Amendment to the Mercer County Water Quality Management Plan, Northeast Water Quality Management Plan, Upper Delaware Water Quality Management Plan, Upper Raritan Water Quality Management Plan, and Sussex County Water Quality Management Plan

Total Maximum Daily Loads for Fecal Coliform to Address 28 Streams in the Northwest Water Region

Watershed Management Area 1
(Delaware River, Flat Brook, Paulins Kill, and Pequest, Lopatcong, Pohatcong and Musconetcong Rivers)
Watershed Management Area 2
(Wallkill River, and Pochuck, Papakating, Rutgers Creeks)
Watershed Management Area 11
(Harihokake, Nishisakawick, Lockatong, Wickecheoke, Alexauken, Moore, Jacobs and Assunpink Creeks)

Proposed:	April 21, 2003
Established:	June 27, 2003
Approved (by EPA Region 2):	September 29, 2003
Adopted:	

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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 Northwest 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 twenty-eight TMDLs addressing fecal coliform loads to the waterbodies identified in Table 1.

Table 1 Fecal coliform-impaired stream segments in the Northwest 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	1	Dry Brook at Rt 519 near Branchville	01443370	Sussex	6.7
2	1	Paulins Kill at Balesville	01443440	Sussex	13.7
3	1	Paulins Kill at Blairstown	01443500	Sussex, Warren	49.7
4	1	Jacksonburg Creek near Blairstown	01443600	Sussex, Warren	5.1
5	1	Pequest River at Rt 206 Below Springdale	01444970	Sussex	9.0
6	1	Pequest River at Pequest	01445500	Sussex, Warren	15.6
7	1	Pequest River at Belvidere	01446400	Sussex, Warren	2.3
8	1	Pohatcong Creek at New Village	01455200	Sussex, Warren	17.0
9	1	Musconetcong River at Beattystown	01456200	Sussex, Warren, Morris	17.9
10	1	Musconetcong River near Bloomsbury	01457000	Sussex, Warren, Hunterdon	12.8
11	1	Musconetcong River at Riegelsville	01457400	Sussex, Warren	6.2
12	2	WallKill River at Sparta	01367625	Sussex	10.1
13	2	WallKill River at Scott Rd. at Franklin	01367715	Sussex	2.5
14	2	Wallkill River near Sussex	01367770	Sussex	2.2
15	2	Papakating Creek near Wykertown	01367780	Sussex	4.6
16	2	Papakating Creek at Pelletown	01367800	Sussex	21.7
17	2	WB Papakating Creek at McCoys Corner	01367850	Sussex	13.5
18	2	Papakating Creek near Sussex	01367860	Sussex	1.7
19	2	Papakating Creek at Sussex	01367910	Sussex	2.5
20	2	Wallkill River near Unionville	01368000	Sussex	7.6
21	2	Double Kill at Waywayanda	01368820	Sussex, Passaic	4.1
22	2	Black Creek near Vernon	01368950	Sussex	20.5
23	11	Nishisakawick Creek near Frenchtown	01458570	Hunterdon	13.4
24	11	Copper Creek near Frenchtown	01458710	Hunterdon	3.3
25	11	Plum Brook near Locktown	01461262	Hunterdon	3.4
26	11	Jacobs Creek at Bear Tavern	01462739	Mercer	4.2
27	11	Miry Run at Route 533 at Mercerville	01463850	Mercer	10.1
28	11	Assunpink Creek at Peace Street at Trenton	01464020	Mercer	4.0
Total River Miles					285.4

These twenty-eight 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 contributors to fecal coliform 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 1994-2002, 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 point sources as a whole or apportioned to categories of nonpoint and stormwater point sources within the study area. The extent to which nonpoint and stormwater point sources have been identified and the process by which they will become identified or need to be identified or verified varies by segment based on data availability, watershed size and complexity, and pollutant sources. Implementation strategies to achieve SWQS 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 United States Environmental Protection Agency's (USEPA'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 Northwest Water Region as being impaired by pathogens, as evidenced by the presence of high fecal

coliform concentrations. This report establishes twenty-eight 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 caused 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 with respect to these pollutants until such time as TMDL evaluations for all pollutants have been completed and approved by USEPA. With respect to the fecal coliform impairment, the waterbodies will be moved to Sublist 4 following approval of the TMDLs by USEPA.

3.0 Background

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 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. 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 one or more pollutants. 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. Water quality limited waterbodies require total maximum daily load (TMDL) evaluations.

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.

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 the TMDLs in this report address the following items in the May 20, 2002 guideline document:

1. Identification of waterbody(ies), pollutant of concern, pollutant sources and priority ranking.
2. Description of applicable water quality standards and numeric water quality target(s).
3. Loading capacity – linking water quality and pollutant sources.
4. Load allocations.
5. 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.

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 elevated concentrations of fecal coliform bacteria. Fecal coliform concentrations were found to exceed New Jersey's Surface Water Quality Standards (SWQS), published at N.J.A.C. 7-9B et seq., for the segments in the Northwest Water Region identified in Table 2. As reported in the proposed *2002 Integrated List of Waterbodies*, 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 Northwest Water Region.

TMDL No.	WMA	Station Name/Waterbody	Site ID	River Miles	Management Response
1	1	Dry Brook at Rt. 519 near Branchville	1443370	6.7	Establish TMDL
2	1	Paulins Kill at Balesville	1443440	13.7	Establish TMDL
3	1	Paulins Kill at Blairstown	1443500	49.7	Establish TMDL
4	1	Jacksonburg Creek near Blairstown	1443600	5.1	Establish TMDL
5	1	Pequest River at Rt. 206 Below Springdale	1444970	9.0	Establish TMDL
6	1	Pequest River at Pequest	1445500	15.6	Establish TMDL
7	1	Pequest River at Belvidere	1446400	2.3	Establish TMDL
8	1	Pohatcong Creek at New Village	1455200	17.0	Establish TMDL
	1	Musconetcong River at Lake Hopatcong	1455500	1.3	Further water quality monitoring needed to assess and confirm current impairment; move to Sublist 3
	1	Musconetcong River at Lockwood	1455801	2.0	Further water quality monitoring

TMDL No.	WMA	Station Name/Waterbody	Site ID	River Miles	Management Response
					needed to assess and confirm current impairment; move to Sublist 3
9	1	Musconetcong River at Beattystown	1456200	17.9	Establish TMDL
10	1	Musconetcong River near Bloomsbury	1457000	12.8	Establish TMDL
11	1	Musconetcong River at Riegelsville	1457400	6.2	Establish TMDL
12	2	Wallkill River at Sparta	1367625	10.1	Establish TMDL
13	2	Wallkill River at Scott Rd at Franklin	1367715	2.5	Establish TMDL
14	2	Wallkill River near Sussex	1367770	2.2	Establish TMDL
15	2	Papakating Creek near Wykertown	1367780	4.6	Establish TMDL
16	2	Papakating Creek at Pelletown	1367800	21.7	Establish TMDL
17	2	WB Papakating Creek at McCoys Corner	1367850	13.5	Establish TMDL
18	2	Papakating Creek near Sussex	1367860	1.7	Establish TMDL
19	2	Papakating Creek at Sussex	1367910	2.5	Establish TMDL
20	2	Wallkill River near Unionville	1368000	7.6	Establish TMDL
21	2	Double Kill at Waywayanda	1368820	4.1	Establish TMDL
22	2	Black Creek near Vernon	1368950	20.5	Establish TMDL
23	11	Nishisakawick Creek near Frenchtown	1458570	13.4	Establish TMDL
24	11	Copper Creek near Frenchtown	1458710	3.3	Establish TMDL
	11	Wickecheoke Creek at Croton	1461220	15.9	Further water quality monitoring needed to assess and confirm current impairment; move to Sublist 3
25	11	Plum Brook near Locktown	1461262	3.4	Establish TMDL
	11	Wickecheoke Creek at Stockton	1461300	24.0	Further water quality monitoring needed to assess and confirm current impairment; move to Sublist 3
26	11	Jacobs Creek at Bear Tavern	1462739	4.2	Establish TMDL
27	11	Miry Run at Route 533 at Mercerville	1463850	10.1	Establish TMDL
28	11	Assunpink Creek at Peace St. at Trenton	1464020	4.0	Establish TMDL

These twenty-eight TMDLs will address 285 river miles or approximately 86% of the total river miles listed as impaired relative to fecal coliform (329 total river miles of fecal coliform impaired waters) in the Northwest watershed region. Based on a detailed county hydrography stream coverage, 995 stream miles, or 45% of the stream segments in the Northwest region (2223 total miles) are directly affected by the TMDLs due to the fact that the implementation plans cover entire watersheds; not just impaired waterbody segments.

Table 2 identifies four segments for which TMDLs will not be developed at this time based on investigations following the *2002 Integrated List of Waterbodies* proposal. These segments include the Musconetcong River at Lake Hopatcong, station #01455500; Musconetcong River at Lockwood, station #01455801; Wickecheoke Creek at Croton, station #01461220; and Wickecheoke Creek at Stockton, station #01461300. These segments are identified as needing further monitoring to confirm impairment and will be moved to Sublist 3 of the 2002 Integrated List of Waterbodies. Appendix A provides a further discussion of these segments.

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

The Northwest Region includes three management areas in the northwest part of New Jersey. All or parts of the following counties are included within this region: Sussex, Warren, Hunterdon, Mercer, Morris and Monmouth counties. This region offers recreational and scenic opportunities such as fishing, camping, skiing, boating, and hiking.

4.1.1. Watershed Management Area 1

The Upper Delaware Watershed, WMA 1, is located in the northwest portion of New Jersey and is approximately 746 square miles in total area. It includes portions of Sussex, Morris, Hunterdon, and all of Warren Counties. WMA 1 includes areas that are among the most pristine in New Jersey. Fifty-four municipalities, in four counties, make up WMA 1. It is contained within the Valley and Ridge and Highlands physiographic provinces, with well-defined mountain ridges running in a southwest to northeast direction. WMA 1 is made up of 17 sub-basins that can be grouped and described as follows:

Flat Brook Watershed - This sub-basin includes Shimers Brook, Clove Brook, Van Campen's Brook, Dunnfield Creek, and Stony Brook. This group and its tributaries drain an area of 130 square miles in Sussex and Warren Counties. Other major water features include Little Flat Brook, Parker Brook, Tilghman Brook, and several small lakes and ponds. Most of the surface waters of the Flat Brook drainage area within High Point State Park, Stokes State Forest, and all tributaries to the Flat Brook are in the Delaware Water Gap National Recreation Area are classified as FW1. The remainder of this sub-basin has an FW2 classification for TP and TM. This watershed group encompasses 83,384 acres. Up until the establishment of the Delaware Water Gap National Recreation Area, a significant amount of cropland could be found within the Flat Brook and Little Flat Brook valleys. Most of the formerly agricultural land is now in various stages of natural succession.

Paulins Kill Watershed - This sub-basin includes Trout Brook, Delawanna Brook, and Stony Brook. This group and its tributaries drain an area of 197 square miles. The Paulins Kill is 39 miles long and major tributaries include Yards Creek, Blair Creek, Morses Brook, and Culver Brook. All of the surface waters of the Paulins Kill drainage area are classified as FW2, largely for NT and TM with a portion at Lafayette for TP (C1). Numerous lakes and ponds are found throughout the watershed, the largest of these being Culvers Lake, Swartswood Lake, Lake Owassa, Paulins Kill Lake, and Yards Creek Reservoir. This watershed group encompasses 125,846 acres. Land cover within this region is primarily forested (52.5%) with significant agricultural (17%) and scattered suburban development (13.8%) located mostly proximate to the Rt. 94 corridor.

Pequest River Watershed - This sub-basin includes Bear Creek, Beaver Brook, Trout Brook, and Furnace Brook. This group and its tributaries drain an area of 157 square miles in Sussex and Warren counties. The Pequest River is 32 miles long. Most of the Pequest River and tributaries are FW2 waters for TM and NT. The northwesterly tributaries, which include a

portion located within the Whittingham Wildlife Management Area are classified as FW1(TM). There are many small lakes and ponds within the watershed with the majority located in the Pequest headwaters. The larger impoundments are Mountain Lake, Allamuchy Pond, and Wawayanda Lake. This watershed group encompasses 100,542 acres. Land cover within this region is primarily forested (48.1%) and agricultural (21.2%). A significant portion has been developed/urbanized (12.2%). The most heavily forested areas are within Jenny Jump State Forest, a portion of Allamuchy State Park, Pequest Wildlife Management Area, and Whittingham Wildlife Management Area. Notably, Bear Swamp, an extensive area of wetlands, is located in the upper Pequest watershed.

Pohatcong-Lopatcong Creek Watershed - This sub-basin includes Buckhorn Creek and Pophandusing Brook. This group and its tributaries drain an area of 106 square miles entirely in Warren County. From its headwaters in Independence Township, the Pohatcong Creek flows 28 miles to the Delaware River below Phillipsburg. Major tributaries along with the listed streams include Brass Castle Creek, Shabbecong Creek, and Merrill Creek. The Pohatcong Creek surface waters are classified mainly as FW2-TP (C1), while the Lopatcong Creek drainage area is classified as FW2 for TM and NT, except the Allens Mill, Phillipsburg, and Uniontown (tributary) portions classified for TP (C1). The 650-acre Merrill Creek Reservoir is the largest impoundment in this watershed. This watershed group encompasses 67,925 acres. Land cover in this region is predominantly cropland (36.6%) with forested (35.7%) areas concentrated in the upper watershed as well as along the prominent ridges that parallel the valley. Urban developed land is significant, however (18.5%).

Musconetcong Watershed - This sub-basin drains an area of 156 square miles. For its entire length, the Musconetcong River forms the boundary between Morris and Sussex; Hunterdon and Warren; and Morris and Warren counties. This river flows 42 miles to the Delaware River at Riegelsville. Major tributaries include Lubbers Run, Mine Brook, Hances Brook, and several smaller streams. FW2-TP (C1) is the classification for all tributaries of the Musconetcong River, except for that portion of the river from Lake Hopatcong Dam to the Delaware River, which is classified as FW2-TM. The larger impoundments are located in the upper watershed and include Lake Hopatcong, Lake Musconetcong, Cranberry Lake, Lake Lackawanna, Cranberry Reservoir. This watershed group encompasses 99,550 acres. The Musconetcong watershed contains two distinct regions. The upper Musconetcong watershed is primarily forested with significant development occurring along the shores of many of the lakes. The lower Musconetcong watershed is primarily agricultural land with forested areas concentrated along the ridges. The single largest center of employment in the Upper Delaware, the International Trade Zone in Mt. Olive Township, is located in this watershed. Combined, the two regions consist primarily of forest (49.5%), urban land (19.5%), and cropland (17.8%).

Sublist 5 Waterbodies in WMA 1

Eleven river segments of the twenty-eight impaired segments addressed in this report are located in WMA 1. These segments include portions of Dry Brook (#01443370), Paulins Kill (#01443440, #01443500), Pequest River (#01444970, #01445500, #01446400), Jacksonburg Creek (#01443600), Pohatcong Creek (#01455200), and Musconetcong River (#01456200,

#01457000, #01457400). The spatial extent of each segment is identified in Figure 1 and described in Table 3. River miles, watershed sizes and land use/land cover by percent area associated with each segment are listed in Table 4.

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

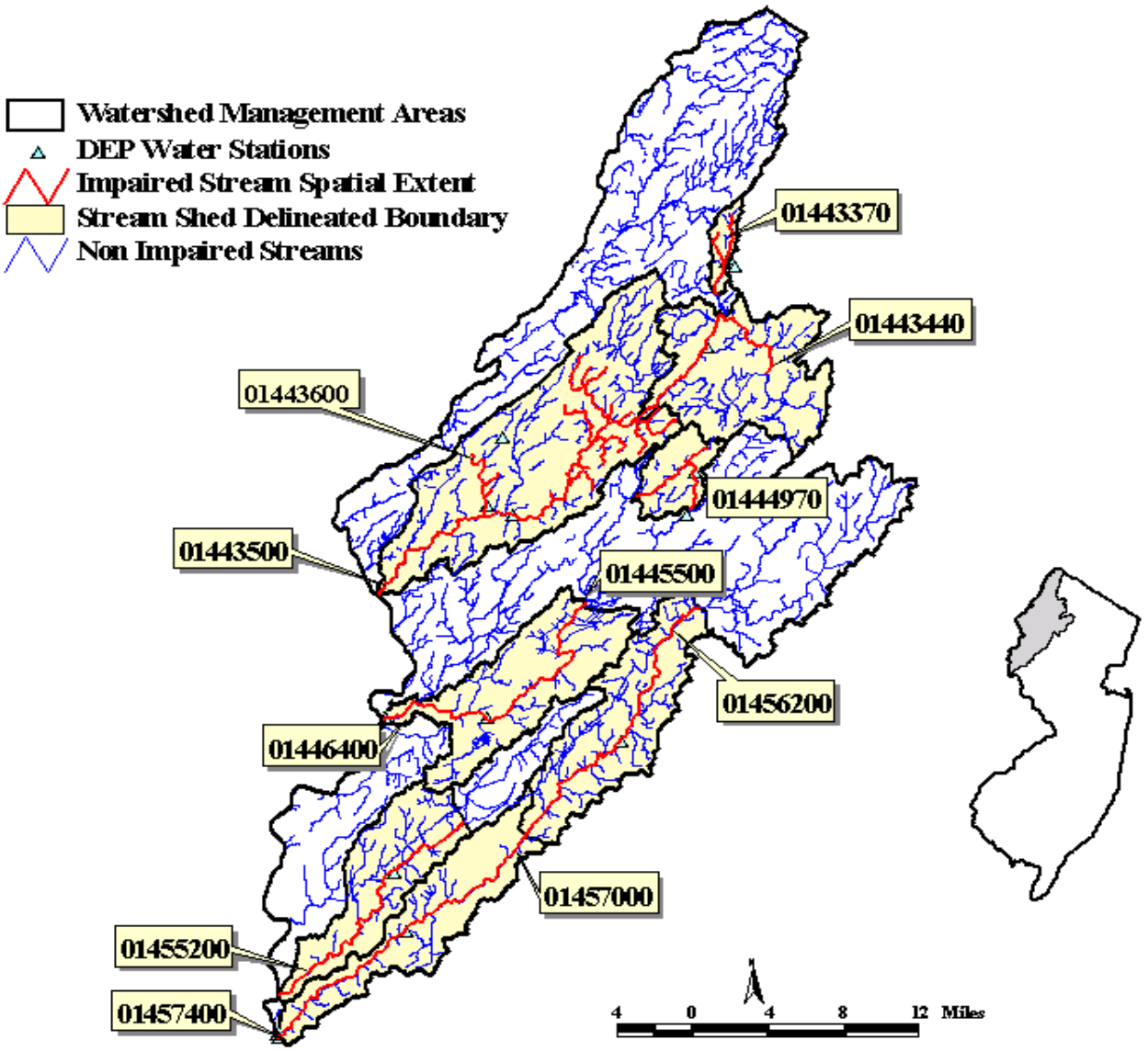


Table 3 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 1.

