Amendment to the Northeast Water Quality Management Plan

Total Maximum Daily Loads for Phosphorus to Address Three (3) Stream Segments in the Northeast Water Region

Watershed Management Area 5 (Hackensack and Pascack Watersheds)

Proposed: July 5, 2005
Established: August 31, 2005
Approved: September 30, 2005
Adopted:

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1.0 Executive Summary

In accordance with Section 305(b) and 303(d) of the Federal Clean Water Act (CWA), the State of New Jersey, Department of Environmental Protection (Department) developed the *2004 Integrated List of Waterbodies* addressing the overall water quality of the State's waters and, in Sublist 5, identifying the list of impaired waterbodies. On October 4, 2004, the Department adopted the *2004 Integrated List of Waterbodies* as an amendment to the Statewide Water Quality Management Plan, pursuant to the Water Quality Planning Act at N.J.S.A.58:11A-7 and the Statewide Water Quality Management Planning rules at N.J.A.C. 7:15-6.4(a). In the Northeast Water Region, Watershed Management Area (WMA) 5, the *2004 Integrated List of Waterbodies* Sublist 5 identifies the three stream segments in Table 1 as impaired with respect to phosphorus, as indicated by the presence of phosphorus concentrations in excess of standards. A TMDL is required to be developed for each of the impairments listed on Sublist 5. A TMDL is developed to identify all the contributors of a pollutant of concern and the load reductions necessary to meet the Surface Water Quality Standards (SWQS) relative to that pollutant. TMDLs are established to address the phosphorus impairment in the waterbodies identified in Table 1.

Table 1 Impaired stream segments identified on the *2004 Integrated List of Waterbodies* to be addressed in this TMDL report.

Impairment Number	WMA	Station Name/Waterbody	Site ID	Sublist	Proposed Action
1	5	Coles Brook at Hackensack	01378560	5	Establish TMDL
2	5	Pascack Brook at Westwood	01377500, 5-PAS-1	5	Establish TMDL
3	5	Musquapsink Brook at River Vale	01377499	5	Establish TMDL

This TMDL report includes implementation strategies to achieve SWQS for phosphorus, including an additional measure, which will be included in the municipal stormwater permits for municipalities within the affected watersheds, to adopt a low phosphorus fertilizer ordinance. The TMDLs in this report were proposed and will be adopted by the Department as amendments to the appropriate area-wide water quality management plans in accordance with N.J.A.C. 7:15-3.4(g). This TMDL report was developed consistent with the United States Environmental Protection Agency's (USEPA's) May 20, 2002 guidance document entitled: "Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992," (Sutfin, 2002) which describes the statutory and regulatory requirements for approvable TMDLs.

2.0 Introduction

In accordance with Section 303(d) of the Federal Clean Water Act (CWA) (33 U.S.C. 1315(B)), the State of New Jersey is required biennially to prepare and submit to the USEPA a report that identifies waters that do not meet or are not expected to meet SWQS after implementation of technology-based effluent limitations or other required controls. This report is commonly referred to as the 303(d) List. In accordance with Section 305(b) of the CWA, the State of New Jersey is also required biennially to prepare and submit to the USEPA a report addressing the overall water quality of the State's waters. This report is commonly referred to as the 305(b) Report or the Water Quality Inventory Report. The *Integrated List of Waterbodies* combines these two assessments and assigns waterbodies to one of five sublists. Sublists 1 through 4 include waterbodies that are generally unimpaired (Sublist 1 and 2), have limited assessment or data availability (Sublist 3), are impaired due to pollution rather than pollutants or have had a TMDL or other enforceable management measure approved by EPA (Sublist 4). Sublist 5

constitutes the traditional 303(d) list for waters impaired or threatened by one or more pollutants, for which a TMDL may be required.

A TMDL represents the assimilative or carrying capacity of a waterbody, taking into consideration point and nonpoint sources of pollutants of concern, natural background and surface water withdrawals. A TMDL quantifies the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards and allocates that loading capacity to known point and nonpoint sources in the form of Waste Load Allocations (WLAs) for point sources, Load Allocations (LAs) for nonpoint sources, and a margin of safety (MOS).

This report establishes three TMDLs that address phosphorus impairment in 25.7 impaired river miles with respect to the waterbodies identified in Table 2. These TMDLs include management approaches to reduce loadings of phosphorus from various sources in order to attain applicable surface water quality standards for phosphorus. With respect to the phosphorus impairment, the waterbodies will be moved to Sublist 4 following approval of the TMDLs by EPA. Two of the waterbodies found in Table 2 have additional impairments other than total phosphorus. Pascack Brook at Westwood (01377500) is listed for Arsenic and Mercury, and Musquapsink Brook at River Vale (01377499) is listed for Arsenic. These additional impairments will be addressed in future TMDL reports.

Recent EPA guidance (Sutfin, 2002) describes the statutory and regulatory requirements for approvable TMDLs, as well as additional information generally needed for EPA to determine if a submitted TMDL fulfills the legal requirements for approval under Section 303(d) and EPA regulations. The Department believes that the TMDLs in this report address the following items in the May 20, 2002 guideline document:

1. Identification of waterbody(ies), pollutant of concern, pollutant sources and priority ranking.
2. Description of applicable water quality standards and numeric water quality target(s).
3. Loading capacity – linking water quality and pollutant sources.
4. Load allocations.
5. Waste load allocations.
6. Margin of safety.
7. Seasonal variation.
8. Reasonable assurances.
9. Monitoring plan to track TMDL effectiveness.
10. Implementation (USEPA is not required to and does not approve TMDL implementation plans).
11. Public Participation.

3.0 Pollutant of Concern and Area of Interest

Pollutant of Concern

The pollutant of concern for these TMDLs is total phosphorus. For the segments in the Northeast Water Region - WMA 5 identified in Table 2, phosphorus concentrations were found to exceed New Jersey's SWQS, found at N.J.A.C. 7-9B. The three impaired segments were assigned a Medium priority ranking in the *2004 Integrated List of Waterbodies* Sublist 5.

Table 2 Waterbodies listed for phosphorus impairment in the Northeast Water Region - WMA 5 for which TMDLs are proposed

TMDL Number	WMA	Station Name/Waterbody	Site ID	County(s)	Impaired River Miles
1	5	Coles Brook at Hackensack	01378560	Bergen	11.8
2	5	Pascack Brook at Westwood	01377500, 5-PAS-1	Bergen	6.6
3	5	Musquapsink Brook at River Vale	01377499	Bergen	7.3
Total Impaired River Miles:					**25.7**

Applicable Water Quality Standards

The impaired segments addressed in this document are classified as Fresh Water 2 (FW2). As stated in N.J.A.C. 7:9B-1.14(c) of the SWQS for FW2 waters, the standards for phosphorus are as follows:

> Phosphorus, Total (mg/l):
>
> i. Lakes: Phosphorus as total P shall not exceed 0.05 in any lake, pond, reservoir, or in a tributary at the point where it enters such bodies of water, except where site-specific criteria are developed pursuant to N.J.A.C. 7:9B-1.5(g)3.
>
> ii. Streams: Except as necessary to satisfy the more stringent criteria in paragraph i. above or where site-specific criteria are developed pursuant to N.J.A.C. 7:9B1.5(g)3, phosphorus as total P shall not exceed 0.1 in any stream, unless it can be demonstrated that total P is not a limiting nutrient and will not otherwise render the waters unsuitable for the designated uses.

Also as stated in N.J.A.C. 7:9B-1.5(g)2:

> Nutrient policies are as follows:
>
> Except as due to natural conditions, nutrients shall not be allowed in concentrations that cause objectionable algal densities, nuisance aquatic vegetation, abnormal diurnal fluctuations in dissolved oxygen or pH, changes to the composition of aquatic ecosystems, or otherwise render the waters unsuitable for the designated uses.

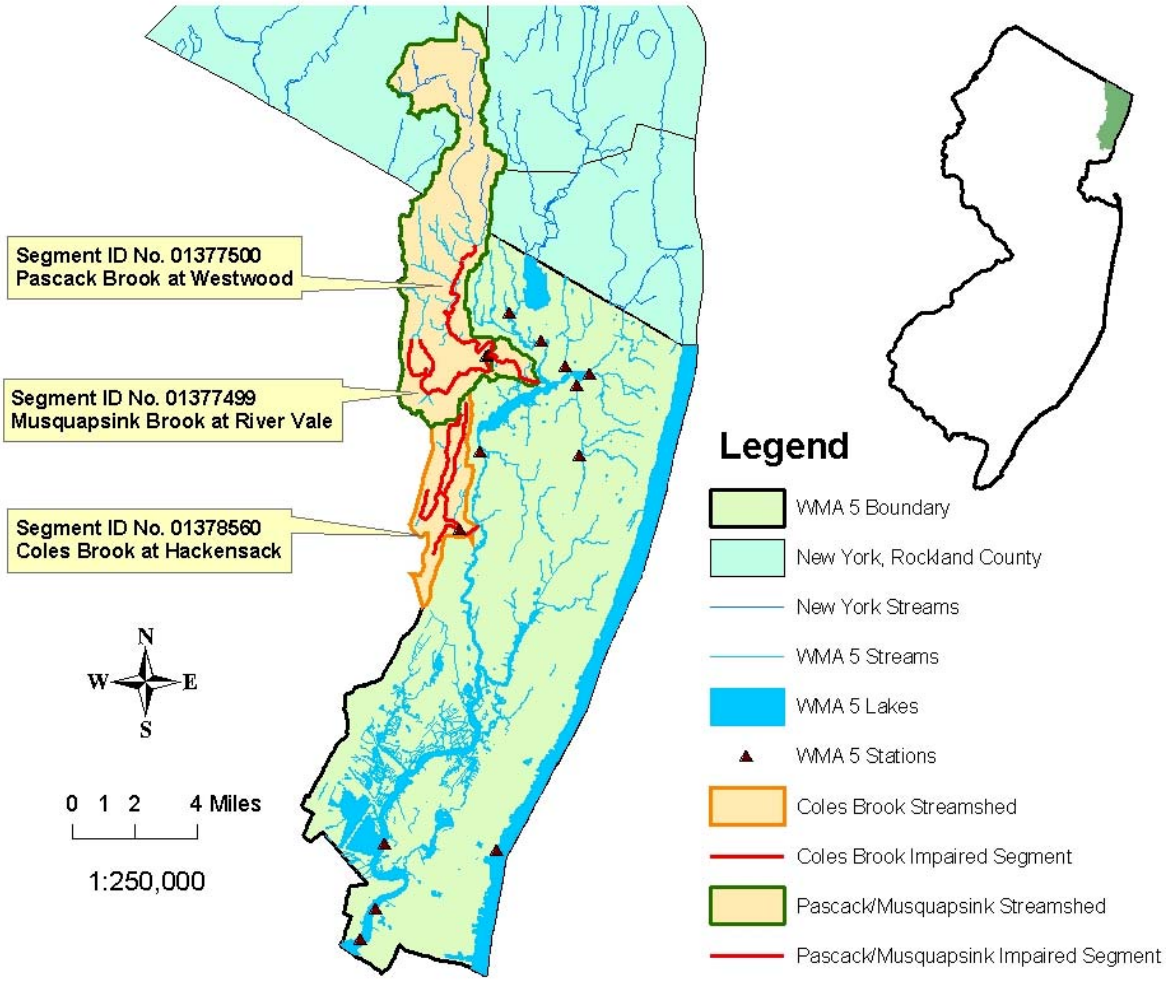
In all FW2 waters, the designated uses are (NJAC 7:9B-1.12):

> 1. Maintenance, migration and propagation of the natural and established aquatic biota;
> 2. Primary and secondary contact recreation;
> 3 Industrial and agricultural water supply;
> 4. Public potable water supply after conventional filtration treatment (a series of processes including filtration, flocculation, coagulation and sedimentation, resulting in substantial particulate removal but no consistent removal of chemical constituents) and disinfection; and
> 5. Any other reasonable uses.

Area of Interest

These TMDLs will address 25.7 impaired river miles within the Northeast Water Region, Watershed Management Area 5. Based on the detailed county hydrography stream coverage, 67.61 overall stream miles in New Jersey and New York are affected by the TMDLs due to the fact that the implementation plans cover entire watersheds, not just impaired waterbody segments. The spatial extent of the impaired segments and the affected drainage areas are depicted in Figure 1.

Figure 1 Spatial extent of impaired segments and affected drainage areas: WMA 5



Watershed Management Area 5 - Hackensack, Hudson, Pascack

Watershed Management Area 5 (WMA 5) has a drainage area of approximately 165 square miles, which includes parts of Hudson and Bergen Counties. WMA 5 is comprised of three watersheds: Hackensack River Watershed, Hudson River Watershed and Pascack Brook Watershed. The Hackensack River originates in New York State and flows south to the Newark Bay. New Jersey's portion of the river is 31 miles long. The Hackensack River Watershed is approximately 85 square miles. Major tributaries include the Pascack Brook, Berry's Creek, Overpeck Creek, and Wolf Creek. The Pascack Brook Watershed has a drainage area of approximately 51 square miles.

