Amendment to the Northeast Water Quality Management Plan

Total Maximum Daily Loads for Fecal Coliform to Address 32 Streams in the Northeast Water Region

Watershed Management Area 3
(Pompton, Pequannock, Wanaque, and Ramapo Rivers)
Watershed Management Area 4
(Lower Passaic and Saddle Rivers)
Watershed Management Area 5
(Hackensack River, Hudson River, and Pascack Brook)
Watershed Management Area 6
(Upper & Middle Passaic, Whippany, and Rockaway Rivers)

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1.0 Executive Summary

In accordance with Section 305(b) of the Federal Clean Water Act (CWA), the State of New Jersey developed the *2002 Integrated List of Waterbodies*, addressing the overall water quality of the State's waters and identifying impaired waterbodies for which Total Maximum Daily Loads (TMDLs) may be necessary. The *2002 Integrated List of Waterbodies* identified several waterbodies in the Northeast Water Region as being impaired by pathogens, as indicated by the presence of fecal coliform concentrations in excess of standards. This report, developed by the New Jersey Department of Environmental Protection (NJDEP), establishes 32 TMDLs addressing fecal coliform loads to the waterbodies identified in Table 1.

Table 1 Fecal coliform-impaired stream segments in the Northeast Water Region, identified in Sublist 5 of the 2002 Integrated List of Waterbodies, for which fecal coliform TMDLs are being established.

TMDL Number	WMA	Station Name/Waterbody	Site ID	County(s)	River Miles
1	3	Macopin River at Macopin Reservoir	01382450	Passaic	1.8
2	3	Wanaque River at Highland Avenue	01387010	Passaic	1.5
3	3	Ramapo River Near Mahwah	01387500	Passaic and Bergen	17.7
4	4	Passaic R. below Pompton R. at Two Bridges	01389005	Passaic	1.83
5	4	Preakness Brook Near Little Falls	01389080	Passaic	8.9
6	4	Deepavaal Brook at Fairfield	01389138	Essex	6.3
7	4	Passaic River at Little Falls	01389500	Passaic and Essex	15.0
8	4	Peckman River at West Paterson	01389600	Passaic and Essex	7.7
9	4	Goffle Brook at Hawthorne	01389850	Passaic and Bergen	10.5
10	4	Diamond Brook at Fair Lawn	01389860	Passaic and Essex	2.5
11	4	WB Saddle River at Upper Saddle River	01390445	Bergen	2.4
12	4	Saddle River at Ridgewood	01390500	Bergen	24.0
13	4	Ramsey Brook at Allendale	01390900	Bergen	6.4
14	4	HoHoKus Brook at Mouth at Paramus	01391100	Bergen	6.2
15	4	Saddle River at Fairlawn	01391200	Bergen	5.0
16	4	Saddle River at Lodi	01391500	Bergen	3.8
17	5	Hackensack River at River Vale	01377000	Bergen	10.0
18	5	Musquapsink Brook at River Vale	01377499	Bergen	7.3
19	5	Pascack Brook at Westwood	01377500	Bergen	6.6
20	5	Tenakill Brook at Cedar Lane at Closter	01378387	Bergen	10.2
21	5	Coles Brook at Hackensack	01378560	Bergen	11.1
22	6	Black Brook at Madison	01378855	Morris	2.4
23	6	Passaic River near Millington	01379000	Morris and Somerset	5.2
24	6	Dead River near Millington	01379200	Somerset	21.9
25	6	Passaic River near Chatham	01379500	Somerset, Union, Essex, and Morris	25.2
26	6	Canoe Brook near Summit	01379530	Essex	17.6
27	6	Rockaway River at Longwood Valley	01379680	Sussex and Morris	11.6
28	6	Rockaway River at Blackwell Street	01379853	Morris	3.5
29	6	Beaver Brook at Rockaway	01380100	Morris	17.0
30	6	Stony Brook at Boonton	01380320	Morris	13.1
31	6	Rockaway River at Pine Brook	01381200	Morris	6.8

TMDL Number	WMA	Station Name/Waterbody	Site ID	County(s)	River Miles
32	6	Passaic River at Two Bridges	01382000	Morris and Essex	14.1
Total River Miles:					305.0

These thirty-two TMDLs will serve as management approaches or restoration plans aimed at identifying the sources of fecal coliform and for setting goals for fecal coliform load reductions in order to attain applicable surface water quality standards (SWQS).

As stated in N.J.A.C. 7:9B-1.14(c) of the New Jersey Surface Water Quality Standards, "Fecal coliform levels shall not exceed a geometric average of 200 CFU/100 ml nor should more than 10 percent of the total sample taken during any 30-day period exceed 400 CFU/100 ml in FW2 waters." Nonpoint and stormwater point sources are the primary contributor to FC loads in these streams and can include storm-driven loads transporting fecal coliform from sources such as geese, farms, and domestic pets to the receiving water. Nonpoint sources also include steady-inputs from sources such as failing sewage conveyance systems and failing or inappropriately located septic systems. Because the total point source contribution other than stormwater (i.e. Publicly-Owned Treatment Works, POTWs) is an insignificant fraction of a percent of the total load, these fecal coliform TMDLs will not impose any change in current practices for POTWs and will not result in changes to existing effluent limits.

Using ambient water quality data monitoring conducted during the water years 1994-2000, summer and all season geometric means were determined for each Category 5 listed segment. Given the two surface water quality criteria of 200 CFU/100 ml and 400 CFU/100 ml in FW2 waters, computations were necessary for both criteria and resulted in two values for percent reduction for each stream segment. The higher (more stringent) percent reduction value was selected as the TMDL and will be applied to nonpoint and stormwater sources as a whole or apportioned to categories of nonpoint and stormwater sources within the study area. The extent to which nonpoint and stormwater sources have been identified and the process by which they will become identified will vary by study area based on data availability, watershed size and complexity, and pollutant sources. Implementation plans for activities to be established in these watersheds are addressed in this report.

Each TMDL shall be proposed and adopted by the Department as an amendment to the appropriate area wide water quality management plan(s) in accordance with N.J.A.C. 7:15-3.4(g).

This TMDL Report is consistent with EPA's May 20, 2002 guidance document entitled: "Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992," (Suftin, 2002) which describes the statutory and regulatory requirements for approvable TMDLs.

2.0 Introduction

Sublist 5 (also known as List 5 or, traditionally, the 303(d) List) of the State of New Jersey's proposed *2002 Integrated List of Waterbodies* identified several waterbodies in the Northeast Water Region as being impaired by pathogens, as evidenced by the presence of high fecal coliform concentrations. This report establishes 32 TMDLs, which address fecal coliform loads to the identified waterbodies. These TMDLs serve as management approaches or restoration plans aimed toward reducing loadings of fecal coliform from various sources in order to attain applicable surface water quality standards for the pathogen indication. Several of these waterbodies are listed in Sublist 5 for impairment cause by other pollutants. These TMDLs address only fecal coliform impairments. Separate TMDL evaluations will be developed to address the other pollutants of concern. The waterbodies will remain on Sublist 5 until such time as TMDL evaluations for all pollutants have been completed and approved by the United States Environmental Protection Agency (USEPA).

3.0 Background

3.1. 305(b) Report and 303(d) List

In accordance with Section 305(b) of the Federal Clean Water Act (CWA) (33 U.S.C. 1315(B)), the State of New Jersey is required to biennially prepare and submit to the United States Environmental Protection Agency (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.

In accordance with Section 303(d) of the CWA, the State is also required to biennially prepare and submit to USEPA a report that identifies waters that do not meet or are not expected to meet surface water quality standards (SWQS) after implementation of technology-based effluent limitations or other required controls. This report is commonly referred to as the 303(d) List. The listed waterbodies are considered water quality-limited and require total maximum daily load (TMDLs) evaluations. For waterbodies identified on the 303(d) List, there are three possible scenarios that may result in a waterbody being removed from the 303(d) List:

Scenario 1: A TMDL is established for the pollutant of concern;
Scenario 2: A determination is made that the waterbody is meeting water quality standards (no TMDL is required); or
Scenario 3: A determination is made that a TMDL is not the appropriate mechanism for achieving water quality standards and that other control actions will result in meeting standards

Where a TMDL is required (Scenario 1), it will: 1) specify the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards; and 2) allocate pollutant loadings among point and nonpoint pollutant sources.

Recent EPA guidance (Suftin, 2002) describes the statutory and regulatory requirements for approvable TMDLs, as well as additional information generally needed for USEPA to determine if a submitted TMDL fulfills the legal requirements for approval under Section 303(d) and EPA regulations. The Department believes that this TMDL report, which includes thirty-two TMDLs, addresses 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. Wasteload 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.
12. Submittal letter.

3.2. Integrated List of Waterbodies

In November 2001, USEPA issued guidance that encouraged states to integrate the 305(b) Report and the 303(d) List into one report. This integrated report assigns waterbodies to one of five categories. In general, Sublists 1 through 4 include waterbodies that are unimpaired, have limited assessment or data availability or have a range of designated use impairments, whereas Sublist 5 constitutes the traditional 303(d) List for waters impaired or threatened by a pollutant for which one or more TMDL evaluations are needed. Where more than one pollutant is associated with the impairment for a given waterbody, that waterbody will remain in Sublist 5 until one of the three possible delisting scenarios are completed. In the case of an Integrated List, however, the waterbody is not delisted but moved to one of the other categories.

Following USEPA's guidance, the Department chose to develop an Integrated Report for New Jersey. New Jersey's proposed *2002 Integrated List of Waterbodies* is based upon these five categories and identifies water quality limited surface waters in accordance with N.J.A.C. 7:15-6 and Section 303(d) of the CWA. These TMDLs address fecal coliform impairments, as listed on Sublist 5 of the State of New Jersey's proposed *2002 Integrated List of Waterbodies.*

3.3. Total Maximum Daily Loads (TMDLs)

A Total Maximum Daily Load (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 water body can assimilate without violating a state's water quality standards and allocates that load capacity to known point and nonpoint sources in the form of wasteload allocations (WLAs), load allocations (LAs), and a margin of safety. A TMDL is developed as a mechanism for identifying all the contributors to surface water quality impacts and setting goals for load reductions for pollutants of concern as necessary to meet the SWQS.

Once one of the three possible delisting scenarios, noted above, is completed, states have the option to remove the waterbody and specific pollutant of concern from Sublist 5 of the *2002 Integrated List of Waterbodies* or maintain the waterbody in Sublist 5 until SWQS are achieved. The State of New Jersey will be removing the waterbodies for fecal impairment from Sublist 5 once these TMDLs are approved by USEPA.

4.0 Pollutant of Concern and Area of Interest

The pollutant of concern for these TMDLs is pathogens, the presence of which is indicated by the elevated concentration of fecal coliform bacterial. Fecal coliform concentrations have been found to exceed New Jersey's Surface Water Quality Standards (SWQS) published at N.J.A.C. 7-9B et seq. As reported in the proposed *2002 Integrated List of Waterbodies*, the New Jersey Department of Environmental Protection (NJDEP) identified waterbodies as being impaired by fecal coliform. The Northeast Water Region listings for fecal coliform impairment are identified in Table 2. Also identified in Table 2 are the river miles and management response associated with each listed segment. All of these waterbodies have a high priority ranking, as described in the *2002 Integrated List of Waterbodies*.

Table 2 Abridged Sublist 5 of the 2002 Integrated List of Waterbodies, listed for fecal coliform impairment in the Northeast Water Region.

TMDL No.	WMA	Station Name/Waterbody	Site ID	River Miles	Management Response
1	3	Macopin River at Macopin Reservoir	1382450	**1.8**	establish TMDL
	3	Pequannock River at Macopin Intake Dam	1382500	**19.1**	none; Re-assessment shows non-impairment
	3	Wanaque River at Wanaque	1387000	**0.6**	water quality monitoring needed to identify if an impairment exists
2	3	Wanaque River at Highland Ave.	1387010	**1.5**	establish TMDL
3	3	Ramapo River near Mahwah	1387500	**17.7**	establish TMDL
4	4	Passaic River below Pompton River at Two Bridges	1389005	**1.8**	establish TMDL
5	4	Preakness Brook Near Little Falls	1389080	**8.9**	establish TMDL
6	4	Deepavaal Brook at Fairfield	1389138	**6.3**	establish TMDL
7	4	Passaic River at Little Falls	1389500	**15.0**	establish TMDL
8	4	Peckman River at West Paterson	1389600	**7.7**	establish TMDL
9	4	Goffle Brook at Hawthorne	1389850	**10.5**	establish TMDL
10	4	Diamond Brook at Fair Lawn	1389860	**2.5**	establish TMDL

TMDL No.	WMA	Station Name/Waterbody	Site ID	River Miles	Management Response
	4	Passaic River at Elmwood Park	1389880	**13.8**	CSO influence
11	4	WB Saddle River at Upper Saddle River	1390445	**2.4**	establish TMDL
12	4	Saddle River at Ridgewood	1390500	**24.0**	establish TMDL
13	4	Ramsey Brook at Allendale	1390900	**6.4**	establish TMDL
14	4	HoHoKus Brook at Mouth at Paramus	1391100	**6.2**	establish TMDL
15	4	Saddle River at Fairlawn	1391200	**5.0**	establish TMDL
16	4	Saddle River at Lodi	1391500	**3.8**	establish TMDL
17	5	Hackensack River at River Vale	1377000	**10.0**	establish TMDL
18	5	Musquapsink Brook at River Vale	1377499	**7.3**	establish TMDL
19	5	Pascack Brook at Westwood	1377500	**6.6**	establish TMDL
20	5	Tenakill Brook at Cedar Lane at Closter	1378387	**10.2**	establish TMDL
	5	Hackensack River at New Milford	1378500	**1.1**	water quality monitoring needed to identify if an impairment exists
21	5	Coles Brook at Hackensack	1378560	**11.1**	establish TMDL
22	6	Black Brook at Madison	1378855	**2.4**	establish TMDL
23	6	Passaic River near Millington	1379000	**5.2**	establish TMDL
24	6	Dead River Near Millington	1379200	**21.1**	establish TMDL
25	6	Passaic River near Chatham	1379500	**25.2**	establish TMDL
26	6	Canoe Brook near Summit	1379530	**17.6**	establish TMDL
27	6	Rockaway River at Longwood Valley	1379680	**11.6**	establish TMDL
28	6	Rockaway River at Blackwell Street	1379853	**3.5**	establish TMDL
29	6	Beaver Brook at Rockaway	1380100	**17.0**	establish TMDL
30	6	Stony Brook at Boonton	1380320	**13.1**	establish TMDL
31	6	Rockaway River at Pine Brook	1381200	**6.8**	establish TMDL
	6	Whippany River at Morristown	1381500	**6.6**	TMDL completed in 1999
	6	Whippany River near Pine Brook	1381800	**6.6**	TMDL completed in 1999
32	6	Passaic River at Two Bridges	1382000	**14.1**	establish TMDL

These thirty-two TMDLs will address 305 river miles or approximately 87% of the total river miles impaired by fecal coliform (352 total FC impaired river miles) in the northeast watershed region. Based on the detailed county hydrography stream coverage, 847 stream miles, or 47% of the stream segments in the northeast region (1800 total miles) are directly affected by the 32 TMDLs due to the fact that the implementation plans cover entire watersheds; not just impaired waterbody segments.

Table 2 identifies six segments for which TMDLs will not be developed at this time based on investigations following the *2002 Integrated List of Waterbodies* proposal. These segments, which are identified as requiring a management response other than "establish TMDL," are discussed in Appendix A along with the listing Sublist to which they will be moved.

These include: #01382500, Pequannock River at Macopin Intake Dam, #01387000, Wanaque River at Wanaque, #01378500, Hackensack River at New Milford, #01381500, Whippany

River at Morristown, #01381800, Whippany River near Pine Brook, and #01389880, Passaic River at Elmwood Park. For each of these segments an explanation of the management response is provided in Appendix A.

4.1. Description of the Northeast Water Region and Sublist 5 Waterbodies

4.1.1. Watershed Management Area 3

Watershed Management Area 3 (WMA 3) includes watersheds that receive water from the Highlands portion of New Jersey. The Pequannock, Wanaque and Ramapo Rivers all flow into the Pompton River. The Pompton River is, in turn, a major tributary to the Upper Passaic River. WMA 3 contains some of the State's major water supply reservoir systems including the Wanaque Reservoir, the largest surface water reservoir in New Jersey. There are four watersheds in WMA 3: Pompton, Ramapo, Pequannock and Wanaque River Watersheds. WMA 3 lies mostly in Passaic County but also includes parts of Bergen, Morris, and Sussex Counties.

The **Pequannock River Watershed** is 30 miles long and has a drainage area of 90 square miles. The headwaters are in Sussex County and the Pequannock River flows east, delineating the Morris/Passaic County boundary line. The Pequannock River joins the Wanaque River and flows to the Pompton River in Wayne Township. Some of the major impoundments within this watershed are Kikeout Reservoir, Lake Kinnelon Reservoir, Clinton Reservoir, Canistear Reservoir, Oak Ridge Reservoir, and Echo Lake Reservoir. The great majority of the land within this watershed is forested and protected for water supply purposes and parklands.

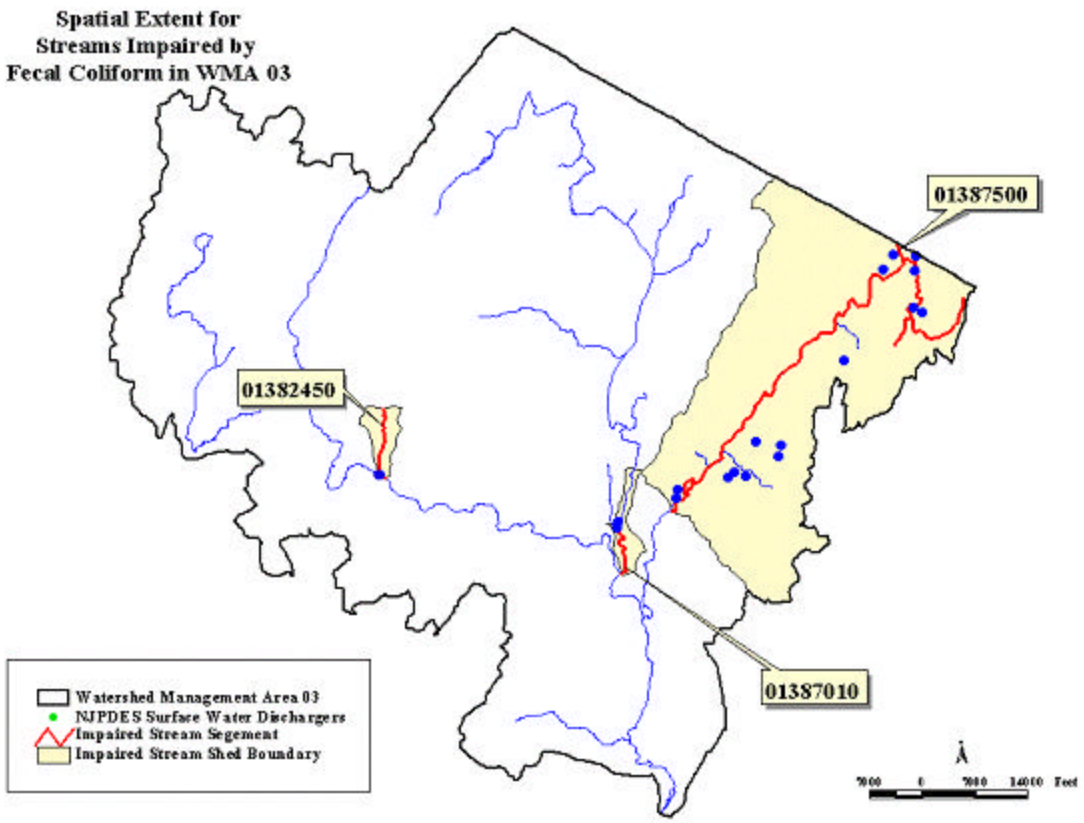
The **Ramapo River and Pompton River Watersheds** comprise a drainage area of about 160 square miles; 110 square miles of which are in New York State. The Ramapo River flows from New York into Bergen County and enters the Pequannock River to form the Pompton River in Wayne Township. The Ramapo River is 15 miles long on the New Jersey side. The Pompton River, a tributary to the Passaic River, is 7 miles long. Some of the major impoundments within this watershed include Point View Reservoir #1, Pompton Lakes, and Pines Lake. Over one-half of this watershed is undeveloped; however, new development is extensive in many areas.

The **Wanaque River Watershed** has a total drainage area of 108 square miles. The headwaters of the river lie within New York State as a minor tributary to Greenwood Lake (located half in New Jersey and half in New York). The New Jersey portion lies in West Milford, Passaic County. The Wanaque River joins up with the Pequannock River in Riverdale Township. The Wanaque River is 27 miles in length. Some of the major impoundments and lakes with this watershed are the Wanaque Reservoir, Greenwood Lake, Arcadia Lake and Lake Inez. Most of the land in this watershed is undeveloped, consisting of vacant lands, reservoirs, parks and farms.

Sublist 5 Waterbodies in WMA 3

Three river segments of the thirty-two impaired segments addressed in this report, the Macopin River (#01382450), Wanaque River (#01387010), and Ramapo River (#01387500) are located in WMA 3. The spatial extent of each segment is identified in Figure 1. River miles, watershed sizes and land use\land cover by percent area associated with each segment are listed in Table 3.

Figure 1 Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 3



Segment #01382450, the Macopin River at Macopin Reservoir, has a watershed area of approximately 1.1 mi^2. Water quality from stations #01382410 and #01382450 were used in assessing the status and spatial extent of bacterial contamination. The length of the impaired stream segment is approximately 1.8 miles and is located on the Macopin River upstream of the confluence of the Macopin and the Pequannock Rivers. A total of 1.9 stream miles (based on county hydrologic stream coverage) are located within its watershed and will be included in the implementation plan.

Table 3 River miles, Watershed size, and Anderson Landuse classification for three Sublist 5 segments, listed for fecal coliform, in WMA 3.

	Segment ID		
	1382450	**1387010**	**1387500**
Sublist 5 impaired river miles (miles)	1.8	1.5	17.7
Total river miles within watershed and included in the implementation plan (miles)	1.9	4.0	87.8
Watershed size (acres)	711	708	26084
Landuse/Landcover			
Agriculture	0.00%	0.00%	0.43%
Barren Land	0.15%	0.17%	0.78%
Forest	89.74%	29.65%	51.20%
Urban	4.11%	55.19%	37.64%
Water	1.97%	4.71%	3.05%
Wetlands	4.04%	10.29%	6.89%

Segment #01387010, the Wanaque River at Highland Avenue at Wanaque, is located on the Wanaque River from the inlet of the Wanaque River at Inez Lake to the confluence of the Wanaque and Pequannock Rivers. Water quality from stations #01387014 and #01387041 were used in assessing the spatial extent of bacterial contamination. The stream segment length is approximately 1.5 miles with a watershed area of approximately 708 acres or 1.1 mi^2.

Segment #01387500, the Ramapo River near Mahwah, is located on the Ramapo River between the NJ-NY borders to the inlet at Pompton Lake. Water quality from station #01387500 was used to assess the spatial extent of bacterial contamination. The impaired stream segment length is approximately 17.7 miles. A total of 87.8 stream miles are located within its watershed and will be included in the implementation plan. The total drainage area for this segment is approximately 26084 acres or 40.8 mi^2.

4.1.2. Watershed Management Area 4

Watershed Management Area 4 (WMA 4) includes the Lower Passaic River (from the Pompton River confluence downstream to the Newark Bay) and its tributaries, including the Saddle River. The WMA 4 drainage area is approximately 180 square miles and lies within portions of Passaic, Essex, Hudson, Morris and Bergen Counties.

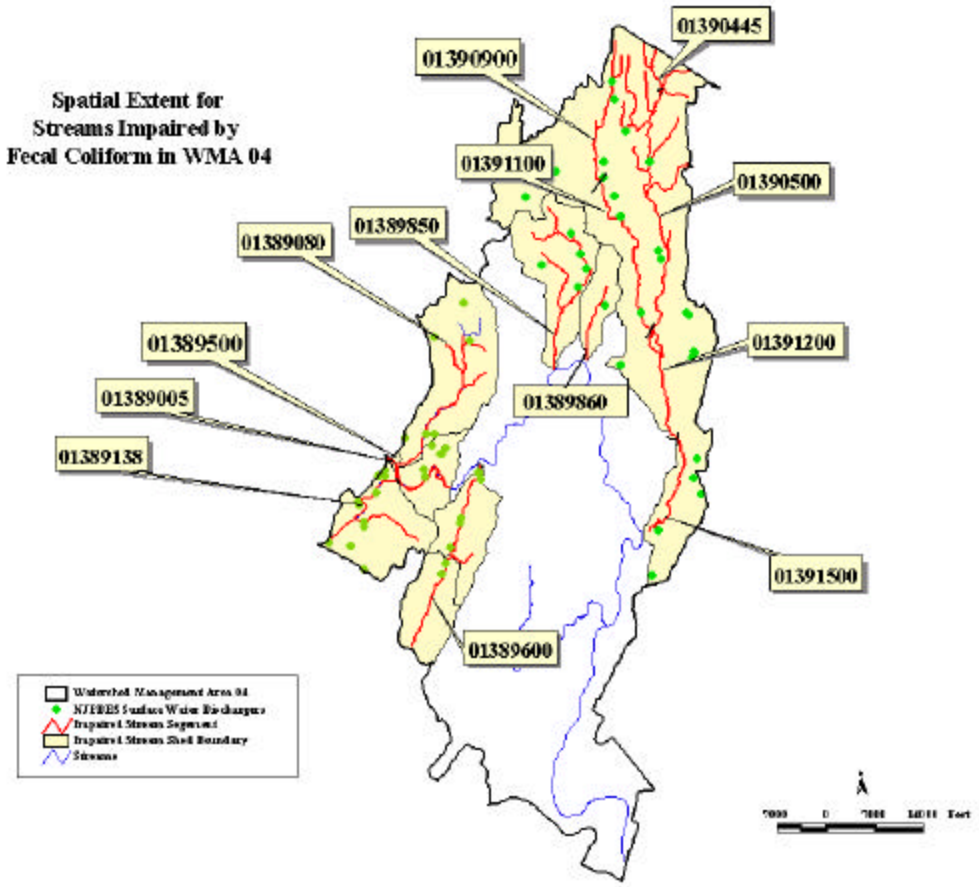
Two watersheds comprise WMA 4: the Lower Passaic River Watershed and Saddle River River Watershed. The **Lower Passaic River Watershed** originates from the confluence of the Pompton River downstream to the Newark Bay. This 33-mile section meanders through Bergen, Hudson, Passaic, and Essex Counties and includes a number of falls, culminating with the Great Falls at Paterson. This watershed has a drainage area of approximately 129 square miles. The major tributaries to this section of the Passaic River are the Saddle River,

Preakness Brook, Second River, and Third River. The Saddle River is one of the larger tributaries to the Lower Passaic River. The **Saddle River Watershed** has a drainage area of approximately 51 square miles. Land in this watershed is extensively developed and contains many older cities and industrial centers including Newark, Paterson, Clifton, and East Orange.

