Wanaque Reservoir TMDL and Cumulative WLAs/LA for the Passaic River Watershed

Presented by
NJ Department of Environmental Protection
Division of Watershed Management

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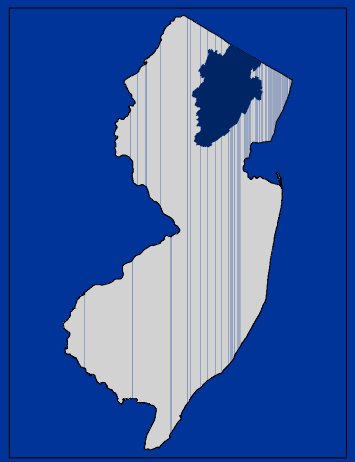
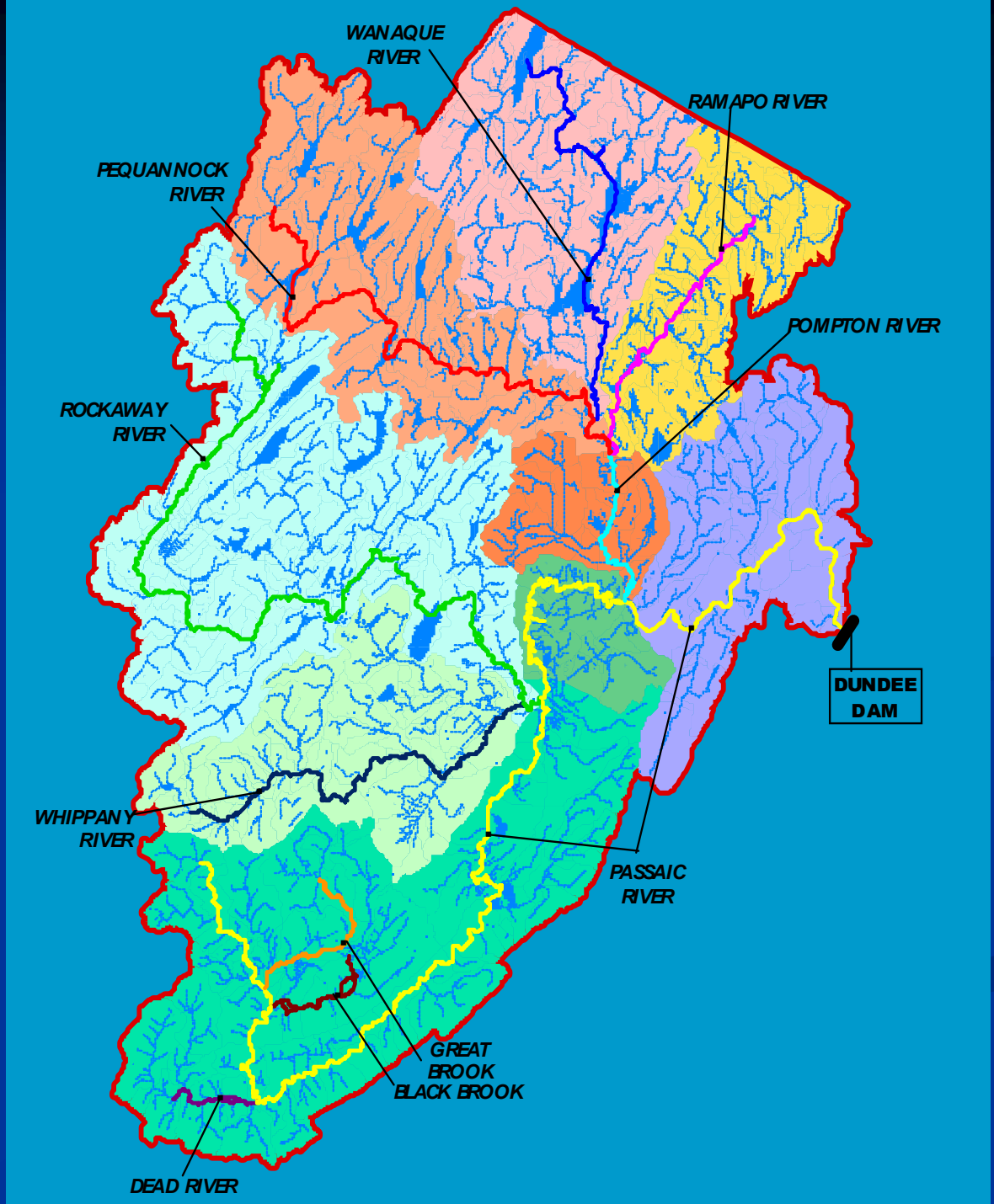
The Problem

- Most of the major waterways within the Passaic River Basin are impaired for total phosphorus- 303d List
- Phosphorus concentrations in the Wanaque Reservoir exceed the phosphorus Lake Criterion

Non-Tidal Passaic River Basin





Phosphorus Criteria

- Streams:

  TP ≤0.1 mg/l **unless** it can be demonstrated that TP is not a limiting nutrient **and**

  TP will not otherwise render the waters unsuitable for designated uses

Except where watershed or site-specific criteria are developed

Existing freshwater lake criteria

- (N.J.A.C. 7:9B-1.14(c)5.i). For FW2 freshwater lakes:
- *"Phosphorus as total P shall not exceed 0.05 (mg/L) in any lake, pond or reservoir, or in a tributary at the point where it enters such bodies or water, except where watershed or site-specific criteria are developed pursuant to N.J.A.C. 7:9B-1.5(g)3."*
- N.J.A.C. 7:9B-1.5(g)3 states that.
- *"The Department may establish watershed or site-specific water quality criteria for nutrients in lakes, ponds, reservoirs or streams, in addition to or in place of the criteria in N.J.A.C. 7:9B-1.14, when necessary to protect existing or designated uses. Such criteria shall become part of these Water Quality Standards.*

Are the Designated Uses Rendered Unsuitable Due to Phosphorus

- **Dissolved oxygen**
  - Does diurnal DO violate criteria?
- **Are algal densities excessive?**
  - Phytoplankton concentration- 24 µg/l chl-a seasonal mean OR 32 µg/l chl-a 2-week mean
  - Periphyton density- 150 mg/m² chl-a seasonal mean OR

    200 mg/m² chl-a single event

Eutrophication in Streams and Lakes

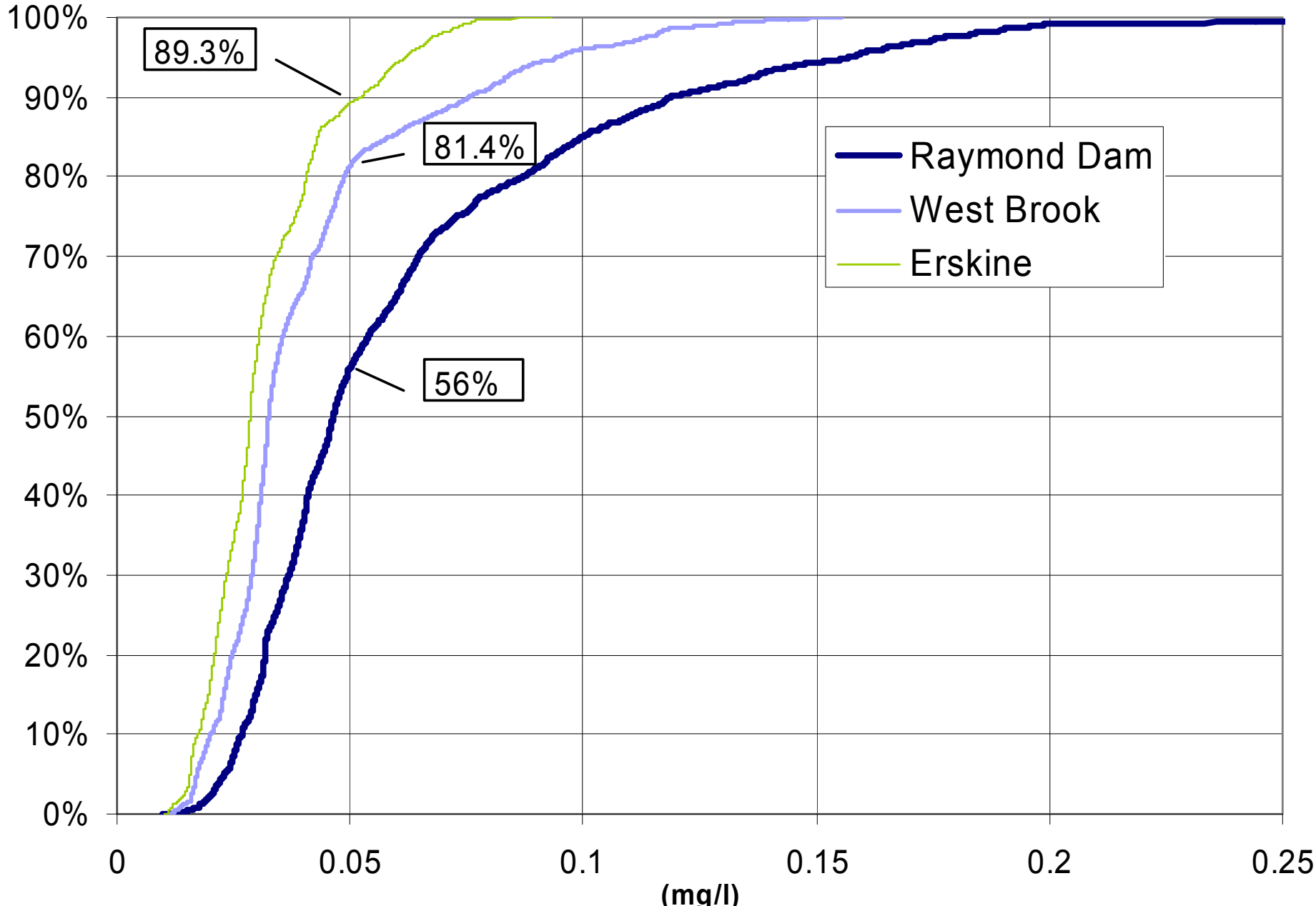
- Acceleration of natural aging process
- excessive loading of silt, organic matter, and nutrients, causing high biological production and decreased basin volume
- Symptoms of eutrophication (primary impacts)
  - oxygen super-saturation during the day
  - oxygen depletion during night
  - high sedimentation (filling in) rate
  - Large pH swing
- algae and aquatic plants are the catalysts
- secondary biological impacts
  - loss of biodiversity
  - structural changes to communities