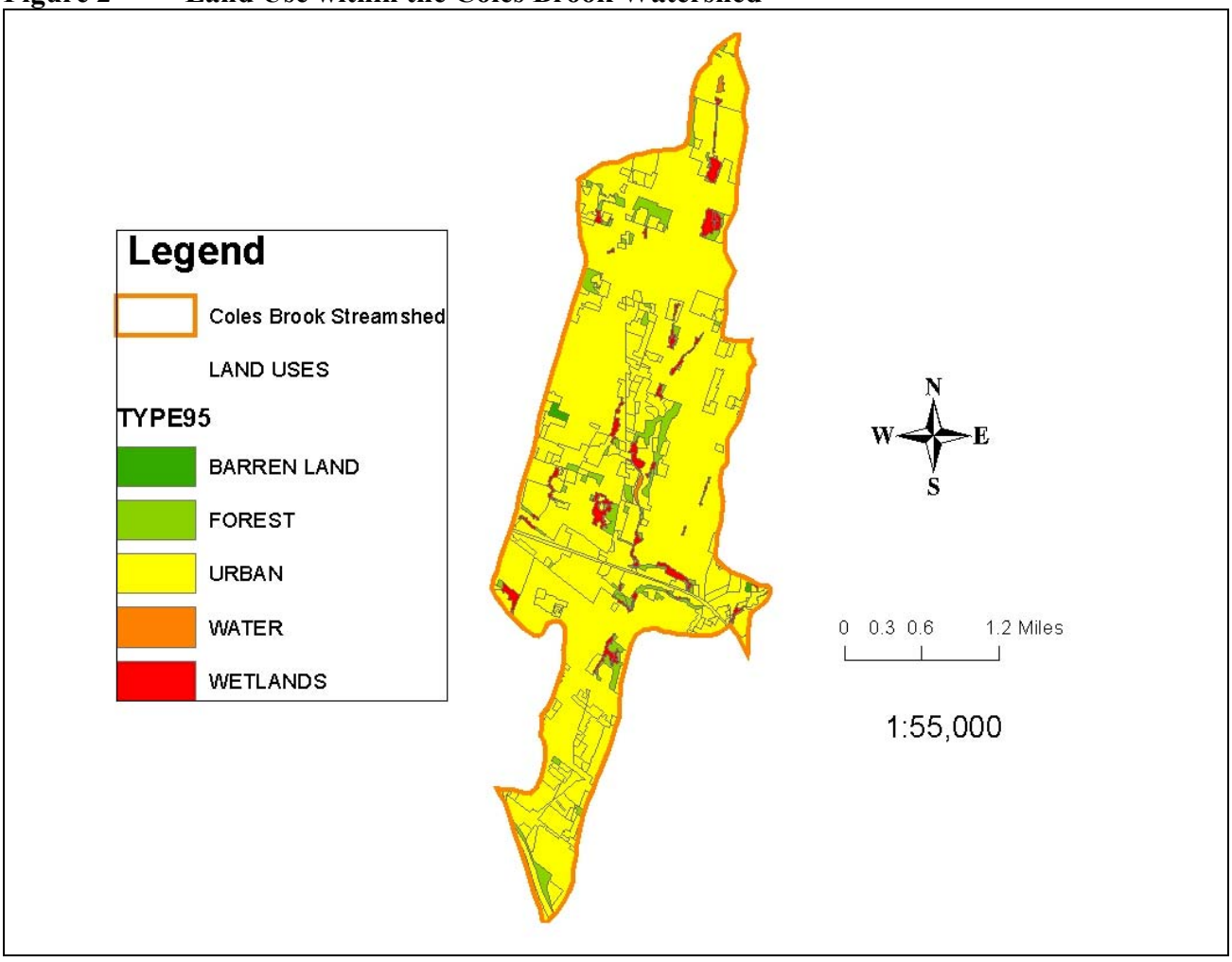
The Hudson River is 315 miles long and begins in New York State at Lake Tear of the Clouds on the southwest side of Mount Marcy, New York's highest peak. The Hudson River Watershed is approximately 29 square miles. The Hudson River forms the boundary between New Jersey and New York States.

Although WMA 5 is the most populated of all the WMAs, approximately 50% of the land is still undeveloped. More than 30% of the developed land is residential development. The remaining developed land is commercial/industrial use. Much of the lower Hackensack River Watershed is tidal marsh known as the Hackensack Meadowlands. This are is home to more than 700 plant and animal species including several rare and threatened species. The Hackensack Meadowlands Development Commission (HMDC) was created by an act of the New Jersey Legislature that became law in January 1969. The act gave the HMDC three mandates, environmental protection, economic development, and solid waste management. The HMDC district size is 19,730 acres, or 32 square miles. Land use in the affected drainage areas is predominantly urban and is presented in Tables 3 and 4, and depicted in Figures 2 and 3.

Table 3 River miles, Watershed size, and Area by Anderson Land Use Classification for Coles Brook

River miles and drainage area	Coles Brook at Hackensack 01378560
Sublist 5 impaired river miles	11.8
Total river miles within watershed and included in the implementation plan	15.5
Watershed size (acres)	4382
Landuse/Landcover (acres)	
Medium / high density residential	2986.8
Low density / rural residential	105.7
Commercial	495.6
Industrial	24.0
Mixed urban / other urban	417.4
Agriculture	0
Forest, wetland, water	341.7
Barren	10.7
Total	4381.9

Figure 2 Land Use within the Coles Brook Watershed



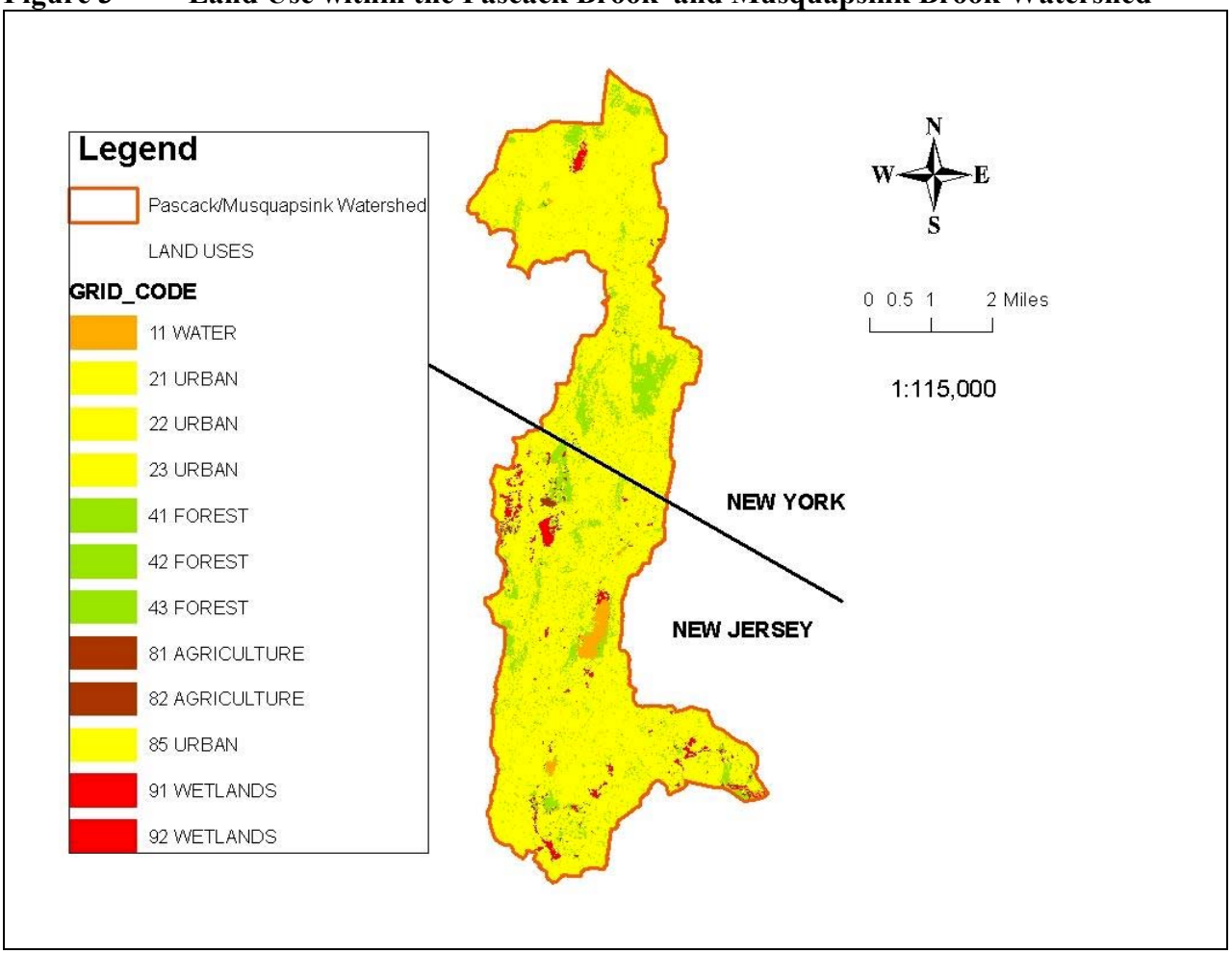
The Coles Brook impaired stream segment is classified as FW2-NT/SE1.

The information for Pascack Brook at Westwood and Musquapsink Brook at River Vale are, at times, addressed in the same figures and tables in this TMDL document. The monitoring station for Pascack Brook at Westwood (01377500) accurately characterizes the flows and water quality at Musquapsink Brook due to the Pascack station location directly below the confluence of the two streams. For this reason, the two impairments are addressed as one in certain areas of this document.

Table 4 River miles, Watershed size, and Area by USGS Land Use Classification for Pascack Brook and Musquapsink Brook

River miles and drainage area	Pascack Brook at Westwood, Musquapsink Brook at River Vale 01377500 (5-PAS-1), 01377499
Sublist 5 impaired river miles	13.9
Total river miles within watershed and included in the implementation plan	52.11
Watershed size (acres)	19101
Land use/Land cover (acres)	
Medium / high density residential	1743.4
Low density / rural residential	12669.7
Commercial	715.6
Industrial	0
Mixed urban / other urban	979.6
Agriculture	99.5
Forest, wetland, water	2893.1
Barren	0
Total	19100.9

Figure 3 Land Use within the Pascack Brook and Musquapsink Brook Watershed



The Pascack Brook and Musquapsink Brook impaired stream segments are classified as FW2-NTC1.

Data Sources

The Department's Geographic Information System (GIS) and GIS coverages for New York were used to describe characteristics of the affected drainage area and in developing this document. The following is general information regarding the data used:

- Land use/Land cover was taken from: "NJDEP 1995/97 Land use/Land cover Update for New Jersey (by WMA)", published 12/01/2000 by the NJDEP, Office of Information Resources Management (OIRM), Bureau of Geographic Information and Analysis (BGIA), and delineated by watershed management area.

- "NJDEP 2004 Integrated Report Results for Non-Tidal Rivers", published 6/2004 by NJDEP, Watershed Assessment Group (WAT). Online at:
http://www.state.nj.us/dep/gis/digidownload/images/ir2004/ir_river_conventionals2004.gif

- Detailed stream coverage of New Jersey: Published 11/01/1998 by the NJDEP, Office of Information Resources Management (OIRM), Bureau of Geographic Information and Analysis (BGIA). "NJDEP Streams of New Jersey (1:24000)." Online at:
http://www.state.nj.us/dep/gis/strmshp.html

- NJDEP 14 Digit Hydrologic Unit Code delineations for New Jersey (DEPHUC14), published 4/5/2000 by Department of Environmental Protection (NJDEP), New Jersey Geological Survey (NJGS). Online at:
http://www.state.nj.us/dep/gis/digidownload/zips/statewide/dephuc14.zip

- NJDEP Digital Elevation Grid for New Jersey (10 meter) published 10/01/2004 by NJ Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information Systems (BGIS). Online at:
http://www.nj.gov/dep/gis/wmalattice.html

- "NJPDES Surface Water Discharges in New Jersey, (1:12,000)", published 09/12/2002 by NJDEP, Environmental Regulation (ER), Division of Water Quality (DWQ), Bureau of Point Source Permitting - Region 1 (PSP-R1). Online at:
http://depnet/gis/digidownload/images/statewide/njpdesswd.gif

- "NJDEP 2004 Integrated Report Stations on Non-Tidal Rivers (Conventionals and Toxics)", published 6/2004 by NJDEP, Water Assessment Team (WAT). Online at:
http://www.state.nj.us/dep/gis/digidownload/images/ir2004/ir_stations_river2004.gif

- "NJDEP Head of Tide Points for Watercourses of New Jersey", published 1986 by NJDEP, Office of Environmental Analysis (OEA), Coast Survey Ltd. (CTD). Online at:
http://www.state.nj.us/dep/gis/digidownload/zips/statewide/hot.zip

- "NJDEP Surface Water Quality Standards of New Jersey", published 11/2003 by NJDEP, Division of Landuse Management, Bureau of Freshwater & Biological Monitoring. Online at:
http://www.state.nj.us/dep/gis/digidownload/zips/statewide/swqs.zip

- "Hydrological Features of New Jersey Feature Map Service, New Jersey State Plane NAD83", published 2005 by New Jersey Office of Information Technology (NJOIT), Office of Geographic Information Systems (OGIS). Online at: Live Data and Maps (ArcIMS Feature Service) - Server=http://njgin.state.nj.us; Service=NJ_Hydrology_FS; ServiceType=feature

- "Municipal, County and State Boundaries of New Jersey Feature Map Service, New Jersey State Plane NAD83", published 2004 by New Jersey Office of Information Technology (NJOIT), Office of Geographic Information Systems (OGIS). Online at: Live Data and Maps (ArcIMS Feature Service) - Server=http://njgin.state.nj.us; Service=NJ_GovtBounds_FS; ServiceType=feature

- "Water Quality Management Areas", created 3/2002 by NJDEP, Water Assessment Team (WAT). Unpublished.

- "Dams in New Jersey", created 6/2003 by NJDEP, Division of Watershed Management (DWM). Unpublished.

- Hydrography (Census 2000) shapefiles downloaded from Cornell University Geospatial Information Repository (CUGIR) - Streams and lakes located in New York State, (Shapefile: 2001). http://cugir.mannlib.cornell.edu/browse_map/browse_map.html

National Land Cover Data (NLCD) for New York, last updated in July 2000, and for New Jersey, last updated in March 2000. The data was produced under the direction of the USGS as part of the Multi-Resolution Land Characterization (MRLC) Regional Land Cover Characterization Project. The data used the NLCD Land Cover Classification Systems to categorize land use. http://edcsgs9.cr.usgs.gov/pub/data/landcover/states/

- High Resolution Digital Ortho-imagery 2000-2001 for Hudson Valley/Catskill Region in New York State downloaded from New York State GIS Clearinghouse. http://www.nysgis.state.ny.us/gateway/mg/high_res.htm

- New York State Digital Elevation Models (DEM) in the format of ASCII DEM was downloaded for the Sloatsburg and Nyack areas from Cornell University Geospatial Information Repository (CUGIR). This information was published by the USGS in August 1998. http://cugir.mannlib.cornell.edu/browse_lis/dem_list.html

- New York State, Rockland County Boundaries, (Shapefile: 2001) http://cugir2.mannlib.cornell.edu/buckets/Display.jsp?id=7385

- New Jersey Environmental Management System (NJEMS)

4.0 Source Assessment

In order to evaluate and characterize phosphorus loadings in the waterbodies of interest in these TMDLs, and thus propose proper management responses, source assessments are critical. Source assessments include identifying the types of sources and their relative contributions to phosphorus loadings, in both time and space variables.

For the purposes of TMDL development, point sources include domestic and industrial wastewater treatment plants that discharge to surface water, as well as surface water discharges of stormwater subject to regulation under the National Pollutant Discharge Elimination System (NPDES). This includes facilities with individual or general industrial stormwater permits and Tier A municipalities and Federal, interstate agency, state and county facilities regulated under the New Jersey Pollutant Discharge Elimination System (NJPDES) municipal stormwater permitting program.

There are no point sources, other than stormwater, that could contribute phosphorus to the impaired waterbodies. Stormwater point sources like nonpoint sources, derive their pollutant load from runoff from land surfaces and load reduction is accomplished through BMPs. The distinction is that stormwater point sources are regulated under the Clean Water Act. Stormwater point sources are or will be addressed through the management practices required through the discharge permits. The Tier A municipalities located in the affected streamsheds are identified in Appendix 3.

For the purposes of TMDL development, potential nonpoint sources include stormwater discharges that are not subject to regulation under NPDES, including Tier B municipalities, which are regulated under the NJPDES municipal stormwater permitting program, and direct stormwater runoff from land surfaces, as well as malfunctioning sewage conveyance systems, failing or inappropriately located septic systems, and direct contributions from wildlife, livestock and pets. There are no Tier B municipalities within the affected streamsheds.