Sublist 5 Waterbodies inWMA 4

Thirteen of the thirty-two TMDLs in the Northeast region are located in WMA 4. Included are several segments of the Saddle River (#01390500, #01391200 and #01391500), West Branch of the Saddle River (#01390445), Ramsey Brook (#01390900), Hohokus Brook (#01391100), the Passaic River (#01389005 and #01389500), Preakness Brook (#01389080), Deepavaal Brook (#01389138), Diamond Brook (#01389860), Goffle Brook (#01389850), and the Peckman River (#01389600). Several of these stream segments are geographically located in close proximity, thus, when these segments were found to contain similar levels of bacteria contamination (geometric means value), water quality data from these segments were grouped when calculating the TMDL. The spatial extent of each segment is identified in Figure 2. River miles, watershed sizes and land use\land cover by percent area associated with each segment are listed in Table 4.

Figure 2 Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 4



Given the proximity and similarity in impairment of several stations in the Saddle River watershed, six segments were grouped for the purposes of this report. These segments include: the West Branch Saddle River at Upper Saddle River (#01390445), Saddle River at Ridgewood (#01390500), Ramsey Brook at Allendale (#01390900), Hohokus Brook at Paramus (#01391100), Saddle River at Fairlawn (#01391200), and the Saddle River at Lodi (#01391500). These stream segments extend from the New York-New Jersey border to the confluence of the Saddle and Passaic Rivers and is contained within a 32933 acres, or 51.5 mi^2, watershed. The combined six stream segments total a length of 45.7 miles. The implementation plan will address all of streams located in this watershed (97.3 miles). Stations #01390445, #01390470, #01390510, #01390518, #01390900, #01391100, #01391490, and #01391500 were used to assess the status and spatial extent of bacterial contamination.

Table 4 River miles, Watershed size, and Anderson Landuse classification for thirteen Sublist 5 segments, listed for fecal coliform, in WMA 4.

	Segment ID		
	1390445, 1390500, 1390900, 1391100, 1391200, 1391500	**1389005,1389500, 1389080, 1389138,1389600**	**1389850,1389860**
Sublist 5 impaired river miles (miles)	45.7	29.8	10.5
Total river miles within watershed and included in the implementation plan (miles)	97.3	56.1	13.3
Watershed size (acres)	32933	14450	7590
Landuse/Landcover			
Agriculture	0.51%	0.12%	0.07%
Barren Land	0.20%	0.79%	0.27%
Forest	10.59%	20.81%	7.96%
Urban	81.89%	69.81%	88.51%
Water	1.06%	1.59%	0.46%
Wetlands	5.75%	6.88%	2.74%

Five Sublist 5 segments, the Passaic River below Pompton River at Two Bridges (#01389005), Passaic River at Little Falls (#1389500), Preakness Brook near Little Falls (#1389080), Deepavaal Brook at Fairfield (#01389138) and Peckman River at West Paterson (#01389600) were grouped based on similarities in geography and bacterial concentrations. Water quality from stations #01389500, #01389080, #01389138, #01382000, and #01389600 were used to assess the status and spatial extent of bacterial contamination. The combined length of the impaired stream segments is approximately 29.8 miles. A total of 56.1 stream miles are located within its watershed and will be included in the implementation plan. The total drainage area for this segment is approximately 14450 acres, or 22.6 mi^2.

Stream segments #01389850 and #01389860 were also grouped in calculating the TMDL percent reduction. Segment #01389850, Goffle Brook at Hawthorne, consists of the entire length of Goffle Brook to the confluence of Goffle Brook with the Passaic River. Segment #01389860, Diamond Brook at Fair Lawn, consists of the entire length of Diamond Brook to the confluence of Diamond Brook with the Passaic River. Water quality from stations #01389850 and #01389860 were used in assessing the status and spatial extent of bacterial contamination for these segments. The length of the impaired #01389850 stream segment is approximately 10.5 miles in a watershed area of approximately 5658 acres or 8.8 mi^2. A total of 13.3 river miles are in the watershed and will be included in the implementation plan. The length of the impaired #01389860 stream segment is approximately 2.5 miles in a watershed area of approximately 1932 acres or 3.0 mi^2.

4.1.3. Watershed Management Area 5

Watershed Management Area 5 (WMA 5) includes parts of Hudson and Bergen Counties and has a watershed area of approximately 165 square miles. 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.

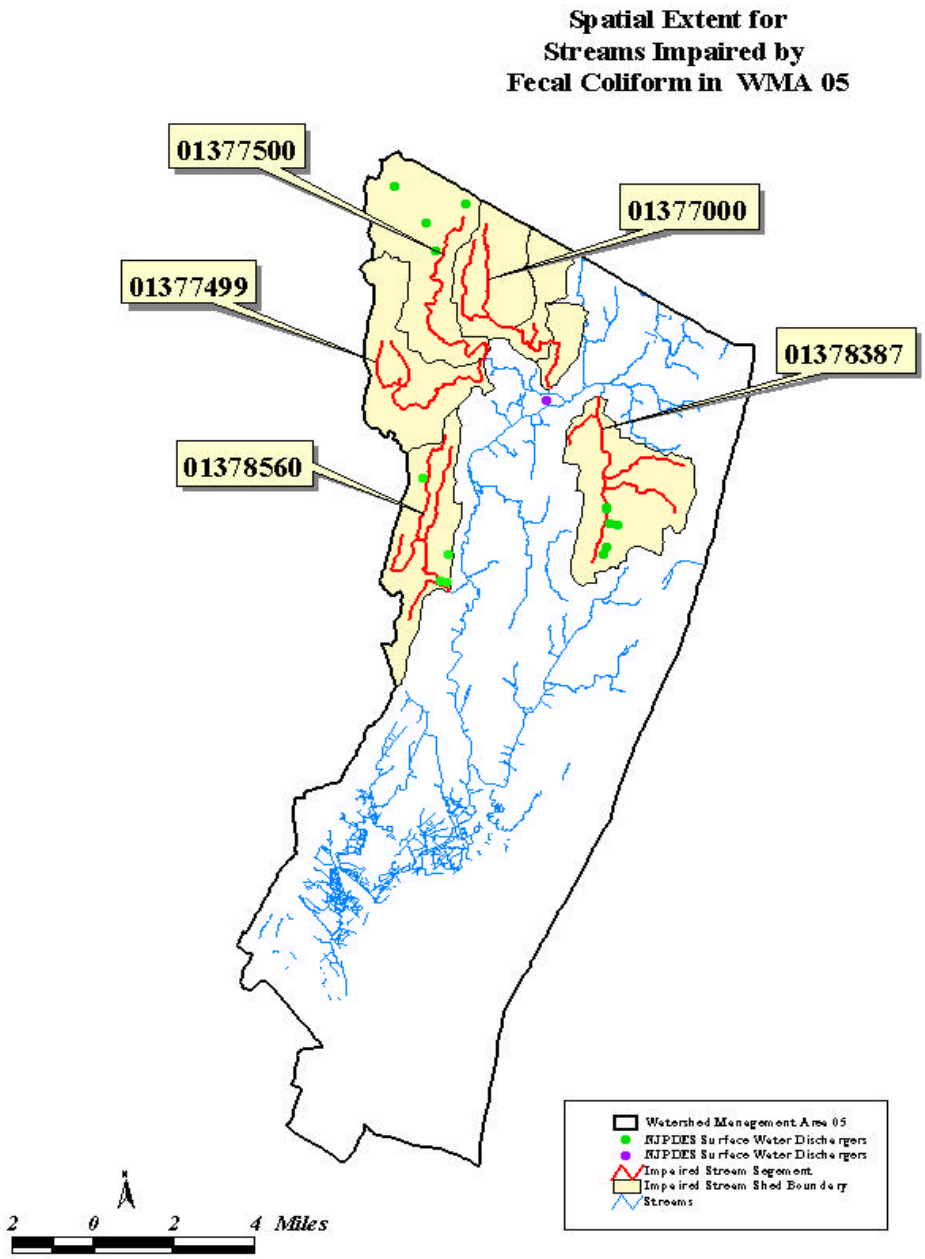
The New Jersey portion of the Hudson River is 315 miles long and begins in New York State at Lake Tear of the Clouds on the southwest side of Mount Marcy, New York's highest peak. The New Jersey portion of the **Hudson River Watershed** is approximately 29 square miles. The Hudson River forms the boundary 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, with more than 30% 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. The Meadowlands are home to more than 700 plant and animal species including several rare and threatened species

Sublist 5 Waterbodies in WMA 5

Five of the thirty-two TMDLs in this report are located in WMA 5. Included are segments in the Hackensack River (#01377000), Pascack Brook (#01377500), Musquapsink Brook (#01377499), Tenakill Brook (#01378387), and Coles Brook (#01378560). The spatial extent of each segment is identified in Figure 3. River miles, watershed size and land use\land cover by percent area associated with each segment are listed in Table 5.

Figure 3 Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 5



Hackensack River at River Vale, (segment #01377000) flows across the New Jersey/New York State line in River Vale/Old Tappan and extends to the inlet of the Oradell Reservoir. Water quality from stations #01377000 and #01376970 (Hackensack River at Old Tappan) were used in assessing the status and spatial extent of bacterial contamination for this segment. The length of the impaired stream segment is approximately 10.0 miles in a

watershed area of approximately 5912 acres or 9.2 mi^2, however a total of 20.3 river miles are located in the watershed and will be included in the implementation plan.

Table 5 River miles, Watershed size, and Anderson Landuse classification for five Sublist 5 segments, listed for fecal coliform, in WMA 5.

	Segment ID			
	1377000	1377499, 1377500	1378387	1378560
Sublist 5 impaired river miles (miles)	10.0	13.8	10.2	11.1
Total river miles within watershed and included in the implementation plan (miles)	20.3	33.3	10.8	14.8
Watershed size (acres)	5902	10430	5626	4241
Landuse/Landcover				
Agriculture	0.07%	0.95%	0.17%	0.00%
Barren Land	0.42%	0.30%	0.13%	0.18%
Forest	13.85%	11.53%	11.32%	4.98%
Urban	65.52%	79.72%	84.43%	91.80%
Water	12.09%	2.31%	0.44%	0.19%
Wetlands	8.05%	5.18%	3.51%	2.84%

Pascack Brook at Westwood, segment #01377500, and Musquapsink Brook at River Vale segment #01377500, were also grouped based on similarities in geography and extent of bacterial contamination. Water quality from stations #01377499 and #01377500 were used in assessing the status and spatial extent of bacterial contamination for these segments. The combined length of the impaired stream segments is approximately 13.8 miles in a watershed area of approximately 10429 acres or 16.3 mi^2, however a total of 33.3 river miles are located within the watershed and will be included in the implementation plan.

Tenakill Brook at Cedar Lane at Closter, segment #01378387, consists of the entire length of Tenakill Brook upstream of USGS station #01378387. Water quality from this station #01378387 was used in assessing the status and spatial extent of bacterial contamination for this segment. The length of the impaired stream segment is approximately 10.2 miles in a watershed area of approximately 5625 acres or 8.8 mi^2. A total of 10.8 river miles are included in this watershed and will be included in the implementation plan

Coles Brook at Hackensack, segment #01378560, consists of the entire length of Coles Brook upstream of USGS station #01378560. Water quality from station #01378560 was used in assessing the status and spatial extent of bacterial contamination for this segment. The length of the impaired stream segment is approximately 11.1 miles in a watershed area of approximately 4240 acres or 6.6 mi^2. A total of 14.8 river miles are included in this watershed and will be included in the implementation plan.

4.1.4. Watershed Management Area 6

Watershed Management Area 6 (WMA 6) represents the area drained by waters from the upper reaches of the Passaic River Basin including the Passaic River from its headwaters in Morris County to the confluence of the Pompton River. Extensive suburban development and reliance upon ground water sources for water supply characterize WMA 6. WMA 6 lies in portions of Morris, Somerset, Sussex and Essex counties and includes the Upper & Middle Passaic River, Whippany River and Rockaway River Watersheds.

The **Upper Passaic River Watershed** is approximately 50 miles long and consists of a drainage area approximately 200 square miles in portions of Somerset, Morris, and Essex Counties. This section of the Passaic River is a significant source of drinking water for a much of northeastern New Jersey. Major tributaries to the Upper Passaic River include the Dead River, Rockaway River, Whippany River, and Black Brook. The Great Swamp National Wildlife Refuge is located within the Upper Passaic River Watershed. Approximately one-half of this watershed is undeveloped or vacant, with the remainder primarily residential and commercial; however, this watershed is facing significant development in the vacant areas. This watershed is subject to frequent flooding.

The **Middle Passaic River Watershed** includes Great Piece Meadows and Deepavaal Brook. The Great Piece Meadows is a freshwater wetland with a drainage area of approximately 12 square miles and is prone to flooding. Various owners privately own the Great Piece Meadows.

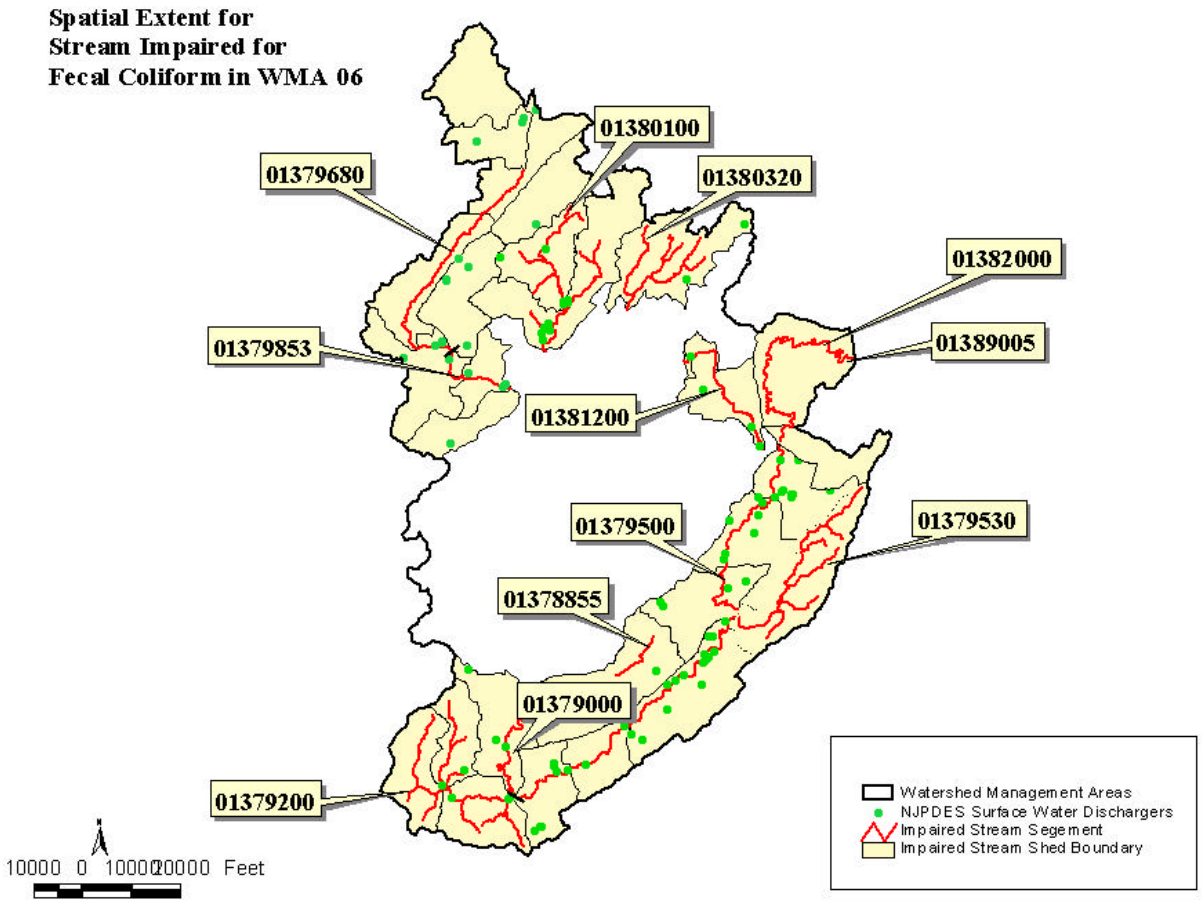
The **Rockaway River Watershed** has a drainage area of approximately 133 square miles and is approximately 37 miles long. The Rockaway River flows east to its confluence with the Whippany River at Pine Brook. Major tributaries include Stone Brook, Mill Brook, Beaver Brook, and Den Brook. The land use patterns in this area are complex and include vacant areas, parklands, residential development and industrial/commercial uses.

The **Whippany River Watershed** drains approximately 69 square miles and is located entirely within Morris County. The river is approximately 18 miles long and flows to the Passaic River. Two major tributaries are Black Brook and Troy Brook. The population is centered in Morristown, Parsippany-Troy Hills, Hanover Township and East Hanover Township.

Sublist 5 Waterbodies WMA 6

Eleven of the thirty-two TMDLs in this report are located in WMA 6. Included are segments in the Black Brook (#01378855), Dead River (#01379200), Passaic River (#01379000, #01379500, and #01382000), Rockaway River (#01379680, #01379853, and #01381200), Canoe Brook (#01379530), Beaver Brook (#01380100), and Stony Brook (#01380320). The spatial extent of each segment is identified in Figure 4. River miles, watershed size and land use\land cover by percent area associated with each segment are listed in Table 6.

Figure 4 Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 6



Five segments, the Black Brook at Madison (#01378855), Passaic River near Millington (#01379000), Dead River near Millington (#01379200), the Passaic River near Catham (#01379500), and Canoe Brook near Summit (#01379530), comprise a large portion of the Passaic River headwater region and were grouped based on geographical similarities and bacterial geometric mean concentrations. Water quality from stations #01378855, #01379000, #01379200, #001379500, and #01379530 were used to assess the status and spatial extent of bacterial contamination. The combined length of the impaired stream segments is approximately 71.0 miles. A total of 204.8 stream miles are located within its watershed and will be included in the implementation plan. The total drainage area for this segment is approximately 66,759 acres, or 104.3 mi^2.

Table 6 River miles, Watershed size, and Anderson Landuse classification for eleven Sublist 5 segments, listed for fecal coliform, in WMA 6.

	Segment ID					
	1378855,1379000, 1379200,1379500, 1379530	1379680 1379853	1380100	1380320	1381200	1382000
Sublist 5 impaired river miles (miles)	71.0	15.1	16.9	13.1	6.8	14.9
Total river miles within watershed and included in the implementation plan (miles)	204.8	105.8	43.0	25.0	18.4	53.0
Watershed size (acres)	66759	39246	14528	7864	4861	11019
Landuse/Landcover						
Agriculture	2.23%	0.36%	0.16%	2.00%	1.44%	0.52%
Barren Land	0.90%	1.23%	2.66%	0.36%	1.62%	0.51%
Forest	19.21%	55.51%	63.14%	62.92%	13.07%	11.83%
Urban	51.57%	27.70%	17.22%	21.24%	66.79%	42.42%
Water	1.45%	3.75%	7.08%	4.03%	2.14%	3.00%
Wetlands	24.65%	11.44%	9.74%	9.46%	14.94%	41.72%

Rockaway River at Longwood Valley, (#01379680), and Rockaway River at Blackwell St. (#01379853) were grouped based on similarities in geography and bacterial contamination. Water quality from stations #01379680, #01379700 and #01379853 were used in assessing the spatial extent of bacterial contamination for these segments. The combined length of the impaired stream segments is approximately 15.1 miles in a watershed area of approximately 39246 acres or 61.3 mi^2. A total of 105.8 river miles are located within the watershed and will be included in the implementation plan.

Beaver Brook at Rockaway, segment #01380100, consists of the entire Beaver Brook to the confluence of Beaver Brook and the Rockaway River. Water quality from station #01380100 was used to assess the status and spatial extent of bacterial contamination. The impaired stream segment length is approximately 16.9 miles. A total of 43.0 stream miles are located within its watershed and will be included in the implementation plan. The total drainage area for this segment is approximately 14528 acres or 22.7 mi^2.

Segment #01380320, Stony Brook at Boonton, consists of the entire Stony Brook to the confluence of Stony Brook and the Rockaway River. Water quality from station #01380100 was used to assess the status and spatial extent of bacterial contamination. The impaired stream segment length is approximately 13.1 miles. A total of 25.0 stream miles are located within its watershed and will be included in the implementation plan. The total drainage area for this segment is approximately 7864 acres or 12.3 mi^2.

Segment #01381200, Rockaway River at Pine Brook, is located on the downstream portion of the Rockaway River between the outlet of the Boonton Reservoir and the confluence of the

Rockaway and the Whippany Rivers. Water quality from station #01381200 was used to assess the status and spatial extent of bacterial contamination. The impaired stream segment length is approximately 6.8 miles. A total of 18.4 stream miles are located within its watershed and will be included in the implementation plan. The total drainage area for this segment is approximately 4861 acres or 7.6 mi^2.

Segment #01382000, Passaic River at Two Bridges, is located on the Passaic River between the confluence of the Whippany and Passaic Rivers to the confluence of the Passaic and Pompton Rivers. Water quality from station #01382000 was used to assess the status and spatial extent of bacterial contamination. This segment was not grouped with other segments based on its relatively lower bacterial concentrations compared with those found in up and downstream on the Passaic River. The impaired stream segment length is approximately 14.9 miles in a drainage area of approximately 11019 acres or 17.2 mi^2. A total of 53.0 stream miles are located within its watershed and will be included in the implementation plan.

4.2. Data Sources

The Department's Geographic Information System (GIS) was used extensively to describe northeast watershed characteristics. In concert with USEPA's November 2001 listing guidance, the Department is using Reach File 3 (RF3) in the 2002 Integrated Report to represent rivers and streams. The following is general information regarding the data used to describe the watershed management area:

- Land use/Land cover information was taken from the 1995/1997 Land Use/Land cover Updated for New Jersey DEP, published 12/01/2000 by Office of Information Resources Management (OIRM), Bureau of Geographic Information and Analysis (BGIA), delineated by watershed management area.
- 2002 Assessed Rivers coverage, NJDEP, Watershed Assessment Group, unpublished coverage.
- County Boundaries: Published 11/01/1998 by the NJDEP, Office of Information Resources Management (OIRM), Bureau of Geographic Information and Analysis (BGIA), "NJDEP County Boundaries for the State of New Jersey." Online at: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/stco.zip
- Detailed stream coverage (RF3) by County: Published 11/01/1998 by the NJDEP, Office of Information Resources Management (OIRM), Bureau of Geographic Information and Analysis (BGIA). "Hydrography of XXX County, New Jersey (1:24000)." Online at: http://www.state.nj.us/dep/gis/digidownload/zips/strm/
- NJDEP 14 Digit Hydrologic Unit Code delineations (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
- NJPDES Surface Water Discharges in New Jersey, (1:12,000), published 02/02/2002 by Division of Water Quality (DWQ), Bureau of Point Source Permitting - Region 1 (PSP-R1).

5.0 Applicable Water Quality Standards

5.1. New Jersey Surface Water Quality Standards for Fecal Coliform

As stated in N.J.A.C. 7:9B-1.14(c) of the New Jersey SWQS, the following are the criteria for freshwater fecal coliform:

> "Fecal coliform levels shall not exceed a geometric average of 200 CFU/100 ml nor should more than 10 percent of the total sample taken during any 30-day period exceed 400 CFU/100 ml in FW2 waters".

All of the waterbodies covered under these TMDLs have a FW1 or FW2 classification (NJAC 7:9B-1.12). The designated use, i.e. surface water uses, both existing and potential, that have been established by the Department for waters of the State, for all of the waterbodies in the Northeast Water Region is as stated below:

In all FW1 waters, the designated uses are:
1. Set aside for posterity to represent the natural aquatic environment and its associated biota;
2. Primary and secondary contact recreation;
3. Maintenance, migration and propagation of the natural and established aquatic biota; and
4. Any other reasonable uses.

In all FW2 waters, the designated uses are:
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.

