3.5	7.5
Well Test Data: (from well records)		
Test Date:	3/24/1965	10/18/1966
Yield (gpm):	200	195
Drawdown (feet):	78	109
Static Level (feet):	0	4
Pumping Time (hours):	12	26
Specific Capacity: (gpm/ft drawdown)	2.6	1.8

4. The applicant's diversion consists of four reservoirs that are supplemented by several ground and surface water diversions. The diversions are summarized below.

Permit Number 5111, Oradell Reservoir: The Oradell Reservoir is the primary source of water supply for the UWNJ Hackensack System. The reservoir is held back by a concrete dam. Releases from the dam can be made by seven 7' by 9' sluice gates. The raw water intake consists of a concrete intake located approximately 50 feet from the eastern shoreline of Oradell Reservoir. The normal depth of water at the intake is approximately 17 feet. The water is diverted to the Haworth treatment plant via a 96 inch diameter pipe. Three upstream reservoirs, Woodcliff Lake, Lake Tappan and Lake Deforest release water to the Oradell Reservoir. The reservoir is also supplemented by several pump storage wells and 3 intakes regulated under this permit and other permits detailed below.

The capacity and drainage area of the reservoir system is broken down as follows:

Reservoir	Storage Capacity (bg)	Drainage Area (sq mi)
Lake Deforest	5.670	26.6
Lake Tappan	3.853	22.4
Woodcliff Lake	0.871	19.4
Oradell Reservoir	3.507	44.7
Total	13.901	113.1

Emerson 11 and Haworth 24RW wells and Hirschfield Brook Intake:
The Emerson 11 and Haworth 24RW wells are two raw water wells that discharge directly into Oradell Reservoir. The Emerson Well is located to the west of the reservoir and Haworth 24RW well is located to the east of the reservoir on Lake Shore Drive. The wells have a combined diversion limit of 14 mgm. The Hirschfield Brook intake is located at the confluence of Hirschfield Brook and the Hackensack River. The intake utilizes an inflatable dam to divert water to a wet well under two 60 hp pumps and a 25 hp jockey pump. Water is diverted through a 16 inch pipe to Oradell Reservoir. The diversion from these three sources combined can not exceed 730 mgy. The safe yield of the Emerson 11, Haworth 24RW and Hirschfield Brook diversion is estimated to be 2.0 mgd.

Permit Number 5084, Sparkill Creek Intake & Lafayette Street Wells: Surface water is diverted by a 3 mgd pump station on Sparkill Creek located at the end of Danny's Lane. Water is diverted approximately 3,300 feet via a 12 inch diameter pipe to Dorotockeys Run, a tributary of the Hackensack River. The discharge location is approximately 3 miles north of Oradell Reservoir. During a drought year, the safe yield of the Sparkill Creek diversion is estimated at 0.5 mgd.

The Lafayette Street Wells (6 & 7) are located east of Lafayette Street and west of Dorotockeys Run. The wells are permitted to divert 17 mgm and discharge the water into Dorotockeys Run, a tributary of the Hackensack River. The wells are located approximately 1.5 miles north of Oradell Reservoir.

Permit Number 5107, Saddle River Intake & Paramus Wells: The intake is situated on the eastern shore of the Saddle River. UWNJ constructed a weir below the confluence of the Saddle River and Hohokus Brook. The weir causes Hohokus Brook to back up the Saddle River and reverses flow in the stretch of river between the pump station and the confluence when the pump station is operating. Surface water is diverted through a 30 inch diameter force main approximately 3.5 miles from the Saddle River to Musquapsick Brook, a tributary of Pascack Brook. The force main also has a connection to the Oradell Aquaduct where it can be discharged directly to the Oradell Reservoir. The pump station contains three pumps. One pump is rated at 11.7 mgd and two pumps are rated at 11.5 mgd for a combined pumping capacity of 34.7 mgd. Due to hydraulic constraints, the maximum obtainable pumping rate is 22 mgd. The Paramus wells are located adjacent to the Saddle River. The wells discharge to the Saddle River at a point upstream of the dam and the water is captured by the Saddle River intake. The estimated safe yield of the Saddle River diversion is 9.5 mgd.

Permit Numbers 5094 & 5274, Wanaque South Project: UWNJ is 50 percent owner of the Wanaque South Project, a joint venture with North Jersey District Water Supply Commission. At the time of construction, the approved safe yield of the Wanaque South Project was 79 mgd from the Two Bridges Pump Station (located on the Pompton River upstream of the confluence with the Passaic River), an expansion of the Ramapo River Pump Station, and the construction of Monksville Reservoir. As 50 percent owner, UWNJ is entitled to 50 percent of the Wanaque South safe yield, or 39.5 mgd. The water is diverted from the three sources to the Pompton Lakes Pump Station where it is diverted to the Oradell Reservoir via the Oradell Aquaduct.

Permit Number 2225P, Harrington Park and Haworth Heating & Cooling Wells: There are two wells on Old Hook Road and two wells east of McGee Pond. These four wells are used for once through heating and cooling of two buildings. These sources discharge directly into Oradell Reservoir.

Permit Number 5088, Woodcliff Lake and Old Tappan Wells: The Westwood well and Hillsdale well diversions are discharged into Pascack Brook at a location downstream of Woodcliff Lake. The Woodcliff Lake well is discharged directly into Woodcliff Lake Reservoir. The Old Tappan well is a finished water well that is connected to UWNJ's system. The wells are permitted to divert up to 39.06 mgm and 394 mgy.

Emerson Golf Course and Rivervale Country Club: UWNJ allows two golf courses to divert water directly from the reservoirs. Emerson Golf Course is located on the southwestern shore of Oradell Reservoir and Rivervale Country Club is located on the western shore of Lake Tappan. The golf courses are treated as retail customers and do not have any limit on the amount of water they can divert. UWNJ is required to report the water diverted by the golf courses on a monthly basis. This water is counted against UWNJ's total allocation.

The safe yield of the all the wells and surface water sources in permits 5084, 5088 and 2225P is estimated to be 1.0 mgd.

The Bureau has previously determined the safe yield of UWNJ's system to be 118 mgd. The safe yield is broken down as follows:

Source	Safe Yield (mgd)*
Lake Deforest	8
Oradell Reservoir	38
Woodcliff Lake	3.0
Lake Tappan	17
Sparkill Creek, Hirschfield Brook & raw water wells	3.0
Saddle River (22 mgd max. pump capacity)	9.5
Wanaque South Project	39.5
Total	118

* After conservation releases are met.

5a. A review of quarterly diversion reports indicates the following water use from the Emerson 11 Well and Haworth 24RW Well:

Year	Annual Use (mg)	Maximum Monthly Use (mg)	Average Monthly Use (mg)*	Existing Allocation (mgm)	(mgy)
2009	11.642	5.842 (Apr)	1.455 (8)	14	168
2008	39.752	14.190 (Jul)**	4.417 (9)	14	168
2007	86.716	15.147 (Jul)**	12.388 (7)	14	168
2006	16.983	11.151 (Aug)	8.492 (2)	14	168
2005	60.719	15.407 (Aug)**	12.144 (5)	14	168
2004	7.499	5.929 (Jul)	3.750 (2)	14	168

** Values in excess of pump capacity.

5b. A review of quarterly diversion reports indicates the following water use from Hirschfield Brook:

Year	Annual Use (mg)	Maximum Monthly Use (mg)	Average Monthly Use (mg)*	Existing Allocation (mgm)	(mgy)
2009	120.761	56.488 (Apr)	24.152 (5)	210	730
2008	188.317	67.687 (Aug)	37.663 (5)	210	730
2007	269.309	62.258 (Sept)	38.473 (7)	210	730
2006	12.753	12.541 (Jul)	3.188 (4)	210	730
2005	157.582	44.592 (Jul)	26.264 (4)	210	730
2004	7.420	3.536 (Mar)	1.855 (4)	210	730

5c. A review of quarterly diversion reports indicates the following water use from the Emerson 11 Well and Haworth 24RW Well and Hirschfield Brook:

Year	Annual Use (mg)	Maximum Monthly Use (mg)	Average Monthly Use (mg)*	Existing Allocation (mgy)
2009	132.403	62.330 (Apr)	14.711 (5)	730
2008	228.069	81.717 (Aug)	25.341 (9)	730
2007	356.025	75.570 (Sept)	50.861 (7)	730
2006	29.736	12.541 (Jul)	5.947 (5)	730
2005	218.301	59.518 (Jul)	36.384 (6)	730
2004	14.919	7.686 (Jul)	2.984 (5)	730

* (#) indicates the number of months pumping occurred.

5d. A review of quarterly diversion reports indicates the following water use by Emerson Golf Course and Rivervale Country Club:

Year	Annual Use (mg)
2009	63.938
2008	20.3*
2007	51.923
2006	21.494
2005	51.059
2004	33.568

* Usage was not reported for Rivervale Country Club.

Prior to 2009, UWNJ did not keep accurate enough records to determine the monthly usage of the golf courses.

5e. A review of quarterly diversion reports indicates the following total diversion from Oradell Reservoir (Includes golf course diversions in annual & average monthly use only):

Year	Annual Use (mg)	Maximum Monthly Use (mg)	Average Monthly Use (mg)	Existing Allocation (mgm)	(mgy)
2009	36,137.357	3,315.880 (Aug)	3,011.446	4,860	43,070
2008	39,120.990	3,940.224 (Jul)	3,260.083	4,860	43,070
2007	39,091.141	4,022.710 (Jul)	3,257.618	4,860	43,070
2006	37,315.464	3,894.820 (Aug)	3,109.622	4,860	43,070
2005	37,884.459	4,081.430 (Aug)	3,157.038	4,860	43,070
2004	35,959.698	3,505.661 (Jul)	2,996.642	4,860	43,070

5f. A review of quarterly diversion reports indicates the following total water demand for United Water New Jersey's system (includes Oradell Reservoir draft, Saddle River Wells water purchased from Jersey City MUA and Passaic Valley Water Commission):

Year	Annual Use (mg)	Maximum Monthly Use (mg)	Average Monthly Use (mg)
2009	39,520.619	3,768.185 (Aug)	3,293.385
2008	42,224.025	4,375.395 (Jul)	3,518.669
2007	42,313.380	4,257.460 (Jul)	3,454.338
2006	40,302.120	4,303.400 (Aug)	3,358.510
2005	41,452.050	4,458.040 (Aug)	3,454.338
2004	38,692.685	3,896.216 (Jul)	3,224.390

5g. UWNJ reported the following water sold under contracts (Saddle Brook, Fair Lawn, Wallington, Saddle River, Jersey City, PVWC, Allendale, Mahwah, Ramsey and Ridgewood)

Year	Annual Use (mg)	Maximum Monthly Use (mg)	Average Monthly Use (mg)
2009	1,683.022	195.570 (Aug)	136.560
2008	1,654.145	252.534 (Sept)	137.845
2007	1,703.320	229.709 (Jul)	141.943
2006	1,678.255	249.939 (Aug)	139.855
2005	1,416.987	281.895 (Aug)	118.082
2004	921.613	115.890 (Sept)	76.801

5h. A review of quarterly diversion reports indicates the following total water use for United Water New Jersey's system (includes Oradell Reservoir draft, Saddle River Wells, water purchased from Jersey City MUA and Passaic Valley Water Commission, excluding sales):

Year	Annual Use (mg)	Maximum Monthly Use (mg)	Average Monthly Use (mg)
2009	37,881.904	3,572.615 (Aug)	3,156.825
2008	40,569.880	4,174.422 (Jul)	3,380.823
2007	40,661.983	4,027.750 (Jul)	3,388.499
2006	38,645.354	4,053.460 (Aug)	3,220.446
2005	40,086.119	4,207.610 (Sept)	3,340.510
2004	37,771.072	3,780.326 (Jul)	3,147.589

6. The population served by the UWNJ Northeast system is approximately 772,411, which represents an average monthly consumption of 91 gpcd, and a peak monthly consumption of 101 gpcd based upon 2009 water use data, with a 68 percent residential use component.

7. The applicant's diversion sources are located within: Planning Area 6, the Hackensack River planning area as designated by the New Jersey State Water Supply Master Plan; the Northeast Drought Region; and the Hackensack, Hudson and Pascack Watershed Management Area.

8. A site inspection was conducted on September 12, 2008 and December 15, 2009. The following information was obtained during this inspection:

	Condition	Pump House Condition	Pump Type/ Horse Power	Meter Type	Meter Reading
Oradell Intake	Excellent	Excellent	-	Hour	-
Hirschfield Brook Intake	Excellent	Excellent	2 VT	Hour	Pump 1- 2850.8 hrs Pump 2- 52638.3 hrs
Emerson 11	Excellent	Excellent	Sub	Turbine	-
Haworth 24RW	Excellent	None	Sub	Turbine	618500

9. The sources are located as follows:

	State Plane X	State Plane Y	Location
Emerson 11 Well	625549	780289	Glenwood Avenue, Emerson Borough
Haworth 24RW Well	630605	778192	Lake Shore Drive, Haworth Borough
Hirschfield Brook Intake	623915	770397	Pine Avenue, New Milford Borough
Oradell Reservoir Intake	626032	775454	Lake Shore Drive, Haworth Borough

10. Flow meters for all diversion sources have been calibrated within the past 5 years. The Emerson 11 well was calibrated on June 2, 2006. The Haworth 24RW well was calibrated on May 23, 2006. The meter for the Hirschfield Brook diversion was calibrated on January 17, 2008. The raw and finished water meters at the Haworth Plant are calibrated each month.

11. The applicant has failed to comply with existing permit condition no. 17 dealing with failure to maintain the required 12.9 cfs passing flow from Oradell Reservoir as required by existing permit condition no. 17. The minimum flow release from Oradell Reservoir was violated 139 days in 2003, 91 days in 2004, 125 days in 2005, 44 days in 2006, 67 days in 2007, and 30 days in 2008. There were no passing flow violations in 2009. These violations occurred because UWNJ was utilizing a second USGS stream flow gauge on the Hackensack River at New Milford that was maintained and calibrated by USGS but not used in their network. This gauge did not read identical to the other USGS flow gauge at this location that the Department was using to determine the minimum passing flow. UWNJ has since abandoned the gauge they were using and are now using the same gauge that USGS collects and publishes data for. This should eliminate most future passing flow violations.

12. Water, after use, will be discharged to local septic systems and regional sewerage authorities of the municipalities served.

13. The system has the following interconnections with adjacent systems:

Interconnection with	No.	Size	Use
Saddle Brook Water Dept.	1	16"	Normal
	2	8"	Normal
	3	8"	Normal
	4	12"	Normal
Saddle River Water Utility	1	20"	Normal
	2	20"	Normal
Fair Lawn Water Dept.	1	12"	Normal
Wallington Water Dept.	1	8"	Normal

Interconnection with	No.	Size	Use
Passaic Valley Water Comm.	1	20"	Emergency
	2	6"	Emergency
	3	12"	Emergency
	4	6"	Emergency
Jersey City Water Dept.	1	20"	Normal
	2	12"	Normal
United Water NY	1	12"	Normal
	2	6"	Normal
	3	16"	Emergency
Ridgewood Water Dept.	1	6"	Emergency
	2	8"	Emergency
	3	6"	Emergency
	4	6"	Emergency
	5	12"	Emergency
Hoboken/Jersey City	1	20"	Normal
	2	12"	Emergency
Park Ridge Water Dept.	1	8"	Emergency
	2	10"	Emergency
	3	6"	Emergency
	4	6"	Emergency
Oakland Water Dept.	1	8"	Emergency
Ho-Ho-Kus Water Dept.	1	6"	Emergency
Borough of Allendale	1	20"	Normal
Township of Mahwah	1	24"	Normal
Borough of Ramsey	1	24"	Bulk Sale

14. The applicant has agreements for the sale or purchase of water from the following:

Other Contracts With	Sell or Buy	Contract Amount Guaranteed	Contract Amount Guaranteed+ Surplus	2000-2008 Average Purchase	2000-2008 Peak Purchase	Effective Date	Status
Passaic Valley Water Comm.	Buy	Emergency	Emergency	-	-	10/95	Automatic Annual renewal
Jersey City Water Dept.	Buy	7 MGD 2555 MGY	7 MGD 2555 MGY	-	-	3/96	Expires 2011
Park Ridge Water Dept.	Sale	Emergency	Emergency	-	-	5/84	Automatic Annual renewal

Other Contracts With	Sell or Buy	Contract Amount Guaranteed	Contract Amount Guaranteed+ Surplus	2000-2008 Average Purchase	2000-2008 Peak Purchase	Effective Date	Status
Wallington Borough	Sale	Emergency	Emergency	-	-	12/26/50 Amended 12/4/06	12/4/16
Ho-ho-Kus Water Dept.	Sale	Emergency	1 MGD Emergency	-	-	5/88	Automatic Annual renewal
Township of Mahwah	Sale	≤ 0.95 MGD ≤ 29.45 MGM ≤ 346.75 MGY	≤ 4 MGD ≤ 124 MGM ≤ 730 MGY	0.714 MGD* 22.787 MGM 273.450 MGY	1.959 MGD* 62.395 MGM 368.390 MGY	1/02 Amended 2/26/09	Expires 4/17
Fairlawn Water Dept.	Sale	≤ 0.356 MGD ≤ 11.04 MGM ≤130 MGY	≤ 2 MGD ≤ 62 MGM ≤ 730 MGY	0.519 MGD 15.838 MGM 190.058 MGY	1.535 MGD 47.582 MGM 369.003 MGY	8/18/66 Amended 11/24/09**	Automatic Renewal 11/2014**
Saddle River Water Utility	Sale	≤ 0.775 MGD ≤ 16.5 MGM ≤ 146.00 MGY	≤ 1.5 MGD ≤ 46.5 MGM ≤ 547.5 MGY	0.085 MGD 2.590 MGM 30.494 MGY	0.290 MGD 8.986 MGM 49.233 MGY	7/31/97 Amended 11/2009	Expires 7/17
Borough of Allendale	Sale	≤ 0.3 MGD ≤ 9.3 MGM ≤ 109.5 MGY	≤ 1.25 MGD ≤ 38.75 MGM ≤ 456.25 MGY	0.384 MGD*** 11.786 MGM 141.437 MGY	1.297 MGD*** 40.200 MGM 170.469 MGY	12/00	Expires 2015
Ridgewood Water Department	Sale	≤ 0.55 MGD ≤ 17.05 MGM ≤ 200.75 MGY	≤ 3.45 MGD ≤ 106.95 MGM ≤ 529.25 MGY	-	0.893 MGD★ 26.790 MGM 130.931 MGY	3/9/65 Amended 2/05	Expires 2015
Borough of Ramsey	Sale	≤ 0.4 MGD ≤ 12.4 MGM ≤ 146 MGY	≤ 3.5 MGD ≤ 108 MGM ≤ 848 MGY	0.730 MGD★★ 21.478 MGM 229.096 MGY	2.037 MGD★★ 48.676 MGM 326.042 MGY	12/05	Expires 2025
Saddle Brook Water Dept.	Sale	≤ 2.85 MGD ≤ 88 MGM ≤ 625 MGY	-	1.460 MGD 44.822 MGM 537.859 MGY	2.463 MGD 76.339 MGM 580.101 MGY	8/66 Amended 7/7/06	Expires 2016

* 2003-2008 **Subject to execution ***2002-2008 ★ 2008 only ★★ 5/06-2008

15. The system is 100 percent metered.

16. The applicant has indicated that their system wide non-revenue water is 24.8 percent and their unaccounted-for-water is 18.7 percent for a 12 month rolling average ending December 2010. UWNJ should continue to implement the plan and achieve a system wide unaccounted-for-water of 15 percent or less.

17. The water system has storage capacity of 47.35 MG, as compared with a 2009 average water demand of 103 MGD.

18. The applicant submitted a Water Conservation Plan on March 4, 2010.

19. The minimum passing flow requirement for the surface diversions have been established as follows:

Oradell Reservoir

Maintain a minimum flow of 12.9 cfs (8.35 mgd) on a daily average basis on the Hackensack River at New Milford, U.S.G.S. gauge number 01378500. The passing flow is maintained by adjusting the sluice gates. The passing flow requirement is based on the excess diversion law.

Lake Tappan

The flow of the Hackensack River at the point below the Lake Tappan dam is currently required to be maintained at a minimum of 12.4 mgd. The releases from Lake Tappan, except natural spillage, may not exceed the sum of the 23 mgd plus the Lake Deforest Reservoir release. The minimum release of 12.4 mgd can be altered as noted below:

a. If Lake Tappan is below 10% of its capacity, the release from Lake Tappan should not exceed the Lake Deforest release.

b. If Oradell reservoir is spilling or near spilling (i.e. above 95% of capacity), no minimum release from Lake Tappan is required.

c. If Lake Tappan is below 70% of its capacity and Oradell reservoir is above 70% of its capacity, no minimum release from Lake Tappan is required.

The normal release from Lake Deforest is 9.75 mgd of which, 2.0 mgd is allotted for Nyack. This leaves 7.75 mgd as the flow designated for New Jersey.