Segment ID	Watershed area associated with impaired stream segments
01443370	Northeast branch of Dry Brook watershed upstream of its confluence with Paulins Kill.
01443440	The Paulins Kill River watershed upstream of, and including, Paulins Kill Lake
01444970	Pequest River watershed upstream of Kymer Brook
01443500, 01443600	Begins at the outlet of Paulins Kill Lake and extends to the Delaware

Segment ID	Watershed area associated with impaired stream segments
	River
01445500, 01446400	Watershed area that extends from the confluence of Bear Creek and Pequest River to the Delaware River
01455200	Pohatcong Creek watershed area draining directly to the area downstream of the confluence of Shabbecong Creek with Pohatcong Creek to the Delaware River.
01456200	Musconetcong River watershed upstream from Waterloo to the town of Changewater
01457000, 01457400	Musconetcong River watershed from Changewater to the Delaware River

Table 4 River miles, Watershed size, and Anderson Land Use classification for eleven Sublist 5 segments, listed for fecal coliform, in WMA 1.

	Segment ID							
	01443370	**01443440**	**01444970**	**01443500 01443600**	**01445500 01446400**	**01455200**	**01456200**	**01457000 01457400**
Sublist 5 impaired river miles (miles)	6.7	13.7	9.0	55.7	17.9	17.0	17.9	19.0
Total river miles within the delineated watershed and included in the implementation plan (miles)	11.2	88.1	19.0	179.5	80.2	63.5	91.3	50.3
Watershed size (acres)	3277	34921	8611	69083	32718	25076	32587	27163
Land use/ Land cover								
Agriculture	17.3%	22.5%	21.8%	14.3%	14.6%	41.2%	18.2%	42.9%
Barren Land	0.7%	1.7%	0.2%	0.2%	1.2%	0.6%	1.3%	0.3%
Forest	53.7%	38.4%	46.6%	59.4%	50.7%	35.6%	51.9%	35.5%
Urban	16.5%	16.7%	12.3%	12.2%	13.5%	14.8%	19.5%	15.7%
Water	1.5%	3.1%	2.2%	4.0%	1.4%	3.2%	1.7%	0.8%
Wetlands	10.4%	17.6%	16.9%	9.9%	18.6%	4.6%	7.5%	4.8%

4.1.2. Watershed Management Area 2

The Wallkill River, Pochuck Creek, and Papakating Creek Watershed, located predominantly in Sussex County, lies between the Valley and Ridge physiographic Province (western portion of WMA 2) and the Highlands (eastern portion). It encompasses 208 square miles.

Thirteen municipalities lie entirely or partially within the boundaries of WMA 2. Watershed land uses include rural and centralized residential development, agriculture, commercial uses, industrial uses, and recreational (e.g., golf, skiing, Wallkill National Wildlife Refuge). The main stem of the Wallkill River originates at the outlet of Lake Mohawk in Sparta Township, and flows north into New York to the Hudson River. Lakes and ponds in this watershed include Lake Mohawk, Newton Reservoir, Beaver Lake, Lake Grinnell, and Wallkill Lake. There are over 80 dams and impoundments on the rivers and streams in WMA 2 creating localized lake-like conditions, which can affect flow, water quality, and sedimentation. Watershed land uses include extensive areas of forest, wetlands and water, with about 16% agriculture and 15% urban/suburban.

The majority of the waterways in this region are classified as nontrout streams and designated for primary and secondary contact recreational uses. It should be noted that as required under New Jersey Chapter 15, Water Quality Management Planning, N.J.A.C. 7:15-7.2(e), the TMDLs for WMA 2 must be developed as to fully protect the designated and existing uses of the waters of the adjacent state at the New Jersey border. As the Wallkill River flows across the border of New Jersey into New York State, the river and its tributaries are classified as C waterbodies. Part 703 of the New York Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations defines the standard for Fecal Coliforms per 100mL in a class C waterbody as "the monthly geometric mean, from a minimum of five examinations, shall not exceed 200mL".

Papakating Creek drains an area of 61 square miles, and joins the Wallkill River just east of Sussex Borough. Major tributaries to the Papakating include the West Branch Papakating Creek and the Clove Brook, as well as a tributary from Lake Neepaulin.

The Pochuck Creek basin, consisting of 49 square miles, is a separate sub-watershed in this area, in which the Pochuck Creek also flows north and intersects the Wallkill River above Eden, New York in Orange County. The major tributaries to the Pochuck include the Black Creek, the Wawayanda Creek, and Lake Lookout Brook. Significant lakes in the region include Upper Greenwood Lake, Lake Wawayanda, and Highland Lake.

The Rutgers Creek Tributaries have a drainage area of 3.2 square miles in the New Jersey portion of this largely New York based watershed, which enters New Jersey in the northwestern corner of WMA 2. These tributaries are part of a larger system that drains portions of the western Wallkill River watershed in New York State and joins the mainstem Wallkill River north of Eden in Orange County.

Sublist 5 Waterbodies in WMA 2

Eleven river segments of the twenty-eight impaired segments addressed in this report are located in WMA 2, These segments include portions of the Wallkill River (#01367625, #01367715, #01367770, #01368000), Papakating Creek (#01367780, #01367800, #01367860, #01367910), West Branch Papakating Creek (#01367850), Double Kill (#01368820), and Black Creek (#01368950). The spatial extent of each segment is identified in Figure 2 and described

in Table 5. River miles, watershed sizes and land use/land cover by percent area associated with each segment are listed in Table 6.

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

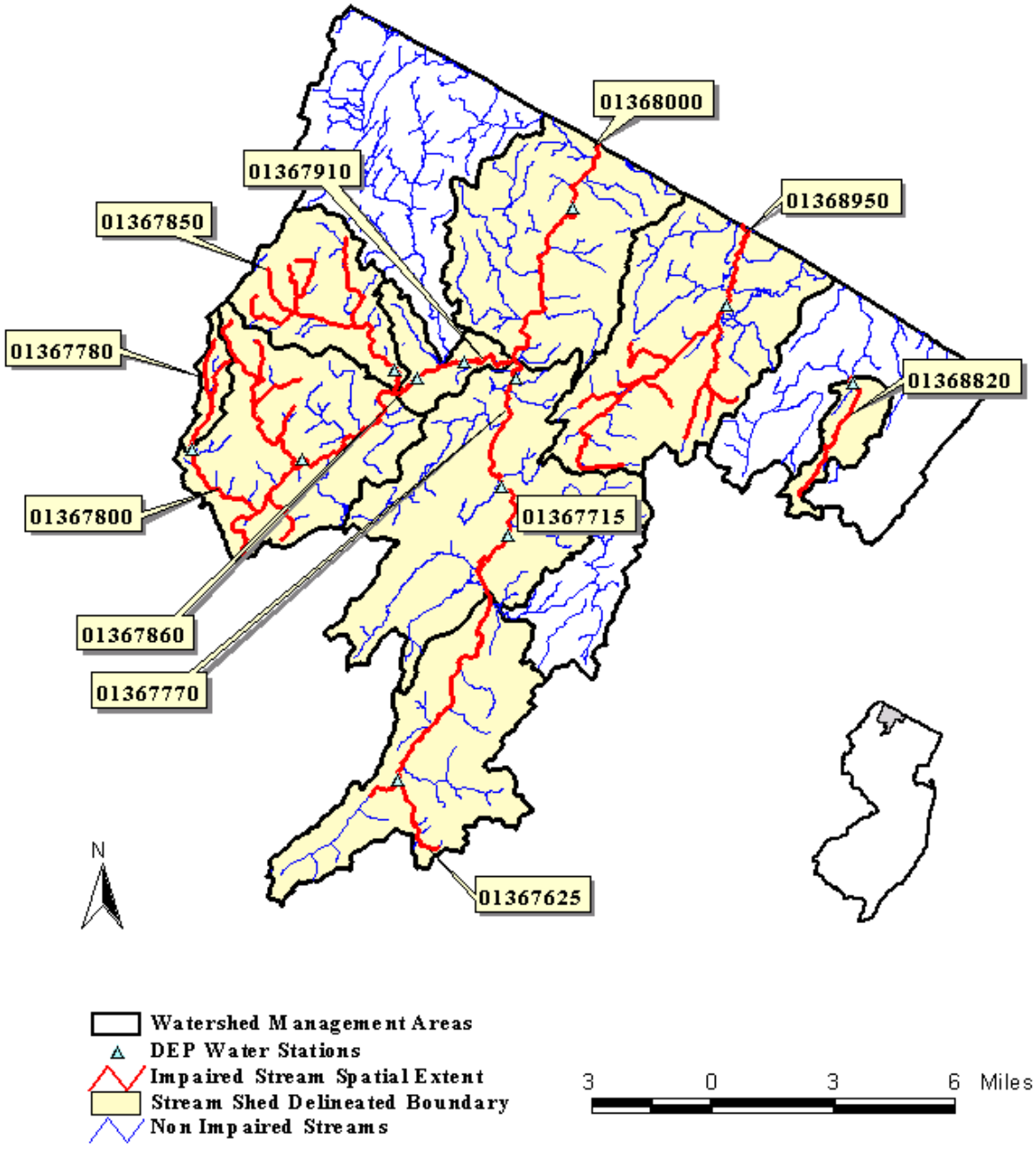


Table 5 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 2.

Segment ID	Watershed area associated with impaired stream segments
01367625	Wallkill River watershed area from Lake Mohawk (Wallkill River headwaters) to Franklin Pond and including all tributaries to this segment
01367715, 01367770	Wallkill River watershed area from Franklin Pond to the confluence of Wallkill River with Papakating Creek
01367780	Papakating Creek watershed upstream of station #01367780 near Wykertown
01367800	Papakating Creek watershed upstream of the confluence of the West Branch Papakating Creek with Papakating Creek excluding the watershed upstream of Wykertown.
01367850	West Branch Papakating Creek watershed upstream of the confluence of West Branch Papakating Creek with Papakating Creek.
01367860, 01367910	Papakating Creek watershed that extends from the confluence of Papakating Creek with the West Branch Papakating Creek to the confluence of Papakating Creek with the Wallkill River
01368000	Wallkill River watershed which extends from the confluence of the Papakating Creek with the Wallkill River to the New Jersey/New York border
01368820	The watershed associated with the southeast headwater branch of Double Kill to approximately 400 yards downstream of its intersection with Waywayanda Road
01368950	The Black Creek headwaters watershed north to the New Jersey/New York border

Table 6 River miles, Watershed size, and Anderson Land Use classification for eleven Sublist 5 segments, listed for fecal coliform, in WMA 2.

	Segment ID								
	01367625	**01367715 01367770**	**01367780**	**01367800**	**01367850**	**01367860 01367910**	**01368000**	**01368820**	**01368950**
Sublist 5 impaired river miles (miles)	10.1	4.7	4.6	21.7	13.5	4.2	7.6	4.1	20.5
Total river miles within the delineated watershed and included in the implementation plan (miles)	30.9	52.4	5.6	45	23.5	8.3	49.2	6.9	59.1

	Segment ID								
	01367625	01367715 01367770	01367780	01367800	01367850	01367860 01367910	01368000	01368820	01368950
Watershed size (acres)	14091	20625	12867	14462	7361	2848	15956	2473	17890
Land use/ Land cover									
Agriculture	2.2%	16.6%	24.1%	33.8%	27.4%	28.8%	21.1%	0.0%	9.9%
Barren Land	0.7%	2.9%	0.3%	0.9%	0.4%	0.1%	0.4%	0.0%	0.6%
Forest	53.9%	47.6%	51.6%	40.0%	43.3%	27.7%	36.3%	79.3%	50.5%
Urban	23.5%	15.4%	11.1%	9.7%	14.1%	20.5%	11.9%	0.5%	19.9%
Water	8.2%	1.6%	0.2%	1.1%	1.4%	2.2%	1.9%	1.1%	1.9%
Wetlands	11.5%	15.9%	12.6%	14.7%	13.4%	20.7%	28.5%	19.2%	17.3%

4.1.3. Watershed Management Area 11

The Central Delaware Tributaries, or WMA 11, is 272 square miles in area and includes all or parts of 24 municipalities within Hunterdon, Mercer, and Monmouth County. The northern section of the Central Delaware Tributaries is located within the Highlands Region, while the southern and eastern sections are located within the Inner Coastal Plain, and the remaining central sections of are primarily within the Piedmont physiographic province. The following information was adapted from the Regional Planning Partnership Settings Report of the Central Delaware Tributaries, released in November 2001 (Regional Planning Partnership, 2001).

The **Hakihokake/Harihokake/Nishisakawick Creek** watershed drainage basin is 63 square miles. Located in the northern part of Hunterdon County, it includes Milford and Frenchtown Boroughs, Kingwood, Holland and Alexandria Townships. The Hakihokake Creek is approximately 6.25 miles long. The creek's headwaters begin at 820 ft. in the Musconetcong Mountains in forested wetlands in Holland and Alexandria Townships and run southwest through Sweet Hollow and Little York gently dropping 710 feet to the Delaware River at Milford Borough (110 feet above sea level). The Harihokake is approximately 7.5 miles long. Its headwaters begin at 740 ft from springs in the Musconetcong Mountains in Alexandria Township. On its way south it passes through Mt. Pleasant slowly dropping 630 feet to the Delaware River. The Nishisakawick is approximately 7.5 miles long. Its headwaters begin at 720 ft in forested wetlands in Alexandria Township and it flows through Camp Marudy Lake, past Camp Marudy, and through Everittstown on its way southwest past farms and developed land slowly dropping 610 feet to the Delaware River at Frenchtown Borough.

The **Little Nishisakawick** springs from wetlands in Kingwood Township at 480 ft and flows approximately 4 miles southwest through mostly agricultural land gently dropping 370 feet to the Delaware River.

Copper Creek is approximately 3.5 miles long and rises at 480 ft from wetlands and a lake near Baptistown in Kingwood Township. It flows southwest to enter the Delaware River.

Warford Creek is 2.5 miles long and rises at 460 ft near Barbertown in Kingwood Township. It travels southwest to the Delaware River opposite Treasure Island.

The **Lockatong Creek/Wickecheoke Creek** watershed drainage basin is 55 square miles. Located in Central Hunterdon County, it includes all of or portions of Franklin Township, Delaware Township, Raritan Township, and Kingwood Township. The Lockatong Creek is thirteen miles long and rises from springs and wetlands near Quakertown in Franklin Township. It flows south through farms and woodlands in Franklin, Kingwood and Delaware Townships falling 500 feet in elevation before emptying into the D&R Canal (and Delaware River). It drains a 27.8 sq. mi. watershed. The Wickecheoke is 14 miles long and rises from wetlands in Franklin and Raritan Townships, flowing south through Delaware and Kingwood Townships to the D&R Canal and Delaware River at Prallsville Mills in Stockton. The Wickecheoke drains a 26.57 sq. mi. watershed.

The 22 mile long Delaware and Raritan feeder Canal begins its intake from the Delaware River opposite Bulls Island at Raven Rock (six miles north of Lambertville) and joins the main canal at Trenton. From Trenton it travels east seven miles before leaving the Central Delaware Tributaries and entering the Millstone River watershed management area (WMA 10) on its way to the Raritan River.

Alexauken Creek/Moore Creek/Jacobs Creek watershed drainage is 63 square miles, located in Southern Hunterdon County, and includes all of or parts of the following municipalities: Stockton Borough, West Amwell Township, Lambertville City, Hopewell Township, Pennington Borough, and Ewing Township. The Alexauken is approximately five miles long and runs southwest through forest and farmland from its headwaters at 220ft in West Amwell, through a small lake in East Amwell. It parallels the Black River and Western Railroad until it enters the Delaware above Lambertville at Holcombe Island. Swan Creek is approximately one mile long from its reservoirs to Lambertville where it crosses under Route 29 before entering the Delaware River. Moores Creek is approximately 5.25 miles long rising from a lake southwest of Coopers Corners in Hopewell. It runs through West Amwell Township through forest and agricultural land back into Hopewell Township to drain into the Delaware River. Jacobs Creek also has its headwaters in Hopewell and Pennington and flows west of Pennington Mountain 7.5 miles through forest, agricultural and developed land into Somerset where it enters the Delaware River.

Fiddlers Creek is separated from Moores Creek by Strawberry Hill and Baldpate Mountain (475 ft). It rises south of Ackers Corners at 220 ft and empties into the D&R Canal just north of Titusville (at 40 ft above sea level).

Woolsey Brook rises in Pennington and after flowing southwest joins Jacobs Creek just north of Somerset.

Airport Brook begins north of exit 3 on I-95 and runs three miles west passing Mercer County Airport to join Jacobs Creek north of Somerset.

Gold Run begins at a small lake in Ewing and runs two miles southwest passing the State School for the Deaf and enters the Delaware River south of Lower Ferry Road.
Seven dischargers are located in the watershed

The **Assunpink Creek** above the Shipetaukin rises in forested wetlands in Roosevelt and Millstone Townships. It is joined by the New Sharon Branch as it travels northwest through Washington, West Windsor, and Lawrence Townships where the Shipetaukin Creek joins it. As it travels farther northwest away from the wetlands of the Assunpink Wildlife Management Area, past Central Mercer County Park, and Bear Swamp to Whitehead Mill Pond the landscape becomes increasingly urbanized.

The **New Sharon Branch** rises at 110 ft from a small lake in Upper Freehold and runs 5 miles northwest through New Sharon to wetlands around Carsons Mills where it joins the Assunpink.

