Non-Tidal Passaic River Basin Nutrient TMDL Study

Presented to:
Passaic River Basin Stakeholders

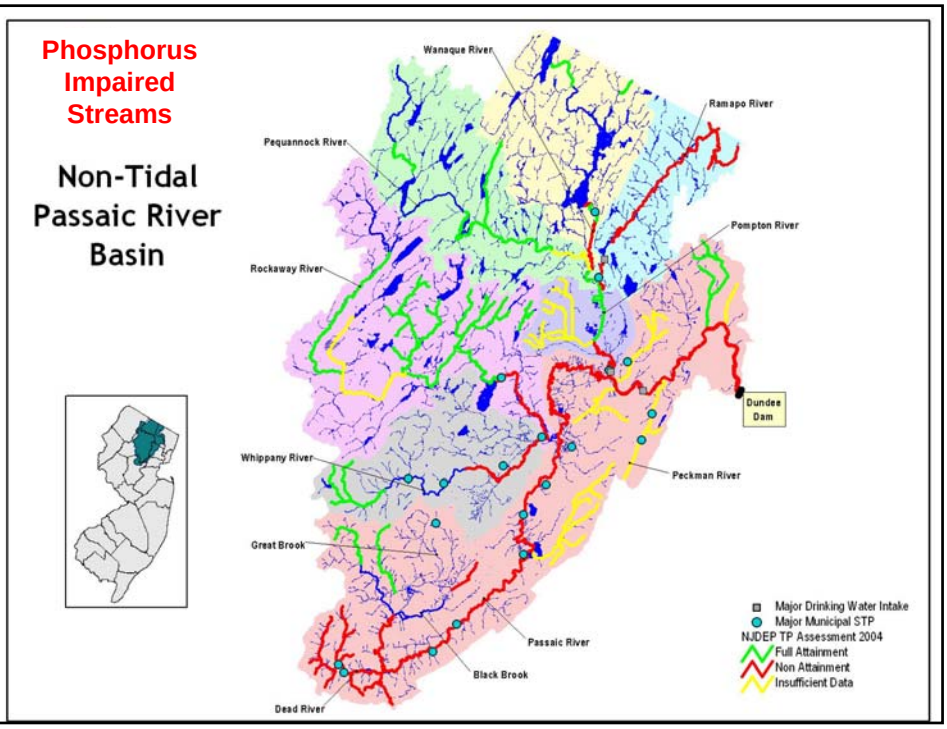
May 19, 2006

Agenda

- Purpose of Study
- Phase I – Watershed Monitoring
- Phase II – Watershed Modeling
  - Model Calibration
  - Impact of Phosphorus Reductions on Productivity
- Watershed-Specific Criteria
- Conclusion

Purpose of Study

- To provide a scientifically defensible approach to applying the nutrient criteria in the SWQS and establishing a nutrient Total Maximum Daily Load (TMDL) for the Non-Tidal Passaic River Basin
- To establish nutrient load reductions that will translate into environmental benefits as defined by either the SWQS or site specific criteria



Surface Water Quality Standards

- Lakes
  - Phosphorus as TP shall not exceed 0.05 mg/l in any lake, pond or reservoir, or in any tributary at the point where it enters such waterbody, except where site-specific criteria are developed where necessary to protect uses.
- Streams
  - Except as necessary to satisfy the Lakes criteria or where site specific criteria are developed, TP shall not exceed 0.1 mg/l in streams unless phosphorus is not limiting productivity and is not rendering waters unsuitable

Nutrient Policies 7:9B-1.5(g)

- Except as due to natural conditions, nutrients shall not be allowed in concentrations that cause objectionable algal densities, nuisance aquatic vegetation or otherwise render the waters unsuitable for the designated uses.
- The Department may establish site specific water quality criteria for nutrients in lakes, in addition to or more stringent, when necessary to protect designated uses.

Pollutants of Concern

- Total Phosphorus (Primary Pollutant of Concern)
  - Regulated due to potential to stimulate excessive plant and algal growth
    - Segment is listed where stream concentrations exceed 0.1 mg/l
    - SWQS also contain narrative criteria (evaluated after listing)
  - Phosphorus is a causal parameter
    - Response parameters include dissolved oxygen and plant/algal growth
- Total Nitrogen
  - Need tool to translate load allocation from NY/NJ Harbor TMDL to load and wasteload allocations throughout the system

Phase I: Watershed Monitoring

- Monitoring Program
  - Data to Verify Impairment and Establish Critical Locations
  - Data to Calibrate and Validate Watershed Model
  - Data to Characterize Nutrient Sources
    - point
    - nonpoint
- 11"×17" Handout shows all sampling locations
- Prior Presentations on monitoring results - April 27, 2004 and September 28, 2004

Water Quality Data (Collected in 2003)

- To identify impairments
  - Diurnal DO, pH, temperature; phytoplankton; periphyton
- To calibrate and validate model
  - Diurnal DO, pH, temperature; phytoplankton; periphyton
  - Grab Chemistry: pH, temperature, DO, alkalinity, $CBOD_5$, P-series, N-series, iron, TDS, TSS, TOC, turbidity
- To characterize nutrient sources
  - STPs: pH, temperature, DO, alkalinity, $CBOD_5$, P-series, N-series, TDS, TSS, TOC
  - Stormwater: alkalinity, $CBOD_5$, P-series, N-series, TDS, TSS, TOC
- Additional Data
  - Stream cross sections
  - SOD measurements
  - Diurnal solar radiation (light intensity)
  - Underwater light extinction

Water Quality Data (Collected in 2004)

- Additional data so could model each tributary explicitly rather than as a boundary condition
- Rockaway River
  - 4 stream locations plus one tributary location
  - one diurnal event
- Peckman River
  - 5 stream locations plus two tributary locations
  - one diurnal event
- Dead River
  - 4 stream locations plus one tributary location
  - one diurnal event

Other Calibration / Validation Data

- NJDEP Diurnal DO Measurements
  - Passaic River at Chatham 2002
  - Passaic River at Little Falls 2002
  - Pompton River 1999 and 2002
- PVSC Historical Phytoplankton Chlorophyll-a
  - Passaic River from Great Falls to Dundee
- USGS Continuous DO and Temperature Measurements
  - Ramapo River at Pompton Lakes
  - Passaic River at Two Bridges
- PVWC Historical Stream Chemistry Data
- Stream Chemistry Data from Dischargers

General Observations and Assessment

- Upper and Mid-Passaic River Watershed
  - Phosphorus is very high
  - Productivity is low
    - Few macrophytes
    - Diurnal DO swings are generally small to none
    - Naturally low DO – productivity generally increases average DO
    - Chatham is exception
- Pompton River Watershed
  - Phosphorus is generally low
  - Productivity is low to moderate
  - DO is higher than Passaic
- Lower Passaic River Watershed
  - Phosphorus is very high
  - Productivity is very high under critical conditions
  - Macrophytes and phytoplankton are important

Phase II: Watershed Modeling

- Watershed Model Purpose and Overview
- Calibration and Validation Summary

Watershed Model Purpose

- Purpose
  - To relate point and nonpoint sources of nutrients to water quality impacts under a variety of conditions, including critical conditions
- Critical Water Quality Indicators
  - Dissolved oxygen was identified as a primary water quality indicator
  - Phytoplankton (measured as water column chlorophyll-a)
  - Phosphorus concentration and loads
  - Nitrogen components (ammonia, nitrate, and organic nitrogen)

Nutrient Response Indicators

- Phosphorus
  - Impacts water quality by stimulating excessive plant and algae growth
- Dissolved oxygen (DO)
  - DO influenced by BOD and SOD in addition to photosynthesis
  - Excessive plant and algae growth results in diurnal swing due to photosynthesis/respiration cycle
- Phytoplankton (chlorophyll-a)
  - Excessive phytoplankton growth results in algal blooms
- Study emphasized impact of phosphorus on dissolved oxygen and phytoplankton Chl-a

Model Overview

- Flow model
  - DA-FLOW one-dimensional flow model by USGS
  - modified to account for mixing at confluence
- Water quality model
  - one dimensional dynamic simulation using WASP 7 with EUTRO
  - large-scale unified system model
- Watershed Model Integration Tool (WAMIT)
  - Nonpoint source simulation using flow-weighted EMCs
  - DA-FLOW and WASP integration

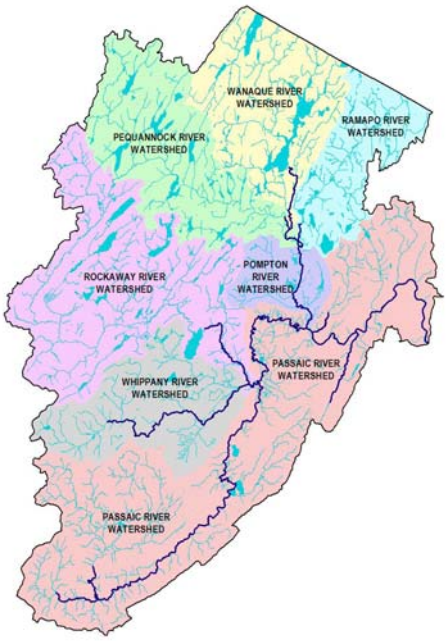
Model Inputs

- Basin Information
- NPS Loads
- Boundary Conditions
  - Discharger flows and quality
  - Water supply diversions
  - Headwater boundaries
- Time series data
  - solar radiation
  - stream temperature
- Water quality kinetic parameters
  - Local and global

Watershed Model Spatial and Temporal Extent

- Spatial Extent (next slide)
  - Location of continuous streamflow gauges that drive the flow model
  - Inclusion of STP discharges that represent substantial phosphorus sources
  - Inclusion of streams designated by NJDEP as impaired by phosphorus
- Temporal Extent (October 1, 1999 – November 30, 2003)
  - WY2000 – "normal"
  - WY2001 – dry
  - WY2002 – extreme drought
  - WY2003 – wet

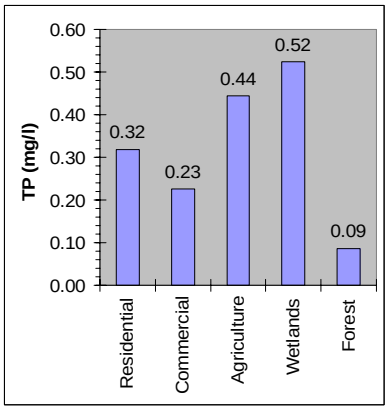
Modeled Segments of The Passaic Basin

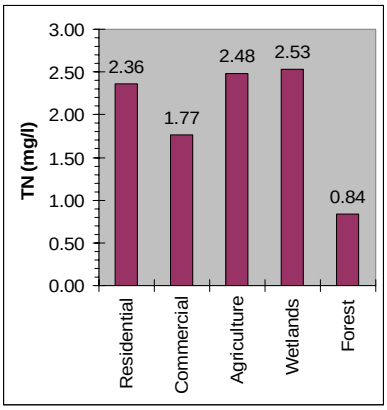


Nonpoint Source Loads

- Hydrograph Separation
  - Contributing runoff
  - Contributing baseflow
- Runoff Loads
  - Flow-weighted runoff EMC × contributing runoff
  - Curve number method only used to weight EMC
- Baseflow Loads
  - Baseflow concentration × contributing baseflow

Runoff EMCs



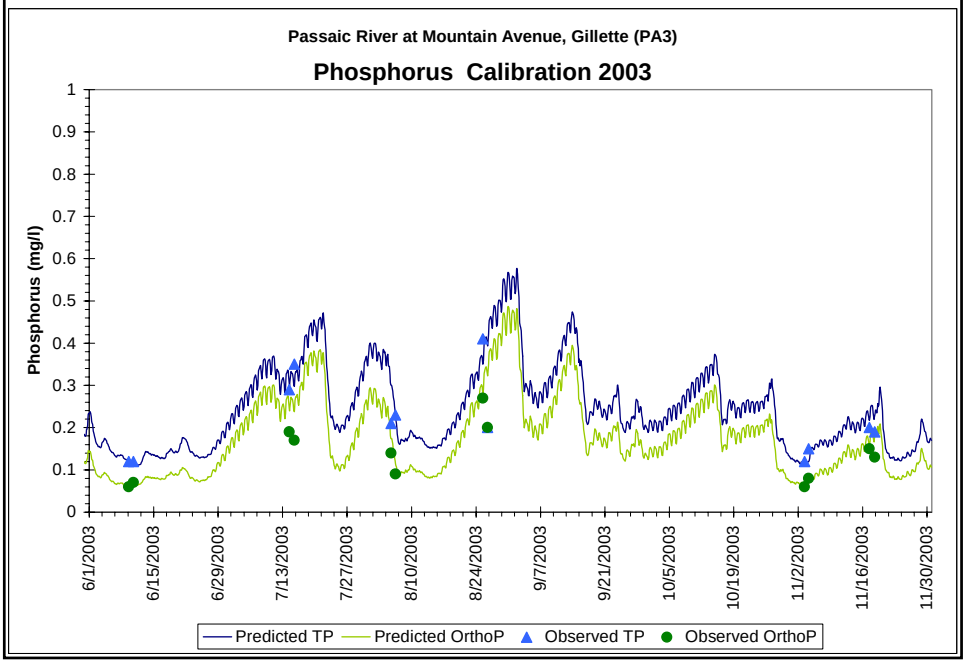


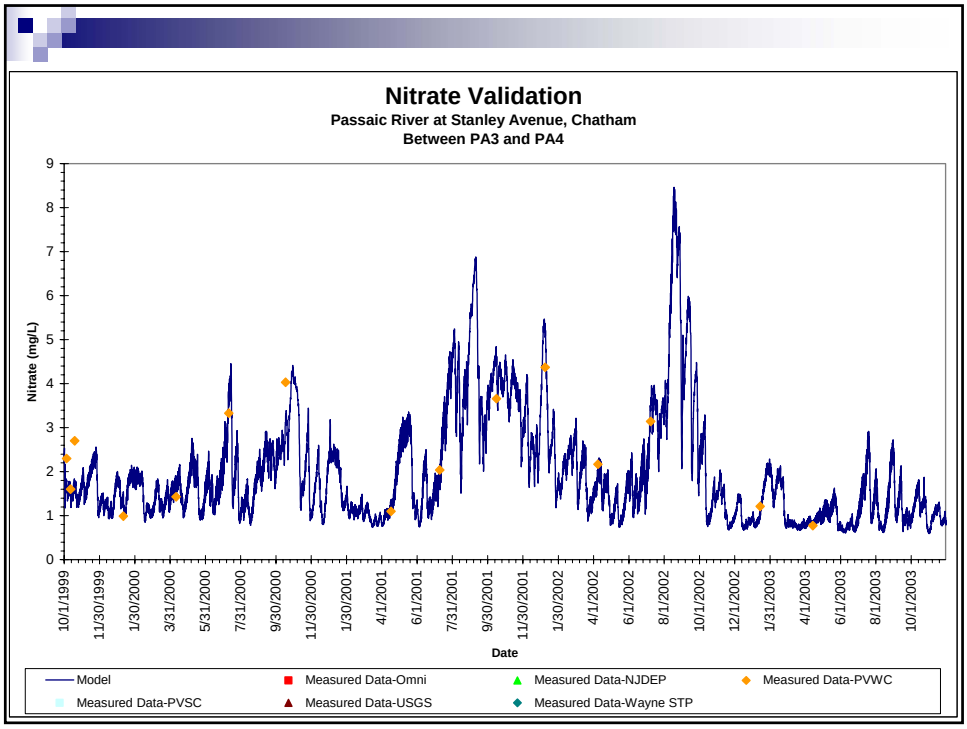
Baseflow Concentrations

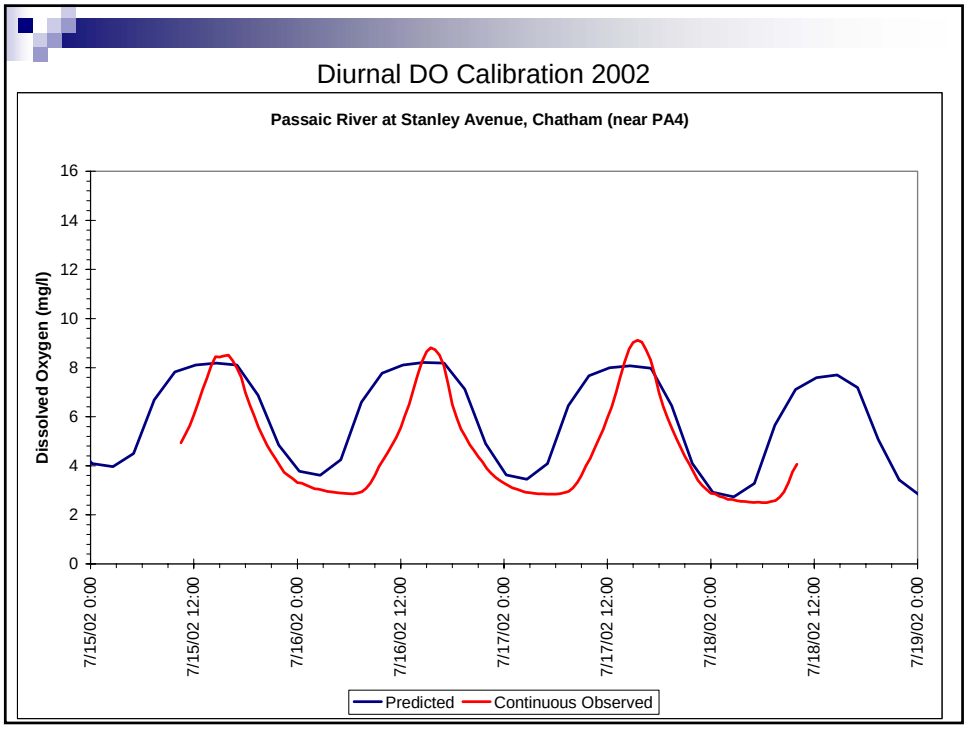
Branch Groupings	Basis	TP (mg/l)	OrthoP (mg/l)
Forest Dominated (Wanaque - 2)	RAB, HAB, PRB, PA1	0.045	0.021
Major Tribs(3,4,5,6,7,13)	WIB, TBB, CrookB1, WI1	0.054	0.023
Upper Passaic / Minor Tribs (8,9,10,11,12,14)	DRB, WIB, SBB, TBB	0.063	0.022
Lower Passaic (15,16,17)	SBB, P2	0.060	0.031