The phosphorus loads in the affected watersheds are contributed by stormwater point sources and nonpoint sources. These loads are effectively estimated using loading coefficients for land uses present in the watersheds. Watershed loads for total phosphorus were, therefore, estimated using the Unit Areal Load (UAL) methodology, which applies pollutant export coefficients obtained from literature sources to the land use patterns within the watershed, as described in USEPA's Clean Lakes Program guidance manual (Reckhow, 1979b). Land use was determined using the Department's GIS system from the 1995/1997 land use coverage for the Coles Brook impaired watershed. The Department reviewed phosphorus export coefficients from an extensive database (Appendix 1) and selected the land use categories and values shown in Table 5. In order to apply a uniform coverage for the entire Pascack Brook and Musquapsink Brook impaired watershed, land use was determined using the USGS 2000 National Land Cover Data (NLCD) for both New York and New Jersey. The NLCD classification of land use types is different from the Department's 1995/1997 land use classification. Adjustments were made to assign an appropriate TP Export Coefficient for each type of NLCD land use, shown in Table 5.

Table 5: Phosphorus export coefficients (Unit Areal Loads)

Land use/Land cover	LU/LC codes[1]	USGS Grid_code	UAL (kg TP/ha/yr)
Mixed density residential	1100	n/a	1.2
Medium / high density residential	1110, 1120, 1150	22	1.6
Low density / rural residential	1130, 1140	21	0.7
Commercial	1200	23	2.0
Industrial	1300, 1500	n/a	1.7
Mixed urban / other urban	other urban codes	85	1.0

[1] LU/LC code is an attribute of the land use coverage that provides the Anderson classification code for the land use. The Anderson classification system is a hierarchical system based on four digits. The four digits represent one to four levels of classification, the first digit being the most general and the fourth digit being the most specific description.

Land use/Land cover	LU/LC codes[1]	USGS Grid_code	UAL (kg TP/ha/yr)
Agricultural	2000	81, 82	1.5
Forest, wetland, water	1750, 1850, 2140, 2150, 4000, 5000, 6000, 7430, 8000	11, 41, 42, 43, 91, 92	0.1
Barren land	7000	32	0.5

Units: 1 hectare (ha) = 2.47 acres, 1 kilogram (kg) = 2.2 pounds (lbs), 1 kg/ha/yr = 0.89 lbs/acre/yr

5.0 Water Quality Analysis

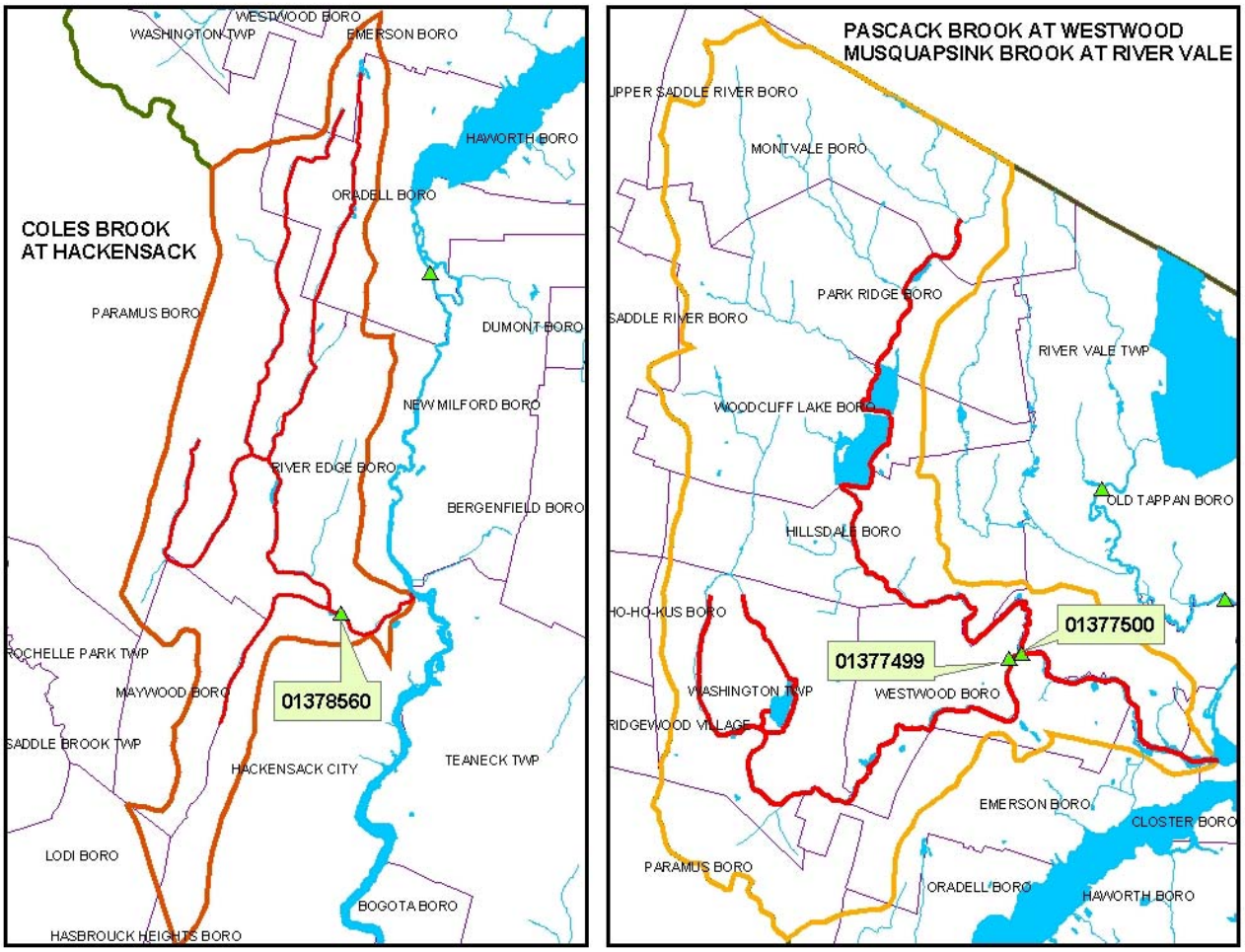
The data set used in this TMDL was generated by the USGS/NJDEP ambient monitoring program and the Department's supplemental monitoring project identified as the Existing Water Quality (EWQ) monitoring program. The USGS data spanned from November 1997 thru August 2003. The EWQ monitoring was conducted from August 2000 to August 2004. The sampling locations for the evaluated data are found in Figure 4. A summary of total phosphorus sampling data is found in Table 6 below. The full data set can be found in Appendix 2. Due to incomplete flow data available, some of the values within Appendix 2 were calculated by developing a stage/discharge relationship at the Coles Brook and Pascack Brook sampling sites. The calculated flow values were then used to perform the regression analyses in Section 6.0.

The information for Pascack Brook at Westwood and Musquapsink Brook at River Vale are, at times, addressed in the same figures and tables in this TMDL document. The monitoring station for Pascack Brook at Westwood (01377500) accurately characterizes the flows and water quality at Musquapsink Brook due to the Pascack station location directly below the confluence of the two streams. For this reason, the two impairments are addressed as one in certain areas of this document.

Table 6 Summary of Total Phosphorus sampling data

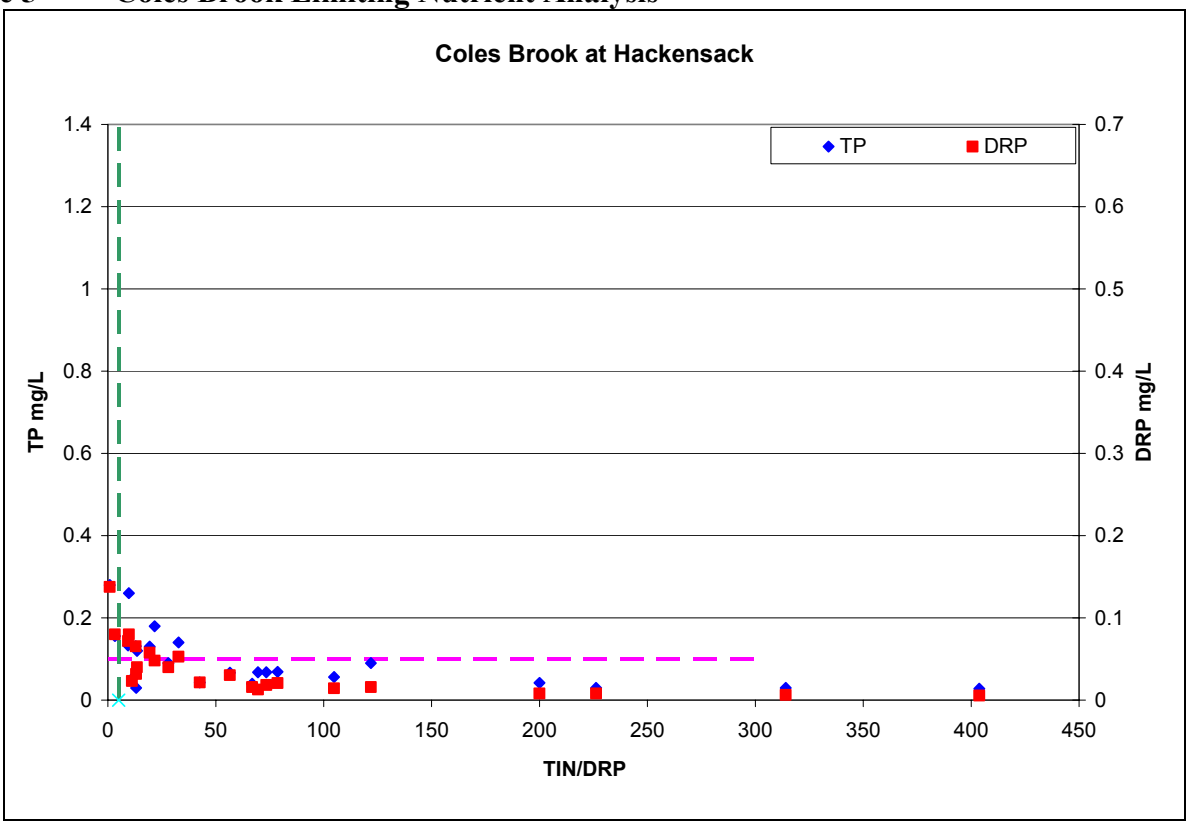
Water Quality Sample Locations	Site Number	# of samples	Average (mg/L)	% exceeding 0.1 mg/L
Coles Brook at Hackensack	01378560	24	0.10	37.5%
Pascack Brook at Westwood	01377500, 5-PAS-1	16	0.07	25%
Musquapsink Brook at River Vale	01377499	8	0.24	37.5%

Figure 4 Location of Monitoring Sites



The Department's March 2003 guidance document, entitled *"Technical Manual for Phosphorus Evaluations (N.J.A.C. 7:9B-1.14(c)) for NJPDES Discharge to Surface Water Permits"*, recommends considering ratios of nitrogen and phosphorus to suggest whether phosphorus is the limiting nutrient. When the ratio of total inorganic nitrogen (TIN) to total orthophosphate (TOP) or dissolved reactive phosphorus (DRP) is smaller than or equal to 5, then phosphorus is generally not limiting the system. This document may be downloaded from the Department's web page at www.state.nj.us/dep/dwq/techmans/phostcml.pdf. Figures 5-7 depict the relationship of these two key nutrients at each station. At these stations, when the total phosphorus exceeded 0.1 mg/L and the DRP < 0.05 mg/L, the ratio TIN/DRP exceeded 5. This suggests that phosphorus is the limiting nutrient and the 0.1 mg/l criterion applies. Detailed discussion of the nitrogen-phosphorus relationship is found in Appendix 4.

Figure 5 Coles Brook Limiting Nutrient Analysis



TIN = dissolved nitrite, nitrate and ammonia. TIN calculated as: a sum of dissolved ammonia (P00608) & dissolved nitrite and nitrate (P00631) or a sum of total ammonia (P00610) and total nitrite & nitrate (P00630)
DRP = dissolved reactive phosphorus: orthophosphorus (P00671) if available, or 80% dissolved phosphorus (P00666)