5.2. Pathogen Indicators in New Jersey's Surface Water Quality Standards (SWQS)

A subset of total coliform, fecal coliform, originates from the intestines of warm-blooded animals. Therefore, because they do not include organisms found naturally in soils, fecal coliform is preferred over total coliform as a pathogen indicator. In 1986, USEPA published a document entitled *"Implementation Guidance for Ambient Water Quality Criteria for Bacteria – 1986"* that contained their recommendations for water quality criteria for bacteria to protect bathers from gastrointestinal illness in recreational waters. The water quality criteria established levels of indicator bacteria *Escherichia coli* (*E. coli*) for fresh recreational water and enterococci for fresh and marine recreational waters in lieu of fecal coliforms. Historically, the New Jersey has listed water bodies for exceedances of the fecal coliform criteria.

Therefore, the Department is obligated to develop TMDLs for Sublist 5 water bodies based upon fecal coliform, at least until New Jersey has the transition to *E. coli* and enterococci in the Department's SWQS and until sufficient data have been collected to either develop a TMDL or to support a proposal to move the waterbodies to one of the other four categories.

6.0 Source Assessment

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

6.1. Assessment of Point Sources other than Stormwater

Municipal point sources of fecal coliform for these TMDLs are listed in Appendix B. Municipal treatment plants are required to disinfect effluent prior to discharge and to meet surface water quality criteria for fecal coliform in their effluent. While there are some industrial treatment plants that also treat domestic wastewater, these facilities are few in number and are also required to disinfect effluent prior to discharge. In addition, New Jersey's Surface Water Quality Standards at N.J.A.C. 7:9B-1.5(c)4 reads "No mixing zones shall be permitted for indicators of bacterial quality including, but not limited to, fecal coliforms and enterococci". This mixing zone policy is applicable to both municipal and industrial treatment plants.

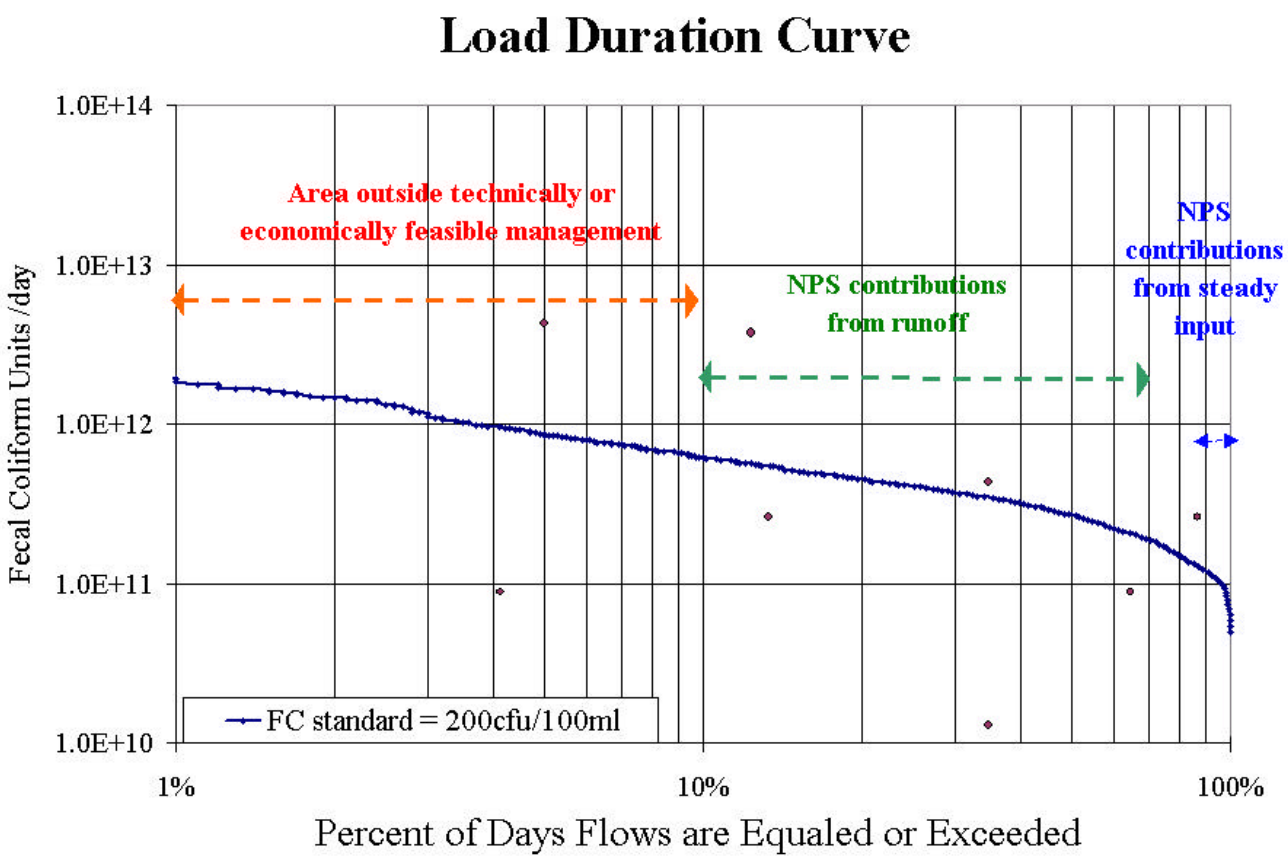
Since POTWs and industrial treatment plants routinely achieve essentially complete disinfection (less than 20 CFU/100ml), the requirement to disinfect is, in effect, more stringent than the fecal coliform effluent criteria. The percent of the total point source contribution is an insignificant fraction of the total load. Consequently, these fecal coliform TMDLs will not impose any change in current practices for POTWs and industrial treatment plants and will not result in changes to existing effluent limits. The methodology used in this report is inappropriate for use in areas affected by combined sewer overflows (CSOs) or in areas influenced by tidal action. Therefore, stream segments falling into these two categories will be excluded from the discussion of TMDLs in this report.

6.2. Assessment of Nonpoint and Stormwater Sources

Nonpoint and stormwater sources include storm-driven loads such as runoff from various land uses that transport fecal coliform from sources such as geese, farms, and domestic pets to the receiving water. Domestic pet waste, geese waste, as well as loading from storm water detention basins will be addressed by the Phase II MS4 program. Nonpoint sources also include steady-inputs from "illicit" sources such as failing sewage conveyance systems, sanitary sewer overflows (SSOs), and failing or inappropriately located septic systems. When "illicit" sources are identified, appropriate enforcement measures will be taken to eliminate them.

When streamflow gauge information is available, a load duration curve (LDC) is useful in identifying and differentiating between storm-driven and steady-input sources. As an example, Figure 5 represents a LDC using the 200 CFU / 100 ml criterion.

Figure 5 Example Load Duration Curve (LDC)



The load duration curve method is based on comparison of the frequency of a given flow event with its associated water quality load. A LDC can be developed using the following steps:

1. Plot the Flow Duration Curve, Flow vs. % of days flow exceeded.
2. Translate the flow-duration curve into a LDC by multiplying the water quality standard, the flow and a conversion factor, the result of this multiplication is the maximum allowable load associated with each flow
3. Graph the LDC, maximum allowable load vs. percent of time flow is equaled or exceeded
4. Water quality samples are converted to loads (sample water quality data multiplied by daily flow on the date of sample).
5. Plot the measured loads on the LDC.

Values that plot below the LDC represent samples below the concentration threshold whereas values that plot above represent samples that exceed the concentration threshold. Loads that plot above the curve and in the region between 85 and 100 percent of days in which flow is exceeded indicate a steady-input source contribution. Loads that plot in the region between 10 and 70 percent suggest the presence of storm-driven source contributions. A combination of both storm-driven and steady-input sources occurs in the transition zone between 70 and 85 percent. Loads that plot above 99 percent or below 10 percent represent values occurring during either extreme low or high flows conditions and are thus considered to be outside the region of technically and economically feasible management. In this report, LDCs are used only for TMDL implementation and not in calculating TMDLs.

7.0 Water Quality Analysis

Relating pathogen sources to in-stream concentrations is distinguished from quantifying that relationship for other pollutants given the inherent variability in population size and dependence not only on physical factors such as temperature and soil characteristics, but also on less predictable factors such as re-growth media. Since fecal coliform loads and concentrations can vary many orders of magnitude over short distances and over time at a single location, dynamic model calibrations can be very difficult to calibrate. Options available to control non-point sources of fecal coliform typically include measures such as goose management strategies, pooper-scooper ordinances, and septic system maintenance. However, the effectiveness of these control measures is not easily measured. Given these considerations, detailed water quality modeling may not provide adequate insight or guidance toward the development of implementation plans for fecal coliform reductions.

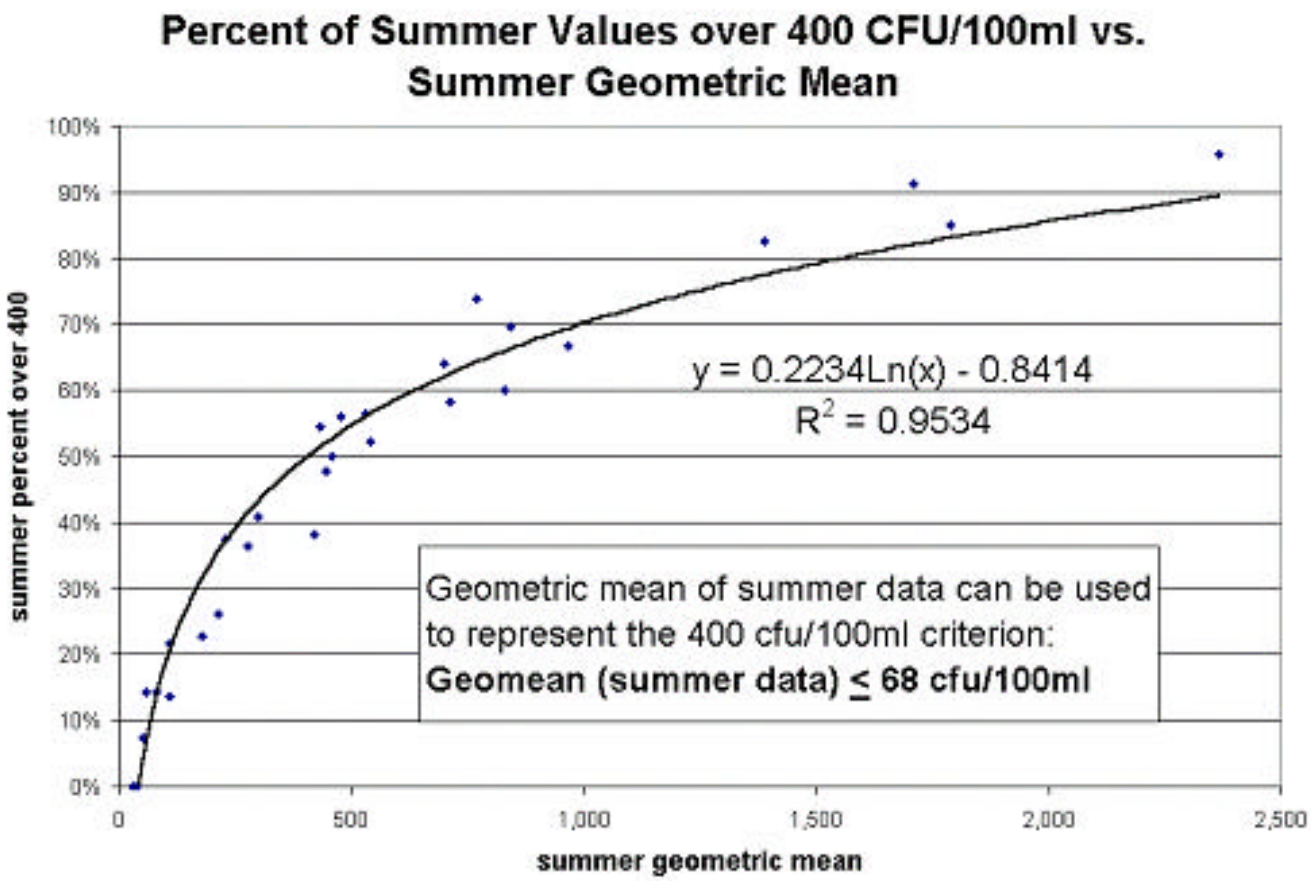
As described in EPA guidance, a TMDL identifies the loading capacity of a waterbody for a particular pollutant. EPA regulations define loading capacity as the greatest amount of loading that a waterbody can receive without violating water quality standards (40 C.F.R. 130.2). The loadings are required to be expressed as either mass-per-time, toxicity, or other appropriate measures (40 C.F.R. 130.2(i)). For these TMDLs, the load capacity is expressed as a concentration set to meet the state water quality standard. For bacteria, it is appropriate and justifiable to express the components of a TMDL as percent reduction based on concentration. The rationale for this approach is that:

- expressing a bacteria TMDL in terms of concentration provides a direct link between existing water quality and the numeric target;
- using concentration in a bacteria TMDL is more relevant and consistent with the water quality standards, which apply for a range of flow and environmental conditions; and
- follow-up monitoring will compare concentrations to water quality standards.

Given the two criteria of 200 CFU / 100 ml and 400 CFU / 100 ml in FW2 waters, computations were necessary for both criteria and resulted in two percent reduction values. The higher percent reduction value was applied in the TMDL so that both the 200 CFU / 100 ml and 400 CFU / 100 ml criteria were satisfied.

To satisfy the 200 CFU/100ml criteria, the geometric mean of all available data between water years 1994-2000 was compared to an adjusted target concentration. The adjusted target accounts for an explicit margin of safety and is equal to 200 minus the margin of safety. A calculation incorporating all available data is generally conservative since most samples are taken during the summer when fecal coliform is generally higher. A geometric mean of summer data was used to develop a percent reduction to satisfy the 400 CFU/100 ml criteria. A summer geometric mean can be used to represent the 400 criteria by regressing the percent over 400 CFU/100 ml against the geometric mean (Figure 6). Thus, each datapoint on Figure 6 represents all the data from one individual monitoring station. Sites with 20 or more summer data points were used to develop this regression, in order to make use of more significant values for percent exceedance. The resulting regression has an r-squared value of 0.9534. Solving for X when Y is equal to 10% yields a geometric mean threshold of 68 CFU/100ml. This means that, using summer data, a geometric mean of 68 can be used to represent the 400 CFU/100ml criterion. Since the geometric mean is a more reliable statistic than percentile when limited data are available, 68 CFU/100ml was used to represent the 400 CFU/100ml criterion for all sites. The inclusion of all data from summer months (May through September) to compare with the 30-day criterion is justified because summer represents the critical period when primary and secondary contact with water bodies is most prevalent. A more detailed justification for using summer data can be found in Section 7.1,"Seasonal Variation and Critical Conditions."

Figure 6 **Percent of summer values over 400 CFU/100ml as a function of summer geometric mean values**



$y = 0.2234\text{Ln}(x) - 0.8414$ Equation 1

$R^2 = 0.9534$

Geometric mean, and summer geometric mean, and percent reductions were determined at each location for both criteria using Equations 2 through 4. To satisfy the 200 CFU / 100ml criteria, equations 2 and 3 were applied. Equations 2 and 4 were used in satisfying the 400 CFU / 100ml criteria.

$$Geometric\ Mean\ \ for\ 200 CFU\ criteria = \sqrt[n]{y_1 y_2 y_3 y_4 .... y_n}$$ Equation 2

where:
y = sample measurement
n = total number of samples

$$200\ CFU\ criteria\ \ Percent\ \text{Re}duction = \frac{(Geometric\ \ mean - (200 - e))}{Geometric\ \ mean} \times 100\ \%$$ Equation 3

$$400\ CFU\ criteria\ Percent\text{Re}duction = \frac{(SummerGeometric\ mean - (68 - e))}{SummerGeometric\ mean} \times 100\ \%$$ Equation 4

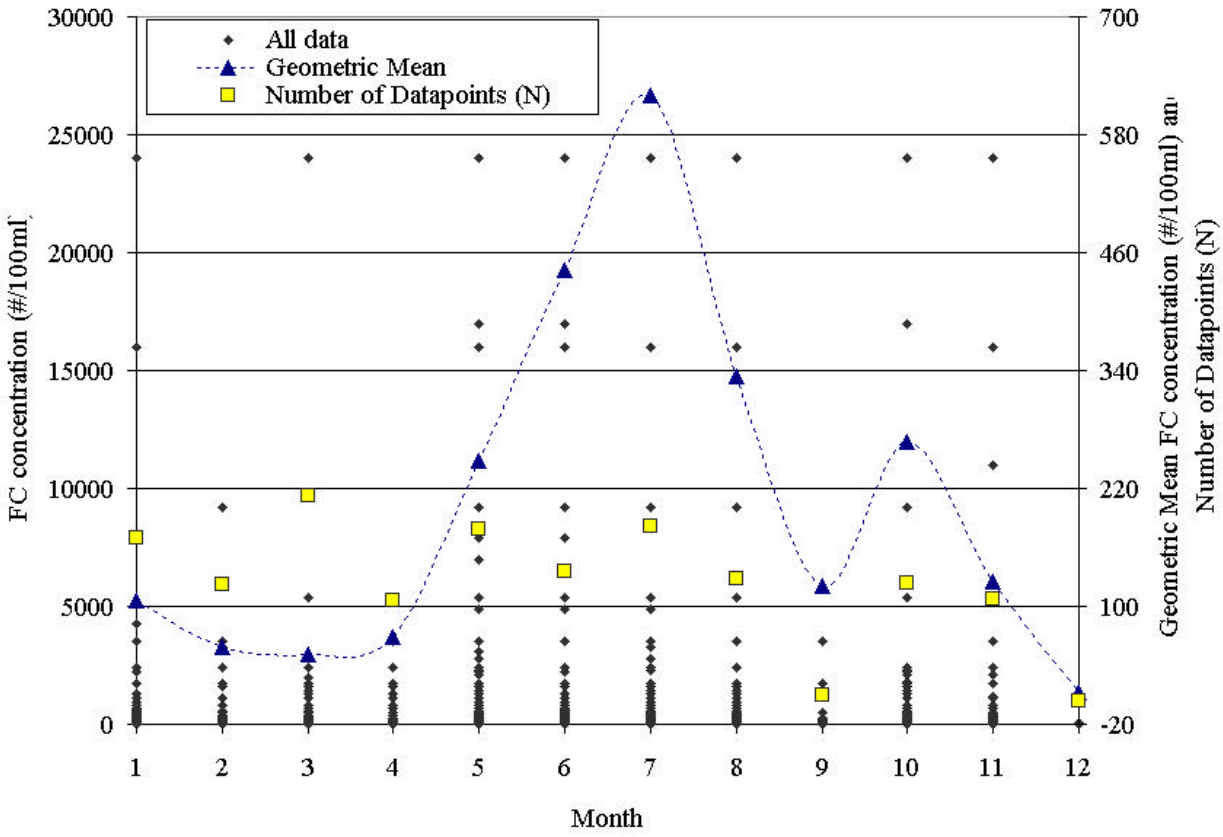
where:
e = (margin of safety)

This percent reduction can be applied to nonpoint and stormwater sources as a whole or be apportioned to categories of nonpoint and stormwater sources within the study area. The extent to which nonpoint and stormwater sources have been identified and the process by which they will become identified will vary by study area based on data availability, watershed size and complexity, and pollutant sources.

7.1. Seasonal Variation/Critical Conditions

These TMDLs will attain applicable surface water quality standards year round. The approach outlined in this paper is conservative given that in most cases fecal coliform data were collected during the summer months, a time when in-stream concentrations are typically the highest. This relationship is evidenced when calculating, on a monthly basis, the geometric mean of fecal coliform data collected statewide. Statewide fecal coliform geometric means during water years 1994-1997 were compared on a monthly basis and are shown in Figure 7. The 1994-1997 period was chosen for this analysis so that the significance of the number of individual datapoints for any given month was minimized. During the 1994-1997 period year-round sampling for fecal coliform was conducted by sampling four times throughout the year. Following 1997, the fecal coliform sampling protocol was changed to five samples during a 30-day period in the summer months. As evident in Figure 7, higher monthly geometric means are observed between May and September with the highest values occurring during mid-summer. This relationship is also evident when using the entire 1994-2002 dataset or datasets from individual water years. Given this relationship, summer is considered the critical period for violating fecal coliform SWQS and, as such, sampling during this period is considered adequate for meeting year round protections and designated uses.

Figure 7 Statewide monthly fecal coliform geometric means during water years 1994-1997 using USGS/NJDEP data.



7.2. Margin of Safety

A Margin of Safety (MOS) is provided to account for "lack of knowledge concerning the relationship between effluent limitations and water quality" (40 CFR 130.7(c)). For these TMDLs calculations, both an implicit and explicit Margin of Safety (MOS) are incorporated. Implicitly, a MOS is inherent in the estimates of current pollutant loadings, the targeted water quality goals (New Jersey's SWQS) and the allocations of loading. This was accomplished by taking conservative assumptions throughout the TMDL evaluation and development. Examples of some of the conservative assumptions include treating fecal coliform as a conservative substance, applying the fecal coliform criteria to stormwater sources, and applying the fecal coliform criteria to the stream during all weather conditions. Fecal coliforms decay in the environment (i.e. outside the fecal tract) relatively rapidly, yet this analysis assumes a linear relationship between fecal load and instream concentration. Furthermore, it is generally recognized that fecal contamination from stormwater poses much less risk of illness than fecal contamination from sewage or septic system effluent (Cabelli, 1989). Finally, much of the fecal coliform is flushed into the system during rainfall events and passes through the system in a short time. Primary and secondary recreation generally occur during dry periods.

An explicit MOS is provided by incorporating a confidence level multiplier associated with log-normal distributions in the calculation of the load reduction for both the 200 and 400 standards. Using this method, the 200 and 400 targets are reduced based on the number of data points and the variability within each data set. For these TMDLs, a confidence level of 90% was used in calculating the MOS. As a result, and as identified in Appendix C, the target value will be different for each stream segment or grouped segments. The explicit margin of safety is calculated using the following steps:

1- FC data (x) will transformed to Log form data (y),
2- the mean of the Log- transformed data (y) is determined, $\bar{y}$
3- Determine the standard deviation of the Log-transformed data, S_y using the following equation:

$$S_y = \sqrt{\frac{\sum_i (y_i - \bar{y})^2}{N-1}}$$

4- Determine the Geometric mean of the FC data (GM)
5- Determine the standard deviation of the mean (standard error of the mean), $s_{\bar{y}}$, using the following equation:

$$s_{\bar{y}} = \frac{s_y}{\sqrt{N}}$$

6- For the 200 standard ($x_{standard}$), $y_{standard}$ = Log(200)= 2.301, thus for a confidence level of 90%, the target value will be the lower confidence limit (n= -1.64), $y_{target} = y_{std} - n \cdot s_{\bar{y}}$, for example, the 200 criteria: $y_{target} = 2.301 - n * s_{\bar{y}}$
7- The target value for x, $x_{target} = 10^{y\ target}$
8- The margin of safety (e) therefore will be $e = x_{standard} - x_{target}$
9- Finally, the load reduction = $\frac{GM - x_{target}}{GM} \cdot 100\%$, for example the 200 criteria will be defined as: $\frac{(GM - (200 - e))}{GM} \cdot 100\%$

   The 400 criteria would be defined as: $\frac{(GM - (68 - e))}{GM} \cdot 100\%$

8.0 TMDL Calculations

Because these TMDLs are calculated based on ambient water quality data, the allocations are provided in terms of percent reductions. In the same way, the loading capacity of each stream is expressed as a function of the current load:

$LC = (1 - PR) \times L_o$, where

LC = loading capacity for a particular stream;
PR = percent reduction as specified in Tables 7-10;

L_o = current load.

8.1. Wasteload Allocations and Load Allocations

For the reasons discussed previously, these TMDLs do not include WLAs for traditional point sources (POTWs, industrial, etc.). WLAs are hereby established for all NJPDES-regulated point sources (including NJPDES-regulated stormwater), while LAs are established for all stormwater sources that are not subject to NJPDES regulation, and for all nonpoint sources. Both WLAs and LAs are expressed as percentage reductions for particular stream segments.

Table 7 identifies the required percent reduction necessary for each stream segment or group of segments to meet the fecal coliform SWQS. The reductions reported in these tables include a margin of safety factor and represent the higher percent reduction (more stringent) required of the two criteria. Reductions that are required under each criteria are located in Appendix C. In all cases, the 400 CFU/100ml criteria was the more stringent of the two criteria, thus values reported in Table 7 were equal to the percent required to meet the 400 CFU/100ml criteria.

Table 7 TMDLs for fecal coliform-impaired stream segments in the Northeast Water Region as identified in Sublist 5 of the 2002 Integrated List of Waterbodies. The reductions reported in this table represent the higher, or more stringent, percent reduction required of the two fecal colifom criteria.