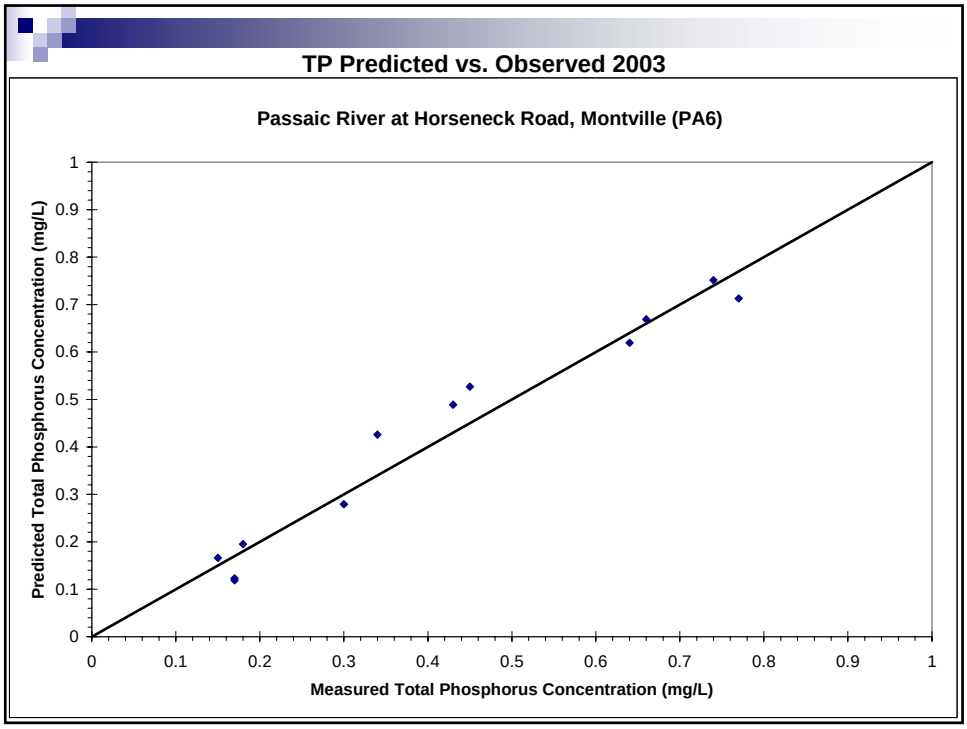
Calibration and Validation Data

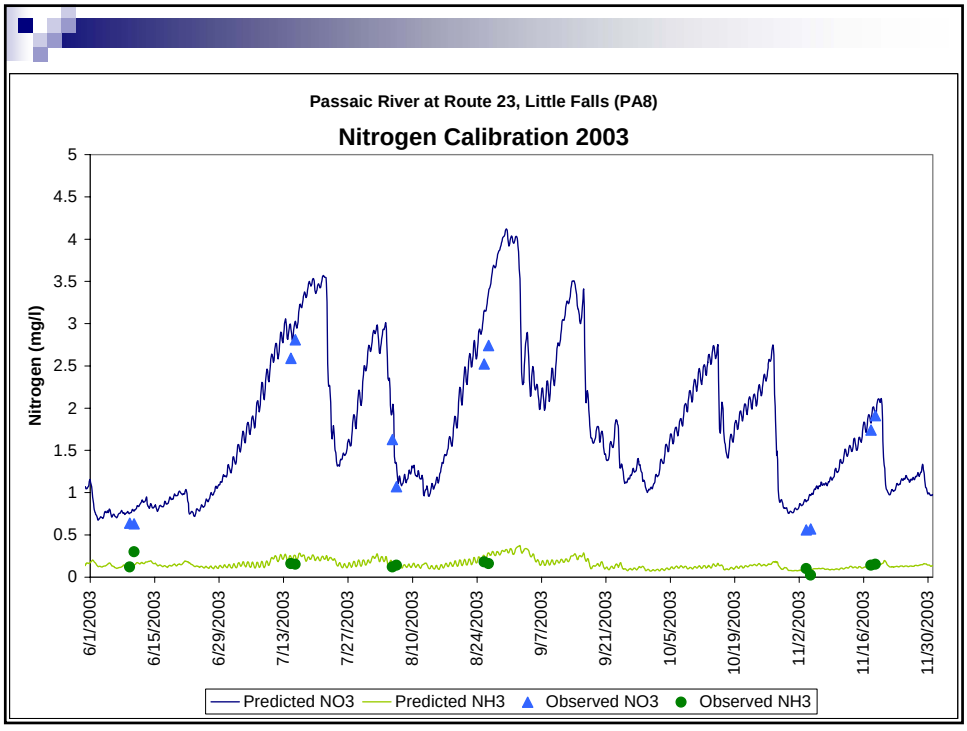
- Calibration Data
  - TRC Omni data collected in 2003
  - NJDEP diurnal DO data collected 2002
  - PVSC chlorophyll-a data from 2001 and 2002
- Validation Data
  - TRC Omni, NJDEP, USGS, PVSC, PVWC data collected from 1999 to 2003

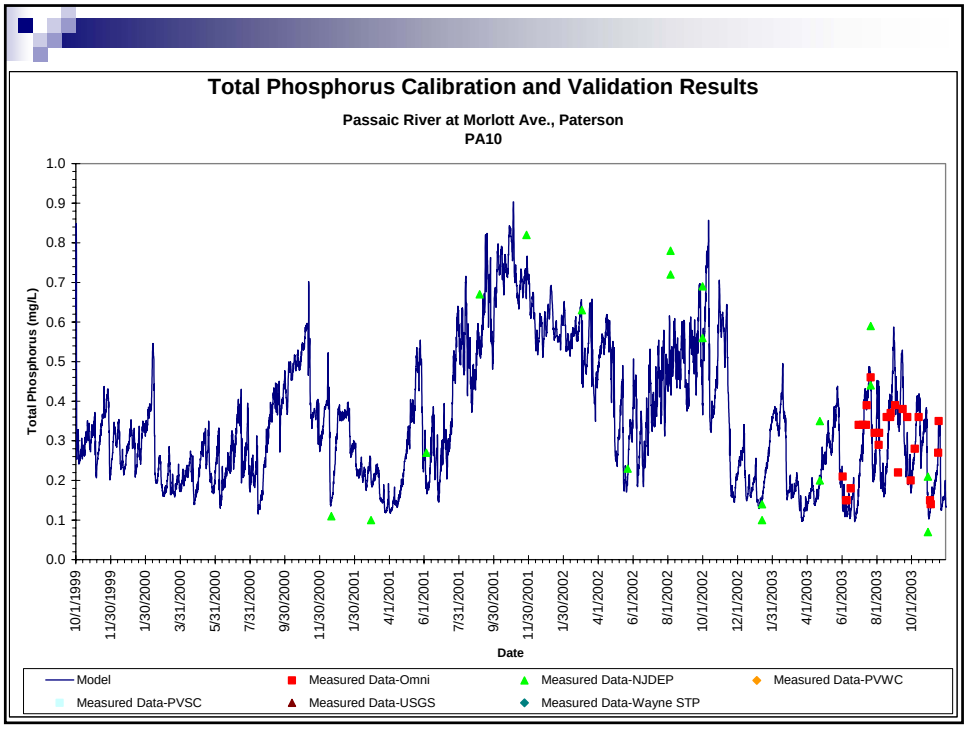


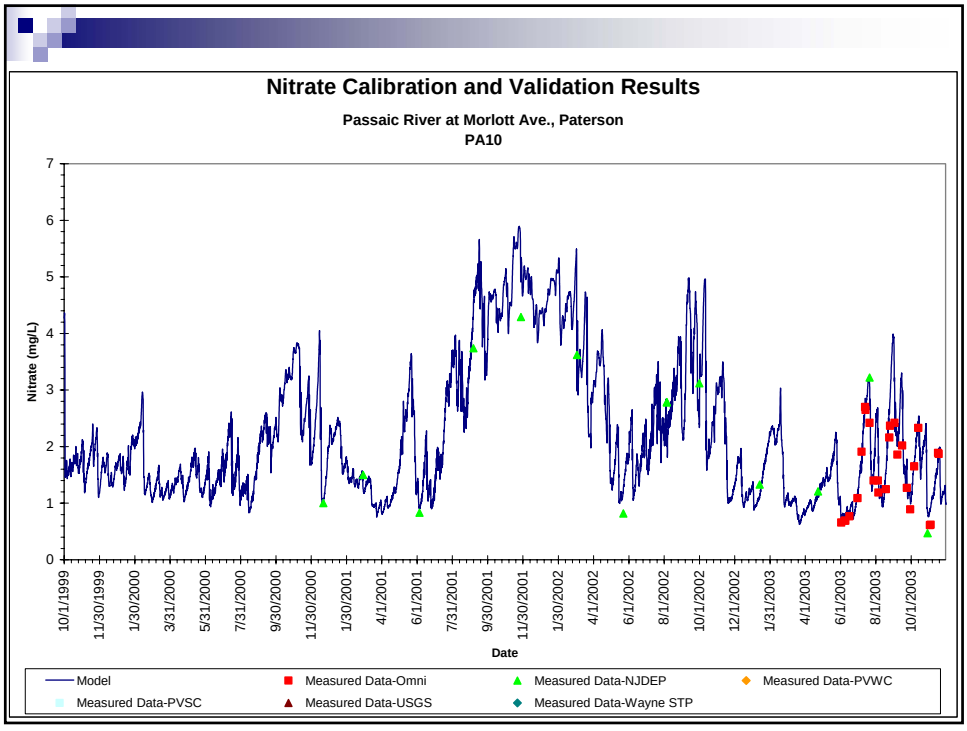

Nitrate Validation
Passaic River at Stanley Avenue, Chatham
Between PA3 and PA4
Nitrate (mg/L)
0
1
2
3
4
5
6
7
8
9
10/1/1999
11/30/1999
1/30/2000
3/31/2000
5/31/2000
7/31/2000
9/30/2000
11/30/2000
1/30/2001
4/1/2001
6/1/2001
7/31/2001
9/30/2001
11/30/2001
1/30/2002
4/1/2002
6/1/2002
8/1/2002
10/1/2002
12/1/2002
1/31/2003
4/1/2003
6/1/2003
8/1/2003
10/1/2003
Date
Model
Measured Data-Omni
Measured Data-NJDEP
Measured Data-PVWC
Measured Data-PVSC
Measured Data-USGS
Measured Data-Wayne STP


Diurnal DO Calibration 2002
Passaic River at Stanley Avenue, Chatham (near PA4)
Dissolved Oxygen (mg/l)
0
2
4
6
8
10
12
14
16
7/15/02 0:00
7/15/02 12:00
7/16/02 0:00
7/16/02 12:00
7/17/02 0:00
7/17/02 12:00
7/18/02 0:00
7/18/02 12:00
7/19/02 0:00
Predicted
Continuous Observed

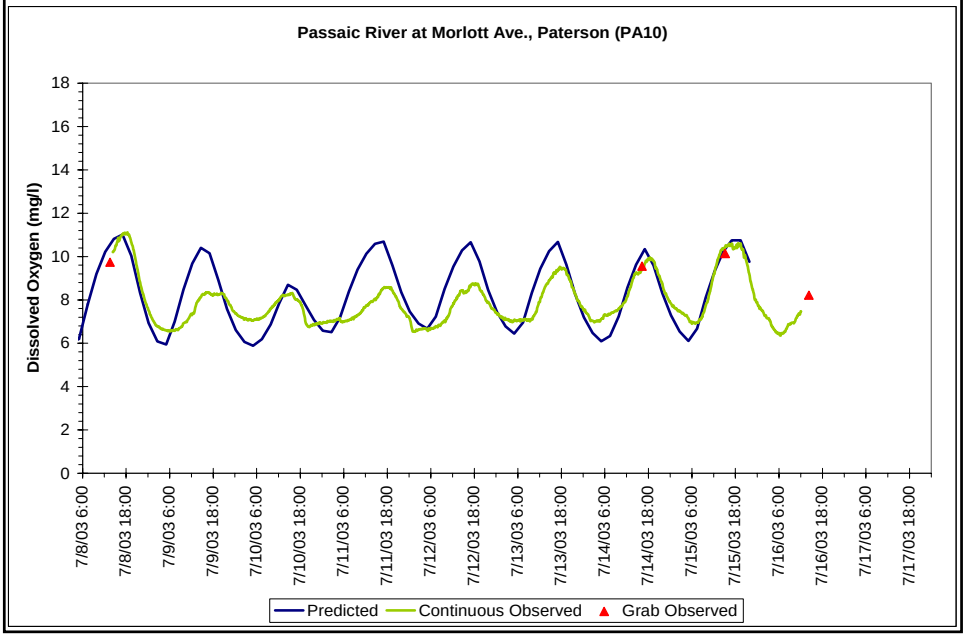

TP Predicted vs. Observed 2003
Passaic River at Horseneck Road, Montville (PA6)
Predicted Total Phosphorus Concentration (mg/L)
Measured Total Phosphorus Concentration (mg/L)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Passaic River at Route 23, Little Falls (PA8)
Nitrogen Calibration 2003
Nitrogen (mg/l)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
6/1/2003
6/15/2003
6/29/2003
7/13/2003
7/27/2003
8/10/2003
8/24/2003
9/7/2003
9/21/2003
10/5/2003
10/19/2003
11/2/2003
11/16/2003
11/30/2003
Predicted NO3
Predicted NH3
Observed NO3
Observed NH3