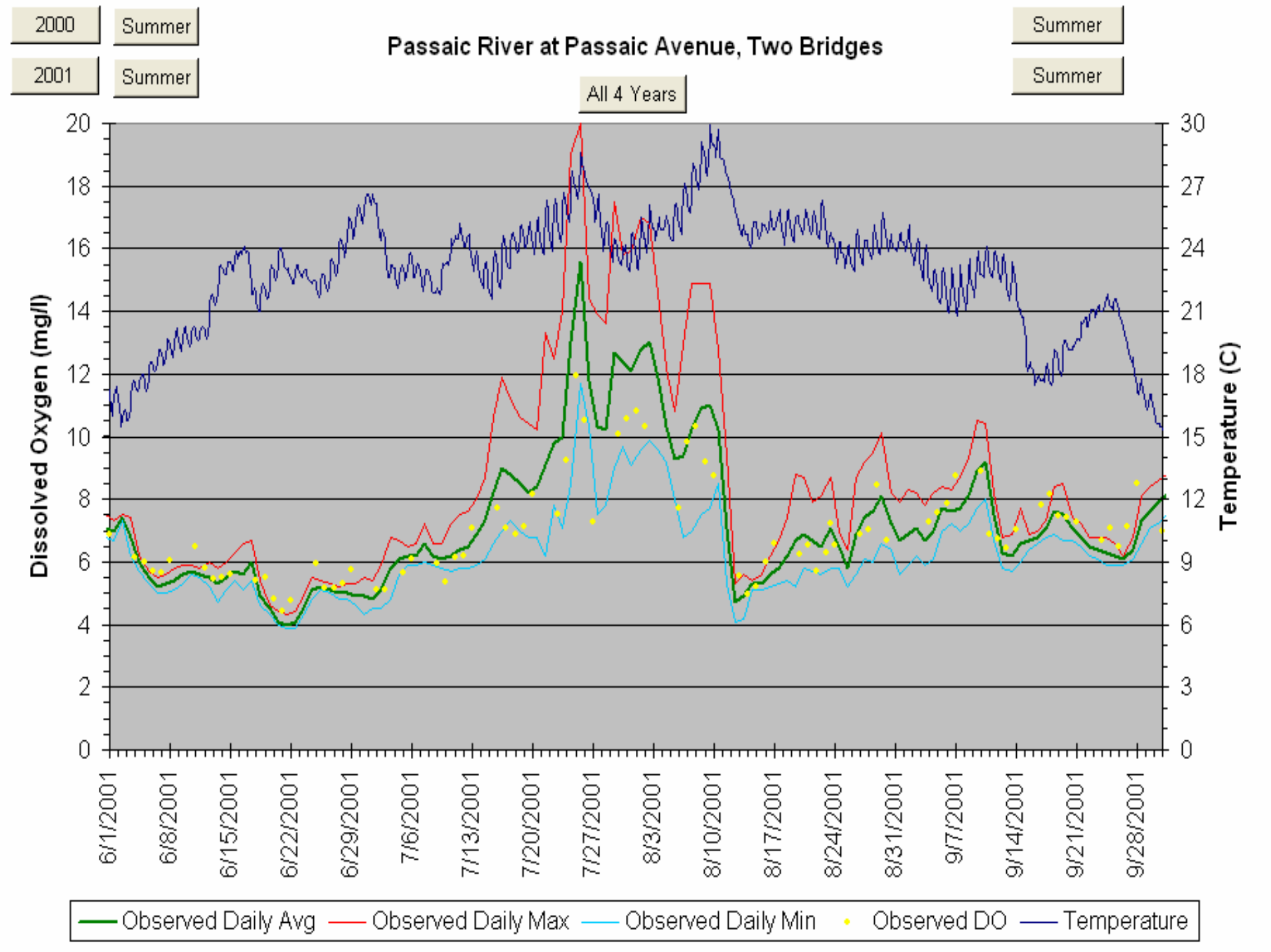
The Plan

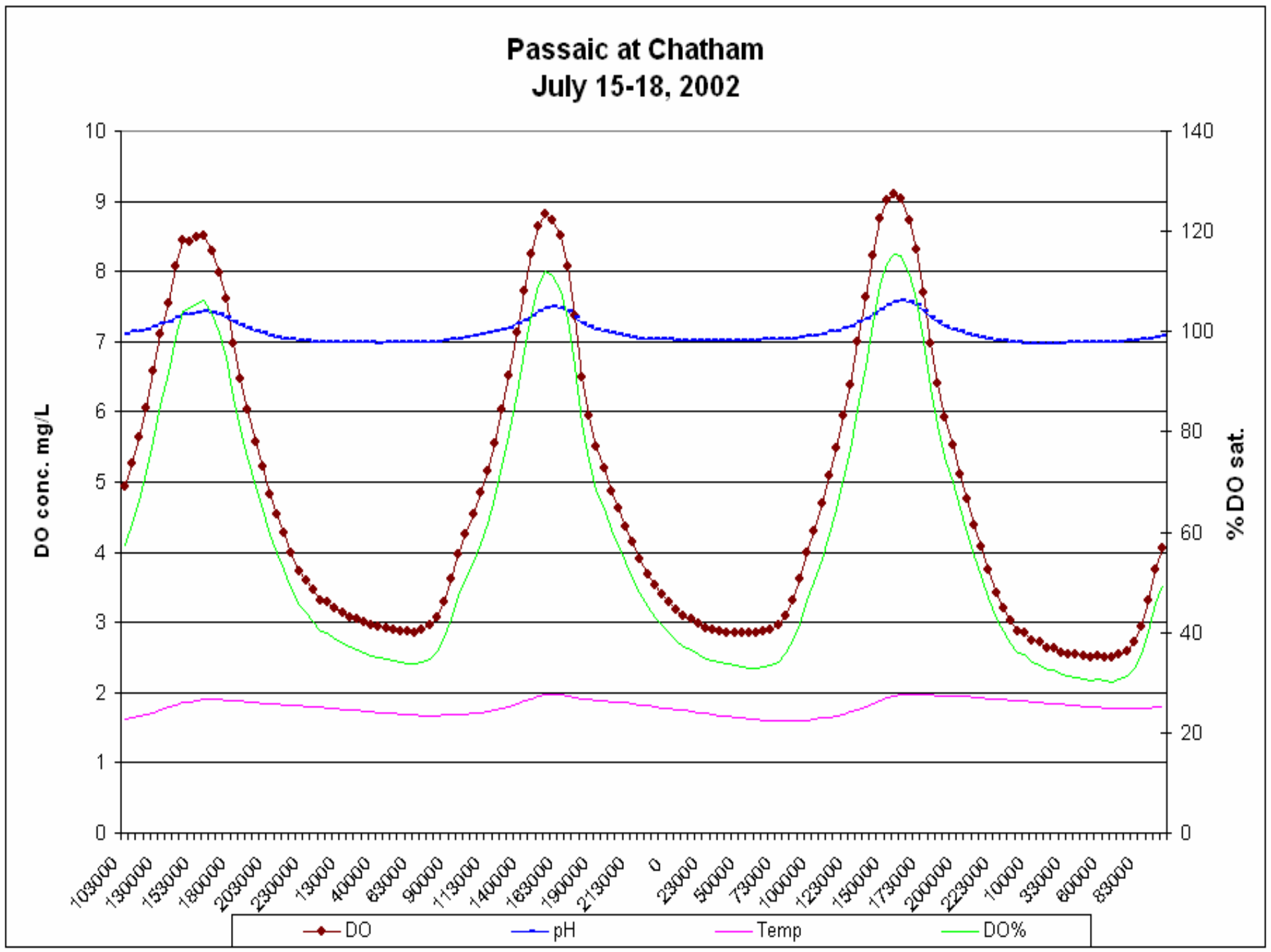
- **Phase 1**
  - TP reductions needed to satisfy water quality concerns in the Wanaque reservoir?
  - LA/WLAs based on Reservoir Endpoint
- **Phase 2**
  - TMDL to address all nutrient-related water quality impairments in non-tidal Passaic river basin
  - LA/WLA as applicable

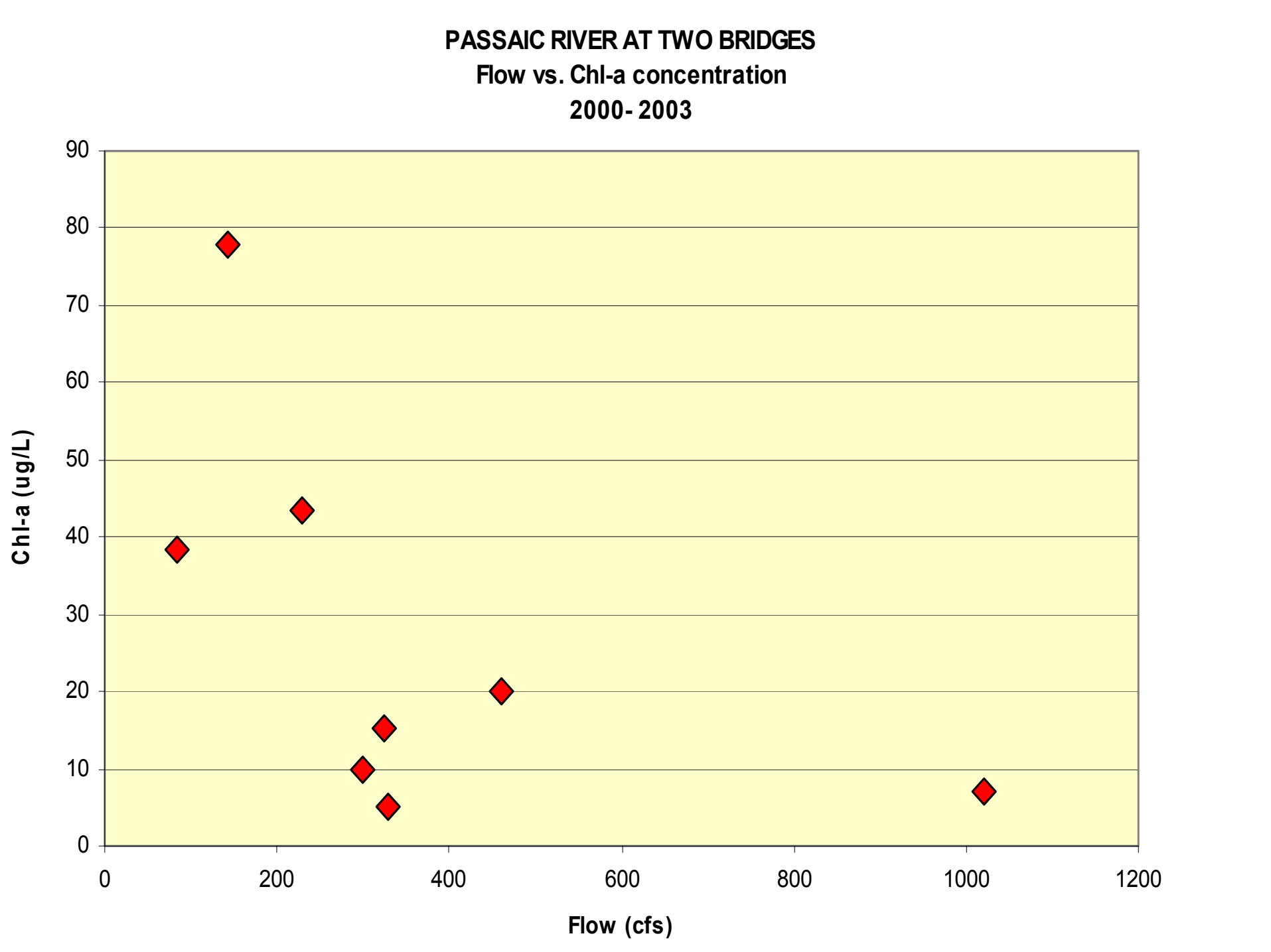
Phase 2 TMDL

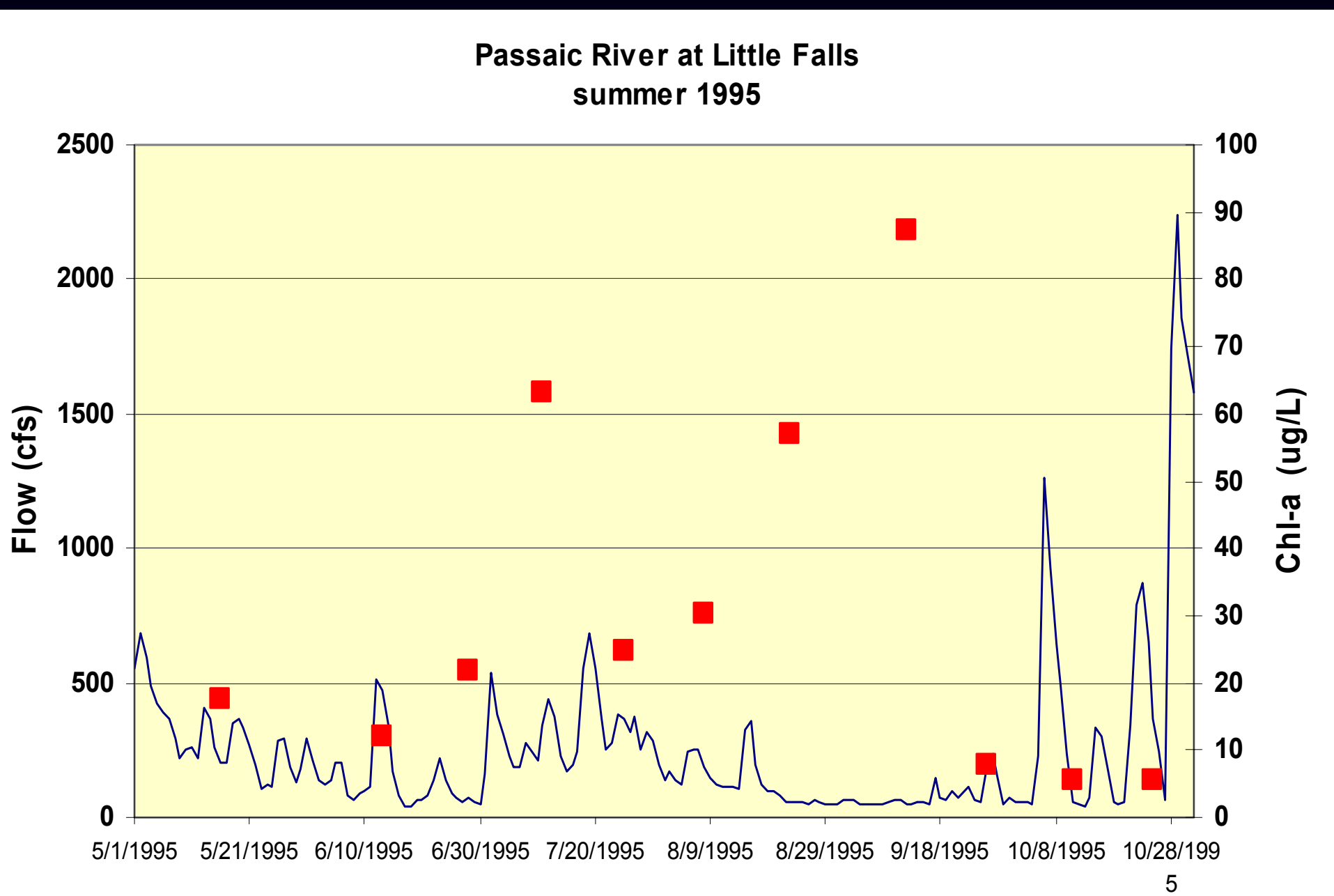
- Phase 2 will:
  - Employ a dynamic model
  - Identify other critical locations
  - Include non-tidal Passaic and tributaries downstream of confluence
  - Establish TMDLs for in-stream impairments
  - May modify WLAs and LAs set in Phase 1
  - Provide the tool to assess proposed trades


Simulated Baseline Total Phosphorus Concentrations (surface)
10-Year (1993-2002) Cumulative Distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
89.3%
81.4%
56%
Raymond Dam
West Brook
Erskine
0
0.05
0.1
0.15
0.2
0.25
(mg/l)


2000
Summer
2001
Summer
Passaic River at Passaic Avenue, Two Bridges
All 4 Years
Summer
Summer
Dissolved Oxygen (mg/l)
Temperature (C)
0
2
4
6
8
10
12
14
16
18
20
0
3
6
9
12
15
18
21
24
27
30
6/1/2001
6/8/2001
6/15/2001
6/22/2001
6/29/2001
7/6/2001
7/13/2001
7/20/2001
7/27/2001
8/3/2001
8/10/2001
8/17/2001
8/24/2001
8/31/2001
9/7/2001
9/14/2001
9/21/2001
9/28/2001
Observed Daily Avg
Observed Daily Max
Observed Daily Min
Observed DO
Temperature


Passaic at Chatham
July 15-18, 2002
DO conc. mg/L
% DO sat.
0
1
2
3
4
5
6
7
8
9
10
0
20
40
60
80
100
120
140
103000
130000
153000
180000
203000
230000
13000
40000
63000
90000
113000
140000
163000
190000
213000
0
23000
50000
73000
100000
123000
150000
173000
200000
223000
10000
33000
60000
83000
DO
pH
Temp
DO%


PASSAIC RIVER AT TWO BRIDGES
Flow vs. Chl-a concentration
2000- 2003
Chl-a (ug/L)
90
80
70
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
Flow (cfs)


Passaic River at Little Falls
summer 1995
Flow (cfs)
Chl-a (ug/L)
2500
2000
1500
1000
500
0
100
90
80
70
60
50
40
30
20
10
0
5/1/1995
5/21/1995
6/10/1995
6/30/1995
7/20/1995
8/9/1995
8/29/1995
9/18/1995
10/8/1995
10/28/199
5