UWNJ has requested to increase the Lake Tappan maximum release from 23 mgd plus the Lake Deforest release to 60 mgd plus any additional release from Lake Deforest above the normal 9.75 mgd. UWNJ's summer demands can reach up to 150 to 160 mgd during the summer. The maximum release of 30.75 mgd from Lake Tappan plus a peak diversion of 50 mgd from Wanaque South can supply a total of 80.75 mgd of this demand. The remaining demand must be supplied from storage in Oradell Reservoir. This demand causes the storage in Oradell Reservoir to drop quickly and threatens UWNJ's ability to meet summer peak demands while ample storage remains in Lake Tappan. UWNJ must maintain a minimum water elevation in Oradell Reservoir of 9.5 feet (20% of capacity). If the water elevation in Oradell Reservoir drops below this point, UWNJ would be unable to draw enough water through the bottom intake gates to meet demands. While this is the minimum storage needed to meet demands, this should not be considered a target to be maintained. Lower

water levels in Oradell Reservoir also create water quality concerns and excessive algae growth, which requires the application of chemicals to treat and can cause taste and odor issues. The reservoir system must be operated to maintain a sufficient volume of water in Oradell Reservoir to meet demands. If storage in Oradell Reservoir is drawn down to the point that UWNJ is unable to meet the potable demand, any usable storage remaining in the upstream reservoirs (i.e. Lake Tappan and Woodcliff Lake) is of no consequence. Based on data provided, a minimum storage of 44% (elevation 14.7 feet) of capacity should be maintained in Oradell Reservoir. As there is a time delay from when additional water released from Lake Tappan will reach Oradell Reservoir, the storage volume maintained should be greater than the minimum necessary to sustain the demand and maintain acceptable water quality.

Lake Deforest

The State of New York established rules for the release of water from Lake Deforest in the Sixth Modifying Decision to Water Supply Application No. 2189, adopted on November 1, 1982. The rules governing the release from Lake Deforest are as follows:

When the storage in Deforest Reservoir is below the rule curve, a release of 9.75 mgd is to be made. If the Deforest Reservoir storage is above the rule curve at any time of the year and if:

a. combined storage of the three downstream reservoirs is greater than 50% of their capacity, then the release is 9.75 mgd, immediately above the Nyack intake works.

b. combined storage of the three downstream reservoirs is less than 50% of their capacity and at a higher percentage storage than the percentage storage in Deforest, then the release is 15 mgd, below Nyack's intake.

c. combined storage of the three downstream reservoirs is less than 50% of their capacity and at a lower percentage storage than the percentage storage in Deforest, then the release is 25 mgd, below Nyack's intake works.

Hirschfield Brook

On Hirschfield Brook, at the point of diversion, the drainage area is approximately 4.66 square miles and a MA7CD10 of 0.7 mgd (1.1 cfs) was determined in the original permit issued on January 21, 1965. At that time, a minimum passing flow was not established.

20. At the point of diversion, the water quality classification is FW2-NT(C1).

21. There are no diversions between Lake Tappan and Oradell Reservoir.

22. UWNJ has 5 permits (5094, 5274, 5084, 5088, and 2225P) that discharge water directly to or to tributaries that feed Oradell Reservoir. There are no sewerage treatment plants upstream of Oradell Reservoir. The Hackensack River is tidal downstream of USGS gage 01378500.

23. The estimated system wide consumptive use of water is 100 percent, which is equivalent to 111.1 mgd based on 2008 water usage.

24. UWNJ has requested this permit be renewed with an expiration date of 20 years from the date of issuance. The UWNJ has just completed a major renovation project at the Haworth Treatment Plant and additional renovations at the Upper Saddle River wells and other infrastructure. UWNJ has invested a significant amount of money to finance the projects. A 20-year permit is needed to ensure the diversion available while UWNJ is amortizing these new investments.

Staff Analysis and Conclusions

1. The applicant's failure to maintain the required passing flow below Oradell Reservoir has been addressed by UWNJ by abandoning the stream flow gauge they were using to monitor the passing flow and connecting their monitoring system to the USGS flow gauge at the same location that USGS publishes data for and that the Bureau uses for confirmation of compliance with the permit condition. This should eliminate most future violations.

2. In 1997, the maximum passing flow for Lake Tappan was established as 23 mgd plus the Lake Deforest release. When added to the minimum release available for New Jersey of 7.75 mgd release from Lake Deforest, a total maximum release of 30.75 mgd is permitted from Lake Tappan. This makes no allowance for increased releases as seasonal demand increases. The applicant requests they be permitted to release up to 60 mgd at all times plus any increase in the release from Lake Deforest above the normal 9.75 mgd release. The Bureau has concerns that increasing the release from Lake Tappan in this manner could exhaust the storage in the lake too early in the summer. The Bureau agrees, as discussed in Findings of Fact No. 19 above, that an increase in the maximum passing flow is necessary, and proposes the following more conservative conditions to allow for increased releases from Lake Tappan.

   The release rules governing the operation of Lake Tappan should be modified to include the following exception to the release rules:

   - The maximum release from Lake Tappan can be increased up to 52 mgd plus the Lake Deforest release at times when the percent of storage in Lake Tappan exceeds that of the Oradell Reservoir by 10 percent or more.

   - The maximum release from Lake Tappan can be increased up to 52 mgd plus the Lake Deforest release at times when the Oradell Reservoir is below 45 percent of its capacity regardless of Lake Tappan storage.

3. The applicant's current water use is reasonable.

4. The applicant's current allocation may not be adequate to meet their future demands. Demand projections provided by the applicant indicate that their ten year demands (for permits 5081, 5082, 5084, 5088, 5094, 5107, 5111, 5274 and 2225P) will be 4,030 mgm, and 47,450 mgy with a peak month demand of 5,158 mgm. According to the Bureau of Water Systems and Well Permitting UWNJ has approved water main extension projects with a combined demand of 169.914 mgm and 1,332.252 mgy. Including the Upper Saddle River wells and bulk purchases from Jersey City, UWNJ has an available supply of 46,318.5 mgy and 5,139 mgm. UWNJ's 10 year demand projections indicate they will exceed their available supply within the next 10 years if the projections prove to be

accurate and an additional source of supply is not obtained. UWNJ is actively pursuing several supply options available to them including the expansion of the Wanaque South Pump Station, Dundee Water Treatment Plant & additional supply though wholesale contracts. Development of these options would allow UWNJ to meet the projected supply demand.

5. Public community water supply systems are in the public interest because they are generally safer and more reliable than individual domestic wells that are not subject to the same testing, monitoring and standards as a public community supply well. Historically the Department has viewed local governmental approval of a project as signifying that it is in the public interest. Therefore the proposed diversion is considered to be in the public interest in accordance with N.J.A.C. 7:19-2.2(f)1.

6. The applicant reviewed the potential effects of a change in reservoir level on the fish population in Lake Tappan and came to the following conclusions. Lake Tappan presently supports a warm water fishery comprised of black bass, sunfishes, bullheads, carp and a variety of minnows with carp being the dominate species. Lake Tappan has been used as a water supply reservoir since it was built in 1966, and the species existing in the lake can respond quickly following major drawdowns. The increased release would increase the frequency and duration of these drawdown periods and will likely disrupt fish spawning by reducing the water elevation causing fish to abandon their nests. The applicant notes the fish species should recover as long as the duration of the low water elevations does not persist for several consecutive seasons. However, the spawning season should typically not overlap with the high demand water season when the fluctuations in water level would be expected to occur. The increased frequency and duration of the drawdown may also cause several bird species including bald eagles and ospreys that are known to forage along Lake Tappan to move to other feeding locations.

7. The request to increase the release from Lake Tappan to 60 mgd is not expected to create problems for downstream water users because the applicant is proposing to increase the flow in the Hackensack River between Lake Tappan and Oradell Reservoir. There are no permitted withdrawals on the Hackensack River between Lake Tappan and Oradell Reservoir.

   Therefore, the proposed diversion is just and equitable to the other surface water users as it does not adversely affect other existing withdrawals, in accordance with N.J.A.C. 7:19-2.2(f)3.

   Therefore, approval of this application at the recommended rates is in accordance with N.J.A.C. 7:19-2.2(f)3.

8. The proposed diversion is located within Planning Area 4 of the New Jersey Statewide Water Supply Plan, August 1996 (NJSWSP). According to the NJSWSP, in Area 4, Hackensack River, due to extensive interconnections, Area 4 has been combined with areas 5 and 6. In these three areas, a surplus of 107 mgd exists. The NJSWSP recommends generating a model of the Passaic and Hackensack Rivers be developed to evaluate the regions reservoirs, promote water conservation, and work to preserve and improve the water quality up-stream of potable supply intakes.

   The request to increase the maximum release from Lake Tappan will allow UWNJ to better manage the reservoir system and meet peak demands from Oradell Reservoir. Therefore, this application is in accordance with N.J.A.C. 7:19-2.2(h).

9. The applicant has no alternate source of water capable of supplying their demand.

10. This permit should be issued with an expiration of 20 years of the effective date.

Summary

The Department has completed its review of this application pursuant to N.J.A.C. 7:19-1 et. seq. The review of this application reveals that it does not have any adverse impacts and meets, based upon the information certified to in the application, the statutory requirements of N.J.S.A. 58:1A-1 et. seq.

Therefore, based upon a review of the information submitted with the application and existing water allocation files, the following conclusions have been reached regarding this application:

- The applicant's maximum diversion rate of 154,000 gpm from the Oradell Reservoir should be approved as previously permitted.
- The applicant's monthly allocation of 4,860 mgm from the Oradell Reservoir should be renewed as previously permitted.
- The applicant's annual allocation of 43,070 mgy from the Oradell Reservoir should be renewed as previously permitted.
- The applicant should maintain a minimum daily average passing flow of 12.9 cfs on the Hackensack River as measured at the U.S.G.S. stream gage number 01378500 at New Milford.
- The applicant's monthly allocation of 14 mgm from wells Emerson 11 and Haworth 24RW should be approved as previously permitted.
- The applicant's annual allocation of 730 mgy from wells Emerson 11 and Haworth 24RW and Hirschfield Brook should be approved as previously permitted.
- The maximum diversion rate from well Haworth 24RW should be limited to 160 gpm as previously permitted.
- The maximum diversion rate from well Emerson 11 should be limited to 170 gpm as previously permitted.
- The minimum passing flows for the Hackensack River below Lake Tappan Reservoir should be revised as described in the Staff Analysis and Conclusions Section number 2 above and the Findings of Fact Section number 19 above.
- The applicant should continue to be required to report the monthly diversions by Rivervale Country Club and Emerson Golf Course.

- The applicant should continue to reduce their unaccounted-for water to more acceptable levels. This should be added as a requirement within the Water Conservation and Drought Management Plan.

- The applicant should be required to submit a Water Supply System Plan that details how future demands will be met.

Therefore this application should be approved in accordance with the following recommendations as the applicant has satisfied the requirements of N.J.A.C. 7:19-2.2 et seq.

References

In addition to the historical information on file at the Bureau of Water Allocation and the application submitted, the following information sources were also utilized to establish the recommendations contained within this Staff Report:

Bureau of Water Systems and Well Permitting PWSID No. 0238001

March 1, 2001. The New Jersey State Development and Redevelopment Plan. New Jersey State Planning Commission, Trenton, New Jersey.

August 1996. Water for the 21st Century: Vital Resource, New Jersey Statewide Water Supply Plan. New Jersey Department of Environmental Protection – Office of Environmental Planning, Trenton, New Jersey.

Recommendations

Issuance of the permit is recommended with an expiration date of 20 years from the effective date and is subject to the attached specific conditions:

JGO 2/16/11
dy 2/28/11

Date: 2/15/11

Robert Hudgins
Bureau of Water Allocation

Administrative Hearing Request Checklist
And Tracking Form for Permits

1. Permit Being Appealed:

_____
Title and Type of Permit

_____ _____
Issuance Date of Permit Permit Number

2. Person Requesting Hearing:

_____ _____
Name/Company Name of Attorney (if applicable)

_____ _____

_____ _____
Address Address of Attorney

3. The following information must be included with the request:

   a. The date the permittee received the final permit;
   b. A copy of permit with a list of all permit conditions and issues contested;
   c. The legal and factual questions at issue;
   d. A statement as to whether or not the permittee raised each legal and factual issues during the public comment period of the permit;
   e. Suggested revised or alternative permit conditions;
   f. An estimate of the time required for the hearing;
   g. A request, if necessary, for a barrier-free hearing location for physically disabled persons;
   h. A clear indication of any willingness to negotiate a settlement with the Department prior to the Department's processing of the hearing request to the Office of Administrative Law; and
   i. This form, completed with all of the information listed above, signed, and dated, including attachments, to:

      i. Office of Legal Affairs
         ATTENTION: Adjudicatory Hearing Requests
         Department of Environmental Protection
         401 East State Street
         P.O. Box 402
         Trenton, New Jersey 08625-0402

      ii. Diane E. Zalaskus, P.E.
         Division of Water Supply
         Bureau of Water Allocation
         P.O. Box 426
         Trenton, New Jersey 08625

      iii. All co-permittees (w/attachments)

4. Signature: _____ Date: _____

APPENDIX F

ANNUAL FLOOD DATA AT PARK RIDGE, HILLSDALE AND WESTWOOD GAUGING STATIONS (SOURCE U.S. GEOLOGICAL SURVEY)

USGS Home
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National Water Information System: Web Interface

USGS Water Resources

Data Category: Surface Water
Geographic Area: New Jersey
GO

News updated July, 2011

Peak Streamflow for New Jersey

ALL DATA ARE AT LOCAL TIME

*****INFORMATION ON HURRICANE IRENE 2011*****

USGS 01377370 Pascack Brook at Park Ridge NJ

Available data for this site Surface-water: Peak streamflow GO

Bergen County, New Jersey
Hydrologic Unit Code 02030103
Latitude 41°02'12", Longitude 74° 02'21" NAD83
Drainage area 13.4 square miles
Gage datum 129.9 feet above NGVD29

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1945	Jul. 23, 1945		1,300[7,8,E]
1999	Sep. 16, 1999		5,660[7,E]
2005	Jul. 18, 2005	5.84	2,190
2006	Oct. 08, 2005	5.37	1,600
2007	Apr. 16, 2007	6.03	2,450
2008	Sep. 06, 2008	5.82	2,160
2009	May 07, 2009	5.05	1,240
2010	Aug. 22, 2010	5.60	1,880[E]

Peak Streamflow Qualification Codes.

- 7 -- Discharge is an Historic Peak
- 8 -- Discharge actually greater than indicated value
- E -- Only Annual Maximum Peak available for this year

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U.S. Department of the Interior | U.S. Geological Survey
Title: Surface Water for New Jersey: Peak Streamflow
URL: http://nwis.waterdata.usgs.gov/nj/nwis/peak?

Page Contact Information: New Jersey Water Data Maintainer
Page Last Modified: 2011-10-18 09:51:03 EDT
0.18 0.17 nadww01

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National Water Information System: Web Interface

USGS Water Resources

Data Category: Surface Water
Geographic Area: New Jersey
GO

News updated July, 2011

Peak Streamflow for New Jersey

ALL DATA ARE AT LOCAL TIME

INFORMATION ON HURRICANE IRENE 2011

USGS 01377460 Pascack Brook at Hillsdale NJ

Available data for this site | Surface-water: Peak streamflow | GO

Bergen County, New Jersey
Hydrologic Unit Code 02030103
Latitude 41°00'06", Longitude 74° 02'35" NAD83
Drainage area 20.7 square miles
Gage datum 55 feet above NAVD88

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format

Water Year	Date	Gage Height (feet)	Stream - flow (cfs)	Water Year	Date	Gage Height (feet)	Stream - flow (cfs)
1999	Sep. 16, 1999	15.48	7,610[5]	2005	Jul. 18, 2005	10.49	1,360[5]
2000	Jul. 30, 2000	7.36	412[5]	2006	Oct. 12, 2005	11.14	1,600[5]
2001	Mar. 30, 2001	9.05	950[5]	2007	Apr. 16, 2007	12.90	2,820[5]
2002	Jul. 19, 2002	6.45[4]	208[4]	2008	Sep. 06, 2008	9.39	908[5]
2003	Jan. 02, 2003	10.36	1,220[5]	2009	Jun. 18, 2009	10.77	1,370[5]
2004	Jul. 23, 2004	11.69	1,830[5]	2010	Aug. 23, 2010	10.35	1,220[5]

Peak Gage-Height Qualification Codes.

- 4 -- Gage height below minimum recordable elevation

Peak Streamflow Qualification Codes.

- 4 -- Discharge less than indicated value, which is Minimum Recordable Discharge at this site
- 5 -- Discharge affected to unknown degree by Regulation or Diversion

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U.S. Department of the Interior | U.S. Geological Survey
Title: Surface Water for New Jersey: Peak Streamflow
URL: http://nwis.waterdata.usgs.gov/nj/nwis/peak?

Page Contact Information: New Jersey Water Data Maintainer
Page Last Modified: 2011-10-11 10:52:35 EDT
0.2 0.18 nadww01

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USGS Water Resources

Data Category: Surface Water | Geographic Area: New Jersey | GO

News updated July, 2011

Peak Streamflow for New Jersey

ALL DATA ARE AT LOCAL TIME

*****INFORMATION ON HURRICANE IRENE 2011*****

USGS 01377500 Pascack Brook at Westwood NJ

Available data for this site | Surface-water: Peak streamflow | GO

Bergen County, New Jersey
Hydrologic Unit Code 02030103
Latitude 40°59'34", Longitude 74° 01'16" NAD83
Drainage area 29.6 square miles
Gage datum 28.62 feet above NGVD29

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format

Water Year	Date	Gage Height (feet)	Stream - flow (cfs)	Water Year	Date	Gage Height (feet)	Stream - flow (cfs)
1999	Sep. 16, 1999	12.22	9,630[5]	2005	Jul. 19, 2005	4.65	1,170[5]
2000	Jul. 30, 2000	4.37	900[5]	2006	Oct. 13, 2005	5.33	1,600[5]
2001	Jun. 17, 2001	4.87	1,200[5]	2007	Apr. 16, 2007	7.36	3,260[5]
2002	Jul. 19, 2002	3.29	407[5]	2008	Sep. 07, 2008	4.90	1,320[5]
2003	Jan. 02, 2003	4.73	1,110[2,5]	2009	Dec. 12, 2008	5.09	1,440[5]
2004	Jul. 23, 2004	5.96	2,020[5]	2010	Aug. 23, 2010	5.02	1,330[5]

Peak Streamflow Qualification Codes.

- 2 -- Discharge is an Estimate
- 5 -- Discharge affected to unknown degree by Regulation or Diversion

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U.S. Department of the Interior | U.S. Geological Survey

Title: Surface Water for New Jersey: Peak Streamflow
URL: http://nwis.waterdata.usgs.gov/nj/nwis/peak?