Figure 6 Pascack Brook Limiting Nutrient Analysis

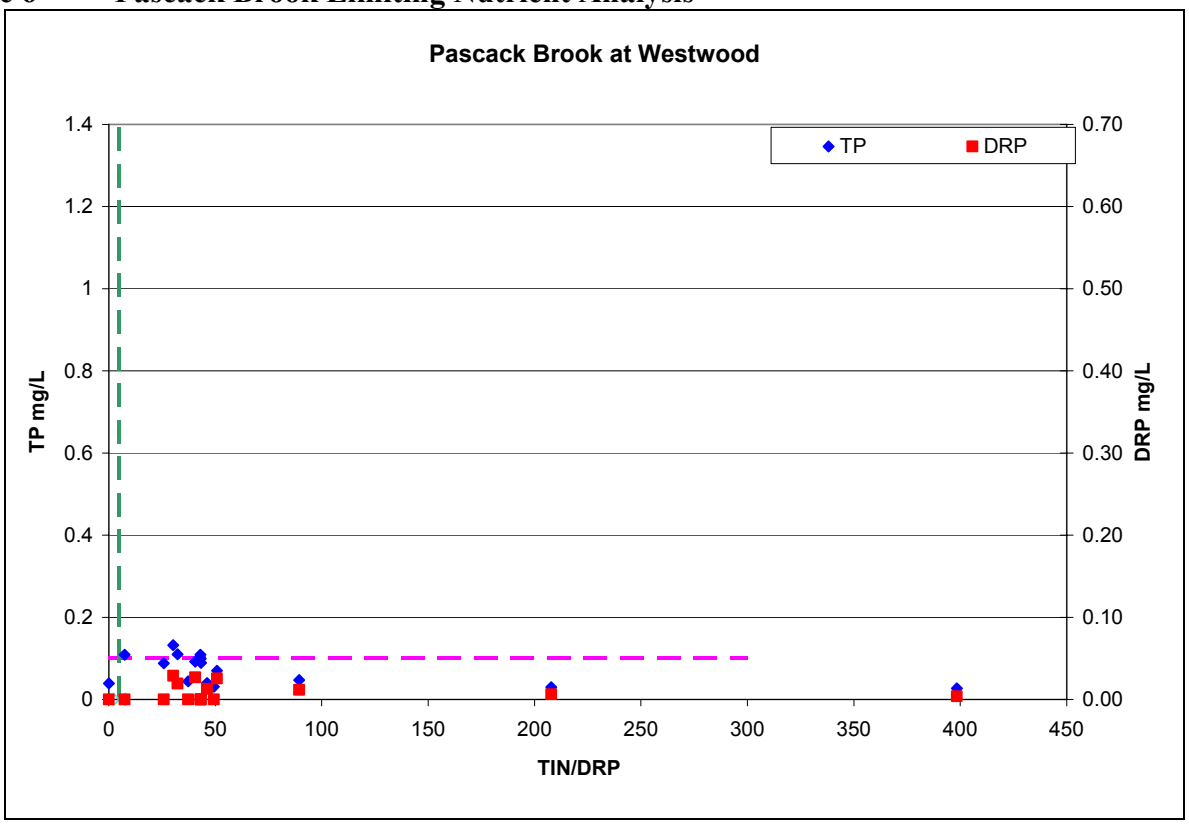
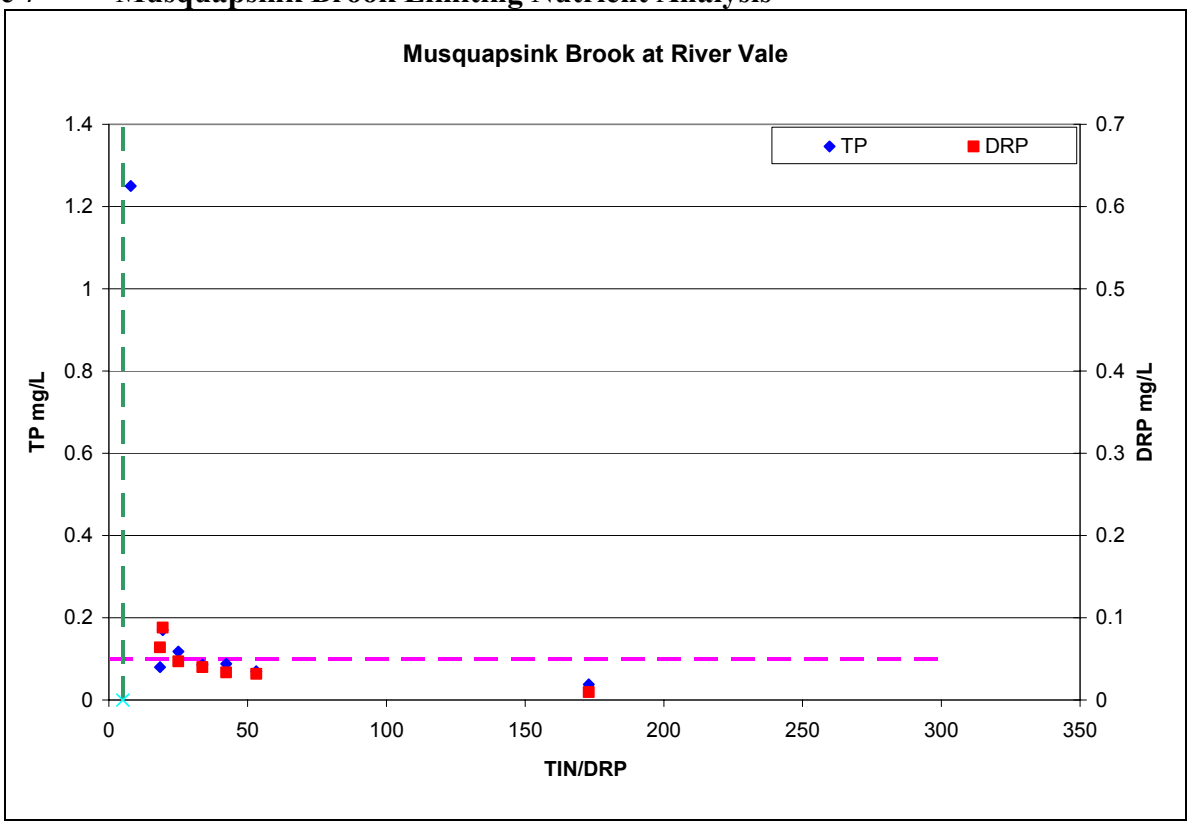


Figure 7 Musquapsink Brook Limiting Nutrient Analysis



Seasonal Variation/Critical Conditions

The application of a flow-integrated regression technique for determining loading reductions for impaired segments works well in watersheds that exhibit most of the loading exceedances from nonpoint and stormwater point sources of pollution. The analytical technique used to calculate these TMDLs represents the entire range of flows and all seasons for which the total phosphorus data were collected. Since the technique uses data from annual monitoring programs, seasonal variation and critical conditions are incorporated into the analysis by assessing the loadings over the entire range of flows. Therefore, the method implicitly represents all seasonal meteorological and hydrological conditions. The loading reduction calculated to attain SWQS will do so under all conditions, according to the data available. In this way, the TMDL addresses seasonal variation and critical conditions.

6.0 TMDL Calculations

A regression technique, derived from a load duration method (Stiles 2002), was developed by the Department for data-limited TMDLs where nonpoint and stormwater point sources are predominant. For this technique, linear regression is used to develop a flow-integrated relationship between measured pollutant concentrations and the associated flows at a single monitoring site. The method, known as the Flow-Integrated Reduction of Exceedances (FIRE), provides an accurate estimation of the load that will not cause an exceedance of the water quality standard. The FIRE method is applied over the entire range of flows, eliminating the need to establish a single target flow to estimate an average annual loading reduction. For this approach, calculated phosphorus loads based on actual data are plotted against corresponding flows. The regression relationship between the load and flow for exceedances of the SWQS is established and the regression line drawn. The target load line corresponding with the TP concentration of 0.1 mg/L is plotted on the same graph with the linear exceedance regression line. For this technique, a zero-intercept for the regression line is assumed. The zero intercept is within the 95 percent confidence interval, so the zero intercept cannot be rejected as the point of origin. In addition, given the predominance of nonpoint sources, at zero flow there would be zero load. Given a common intercept, the difference between the slopes of the two lines gives the percent load reduction needed to attain SWQS. The resultant percent reduction is the same whether the y-axis is expressed as pounds per day, pounds per year, or as metric units of kilograms per day or per year.

A Margin of Safety (MOS) must be provided to account for "lack of knowledge concerning the relationship between effluent limitations and water quality" (40 CFR 130.7(c)). A MOS accounts for uncertainty in the loading estimates, physical parameters and the model itself. The MOS, as described in USEPA guidance (Sutfin, 2002), can be either explicit or implicit (i.e., addressed through conservative assumptions used in establishing the TMDL). For this TMDL calculation, an explicit MOS has been incorporated as described below.

A percent loading reduction that includes a margin of safety is estimated by taking the difference between the upper 95 percent confidence limit of the slope of the exceedance regression line and the slope of the target loading. The margin of safety component is the difference between the exceedance regression line and the 95 percent confidence limit for the regression.

The regression results for the impaired segments are presented in Table 7 and 8, and Figure 8 and 9 below.

Table 7 **Coles Brook at Hackensack (01378560) Regression Analysis**

Results from Regression Analysis		
Target Loading Slope	=	**0.5390**
Exceedance Regression Slope	=	**0.7940**
Upper 95% Confidence Limit of Exceedance Regression Slope	=	**0.9927**

To achieve SWQS of 0.1 mg/L TP, the required reductions are as follows:

Required TP Load Reduction based on the regression line

$$(1-\frac{0.539}{0.7940})x100\% = 0.3212x100\% = 32.12\%$$

The portion of the reduction attributed to MOS is calculated as follows:

$$\text{MOS} = (1-\frac{0.794}{0.9927})x100\% = 0.2002x100\% = 20.02\%$$

Figure 8 Percent Reduction for the Coles Brook at Hackensack Using Regression Method

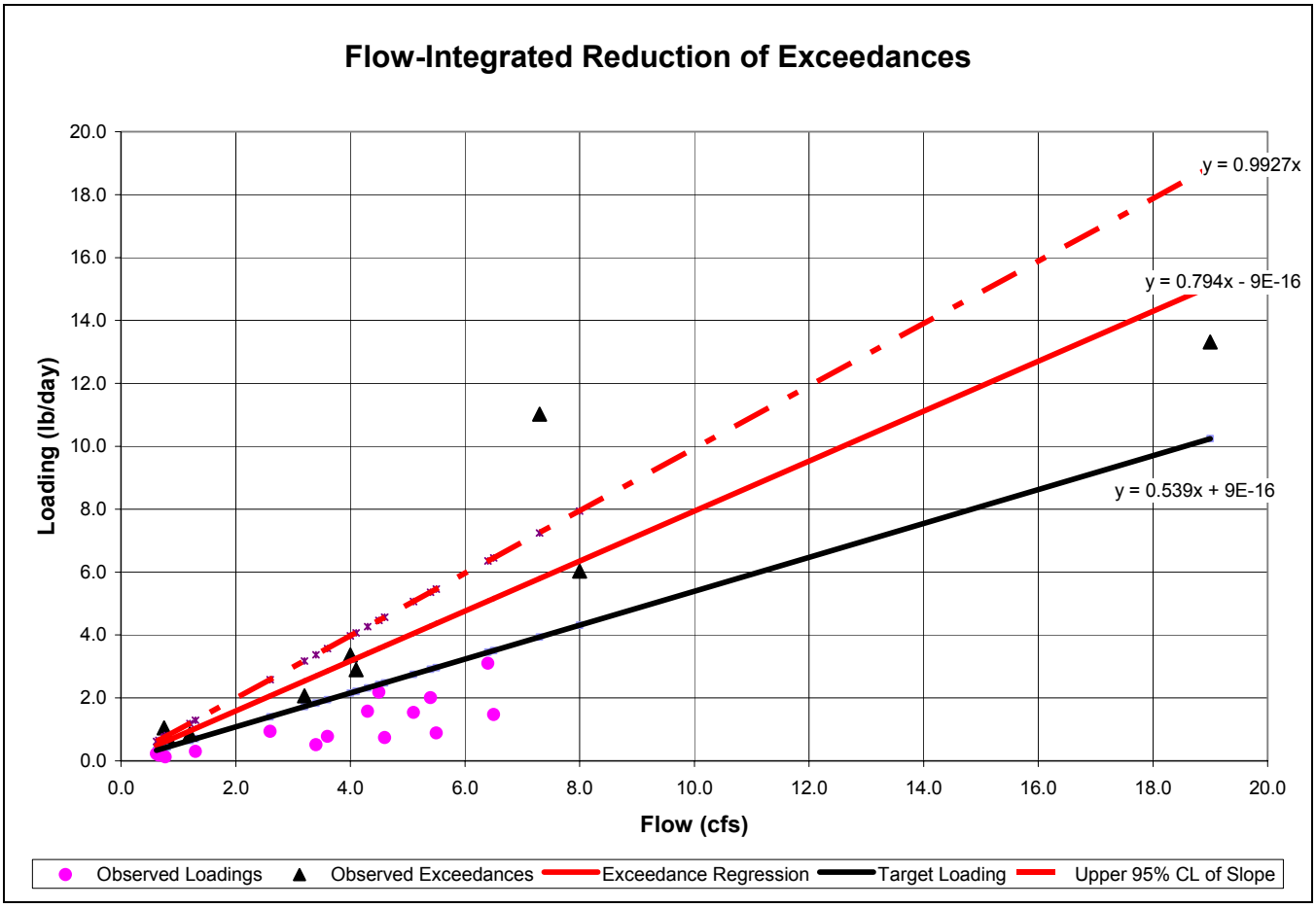


Table 8 Pascack Brook (01377500) and Musquapsink Brook (01377499) Regression Analysis

Results from Regression Analysis		
Target Loading Slope	=	**0.5390**
Exceedance Regression Slope	=	**0.6051**
Upper 95% Confidence Limit of Exceedance Regression Slope	=	**0.6824**

To achieve SWQS of 0.1 mg/L TP, the required reductions are as follows:

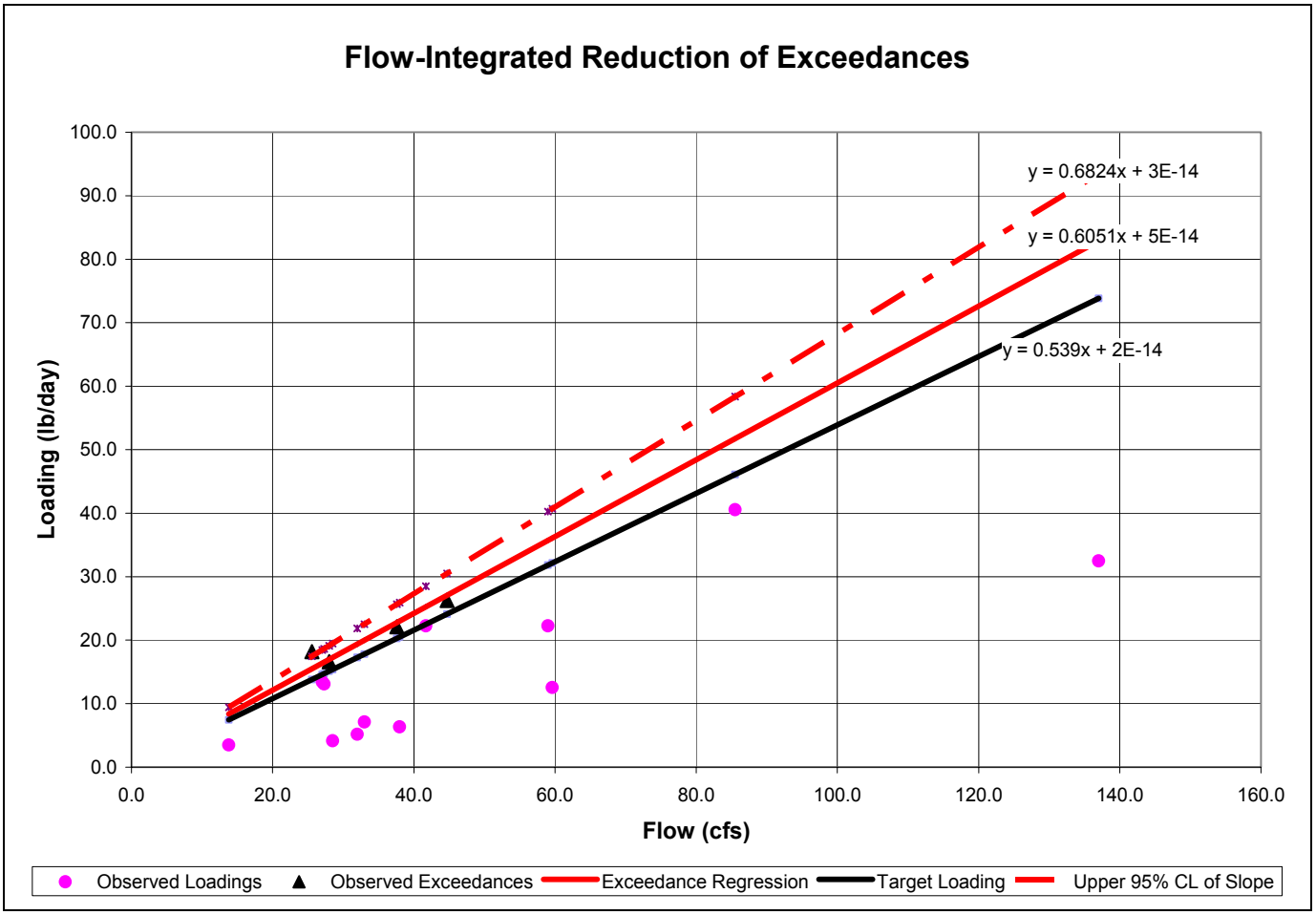
Required TP Load Reduction based on the regression line

$$(1-\frac{0.539}{0.6051})x100\% = 0.1092x100\% = 10.92\%$$

The portion of the loading reduction attributed to MOS is:

$$\text{MOS} = (1-\frac{0.6051}{0.6824})x100\% = 0.1132x100\% = 11.32\%$$

Figure 9 Percent Reduction for Pascack Brook and Musquapsink Brook Using Regression Method



To determine the TMDL for each stream segment, the target load is calculated as shown above. The load that corresponds to the MOS is calculated and then subtracted from the target load. The result is the allocable load. Loads from some land uses, specifically forest, wetland, water and barren land, are not adjustable. There are no measures that can reasonably be applied to runoff from these sources to reduce the loads generated. As a result, existing loads from these sources are equal to the future loads. Therefore, in order to achieve the TMDL, the load reduction from land uses for which reduction measures can reasonably be applied must be increased proportionally. The procedure to do this is described in more detail in Appendix 5.