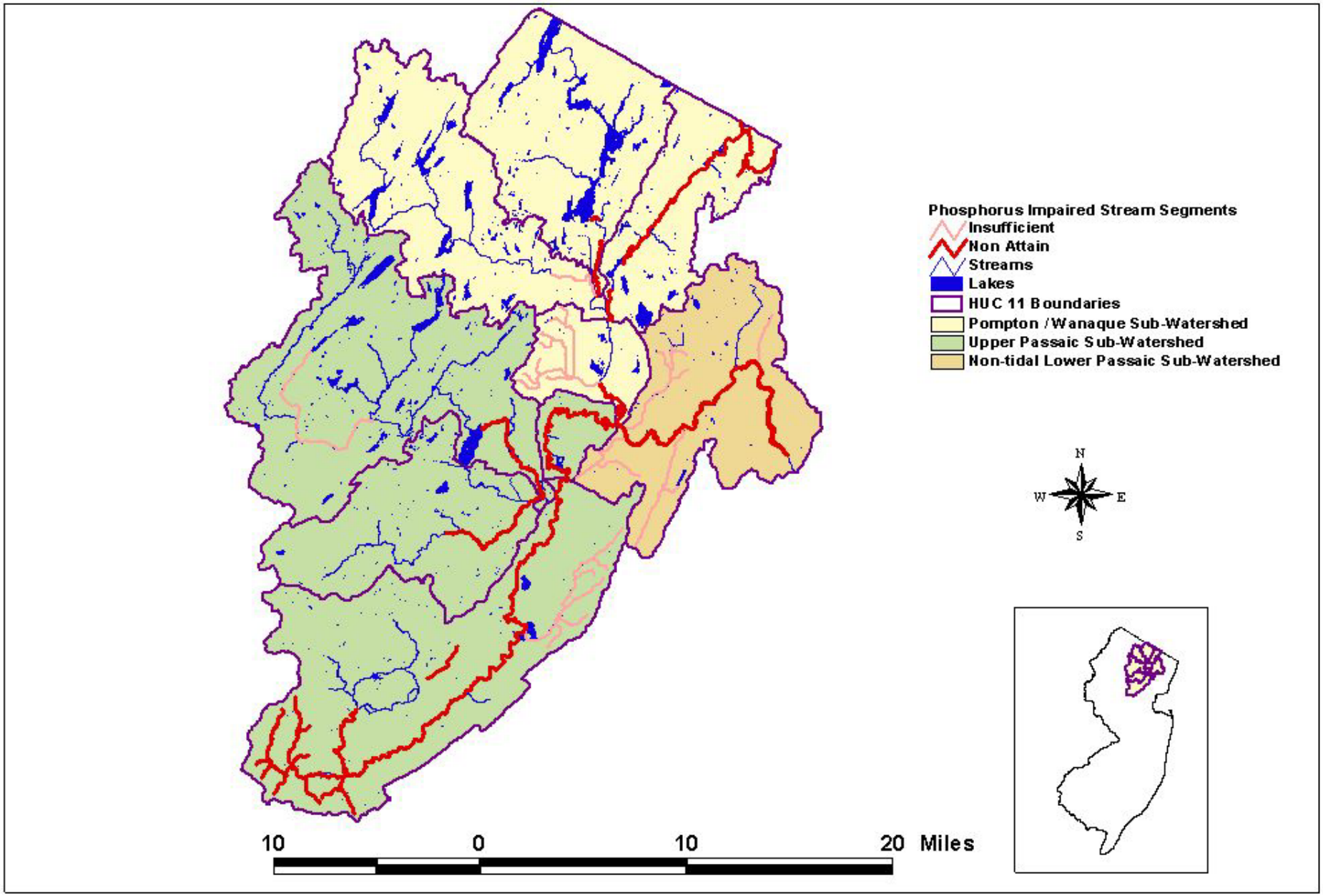
Potential Water Quality Drivers

- Water Supply Concerns:
  - Reservoir Algae blooms (taste and order)
  - Potable water treatment (cost)
- In-stream & lake eutrophication
  - Algae (floating and attached)
  - Rooted plants (macrophytes)
  - Dissolved oxygen (DO)
  - pH
- Downstream considerations
  - NY/NJ Harbor Nutrient TMDL

Wanaque Reservoir Selected Endpoint

- Candidate Endpoints
  - Existing criterion
  - Existing criterion met on seasonal basis
- Selected Existing Criterion
  - Existing criterion is achievable and will restore Reservoir to mesotrophic condition
  - Alternate criterion would, at best, achieve marginally mesotrophic/eutrophic condition
  - Alternate criterion not "…*necessary to protect existing or designated uses.*"

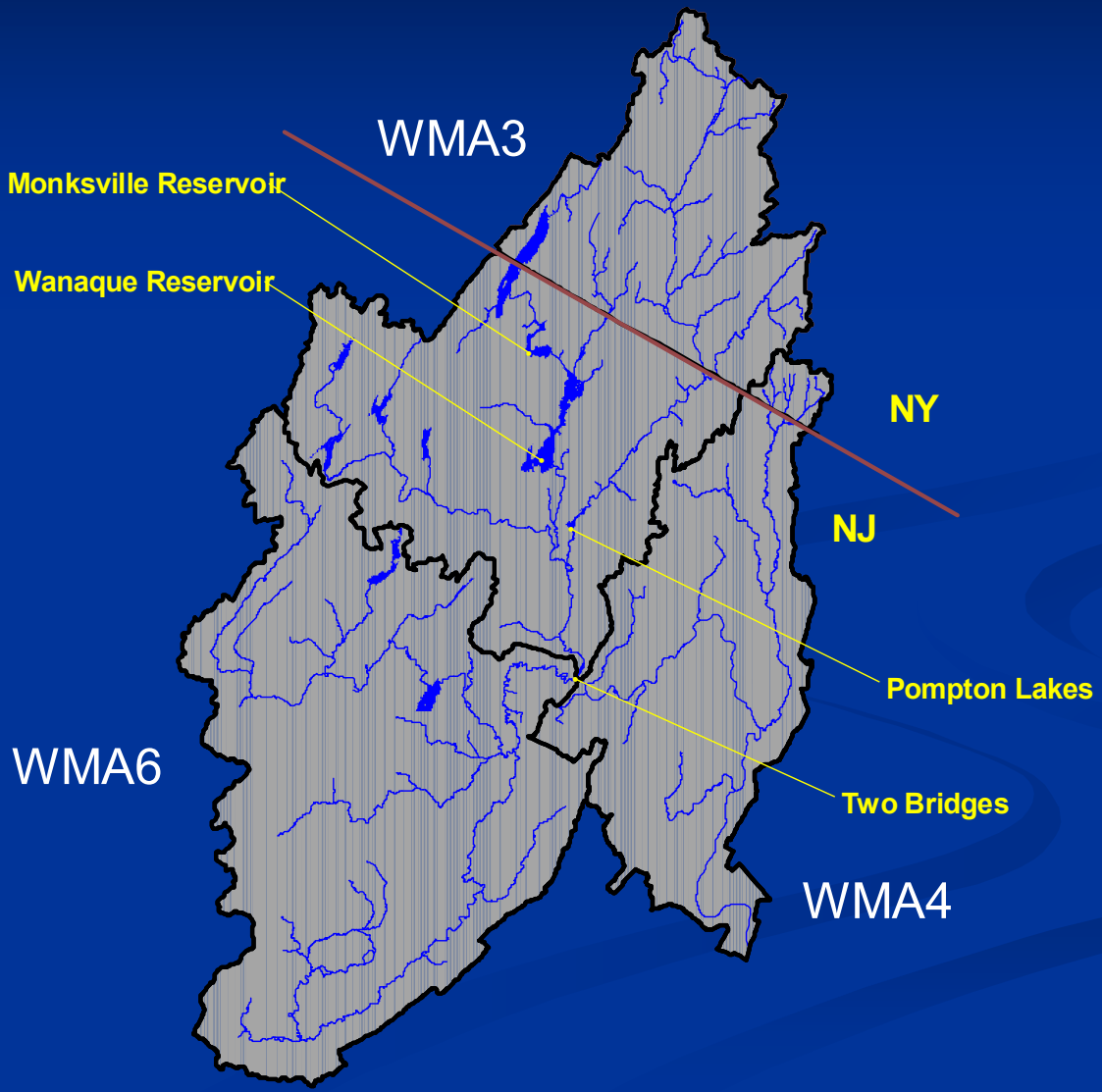
Passaic River TMDL Subbasin Delineations
Phosphorus Impaired Stream Segments



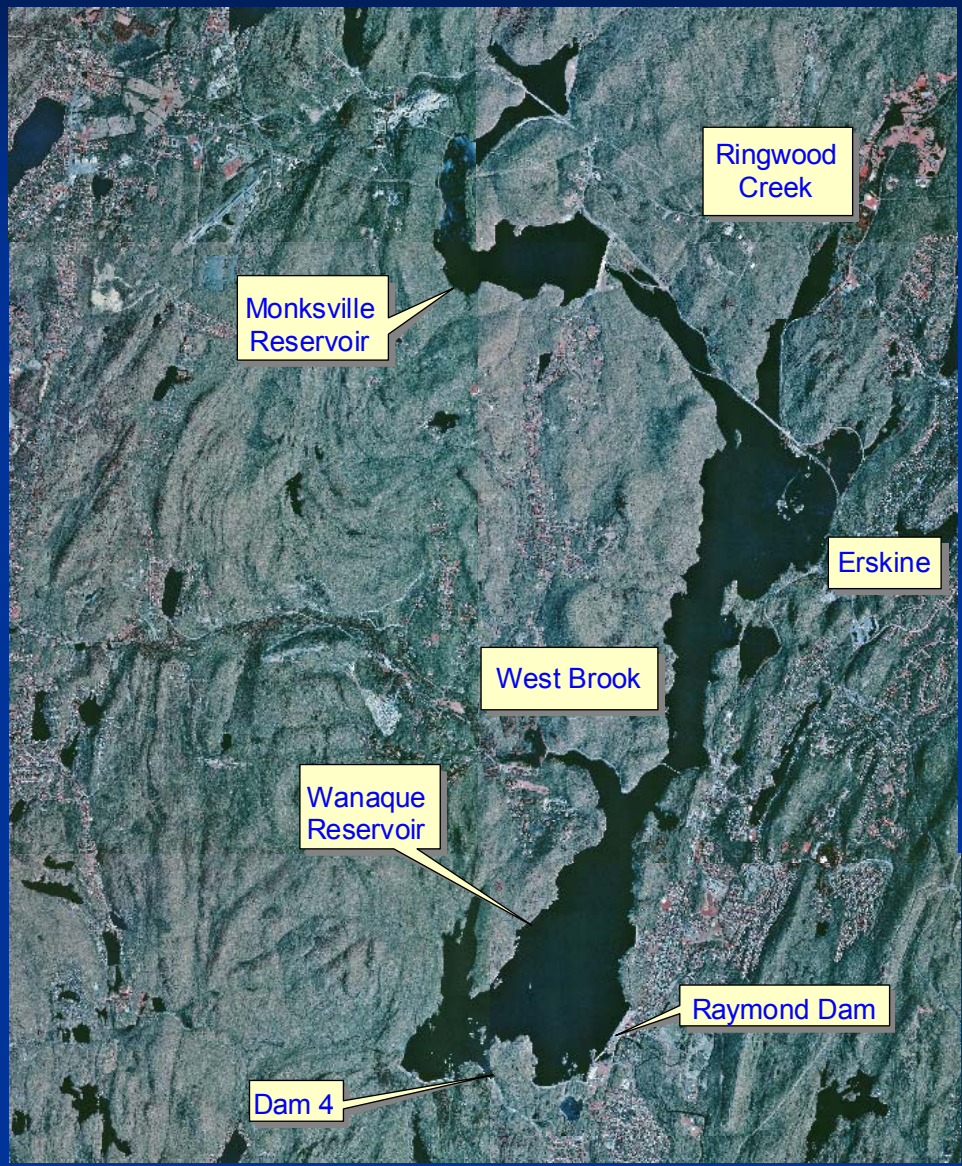
Phase 1 Approach

- Re-verify an existing Reservoir Water Quality Model " LA-WATERS"
- Refine & expand an existing Mass-Balance Model for the Passaic River and its tributaries
- Link the Reservoir and River Models to determine Reservoir loading capacity & distribute load to sources