TMDL No.	WMA	Station Name/Waterbody	Sublist 5 Segment	Summer Geometric Mean CFU/100ml	MOS as a percent of the target conc.[1]	Percent Reduction (LA) without MOS	Percent Reduction (LA) with MOS	Wasteload Allocation (WLA) as a Percent Reduction, with MOS
1	3	Macopin River at Macopin Reservoir	01382450	59	46%	-16%	**37%**	**37%**
2	3	Wanaque River at Highland Avenue	01387010	208	53%	67%	**85%**	**85%**
3	3	Ramapo River near Mahwah	01387500	431	44%	84%	**91%**	**91%**

TMDL No.	WMA	Station Name/Waterbody	Sublist 5 Segment	Summer Geometric Mean CFU/100ml	MOS as a percent of the target conc.[1]	Percent Reduction (LA) without MOS	Percent Reduction (LA) with MOS	Wasteload Allocation (WLA) as a Percent Reduction, with MOS
4	4	West Branch Saddle River at Upper Saddle R.	01390445	1,144	30%	94%	**96%**	**96%**
5	4	Saddle River at Saddle River	01390500					
6	4	Saddle River at Ridgewood Ave at Ridgewood	01390900					
7	4	Hohokus Brook at Mouth at Paramus	01391100					
8	4	Saddle River at Rochelle Park	01391200					
9	4	Saddle River at Lodi	01391500					
10	4	Passaic R. below Pompton R. at Two Bridges	01389005	652	30%	90%	**93%**	**93%**
11	4	Passaic River at Little Falls	01389500					
12	4	Preakness Brook near Little Falls	01389080					
13	4	Peckman River at West Paterson	01389600					
14	4	Deepavaal Brook at Fairfield	01389138					
15	4	Diamond Brook at Fair Lawn	01389860	1,544	47%	96%	**98%**	**98%**
16	4	Goffle Brook at Hawthorne	01389850					
17	5	Hackensack River at River Vale	01377000	294	34%	77%	**85%**	**85%**
18	5	Musquapsink Brook at River Vale	01377499	709	54%	90%	**96%**	**96%**
19	5	Pascack Brook at Westwood	01377500					
20	5	Tenakill Brook at Cedar Lane at Closter	01378387	159	91%	57%	**96%**	**96%**
21	5	Coles Brook at Hackensack	01378560	1,093	68%	94%	**98%**	**98%**
22	6	Black Brook at Madison	01378855	1,370	29%	95%	**96%**	**96%**
23	6	Passaic River near Millington	01379000					
24	6	Dead River Near Millington	01379200					
25	6	Passaic River near Chatham	01379500					
26	6	Canoe Brook near Summit	01379530					
27	6	Rockaway River at Longwood Valley	01379680	373	54%	82%	**92%**	**92%**
28	6	Rockaway River at Blackwell Street	01379853					
29	6	Beaver Brook at Rockaway	01380100	362	43%	81%	**89%**	**89%**
30	6	Stony Brook at Boonton	01380320	214	32%	68%	**78%**	**78%**
31	6	Rockaway River at Pine Brook	01381200	571	28%	88%	**91%**	**91%**
32	6	Passaic River at Two Bridges	01382000	276	33%	75%	**83%**	**83%**

[1] MOS as a percent of target is equal to: $\frac{e}{200\ CFU/100ml}$ or $\frac{e}{68\ CFU/100ml}$ where "e" is defined as the MOS in Section 7.2

8.2. 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 (Section 8.0), and both WLAs and LAs are expressed as percentage reductions for particular stream segments (Section 8.1). Therefore, the percent reductions from current levels must be attained in consideration of any new sources that may accompany future development.

9.0 Follow - up Monitoring

The NJDEP's primary surface water quality monitoring unit is the Office of Water Monitoring Management. In association with the Water Resources Division of the U.S. Geological Survey, the NJDEP 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. Bacteria monitoring, as part of the ASMN network, are conducted five times during a consecutive 30-day summer period each year. The data from this network has been used to assess the quality of freshwater streams and percent load reductions. Although other units also perform monitoring functions, the ASMN will remain a principal source of FC monitoring.

10.0 Implementation

When bacterial sources are easily identifiable, measures outlined in section 10.2, Source Categories and Best Management Practices (BMPs), will be applied to reduce bacterial loading to meet SWQ standards. When bacterial sources are not easily identifiable, load duration curves will be used in conjunction with bacterial source tracking, if necessary, to identify pathogen sources.

Much of the stormwater discharged to the surface waters in question is discharged through "small municipal separate storm sewer systems" (small MS4s) that are proposed to be regulated under the Department's proposed Phase II NJPDES stormwater rules for the Municipal Stormwater Regulation Program. Under those proposed rules and associated draft general permits, nearly all municipalities (and various county, State, and other agencies) in the Northeast Region will be required to implement various control measures that should substantially reduce bacteria loadings, including measures to eliminate "illicit connections" of domestic sewage and other waste to the small MS4, adopt and enforce a pet waste ordinance, prohibit feeding of unconfined wildlife on public property, clean catch basins, perform good housekeeping at maintenance yards, and provide related public education and employee training. The WLAs and LAs in Table 7 are not themselves "Additional Measures" under proposed N.J.A.C. 7:14A-25.6 or 25.8.

Sections 10.2 and 10.4 identify BMPs and monitoring measures that in some respects are in addition to the control measures required in these general permits. These BMPs and monitoring measures are also not "Additional Measures" under proposed N.J.A.C. 7:14A-25.6 or 25.8. However, the Department will seek to have these BMPs and monitoring measures implemented through means other than requirements in these general permits. Also, in the future, the Department may propose and adopt WQM plan amendments that identify one or more of these BMPs (or other BMPs) and monitoring measures as "Additional Measures" for some or all of the permittees under these general permits.

10.1. Load Duration Curve (LDC)

As explained in Section 6.2, a LDC can be a beneficial tool as a first step in identifying potential pathogen sources. LDCs for listed segments in the Northeast region are located in Appendix D. In each case, thirty (30) years of USGS gage flow data (water years 1970-2000), from the listed station, were used in generating the curve. When a recent 30-year period was not available at the listed station, an adjacent station was selected based on station correlation information in US Geological Survey Open File Report 81-1110 (USGS, 1982). When an adjacent station was used in the manner, flows were adjusted to the station of interest based on a ratio of watershed size. LDCs were not developed for stations in which a satisfactory correlation could not be found.

10.2. Source Categories and Best Management Practices

The TMDLs developed in this report were developed with the assistance of stakeholders in WMAs 3, 4, 5 and 6 as part of the Department's ongoing watershed management efforts. Through the creation of the watershed management planning process over the past several years, Public Advisory Committees (PACs) and Technical Advisory Committees (TACs) were created in all 20 WMAs. Whereas the PACs serve in an advisory capacity to the New Jersey Department of Environmental Protection, and examined and commented on a myriad of issues in the watersheds, the TACs were focused on the scientific, ecological, and engineering issues relevant to the mission of the PAC. The Department in collaboration with the Northeast TACs narrowed the scope of the primary sources of fecal contamination to the following:

Non-Human Sources of Fecal Coliform

- Canada geese
- Pet Waste
- Stormwater basins
- Direct stormwater discharges to waterbodies
- Farms, zoos and livestock

Human Sources of Fecal Coliform

- Malfunctioning or older improperly sized septic systems

- Failing sewage conveyance systems
- Improper garbage storage and disposal

10.3. Management Strategies

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). A combination of best management practices and direct remedies of illicit sources that are found through track-down monitoring will be used to implement these TMDLs.

10.3.1. Short-Term Management Strategies

Short-term management strategies include existing projects dubbed "Action Now" that are on the ground projects funded by the Department to address fecal and other NPS impairments to an impaired waterbody. These projects include stream bank restoration projects, ordinance development and catchbasin cleanouts. Funding sources include Clean Water Act 319(h) funds and State sources. Since 1998, 319(h) funds have provided approximately $3 million annually.Priority is given to funding projects that address TMDL implementation, development of stormwater management plans and projects that address impairment based on Sublist 5 listed waterbodies.

An example of such a project is a two-year project evaluating stormwater quality in a low-density residential area located in Hanover Township, Morris County. As part of the study, catch basin cleaning and public education and outreach were conducted. The outreach program targeted homeowners, landscapers and pet owners and was based on enhancing awareness and effecting behaviors that would reduce specific potential sources of NPS contaminants.

10.3.2. Long–Term Management Strategies

While short-term management measures will begin to reduce sources of fecal coliform in the Northeast Water Region, additional measures will be needed to verify and further reduce or eliminate these sources. Some of these measures may be implemented now, where resources are available and sources have already been identified as causing the fecal impairment. Both short-term and long-term management strategies that address fecal reduction related to these identified sources may be eligible for future Departmental funding.

Source Categories for Long-Term Management Strategies

1) Canada Geese

Geese are migratory birds that are protected by the Migratory Bird Treaty Act of 1918 and other Federal and State Laws. Resident Canada geese are those birds that do not migrate, but are protected by this and other legislation. The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS)-Wildlife Services program reports that the 1999 estimated population of non-migratory geese in New Jersey was 83,000. Geese and other pest waterfowl have been identified as one of several primary sources of pathogen loading to impaired water bodies in the Northeast Region. Geese may produce up to 1½ pounds of fecal matter a day.

Canada Goose Damage Management Plan

Because geese are free to move about and commonly graze and rest on large grassy areas associated with schools, parks, golf courses, corporate lawns and cemeteries, solutions are best developed and conducted at the community level through a community-based goose damage management program. USDA's Wildlife Services program recommends that a community prepare a written Canada Goose Damage Management Plan that may include the following actions:

- Initiate a fact-finding and Communication Plan
- Enact and Enforce a No Feeding Ordinance
- Conduct Goose Damage Control Activities such as Habitat Modification
- Review and Update Land Use Policies
- Reduce or Eliminate Goose Reproduction (permit required)
- Hunt Geese to Reinforce Nonlethal Actions (permit required)

Procedures such as handling nests and eggs, capturing and relocating birds, and the hunting of birds require a depredation permit from either the USDA APHIS Wildlife Services or U.S. Fish and Wildlife Services. Procedures requiring permits should be a last resort after a community has exhaustedthe other listed measures. The Department's draft guide *Management of Canada Geese in Suburban Areas, March 2001*, which may be found at www.state.nj.us/dep/watershedmgt under publications, provides extensive guidance on how to modify habitat to serve as a deterrent to geese as well as other prevention techniques such as education through signage and ordinances.

2) Stormwater Detention Basins and Impoundments

Stormwater detention basins may act as sources of fecal coliform due to the accumulation of geese and pet waste in basins. Under certain conditions, coliform will increase in numbers in basins. As a result, significant quantities of fecal coliform can be discharged during storm events.

Impoundments created by small dams across streams have been a measure commonly used for flood control by municipalities in New Jersey. In addition to flood control, the impoundments were often incorporated into public parks in order to provide recreational opportunities for residents. Many of the impoundments are surrounded by mowed turf areas, which in combination with open water serve as an ideal habitat for geese and an

attraction for pet walking. Specific management measures to reduce fecal coliform inputs to these waterbodies include:

- Development of Stormwater Management Plan
- Establishment of Riparian Buffers and "no mow" zones
- No feed ordinances for all waterfowl and wildlife and signage
- Retrofit of detention / retention basins to achieve water quality control
- Conduct regularly scheduled stormwater basin cleanout and maintenance, storm sewer inlet cleanouts and street sweeping programs

3) Pet Waste

Specific management measures to reduce pet waste include:

- Adoption of pet waste disposal i.e. pooper scooper ordinances
- Signage in parks and other public recreation areas
- Provide plastic bags dispensers in public recreation areas

4) Agricultural

Agricultural activities are potential sources of fecal coliform. Possible contributors are direct contributions from livestock permitted to traverse streams and stream corridors, manure management from feeding operations, use of manure as a soil fertilizer / amendment. Implementation of conservation management plans and best management practices are the best means of controlling agricultural sources of fecal coliform. Several programs are available to assist farmers in the development and implementation of conservation management plans and best management practices.

Agricultural Conservation Programs

The Natural Resource Conservation Service is the primary source of assistance for landowners in the development of resource management pertaining to soil conservation, water quality improvement, wildlife habitat enhancement, and irrigation water management. The USDA Farm Services Agency performs most of the funding assistance. All agricultural technical assistance is coordinated through the locally led Soil Conservation Districts. There are a number of USDA farm programs currently addressing NPS pollution. A few of these include:

- **The Environmental Quality Incentive Program (EQIP)** is designed to provide technical, financial, and educational assistance to farmers / producers for conservation practices that address natural resource concerns, such as water quality. Practices under this program include integrated crop management, grazing land management, well sealing, erosion control systems, agri-chemical handling facilities, vegetative filter strips / riparian buffers, animal waste management facilities and irrigation systems.

- **The Conservation Reserve Program (CRP)** is designed to provide technical and financial assistance to farmers / producers to address the agricultural impacts on water quality and to maintain and improve wildlife habitat. CRP practices include the establishment of filter strips, riparian buffers and permanent wildlife habitats. This program provides the basis for the Conservation Reserve Enhancement Program (CREP).

- **The Wetland Reserve Program (WRP)** is designed to address the restoration of previously farmed wetlands. Easements are purchased for a 10-year, 30-year, or permanent duration.

- **Integrated Crop Management** is a best management practice designed to reduce the application of fertilizers and herbicides using soil samples and education to control nutrient and pesticide application to cropland.

- **The Farmland Preservation Program (FPP)** is designed to strengthen the agricultural industry and preserve important farmlands to enhance the economy and quality of life in the Garden State. Four different programs are available: The eight-year Program, where landowners voluntarily restrict non-agricultural development on their land for 8 years. In exchange, participants are eligible for cost-sharing grants for soil and water conservation projects, as well as other statutory benefits and protections. The Easement Purchase Program, where landowners sell the development rights on their land to the County Agriculture Development Board (CADB), non-profit organizations or directly to the State. Compensation for this sale is based upon the appraised value of the development rights on the land. The landowner retains ownership of the land and is eligible for cost-sharing grants for soil and water conservation projects and other benefits. The Fee Simple Program, where farms are acquired by the State Agriculture Development Committee (SADC, which is in but not of, the NJDA) based upon their fair market value and auction them off to private owners, after agricultural deed restrictions have been placed on the land. Lastly, there is the Easement Donation Program, where landowners donate their development easements to the SADC or the CADB. All of these programs have been in place since 1983.

- **The Soil & Water Conservation Cost-Sharing Program** is available to participants in a Farmland Preservation Program pursuant to the Agriculture Retention and Development Act. A Farmland Preservation Program (FPP) means any voluntary FPP or municipally approved FPP, the duration of which is at least 8 years, which has as its principal purpose as long term preservation of significant masses of reasonably contiguous agricultural land within agricultural development areas. The maintenance and support of increased agricultural production must be the first priority use of the land. Eligible practices include erosion control, animal waste control facilities, and water management practices. Cost sharing is provided for up to 50% of the cost to establish eligible practices.

- **The State Conservation Cost Share Program (CCSP)** is administered by the State Soil Conservation Committee and is integrated with the federal Environmental Quality Incentives Program (EQIP). It provides technical and financial assistance to producers for prevention and control of nonpoint sources of pollution. Cost sharing is provided for up to 75%, and in some cases 90% of the cost of installing approved conservation practices. Applications are approved based upon their environmental benefits and water quality enhancements.

- **Conservation Reserve Enhancement Program (CREP).** The New Jersey Departments of Environmental Protection and Agriculture, in partnership with the Farm Service Agency and Natural Resources Conservation Service, has recently submitted a proposal to the USDA to offer financial incentives for agricultural landowners to voluntarily implement conservation practices on agricultural lands. The NJ Conservation Reserve Enhancement Program (NJ CREP) will be part of the USDA's Conservation Reserve Program (CRP). The enrollment of farmland into CREP in New Jersey is expected to improve stream health through the installation of water quality conservation practices on New Jersey farmland. Following are some highlights of the New Jersey CREP proposal:

    - 30,000 acres of agricultural land are targeted for conservation, with 4,000 acres of agricultural land targeted for permanent conservation easement. Farmland enrolled but not permanently preserved will be under rental contract for 10-15 years
    - Conservation practices under the program are riparian buffers, filter strips, contour buffer strips, and grass waterways.
    - Water quality benefits of the program are expected to assist in achieving biologically healthy streams.
    - Permanent preservation of 4,000 acres of CREP lands will aid in reaching open space preservation goals.
    - The proposal is for a $100 million program representing a 3:1 Federal/State match, with New Jersey providing $23 million and USDA – Commodity Credit Corporation committing $77 million.

5) Stormwater Management

The Department has recently proposed Stormwater Management Rules and NJPDES Phase II Municipal Stormwater Regulation Rules that will establish standards and a regulatory program for stormwater management. Stormwater general permits issued by the Municipal Stormwater Regulation Program will address stormwater pollution

6) Malfunctioning and Older Improperly Sized Septic Systems; Illicit Connections of Domestic Sewage

Malfunctioning and older improperly sized septic systems contribute to fecal coliform loading in two ways: the system may fail hydraulically, where there is surface break out; or

hydrogeologically, under conditions when soils are inadequate to filter pathogens. Specific management measures include the implementation of the NJPDES Municipal Stormwater Regulation Program, Sanitary Surveys, Septic System Management Programs and future sewer service area designations for service to domestic treatment works.

Sanitary surveys are conducted in an effort to evaluate the water quality of natural surface waters and identify those components that affect water quality, including geographic factors and pollution sources. The focus of the sanitary survey is to identify nonpoint and stormwater source contribution of fecal coliform within the watershed. It is accomplished by sampling for various types of fecal indicators (fecal coliform, enterococcus, fecal streptococcus, *E. coli* and coliphage) during wet and dry weather conditions. Where potential problems with septic systems are identified, as described below, a trackdown study may be warranted. This could lead to an analysis of alternatives to address any identified inadequacies, such as rehabilitation of septic systems or connection to a sewage treatment system, as appropriate.

10.4. Potential Sources of Fecal Impairment to Impaired Water Bodies

In an effort to locate pathogen sources to streams listed in this report, each stream segment was walked and potential sources noted based on the source categories listed in Section 10.2. The information gathered during those site visits is listed below by their respective WMA. The below are not considered to be a list of comprehensive sources, rather they will be used in conjunction with additional site visits, LDCs, and as appropriate, bacterial source tracking to identify actual pathogen sources.

10.4.1. Watershed Management Area 3

Macopin River at Macopin Reservoir (Site ID #01382450)

Potential sources noted within this watershed include detention basins at the upper end of Echo Lake, stables (Echo Lake Stables) located on east Echo Lake Road near Echo Lake above Macopin Gorge, and potential septic source located on Route 23 (City of Newark).

Wanaque River at Highland Avenue (Site ID #01387010)

Canada Geese were observed at a number of locations within this watershed. These areas include: the Wanaque Athletic Fields, Lake Inez, Lower Twin Lake (large geese population), and Skyland Lake. Possible problem stormwater detention basins were noted specifically at Pompton Lakes, Lake Inez and Skyland Lake. Potential failing septics noted at Dupont Village and Wanaque; these areas in the process of being sewered. . Possible pet sources observed at Lower Twin Lake and Skyland Lake.

Ramapo River near Mahwah (Site ID #01387500)

Potential sources in failing septic systems located in Oakland. Almost all Oakland is on septic systems, many failing and solid rock below ~3-feet. Stormwater outfalls present where Masonicus Brook and Mahwah Rivers converge. Canada geese observed at Ramapo College atlethic fields, and other recreational fields. Horse farms located across from Ramapo College. Crystal Lake (bathing beach) has been closed several times due to high fecal concentrations.

10.4.2. Watershed Management Area 4

Passaic River below Pompton River at Two Bridges (Site ID #01389005)

This entire segment is highly developed with many stormwater outfalls, however, much of this area was developed prior to the practice of constructing detention basins. This area may benefit from stormwater management retrofits. Sources upstream on the Pompton River at Packanack Lake (Site ID #01388600) include potential failing septic systems in the Hoffman Grove section of Wayne (110 homes potential); open manure storage observed on Black Oak Ridge Road and Cross Road. Canada Geese observed at Wayne Municipal Park (Sheffield Fields), Packanack Lake Country Club, Pompton Lakes crossroads at golf driving range, Old MacDonald Park, Pequannock Park (directly above testing site), and Kehum Park.

Preakness Brook near Little Falls (Site ID #01389080)

Potential sources include: animal agriculture from Van Pien Dairy Farm, pet sources from Tintle Park, wildlife and geese sources from Preakness Golf Course, High School on Valley Road, High Mountain Golf Course, Wetland area,

Deepavaal Brook at Fairfield (Site ID #01389138)

Geese were observed at Mountain Ridge Golf Course and Green Brook Country Club.

Passaic River at Little Falls (Site ID #01389500)

Geese observed at the Passaic County Golf Course on River Road and island middle of Passaic River. Potential human source from a significant homeless population. Several stormwater pipes observed to discharge directly to the river.

Peckman River at West Paterson (Site ID #01389600)

Geese and wildlife were observed in several areas including: town parks, reservoir lands, golf course, and Essex County park. Other potential sources included pet waste from residential areas located adjacent to the river and stormwater pipes discharging directly to river north of the golf course.

Goffle Brook at Hawthorne (Site ID #01389850)

Site visit confirmed over 200 geese, 150 ring-billed and laughing gulls, 75 ducks and 100 pigeons, and pets at Goffle Brook Park. Potential source includes failing septic systems in upper reach.

Diamond Brook at Fair Lawn (Site ID #01389860)

Geese, wildlife, pet wildlife observed at the Passaic County Park System. Geese observed at the Vander Plat Park fields. Garbage, including disposable diapers, observed behind Pathmark on Hemlock Ave. Geese observed at Fair Lawn Memorial Cemetery.

WB Saddle River at Upper Saddle River (Site ID #01390445)

Stormwater, Geese, and wildlife noted as potential sources.

Saddle River at Ridgewood (Site ID #01390500)

Potential septic system impact from homes located directly beside the river on Old Stone Church Road. Gulls, cormorants (16) and over 80 geese observed at Otto C. Pehle Section of Saddle River Park. Pets, wildlife observed throughout the watershed and potential impact from Wild Duck Pond Park.

Ramsey Brook at Allendale (Site ID #01390900)

Wildlife (geese, deer, foxes, and dogs) observed at Crestwood Park. Geese and other wildlife observed at Apple Ridge golf course, Ramsey Country Club golf course, Lake Street at Ramsey, and Napolekao Pond. Potentially failing septics in Mahwah.

HoHoKus Brook at the mouth of the Saddle River, Paramus (Site ID #01391100)

Potential failing septic systems in HoHoKus and Wyckoff. Geese observed or apparent at Whites' Pond, Saddle River Park, Glen Rock Section (50 geese observed), Dunkerhook Park, and Wild Duck Pond. Dog walking observed at Saddle River Park, Glen Rock Section and Dunkerhook Park. Poultry farm observed and appears to be an enclosed operation

Saddle River at Fairlawn (Site ID #01391200)

Wildlife (150 geese, 75 seagulls, 25 doves) observed at Saddle River park, Wild Duck Pond area. No-feed signs posted (dog and waterfowl both), however, people observed still feeding waterfowl. At the Saddle River Park at Rochelle Park, no geese were observed but physical signs apparent and ducks appear to be fed. Geese observed at Bergen County Golf Courses and Ridgewood Country Club.

Saddle River at Lodi (Site ID #01391500)

Geese and pet walking observed at the Main St. Cemetery.

10.4.3. Watershed Management Area 5

Hackensack River at River Vale (Site ID #01377000)

Geese observed at Golf Course, Open Spaces, and County Park. Septic Systems in Old Tappan recently converted to sewers.

Musquapsink Brook at River Vale (Site ID #01377499)

Canada Geese observed at elementary school ballfields and nearby cemeteries. No septics are located in this area. Pumping from the Saddle River and discharging to the Musquapsink Brook represents a potential source of FC.

Pascack Brook at Westwood (Site ID #01377500)

No septics are located in this area. Potential sources included: Woodcliff Lake Reservoir, Corporate Parks in Montvale (source of geese droppings to Bear Brook which feeds into Pascack Brook), waste management transfer station, geese around the Woodcliff Lake, stormdrains discharge into Woodcliff Lake, and street sweeping materials from DPWs for Park Ridge, Hillsdale, and Westwood.

Tenakill Brook at Cedar Lane at Closter (Site ID #01378387)

Potential sources include: failing septics in Alpine, geese and waterfowl at Tenakill Middle School ballfields, Alpine Country Club, Tenafly Park, Demarest Nature Center, and Demarest Park/Duck Pond. The municipal park is located adjacent to Demarest Duck pond along Tenakill Brook and is subjected to geese and other waterfowl depositing droppings on turf areas within the park. Demarest Duck Pond is also the receiving body for stormwater outfalls that capture runoff from nearby roads, residential areas and commercial areas. Dredging of Demarest Duck Pond is slated for completion during 2003. Demarest Borough is committed to the shoreline restoration and nonpoint source improvement to the pond and park area and has sought additional funding to stabilize 1,600 linear feet of degraded shoreline around Demarest Duck Pond along Tenakill Brook with a 20 foot wide native vegetative buffer. The Environmental Commission has already implemented several small restoration projects along Tenakill Brook and is an active participant in the Department's Watershed process.

Coles Brook at Hackensack (Site ID #01378560)

No septics or agriculture are located in this watershed. Geese/Waterfowl, disposable diapers, and dog waste observed at Van Saun Park. Potential sources of pet waste include Oradell, River Edge, Paramus, and Emerson residential areas. Geese observed at the Emerson Golf Course, Paramus Middle School alongside Bkanky Brook (feeds into Coles Brook). Zoo observed, however, recently tied to sanitary sewer.