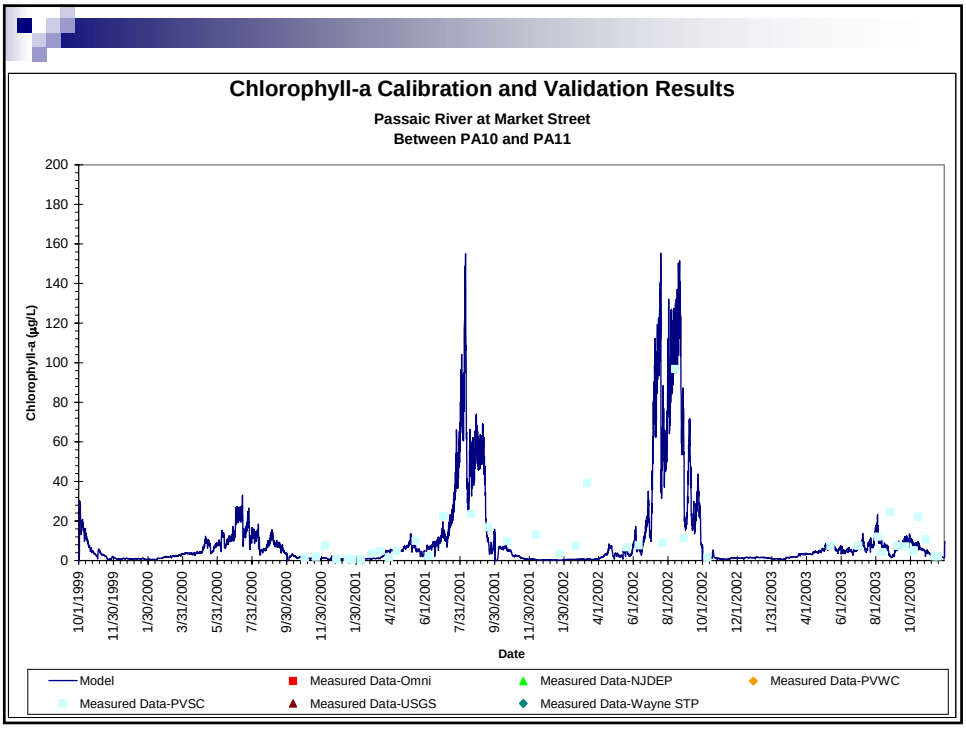

Total Phosphorus Calibration and Validation Results
Passaic River at Morlott Ave., Paterson
PA10
Total Phosphorus (mg/L)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10/1/1999
11/30/1999
1/30/2000
3/31/2000
5/31/2000
7/31/2000
9/30/2000
11/30/2000
1/30/2001
4/1/2001
6/1/2001
7/31/2001
9/30/2001
11/30/2001
1/30/2002
4/1/2002
6/1/2002
8/1/2002
10/1/2002
12/1/2002
1/31/2003
4/1/2003
6/1/2003
8/1/2003
10/1/2003
Date
Model
Measured Data-Omni
Measured Data-NJDEP
Measured Data-PVWC
Measured Data-PVSC
Measured Data-USGS
Measured Data-Wayne STP

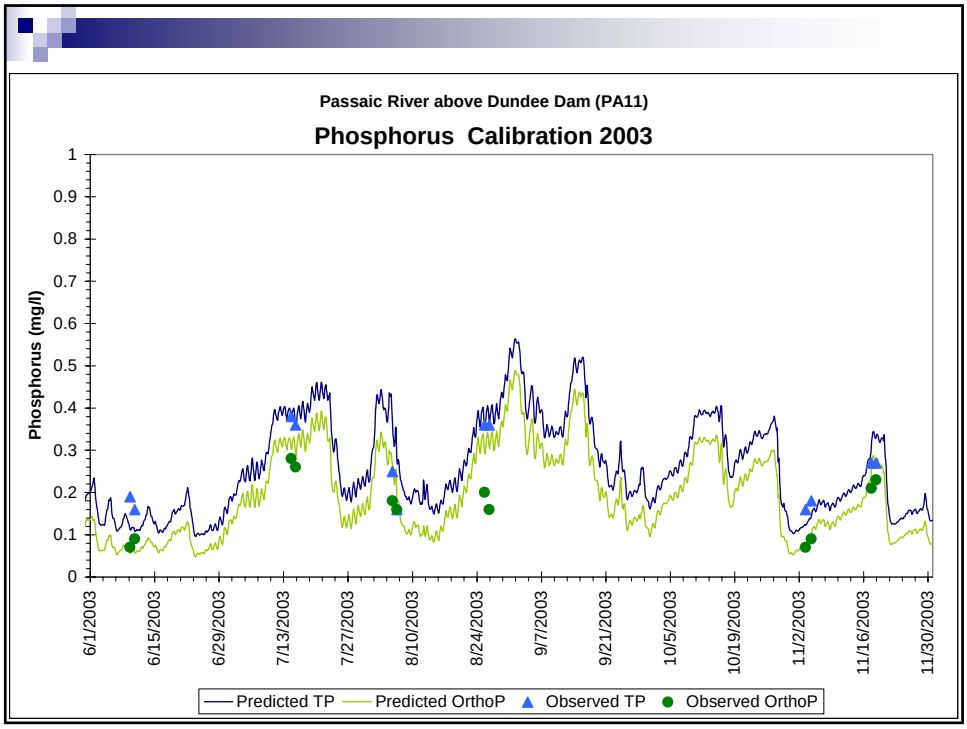

Nitrate Calibration and Validation Results
Passaic River at Morlott Ave., Paterson
PA10
Nitrate (mg/L)
7
6
5
4
3
2
1
0
10/1/1999
11/30/1999
1/30/2000
3/31/2000
5/31/2000
7/31/2000
9/30/2000
11/30/2000
1/30/2001
4/1/2001
6/1/2001
7/31/2001
9/30/2001
11/30/2001
1/30/2002
4/1/2002
6/1/2002
8/1/2002
10/1/2002
12/1/2002
1/31/2003
4/1/2003
6/1/2003
8/1/2003
10/1/2003
Date
Model
Measured Data-Omni
Measured Data-NJDEP
Measured Data-PVWC
Measured Data-PVSC
Measured Data-USGS
Measured Data-Wayne STP

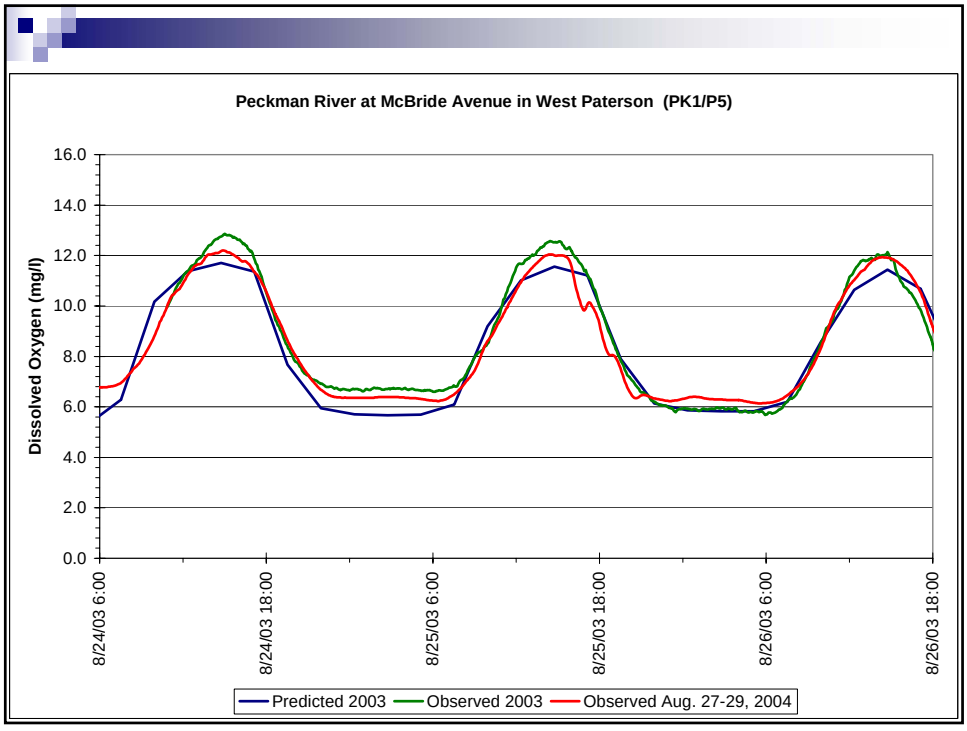
Diurnal DO Calibration Results



Chlorophyll-a Calibration and Validation Results




Passaic River above Dundee Dam (PA11)
Phosphorus Calibration 2003
Phosphorus (mg/l)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6/1/2003
6/15/2003
6/29/2003
7/13/2003
7/27/2003
8/10/2003
8/24/2003
9/7/2003
9/21/2003
10/5/2003
10/19/2003
11/2/2003
11/16/2003
11/30/2003
Predicted TP
Predicted OrthoP
Observed TP
Observed OrthoP

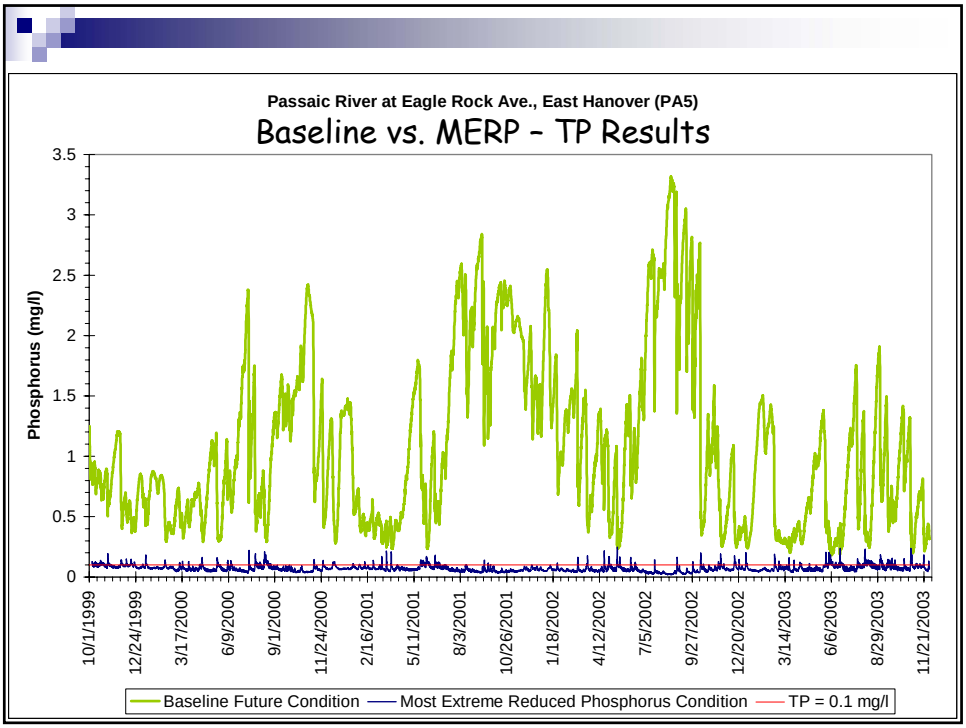

Peckman River at McBride Avenue in West Paterson (PK1/P5)
Dissolved Oxygen (mg/l)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
8/24/03 6:00
8/24/03 18:00
8/25/03 6:00
8/25/03 18:00
8/26/03 6:00
8/26/03 18:00
Predicted 2003
Observed 2003
Observed Aug. 27-29, 2004

Calibration and Validation Summary

- System-wide water quality model calibrated and validated for:
  - nutrients
  - dissolved oxygen
  - chlorophyll-a
- Impact of point and nonpoint source reductions on dissolved oxygen, phosphorus, and chlorophyll-a can be calculated

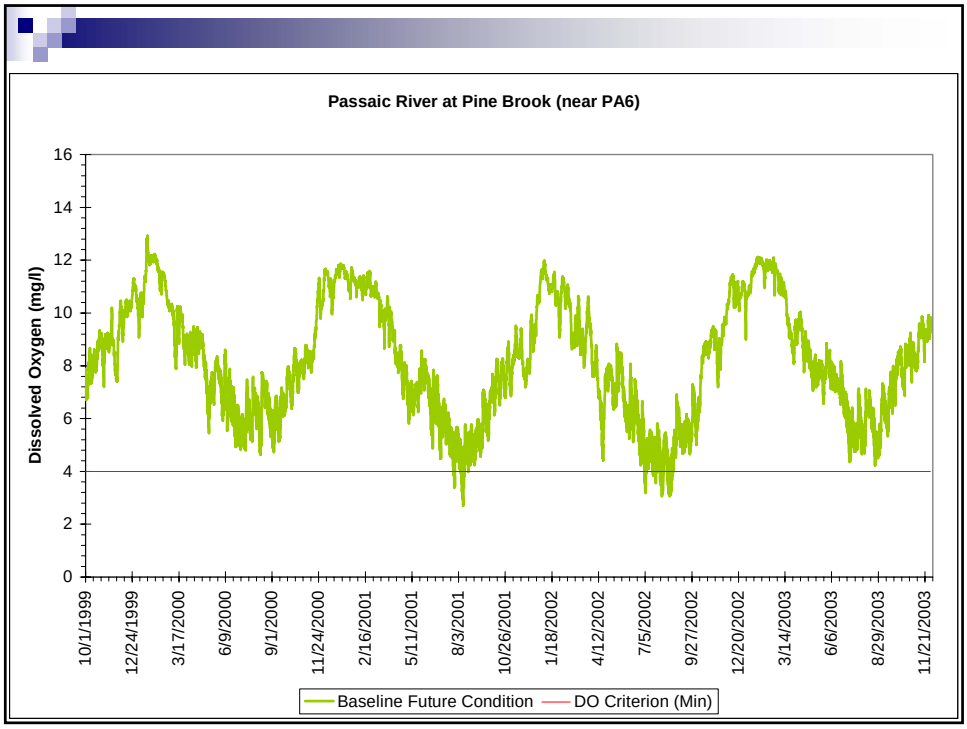
Impact of Phosphorus Reductions on Productivity

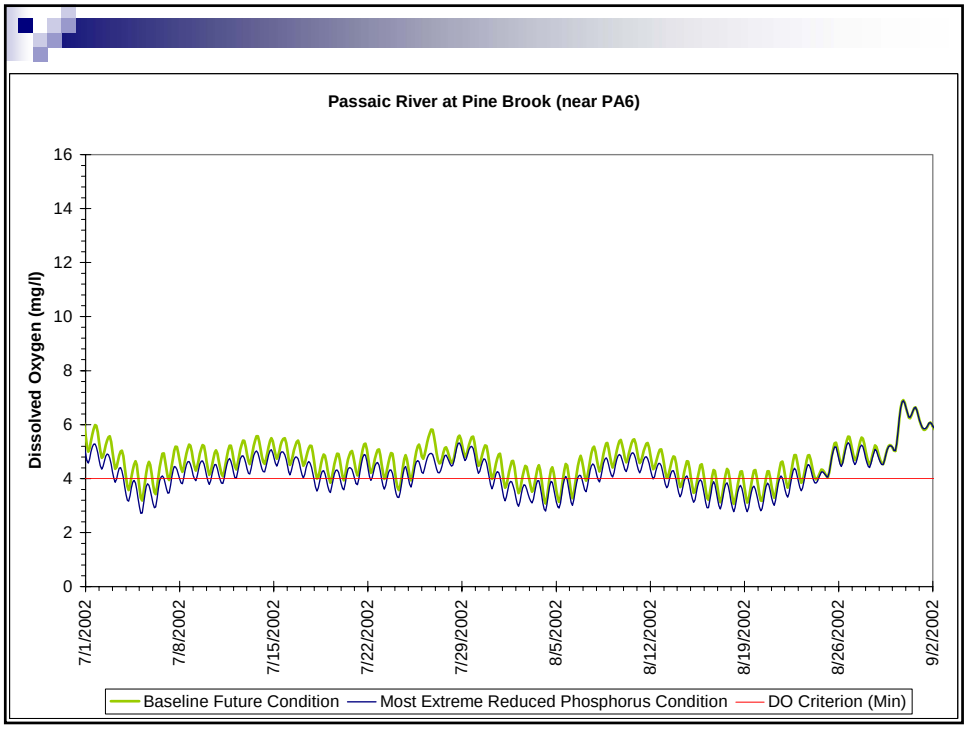
- Baseline Future Condition – Upper Bound
  - Permitted STP flows and concentrations
  - Headwater lakes with TMDLs set to 0.05 mg/l TP
  - Future diversion scenario at full allocation for NJDWSC
- Most Extreme Reduced Phosphorus Condition (MERP) – Lower Bound
  - Permitted flows for point sources
  - Point Sources set to 0.05 mg/l TP
  - Phosphorus loads from urban and agricultural land uses reduced by 80%
  - Incorporated model enhancements