The **Shipetaukin Creek** rises at 210 ft in Hopewell near Van Kirk Road and runs five and one half miles southeast before joining the Assunpink Creek at Whitehead Mills Pond.
Bridegroom Run starts in West Windsor near Edinburg and runs two miles west before it joins the Assunpink Creek in Central Mercer County Park.

The two largest lakes in the Central Delaware Tributaries are found in this watershed: the 227-acre Assunpink Lake and a 270-acre unnamed lake (both created by dams).

Miry Run (rising from wetlands in Washington Township) and the West Branch of the Shabakunk Creek (Ewing), the Shabakunk Creek (Hopewell), and the Little Shabakunk Creek (Lawrence) contribute to the **Assunpink Creek** as it flows southwest through Lawrence Township and Trenton to the Delaware River. In total the Assunpink Creek is about 25 miles long. This part of the Central Delaware Tributaries is highly urbanized with the Assunpink channeled with concrete sides for flood control purposes.

The **Little Shabakunk Creek** begins in Lawrence Township near Bunkerhill Road and travels east 3.5 miles before entering the Assunpink Creek north of East Trenton Heights.

The **Shabakunk Creek** begins near Twin Pine Airport in Hopewell and travels 7.5 miles in total through Ewing Township (picking up flow from the two artificial lakes Ceva Lake and Sylvia Lake) before entering Lawrence Township and flowing through Colonial Lake (another artificial lake) on its way to join the Assunpink Creek at Whitehead Mills Pond.

The **West Branch of the Shabakunk Creek** begins north of Rambling Creek Park in Ewing Township then travels for five miles south then east into Lawrence Township where it joins the Shabakunk Creek west of Route 206.

Pond Run starts in Hamilton Square and runs four miles west through Veterans County Park, Bromley Park and railyards before joining the Assunpink Creek just north of Olden Avenue.

Miry Run rises in Washington Township north of the Trenton Robbinsville airport and runs 7.5 miles northwest through wetlands north of Hamilton Square to join the Assunpink Creek just east of Whitehead Rd. at Whitehead Mills Pond.

Sublist 5 Waterbodies in WMA 11

Six river segments of the twenty-eight impaired segments addressed in this report are located in WMA 11, including: Nishisakawick Creek near Frenchtown, #01458570; Copper Creek near Frenchtown, #01458710; Plum Brook near Locktown, #01461262; Jacobs Creek at Bear Tavern, #01462739; Miry Run at Route 533 at Mercerville,# 01463850; Assunpink Creek at Peace Street at Trenton, # 01464020. The spatial extent of each segment is identified in Figure 3 and described in Table 7. River miles, watershed sizes and land use/land cover by percent area associated with each segment are listed in Table 8.

Figure 3 Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 11

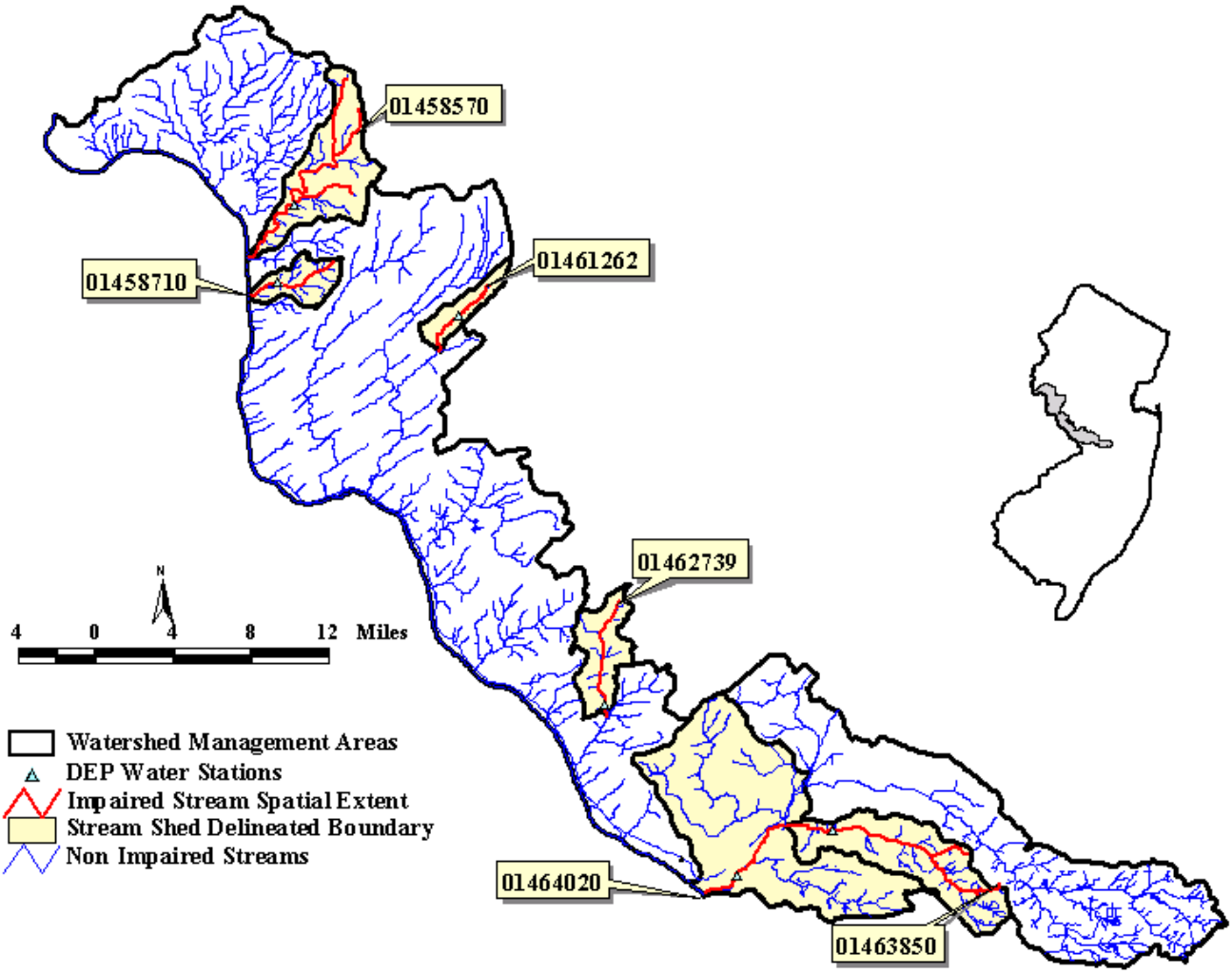


Table 7 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 19.

Segment ID	Watershed area associated with impaired stream segments
01458710	The Copper Creek watershed from its headwaters to the Delaware River.
01461262	North Branch of Plum Creek, north of Ferry Road in Hunterdon County.
01462739	Jacobs Creek watershed upstream of its confluence with Woolsey Brook.
01463850	Miry Run watershed upstream of its confluence with Assunpink Creek.
01464020	Assunpink Creek watershed downstream of the confluence of Assunpink Creek with Shipetaukin Creek. Includes the West Branch Shabakunk Creek,

Segment ID	Watershed area associated with impaired stream segments
	Shabakunk Creek, Little Shabakunk Creek, Delaware and Raritan Canal, and Pond Run
01458570	Nishisakawick Creek watershed

Table 8 River miles, Watershed size, and Anderson Land Use classification for six Sublist 5 segments, listed for fecal coliform, in WMA 11.

	Segment ID					
	01458710	**01461262**	**01462739**	**01463850**	**01464020**	**01458570**
Sublist 5 impaired river miles (miles)	3.3	3.4	4.2	10.1	4.0	13.4
Total river miles within the delineated watershed and included in the implementation plan (miles)	10.4	3.7	8.8	30.3	52.8	25.3
Watershed size (acres)	2119	1678	3543	7911	20611	7064
Land use/Land cover						
Agriculture	50.4%	26.8%	43.9%	20.3%	4.1%	51.3%
Forest	29.8%	39.6%	32.8%	3.4%	8.8%	23.7%
Urban	8.3%	11.0%	20.7%	48.9%	72.7%	15.6%
Water	0.1%	0%	0.4%	1.1%	1.1%	0.3%
Wetlands	11.3%	22.6%	1.7%	24.8%	11.6%	9%
Barren Land	0%	0%	.5%	1.4%	1.7%	0%

4.2. Data Sources

The Department's Geographic Information System (GIS) was used extensively to describe Northwest 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).
- Dams statewide coverage. Published 5/16/2000 by Dam Safety Section. Titled "NJDEP Dams for the State of New Jersey." New Jersey Department of Environmental Protection (NJDEP). Online at: http://www.state.nj.us/dep/gis/digidownload/zips/statewide/dams.zip

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 samples taken during any 30-day period exceed 400 CFU/100 ml in FW2 waters".

All of the waterbodies covered under these TMDLs have a FW2 classification (NJAC 7:9B-1.12) with the exception of a two short segments of Black Creek and the entire impaired length of Double Kill which are classified as FW1 waters. 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 Northwest 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, 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, until New Jersey makes the transition to *E. coli* and enterococci in its SWQS and sufficient data have been collected to assess impairment in accordance with the revised indicators.

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

Point sources of fecal coliform, namely sewage treatment discharges, for these TMDLs are listed in Appendix B. Sewage treatment plants, whether municipal or industrial, are required to disinfect effluent prior to discharge and to meet surface water quality criteria for fecal coliform in their effluent. 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 sewage treatment plants.

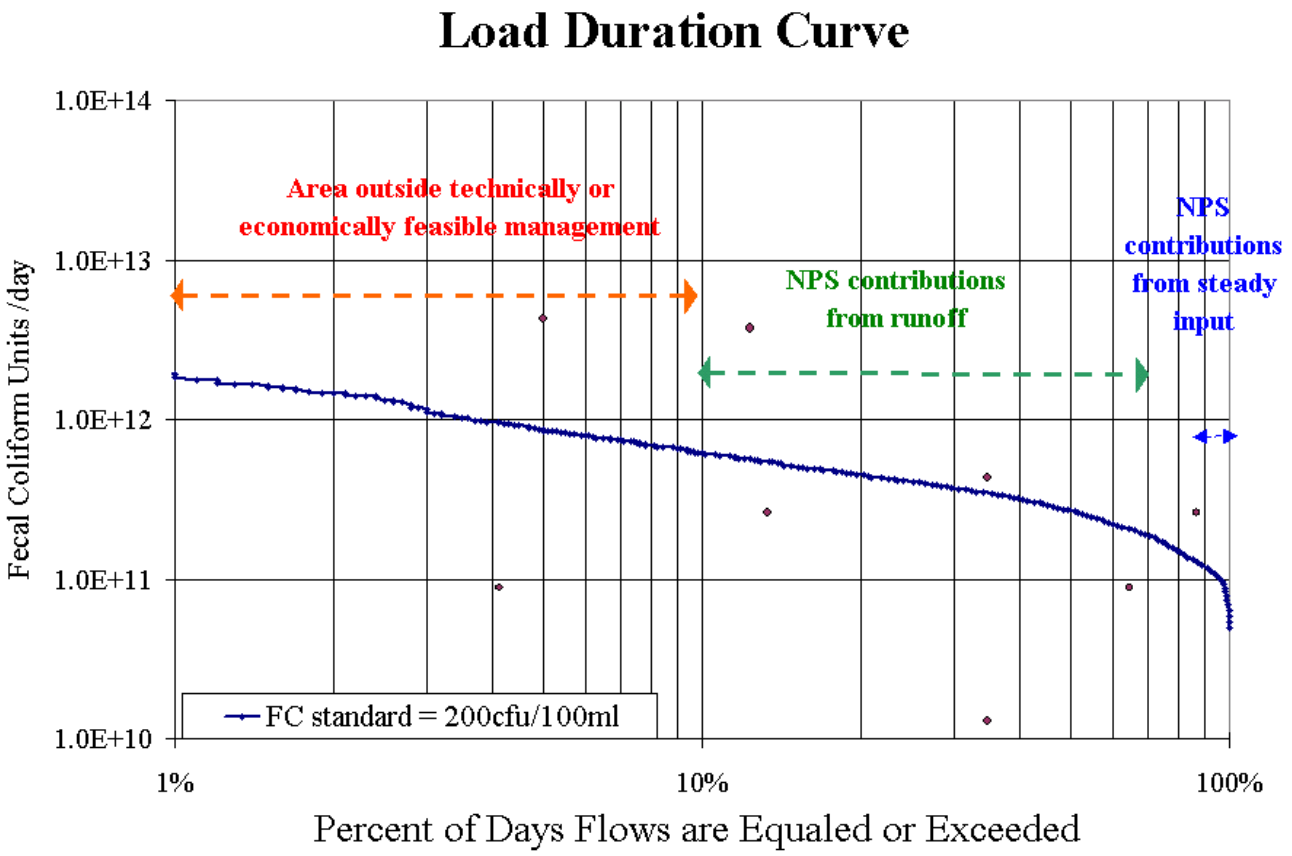
Since sewage treatment plants routinely achieve essentially complete disinfection (less than 20 CFU/100ml), the requirement to disinfect results in fecal coliform concentrations well below the criteria and permit limit. The percent of the total point source contribution is an insignificant fraction of 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.

6.2. Assessment of Nonpoint and Stormwater Point Sources

Nonpoint and stormwater point 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, either through the Phase II MS4 requirements or trackdown studies conducted by the Department, appropriate enforcement measures will be taken to eliminate them.

When streamflow gage 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 4 represents a LDC using the 200 CFU/100 ml criterion.

Figure 4 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.

LDCs for listed segments in the Northwest 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.

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, pet waste ordinances, agricultural conservation management plans, and septic system replacement and maintenance. 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:

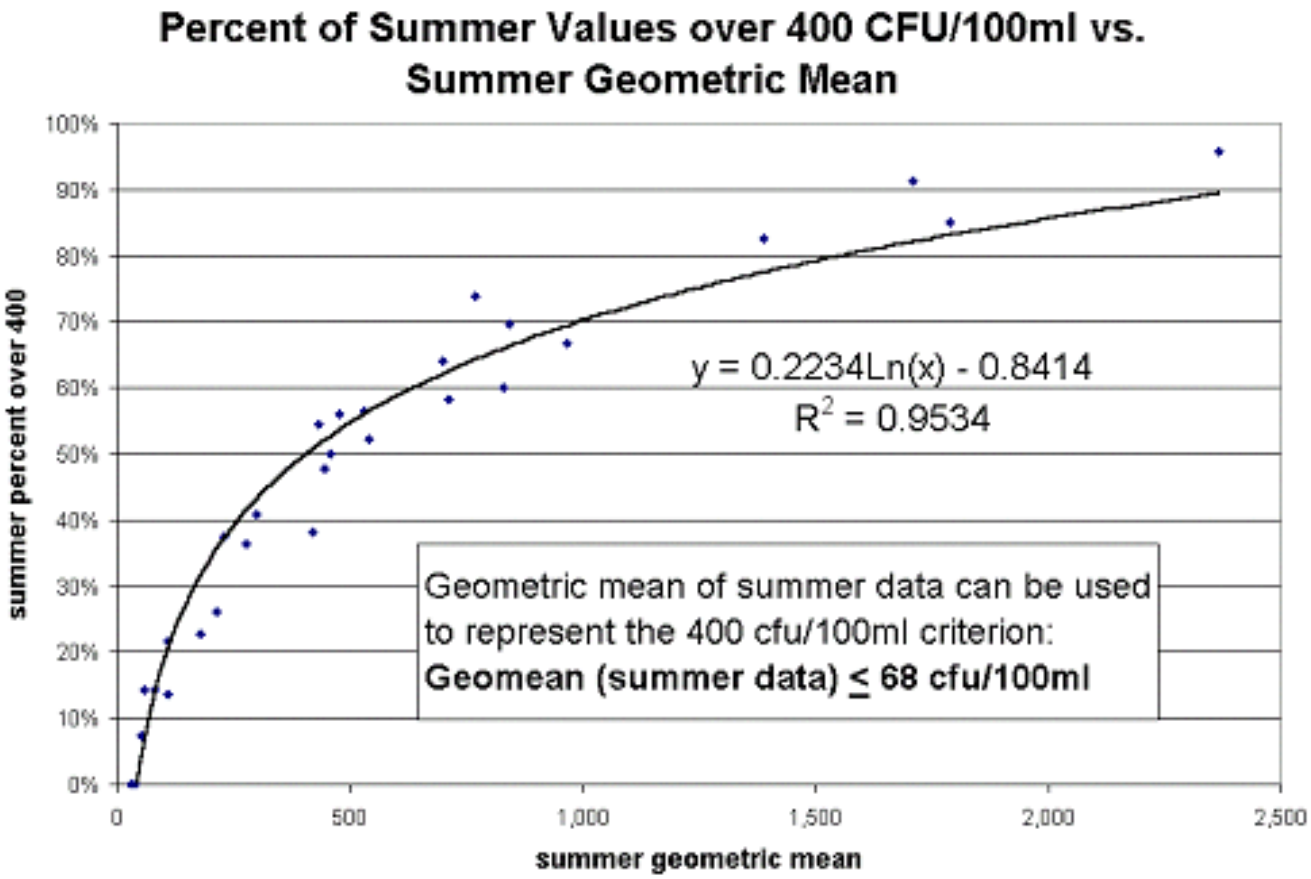
- expressing a bacteria TMDL in terms of concentration provides a direct link between existing water quality and the numeric target;
- using concentration in a bacteria TMDL is more relevant and consistent with the water quality standards, which apply for a range of flow and environmental conditions; 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 1994-2002 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 5). Thus, each datapoint on Figure 5 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. A statewide regression was used rather than regional regressions because the regression shape was not region-specific and the strength of the correlation was highest when all statewide data were included. 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 5 **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

