

**Amendment to the
Sussex County Water Quality Management Plan and Upper
Delaware Water Quality Management Plan**

**Total Maximum Daily Loads for
Pathogens to Address 11 Lakes in the
Northwest Water Region**

Watershed Management Area 1

(Lake Winona, Lake Hopatcong, Green Valley Beach Campground, Forest Lake, Fox Hollow Lake, Lackawanna Lake, and Furnace Lake)

Watershed Management Area 2

(Crystal Springs Lake, Deer Trail Lake, Lake Mohawk, and Sleepy Valley Lake)

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New Jersey Department of Environmental Protection
and**



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EXECUTIVE SUMMARY

In accordance with Section 305(b) and 303(d) of the Federal Clean Water Act (CWA), the State of New Jersey, Department of Environmental Protection (Department) is required to assess the overall water quality of the State's waters and identify those waterbodies with a water quality impairment for which TMDLs may be necessary. A TMDL is developed to identify all the contributors of a pollutant of concern and the load reductions necessary to meet the Surface Water Quality Standards (SWQS) relative to that pollutant. The Department fulfills its assessment obligation under the CWA through the Integrated Water Quality Monitoring and Assessment Report, which includes the Integrated List of Waterbodies, issued biennially. On October 4, 2004 the Department adopted the *2004 Integrated List of Waterbodies* as an amendment to the Statewide Water Quality Management Plan (36 NJR 4543(a)), as part of the Department's continuing planning process pursuant to the Water Quality Planning Act at N.J.S.A. 58:11A-7 and the Water Quality Management Planning rules at N.J.A.C. 7:15-6.4(a). The *2004 Integrated List of Waterbodies* identifies eleven lakes as impaired with respect to pathogens in the Northwest Water Region.

The Department has recently adopted the *2006 Integrated Water Quality Monitoring and Assessment Report*, including the *2006 Integrated List of Waterbodies*, which identifies impairments based on HUC 14 Assessment Units rather than stream segments associated with discrete monitoring locations. This change in assessment methodology allows establishment of a stable base of assessment units for which the attainment or non-attainment status of all designated uses within each subwatershed or assessment unit will be identified. In addition, lakes are assessed and listed separately when impaired. The *2006 Integrated List of Waterbodies* identifies eleven lakes that are impaired with respect to pathogens in the Northwest Water Region. A lake is determined to be impaired if it does not fully support primary contact recreation as evidenced by beach closings in accordance with Health Department standards. The water quality trigger for beach closings is exceedance of 200 cfu/100 ml of fecal coliform (NJDOH, 2004). TMDLs are adopted for the impaired lakes listed in Table 1.

Table 1. Lakes in the Northwest Water Region impaired for pathogens for which TMDLs are adopted.

TMDL Number	WMA	Lake Assessment Unit Name	County(s)*
1	1	Lake Winona	Morris/Sussex
2	1	Lake Hopatcong	Morris/ Sussex
3	1	Green Valley Beach Campground	Sussex
4	1	Forest Lake	Sussex
5	1	Fox Hollow Lake	Sussex

TMDL Number	WMA	Lake Assessment Unit Name	County(s)*
6	1	Lackawanna Lake	Sussex
7	1	Furnace Lake	Warren
8	2	Crystal Springs Lake	Sussex
9	2	Deer Trail Lake	Sussex
10	2	Lake Mohawk	Sussex
11	2	Sleepy Valley Lake	Sussex

*The drainage area/lakeshed for each lake may encompass municipalities beyond the identified County in which the lake is located.

Nonpoint and stormwater point sources are the primary sources of fecal coliform loads to the impaired lakes. Source loads were estimated for land uses in each watershed using the Watershed Treatment Model (WTM) (WTM, 2001). The WTM model is a series of spreadsheets that quantifies the loading of pathogen indicators based on land use distribution, stream network length in the watershed, and annual rainfall. Traditional point sources, i.e., treatment facilities that have a sanitary waste component, were considered de minimus due to the use of effective disinfection practices by these facilities. TMDLs were developed based on an analysis of the existing pathogen indicator data compared to Health Department indicator criteria and the loading capacity has been allocated among the point and nonpoint sources.

This report establishes eleven TMDLs that were adopted as amendments to the appropriate area-wide water quality management plan in accordance with N.J.A.C. 7:15-3.4(g). This report was developed consistent with EPA's May 20, 2002 guidance document entitled: "Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992," (Sutfin, 2002) which describes the statutory and regulatory requirements for approvable TMDLs. These TMDLs were approved by EPA on September 28, 2007, and will be adopted as amendments to the Sussex County and Upper Delaware Water Quality Management Plans in accordance with N.J.A.C. 7:15-3.4 (g).

1.0 INTRODUCTION

In accordance with Section 303(d) of the Federal Clean Water Act (CWA) (33 U.S.C. 1315(B)), the State of New Jersey, Department of Environmental Protection (Department) is required biennially to prepare and submit to the EPA a report that identifies waters that do not meet or are not expected to meet water quality standards after implementation of technology-based effluent limitations or other required controls. This report is commonly referred to as the 303(d) List. In accordance with Section 305(b) of the CWA, the Department is also

required biennially to prepare and submit to the EPA a report addressing the overall water quality of the State's waters. This report is commonly referred to as the 305(b) Report or the Water Quality Inventory Report. The Integrated Water Quality Monitoring and Assessment Report combines these two assessments and assigns waterbodies to one of five sublists on the Integrated List of Waterbodies. Sublists 1 through 4 include waterbodies that are generally unimpaired (Sublist 1 and 2), have limited assessment or data availability (Sublist 3), are impaired due to pollution rather than pollutants, or have had a TMDL or other enforceable management measure approved by EPA (Sublist 4). Sublist 5 constitutes the traditional 303(d) list for waters impaired or threatened by one or more pollutants, for which a TMDL may be required.

In the New Jersey 2004 *Integrated Water Quality Monitoring and Assessment Report* the water quality impairments were identified by segment name and pollutant(s) or non-attained designated use responsible for the finding that the segment was impaired. Each segment was assessed using the data from one or more discrete monitoring locations that were determined to be representative of the water quality in that segment. This impaired segment delineation method was changed in 2006.

The New Jersey 2006 *Integrated Water Quality Monitoring and Assessment Report* now identifies impairments based on designated use attainment and then lists the parameters responsible for the non-attainment of the designated use. The assessments are conducted for each of the seven categories of designated use, which include aquatic life, recreational use (primary and secondary contact), drinking water, fish consumption, shellfish harvesting (if applicable), agricultural water supply use and industrial water supply use. In addition, lakes are assessed and listed separately if impaired. In the Northwest Water Region, the 2006 *Integrated List of Waterbodies* currently identifies eleven lakes as impaired for pathogens. These lakes do not fully support primary contact recreation as evidenced by beach closings and water quality data that demonstrate exceedance of the water quality criterion that triggers closings.

A TMDL represents the assimilative or carrying capacity of a waterbody, taking into consideration point and nonpoint sources of pollutants of concern, natural background, and surface water withdrawals. A TMDL quantifies the amount of a pollutant a waterbody can assimilate and still conform to applicable water quality standards and support designated uses. The TMDL or loading capacity is allocated to known point and nonpoint sources in the form of waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and a margin of safety (MOS).

Recent EPA guidance (Sutfin, 2002) describes the statutory and regulatory requirements for approvable TMDLs, as well as additional information generally needed for EPA to determine if a submitted TMDL fulfills the legal requirements for approval under Section 303(d) and EPA regulations. These TMDLs address the following required 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.

This report establishes eleven TMDLs for pathogens to address the impaired lakes in the Northwest Water Region. All of the impaired lakes were listed for fecal coliform and assigned a high priority on the *2004 Integrated List of Waterbodies* and a High priority ranking on the *2006 Integrated List of Waterbodies* Sublist 5. These TMDLs include management approaches to reduce pathogen contributions from various sources in order to attain applicable surface water quality standards and fully support the designated primary contact recreation use. These TMDLs affect the drainage areas of the impaired lakes due to the fact that the implementation measures must be applied to the contributing drainage areas, not just the impaired lakes. Following approval of the TMDLs by EPA, pathogens will be removed as a basis of impairment in the next Integrated List. In addition to the pathogen impairments, Lake Hopatcong was listed for mercury and unknown pollutants on the *2006 Integrated List*. These pollutants will be addressed in future TMDL efforts. A total phosphorus TMDL was approved by EPA in 2003 for Lake Hopatcong.

2.0 POLLUTANT OF CONCERN AND AREA OF INTEREST

The pollutant of concern for these TMDLs is pathogens. Standards are established in terms of indicator organisms which, when present in excess of the standard, suggest that the waterbody is not suitable for primary contact recreation because of an elevated risk of disease. New Jersey Surface Water Quality Standards (SWQS) include pathogen indicator criteria for the assessment of the recreational use (primary and secondary contact recreation) for all waterbodies. However, for lakes with bathing beaches, the New Jersey Health Department Standards N.J.A.C. 8:26-7.18 establish the basis for beach closings. These standards are more stringent than the Surface Water Quality Standards. As a result, the Health Department Standards will serve as the water quality target for these TMDLs. The Health Department Standards and SWQS are summarized as follows:

As stated in N.J.A.C. 8:26-7.18 Microbiological water quality standards for bathing beaches:

The multiple-tube fermentation technique for fecal coliforms shall be conducted in accordance with the procedures set for in Method 9222D Fecal Coliform Membrane Filter Procedure or Method 9221E.2. Fecal Coliform MPN Procedure (A-1 medium) found in the 19th edition of "Standard Methods for the Examination of Water and Wastewater." American Public Health Association, incorporated herein by reference, as amended and supplemented. The estimated fecal coliform concentrations shall not exceed 200 fecal coliform per 100 milliliters.

As stated in N.J.A.C. 7:9B-1.14(d) of the New Jersey Surface Water Quality Standards Fresh Water 2 (FW2) waters:

1. Bacterial quality (Counts/100 ml)

ii. Primary Contact Recreation:

- (2) E. Coli levels shall not exceed a geometric mean of 126/100 ml or a single sample maximum of 235/100 ml.

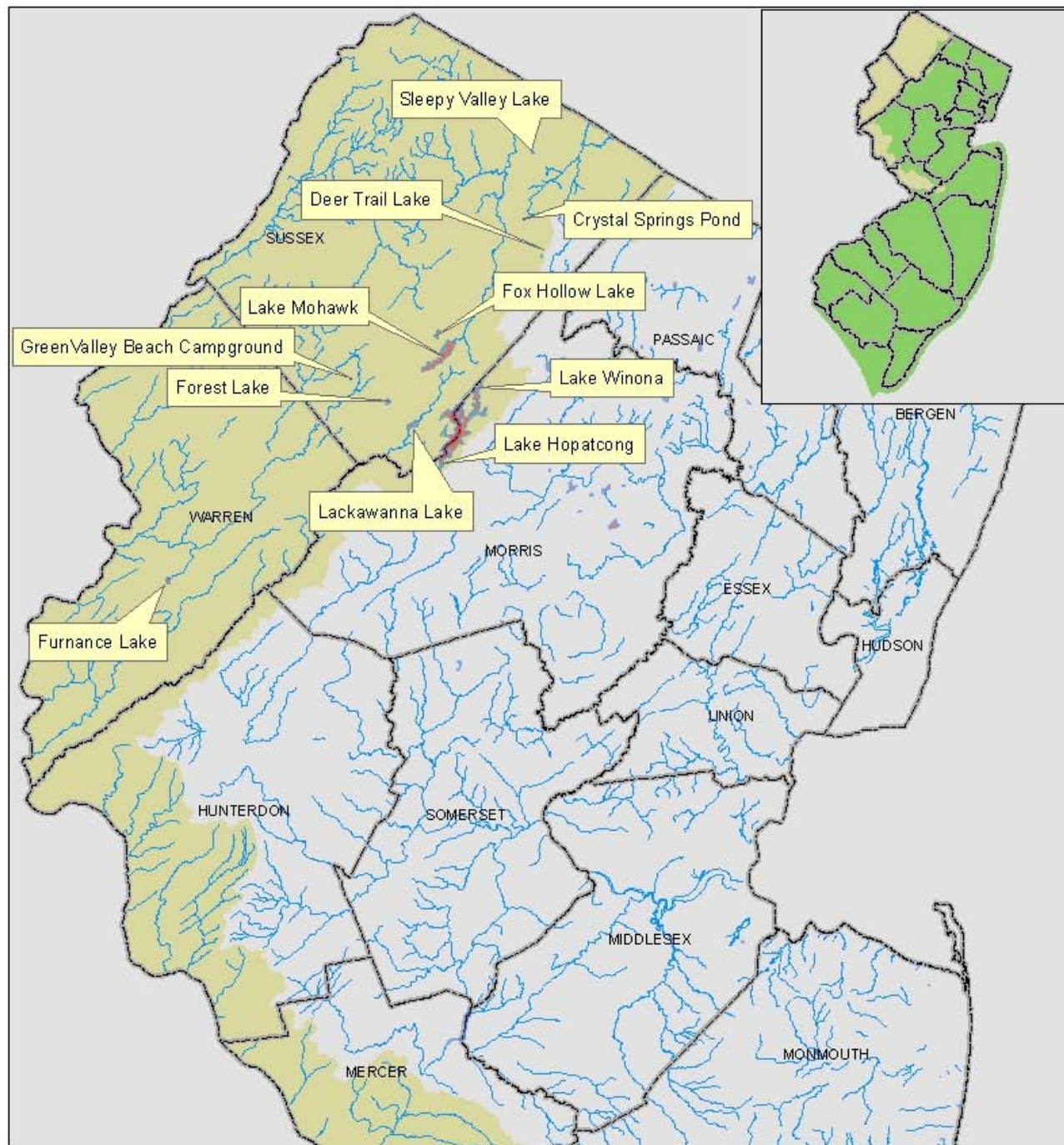
The lakes assessed as impaired based on water quality data and for which TMDLs have been developed are identified in Table 2 and depicted in Figures 1 and 2.

Table 2. Impaired Waterbodies as identified on the 2004 *Integrated List of Waterbodies* and the 2006 *Integrated List* for which Pathogen TMDLs are being adopted.

TMDL Number	WMA	Lake Assessment Unit Name	Lake Assessment Unit ID	2004 Status	2006 Status	County(s)*	Proposed Action
1	1	Lake Winona	Lake Winona-01	Sublist 5	Sublist 5	Morris/ Sussex	Adopt TMDL
2	1	Lake Hopatcong	Lake Hopatcong-01	Sublist 5	Sublist 5	Morris/ Sussex	Adopt TMDL
3	1	Green Valley Beach Campground	Green Valley Beach Campground-01	Sublist 5 (as Pequest River at Green Valley Beach Campground)	Sublist 5	Sussex	Adopt TMDL
4	1	Forest Lake	Forest Lake-01	Sublist 5	Sublist 5	Sussex	Adopt TMDL
5	1	Fox Hollow Lake	Fox Hollow Lake-01	Sublist 5	Sublist 5	Sussex	Adopt TMDL
6	1	Lackawanna Lake	Lackawanna Lake-01	Sublist 5	Sublist 5	Sussex	Adopt TMDL
7	1	Furnace Lake	Furnace Lake-01	Sublist 5	Sublist 5	Warren	Adopt TMDL
8	2	Crystal Springs Lake	Crystal Springs Pond -02	Sublist 5	Sublist 5	Sussex	Adopt TMDL
9	2	Deer Trail Lake	Deer Trail Lake-02	Sublist 5	Sublist 5	Sussex	Adopt TMDL

TMDL Number	WMA	Lake Assessment Unit Name	Lake Assessment Unit ID	2004 Status	2006 Status	County(s)*	Proposed Action
10	2	Lake Mohawk	Lake Mohawk-02	Sublist 5	Sublist 5	Sussex	Adopt TMDL
11	2	Sleepy Valley Lake	Sleepy Valley-02	Sublist 5	Sublist 5	Sussex	Adopt TMDL

*The drainage area/lakeshed for each lake may encompass municipalities beyond the identified County in which the lake is located.



Northwest Water Region By County

Legend

- TMDL Lake
- County
- Northwest Water Region
- Streams

0 5 10 15 20 Miles



Figure 1. Pathogen impaired lakes in the Northwest Water Region by county.

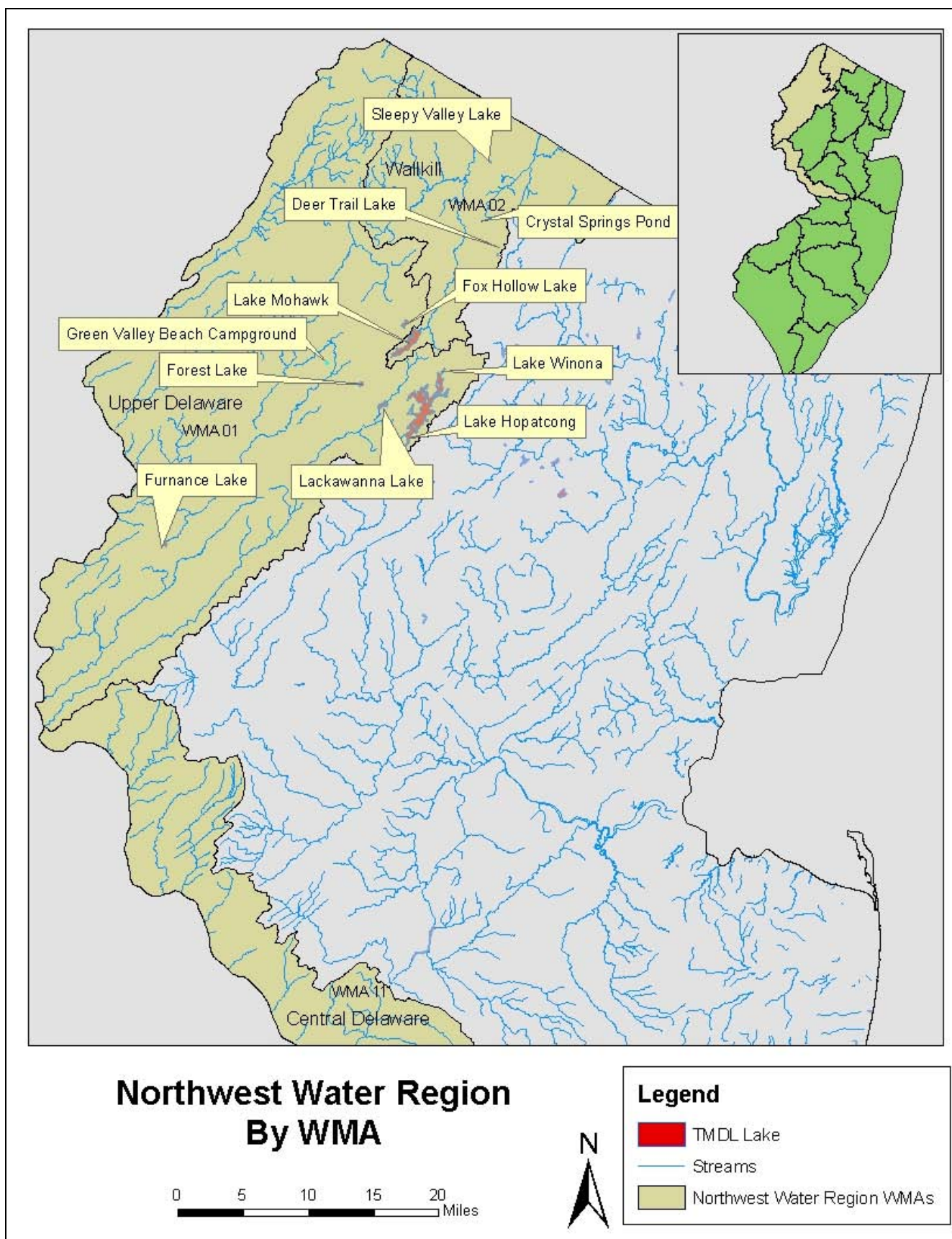


Figure 2. Pathogen impaired lakes in the Northwest Water Region by WMA.

Deer Trail Lake, Furnace Lake, Lackawanna Lake, Lake Hopatcong and Lake Winona are classified as Fresh Water 2 (FW2), Trout Maintenance (TM). All other impaired lakes addressed in this document are classified as FW2, Non-Trout (NT).

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

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

3.0 SOURCE ASSESSMENT

A source assessment was conducted to identify and characterize potential pathogen sources that may be impacting water quality in the listed waters. Both point and nonpoint sources were considered in TMDL development. Source assessment also includes the determination of the relative contribution of the primary bacteria sources to facilitate proper management responses through TMDL implementation. A variety of information was used to characterize possible pathogen sources including land use information gathered for each watershed, point source information, literature sources, and other available data.

3.2 Assessment of Point Sources

For TMDL development purposes, point sources include domestic and industrial wastewater treatment plants that discharge to surface waters, as well as surface water discharges of stormwater subject to regulation under the National Pollutant Discharge Elimination System (NPDES). This includes facilities with individual or general industrial stormwater permits, Tier A municipalities, and federal, interstate agency, state, and county facilities regulated under the New Jersey Pollutant Discharge Elimination System (NJPDES) municipal stormwater permitting program. Tier A municipalities are generally located within the more densely populated regions of the state or along the coast. These municipalities meet the population size requirements of EPA's Municipal Separate Storm Sewer System (MS4) program for regulating urban stormwater discharges. Stormwater point sources, like stormwater nonpoint sources, derive their pollutant loads from runoff from land surfaces and load reduction is accomplished through the use of best management practices (BMPs). The distinction is that stormwater point sources are regulated under the Clean Water Act (under the MS4 program). Stormwater point sources will be addressed through the management practices required through the MS4 permits.

Wastewater treatment facilities and Tier A municipalities that directly discharge to the pathogen impaired lakes in the Northwest Water Region are identified in Appendix B. Per Department NJPDES Regulation, N.J.A.C. 7:14A-12.5(a), "All wastewater that could contain pathogenic organisms such as fecal coliform and/or enterococci organisms shall be subject to continuous year round disinfection prior to discharge into surface waters." Therefore, loads from wastewater treatment facilities were considered de minimus, consistent with previous pathogen TMDLs developed by the Department. The NJPDES permit limits for these point sources will not be changed as a result of these TMDLs and will remain a 200 cfu/100 ml monthly geometric mean and a 400 cfu/100 ml weekly geometric mean.] Stormwater loads from Tier A MS4 systems are point sources that can be significant. These loads were estimated using the watershed loading methods described in the nonpoint source section, as they will be addressed through BMPs.

3.3 Assessment of Nonpoint Sources

Nonpoint sources that may affect lakes include stormwater discharges that are not subject to regulation under the Clean Water Act, including Tier B municipalities, direct stormwater runoff from land surfaces, as well as malfunctioning sewage conveyance systems, failing or inappropriately located septic systems, and direct contributions from wildlife, livestock and pets. Tier B municipalities are generally located in more rural, non-coastal regions of the state.

Watershed Treatment Model (WTM) (WTM, 2001), a steady-state spreadsheet model, was chosen to estimate nonpoint source bacteria loads for these TMDLs. WTM simulates loadings generated by watershed washoff processes. The WTM model was selected because it encompasses local rainfall data and stream length information to better tailor load estimates. In addition, it has been successfully applied in previous coastal TMDL studies, including the development of pathogen TMDLs for impaired shellfish waterbodies in New Jersey. The goal of applying WTM is to characterize all the point and nonpoint sources, as available data allows, in the existing system and to determine their relative contributions to the waterbody of interest. The loading values thus derived serve as the reference point from which reductions are made to meet TMDL targets.

The WTM model is a series of spreadsheets that quantifies the loading of pathogen indicators based on land use distribution, stream network length in the watershed, and annual rainfall. The model is designed as a planning level tool for watersheds that do not have sufficient data for complex modeling applications. Pathogen concentrations in runoff and receiving waters are highly variable due to many factors, therefore average annual land use loads derived using the WTM model are gross estimates. Although the WTM model has several tiers of data specificity, loading estimates can be calculated with simple land use data, as they were for these lake TMDLs. Land use loads are calculated on an annual basis by using a series of coefficients for runoff volume and pathogen loading derived from scientific literature. General land use categories are assigned either a coefficient that is then multiplied by an annual runoff volume to calculate an annual load (e.g., urban land uses) or an annual unit

area load that is applied as a function of land use (e.g., rural land uses). These coefficients are presented in Table 3 and discussed in the WTM user manual (Caraco, 2001). According to the WTM user manual, the urban loading coefficient was based on the median urban runoff value derived from Nationwide Urban Runoff Program (NURP) monitoring data (Pitt, 1998). Loading values for rural land uses were taken from Horner et. al., 1994. Note that barren land is not represented in the WTM model, therefore it was assumed that the forest loading value was reasonable for this land use type.

Table 3. Default WTM land use categories and loading variables.

WTM Land Use	Corresponding New Jersey Land Uses	Average % Impervious Cover	Fecal Coliform Conc. (MPN/100 ml) or Annual Load (billion/acre)
Low Density Residential	Low Density Residential, Rural Residential, Recreational Land, Athletic Fields	19	20,000
Medium Density Residential	Medium Density Residential, Mixed Residential, Mixed Urban or Built-Up, Other Urban or Built-Up, Military Reservations, No Longer Military	35	20,000
High Density Residential	High Density Residential	56	20,000
Commercial	Commercial Services	71	20,000
Roadway	Transportation/Communication/Utilities	39	20,000
Industrial	Industrial, Industrial/Commercial	78	20,000
Forest	Forest/Wetland	0	Load: 12 billion/acre
Rural	Agriculture	0	Load: 39 billion/acre
Barren (replaced "Vacant Lots" category in WTM)	Barren	2	Load: 12 billion/acre (estimated)

The watershed for each TMDL waterbody was delineated using the Hydrologic Unit Coverage (HUC-14 digit) developed by NJDEP, digital elevation model (DEM) data, the National Hydrography Dataset (NHD) stream coverage for New Jersey, and ArcHydro, a watershed delineation tool available as an extension for the ArcGIS geospatial mapping software suite. Land use data for each watershed was obtained from the 2002 land use coverage developed for New Jersey's WMAs. Land use categories were consolidated into broader groups for use in estimating land-based loads using the WTM model and for presenting the loading results. The percent impervious information for each land use category was derived from the percent impervious information in the Department's GIS land use coverage, averaged across similar land uses. The bacterial loads for urban areas in each watershed were calculated based on the default fecal coliform concentration literature value for urban land uses, the average percent impervious cover, and the annual runoff volume calculated by the WTM model. Agricultural, forest, and barren land use loads were calculated based on the specific loading rate for each category. The literature loading rate for forested land was applied to wetland areas to estimate a wetland land use load. Waterways were not included in loading calculations based on WTM model assumptions.

Direct contributions from illicit discharges, livestock, pets, and wildlife (e.g. seagulls, geese, and other waterfowl in particular) were not estimated based on the lack of site-specific information needed to represent these sources. Population estimates, bacteria production rates, and other information would be needed to estimate these sources. Bacteria may also be present in the sediment in some areas, as a result of contamination from stormwater, failing septic systems, malfunctioning sewer systems, agricultural runoff, and other sources. For these TMDLs, the loads contributed by wildlife, sediment, and the other sources were assumed to be included in the land use loading coefficients.

The drainage area and land use distribution of the impaired watersheds are presented in Table 4. Maps of the watershed land use distributions are presented in Appendix C.

Table 4. Land use area distributions for impaired watersheds in the Northwest Water Region.

WMA	Lake Assessment Unit ID	Agriculture		Barren Land		Forest		Urban		Water		Wetland		Total Area
		km ²	%	km ²	%	km ²	%	km ²	%	km ²	%	km ²	%	
1	Forest Lake-01	0.00	0.0	0.00	0.0	0.37	34.8	0.50	47.4	0.19	17.9	0.00	0.0	1.05
1	Fox Hollow Lake-01	0.05	1.3	0.02	0.5	1.27	35.0	1.28	35.1	0.40	10.9	0.63	17.3	3.64
1	Furnace Lake-01	0.89	12.7	0.07	1.0	4.09	58.1	1.04	14.7	0.24	3.4	0.71	10.1	7.04
1	Green Valley Beach Campground-01	0.05	40.8	0.00	0.0	0.01	12.3	0.04	37.4	0.01	8.6	0.00	0.9	0.12
1	Lackawanna Lake-01	0.47	1.4	0.36	1.1	22.35	65.2	5.89	17.2	1.80	5.2	3.44	10.0	34.31
1	Lake Hopatcong-01	0.01	0.0	1.00	1.5	31.90	48.5	16.81	25.6	10.91	16.6	5.11	7.8	65.73
1	Lake Winona-01	0.00	0.0	0.00	0.0	2.54	73.7	0.48	14.1	0.04	1.2	0.38	11.0	3.44
2	Crystal Springs Pond -02	0.00	0.0	0.01	3.7	0.03	9.5	0.24	83.8	0.01	3.0	0.00	0.0	0.28
2	Deer Trail Lake-02	0.00	0.0	0.00	0.0	0.60	72.5	0.17	20.4	0.04	5.1	0.02	2.0	0.83
2	Lake Mohawk-02	0.00	0.0	0.01	0.1	2.79	25.2	5.02	45.4	3.11	28.1	0.14	1.2	11.06
2	Sleepy Valley-02	0.00	0.0	0.02	0.5	1.80	54.0	0.91	27.2	0.25	7.6	0.36	10.7	3.34

4.0 WATER QUALITY ANALYSIS

Relating pathogen sources to concentrations of indicator organisms in the impaired waters 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 bacteria loads and concentrations can vary many orders of magnitude over short distances and over time at a single location, dynamic water quality models can be very difficult to calibrate. Options available to control nonpoint sources of bacteria typically include measures such as sewage infrastructure improvements, goose management strategies, pet waste ordinances, agricultural conservation management plans, and septic system replacement and maintenance. The effectiveness of these control measures is not easily measured relative to observed ambient concentrations. Given these considerations, detailed water quality modeling was not selected for determining the load reductions needed to attain standards and support the designated primary contact recreation use.

Fecal coliform data collected by county and township municipal health departments were used as the basis for TMDL development for the listed pathogen impaired lakes. These data were reviewed to identify potential data excursions in accordance with the Quality Assurance Project Plan (QAPP) that was developed for this study (QAPP, 2007). The percent reduction required to meet New Jersey bathing beach requirements was calculated based on comparing the maximum fecal coliform concentration recorded for each lake to the TMDL target (200 cfu/100 ml). The data available for each lake are included in Appendix D.

4.1 Seasonal Variation/Critical Conditions

The technical approach used to develop these TMDLs includes consideration of seasonal variability and critical conditions. The TMDL lakes are listed as impaired based on the designated primary contact bathing use. Water quality criteria for bathing beaches are established by the New Jersey Department of Health (NJDOH), which conducts monitoring at the municipal level in support of meeting the applicable criteria. Bathing beaches are typically in use during the late spring and summer months and data collection efforts are coordinated to coincide with this time period (May-September). TMDL loading reductions are based on the single sample maximum concentration identified in the record of observed in-lake water quality, therefore, TMDL development is based on the highest concentration observed for the time period of greatest exposure. Seasonal variability is of less importance because of the need to meet NJDOH bathing beach requirements during the summer critical condition period. TMDL loads are presented as average annual loads, which incorporate the summer critical condition period and the average load contributed during the other seasons.

4.2 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, both an implicit and explicit Margin of Safety (MOS) were incorporated. An implicit

MOS was incorporated by using conservative assumptions, including treating fecal coliform as a conservative substance (source loads were estimated without including die-off rates, soil incorporation, etc.) and using conservative methods to estimate land-based loads. In addition, a 5% explicit MOS was calculated for each lake.