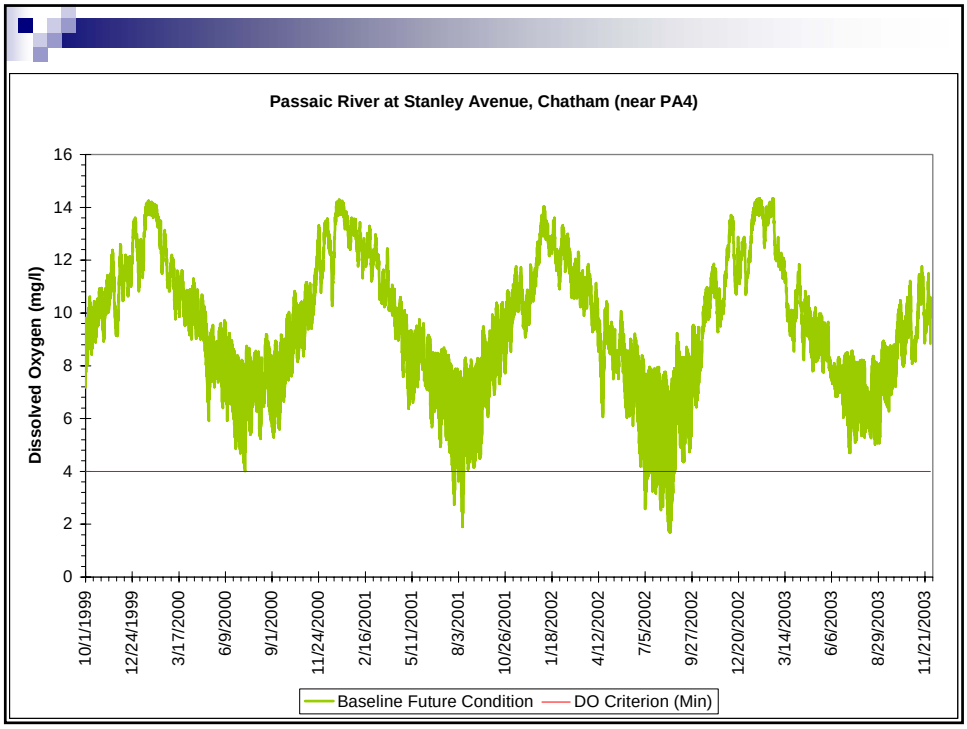


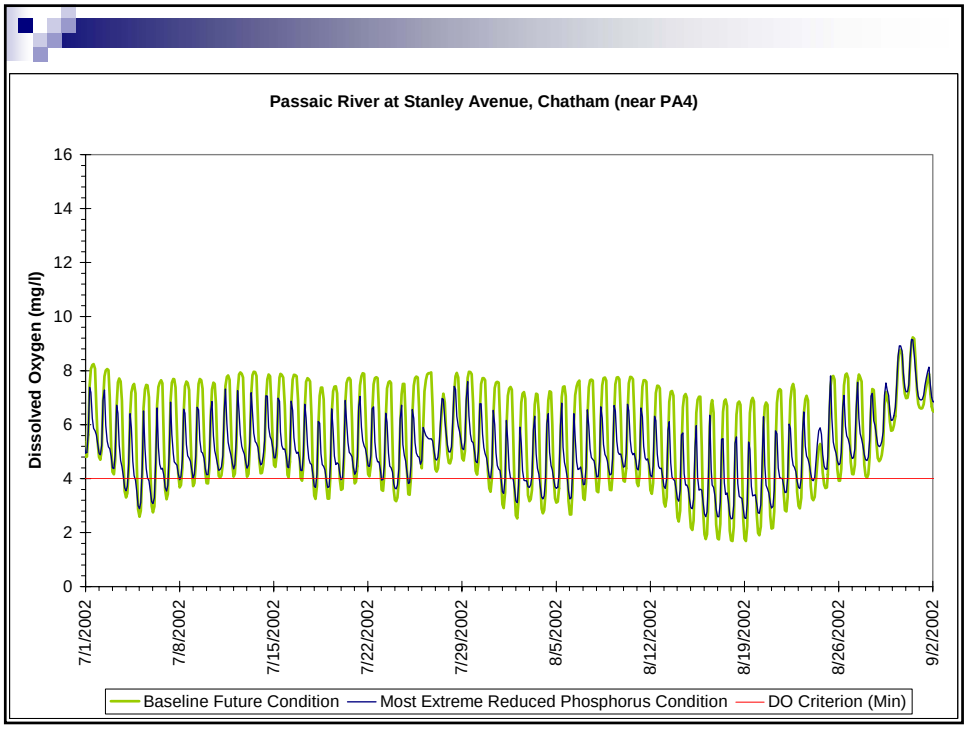
Passaic River Mainstem

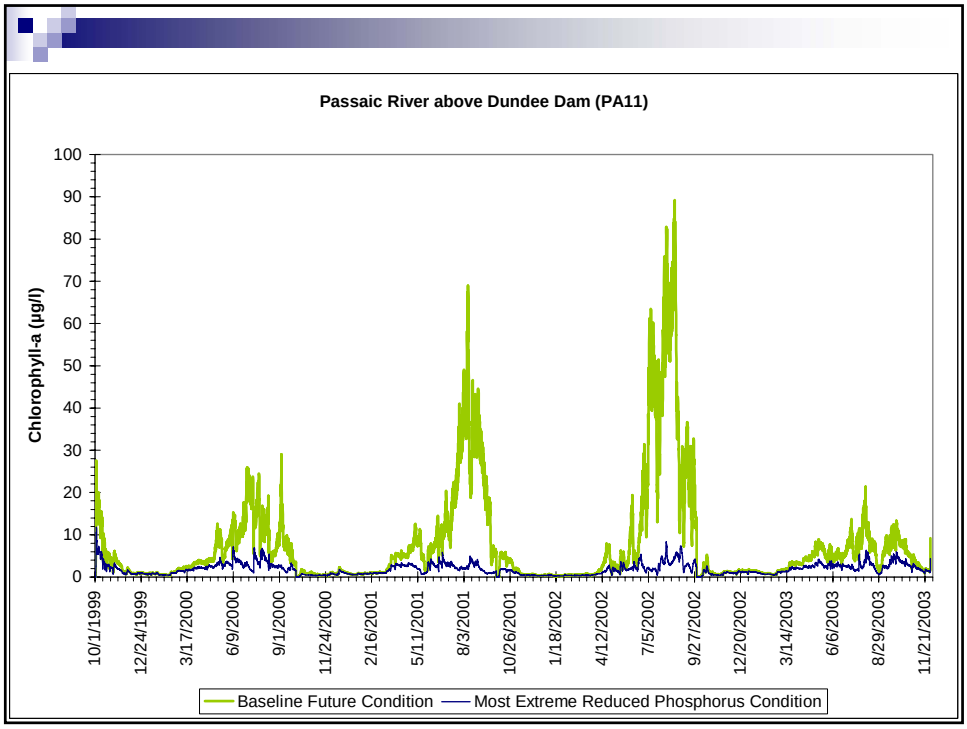
- Passaic Headwaters to Pompton Confluence
  - Passaic River at Pine Brook (most representative) [PA6]
  - Passaic River at Stanley Avenue, Chatham (higher productivity) [~ PA4]
- Downstream Passaic River (Little Falls to Dundee)
  - Passaic River at Dundee [PA11]

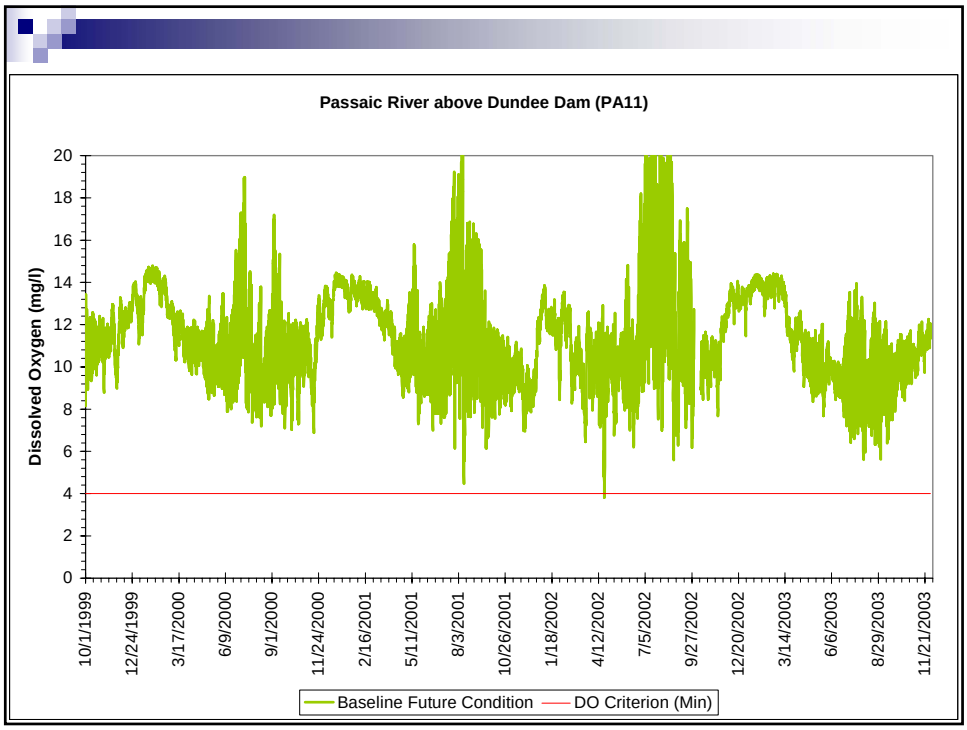

Passaic River at Pine Brook (near PA6)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
DO Criterion (Min)

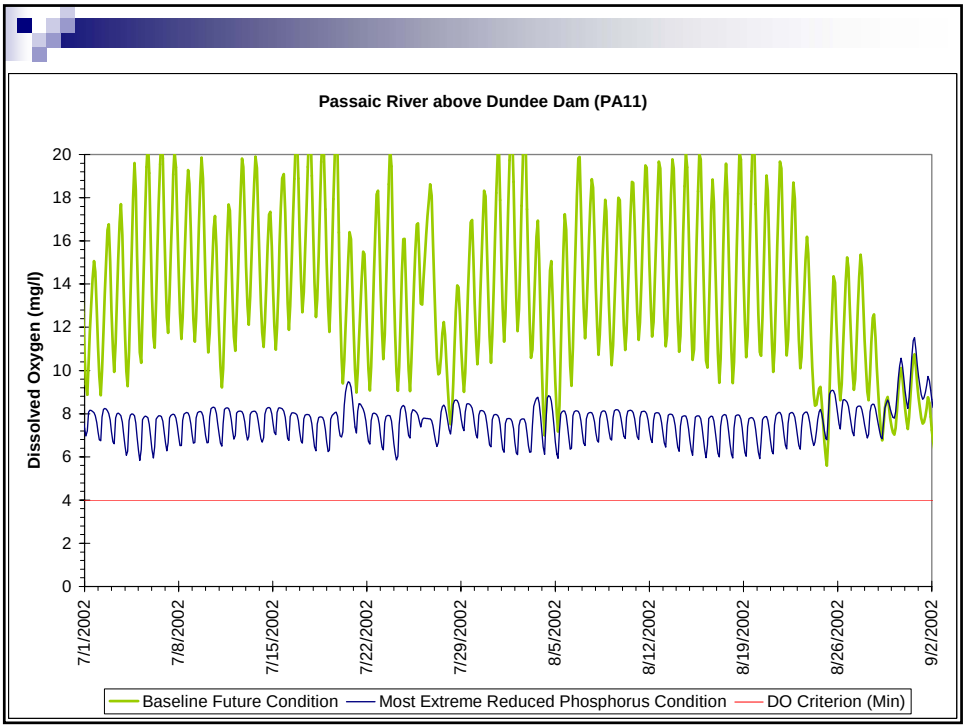

Passaic River at Pine Brook (near PA6)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)


Passaic River at Stanley Avenue, Chatham (near PA4)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
DO Criterion (Min)


Passaic River at Stanley Avenue, Chatham (near PA4)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)


Passaic River above Dundee Dam (PA11)
Chlorophyll-a (µg/l)
100
90
80
70
60
50
40
30
20
10
0
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition


Passaic River above Dundee Dam (PA11)
Dissolved Oxygen (mg/l)
20
18
16
14
12
10
8
6
4
2
0
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
DO Criterion (Min)

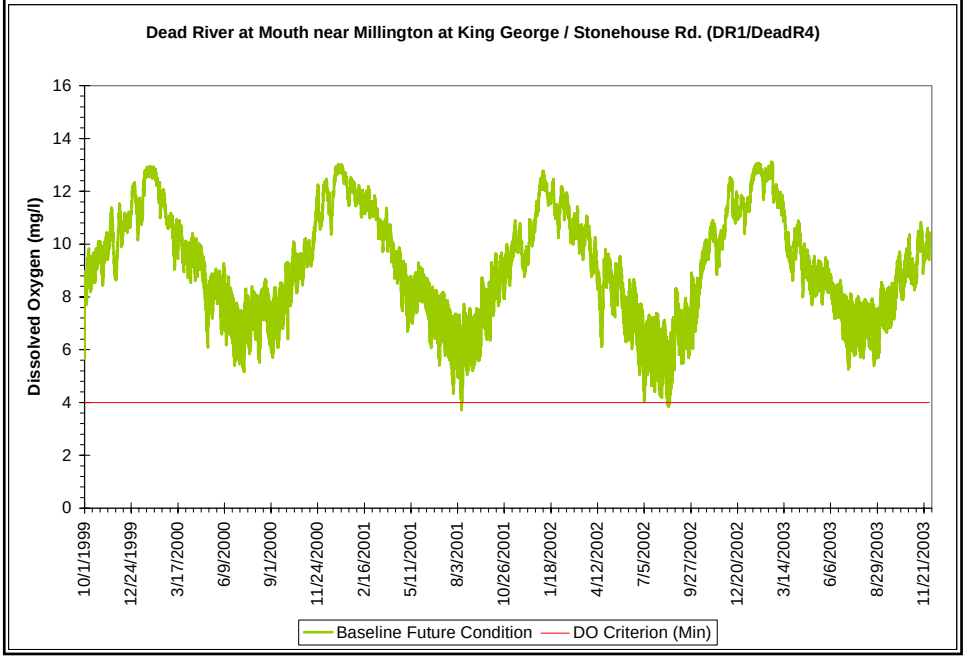


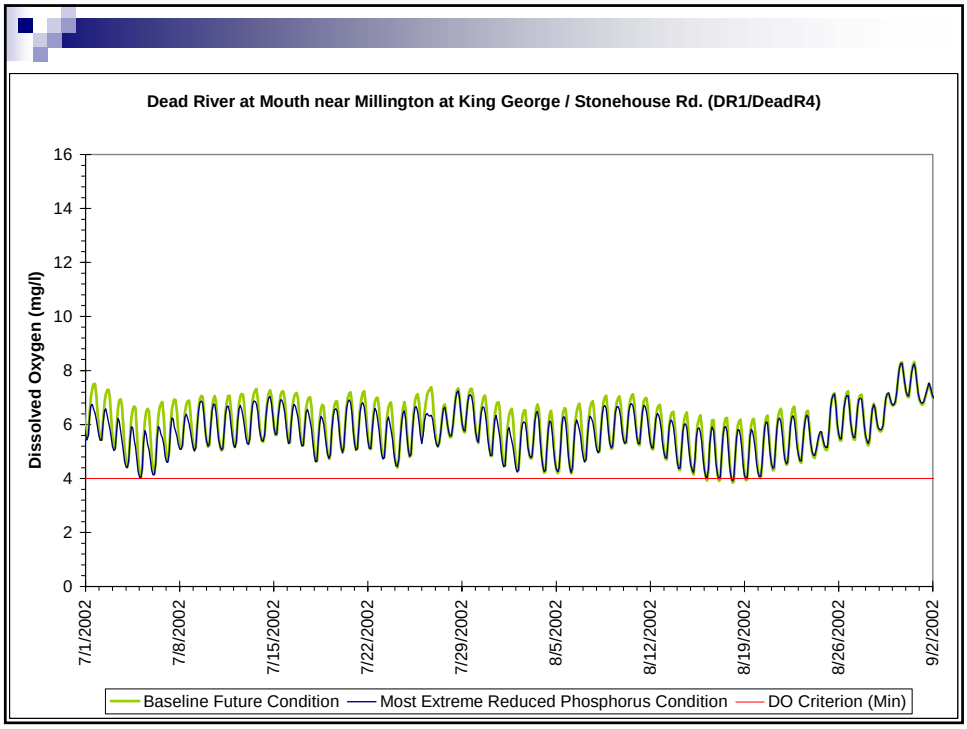
Phosphorus Reduction Impact Summary: Passaic River Mainstem