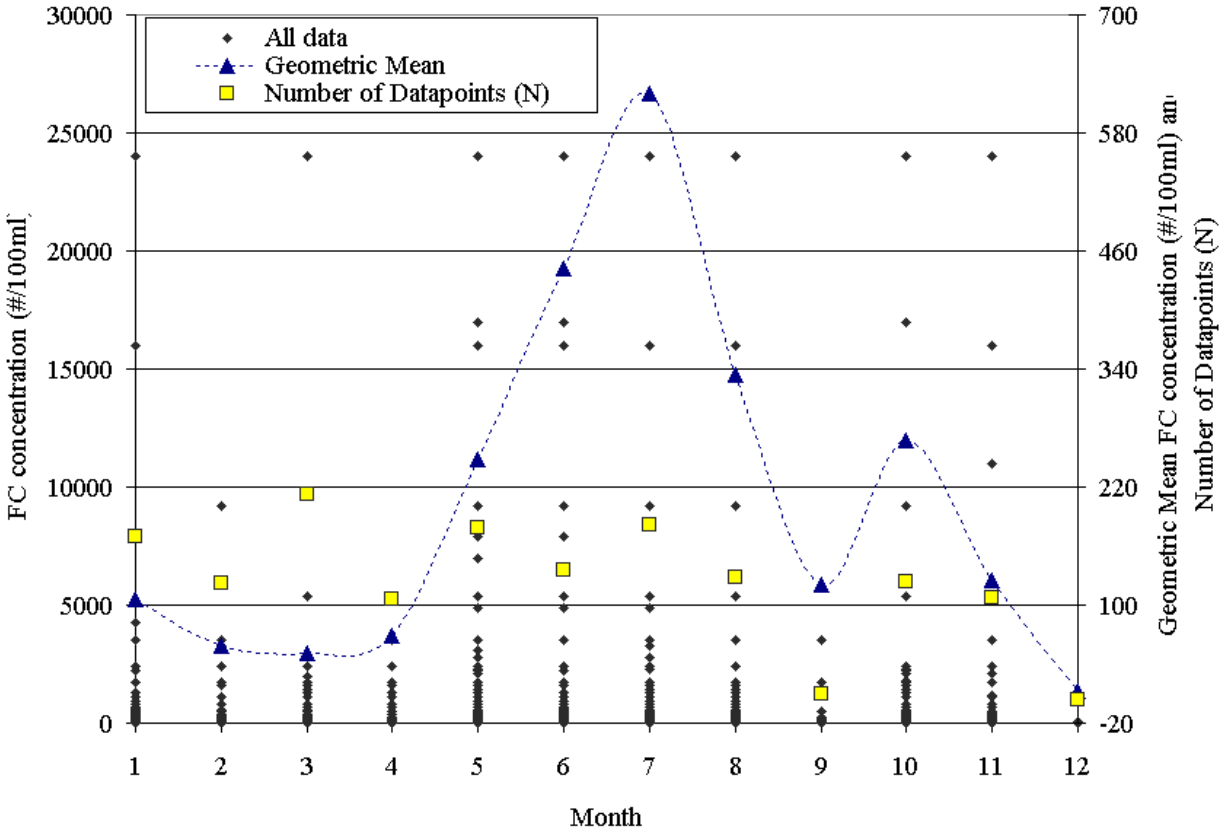
where:
e = (margin of safety)

This percent reduction can be applied to nonpoint and stormwater point sources as a whole or be apportioned to categories of nonpoint and stormwater point sources within the study area. The extent to which nonpoint and stormwater point sources have been identified or need to be identified varies 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 month basis and are shown in Figure 6. 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 6, 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 6 **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 point 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 9 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 9 were equal to the percent required to meet the 400 CFU/100ml criteria.

Table 9 TMDLs for fecal coliform-impaired stream segments in the Northwest 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 Number	WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Load Allocation (LA) and Margin of Safety (MOS)					Wasteload Allocation (WLA)
					Summer N	Summer geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	
1	1	01443370	01443370	Dry Brook at Rt. 519 near Branchville	5	652	48%	5%	95%	95%
2	1	01443440	01443440	Paulins Kill at Balesville	8	1537	53%	2%	98%	98%
3	1	01444970	01444970, 01445000	Pequest River at Rt. 206 Below Springdale, Peqest River at Huntsville	9	342	45%	9%	89%	89%
4 5	1	01443500, 01443600	01443500, 01443600	Paulins Kill at Blairstown, Jacksonburg Creek near Blairstown	38	216	29%	9%	78%	78%
6 7	1	01445500, 01446400	01445500, 01446400	Pequest River at Pequest, Pequest River at Belvidere	28	695	30%	3%	93%	93%
8	1	01455200	01455200	Pohatcong Creek at New Village	8	2679	51%	1%	99%	99%

TMDL Number	WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Load Allocation (LA) and Margin of Safety (MOS)					Wasteload Allocation (WLA)
					Summer N	Summer geometric mean CFU/100ml	MOS as a percent of the target concentration	Percent reduction without MOS	Percent reduction with MOS	
9	1	01456200	01456200	Musconetcong River at Beattystown	8	502	45%	6%	93%	93%
10 11	1	01457000, 01457400	01457000, 01457400	Musconetcong River near Bloomsbury, Musconetcong River at Riegelsville	40	698	29%	3%	93%	93%
12	2	01367625	01367625, 01367700	Wallkill River at Sparta, Wallkill River at Franklin	21	362	48%	9%	90%	90%
13 14	2	01367715, 01367770	01367715, 01367770	Wallkill River at Scott Rd at Franklin, Wallkill River near Sussex	34	596	36%	4%	93%	93%
15	2	01367780	01367780	Papakating Creek near Wykertown	10	483	46%	6%	92%	92%
16	2	01367800	01367800	Papakating Creek at Pelletown	14	1172	28%	2%	96%	96%
17	2	01367850	01367850	WB Papakating Creek at McCoys Corner	5	5054	60%	1%	99%	99%
18 19	2	01367860, 01367910	01367860, 01367910	Papakating Creek near Sussex, Papakating Creek at Sussex	13	2425	47%	1%	99%	99%
20	2	01368000	01368000	Wallkill River near Unionville	8	765	46%	4%	95%	95%
21	2	01368820	01368820	Double Kill at Waywayanda	19	70	46%	44%	47%	47%
22	2	01368950	01368950	Black Creek near Vernon	8	2137	54%	2%	99%	99%
23	11	01458570	01458570	Nishisakawick Creek near Frenchtown	19	192	35%	12%	77%	77%
24	11	01458710	01458710	Copper Creek near Frenchtown	5	502	82%	11%	98%	98%
25	11	01461262	01461262	Plum Brook near Locktown	5	662	86%	9%	99%	99%
26	11	01462739	01462739	Jacobs Creek at Bear Tavern	5	1049	52%	3%	97%	97%
27	11	01463850	01463850	Miry Run at Route 533 at Mercerville	19	977	37%	3%	96%	96%
28	11	01464020	01464020	Assunpink Creek at Peace Street at Trenton	18	3417	51%	1%	99%	99%

[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. Strategies for source reduction will apply equally well to new development as to existing development.

9.0 Follow - up Monitoring

The Water Resources Division of the U.S. Geological Survey and 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 events, 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 fecal coliform monitoring.

10.0 Implementation

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).

Development of effective management measures depends on accurate source assessment. Fecal coliform is contributed to the environment from a number of categories of sources including human, domestic or captive animals, agricultural practices, and wildlife. Fecal coliform from these sources can reach waterbodies directly, through overland runoff, or through sewage or stormwater conveyance facilities. Each potential source will respond to one or more management strategies designed to eliminate or reduce that source of fecal coliform. Each management strategy has one or more entities that can take lead responsibility to effect the strategy. Various funding sources are available to assist in accomplishing the management strategies. The Department will address the sources of impairment through systematic source trackdown, matching strategies with sources, selecting responsible entities and aligning available resources to effect implementation.

For example, the stormwater discharged to the impaired segments through "small municipal separate storm sewer systems" (small MS4s) will 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, many municipalities (and various county, State, and other agencies) in the Northwest 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. Sewage conveyance facilities are potential sources of fecal coliform in that equipment failure or operational problems may result in the release of untreated sewage. These sources, once identified, can be eliminated through appropriate corrective measures that can be effected through the Department's enforcement authority. Inadequate on-site sewage disposal can also be a source of fecal coliform. Systems that were improperly designed, located or maintained may result in surfacing of effluent and illicit remedies such as connections to storm sewers or streams add human waste directly to waterbodies. Once these problems have been identified through local health departments, sanitary surveys or other means, alternatives to address the problems can be evaluated and the best solution implemented. The Department has committed a portion of its CWA 319(h) pass through grant funds to assist municipalities in meeting Phase II requirements. In addition, The New Jersey Environmental Infrastructure Financing Program, which includes New Jersey's State Revolving Fund, provides low interest loans to assist in correction of water quality problems related to stormwater and wastewater management.

Agricultural activities are another example of potential sources of fecal coliform. Possible contributors are direct contributions from livestock permitted to traverse streams and stream corridors, manure management from feeding operations, or 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. 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. The funding programs 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 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 through CREP. 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.

- **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.

10.1. Source Trackdown

Through the watershed management process and the New Jersey Watershed Ambassador Program, river assessments and visual surveys of the impaired segment watersheds were conducted to identify potential sources of fecal coliform. Watershed partners, who are intimately familiar with local land use practices, were able to share information relative to potential fecal coliform sources. 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. Supplemental training was provided through the fall/winter of 2002 to prepare the members to perform river assessments on the impaired segments. Each member was provided with detailed maps of the impaired segments within their watershed management area. The Department worked with and through watershed partners and AmeriCorps members to conduct RATs surveys in fall of 2002. The Department reviewed monitoring data, RATs surveys, other information supplied by watershed partners, load duration curves, and aerial photography of the impaired segments to formulate segment specific strategies. Segment specific monitoring strategies in combination with generic strategies appropriate to the sources in each segment will lead to reductions in fecal coliform loads in order to attain SWQS.

10.1.1. Short Term Management Strategies

Short term management measures include projects recently completed, underway and planned which will address sources of fecal coliform load. Pertinent projects in the Northwest are as follows:

WMA 1

- Swartswood Lake and Watershed Association and Swartswood State Park is currently working on a project that will characterize and assess (including water quality monitoring for nutrients) the Swartswood Lake Watershed. It will implement the construction of a detention basin near the beach are of Swartswood State Park to aid in the control of nutrients and fecal. This project complements existing source control measures currently in place within the lake/watershed area.

- Liberty Township is currently undertaking a Nonpoint Source Pollution Control Project involving Mountain Lake and Mountain Lake Brook. This project will restore a moderately impaired biological monitoring site through the implementation of stormwater management devices to collect and filter nonpoint source pollutants. The project will replace failing devices and replace them with catch basin filters and large capacity vortex-type advanced oil and grit separator. The project will develop a restoration management strategy for area on Mountain Lake Brook and the lakebank and target education to the lake residents.

WMA 2

- The Township of Sparta is currently restoring 5,700 feet of the stream and stream environs of Sparta Glen Brook, which was significantly impacted by a significant short duration storm in 2000. The project includes re-channelization of the stream, re-establishment of the stream habitat and streambank and restoration of the riparian buffer and forest transition zone.
- The North Jersey RC&D Council in partnership with Rutgers Cooperative Extension, New Jersey Farm Bureau and the North East Organic Farming Association, is undertaking a nonpoint source project that will provide targeted education and implementation to the agricultural community in the Walkill watershed. The project will work with farmers to protect water quality through the adoption of sustainable farming practices. Work will focus on grazing practices and supporting organic and transition to organic operations.

WMA 11

- Several lakes in Watershed Management Area 11 have received 319 (h) funding to restore stream banks and reduce the amount of non point source pollution entering into and exiting the lake. Hamilton Township, Mercer County, is currently working to retrofit Robert L. Martin Lake with a biofilter wetland to restore water quality to Pond Run and Assunpink Creek. This project will 1) implement a land use study of the upper portion of Pond Run to characterize potential non-point source and point sources loads 2) conduct a physical assessment of Pond Run and Robert L. Martin Lake 3) to design and implement restoration activities, design and implement a water quality monitoring program, and 4)

develop a long term watershed management and restoration plan that includes evaluation of various BMPs, geese management plan, and stream habitat improvements and construction of a treatment wetland at the lake outlet.

- The City of Trenton is working to restore stream banks along the Assunpink Creek by removing concrete and restoring a more natural environment, which will help to reduce NPS pollution.

- The Township of Hopewell, Mercer County is currently constructing a parking lot on municipal owned property using innovated design and construction technology. This demonstration project is intended to promote groundwater recharge and improve water quality through the use of enhanced NJDEP sand media filtration

10.1.2. Long–Term Management Strategies

Long term strategies include source trackdown as well as selection and implementation of specific management measures that will address the identified sources. Source categories and responses are summarized below:

Source Category	Responses	Potential Responsible Entity	Funding options
Human Sources			
Inadequate (per design, operation, maintenance, location, density) on-site disposal systems	Confirm inadequate condition; evaluate and select cost effective alternative, such as rehabilitation or replacement of systems, or connection to centralized treatment system	Municipality, MUA, RSA	CWA 604(b) for confirmation of inadequate condition; Environmental Infrastructure Financing Program for construction of selected option
Inadequate or improperly maintained stormwater facilities; illicit connections	Measures required under Phase II Stormwater permitting program plus Alternative measures as determined needed through TMDL process	Municipalty, State and County regulated entities, stormwater utilities	CWA 319(h)
Malfunctioning sewage conveyance facilities	Identify through source trackdown	Owner of malfunctioning facility— compliance issue	User fees
Domestic/captive animal sources			

Pets	Pet waste ordinances	Municipalities for ordinance adoption and compliance	
Horses, livestock, zoos	Confirm through source trackdown: SCD/NRCS develop conservation management plans	Property owner	EQIP, CRP, CREP (when approved),
Agricultural practices	Confirm through source trackdown; SCD/NRCS develop conservation management plans	Property owner	EQIP, CRP, CREP (when approved)
Wildlife			
Nuisance concentrations, eg resident Canada geese	Feeding ordinances; Goose Management BMPs	Municipalities for ordinance; Community Plans for BMPs	CBT, CWA 319(h)
Indigenous wildlife	Confirm through trackdown; consider revising designated uses	State	NA

10.2. Segment Specific Recommendations

10.2.1. Watershed Management Area 1

Musconetcong River at Reigelsville (Site ID #01457400) and near Bloomsbury (Site ID #01457000)

Land use in the area is predominantly agriculture, with urban, including some older development on septic systems, and forest. Potential sources of fecal coliform include: livestock; land application of manure; older septic systems in Warren Glen and Finesville area.; geese; and beaver in the river between Finesville and the Delaware River. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs; Phase II stormwater program.

Musconetcong River at Beattystown (Site ID #01456200)

Predominant land uses in this area include forest, agriculture, and urban. Potential sources of fecal coliform include geese, septics, fish hatchery, and beaver. Load duration curve consistent with a mix of steady state and storm driven sources. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs; Phase II stormwater program.

Pohatcong Creek at New Village (Site ID #01455200)

Predominant land uses in the area include agriculture, barren land and forest. Potential sources of fecal coliform include livestock, poultry farming, land application of manure, geese, and septic systems. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs

Pequest River at Belvidere (Site ID #01446400) and at Pequest (Site ID #01445500)

Predominant land uses in the area include urban and agricultural and forest. Potential sources of fecal coliform include dairy, sludge farming, geese, septic system, and seagulls on landfill areas. Load duration curve is consistent with steady state sources at Belvidere and with storm driven sources at Pequest. Monitoring: fecal coliform survey to narrow the scope and sources of impairment.

Pequest River at Route 206 Below Springdale (Site ID #01444970)

Predominant land uses in the area include forest, water, urban, and agriculture. Potential sources of fecal coliform include domestic pet waste and geese. Load duration curve is consistent with a mix of steady state and storm driven sources. Monitoring: augment data with additional sampling to better characterize the sources.

Paulins Kill at Blairstown (Site ID #01443500) and Jacksonburg Creek near Blairstown (Site ID #01443600)

Predominant Land uses in the area include forest, agriculture and urban. Potential sources of fecal coliform include septics/cesspools, geese, livestock, horse farms, deer, and beaver. Load duration curve is consistent with a mix of steady state and storm driven sources. Monitoring: Coliphage and MAR to differentiate human, domestic and wildlife sources.

Paulins Kill at Balesville (Site ID #01443440)

Predominant land uses in the area include agriculture, urban, and forest. Potential sources of fecal coliform include septic systems, geese, agriculture, waterfowl, and seagulls on landfill. Load duration curve consistent with a mix of steady state and storm driven sources, with a tendency towards storm driven sources. Monitoring: fecal coliform survey to narrow the scope of impairment.

Dry Brook at Route 519 near Branchville (Site ID #01443370)

Predominant land uses in the area include forest, urban, and agriculture. There is a healthy riparian area with abundant wildlife. Load duration curve consistent with storm driven sources. Potential sources of fecal coliform include: septic systems, livestock, and geese. Monitoring: Coliphage to determine if there are human sources.

10.2.2. Watershed Management Area 2

Papakating Creek near Wykertown (Site ID #01367780)

Land uses in this area primarily include agricultural, forest and residential. There are several ponds in this area that are formed from the Creek's waters. Potential sources of fecal coliform include septic systems, wildlife, particularly deer, and horses. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs.

West Branch Papakating Creek at McCoys Corner (Site ID #01367850)

Land uses in this area include both residential and agriculture. There is a year round wetlands pond in the area that is home to a very large waterfowl population. In addition, this area has a heavy wildlife presence, particularly deer. Septic systems could be a potential source since the West Branch of the Papakating travels through the backyards of many older homes. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs.

Papakating Creek At Sussex (Site ID #01367910)

This section of the Papakating is very wide, slow moving and has very heavy bank erosion. Possible sources of fecal contamination could be wildlife, particularly deer and geese, and farm animals, especially cows. Just before this location on the Papakating both the Lake Neepaulin Tributary as well as the Clove Brook empty in the Creek. Both come from densely developed lake communities, both of which also have large geese populations. The Clove Brook also travels through Sussex Borough, which is sewered. The Clove Brook originates and travels through highly agricultural lands before emptying into the Clove Brook. Along these stream reaches, fecal coliform input from grazing farm animals could be significant. Monitoring: fecal sampling is recommended in order to refine the extent of impairment and significant sources. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs.

Papakating Creek at Pelletown (Site ID #01367800)

This site is located just after the confluence of a tributary to the Papakating, which travels through densely wooded areas. This area has a lot of agricultural uses including nurseries and pet farms. This area also has a very large wildlife presence

of deer and geese. There are very large cattle farms in this area, where cattle have access to the stream. Monitoring: extensive fecal coliform sampling is proposed to differentiate the significant contributions in terms of the numerous tributaries, as this impaired segment is 21.7 miles long. A flow monitoring station will be established and limited coliphage sampling is also proposed.