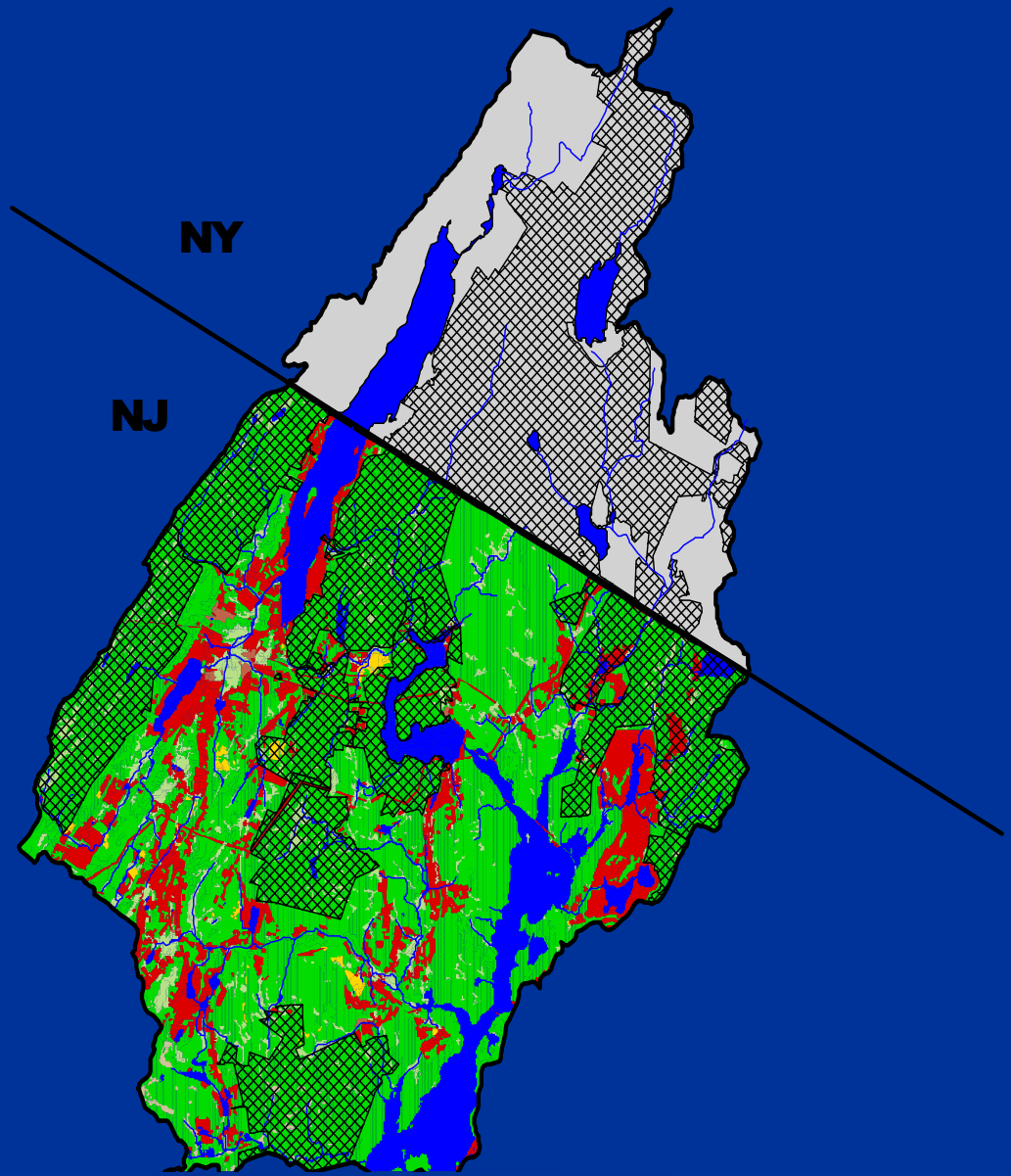
Passaic Watershed



Wanaque Reservoir



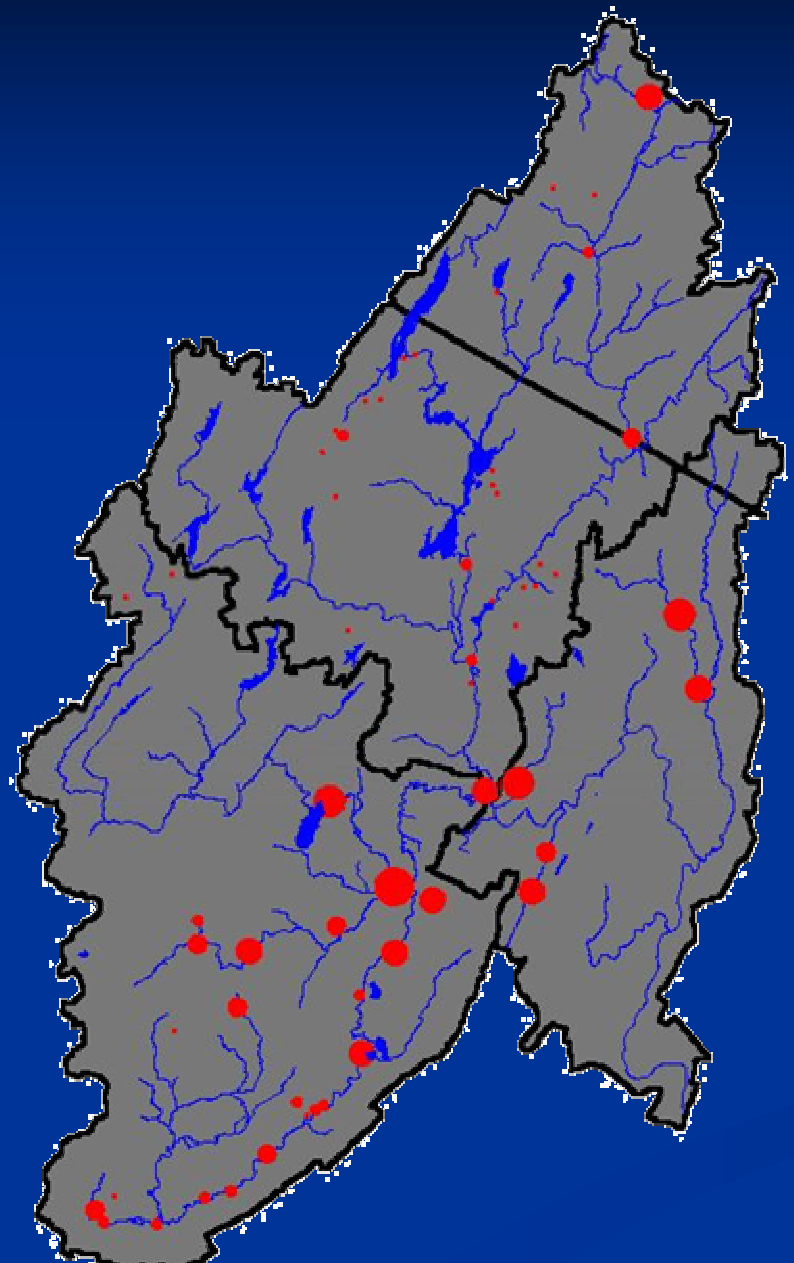
Tributary Watershed



Reservoir Source Assessment

- **Tributary Watershed- Wanaque**
  - Relatively undeveloped
  - Minimal point source impact within NJ
  - High quality water
- **Intake Watersheds**
  - Passaic, Pompton, Ramapo
  - Significant point-source contributions
  - Water quality compromised

DISTRIBUTION OF MUNICIPAL DISCHARGERS



Current Discharge Flows (mgd)

- 0.001 – 0.10
- 0.10 – 1.00
- 1.00 – 2.00
- 2.00 – 5.00
- 5.00 – 10.0
- 10.0 – 15.0

CUMULATIVE PS LOADINGS AT INTAKES

LOCATION	FLOW [mgd]	TP LOADINGS [lbs/day]
Pompton Lakes Intake	Mean (Design)	Mean (Design)
Ramapo River*	6.0 (6.6)	76.1 (83.7)
Two Bridges Intake		
Pompton River	12.45 (16.6)	221.1 (309)
Passaic River	45.2 (67.2)	1,020.0 (1516.5)
Two Bridges Intake Totals:	57.6 (83.8)	1,241.1 (1825.5)

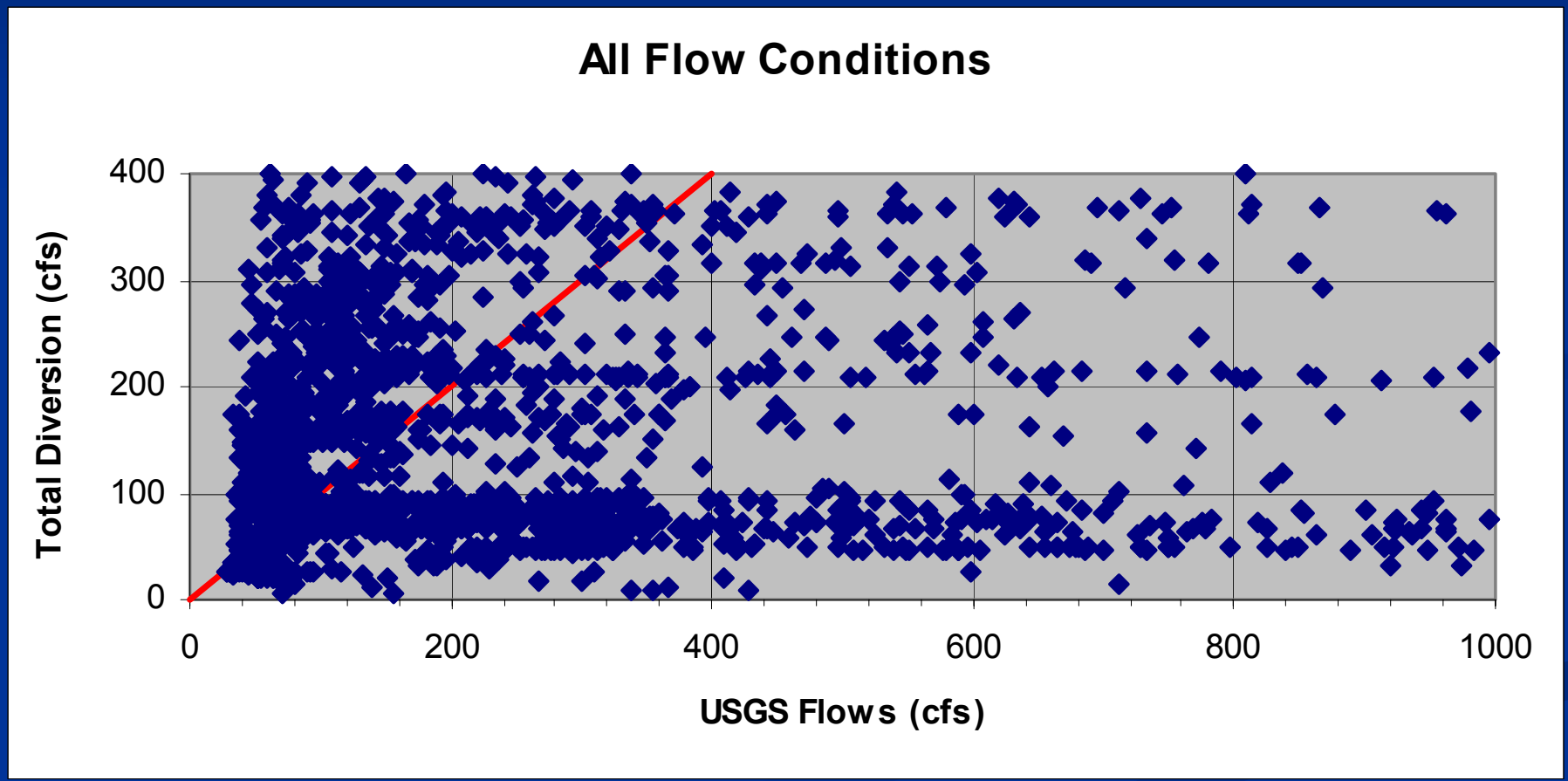
* 5.9 mgd of the mean flow (and 76.0 lbs/day of loadings) originates from New York

CUMULATIVE NPS LOADINGS AT INTAKES

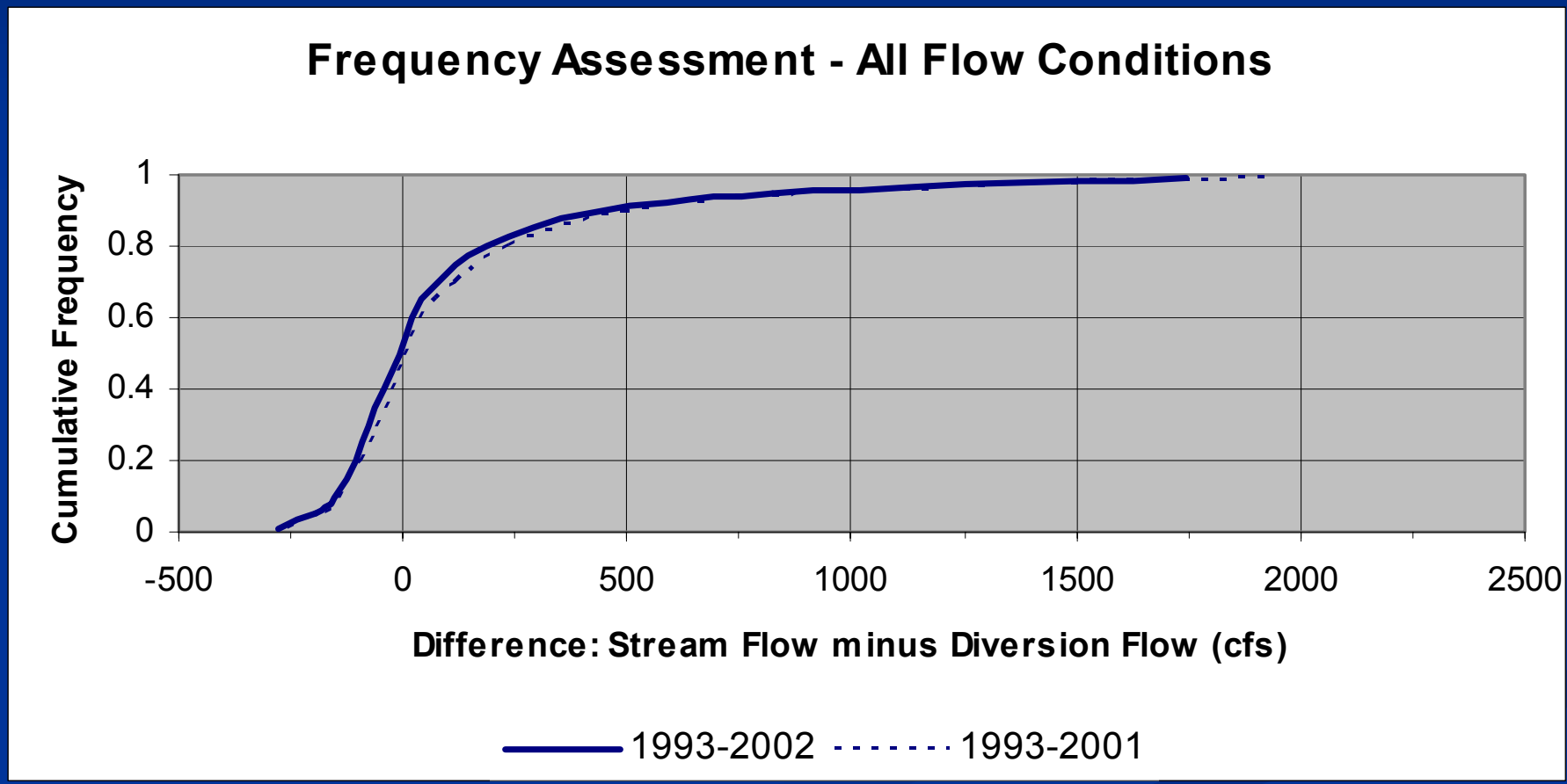
LOCATION	MEAN TP LOADINGS (lbs/day)
Pompton Lakes Intake	
Ramapo River	100
Two Bridges Intake	
Pompton River	178
Passaic River	269
Two Bridges Intake Totals:	447