Page Contact Information: New Jersey Water Data Maintainer
Page Last Modified: 2011-10-12 16:02:34 EDT
0.18 0.18 nadww01

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National Water Information System: Web Interface

USGS Water Resources

Data Category: Surface Water | Geographic Area: New Jersey | GO

News updated July, 2011

Peak Streamflow for New Jersey

ALL DATA ARE AT LOCAL TIME

*****INFORMATION ON HURRICANE IRENE 2011*****

USGS 01377500 Pascack Brook at Westwood NJ

Available data for this site Surface-water: Peak streamflow GO

Bergen County, New Jersey
Hydrologic Unit Code 02030103
Latitude 40°59'34", Longitude 74° 01'16" NAD83
Drainage area 29.6 square miles
Gage datum 28.62 feet above NGVD29

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format

Water Year	Date	Gage Height (feet)	Stream - flow (cfs)	Water Year	Date	Gage Height (feet)	Stream - flow (cfs)
1935	Oct. 05, 1934	2.78	216[5]	1973	Feb. 03, 1973	6.75	1,940[5]
1936	Mar. 12, 1936	5.53	1,190[5]	1974	Dec. 21, 1973	6.08	1,590[5]
1937	May 15, 1937	3.92	547[5]	1975	Sep. 27, 1975	4.86	1,050[5]
1938	Sep. 22, 1938	5.37	1,120[5]	1976	Jul. 01, 1976	5.01	1,110[5]
1939	Dec. 06, 1938	3.77	496[5]	1977	Mar. 23, 1977	4.76	1,010[5]
1940	Mar. 15, 1940	4.81	893[5]	1978	Nov. 08, 1977	6.24	1,790[5]
1941	Feb. 08, 1941	3.90	547[5]	1979	Jan. 21, 1979	4.49	898[5]
1942	Aug. 17, 1942	4.28	613[5]	1980	Apr. 10, 1980	4.11	683[5]
1943	Dec. 31, 1942	4.30	620[5]	1981	May 12, 1981	4.73	950[5]

1944	Apr. 25, 1944	4.16	571[5]	1982	Jan. 04, 1982	3.72	533[5]
1945	Jul. 23, 1945	6.76	1,610[5]	1983	Apr. 16, 1983	4.06	663[5]
1946	Jul. 23, 1946	4.98	813[5]	1984	Jul. 07, 1984	4.97	1,290[5]
1947	Apr. 06, 1947	3.84	451[5]	1985	Sep. 27, 1985	4.46	828[5]
1948	Apr. 02, 1948	3.52	368[5]	1986	Nov. 17, 1985	4.25	739[5]
1949	Jan. 06, 1949	3.67	405[5]	1987	Apr. 04, 1987	5.36	1,250[5]
1950	Mar. 23, 1950	3.03	266[5]	1988	Jul. 22, 1988	4.05	659[5]
1951	Mar. 31, 1951	6.50	1,470[5]	1989	May 17, 1989	5.51	1,650[5]
1952	Jun. 01, 1952	5.75	1,120[5]	1990	May 16, 1990	4.86	1,190[5]
1953	Mar. 13, 1953	5.90	1,180[5]	1991	Mar. 04, 1991	4.87	1,200[5]
1954	Sep. 12, 1954	4.15	535[5]	1992	Sep. 03, 1992	3.67	559[5]
1955	Aug. 19, 1955	6.06	1,190[5]	1993	Nov. 23, 1992	4.60	1,030[5]
1956	Oct. 16, 1955	6.45	1,330[5]	1994	Jan. 28, 1994	4.43	937[5]
1957	Apr. 06, 1957	3.72	410[5]	1995	Jan. 20, 1995	3.97	704[5]
1958	Feb. 28, 1958	5.37	1,120[5]	1996	Jan. 19, 1996	4.96	1,250[5]
1959	Mar. 07, 1959	3.20	390[5]	1997	Oct. 20, 1996	4.74	1,120[5]
1960	Sep. 12, 1960	5.09	976[5]	1998	May 10, 1998	4.50	973[5]
1961	Apr. 16, 1961	4.17	638[5]	1999	Sep. 16, 1999	12.22	9,630[5]
1962	Mar. 13, 1962	4.98	926[5]	2000	Jul. 30, 2000	4.37	900[5]
1963	Mar. 06, 1963	4.15	470[5]	2001	Jun. 17, 2001	4.87	1,200[5]
1964	Nov. 07, 1963	3.64	486[5]	2002	Jul. 19, 2002	3.29	407[5]
1965	Feb. 08, 1965	3.70	503[5]	2003	Jan. 02, 2003	4.73	1,110[2,5]
1966	Sep. 21, 1966	3.65	489[5]	2004	Jul. 23, 2004	5.96	2,020[5]
1967	Mar. 06, 1967	3.78	532[5]	2005	Jul. 19, 2005	4.65	1,170[5]
1968	May 29, 1968	6.61	1,640[5]	2006	Oct. 13, 2005	5.33	1,600[5]
1969	Mar. 25, 1969	4.96	1,040[5]	2007	Apr. 16, 2007	7.36	3,260[5]
1970	Apr. 03, 1970	5.40	1,240[5]	2008	Sep. 07, 2008	4.90	1,320[5]
1971	Sep. 12, 1971	7.57	2,440[5]	2009	Dec. 12, 2008	5.09	1,440[5]
1972	Jun. 19, 1972	5.34	1,260[5]	2010	Aug. 23, 2010	5.02	1,330[5]

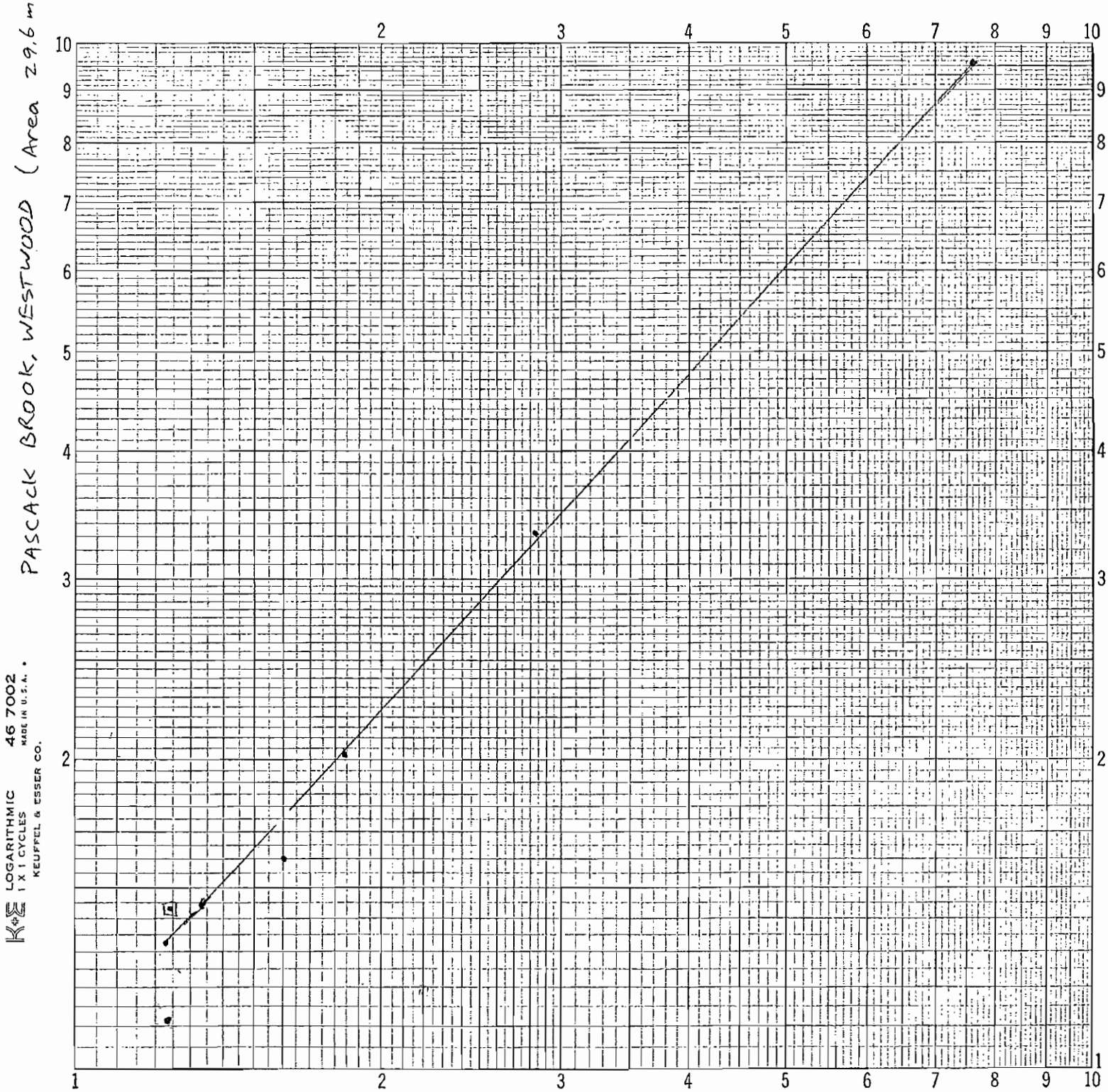
Peak Streamflow Qualification Codes.

- 2 -- Discharge is an Estimate
- 5 -- Discharge affected to unknown degree by Regulation or Diversion

---

Questions about sites/data? Data Tips

$Q \sim A^{0.67}$



PASCACK BROOK, HILLSDALE

(Area 20.7 mi²)

APPENDIX G

REALTIME FLOOD DATA AT PARK RIDGE AND WESTWOOD GAUGING STATIONS

PERIOD – JUNE - SEPTEMBER, 2011

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USGS Water Resources
Data Category: Real-time
Geographic Area: New Jersey
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INFORMATION ON HURRICANE IRENE 2011

USGS 01377370 Pascack Brook at Park Ridge NJ

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site | Time-series: Real-time data | GO

Estimated flood stage is 4.5 feet.Occasional dips in stage may be due to operation of hydroelectric generators at site.

Rain gage data is available from this location at this link.

LOCATION. --Lat 41°02'12", long 74° 02'21" referenced to North American Datum of 1983, Park Ridge Borough, Bergen County, NJ, Hydrologic Unit 02030103, at right end of Mill Pond Dam at the western outflow of Silver Lake (Electric Lake), 0.4 mi east of Park Ridge, and 0.5 mi upstream of Woodcliff Lake.
DRAINAGE AREA. --13.4 mi2.
PERIOD OF RECORD. --April 2004 to current year.
GAGE. --Water-stage recorder and concrete dam. Datum of gage is 129.9 above NGVD of 1929.
EXTREMES OUTSIDE PERIOD OF RECORD. --Flood of July 23,

1945 reached a discharge of approximately 1,300 ft3/s (as reported by New Jersey State Water Policy Commission; dam failed, discharge may have been greater). Flood of September 16, 1999 reached a discharge of 5,730 ft3/s (based on slope-area computation upstream of Grand Avenue, 0.5 mi upstream from gage, adjusted for change in drainage area).
COOPERATION. --Funding for this gage is provided by the New Jersey Department of Environmental Protection.

Boating Safety Tips

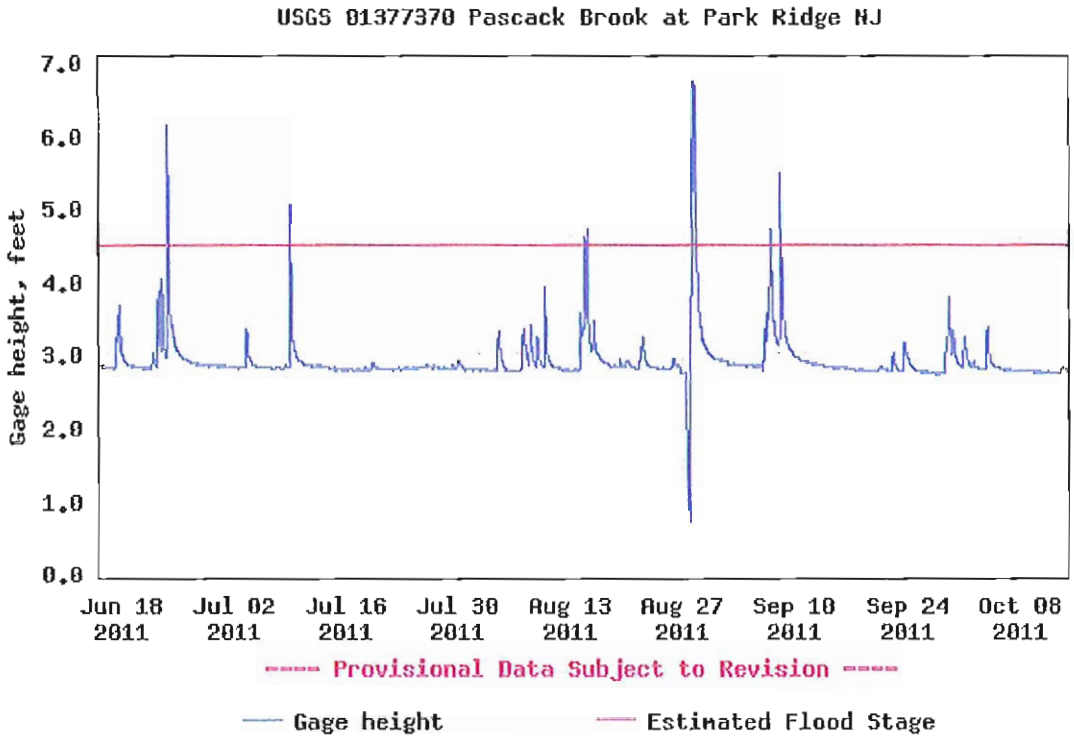
This station managed by the West Trenton, NJ Water Science Center.

Available Parameters	Output format	Days	
☐ All 2 Available Parameters for this site	◉ Graph	120	
☑ 00065 Gage height	○ Graph w/ stats	(1-120)	GO
☑ 00060 Discharge	○ Graph w/o stats		
	○ Table		
	○ Tab-separated		

Summary of all available data for this site

Gage height, feet

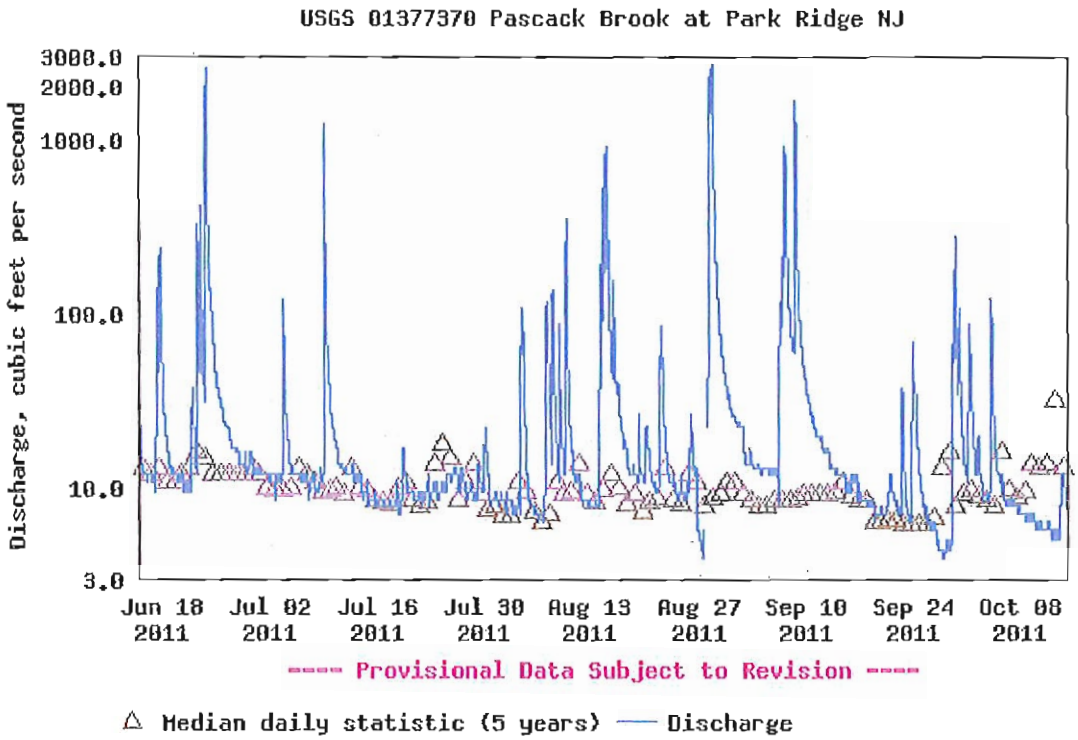
Most recent instantaneous value: 2.79 10-13-2011 20:00 EDT



Create presentation-quality / stand-alone graph. Subscribe to WaterAlert

Discharge, cubic feet per second

Most recent instantaneous value: 8.7 10-13-2011 20:00 EDT



Create presentation-quality / stand-alone graph. Subscribe to WaterAlert

Daily discharge statistics, in cfs, for Oct 13 based on 5 years of record more

Min (2009)	Most Recent Instantaneous Value Oct 13	25th percen-tile	Median	Mean	75th percen-tile	Max (2006)
8.1	8.7	8.9	13	73	166	317

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URL: http://waterdata.usgs.gov/nj/nwis/uv?

Page Contact Information: New Jersey Water Data Support Team

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USGS Water Resources
Data Category: Real-time
Geographic Area: New Jersey
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ALL DATA ARE AT LOCAL TIME

INFORMATION ON HURRICANE IRENE 2011

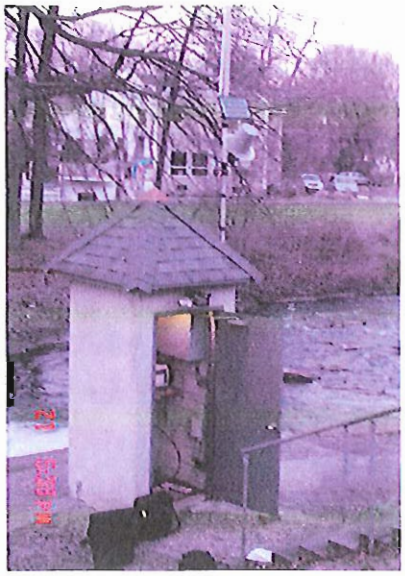
USGS 01377500 Pascack Brook at Westwood NJ

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site Time-series: Real-time data GO

National Weather Service flood stage for this gage is 5 feet. Reservoir releases from Woodcliff Lake are included in the flow at this gage.

LOCATION. --Lat 40°59'34", long 74°01'16" referenced to North American Datum of 1983, Westwood Borough, Bergen County, NJ, Hydrologic Unit 02030103, on right bank 75 ft upstream from bridge on Harrington Avenue in Westwood, 500 ft downstream from Musquapsink Brook, and 2.3 mi upstream from mouth.
DRAINAGE AREA. --29.6 mi2.
PERIOD OF RECORD. --October 1934 to current year.
GAGE. --Water-stage recorder, crest-stage gage, and concrete control. Datum of gage is 28.62 ft above NGVD of 1929.
COOPERATION. --Funding for this gage is provided by Bergen County New Jersey and United Water New Jersey.



Boating Safety Tips

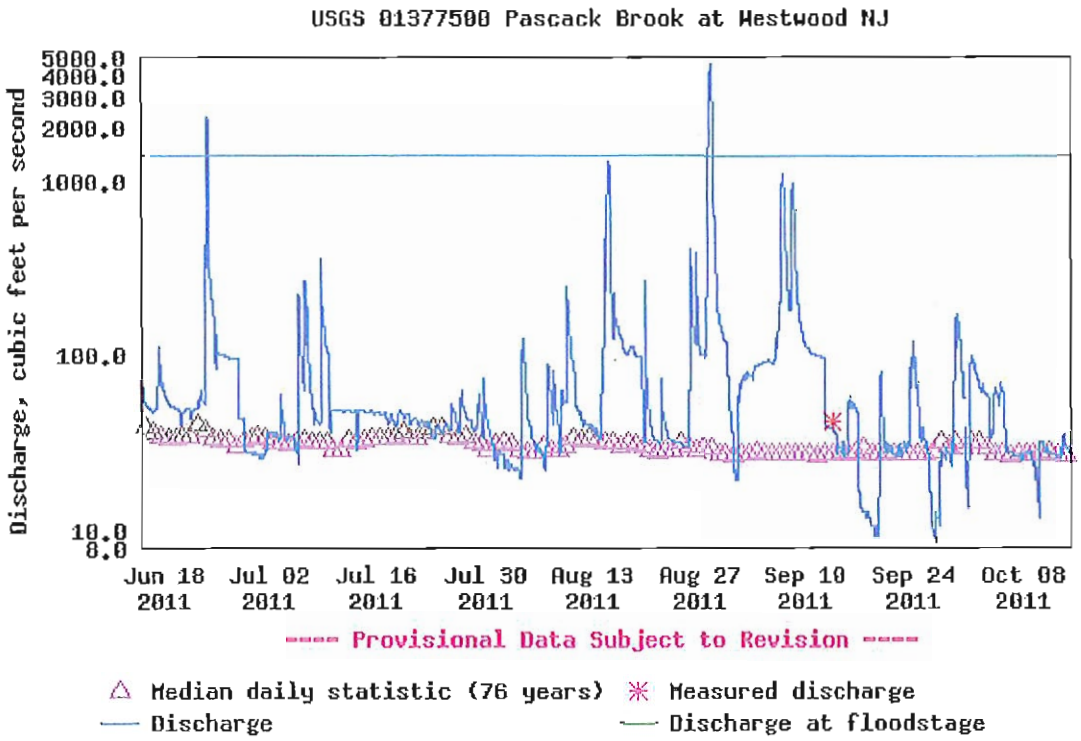
This station managed by the West Trenton, NJ Water Science Center.