Papakating Creek near Sussex (Site ID #01367860)

This site flows through a cow pasture with limited to no buffer around the stream. This area has heavy bank erosion and has a large geese population. Approximately a 4-mile reach of the Papakating prior to this location travels through highly active agricultural lands. Potential sources of fecal coliform include horses, cattle, geese, and septic systems. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs.

Wallkill River At Sparta (Site ID # 01367625)

Land uses include forest, township parks, and some agricultural uses where potential sources are geese, domestic pets, horses, and wildlife. This area also has significant beaver activity.

This location is only a mile downstream from Lake Mohawk where the headwaters of the Walkill River originates. Lake Mohawk is the second largest lake in New Jersey, and is surrounded by a heavily developed, large lake community dependent upon septic systems. Portions of the community to the northeast of Lake Mohawk are in the process of being sewered. Along this stretch of the river, between the headwaters and the sampling point, is the Sparta Plaza Package Plant that discharges directly to the Wallkill. The confluence of the Glen Brook, which originates from Newton Reservoir (Morris Lake) and the very small Sunset Lake, is located just before this sampling site. Since the floods of August 2000, the Glen Brook has been depositing large amounts of sediment into the Wallkill, during heavy rain events, as a result of severe streambank erosion. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs; Phase II stormwater program.

Wallkill River At Scott Rd At Franklin (Site ID #01367715)

Approximately 2 miles prior to the sample location is Franklin Pond, which has had significant problems with large geese populations. Two other tributaries, the Wildcat Brook and an unnamed tributary whose source is Kimble's Pond, enter the Wallkill prior to this location. Both tributaries travel through farm operations, mostly small horse farms. There are also two golf courses within this immediate watershed area. Primary sources of fecal coliform are geese and horses. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs; Phase II stormwater program.

Wallkill River Near Sussex (Site ID #01367770)

Potential fecal sources include wildlife, particularly deer and geese. Prior to this location, the Wallkill travels through Hamburg Borough, which is sewered. The characteristics of the river do vary dramatically throughout this stretch, particularly as a result of a large, 15—20 foot dam/waterfall at an old limestone kiln. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs; Phase II stormwater program.

Wallkill River near Unionville (Site ID #01368000)

This site is within the Wallkill River Wildlife Refuge. The most probable cause of the fecal coliform impairment is wildlife. This area also contains agricultural activity, particularly cattle and cow pastures. Strategies: prioritize for EQIP funds to install agricultural BMPs

Double Kill at Waywayanda (Site ID #01368820)

This site is located within Waywayanda State Park and is classified as an FW1 waterbody. The most probable source of fecal coliform impairment is wildlife. There are no other sources present. Monitoring: this would be an ideal location to establish a reference condition for segments that have wildlife-only sources. If it is determined that the natural wildlife population is the sole source of bacterial impairment, this would inform the basis for an alternate response, such as a site-specific criterion or a modification of the designated use, which may be the most appropriate means to address wildlife-only sources.

Black Creek near Vernon (Site ID #01368950)

This segment is 20.5 miles long. Most probable potential sources in this area include horse farms, goats, cows, geese, significant beaver activity, deer, and bear. Monitoring: extensive fecal coliform sampling is proposed to differentiate the significant contributions in terms of the numerous tributaries. This segment includes two areas classified as FW1 waters due to the presence of adjacent state park areas.

10.2.3. Watershed Management Area 11

Nishisakawick Creek near Frenchtown (Site ID #01458570)

Land uses in the area include forest, field & pasture, agriculture, and residential, with agricultural uses being the predominant land use. Possible sources of fecal coliform include livestock, geese, wildlife, and domestic pets. This area is primarily on septic systems. Horses are the primary domestic animal in this area. Load duration curve is consistent with a mix of steady state and storm driven sources. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs; Phase II stormwater program.

Copper Creek near Frenchtown (Site ID #01458710)

Land uses in this area include forest, field & pasture, residential, and agriculture. There area more residential homes in this area and less forest and agricultural lands. This area is primarily on septic systems. Storage and land application of manure is practiced. Livestock includes sheep, horses, bulls, pigs, horses, and cows. Load duration curve is consistent with a mix of steady state and storm driven sources. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs; Phase II stormwater program.

Plum Brook near Locktown (Site ID #01461262)

Land uses in the area include forest, field & pasture, agriculture, and residential with agriculture being the predominant use. Possible sources of contamination include livestock, geese, wildlife and domestic pets. Many forms of livestock present near streams: horses, cows, sheep; there are also several farms with chickens. Many residents own homes with one or two horses. Also, other domestic pets were observed. Deer were also observed. Geese and septic systems are also potential sources. Load duration curve is consistent with a mix of steady state and storm driven sources. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs; Phase II stormwater program.

Jacobs Creek at Bear Tavern (Site ID #01462739)

Land uses in the area include forest, field/pasture, agricultural, and residential uses. Agriculture is the predominant land use. There is a lot of development occurring in this area and most of the agriculture that is present is horses. Possible fecal coliform sources in the area include crop agriculture, horses, geese, deer, sheep, and domestic pets. This area is primarily on septic systems, with a few areas being sewered. Load duration curve is consistent with a mix of steady state and storm driven sources. Strategies: prioritize for EQIP funds to install agricultural BMPs; organize local community based goose management programs; Phase II stormwater program.

Miry Run at Route 533 At Mercerville (Site ID #01463850)

Beginning at Spring Garden Road ending at Pond Road: Land uses in this area include forest, field/pasture, agriculture, residential, and commercial uses. The predominant land uses in the area are urban uses. Possible sources of fecal coliform include geese, wildlife, and domestic pets. Pond Run to Quakerbridge Road: Land uses in this area include forest, fields, agriculture, residential and commercial uses. Urban land use is the predominant use in this area. Possible sources of fecal coliform include geese, wildlife, and domestic pets. The majority of this area is sewered except for an area between Line Road and Old Trenton Road in West Windsor. Quakerbridge Road to the point where Miry Run enters the Assunpink Creek near Sweet Briar. Predominant land use is urban, other land uses in the area include forest, and commercial. Possible sources of fecal contamination include geese, wildlife and, domestic pets. This area is mostly sewered. Strategies: organize local community based goose management programs; Phase II stormwater program.

Assunpink Creek At Peace Street At Trenton (Site ID #01464020)

Beginning where Miry Run enters Assunpink at Sweet Briar Ave and ending where the Assunpink Crosses under Nottingham Way: Urban land use is predominant in this area. Other land uses include forest, commercial, industrial, and wetlands. Possible sources of fecal coliform include geese, wildlife, and domestic pets. This area is mainly sewered. Beginning at Nottingham Way and ending at Clinton Avenue: Urban use is the predominant land use in the area. Other minor land uses include forest, commercial, and industrial uses. Possible sources of fecal coliform include geese, wildlife, and domestic pets. This area is entirely sewered. Beginning at Stockton Street, Mill Hill Park area and ending at the Delaware River: This area runs through downtown Trenton. There are some residential areas, where domestic pets could be a potential source of fecal coliform. In addition, there are a few parks were geese flock, which could be an additional contributing factor for fecal coliform. Strategies: organize local community based goose management programs; Phase II stormwater program.

10.3. 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.

10.4. Reasonable Assurance

With the implementation of follow-up monitoring, source identification and source reduction as described for each segment, the Department has reasonable assurance that New Jersey's

Surface Water Quality Standards will be attained for fecal coliform. The Department proposes to undertake the identified monitoring responses beginning in 2003-2004. As a generalized strategy, the Department proposes the following with regard to categorical sources: 1) As septic system sources are identified through the monitoring responses, municipalities will be encouraged to enter the Environmental Infrastructure Financing Program, which includes New Jersey's State Revolving Fund, to evaluate, select and implement the best overall solution to such problems; 2) To address storm water point sources, the Phase II stormwater permitting program will require control measures to be phased in from the effective date of authorization to 60 months from that date; 3) The locations of impaired segments with significant agricultural land uses will be provided to the State Technical Committee for consideration in the FFY 2004 round of EQIP project selection; 4) Through continuing engagement of watershed partners, measures to identify and address other sources will be pursued, including encouragement and support of community based goose management programs, where appropriate. The Department has dedicated a portion of its Corporate Business Tax and FY 2002 Clean Water Act Section 319(h) funds to carry out the segment specific source trackdown recommendations. A portion of FY 2003 319(h) funds will be dedicated to assisting municipalities in implementing the requirements of the Phase II municipal stormwater permitting program.

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.

The Department's ambient monitoring network will be the means to determine if the strategies identified have been effective. Where trackdown monitoring has been recommended, the results of this monitoring as well as ambient monitoring will be evaluated to determine if additional strategies for source reduction are needed.

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. Further, the Department shall propose each TMDL as an amendment to the appropriate areawide water quality management plan in accordance with procedures at N.J.A.C. 7:15-3.4(g). As part of the public participation process for the development and implementation of the TMDLs for fecal coliform in the Northwest Water Region, the Department worked collaboratively with a series of stakeholder groups as part of the Department's ongoing watershed management efforts.

The Department's watershed management process includes a comprehensive stakeholder process that includes of members from major stakeholder groups, (agricultural, business and industry, academia, county and municipal officials, commerce and industry, purveyors and

dischargers, and environmental groups). As part of this watershed management planning process, Public Advisory Committees (PACs) and Technical Advisory Committees (TACs) were created in all 20 WMAs. The PACs serve in an advisory capacity to the Department, examining and commenting on a myriad of issues in the watersheds. The TACs are focused on scientific, ecological, and engineering issues relevant to the issues of the watershed, including water quality impairments and management responses to address them.

The Department shared the Department's TMDL process through a series of presentations and discussions with the WMA 1, WMA 2, and WMA 11 PAC and TAC members. In June 2002 the Department gave a presentation on the New Jersey 2002 Integrated List of Waterbodies and the Water Quality Monitoring and Assessment Methodology to the Upper Delaware Watershed Project Work Group (WMA 1), and also encouraged submittal of any comments. On January 29, 2003 a presentation was given to the project Upper Delaware Project Work Group onhe expedited TMDL process. On March 4, 2003 a TAC meeting was held to discuss potential sources of fecal coliform contamination for WMA 1 impaired stream segments. In addition to the TAC meetings, NJRC&D continued to reach out to key stakeholders such as the county Health Departments and Watershed Associations to gather data on potential sources of fecal coliform.

Various presentations on TMDL development for the Wallkill River Watershed were made to the WMA 2 TAC. Presentations included: Introduction to TMDLs, February 28, 2002; Assessment and Technical Approach Paper for the Wallkill River Watershed, March 28, 2002; and 2002 Integrated List and Methodology, June 27, 2002; Fecal Coliform Expedited TMDLs, October 24, 2002. In addition to the presentations, the TAC has been instrumental in providing comments and suggestions to the Department during this process. Once the TAC has finished with its review of TMDL work, the information is presented to the PAC.

Various presentations on TMDL development were given to the Characterization and Assessment Committee (TAC) for WMA 11. Presentations included: Introduction to TMDLs, May 23, 2002; 2002 Integrated List and Methodology, May 23, 2002; and Fecal Coliform Expedited TMDLs, November 7, 2002. WMA 11 PAC also received the Fecal Coliform Expedited TMDL presentation on December 9, 2002.

Additional input was received through the NJ EcoComplex (NJEC). The Department contracted with NJEC in July 2001. The NJEC consists of a review panel of New Jersey University professors whose role is to provide comments on the Department's technical approaches for development of TMDLs and management strategies. The New Jersey Statewide Protocol for Developing Fecal TMDLs was presented to NJEC on August 7, 2002 and was subsequently reviewed and approved. The protocol was also presented at the SETAC Fall Workshop on September 13, 2002 and met with approval.

Amendment Process

In accordance with N.J.A.C. 7:15–7.2(g), these TMDLs are hereby proposed by the Department as amendments to the Mercer County Water Quality Management Plan, Northeast Water Quality Management Plan, Upper Delaware Water Quality Management Plan, Upper Raritan Water Quality Management Plan, and Sussex County Water Quality Management Plan.

Notice proposing these TMDLs was published April 21, 2003 in the New Jersey Register and in newspapers of general circulation in the affected area in order to provide the public an opportunity to review the TMDLs and submit comments. In addition, a public hearing will be held on May 22, 2003. Notice of the proposal and the hearing has also been provided to applicable designated planning agencies and to affected municipalities.

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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.

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

- **#01461300, Wickecheoke Creek at Croton**
- **#01461220, Wickecheoke Creek at Stockton**
- **#01455801, Musconetcong River at Lockwood**
- **#01455500, Musconetcong River at Lake Hopatcong**

Stations #01455500, 01461300, and #01455801 were included on Sublist 5 based on their inclusion on previous 303(d) lists with no recent data to assess their current attainment status. Station #01461220 was included on Sublist 5 of the 2002 Integrated List based on less than five data points. Therefore, TMDLs will not be developed for these locations until further monitoring is conducted and indicate violation(s) of the surface water quality standards.

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

WMA	Station #	NJPDES	Facility Name	Discharge Type[a]	Receiving waterbody
1	1457400	NJ0107905.001A	Greenwich Twp	MMJ	Musconetcong River
1	1456200	NJ0021369.002A	Hackettstown MUA	MMJ	Musconetcong River
1	1456200	NJ0028592.001A	Diamond Hills Estates Sewer Co	MMI	Hances Brook
1	1455200	NJ0020711.001A	Warren Co - Tech School	MMI	Pohatcong Creek
1	1455200	NJ0133965.001A	Alpha Boro Well 3	MMI	Pohatcong Creek via unnamed trib
1	1455200	NJ0021113.001A	Washington Borough WTF	MMI	Shabbecong Creek
1	1455200	NJ0021113.001B	Washington Borough WTF	MMI	Pohatcong Creek
1	1443440	NJ0022063.001A	Sussex County MUA - Service Center	MMI	Paulins Kill via Marsh's farm creek
1	1443440	NJ0028894.001A	Kittatiny Regional School	MMI	Paulins Kill
1	1443440	NJ0024163.001A	Big N Shopping - Kennedy Constr	MMI	Paulins Kill via unnamed trib
1	1443440	NJ0050580.001A	Sussex County MUA - Hampton Commons	MMI	Paulins Kill River via unnamed trib
1	1443440	NJ0020184.001A	Town of Newton WTP	MMJ	Moores Creek
1	1443440	NJ0027049.001A	Pope John XXIII High School	MMI	Fox Hollow Lake via unnamed trib
1	1443440	NJ0028894.XXX	Kittatiny Regional School	MMI	Paulins Kill
1	1443440	NJ0026701.001A	Sussex County BOCF	MMI	Lake Kemah via unnmd trib
1	1443500	NJ0031046.001A	North Warren BOE - High School	MMI	Paulins Kill
1	1446400	NJ0035483.001A	Warren County MUA - Oxford	MMI	Pequest River
2	1368950	NJ0023949.001A	Legends Resort & Country Club	MMI	Black Creek (G. Gorge Resort trib)
2	1368950	NJ0023841.001A	Vernon Twp BOE	MMI	Lounsberry Hollow Brook (Wallkill River)
2	1368950	NJ0023027.001A	Vernon Valley Recreation	MMI	Black Creek
2	1367625	NJ0023949.001A	Legends Resort & Country Club	MMI	Black Creek (G. Gorge Resort trib)
2	1367625	NJ0027073.001A	Sparta Twp BOE - High School 1	MMI	Wallkill River via unnamed trib
2	1367625	NJ0027081.001A	Sparta Twp BOE- High School 2	MMI	Wallkill River via unnamed trib
2	1367625	NJ0027057.001A	Sparta Twp - Sparta Plaza	MMI	Wallkill River via unnamed trib
2	1367625	NJ0023841.001A	Vernon Twp BOE	MMI	Lounsberry Hollow Brook (Wallkill River)
2	1367625	NJ0136603.001A	Morris Lake WTP	MMI	Morris Lake
2	1367625	NJ0023027.001A	Vernon Valley Recreation	MMI	Black Creek
2	1367850	NJ0031585.001A	High Point Regional High School	MMI	Papakating Creek W B
2	1368000	NJ0029041.001A	Regency At Sussex Apts	MMI	Layton Road Brook (Wallkill R)
2	1367715	NJ0053350.001A	Sussex County MUA - Upper Wallkill	MMJ	Wallkill River
11	1464020	NJ0024759.001A	Ewing-Lawrence SA	MMJ	Assunpink Creek
11	1458710	NJ0023311.001A	Kingwood Twp - Elementary School	MMI	Krial Pond

11	1458570	NJ0023001.001A	Camp Tecumseh - Salvation Army Camp	MMI	Nishisakawick Creek
11	1458570	NJ0027553.001A	Alexandria Twp BOE - Wilson School	MMI	Nishisakawick Creek
11	1458570	NJ0035670.001A	Alexandria Twp BOE - Middle School	MMI	Nishisakawick Creek
11	1462739	NJ0021776.001A	Hopewell Valley Bear Tavern School	MMI	Jacob's Creek via unnamed tributary

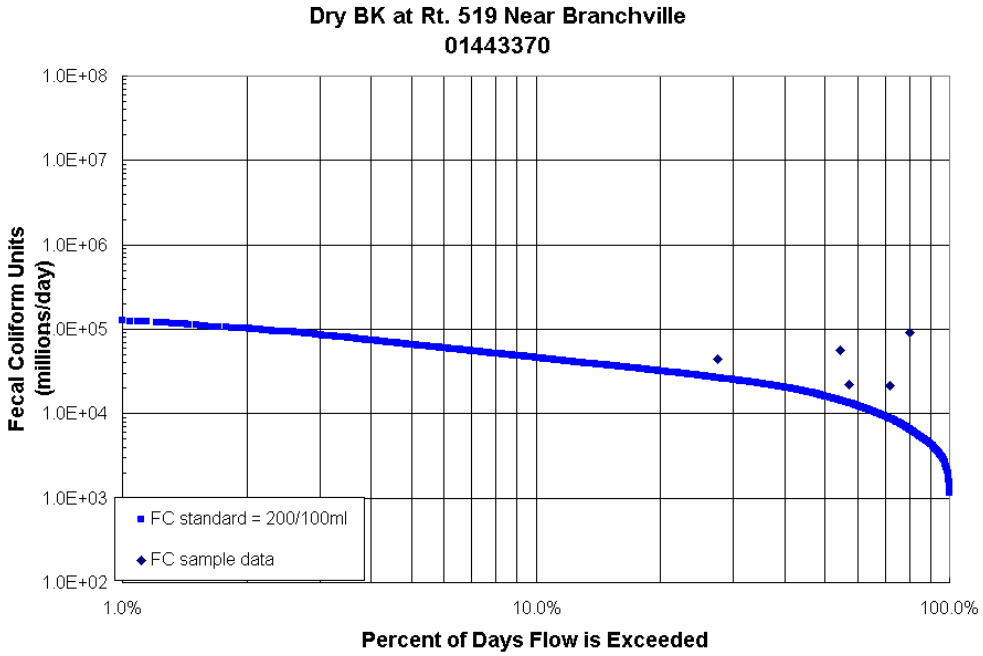
[a] "MMI" indicates a Municipal Minor discharge and "MMJ" indicates Municipal Major discharge.