10.4.4. Watershed Management Area 6

Black Brook at Madison (Site ID #01378855)

The headwaters of this segment include the Fairmount Country Club where geese are a contributing factor. At Green Village Packing Company on Britten Road in Green Village, residents have reported that the company has, in recent years, dumped its animal wastes and scraps into local woods. Following complaints, the company has been shipping them out via truck. Recent complaints are that the trucks leak. Other potential sources include: Miele Kennel, Rolling Knolls Landfill, Britten Road, Chatham, and wildlife (deer and geese)

Passaic River Near Millington (Site ID #01379000)

This segment is directly adjacent to the Great Swamp Wildlife Refuge, thus wildlife are a potential source. Geese populations were observed at the following locations: AT&T Corporation grounds off Madisonville Road, Somerset County Environmental Education Center ponds, Southard Park, Basking Ridge Golf Course, northeast of the intersection of White Bridge Road and Carlton Road, at the Southwest corner of the intersection of White Bridge Road and Pleasant Plains Road, east of Pleasant Plains Road, north of White Bridge Road; east of the Passaic River, north of Stone House Road; and south of White Bridge Road, east of Pleasant Plains Road in Long Hill Township. The majority of this watershed contains urbanized landuse that has many detention basins, pets, and deer. Other potential sources include: Somerset County horse stables and horse trails through Lord Stirling Park and livestock populations at the southwest corner of the intersection of White Bridge Road and Carlton Road; east of the Passaic River, north of Stone House Road; and east of Pleasant Plains Road between White Bridge Road and Sherwood Lane.

Dead River Near Millington (Site ID #01379200)

Potential sources in this watershed include: Geese (New Jersey National Golf Course, Pleasant Valley road near King George Road where a large geese population of approximately 1000 was observed), pets, livestock and pastures present.

Passaic River Near Chatham (Site ID #01379500)

The following potential sources in this watershed include: geese (at Canoe Brook Country Club, Brook Lake Country Club and Cedar Ridge Country Club), wildlife, failing septics, pets, detention basins, and landfills (Bradley Loren Landfill, Florham Park Borough Waste Landfill, Vitto Marchetto Sanitary Landfill, Passaic Township Sanitary Landfill)

Canoe Brook Near Summit (Site ID #01379530)

Geese are suspected at Essex Fells Country Club, Crestmont Country Club, East Orange Golf Club and Summit Municipal Golf Course. Wildlife, especially deer, and pets are also thought to contribute a bacteria load.

Rockaway River at Longwood Valley (Site ID #01379680)

Wildlife and failing septics noted as potential sources.

Rockaway River at Blackwell Street (Site ID #01379853)

Potential sources include Hurd Park (goose population, no riparian buffer), and landfills.

Beaver Brook near Rockaway (Site ID #01380100)

This watershed contains several lake communites; many of which are on septic systems. Thus the potential for failing septics exist throughout the watershed. A portion of this watershed is designated as wildlife management area or reservoir protection area, thus, wildlife contribution is a potential. Geese observed at Rockaway Township recreational field located off of Old Beach Glen.

Stony Brook at Boonton (Site ID #01380320)

Canada geese observed at the picnic area of Pyramid Mountain Natural Historic Area, and at Rockaway Valley athletic fields off of Rockaway Valley Road, in Caterbury, and on Hill Road. Livestock operations are located off of Hill Road abutting a tributary to the impaired segment, near intersection of Kingsland and Rockaway Valley, and at intersection of Birchwood and Valley.

Rockaway River at Pine Brook (Site ID #01381200)

Potential sources include: Sharkey Landfill, Ecology Lake Club Sanitary Land Fill, Knoll East County Club Golf Course, wildlife, and geese.

Passaic River at Two Bridges (Site ID #01382000)

Wildlife and leaking septics noted as potential sources.

10.5. Pathogen Indicators and Bacterial Source Tracking

Advances in microbiology and molecular biology have produced several methodologies that discriminate among sources of fecal coliform and thus more accurately identify pathogen sources. The numbers of pathogenic microbes present in polluted waters are few and not readily isolated nor enumerated. Therefore, analyses related to the control of these pathogens must rely upon indicator microorganisms. The commonly used pathogen indicator organisms are the coliform groups of bacteria, which are characterized as gram-negative, rod-shaped bacteria. Coliform bacteria are suitable indicator organism because they

are generally not found in unpolluted water, are easily identified and quantified, and are generally more numerous and more resistant than pathogenic bacteria (Thomann and Mueller, 1987).

Tests for fecal organisms are conducted at an elevated temperature (44.5°C), where the growth of bacteria of non-fecal origin is suppressed. While correlation between indicator organisms and diseases can vary greatly, as seen in several studies performed by the EPA and others, two indicator organisms *Esherichia coli* (*E. coli*) and enterococci species showed stronger correlation with incidence of disease than fecal coliform (USEPA, 2001). Recent advances have allowed for more accurate identification of pathogen sources. A few of these methods, including, molecular, biochemical, and chemical are briefly described in the following paragraph.

Molecular (genotype) methods are based on the unique genetic makeup of different strains, or subspecies, of fecal bacteria (Bowman et al, 2000). An example of this method includes "DNA fingerprinting" (i.e., a ribotype analysis which involves analyzing genomic DNA from fecal *E. coli* to distinguish human and non-human specific strains of *E. coli*.). Biochemical (phenotype) methods include those based on the effect of an organism's genes actively producing a biochemical substance (Graves et al., 2002; Goya et al 1987). An example of this method is multiple antibiotic resistance (MAR) testing of fecal *E. coli.* In MAR testing, *E. coli* are isolated from fecal samples and exposed to 10-15 different antibiotics. In theory, *E. coli* originating from wild animals should show resistance to a smaller number of antibiotics than *E. coli* originating from humans or pets. Given this general trend, MAR patterns or '"signatures" can be defined for each class of *E. coli* species. Chemical methods are based on finding chemical compounds associated with human wastewater, and useful in determining if the sources are human or non-human. Such methods measure the presence of optical brighteners, which are contained in all laundry detergents, and soap surfactants in the water column. Unlike the optical brightener method, the measurement of surfactants may allow for some quantification of the source.

BST methods have already been successfully employed at the NJDEP in the past decade. Since 1988, the Department's Bureau of Marine Water Monitoring has worked cooperatively with the University of North Carolina in developing and determining the application of RNA coliphage as a pathogen indicator. This research was funded through USEPA and Hudson River Foundation grants. These studies showed that the RNA coliphages are useful as an indicator of fecal contamination, particularly in chlorinated effluents and that they can be serotyped to distinguish human and animal fecal contamination. Through these studies, the Department has developed an extensive database of the presence of coliphages in defined contaminated areas (point human, non-point human, point animal, and non-point animal). More recently, MAR and DNA fingerprinting analyses of *E. coli* are underway in the Manasquan estuary to identify potential pathogen sources (Palladino and Tiedemann, 2002). These studies along with additional sampling within the watershed will be used to implement the necessary percent load reduction.

10.6. Reasonable Assurance

With the implementation of follow-up monitoring, source identification and source reduction, the Department is reasonably assured that New Jersey's Surface Water Quality Standards will be attained for fecal coliform. Activities directed in the watersheds to reduce fecal coliform loading shall include options, included but not limited to education projects that teach best management practices, approval of projects funded by CWA Section 319 Nonpoint Source (NPS) Grants, recommendations for municipal ordinances regarding feeding of wildlife and pooper-scooper laws, and stormwater control measures.

The fecal coliform reductions proposed in these TMDLs assume that existing NJPDES permitted municipal facilities will continue to meet New Jersey's Surface Water Quality Standard requirements for disinfection. Any future facility will be required to meet water quality standards for disinfection.

11.0 Public Participation

The Water Quality Management Planning Rules NJAC 7:15-7.2 require 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. Accordingly the Department shall propose each TMDL as an amendment to the appropriate areawide water quality management plan. As part of the public participation process for the development and implementation of the TMDLs for fecal coliform in the Northeast Water Region, the NJDEPs, Division of Watershed Management, Northeast Bureau worked collaboratively with a series of stakeholder groups throughout New Jersey as part of the Department's ongoing watershed management efforts.

The Department's watershed management process was designed to be a comprehensive stakeholder driven process that is representative of members from each major stakeholder group (agricultural, business and industry, academia, county and municipal officials, commerce and industry, purveyors and dischargers, and environmental groups). As stated previously, through the creation of this watershed management planning process over the past several years Public Advisory Committees (PACs) and Technical Advisory Committees (TACs) were created in all 20 WMAs. Whereas the PACs serve in an advisory capacity to the Department, and examined and commented on a myriad of issues in the watersheds, the TACs were focused on scientific, ecological, and engineering issues relevant to the mission of the PAC.

The Northeast Bureau discussed with the WMA 3, WMA 4, WMA 5 and WMA 6 TAC members the Department's TMDL process through a series of presentations and discussions that culminated in the development of the 32 TMDLs for Streams Impaired by Fecal Coliform in the Northeast Water Region. The below paragraphs outline public involvement.

- Integrated Listing Methodology presentations were made by the Northeast Bureau within the DWM to the Northeast TACs throughout the month June; requesting that they review the Integrated List and submit comments to the Department by the September deadline. Presentations were made to WMA 5 TAC on June 18, 2002; WMA 6 TAC on June 20, 2002; WMA 3 TAC on June 21, 2002; and WMA 4 TAC on June 27, 2002.
- Expedited Fecal Coliform and Lake TMDL presentations were given at the September TAC meetings. The finalized Sublist 5 list was also disseminated. The TACs were briefed about the executed Memorandum of Agreement between the Department and EPA Region 2 with the imminent timeline. The TACs were asked to review sites and think about sources for discussion at the October TAC meetings at which time the Northeast Bureau would bring maps with municipalities and impaired stream segments and other features to facilitate the conversation.
- At the October TAC meetings (WMA 5: October 15, 2002; WMA 3 October 19, 2002; WMA 4 October 24, 2002 and WMA 6 October 28, 2002) TAC members were asked to identify based on their local knowledge potential sources of impairment. Draft copies of the Northeast Fecal TMDL report were distributed for informational purposes only. TAC members were advised that the formal comment period would be during the New Jersey Register Notice, but that the Department was interested in their input on policy issues affecting the development of the TMDL.
- At the November and December TAC meetings, the draft Fecal TMDL Report was distributed for informal comments prior to the NJR Notice.

Additional public participation and input was received through the NJ EcoComplex. The Department contracted with Rutgers NJ EcoComplex (NJEC) in July 2001. The role of NJEC is to provide comments on the Department's management strategies, including those related to the development of TMDL values. NJEC consists of a review panel of New Jersey University professors who provide a review of the technical approaches developed by the Department. The New Jersey Statewide Protocol for Developing Fecal TMDLs was presented to NJEC on August 7, 2002 and was subsequently reviewed and approved. The statewide approach was also presented the Passaic TMDL Workgroup in May 2002 for their input and approval. The New Jersey's Statewide Protocol for Developing Lake and Fecal TMDLs was presented by the Northeast Bureau at the SETAC Fall Workshop on September 13, 2002 and met with their approval.

11.1. AmeriCorps Participation

AmeriCorps is a national service initiative that was started in 1993 and is the domestic Peace Corps. The New Jersey Watershed Ambassadors Program is a community-oriented AmeriCorps environmental program designed to raise awareness about watershed issues in New Jersey. Through this program, AmeriCorps members are placed in watershed management areas across the state to serve their local communities. Watershed Ambassadors monitor the rivers of New Jersey through River Assessment Teams (RATs) and Biological Assessment Teams (BATs) volunteer monitoring programs.

Representatives from the Department in conjunction with the Watershed Ambassadors conducted RATs surveys on each of the impaired segments. These visual assessments were conducted from October to December 2002.

11.2. Public Participation Process

In accordance with N.J.A.C. 7:15–7.2(g), these TMDLs are hereby proposed by the Department as an amendment to the Northeast Water Quality Management Plan. N.J.A.C. 7:15-3.4(g)5 states that when the Department proposes to amend the areawide plan on its own initiative, the Department shall give public notice by publication in a newspaper of general circulation in the planning area, shall send copies of the public notice to the applicable designated planning agency, if any, and may hold a public hearing or request written statements of consent as if the Department were an applicant. The public notice shall also be published in the New Jersey Register.

Notice of these TMDLs was published January 21, 2003 pursuant to the above noted Administrative Code, in order to provide the public an opportunity to review the TMDLs and submit comments. The Department has determined that due to the level of interest in these TMDLs, a public hearing will be held. Public notice of the hearing, provided at least 30 days before the hearing, was published in the New Jersey Register and in two newspapers of general circulation and will be mailed to the applicable designated planning agency, if any, and to each party, if any, who was requested to issue written statement of consents for the amendment.

All comments received during the public notice period and at any public hearings will become part of the record for these TMDLs. All comments will be considered in the establishment of these TMDLs and the ultimate adoption of these TMDLs. When the Department takes final agency action to establish these TMDLs, the final decision and supporting documentation will be sent to U.S.E.P.A. Region 2 for review and approval pursuant to 303(d) of the Clean Water Act (33 U.S.C. 1313(d)) and 40 CFR 130.7.

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Appendix A: Explanation of stream segments in Sublist 5 of the *2002 Integrated List of Waterbodies* for which TMDLs will not be developed in this report.

Data to support removing River Segments from List 5 to List 1 for Fecal Coliform.

- Pequannock River at Macopin Intake Dam, Station #01382500

Re-assessments of data from station #01382500, the Pequannock River at Macopin Intake Dam, indicate that the water quality standards are met at this location. Measurements taken between 2/22/1994 and 7/17/00 at Station #01382500, show a geometric mean of 34 CFU/100 ml, and that 7.8% of values are over 400 CFU/100ml.

River segments to be moved from Sublist 5 to Sublist 3 for fecal coliform.

- Wanaque River at Wanaque, #01387000;
- Hackensack River at New Milford, #01378500

Two segments listed on Sublist 5, station #01387000, the Wanaque River at Wanaque (WMA 3), and station #01378500 the Hackensack River at New Milford (WMA 5), were included on Sublist 5 based on their listings on previous 303(d) lists with no recent data to assess their current attainment status. Therefore, TMDLs will not be developed for these locations until and unless recent data indicated violations of the surface water quality standards.

River segments to be moved from Sublist 5 to Sublist 4 for fecal coliform.

- Whippany River at Morristown, #01381500;
- Whippany River near Pine Brook, #01381800

Two segments, #01381500, the Whippany River at Morristown, and #01381800, the Whippany River near Pine Brook, were included as part of the Whippany River Watershed Fecal Coliform TMDL adopted on 4/16/2000 and published in the New Jersey Register on 6/5/2000. Upon adoption of this TMDL Report, the Department will remove these two waterbodies for fecal coliform from Sublist 5 to move them to Sublist 4 as identified in the below table.

Sublist 5 river segments listed for fecal coliform for which TMDLs will not be developed in this report.

- Passaic River at Elmwood Park, #01389880

The Passaic River at Elmwood Park, segment #01389880, is located in an area affected by combined sewer overflows (CSOs). CSOs are sewage systems that use a single pipe to transport both stormwater runoff from rainstorms and sewage from households, businesses

and industries to sewage treatment plants. During dry weather, combined sewers send all wastewater to the STPs. During wet weather, stormwater quickly fills the combined sewers, which carry both sanitary sewage and runoff from streets, parking lots, and rooftops. The overflows carry bacteria from the untreated sewage as well as other pollutants in the stormwater. Additional potential FC sources were identified during a site visit on October 24, 2002 and include geese (at park on River Road across from High School), homeless populations, and dog pounds/shelters.

The methodology employed in this report is not appropriate for use in areas affected CSOs, thus, this stream segment will be addressed with a separate management approach.

List of Sublist 5 segments to be moved to Categories 1, 3 or 4 based upon reassessment of data, the need for current data, or the prior completion of a TMDL report.

WMA	Station Name/Waterbody	Site ID	New Sublist Listing	Explanation
03	Pequannock River at Macopin Intake Dam	01382500	Sublist 1	Re-assessment shows non-impairment
03	Wanaque River at Wanaque	01387000	Sublist 3	Updated monitoring needed
04	Passaic River at Elmwood Park	01389880	No change	CSO influence
05	Hackensack River at New Milford	01378500	Sublist 3	Updated monitoring needed
06	Whippany River at Morristown	01381500	Sublist 4	TMDL completed in 1999
06	Whippany River near Pine Brook	01381800	Sublist 4	TMDL completed in 1999

Appendix B: Municipal POTWs Located in the TMDLs' Project Areas

WMA	Station #	NJPDES	Facility Name	Discharge Type	Receiving waterbody
3	1387500	NJ0027774.001A	Oakland Boro - Oakwood Knolls	MMI	Ramapo River via storm sewer
3	1387500	NJ0080811.001A	Oakland Twp - Riverbend	MMI	Ramapo River
3	1387500	NJ0021253.001A	Ramapo BOE - Indian High	MMI	Pond Creek (Ramapo River)
3	1387500	NJ0053112.001A	Oakland Boro - Chapel Hill Estates	MMI	Ramapo River via pond and storm sewer
3	1387500	NJ0021342.001A	Oakland Boro Skyview-Highbrook STP	MMI	Caille Lk via unnamed tributary & storm sewer
3	1387500	NJ0021946.001A	US Army - Nike Base	MMI	Darlington Brook via unnamed tributary
3	1387500	NJ0030384.001A	Oakland BOE - Manito Ave	MMI	Caille Lake via unnamed tributary and storm sewer
3	1387500	NJ0030384.001V	Oakland BOE - Manito Ave	MMI	Caille Lake via unnamed tributary and storm sewer
4	1389600	NJ0025330.001A	Cedar Grove Twp STP	MMJ	Peckman River
4	1389600	NJ0024490.004A	Verona Twp	MMJ	Peckman River
4	1389600	NJ0021687.001A	Essex County Hospital	MMJ	Peckman River
4	1389080	NJ0028002.001A	Wayne Twp - Mountain View	MMJ	Singac Brook (Preakness)
4	1389080	NJ0021261.001A	NJDHS-NJ Development Center	MMI	Passaic River
6	1379200	NJ0022845.001A	Harrison Brook STP	MMJ	Dead River
6	1379500	NJ0020427.001A	Caldwell Boro STP	MMJ	Passaic River via unnamed tributary
6	1379500	NJ0024511.001A	Livingston Twp	MMJ	Passaic River
6	1379500	NJ0025518.001A	Florham Park SA	MMJ	Passaic River
6	1379500	NJ0024937.001A	Molitor Water Pollution	MMJ	Passaic River
6	1379500	NJ0021636.001A	New Providence Boro	MMJ	Passaic River
6	1379500	NJ0024937.002A	Molitor Water Pollution	MMJ	Passaic River
6	1379500	NJ0027961.001A	Berkeley Heights	MMJ	Passaic River
6	1379500	NJ0020427.SL3A	Caldwell Boro STP	MMJ	Sludge Application
6	1379500	NJ0020427.SL3B	Caldwell Boro STP	MMJ	Sludge Application
6	1379500	NJ0020427.SL3M	Caldwell Boro STP	MMJ	Sludge Application
6	1381200	NJ0022349.001A	Rockaway Valley SA	MMJ	Rockaway River
6	1381200	NJ0024970.001A	Parsippany-Troy Hills SA	MMJ	Whippany River
6	1378855	NJ0020290.001A	Chatham Township - Main	MMI	Black Brook
6	1379200	NJ0021083.001A	Veterans Adm Medical Center	MMI	Harrisons Brook via unnamed tributary
6	1379200	NJ0022497.001A	Warren Twp SA - Stage 4	MMI	Dead River
6	1379200	NJ0050369.001A	Warren Twp SA - Stage 5	MMI	Dead River
6	1379500	NJ0020281.001A	Chatham Hill STP	MMI	Passaic River
6	1379500	NJ0052256.001A	Chatham Township - Chatham Glen	MMI	Passaic River

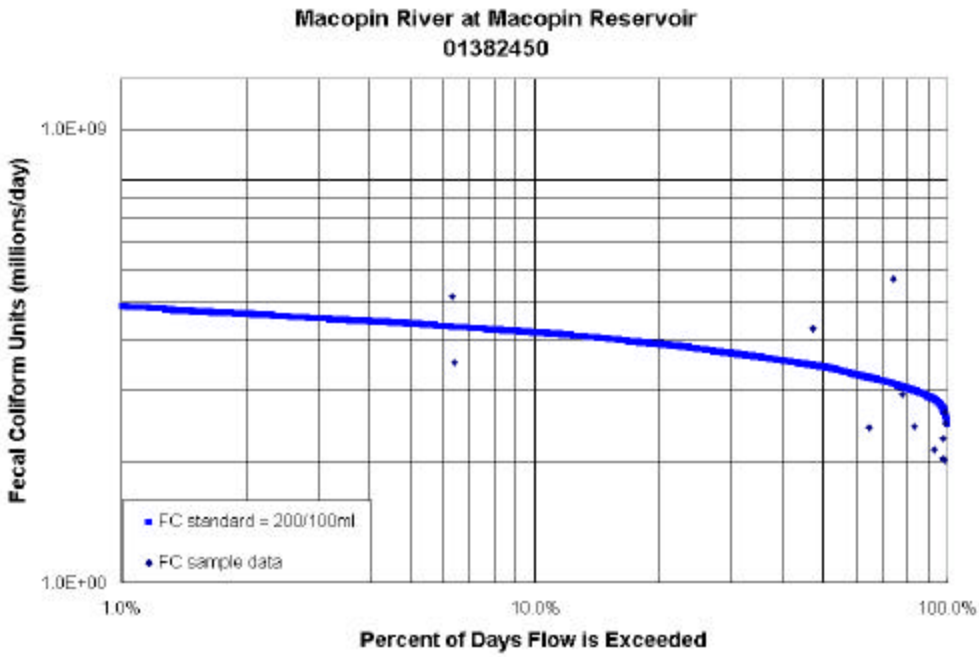
6	1379500	NJ0022489.001A	Warren Twp SA - Stage 1 & 2	MMI	Passaic River
6	1379500	NJ0024465.001A	Long Hill Twp STP - Stirling Hills	MMI	Passaic River
6	1379500	NJ0021938.001A	US Army - Nike Base	MMI	Passaic River
6	1380320	NJ0022276.001A	Stonybrook School	MMI	Untermeyer Lake via storm sewer
6	1379680	NJ0021091.001A	Jefferson Twp High - Middle School	MMI	Edison Brook
6	1379680	NJ0026867.001A	Jefferson Twp - White Rock	MMI	Mitt Pond (Russia Brook)
6	1379853	NJ0026603.001A	Randolph Twp BOE - High School	MMI	Mill Brook via unnamed tributary
6	1379853	NJ0032808.001A	Rockaway Townsquare Mall	MMI	Green Pond Brook

Appendix C: TMDL Calculations

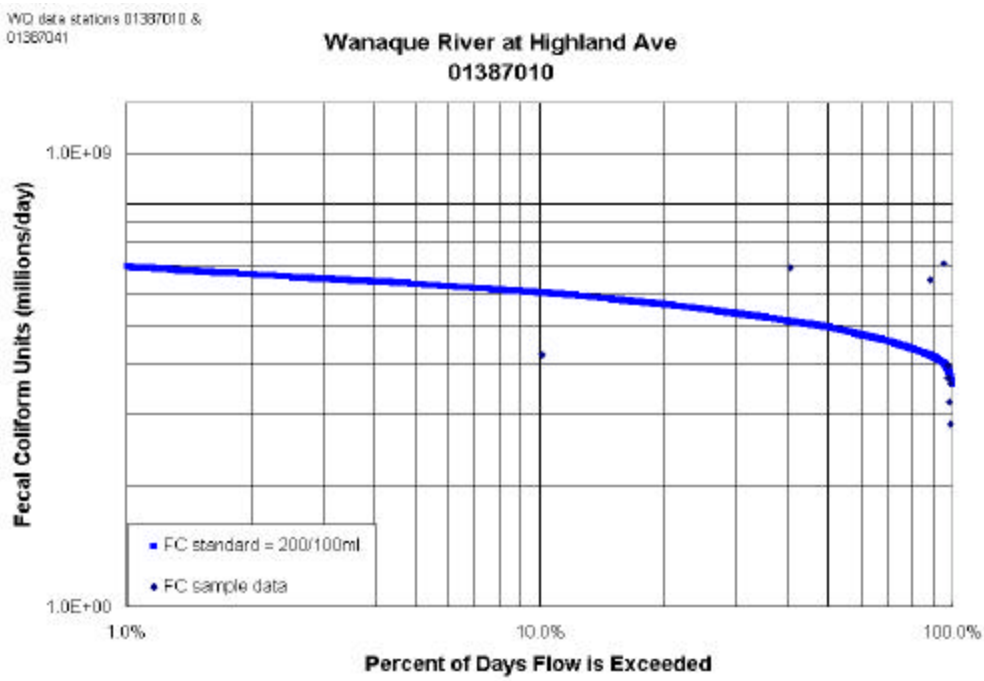
WMA	Station Names	303(d) Category 5 Segments	Water Quality Stations	Load Allocation (LA) and Margin of Safety (MOS)								Wasteload Allocation (WLA)
				200 FC/100ml Standard				400 FC/100ml Standard				
				Geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	Summer geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	
3	Macopin R at Echo Lake, Macopin R at Macopin Reservoir	01382450	01382410, 01382450	59	46%	-240%	-85%	59	46%	-16%	37%	37%
3	Wanaque R at Highland Avenue, Wanaque R at Pompton Lakes	01387010	01387010, 01387041	160	53%	-25%	42%	208	53%	67%	85%	85%
3	Ramapo R near Mahwah	01387500	01387500	291	44%	31%	61%	431	44%	84%	91%	91%
4	West Branch Saddle R at Upper Saddle River, Saddle R at Saddle River, Saddle R at Ridgewood Ave, Saddle R at Grove St., Ramsey Bk at Allendale, Hohokus Bk at Paramus, Saddle R at Rochelle Park, and Saddle R at Lodi	01390445, 01390500, 01390900, 01391100, 01391200, 01391500	01390445, 01390470, 01390510, 01390518, 01390900, 01391100, 01391490, 01391500	1,157	30%	83%	88%	1,144	30%	94%	96%	96%
4	Passaic R below Pompton R at Two Bridges, Passaic R at Little Falls, Preakness Bk, near Little Falls, Peckman R at W. Patterson, and Deepavaal Bk at Fairfield	01389005, 01389500, 01389080, 01389600, 01389138	01389500, 01389080, 01389600, 01389138	583	30%	66%	76%	652	30%	90%	93%	93%
4	Goffle Bk at Hawthorne, Diamond Bk at Fair Lawn	01389850, 01389860	01389850, 01389860	1,515	47%	87%	93%	1,544	47%	96%	98%	98%