Available Parameters	Output format	Days	
☐ All 2 Available Parameters for this site	◉ Graph	120	
☑ 00060 Discharge	○ Graph w/ stats	(1-120)	GO
☑ 00065 Gage height	○ Graph w/o stats		
	○ Table		
	○ Tab-separated		

Summary of all available data for this site

Discharge, cubic feet per second

Most recent instantaneous value: 29 10-13-2011 19:45 EDT



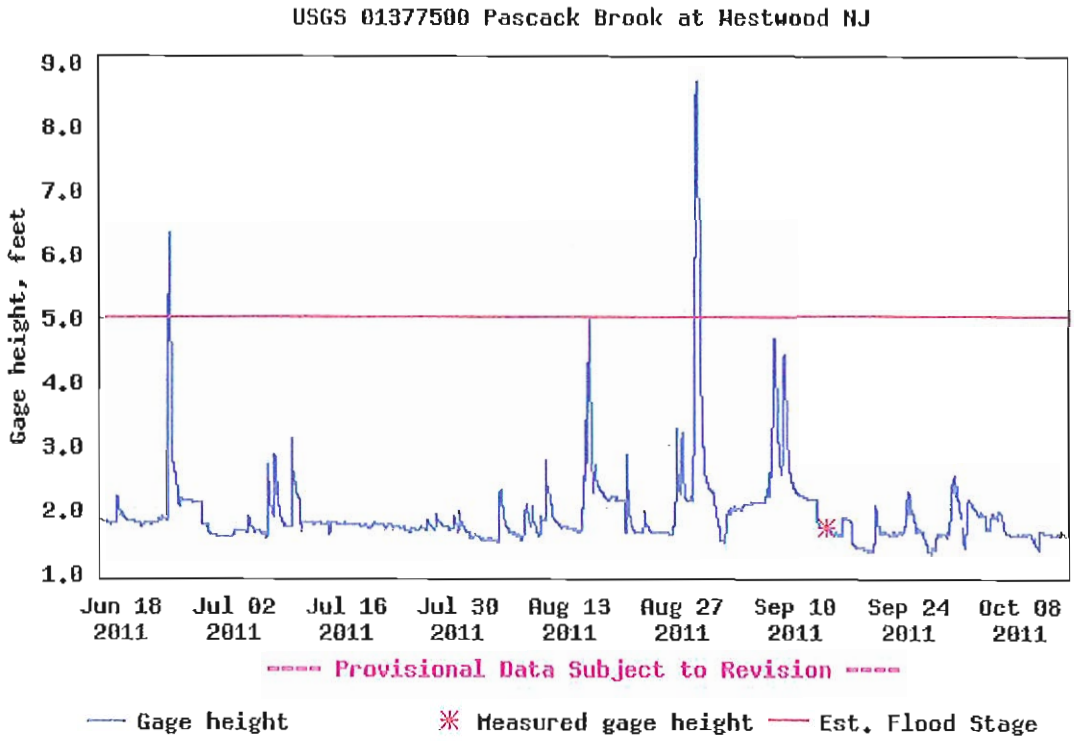
Create presentation-quality / stand-alone graph. Subscribe to WaterAlert

Daily discharge statistics, in cfs, for Oct 13 based on 76 years of record more

Min (1965)	25th percen-tile	Median	Most Recent Instantaneous Value Oct 13	75th percen-tile	Mean	Max (2006)
7.8	20.	28	29	38	45	968

Gage height, feet

Most recent instantaneous value: 1.58 10-13-2011 19:45 EDT



Create presentation-quality / stand-alone graph. Subscribe to WaterAlert

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Help

Data Tips
Explanation of terms
News

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U.S. Department of the Interior | U.S. Geological Survey

Title: USGS Real-Time Water Data for New Jersey
URL: http://waterdata.usgs.gov/nj/nwis/uv?

Page Contact Information: New Jersey Water Data Support Team
Page Last Modified: 2011-10-13 20:21:33 EDT
1.8 0.71 caww02

Data obtained from the U.S.G.S. Database for Gage 01377370 on the Pascack Brook at Park Ridge, NJ

Agency	Site No.	Date & Time	TZ	Gage Height (ft)	Discharge (cfs)
USGS	1377370	6/23/2011 9:00	EDT	2.99	36
USGS	1377370	6/23/2011 9:15	EDT	2.98	35
USGS	1377370	6/23/2011 9:30	EDT	2.98	35
USGS	1377370	6/23/2011 9:45	EDT	2.98	35
USGS	1377370	6/23/2011 10:00	EDT	2.97	33
USGS	1377370	6/23/2011 10:15	EDT	2.97	33
USGS	1377370	6/23/2011 10:30	EDT	2.96	31
USGS	1377370	6/23/2011 10:45	EDT	2.96	31
USGS	1377370	6/23/2011 11:00	EDT	2.96	31
USGS	1377370	6/23/2011 11:15	EDT	2.96	31
USGS	1377370	6/23/2011 11:30	EDT	3.02	41
USGS	1377370	6/23/2011 11:45	EDT	3.26	95
USGS	1377370	6/23/2011 12:00	EDT	3.78	288
USGS	1377370	6/23/2011 12:15	EDT	4.74	944
USGS	1377370	6/23/2011 12:30	EDT	5.1	1290
USGS	1377370	6/23/2011 12:45	EDT	5.26	1470
USGS	1377370	6/23/2011 13:00	EDT	5.12	1320
USGS	1377370	6/23/2011 13:15	EDT	5.28	1490
USGS	1377370	6/23/2011 13:30	EDT	5.21	1410
USGS	1377370	6/23/2011 13:45	EDT	5.42	1660
USGS	1377370	6/23/2011 14:00	EDT	5.66	1960
USGS	1377370	6/23/2011 14:15	EDT	5.79	2120
USGS	1377370	6/23/2011 14:30	EDT	5.92	2300
USGS	1377370	6/23/2011 14:45	EDT	5.84	2190
USGS	1377370	6/23/2011 15:00	EDT	5.67	1970
USGS	1377370	6/23/2011 15:15	EDT	6.12	2580
USGS	1377370	6/23/2011 15:30	EDT	5.85	2200
USGS	1377370	6/23/2011 15:45	EDT	6.06	2500
USGS	1377370	6/23/2011 16:00	EDT	5.94	2330
USGS	1377370	6/23/2011 16:15	EDT	5.87	2230
USGS	1377370	6/23/2011 16:30	EDT	5.84	2190
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USGS	1377370	6/23/2011 17:30	EDT	5.2	1400
USGS	1377370	6/23/2011 17:45	EDT	5.19	1390
USGS	1377370	6/23/2011 18:00	EDT	5.12	1320
USGS	1377370	6/23/2011 18:15	EDT	4.93	1120
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USGS	1377370	6/23/2011 20:15	EDT	3.88	338
USGS	1377370	6/23/2011 20:30	EDT	3.81	302
USGS	1377370	6/23/2011 20:45	EDT	3.77	283
USGS	1377370	6/23/2011 21:00	EDT	3.73	265
USGS	1377370	6/23/2011 21:15	EDT	3.71	255
USGS	1377370	6/23/2011 21:30	EDT	3.68	242
USGS	1377370	6/23/2011 21:45	EDT	3.65	229
USGS	1377370	6/23/2011 22:00	EDT	3.63	221
USGS	1377370	6/23/2011 22:15	EDT	3.62	217
USGS	1377370	6/23/2011 22:30	EDT	3.59	205
USGS	1377370	6/23/2011 22:45	EDT	3.57	197
USGS	1377370	6/23/2011 23:00	EDT	3.56	193
USGS	1377370	6/23/2011 23:15	EDT	3.54	185
USGS	1377370	6/23/2011 23:30	EDT	3.52	178
USGS	1377370	6/23/2011 23:45	EDT	3.5	170
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USGS	1377370	6/24/2011 0:15	EDT	3.48	163
USGS	1377370	6/24/2011 0:30	EDT	3.47	160
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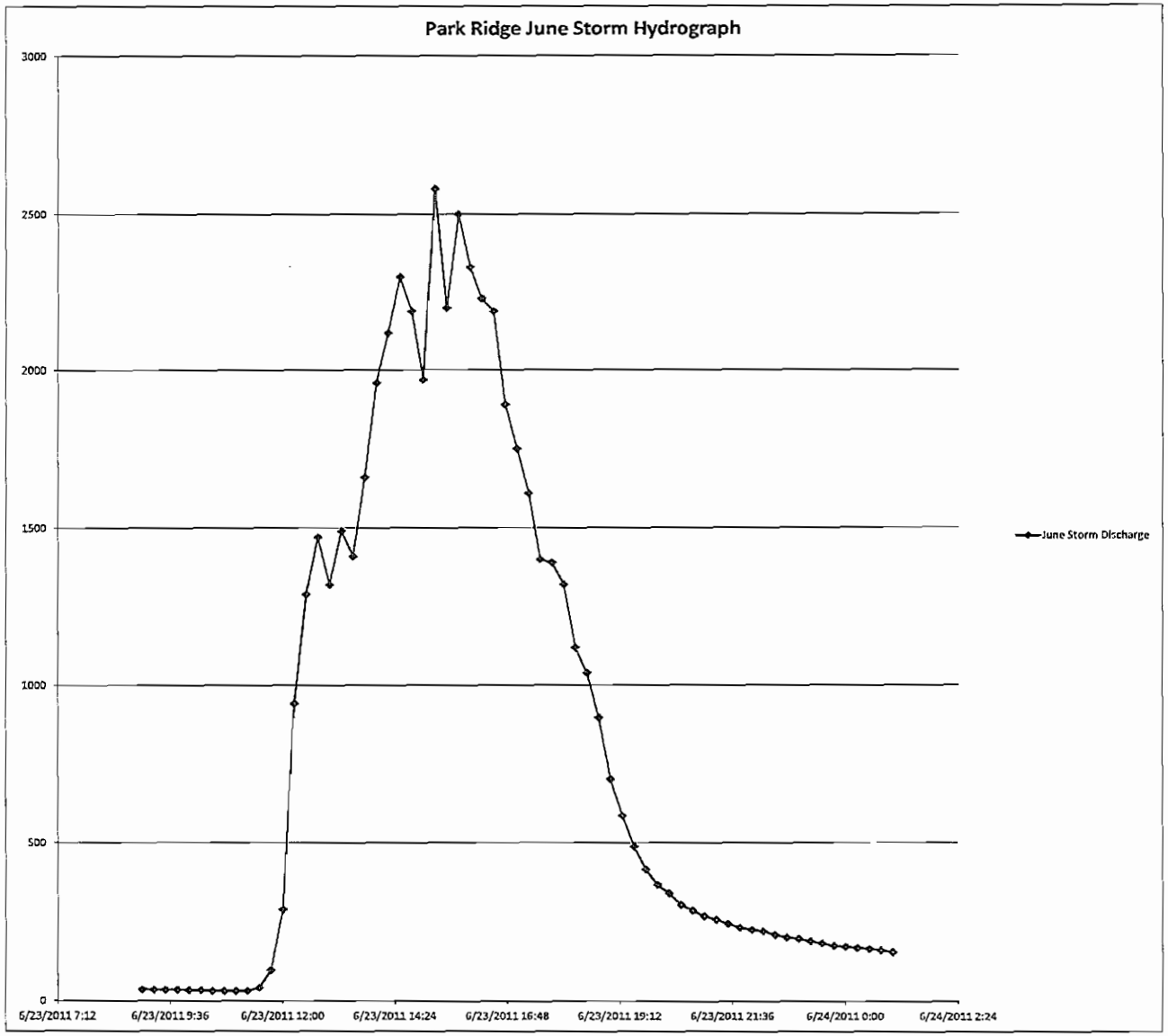

Data obtained from the U.S.G.S. Database for Gage 01377500 on the Pascack Brook at Westwood, NJ

Agency	Site No.	Date & Time	TZ	Gage Height (ft)	Discharge (cfs)
USGS	1377500	6/23/2011 11:00	EDT	1.8	53
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USGS	1377500	6/23/2011 12:00	EDT	1.83	56
USGS	1377500	6/23/2011 12:15	EDT	1.88	63
USGS	1377500	6/23/2011 12:30	EDT	2.12	100
USGS	1377500	6/23/2011 12:45	EDT	2.55	192
USGS	1377500	6/23/2011 13:00	EDT	2.94	303
USGS	1377500	6/23/2011 13:15	EDT	3.24	407
USGS	1377500	6/23/2011 13:30	EDT	3.3	430
USGS	1377500	6/23/2011 13:45	EDT	3.26	415
USGS	1377500	6/23/2011 14:00	EDT	3.16	378
USGS	1377500	6/23/2011 14:15	EDT	3.06	343
USGS	1377500	6/23/2011 14:30	EDT	3	322
USGS	1377500	6/23/2011 14:45	EDT	3.14	370
USGS	1377500	6/23/2011 15:00	EDT	3.66	581
USGS	1377500	6/23/2011 15:15	EDT	4.04	762
USGS	1377500	6/23/2011 15:30	EDT	4.3	901
USGS	1377500	6/23/2011 15:45	EDT	4.5	1020
USGS	1377500	6/23/2011 16:00	EDT	4.68	1120
USGS	1377500	6/23/2011 16:15	EDT	4.84	1210
USGS	1377500	6/23/2011 16:30	EDT	5	1310
USGS	1377500	6/23/2011 16:45	EDT	5.16	1420
USGS	1377500	6/23/2011 17:00	EDT	5.3	1510
USGS	1377500	6/23/2011 17:15	EDT	5.42	1590
USGS	1377500	6/23/2011 17:30	EDT	5.54	1680
USGS	1377500	6/23/2011 17:45	EDT	5.95	1980
USGS	1377500	6/23/2011 18:00	EDT	5.99	2010
USGS	1377500	6/23/2011 18:15	EDT	6.09	2090
USGS	1377500	6/23/2011 18:30	EDT	6.15	2130
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USGS	1377500	6/23/2011 19:15	EDT	6.29	2250
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USGS	1377500	6/23/2011 20:45	EDT	6.28	2240
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USGS	1377500	6/23/2011 22:00	EDT	5.56	1690
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USGS	1377500	6/23/2011 22:30	EDT	5.19	1440
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USGS	1377500	6/23/2011 23:45	EDT	3.92	702
USGS	1377500	6/24/2011 0:00	EDT	3.67	585
USGS	1377500	6/24/2011 0:15	EDT	3.47	498
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USGS	1377500	6/24/2011 1:30	EDT	3.03	332
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USGS	1377500	6/24/2011 2:15	EDT	2.88	284
USGS	1377500	6/24/2011 2:30	EDT	2.82	266
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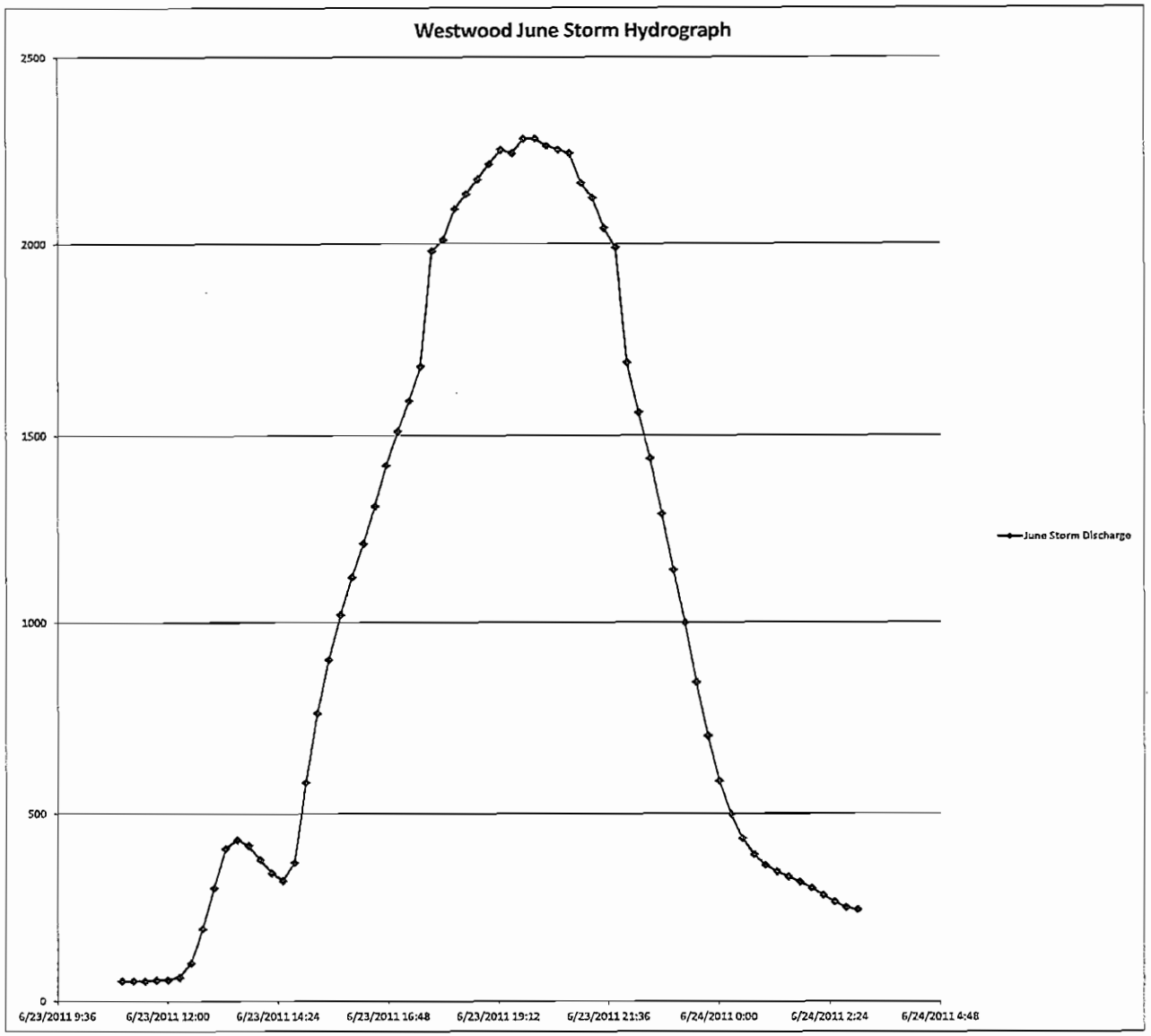

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ISGS	01377500	2011-08-28 04:00		EDT	1160	P	4.75	P
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JSGS	01377500	2011-08-28 04:45		EDT	1410	P	5.15	P
JSGS	01377500	2011-08-28 05:00		EDT	1520	P	5.32	P
JSGS	01377500	2011-08-28 05:15		EDT	1630	P	5.47	P
JSGS	01377500	2011-08-28 05:30		EDT	1730	P	5.62	P
JSGS	01377500	2011-08-28 05:45		EDT	1980	P	5.95	P
JSGS	01377500	2011-08-28 06:00		EDT	1980	P	5.95	P
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USGS	01377500	2011-08-28 18:45	EDT	2110	P	6.12	P
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USGS	01377500	2011-08-28 19:15	EDT	1960	P	5.92	P
USGS	01377500	2011-08-28 19:30	EDT	1750	P	5.65	P
USGS	01377500	2011-08-28 19:45	EDT	1660	P	5.52	P
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USGS	01377500	2011-08-28 20:15	EDT	1500	P	5.29	P
USGS	01377500	2011-08-28 20:30	EDT	1420	P	5.17	P
USGS	01377500	2011-08-28 20:45	EDT	1330	P	5.02	P
USGS	01377500	2011-08-28 21:00	EDT	1250	P	4.89	P
USGS	01377500	2011-08-28 21:15	EDT	1160	P	4.74	P
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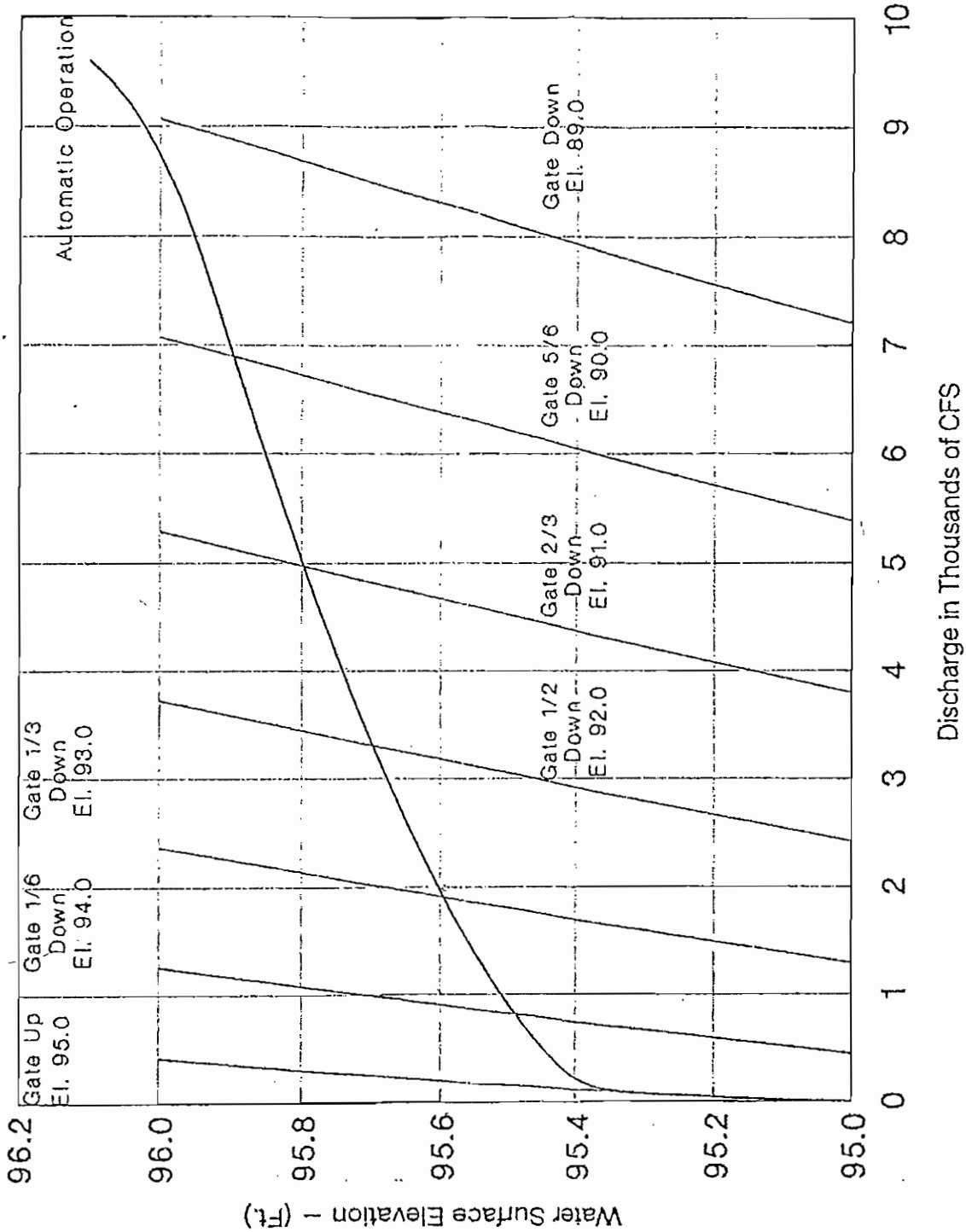
USGS	01377						