TWO BRIDGES INTAKE PUMPAGE

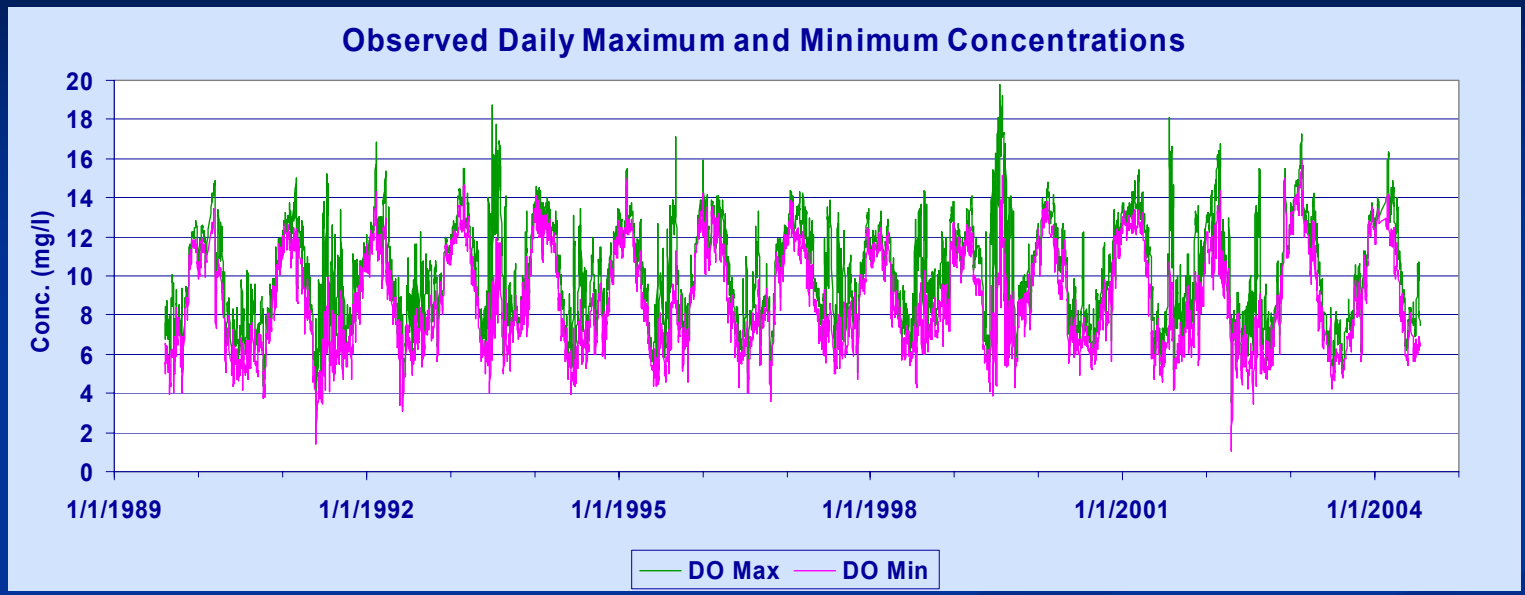
TWO BRIDGES INTAKE PUMPAGE

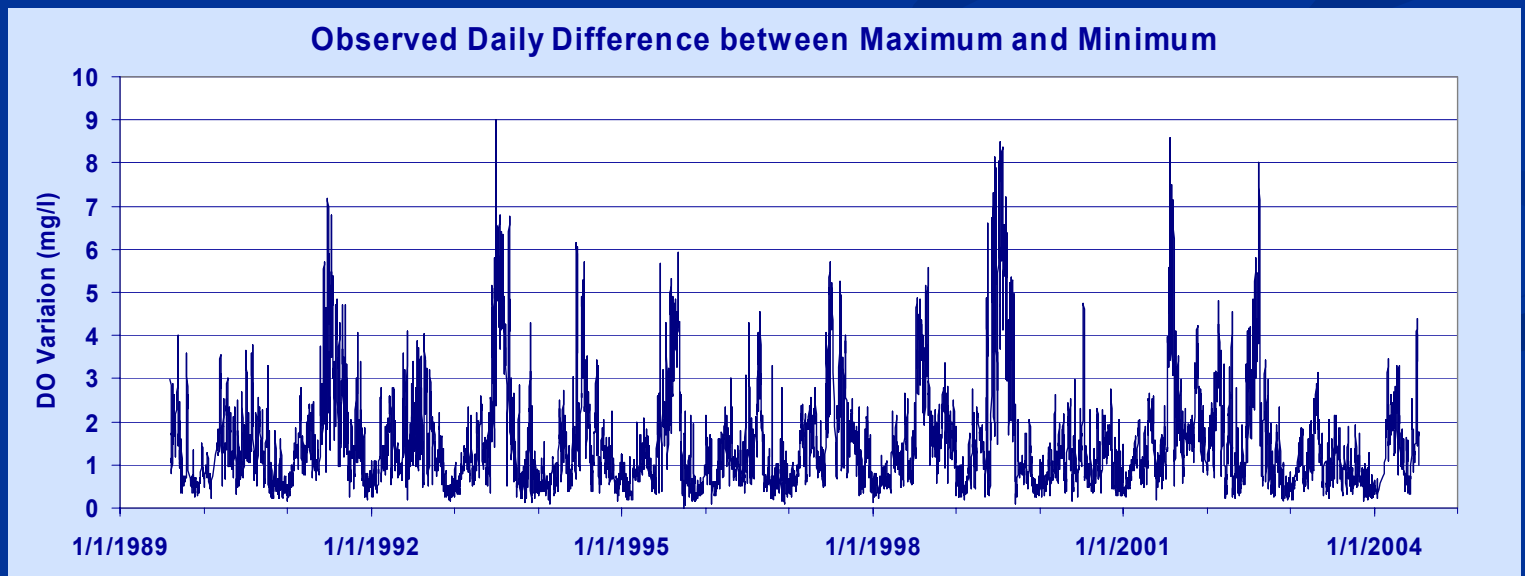


TWO BRIDGES INTAKE PUMPAGE



DO VARIATION:
PASSAIC RIVER BELOW TWO BRIDGES





RIVER MODEL

- Simple mass-balance model based on Passaic QUAL2E and WMA Characterization Studies
- Predicts concentration based on dilution of cumulative upstream discharges and NPS load
- Uses USGS flows and 1997-2000 DMR data
- Applied on a daily basis

NONPOINT-SOURCE LOADS

- Modified procedure in the WMA Characterization Studies to simulate stormwater impacts
- Separated USGS flows into runoff and base flow components using HYSEP
- Computed runoff load based on NJDEP's UAL coefficients and GIS land-use data
- Calibrated NPS mass-balance to simulate calculated annual runoff load

RIVER MODEL FORMULATION

Storm-Runoff Source Load

PS Load

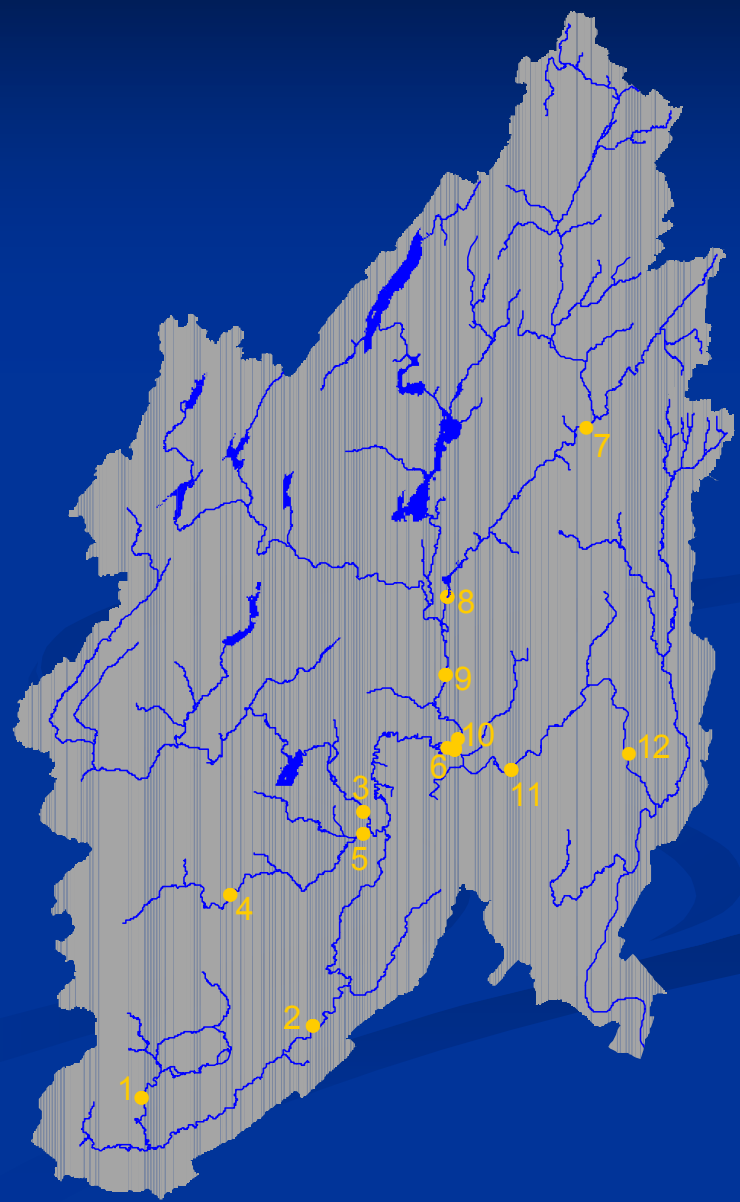
Base Flow Load

$$C_{Riv}Q_{Riv} = \sum C_{Dis}Q_{Dis} + C_{SW}Q_{SW} + C_{BF}\left(Q_{BF} - Q_{Dis}\right)$$

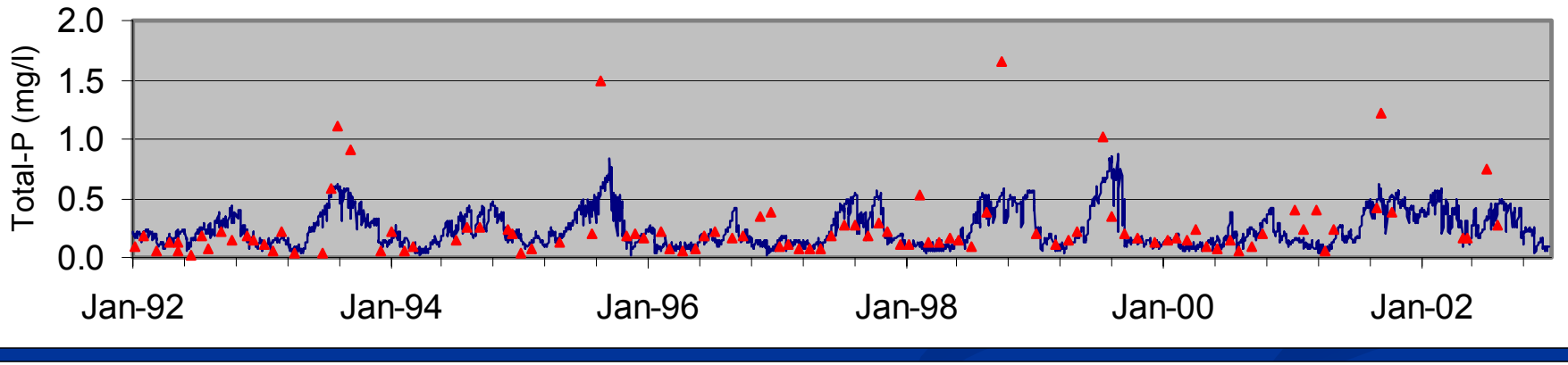
$$C_{SW} = \frac{\sum K_{UAL}A_{LU}}{\sum Q_{SW}}$$

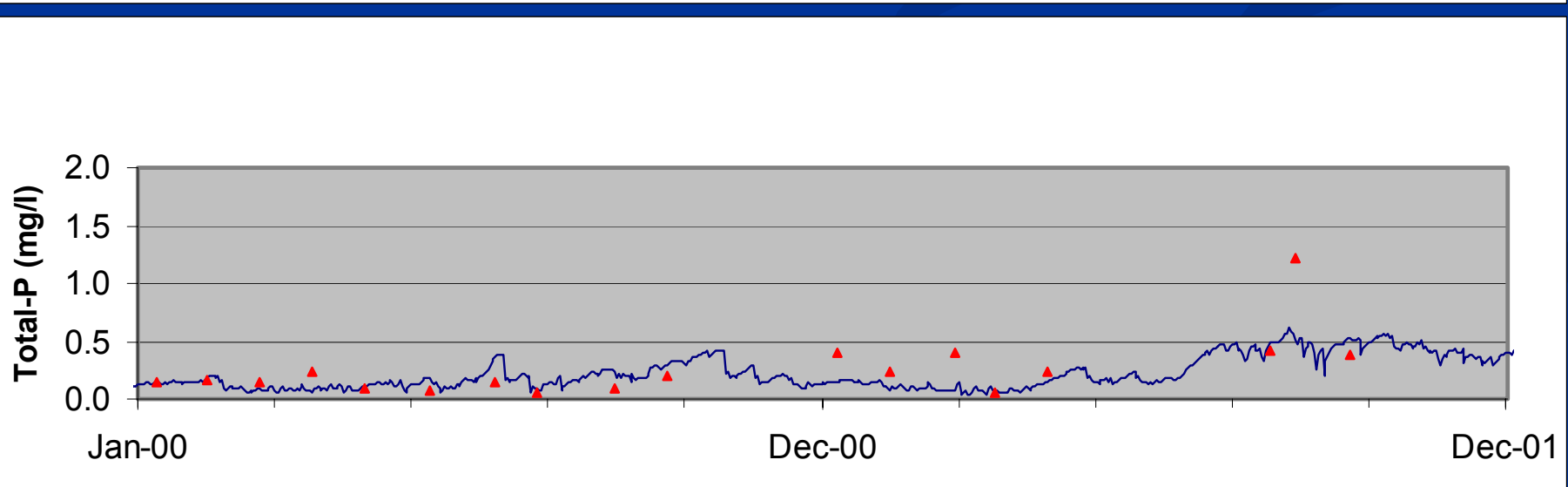
SELECTED CONTROL SITES

Station	Location
1	Passaic River – Millington
2	Passaic River – Chatham
3	Rockaway River – Pine Brook
4	Whippany River - Morristown
5	Whippany River – Pine Brook
6	Passaic River – Two Bridges
7	Ramapo River - Mahwah
8	Ramapo River – Pompton Lakes
9	Pompton River - Packanack Lake
10	Pompton River – Two Bridges
11	Passaic River – Little Falls
12	Passaic River – Elmwood Park