5.0 TMDL CALCULATIONS

Pathogen load percent reductions were calculated by comparing the maximum fecal coliform concentration recorded for each lake to the TMDL target concentration (200 cfu/100 ml). Load capacities were the remaining loads after applying the required reductions on the current loads. In addition, 5% of the load capacity was reserved as the explicit MOS (see example below). The percent reduction specified for each lake was applied equally to pathogen sources in each watershed except in cases where load reductions could be met without reducing the loads contributed by forest, wetlands and barren lands: in such cases these loadings were not reduced in the TMDL allocation. In cases where load reductions on these land use sources were greater than or equal to 99.5%, the percent reduction specified for each lake was applied equally to all pathogen sources including forest and barren land loads.

Percent Reduction = $(1 - \text{TMDL target conc.} / \text{max conc.}) \times 100$

Load Capacity = $(1 - \text{percent reduction}) \times \text{overall current load (using WTM)}$

MOS = $5\% \times \text{Load capacity}$

Overall percent reduction = $1 - (\text{Load capacity} - \text{MOS}) / \text{overall current load}$

Overall current load = agricultural and urban land use loads + forest, wetland and barren land loads

When $1 - \frac{\text{Load Capacity} - \text{MOS} - \text{Forest, Wetland and Barren Land Load}}{\text{Agricultural and Urban Land Use Load}} \geq 99.5\%$,

Require the same percent reduction on Forest, Wetland and Barren land loads as on other land use loads;

Otherwise,

Zero percent reduction on Forest, Wetland and Barren lands loads

5.1 Wasteload Allocations and Load Allocations

WLAs were established for municipal stormwater discharges subject to regulation under the CWA. LAs were established for all stormwater sources that are not subject to regulation under the CWA and for all other nonpoint sources. Stormwater point sources that received a WLA were distinguished from stormwater sources receiving a LA on the basis of land use type and municipal tier designation (Tier A/Tier B).

This distribution of loading capacity between WLAs and LAs is consistent with recent EPA guidance that clarifies existing regulatory requirements for establishing WLAs for stormwater discharges (Wayland, November 2002). Stormwater discharges are captured

within the runoff sources quantified according to land use, as described previously. Distinguishing between regulated and unregulated stormwater is necessary in order to express WLAs and LAs numerically; however, “EPA recognizes that these allocations might be fairly rudimentary because of data limitations and variability within the system” (Wayland, November 2002, p.1). Therefore, allocations are established according to source categories as shown in Table 5. This demarcation between WLAs and LAs based on land use source categories is not perfect, but it represents the best estimate defined as narrowly as data allow. The Department acknowledges that there may be stormwater sources in the residential, commercial, industrial, and mixed urban runoff source categories that are not NJPDES-regulated. Nothing in these TMDLs shall be construed to require the Department to regulate a stormwater source under NJPDES that would not already be regulated as such, nor shall anything in these TMDLs be construed to prevent the Department from regulating a stormwater source under NJPDES.

Table 5. Assignment of WLAs and LAs for stormwater point sources and nonpoint sources.

Land Use Source Category	Municipal Tier	TMDL Allocation Type
High density residential	A	WLA
Medium density residential (incl. mixed residential, mixed urban, other urban, military reservations, and no longer military)	A	WLA
Low density residential (incl. rural residential, recreational land, and athletic fields)	A	WLA
Commercial	A	WLA
Industrial	A	WLA
Roadways	A	WLA
High density residential	B	LA
Medium density residential (incl. mixed residential, mixed urban, other urban, military reservations, and no longer military)	B	LA
Low density residential (incl. rural residential, recreational land, and athletic fields)	B	LA
Commercial	B	LA
Industrial	B	LA
Roadways	B	LA
Agricultural	N/A	LA
Forest/Wetland	N/A	LA
Barren land	N/A	LA

A summary of the WLAs, LAs, and MOS is provided for each lake in Table 6 and source loads and allocations are presented in Table 7. As described above, when the loads contributed by forest/wetland/barren lands were not reduced in the TMDL allocation table, the load reduction for urban lands and agricultural lands was increased proportionally to meet the overall percent reduction required for each lake. Note that the overall percent reduction shown in Tables 6 and 7 takes into account the 5% explicit MOS if not based on the previously established stream Fecal Coliform TMDL.

In cases where impaired lakeshed is hydrologically connected to a streamshed addressed in an established Fecal Coliform TMDL or to another impaired lakeshed, different approaches were utilized to calculate the load reduction for each “nested” watershed.

Lakeshed connected with the Fecal Coliform TMDL established streamshed

If the entire lakeshed is located within the impaired streamshed, the more stringent overall percent reduction between the lake and the stream is applied to the lakeshed. When the streamshed is part of the lakeshed, the rivershed is treated as an upper stream “lake” shed. The same approach, as described below for the nested lakesheds, was used to determine the adjusted load reduction for different areas.

Lakeshed connected with another impaired lakeshed

The following methodology was used to determine the adjusted percent reduction for the nested lake watersheds:

1. Existing pathogen loads calculated for each lake watershed (using WTM) were reduced based on the overall percent reduction that was calculated from the observed lake water quality data. The reduced load was termed the target load.
2. The target load for the upstream watershed was subtracted from the target load of the downstream watershed, giving a target load for the downstream (local) watershed area. The existing load for the downstream (local) watershed was calculated similarly.
3. If the target load for the downstream (local) watershed area was less than or equal to zero, the downstream lake’s higher percent reduction needed to be applied to the upper stream lakeshed. This means that the entire drainage area of the downstream lake is ruled by the downstream lake’s reduction percentage.
4. If the target load of the downstream (local) watershed area was higher than zero, the percent difference between the existing and target loads for the downstream (local) watershed was calculated. This adjusted percent reduction superseded the original downstream lake percent reduction and was used as the required percent reduction for the downstream (local) watershed area while the upstream lakeshed stayed with the original overall percent reduction. The adjusted percent reduction would be higher than the original overall percent reduction for the downstream lake when the upstream lake required a less percent reduction than the downstream lake and less than the original value if the upstream lake required a higher percent reduction than the downstream lake.

Table 6. TMDL calculations for pathogen impaired lakes in the Northwest Water Region.

WMA	Lake Assessment Unit ID	WLA (10 ⁶ colonies/yr)	LA (10 ⁶ colonies/yr)	MOS (10 ⁶ colonies/yr)	TMDL (10 ⁶ colonies/yr)	Overall % Reduction	% MOS	Reduction from associated Stream TMDL
1	Forest Lake-01	5.13E+02	1.72E+01	2.79E+01	5.58E+02	98.42%	5.00%	
1	Fox Hollow Lake-01 ^c	1.48E+03	1.23E+02	8.46E+01	1.69E+03	98.00%	N/A	98%
1	Furnace Lake-01 ^c	0.00E+00	5.47E+03	2.88E+02	5.76E+03	93.00%	N/A	93%
1	Green Valley Beach Campground-01	7.85E-02	2.28E+02	1.20E+01	2.40E+02	90.50%	5.00%	
1	Lackawanna Lake-01	2.23E+04	5.77E+03	1.48E+03	2.95E+04	92.96%	5.00%	
1	Lake Hopatcong-01 ^b	4.37E+04	3.35E+03	2.48E+03	4.96E+04	96.79% ^b	5.00%	
1	Lake Winona-01 ^a	8.92E+02	1.64E+02	5.56E+01	1.11E+03	98.10%	5.00%	
2	Crystal Springs Pond -02	0.00E+00	5.02E+03	2.64E+02	5.28E+03	75.32%	5.00%	
2	Deer Trail Lake-02	0.00E+00	3.08E+03	1.62E+02	3.24E+03	74.25%	5.00%	
2	Lake Mohawk-02 ^d	5.25E+03	1.50E+02	2.84E+02	5.68E+03	98.27%	5.00%	90%
2	Sleepy Valley-02 ^c	0.00E+00	3.30E+03	1.74E+02	3.48E+03	95.00%	N/A	95%

a. within the watershed of Lake Hopatcong and stays with its own reduction

b. Reduction on the local Lake Hopatcong watershed is less than the original overall percent reduction (96.83%) after taking into account Lake Winona's higher reduction.

c. lake shed located within a stream watershed and goes with the stream's reduction

- Fox Hollow Lake is nested with the watershed of Paulins Kill at Balesville, on which a reduction of 98% was required (NJDEP, 2003).
- Furnace Lake is nested with the watershed of Pequest River at Pequest, on which a reduction of 93% was required (NJDEP, 2003).
- Sleepy Valley is nested with the watershed of Wallkill River near Unionville, on which a reduction of 95% was required (NJDEP, 2003).

d. lake shed located within a stream watershed and stays with its own reduction

- Lake Mohawk is nested with the watershed of Wallkill River at Sparta, on which a reduction of 90% was required (NJDEP, 2003).

Table 7. Northwest Water Region land-based load allocations.

WMA	Lake Assessment Unit ID	Overall % Reduction	Agriculture			Barren Land			Forest/Wetland			Urban Total (WLA)			Urban Total (LA)		
			Existing Load (10 ⁶ colonies/yr)	Percent Reduction	Allocated Load (10 ⁶ colonies/yr)	Existing Load (10 ⁶ colonies/yr)	Percent Reduction	Allocated Load (10 ⁶ colonies/yr)	Existing Load (10 ⁶ colonies/yr)	Percent Reduction	Allocated Load (10 ⁶ colonies/yr)	Existing Load (10 ⁶ colonies/yr)	Percent Reduction	Allocated Load (10 ⁶ colonies/yr)	Existing Load (10 ⁶ colonies/yr)	Percent Reduction	Allocated Load (10 ⁶ colonies/yr)
1	Forest Lake-01	98%	0.00E+00	98%	0.00E+00	0.00E+00	98%	0.00E+00	1.09E+03	98%	1.72E+01	3.24E+04	98%	5.13E+02	0.00E+00	98%	0.00E+00
1	Fox Hollow Lake-01	98%	4.62E+02	98%	9.25E+00	5.83E+01	98%	1.17E+00	5.64E+03	98%	1.13E+02	7.42E+04	98%	1.48E+03	0.00E+00	98%	0.00E+00
1	Furnace Lake-01	93%	8.61E+03	93%	6.03E+02	2.16E+02	93%	1.51E+01	1.42E+04	93%	9.96E+02	0.00E+00	93%	0.00E+00	5.51E+04	93%	3.86E+03
1	Green Valley Beach Campground-01	91%	4.68E+02	92%	3.61E+01	0.00E+00	0%	0.00E+00	4.67E+01	0%	4.67E+01	1.02E+00	92%	7.85E-02	1.89E+03	92%	1.45E+02
1	Lackawanna Lake-01	93%	4.50E+03	93%	3.17E+02	1.07E+03	93%	7.52E+01	7.65E+04	93%	5.38E+03	3.16E+05	93%	2.23E+04	0.00E+00	93%	0.00E+00
1	Lake Hopatcong-01	97%	1.01E+02	97%	3.25E+00	2.97E+03	97%	9.56E+01	1.01E+05	97%	3.25E+03	1.36E+06	97%	4.37E+04	0.00E+00	97%	0.00E+00
1	Lake Winona-01	98%	0.00E+00	98%	0.00E+00	0.00E+00	98%	0.00E+00	8.64E+03	98%	1.64E+02	4.70E+04	98%	8.92E+02	0.00E+00	98%	0.00E+00
2	Crystal Springs Pond -02	75%	0.00E+00	76%	0.00E+00	3.11E+01	0%	3.11E+01	7.87E+01	0%	7.87E+01	0.00E+00	76%	0.00E+00	2.02E+04	76%	4.91E+03
2	Deer Trail Lake-02	74%	0.00E+00	88%	0.00E+00	0.00E+00	0%	0.00E+00	1.84E+03	0%	1.84E+03	0.00E+00	88%	0.00E+00	1.01E+04	88%	1.24E+03
2	Lake Mohawk-02	98%	0.00E+00	98%	0.00E+00	2.67E+01	98%	4.61E-01	8.67E+03	98%	1.50E+02	3.04E+05	98%	5.25E+03	0.00E+00	98%	0.00E+00

WMA	Lake Assessment Unit ID	Overall % Reduction	Agriculture			Barren Land			Forest/Wetland			Urban Total (WLA)			Urban Total (LA)		
			Existing Load (10 ⁶ colonies/yr)	Percent Reduction	Allocated Load (10 ⁶ colonies/yr)	Existing Load (10 ⁶ colonies/yr)	Percent Reduction	Allocated Load (10 ⁶ colonies/yr)	Existing Load (10 ⁶ colonies/yr)	Percent Reduction	Allocated Load (10 ⁶ colonies/yr)	Existing Load (10 ⁶ colonies/yr)	Percent Reduction	Allocated Load (10 ⁶ colonies/yr)	Existing Load (10 ⁶ colonies/yr)	Percent Reduction	Allocated Load (10 ⁶ colonies/yr)
2	Sleepy Valley-02	95%	1.33E+01	95%	6.63E-01	4.65E+01	95%	2.32E+00	6.41E+03	95%	3.21E+02	0.00E+00	95%	0.00E+00	5.96E+04	95%	2.98E+03

5.2 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 for the lakes addressed in these TMDLs. Wastewater treatment facilities will continue to be required to achieve disinfection. Nonpoint source reduction strategies applied to land uses will be equally effective with respect to existing and future use of the land.

6.0 FOLLOW - UP MONITORING

Monitoring requirements for the listed lakes are established under NJDOH regulations for state bathing beaches. NJDOH regulations include sampling requirements before and during seasonal operation. Before bathing beaches are opened each year, NJDOH requires a pre-operational assessment, which includes

- A review of historical sampling and epidemiological data
- A field investigation of the bathing and surrounding areas to identify sources of potential contamination
- A sampling of waters in the bathing area and in areas of suspected sources of contamination

During the bathing season, NJDOH requires that bathing beach water be sampled one week prior to opening and at one-week intervals once in use. Samples are collected during periods of maximum user load and from depths used for bathing. In cases where water samples were found to meet the NJDOH water quality criterion for three consecutive months in the prior year, operators can apply for biweekly sampling responsibilities (NJDOH, 2004).

7.0 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, citing criteria, operating methods, or other alternatives” (USEPA, 1993).

Development of effective management measures depends on accurate source assessment. Coliform bacteria are contributed to the environment from a number of categories of sources including human, domestic or captive animals, agricultural practices, and wildlife. Coliform bacteria 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 coliform bacteria. 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 by matching strategies with sources, selecting responsible entities and aligning available resources to effect implementation.

For example, the stormwater discharged to the impaired waterbodies through “municipal separate storm sewer systems” (MS4s) are regulated under the Department’s Municipal Stormwater Regulation Program. Under these rules and associated general permits, many municipalities (and various county, State, and other agencies) are 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 MS4s. Measures that are currently in effect include ordinances to manage pet waste, 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. These measures are required in accordance with the Department’s Municipal Stormwater Regulation program. The Department has provided State funds as well as a portion of its Clean Water Act 319(h) pass through grant funds to assist municipalities in meeting these requirements.

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 affected 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; 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 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.

Geese are migratory birds that are protected by the Migratory Bird Treaty Act of 1918 and other Federal and State Laws. Resident Canada geese do not migrate, but are nevertheless protected by this and other legislation. The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS)-Wildlife Services program reports that the 1999 estimated population of non-migratory geese in New Jersey was 83,000. Geese may produce up to 1½ pounds of fecal matter a day and when the congregate in large numbers they can represent a locally significant source of coliform bacteria. This may warrant taking steps to reduce populations in areas with excessive populations.

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

- Initiate a fact-finding and communication plan
- Enact and enforce a “no feeding” ordinance (already required per MS4 permits)
- Conduct goose damage control activities such as habitat modification

- Review and update land use policies
- Reduce or eliminate goose reproduction (permit required)
- Hunt geese to reinforce nonlethal actions (permit required)

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

In coastal areas, other waterfowl are naturally present in significant numbers and vary seasonally with migratory patterns. Other wildlife contributions may include deer populations, which have been identified as a potential fecal coliform source in the impaired watersheds. The forested and low-density residential areas that provide deer habitat can be found in close proximity to the impaired watersheds. Deer have been evaluated in fecal coliform TMDLs by other States (e.g. Alabama and South Carolina) and could be a fecal coliform source in New Jersey. Management measures to reduce coliform bacteria contributed by wildlife are not generally practicable, but could respond to measures such as improved riparian buffers.

Agricultural activities are another example of potential sources of coliform bacteria. 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 coliform bacteria. 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 Conservation Reserve Enhancement Program** The New Jersey Departments of Environmental Protection and Agriculture, in partnership with the Farm Service Agency and Natural Resources Conservation Service, have established a \$100 million dollar CREP agreement. The program matches \$23 million of State money with \$77 million from the Commodity Credit Corporation within USDA. Through CREP, financial incentives are offered for agricultural landowners to voluntarily implement conservation practices on agricultural lands. NJ CREP will be part of the USDA's Conservation Reserve Program (CRP). There will be a ten-year enrollment period, with CREP leases ranging between 10-15 years. The State intends to augment this program thereby making these leases permanent easements. 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.

Management strategies are summarized below in Table 8.

Table 8. Implementation management strategies.

Source Category	Responses	Potential Responsible Entity	Funding options
Human Sources			
Inadequate (per design, operation, maintenance, location, density) on-site disposal systems	Sanitary surveys, septic management programs/ordinances	Municipality	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 Municipal Stormwater permitting program including any additional measures determined in the future to be needed through TMDL process	Municipality, State and County regulated entities, stormwater utilities	CWA 319(h); Environmental Infrastructure Financing Program for construction of selected option
Malfunctioning sewage conveyance facilities	Identify through source trackdown and repair	Owner of malfunctioning facility-compliance issue	User fees
Domestic/captive animal sources			
Pets	Pet waste ordinances	Municipalities for ordinance adoption and compliance	State source and CWA 319(h) assistance to municipalities to implement municipal stormwater regulations

Source Category	Responses	Potential Responsible Entity	Funding options
Horses, livestock, zoos	Confirm through source trackdown: SCD/NRCS develop conservation management plans	Property owner	EQIP, CRP, CREP
Agricultural practices	Confirm through source trackdown; SCD/NRCS develop conservation management plans, exercise CAFO/AFO authority if applicable	Property owner	EQIP, CRP, CREP
Wildlife			
Locally excessive populations of resident Canada geese or other waterfowl	Feeding ordinances; Goose Management BMPs	Municipality for ordinance; local community groups for BMPs	State source; CWA 319(h)
Indigenous wildlife	Confirm through trackdown; riparian buffer restoration; consider revising designated uses	State	State source

7.1 Specific Projects

In addition to the more generalized strategies described previously, a number of projects have been undertaken which are expected to aid in achieving the load reductions assigned to the impaired waterbodies. Ongoing activities to develop and implement watershed restoration plans are expected to result in additional specific projects to reduce pollutant loads.

Table 9. Northwest Water Region Outreach and Restoration Projects

WMA	FY	Funding Source	Recipient	Project Title	Grant Amount
1	2005	319(h)	Lake Hopatcong Commission	Implementation of Nonpoint Source Management Measures to Reduce the Phosphorus and Sediment Loads Entering Lake Hopatcong	\$910,440
1	2006	CBT	Princeton Hydro, LLC	Refined Phosphorus TMDL and Restoration Plan for Lake Hopatcong and Lake Musconetcong	\$94,000
1	2007	319(h)	Sussex County Municipal Utilities Authority, Wallkill River Watershed Management Group	Watershed Restoration Plan for the Paulins Kill Headwaters to Balesville: Three Phased Approach (Fox Hollow Lake)	\$464,025

8.0 REASONABLE ASSURANCE

With the implementation of source reduction measures such as reducing the number of failing septic systems, leaching sewer lines, and controlling agricultural runoff, the Department has reasonable assurance that a significant improvement in the support of primary contact recreation in the impaired lakes will be attained. The results from on-going existing monitoring programs will be evaluated to determine effectiveness of the identified measures and if additional measures are needed.

9.0 PUBLIC PARTICIPATION

The Water Quality Management Planning Rules at N.J.A.C. 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 adopt each TMDL as an amendment to the appropriate area-wide water quality management plan in accordance with procedures at N.J.A.C. 7:15-3.4(g). As part of the public participation process for the development and implementation of the subject TMDLs, the Department solicited information from stakeholder groups and from the general public directly and through a web posting beginning in October 2006. Additionally in November 2006, the list of impaired lakes was distributed to the New Jersey volunteering monitoring community, through the Watershed Watch Network. The Watershed Watch Network is a program acting as an umbrella for all of the volunteer monitoring programs within New Jersey. Interested parties had the opportunity to supply the Department with information about each via e-mail. The Department specifically solicited information regarding potential sources and/or current non point sources of pollution reduction projects within the impaired watersheds. Information received regarding potential sources of fecal contamination were assessed in the development of these TMDLs.

10.0 AMENDMENT PROCESS

Notice proposing these TMDLs appeared in the July 16, 2007 New Jersey Register and in a newspaper of general circulation in order to provide the public an opportunity to review the TMDL document and submit formal comments. In addition, a public hearing was held on August 17, 2007 at the New Jersey Department of Environmental Protection Public Hearing Room, 401 E. State St., Trenton, NJ 08608. There was an informal presentation from 1:00 p.m. to 2:00 p.m., followed by the public hearing from 2:00 p.m. until the end of testimony, whichever was earlier. One person attended the hearing and no testimony was given. Notice of the proposal and hearing was provided to affected counties, municipalities and lake associations in the watershed.

There were no comments received during the public notice period or at the public hearing. This TMDL was approved by EPA on September 28, 2007 and was adopted on October 19, 2009 as an amendment to the Sussex County and Upper Delaware Water Quality Management Plans in accordance with New Jersey's Water Quality Management Planning Rules at N.J.A.C. 7:15-3.4 (g).

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APPENDIX B: NJPDES WASTEWATER TREATMENT FACILITIES, TIER A MUNICIPALITIES, TIER B MUNICIPALITIES

Northwest Water Region Wastewater Treatment Facilities

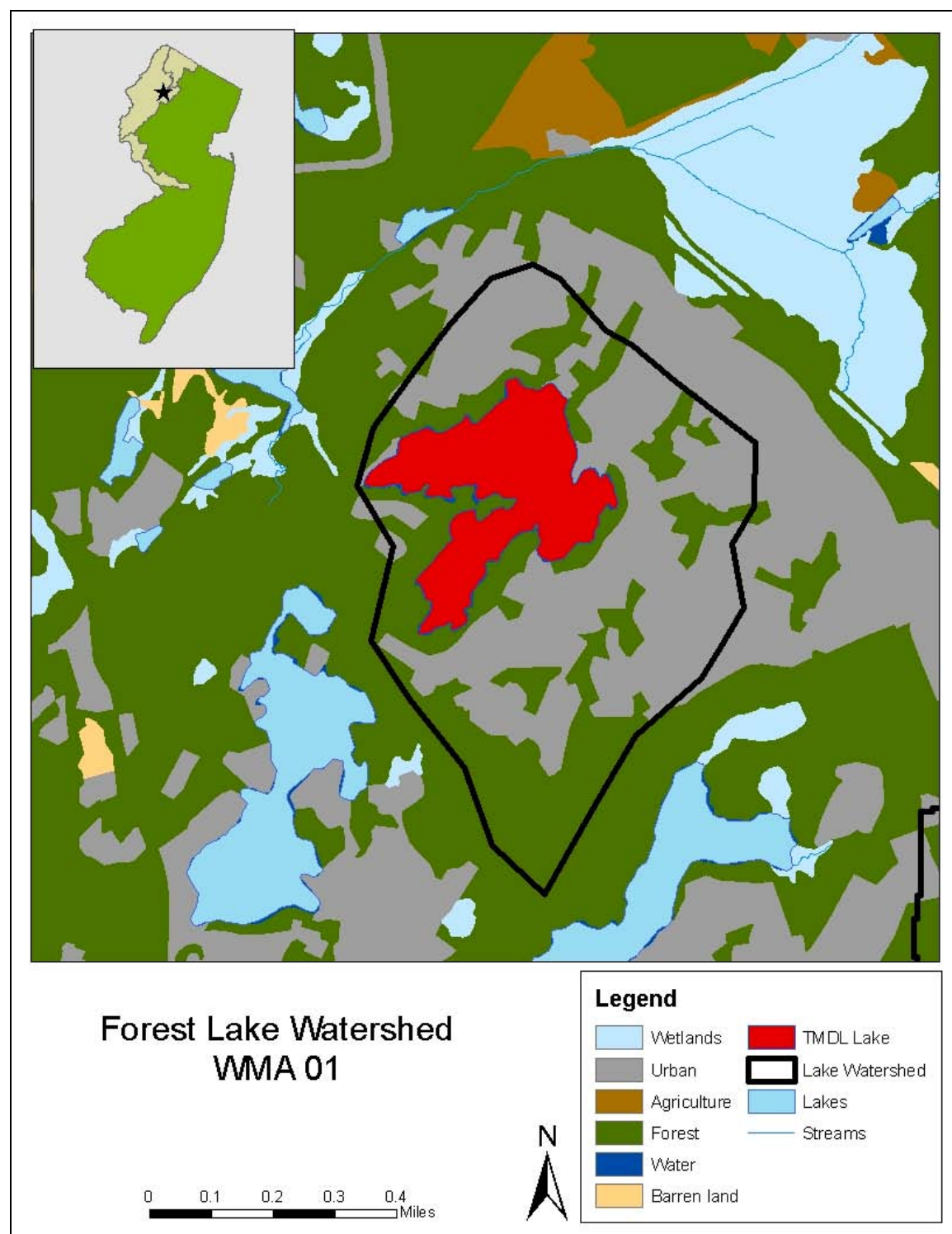
NJPDES ID	Facility Name	Pipe	FC Limit	Permit Category*	Receiving Waters/Associated Lake
NJ0021105	Jefferson Twp - Arthur Stanlick School	001A	NA	A	Lake Shawnee via unnamed trib/Lake Hopatcong
NJ0027049	Pope John XXIII High School	001A	NA	A	Fox Hollow Lake via unnamed trib

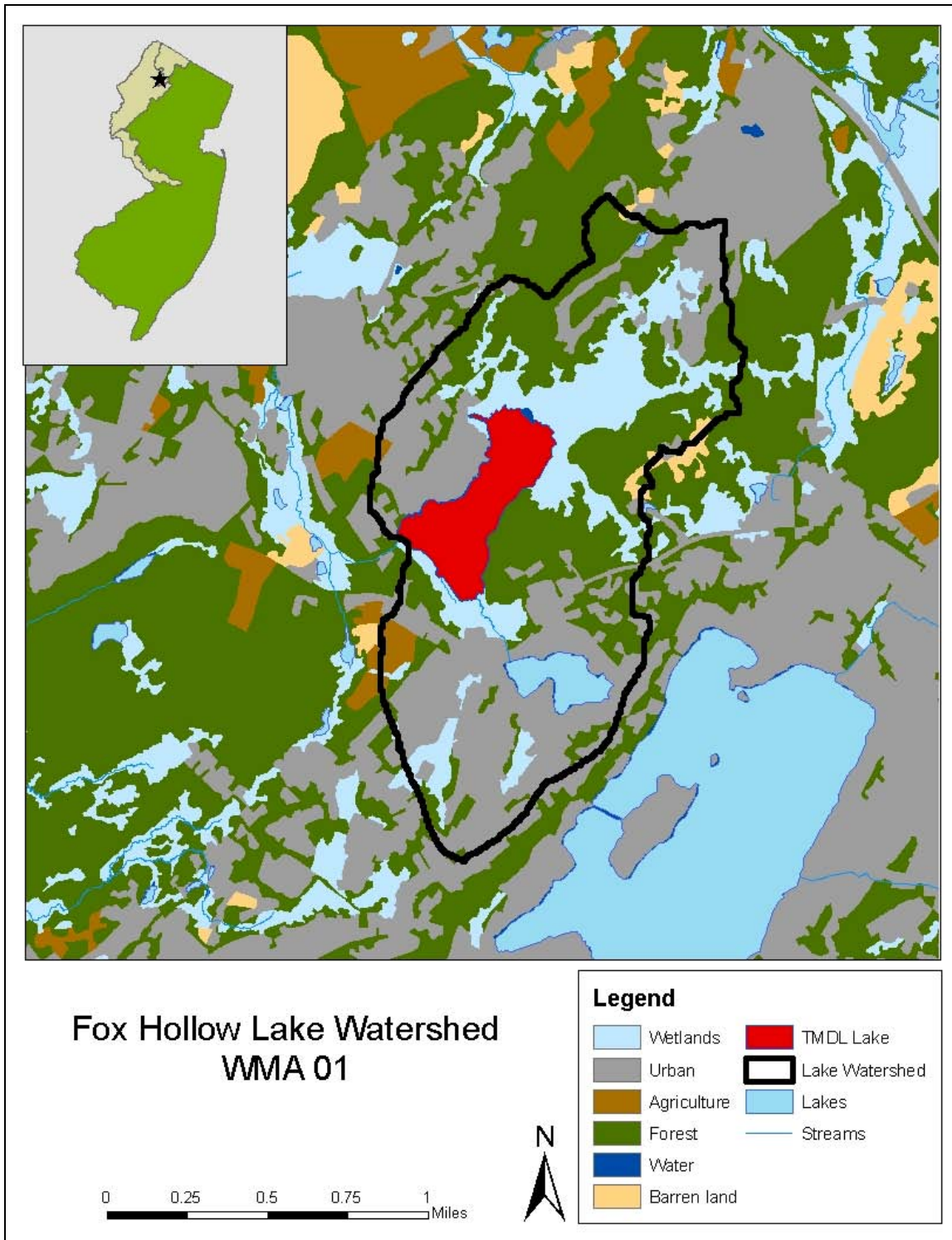
*Permit Categories: A = Sanitary Surface Water Discharge

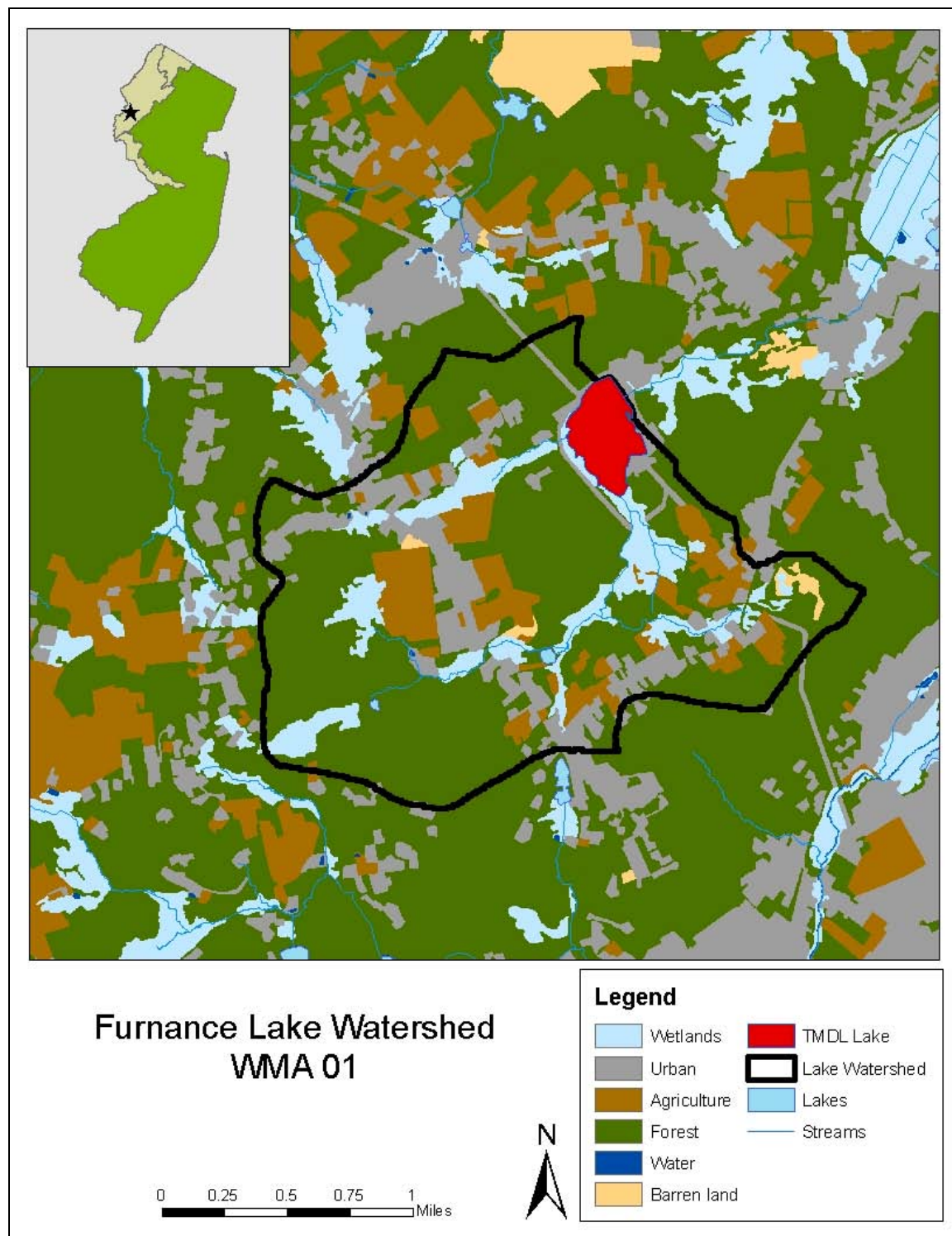
Northwest Water Region Tier A and Tier B Municipalities