Wasteload Allocations and Load Allocations

WLAs are established for all point sources, while LAs are established for nonpoint sources, as these terms are defined in "Source Assessment." There are no point sources, other than stormwater point sources in the affected streamsheds. Both WLAs and LAs are expressed as percent reductions for particular stream segments, and are differentiated as discussed below.

Stormwater discharges can be a point source or a nonpoint source, depending on NJPDES regulatory jurisdiction, yet the suite of measures to achieve reduction of loads from stormwater discharges is the same, regardless of this distinction. Stormwater point sources receiving a WLA are distinguished from

stormwater generating areas receiving a LA on the basis of land use. This distribution of loading capacity between WLAs and LAs is consistent with recent EPA guidance that clarifies existing regulatory requirements for establishing WLAs for stormwater discharges (Wayland, November 2002). Stormwater discharges are captured within the runoff sources quantified according to land use, as described previously. Distinguishing between regulated and unregulated stormwater is necessary in order to express WLAs and LAs numerically; however, "EPA recognizes that these allocations might be fairly rudimentary because of data limitations and variability within the system" (Wayland, November 2002, p.1). Therefore allocations are established according to source categories as shown in Table 9. This demarcation between WLAs and LAs based on land use source categories is not perfect, but it represents the best estimate defined as narrowly as data allow. The Department acknowledges that there may be stormwater sources in the residential, commercial, industrial and mixed urban runoff source categories that are not NJPDES-regulated. Nothing in these TMDLs shall be construed to require the Department to regulate a stormwater source under NJPDES that would not already be regulated as such, nor shall anything in these TMDLs be construed to prevent the Department from regulating a stormwater source under NJPDES.

Table 9 Distribution of WLAs and LAs among source categories

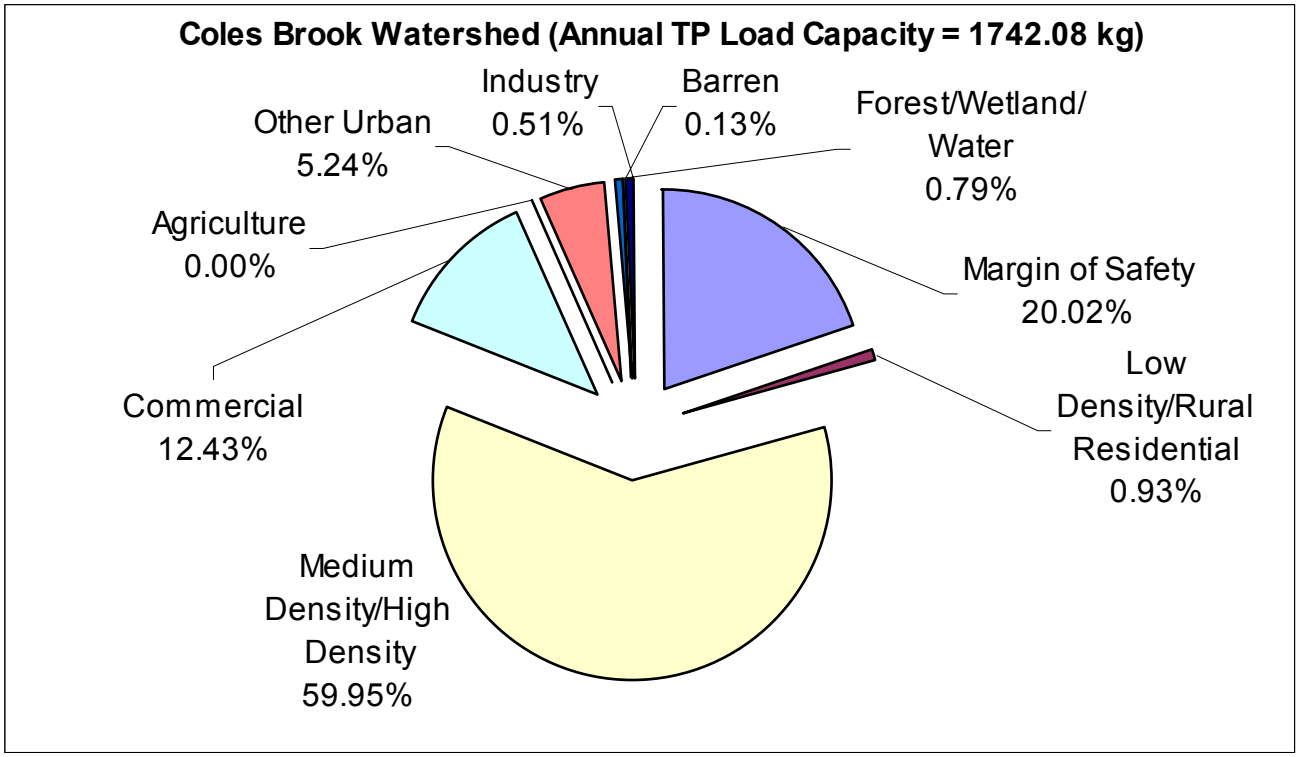
Source Category	**TMDL Allocation**
Nonpoint and Stormwater Sources	
Medium / high density residential	WLA
Low density / rural residential	WLA
Commercial	WLA
Industrial	WLA
Mixed urban / other urban	WLA
Agricultural	LA
Forest, wetland, water	LA
Barren land	LA

Wasteload allocations and load allocations for sources within the drainage area of the impaired segment are presented in Tables 10 and 11, and in Figures 10 and 11.

Table 10 TMDL calculations for the Coles Brook at Hackensack (01378560)

	Coles Brook Watershed			
	Current kg TP/yr (lbs/yr)	**Reduced kg TP/yr (lbs/yr)**	**% of Current Load**	**% Reduction**
Impaired Stream Calculated Load	2566.41 (5657.97)	n/a	100%	n/a
Loading capacity (LC)	n/a	1742.08 (3840.63)	67.88%	n/a
Load allocation (LC-MOS)	n/a	1393.32 (3071.75)	54.29%	n/a
Point Sources other than Stormwater	n/a			
Nonpoint and Stormwater Sources	**kg TP/yr (lbs/yr)**	**kg TP/yr (lbs/yr)**	**% of LC**	**% Reduction**
Medium / high density residential	1933.94 (4263.60)	1044.40 (2302.51)	59.95%	46.00%
Low density / rural residential	29.94 (66.00)	16.17 (35.65)	0.93%	46.00%
Commercial	401.13 (884.34)	216.62 (477.57)	12.43%	46.00%
Industrial	16.48 (36.33)	8.90 (19.62)	0.51%	46.00%
Mixed urban / other urban	168.93 (372.43)	91.23 (201.13)	5.24%	46.00%
Agricultural	0	0	0%	46.00%
Forest, wetland, water	13.83 (30.49)	13.83 (30.49)	0.79%	0%
Barren land	2.17 (4.78)	2.17 (4.78)	0.12%	0%
Margin of Safety (MOS)	n/a	348.76 (768.88)	22.63%	n/a
TOTAL	2566.41 (5657.97)	1742.08 (3840.63)	100.00%	32.12%

Figure 10 Phosphorus allocations for the Coles Brook at Hackensack (01378560)



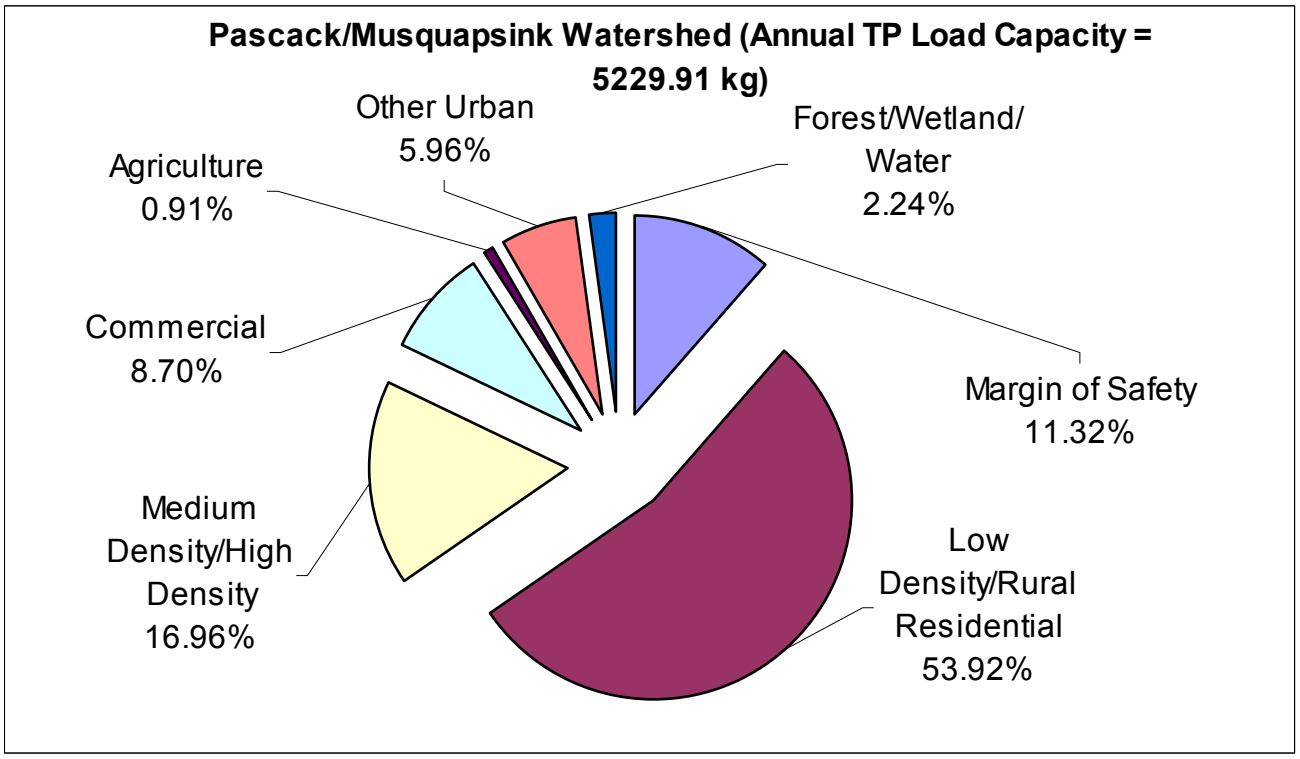
Where portions of the Pascack Brook watershed are located in New York State, the TP TMDL calculations below should be used as guidance for developing a load reduction level. New York State shall separately evaluate the headwaters' contributory TP load to the stream in detail. The TMDL for Pascack Brook requires the TP stream concentration meet the SWQS of 0.1 mg/l where the headwaters of the impaired segment enter New Jersey.

Table 11 TMDL calculations for Pascack Brook (01377500) and Musquapsink Brook (01377499)

	Pascack/Musquapsink			
	Current kg TP/yr (lbs/yr)	**Reduced kg TP/yr (lbs/yr)**	**% of Current Load**	**% Reduction**
Impaired Stream Calculated Load	5871.02 (12943.38)	n/a	100%	n/a
Loading capacity (LC)	n/a	5229.91 (11529.98)	89.08%	n/a
Load allocation (LC-MOS)	n/a	4637.88 (10224.78)	79.00%	n/a
Point Sources other than Stormwater	n/a			
Nonpoint and Stormwater Sources	**kg TP/yr (lbs/yr)**	**kg TP/yr (lbs/yr)**	**% of LC**	**% Reduction**
Medium / high density residential	1128.87 (2488.73)	886.95 (1955.39)	16.96%	21.43%
Low density / rural residential	3589.07 (7912.54)	2819.90 (6216.82)	53.92%	21.43%
Commercial	579.16 (1276.83)	455.04 (1003.19)	8.70%	21.43%
Industrial	0	0	0%	21.43%
Mixed urban / other urban	396.44 (874.00)	311.48 (686.70)	5.96%	21.43%
Agricultural	60.39 (133.14)	47.45 (104.61)	0.91%	21.43%
Forest, wetland, water	117.09 (258.14)	117.09 (258.14)	2.24%	0%
Barren land	0	0	0%	0%
Margin of Safety (MOS)	n/a	592.03 (1305.20)	11.32%	n/a
TOTAL	5871.02 (12943.38)	5229.91 (11529.98)	100.00%	10.92%

Figure 11 Phosphorus allocations for the Pascack Brook at Westwood (01377500) and

Musquapsink Brook at River Vale (01377499)



Reserve Capacity

Reserve capacity is an optional means of reserving a portion of the loading capacity to allow for future growth. Reserve capacities are not included at this time. The loading capacity of each stream is expressed as a function of the current load, and both WLAs and LAs are expressed as percentage reductions for particular stream segments. Therefore, the percent reductions from current levels must be attained in consideration of any new sources that may accompany future development.

7.0 Follow-up Monitoring

The Water Resources Division of the U.S. Geological Survey and the Department have cooperatively operated the Ambient Stream Monitoring Network (ASMN) in New Jersey since the 1970s. The ASMN currently includes approximately 115 stations that are routinely monitored on a quarterly basis. A second ambient monitoring network, NJDEP's Supplemental Ambient Surface Water Network (100 stations), has improved spatial coverage for water quality monitoring in New Jersey. The data from this these networks have been used to assess the quality of freshwater streams and percent load reductions. The ambient networks, as well as targeted studies, will be the means to determine the effectiveness of TMDL implementation and the need for additional management strategies.

8.0 Implementation Plan

Management measures are "economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint and stormwater sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint and stormwater source pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives" (USEPA, 1993).