APPENDIX H

FLOOD ROUTING THROUGH WOODCLIFF LAKE RESERVOIR

JUNE 23, 2011 AND JULY 8, 2011 STORMS



Prepared By: Buck, Seifert & Jost, Inc.
November 1993

Gates lower automatically for WSE between 95.5 feet and 96.0 feet
Discharge = C*L*h ^ 3/2 3.2<C<3.95, L = L(eff), h = WSE – GCE

L = 65 ft × 2 gates = 130 ft

Curves indicate flow over both gates, for different sustained gate crest elevations, or Automatic Operation of the gates.
GCE = Gate Crest Elevation

Figure No. 2B
Woodcliff Lake Dam
Bascule Gate Discharge Rating Curve

Figure No. 3
Woodcliff Lake Dam
Reservoir Storage

Water Surface Elev. (Ft.)	Reservoir Storage Volume (MG)	Reservoir Storage Volume (Acre-Ft)
67.87	2.1	6.6
68	2.1	6.4
68.5	2.3	7.0
69	3.1	9.5
69.5	4.5	13.8
70	6.6	20.1
70.5	9.2	28.3
71	12.5	38.5
71.5	16.5	50.6
72	21.1	64.7
72.5	26.3	80.8
73	32.2	98.9
73.5	38.8	119.0
74	46.0	141.1
74.5	53.8	165.2
75	62.4	191.4
75.5	71.5	219.5
76	81.4	249.7
76.5	91.9	281.9
77	103.0	316.1
77.5	114.8	352.3
78	127.2	390.5
78.5	140.3	430.6
79	154.0	472.7
79.5	168.4	516.8
80	183.4	562.8
80.5	199.0	610.7
81	215.2	660.5
81.5	232.1	712.1
82	249.5	765.6
82.5	267.5	820.9
83	286.1	878.0
83.5	305.3	936.9
84	325.0	997.4
84.5	345.3	1,059.7
85	366.1	1,123.6
85.5	387.5	1,189.1
86	409.3	1,256.2
86.5	431.7	1,324.8
87	454.5	1,394.8
87.5	477.8	1,466.4
88	501.6	1,539.3
88.5	525.8	1,613.5
89	550.4	1,689.0
89.5	575.4	1,765.8

Water Surface Elev. (Ft.)	Reservoir Storage Volume (MG)	Reservoir Storage Volume (Acre-Ft)
90	600.8	1,843.7
90.5	626.5	1,922.7
91	652.6	2,002.8
91.5	679.0	2,083.9
92	705.8	2,165.9
92.5	732.8	2,248.8
93	760.0	2,332.5
93.5	787.5	2,416.9
94	815.3	2,501.9
94.5	843.2	2,587.6
95	871.2	2,673.7
95.5	899.5	2,760.3
96	927.8	2,847.2
96.5	956.2	2,934.4
97	984.7	3,021.8
97.5	1,013.2	3,109.3
98	1,041.7	3,196.8
98.5	1,070.2	3,284.2
99	1,098.6	3,371.5
99.5	1,127.0	3,458.5
100	1,155.2	3,545.2
100.5	1,183.3	3,631.4
101	1,211.2	3,717.0
101.5	1,238.9	3,802.0
102	1,266.4	3,886.3
102.5	1,293.5	3,969.7
103	1,320.4	4,052.1
103.5	1,346.9	4,133.5
104	1,373.0	4,213.7
104.5	1,398.7	4,292.6
105	1,424.0	4,370.0
105.5	1,448.8	4,446.0
106	1,473.0	4,520.4
106.5	1,496.6	4,592.9
107	1,519.7	4,663.6
107.5	1,542.0	4,732.3
108	1,563.7	4,798.9
108.5	1,584.7	4,863.2
109	1,604.9	4,925.1
109.5	1,624.2	4,984.5
110	1,642.7	5,041.3

BY H.P. DATE 10/18/11 SHEET NO. 1 OF

CHKD. DATE JOB NO. WW532

SUBJECT FLOOD OF JUNE 23, 2011

ESTIMATED INFLOW HYDROGRAPH

AT WOODCLIFF LAKE RESERVOIR

Time hrs		Q_{PR} cfs	Q_R (1)
11:45	0	95	123
12:00	0.25	288	374
12:15	0.5	944	1227
12:30	0.75	1290	1677
12:45	1.0	1470	1911
13:00	1.25	1320	1716
13:15	1.50	1490	1937
13:30	1.75	1410	1833
13:45	2.0	1660	2158
14:00	2.25	1960	2548
14:15	2.50	2120	2756
14:30	2.75	2300	2990
14:45	3.0	2190	2847
15:00	3.25	1970	2561
15:15	3.50	2580	3354
15:30	3.75	2200	2860
15:45	4.0	2500	3250
16:00	4.25	2330	3029
16:15	4.50	2230	2899
16:30	4.75	2190	2847
16:45	5.0	1890	2457
17:00	5.25	1750	2275
17:15	5.50	1610	2093
17:30	5.75	1400	1820
17:45	6.0	1390	1807
18:00	6.25	1320	1716

(1) $Q_R = Q_{PR} (19.6/13.4)^{0.67} = 1.3\, Q_{PR}$

BY _____ DATE 10/6/11 SHEET NO. _____ OF _____

CHKD. _____ DATE _____ JOB NO. _____

SUBJECT _____

Woodcliff Lake Reservoir

Stage - Storage - Discharge Relation

Automatic Operation *

Elev.	Storage Ac-ft	Discharge
68	6.4	0
89	1,689	0
90	1,844	
91	2,003	
92	2,166	
93	2,333	
94	2,502	
95	2,674	0
95.4	2,743	200
95.5	2,760	1000
95.6	2,778	2000
95.7	2,795	3500
95.8	2,813	5000
95.9	2,830	7000

Effective storage =

2830 − 2674 = 156 Ac-ft

≃ 6.8×10^6 cf

* gates lower automatically for W.S.El. between 95.2' and 96.0'

```
*****************************************
*                                       *
*         WOODCLIFF LAKE RESERVOIR      *
*           JUNE 23, 2011 STORM         *
*             BOTH GATES OPEN           *
*   BOSWELL ENGINEERING, S. HACKENSACK,NJ *
*                                       *
*****************************************
```

Inflow Hydrograph: A:WL-JUNE .HYD
Rating Table file: A:WL-RES .PND

----INITIAL CONDITIONS----
Elevation = 95.00 ft
Outflow = 0.00 cfs
Storage = 2673.70 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
95.00	0.0	2673.700
95.40	200.0	2743.000
95.50	1000.0	2760.300
95.60	2000.0	2778.000
95.70	3500.0	2795.000
95.80	5000.0	2813.000
95.90	7000.0	2830.000

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
258814.2	258814.2
265522.4	265722.4
267197.0	268197.0
268910.4	270910.4
270556.0	274056.0
272298.4	277298.4
273944.0	280944.0

Time increment (t) = 0.250 hrs.

Pond File: A:WL-RES .PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT .HYD

INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
0.000	123.00
0.250	374.00
0.500	1227.00
0.750	1677.00
1.000	1911.00
1.250	1716.00
1.500	1937.00
1.750	1833.00
2.000	2158.00
2.250	2548.00
2.500	2756.00
2.750	2990.00
3.000	2847.00
3.250	2561.00
3.500	3354.00
3.750	2860.00
4.000	3250.00
4.250	3029.00
4.500	2899.00
4.750	2847.00
5.000	2457.00
5.250	2275.00
5.500	2093.00
5.750	1820.00
6.000	1807.00
6.250	1716.00

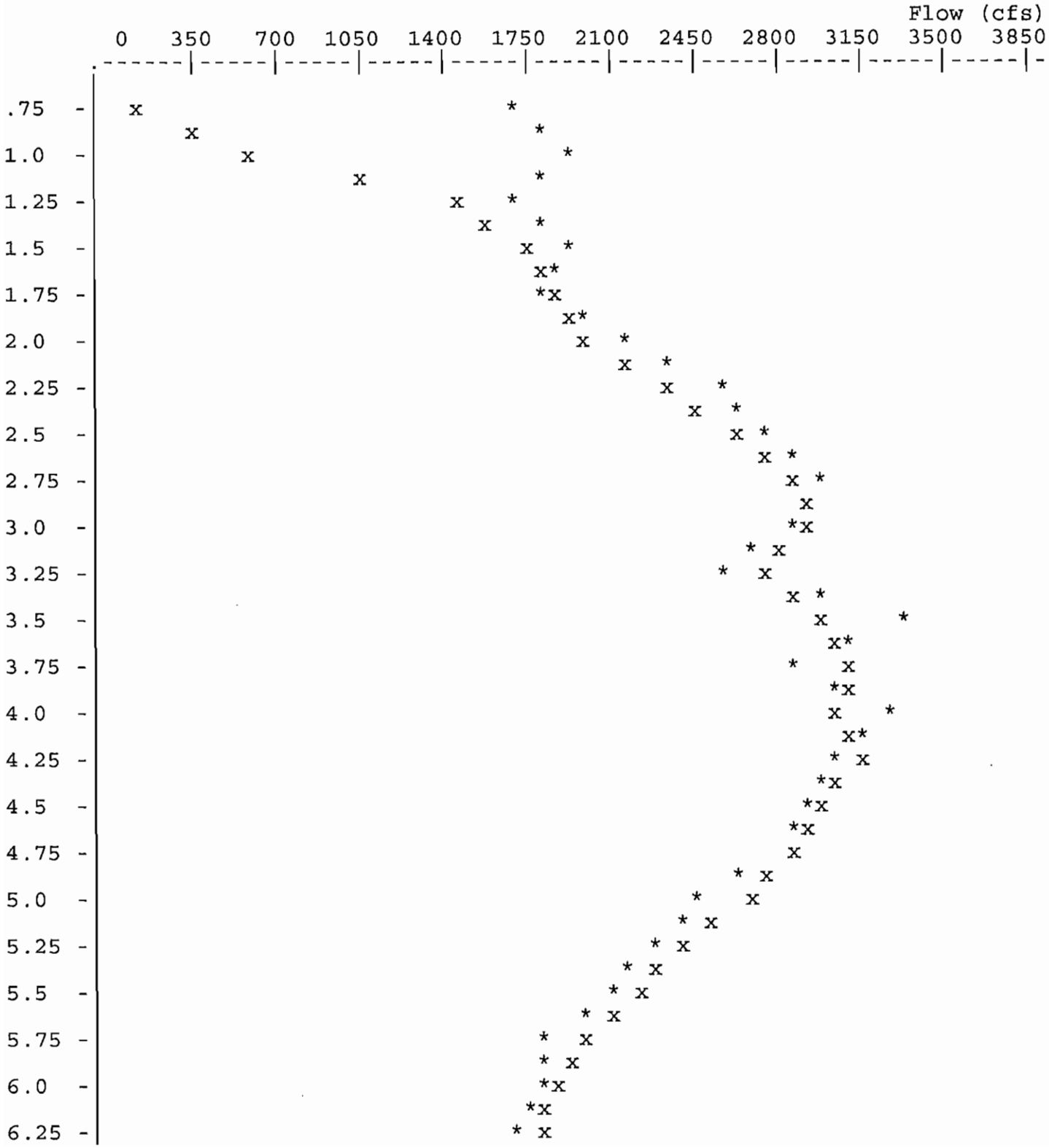
ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
-----	258814.2	258814.2	0.00	95.00
497.0	259282.4	259311.2	14.39	95.03
1601.0	260763.6	260883.4	59.91	95.12
2904.0	263386.6	263667.6	140.51	95.28
3588.0	265765.0	266974.6	604.79	95.45
3627.0	266511.2	269392.0	1440.38	95.54
3653.0	266714.2	270164.2	1724.99	95.57
3770.0	266798.4	270484.2	1842.93	95.58
3991.0	266878.6	270789.4	1955.39	95.60
4706.0	266941.6	271584.6	2321.49	95.62
5304.0	266972.2	272245.6	2636.70	95.64
5746.0	266994.1	272718.2	2862.06	95.66
5837.0	266999.3	272831.1	2915.89	95.66
5408.0	266979.7	272407.3	2713.81	95.65
5915.0	267002.3	272894.7	2946.22	95.66
6214.0	267017.1	273216.3	3099.56	95.67
6110.0	267013.0	273127.1	3057.06	95.67
6279.0	267020.6	273292.0	3135.68	95.68
5928.0	267004.8	272948.6	2971.95	95.66
5746.0	266995.6	272750.8	2877.58	95.66
5304.0	266974.7	272299.6	2662.44	95.64
4732.0	266947.3	271706.7	2379.72	95.63
4368.0	266929.1	271315.3	2193.06	95.61
3913.0	266892.5	270842.1	1974.84	95.60
3627.0	266807.6	270519.5	1855.92	95.59
3523.0	266758.0	270330.6	1786.32	95.58

Pond File: A:WL-RES .PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT .HYD

EXECUTED: 11-02-2011
09:22:30

Peak Inflow = 3354.00 cfs
Peak Outflow = 3135.68 cfs
Peak Elevation = 95.68 ft



********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: A:WL-RES .PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT .HYD

Starting Pond W.S. Elevation = 95.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 3354.00 cfs
Peak Outflow = 3135.68 cfs
Peak Elevation = 95.68 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 2673.70 ac-ft
Peak Storage From Storm = 117.17 ac-ft

Total Storage in Pond = 2790.87 ac-ft

Warning: Inflow hydrograph truncated on left side.
Warning: Inflow hydrograph truncated on right side.

						PARK RIDGE		W.L, RES,	Time
19	P								
USGS	01377370	2011-07-08 17:45	EDT	3.15	P	68	P	88	0
USGS	01377370	2011-07-08 18:00	EDT	3.56	P	193	P	251	0.25
USGS	01377370	2011-07-08 18:15	EDT	4.09	P	456	P	593	0.50
USGS	01377370	2011-07-08 18:30	EDT	4.47	P	719	P	935	0.75
USGS	01377370	2011-07-08 18:45	EDT	4.58	P	806	P	1048	1.0
USGS	01377370	2011-07-08 19:00	EDT	4.63	P	848	P	1102	1.25
USGS	01377370	2011-07-08 19:15	EDT	4.57	P	798	P	1037	1.50
USGS	01377370	2011-07-08 19:30	EDT	4.66	P	874	P	1136	1.75
USGS	01377370	2011-07-08 19:45	EDT	4.87	P	1060	P	1378	2.0
USGS	01377370	2011-07-08 20:00	EDT	4.94	P	1130	P	1469	2.25
USGS	01377370	2011-07-08 20:15	EDT	4.97	P	1160	P	1508	2.50
USGS	01377370	2011-07-08 20:30	EDT	5.04	P	1230	P	1599	2.75
USGS	01377370	2011-07-08 20:45	EDT	5.04	P	1230	P	1599	3.0
USGS	01377370	2011-07-08 21:00	EDT	5.00	P	1190	P	1547	3.25
USGS	01377370	2011-07-08 21:15	EDT	4.90	P	1090	P	1417	3.50
USGS	01377370	2011-07-08 21:30	EDT	4.82	P	1020	P	1326	3.75
USGS	01377370	2011-07-08 21:45	EDT	4.72	P	926	P	1204	4.0
USGS	01377370	2011-07-08 22:00	EDT	4.57	P	798	P	1037	4.25
USGS	01377370	2011-07-08 22:15	EDT	4.37	P	643	P	836	4.50
USGS	01377370	2011-07-08 22:30	EDT	4.13	P	481	P	625	4.75
USGS	01377370	2011-07-08 22:45	EDT	3.99	P	397	P	516	5.0
USGS	01377370	2011-07-08 23:00	EDT	3.86	P	327	P	425	5.25
USGS	01377370	2011-07-08 23:15	EDT	3.74	P	269	P	350	5.50
USGS	01377370	2011-07-08 23:30	EDT	3.67	P	238	P	309	5.75
USGS	01377370	2011-07-08 23:45	EDT	3.61	P	213	P	277	6.0
USGS	01377370	2011-07-09 00:00	EDT	3.55	P	189	P		
USGS	01377370	2011-07-09 00:15	EDT	3.50	P	170	P		
USGS	01377370	2011-07-09 00:30	EDT	3.47	P	160	P		
USGS	01377370	2011-07-09 00:45	EDT	3.43	P				

EXECUTED: 11-02-2011 08:31:09

```
*****************************************
*                                       *
*        WOODCLIFF LAKE RESERVOIR       *
*          JULY 8,  2011 STORM          *
*            BOTH GATES OPEN            *
*   BOSWELL ENGINEERING, S. HACKENSACK,NJ *
*                                       *
*****************************************
```

Inflow Hydrograph: A:WL-JUL8 .HYD
Rating Table file: A:WL-RES .PND

----INITIAL CONDITIONS----
Elevation = 95.00 ft
Outflow = 0.00 cfs
Storage = 2673.70 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
95.00	0.0	2673.700
95.40	200.0	2743.000
95.50	1000.0	2760.300
95.60	2000.0	2778.000
95.70	3500.0	2795.000
95.80	5000.0	2813.000
95.90	7000.0	2830.000

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
258814.2	258814.2
265522.4	265722.4
267197.0	268197.0
268910.4	270910.4
270556.0	274056.0
272298.4	277298.4
273944.0	280944.0

Time increment (t) = 0.250 hrs.