WMA	Station Names	303(d) Category 5 Segments	Water Quality Stations	Load Allocation (LA) and Margin of Safety (MOS)								Wasteload Allocation (WLA)
				200 FC/100ml Standard				400 FC/100ml Standard				
				Geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	Summer geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	
5	Hackensack R. at Rivervale	01377000	01377000, 01376970	248	34%	19%	46%	294	34%	77%	85%	85%
5	Pascack Br at Westwood and Musquapsink Br at Rivervale	01377499, 01377500	01377499, 01377500	709	54%	72%	87%	709	54%	90%	96%	96%
5	Tenakill Br at Cedar Lane at Closter	01378387	01378387	159	91%	-26%	88%	159	91%	57%	96%	96%
5	Coles Br at Hackensack	01378560	01378560	1,093	68%	82%	94%	1,093	68%	94%	98%	98%
6	Black Brook at Madison, Passaic R nr Millington, Dead R nr Millington, Canoe Brook nr Summit, Passaic R nr Catham	01378855, 01379000, 01379200, 01379530, 01379500	01378855, 01379000, 01379200, 01379530, 01379500	675	29%	70%	79%	1,370	29%	95%	96%	96%
6	Rockaway R at Longwood Valley, Rockaway R at Berkshire Valley, Rockaway R at Blackwell St.	01379680, 01379853	01379680, 01379700, 01379853	253	54%	21%	64%	373	54%	82%	92%	92%
6	Beaver Brook at Rockaway	01380100	01380100	362	43%	45%	68%	362	43%	81%	89%	89%
6	Stony Brook at Boonton	01380320	01380320	214	32%	7%	37%	214	32%	68%	78%	78%
6	Rockaway R at Pine Brook	01381200	01381200	281	28%	29%	49%	571	28%	88%	91%	91%
6	Passaic R at Two Bridges	01382000	01382000	227	33%	12%	41%	276	33%	75%	83%	83%

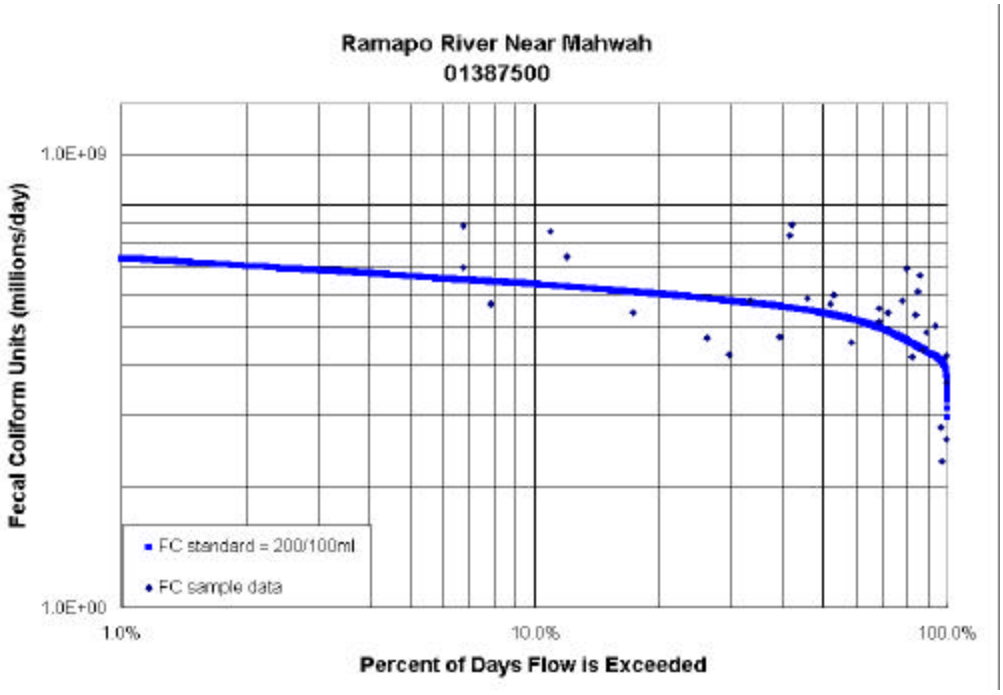
Appendix D: Load Duration Curves for each listed waterbody



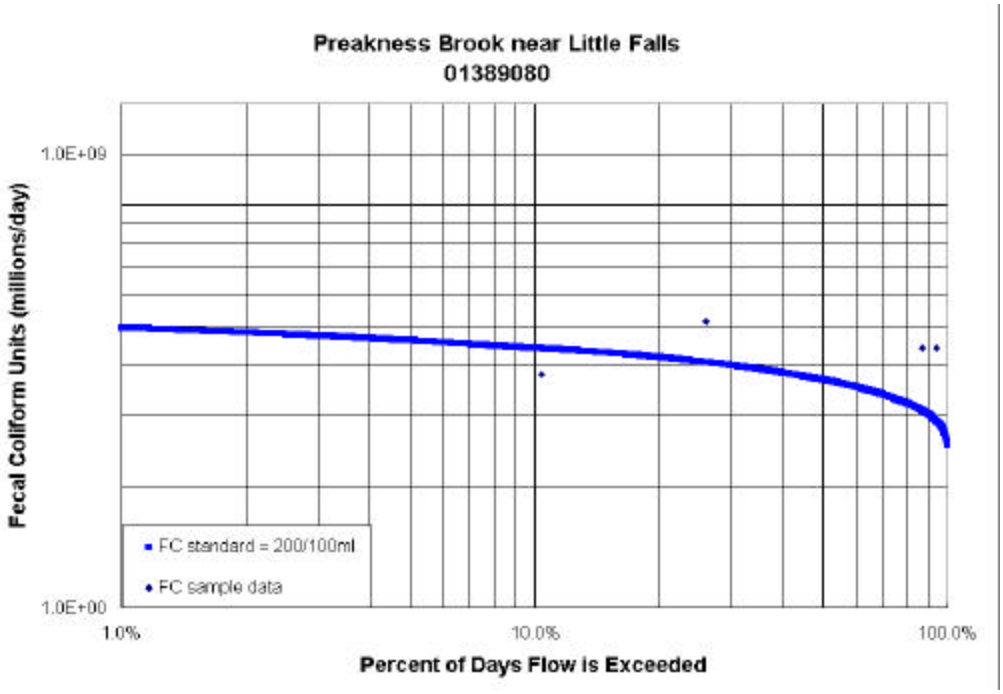
Load Duration Curve for Macopin River at Macopin Reservoir. Fecal coliform data from USGS station #01382450 during the period 10/1997 through 8/2000. Water years 1970-2000 from USGS station #01388500 (Pompton River at Pompton Plains NJ) were used in generating the FC standard curve.



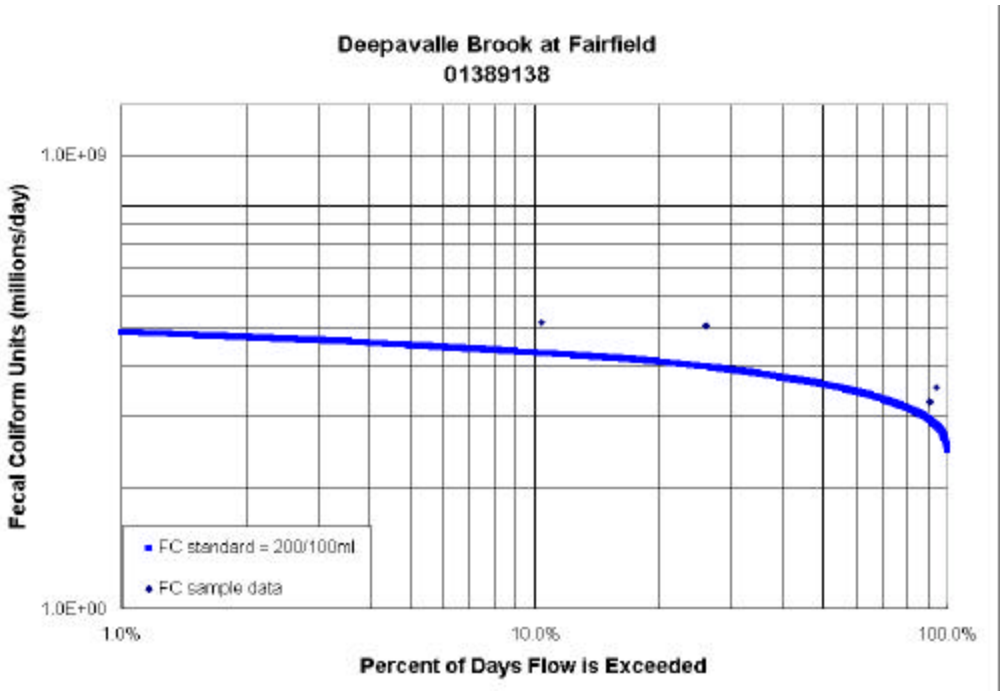
Load Duration Curve for Wanaque River at Highland Ave. Fecal coliform data from USGS station # 01387010 & 01387041 during the period 1/27/97 through 8/9/99. Water years 1970-2000 from USGS station # 01388500 (Pompton River at Pompton Plains NJ) were used in generating the FC standard curve.



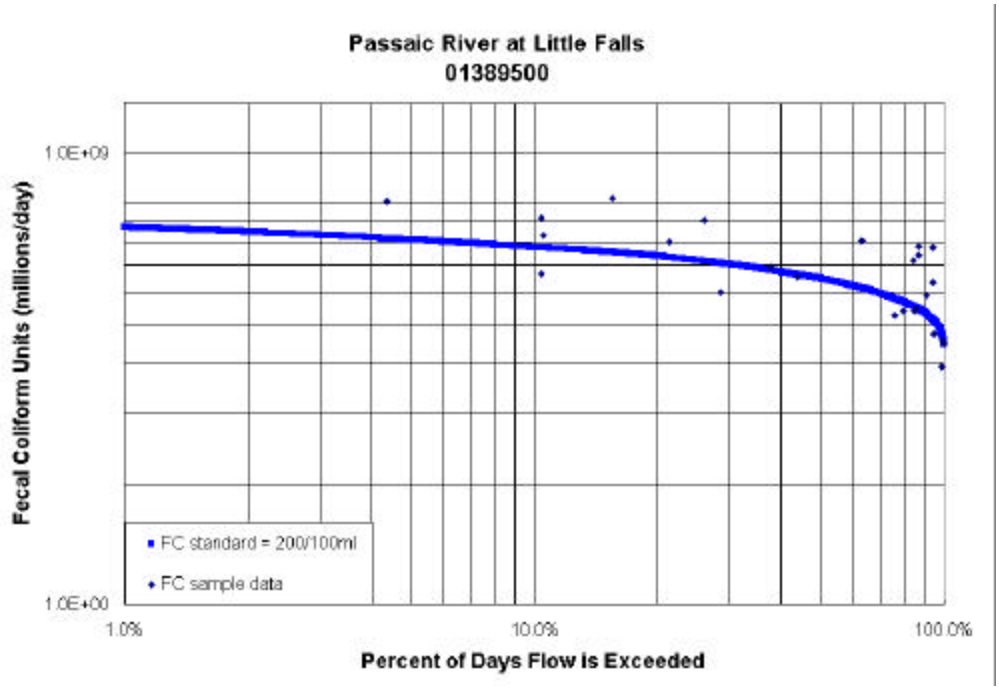
Load Duration Curve for Ramapo River Near Mahwah. Fecal coliform data from USGS station #01387500 during the period 2/24/94 8/3/00. Water years 1970-2000 from USGS station #01387500 (Ramapo River Near Mahwah) were used in generating the FC standard curve.



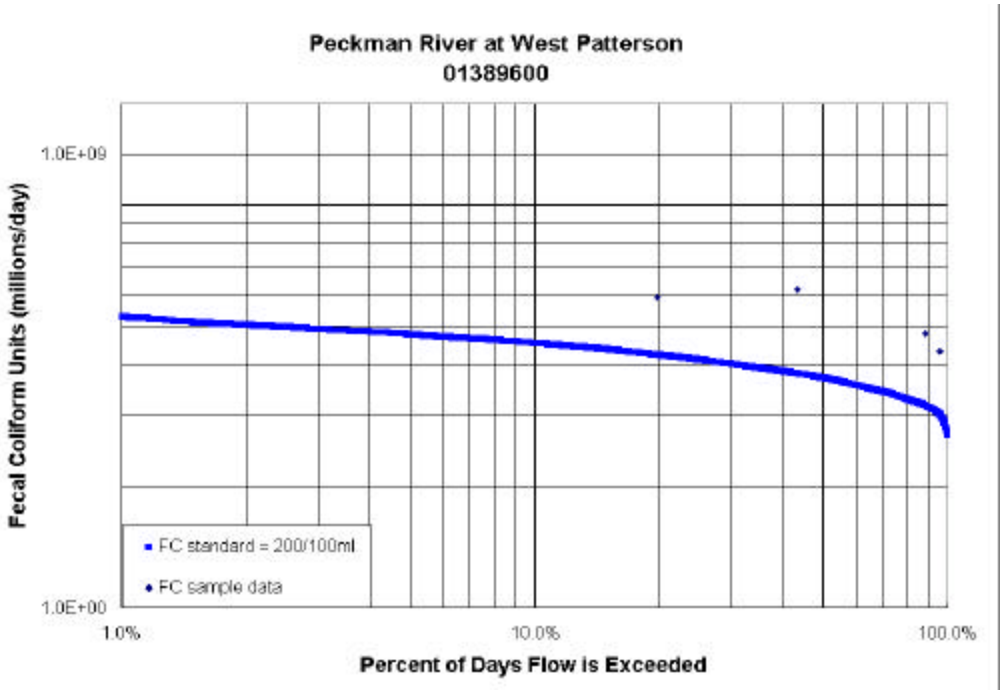
Load Duration Curve for Preakness Brook Near Little Falls. Fecal coliform data from USGS station #01389080 during the period 4/16/98 through 9/23/98. Water years 1970-2000 from USGS station #01389500 (Passaic River at Little Falls) were used in generating the FC standard curve.



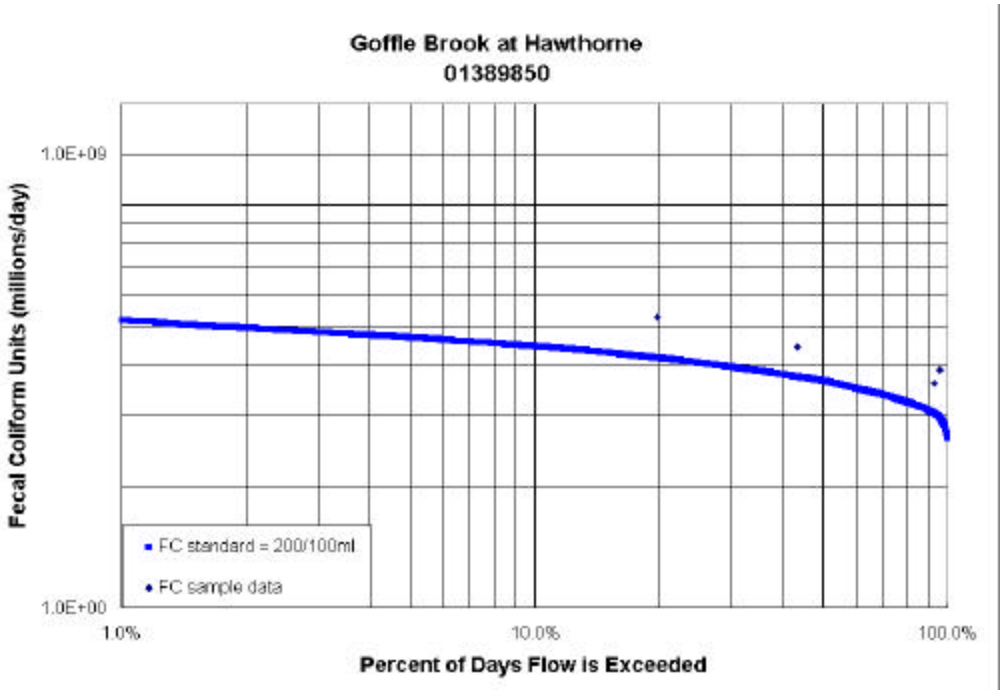
Load Duration Curve for Deepavalle Brook at Fairfield. Fecal coliform data from USGS station #01389138 during the period 4/16/98 through 9/23/98. Water years 1970-2000 from USGS station #01389500 (Passaic River at Little Falls) were used in generating the FC standard curve.



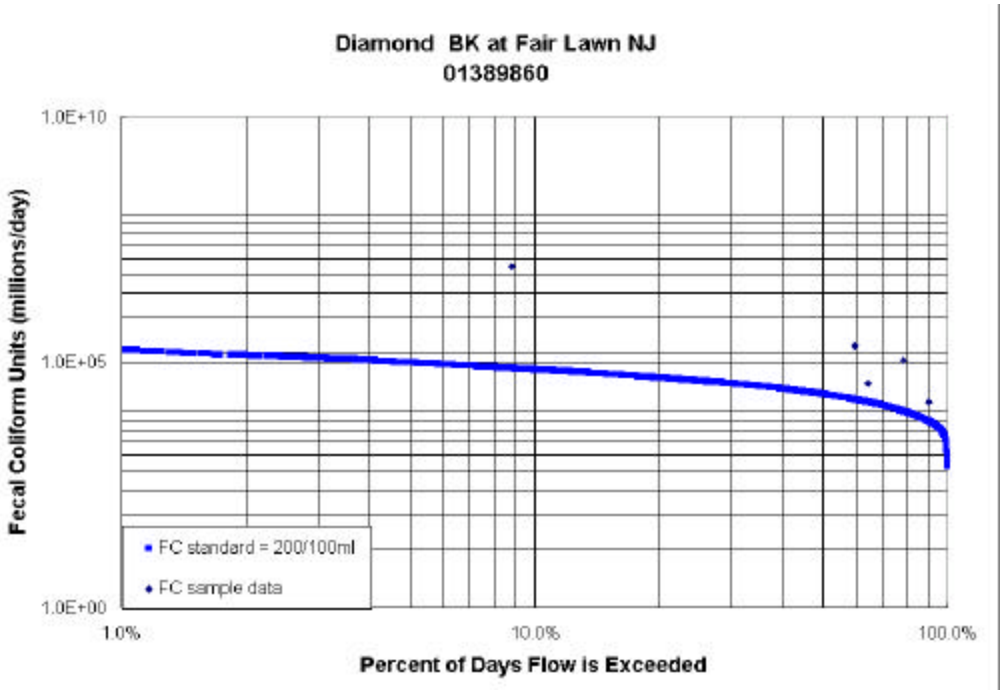
Load Duration Curve for Passaic River at Little Falls. Fecal coliform data from USGS station #01389500 during the period 2/18/94 through 9/23/98. Water years 1970-2000 from USGS station #01389500 (Passaic River at Little Falls) were used in generating the FC standard curve.



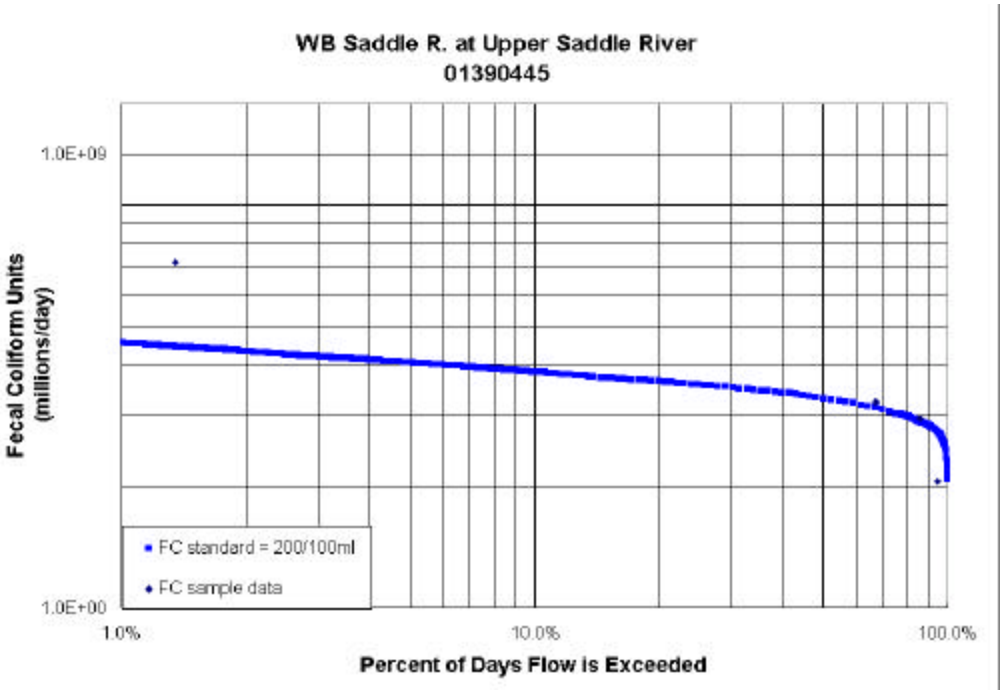
Load Duration Curve for Peckman River at West Patterson. Fecal coliform data from USGS station #01389600 during the period 4/23/98 through 9/24/98. Water years 1970-2000 from USGS station #01388500 (Pompton River at Pompton Plains NJ) were used in generating the FC standard curve.



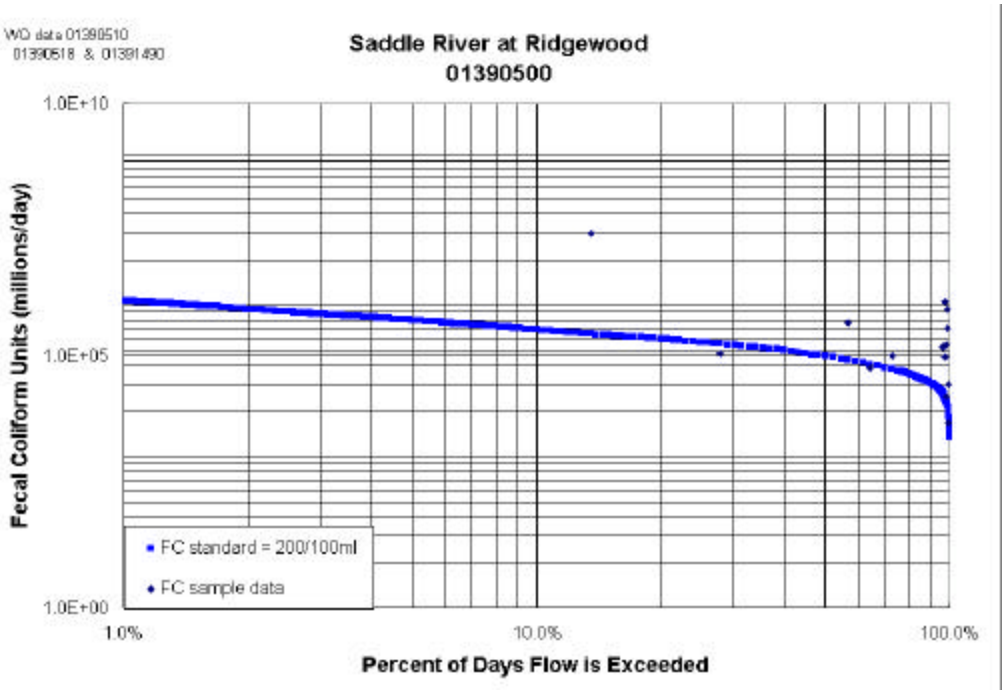
Load Duration Curve for Goffle Brook at Hawthorne. Fecal coliform data from USGS station #01389850 during the period 4/23/98 through 9/24/98. Water years 1970-2000 from USGS station #01388500 (Pompton River at Pompton Plains NJ) were used in generating the FC standard curve.