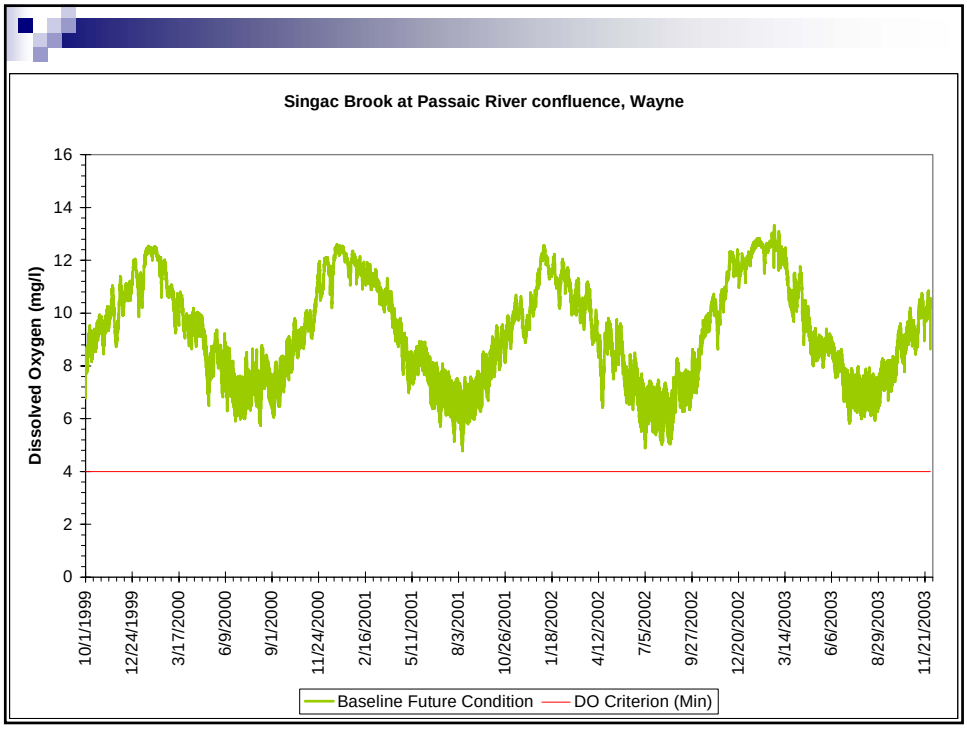
- Passaic Headwaters to Pompton Confluence
  - minimal change in dissolved oxygen
- Downstream Passaic River (Little Falls to Dundee)
  - chlorophyll-a peaks reduced substantially
  - diurnal DO variation reduced substantially
  - much more desirable DO and phytoplankton condition

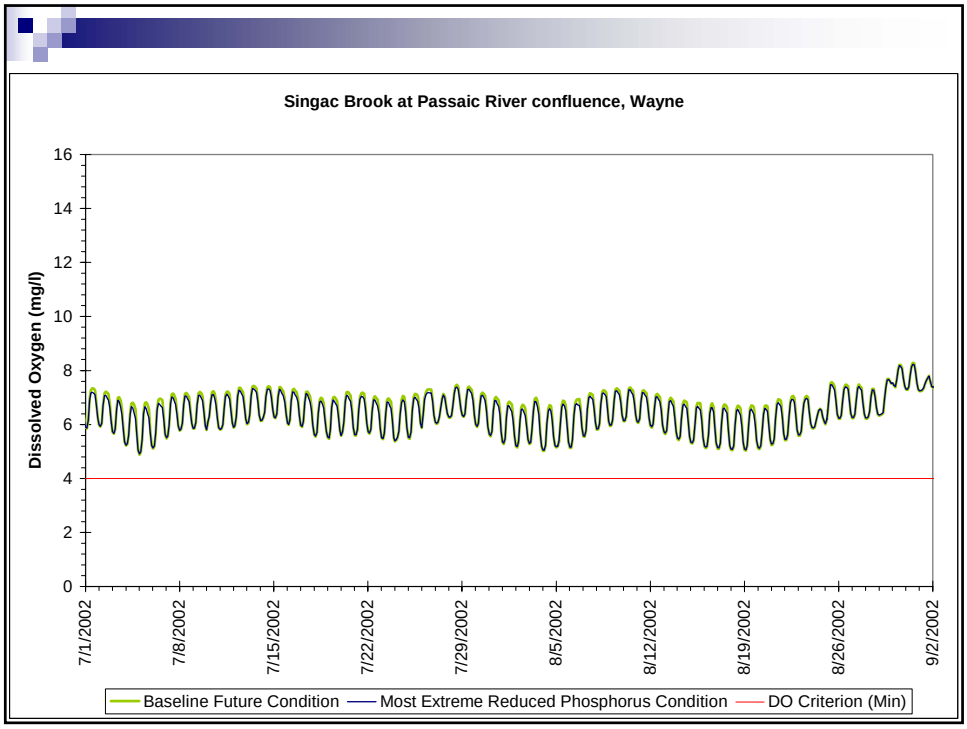
Dead River, Singac Brook, Peckman River

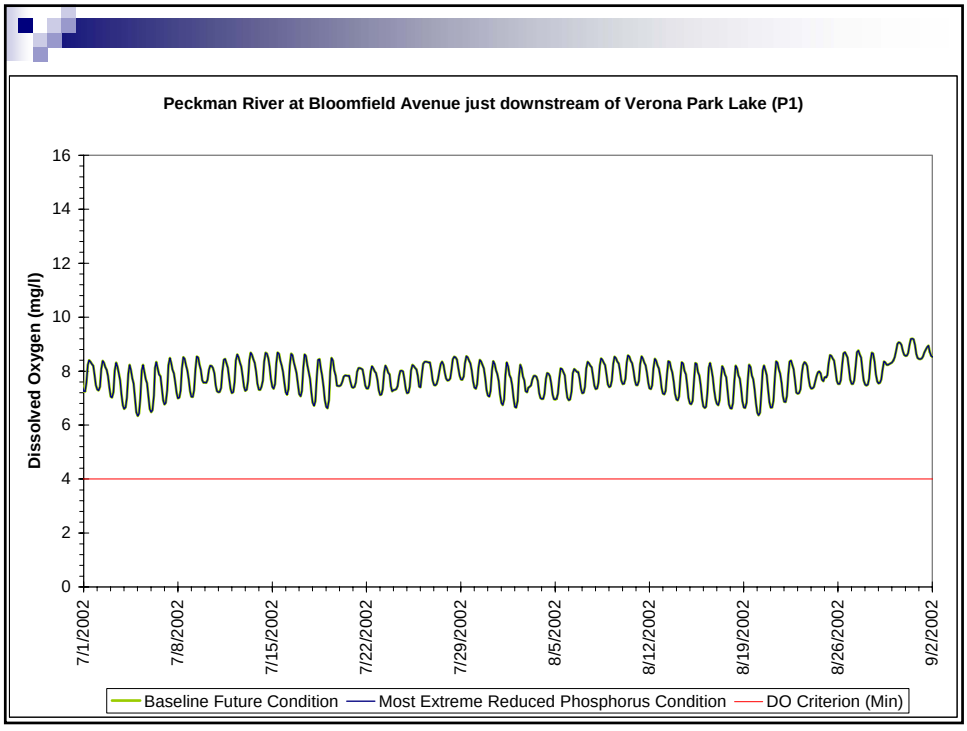
- Dead River near Millington
- Singac Brook at Wayne
- Peckman River
  - Representative Locations in Verona and Cedar Grove (P1, P2, P3, P4)
  - Peckman River in West Paterson (PK1/P5)

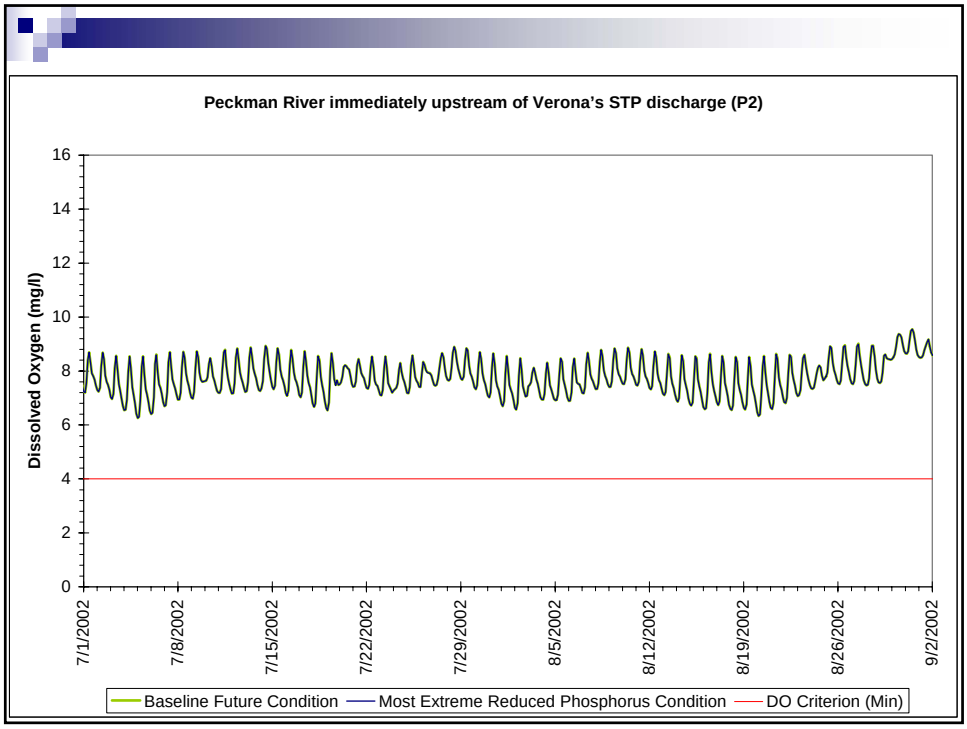


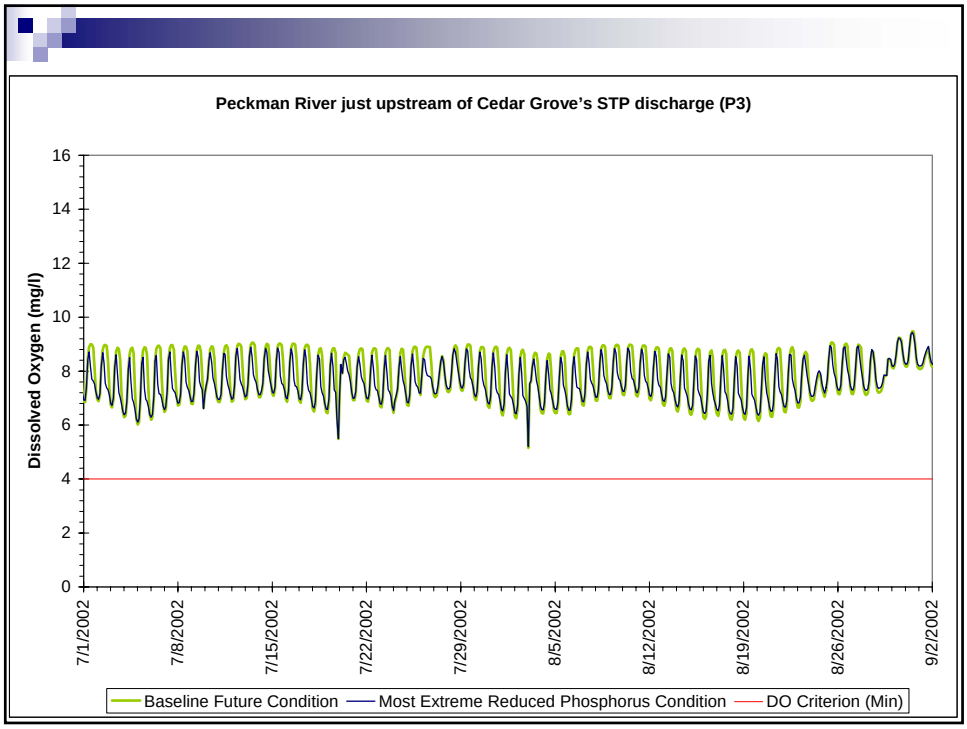

Dead River at Mouth near Millington at King George / Stonehouse Rd. (DR1/DeadR4)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)

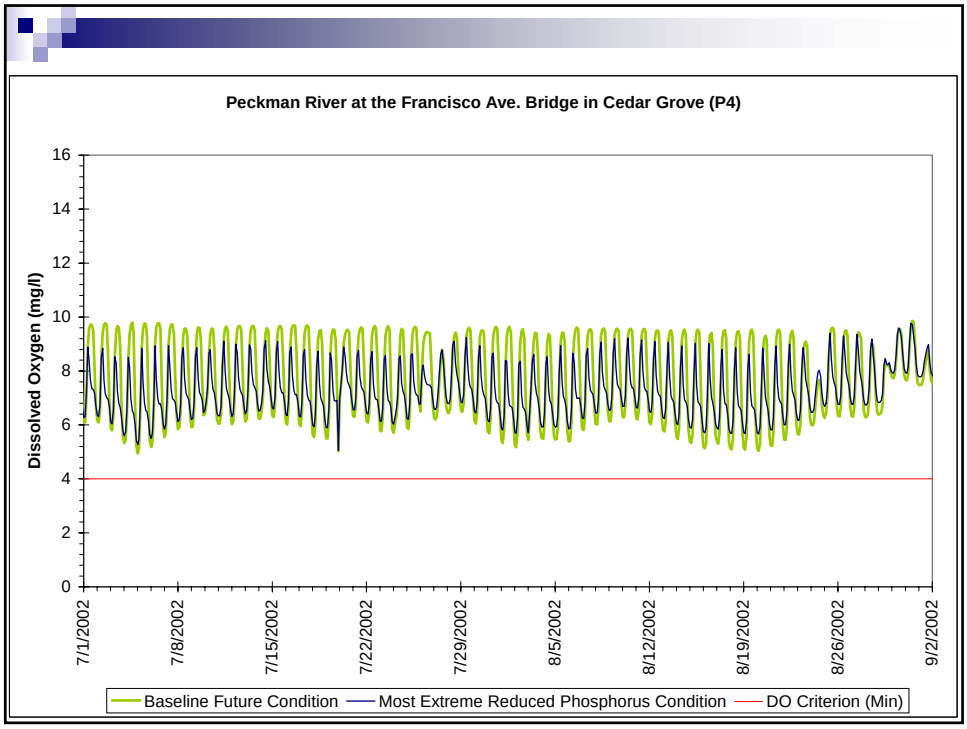

Singac Brook at Passaic River confluence, Wayne
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
DO Criterion (Min)

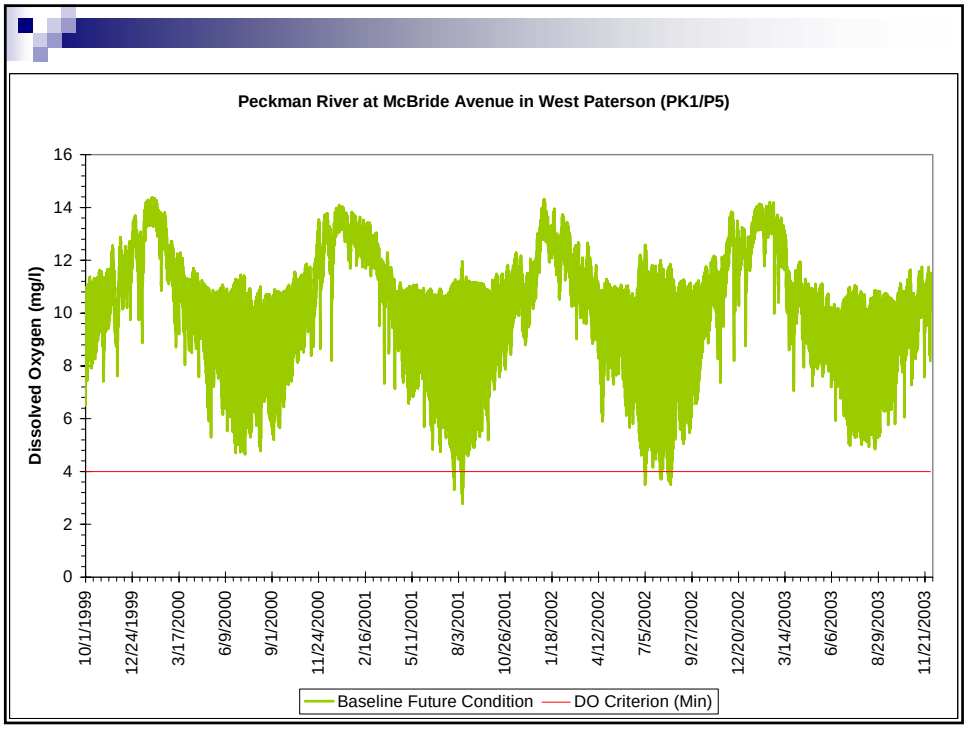

Singac Brook at Passaic River confluence, Wayne
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)