Appendix C: TMDL Calculations

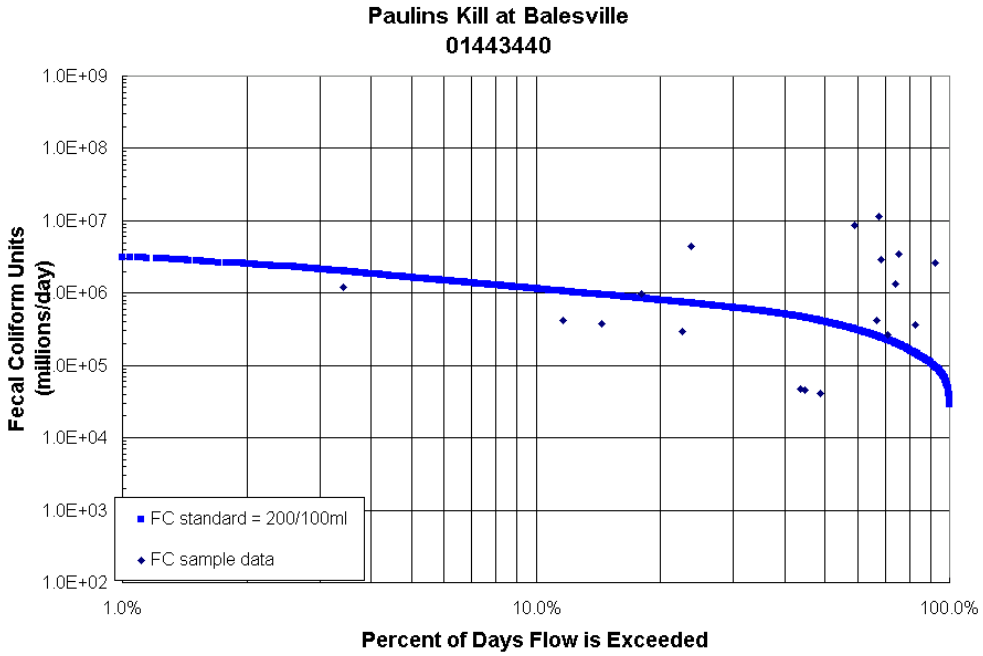
WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Load Allocation (LA) and Margin of Safety (MOS)										Wasteload Allocation (WLA)	Period of record used in analysis
				200 FC/100ml Standard					400 FC/100ml Standard						
				N (# of values)	Geometric Mean CFU/100ml	MOS as a Percent of the Target	Percent Reduction due to MOS	Percent Reduction with MOS	Summer N	Summer Geometric Mean CFU/100ml	MOS as a Percent of the Target	Percent Reduction due to MOS	Percent Reduction with MOS		
1	01443370	01443370	Dry Brook At Rt 519 Near Branchville	5	652	48%	15%	84%	5	652	48%	5%	95%	95%	6/28/00 - 7/24/00
1	01443440	01443440	Paulins Kill At Balesville	19	337	53%	32%	72%	8	1537	53%	2%	98%	98%	2/7/94 - 8/4/97
1	01444970	01444970, 01445000	Pequest River At Rt206 Below Springdale, Peqest River at Huntsville	9	342	45%	26%	68%	9	342	45%	9%	89%	89%	6/17/98 - 7/26/00
1	01443500, 01443600	01443500, 01443550, 01443600	Paulins Kill At Blairstown, Jacksonburg Creek Near Blairstown	49	161	29%	36%	12%	38	216	29%	9%	78%	78%	2/15/94 - 8/29/01
1	01445500, 01446400	01445500, 01446400	Pequest River At Pequest, Pequest River At Belvidere	39	441	30%	14%	68%	28	695	30%	3%	93%	93%	2/14/94 - 8/29/01
1	01455200	01455200	Pohatcong Creek At New Village	19	741	51%	14%	87%	8	2679	51%	1%	99%	99%	2/15/94 - 8/4/97
1	01456200	01456200	Musconetcong River At Beattystown	19	138	45%	65%	20%	8	502	45%	6%	93%	93%	2/7/94 - 8/11/97
1	01457000, 01457400	01457000, 01457400	Musconetcong River Near Bloomsbury, Musconetcong River At Riegelsville	62	366	29%	16%	61%	40	698	29%	3%	93%	93%	2/7/94 - 8/29/01
2	01367625	01367625, 01367700	Wallkill River At Sparta, Wallkill River at Franklin	21	362	48%	26%	71%	21	362	48%	9%	90%	90%	6/8/98 - 8/1/01
2	01367715, 01367770	01367715, 01367770	Wallkill River At Scott Rd At Franklin, Wallkill River Near Sussex	45	361	36%	20%	64%	34	596	36%	4%	93%	93%	3/1/94 - 8/1/01
2	01367780	01367780	Papakating Creek Near Wykertown	10	483	46%	19%	77%	10	483	46%	6%	92%	92%	6/22/99 - 8/1/01

WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Load Allocation (LA) and Margin of Safety (MOS)										Wasteload Allocation (WLA)	Period of record used in analysis
				200 FC/100ml Standard					400 FC/100ml Standard						
				N (# of values)	Geometric Mean CFU/100ml	MOS as a Percent of the Target	Percent Reduction due to MOS	Percent Reduction with MOS	Summer N	Summer Geometric Mean CFU/100ml	MOS as a Percent of the Target	Percent Reduction due to MOS	Percent Reduction with MOS		
2	01367800	01367800	Papakating Creek At Pelletown	14	1172	28%	5%	88%	14	1172	28%	2%	96%	96%	6/22/99 - 8/1/01
2	01367850	01367850	WB Papakating Creek At McCoys Corner	5	5054	60%	2%	98%	5	5054	60%	1%	99%	99%	6/28/00 - 7/24/00
2	01367860, 01367910	01367860, 01367910	Papakating Creek Near Sussex, Papakating Creek	24	932	47%	10%	89%	13	2425	47%	1%	99%	99%	2/16/94 - 9/15/98
2	01368000	01368000	Wallkill River Near Unionville	19	491	46%	19%	78%	8	765	46%	4%	95%	95%	3/8/94 - 7/23/97
2	01368820	01368820	Double Kill At Waywayanda	19	70	46%	131%	-56%	19	70	46%	44%	47%	47%	6/8/98 - 8/1/01
2	01368950	01368950	Black Creek Nr Vernon	19	549	54%	20%	83%	8	2137	54%	2%	99%	99%	2/28/94 - 7/23/97
11	01458570	01458570	Nishisakawick Creek Near Frenchtown	19	192	35%	36%	32%	19	192	35%	12%	77%	77%	6/8/98 - 8/9/01
11	01458710	01458710	Copper Creek Near Frenchtown	5	502	82%	33%	93%	5	502	82%	11%	98%	98%	7/6/00 - 8/3/00
11	01461262	01461262	Plum Brook Near Locktown	5	662	86%	26%	96%	5	662	86%	9%	99%	99%	6/8/98 - 7/21/98
11	01462739	01462739	Jacobs Creek At Bear Tavern	5	1049	52%	10%	91%	5	1049	52%	3%	97%	97%	6/9/99 - 7/1/99
11	01463850	01463850	Miry Run At Route 533 At Mercerville	19	977	37%	8%	87%	19	977	37%	3%	96%	96%	6/8/98 - 6/11/01
11	01464020	01464020	Assunpink Creek At Peace Street At Trenton	18	3417	51%	3%	97%	18	3417	51%	1%	99%	99%	6/8/98 - 6/11/01

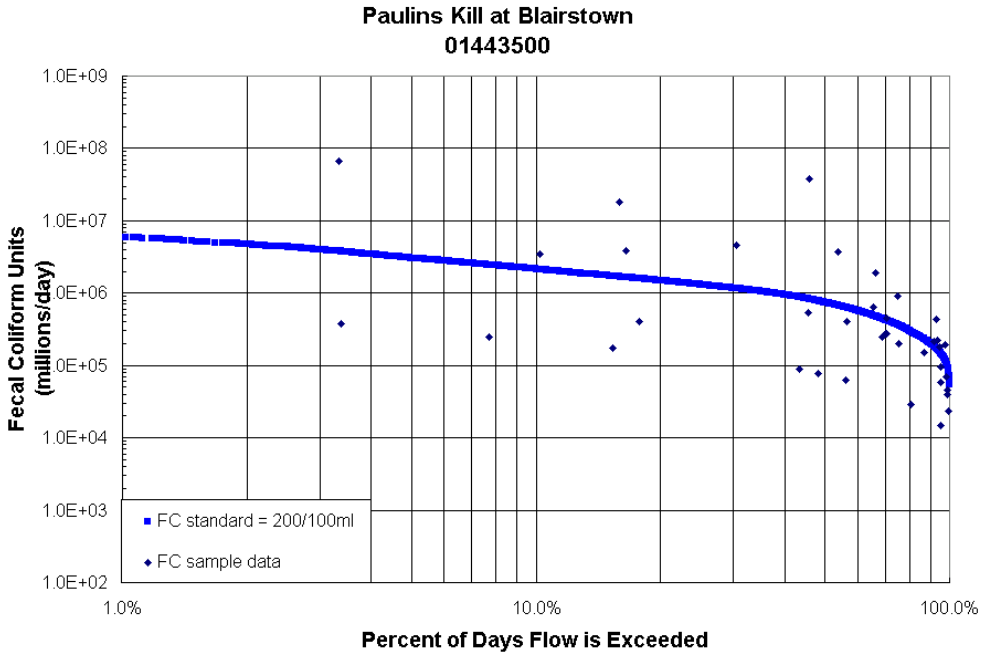
Appendix D: Load Duration Curves for selected listed waterbodies



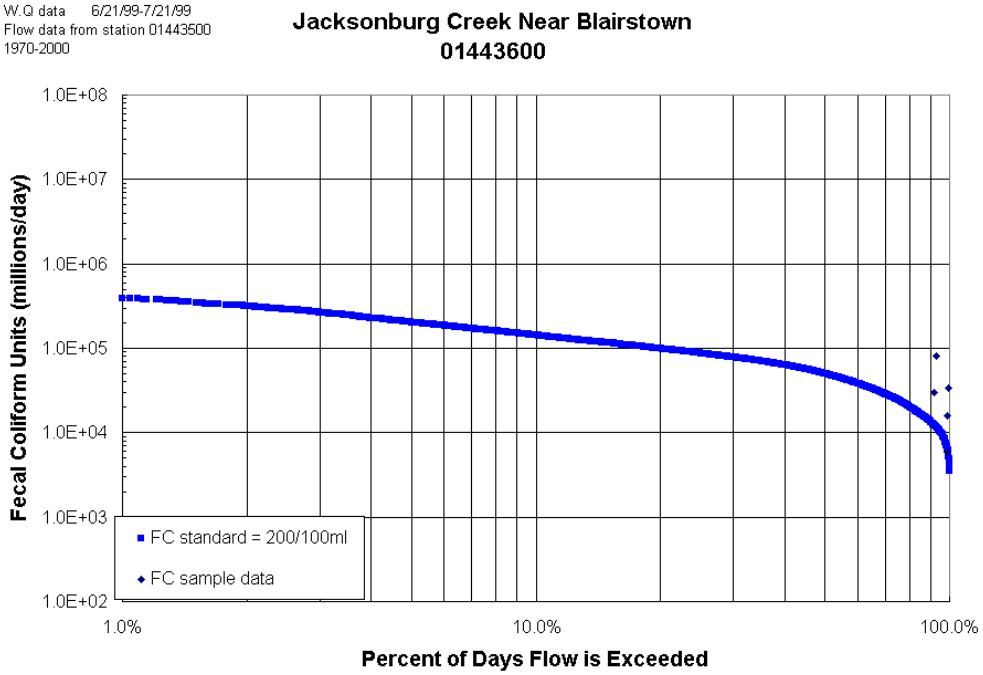
Load Duration Curve for Dry Brook at Rt. 519 near Branchville. Fecal coliform data from USGS station # 01443370 during the period 6/28/00 through 7/24/00. Water years 1970-2000 from USGS station # 01443500 (Paulins Kill at Blairstown) were used in generating the FC standard curve.



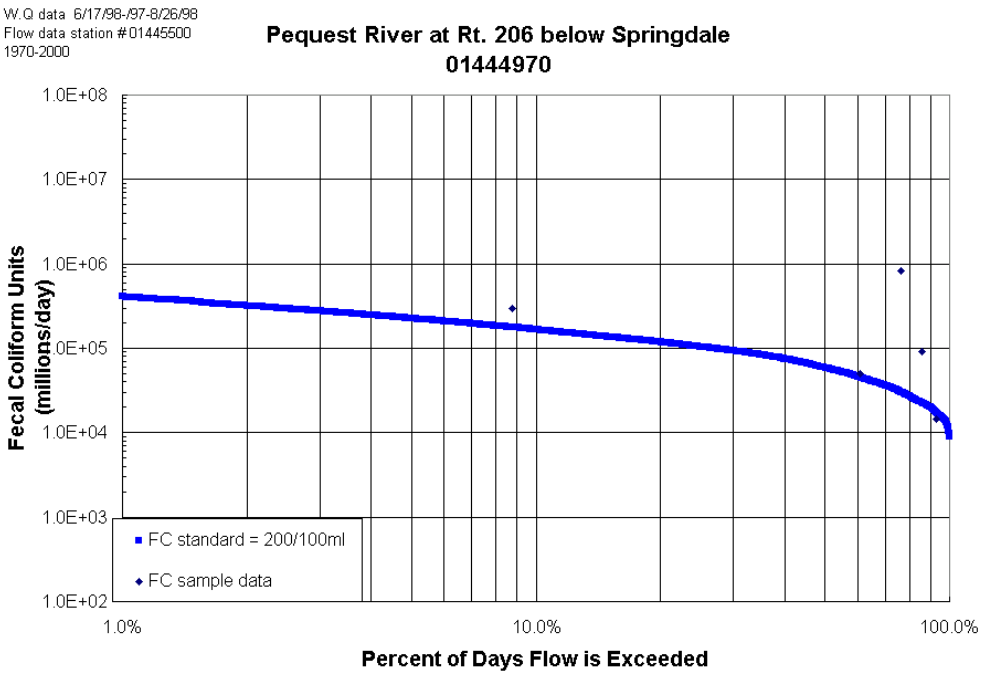
Load Duration Curve for Paulins Kill at Balesville. Fecal coliform data from USGS station # 01443440 during the period 2/7/94 through 8/4/97. Water years 1970-2000 from USGS station # 01443500 (Paulins Kill at Blairstown) were used in generating the FC standard curve.



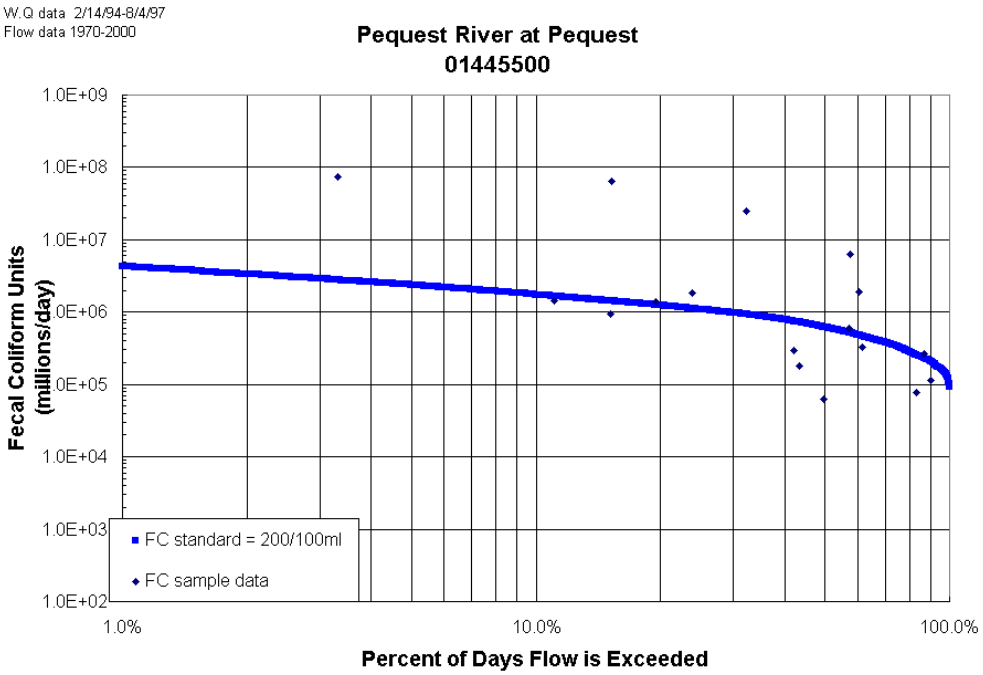
Load Duration Curve for Paulins Kill at Blairstown. Fecal coliform data from USGS station # 01443500 during the period 2/15/94 through 8/29/01. Water years 1970-2001 from USGS station # 01443500 were used in generating the FC standard curve.