The Department recognizes that TMDLs alone are not sufficient to restore impaired stream segments. The TMDL establishes the required pollutant reduction targets while the implementation plan identifies some of the regulatory and non-regulatory tools to achieve the reductions, matches management measures with sources, and suggests responsible entities for non-regulatory tools. This provides a basis for aligning available resources to assist with implementation activities. Projects proposed by the State, local government units and other stakeholders that would implement the measures identified within the impaired watershed are a priority for available State (for example, CBT) and federal (for example, 319(h)) funds. In addition, the Department's ongoing watershed management initiative will develop detailed watershed restoration plans for impaired stream segments in a priority order that will identify more specific measures to achieve the identified load reductions.

The stormwater facilities subject to regulation under NPDES in this watershed must be assigned WLAs. The WLAs for these point sources are expressed in terms of the required percent reduction for nonpoint sources and are applied to the land use categories that correspond to the areas regulated under industrial and municipal stormwater programs. The BMPs required through stormwater permits, including the additional measure discussed below, are generally expected to achieve the required load reductions. The success of these measures will be assessed through follow up monitoring. As needed through adaptive management, other additional measures may need to be identified and included in stormwater permits. Follow up monitoring or watershed restoration plans may determine that other additional measures are required, which would then be incorporated into Phase II permits. Additional measures that may be considered include, for example, more frequent street sweeping and inlet cleaning, or retrofit of

stormwater management facilities to include nutrient removal. A more detailed discussion of stormwater source control measures follows.

On February 2, 2004 the Department promulgated two sets of stormwater rules: The Phase II New Jersey Pollutant Discharge Elimination System (NJPDES) Stormwater Rules, N.J.A.C. 7:14A and the Stormwater Management Rules, N.J.A.C. 7:8

Municipal Stormwater Regulation Program

The Phase II NJPDES rules for the Municipal Stormwater Regulation Program require municipalities, highway agencies, and regulated "public complexes" to develop stormwater management programs consistent with the NJPDES permit requirements. The stormwater discharged through "municipal separate storm sewer systems" (MS4s) is regulated under the Department's Phase II NJPDES stormwater rules. Under these rules and associated general permits, Tier A municipalities are required to implement various control measures that should substantially reduce phosphorus loadings in the impaired watersheds. These control measures include adoption and enforcement of a pet waste disposal ordinance, prohibiting the feeding of unconfined wildlife on public property, cleaning catch basins, performing good housekeeping at maintenance yards, and providing related public education and employee training. These basic requirements will provide for a measure of load reduction from existing development. As the Phase II stormwater rules are a federal mandate, New York has also developed a municipal stormwater program.

Each impaired watershed was assessed for the applicability of a mandatory low phosphorous fertilizer ordinance to aid in the reduction of phosphorus loading from nonpoint sources. If the watershed contained a high percentage of agricultural land uses, it was determined that the greatest nonpoint source reductions would be achieved through the implementation of agricultural BMPs, and therefore the low phosphorus fertilizer ordinance for urban land uses was not required as an additional measure. However, in those sub-watersheds which contained a small percentage of agricultural land uses, and a high percentage of urban land uses, it was determined that the low phosphorus fertilizer ordinance was necessary in order to effectively reduce the phosphorus load originating from the urban land uses.

In the impaired watersheds covered by these established TMDLs, it was determined that the low phosphorus fertilizer ordinance was required based on the guidelines provided above.

Therefore, all municipalities with contributory drainage area into the impaired stream segments will be required to adopt an ordinance as an additional measure that prohibits the outdoor application of fertilizer other than low phosphorus fertilizer, consistent with a model ordinance provided by the Department. Fertilizer does not include animal or vegetable manure or compost. This model ordinance has been posted on www.njstormwater.org. The additional measure is as follows:

Low Phosphorus Fertilizer Ordinance

Minimum Standard – Municipalities listed in Appendix 3 shall adopt and enforce an ordinance, consistent with a model ordinance provided by the Department, to prohibit the outdoor application of fertilizer other than low phosphorus fertilizer, except:

Any application of fertilizer at a commercial farm that is exempted by the Right to Farm Act, N.J.S.A. 4:1C-1 et seq.

Any application of fertilizer needed for establishing new vegetation after land disturbance in accordance with the requirements established under the Soil Erosion and Sediment Control Act, N.J.S.A. 4:24-39 et seq. and implementing rules.

Measurable Goal - Municipalities listed in Appendix 3 shall certify annually that they have met the Low Phosphorus Fertilizer Ordinance minimum standard.

Implementation - Within 6 months from adoption of the TMDL, municipalities listed in Appendix 3 shall have fully implemented the Low Phosphorus Fertilizer Ordinance minimum standard.

Stormwater Management Rules

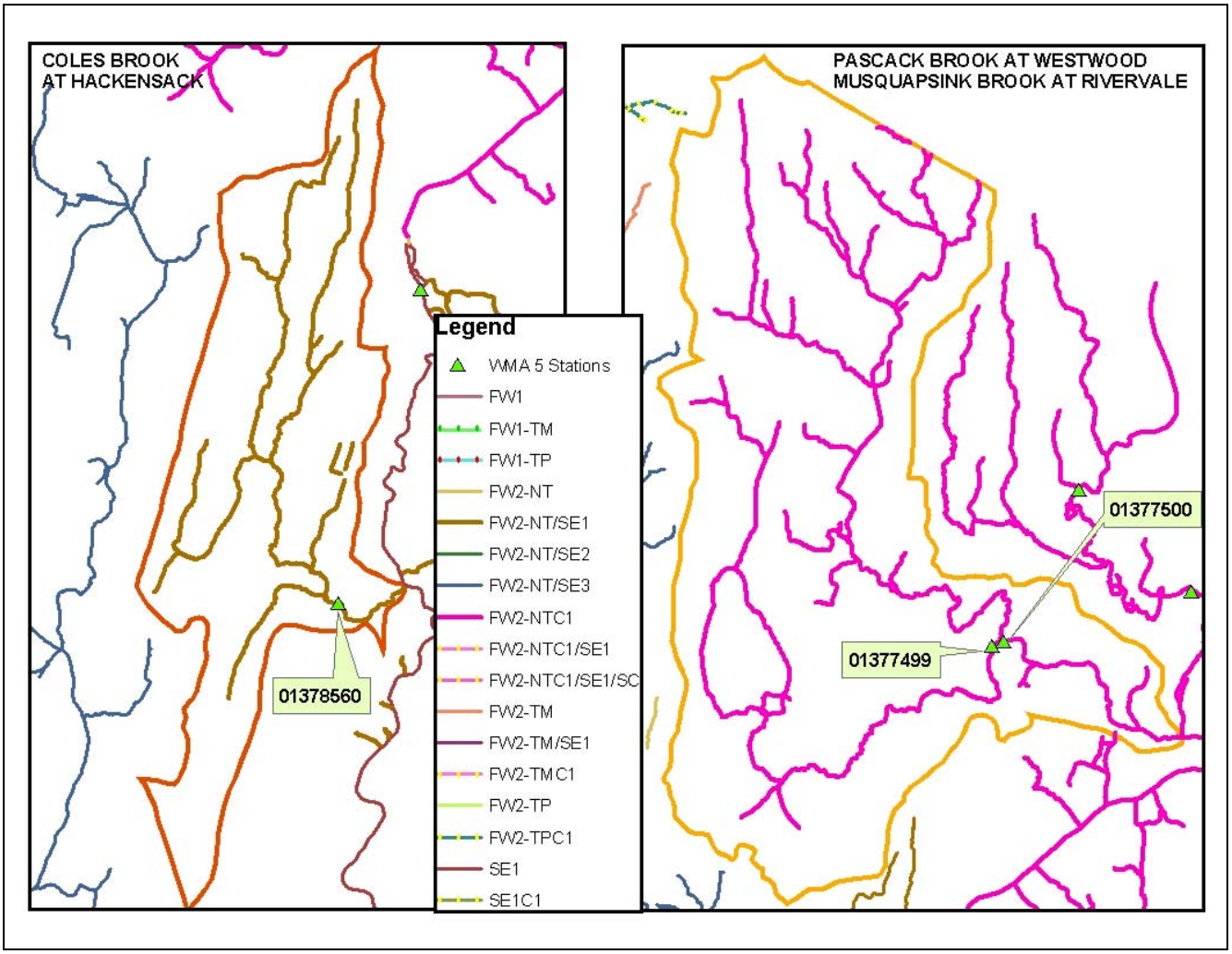
The Stormwater Management Rules have been updated for the first time since their original adoption in 1983. These rules establish statewide minimum standards for stormwater management in new development, and the ability to analyze and establish region-specific performance standards targeted to the impairments and other stormwater runoff related issues within a particular drainage basin through regional stormwater management plans. The Stormwater Management Rules are currently implemented through the Residential Site Improvement Standards (RSIS) and the Department's Land Use Regulation Program (LURP) in the review of permits such as freshwater wetlands, stream encroachment, CAFRA, and Waterfront Development.

The Stormwater Management Rules focus on the prevention and minimization of stormwater runoff and pollutants in the management of stormwater. The rules require every project to evaluate methods to prevent pollutants from becoming available to stormwater runoff and to design the project to minimize runoff impacts from new development through better site design, also known as low impact development. Some of the issues that are required to be assessed for the site are the maintenance of existing vegetation, minimizing and disconnecting impervious surfaces, and pollution prevention techniques. In addition, performance standards are established to address existing groundwater that contributes to baseflow and aquifers, to prevent increases to flooding and erosion, and to provide water quality treatment through stormwater management measures for TSS and nutrients.

As part of the requirements under the municipal stormwater permitting program, municipalities are required to adopt and implement municipal stormwater management plans and stormwater control ordinances consistent with the requirements of the stormwater management rules. As such, in addition to changes in the design of projects regulated through the RSIS and LURP, municipalities will also be updating their regulatory requirements to provide the additional protections in the Stormwater Management Rules within approximately two years of the issuance of the NJPDES General Permit Authorization.

Furthermore, the New Jersey Stormwater Management Rules establish a 300-foot special water resource protection area (SWRPA) around Category One (C1) waterbodies and their intermittent and perennial tributaries, within the HUC 14 subwatershed. In the SWRPA, new development is typically limited to existing disturbed areas to maintain the integrity of the C1 waterbody. C1 waters receive the highest form of water quality protection in the state, which prohibits any measurable deterioration in the existing water quality. Figure 12 shows the category one (C1) waterways in the Pascack Brook/Musquapsink Brook Watershed. Definitions for surface water classifications, detailed segment description, and designated uses may be found in various amendments to the Surface Water Quality Standards at www.state.nj.us/dep/wmm/sgwqt/sgwqt.html.

Figure 12 Category One Waterways within Coles Brook, Pascack Brook, and Musquapsink Brook



Segment Specific Measures

Source assessment within the impaired watersheds was conducted previously by the Department for the recently completed fecal coliform TMDLs and as part of the March 2005 Draft *Watershed Characterization and Assessment Report* prepared by Malcolm Pirnie for the Bergen County Department of Health Services. The findings confirm most of the sources will respond to the municipal stormwater management program basic measures and the additional measure established through this TMDL report. Corporate lawns and goose populations were identified as sources that need to be addressed beyond these measures. Goose management programs and corporate stewardship programs to effect alternative landscaping practices that minimize goose habitat and the need for fertilizer are the implementation measures identified to respond to these sources.

Coles Brook (Site ID # 01378560)

Based on the documented land uses in this watershed, total phosphorus loads are primarily contributed by runoff from high/medium residential properties and commercial lands. More specific sources include geese, pet waste, and fertilization of lawns and golf courses. According to data collected by United Water, headwaters and tributaries of the Pascack Brook show no signs of

phosphorus as being a concern until at least 1.0 mile downstream of Woodcliff Lake. Since the predominant land use downstream of Woodcliff Lake is residential, targeted programs should be developed and implemented to educate homeowners on stormwater management and the proper application of fertilizers. Since this watershed area is sewered, onsite wastewater treatment systems are not a potential source of pollution in this watershed. No agriculture is located in this watershed. Geese/waterfowl, disposable diapers, and dog waste were observed at Van Saun Park. Geese were observed at the Emerson Golf Course, Paramus Middle School alongside Behnke Brook (feeds into Coles Brook) and at commercial complexes. A zoo was observed but is serviced by sanitary sewers. Community based goose management programs are recommended as an implementation measure.

Musquapsink Brook at River Vale (Site ID #01377499) and Pascack Brook at Westwood (Site ID #01377500)

Canada Geese were observed at elementary school ballfields and nearby cemeteries in the Musquapsink Brook watershed. For Pascack Brook, a potential source of phosphorus is the Canada goose populations at Washington Lake, now known as Schlegel Lake in Washington Township. Schlegel Lake is a private waterbody, owned by the surrounding homeowners. Other sources included: Woodcliff Lake Reservoir, Corporate Parks in Montvale (source of geese droppings to Bear Brook which feeds into Pascack Brook). A goose management strategy should be developed for Schlegel Lake, for athletic fields and cemeteries, and commercial complexes that maintain large areas of grass. These areas provide habitat areas for Canada geese. A goose management strategy will reduce both fecal coliform and phosphorus load generated by the goose population. Efforts to reduce eutrophication in Schlegel Lake will benefit the overall watershed and the potable water supply to which the Musquapsink Brook flows. Commercial complexes with large area of grass also need to be fertilized; an inventory of the commercial facilities should be prepared and a targeted plan to promote alternative landscaping strategies should be implemented.

Current Implementation Projects

The Hackensack Riverkeeper, Inc. was awarded a 319(h) grant on February 9, 2001 to restore approximately 750 linear feet of Coles Brook. The subject area is located adjacent to Staib Park, Bergen County, New Jersey. The restoration project included:

- A decrease in impervious surfaces, which currently abut the riparian area;
- An increase in buffer area, which acts as a filtration for storm water runoff;
- In-stream bioengineering, which helps prevent further and future stream bank erosion;
- Bank stabilization through vegetative management;
- Erosion control; and
- A public stewardship and awareness program for local residents, schools, industries, and government officials.

Also, the Bergen County Department of Parks was awarded a 319(h) grant in 2002 to perform erosion control work on Van Saun Brook.

Priority Stream Segment Restoration Plans

In addition to the generic and specific, current and future implementation measures identified above, the Department, through its watershed management program, is undertaking the development of watershed restoration plans for priority stream segments. These restoration plans will identify specific measures and the means to accomplish them, beyond those identified in this TMDL report, that will assist in

attainment of the required load reductions. Due to the number of TMDLs recently generated, the Department must prioritize which stream segments will be the focus of initial consideration. The Department's nutrient policy states that, "Except as due to natural conditions, nutrients shall not be allowed in concentrations that cause objectionable algal densities, nuisance aquatic vegetation, abnormal diurnal fluctuations in dissolved oxygen or pH, changes to the composition of aquatic ecosystems, or otherwise render the water unsuitable for the designated uses (N.J.A.C. 7:9B-1.5(g)3)." With respect to nutrient TMDLs, the initial priority will be given to those streams where use impairments exist in the impaired stream or downstream lakes, beyond simple exceedance of the water quality criterion. Other priority considerations include:

- Headwater area;
- Proximity to drinking water supply;
- Proximity to recreation area;
- Possibility of adverse human health conditions;
- Proximity to a lake intake;
- Existence of eutrophication;
- Phosphorus is identified as the limiting nutrient;
- Existence of use impairments;
- Ability to create a measurable change;
- Probability of human source;
- Stream Classifications;
- High success level.