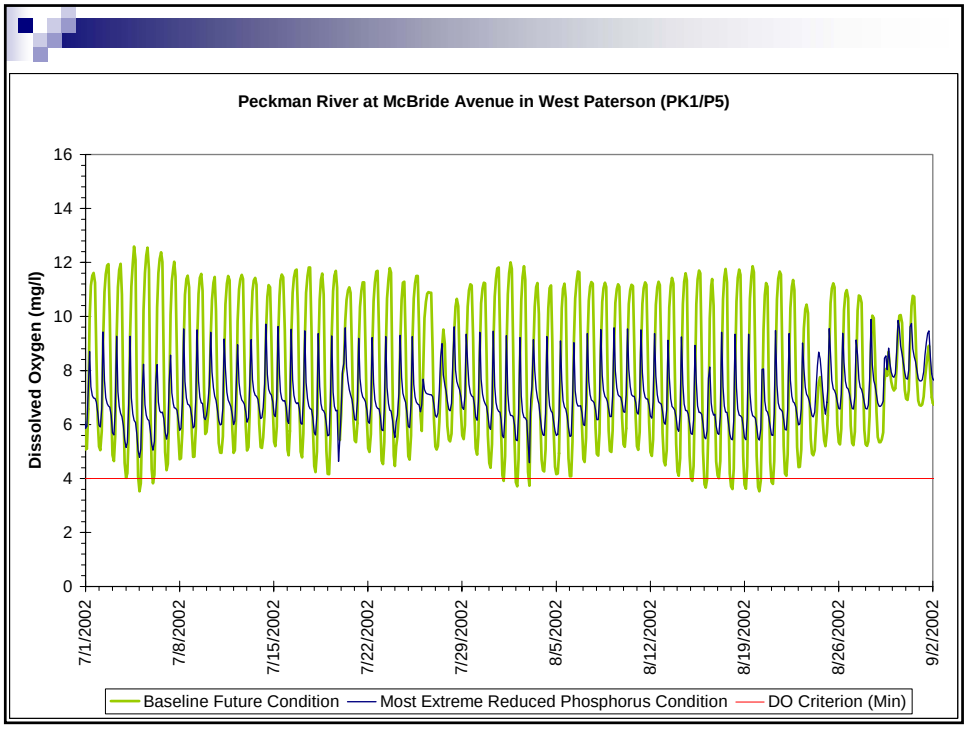

Peckman River at Bloomfield Avenue just downstream of Verona Park Lake (P1)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)

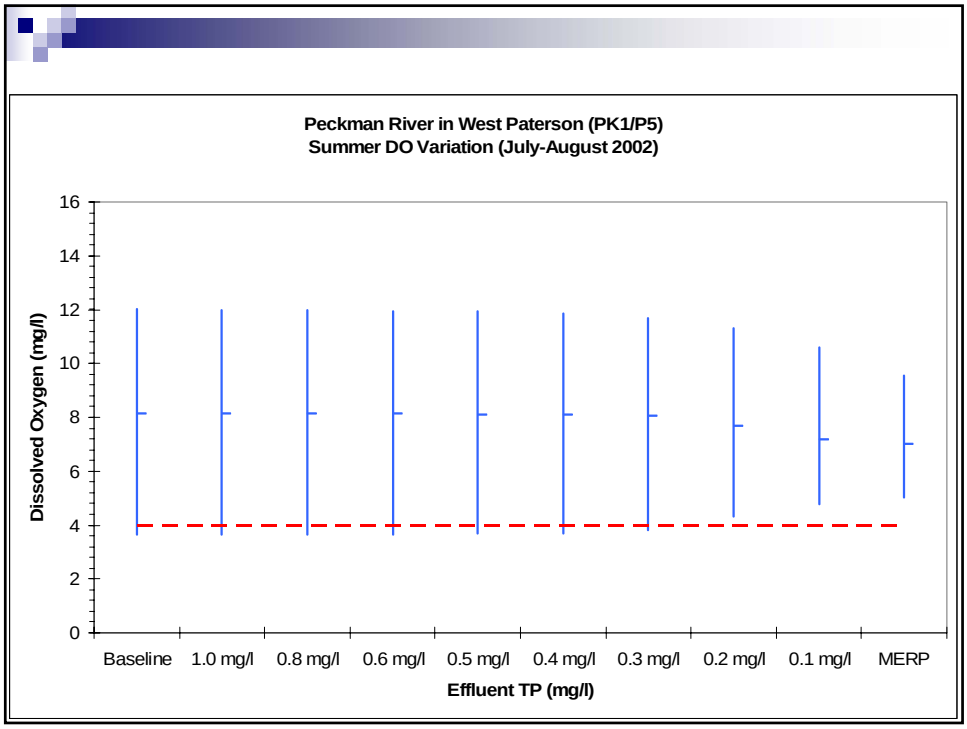

Peckman River immediately upstream of Verona's STP discharge (P2)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)


Peckman River just upstream of Cedar Grove's STP discharge (P3)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)


Peckman River at the Francisco Ave. Bridge in Cedar Grove (P4)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)


Peckman River at McBride Avenue in West Paterson (PK1/P5)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
DO Criterion (Min)


Peckman River at McBride Avenue in West Paterson (PK1/P5)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)

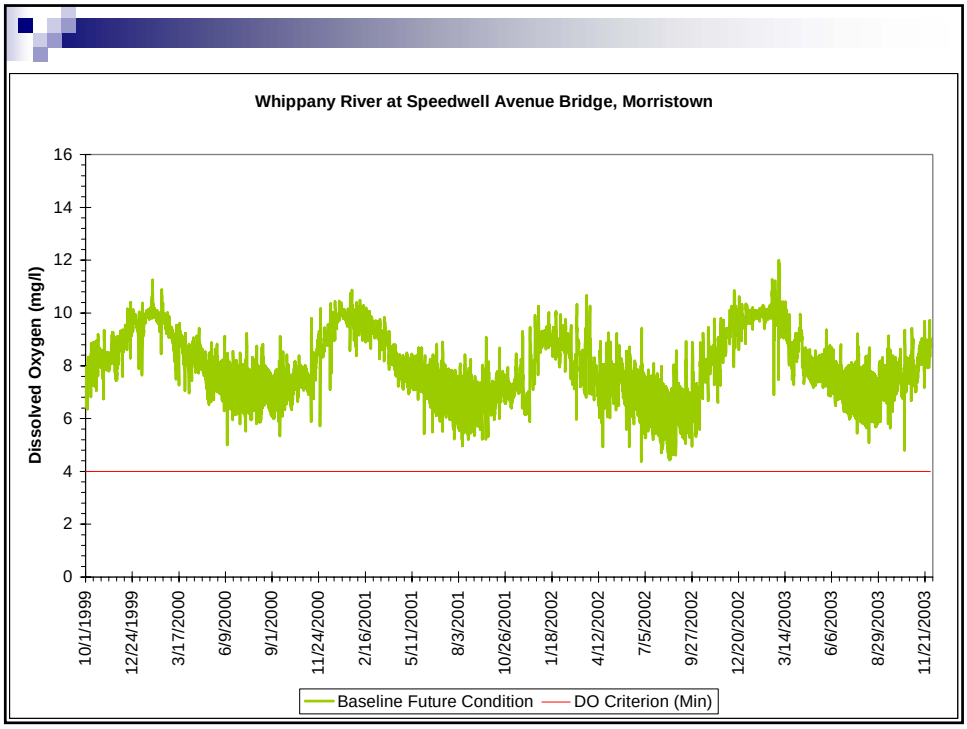

Peckman River in West Paterson (PK1/P5)
Summer DO Variation (July-August 2002)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
Baseline
1.0 mg/l
0.8 mg/l
0.6 mg/l
0.5 mg/l
0.4 mg/l
0.3 mg/l
0.2 mg/l
0.1 mg/l
MERP
Effluent TP (mg/l)

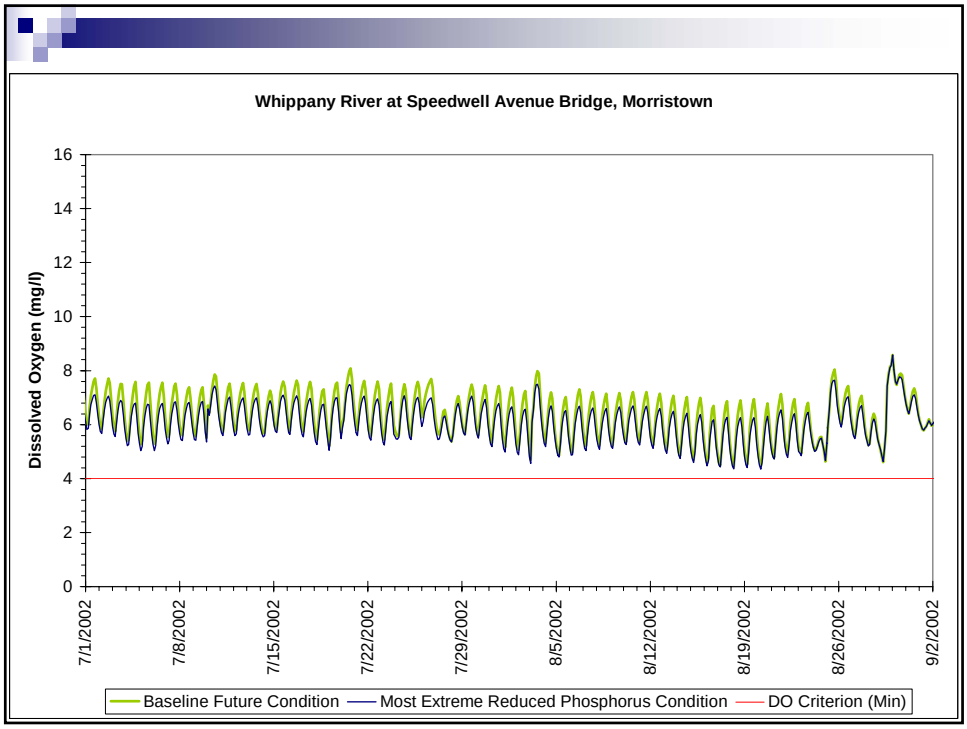
Phosphorus Reduction Impact Summary: Dead River, Singac Brook, Peckman River

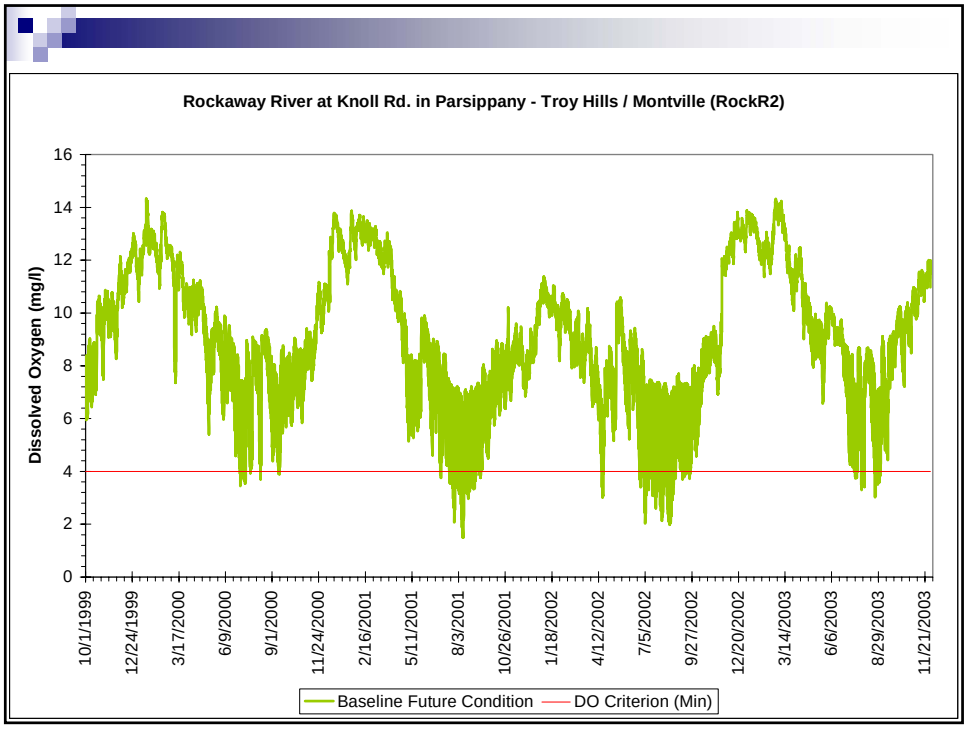
- Dead River
  - Minimal change in dissolved oxygen
- Singac Brook
  - No discernible change in dissolved oxygen
- Peckman River (Generally)
  - Little to no change in dissolved oxygen
  - Healthy dissolved oxygen levels
- Peckman River in West Paterson (less than ½ mile)
  - Substantial diurnal DO swings
  - Theoretical improvement with extremely high phosphorus reduction
    - Sensitivity to phosphorus reduction very low compared to model accuracy

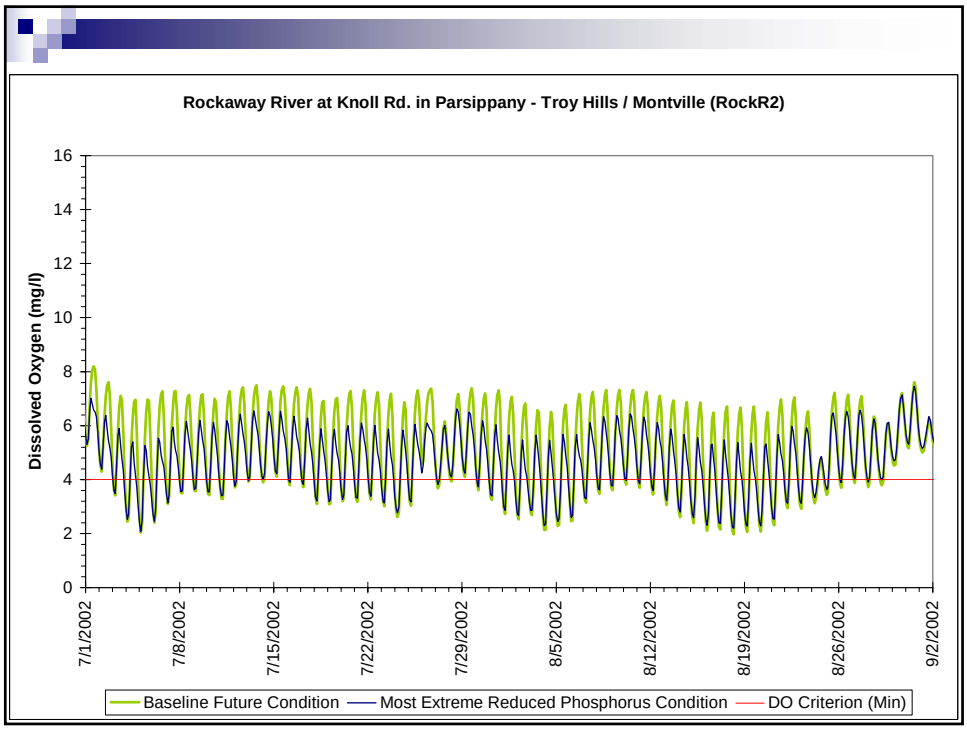
Whippany and Rockaway Rivers

- Whippany River at Speedwell Avenue Bridge in Morristown
- Rockaway River at Knoll Rd. in Parsippany – Troy Hills


Whippany River at Speedwell Avenue Bridge, Morristown
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
DO Criterion (Min)