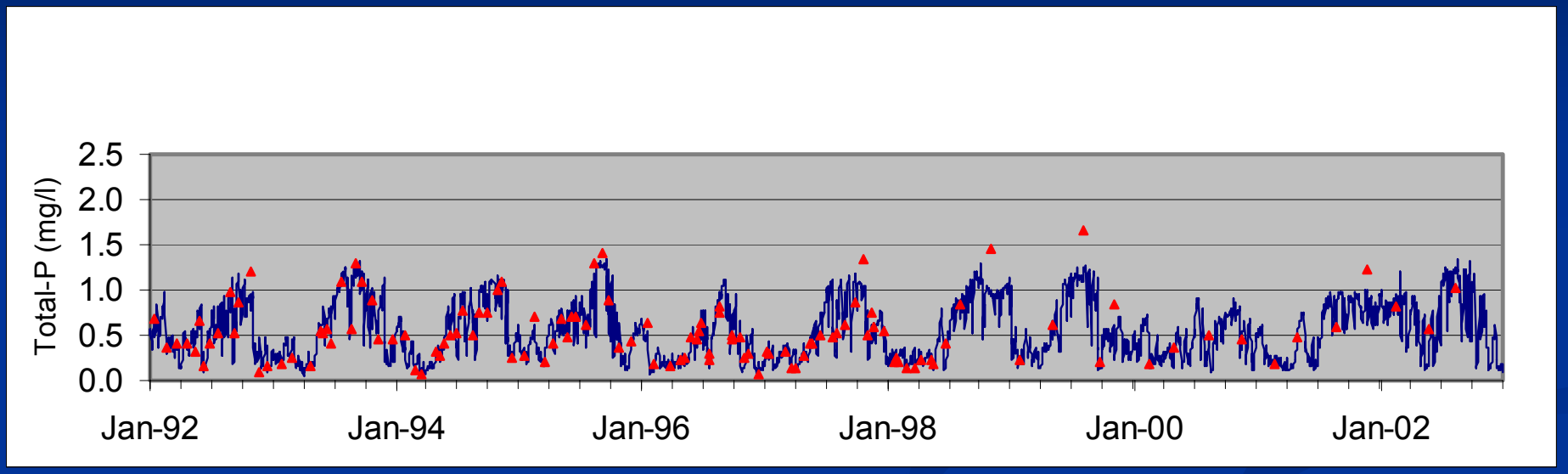


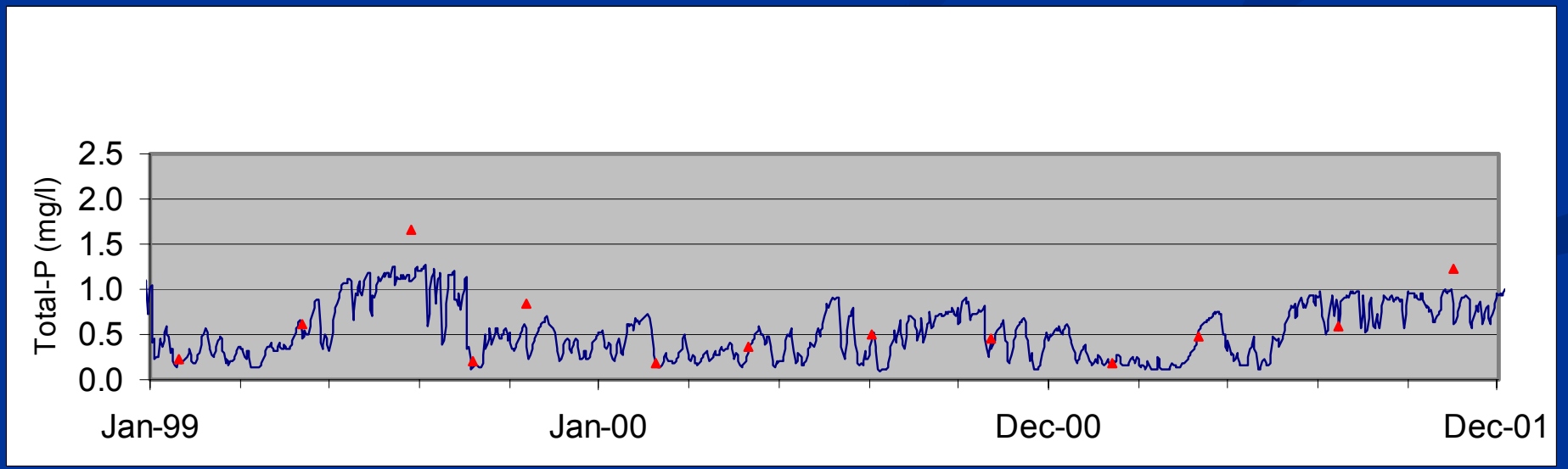
Mass Balance Simulation of Total Phosphorus for the Pompton River at Two Bridges -- Station 01388600 (1992-2002)



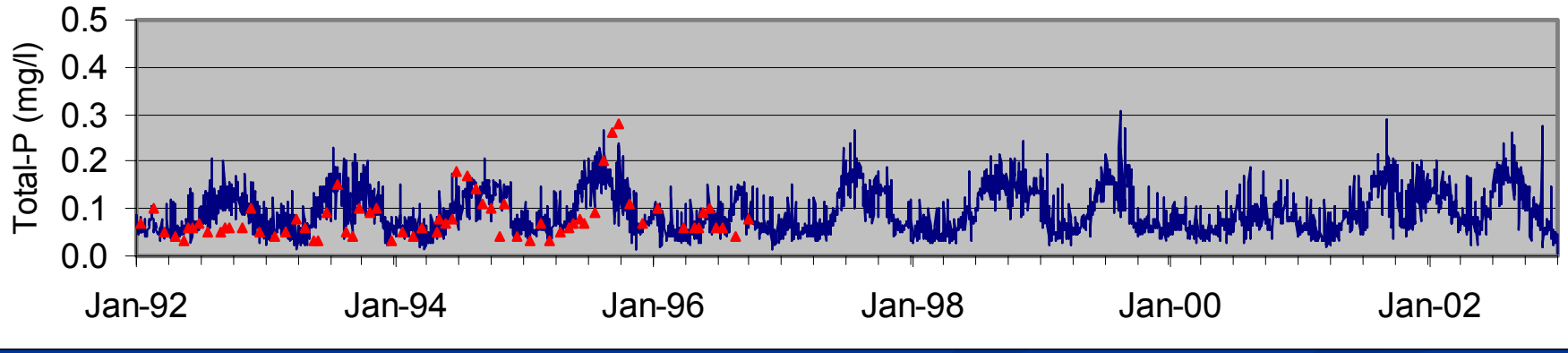


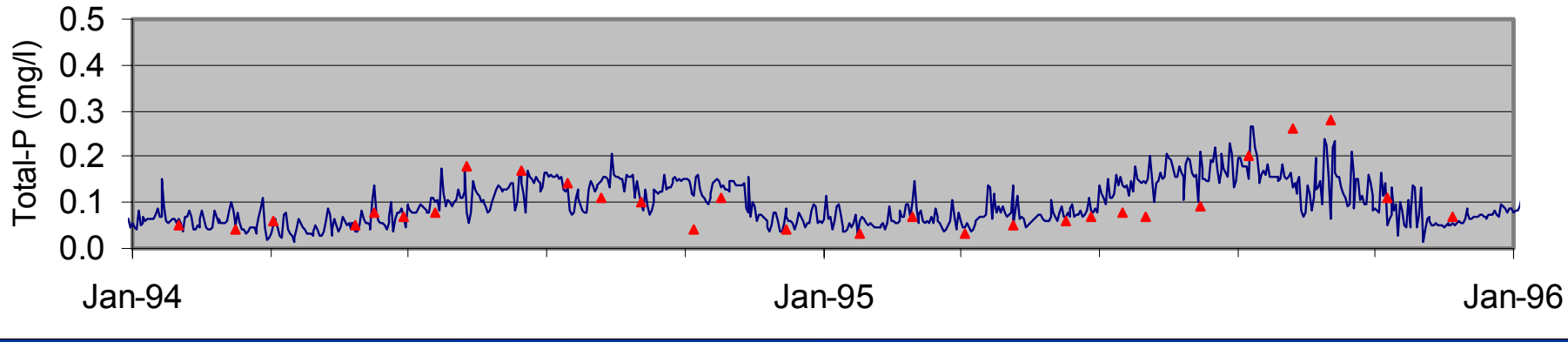
Mass Balance Simulation of Total Phosphorus for the Passaic River at Two Bridges -- Station 01382000 (1992-2002)



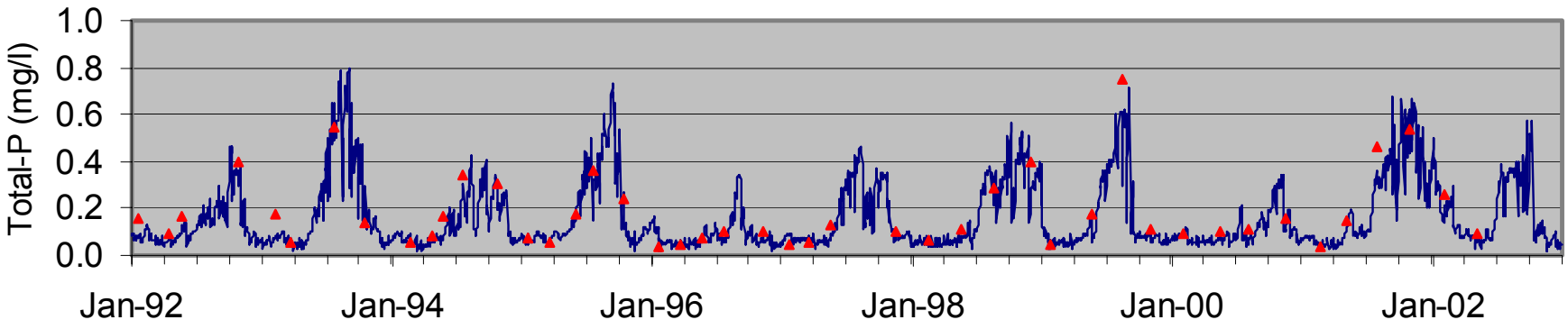


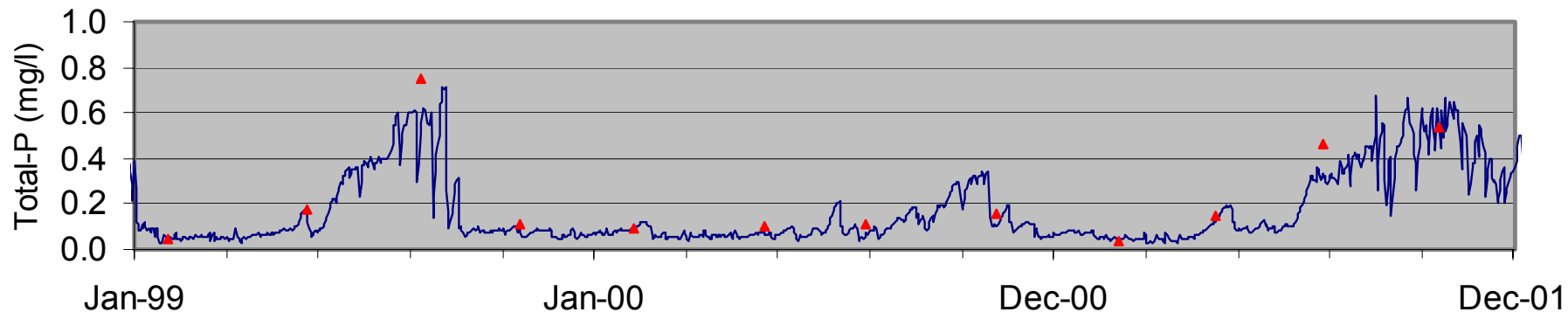
Mass Balance Simulation of Total Phosphorus for the Ramapo River at Pompton Lakes -- Station 01388000 (1992-2002)