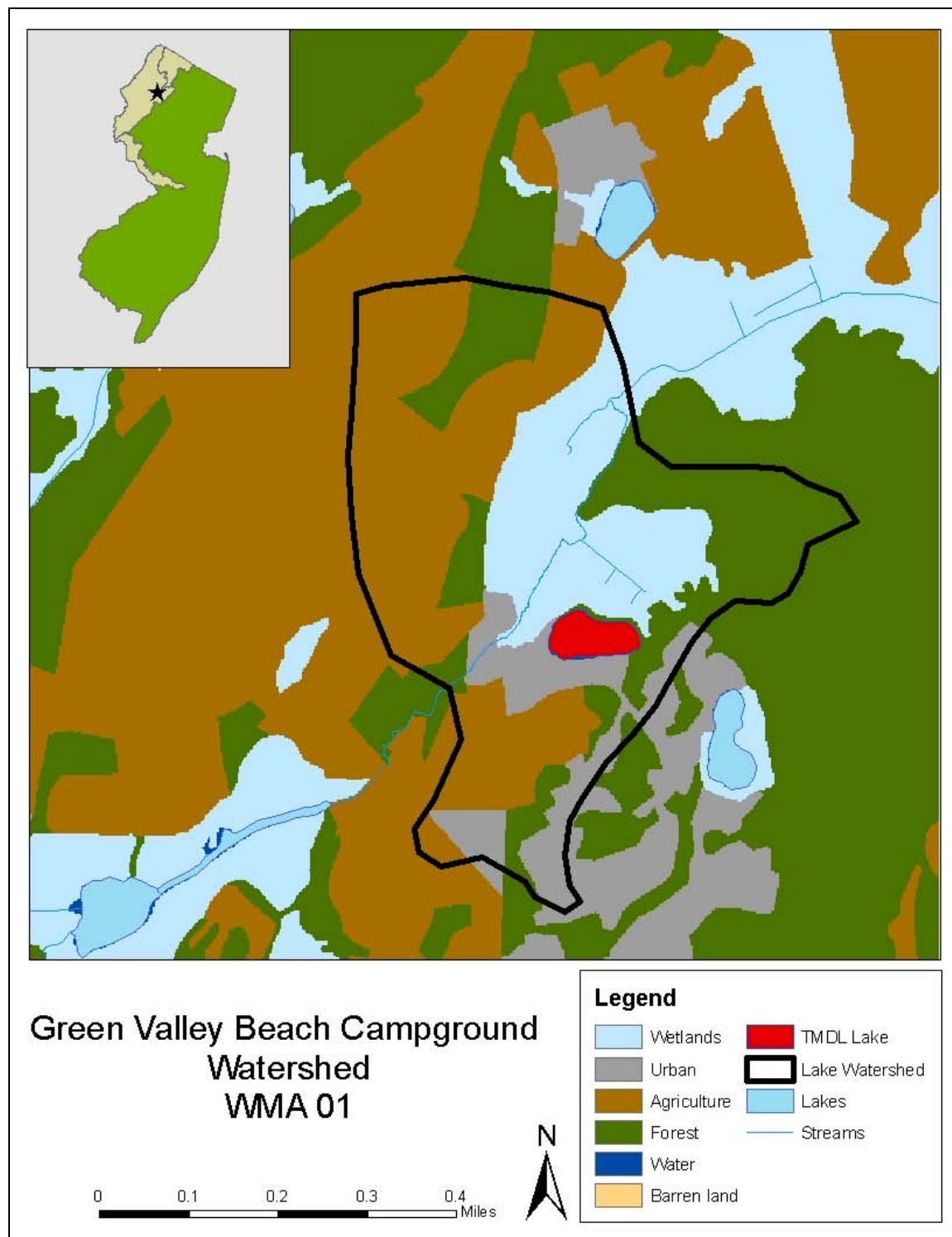
Tier	Watershed	Municipality	WMA	Permit #
A	Fox Hollow	Sparta Twp	1	NJG0148059
	Green Valley Beach Campground	Andover Twp	1	NJG0153290
	Lake Hopatcong	Sparta Twp	1	NJG0148059
		Jefferson Twp	1	NJG0151793
		Hopatcong Boro	1	NJG0147931
		Mount Arlington Boro	1	NJG0153265
		Roxbury Twp	1	NJG0152641
	Lackawanna Lake	Sparta Twp	1	NJG0148059
		Hopatcong Boro	1	NJG0147931
		Byram Twp	1	NJG0149209
	Forest Lake	Andover Twp	1	NJG0153290
		Byram Twp	1	NJG0149209
	Lake Winona	Sparta Twp	1	NJG0148059
		Jefferson Twp	1	NJG0151793
	Lake Mohawk	Sparta Twp	2	NJG0148059
		Andover Twp	2	NJG0153290
		Byram Twp	2	NJG0149209
B	Furnace Lake	White Twp	1	NJG0149683
		Oxford Twp	1	NJG0151904
		Washington Twp	1	NJG0150690
	Green Valley Beach Campground	Green Twp	1	NJG0152943
	Deer Trail Lake	Hardyston Twp	2	NJG0152269
	Crystal Springs Lake	Hardyston Twp	2	NJG0152269

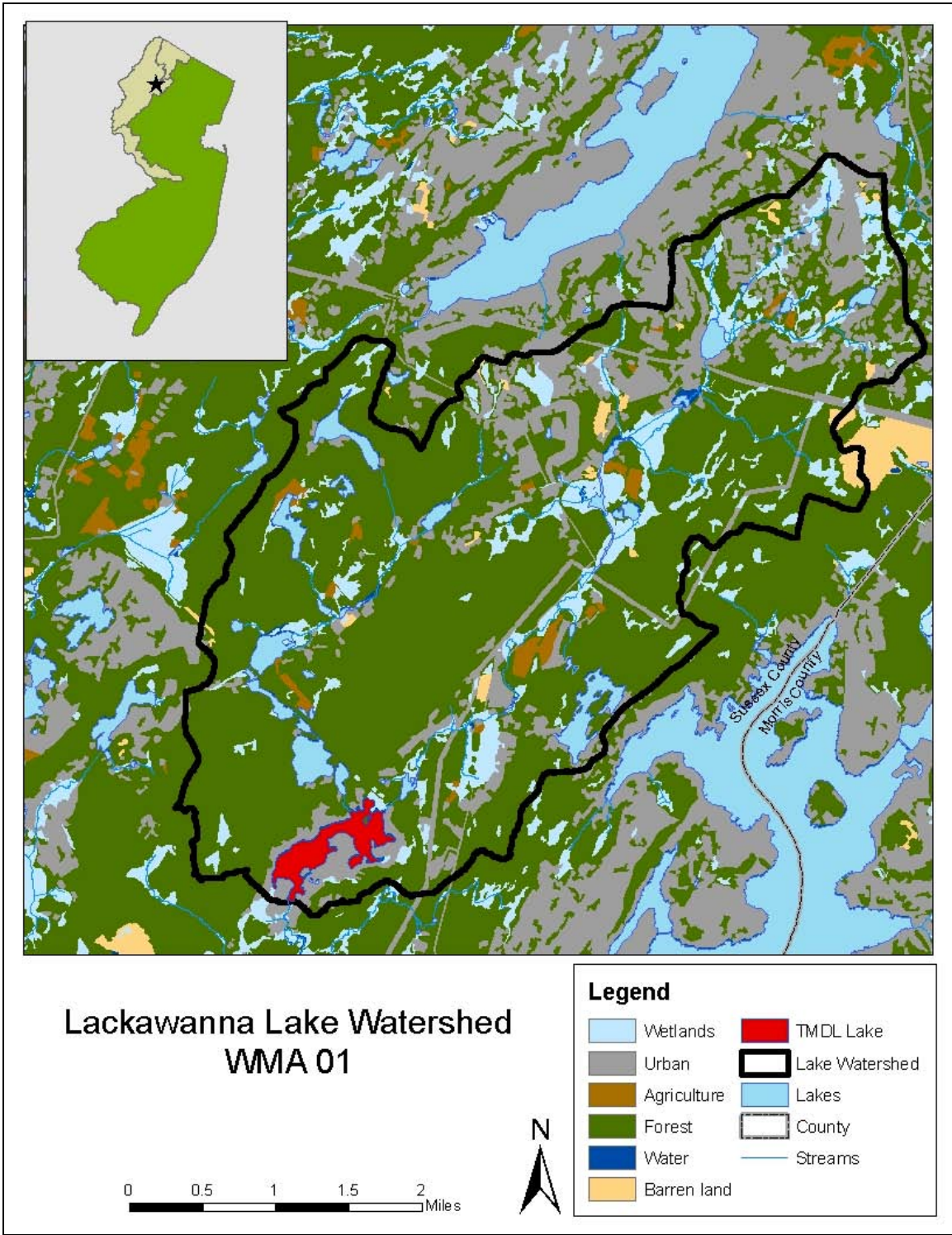
APPENDIX C: LAKE WATERSHED MAPS

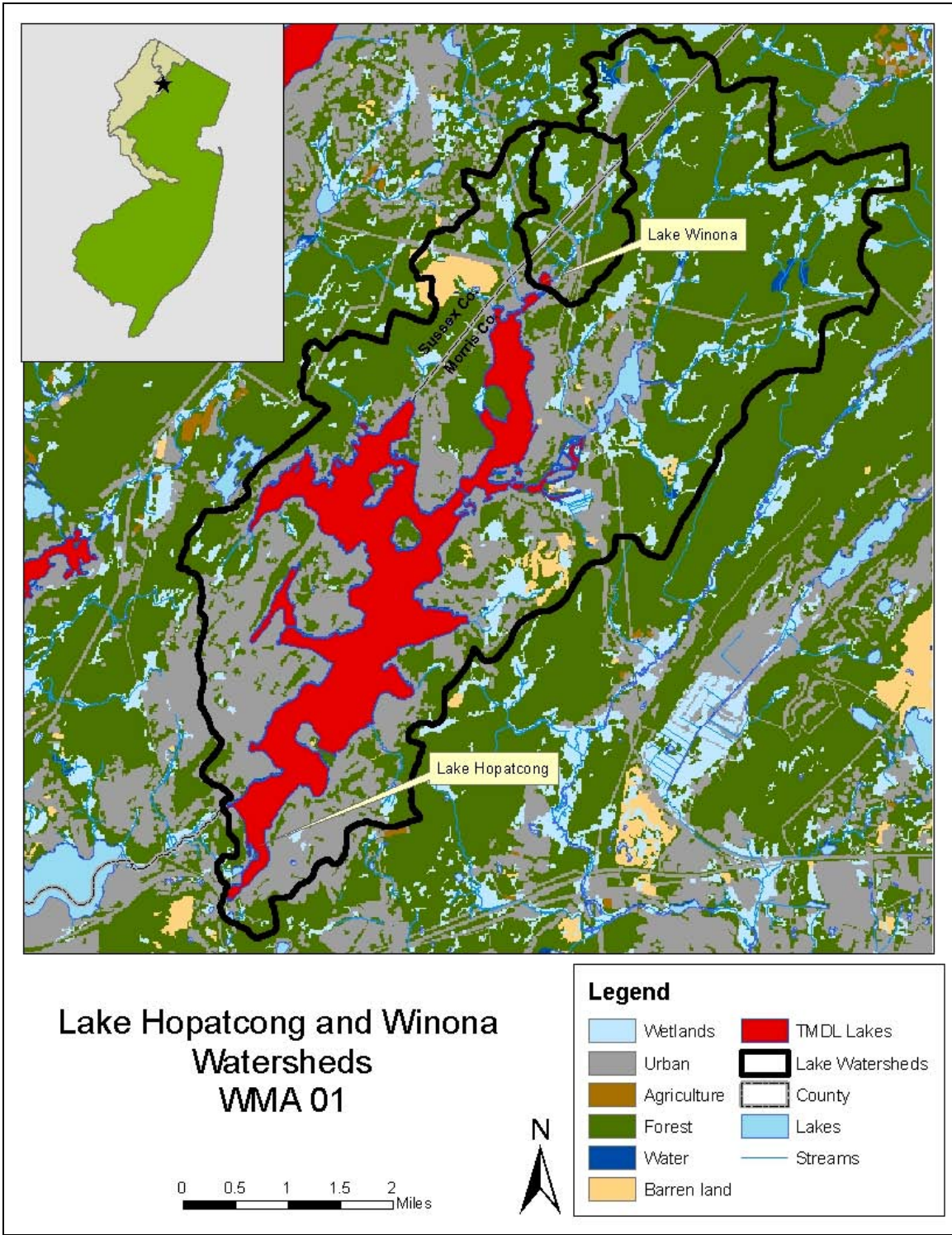


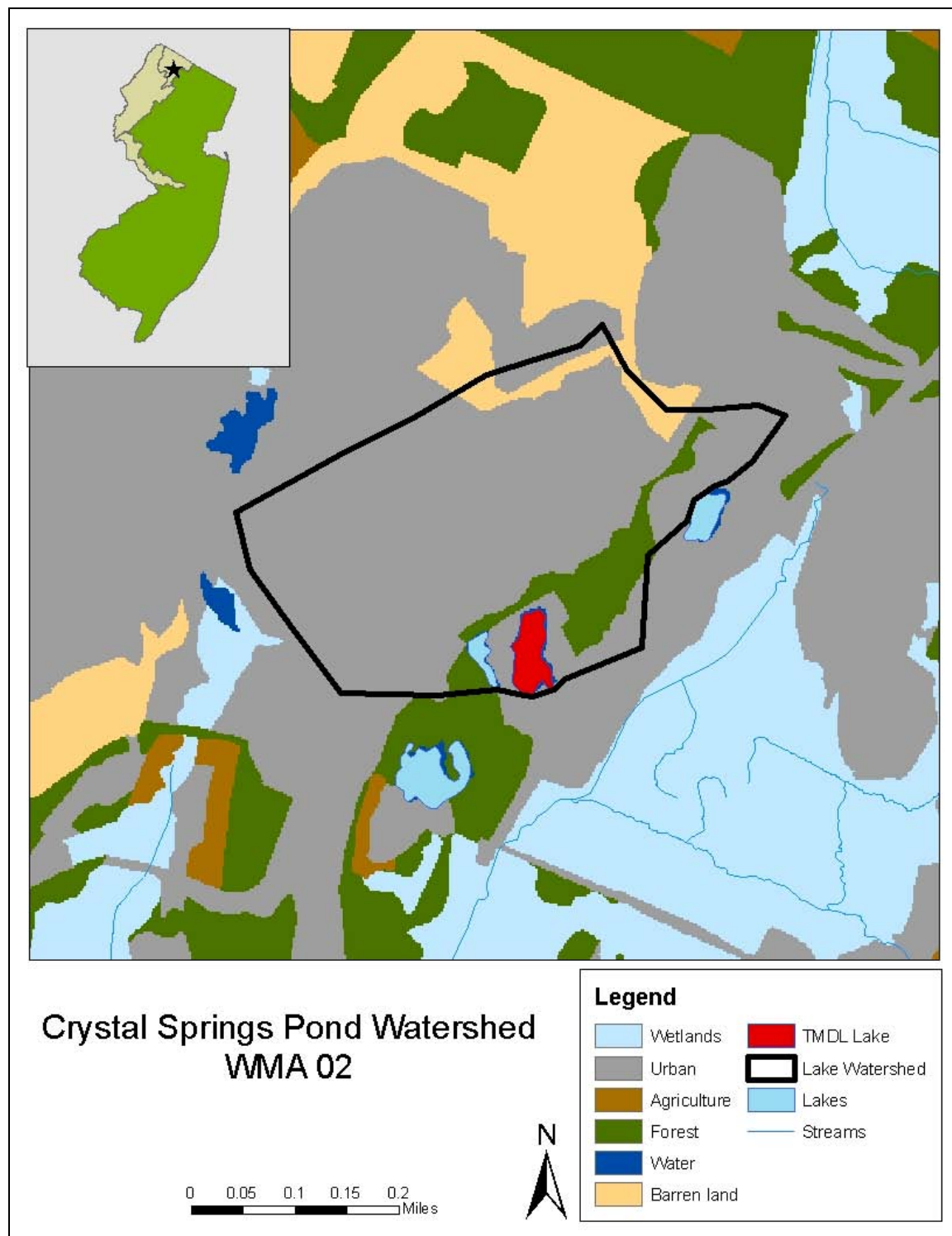


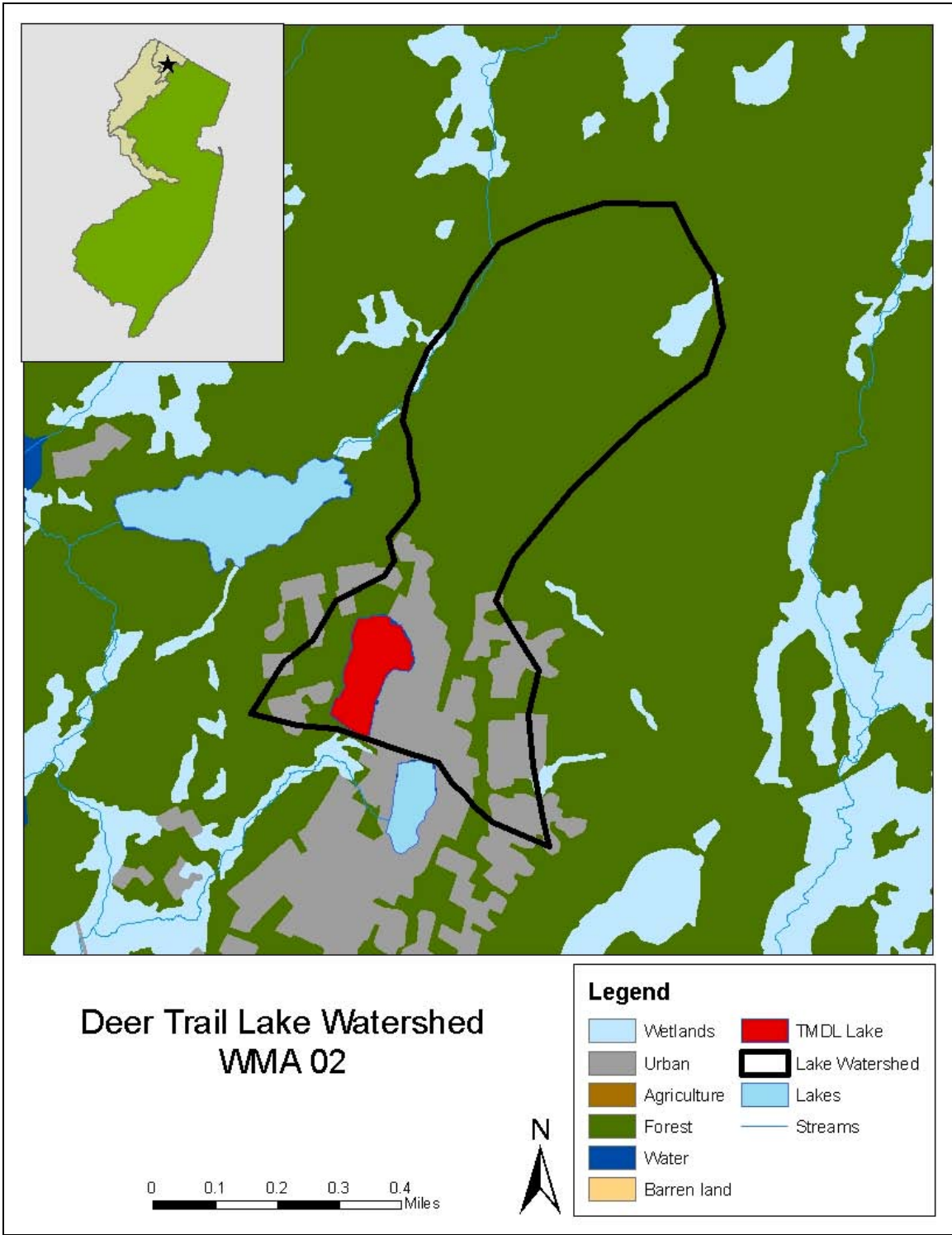


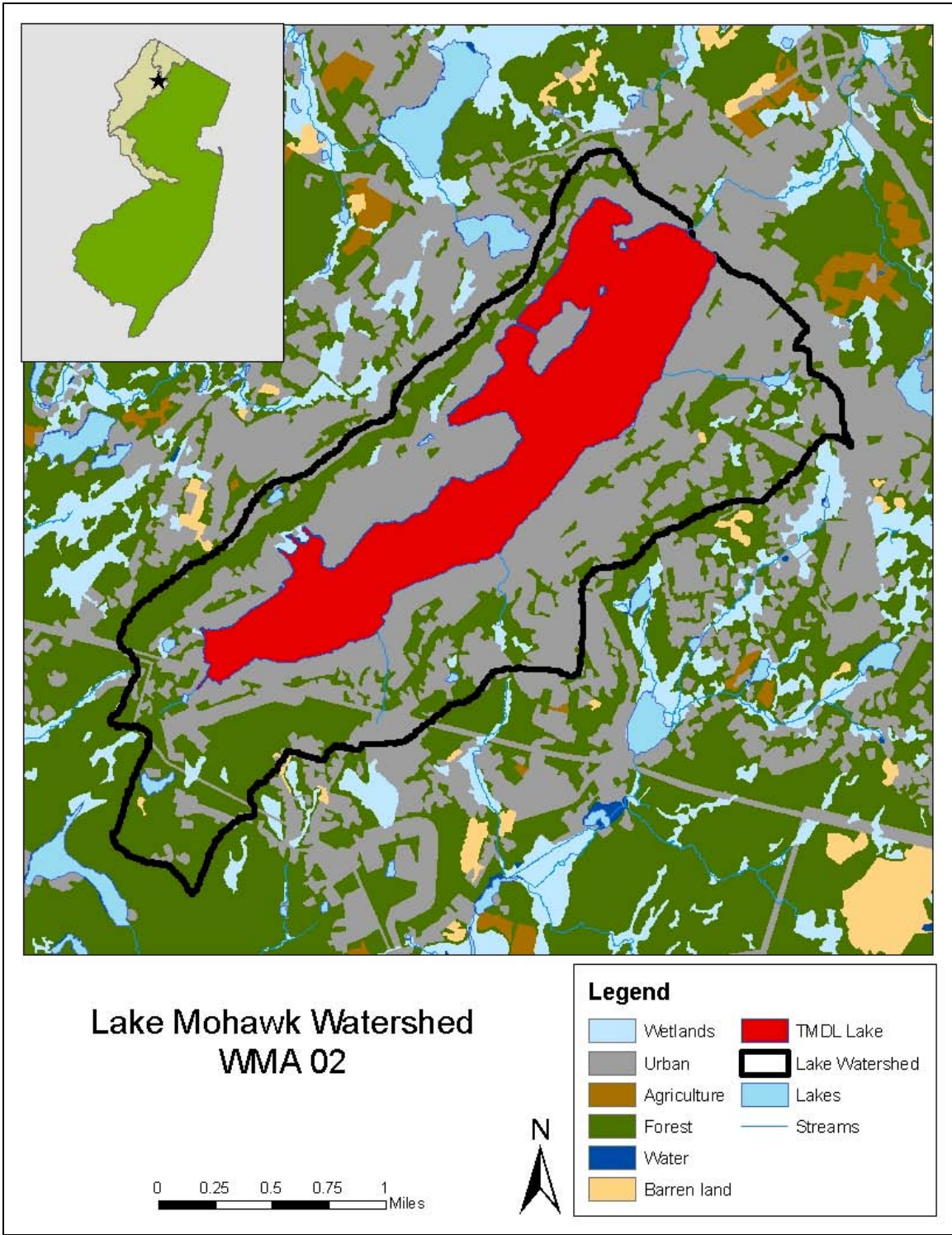


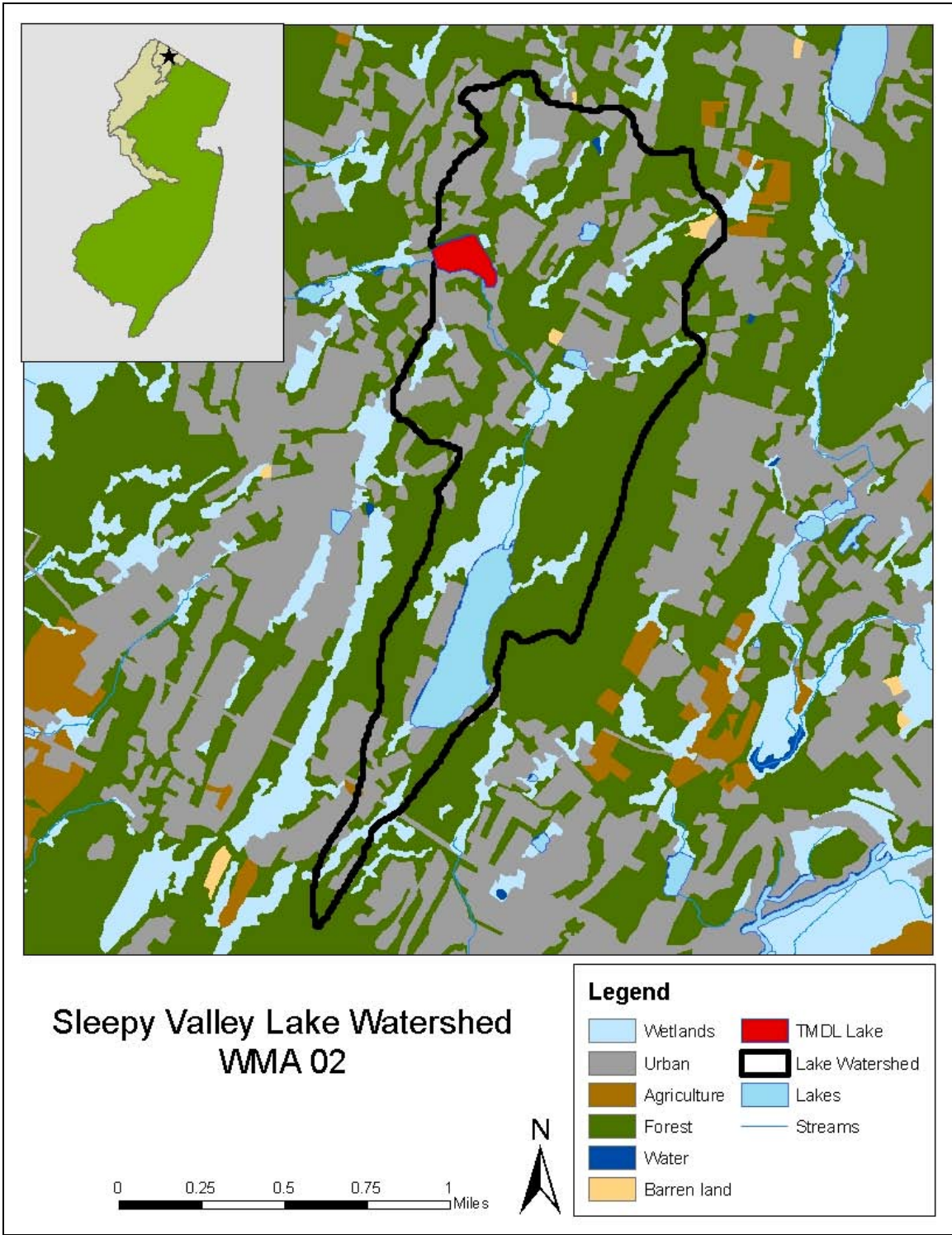












APPENDIX D: NORTHWEST WATER REGION WATER QUALITY DATA

* Highlighted values are greater than 200
cfu/100 ml of fecal coliform bacteria

WMA 01

Forest Lake			
Stats:			
count	333	mean+3stdev	2657
median	10	% Reduction	98%
max	12000		
stdev	834	no data excluded	
mean	154		
mean+3stdev	2657		

DATA			
Station	Date	Value	Remark
SXL190402	05/18/98	2	K
SXL190402	06/03/98	2	K
SXL190402	06/17/98	2	K
SXL190402	07/01/98	30	
SXL190402	07/13/98	50	
SXL190402	07/31/98	30	
SXL190402	08/10/98	98	
SXL190402	08/17/98	1	
SXL190402	09/01/98	20	
SXL190403	05/18/98	2	K
SXL190403	06/03/98	20	
SXL190403	06/17/98	350	
SXL190403	06/20/98	2	K, RESAMPLE
SXL190403	06/22/98	2	K, RESAMPLE

SXL190403	07/01/98	60	
SXL190403	07/13/98	2	K
SXL190403	07/13/98	2	K
SXL190403	07/31/98	30	
SXL190403	07/31/98	2	K
SXL190403	08/14/98	40	
SXL190403	09/01/98	2	K
SXL190404	05/18/98	2	K
SXL190404	06/03/98	2	K
SXL190404	06/17/98	40	
SXL190404	07/01/98	2	K
SXL190404	07/13/98	20	
SXL190404	07/31/98	2	K
SXL190404	08/14/98	2	K
SXL190404	09/01/98	30	
SXL190405	05/18/98	150	
SXL190405	06/03/98	30	
SXL190405	06/17/98	120	
SXL190405	07/01/98	70	
SXL190405	07/13/98	20	
SXL190405	07/31/98	2	K
SXL190405	08/14/98	2	K
SXL190405	09/01/98	2	K
FOREST LAKE: BOARDWALK BEACH	05/24/99	190	
SXL190402	06/11/99	20	
SXL190402	06/18/99	10	K
SXL190402	07/05/99	10	K
SXL190402	07/22/99	20	
SXL190402	08/05/99	10	
SXL190402	08/17/99	10	K
SXL190402	08/02/99	40	
FOREST LAKE: COVE BEACH	05/24/99	10	
SXL190403	06/11/99	10	K

SXL190403	06/18/99	20	
SXL190403	07/05/99	10	K
SXL190403	07/22/99	10	K
SXL190403	08/05/99	10	K
SXL190403	08/17/99	10	K
SXL190403	09/02/99	30	
FOREST LAKE: HARBOR VIEW BEACH	05/24/99	12000	
SXL190404	05/28/99	680	beach closed, RESAMPLE
SXL190404	06/01/99	780	beach closed, RESAMPLE
SXL190404	06/11/99	10	K, RESAMPLE
SXL190404	06/18/99	10	K
SXL190404	06/25/99	10	K
SXL190404	07/05/99	10	K
SXL190404	07/09/99	10	K
SXL190404	07/15/99	10	K
SXL190404	07/22/99	10	
SXL190404	07/26/99	10	
SXL190404	08/05/99	20	
SXL190404	08/13/99	10	K
SXL190404	08/17/99	50	
SXL190404	08/27/99	180	
SXL190404	09/02/99	10	K
FOREST LAKE: MAIN BEACH	05/24/99	130	
SXL190405	06/11/99	160	
SXL190405	06/18/99	10	K
SXL190405	07/05/99	10	K
SXL190405	07/22/99	40	
SXL190405	08/05/99	10	
SXL190405	08/17/99	20	
SXL190405	09/02/99	20	