Whippany River at Speedwell Avenue Bridge, Morristown
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)


Rockaway River at Knoll Rd. in Parsippany - Troy Hills / Montville (RockR2)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
DO Criterion (Min)

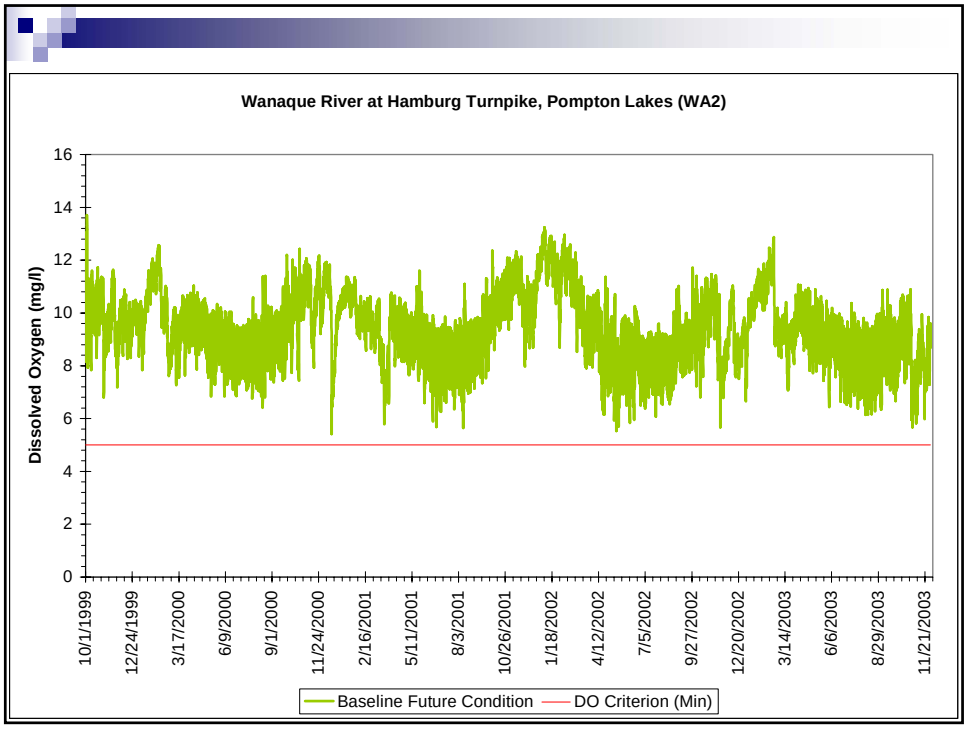

Rockaway River at Knoll Rd. in Parsippany - Troy Hills / Montville (RockR2)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)

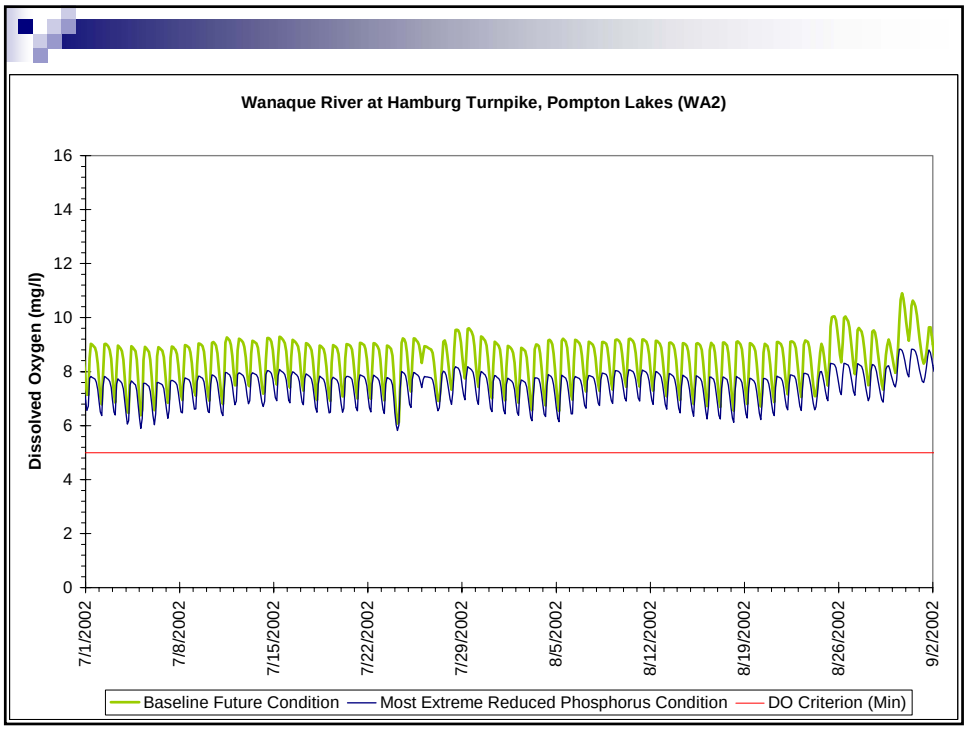
Phosphorus Reduction Impact Summary: Whippany and Rockaway Rivers

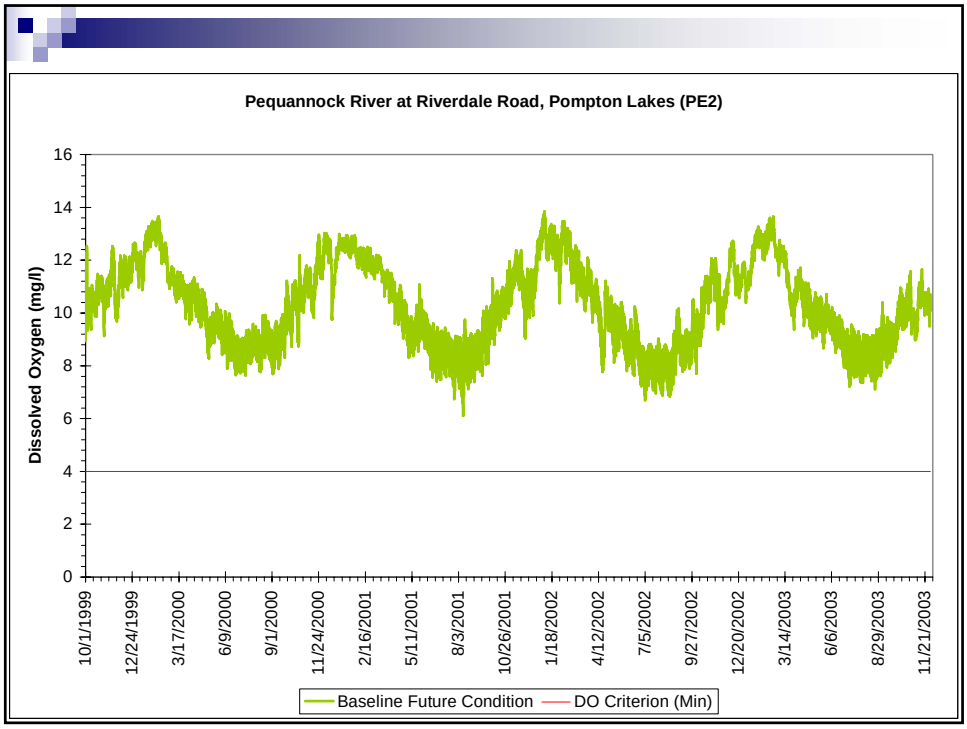
- Whippany River
  - minimal change in dissolved oxygen
- Rockaway River
  - minimal change in dissolved oxygen

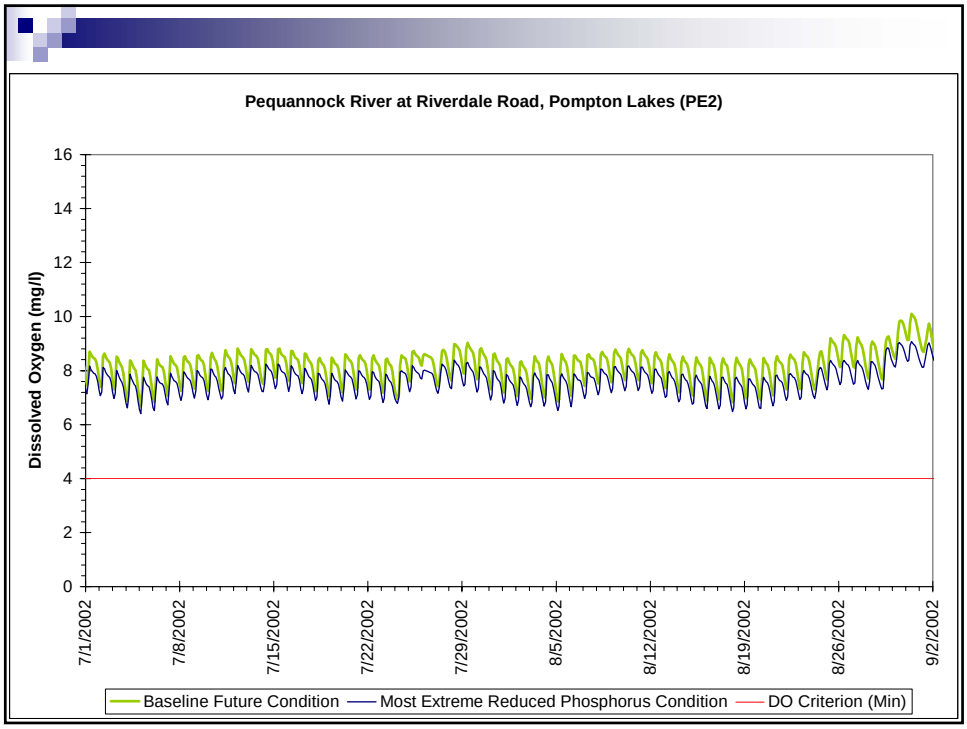
Wanaque, Pequannock, and Pompton Rivers

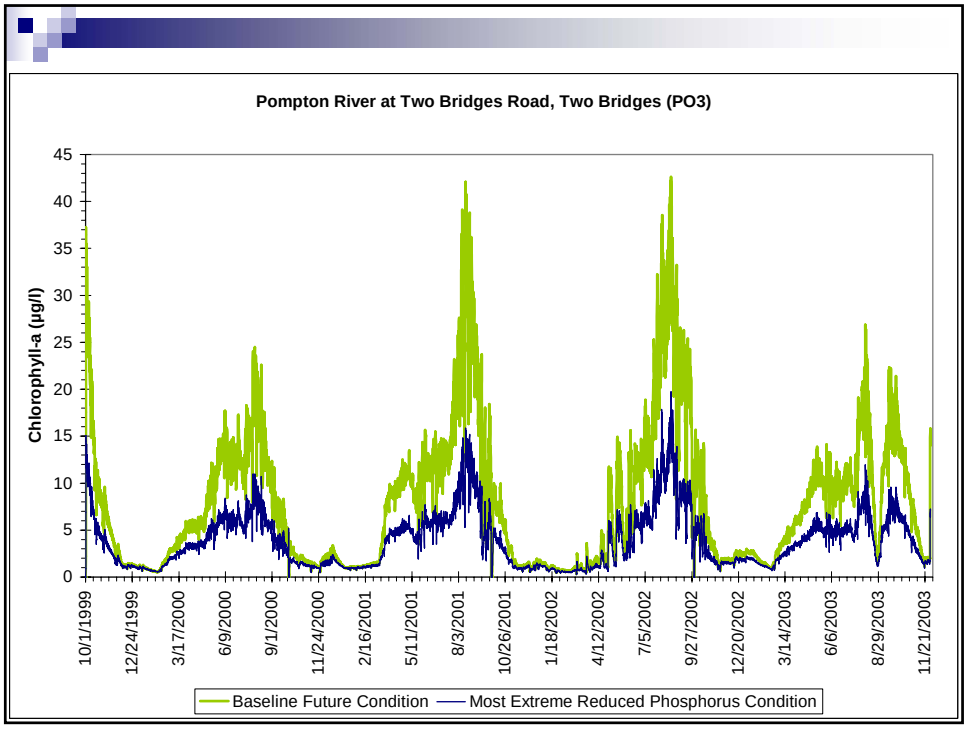
- Wanaque River at Pompton Lakes
- Pequannock River at Pompton Lakes
- Pompton River at Two Bridges

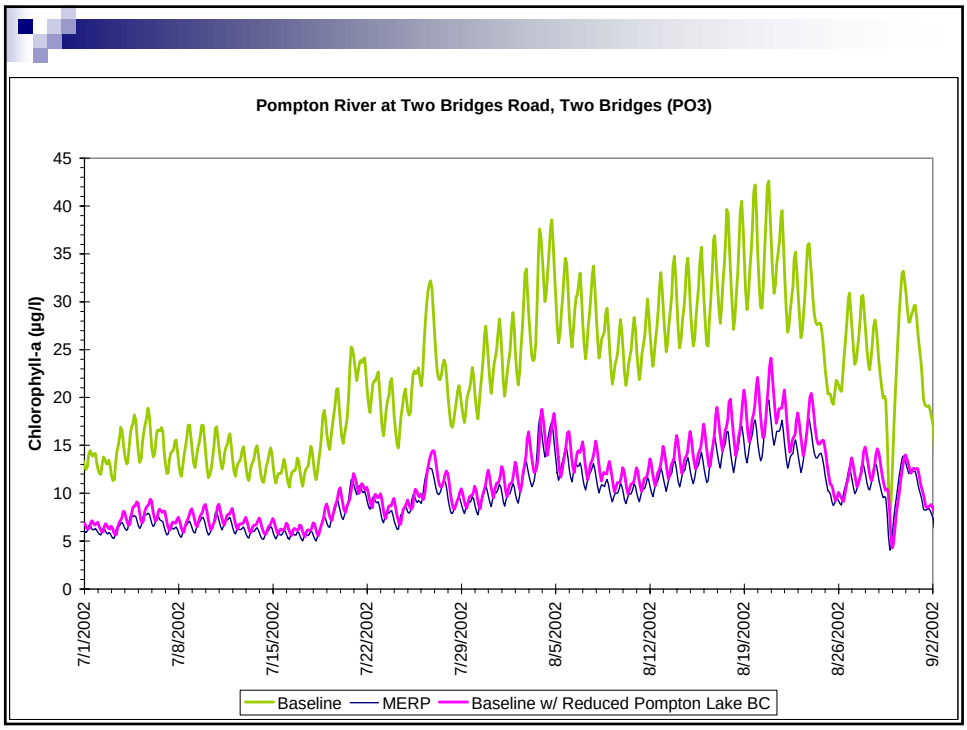

Wanaque River at Hamburg Turnpike, Pompton Lakes (WA2)
Dissolved Oxygen (mg/l)
0
2
4
6
8
10
12
14
16
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
DO Criterion (Min)

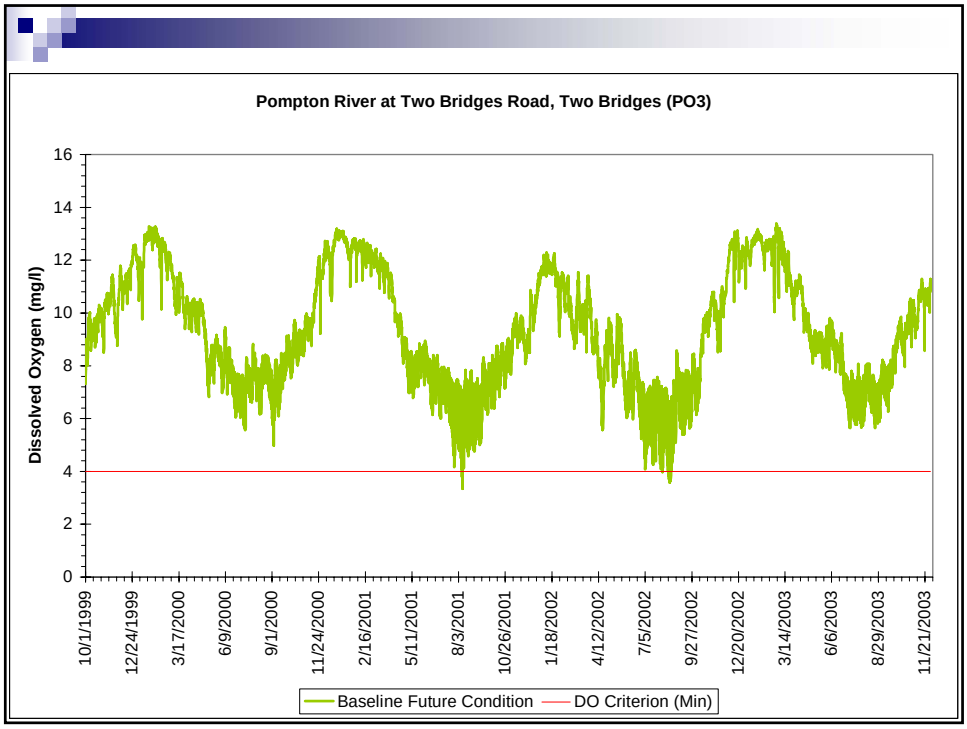

Wanaque River at Hamburg Turnpike, Pompton Lakes (WA2)
Dissolved Oxygen (mg/l)
0
2
4
6
8
10
12
14
16
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)