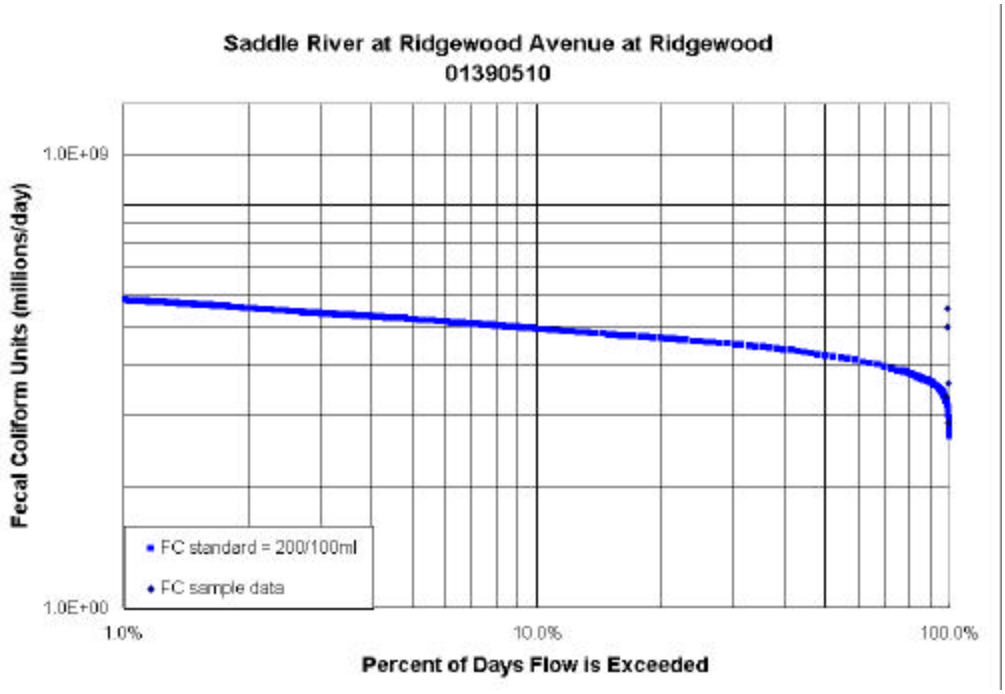
Load Duration Curve for Diamond Brook at Fair Lawn. Fecal coliform data from USGS station # 01389860 during the period 6/29/00-7/27/00. Water years 1970-2000 from USGS station # 01388500 (Pompton River at Pompton Plains NJ) were used in generating the FC standard curve



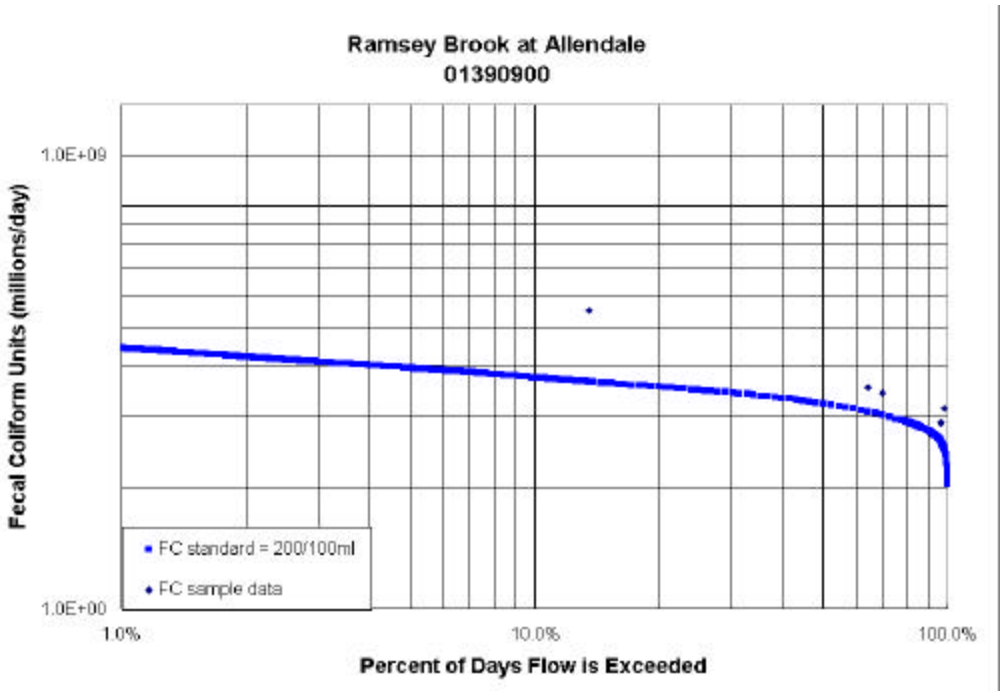
Load Duration Curve for WB Saddle R at Upper Saddle River. Fecal coliform data from USGS station #01390445 during the period 11/4/99 through 8/7/00. Water years 1970-2001 from USGS station #01390500 (Saddle River at Ridgewood) were used in generating the FC standard curve.



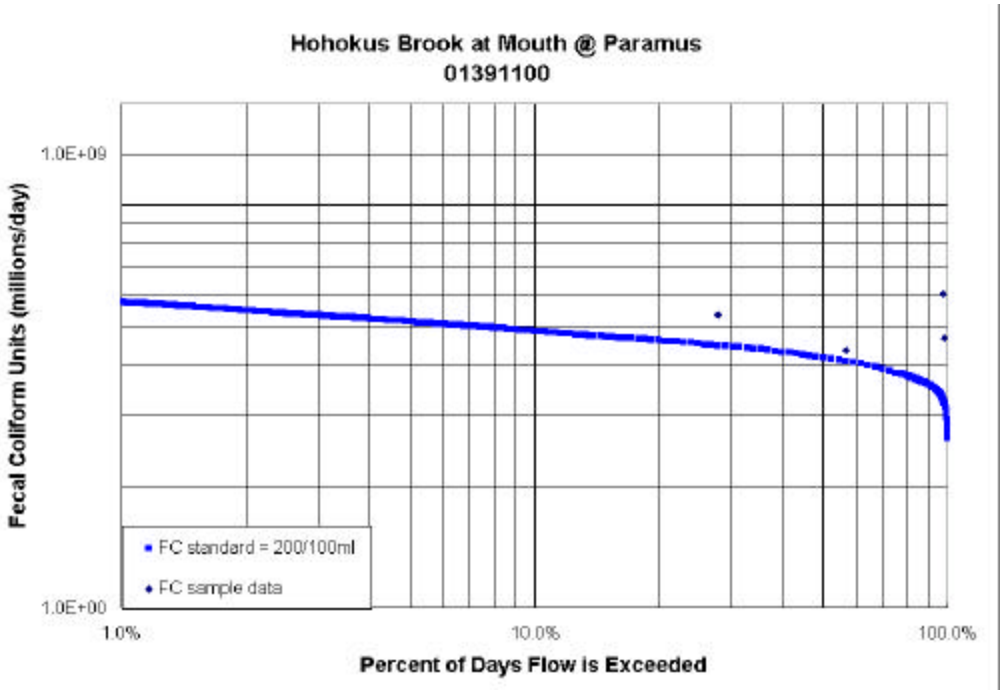
Load Duration Curve for the Saddle River at Ridgewood. Fecal coliform data from USGS stations #01390510, #01390518, and #01391490.during the period 11/6/97-8/9/99. Water years 1970-2001 from USGS station #01390500 (Saddle River at Ridgewood) were used in generating the FC standard curve.



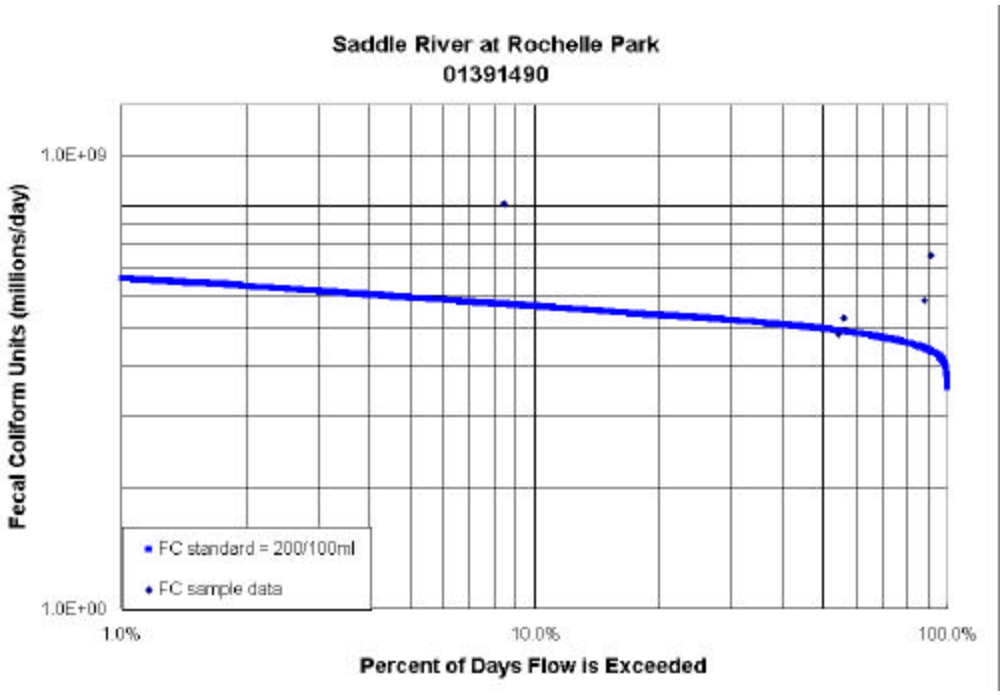
Load Duration Curve for Saddle River at Ridgewood Avenue at Ridgewood. Fecal coliform data from USGS station #01390510 during the period 7/13/99 through 8/9/99. Water years 1970-2001 from USGS station #01390500 (Saddle River at Ridgewood) were used in generating the FC standard curve.



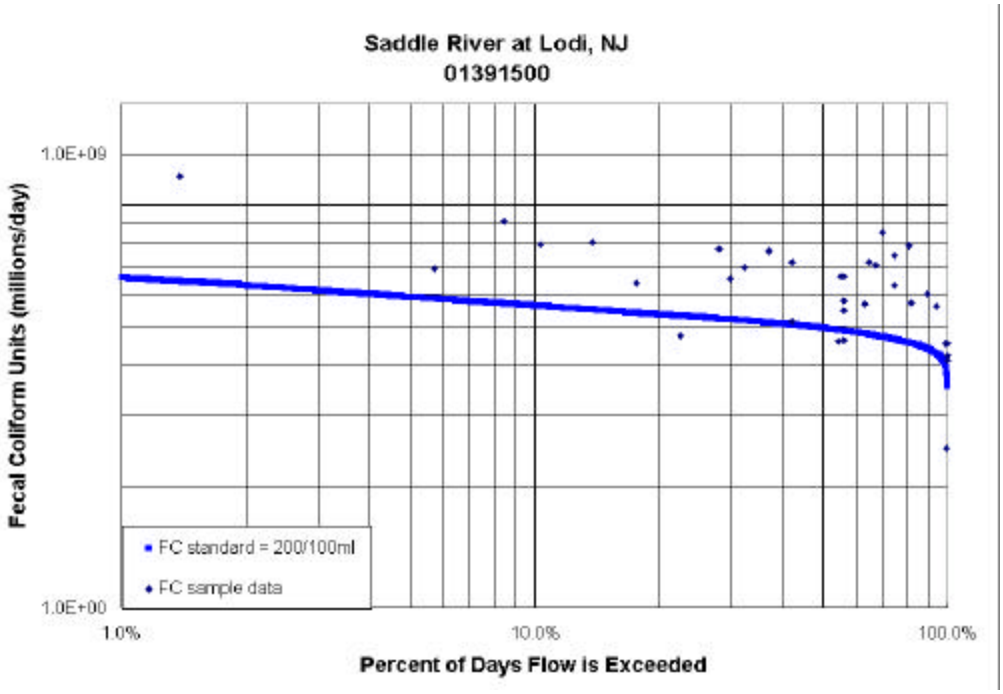
Load Duration Curve for Ramsey Brook at Allendale. Fecal coliform data from USGS station #01390900 during the period 11/6/97 through 9/1/98. Water years 1970-2000 from USGS station #01390500 (Saddle River at Ridgewood) were used in generating the FC standard curve.



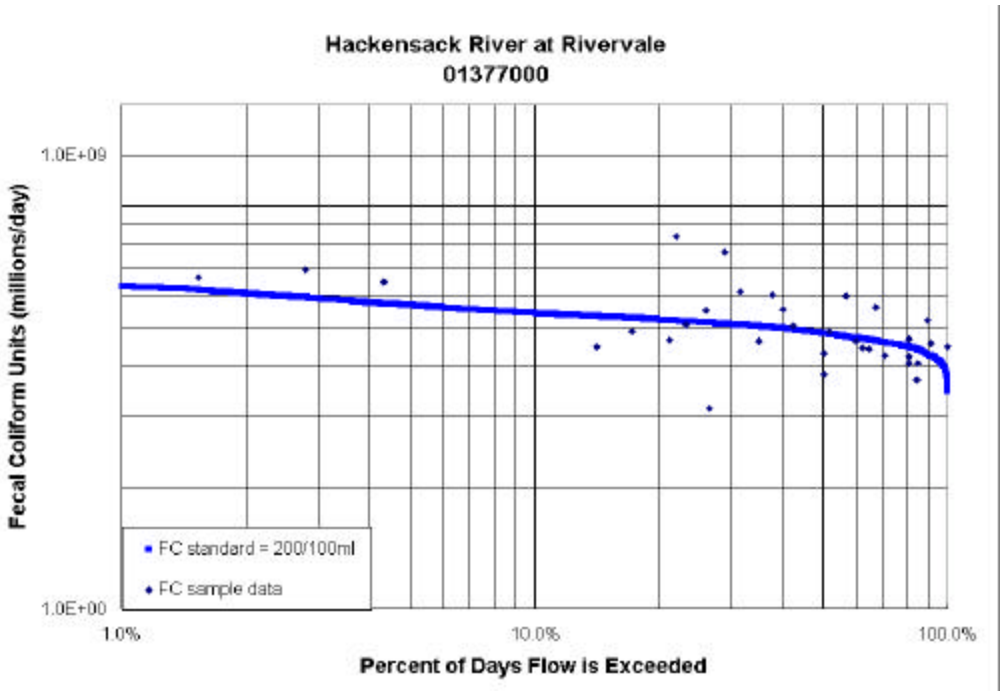
Load Duration Curve for Hohokus Brook at Mouth@ Paramus. Fecal coliform data from USGS station #01391100 during the period 4/23/98 through 9/24/98. Water years 1970-2000 from USGS station #01390500 (Saddle River at Ridgewood) were used in generating the FC standard curve.



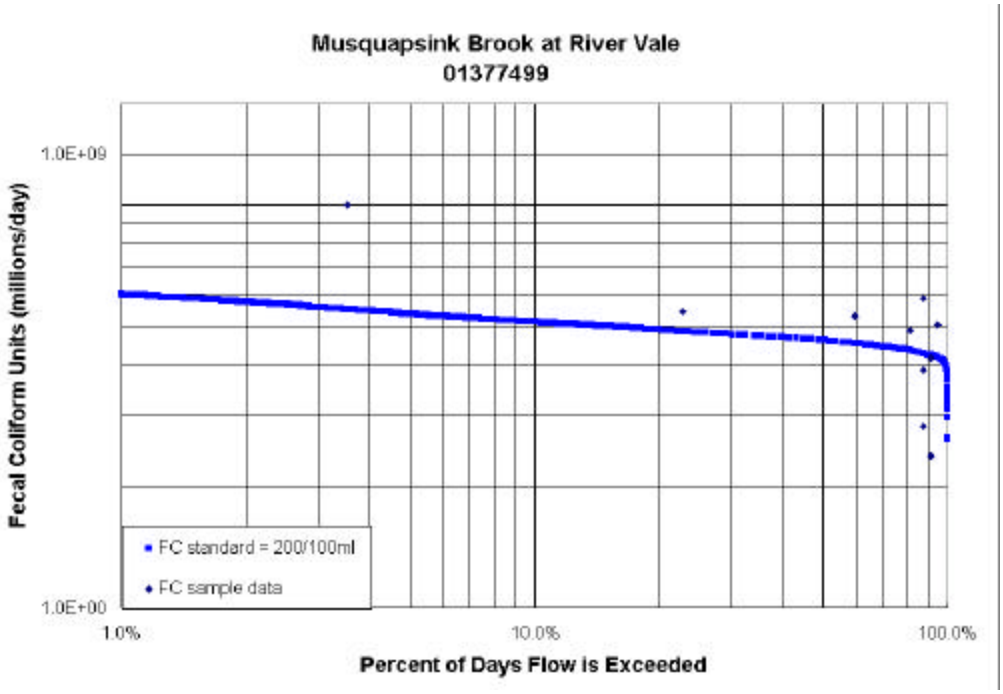
Load Duration Curve for the Saddle River at Rochelle Park. Fecal coliform data from USGS station #01391490 during the period 11/6/97 through 9/16/98. Water years 1970-2001 from USGS station #01391500 (Saddle River at Lodi) were used in generating the FC standard curve.



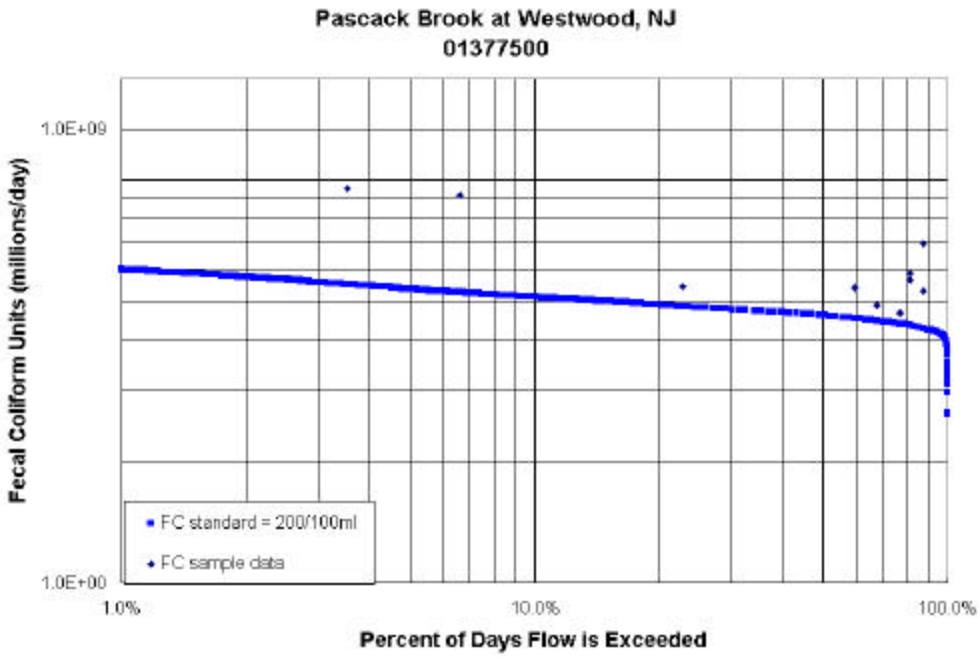
Load Duration Curve for the Saddle River at Lodi. Fecal coliform data from USGS station #01391500 during the period 2/22/94 through 9/13/00. Water years 1970-2000 from USGS station #01391500 (Saddle River at Lodi) were used in generating the FC standard curve.



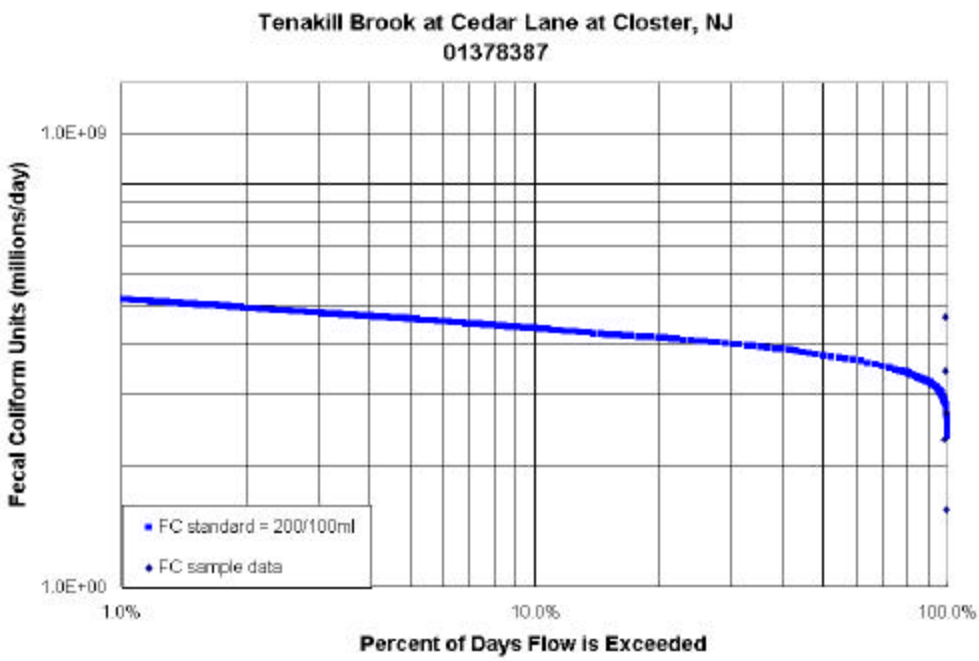
Load Duration Curve for the Hackensack River at River Vale. Fecal coliform data from USGS station #01377000 during the period 2/17/94 through 8/3/00. Water years 1970-2000 from USGS station #01377000 (Hackensack River at River Vale) were used in generating the FC standard curve.



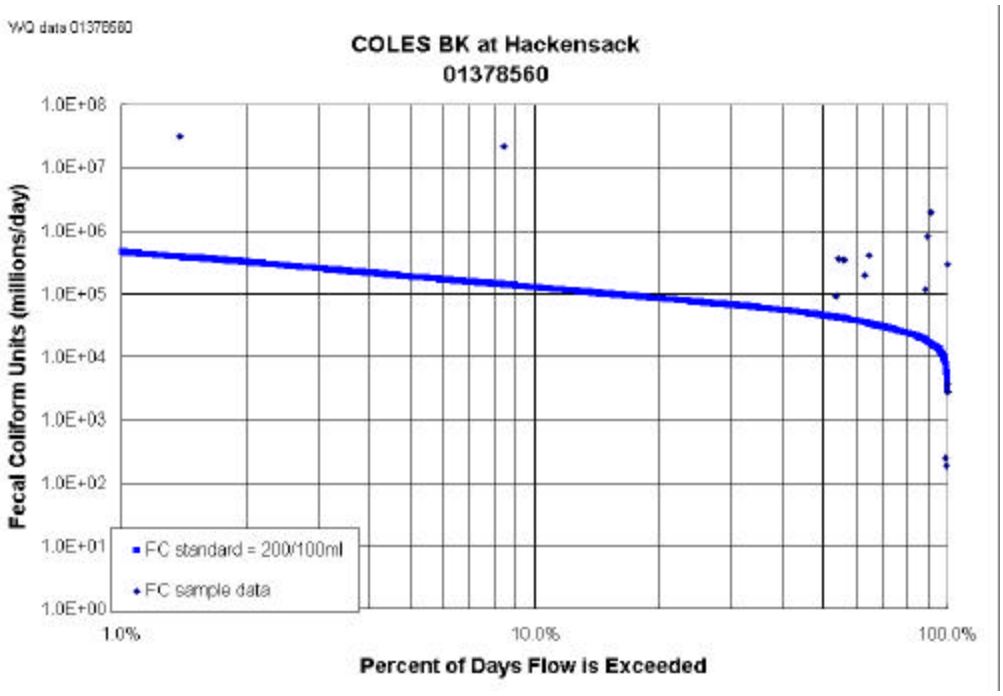
Load Duration Curve for the Musquapsink Brook at River Vale. Fecal coliform data from USGS station #01377499 during the period 7/13/99 through 9/7/00. Water years 1970-2000 from USGS station #01377499 (Musquapsink Brook at River Vale) were used in generating the FC standard curve.



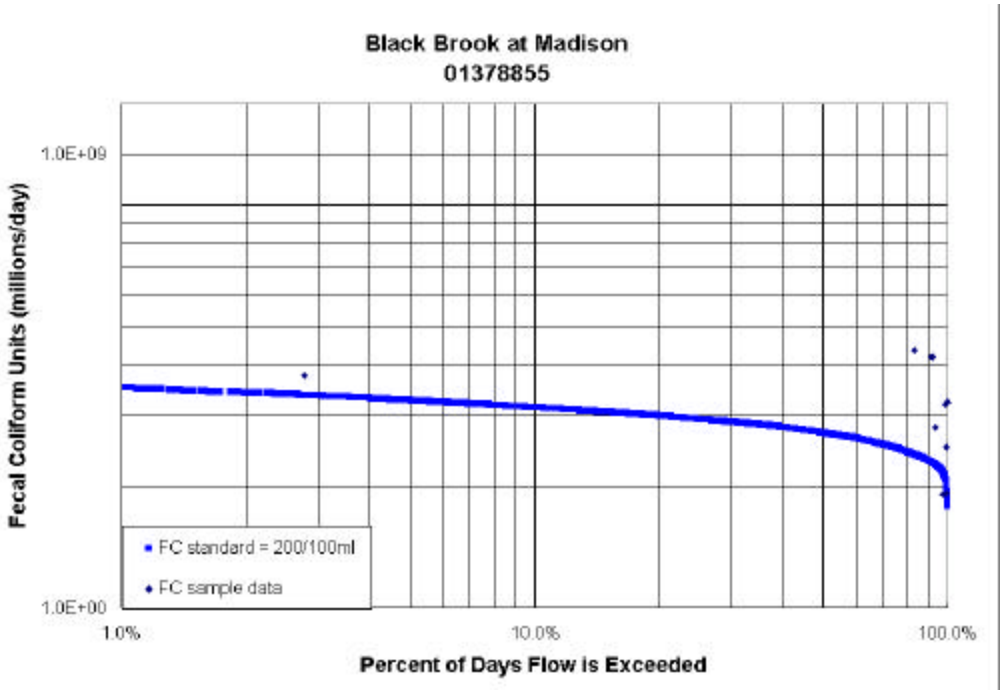
Load Duration Curve for the Pascack Brook at Westwood. Fecal coliform data from USGS station #01377500 during the period 6/1/98 through 9/6/98. Water years 1970-2000 from USGS station #01377500 (Pascack Brook at Westwood) were used in generating the FC standard curve.