EXECUTED: 11-02-2011 08:31:09

Pond File: A:WL-RES .PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT .HYD

INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
0.000	88.00
0.250	251.00
0.500	593.00
0.750	935.00
1.000	1048.00
1.250	1102.00
1.500	1037.00
1.750	1136.00
2.000	1378.00
2.250	1469.00
2.500	1508.00
2.750	1599.00
3.000	1599.00
3.250	1547.00
3.500	1417.00
3.750	1326.00
4.000	1204.00
4.250	1037.00
4.500	836.00
4.750	625.00
5.000	516.00
5.250	425.00
5.500	350.00
5.750	309.00
6.000	277.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
-----	258814.2	258814.2	0.00	95.00
339.0	259133.5	259153.2	9.81	95.02
844.0	259910.2	259977.5	33.68	95.07
1528.0	261286.2	261438.2	75.97	95.15
1983.0	263011.3	263269.2	128.98	95.26
2150.0	264793.8	265161.3	183.75	95.37
2139.0	265750.2	266932.8	591.29	95.45
2173.0	266100.3	267923.2	911.47	95.49
2514.0	266306.7	268614.3	1153.76	95.52
2847.0	266448.6	269153.7	1352.58	95.54
2977.0	266520.0	269425.6	1452.77	95.55
3107.0	266573.0	269627.0	1527.02	95.55
3198.0	266610.9	269771.0	1580.08	95.56
3146.0	266607.1	269756.9	1574.86	95.56
2964.0	266558.3	269571.1	1506.41	95.55
2743.0	266487.4	269301.3	1406.97	95.54
2530.0	266412.7	269017.4	1302.32	95.53
2241.0	266317.1	268653.7	1168.30	95.52
1873.0	266194.6	268190.1	997.76	95.50
1461.0	266005.7	267655.6	824.96	95.48
1141.0	265825.8	267146.7	660.44	95.46
941.0	265691.5	266766.8	537.63	95.44
775.0	265585.4	266466.5	440.56	95.43
659.0	265506.9	266244.4	368.75	95.42
586.0	265453.4	266092.9	319.77	95.41

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: A:WL-RES .PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT .HYD

Starting Pond W.S. Elevation = 95.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 1599.00 cfs
Peak Outflow = 1580.08 cfs
Peak Elevation = 95.56 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 2673.70 ac-ft
Peak Storage From Storm = 96.87 ac-ft

Total Storage in Pond = 2770.57 ac-ft

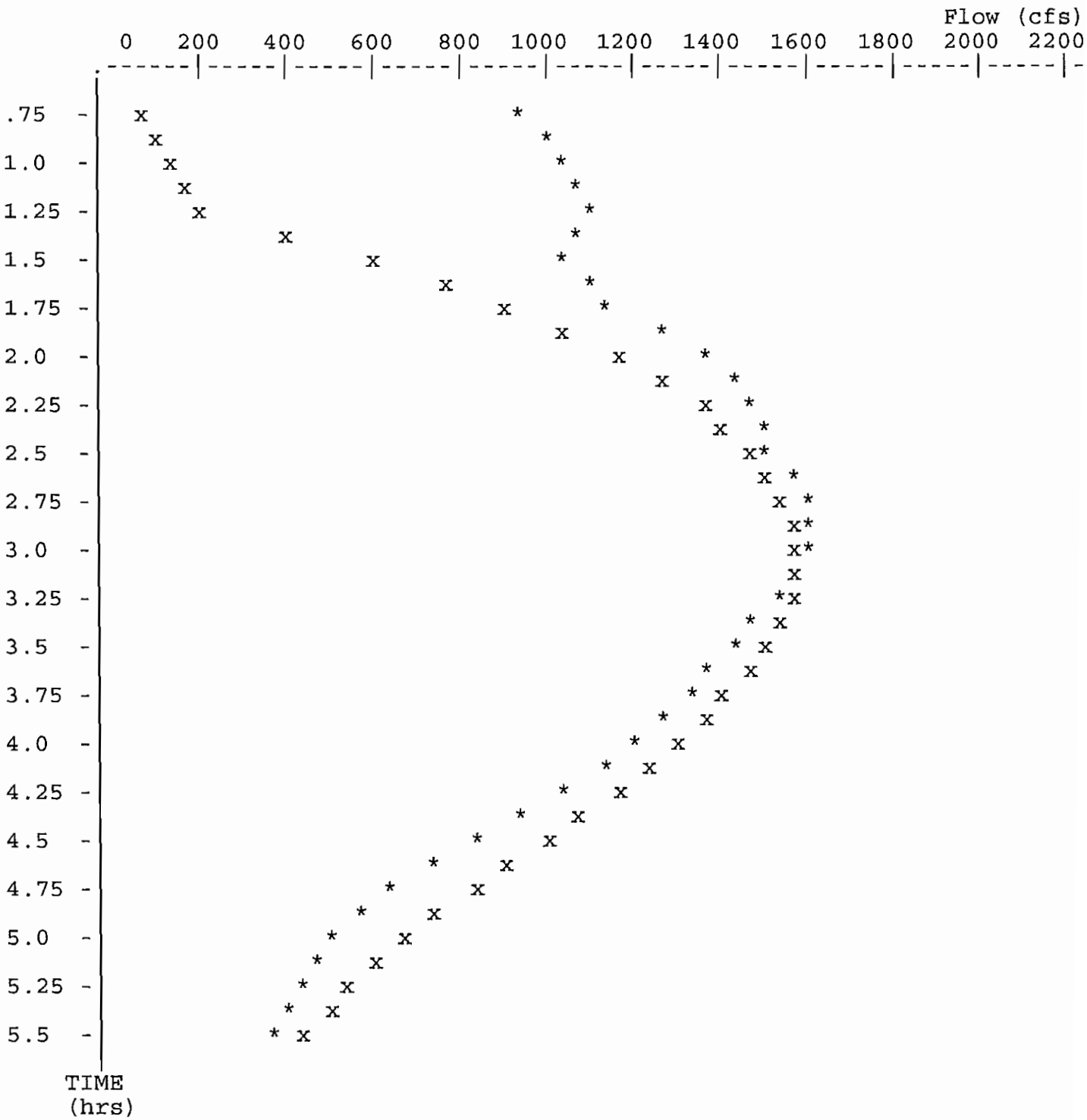
Warning: Inflow hydrograph truncated on left side.
Warning: Inflow hydrograph truncated on right side.

POND-2 Version: 5.21 S/N:

Pond File: A:WL-RES .PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT .HYD

EXECUTED: 11-02-2011
08:31:09

Peak Inflow = 1599.00 cfs
Peak Outflow = 1580.08 cfs
Peak Elevation = 95.56 ft

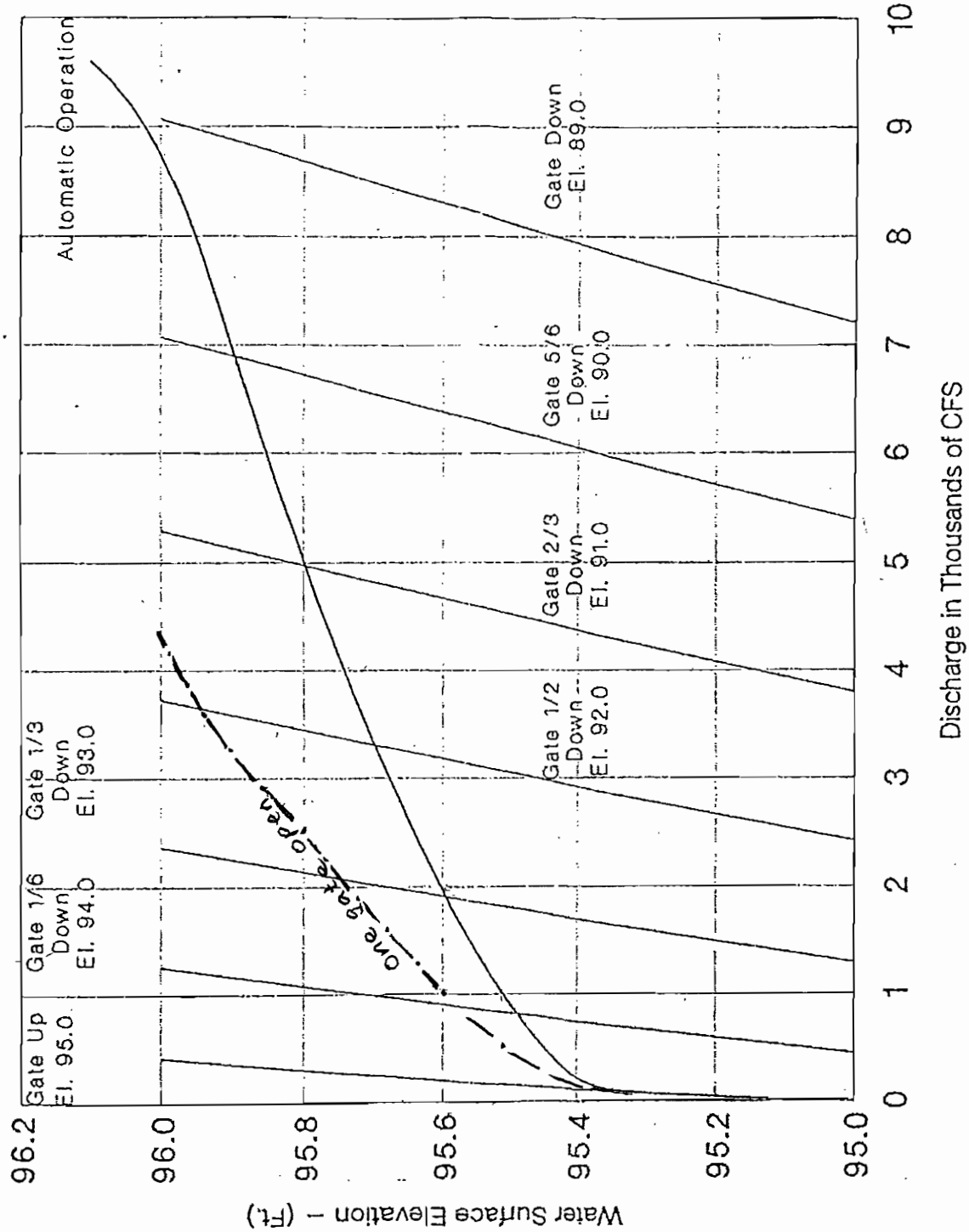


x File: A:WL-OUT8 .HYD Qmax = 1580.0 cfs

APPENDIX I

SUGGESTED MODIFICATIONS
IN
WOODCLIFF LAKE RESERVOIR OPERATION

JUNE 23RD AND JULY 8TH STORMS



Prepared By: Buck, Seifert & Jost, Inc.
November 1993

Gates lower automatically for WSE between 95.5 feet and 96.0 feet
Discharge = C*L*h ^ 3/2 3.2<C<3.95, L = L(eff), h = WSE – GCE

L = 65 ft × 2 gates = 130 ft

Curves indicate flow over both gates, for different sustained gate crest elevations, or Automatic Operation of the gates.
GCE = Gate Crest Elevation

Figure No. 2B
Woodcliff Lake Dam
Bascule Gate Discharge Rating Curve

```
*********************************************
*                                           *
* WOODCLIFF LAKE RESERVOIR, ONE GATE OPEN   *
*           JUNE 23, 2011 STORM             *
*             ONE GATE OPEATING             *
*   BOSWELL ENGINEERING, S. HACKENSACK,NJ   *
*                                           *
*********************************************
```

Inflow Hydrograph: A:WL-JUNE .HYD
Rating Table file: A:WL-RES-M.PND

----INITIAL CONDITIONS----
Elevation = 95.00 ft
Outflow = 0.00 cfs
Storage = 2673.70 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
95.00	0.0	2673.700
95.40	100.0	2743.000
95.50	500.0	2760.300
95.60	1000.0	2778.000
95.70	1750.0	2795.000
95.80	2500.0	2813.000
95.90	3500.0	2830.000

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
258814.2	258814.2
265522.4	265622.4
267197.0	267697.0
268910.4	269910.4
270556.0	272306.0
272298.4	274798.4
273944.0	277444.0

Time increment (t) = 0.250 hrs.

Pond File: A:WL-RES-M.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-M.HYD

INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
0.000	123.00
0.250	374.00
0.500	1227.00
0.750	1677.00
1.000	1911.00
1.250	1716.00
1.500	1937.00
1.750	1833.00
2.000	2158.00
2.250	2548.00
2.500	2756.00
2.750	2990.00
3.000	2847.00
3.250	2561.00
3.500	3354.00
3.750	2860.00
4.000	3250.00
4.250	3029.00
4.500	2899.00
4.750	2847.00
5.000	2457.00
5.250	2275.00
5.500	2093.00
5.750	1820.00
6.000	1807.00
6.250	1716.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
-----	258814.2	258814.2	0.00	95.00
497.0	259296.6	259311.2	7.30	95.03
1601.0	260836.4	260897.6	30.60	95.12
2904.0	263595.6	263740.4	72.36	95.29
3588.0	266381.6	267183.6	401.01	95.48
3627.0	267947.1	270008.6	1030.75	95.60
3653.0	268542.1	271600.1	1529.01	95.67
3770.0	268808.4	272312.1	1751.84	95.70
3991.0	269002.5	272799.4	1898.48	95.72
4706.0	269364.4	273708.5	2172.02	95.76
5304.0	269746.7	274668.4	2460.89	95.79
5746.0	269967.8	275492.7	2762.42	95.83
5837.0	270044.0	275804.8	2880.41	95.84
5408.0	269957.9	275452.0	2747.05	95.82
5915.0	270060.6	275872.9	2906.14	95.84
6214.0	270158.6	276274.6	3057.99	95.86
6110.0	270157.2	276268.6	3055.73	95.86
6279.0	270198.1	276436.2	3119.06	95.86
5928.0	270122.4	276126.1	3001.84	95.85
5746.0	270059.5	275868.4	2904.44	95.84
5304.0	269936.3	275363.5	2713.60	95.82
4732.0	269746.6	274668.3	2460.85	95.79
4368.0	269526.1	274114.6	2294.23	95.77
3913.0	269257.2	273439.1	2090.98	95.75
3627.0	269036.2	272884.2	1923.98	95.72
3523.0	268906.8	272559.2	1826.20	95.71

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: A:WL-RES-M.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-M.HYD

Starting Pond W.S. Elevation = 95.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 3354.00 cfs
Peak Outflow = 3119.06 cfs
Peak Elevation = 95.86 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 2673.70 ac-ft
Peak Storage From Storm = 149.82 ac-ft

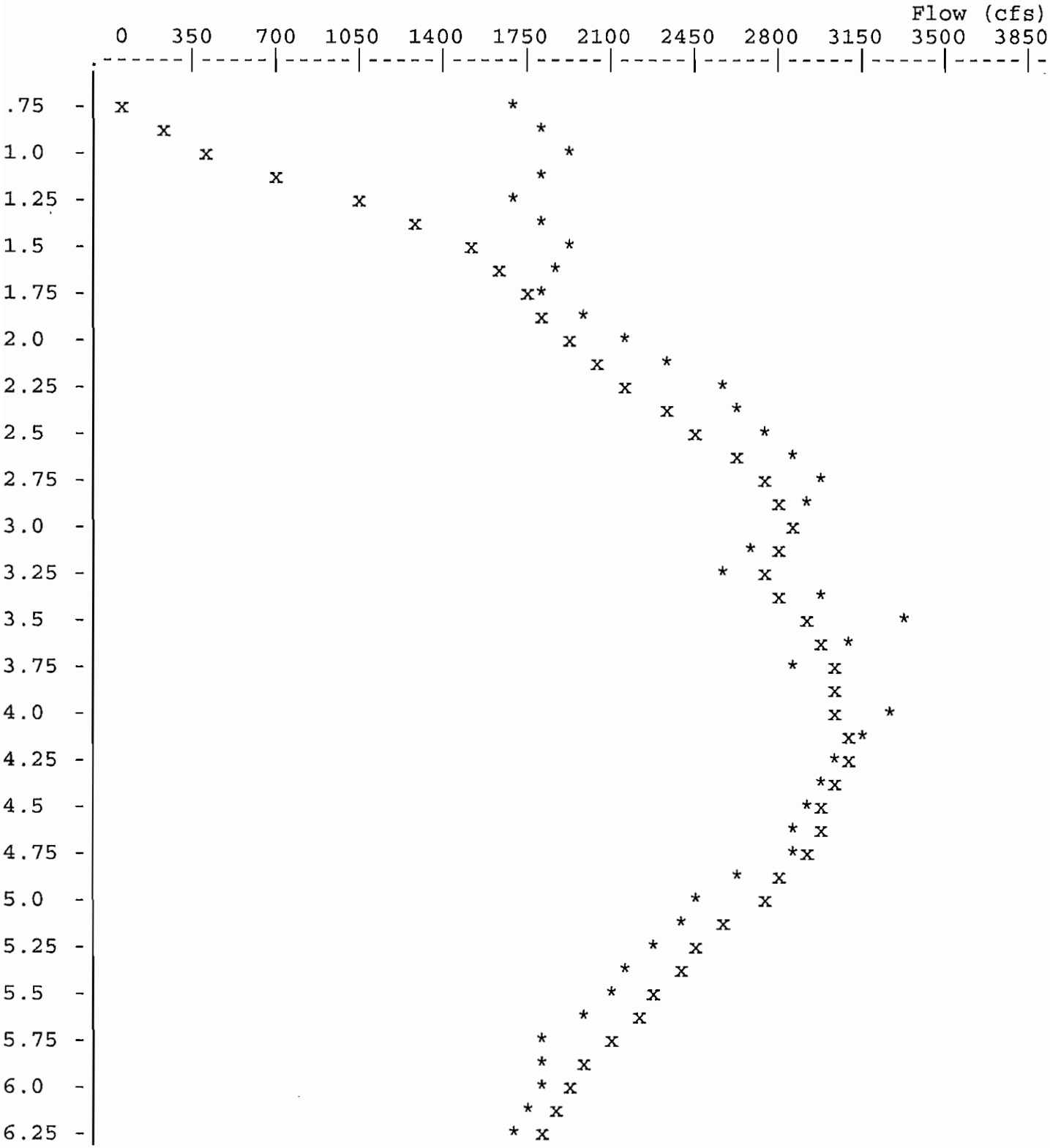
Total Storage in Pond = 2823.52 ac-ft

Warning: Inflow hydrograph truncated on left side.
Warning: Inflow hydrograph truncated on right side.

Pond File: A:WL-RES-M.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-M.HYD

EXECUTED: 11-02-2011
09:30:11

Peak Inflow = 3354.00 cfs
Peak Outflow = 3119.06 cfs
Peak Elevation = 95.86 ft



EXECUTED: 11-01-2011 16:18:57

```
*****************************************************************
*                                                               *
*   WOODCLIFF LAKE RESERVOIR, LOWER GATES TO 93' BEFORE STORM   *
*                      JUNE 23, 2011 STORM                      *
*                       ONE GATE OPERATING                      *
*              BOSWELL ENGINEERING, S. HACKENSACK,NJ            *
*                                                               *
*****************************************************************
```

Inflow Hydrograph: A:WL-JUNE .HYD
Rating Table file: A:WL-RES-L.PND

----INITIAL CONDITIONS----
Elevation = 93.00 ft
Outflow = 0.00 cfs
Storage = 2332.50 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
93.00	0.0	2332.500
95.00	0.0	2673.700
95.40	100.0	2743.000
95.50	500.0	2760.300
95.60	1000.0	2778.000
95.70	1750.0	2795.000
95.80	2500.0	2813.000
95.90	3500.0	2830.000

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
225786.0	225786.0
258814.2	258814.2
265522.4	265622.4
267197.0	267697.0
268910.4	269910.4
270556.0	272306.0
272298.4	274798.4
273944.0	277444.0

Time increment (t) = 0.250 hrs.

Pond File: A:WL-RES-L.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-L.HYD

INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
0.000	123.00
0.250	374.00
0.500	1227.00
0.750	1677.00
1.000	1911.00
1.250	1716.00
1.500	1937.00
1.750	1833.00
2.000	2158.00
2.250	2548.00
2.500	2756.00
2.750	2990.00
3.000	2847.00
3.250	2561.00
3.500	3354.00
3.750	2860.00
4.000	3250.00
4.250	3029.00
4.500	2899.00
4.750	2847.00
5.000	2457.00
5.250	2275.00
5.500	2093.00
5.750	1820.00
6.000	1807.00
6.250	1716.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
-----	225786.0	225786.0	0.00	93.00
497.0	226283.0	226283.0	0.00	93.03
1601.0	227884.0	227884.0	0.00	93.13
2904.0	230788.0	230788.0	0.00	93.30
3588.0	234376.0	234376.0	0.00	93.52
3627.0	238003.0	238003.0	0.00	93.74
3653.0	241656.0	241656.0	0.00	93.96
3770.0	245426.0	245426.0	0.00	94.19
3991.0	249417.0	249417.0	0.00	94.43
4706.0	254123.0	254123.0	0.00	94.72
5304.0	259409.0	259427.0	9.00	95.04
5746.0	264968.7	265155.0	93.13	95.37
5837.0	268245.1	270805.7	1280.30	95.64
5408.0	269342.4	273653.1	2155.37	95.75
5915.0	269910.4	275257.4	2673.49	95.82
6214.0	270122.0	276124.4	3001.21	95.85
6110.0	270148.2	276232.0	3041.87	95.85
6279.0	270195.9	276427.2	3115.68	95.86
5928.0	270121.9	276123.9	3001.01	95.85
5746.0	270059.4	275867.9	2904.24	95.84
5304.0	269936.3	275363.4	2713.55	95.82
4732.0	269746.6	274668.3	2460.84	95.79
4368.0	269526.1	274114.6	2294.23	95.77
3913.0	269257.2	273439.1	2090.97	95.75
3627.0	269036.2	272884.2	1923.98	95.72
3523.0	268906.8	272559.2	1826.20	95.71

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: A:WL-RES-L.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-L.HYD

Starting Pond W.S. Elevation = 93.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 3354.00 cfs
Peak Outflow = 3115.68 cfs
Peak Elevation = 95.86 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 2332.50 ac-ft
Peak Storage From Storm = 490.97 ac-ft

Total Storage in Pond = 2823.47 ac-ft

Warning: Inflow hydrograph truncated on left side.
Warning: Inflow hydrograph truncated on right side.