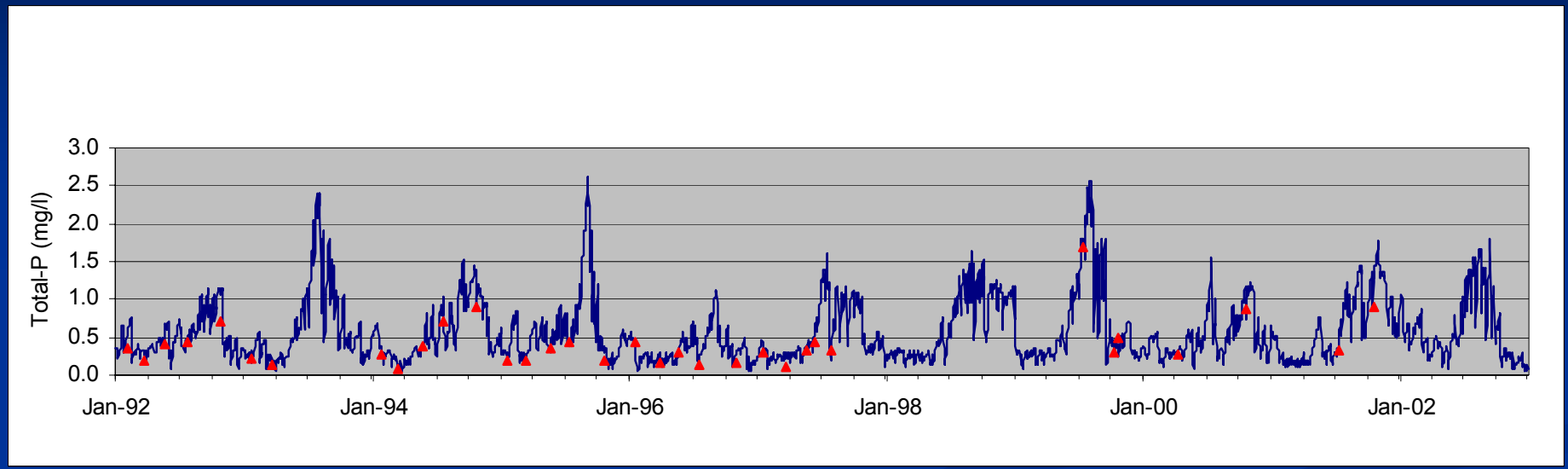


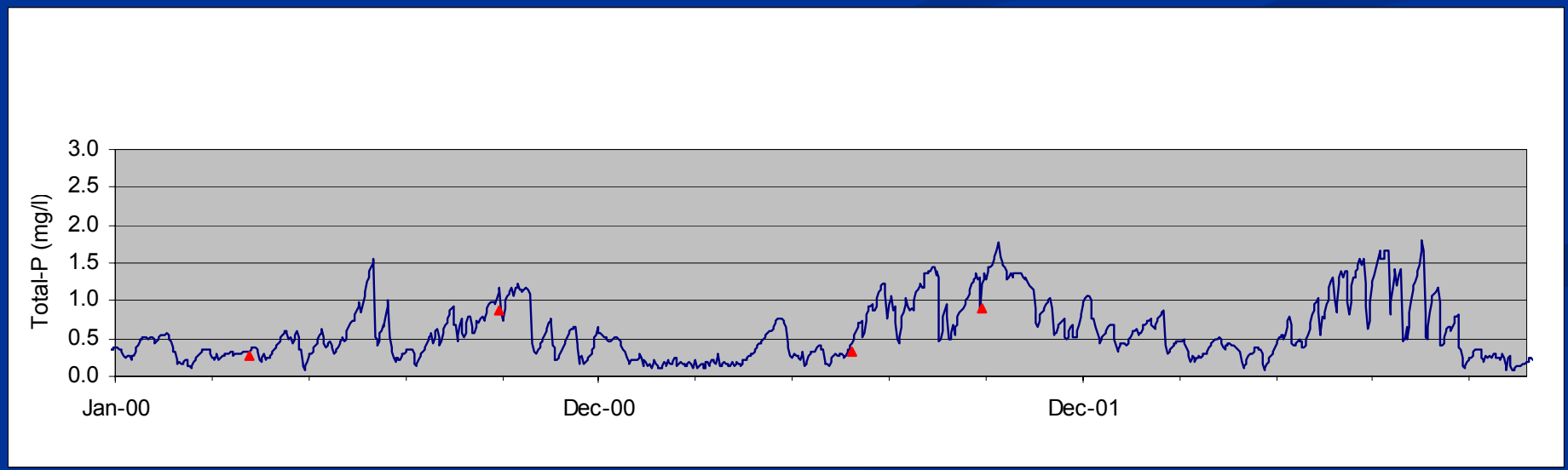
Mass Balance Simulation of Total Phosphorus for the Ramapo River at Mahwah -- Station 01387500 (1992-2002)



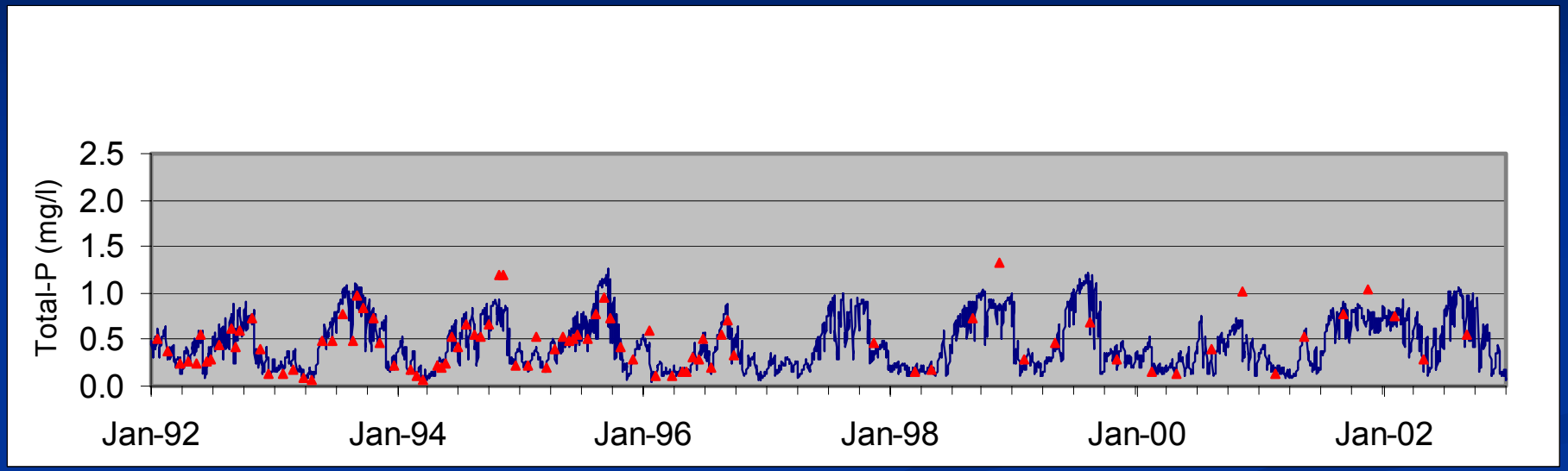


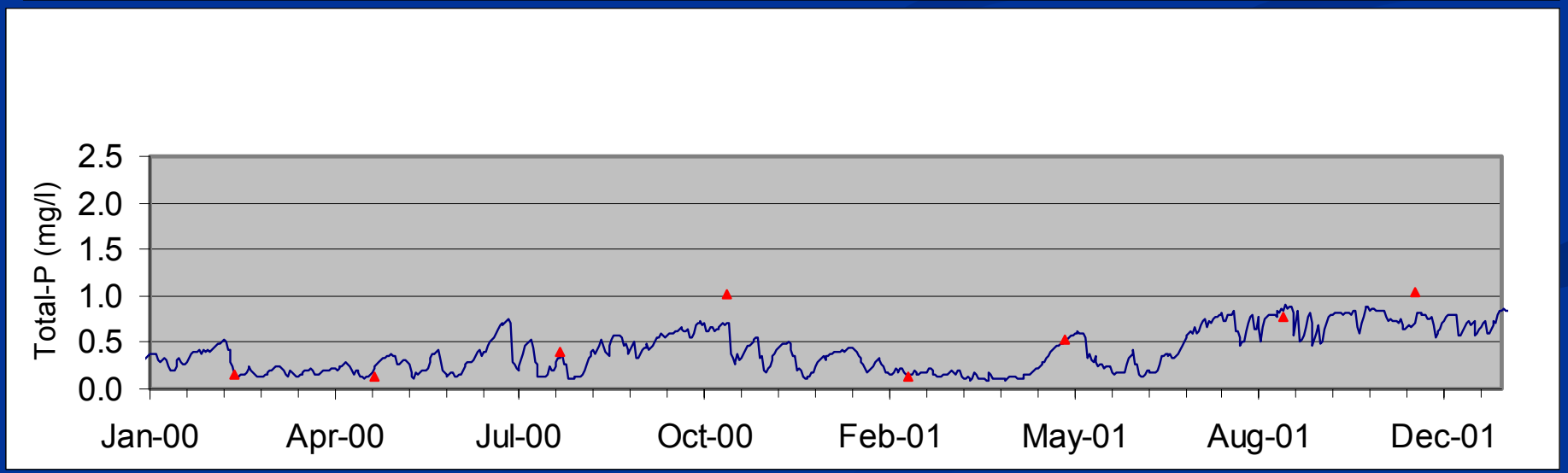
Mass Balance Simulation of Total Phosphorus for the Passaic River at Chatham -- Station 01379500 (1997-2000)





Mass Balance Simulation of Total Phosphorus for the Passaic River at Little Falls -- Station 01389500 (1992-2002)





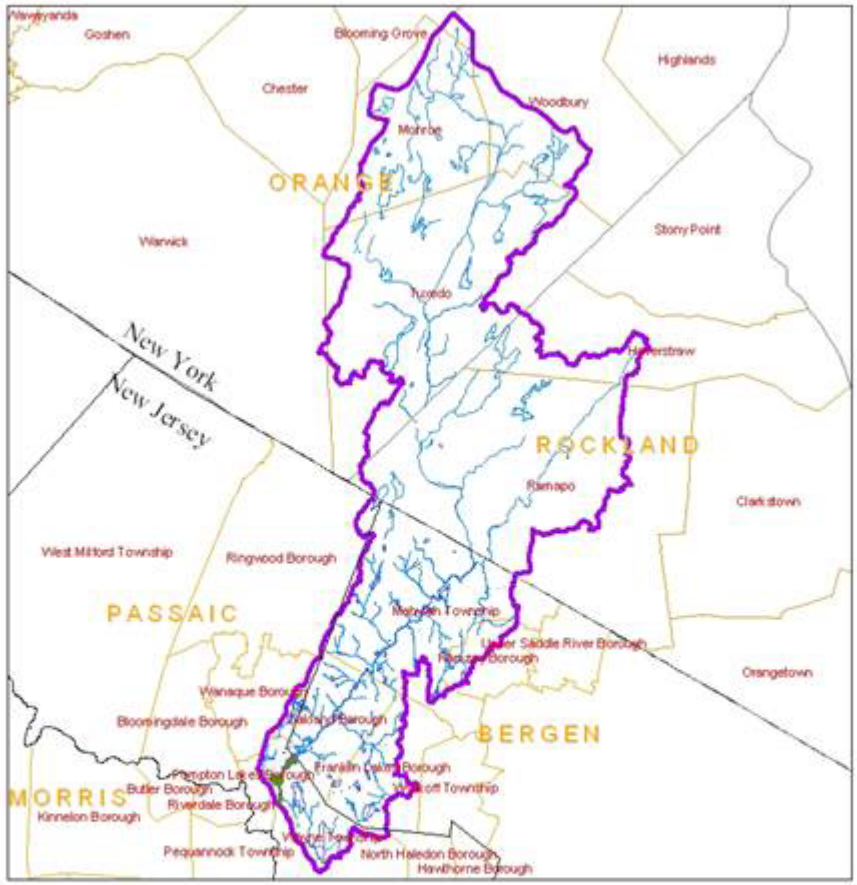
Pompton Lake/Ramapo River

- Phase 1 also addresses Pompton Lake and Ramapo River above Pompton Lake
- Most of the load reduction must occur in New York
- WLAs/LAs established in Phase 1 will not be modified in Phase 2, subject to trading

Margin of Safety (MoS) and Reserve Capacity (RC)

- Explicit MoS for the Wanaque Reservoir of 6.0 %
- Explicit RC of 1.0 %
- MoS & RC for Wanaque Reservoir is 1220 lbs/year or 7.4 % of the TMDL (16,501 lbs/year)

Location of Pompton Lake and Its Watershed



N
W E
S

1:236,000

Legend

- Pompton Lake
- Pompton Lake Watershed
- Stream and Lake
- Municipal
- County

Table 6.2: TMDL calculations for Ramapo River Watershed (at Pompton Lakes) (average annual loads and percent reductions)

	Existing Conditions[1]		TMDL Specification		Percent
	lbs TP/yr	% of CWL	lbs TP/yr	% of CWL	Reduction[2]
Cumulative Watershed Load (CWL)	43,925	100%	13,780	100%	69%
Point Sources other than Stormwater					
NJPDES Dischargers[3]	37	0.1%	149	1.1%	0%
Internal Loading					
Sediment/Base Flow	1,634	3.7%	1,634	11.9%	0%
Boundary Inputs					
New York[4]	28,320	64.5%	6,851	49.7%	76%
Land Use Surface Runoff[5]					
Low Intensity Residential	3,087	7.0%	617	4.5%	80%
High Intensity Residential	4,739	10.8%	948	6.9%	80%
Commercial/Industrial/Transportation	2,758	6.3%	552	4.0%	80%
Mixed Urban/Recreational	1,426	3.2%	285	2.1%	80%
Crops/Pasture/Hay	191	0.4%	38	0.3%	80%
Deciduous Forest	1,206	2.7%	1,206	8.8%	0%
Evergreen Forest	6	0.0%	6	0.0%	0%
Mixed Forest	44	0.1%	44	0.3%	0%
Shrubland	36	0.1%	36	0.3%	0%
Woody Wetlands	138	0.3%	138	1.0%	0%
Herbaceous Wetlands	10	0.0%	10	0.1%	0%
Open Water	142	0.3%	142	1.0%	0%
Disturbed Areas	150	0.3%	150	1.1%	0%
Other Allocations					
Margin of Safety	n/a	n/a	832	6.0%	n/a
Reserve Capacity	n/a	n/a	141	1.0%	n/a

[1] average annual loads based on 1993-2002 model simulation
[2] = 1 - (TMDL load /Existing load)*100
[3] detailed listing of individual discharge facilities is provided with Table 6.10
[4] includes PS and NPS discharges to Ramapo River within New York State

WLAs for Treatment Facilities on the Pompton Lake watershed

DES #	Facility Name	Current Flow (mgd)[2]	Current Load (lbs/yr)[3]	Permitted Flow (mgd)	WLA (lbs/yr)[4]	Load % Reduction*
029858	OAKLAND CARE CENTER	0.0239	9.5	0.0300	18.3	*
053112	OAKLAND-CHAPEL HILL ESTATES STP	0.0069	0.5	0.0100	6.1	*
080811	RAMAPO RIVER CLUB STP	0.0696	14.2	0.1137	69.2	*
027774	OAKLAND-OAKWOOD KNOLLS WWTP	0.0177	2.4	0.0350	21.3	*
021253	RAMAPO-INDIAN HILLS H.S. WTP	0.0068	7.1	0.0336	20.5	*
021342	OAKLAND-SKYVIEW-HIGH BROOK STP	0.0130	2.3	0.0230	14.0	*