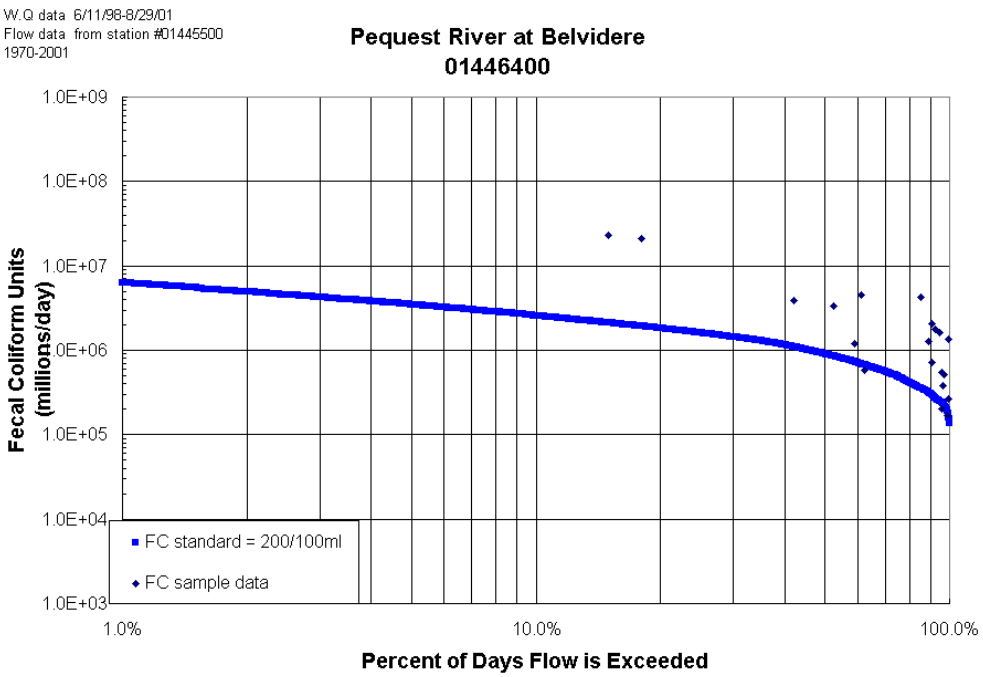
Load Duration Curve for Jacksonburg Creek near Blairstown. Fecal coliform data from USGS station # 01443600 during the period 6/21/99 through 7/21/99. Water years 1970-2000 from USGS station # 01443500 (Paulins Kill at Blairstown) were used in generating the FC standard curve.



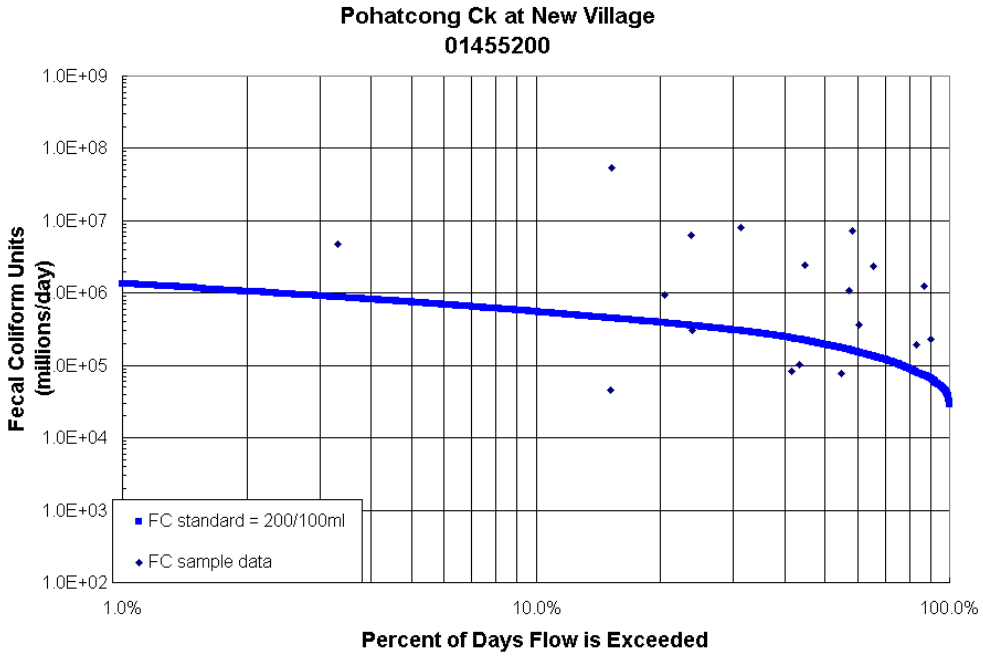
Load Duration Curve for Pequest River at 206 below Springdale. Fecal coliform data from USGS station # 01444970 during the period 6/17/98 through 8/26/98. Water years 1970-2000 from USGS station # 01445500 (Pequest River at Pequest) were used in generating the FC standard curve.



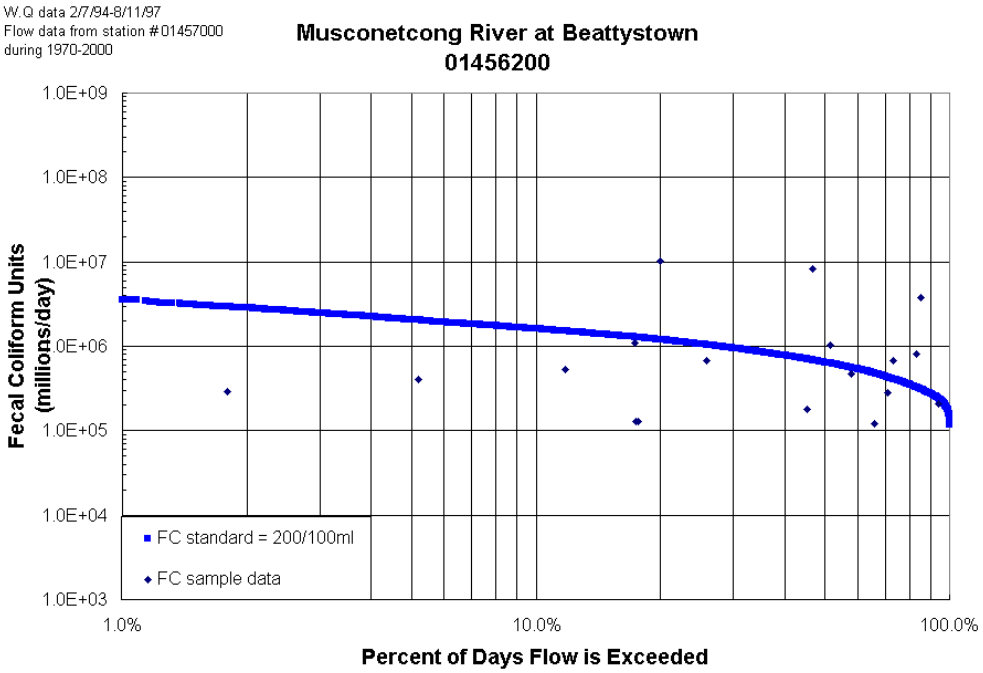
Load Duration Curve for Pequest River at Pequest. Fecal coliform data from USGS station # 01445500 during the period 2/14/94 through 8/4/97. Water years 1970-2000 from USGS station # 01445500 were used in generating the FC standard curve.



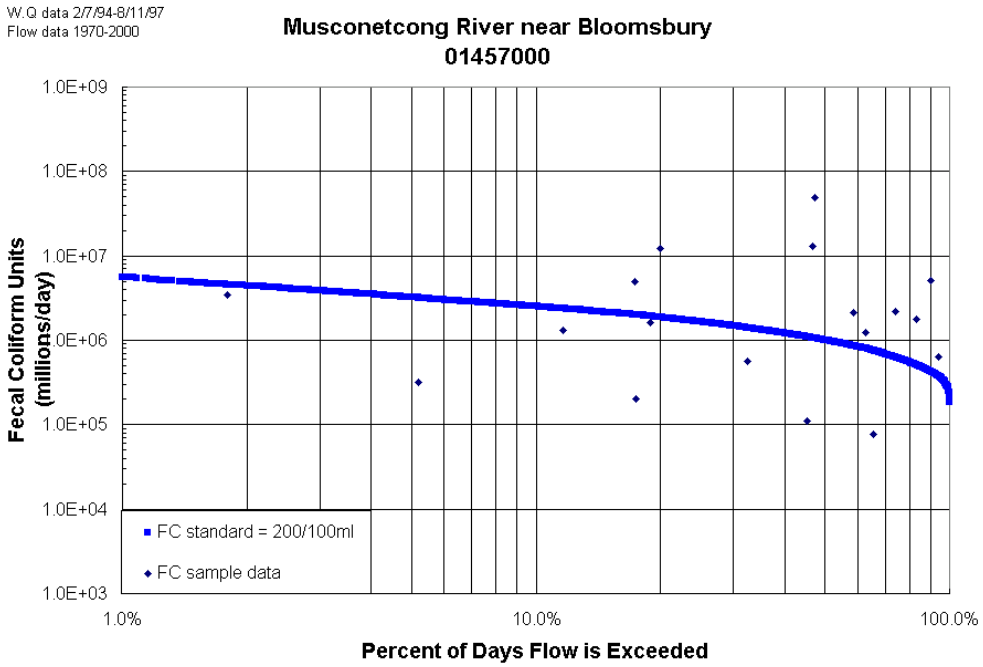
Load Duration Curve for Pequest River at Belvidere. Fecal coliform data from USGS station # 01446400 during the period 6/11/98 through 8/29/01. Water years 1970-2001 from USGS station # 01445500 (Pequest River at Pequest) were used in generating the FC standard curve.



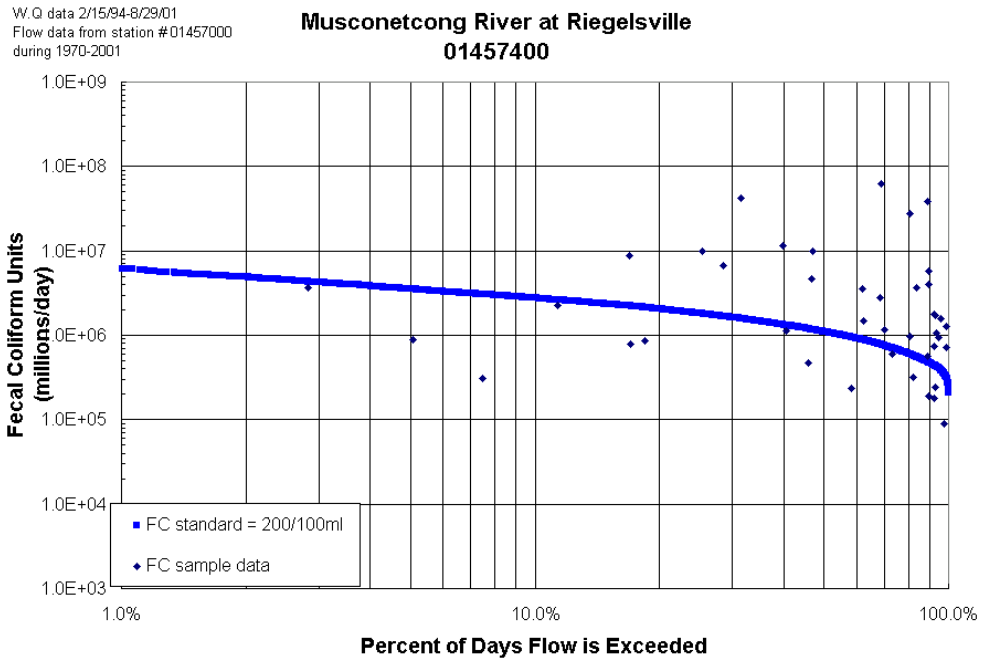
Load Duration Curve for Pohatcong Creek at New Village. Fecal coliform data from USGS station # 01455200 during the period 2/15/94 through 8/4/97. Water years 1970-2000 from USGS station # 01445500 (Pequest River at Pequest) were used in generating the FC standard curve.



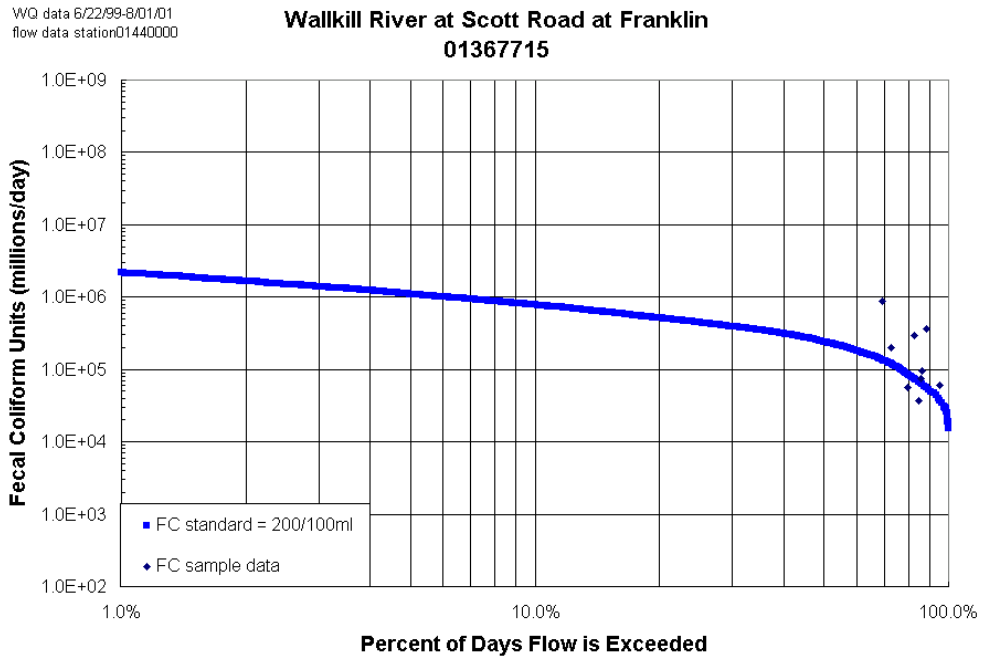
Load Duration Curve for Musconetong River at Beattystown. Fecal coliform data from USGS station # 01456200 during the period 2/7/94 through 8/11/97. Water years 1970-2000 from USGS station # 01457000 (Musconetong River near Bloomsbury) were used in generating the FC standard curve.



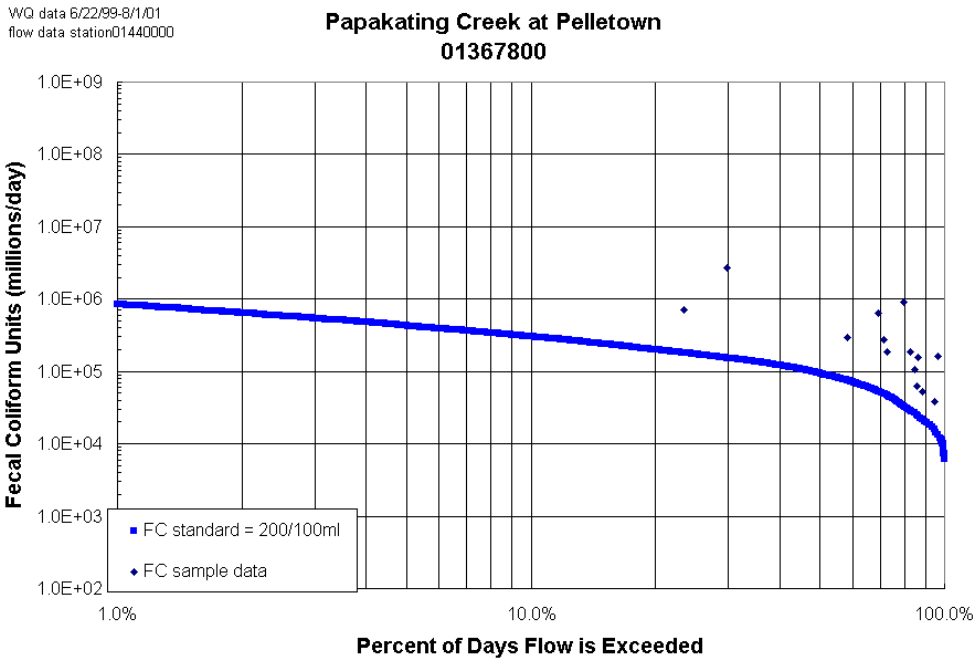
Load Duration Curve for Musconetong River near Bloomsbury. Fecal coliform data from USGS station # 01457000 during the period 2/7/94 through 8/11/97. Water years 1970-2000 from USGS station # 01457000 were used in generating the FC standard curve.



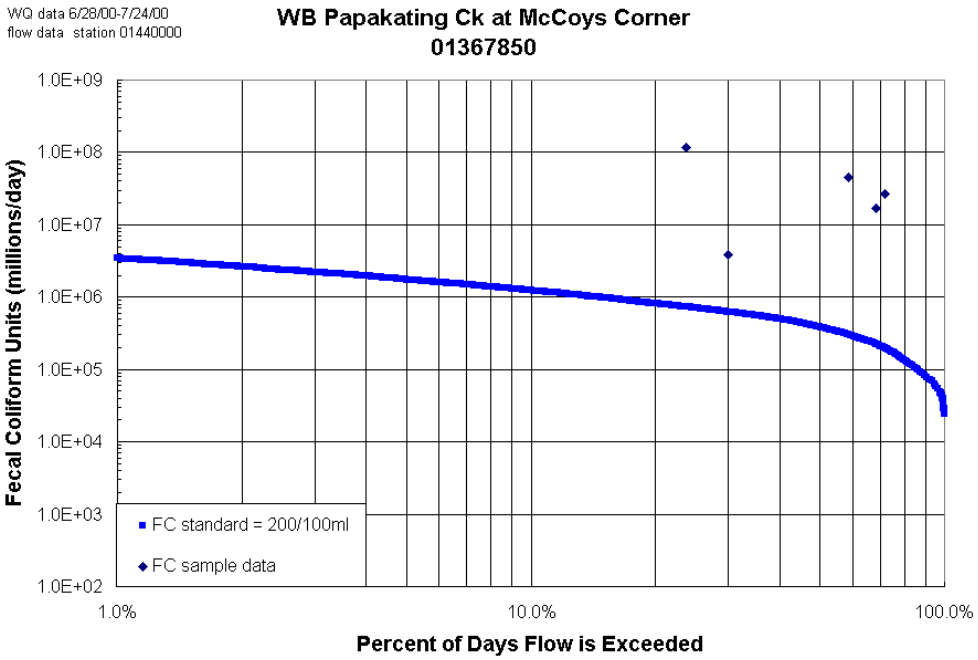
Load Duration Curve for Musconetong River at Riegelsville. Fecal coliform data from USGS station # 01457400 during the period 2/15/94 through 8/29/01. Water years 1970-2001 from USGS station # 01457000 (Musconetong River near Bloomsbury) were used in generating the FC standard curve.