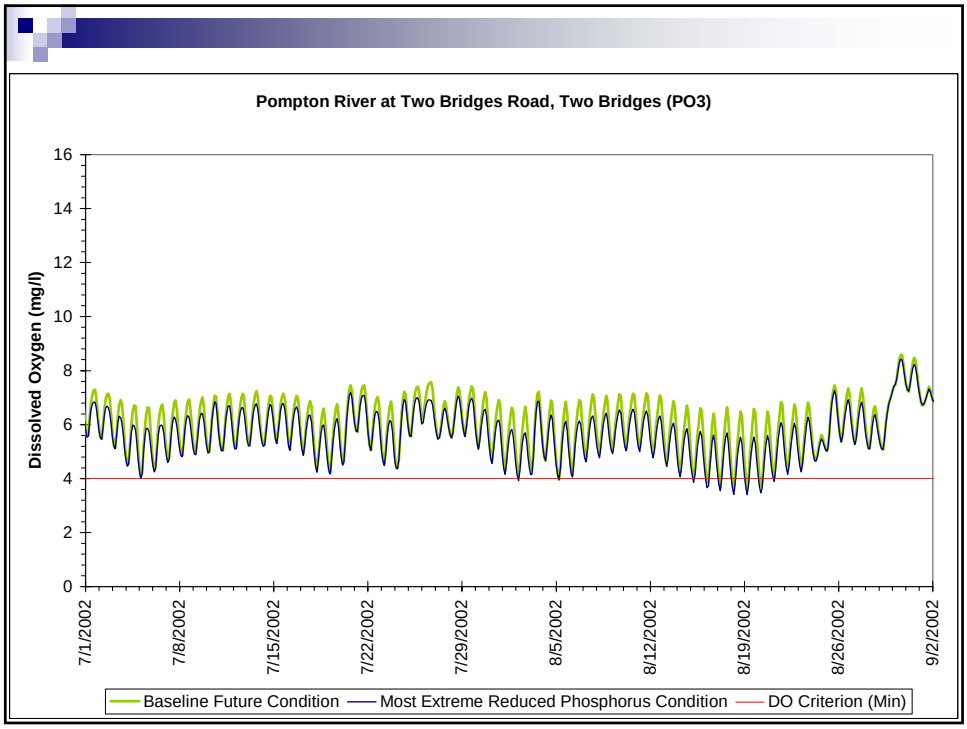

Pequannock River at Riverdale Road, Pompton Lakes (PE2)
Dissolved Oxygen (mg/l)
0
2
4
6
8
10
12
14
16
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
DO Criterion (Min)


Pequannock River at Riverdale Road, Pompton Lakes (PE2)
Dissolved Oxygen (mg/l)
0
2
4
6
8
10
12
14
16
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)


Pompton River at Two Bridges Road, Two Bridges (PO3)
Chlorophyll-a (µg/l)
0
5
10
15
20
25
30
35
40
45
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition


Pompton River at Two Bridges Road, Two Bridges (PO3)
Chlorophyll-a (µg/l)
0
5
10
15
20
25
30
35
40
45
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline
MERP
Baseline w/ Reduced Pompton Lake BC


Pompton River at Two Bridges Road, Two Bridges (PO3)
Dissolved Oxygen (mg/l)
0
2
4
6
8
10
12
14
16
10/1/1999
12/24/1999
3/17/2000
6/9/2000
9/1/2000
11/24/2000
2/16/2001
5/11/2001
8/3/2001
10/26/2001
1/18/2002
4/12/2002
7/5/2002
9/27/2002
12/20/2002
3/14/2003
6/6/2003
8/29/2003
11/21/2003
Baseline Future Condition
DO Criterion (Min)


Pompton River at Two Bridges Road, Two Bridges (PO3)
Dissolved Oxygen (mg/l)
0
2
4
6
8
10
12
14
16
7/1/2002
7/8/2002
7/15/2002
7/22/2002
7/29/2002
8/5/2002
8/12/2002
8/19/2002
8/26/2002
9/2/2002
Baseline Future Condition
Most Extreme Reduced Phosphorus Condition
DO Criterion (Min)

Phosphorus Reduction Impact Summary: Wanaque, Pequannock, and Pompton Rivers

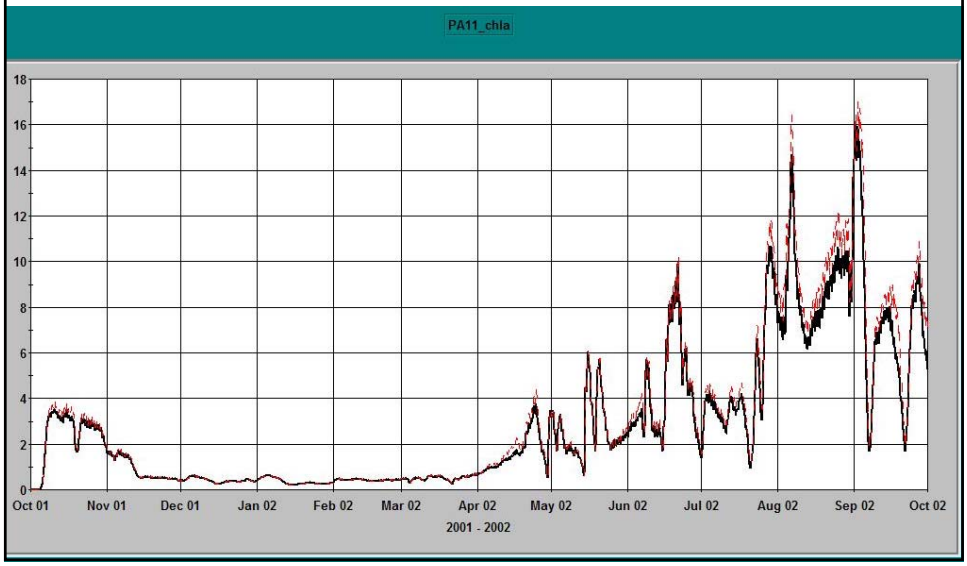
- Wanaque and Pequannock Rivers
  - minimal change in dissolved oxygen
- Pompton River at Two Bridges
  - minimal change in dissolved oxygen
  - minor change in phytoplankton Chl-a
  - Phytoplankton in Pompton River driven by boundary condition in Ramapo River at Pompton Lake

How do nonpoint sources affect productivity in the Passaic River?

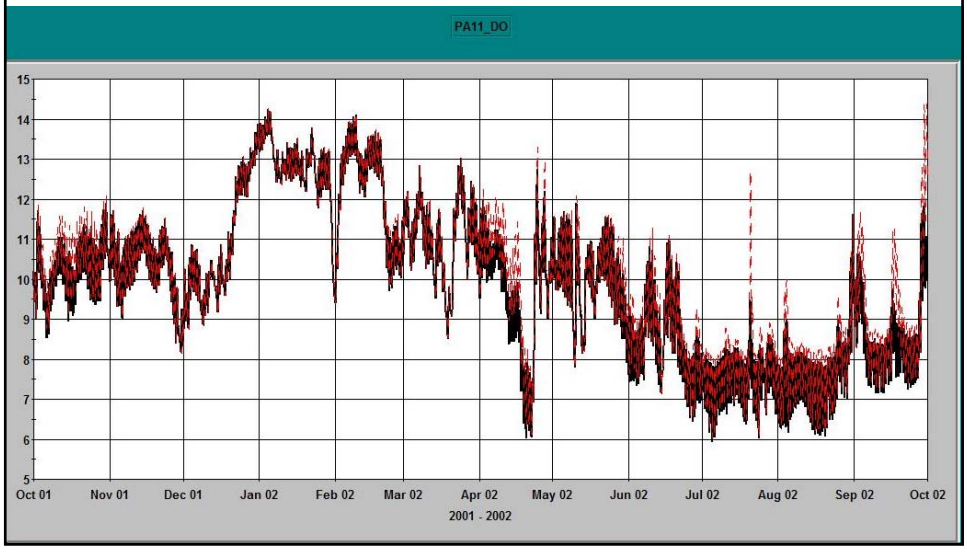
- Nonpoint Source Reduction Combinations
  - Based on reduced phosphorus scenario

    (PS = 0.1 mg/l, NPS reduced 80%)
    - NPS reduced by 40%
    - NPS not reduced at all
    - DO and chl-a evaluated at all critical locations
  - Results
    - 40% NPS reduction produces the same productivity as 80% NPS reduction
    - 0% NPS reduction produces very minor difference in productivity compared with 80% NPS reduction
    - However, downstream loads are reduced with NPS reductions, which matters for the Wanaque Reservoir

Chl-a in Passaic River at Dundee (PA11) Nonpoint Sources Not Reduced (red)



DO in in Passaic River at Dundee (PA11) Nonpoint Sources Not Reduced (red)

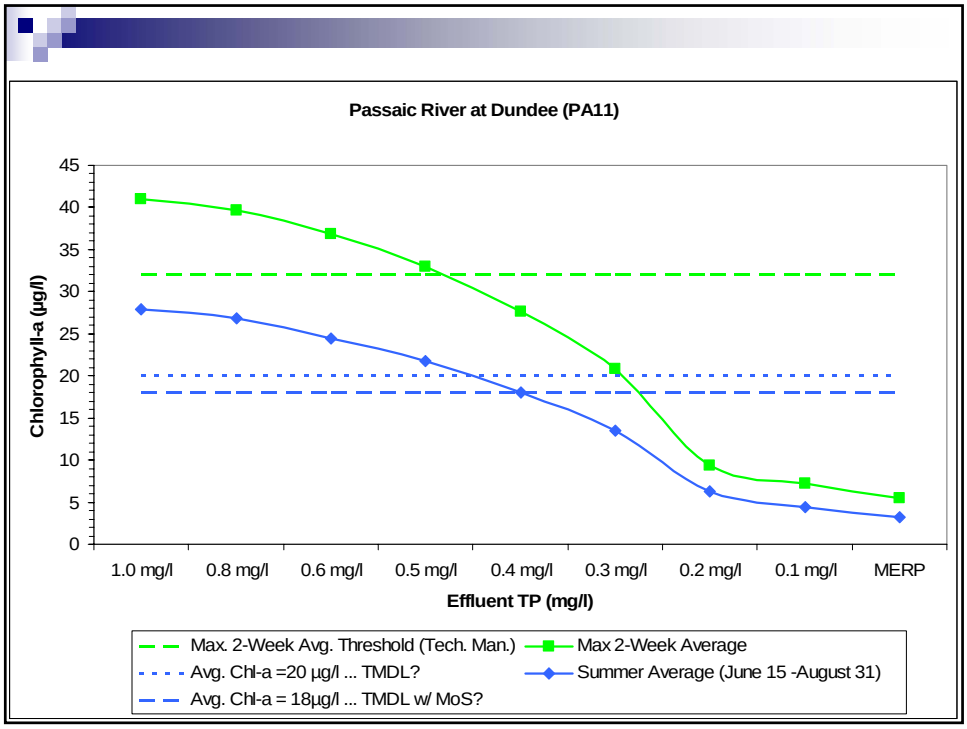


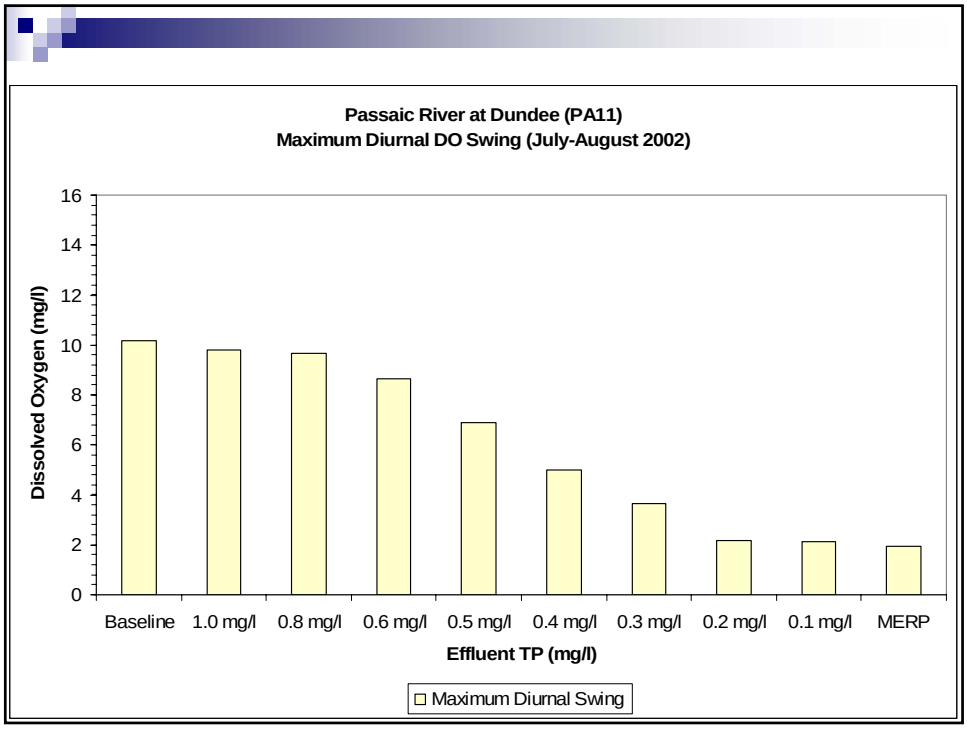
Critical Locations

- Based on assessment of stream response and the Wanaque Reservoir TMDL, critical locations have been identified as follows:
  - Wanaque Reservoir
  - Passaic River at Dundee
- Other areas of concern:
  - Passaic River at Chatham
  - Peckman River at mouth
- TP numeric criterion does not apply in the rest of the system based on the application of the narrative criteria

Endpoints

- Establishing endpoints based on the response indicators is proposed
- Chlorophyll-a selected:
  - Wanaque Reservoir – 10 µg/l seasonal average
  - Passaic at Dundee – 20 µg/l seasonal average


Passaic River at Dundee (PA11)
Chlorophyll-a (µg/l)
45
40
35
30
25
20
15
10
5
0
1.0 mg/l
0.8 mg/l
0.6 mg/l
0.5 mg/l
0.4 mg/l
0.3 mg/l
0.2 mg/l
0.1 mg/l
MERP
Effluent TP (mg/l)
Max. 2-Week Avg. Threshold (Tech. Man.)
Max 2-Week Average
Avg. Chl-a =20 µg/l ... TMDL?
Summer Average (June 15 -August 31)
Avg. Chl-a = 18µg/l ... TMDL w/ MoS?


Passaic River at Dundee (PA11)
Maximum Diurnal DO Swing (July-August 2002)
Dissolved Oxygen (mg/l)
16
14
12
10
8
6
4
2
0
Baseline
1.0 mg/l
0.8 mg/l
0.6 mg/l
0.5 mg/l
0.4 mg/l
0.3 mg/l
0.2 mg/l
0.1 mg/l
MERP
Effluent TP (mg/l)
Maximum Diurnal Swing

Allocation Scenarios

- Critical locations and proposed endpoints drive different load reduction requirements
- System kinetics suggest breaking down into management zones
- Load reductions can be achieved by a combination of wastewater treatment and treatment of water diverted to the reservoir
- Need to assess cost effectiveness of achieving load reductions, recognizing that the public pays

Next Steps

- Integrate with Wanaque Reservoir TMDL to determine final load reductions needed for each endpoint
- Propose TMDL with site specific criteria
- EPA must approve site specific criteria; TMDL approval would be contingent on adoption of criteria in rule
- Implementation through permit modifications and NPS reduction measures

Discussion