SXL190402	05/12/00	10	K
SXL190402	06/23/00	10	
SXL190402	06/27/00	10	K
SXL190402	07/05/00	20	
SXL190402	07/11/00	10	K
SXL190402	07/18/00	10	
SXL190402	08/01/00	40	
SXL190402	08/08/00	10	
SXL190402	08/15/00	40	
SXL190402	08/29/00	10	
SXL190403	05/12/00	10	K
SXL190403	06/23/00	10	K
SXL190403	06/27/00	10	K
SXL190403	07/05/00	10	K
SXL190403	07/11/00	20	
SXL190403	07/18/00	10	K
SXL190403	08/01/00	30	
SXL190403	08/08/00	10	K
SXL190403	08/15/00	100	
SXL190403	08/29/00	10	K
SXL190404	05/12/00	70	
SXL190404	06/23/00	10	K
SXL190404	06/27/00	10	K
SXL190404	07/05/00	40	
SXL190404	07/11/00	10	K
SXL190404	07/18/00	30	
SXL190404	08/01/00	20	
SXL190404	08/08/00	30	
SXL190404	08/15/00	20	
SXL190404	08/29/00	10	K
SXL190405	05/12/00	40	
SXL190405	06/23/00	10	K
SXL190405	06/27/00	10	K
SXL190405	07/05/00	10	K
SXL190405	07/11/00	10	K
SXL190405	07/18/00	60	

SXL190405	08/01/00	20	
SXL190405	08/08/00	10	
SXL190405	08/29/00	20	
Boardwalk Beach	05/17/01	10	K
Boardwalk Beach	06/07/01	10	K
Boardwalk Beach	06/15/01	10	K
Boardwalk Beach	06/19/01	10	K
Boardwalk Beach	06/26/01	10	K
Boardwalk Beach	07/12/01	10	K
Boardwalk Beach	07/24/01	10	K
Boardwalk Beach	07/29/01	10	K
Boardwalk Beach	08/01/01	10	K
Boardwalk Beach	08/07/01	10	K
Boardwalk Beach	08/16/01	10	K
Boardwalk Beach	08/23/01	8	
Cove Beach	05/17/01	10	K
Cove Beach	06/07/01	80	
Cove Beach	06/15/01	10	
Cove Beach	06/19/01	20	
Cove Beach	06/26/01	10	
Cove Beach	07/12/01	40	
Cove Beach	07/24/01	10	K
Cove Beach	07/29/01	380	
Cove Beach	08/01/01	10	K
Cove Beach	08/07/01	10	K
Cove Beach	08/16/01	140	
Harbor View Beach	05/17/01	10	K
Harbor View Beach	06/07/01	20	
Harbor View Beach	06/15/01	70	
Harbor View Beach	06/19/01	640	Beach closed voluntarily
Harbor View Beach	06/26/01	200	Beach reopened 6/29
Harbor View Beach	07/12/01	20	

Harbor View Beach	07/24/01	10	K
Harbor View Beach	07/29/01	10	K
Harbor View Beach	08/01/01	20	
Harbor View Beach	08/07/01	70	
Harbor View Beach	08/16/01	2400	Voluntary closure
Harbor View Beach	08/21/01	10	K
Main Beach	05/17/01	10	K
Main Beach	06/07/01	10	K
Main Beach	06/15/01	190	
Main Beach	06/19/01	200	
Main Beach	06/26/01	150	
Main Beach	07/12/01	10	
Main Beach	07/24/01	10	K
Main Beach	07/29/01	10	K
Main Beach	08/01/01	10	K
Main Beach	08/07/01	30	
Main Beach	08/16/01	40	
BOARDWALK BEACH	05/16/02	20	
BOARDWALK BEACH	05/31/02	10	K
BOARDWALK BEACH	06/05/02	50	
BOARDWALK BEACH	06/10/02	10	
BOARDWALK BEACH	06/25/02	10	K
BOARDWALK BEACH	06/28/02	10	
BOARDWALK BEACH	07/02/02	10	
BOARDWALK BEACH	07/15/02	10	K
BOARDWALK BEACH	07/26/02	10	K

BOARDWALK BEACH	07/31/02	10	K
BOARDWALK BEACH	08/13/02	20	
BOARDWALK BEACH	08/15/02	10	K
BOARDWALK BEACH	08/19/02	60	
BOARDWALK BEACH	08/22/02	40	
BOARDWALK BEACH	08/26/02	30	
COVE BEACH	05/16/02	50	
COVE BEACH	05/31/02	260	
COVE BEACH	06/05/02	10	K, RESAMPLE
COVE BEACH	06/10/02	10	
COVE BEACH	06/25/02	100	
COVE BEACH	06/28/02	310	
COVE BEACH	07/02/02	10	RESAMPLE
COVE BEACH	07/15/02	30	
COVE BEACH	07/26/02	10	
COVE BEACH	07/31/02	10	K
COVE BEACH	08/13/02	310	RESAMPLE
COVE BEACH	08/15/02	4900	RESAMPLE, CLOSED
COVE BEACH	08/19/02	40	RESAMPLE
COVE BEACH	08/22/02	130	
COVE BEACH	08/26/02	300	
HARBOR VIEW BEACH	05/16/02	10	K
HARBOR VIEW BEACH	05/31/02	10	
HARBOR VIEW BEACH	06/05/02	260	
HARBOR VIEW BEACH	06/10/02	20	RESAMPLE
HARBOR VIEW BEACH	06/25/02	40	
HARBOR VIEW BEACH	06/28/02	190	
HARBOR VIEW BEACH	07/02/02	30	

HARBOR VIEW BEACH	07/11/02	370	
HARBOR VIEW BEACH	07/15/02	10	RESAMPLE
HARBOR VIEW BEACH	07/26/02	140	
HARBOR VIEW BEACH	07/31/02	10	
HARBOR VIEW BEACH	08/13/02	10	
HARBOR VIEW BEACH	08/15/02	80	
HARBOR VIEW BEACH	08/19/02	160	
HARBOR VIEW BEACH	08/22/02	160	
HARBOR VIEW BEACH	08/26/02	100	
MAIN BEACH	05/16/02	10	K
MAIN BEACH	05/31/02	10	K
MAIN BEACH	06/05/02	100	
MAIN BEACH	06/10/02	30	
MAIN BEACH	06/25/02	220	HEAVY RAINS
MAIN BEACH	07/02/02	100	
MAIN BEACH	07/11/02	10	
MAIN BEACH	07/15/02	10	K
MAIN BEACH	07/26/02	80	
MAIN BEACH	07/31/02	20	
MAIN BEACH	08/13/02	40	
MAIN BEACH	08/15/02	5100	
MAIN BEACH	08/19/02	920	RESAMPLE
MAIN BEACH	08/22/02	200	RESAMPLE
MAIN BEACH	08/26/02	200	RESAMPLE
Forest Lake:Boardwalk Beach	05/30/03	10	K
	06/09/03	10	K
	06/16/03	10	K
	06/24/03	10	K
	06/27/03	10	

	06/30/03	80	
	07/07/03	20	
	07/24/03	10	
	08/11/03	40	
	08/20/03	20	
	08/25/03	60	
Forest Lake:Cove Beach	05/30/03	10	K
	06/09/03	10	K
	06/16/03	10	K
	06/24/03	10	K
	06/27/03	10	
	06/30/03	30	
	07/07/03	10	K
	07/24/03	230	
	07/29/03	10	K
	08/05/03	10	
	08/11/03	230	
	08/20/03	30	
	08/25/03	10	K
Forest Lake:Harborview Beach	05/30/03	40	
	06/09/03	10	K
	06/16/03	10	K
	06/24/03	10	K
	06/27/03	30	
	06/30/03	30	
	07/07/03	50	
	07/24/03	90	
	07/29/03	10	K
	08/05/03	60	
	08/11/03	60	
	08/20/03	3000	
	08/25/03	30	

Forest Lake: Main Beach	05/30/03	10	K
	06/09/03	20	
	06/16/03	70	
	06/24/03	330	
	06/27/03	140	
	06/30/03	70	
	07/07/03	80	
	07/24/03	60	
	07/29/03	10	
	08/05/03	10	
	08/11/03	80	
	08/20/03	10	
	08/25/03	60	
Forest Lake: Boardwalk	05/17/04	10	
	06/02/04	10	K
	06/09/04	1100	
	06/11/04	20	
	06/16/04	80	
	06/23/04	40	
	06/29/04	10	K
	07/06/04	10	K
	07/15/04	10	K
	07/20/04	10	
	07/26/04	10	K
	08/03/04	10	K
	08/10/04	10	K
	08/18/04	10	K
	08/25/04	10	K
Forest Lake: Cove	05/17/04	10	K
	06/02/04	10	K
	06/09/04	40	
	06/11/04	590	
	06/16/04	10	K
	06/23/04	30	

	06/29/04	30	
	07/06/04	40	
	07/15/04	10	K
	07/20/04	10	K
	07/26/04	10	K
	08/03/04	10	K
	08/10/04	10	K
	08/18/04	10	K
	08/25/04	30	
Forest Lake: Harborview	05/17/04	10	K
	06/02/04	40	
	06/09/04	510	preseason testing
	06/11/04	300	preseason testing
	06/16/04	40	
	06/23/04	10	K
	06/29/04	10	
	07/06/04	10	K
	07/15/04	40	
	07/20/04	10	
	07/26/04	10	K
	08/03/04	10	
	08/10/04	10	K
	08/18/04	10	
	08/25/04	110	
Forest Lake: Main	05/17/04	10	
	06/02/04	50	
	06/09/04	4900	
	06/11/04	50	
	06/16/04	90	
	06/23/04	110	
	06/29/04	30	
	07/06/04	40	
	07/15/04	100	
	07/20/04	10	K
	07/26/04	10	K

	08/03/04	30	
	08/10/04	10	K
	08/18/04	10	
	08/25/04	10	

Fox Hollow Lake			
count	116	mean+3stddev	2755
median	20	%reduction	80%
Max	9300		
stdev	868	1 value excluded (9300)	
mean	152	Excluded. Next highest value in dataset is 1000. Also, there was no remark code and resample concentration is 50 (9300 possibly a data entry error)	
mean+3stddev	2755		

STATION	DATE	VALUE	REMARK
SXL115	5/26/1998	10	K
SXL115	6/1/1998	100	
SXL115	6/8/1998	20	
SXL115	6/15/1998	370	
SXL115	6/17/1998	70	RESAMPLE
SXL115	6/22/1998	10	K
SXL115	6/29/1998	10	K
SXL115	7/6/1998	40	
SXL115	7/13/1998	10	K
SXL115	7/20/1998	40	
SXL115	7/27/1998	310	
SXL115	7/29/1998	170	RESAMPLE
SXL115	8/3/1998	40	
SXL115	8/10/1998	10	K
SXL115	8/17/1998	560	
SXL115	8/19/1998	120	RESAMPLE
SXL115	8/24/1998	20	
SXL115	8/31/1998	100	
Fox Hollow	5/24/1999	10	
SXL115	6/1/1999	10	K
SXL115	6/7/1999	10	K
SXL115	6/14/1999	40	
SXL115	6/21/1999	150	
SXL115	6/28/1999	10	
SXL115	7/6/1999	30	

SXL115	7/12/1999	10	K
SXL115	7/19/1999	20	
SXL115	7/26/1999	310	
SXL115	7/28/1999	260	Resample
SXL115	8/2/1999	630	
SXL115	8/4/1999	170	Resample
SXL115	8/9/1999	40	
SXL115	8/16/1999	30	
SXL115	8/23/1999	10	K
SXL115	8/30/1999	50	
Fox Hollow Lake	5/22/2000	70	
SXL115	5/30/2000	10	
SXL115	6/5/2000	10	K
SXL115	6/12/2000	170	
SXL115	6/19/2000	60	
SXL115	6/26/2000	30	
SXL115	7/5/2000	70	
SXL115	7/10/2000	10	K
SXL115	7/17/2000	20	
SXL115	7/24/2000	10	K
SXL115	7/31/2000	170	
SXL115	8/7/2000	9300	
SXL115	8/9/2000	50	Resample
SXL115	8/16/2000	20	
SXL115	8/21/2000	10	
SXL115	8/28/2000	70	
Fox Hollow Lake			
	5/23/2001	170	
	6/4/2001	8	
	6/11/2001	330	
	6/14/2001	112	
	6/18/2001	2	K
	6/25/2001	4	
	7/2/2001	96	
	7/9/2001	28	
	7/16/2001	18	
	7/23/2001	30	
	7/30/2001	40	
	8/6/2001	114	
	8/13/2001	4	
	8/20/2001	30	
	8/27/2001	18	

	5/20/2002	20	
	5/29/2002	20	
	6/3/2002	10	K
	6/10/2002	1000	
	6/14/2002	50	Resample
	6/17/2002	30	
	6/24/2002	360	
	6/26/2002	10	K
	7/1/2002	20	
	7/8/2002	50	
	7/15/2002	10	
	7/22/2002	10	
	7/29/2002	10	K
	8/5/2002	50	
	8/12/2002	10	
	8/19/2002	80	
	8/26/2002	40	
FOX HOLLOW LAKE	5/21/2003	10	
	5/28/2003	40	
	6/2/2003	10	
	6/9/2003	30	
	6/16/2003	260	
	6/18/2003	40	Resample
	6/23/2003	20	
	6/30/2003	140	
	7/7/2003	10	
	7/14/2003	10	K
FOX HOLLOW LAKE	7/21/2003	10	
	7/28/2003	10	
	8/4/2003	30	
	8/11/2003	10	
	8/18/2003	10	K
	8/25/2003	10	K
	5/24/2004	10	K
	6/2/2004	10	K
	6/7/2004	10	K
	6/14/2004	90	
FOX HOLLOW LAKE	6/17/2004	10	K
	6/18/2004	20	
	6/21/2004	10	K
	6/28/2004	10	
	7/7/2004	10	

	7/12/2004	50	
	7/21/2004	10	
	7/26/2004	10	K
	8/2/2004	10	K
	8/9/2004	10	
	8/16/2004	10	
	8/23/2004	50	
	8/30/2004	10	

Furnace Lake			
count	122	mean+3stddev	589
median	30	%reduction	76%
max	840		
stddev	162	no data excluded	
mean	103		
mean+3stddev	589		

STATION	DATE	VALUE	REMARKS
WC3	5/5/1998	160	
WC3	5/26/1998	90	
WC3	6/2/1998	1	
WC3	6/9/1998	10	
WC3	6/16/1998	140	
WC3	6/23/1998	40	
WC3	6/30/1998	260	
WC3	7/7/1998	40	
WC3	7/14/1998	1	
WC3	7/21/1998	1	
WC3	7/28/1998	1	
WC3	8/4/1998	10	
WC3	8/11/1998	50	
WC3	8/18/1998	30	
WC3	8/25/1998	1	
WC3	9/1/1998	10	
WC3	5/11/1999	10	
WC3	5/18/1999	10	
WC3	5/25/1999	30	
WC3	6/1/1999	10	
WC3	6/8/1999	20	
WC3	6/15/1999	90	
WC3	6/22/1999	100	
WC3	6/29/1999	380	
WC3	7/2/1999	10	
WC3	7/6/1999	30	

WC3	7/13/1999	50	
WC3	7/20/1999	190	
WC3	7/27/1999	400	
WC3	7/29/1999	10	
WC3	8/3/1999	10	
WC3	8/10/1999	50	
WC3	8/17/1999	120	
WC3	8/24/1999	20	
WC3	8/31/1999	10	
Furnace Lake Beach	5/16/2000	180	
Furnace Lake Beach	5/23/2000	60	
Furnace Lake Beach	5/30/2000	80	
Furnace Lake Beach	6/5/2000	10	
Furnace Lake Beach	6/12/2000	420	
Furnace Lake Beach	6/14/2000	180	
Furnace Lake Beach	6/19/2000	50	
Furnace Lake Beach	6/27/2000	10	
Furnace Lake Beach	7/3/2000	70	
Furnace Lake Beach	7/10/2000	40	
Furnace Lake Beach	7/20/2000	550	
Furnace Lake Beach	7/24/2000	10	
Furnace Lake Beach	7/27/2000	180	
Furnace Lake Beach	7/31/2000	580	
Furnace Lake Beach	8/3/2000	10	
Furnace Lake Beach	8/7/2000	710	
Furnace Lake Beach	8/9/2000	10	
Furnace Lake Beach	8/15/2000	20	
Furnace Lake Beach	8/21/2000	170	
Furnace Lake Beach	8/28/2000	30	67.45346506

	5/17/2001	10	
	5/24/2001	90	
	5/31/2001	10	
	6/4/2001	10	
	6/11/2001	10	
	6/18/2001	20	
	6/25/2001	10	
	7/2/2001	10	
	7/9/2001	40	
	7/16/2001	10	
	7/23/2001	100	
	7/30/2001	30	
	8/6/2001	840	
	8/8/2001	410	
	8/9/2001	470	
	8/13/2001	10	
	8/13/2001	20	
	8/20/2001	20	
	8/20/2001	130	
	8/27/2001	20	33.73
FURNACE LAKE BEACH	6/24/2002	10	
	7/1/2002	10	
	7/8/2002	10	
	7/15/2002	10	
	7/22/2002	10	
	7/29/2002	10	
	8/5/2002	30	
	7/12/2002	180	
	8/19/2002	10	
	8/26/2002	10	14.90
Furnace Lake Beach	5/12/2003	40	
	5/20/2003	490	
	5/22/2003	10	
	5/27/2003	10	
	6/2/2003	80	
	6/9/2003	120	
	6/16/2003	40	
	6/23/2003	180	
	6/30/2003	30	
	7/7/2003	10	
	7/14/2003	30	
	7/21/2003	30	

	7/28/2003	60	
	8/4/2003	180	
	8/11/2003	100	
	8/18/2003	70	
	8/25/2003	40	51.10
FURNACE LAKE BEACH	05/24/04	40	
	06/01/04	10	
	06/07/04	600	
	06/10/04	10	
	06/16/04	20	
	06/23/04	30	
	06/29/04	10	
	07/06/04	10	
	07/13/04	110	
	07/19/04	120	
	07/29/04	190	
	08/02/04	600	
	0/03/2004	120	
	08/09/04	20	
	08/17/04	20	
	08/23/04	10	
	08/30/04	230	
	08/31/04	270	
	09/01/04	210	
	09/02/04	60	55.66

Green Valley Beach CG			
count	55	mean+3stddev	1855
median	50	% Reduction	91%
max	2000		
stdev	535	no data excluded	
mean	249		
mean+3stddev	1855		

STATION	DATE	VALUE	REMARK
	5/20/2003	10	
	6/26/2003	60	
	8/4/2003	160	
	5/7/2002	4	
	5/21/2002	30	
	5/28/2002	40	

	6/5/2002	10	
	6/11/2002	240	
	6/18/2002	120	RESAMPLE
	6/18/2002	120	
	6/26/2002	150	
	7/3/2002	60	
	7/8/2002	30	
	7/16/2002	30	
	7/23/2002	90	
	7/30/2002	130	
	8/6/2002	50	
	8/13/2002	10	K
	8/20/2002	10	K
	8/27/2002	10	K
	5/22/2001	2000	L not being used
	7/31/2001	10	
	8/7/2001	20	
	8/21/2001	420	Lake not being used
SXL190801	5/24/2000	250	
SXL190801	5/26/2000	10	K
SXL190801	6/1/2000	80	
SXL190801	6/7/2000	180	
SXL190801	6/13/2000	3	
SXL190801	6/21/2000	2000	L
SXL190801	6/26/2000	2000	L, beach closed
SXL190801	6/27/2000	1330	
SXL190801	6/29/2000	1	K, resample beach reopened
SXL190801	7/5/2000	140	
SXL190801	7/11/2000	230	
SXL190801	7/18/2000	130	
SXL190801	7/25/2000	120	
SXL190801	8/1/2000	190	
SXL190801	8/7/2000	10	K
SXL190801	8/8/2000	90	
SXL190801	8/15/2000	10	K
SXL190801	8/22/2000	10	K
SXL190801	12/13/4611	700	
SXL190801	3/3/4612	40	RESAMPLE
SXL190801	3/10/4612	140	
SXL190801	3/17/4612	20	
SXL190801	3/24/4612	NEG	

SXL190801	3/31/4612	2000	L
SXL190801	6/15/4612	10	
SXL190801	6/23/4612	NEG	
SXL190801	6/30/4612	NEG	
SXL190801	7/7/4612	NEG	
SXL190801	9/21/4612	N20	
SXL190801	10/5/4612	10	
SXL190801	10/12/4612	70	
SXL190801	10/19/4612	50	
SXL190801	7/2/1998	40	
SXL190801	8/6/1998	2	K
SXL190801	8/27/1998	20	
SXL190801	9/3/1998	10	

Lake Lackawanna			
count	91	mean+3stdev	1051
median	60	%reduction	93%
max	2700		
stdev	306	no data excluded	
mean	134		
mean+3stdev	1051		

STATION	DATE	VALUE	REMARK
SXL190408	5/30/1998	730	
SXL190408	6/4/1998	90	RESAMPLE
SXL190408	6/5/1998	40	RESAMPLE
SXL190408	6/17/1998	510	
SXL190408	6/23/1998	30	RESAMPLE
SXL190408	6/25/1998	2	K
SXL190408	6/29/1998	90	
SXL190408	7/6/1998	290	
SXL190408	7/8/1998	60	RESAMPLE
SXL190408	7/13/1998	150	
SXL190408	7/20/1998	50	
SXL190408	7/27/1998	50	
SXL190408	8/3/1998	40	
SXL190408	8/10/1998	70	
SXL190408	8/18/1998	130	
SXL190408	8/31/1998	70	
SXL190408	9/1/1998	60	
LAKE LACKAWANNA: SPEERS BEACH	6/9/1999	30	
SXL190408	6/18/1999	20	

SXL190408	6/26/1999	20	
SXL190408	7/7/1999	120	
SXL190408	7/16/1999	10	K
SXL190408	7/22/1999	30	
SXL190408	7/29/1999	60	
SXL190408	8/6/1999	10	K
SXL190408	8/12/1999	60	
SXL190408	8/23/1999	30	
SXL190408	6/7/2000	430	
SXL190408	6/9/2000	10	K
SXL190408	6/22/2000	200	
SXL190408	6/27/2000	770	
SXL190408	7/2/2000	70	
SXL190408	7/14/2000	80	
SXL190408	7/21/2000	50	
SXL190408	8/3/2000	170	
SXL190408	8/8/2000	120	
SXL190408	8/16/2000	20	
SXL190408	8/22/2000	10	K
SXL190408	8/22/2000	10	K
Speers Beach	5/24/2001	2700	not presently in use
Speers Beach	5/30/2001	40	
Speers Beach	6/7/2001	130	
Speers Beach	6/9/2001	50	
Speers Beach	6/12/2001	30	
Speers Beach	6/19/2001	200	
Speers Beach	6/22/2001	40	
Speers Beach	6/29/2001	40	
Speers Beach	7/5/2001	100	
Speers Beach	7/12/2001	220	
Speers Beach	7/16/2001	70	
Speers Beach	7/24/2001	10	
Speers Beach	7/30/2001	10	
Speers Beach	8/7/2001	260	
Speers Beach	8/16/2001	100	
Speers Beach	8/23/2001	50	
Speers Beach	8/23/2001	50	
SPEERS BEACH	5/14/2002	130	
SPEERS BEACH	6/17/2002	170	
SPEERS BEACH	6/25/2002	210	
SPEERS BEACH	7/11/2002	30	
SPEERS BEACH	7/15/2002	30	
SPEERS BEACH	7/26/2002	20	

SPEERS BEACH	7/31/2002	80	
SPEERS BEACH	8/8/2002	30	
SPEERS BEACH	8/20/2002	30	
SPEERS BEACH	8/26/2002	200	
Lake Lackawanna:Speers Beach	5/27/2003	60	
	5/29/2003	200	
	6/17/2003	80	
	6/27/2003	20	
	6/30/2003	360	
	7/2/2003	70	
	7/7/2003	210	
	7/24/2003	80	
	7/28/2003	40	
	8/5/2003	70	
	8/11/2003	30	
Lake Lackawanna: Spears Beach	5/13/2004	90	
	6/9/2004	40	
	6/16/2004	20	
	6/23/2004	480	
	6/29/2004	50	
	7/6/2004	160	
	7/15/2004	70	
	7/20/2004	10	
	7/26/2004	10	
	8/3/2004	20	
	8/3/2004	20	
	8/10/2004	20	
	8/18/2004	40	
	8/25/2004	140	

Lake Hopatcong			
Stats with state Park			
count	825	mean+3stddev	1170
Median	20	%reduction	97%
max	6000		
stdev	357	no data excluded	
mean	98		
mean+3stddev	1170		

STATION	DATE	VALUE	REMARK
SXL191201	06/03/98	2	
SXL191201	06/17/98	5	

SXL191201	07/01/98	12	
SXL191201	07/15/98	1	
SXL191201	07/29/98	3	
SXL191201	08/05/98	1	K
SXL191201	08/19/98	1	
SXL191202	07/01/98	106	
SXL191202	07/15/98	22	
SXL191202	07/29/98	2	
SXL191202	08/12/98	18	
SXL191202	08/26/98	64	
SXL191202	09/09/98	41	
SXL191203	07/08/98	4	
SXL191203	07/22/98	29	
SXL191203	08/05/98	90	
SXL191203	08/19/98	28	
SXL191204	06/03/98	1	
SXL191204	06/17/98	15	
SXL191204	07/01/98	3	
SXL191204	07/15/98	1	K
SXL191204	07/29/98	2	
SXL191204	08/12/98	8	
SXL191204	08/26/98	3	
SXL191205	06/24/98	15	
SXL191205	07/08/98	4	
SXL191205	07/22/98	14	
SXL191205	08/05/98	26	
SXL191207	06/09/98	40	
SXL191207	07/02/98	10	K
SXL191207	07/06/98	30	
SXL191207	07/23/98	100	
SXL191207	08/20/98	10	K
SXL191208	06/09/98	50	
SXL191208	06/25/98	30	
SXL191208	07/02/98	200	
SXL191208	07/06/98	10	K
SXL191208	07/23/98	10	K
SXL191208	08/20/98	10	K
SXL191209	06/09/98	50	
SXL191209	07/02/98	9	
SXL191209	07/06/98	10	K
SXL191209	07/23/98	50	
SXL191209	08/20/98	10	K
SXL191210	07/03/98	20	
SXL191211	07/08/98	500	
SXL191211	07/10/98	168	RESAMPLE

SXL191211	07/22/98	179	
SXL191211	08/26/98	550	
SXL191211	08/28/98	65	RESAMPLE
SXL191212	07/08/98	16	
SXL191212	07/22/98	50	
SXL191212	08/05/98	22	
SXL191212	08/19/98	27	
SXL191213	07/08/98	6	
SXL191213	07/22/98	18	
SXL191213	08/05/98	15	
SXL191213	08/19/98	15	
SXL191213	09/02/98	12	
SXL191214	07/21/98	20	
SXL191214	08/21/98	20	
SXL191215	06/17/98	750	
SXL191215	06/19/98	7	RESAMPLE
SXL191215	07/01/98	875	
SXL191215	07/06/98	122	RESAMPLE
SXL191215	07/15/98	7	
SXL191215	07/22/98	106	
SXL191215	08/05/98	111	
SXL191216	06/24/98	99	
SXL191216	07/08/98	2	K
SXL191216	07/22/98	75	
SXL191216	08/05/98	13	
SXL191216	08/19/98	14	
SXL191217	06/24/98	1900	
SXL191217	06/26/98	2500	RESAMPLE
SPERRY SPRINGS	05/26/99	7	
SXL191201	06/09/99	16	
SXL191201	06/23/99	2	
SXL191201	07/07/99	2	
SXL191201	08/18/99	4	
SHADY LAWN BEACH CLUB	06/09/99	331	
SXL191202	06/10/99	2	RESAMPLE
SXL191202	06/23/99	100	
SXL191202	07/07/99	146	
SXL191202	07/21/99	248	
SXL191202	07/22/99	50	RESAMPLE
SXL191202	08/18/99	98	
SXL191202	09/01/99	44	
BECK LANE PROPERTIES	05/26/99	9	
SXL191204	06/09/99	5	

SXL191204	06/23/99	1	
SXL191204	07/07/99	1	K
SXL191204	08/18/99	2	
SXL191204	09/01/99	18	
ELBA POINT HOMEOWNERS	06/23/99	1	K
SXL191205	07/07/99	10	
SXL191205	08/04/99	17	
WILDWOOD SHORES POA	06/28/99	50	
SXL191207	07/13/99	20	
SXL191207	08/11/99	10	K
SXL191207	08/26/99	220	
WILDWOOD SHORES POA	06/28/99	80	
SXL191208	07/13/99	10	K
SXL191208	08/11/99	10	
SXL191208	08/26/99	340	
WILDWOOD SHORES POA	06/28/99	30	
SXL191209	07/13/99	10	K
SXL191209	08/11/99	10	K
SXL191209	08/26/99	350	
HOPATCONG GARDENS COMM. CLUB	07/01/99	10	
SXL191210	07/09/99	30	
SXL191210	07/18/99	10	
SXL191210	07/24/99	10	K
SXL191210	07/30/99	1800	
SXL191210	08/12/99	10	
SXL191210	08/29/99	30	
CRESCENT COVE	06/24/99	76	
SXL191211	07/07/99	212	
SXL191211	07/09/99	1	RESAMPLE K
SXL191211	07/22/99	1	K
SXL191211	08/04/99	1	K
SXL191211	08/18/99	102	
RANDAL BEACH CLUB	07/07/99	18	
SXL191213	07/21/99	18	
SXL191213	08/04/99	5	
SXL191213	08/18/99	1	K
SXL191213	09/01/99	54	
DOX INC	07/01/99	10	
SXL191214	08/19/99	120	
INGRAM COVE	06/09/99	130	

COMMUNITY			
SXL191215	06/16/99	1	K
SXL191215	06/30/99	394	
SXL191215	07/14/99	36	RESAMPLE
SXL191215	07/28/99	68	
HOMESTEAD BEACH	06/23/99	21	
SXL191216	07/07/99	12	
SXL191216	07/22/99	18	
SXL191216	08/04/99	36	
SXL191216	08/18/99	114	
SHAWNEE DOCK ASSOCIATION	08/12/99	10	K
SXL191218	08/19/99	10	
SXL191218	08/29/99	50	
BYRAM BAY COMMUNITY CLUB	06/10/99	64	
SXL191219	07/08/99	200	L
SXL191219	07/12/99	28	RESAMPLE
SXL191219	07/29/99	20	
COLONY CLUB	06/30/99	24	
SXL191220	07/14/99	1	K
SXL191220	07/28/99	1	K
SXL191220	08/11/99	1	K
SXL191220	08/25/99	6	
SXL191220	09/08/99	6	
SPERRY SPRINGS	05/24/00	10	K
SXL191201	06/07/00	60	
SXL191201	06/21/00	70	
SXL191201	07/05/00	10	K
SXL191201	07/19/00	10	
SXL191201	08/02/00	120	
SXL191201	08/16/00	90	
SHADY LAWN BEACH CLUB	06/05/00	30	
SXL191202	06/19/00	10	K
SXL191202	07/05/00	20	
SXL191202	07/17/00	520	
SXL191202	08/07/00	40	
SXL191202	08/21/00	30	
SXL191202	08/28/00	1600	TNTC
SXL191202	08/30/00	10	K
BECK LANE PROPERTIES	05/24/00	20	
SXL191204	06/07/00	20	
SXL191204	06/21/00	20	
SXL191204	07/05/00	10	K