2 current flows are based on NJDEP's Municipal STP Flow Database for 2002

3 current loads are based on facility's reported 1997-2000 discharge load

4 based on a LTA effluent concentration of 0.20 mg/l

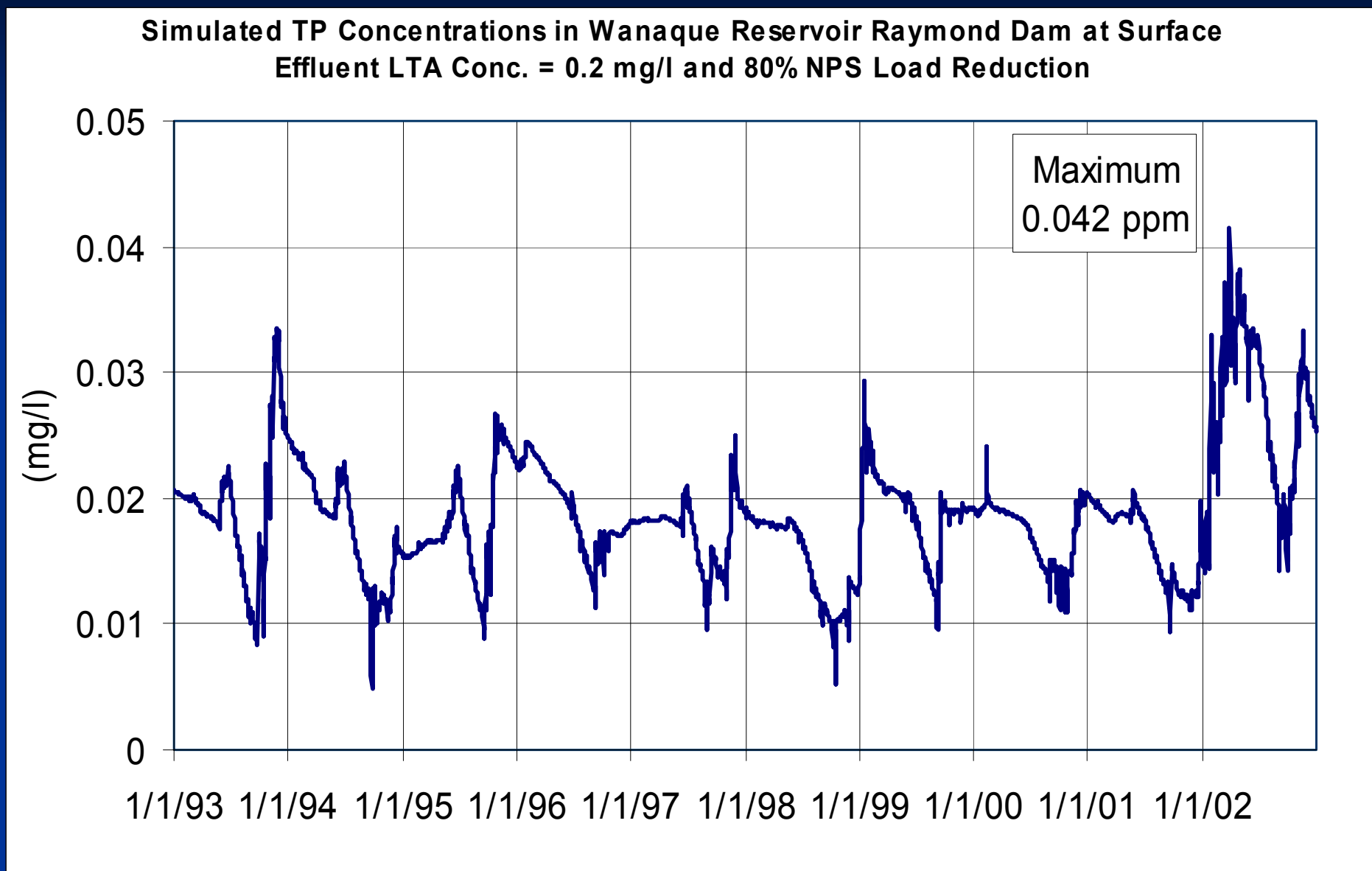
* denotes that projected TMDL is greater than the reported discharge load

MODEL LINKAGES

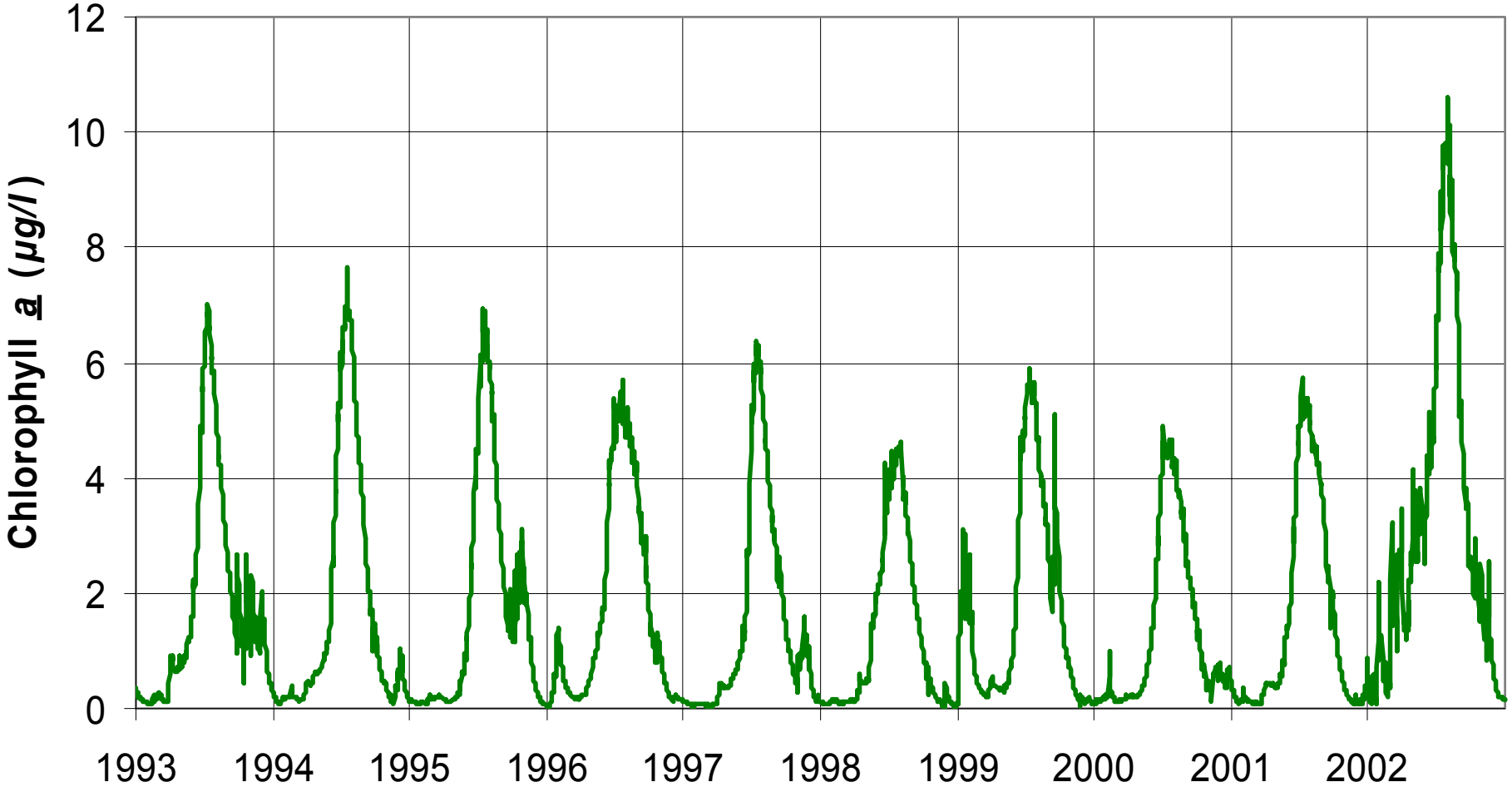
- Calibrated River model provides time series of daily loads at Reservoir intakes
- Allows for Reservoir model simulations of diversions impacts

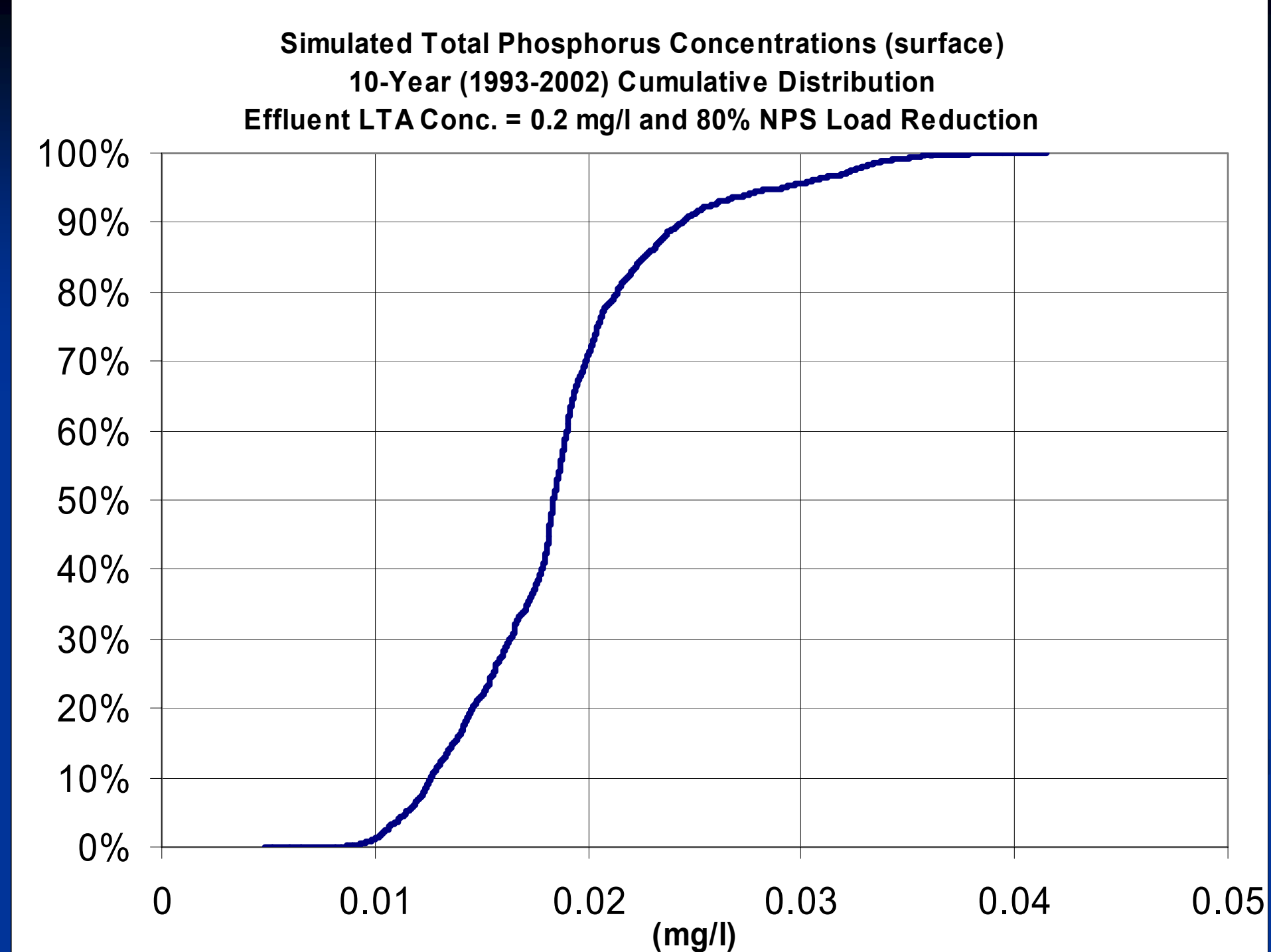
RESERVOIR MODEL ANALYSIS

- Apply calibrated LA-WATERS model
- Develop intake input based on River model output
- Re-simulate 11-year baseline condition


Simulated TP Concentrations in Wanaque Reservoir Raymond Dam at Surface
Effluent LTA Conc. = 0.2 mg/l and 80% NPS Load Reduction
Maximum
0.042 ppm
(mg/l)
0.05
0.04
0.03
0.02
0.01
0
1/1/93
1/1/94
1/1/95
1/1/96
1/1/97
1/1/98
1/1/99
1/1/00
1/1/01
1/1/02

Simulated Chlorophyll-a Concentrations in Wanaque Reservoir
Raymond Dam at Surface
Effluent LTA Conc. = 0.2 mg/l; NPS Reduction = 80%




Simulated Total Phosphorus Concentrations (surface)
10-Year (1993-2002) Cumulative Distribution
Effluent LTA Conc. = 0.2 mg/l and 80% NPS Load Reduction
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.01
0.02
0.03
0.04
0.05
(mg/l)

Allocations

- Model results indicate that full compliance with TP criterion can be achieved by:
  - Reducing cumulative upstream discharge load (PS TP load) to 139 lbs/day (~ 83%), and
  - Reducing NPS load by 80%
- Trading:
  - point to point source
  - STP – Stormwater (MS4)
  - Treat diversion water

NPS Strategies

- NPS & Stormwater PS reductions
  - Stormwater
    - SBR (inlet cleaning, street sweeping, pet waste, etc)
    - Low Phosphorus Fertilizer Ordinance
    - Retrofits (319 projects)
  - Buffers Restorations
  - Ag BMPs
  - Goose management
  - Septic system management
  - Low maintenance landscaping at corporate campuses

Next Steps

- Comments due September 3
- Response to Comments – EPA for approval
- Point Source implementation meeting on November 1, 2005 at DEP public hearing room
- Low phosphorus ordinance -- additional measure post adoption as amendment

Comments are due September 3

All TMDL documents are posted
at
http://www.state.nj.us/dep/watershedmgt/tmdl.htm

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Questions?