9.0 Reasonable Assurance

Commitment to carry out the activities described in the implementation plan to reduce phosphorus loads provides reasonable assurance that the SWQS will be attained for phosphorus in the (name of watershed/WMA or Water region). Reasonable Assurance for the implementation of these TMDLs has been considered for point and nonpoint sources for which phosphorus load reductions are necessary. Moreover, stormwater sources for which WLAs have been established will be regulated as NJPDES point sources. Follow-up monitoring will identify if the strategies implemented are completely, or only partially successful. It will then be determined if other management measures can be implemented to fully attain the SWQS or if it will be necessary to consider other approaches, such as use attainability.

10.0 Public Participation

The Water Quality Management Planning Rules at NJAC 7:15-7.2 requires the Department to initiate a public process prior to the development of each TMDL and to allow public input to the Department on policy issues affecting the development of the TMDL. Further, the Department shall propose each TMDL as an amendment to the appropriate area-wide water quality management plan in accordance with procedures at N.J.A.C. 7:15-3.4(g).

Outreach was performed in the form of presenting the TMDL process and method used in this document at the WMA 5 TAC meeting on May 17th, 2005. Printed, detailed maps of the three impaired segments were distributed. In addition, electronic maps showing the spatial extent of the impaired segments and a PowerPoint presentation describing the TMDL process and method used were posted online at http://www.state.nj.us/dep/watershedmgt/tmdl_segments.htm on June 1st, 2005 and public comment was solicited.

Amendment Process

In accordance with N.J.A.C. 7:15–7.2(g), these TMDLs were proposed by the Department as an amendment to the Northeast WQMP. Notice proposing these TMDLs was published on July 5, 2005 in the New Jersey Register and in newspapers of general circulation in the affected area in order to provide the public an opportunity to review the TMDLs and submit comments. In addition, a public hearing was held on the established TMDLs on August 9, 2005 with an informal presentation from 7:00 to 7:30pm, and the public hearing from 7:30 to 9:00pm at the Bergen County Dept. of Health Services, Community Services Building, 327 East Ridgewood Avenue, Paramus, New Jersey 07652-4895. Notice of the proposal and the hearing was provided to affected municipalities. The Department considered all timely comments prior to making a decision to adopt these TMDLs. The outcome of the public participation process is described in Appendix 6.

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Wayland, R.H. III. November 22, 2002. Memo: Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs. Office of Wetlands, Oceans and Watersheds, U.S.E.P.A.

Watershed Management Area 5 Characterization and Assessment – Draft Report March 2005. Prepared by Malcolm Pirnie.

Appendix 1: Database of Phosphorus Export Coefficients

In December 2001, the Department concluded a contract with the USEPA, Region 2, and a contracting entity, TetraTech, Inc., the purpose of which was to identify export coefficients applicable to New Jersey. As part of that contract, a database of literature values was assembled that includes approximately four-thousand values accompanied by site-specific characteristics such as location, soil type, mean annual rainfall, and site percent-impervious. In conjunction with the database, the contractor reported on recommendations for selecting values for use in New Jersey. Analysis of mean annual rainfall data revealed noticeable trends, and, of the categories analyzed, was shown to have the most influence on the reported export coefficients. Incorporating this and other contractor recommendations, the Department took steps to identify appropriate export values for these TMDLs by first filtering the database to include only those studies whose reported mean annual rainfall was between 40 and 51 inches per year. From the remaining studies, total phosphorus values were selected based on best professional judgment for eight land uses categories.

The sources incorporated in the database include a variety of governmental and non-governmental documents. All values used to develop the database and the total phosphorus values in this document are included in the below reference list.

Export Coefficient Database Reference List

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Appendix 2: Database of Sampling Results

		Total or Dissolved NH3-P00610 or P00608	Total or dissolved NO3+NO2-P00630 or P00631	Ortho P or 80% of total dissolved phosphorus-P00671 or P00666	TP - P00665		Discharge Inst. Flow, P00061	
Sample Date	**Station ID**	**NH_3**	**$NO_3 + NO_2$**	**DRP**	**TP**	**TIN/DRP**	**Flow, cfs**	**Data Source**
11/23/1998	1377499	0.03	1.15	0.064	0.08	18.44	n/a	USGS
2/4/1999	1377499	0.18	1.52	0.032	0.07	53.13	n/a	USGS
5/6/1999	1377499	0.03	1.68	0.088	0.17	19.43	n/a	USGS
8/24/1999	1377499	0.03	7.62	0.968	1.25	7.90	n/a	USGS
11/18/1999	1377499	0.06	1.36	0.0336	0.088	42.26	n/a	USGS
2/8/2000	1377499	0.04	1.62	0.0096	0.038	172.92	n/a	USGS
5/23/2000	1377499	0.19	0.99	0.0472	0.118	25.00	n/a	USGS
9/7/2000	1377499	0.03	1.32	0.04	0.086	33.75	n/a	USGS
11/5/1997	1377500	0.03	0.56	0.01	0.04	46.09	33.0	USGS
2/9/1998	1377500	0.03	1.3	0.01	0.03	207.81	32.0	USGS
5/19/1998	1377500	0.14	1.16	0.03	0.07	50.78	59.0	USGS
9/10/1998	1377500	0.03	0.59	0.02	0.11	32.29	28.0	USGS
11/22/1999	1377500	0.03	1	0.01	0.047	89.41	13.8	USGS
2/8/2000	1377500	0.03	1.5	0.00	0.027	398.44	28.5	USGS
5/25/2000	1377500	0.13	0.96	0.03	0.092	40.55	27.0	USGS
9/6/2000	1377500	0.05	0.82	0.03	0.132	30.21	25.6	USGS
11/13/02	1377500	0.038	0.542	0.078	0.109	7.44	37.6*	EWQ
2/24/03	1377500	0.173	1.13	0.035	0.044	37.23	137.0	EWQ
6/9/03	1377500	0.146	0.862	0.039	0.088	25.85	85.5	EWQ
9/8/03	1377500	0.053	1.03	0.025	0.089	43.32	27.3	EWQ
12/2/2003	1377500	0.133	1.2	0.027	0.031	49.37	38.0	EWQ
3/1/04	1377500	0.064	1.46	Non-Detect	0.039	Non-Calc	59.6*	EWQ
5/18/04	1377500	0.127	1.04	0.027	0.099	43.22	41.7*	EWQ
8/19/04	1377500	0.112	1.05	0.027	0.109	43.04	44.7*	EWQ
11/5/1997	1378560	0.03	1.04	0.016	0.04	66.88	3.6	USGS
2/3/1998	1378560	0.03	1.78	0.008	0.03	226.25	4.6	USGS
5/18/1998	1378560	0.21	1.74	0.016	0.09	121.88	6.4	USGS
8/4/1998	1378560	0.2	0.84	0.048	0.18	21.67	0.81	USGS
11/4/1998	1378560	0.03	0.39	0.032	0.03	13.13	0.77	USGS
1/25/1999	1378560	0.07	1.05	0.04	0.09	28.00	4.5	USGS
5/5/1999	1378560	0.03	0.51	0.04	0.12	13.50	3.2	USGS
8/4/1999	1378560	0.44	0.34	0.08	0.26	9.75	0.75	USGS
11/3/1999	1378560	0.03	0.09	0.1376	0.28	0.87	7.3	USGS
2/23/2000	1378560	0.07	1.53	0.008	0.042	200.00	6.5	USGS
5/2/2000	1378560	0.13	1.38	0.0144	0.056	104.86	5.1	USGS
8/23/2000	1378560	0.03	1.69	0.0304	0.067	56.58	2.6	USGS
11/1/2000	1378560	0.07	0.85	0.0216	0.043	42.59	1.3	USGS
2/13/2001	1378560	0.06	1.95	0.0064	0.03	314.06	5.5	USGS
5/3/2001	1378560	0.15	1.2	0.0184	0.068	73.37	4.3	USGS
8/13/2001	1378560	0.12	0.73	0.0656	0.131	12.96	4.1	USGS
11/14/2001	1378560	0.09	0.17	0.0232	0.052	11.21	0.66	USGS
3/13/2002	1378560	0.05	0.84	0.0128	0.068	69.53	0.62	USGS

5/28/2002	1378560	0.27	1.46	0.0528	0.14	32.77	8*	USGS
8/7/2002	1378560	0.08	0.59	0.072	0.133	9.31	1.2	USGS
11/14/2002	1378560	0.03	0.23	0.08	0.156	3.25	4	USGS
2/3/2003	1378560	0.101	2.16	0.0056	0.028	403.75	3.4	USGS
5/29/2003	1378560	0.215	1.42	0.0208	0.069	78.61	5.4	USGS
8/6/2003	1378560	0.195	0.92	0.0576	0.13	19.36	19	USGS

Footnote: * - These values were calculated by developing a stage/discharge relationship at this site. The values were then used to perform the regression analysis.

Appendix 3: Tier A Municipalities in Affected Drainage Areas

NJPDES Permit No.	Facility/Municipality Name	Discharge Type	Receiving Waterbody	Additional Measures
NJG0150061	Emerson Boro	Tier A Municipal Stormwater General Permit	Coles & Musquapsink	Low phosphorus ordinance
NJG0154504	Hackensack City	Tier A Municipal Stormwater General Permit	Coles Brook	Low phosphorus ordinance
NJG0151718	Harrington Park Boro	Tier A Municipal Stormwater General Permit	Pascack Brook	Low phosphorus ordinance
NJG0148202	Hillsdale Boro	Tier A Municipal Stormwater General Permit	Pascack & Musquapsink	Low phosphorus ordinance
NJG0150118	Lodi Boro	Tier A Municipal Stormwater General Permit	Coles Brook	Low phosphorus ordinance
NJG0152561	Maywood Boro	Tier A Municipal Stormwater General Permit	Coles Brook	Low phosphorus ordinance
NJG0153761	Montvale Boro	Tier A Municipal Stormwater General Permit	Pascack Brook	Low phosphorus ordinance
NJG0150525	Oradell Boro	Tier A Municipal Stormwater General Permit	Coles & Musquapsink	Low phosphorus ordinance
NJG0148288	Paramus Boro	Tier A Municipal Stormwater General Permit	Coles & Musquapsink	Low phosphorus ordinance
NJG0154539	Park Ridge Boro	Tier A Municipal Stormwater General Permit	Pascack Brook	Low phosphorus ordinance
NJG0150142	River Edge Boro	Tier A Municipal Stormwater General Permit	Coles Brook	Low phosphorus ordinance
NJG0152927	River Vale Twp	Tier A Municipal Stormwater General Permit	Pascack Brook	Low phosphorus ordinance
NJG0150541	Saddle River Boro	Tier A Municipal Stormwater General Permit	Pascack & Musquapsink	Low phosphorus ordinance
NJG0147729	Washington Twp	Tier A Municipal Stormwater General Permit	Pascack & Musquapsink	Low phosphorus ordinance
NJG0148462	Westwood Boro	Tier A Municipal Stormwater General Permit	Pascack & Musquapsink	Low phosphorus ordinance
NJG0149900	Woodcliff Lake Boro	Tier A Municipal Stormwater General Permit	Pascack & Musquapsink	Low phosphorus ordinance
n/a	Clarkstown (NY)	n/a	Pascack Brook	n/a
n/a	Orangetown (NY)	n/a	Pascack Brook	n/a
n/a	Ramapo (NY)	n/a	Pascack Brook	n/a

Appendix 4: Phosphorus Criterion Applicability Determination

This discussion is taken from the New Jersey Department of Environmental Protection's 2003 report, *Technical Manual for Phosphorus Evaluation for NJPDES Discharge to Surface Water Permits,* Division of Water Quality, N.J.A.C. 7:9b-1.14(c).

Is Phosphorus Limiting?

The limiting nutrient can be evaluated using available nutrient concentrations by using the following thresholds to exclude phosphorus as the limiting nutrient (The acronyms TIN and DRP refer to biologically-available forms of nitrogen and phosphorus, respectively: TIN = dissolved nitrite, nitrate and ammonia; DRP = dissolved reactive phosphorus):

IF [DRP] $\geq$ 0.05 mg/l

OR TIN/DRP $\leq$ 5

THEN phosphorus can be excluded as the limiting nutrient

Figures A and B below show examples of how to plot pairs of TP and DRP data along a TIN/DRP axis to visually evaluate the phosphorus limitation thresholds at a particular location. By making the TP range twice the DRP range, the thresholds of 0.1 mg/l TP and 0.05 mg/l DRP coincide, simplifying the interpretation. Episodes when TP > 0.1 mg/l AND DRP $\leq$ 0.05 mg/l and TIN/DRP $\geq$ 5 can be identified by seeing TP in the upper right quadrant while DRP is in the lower right quadrant. If phosphorus cannot be excluded as the limiting nutrient for more than 10% of the samples that exceed the 0.1 mg/l threshold (a minimum of 2 samples), then the 0.1 mg/l criterion is applicable.