SXL191204	07/19/00	10	K
SXL191204	08/02/00	1200	
SXL191204	08/07/00	370	
SXL191204	08/16/00	450	
SXL191204	08/28/00	10	K
ELBA POINT HOMEOWNERS	06/05/00	2	
SXL191205	06/20/00	8	
SXL191205	07/03/00	16	
SXL191205	07/19/00	2	K
SXL191205	08/01/00	48	
SXL191205	08/15/00	152	
SXL191205	08/29/00	12	
WILDWOOD SHORES POA Pebble	07/14/00	10	
SXL191207	07/30/00	40	
SXL191207	08/01/00	10	K
SXL191207	08/09/00	20	
SXL191207	08/17/00	10	
SXL191207	08/25/00	10	K
SXL191207	08/30/00	10	K
WILDWOOD SHORES POA lines	07/14/00	10	K
SXL191208	08/09/00	50	
SXL191208	08/17/00	20	
SXL191208	08/25/00	10	
SXL191208	08/30/00	10	
WILDWOOD SHORES POA Bass Rock	07/14/00	10	K
SXL191209	08/09/00	10	K
SXL191209	08/17/00	10	K
SXL191209	08/25/00	10	
SXL191209	08/30/00	10	K
HOPATCONG GARDENS COMM. CLUB	06/04/00	30	
SXL191210	06/21/00	20	
SXL191210	07/01/00	20	
SXL191210	07/21/00	70	
SXL191210	08/17/00	60	
CRESCENT COVE	06/29/00	288	
SXL191211	07/05/00	28	
SXL191211	07/19/00	24	
SXL191211	08/03/00	164	
SXL191211	08/21/00	44	
RANDAL BEACH CLUB	06/28/00	10	

SXL191213	07/12/00	20	
SXL191213	07/26/00	10	K
SXL191213	08/09/00	10	K
SXL191213	08/21/00	40	
DOX INC	07/02/00	150	
SXL191214	07/21/00	10	K
SXL191214	08/17/00	10	
SXL191214	08/22/00	10	K
INGRAM COVE COMMUNITY	05/25/00	144	
SXL191215	06/05/00	114	
SXL191215	06/20/00	20	
SXL191215	07/03/00	14	
SXL191215	07/19/00	28	
SXL191215	08/01/00	364	
SXL191215	08/03/00	280	
SXL191215	08/08/00	44	
SXL191215	08/15/00	184	
SXL191215	08/29/00	192	
HOMESTEAD BEACH	06/09/00	32	
SXL191216	06/21/00	20	
SXL191216	07/05/00	88	
SXL191216	07/19/00	64	
SXL191216	08/02/00	40	
SXL191216	08/21/00	112	
SHAWNEE DOCK ASSOCIATION	07/02/00	10	K
SXL191218	07/08/00	20	
SXL191218	07/21/00	50	
SXL191218	07/30/00	10	K
SXL191218	08/17/00	20	
SXL191218	08/22/00	100	
BYRAM BAY COMMUNITY CLUB	05/24/00	22	
SXL191219	06/22/00	76	
SXL191219	08/03/00	20	
SXL191219	08/17/00	40	
COLONY CLUB	07/19/00	10	
SXL191220	08/02/00	70	
SXL191220	08/16/00	500	followed flood conditions
SXL191220	08/28/00	160	
	06/05/01	10	K
	06/09/01	10	K

	06/19/01	70	
	06/25/01	80	
	07/12/01	50	
	07/16/01	20	
	07/30/01	20	
	08/06/01	10	K
	06/11/01	10	
	06/25/01	120	
	07/09/01	50	
	07/23/01	40	
	08/06/01	50	
	08/20/01	110	
	05/30/01	30	
	06/13/01	10	K
	06/27/01	20	
	07/10/01	200	
	07/25/01	10	K
	08/08/01	200	
	08/22/01	10	
	06/15/01	148	
	06/21/01	2	
	07/03/01	92	
	07/19/01	22	
	08/02/01	4	
	08/13/01	68	
Pebble Beach Ave	05/29/01	40	
Pebble Beach Ave	06/10/01	10	
Pebble Beach Ave	06/27/01	10	
Pebble Beach Ave	07/12/01	10	
Pebble Beach Ave	07/17/01	30	
Pebble Beach Ave	07/25/01	10	K
Pebble Beach Ave	08/03/01	10	K
Lines Ave	05/29/01	10	K
Lines Ave	06/10/01	210	
Lines Ave	07/12/01	20	
Lines Ave	07/17/01	10	K
Lines Ave	07/25/01	20	
Lines Ave	08/03/01	10	K
Lines Ave	08/16/01	40	

Bass Rock Road	05/29/01	30	
Bass Rock Road	06/10/01	20	
Bass Rock Road	06/27/01	10	K
Bass Rock Road	07/12/01	10	K
Bass Rock Road	07/17/01	10	
Bass Rock Road	07/25/01	10	
Bass Rock Road	08/03/01	10	K
Bass Rock Road	08/16/01	40	
	05/29/01	20	
	05/24/01	3	
	07/02/01	30	
	07/18/01	10	
	08/01/01	10	
	08/15/01	210	
	08/29/01	50	
	05/29/01	70	
	06/05/01	80	
	06/09/01	30	
	06/19/01	10	
	07/05/01	10	K
	07/30/01	10	K
	08/23/01	10	
	06/05/01	20	
	06/09/01	10	K
	06/19/01	110	
	06/25/01	150	
	07/05/01	70	
	07/12/01	40	
	07/16/01	10	K
	07/30/01	60	
	08/06/01	420	
	08/23/01	250	
	06/26/01	28	
	07/12/01	72	
	07/24/01	12	
	08/08/01	54	
	08/22/01	40	
	05/29/01	40	
	06/05/01	10	
	06/09/01	10	K
	06/19/01	40	
	06/25/01	60	
	07/05/01	20	
	07/12/01	20	
	07/16/01	10	K

	08/07/01	10	K
	08/23/01	10	K
	06/21/01	2	
	07/10/01	7	
	07/31/01	13	
	08/21/01	6	
	06/20/01	10	
	07/02/01	600	
	07/09/01	30	
	07/18/01	10	K
	08/01/01	20	
	08/15/01	530	
	08/29/01	810	
MAXIM DRIVE	05/28/02	10	K
MAXIM DRIVE	05/31/02	60	
MAXIM DRIVE	06/06/02	930	
MAXIM DRIVE	06/09/02	10	
MAXIM DRIVE	06/17/02	40	
MAXIM DRIVE	06/25/02	60	
MAXIM DRIVE	07/05/02	50	
MAXIM DRIVE	07/08/02	40	
MAXIM DRIVE	07/15/02	10	K
MAXIM DRIVE	08/12/02	10	K
MAXIM DRIVE	08/20/02	20	
W. SHORE DRIVE	06/26/02	50	
W. SHORE DRIVE	07/01/02	10	K
W. SHORE DRIVE	07/10/02	TNTC	
W. SHORE DRIVE	07/12/02	50	
W. SHORE DRIVE	07/24/02	70	
W. SHORE DRIVE	08/07/02	60	
W. SHORE DRIVE	08/21/02	17	
108 MAXIM DRIVE	06/03/02	20	
108 MAXIM DRIVE	06/17/02	70	
108 MAXIM DRIVE	07/01/02	10	K
108 MAXIM DRIVE	07/15/02	10	K
108 MAXIM DRIVE	07/29/02	4	

108 MAXIM DRIVE	08/12/02	10	K
ITHANELL ROAD	05/31/02	150	
ITHANELL ROAD	06/09/02	20	
ITHANELL ROAD	06/17/02	10	K
ITHANELL ROAD	06/25/02	20	
ITHANELL ROAD	07/05/02	5600	
ITHANELL ROAD	07/08/02	100	
ITHANELL ROAD	07/15/02	10	
ITHANELL ROAD	08/26/02	140	
19 PEBBLE BCH RD	06/08/02	30	
19 PEBBLE BCH RD	06/17/02	10	
19 PEBBLE BCH RD	07/05/02	40	
19 PEBBLE BCH RD	07/09/02	30	
19 PEBBLE BCH RD	07/16/02	10	
19 PEBBLE BCH RD	07/24/02	10	K
19 PEBBLE BCH RD	07/31/02	10	
19 PEBBLE BCH RD	08/07/02	10	K
19 PEBBLE BCH RD	08/15/02	60	
19 PEBBLE BCH RD	08/20/02	240	
19 PEBBLE BCH RD	08/27/02	10	K
31 LINES AVENUE	06/08/02	10	K
31 LINES AVENUE	06/17/02	30	
31 LINES AVENUE	07/05/02	70	
31 LINES AVENUE	07/09/02	310	
31 LINES AVENUE	07/12/02	50	
31 LINES	07/24/02	10	K

AVENUE			
31 LINES AVENUE	07/31/02	10	
31 LINES AVENUE	08/15/02	30	
31 LINES AVENUE	08/20/02	180	
31 LINES AVENUE	08/27/02	20	
3 BASS LAKE ROAD	06/08/02	80	
3 BASS LAKE ROAD	06/17/02	20	
3 BASS LAKE ROAD	06/26/02	60	
3 BASS LAKE ROAD	07/05/02	10	K
3 BASS LAKE ROAD	07/09/02	20	
3 BASS LAKE ROAD	07/16/02	10	K
3 BASS LAKE ROAD	07/24/02	10	K
3 BASS LAKE ROAD	07/31/02	80	
3 BASS LAKE ROAD	08/15/02	20	
3 BASS LAKE ROAD	08/20/02	100	
3 BASS LAKE ROAD	08/27/02	10	K
	06/14/02	240	
	06/18/02	122	
	06/24/02	139	
	07/01/02	330	
	07/03/02	460	
	07/08/02	105	
	07/15/02	91	
	07/24/02	200	
	07/29/02	100	
	08/01/02	34	
	08/01/02	1	K
	08/12/02	210	
	08/19/02	60	
	08/26/02	200	
	08/29/02	600	L
	07/05/02	20	
	07/08/02	10	K
	07/26/02	10	K

	07/31/02	40	
	08/12/02	10	K
	08/26/02	50	
COVE ROAD	05/31/02	10	
COVE ROAD	06/06/02	980	
COVE ROAD	06/09/02	10	
COVE ROAD	06/25/02	40	
COVE ROAD	07/05/02	160	
COVE ROAD	07/08/02	160	
COVE ROAD	07/31/02	40	
COVE ROAD	08/12/02	10	
COVE ROAD	08/20/02	240	
COVE ROAD	08/26/02	140	
MARINERS ROAD	06/11/02	18	
MARINERS ROAD	06/21/02	86	
MARINERS ROAD	07/10/02	150	
MARINERS ROAD	07/23/02	62	
MARINERS ROAD	08/08/02	24	
MARINERS ROAD	08/21/02	68	
18 CHINCOPEE AVE	06/04/02	10	
18 CHINCOPEE AVE	06/17/02	10	K
18 CHINCOPEE AVE			INACTIVE
	05/22/02	4	
	06/07/02	122	
	06/27/02	12	
	07/12/02	22	
	07/30/02	5	
	08/09/02	17	
	08/28/02	18	
Sperry Springs-Maxim Drive	05/29/03	10	K
	06/03/03	10	
	06/09/03	30	
	06/24/03	40	
	06/30/03	40	
	07/07/03	10	K
	07/14/03	40	
	07/21/03	30	
	07/28/03	10	K

	08/05/03	10	K
	08/11/03	10	K
	08/18/03	10	K
	08/25/03	10	
Shady Lawn Beach Club	07/02/03	10	K
	07/16/03	70	
	07/30/03	20	
	08/13/03	380	
	08/18/03	160	
	08/27/03	20	
Beck Lane Properties	05/28/03	10	
	06/11/03	110	
	06/25/03	10	
	07/08/03	10	K
	07/23/03	70	K
	08/06/03	30	
	08/20/03	12	
Elba Point Homeowners	05/14/03	10	
	05/30/03	10	K
	06/03/03	10	
	06/09/03	10	K
	06/24/03	20	
	06/30/03	10	K
	07/07/03	6000	L
	07/09/03	10	K
	07/14/03	20	
	07/21/03	20	
	07/28/03	10	
	08/05/03	310	
	08/08/03	110	
	08/11/03	130	
	08/18/03	20	
	08/25/03	10	K
Wildwood Shores POA Pebble Beach Rd	05/30/03	10	K
	06/03/03	70	
	06/09/03	10	
	06/27/03	10	K
	07/21/03	150	
	08/13/03	10	K
Wildwood	05/30/03	10	

Shores POA Lines Ave			
	06/03/03	50	
	09/06/03	10	K
	06/27/03	10	
	07/21/03	50	
	08/13/03	10	K
Wildwood Shores POA Bass Lake Rd	05/30/03	20	
	06/03/03	40	
	06/09/03	10	
	06/27/03	10	K
	07/21/03	40	
	08/13/03	30	
Crescent Cove	06/03/03	180	
	06/27/03	190	
	07/01/03	260	
	07/03/03	600	K
	07/07/03	10	L
	07/15/03	500	
	07/17/03	20	
	07/22/03	10	
	07/28/03	70	
	08/04/03	110	
	08/12/03	60	K
	08/18/03	20	
	08/25/03	20	
DOX Inc.	07/07/03	10	K
	07/14/03	20	
	07/21/03	10	K
	07/28/03	10	
	08/05/03	10	
	08/11/03	10	K
	08/18/03	20	
	08/25/03	20	
Ingram Cove Community	05/29/03	210	
	06/03/03	10	K
	06/09/03	20	
	06/24/03	10	K
	06/30/03	40	
	07/07/03	30	
	07/14/03	100	
	07/21/03	70	
	07/28/03	90	

	08/05/03	450	
	08/11/03	300	
	08/18/03	20	
	08/25/03	140	
Homestead Beach	06/23/03	20	
	07/08/03	82	
	07/25/03	144	
	08/13/03	94	
	08/25/03	20	
Byram Bay Community	06/06/03	34	
	07/03/03	36	
	07/18/03	32	
	08/06/03	52	
	08/20/03	53	
	08/29/03	13	
Sperry Springs	06/16/04	2100	
	06/18/04	10	
	06/23/04	10	
	06/29/04	280	
	07/01/04	10	K
	07/06/04	10	K
	07/15/04	90	
	07/20/04	30	
	07/26/04	50	
	08/03/04	10	K
	08/10/04	40	
	08/18/04	10	
	08/25/04	40	
Shady Lawn	06/02/04	20	
	06/16/04	10	K
	06/30/04	20	
	07/14/04	100	K
	07/28/04	20	
	08/11/04	20	
	08/25/04	40	
Beck Lane	05/17/04	10	
	06/02/04	20	
	06/16/04	10	K
	06/30/04	10	
	07/14/04	10	
	07/28/04	10	K
	08/11/04	10	K
	08/25/04	20	

Elba Point	05/17/04	10	
	06/02/04	20	
	06/22/04	20	
	06/30/04	20	
	07/14/04	10	K
	07/28/04	10	
	08/11/04	40	
	08/25/04	10	
Wildwood Shores Pebble Beach	06/01/04	10	
	06/10/04	10	K
	06/14/04	10	K
	06/22/04	10	
	07/07/04	10	K
	07/20/04	10	K
	08/02/04	10	K
	08/19/04	10	
	08/30/04	10	K
Wildwood Shores Lines Ave	06/01/04	10	K
	06/10/04	30	
	06/14/04	10	
	06/22/04	20	
	07/07/04	20	
	07/20/04	50	
	08/02/04	90	
	08/19/04	30	
	08/30/04	10	K
Wildwood Shores Bass Rock Lane	06/10/04	10	K
	06/14/04	10	
	06/22/04	10	
	07/07/04	10	K
	07/20/04	10	K
	08/02/04	10	K
	08/19/04	10	
	08/30/04	10	K
Crescent Cove	07/15/04	600	L
	07/07/04	70	
	07/15/04	600	L
	07/20/04	200	
	07/29/04	110	
	08/02/04	20	

	08/09/04	100	
	08/17/04	40	
	08/24/04	130	
Dox Inc.	07/06/04	10	K
	07/20/04	40	
	08/03/04	10	K
	08/18/04	10	
Ingram Cove Community	06/16/04	20	
	06/23/04	380	
	06/29/04	100	
	07/06/04	1	K
	07/15/04	40	
	07/20/04	130	
	07/23/04	130	
	07/26/04	430	
	08/10/04	40	
	08/25/04	120	
Homestead Beach	06/21/04	14	
	07/06/04	311	
	07/08/04	66	
	07/19/04	156	
	08/03/04	38	
	08/16/04	18	
Byram Beach Community Club	05/26/04	36	
	06/09/04	48	
	07/08/04	7	
	07/23/07	18	
	08/11/04	23	
Beach Center	08/26/04	26	
	05/18/98	16	
	05/26/98	10	
	06/01/98	60	
	06/08/98	6	
	06/15/98	2	
	06/22/98	1	
	06/29/98	12	
	07/06/98	1	K
	07/13/98	29	
	07/20/98	4	
	07/27/98	1	K
	08/03/98	46	
	08/10/98	24	

	08/17/98	6	
	08/24/98	4	
	08/31/98	23	
Beach Center	05/22/00	10	
Beach Center	05/30/00	1	
Beach Center	06/05/00	1	
Beach Center	06/12/00	110	
Beach Center	06/19/00	4	
Beach Center	06/26/00	52	
Beach Center	07/05/00	18	
Beach Center	07/10/00	52	
Beach Center	07/17/00	5	
Beach Center	07/24/00	110	
Beach Center	07/31/00	11	
Beach Center	08/07/00	1	
Beach Center	08/16/00	69	
Beach Center	08/21/00	1700	
Beach Center	08/23/00	52	
Beach Center	08/28/00	7	
	05/21/01	1	k
	05/29/01	6	
	06/04/01	3	
	06/11/01	7	
	06/18/01	5	
	06/25/01	2	
	07/02/01	22	
North	05/21/02	3	
North	05/31/02	9	
North	06/04/02	280	
North	06/06/02	1100	
North	06/07/02	390	
North	06/10/02	11	
North	06/18/02	14	
North	06/24/02	158	
North	07/02/02	100	
North	07/05/02	36	
North	07/08/02	101	
North	07/19/02	2380	
North	07/26/02	10	k
North	08/02/02	290	
North	08/05/02	10	
North	08/09/02	60	
North	08/16/02	80	
North	08/23/02	20	
North	08/30/02	110	

South	07/05/02	1	k
South	07/19/02	320	
South	07/26/02	10	k
South	08/02/02	360	
South	08/05/02	20	
South	08/09/02	40	
South	08/16/02	10	
South	08/23/02	70	
South	08/30/02	40	
North	05/23/03	10	
North	05/27/03	10	
North	06/02/03	10	
North	06/09/03	10	
North	06/16/03	10	
North	06/23/03	10	
North	07/01/03	70	
North	07/07/03	10	
North	07/15/03	20	
North	07/22/03	50	
North	07/28/03	20	
North	08/04/03	100	
North	08/18/03	20	
North	08/25/03	60	
South	05/23/03	10	
South	05/27/03	10	
South	06/02/03	10	
South	06/09/03	10	
South	06/16/03	10	
South	06/23/03	80	
South	07/01/03	200	
South	07/07/03	50	
South	07/15/03	10	
South	07/22/03	80	
South	07/28/03	10	
South	08/04/03	10	
South	08/18/03	10	
South	08/25/03	10	
North	05/18/04	10	
	05/24/04	20	
	06/03/04	10	k
	06/10/04	30	
	06/14/04	20	
	06/22/04	100	
	06/29/04	200	
	07/07/04	50	

	07/13/04	600	L
	07/14/04	50	
	07/20/04	180	
	07/26/04	10	k
	08/02/04	50	
	08/09/04	10	k
	08/17/04	20	
	08/23/04	30	
	08/30/04	10	
South	05/18/04	30	
	05/24/04	20	
	06/03/04	10	k
	06/10/04	10	
	06/14/04	30	
	06/22/04	30	
	06/29/04	150	
	07/07/04	90	
	07/13/04	70	
	07/20/04	330	
	07/23/04	30	
	07/26/04	10	k
	08/02/04	30	
	08/09/04	20	
	08/17/04	80	
	08/23/04	40	
	08/30/04	60	
North	08/29/05	70	
	08/22/05	10	k
	08/15/05	90	
	08/08/05	210	
	08/10/05	80	resample
	08/01/05	110	
	07/25/05	80	
	07/18/05	70	
	07/11/05	20	
	07/05/05	70	
	06/30/05	70	
	06/23/05	60	
	06/13/05	10	
	04/09/08	10	
	06/06/05	40	
	06/01/05	10	k
	05/26/05	10	k
	05/24/05	80	
	05/16/05	10	k

South	08/29/05	70	
	08/22/05	80	
	08/15/05	110	
	08/08/05	290	
	08/10/05	160	resample
	08/01/05	60	
	07/25/05	110	
	07/18/05	160	
	07/11/05	40	
	07/05/05	30	
	06/30/05	70	
	06/23/05	20	
	06/13/05	10	
	06/06/05	10	k
	06/01/05	10	k
	05/26/05	10	k
	05/24/05	530	
	05/16/05	10	

Lake Winona			
count	48	mean+3stdev	6920
median	75	% Reduction	98%
max	10000		
Stdev	2046	no data excluded	
mean	781		
mean+3stdev	6920		

Station	Date	Value	Remarks
Lake Winona Civic Association	06/22/99	10	
	06/29/99	14	
	07/08/99	3	
	07/15/99	44	
	07/19/99	4	
	07/26/99	26	
	08/04/99	1	
	08/09/99	1	K
	08/16/99	106	
	08/23/99	408	
	09/03/99	4	
	06/25/02	100	
	07/05/02	10	
	07/09/02	360	

	07/11/02	10	k
	07/15/02	90	
	07/26/02	20	
	07/31/02	130	
	08/13/02	10	k
	08/20/02	240	
	08/22/02	90	
	08/26/02	60	
Lake Winona Civic Association	05/30/03	550	
	06/03/03	100	
	06/09/03	90	
	06/15/03	90	
	06/24/03	40	
	06/30/03	10	k
	07/07/03	10	
	07/14/03	30	
	07/21/03	50	
	07/28/03	20	
	08/05/03	350	
	08/18/03	30	
	08/25/03	10	k
Lake Winona Civic Association	06/16/04	450	
	06/17/04	60	
	06/25/04	240	
	06/29/04	6700	
	07/01/04	10000	
	07/15/04	550	
	07/20/04	440	
	07/22/04	1100	
	07/26/04	50	
	08/03/04	6000	
	08/10/04	6000	
	08/18/04	300	
	08/25/04	2500	

WMA 02

Crystal Springs			
count	9	mean+3stdev	988
Median	250	%reduction	74%

Max	770		
stdev	254	no data excluded	
mean	227		
mean+3stdev	988		

STATION	DATE	VALUE	REMARK
SXHR136	07/27/00	770	
SXHR136	08/03/00	360	
SXHR136	08/14/00	250	
SXHR136	08/16/00	300	Resample
SXHR136	08/24/00	320	
SXHR136	08/29/00	10	
SXLHR136	06/08/99	10	K
SXLHR136	06/30/99	10	K
SXLHR136	08/04/99	10	K

Deer Trail Lake			
count	16	mean+3stdev	653
Median	7	%reduction	73%
Max	738		
stdev	190	no data excluded	
mean	84		
mean+3stdev	653		

STATION	DATE	VALUE	REMARK
SXL191112	07/07/98	1	
SXL191112	07/13/98	2	
SXL191112	07/28/98	5	
SXL191112	08/04/98	7	
SXL191112	08/11/98	9	
SXL191112	09/02/98	1	
	07/02/01	180	
	07/10/01	6	
	07/17/01	12	
	07/24/01	26	
	07/31/01	258	
	08/03/01	738	
	08/07/01	2	K
	08/15/01	82	
	08/22/01	2	K
	08/27/01	6	

Lake Mohawk			

count	1134	mean+3stddev	1516
median	20	% Reduction	98%
max	11000		
Stdev	476	no data excluded	
mean	89		
mean+3stddev	1516		

STATION	DATE	VALUE	REMARK
SXL102	05/18/98	10	K
SXL102	05/26/98	10	K
SXL102	06/01/98	210	
SXL102	06/03/98	10	K, RESAMPLE
SXL102	06/08/98	10	K
SXL102	06/15/98	50	
SXL102	06/22/98	10	K
SXL102	06/29/98	10	K
SXL102	07/06/98	10	K
SXL102	07/13/98	1200	
SXL102	07/16/98	30	RESAMPLE
SXL102	07/20/98	50	
SXL102	07/27/98	60	
SXL102	08/03/98	10	K
SXL102	08/10/98	280	
SXL102	08/12/98	90	RESAMPLE
SXL102	08/17/98	10	K
SXL102	08/24/98	100	
SXL102	08/31/98	220	
SXL102	09/02/98	60	
SXL103	05/18/98	30	
SXL103	05/26/98	10	K
SXL103	06/01/98	50	
SXL103	06/08/98	10	K
SXL103	06/15/98	10	K
SXL103	06/22/98	30	
SXL103	06/29/98	10	K
SXL103	07/06/98	10	K
SXL103	07/13/98	10	K
SXL103	07/20/98	10	K
SXL103	07/27/98	10	K
SXL103	08/03/98	10	K
SXL103	08/10/98	10	K
SXL103	08/17/98	10	K
SXL103	08/24/98	10	K
SXL103	08/31/98	10	K
SXL104	05/18/98	20	
SXL104	05/26/98	10	K

SXL104	06/01/98	100	
SXL104	06/08/98	10	K
SXL104	06/15/98	50	
SXL104	06/22/98	10	K
SXL104	06/29/98	10	K
SXL104	07/06/98	10	K
SXL104	07/13/98	30	
SXL104	07/20/98	40	
SXL104	07/27/98	20	
SXL104	08/03/98	10	K
SXL104	08/10/98	10	K
SXL104	08/17/98	10	K
SXL104	08/24/98	10	K
SXL104	08/31/98	10	K
SXL105	05/18/98	20	
SXL105	05/26/98	10	K
SXL105	06/01/98	650	
SXL105	06/03/98	40	RESAMPLE
SXL105	06/08/98	10	K
SXL105	06/15/98	20	
SXL105	06/22/98	20	
SXL105	06/29/98	10	K
SXL105	07/06/98	40	
SXL105	07/13/98	10	K
SXL105	07/20/98	10	K
SXL105	07/27/98	120	
SXL105	08/03/98	30	
SXL105	08/10/98	10	K
SXL105	08/17/98	10	K
SXL105	08/24/98	20	
SXL105	08/31/98	10	K
SXL106	05/18/98	360	
SXL106	05/20/98	40	RESAMPLE
SXL106	05/26/98	410	
SXL106	05/28/98	10	K
SXL106	06/01/98	290	
SXL106	06/03/98	50	RESAMPLE
SXL106	06/08/98	10	K
SXL106	06/15/98	50	
SXL106	06/22/98	10	K
SXL106	06/29/98	40	
SXL106	07/06/98	10	K
SXL106	07/13/98	10	K
SXL106	07/20/98	50	
SXL106	07/27/98	50	
SXL106	08/03/98	10	K
SXL106	08/10/98	20	

SXL106	08/17/98	30	
SXL106	08/24/98	70	
SXL106	08/31/98	60	
SXL108	05/18/98	130	
SXL108	05/26/98	130	
SXL108	06/01/98	90	
SXL108	06/03/98	70	
SXL108	06/08/98	210	
SXL108	06/15/98	20	RESAMPLE
SXL108	06/17/98	200	
SXL108	06/22/98	10	K
SXL108	06/29/98	10	K
SXL108	07/06/98	10	K
SXL108	07/13/98	30	
SXL108	07/20/98	10	K
SXL108	07/27/98	10	K
SXL108	08/03/98	10	K
SXL108	08/10/98	40	
SXL108	08/17/98	660	
SXL108	08/19/98	220	RESAMPLE
SXL108	08/24/98	70	
SXL108	08/31/98	10	K
SXL109	05/18/98	10	K
SXL109	05/26/98	10	K
SXL109	06/01/98	90	
SXL109	06/08/98	50	
SXL109	06/15/98	120	
SXL109	06/22/98	20	
SXL109	06/29/98	40	
SXL109	07/06/98	10	K
SXL109	07/13/98	10	K
SXL109	07/20/98	10	K
SXL109	07/27/98	20	
SXL109	08/03/98	10	K
SXL109	08/10/98	20	
SXL109	08/17/98	20	
SXL109	08/24/98	110	
SXL109	08/31/98	10	K
SXL111	05/18/98	20	
SXL111	05/26/98	10	K
SXL111	06/01/98	80	
SXL111	06/08/98	20	
SXL111	06/15/98	1200	
SXL111	06/17/98	120	RESAMPLE
SXL111	06/22/98	20	
SXL111	06/29/98	70	
SXL111	07/06/98	40	

SXL111	07/13/98	80	
SXL111	07/27/98	50	
SXL111	08/03/98	10	K
SXL111	08/10/98	10	K
SXL111	08/17/98	270	
SXL111	08/19/98	10	K, RESAMPLE
SXL111	08/24/98	160	
SXL111	08/31/98	60	
SXL112	05/18/98	10	K
SXL112	05/26/98	10	K
SXL112	06/01/98	160	
SXL112	06/08/98	10	K
SXL112	06/15/98	10	K
SXL112	06/22/98	10	K
SXL112	06/29/98	10	K
SXL112	07/06/98	30	
SXL112	07/13/98	60	
SXL112	07/20/98	20	
SXL112	07/27/98	10	K
SXL112	08/03/98	10	K
SXL112	08/10/98	10	K
SXL112	08/17/98	10	K
SXL112	08/24/98	10	K
SXL112	08/31/98	30	
SXL113	05/18/98	10	K
SXL113	05/26/98	10	K
SXL113	06/01/98	80	
SXL113	06/08/98	10	K
SXL113	06/15/98	50	
SXL113	06/22/98	10	K
SXL113	06/29/98	10	K
SXL113	07/06/98	10	K
SXL113	07/13/98	10	K
SXL113	07/20/98	20	
SXL113	07/27/98	50	
SXL113	08/03/98	30	
SXL113	08/10/98	10	K
SXL113	08/17/98	10	K
SXL113	08/24/98	10	K
SXL113	08/31/98	10	K
1	05/24/99	10	K
SXL101	06/01/99	210	
SXL101	06/03/99	12	Resample
SXL101	06/04/99	1	Resample
SXL101	06/07/99	20	
SXL101	06/14/99	10	K
SXL101	06/23/99	150	

SXL101	06/28/99	130	
SXL101	07/06/99	160	
SXL101	07/12/99	10	
SXL101	07/19/99	280	
SXL101	07/21/99	10	Resample
SXL101	07/26/99	40	
SXL101	08/02/99	10	K
SXL101	08/09/99	10	K
SXL101	08/16/99	50	
SXL101	08/23/99	90	
SXL101	08/30/99	40	
2	05/24/99	380	
SXL102	05/26/99	240	Resample
SXL102	05/27/99	84	Resample
SXL102	06/01/99	120	
SXL102	06/07/99	50	
SXL102	06/14/99	10	
SXL102	06/21/99	90	
SXL102	06/28/99	50	
SXL102	07/06/99	270	
SXL102	07/08/99	47	Resample
SXL102	07/09/99	4	Resample
SXL102	07/12/99	10	K
SXL102	07/19/99	40	
SXL102	07/26/99	590	
SXL102	07/28/99	120	Resample
SXL102	08/02/99	20	
SXL102	08/09/99	20	
SXL102	08/16/99	10	K
SXL102	08/23/99	100	
SXL102	08/30/99	30	
3	05/24/99	4600	
SXL103	05/26/99	70	Resample
SXL103	06/01/99	10	K
SXL103	06/07/99	10	K
SXL103	06/14/99	10	K
SXL103	06/21/99	10	K
SXL103	06/28/99	10	
SXL103	07/06/99	10	K
SXL103	07/12/99	50	
SXL103	07/19/99	10	K
SXL103	07/26/99	20	
SXL103	08/02/99	10	K
SXL103	08/09/99	50	
SXL103	08/16/99	10	
SXL103	08/23/99	10	K
SXL103	08/30/99	10	K