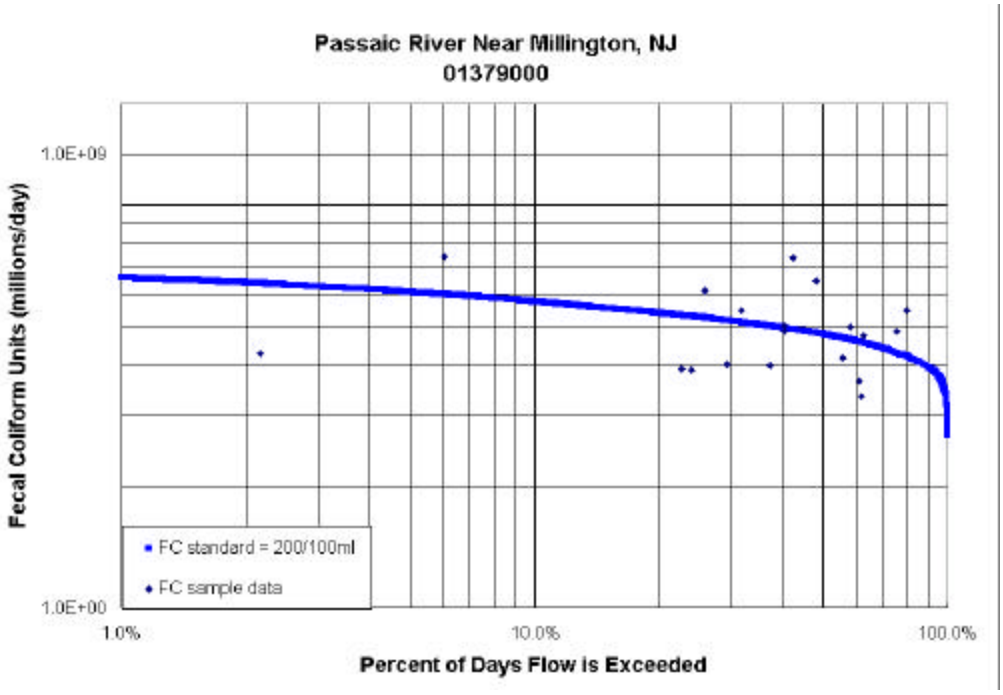
Load Duration Curve for the Tenakill Brook at Cedar Lane at Closter. Fecal coliform data from USGS station #01378387 during the period 7/13/99 through 8/9/99. Water years 1970-2001 from USGS station #01390500 (Saddle River at Ridgewood) were used in generating the FC standard curve.



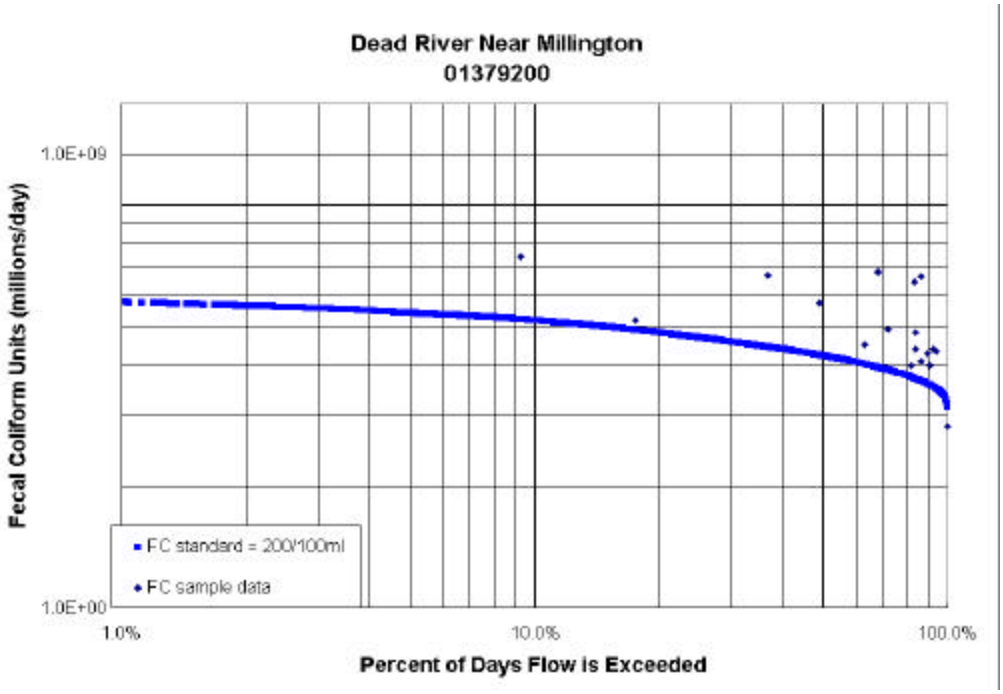
Load Duration Curve for Coles Brook at Hackensack. Fecal coliform data from USGS station # 01378387 during the period 11/5/97 through 8/23/00. Water years 1970-2001 from USGS station # 01391500 (Saddle River at Lodi) were used in generating the FC standard



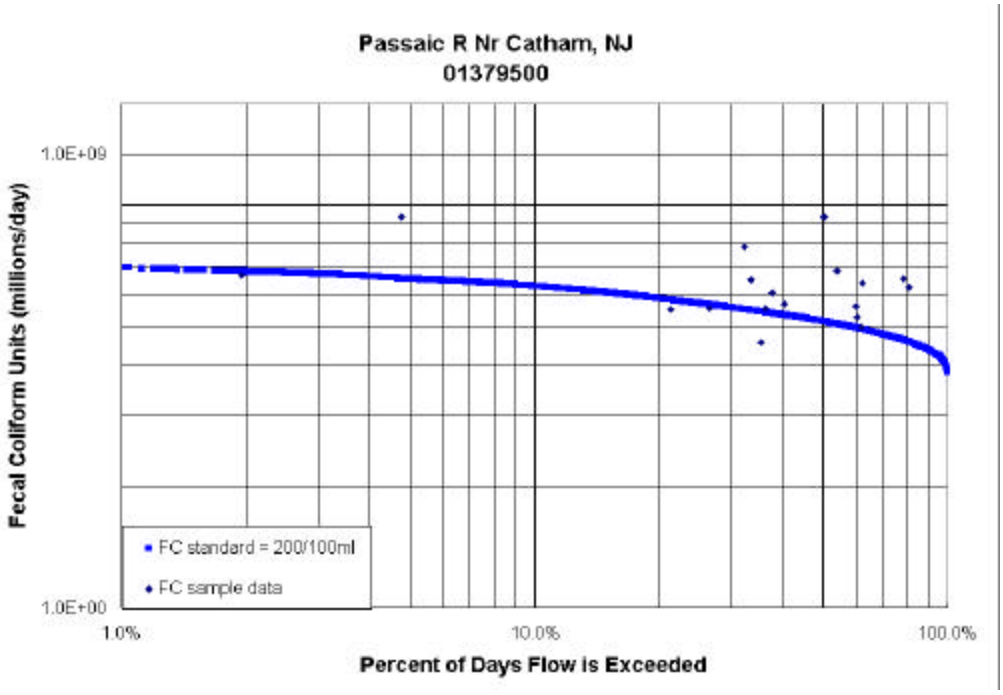
Load Duration Curve for the Black Brook at Madison. Fecal coliform data from USGS station #01378855 during the period 11/18/97 through 9/1/99. Water years 1970-2000 from USGS station #01380500 (Rockaway River above Reservoir at Boonton) were used in generating the FC standard curve.



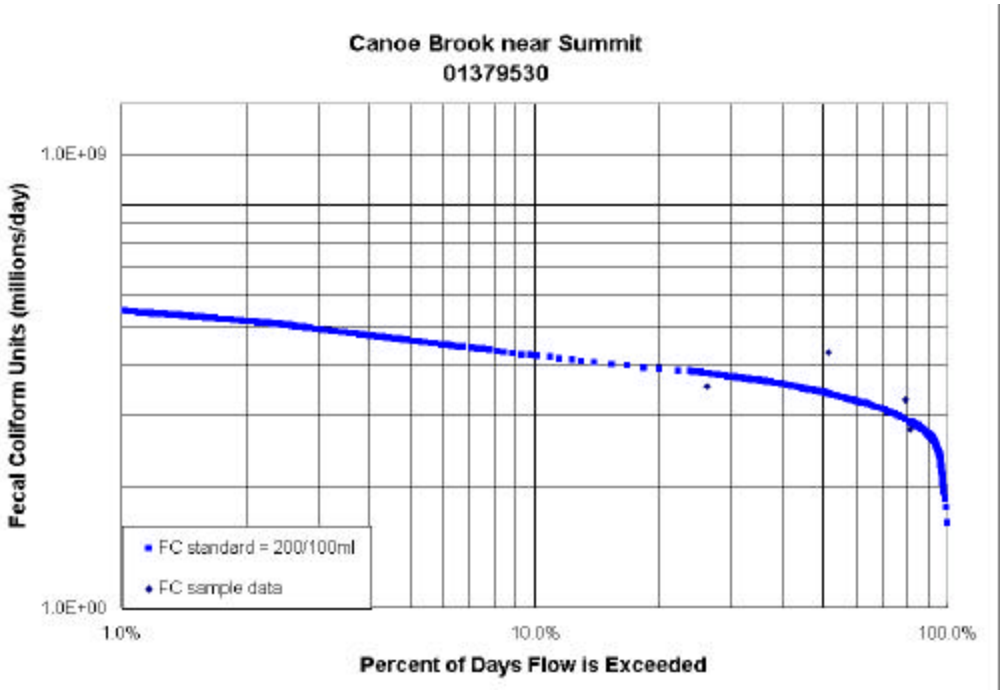
Load Duration Curve for the Passaic R Nr Millington. Fecal coliform data from USGS station #01379000 during the period 10/1997 through 8/2000. Water years 1970-2000 from USGS station #01379000 (Passaic R Nr Millington) were used in generating the FC standard curve.



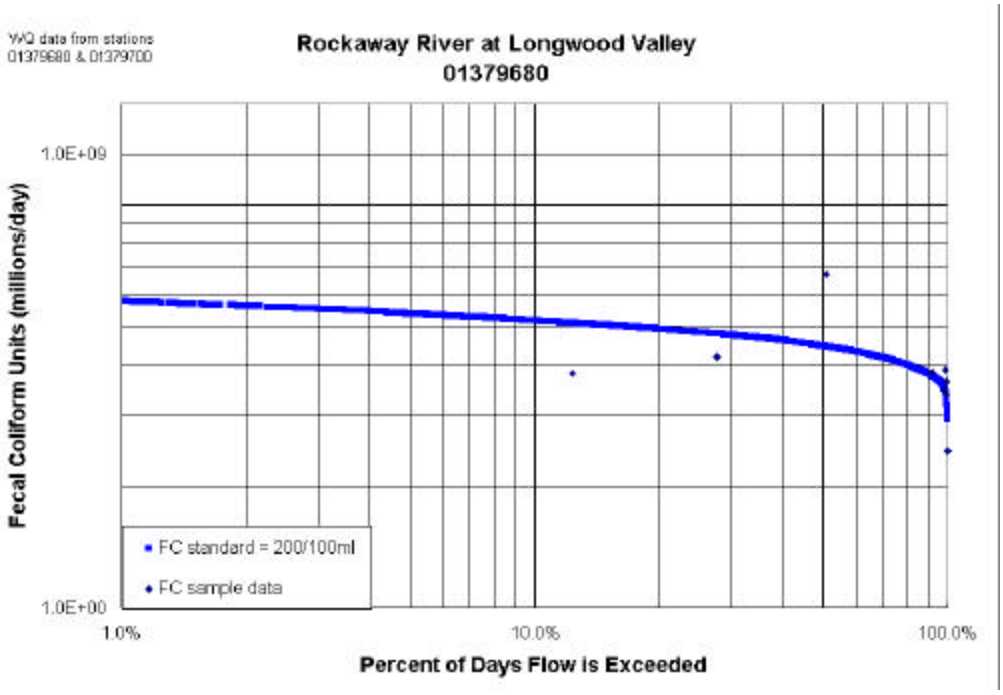
Load Duration Curve for the Dead River near Millington. Fecal coliform data from USGS station #01379200 during the period 10/1997 through 8/2000. Water years 1970-2000 from USGS station #01379500 (Passaic R Nr Catham) were used in generating the FC standard curve.



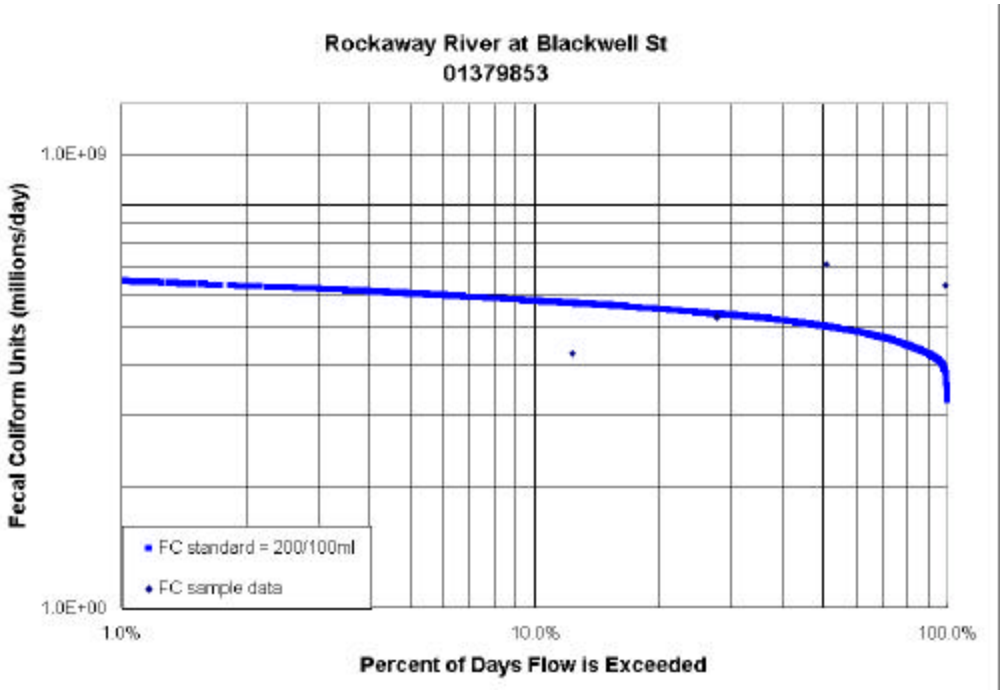
Load Duration Curve for the Passaic R Nr Catham. Fecal coliform data from USGS station #01379500 during the period 10/1997 through 8/2000. Water years 1970-2000 from USGS station #01379500 (Passaic R Nr Catham) were used in generating the FC standard curve.



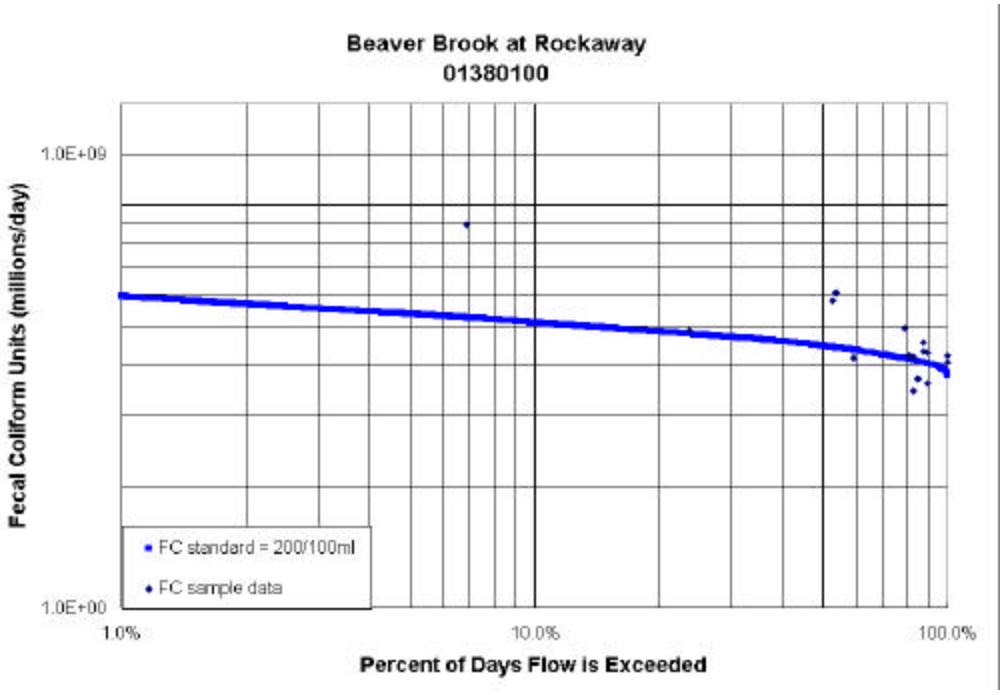
Load Duration Curve for Canoe Brook near Summit. Fecal coliform data from USGS station #01379530 during the period 10/1997 through 8/2000. Water years 1970-2000 from USGS station #01379530 (Canoe Brook near Summit) were used in generating the FC standard curve.



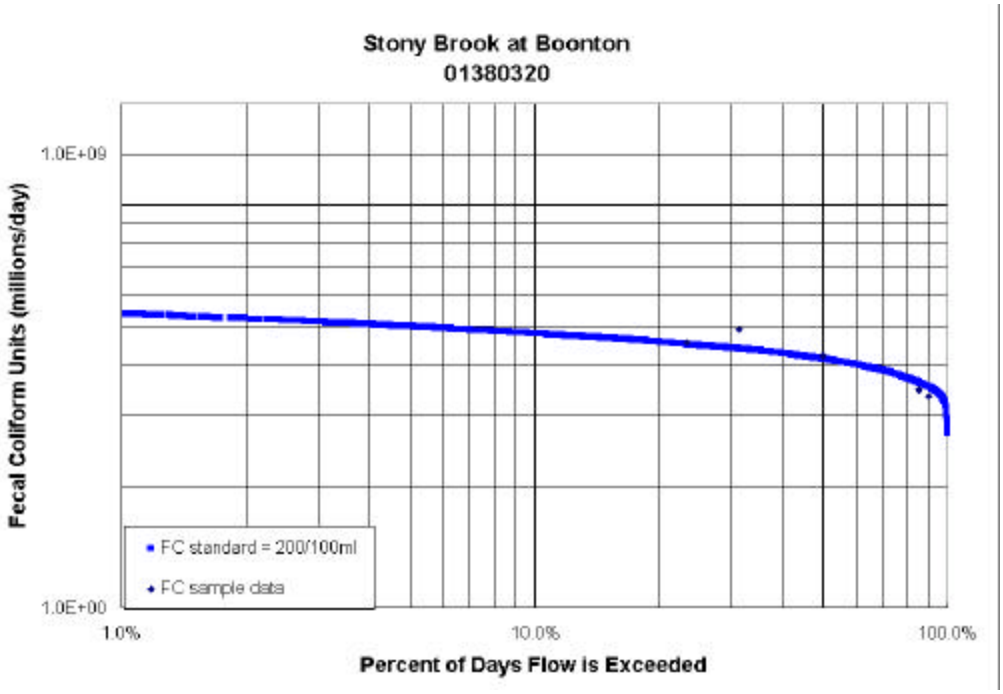
Load Duration Curve for Rockaway River at Longwood Valley. Fecal coliform data from USGS station # 01379680 & 01379700 during the period 1/27/97 through 9/2/99. Water years 1970-2000 from USGS station # 01380500 (Rockaway River above Reservoir at Boonton) were used in generating the FC standard curve.



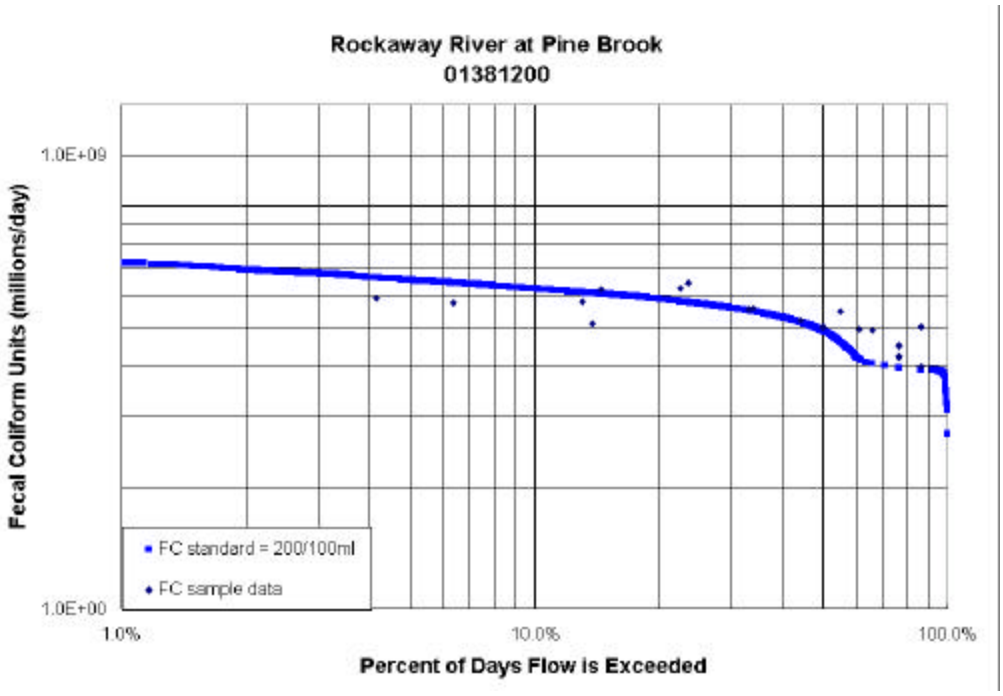
Load Duration Curve for Rockaway River at Blackwell St. Fecal coliform data from USGS station #01379853 during the period 4/15/98 through 9/22/98. Water years 1970-2000 from USGS station #01380500 (Rockaway River above Reservoir at Boonton) were used in generating the FC standard curve.



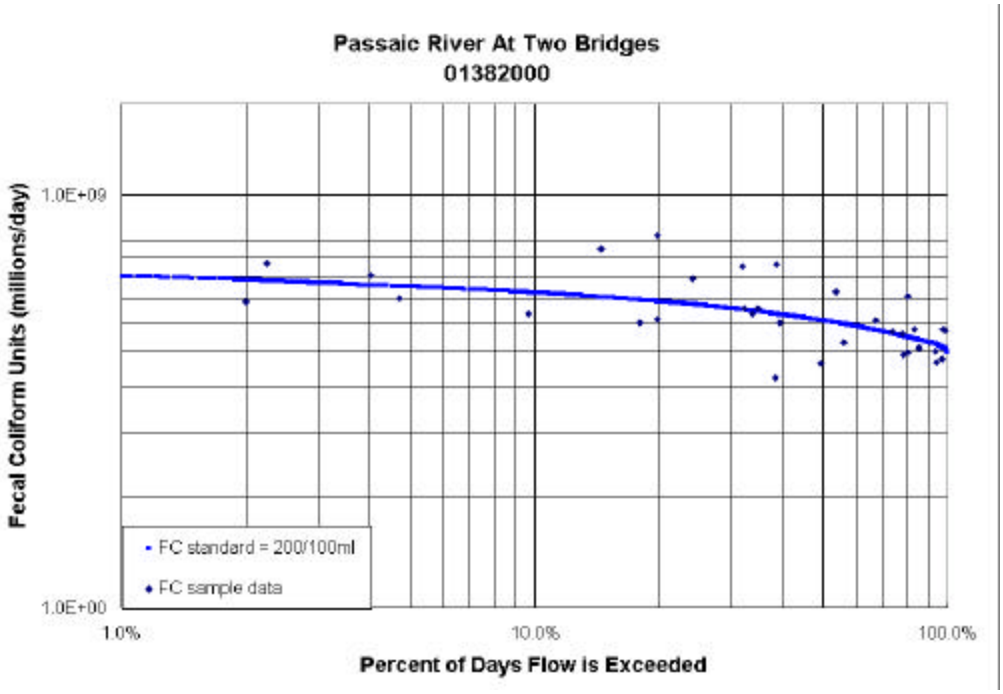
Load Duration Curve for the Beaver Brook At Rockaway. Fecal coliform data from USGS station #01380100 during the period 11/13/97 through 8/7/2000. Water years 1970-2000 from USGS station #01381500 (Whippany River at Morristown, NJ) were used in generating the FC standard curve.



Load Duration Curve for Stony Brook at Boonton. Fecal coliform data from USGS station #01380320 during the period 12/13/99 through 9/7/00. Water years 1970-2000 from USGS station #01380500 (Rockaway River above Reservoir at Boonton) were used in generating the FC standard curve.



Load Duration Curve for the Rockaway R at Pine Brook. Fecal coliform data from USGS station #01381200 during the period 10/1997 through 8/2000. Water years 1970-2000 from USGS station #01381000 (Rockaway River below Reservoir at Boonton, NJ) were used in generating the FC standard curve.



Load Duration Curve for the Passaic River at Two Bridges. Fecal coliform data from USGS station #01382000 during the period 1/27/94 through 810/2000. Water years 1970-2000 from USGS station #01381900 (Passaic R at Pine Brook, NJ) were used in generating the FC standard curve.