Pond File: A:WL-RES-L.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-L.HYD

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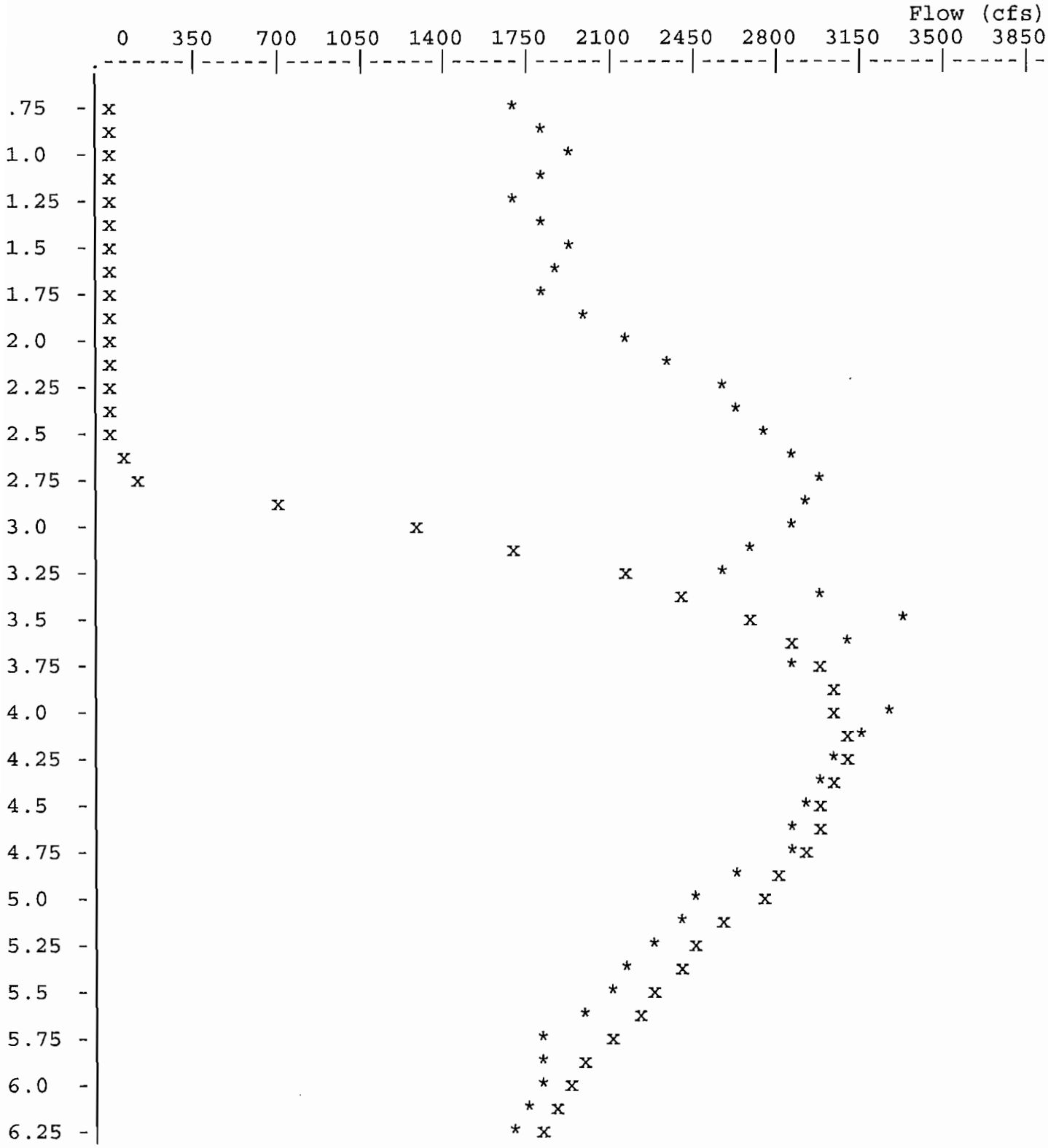
16:18:57

Peak Inflow = 3354.00 cfs
Peak Outflow = 3115.68 cfs
Peak Elevation = 95.86 ft



EXECUTED: 11-01-2011 16:30:52

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*************************************************************
*                                                           *
*   WOODCLIFF LAKE RESERVOIR, LOWER GATES TO 91' BEFORE STORM *
*                    JUNE 23, 2011 STORM                    *
*                  BOTH GATES ARE OPERATING                 *
*            BOSWELL ENGINEERING, S. HACKENSACK,NJ          *
*                                                           *
*************************************************************
```

Inflow Hydrograph: A:WL-JUNE .HYD
Rating Table file: A:WL-RES-W.PND

----INITIAL CONDITIONS----
Elevation = 91.00 ft
Outflow = 0.00 cfs
Storage = 2002.80 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
91.00	0.0	2002.800
95.00	0.0	2673.700
95.40	200.0	2743.000
95.50	1000.0	2760.000
95.60	2000.0	2778.000
95.70	3500.0	2795.000
95.80	5000.0	2813.000
95.90	7000.0	2830.000

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
193871.0	193871.0
258814.2	258814.2
265522.4	265722.4
267168.0	268168.0
268910.4	270910.4
270556.0	274056.0
272298.4	277298.4
273944.0	280944.0

Time increment (t) = 0.250 hrs.

Pond File: A:WL-RES-W.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-W.HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
0.000	123.00	-----	193871.1	193871.1	0.00	91.00
0.250	374.00	497.0	194368.1	194368.1	0.00	91.03
0.500	1227.00	1601.0	195969.1	195969.1	0.00	91.13
0.750	1677.00	2904.0	198873.1	198873.1	0.00	91.31
1.000	1911.00	3588.0	202461.1	202461.1	0.00	91.53
1.250	1716.00	3627.0	206088.1	206088.1	0.00	91.75
1.500	1937.00	3653.0	209741.1	209741.1	0.00	91.98
1.750	1833.00	3770.0	213511.1	213511.1	0.00	92.21
2.000	2158.00	3991.0	217502.1	217502.1	0.00	92.46
2.250	2548.00	4706.0	222208.1	222208.1	0.00	92.75
2.500	2756.00	5304.0	227512.1	227512.1	0.00	93.07
2.750	2990.00	5746.0	233258.1	233258.1	0.00	93.43
3.000	2847.00	5837.0	239095.1	239095.1	0.00	93.79
3.250	2561.00	5408.0	244503.1	244503.1	0.00	94.12
3.500	3354.00	5915.0	250418.1	250418.1	0.00	94.48
3.750	2860.00	6214.0	256632.1	256632.1	0.00	94.87
4.000	3250.00	6110.0	262514.6	262742.1	113.72	95.23
4.250	3029.00	6279.0	266337.4	268793.6	1228.13	95.52
4.500	2899.00	5928.0	266973.1	272265.4	2646.12	95.64
4.750	2847.00	5746.0	266994.1	272719.1	2862.50	95.66
5.000	2457.00	5304.0	266974.6	272298.1	2661.74	95.64
5.250	2275.00	4732.0	266947.3	271706.6	2379.69	95.63
5.500	2093.00	4368.0	266929.1	271315.3	2193.06	95.61
5.750	1820.00	3913.0	266891.9	270842.1	1975.11	95.60
6.000	1807.00	3627.0	266804.4	270518.9	1857.25	95.59
6.250	1716.00	3523.0	266752.6	270327.4	1787.42	95.58

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: A:WL-RES-W.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-W.HYD

Starting Pond W.S. Elevation = 91.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 3354.00 cfs
Peak Outflow = 2862.50 cfs
Peak Elevation = 95.66 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 2002.80 ac-ft
Peak Storage From Storm = 784.98 ac-ft

Total Storage in Pond = 2787.78 ac-ft

Warning: Inflow hydrograph truncated on left side.
Warning: Inflow hydrograph truncated on right side.

Pond File: A:WL-RES-W.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-W.HYD

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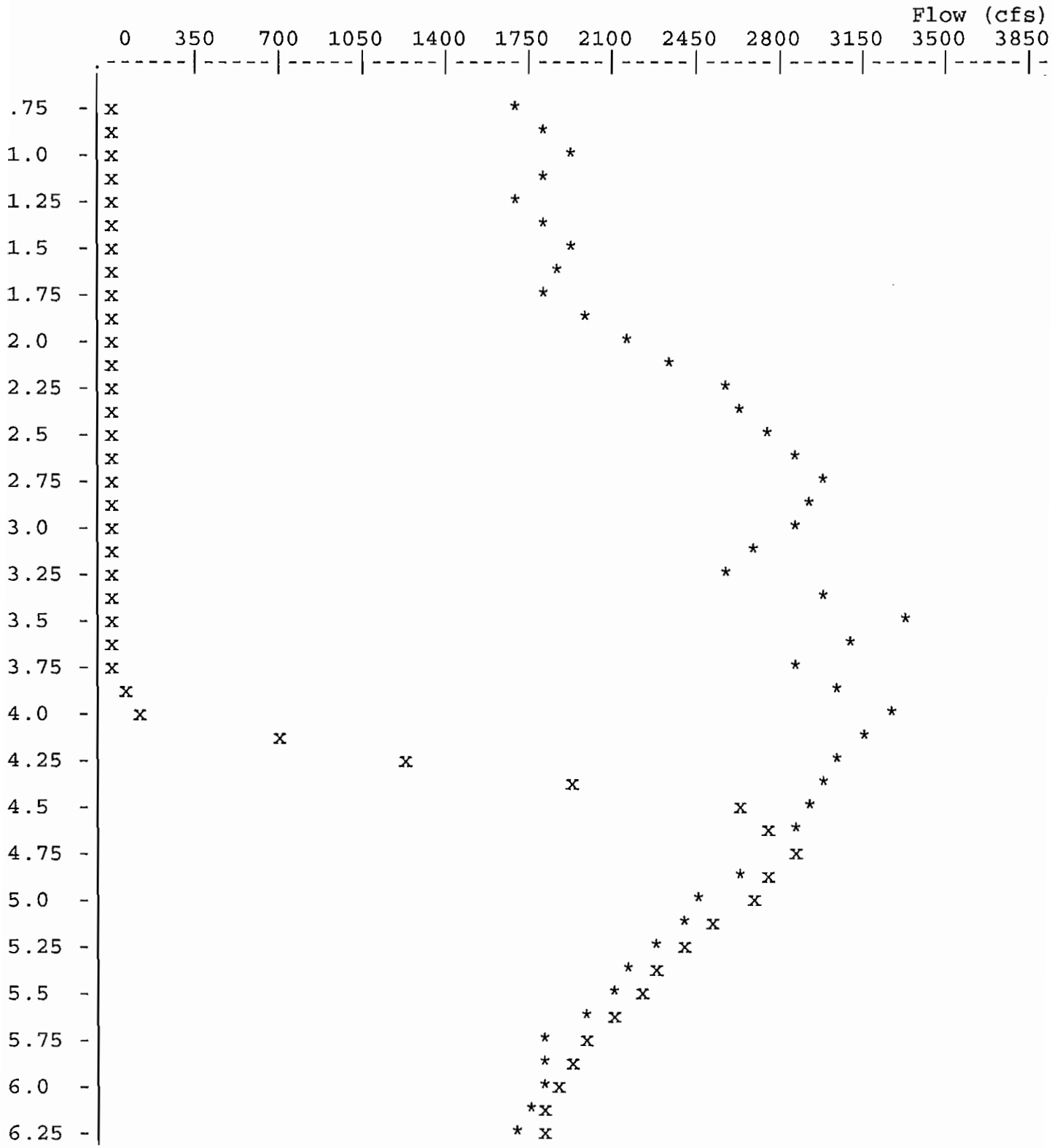
16:30:52

Peak Inflow = 3354.00 cfs
Peak Outflow = 2862.50 cfs
Peak Elevation = 95.66 ft



```
*****************************************************************
*                                                               *
*   WOODCLIFF LAKE RESERVOIR, LOWER GATES TO 91' BEFORE STORM   *
*                      JUNE 23, 2011 STORM                      *
*                       ONE GATE OPERTAING                      *
*              BOSWELL ENGINEERING, S. HACKENSACK,NJ            *
*                                                               *
*****************************************************************
```

Inflow Hydrograph: A:WL-JUNE .HYD
Rating Table file: A:WL-RES-W.PND

----INITIAL CONDITIONS----
Elevation = 91.00 ft
Outflow = 0.00 cfs
Storage = 2002.80 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
91.00	0.0	2002.800
95.00	0.0	2673.700
95.40	100.0	2743.000
95.50	500.0	2760.300
95.60	1000.0	2778.000
95.70	1750.0	2795.000
95.80	2500.0	2813.000
95.90	3500.0	2830.000

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
193871.0	193871.0
258814.2	258814.2
265522.4	265622.4
267197.0	267697.0
268910.4	269910.4
270556.0	272306.0
272298.4	274798.4
273944.0	277444.0

Time increment (t) = 0.250 hrs.

Pond File: A:WL-RES-W.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-W.HYD

INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
0.000	123.00
0.250	374.00
0.500	1227.00
0.750	1677.00
1.000	1911.00
1.250	1716.00
1.500	1937.00
1.750	1833.00
2.000	2158.00
2.250	2548.00
2.500	2756.00
2.750	2990.00
3.000	2847.00
3.250	2561.00
3.500	3354.00
3.750	2860.00
4.000	3250.00
4.250	3029.00
4.500	2899.00
4.750	2847.00
5.000	2457.00
5.250	2275.00
5.500	2093.00
5.750	1820.00
6.000	1807.00
6.250	1716.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
-----	193871.1	193871.1	0.00	91.00
497.0	194368.1	194368.1	0.00	91.03
1601.0	195969.1	195969.1	0.00	91.13
2904.0	198873.1	198873.1	0.00	91.31
3588.0	202461.1	202461.1	0.00	91.53
3627.0	206088.1	206088.1	0.00	91.75
3653.0	209741.1	209741.1	0.00	91.98
3770.0	213511.1	213511.1	0.00	92.21
3991.0	217502.1	217502.1	0.00	92.46
4706.0	222208.1	222208.1	0.00	92.75
5304.0	227512.1	227512.1	0.00	93.07
5746.0	233258.1	233258.1	0.00	93.43
5837.0	239095.1	239095.1	0.00	93.79
5408.0	244503.1	244503.1	0.00	94.12
5915.0	250418.1	250418.1	0.00	94.48
6214.0	256632.1	256632.1	0.00	94.87
6110.0	262626.7	262742.1	57.69	95.23
6279.0	267359.6	268905.7	773.03	95.55
5928.0	269196.9	273287.6	2045.38	95.74
5746.0	269833.7	274942.9	2554.60	95.81
5304.0	269881.2	275137.7	2628.23	95.81
4732.0	269724.7	274613.2	2444.27	95.79
4368.0	269517.4	274092.7	2287.63	95.77
3913.0	269253.7	273430.4	2088.35	95.75
3627.0	269034.8	272880.7	1922.94	95.72
3523.0	268906.3	272557.8	1825.78	95.71

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: A:WL-RES-W.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-W.HYD

Starting Pond W.S. Elevation = 91.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 3354.00 cfs
Peak Outflow = 2628.23 cfs
Peak Elevation = 95.81 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 2002.80 ac-ft
Peak Storage From Storm = 812.38 ac-ft

Total Storage in Pond = 2815.18 ac-ft

Warning: Inflow hydrograph truncated on left side.
Warning: Inflow hydrograph truncated on right side.

Pond File: A:WL-RES-W.PND
Inflow Hydrograph: A:WL-JUNE .HYD
Outflow Hydrograph: A:WL-OUT-W.HYD

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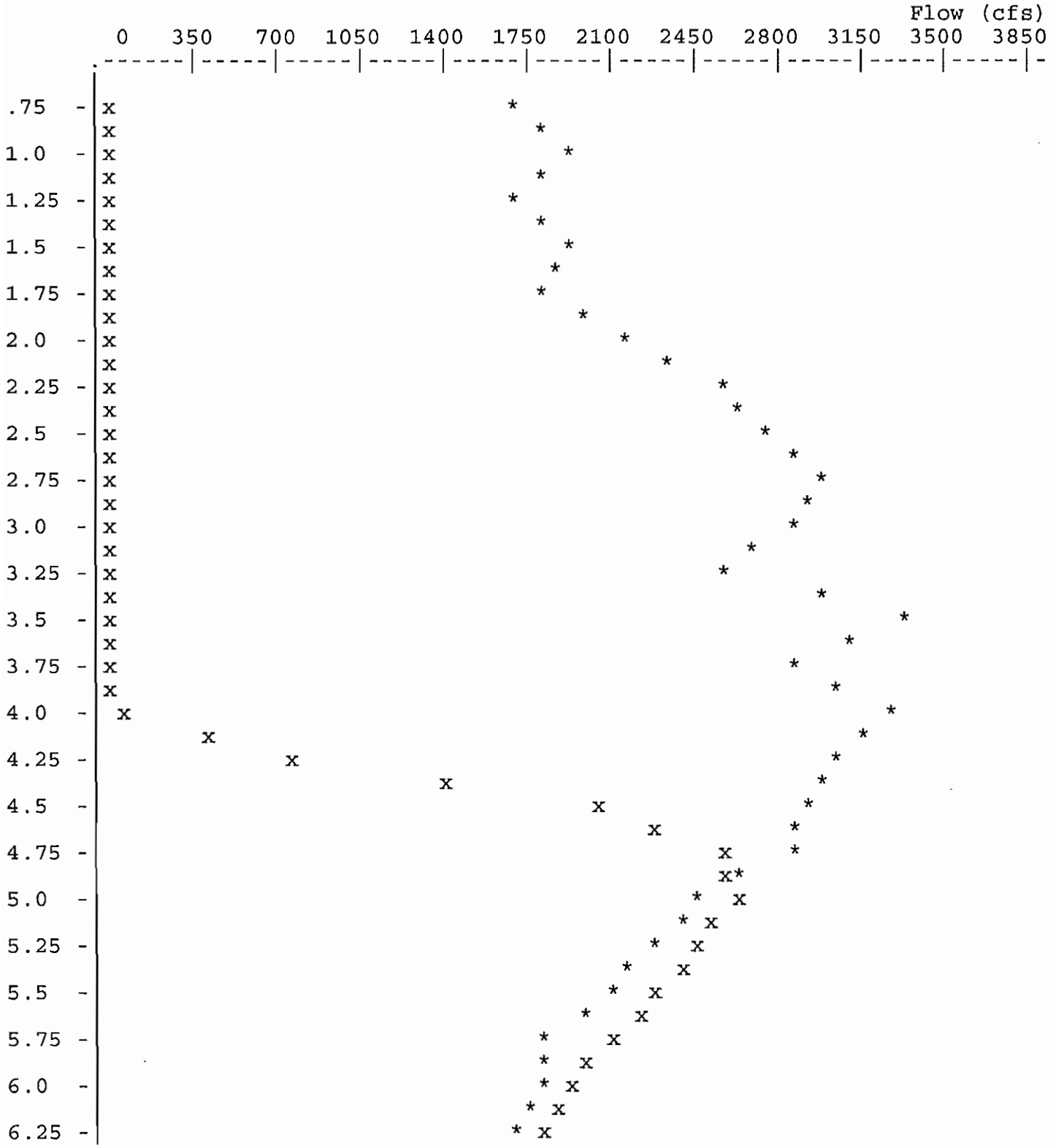
Peak Inflow = 3354.00 cfs
Peak Outflow = 2628.23 cfs
Peak Elevation = 95.81 ft



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*********************************************
*                                           *
* WOODCLIFF LAKE RESERVOIR, ONE GATE OPEN   *
*           JULY 8,  2011 STORM             *
*             ONE GATE OPEATING             *
*   BOSWELL ENGINEERING, S. HACKENSACK,NJ   *
*                                           *
*********************************************
```

Inflow Hydrograph: A:WL-JUL8 .HYD
Rating Table file: A:WL-RES-M.PND

----INITIAL CONDITIONS----
Elevation = 95.00 ft
Outflow = 0.00 cfs
Storage = 2673.70 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
95.00	0.0	2673.700
95.40	100.0	2743.000
95.50	500.0	2760.300
95.60	1000.0	2778.000
95.70	1750.0	2795.000
95.80	2500.0	2813.000
95.90	3500.0	2830.000

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
258814.2	258814.2
265522.4	265622.4
267197.0	267697.0
268910.4	269910.4
270556.0	272306.0
272298.4	274798.4
273944.0	277444.0

Time increment (t) = 0.250 hrs.

Pond File: A:WL-RES-M.PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT-M.HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
0.000	88.00	-----	258814.2	258814.2	0.00	95.00
0.250	251.00	339.0	259143.2	259153.2	4.98	95.02
0.500	593.00	844.0	259952.7	259987.2	17.23	95.07
0.750	935.00	1528.0	261402.4	261480.7	39.17	95.16
1.000	1048.00	1983.0	263251.1	263385.4	67.14	95.27
1.250	1102.00	2150.0	265207.6	265401.1	96.75	95.39
1.500	1037.00	2139.0	266481.8	267346.6	432.44	95.48
1.750	1136.00	2173.0	267222.1	268654.8	716.35	95.54
2.000	1378.00	2514.0	267814.8	269736.1	960.61	95.59
2.250	1469.00	2847.0	268191.3	270661.8	1235.25	95.63
2.500	1508.00	2977.0	268380.7	271168.3	1393.82	95.65
2.750	1599.00	3107.0	268500.1	271487.7	1493.80	95.67
3.000	1599.00	3198.0	268578.7	271698.1	1559.67	95.67
3.250	1547.00	3146.0	268588.7	271724.7	1568.02	95.68
3.500	1417.00	2964.0	268524.4	271552.7	1514.16	95.67
3.750	1326.00	2743.0	268417.7	271267.4	1424.83	95.66
4.000	1204.00	2530.0	268298.2	270947.7	1324.75	95.64
4.250	1037.00	2241.0	268145.5	270539.2	1196.86	95.63
4.500	836.00	1873.0	267950.8	270018.5	1033.84	95.60
4.750	625.00	1461.0	267637.1	269411.8	887.37	95.58
5.000	516.00	1141.0	267289.7	268778.1	744.21	95.55
5.250	425.00	941.0	266989.6	268230.7	620.55	95.52
5.500	350.00	775.0	266734.1	267764.6	515.25	95.50
5.750	309.00	659.0	266510.3	267393.1	441.39	95.49
6.000	277.00	586.0	266327.9	267096.3	384.17	95.47

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: A:WL-RES-M.PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT-M.HYD

Starting Pond W.S. Elevation = 95.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 1599.00 cfs
Peak Outflow = 1568.02 cfs
Peak Elevation = 95.68 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 2673.70 ac-ft
Peak Storage From Storm = 117.18 ac-ft

Total Storage in Pond = 2790.88 ac-ft

Warning: Inflow hydrograph truncated on left side.
Warning: Inflow hydrograph truncated on right side.