4	05/24/99	90	
SXL104	06/01/99	10	K
SXL104	06/07/99	20	
SXL104	06/14/99	30	
SXL104	06/21/99	30	
SXL104	06/28/99	90	
SXL104	07/06/99	530	
SXL104	07/08/99	29	Resample
SXL104	07/09/99	12	Resample
SXL104	07/12/99	10	
SXL104	07/19/99	20	
SXL104	07/26/99	60	
SXL104	08/02/99	10	K
SXL104	08/09/99	110	
SXL104	08/16/99	20	
SXL104	08/23/99	10	K
SXL104	08/30/99	30	
5	05/24/99	310	
SXL105	05/26/99	50	Resample
SXL105	06/01/99	30	
SXL105	06/07/99	10	
SXL105	06/14/99	30	
SXL105	06/21/99	40	
SXL105	06/28/99	60	
SXL105	07/06/99	40	
SXL105	07/12/99	10	
SXL105	07/19/99	80	
SXL105	07/26/99	70	
SXL105	08/02/99	10	K
SXL105	08/09/99	20	
SXL105	08/16/99	450	
SXL105	08/18/99	30	Resample
SXL105	08/23/99	40	
SXL105	08/30/99	10	
6	05/24/99	11,000	
SXL106	05/26/99	510	Resample
SXL106	05/26/99	104	Resample
SXL106	05/27/99	1100	Resample
SXL106	06/01/99	60	
SXL106	06/07/99	80	
SXL106	06/14/99	30	
SXL106	06/21/99	20	
SXL106	06/28/99	450	
SXL106	06/30/99	80	Resample
SXL106	07/06/99	290	
SXL106	07/08/99	163	Resample
SXL106	07/09/99	39	Resample

SXL106	07/12/99	10	
SXL106	07/19/99	30	
SXL106	07/26/99	10	K
SXL106	08/02/99	10	
SXL106	08/09/99	10	K
SXL106	08/16/99	60	
SXL106	08/23/99	10	K
SXL106	08/30/99	20	
Happy Valley	05/24/99	90	
SXL108	06/01/99	110	
SXL108	06/07/99	40	
SXL108	06/14/99	20	
SXL108	06/21/99	160	
SXL108	06/28/99	480	
SXL108	06/30/99	80	Resample
SXL108	07/06/99	40	
SXL108	07/12/99	270	
SXL108	07/19/99	50	
SXL108	07/26/99	20	
SXL108	08/02/99	10	K
SXL108	08/09/99	50	
SXL108	08/16/99	210	
SXL108	08/18/99	490	Resample
SXL108	08/23/99	40	
Tamarack	05/24/99	50	
SXL111	06/01/99	10	
SXL111	06/07/99	10	K
SXL111	06/14/99	80	
SXL111	06/21/99	90	
SXL111	06/28/99	400	
SXL111	06/30/99	50	Resample
SXL111	07/06/99	330	
SXL111	07/08/99	14	
SXL111	07/09/99	21	
SXL111	07/12/99	90	
SXL111	07/19/99	2300	
SXL111	07/21/99	140	Resample
SXL111	07/26/99	140	
SXL111	08/02/99	10	K
SXL111	08/09/99	10	
SXL111	08/16/99	160	
SXL111	08/23/99	10	K
SXL111	08/30/99	20	
Alpine	05/24/99	110	
SXL112	06/01/99	10	K
SXL112	06/07/99	10	
SXL112	06/14/99	10	

SXL112	06/23/99	10	K
SXL112	06/28/99	160	
SXL112	07/06/99	10	K
SXL112	07/12/99	10	K
SXL112	07/19/99	10	K
SXL112	07/26/99	10	K
SXL112	08/02/99	10	K
SXL112	08/09/99	10	
SXL112	08/16/99	50	
SXL112	08/23/99	10	K
SXL112	08/30/99	80	
Upper	05/24/99	410	
SXL113	05/26/99	10	Resample
SXL113	06/01/99	50	
SXL113	06/07/99	20	
SXL113	06/14/99	20	
SXL113	06/23/99	10	K
SXL113	06/28/99	400	
SXL113	06/30/99	10	Resample
SXL113	07/07/99	60	
SXL113	07/12/99	390	
SXL113	07/14/99	10	K
SXL113	07/19/99	580	
SXL113	07/21/99	180	Resample
SXL113	07/26/99	90	
SXL113	08/02/99	20	
SXL113	08/09/99	10	
SXL113	08/16/99	40	
SXL113	08/23/99	10	K
SXL113	08/30/99	10	K
Lake Mohawk Beach 1	06/26/00	40	
SXL101	07/05/00	110	
SXL101	07/10/00	30	
SXL101	08/07/00	20	
SXL101	08/16/00	50	
SXL101	08/28/00	10	K
Lake Mohawk Beach 2	05/22/00	10	K
SXL102	05/30/00	10	K
SXL102	06/05/00	10	K
SXL102	06/12/00	10	
SXL102	06/19/00	10	
SXL102	06/26/00	10	K
SXL102	07/05/00	10	K
SXL102	07/10/00	60	
SXL102	07/17/00	10	K

SXL102	07/24/00	20	
SXL102	07/31/00	10	
SXL102	08/07/00	10	K
SXL102	08/16/00	60	
SXL102	08/21/00	10	
SXL102	08/28/00	20	
Lake Mohawk Beach 3	05/22/00	10	K
SXL103	05/30/00	10	K
SXL103	06/05/00	10	
SXL103	06/12/00	10	
SXL103	06/19/00	20	
SXL103	06/26/00	10	K
SXL103	07/05/00	10	K
SXL103	07/10/00	170	
SXL103	07/17/00	10	K
SXL103	07/24/00	70	
SXL103	07/31/00	10	K
SXL103	08/07/00	20	
SXL103	08/16/00	10	
SXL103	08/21/00	10	K
SXL103	08/28/00	10	K
Lake Mohawk Beach 4	05/22/00	10	K
SXL104	05/30/00	40	
SXL104	06/05/00	10	
SXL104	06/12/00	40	
SXL104	06/19/00	60	
SXL104	06/26/00	10	K
SXL104	07/05/00	10	
SXL104	07/10/00	40	
SXL104	07/12/00	10	K
SXL104	07/17/00	10	K
SXL104	07/24/00	20	
SXL104	07/31/00	10	K
SXL104	08/07/00	20	
SXL104	08/16/00	40	
SXL104	08/21/00	10	K
SXL104	08/28/00	20	
Lake Mohawk Beach 5	05/22/00	10	K
SXL105	05/30/00	10	K
SXL105	06/05/00	7800	
SXL105	06/07/00	10	Resample
SXL105	06/12/00	100	
SXL105	06/19/00	40	
SXL105	06/26/00	10	

SXL105	07/05/00	60	
SXL105	07/10/00	30	
SXL105	07/17/00	150	
SXL105	07/24/00	10	K
SXL105	07/31/00	80	
SXL105	08/07/00	40	
SXL105	08/16/00	20	
SXL105	08/21/00	10	
SXL105	08/28/00	100	
Lake Mohawk Beach 6	05/22/00	50	
SXL106	05/30/00	40	
SXL106	06/05/00	440	
SXL106	06/07/00	60	Resample
SXL106	06/12/00	30	
SXL106	06/19/00	10	
SXL106	06/26/00	40	
SXL106	07/05/00	10	
SXL106	07/10/00	50	
SXL106	07/17/00	40	
SXL106	07/24/00	60	
SXL106	07/31/00	30	
SXL106	08/07/00	60	
SXL106	08/16/00	10	K
SXL106	08/21/00	20	
SXL106	08/28/00	10	K
Lake Mohawk Happy Valley Beach	05/22/00	10	
SXL108	05/30/00	10	K
SXL108	06/05/00	10	
SXL108	06/12/00	30	
SXL108	06/19/00	20	
SXL108	06/26/00	50	
SXL108	07/05/00	20	
SXL108	07/10/00	20	
SXL108	07/17/00	10	
SXL108	07/24/00	20	
SXL108	07/31/00	30	
SXL108	08/07/00	20	
SXL108	08/16/00	30	
SXL108	08/21/00	10	K
SXL108	08/28/00	10	K
Lake Mohawk Tamarack Beach	05/22/00	220	
SXL111	05/30/00	70	

SXL111	06/05/00	230	
SXL111	06/07/00	50	Resample
SXL111	06/12/00	90	
SXL111	06/19/00	90	
SXL111	06/26/00	10	K
SXL111	07/05/00	40	
SXL111	07/10/00	30	
SXL111	07/17/00	30	
SXL111	07/24/00	10	K
SXL111	07/31/00	70	
SXL111	08/07/00	10	K
SXL111	08/16/00	40	
SXL111	08/21/00	40	
SXL111	08/28/00	60	
Lake Mohawk Alpine Beach	05/22/00	10	K
SXL112	05/30/00	10	K
SXL112	06/05/00	10	K
SXL112	06/12/00	290	
SXL112	06/14/00	20	Resample
SXL112	06/19/00	30	
SXL112	06/26/00	10	
SXL112	07/05/00	10	
SXL112	07/10/00	20	
SXL112	07/17/00	10	K
SXL112	07/24/00	10	K
SXL112	07/31/00	10	
SXL112	08/07/00	10	
SXL112	08/16/00	10	K
SXL112	08/21/00	10	
SXL112	08/28/00	30	
Upper Lake Mohawk	05/22/00	70	
SXL113	05/30/00	20	
SXL113	06/05/00	50	
SXL113	06/12/00	700	
SXL113	06/14/00	40	Resample
SXL113	06/19/00	140	
SXL113	06/26/00	10	
SXL113	07/05/00	30	
SXL113	07/10/00	30	
SXL113	07/17/00	50	
SXL113	07/24/00	10	
SXL113	07/31/00	30	
SXL113	08/07/00	40	
SXL113	08/16/00	10	K
SXL113	08/21/00	10	

SXL113	08/28/00	10	K
Beach 1	05/23/01	16	
Beach 1	06/04/01	12	
Beach 1	06/11/01	160	
Beach 1	06/18/01	90	
Beach 1	06/25/01	62	
Beach 1	07/02/01	14	
Beach 1	07/09/01	172	
Beach 1	07/16/01	30	
Beach 1	07/30/01	2	
Beach 1	08/06/01	28	
Beach 1	08/13/01	104	
Beach 1	08/20/01	796	
Beach 1	08/22/01	12	
Beach 1	08/27/01	52	
Beach 2	05/23/01	118	
Beach 2	06/04/01	104	
Beach 2	06/11/01	10	
Beach 2	06/18/01	138	
Beach 2	06/25/01	164	
Beach 2	07/02/01	56	
Beach 2	07/09/01	40	
Beach 2	07/16/01	54	
Beach 2	07/23/01	12	
Beach 2	07/30/01	16	
Beach 2	08/06/01	6	
Beach 2	08/13/01	196	
Beach 2	08/20/01	18	
Beach 2	08/27/01	6	
Beach 3	05/23/01	2	
Beach 3	06/04/01	2	
Beach 3	06/11/01	200	
Beach 3	06/18/01	92	
Beach 3	06/25/01	168	
Beach 3	07/02/01	16	
Beach 3	07/09/01	4	
Beach 3	07/16/01	20	
Beach 3	07/23/01	2	k
Beach 3	08/06/01	2	
Beach 3	08/13/01	6	
Beach 3	08/20/01	2	
Beach 3	08/27/01	2	
Beach 4	05/23/01	40	
Beach 4	06/04/01	40	
Beach 4	06/11/01	200	
Beach 4	06/18/01	136	
Beach 4	06/25/01	96	

Beach 4	07/02/01	62	
Beach 4	07/09/01	26	
Beach 4	07/16/01	2	K
Beach 4	07/23/01	2	K
Beach 4	07/30/01	18	
Beach 4	08/06/01	4	
Beach 4	08/13/01	26	
Beach 4	08/20/01	44	
Beach 4	08/27/01	6	
Beach 5	05/23/01	12	
Beach 5	06/04/01	30	
Beach 5	06/11/01	350	
Beach 5	06/14/01	164	
Beach 5	06/18/01	180	
Beach 5	06/25/01	44	
Beach 5	07/02/01	54	
Beach 5	07/09/01	186	
Beach 5	07/16/01	82	
Beach 5	07/23/01	12	
Beach 5	07/30/01	40	
Beach 5	08/06/01	164	
Beach 5	08/13/01	238	
Beach 5	08/20/01	8	
Beach 5	08/27/01	8	
Beach 6	05/23/01	84	
Beach 6	06/04/01	14	
Beach 6	06/11/01	6	
Beach 6	06/18/01	150	
Beach 6	06/25/01	298	
Beach 6	06/27/01	164	
Beach 6	07/02/01	70	
Beach 6	07/09/01	36	
Beach 6	07/16/01	36	
Beach 6	07/23/01	8	
Beach 6	08/06/01	68	
Beach 6	08/13/01	38	
Beach 6	08/20/01	54	
Beach 6	08/27/01	60	
Alpine	05/23/01	72	
Alpine	06/04/01	6	
Alpine	06/11/01	6	
Alpine	06/18/01	24	
Alpine	06/25/01	34	
Alpine	07/02/01	82	
Alpine	07/09/01	6	
Alpine	07/16/01	2	
Alpine	07/23/01	6	

Alpine	07/30/01	22	
Alpine	08/06/01	32	
Alpine	08/13/01	16	
Alpine	08/20/01	44	
Alpine	08/27/01	122	
Manitou	06/25/01	118	
Manitou	07/09/01	30	
Manitou	07/16/01	36	
Manitou	07/23/01	122	
Manitou	07/30/01	18	
Manitou	08/06/01	104	
Manitou	08/13/01	212	
Manitou	08/15/01	90	
Manitou	08/20/01	350	
Manitou	08/22/01	2	K
Manitou	08/27/01	262	
Manitou	08/30/01	30	
Upper	05/23/01	20	
Upper	06/04/01	52	
Upper	06/11/01	856	
Upper	06/14/01	188	
Upper	06/18/01	230	
Upper	06/20/01	176	
Upper	06/25/01	114	
Upper	07/02/01	98	
Upper	07/09/01	32	
Upper	07/16/01	68	
Upper	07/16/01	172	
Upper	07/23/01	2	K
Upper	07/30/01	2	
Upper	08/06/01	38	
Upper	08/13/01	4	
Upper	08/20/01	30	
Upper	08/27/01	10	
BEACH 1	05/20/02	2	
BEACH 1	05/29/02	50	
BEACH 1	06/03/02	10	
BEACH 1	06/10/02	10	K
BEACH 1	06/17/02	50	
BEACH 1	06/24/02	20	
BEACH 1	07/01/02	30	
BEACH 1	07/08/02	20	
BEACH 1	07/15/02	10	
BEACH 1	07/22/02	10	
BEACH 1	07/29/02	40	
BEACH 1	08/05/02	80	
BEACH 1	08/12/02	20	

BEACH 1	08/19/02	40	
BEACH 1	08/26/02	10	K
BEACH 2	05/20/02	70	
BEACH 2	05/29/02	720	
BEACH 2	05/31/02	91	Resample
BEACH 2	06/03/02	10	
BEACH 2	06/10/02	10	K
BEACH 2	06/17/02	10	
BEACH 2	06/24/02	10	K
BEACH 2	07/01/02	20	
BEACH 2	07/08/02	10	
BEACH 2	07/15/02	10	K
BEACH 2	07/22/02	160	
BEACH 2	07/29/02	40	
BEACH 2	08/05/02	70	
BEACH 2	08/12/02	10	K
BEACH 2	08/19/02	40	
BEACH 2	08/26/02	10	
BEACH 3	05/20/02	10	K
BEACH 3	05/29/02	10	K
BEACH 3	06/03/02	10	K
BEACH 3	06/10/02	10	K
BEACH 3	06/17/02	10	
BEACH 3	06/24/02	30	
BEACH 3	07/01/02	20	
BEACH 3	07/08/02	10	K
BEACH 3	07/15/02	10	K
BEACH 3	07/22/02	30	
BEACH 3	07/29/02	10	K
BEACH 3	08/05/02	10	
BEACH 3	08/12/02	10	K
BEACH 3	08/26/02	40	
BEACH 4	05/20/02	10	K
BEACH 4	05/29/02	200	
BEACH 4	05/31/02	11	Resample
BEACH 4	06/03/02	10	
BEACH 4	06/10/02	10	
BEACH 4	06/17/02	10	
BEACH 4	06/24/02	120	
BEACH 4	07/01/02	20	
BEACH 4	07/08/02	10	K
BEACH 4	07/15/02	30	
BEACH 4	07/22/02	110	
BEACH 4	07/29/02	60	
BEACH 4	08/05/02	10	K
BEACH 4	08/12/02	10	K
BEACH 4	08/19/02	20	

BEACH 4	08/26/02	10	K
BEACH 5	05/20/02	20	
BEACH 5	05/29/02	40	
BEACH 5	06/03/02	10	
BEACH 5	06/10/02	10	K
BEACH 5	06/17/02	10	
BEACH 5	06/24/02	70	
BEACH 5	07/01/02	200	
BEACH 5	07/08/02	180	
BEACH 5	07/15/02	60	
BEACH 5	07/22/02	40	
BEACH 5	07/29/02	40	
BEACH 5	08/05/02	10	
BEACH 5	08/12/02	10	K
BEACH 5	08/19/02	30	
BEACH 5	08/26/02	10	K
BEACH 6	05/20/02	100	
BEACH 6	05/29/02	20	
BEACH 6	06/03/02	20	
BEACH 6	06/10/02	10	
BEACH 6	06/17/02	10	K
BEACH 6	06/24/02	20	
BEACH 6	07/01/02	30	
BEACH 6	07/08/02	20	
BEACH 6	07/15/02	10	K
BEACH 6	07/22/02	50	
BEACH 6	07/29/02	30	
BEACH 6	08/05/02	10	
BEACH 6	08/12/02	30	
BEACH 6	08/19/02	40	
BEACH 6	08/26/02	20	
HAPPY VALLEY	05/20/02	20	
HAPPY VALLEY	05/29/02	130	
HAPPY VALLEY	06/03/02	10	
HAPPY VALLEY	06/10/02	10	K
HAPPY VALLEY	06/17/02	10	
HAPPY VALLEY	06/24/02	10	
HAPPY VALLEY	07/01/02	10	K
HAPPY VALLEY	07/08/02	40	
HAPPY	07/15/02	490	

VALLEY			
HAPPY VALLEY	07/17/02	330	Resample
HAPPY VALLEY	07/18/02	46	Resample
HAPPY VALLEY	07/19/02	163	Resample
HAPPY VALLEY	08/05/02	10	
HAPPY VALLEY	08/12/02	40	
HAPPY VALLEY	08/19/02	10	K
HAPPY VALLEY	08/26/02	30	
MANITOU	05/20/02	40	
MANITOU	05/29/02	10	
MANITOU	06/03/02	10	
MANITOU	06/10/02	30	
MANITOU	06/17/02	10	
MANITOU	06/24/02	180	
MANITOU	07/01/02	60	
MANITOU	07/08/02	40	
MANITOU	07/15/02	130	
MANITOU	07/22/02	90	
MANITOU	07/29/02	200	
MANITOU	08/05/02	10	K
MANITOU	08/12/02	20	
MANITOU	08/19/02	20	
MANITOU	08/26/02	50	
TAMARACK	05/22/02	10	K
TAMARACK	05/29/02	40	
TAMARACK	06/03/02	10	K
TAMARACK	06/10/02	20	
TAMARACK	06/17/02	10	K
TAMARACK	06/24/02	740	
TAMARACK	06/26/02	41	Resample
TAMARACK	07/01/02	40	
TAMARACK	07/08/02	10	
TAMARACK	07/15/02	40	
TAMARACK	07/22/02	40	
TAMARACK	07/29/02	80	
TAMARACK	08/05/02	50	
TAMARACK	08/12/02	30	
TAMARACK	08/19/02	10	
TAMARACK	08/26/02	10	K
ALPINE	05/20/02	20	
ALPINE	05/29/02	10	

ALPINE	06/03/02	20	
ALPINE	06/10/02	10	
ALPINE	06/17/02	10	
ALPINE	06/24/02	40	
ALPINE	07/01/02	10	
ALPINE	07/08/02	10	
ALPINE	07/15/02	30	
ALPINE	07/22/02	10	
ALPINE	07/29/02	10	
ALPINE	08/05/02	10	K
ALPINE	08/12/02	10	K
ALPINE	08/19/02	10	K
ALPINE	08/26/02	20	
	05/20/02	10	
	05/29/02	20	
	06/03/02	20	
	06/10/02	20	
	06/17/02	20	
	06/24/02	10	K
	07/01/02	150	
	07/08/02	20	
	07/15/02	900	
	07/17/02	40	Resample
	07/19/02	18	Resample
	07/22/02	10	
	07/29/02	40	
	08/05/02	10	
	08/12/02	20	
	08/19/02	10	
	08/26/02	10	
LAKE MOHAWK - BEACH 1	05/19/03	10	
	05/28/03	30	
	06/02/03	30	
	06/09/03	10	K
	06/16/03	10	K
	06/23/03	10	
	06/30/03	110	
	07/07/03	10	
	07/14/03	10	
	07/21/03	20	
	07/28/03	10	
	08/04/03	10	
	08/11/03	20	
	08/18/03	10	K
	08/25/03	10	K

	08/18/03	10	
	08/25/03	10	K
LAKE MOHAWK ALPINE	05/21/03	60	
	05/28/03	10	K
	06/02/03	40	
	06/09/03	10	
	06/16/03	30	
	06/23/03	40	
	06/30/03	10	K
	07/07/03	10	
	07/14/03	80	
	07/21/03	30	
	07/28/03	70	
	08/04/03	140	
	08/11/03	180	
	08/18/03	10	K
	08/25/03	20	
LAKE MOHAWK UPPER LAKE	05/21/03	10	
	05/28/03	30	
	06/02/03	50	
	06/09/03	110	
	06/16/03	20	
	06/23/03	50	
	06/30/03	10	K
	07/07/03	10	
	07/14/03	10	K
	07/21/03	20	
	07/28/03	10	K
	08/04/03	70	
	08/11/03	100	
	08/18/03	10	K
	08/25/03	10	K
LAKE MOHAWK BEACH 1	05/24/04	220	
	06/02/04	10	Resample
	06/07/04	10	K
	06/14/04	10	
	06/21/04	10	K
	06/28/04	10	K
	07/07/04	10	
	07/15/04	300	
	07/21/04	10	K, Resample
	07/26/04	20	

	08/02/04	10	
	08/09/04	150	
	08/16/04	340	
	08/18/04	340	Resample
	08/23/04	560	Resample
	08/25/04	20	Resample
	08/30/04	10	K, Resample
LAKE MOHAWK BEACH 2	05/24/04	10	K
	06/02/04	40	
	06/07/04	10	K
	06/14/04	10	K
	06/21/04	10	
	06/28/04	20	
	07/07/04	10	K
	07/15/04	10	
	07/21/04	10	K
	07/26/04	20	
	08/02/04	30	
	08/09/04	10	
	08/16/04	20	
	08/23/04	40	
	08/30/04	10	K
LAKE MOHAWK BEACH 3	05/24/04	10	K
	06/02/04	10	K
	06/07/04	10	
	06/14/04	10	K
	06/21/04	10	
	06/28/04	20	
	07/07/04	10	K
	07/12/04	10	K
	07/21/04	10	K
	07/26/04	20	
	08/02/04	10	
	08/09/04	10	
	08/16/04	30	
	08/23/04	10	
	08/30/04	10	K
LAKE MOHAWK BEACH 4	05/24/04	40	
	06/02/04	30	
	06/07/04	10	
	06/14/04	30	
	06/21/04	10	

	06/28/04	10	K
	07/07/04	20	
	07/12/04	20	
	07/21/04	10	K
	07/26/04	10	
	08/02/04	10	
	08/09/04	10	
	08/16/04	10	K
	08/23/04	10	K
	08/30/04	10	K
LAKE MOHAWK BEACH 5	05/24/04	180	
	06/02/04	20	
	06/07/04	70	
	06/14/04	10	
	06/21/04	10	K
	06/28/04	10	K
	07/07/04	10	K
	07/12/04	20	
	07/21/04	10	
	07/26/04	60	
	08/02/04	20	
	08/09/04	10	K
	08/16/04	10	K
	08/23/04	30	
	08/30/04	380	
	09/02/04	10	K, Resample
LAKE MOHAWK BEACH 6	05/24/04	40	
	06/02/04	10	K
	06/07/04	10	K
	06/14/04	10	K
	06/21/04	10	K
	06/28/04	100	
	07/07/04	80	
	07/12/04	20	
	07/21/04	10	K
	07/26/04	30	
	08/02/04	20	
	08/09/04	10	K
	08/16/04	20	
	08/23/04	50	
	08/30/04	10	K
LAKE MOHAWK HAPPY	05/24/04	490	

VALLEY			
	06/02/04	70	Resample
	06/07/04	10	K
	06/14/04	10	K
	06/21/04	20	
	06/28/04	220	
	06/30/04	10	K, Resample
	07/07/04	10	K
	07/15/04	10	K
	07/21/04	10	k
	07/26/04	20	
	08/02/04	10	
	08/09/04	200	
	08/16/04	10	K
	08/23/04	40	
	08/30/04	90	
LAKE MOHAWK MANITOU	05/24/04	160	
	06/02/04	10	
	06/07/04	20	
	06/14/04	30	
	06/21/04	10	K
	06/28/04	190	
	07/07/04	80	
	07/15/04	10	K
	07/21/04	10	K
	07/26/04	60	
	08/02/04	20	
	08/09/04	10	
	08/16/04	40	
	08/23/04	100	
	08/30/04	10	K
LAKE MOHAWK TAMARACK	05/24/04	130	
	06/02/04	10	K
	06/07/04	50	
	06/14/04	90	
	06/21/04	180	
	06/28/04	70	
	07/07/04	10	K
	07/15/04	6000	L
	07/20/04	14	Resample
	07/21/04	10	K, Resample
	07/26/04	10	K,
	08/02/04	30	

	08/09/04	10	
	08/16/04	50	
	08/23/04	20	
	08/30/04	10	K
LAKE MOHAWK ALPINE	05/24/04	10	
	06/02/04	10	K
	06/07/04	10	K
	06/14/04	10	K
	06/21/04	10	K
	06/28/04	10	K
	07/07/04	10	K
	07/15/04	10	K
	07/21/04	10	K
	07/26/04	20	
	08/02/04	10	
	08/09/04	10	
	08/16/04	10	K
	08/23/04	40	
	08/30/04	10	K
LAKE MOHAWK UPPER LAKE	05/24/04	20	
	06/02/04	10	K
	06/07/04	10	K
	06/14/04	10	K
	06/21/04	20	
	06/28/04	10	
	07/07/04	10	K
	07/12/04	20	
	07/21/04	50	
	07/26/04	20	
	08/02/04	10	K
	08/09/04	10	K
	08/16/04	30	
	08/23/04	160	
	08/30/04	30	

Sleepy Valley			
count	67	mean+3stdev	1568
median	20	%reduction	91%
Max	2300		
stdev	460	no data excluded	
mean	189		
mean+3stdev	1568		

STATION	DATE	VALUE	REMARK
SXL192218	05/28/98	10	K
SXL192218	06/10/98	10	K
SXL192218	06/25/98	10	K
SXL192218	07/10/98	60	
SXL192218	07/22/98	10	K
SXL192218	08/15/98	10	K
SXL192218	08/21/98	10	K
SXL192218	09/02/98	20	
SXL192218	05/24/99	2300	
SXL192218	05/28/99	770	
SXL192218	06/04/99	90	
SXL192218	06/16/99	320	
SXL192218	06/30/99	10	K
SXL192218	07/16/99	30	
SXL192218	07/30/99	10	K
SXL192218	08/11/99	10	K
SXL192218	08/18/99	10	K
SXL192218	08/25/99	10	K
SXL192218	05/22/00	20	BEACH OPENED JULY 1
SXL192218	06/09/00	230	
SXL192218	06/22/00	190	
SXL192218	07/05/00	40	
SXL192218	07/18/00	130	
SXL192218	08/02/00	10	
SXL192218	08/16/00	10	K
SXL192218	08/30/00	10	
	05/30/01	110	
	06/13/01	40	
	06/27/01	140	
	07/11/01	2200	
	07/14/01	520	RESAMPLE
	07/14/01	190	NORTH BRACKET
	07/14/01	400	SOUTH BRACKET
	07/18/01	160	
	07/20/01	50	RESAMPLE
	07/20/01	20	NORTH BRACKET
	07/20/01	90	SOUTH BRACKET
	08/01/01	10	K

	08/15/01	10	K
	08/23/01	10	
	05/24/02	10	
	06/05/02	10	K
	06/19/02	10	
	06/26/02	500	
	06/28/02	180	RESAMPLE
	07/12/02	1	K
	07/26/02	70	
	08/07/02	10	
	08/20/02	80	
Tall Timbers POA	05/19/03	10	K
	06/04/03	250	
	06/10/03	10	RESAMPLE
	06/24/03	20	
	07/09/03	10	K
	07/23/03	420	BEACH CLOSED
	07/31/03	20	RESAMPLE
	08/06/03	560	BEACH CLOSED
	08/13/03	30	RESAMPLE
	08/19/03	10	
Tall Timbers	05/27/04	2000	
	06/08/04	40	
	06/23/04	10	K
	07/07/04	10	K
	07/21/04	10	
	08/03/04	10	
	08/18/04	10	K
	08/23/04	60	

**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 10 Streams in the
Northwest Water Region**

Watershed Management Area 1

(Honey Run, Lopatcong Creek, Musconetcong River, Paulins Kill and
Pohatcong Creek)

Watershed Management Area 11

(Hakihokake Creek, Jacobs Creek and Wickecheoke)

Proposed:	May 2, 2005
Established:	August 19, 2005
Approved:	September 15, 2005
Adopted:	

**New Jersey Department of Environmental Protection
Division of Watershed Management
P.O. Box 418
Trenton, New Jersey 08625-0418**

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1.0 Executive Summary

In accordance with Section 305(b) and 303(d) of the Federal Clean Water Act (CWA), the State of New Jersey, Department of Environmental Protection (Department) developed the 2004 *Integrated List of Waterbodies* addressing the overall water quality of the State's waters and, in Sublist 5, identifying impaired waterbodies for which Total Maximum Daily Loads (TMDLs) may be necessary. On August 9, 2004, the Department adopted the 2004 *Integrated List of Waterbodies* as an amendment to the Statewide Water Quality Management Plan, pursuant to the Water Quality Planning Act at N.J.S.A.58:11A-7 and the Statewide Water Quality Management Planning rules at N.J.A.C. 7:15-6.4(a). In the Northwest Water Region, the 2004 *Integrated List of Waterbodies* Sublist 5 identifies 10 impairments with respect to pathogens, as indicated by the presence of fecal coliform concentrations in excess of standards. TMDLs have been developed addressing fecal coliform impairment in the waterbodies identified in Table 1.

Table 1 Stream segments in the Northwest Water Region identified on the 2004 *Integrated List of Waterbodies*.