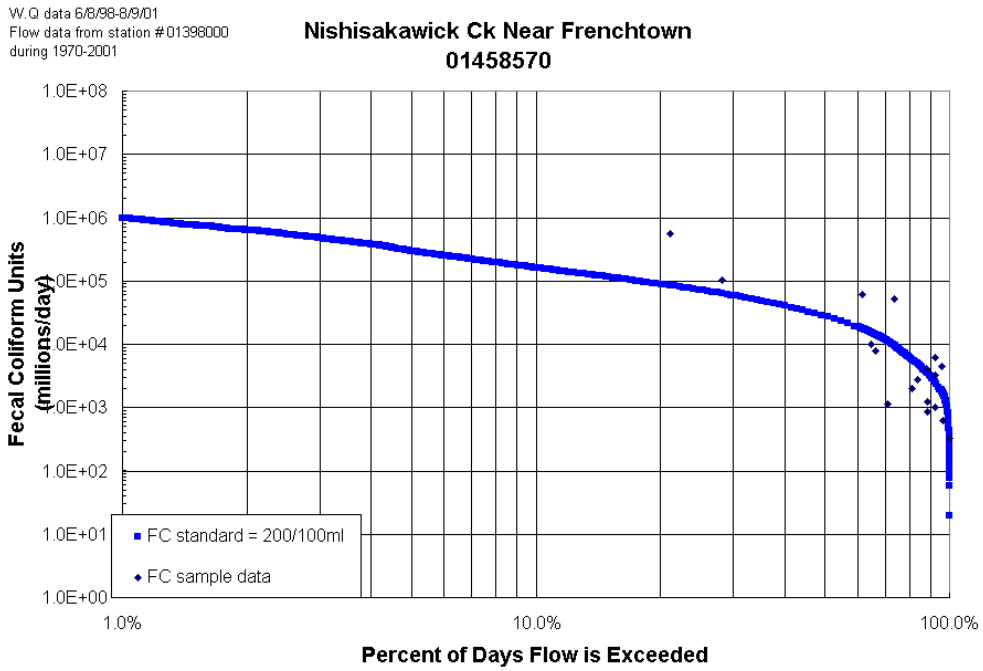
Load Duration Curve for Wallkill River at Scott Road at Franklin Fecal coliform data from USGS station # 01367715 during the period 6/22/99 through 8/01/01. Water years 1970-2001 from USGS station # 01440000 (Flat Brook Near Flatbrookville) were used in generating the FC standard curve.



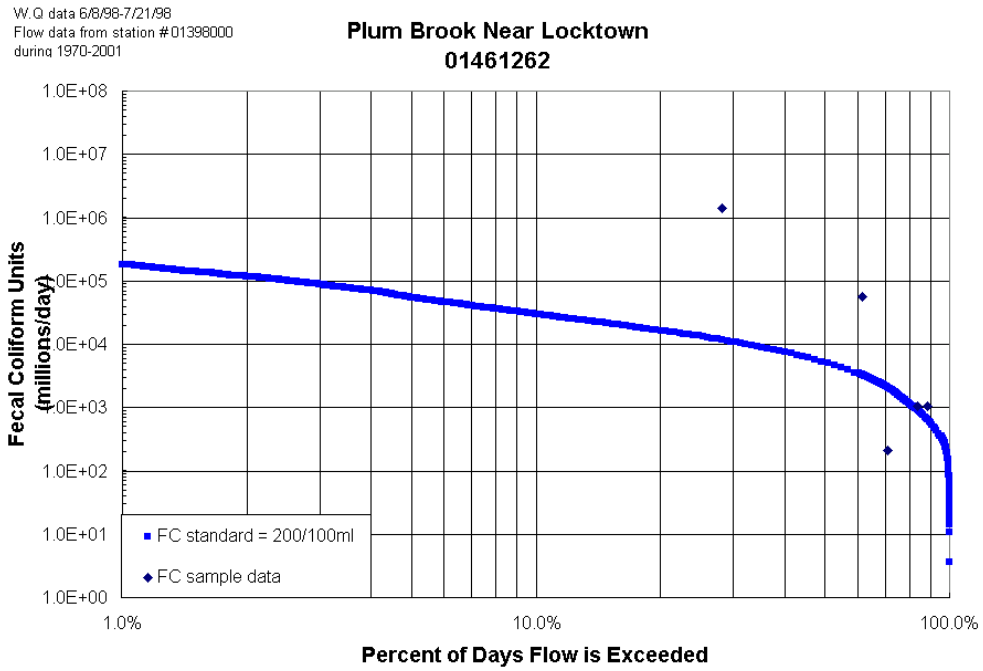
Load Duration Curve for Papakating Creek at Pelletown Fecal coliform data from USGS station # 01367800 during the period 6/22/99 8/01/01. Water years 1970-2001 from USGS station # 01440000 (Flat Brook Near Flatbrookville) were used in generating the FC standard curve.



Load Duration Curve for WB Papakating Creek at McCoys Corner. Fecal coliform data from USGS station # 01367850 during the period 6/28/00 through 7/24/00. Water years 1970-2000 from USGS station # 01440000 (Flat Brook Near Flatbrookville) were used in generating the FC standard curve.

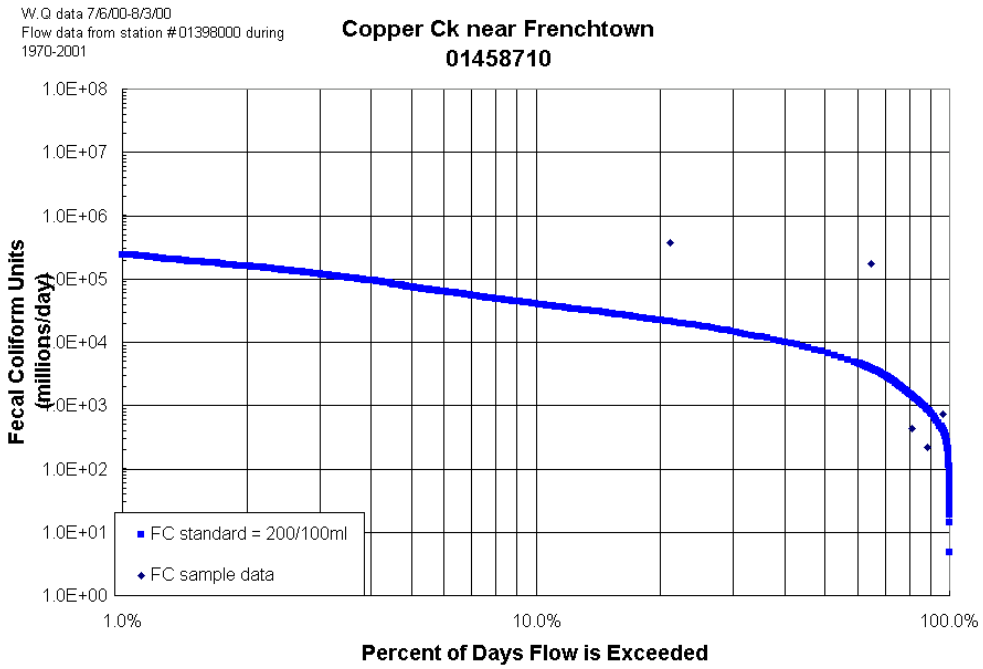


Load Duration Curve for Nishisakawick Creek near Frenchtown. Fecal coliform data from USGS station # 01458570 during the period 6/8/98 through 8/9/01. Water years 1970-2001 from USGS station # 01398000 (Neshanic River at Reaville) were used in generating the FC standard curve.

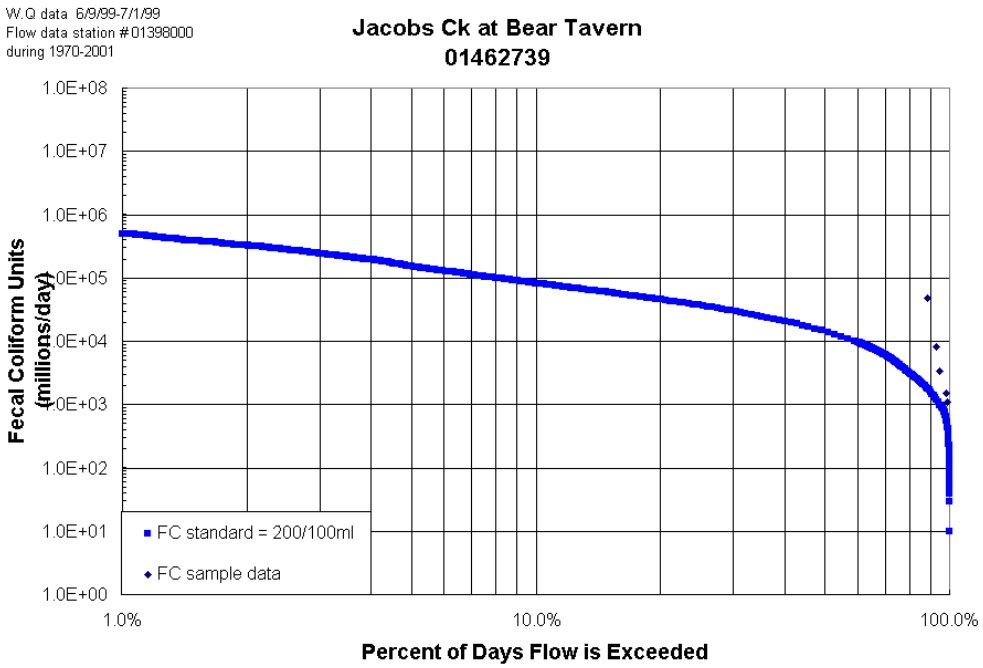


Load Duration Curve for Plum Brook near Locktown. Fecal coliform data from USGS station # 01461262 during the 6/8/98 through 7/21/98. Water years 1970-2001 from USGS station #

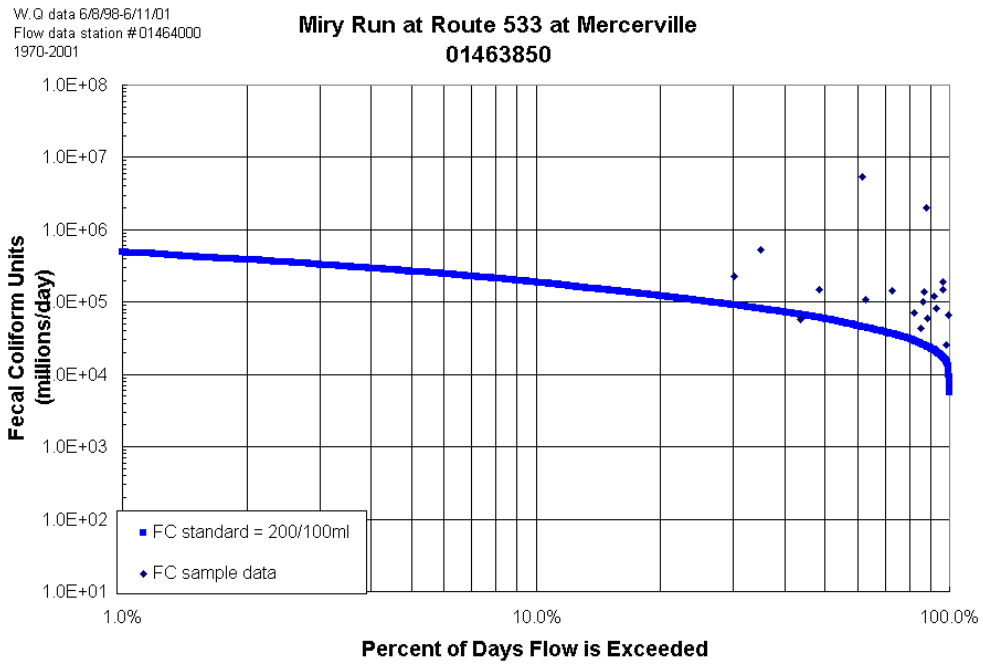
01398000 (Neshanic River at Reaville) were used in generating the FC standard curve.



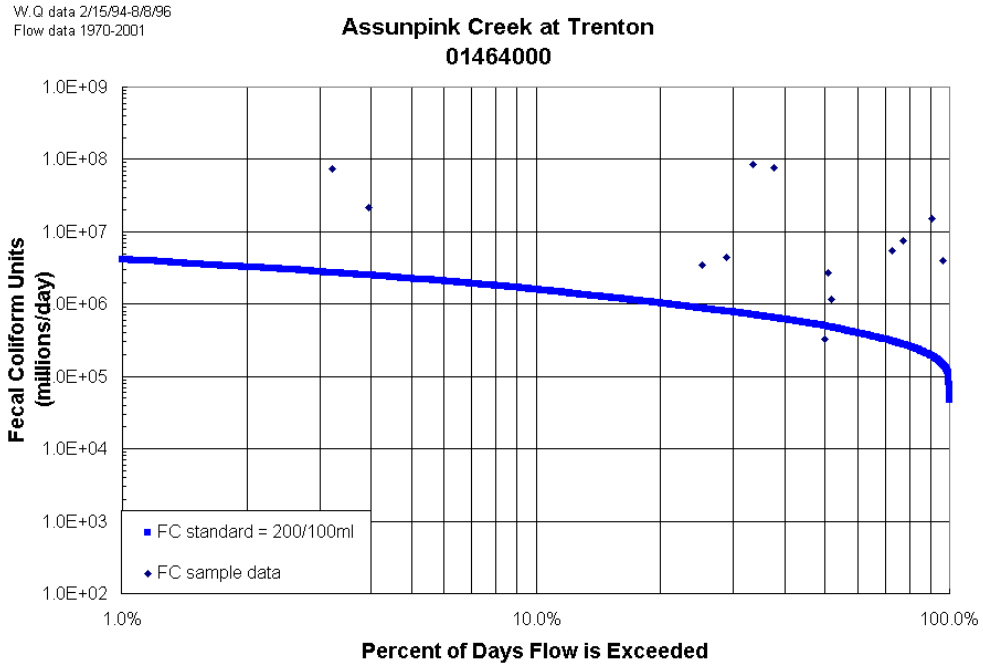
Load Duration Curve for Copper Ck near Frenchtown. Fecal coliform data from USGS station # 01458710 during the period 7/6/00 through 8/3/00. Water years 1970-2001 from USGS station # 01398000 (Neshanic River at Reaville) were used in generating the FC standard curve.



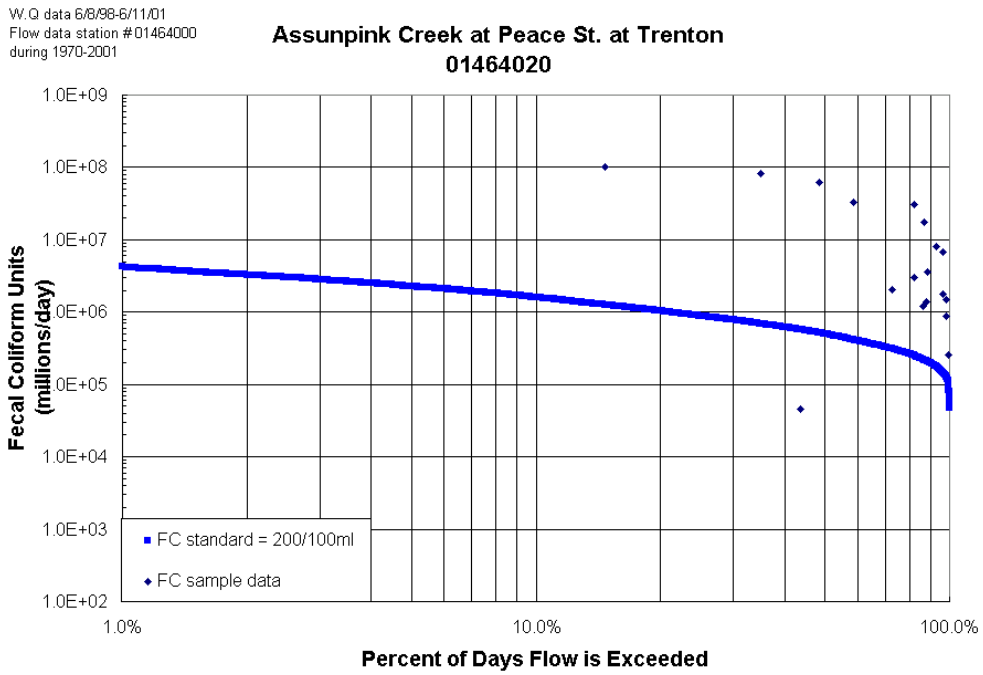
Load Duration Curve for Jacobs Creek at Bear Tavern. Fecal coliform data from USGS station # 01462739 during the period 6/9/99 through 7/1/99. Water years 1970-2001 from USGS station # 01398000 (Neshanic River at Reaville) were used in generating the FC standard curve.



Load Duration Curve for Miry Run at Rt. 533 at Mercerville. Fecal coliform data from USGS station # 01463850 during the period 6/8/98 through 6/11/01. Water years 1970-2001 from USGS station # 01464000 (Assunpink Creek at Trenton) were used in generating the FC standard curve.



Load Duration Curve for Assunpink Creek at Trenton. Fecal coliform data from USGS station # 01464000 during the period 2/15/94 through 8/8/96. Water years 1970-2001 from USGS station # 01464000 were used in generating the FC standard curve.



Load Duration Curve for Assunpink Creek at Peace St. at Trenton. Fecal coliform data from USGS station # 01464020 during the period 6/8/98 through 6/11/01. Water years 1970-2001 from USGS station # 01464000 (Assunpink Creek at Trenton) were used in generating the FC standard curve.