Pond File: A:WL-RES-M.PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT-M.HYD

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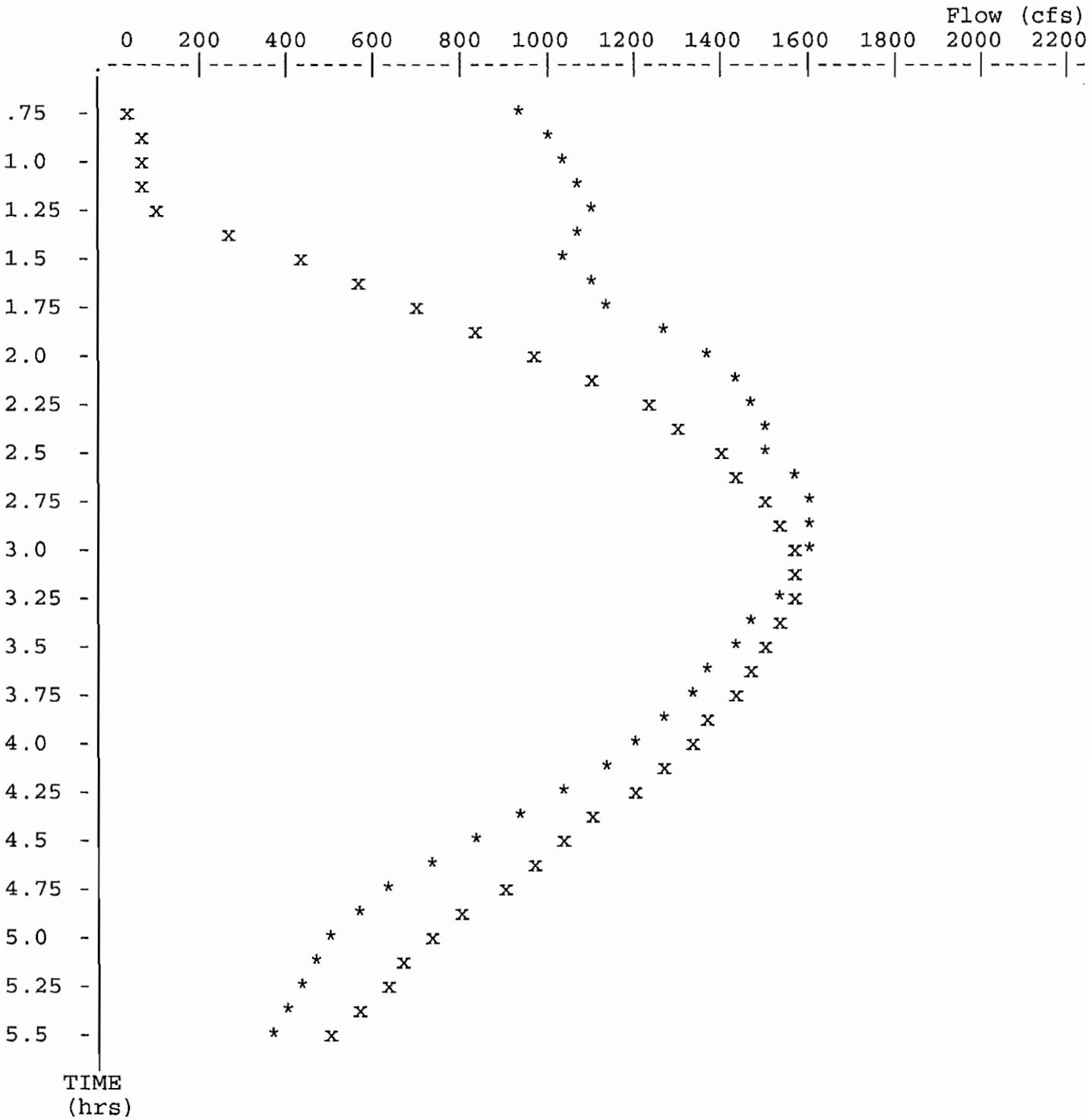
09:31:17

Peak Inflow = 1599.00 cfs
Peak Outflow = 1568.02 cfs
Peak Elevation = 95.68 ft



* File: A:WL-JUL8 .HYD Qmax = 1599.0 cfs
x File: A:WL-OUT-M.HYD Qmax = 1568.0 cfs

```
*************************************************************
*                                                           *
*   WOODCLIFF LAKE RESERVOIR, LOWER GATES TO 93' BEFORE STORM *
*                    JULY 8,  2011 STORM                    *
*                     ONE GATE OPERATING                    *
*             BOSWELL ENGINEERING, S. HACKENSACK,NJ         *
*                                                           *
*************************************************************
```

Inflow Hydrograph: A:WL-JUL8 .HYD
Rating Table file: A:WL-RES-L.PND

----INITIAL CONDITIONS----
Elevation = 93.00 ft
Outflow = 0.00 cfs
Storage = 2332.50 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
93.00	0.0	2332.500
95.00	0.0	2673.700
95.40	100.0	2743.000
95.50	500.0	2760.300
95.60	1000.0	2778.000
95.70	1750.0	2795.000
95.80	2500.0	2813.000
95.90	3500.0	2830.000

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
225786.0	225786.0
258814.2	258814.2
265522.4	265622.4
267197.0	267697.0
268910.4	269910.4
270556.0	272306.0
272298.4	274798.4
273944.0	277444.0

Time increment (t) = 0.250 hrs.

Pond File: A:WL-RES-L.PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT-L.HYD

INFLOW HYDROGRAPH

TIME (hrs)	INFLOW (cfs)
0.000	88.00
0.250	251.00
0.500	593.00
0.750	935.00
1.000	1048.00
1.250	1102.00
1.500	1037.00
1.750	1136.00
2.000	1378.00
2.250	1469.00
2.500	1508.00
2.750	1599.00
3.000	1599.00
3.250	1547.00
3.500	1417.00
3.750	1326.00
4.000	1204.00
4.250	1037.00
4.500	836.00
4.750	625.00
5.000	516.00
5.250	425.00
5.500	350.00
5.750	309.00
6.000	277.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
-----	225786.0	225786.0	0.00	93.00
339.0	226125.0	226125.0	0.00	93.02
844.0	226969.0	226969.0	0.00	93.07
1528.0	228497.0	228497.0	0.00	93.16
1983.0	230480.0	230480.0	0.00	93.28
2150.0	232630.0	232630.0	0.00	93.41
2139.0	234769.0	234769.0	0.00	93.54
2173.0	236942.0	236942.0	0.00	93.68
2514.0	239456.0	239456.0	0.00	93.83
2847.0	242303.0	242303.0	0.00	94.00
2977.0	245280.0	245280.0	0.00	94.18
3107.0	248387.0	248387.0	0.00	94.37
3198.0	251585.0	251585.0	0.00	94.56
3146.0	254731.0	254731.0	0.00	94.75
2964.0	257695.0	257695.0	0.00	94.93
2743.0	260390.3	260438.0	23.85	95.10
2530.0	262799.7	262920.3	60.31	95.24
2241.0	264857.8	265040.7	91.46	95.37
1873.0	266103.4	266730.8	313.70	95.45
1461.0	266615.5	267564.4	474.42	95.49
1141.0	266729.7	267756.5	513.44	95.50
941.0	266680.8	267670.7	494.91	95.50
775.0	266548.8	267455.8	453.49	95.49
659.0	266396.5	267207.8	405.68	95.48
586.0	266258.0	266982.5	362.23	95.47

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: A:WL-RES-L.PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT-L.HYD

Starting Pond W.S. Elevation = 93.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow = 1599.00 cfs
Peak Outflow = 513.44 cfs
Peak Elevation = 95.50 ft

***** Summary of Approximate Peak Storage *****

Initial Storage = 2332.50 ac-ft
Peak Storage From Storm = 428.28 ac-ft

Total Storage in Pond = 2760.78 ac-ft

Warning: Inflow hydrograph truncated on left side.
Warning: Inflow hydrograph truncated on right side.

Pond File: A:WL-RES-L.PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT-L.HYD

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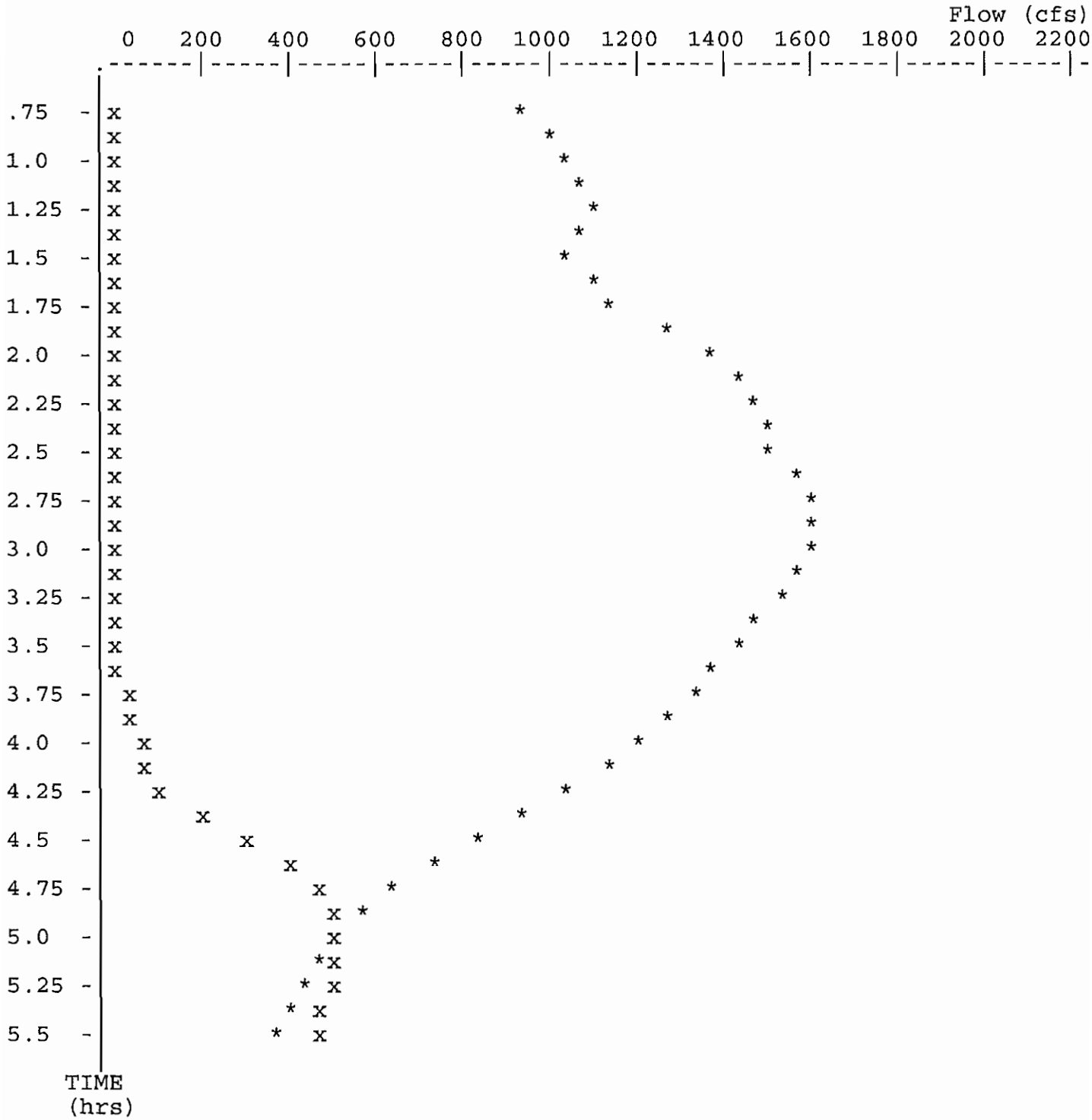
Peak Inflow = 1599.00 cfs
Peak Outflow = 513.44 cfs
Peak Elevation = 95.50 ft



* File: A:WL-JUL8 .HYD Qmax = 1599.0 cfs
x File: A:WL-OUT-L.HYD Qmax = 513.4 cfs

EXECUTED: 11-02-2011 08:45:51

```
*****************************************************************
*                                                               *
*   WOODCLIFF LAKE RESERVOIR, LOWER GATES TO 91' BEFORE STORM   *
*                      JULY 8,  2011 STORM                      *
*                      BOTH GATES OPERATING                     *
*              BOSWELL ENGINEERING, S. HACKENSACK,NJ            *
*                                                               *
*****************************************************************
```

Inflow Hydrograph: A:WL-JUL8 .HYD
Rating Table file: A:WL-RES-W.PND

----INITIAL CONDITIONS----
Elevation = 91.00 ft
Outflow = 0.00 cfs
Storage = 2002.80 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
91.00	0.0	2002.800
95.00	0.0	2673.700
95.40	200.0	2743.000
95.50	1000.0	2760.000
95.60	2000.0	2778.000
95.70	3500.0	2795.000
95.80	5000.0	2813.000
95.90	7000.0	2830.000

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
193871.0	193871.0
258814.2	258814.2
265522.4	265722.4
267168.0	268168.0
268910.4	270910.4
270556.0	274056.0
272298.4	277298.4
273944.0	280944.0

Time increment (t) = 0.250 hrs.

Pond File: A:WL-RES-W.PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT-W.HYD

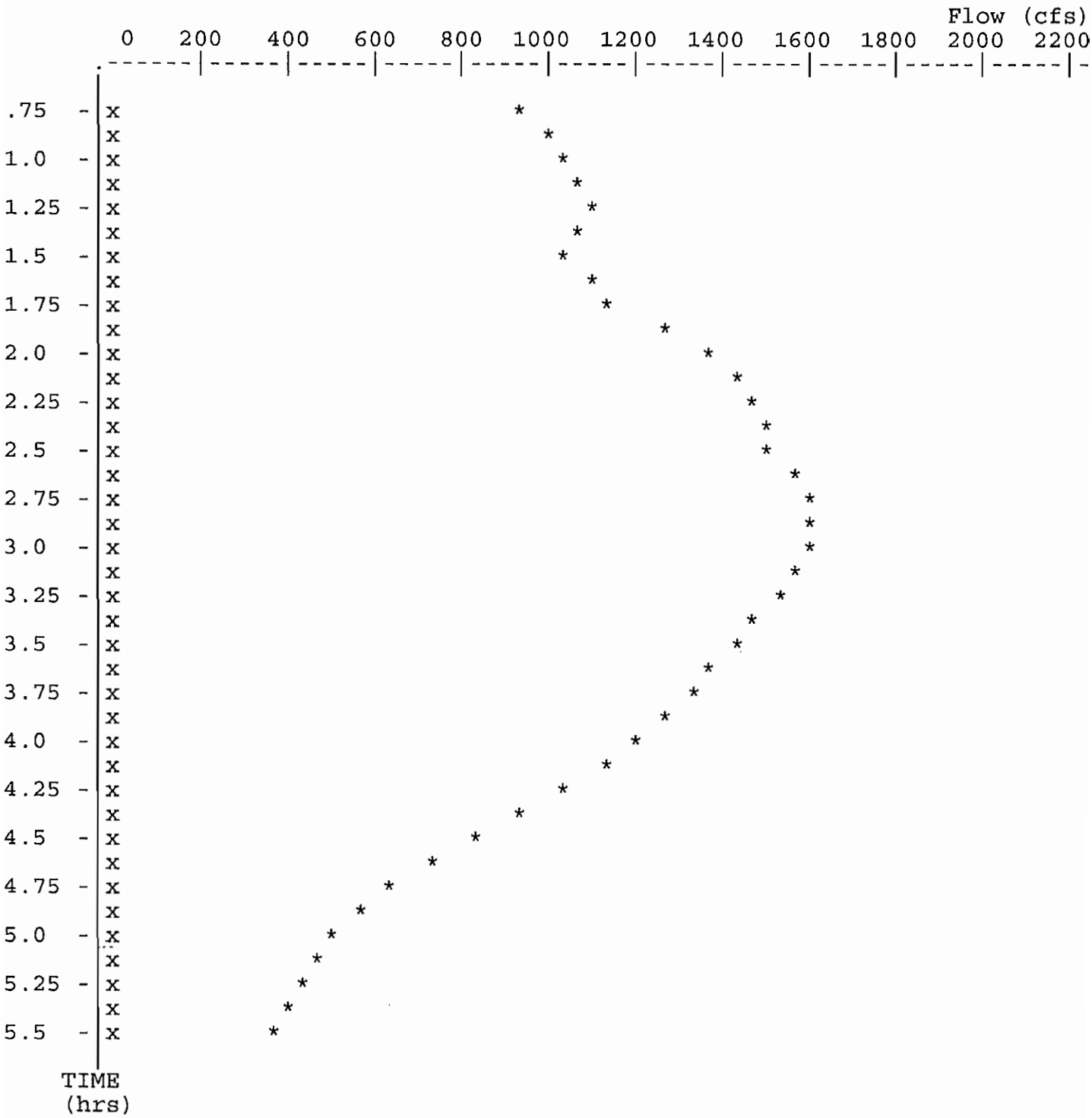
INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
0.000	88.00	-----	193871.1	193871.1	0.00	91.00
0.250	251.00	339.0	194210.1	194210.1	0.00	91.02
0.500	593.00	844.0	195054.1	195054.1	0.00	91.07
0.750	935.00	1528.0	196582.1	196582.1	0.00	91.17
1.000	1048.00	1983.0	198565.1	198565.1	0.00	91.29
1.250	1102.00	2150.0	200715.1	200715.1	0.00	91.42
1.500	1037.00	2139.0	202854.1	202854.1	0.00	91.55
1.750	1136.00	2173.0	205027.1	205027.1	0.00	91.69
2.000	1378.00	2514.0	207541.1	207541.1	0.00	91.84
2.250	1469.00	2847.0	210388.1	210388.1	0.00	92.02
2.500	1508.00	2977.0	213365.1	213365.1	0.00	92.20
2.750	1599.00	3107.0	216472.1	216472.1	0.00	92.39
3.000	1599.00	3198.0	219670.1	219670.1	0.00	92.59
3.250	1547.00	3146.0	222816.1	222816.1	0.00	92.78
3.500	1417.00	2964.0	225780.1	225780.1	0.00	92.97
3.750	1326.00	2743.0	228523.1	228523.1	0.00	93.13
4.000	1204.00	2530.0	231053.1	231053.1	0.00	93.29
4.250	1037.00	2241.0	233294.1	233294.1	0.00	93.43
4.500	836.00	1873.0	235167.1	235167.1	0.00	93.54
4.750	625.00	1461.0	236628.1	236628.1	0.00	93.63
5.000	516.00	1141.0	237769.1	237769.1	0.00	93.70
5.250	425.00	941.0	238710.1	238710.1	0.00	93.76
5.500	350.00	775.0	239485.1	239485.1	0.00	93.81
5.750	309.00	659.0	240144.1	240144.1	0.00	93.85
6.000	277.00	586.0	240730.1	240730.1	0.00	93.89

```
****************** SUMMARY OF ROUTING COMPUTATIONS ******************

Pond File:           A:WL-RES-W.PND
Inflow Hydrograph:   A:WL-JUL8 .HYD
Outflow Hydrograph:  A:WL-OUT-W.HYD


Starting Pond W.S. Elevation =    91.00 ft


         ***** Summary of Peak Outflow and Peak Elevation *****

                    Peak Inflow    =  1599.00 cfs
                    Peak Outflow   =     0.00 cfs
                    Peak Elevation =    93.89 ft


           ***** Summary of Approximate Peak Storage *****

               Initial Storage          =  2002.80 ac-ft
               Peak Storage From Storm  =   484.08 ac-ft
                                          ---------------
               Total Storage in Pond    =  2486.88 ac-ft


        Warning: Inflow hydrograph truncated on left side.
        Warning: Inflow hydrograph truncated on right side.

        >>>>>> Warning, peak outflow = last ordinate point. <<<<<<
```

>>>>>> Warning, peak outflow = last ordinate point. <<<<<<

POND-2 Version: 5.21 S/N:

Pond File: A:WL-RES-W.PND
Inflow Hydrograph: A:WL-JUL8 .HYD
Outflow Hydrograph: A:WL-OUT-W.HYD

EXECUTED: 11-02-2011
08:45:51

Peak Inflow = 1599.00 cfs
Peak Outflow = 0.00 cfs
Peak Elevation = 93.89 ft