Impairment Number	WMA	Station Name/Waterbody	Site ID	Sublist	Proposed Action
1	01	Honey Run near Hope	01445900	5	Establish TMDL
2	01	Lopatcong Creek at Main St in Phillipsburg	DRBCNJ0028	5	Establish TMDL
3	01	Musconetcong River at Lockwood	01455801	5	Establish TMDL
4	01	Paulins Kill at Warbasse Junction Rd near Lafayette	01443250	5	Establish TMDL
5	01	Pohatcong Creek at River Rd Bridge	DRBCNJ0027	5	Establish TMDL
6	11	Hakihokake Creek at Bridge St Bridge in Milford	DRBCNJ0023	5	Establish TMDL
7	11	Jacobs Creek above Rt. 29	DRBCNJ0003	5	Establish TMDL
8, 9, 10	11	Wickecheoke Creek at Croton, Wickecheoke	01461220,	5	Establish TMDL

Impairment Number	WMA	Station Name/Waterbody	Site ID	Sublist	Proposed Action
		Creek at Stockton, Wickecheoke Creek near Sergenstville	01461300 & DRBCNJ0012, 01461282		

As stated in N.J.A.C. 7:9B-1.14(c) of the New Jersey Surface Water Quality Standards (SWQS), “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.” Using ambient water quality data monitoring conducted by USGS/NJDEP and the stakeholder data during water years 1998-2002, summer and all season geometric means were determined for each Category 5 listed waterbody. 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 waterbody. The higher (more stringent) percent reduction value was selected as the TMDL, which was then allocated among the sources. Nonpoint and stormwater point sources are the primary contributors to fecal coliform loads in these waterbodies and can include storm-driven loads transporting fecal coliform from sources such as geese, farm operations, and domestic pets to the receiving water. Nonpoint sources can also include inputs from sources such as malfunctioning sewage conveyance systems and failing or inappropriately located septic systems. Contributions from domestic wastewater treatment plants are a de minimus portion of the total load because disinfection requirements impose an end-of-pipe concentration significantly below the surface water quality standards. This TMDL report includes implementation strategies to achieve SWQS for fecal coliform. The TMDLs in this report have been proposed as amendments to the appropriate area wide water quality management plan in accordance with N.J.A.C. 7:15-3.4(g). This TMDL report was developed consistent with the United States Environmental Protection Agency’s (USEPA’s) May 20, 2002 guidance document entitled: “Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992,” (Sutfin, 2002) which describes the statutory and regulatory requirements for approvable TMDLs.

2.0 Introduction

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

EPA (Sublist 4). Sublist 5 constitutes the traditional 303(d) list for waters impaired or threatened by one or more pollutants, for which a TMDL may be required. In the Northwest Water Region, the *2004 Integrated List of Waterbodies* currently identifies 10 impaired segments.

A TMDL represents the assimilative or carrying capacity of a waterbody, taking into consideration point and nonpoint sources of pollutants of concern, natural background and surface water withdrawals. A TMDL quantifies the amount of a pollutant a 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 waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and a margin of safety (MOS).

This report establishes 10 TMDLs that address fecal coliform impairment in 84.1 river miles with respect to the waterbodies identified in Table 2. These TMDLs include management approaches to reduce fecal coliform loadings from various sources in order to attain applicable surface water quality standards for fecal coliform. With respect to the fecal coliform impairment, the waterbodies will be moved to Sublist 4 following approval of the TMDL by EPA. In addition to the above listed fecal coliform impairments, Honey Run near Hope (01445900) is listed for dissolved oxygen and the Musconetcong River at Lockwood (01455801) is listed for phosphorus and temperature. Paulins Kill at Warbasse Junction Rd near Lafayette (01443250) is listed for dissolved oxygen and phosphorus and Pohatcong Creek at River Rd Bridge (DRBCNJ0027) is listed for phosphorus. Hakiwokake Creek at Bridge St Bridge in Milford (DRBCNJ0023) is listed for pH and temperature and Jacobs Creek above Rt. 29 (DRBCNJ0003) is listed for pH. In the Wickecheoke Creek watershed, the Wickecheoke Creek at Stockton (01461300 & DRBCNJ0012) is listed for phosphorus and temperature. These waterbodies will remain of Sublist 5 with respect to these pollutants and will be addressed in future TMDLs.

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

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

This report establishes 10 TMDLs that address fecal coliform impairment in waterbodies identified in Table 2. These TMDLs include management approaches to reduce loadings of fecal coliform from various sources in order to attain applicable surface water quality standards for fecal coliform. With respect to the fecal coliform impairment, the waterbodies will be moved to Sublist 4 following approval of the TMDLs by USEPA.

3.0 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 SWQS, published at N.J.A.C. 7-9B et seq., for the segments in the Northwest Water Region identified in Table 2. All of these waterbodies have a high priority ranking.

Table 2 Waterbodies listed for fecal coliform impairment in the Northwest Water Region for which TMDLs are required.

TMDL Number	WMA	Station Name/Waterbody	Site ID	County(s)	River Miles
1	01	Honey Run near Hope	01445900	Warren	11.4
2	01	Lopatcong Creek at Main St in Phillipsburg	DRBCNJ0028	Warren	3.2
3	01	Musconetcong River at Lockwood	01455801	Sussex, Morris	2.0
4	01	Paulins Kill at Warbasse Junction Rd near Lafayette	01443250	Sussex	3.0
5	01	Pohatcong Creek at River Rd Bridge	DRBCNJ0027	Warren	16.4
6	11	Hakihokake Creek at Bridge St Bridge in Milford	DRBCNJ0023	Hunterdon	8.0
7	11	Jacobs Creek above Rt. 29	DRBCNJ0003	Mercer	2.1
8, 9, 10	11	Wickecheoke Creek at Croton, Wickecheoke Creek at Stockton, Wickecheoke Creek near Sergenstville	01461220, 01461300 & DRBCNJ0012, 01461282	Hunterdon	38.0
Total River Miles:					84.1

Applicable Water Quality Standards

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). The designated uses, 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 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.

Description of the Northwest Water Region

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.

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, and 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%).

Table 3 River miles, Watershed size, and Anderson Land Use classification for five Sublist 5 segments, listed for fecal coliform, in WMA 1

	Segment ID				
	01445900	DRBCNJ0028	01455801	01443250	DRBCNJ0027
Sublist 5 impaired river miles (miles)	11.4	3.2	2.0	3.0	16.4
Total river miles within the delineated watershed and included in the implementation plan (miles)	19.527	16.46	12.425	24.041	93.165
Watershed sizes (acres)	7244	12645	5090	7588	37212
Land use/Land cover					
Agriculture	33.4%	37.4%	0.8%	16.3%	33.3%
Barren Land	0.1%	3.6%	4.1%	0.7%	0.4%
Forest	38.9%	24.4%	58.2%	26.7%	40.4%
Urban	11.7%	31.0%	23.3%	28.7%	16.4%
Water	1.6%	1.4%	1.9%	3.5%	2.5%
Wetlands	14.3%	2.2%	11.7%	24.0%	7.1%

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

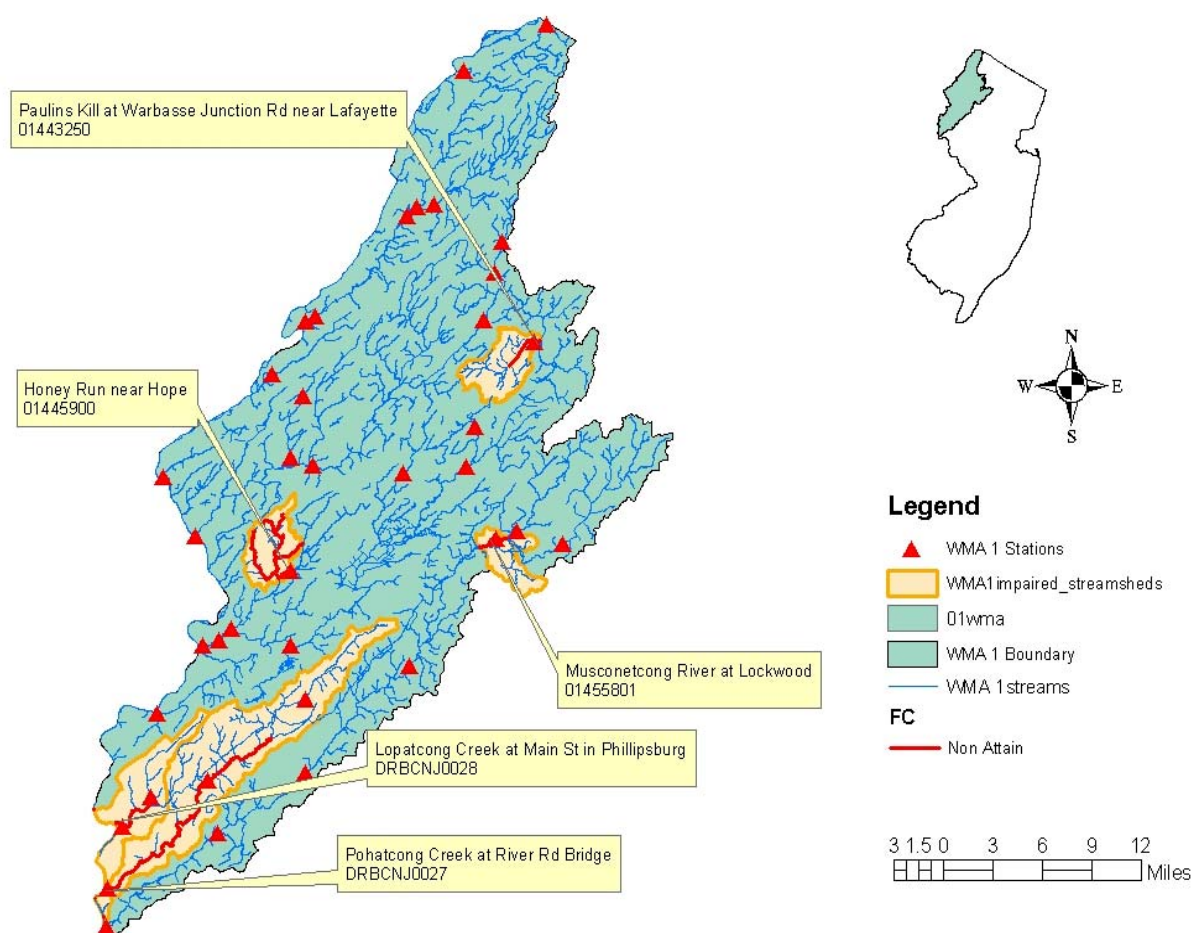
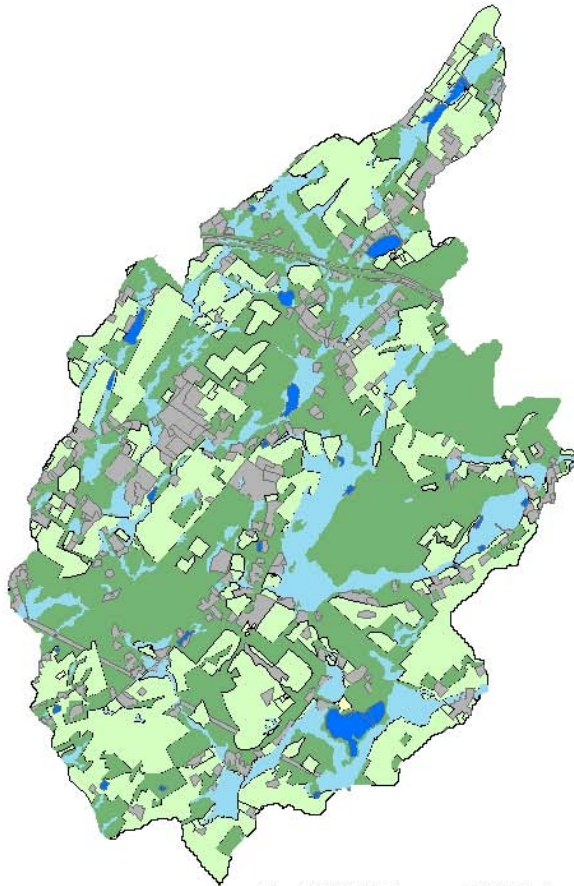


Figure 2 Spatial extent of the Land Use for Honey Run near Hope (01445900)



0 1,850 3,700 7,400 Feet

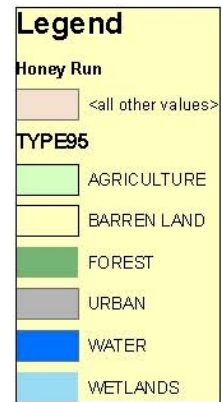
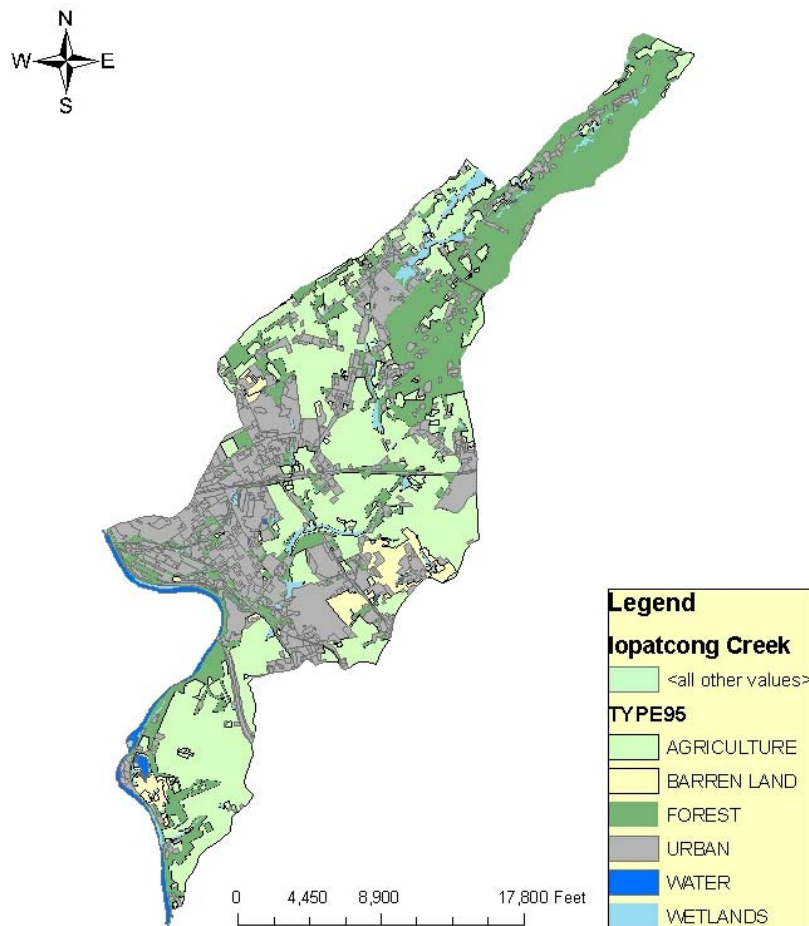


Figure 3 **Spatial extent of the Land Use for Lopatcong Creek at Main St in Phillipsburg (DRBCNJ0028)**



**Figure 4 Spatial extent of the Land Use for Musconetcong River at Lockwood
(01455801)**

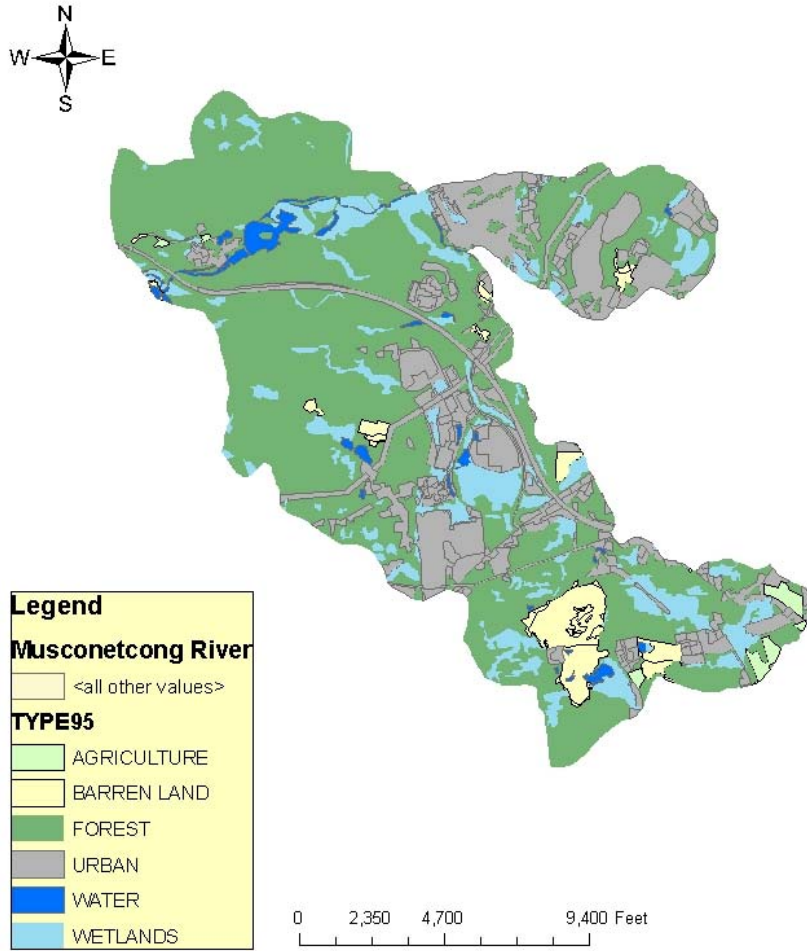


Figure 5 **Spatial extent of the Land Use for Paulins Kill at Warbasse Junction Rd near Lafayette (01443250)**

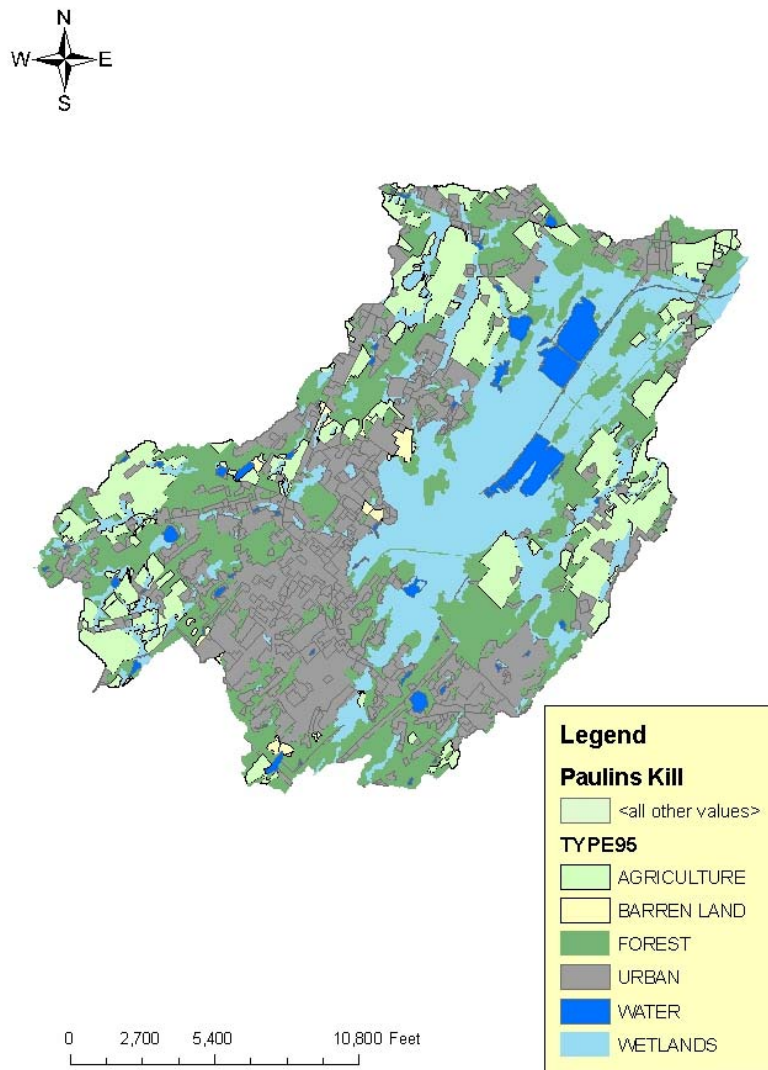
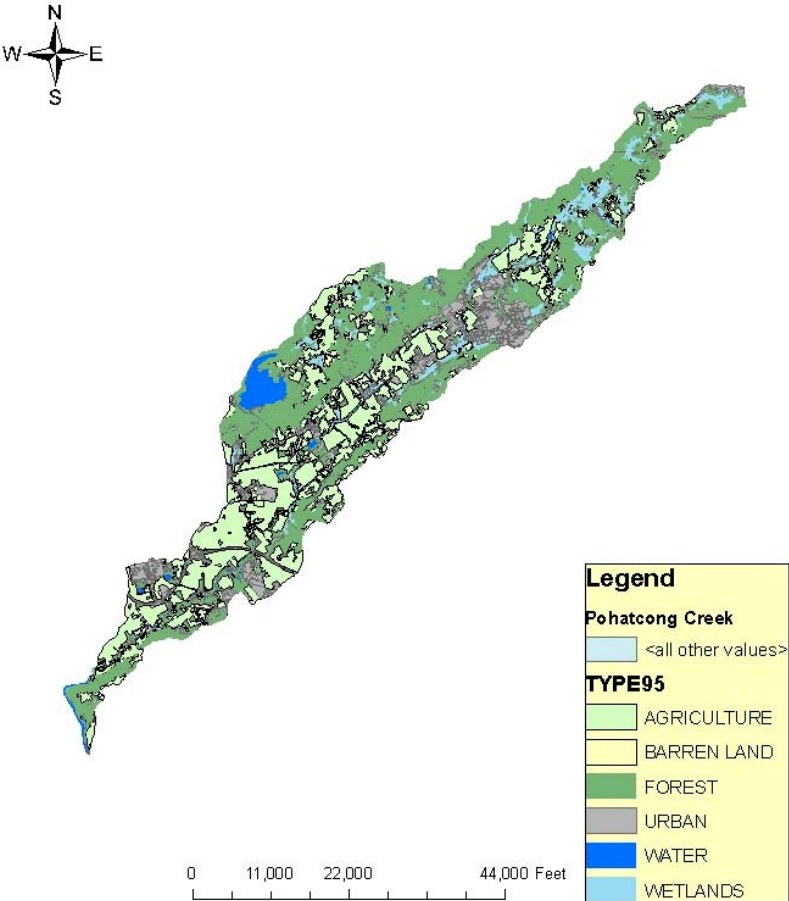


Figure 6 Spatial extent of the Land Use for Pohatcong Creek at River Rd Bridge (DRBCNJ0027)



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 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 **Lokatong 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 Lokatong 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.

Table 4 River miles, Watershed size, and Anderson Land Use classification for three Sublist 5 segments, listed for fecal coliform, in WMA 11.

	Segment ID		
	DRBCNJ0023	DRBCNJ0003	01461220, 01461300 & DRBCNJ0012, 01461282
Sublist 5 impaired river miles (miles)	8.0	2.1	38.0
Total river miles within the delineated watershed and included in the implementation plan (miles)	39.364	14.124	44.739
Watershed sizes (acres)	11101	4997	17146
Land use/Land cover			
Agriculture	28.7%	33.8%	38.8%
Barren Land	0.1%	0.4%	0.1%
Forest	40.5%	28.1%	31.7%
Urban	20.7%	32.1%	10.4%
Water	0.3%	0.5%	0.4%
Wetlands	9.7%	5.1%	18.6%

Figure 7 Spatial extent of Sublist 5 segments for which TMDLs are being developed in WMA 11

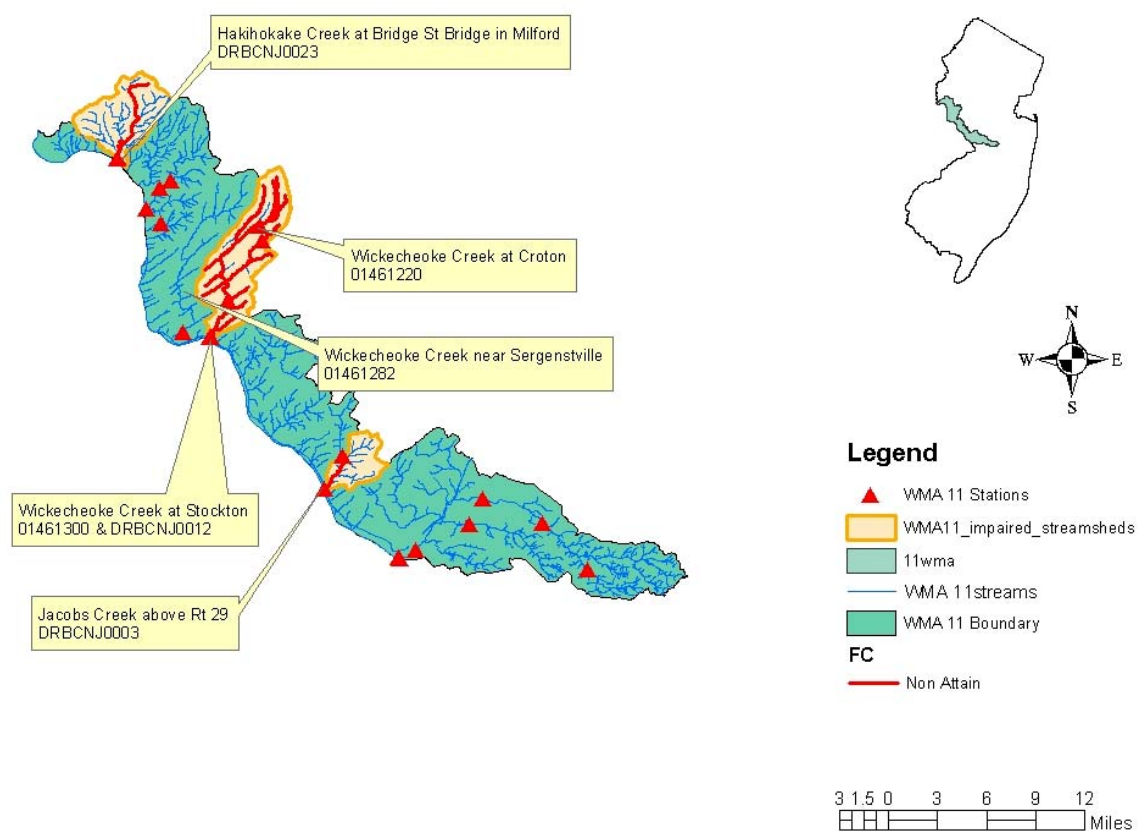


Figure 8 Spatial extent of the Land Use for Hakiwokake Creek at Bridge St Bridge in Milford (DRBCNJ0023)

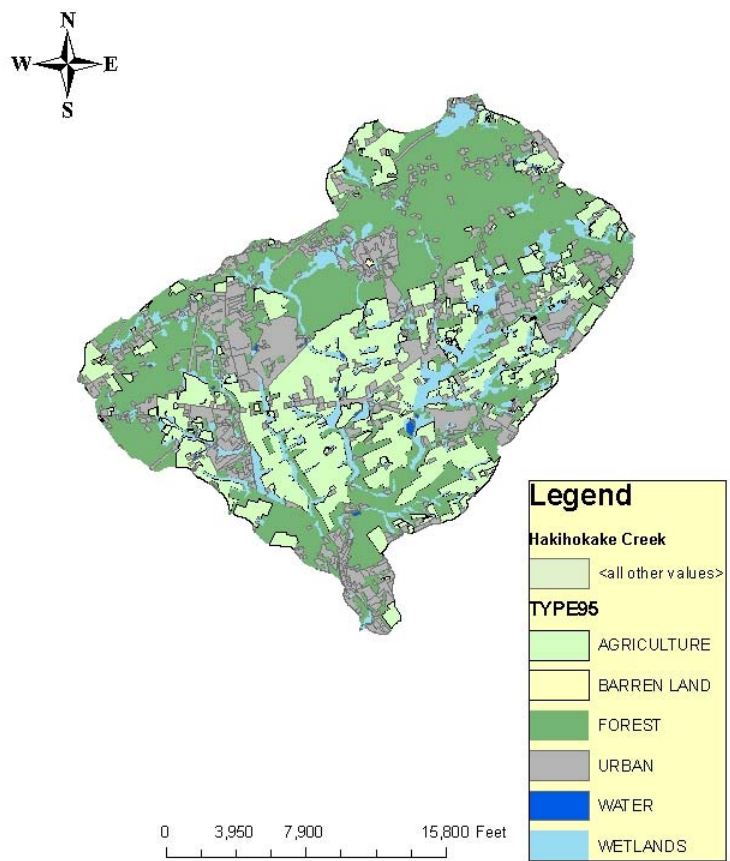


Figure 9 Spatial extent of the Land Use for Jacobs Creek above Rt. 29 (DRBCNJ0003)

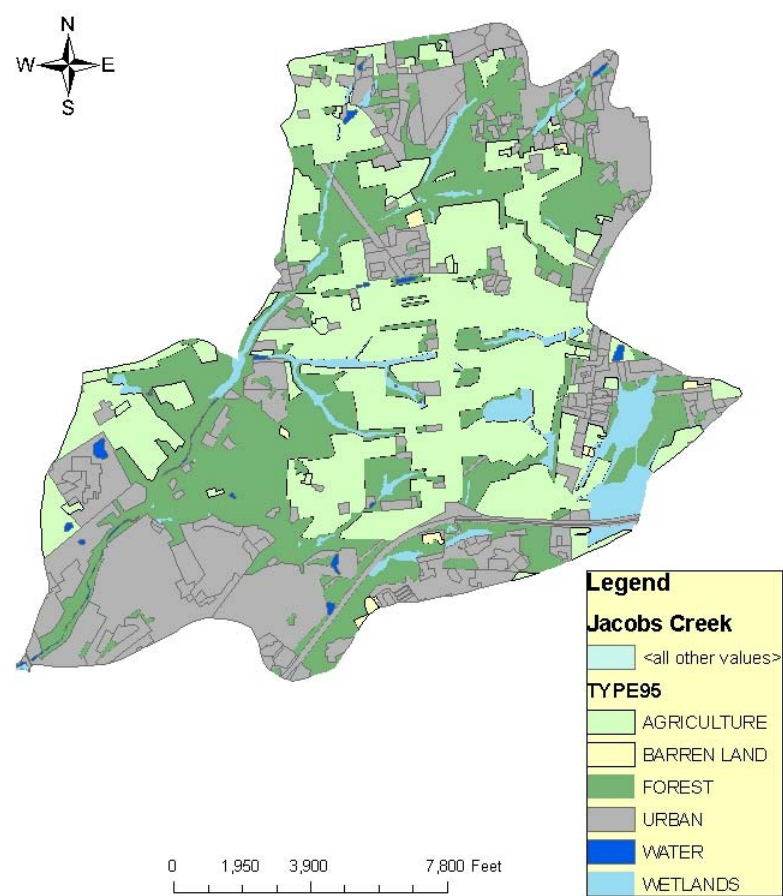
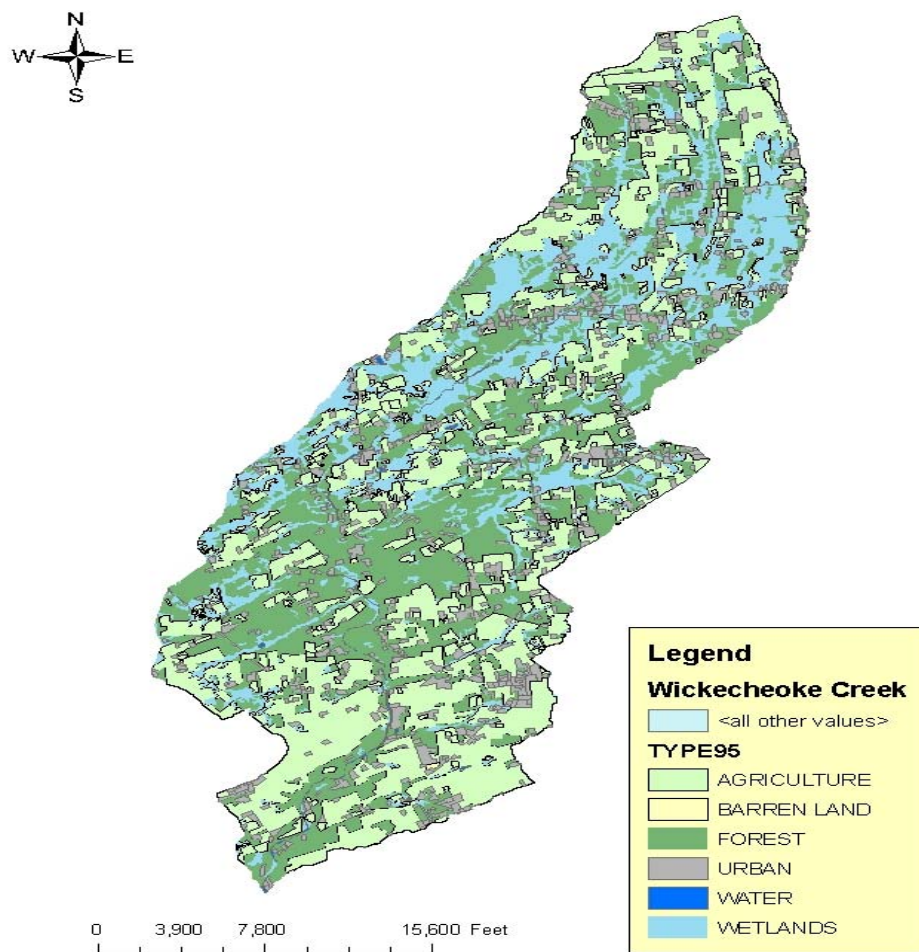


Figure 10 **Spatial extent of the Land Use for Wickecheoke Creek at Croton (01461220), Wickecheoke Creek at Stockton (01461300 & DRBCNJ0012), Wickecheoke Creek near Sergenstville (01461282)**



Data Sources

The Department's Geographic Information System (GIS) was used extensively to describe the Northwest watershed characteristics. The following is general information regarding the data used to describe the watershed management area:

- Land use/Land cover was taken from: "NJDEP 1995/97 Land use/Land cover Update for New Jersey (by WMA)", published 12/01/2000 by the NJDEP, Office of Information Resources Management (OIRM), Bureau of Geographic Information and Analysis (BGIA), and delineated by watershed management area.
- "NJDEP 2004 Integrated Report Results for Non-Tidal Rivers", published 6/2004 by NJDEP, Watershed Assessment Group (WAT). Online at: http://www.state.nj.us/dep/gis/digidownload/images/ir2004/ir_river_conventionals2004.gif
- County Boundaries: Published 01/23/2003 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 of New Jersey: Published 11/01/1998 by the NJDEP, Office of Information Resources Management (OIRM), Bureau of Geographic Information and Analysis (BGIA). "NJDEP Streams of New Jersey (1:24000)." Online at: <http://www.state.nj.us/dep/gis/strmshp.html>
- NJDEP 14 Digit Hydrologic Unit Code delineations for New Jersey (DEPHUC14), published 4/5/2000 by Department of Environmental Protection (NJDEP), New Jersey Geological Survey (NJGS). Online at: <http://www.state.nj.us/dep/gis/digidownload/zips/statewide/dephuc14.zip>
- NJDEP Digital Elevation Grid for New Jersey (10 meter) published 10/01/2004 by NJ Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information Systems (BGIS). Online at: <http://www.nj.gov/dep/gis/wmalattice.html>
- "NJPDES Surface Water Discharges in New Jersey, (1:12,000)", published 09/12/2002 by NJDEP, Environmental Regulation (ER), Division of Water Quality (DWQ), Bureau of PointSource Permitting - Region 1 (PSP-R1). Online at: <http://depnet/gis/digidownload/images/statewide/njpdeswd.gif>

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

4.0 Source Assessment

In order to evaluate and characterize fecal coliform loadings in the waterbodies of interest in these TMDLs, and thus develop 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.