Figure A: Example of site where 0.1 mg/l criterion is applicable and exceeded

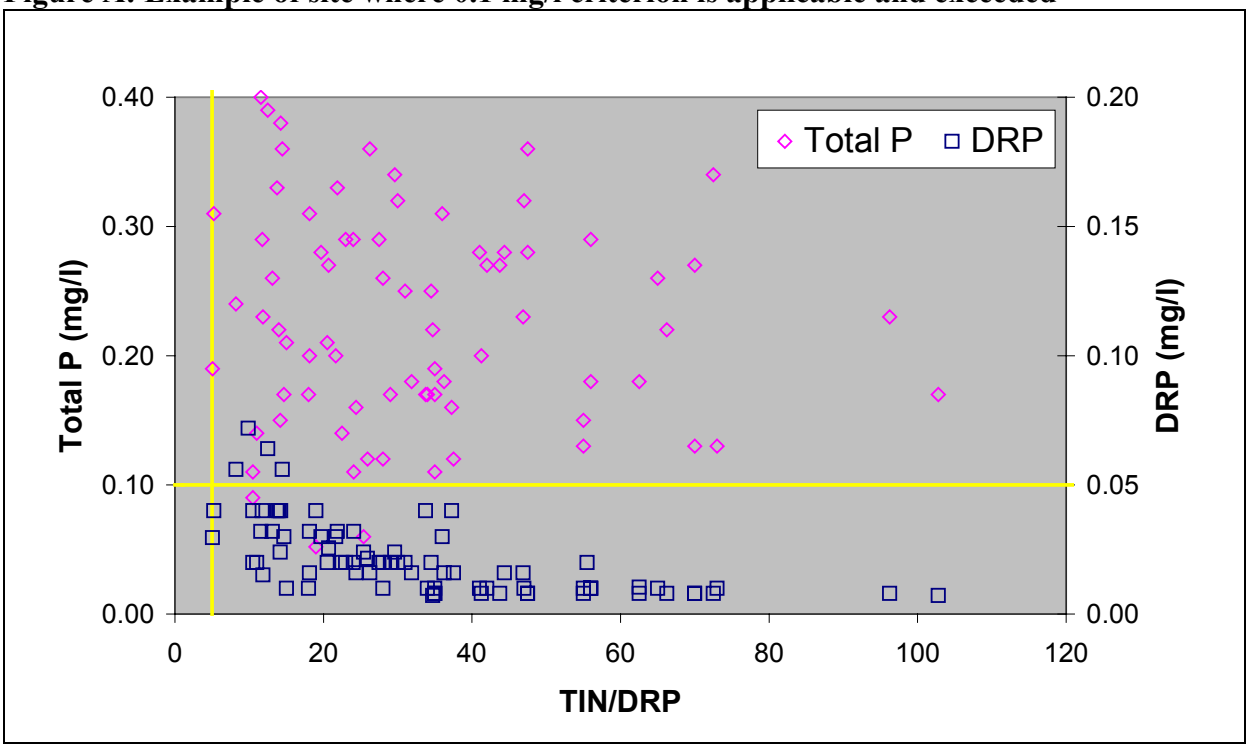
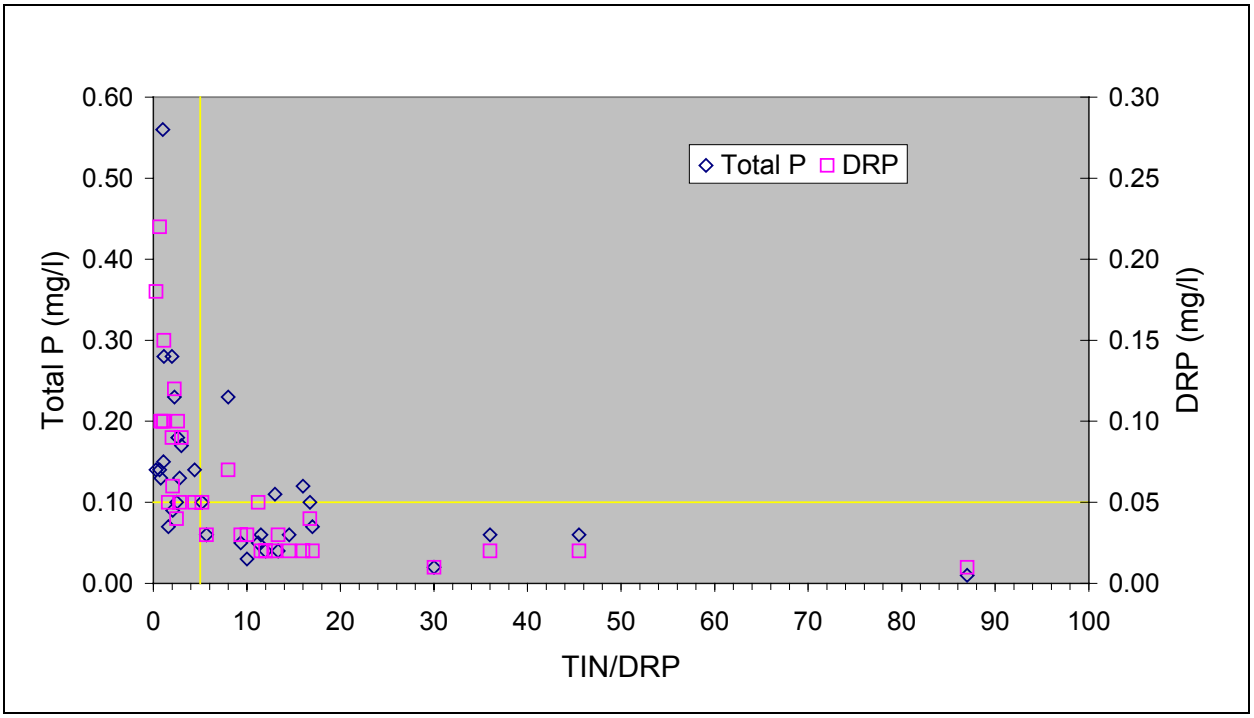


Figure B: Example of site where phosphorus is not limiting algal growth when 0.1 mg/l threshold is exceeded



Appendix 5: Methodology for Applying Percentage reductions to Land Use Loadings

The outputs of the FIRE method establish a percent reduction needed to meet the target load (that which will attain the applicable SWQS) and a margin of safety. These values are then applied to the existing land use loadings within the impaired streamshed to determine the load allocations for various land uses.

Existing loads are determined as follows. GIS is used to determine the area in acres of each of the land uses in the impaired watershed. The loading coefficients identified in the TMDL report are applied to the acres of land use to calculate an existing load for each land use in the impaired streamshed. Existing loads for point sources, other than stormwater point sources (essentially, wastewater treatment plants), if any, in the impaired streamshed are calculated using the average flow and concentration data from the discharge monitoring reports for the facilities. This load is added to the existing TP load calculated from land use.

To calculate the overall target load the percent reduction (the difference between the target load and the exceedance regression) as determined through FIRE is applied to the total existing load. The load associated with the margin of safety as determined through FIRE (the difference between the 95% confidence interval and the exceedance regression) is then removed from the overall target load (target loading line), leaving a reduced amount of loading now available to allocate. The load from any discharges is determined by taking the full permitted flow and assigning an effluent concentration. This load is also removed from the potential allocable load leaving a further reduced amount of allocable load for land uses.

There are a number of land uses from which a reduction in current load cannot be taken. These land uses include Forest, Water, Wetlands, and Barren land. The current loads for these land uses as calculated for existing load are carried over entirely as a component of the future load allocations. Therefore, for these land uses, the existing load and future load are equal. The sum of the non-reduced land use loads is then removed from the reduced allocable land use load leaving the final allocable land use load to be allocated among the land uses that are amenable to load reduction (urban and agricultural). This final allocable land use load is then applied to each land use category in proportion to the amount of each land use in the watershed.

The final percent reduction is calculated by comparing the final WLA or LA for each land use to the existing loads of those land uses. Because of the adjustments made in removing the loads associated with the MOS, the non-reduced land use loads, and discharges, the percent reduction associated with the final allocable land use load is higher than that which appears as an output to FIRE.

Example:

Land- Use	Existing Load	Percent Reduction	Allocation
Agriculture	100	88.85%	11.15
Barren	15	0%	15.00
Commercial	300	88.85%	33.45
Forest	125	0%	125.00
Low Density	40	88.85%	4.46
High Density	250	88.85%	27.88
Other Urban	15	88.85%	1.67
Water	100	0%	100.00
Wetlands	30	0%	30.00
Discharger A	25	0%	25.00
MOS			95.87
TOTAL	**1000**		**469.5**

Output from FIRE

Margin of Safety		**= 20.42%**
Target Loading		**= 46.95%**

Target Load

Target Load = 0.4695 * Existing Load
= 0.4695 * 1000
Target Load = 469.5 lb/yr

Margin of Safety

MOS = 0.2042* Target Load
= 0.2042* 469.5 lb/yr
= 95.87 lb/yr

Allocable Load

AL = Target Load – MOS
= 469.5 –95.87
= 373.63 lb/yr

Allocable Land Use Load

ALUL = AL- Future Discharge Load
= 373.6 – 25
= 348.63 lb/yr

SUM of Non Reducable Land Use Loads

Non Reduceable Land use Load = Existing Forest + Water & Wetlands Load + Barren Land Load
= 125 + 100 + 30 + 15
= 270 kg/yr

Final Allocable Land use Load

Final Allocable Land use Load = Allocable Land use Load – Non Reduce-able Land use Load
= 348.6 – 270
= 78.6 lb/yr

Final Percent Reduction

Final Percent Reduction = 1 – (Final allocable Land use load / Sum of existing load of Reduce-able land uses)
= 1 – (78.6/ 15+250+40+300+100)
= 1 – (78.6/705)
= 0.8885
= 88.85 %

Appendix 6: Response to Comments

This constitutes the New Jersey Department of Environmental Protection's (Department) response to comments raised during the comment period for the Total Maximum Daily Loads (TMDLs) for Total Phosphorus to Address 3 Streams in the Northeast Water Region's Watershed Management Area (WMA) 5, which were proposed July 5, 2005. These TMDLs were proposed as an amendment to the Northeast Water Quality Management Plan and include management approaches to reduce loadings of total phosphorus from various sources in order to attain applicable surface water quality standards for total phosphorus.

The notice proposing the TMDLs was published on July 5, 2005 in the New Jersey Register, the Express Times, and the Star Ledger. The TMDL documents were made available at the Department, upon request by mail, and on the Department's website. The Department conducted a non-adversarial public hearing on August 9, 2005 at the Bergen County Dept. of Health Services, Community Services Building in Paramus, New Jersey. The public comment period ended on August 24, 2005.

Three verbal comments were received during the non-adversarial public hearing. The comments were received from:

1. Raymond Cywinski for United Water New Jersey. (1)
2. Arnold Vernick of the Technical Advisory Committee for WMA 5. (2)
3. Raymond Cywinski, Chairman of the Technical Advisory Committee for WMA 5. (3)

In attendance at the public hearing were Don Suess, Alia Benzecey, Tony DeCandia, Arnold Vernick, Raymond Cywinski, Touray Holland, Pat Kehrberger, Linda Morehouse, Chris Szegun, Jakob Franke, Christie Hirt, Lori Charkey and Mark Becker.

Department initiated changes to the document include the following:

1. The New Jersey Environmental Management System (NJEMS), which contains NJPDES permitted facility information evaluated during TMDL development, has been added to the document under "Data Sources".
2. Priority ranking and impairments not addressed by these TMDLs have been identified in the text.

3. Addition of an addendum demonstrating the methodology to convert the percent reductions obtained from applying FIRE to percent reductions per land use category.
4. Addition of an explanation regarding selection of municipalities that will be required to adopt a low phosphorus fertilizer ordinance.
5. Addition of an existing loads column to the tables identifying the allocation of the TMDL for each segment.

A summary of comments to the proposal and the Department's Responses to those comments follow. The numbers in brackets at the end of each comment corresponds to the verbal commenters listed above.

Comment 1.
United Water New Jersey strongly supports the July 5, 2005 proposed amendment to the Northeast Water Quality Management Plan for the Hackensack and Pascack Watersheds. United Water New Jersey looks forward to working with the NJDEP and New York State DEC and Pascack and Musquapsink watershed municipalities in developing and implementing watershed best management practices designed to reduce the phosphorus levels in the streams. (1)

Response 1.
The Department thanks the commenter for their support.

Comment 2.
Under certain conditions United Water New Jersey diverts water from the Saddle River to the Musquapsink Brook. Monitoring conducted by United Water New Jersey of the diverted water from the Saddle River shows elevated levels of phosphorus at times far in excess of the Surface Water Quality Standard (SWQS). During the months of June through September of 1999, diversions from the Saddle River showed phosphorus concentrations of over 3.0 to 7.0 milligrams/liter. Unless the proper effluent limitations for phosphorus are enforced for the Village of Ridgewood and Northwest Bergen Utilities Authority wastewater treatment plants, the reduction in loadings in the Pascack and Musquapsink will need to be lowered more than proposed to meet the SWQS. (1)

Response 2.
After reviewing the existing water allocation permits for the Saddle River, the Department has been unable to verify that conditions exist as stated in the comment. The Department would need more detailed information including sample data, diversion locations, and the dates of the occurrence(s) to fully evaluate the comment. The Department believes that the technical approach used to establish the loading capacity adequately considers the uncertainties (gaps and variability) in the data, the ability to model and predict concentration response relative to loadings, and the predictability of achieving a load reduction from applying a given management measure. The inclusion of both an implicit and explicit Margin of Safety (MOS) as part of the TMDL calculation is a reflection of the uncertainties and provides for reasonable assurance that the standard will be met.

Comment 3.
The Musquapsink Brook and Pascack Brook TMDLs are premature. There is a need for more data to document the quality of Musquapsink Brook, particularly in relationship to the diversion of water from the Saddle River. Does the diversion coincide with the time that the data was collected? (2)

Response 3.
The data collected and used by the Department is believed to be a representative characterization of the stream water quality and sufficient for development of TMDLs. Collection of additional data would

serve to delay implementation of measures to improve water quality. Assessment of effectiveness of the measures proposed through the ambient water quality network will determine if these measures need to be supplemented by additional measures.

Comment 4.
The Pascack Brook data needs to be collected before the confluence with Musquapsink Brook. Each of the two streams should be evaluated separately. (2)

Response 4.
The Department's *Integrated Water Quality Monitoring and Assessment Method* explains the relationship between monitoring location and spatial location delineation. As stated in the TMDL report, the monitoring station for Pascack Brook at Westwood (01377500) accurately characterizes the flows and water quality at Musquapsink Brook due to the Pascack station location directly below the confluence of the two streams. This approach provides a valid scope for assessing these impairments.

Comment 5.
The map of Pascack Brook shows that the impaired section ends at the New York State line. This is not addressed and should be clarified or corrected. (2)

Response 5.
The Pascack Brook TMDL requires the SWQS to be met at the State border. The Department is committed to working with the New York State Department of Environmental Conservation to address source reductions that may be needed within the New York portion of the watershed.

Comment 6.
Considering the TMDL document says 50 percent of WMA 5 is undeveloped, why is there no reserve capacity considered? (3)

Response 6.
Under this TMDL, the means identified for source reduction apply to new as well as existing development within the impaired watersheds. New development is expected to contribute a de minimus load relative to the existing land use it replaces. This is because new development, where applicable, must comply with municipal ordinances and measures to control the increased stormwater associated with the increased impervious cover of the developed area. The Stormwater Management Rules (N.J.A.C. 7:8) set forth the required components of regional and municipal stormwater management plans, and establish the stormwater management design and performance standards for new (proposed) development. The design and performance standards for new development include groundwater recharge, runoff quantity controls, runoff quality controls, and Category One buffers. Details of the performance standards can be found in Subchapter 5 of the Stormwater Management Rules and were created to address concerns of new development's affect on stream water quality. This is expected to effectively avoid increases in storm driven sources, thereby preventing the water quality problems that are attributed to the existing development and obviating the need for a reserve capacity.

Comment 7.
Municipalities have different implementation capabilities. Will the Department allow trading for the reduction of loading where one municipality that can get a larger reduction can credit another municipality for the excess reduction? (3)

Response 7.
The Department would consider trading proposals developed by affected municipalities.

Comment 8.
In the TMDL document, “Bkanky Brook” should be spelled as “Behnke Brook.” (3)

Response 8.
The Department appreciates the comment and has corrected the spelling.