Assessment of Point Sources other than Stormwater

Wastewater treatment plant discharges within the spatial extent for these TMDLs are listed in Appendix A. 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 wastewater treatment plants and will not result in changes to existing effluent limits.

Assessment of Nonpoint and Stormwater Point Sources

Nonpoint and stormwater point sources include runoff from various land uses that transport fecal coliform from sources such as geese, farms, and domestic pets to the receiving water. Nonpoint sources also include inputs that do not depend on precipitation events such as failing sewage conveyance systems, and failing or inappropriately located septic systems. Stormwater point sources are distinguished from nonpoint sources that derive from stormwater in that they are regulated under the NJPDES program. For Hakiwokake Creek, the Phase II MS4 program is currently limited to public education and control of stormwater from new development and redevelopment through ordinances.

5.0 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:

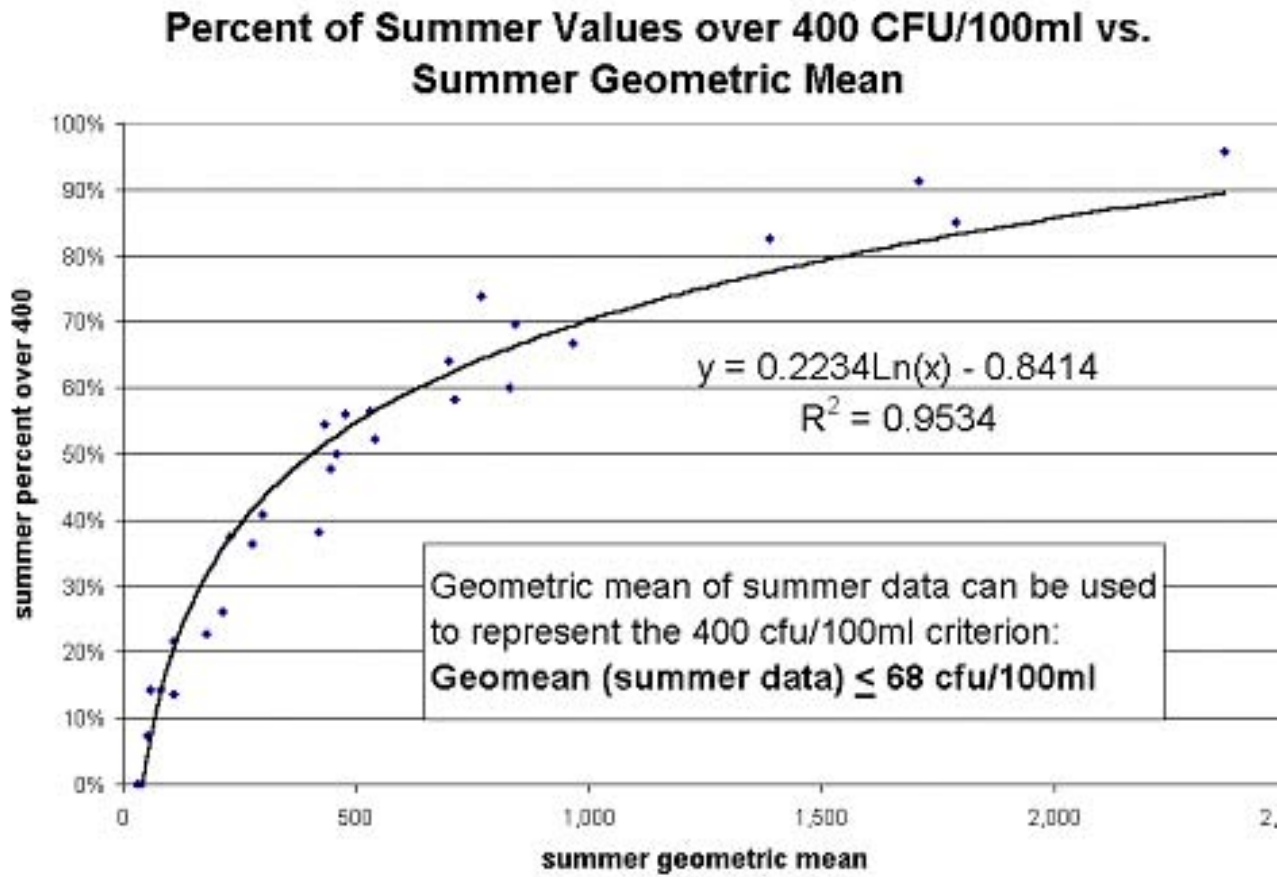
- expressing a bacteria TMDL in terms of concentration provides a direct link between existing water quality and the numeric target;
- using concentration in a bacteria TMDL is more relevant and consistent with the water quality standards, which apply for a range of flow and environmental conditions; 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 3). Thus, each data point on Figure 3 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 the discussion of seasonal variation and critical conditions.

Figure 11 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.

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

Where:

y = sample measurement

n = total number of samples

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

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

where:

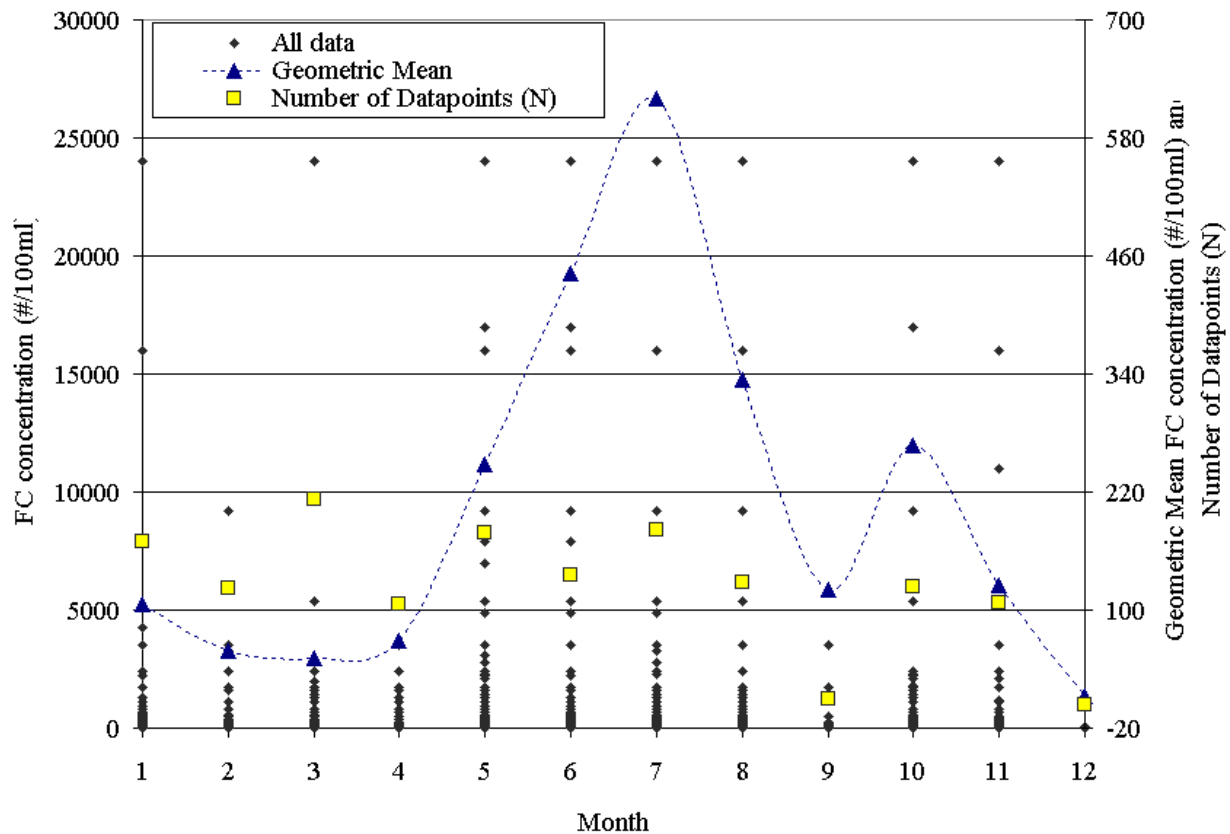
e = (margin of safety)

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.

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 4. The 1994-1997 period was chosen for this analysis so that the significance of the number of individual data points 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 4, 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 12 **Statewide monthly fecal coliform geometric means during water years 1994-1997 using USGS/NJDEP data.**



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.

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

$$\text{as: } \frac{(GM - (200 - e))}{GM} \cdot 100\%$$

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

6.0 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:

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

LC = loading capacity for a particular stream;
 PR = percent reduction as specified in Table 6;
 L_o = current load.

Wasteload Allocations and Load Allocations

Wastewater discharges in the segments for which TMDLs are being established are a de minimus source, as discussed previously, and the WLA calls for a zero percent reduction and will be expressed as the existing effluent limit of 200 CFU/100 ml as a monthly geometric mean

and 400 CFU/100 ml as a weekly geometric mean. WLAs are established for 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. Stormwater point sources receiving a WLA are distinguished from areas receiving a LA on the basis of land use.

This distribution of loading capacity between WLAs and LAs is consistent with recent EPA guidance that clarifies existing regulatory requirements for establishing WLAs for stormwater discharges (Wayland, November 2002). Stormwater discharges are captured within the runoff sources quantified according to land use, as described previously. Distinguishing between regulated and unregulated stormwater is necessary in order to express WLAs and LAs numerically; however, “EPA recognizes that these allocations might be fairly rudimentary because of data limitations and variability within the system” (Wayland, November 2002, p.1). Therefore allocations are established according to source categories as shown in Table 5. This demarcation between WLAs and LAs based on land use source categories is not perfect, but it represents the best estimate defined as narrowly as data allow. The Department acknowledges that there may be stormwater sources in the residential, commercial, industrial and mixed urban runoff source categories that are not NJPDES-regulated. Nothing in these TMDLs shall be construed to require the Department to regulate a stormwater source under NJPDES that would not already be regulated as such, nor shall anything in these TMDLs be construed to prevent the Department from regulating a stormwater source under NJPDES.

Table 5 Distribution of WLAs and LAs among source categories

Source category	TMDL allocation
Nonpoint and Stormwater Sources	
medium / high density residential	WLA
low density / rural residential	WLA
commercial	WLA
industrial	WLA
Mixed urban / other urban	WLA
agricultural	LA
forest, wetland, water	LA
barren land	LA

Table 6 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 B. In all cases, the 400 CFU/100ml criteria was the more stringent of the two

criteria, thus values reported in Table 6 were equal to the percent required to meet the 400 CFU/100ml criteria.

Table 6 TMDLs for fecal coliform-impaired stream segments in the Northwest Water Region as identified in Sublist 5 of the 2004 Integrated List of Waterbodies. The reductions reported in this table represent the higher, or more stringent, percent reduction required of the two fecal coliform criteria.

TMDL Number	WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Wasteload Allocation/Load Allocation (LA) and Margin of Safety (MOS)				
					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	01445900	01445900	Honey Run near Hope	10	570	51%	88%	94%
2	1	DRBCNJ0028	DRBCNJ0028	Lopatcong Creek at Main St in Phillipsburg	8	198	66%	66%	88%
3	1	01455801	01455801	Musconetcong River at Lockwood	46	256	27%	73%	81%
4	1	01443250	01443250	Paulins Kill at Warbasse Junction Rd near Lafayette	10	831	42%	92%	95%
5	1	DRBCNJ0027	DRBCNJ0027	Pohatcong Creek at River Rd Bridge	29	544	41%	88%	93%
6	11	DRBCNJ0023	DRBCNJ0023	Hakihokake Creek at Bridge St Bridge in Milford	8	86	74%	21%	80%
7	11	DRBCNJ0003	DRBCNJ0003	Jacobs Creek above Rt. 29	7	196	45%	65%	81%
8, 9, 10	11	01461220, 01461300, & DRBCNJ0012, 01461282	01461220, 01461300 & DRBCNJ0012, 01461282	Wickecheoke Creek at Croton, Wickecheoke Creek at Stockton, Wickecheoke Creek near Sergenstville	77	167	23%	59%	69%

¹ MOS as a percent of target is equal to: $\frac{e}{200 \text{ CFU} / 100\text{ml}}$ or $\frac{e}{68 \text{ CFU} / 100\text{ml}}$ where "e" is defined as the term in Section 5.0.

Reserve Capacity

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

7.0 Follow - up Monitoring

In association with the Water Resources Division of the U.S. Geological Survey, the NJDEP has cooperatively operated the Ambient Stream Monitoring Network (ASMN) in New Jersey since the 1970s. The ASMN currently includes approximately 115 stations that are routinely monitored on a quarterly basis. Bacteria monitoring, as part of the ASMN network, is 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. The ASMN will remain a principal source of fecal coliform monitoring to determine the effectiveness of implementing these TMDLs. In addition the Department will undertake microbial source trackdown where needed, as discussed under Implementation.

8.0 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” (MS4s) are regulated under the Department’s Phase II

NJPDES stormwater rules for the Municipal Stormwater Regulation Program. Under those rules and associated general permits, many municipalities (and various county, State, and other agencies) in the Northwest Region are 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 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. For Hakiwok Creek, the Phase II MS4 program is currently limited to public education and control of stormwater from new development and redevelopment.

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.

Other wildlife contributions include significant deer populations that have been identified as a potential fecal coliform source in the impaired watersheds. The forested and low-density residential areas that provide deer habitat can be found in close proximity to the impaired stream segments. Deer have been evaluated in fecal coliform TMDLs by other States (e.g. Alabama and South Carolina) and could be a fecal coliform source in New Jersey.

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 Conservation Reserve Enhancement Program** The New Jersey Departments of Environmental Protection and Agriculture, in partnership with the Farm Service Agency and Natural Resources Conservation Service, signed a \$100 million dollar CREP agreement. The program matches \$23 million of State money with \$77 million from the Commodity Credit Corp. within USDA. Through CREP, financial incentives are offered for agricultural landowners to voluntarily implement conservation practices on agricultural lands. NJ CREP will be part of the USDA's Conservation Reserve Program (CRP). There will be a ten-year enrollment period, with CREP leases ranging between 10-15 years. The State intends to augment this program thereby making these leases permanent easements. 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.

Management strategies are summarized as follows:

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 including any additional measures determined in the future to be needed through TMDL process	Municipality, 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
Agricultural practices	Confirm through source trackdown; SCD/NRCS develop conservation management plans	Property owner	EQIP, CRP, CREP
Wildlife			
Nuisance concentrations, e.g. 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

Source Trackdown

Efforts to identify sources include visual assessments and planned track-down monitoring, where appropriate.

Pathogen Indicators and Microbial 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 *Escherichia 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.

MST methods have already been successfully employed at the Department in the past decade. Since 1988, the Department 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, the Department has established a MST methodology that utilizes both genotype (genotyping of F+RNA coliphages) and phenotype (MAR testing) tests. The results of these tests are collectively evaluated to best determine sources of fecal contamination. The Bureau's methodology includes evaluation of long-term microbial results as well as data (GIS Land use coverage, aerial photographs, visual assessments) of actual and potential sources, stormwater monitoring to delineate location of major sources and the use of MAR and F+ coliphage in conjunction with conventional microbial indicators. This methodology has been successfully applied in several areas including; Seaside Park, Long Swamp, Atlantic City, and Parvin State Park. This methodology will be utilized on select TMDL segments as indicated.

Visual Assessment:

Through the watershed management process and the New Jersey Watershed Ambassadors Program, 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 visual assessments and biological assessment volunteer monitoring programs. Supplemental training is provided to prepare the members to perform river assessments on the fecal impaired segments. Each member is 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 visual assessments in March/April 2005.

The Department reviewed monitoring data, visual assessments, 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.

Segment Specific Recommendations

Watershed Management Area 1

Honey Run near Hope (Site ID #01445900)

This segment's primary land uses are field, forest, agriculture, and residential. Potential sources of fecal coliform include: drainage from tributaries (Muddy Brook/Buckaloo Creek) containing waterfowl; horses and other livestock; septic tanks in older development on steep slopes; and Swayze Mill Park recreational area near a large pond in proximity to Honey Run.

Monitoring: fecal coliform to narrow the scope and source of impairment; Coliphage and MAR to differentiate human, domestic and wildlife sources. Strategies: prioritize for EQIP funds to install agriculture BMPs; Phase II stormwater program.

Lopatcong Creek at Main St in Phillipsburg (Site ID #DRBCNJ0028)

This segment's primary land uses are commercial, agriculture, and residential. The segment includes fairgrounds, a golf course, and an animal hospital. Thus, domestic animals and wildlife are possible sources contributing to fecal coliform. There is an outfall pipe with an unknown drainage source present in the higher density recreational/housing areas in Phillipsburg along Lock St. that should be investigated. Monitoring: fecal coliform survey to narrow the scope and source of impairment; Coliphage and MAR to differentiate human, domestic and wildlife sources. Strategies: prioritize for EQIP funds to install agriculture BMPs; Phase II stormwater program.

Musconetcong River at Lockwood (Site ID #01455801)

Primary land uses in this area are forest and residential. A potential source contributing to fecal coliform is the abundance of wildlife existing in this area, in addition to residential runoff. Monitoring: fecal coliform sampling is recommended in order to confirm and refine the extent of impairment. Strategies: Phase II stormwater program.

Paulins Kill at Warbasse Junction Rd near Lafayette (Site ID #01443250)

Primary land uses in this area are forest, wetlands, agriculture, and residential. Potential sources contributing to fecal coliform include wildlife and livestock from farm production. Monitoring: fecal coliform survey to narrow the scope and sources of impairment. Strategies: prioritize for EQIP funds to install agriculture BMPs; Phase II stormwater program.

Pohatcong Creek at River Rd. Bridge (Site ID #DRBCNJ0027)

This segment's primary land uses include rural, agriculture, residential and a wildlife preserve. Within two miles upstream of its confluence with the Delaware River, several farms containing livestock are located within close proximity of the stream. A farm near the intersection of Creek Rd. and Mountain Rd., which houses livestock, contains an outfall draining into a stormwater inlet that leads directly into the Pohatcong. There are also a large chicken operation in the vicinity of Edison Rd. and Asbury Broadway Rd. and several farms with livestock enclosures upstream from this point. Pohatcong Creek Park contains a large population of waterfowl. There is also residential housing on septic systems in this area located in the floodplain, very close to the waterway. Monitoring: fecal coliform survey to narrow the scope and sources of impairment; Coliphage and MAR to differentiate human, domestic and wildlife sources. Strategies: prioritize for EQIP funds to install agriculture BMPs; Phase II stormwater program.

Watershed Management Area 11

Hakihokake Creek at Bridge St Bridge in Milford (Site ID #DRBCNJ0023)

This segment's primary land uses are forest, rural, and residential. Potential sources of fecal coliform include: several houses containing septic systems, an outhouse approximately ten feet from the stream, wildlife, including excessive populations of deer and bear, and farms containing horses and cows. Monitoring: fecal coliform to narrow the scope and source of impairment; Coliphage and MAR to differentiate human, domestic and wildlife sources. Strategies: prioritize for EQIP funds to install agriculture BMPs.

Jacobs Creek above Rt. 29 (Site ID #DRBCNJ0003)

This segment's primary land uses are residential, commercial, and agriculture. Possible sources contributing to fecal coliform may be septic systems from houses in residential areas, horses grazing in fields containing a drainage ditch to the stream, and a vast geese population in fields and corporate lawns of Merrill Lynch and Janssen Pharmaceuticals. Monitoring: fecal coliform to narrow the scope and source of impairment. Strategies: prioritize for EQIP funds to install agriculture BMPs; organize local community based goose management programs; Phase II stormwater program.

Wickecheoke Creek at Croton (Site ID #01461220), Wickecheoke Creek at Stockton (Site ID #01461300 & DRBCNJ0012), and Wickecheoke Creek near Sergenstville (Site ID #01461282)

Primary land uses in this area are forest, wetlands, and agriculture. Potential sources of fecal coliform include wildlife and livestock from agriculture production. Monitoring: fecal coliform survey to narrow the scope of impairment. Strategies: prioritize for EQIP funds to install agriculture BMPs.

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

- North Jersey RC & D, NRCS received a 319 (h) grant during SFY 01 in the amount of \$412,000.00. The project will include a dam removal, as well as a buffer planning and stream bank restoration on the Lopatcong at the Agway in Phillipsburg. In addition, this grant included a buffer planting on the Paulinskill at Footbridge Park in Blairstown. Future work, in regards to this grant, will include a stream bank restoration at a site in Greenwich Township along the Pohatcong. This project is scheduled to be finished June of 2006.

WMA 11

- The New Jersey Water Supply Authority (NJWSA) received a 319 (h) grant during SFY 05 in the amount of \$77,970.00 to develop a watershed restoration and protection plan for the Lockatong and Wickecheoke Creek watershed. NJWSA will compile existing information and data, as well as complete additional field sampling to characterize the area. The plan will include watershed-based technical standards, educational efforts, remedial projects and other implementation methods as necessary. Ordinances will be identified, adapted and recommended for adoption by the municipalities as appropriate. The plan will emphasize opportunities to link assistance programs of farm preservation and other approaches to reduce pollutant loads from agricultural operations.

9.0 Reasonable Assurance

With the implementation of follow-up monitoring, source identification and source reduction as described in general and for each segment, the Department has reasonable assurance that New Jersey's Surface Water Quality Standards will be attained for fecal coliform.

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.

10.0 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 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 on the expedited TMDL process.

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.

Additionally, beginning in March of 2005, GIS maps, including aerial photographs as well as USGS topographical maps of each segment were made available on the Department's website for review and comment. Interested parties had the opportunity to supply the Department with information about each TMDL segment via e-mail. The Department specifically solicited information regarding potential sources and/or current non point sources of pollution reduction projects within the impaired streamsheds.

Additional input was received through the NJ EcoComplex (NJEC). 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 have been proposed and will be adopted 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.

The notice proposing the TMDLs was published on May 2, 2005 in the New Jersey Register and the Star Ledger. The TMDL documents were made available at the Department, upon request by mail, and on the Department's website. The Department conducted a non-adversarial public hearing on June 20, 2005. The public comment period ended on July 5, 2005.

Department initiated changes include the following:

1. The New Jersey Environmental Management System (NJEMS), which contains NJPDES permitted facility information evaluated during TMDL development, has been listed under "Data Sources". This has been added to the document.
2. The priority ranking and other impairments in the subject stream segments that are not addressed in this TMDL have been noted in the document.

Two comment letters were received on the TMDLs. Seven people attended the public hearing; none testified.

The following people submitted written comments on the proposal:

Jennifer A. Murphy, Staff Attorney and David J. Jablonski, Intern
Mid-Atlantic Environmental Law Center
c/o Widener University School of Law
4601 Concord Pike, P.O. Box 7474
Wilmington, Delaware 19803

Barbara Sachau
15 Elm Street
Florham Park, New Jersey 07932

A summary of comments to the proposal, and the Department's Responses to those comments follow. The number(s) in brackets at the end of each comment corresponds to the commenter(s) listed above.

Comment 1.

The Department does not indicate that it developed the Northwest Water Region (NWWR) TMDL with the USEPA's guidance document, "Protocol for Developing Pathogen TMDLs", First Edition, January 2001, USEPA Document Number EPA 841-R-00-002, ("Pathogen Protocol"). The Department does not express a rationale for not using the Pathogen Protocol. The Pathogen Protocol is the more specific guidance document, and should have been utilized in the development of the NWWR TMDL. (1)

Response 1.

The USEPA guidance document "Protocol for Developing Pathogen TMDLs" establishes an organizational framework for states to utilize in the development of pathogen TMDLs. The Department did utilize this guidance in the development of New Jersey's statewide protocol for fecal coliform TMDLs. This document is included as a reference in Section 10.0 of the NWWR TMDL.

Comment 2.

The NWWR TMDL does not contain an analysis of the sampling data used to construct the NWWR TMDL. The proposed TMDL does not distinguish between the 10 stream segments in any manner regarding sampling data and the SWQS exceedances evidenced by that sampling data. At the least, the NWWR TMDL should be more specific as to; the date and time of sampling events, the location of sampling events, (including which stream segment and the sample location in that stream segment), the type of samples collected for each sampling; date, the sampling methods employed, the method(s) of analysis and the detected concentration of the sample. (1)

Response 2.

All data used in the TMDL process is publicly accessible through the internet at <http://waterdata.usgs.gov/nj/nwis/qw>. All water quality data for each stream segment was fully assembled prior to performing the calculations found in Section 5.0 Water Quality Analysis of the TMDL document. This analysis was done for each segment separately. The sampling information has been added to the document as an appendix for added

convenience. The Department performs an analysis of all available water quality data for assessed waters statewide to determine compliance with the Surface Water Quality Standards biennially to compile the Integrated Water Quality Monitoring and Assessment Report. The methods the Department used to develop the 2004 Integrated List of Water Bodies are described in detail in the 2004 Integrated Water Quality Monitoring and Assessment Methods Document. All water bodies that appear on Sublist 5 of the Integrated List have been assessed relative to the New Jersey Surface Water Quality Standards and found to be in non-attainment of the standards.

Comment 3.

The NWWR TMDL does not contain a rationale as to why the Department decided to group these 10 stream segments under the same TMDL. Each of these waterbodies is in a different County, and both are in different watershed management areas (NWWR TMDL, p. 8, 13). The Department has not addressed the relevant and pertinent issues within each of these impaired Watersheds, which would support the Department's decision to propose one TMDL for both stream segments. (1)

Response 3.

To clarify, the Department is proposing separate TMDLs for each of the impaired segments, based on the water quality data relevant to each. For convenience of review and to avoid unnecessary duplication, considering the application of the same approved TMDL method on multiple streams, the Department has grouped the impaired segments by water region in a single document. Tailoring of strategies for addressing each of the impaired segments, taking into account unique characteristics of each segment, is reflected in the section "Segment Specific Recommendations".

Comment 4.

The Department does not specify whether any of the 11 point source dischargers identified within impaired watersheds, (NWWR TMDL, Appendix A, p. 38), has "routinely achieved essentially complete disinfection". NWWR TMDL, p. 16. The Department provides no analysis regarding the facilities' operational history or their locations. The Department does not specify whether these point sources have an effluent limitation for fecal coliform. NWWR TMDL, p. 16. The Department offers absolutely no support for its statement, "[t]he percent of the total point source contribution is an insignificant fraction of the total load". NWWR TMDL, p. 16. The NWWR TMDL is inadequate because there is no meaningful analysis of the 11 identified point sources, two of which are labeled "major" discharges, (NWWR TMDL, Appendix A, p. 38), and their impact on the 10 stream segments. (1)

Response 4.

In Sections 4.0 Source Assessment and 6.0 TMDL Calculations of the RWR TMDL, the Department identifies 11 wastewater treatment plants within the impaired watersheds, other than stormwater, which discharge to the impaired segments. Two are minor industrial discharges and nine are domestic treatment works, all of which contribute a de minimus load. The WLA is expressed as a 0% reduction. For clarity, the existing effluent limit for domestic treatment works has been added to the text and a map of the discharge locations

has been added to the appendices. The noted discharges and municipal stormwater point sources are the only point sources, as this term is applied in TMDL development, in the impaired segments. WLAs are established for stormwater discharges subject to regulation under the Clean Water Act. In accordance with EPA guidance discussed in the document, stormwater point sources receive a WLA expressed as a percentage reduction for particular stream segments on the basis of land use. The Department recognizes sewage conveyances and septic malfunctions as potential sources of fecal coliform in Section 4.0 Source Assessment and in Section 8.0 Implementation, but is not aware of any actual malfunctions. This potential would be as the result of a malfunction, not by design. The Department investigates reports of noncompliance with NJPDES permits, illegal point and nonpoint discharges, and accidental discharges. These discharges are not considered ongoing point sources that warrant a WLA; rather, they are ephemeral events that are promptly addressed through compliance and enforcement measures as they occur. Segment specific recommendations include track down monitoring, as appropriate, to identify if any human sources, eg, malfunctioning conveyance systems or septic systems, are actually present. If such sources are found to exist, they will be referred for appropriate compliance measures and/or management measures. With regard to permitting of septic systems, Chapter 199 establishes requirements for septic system design and installation. Permitting for these systems is a local function, except that the Department certifies designs for development that includes 50 or more reality improvements.

Comment 5.

The Department mischaracterizes nonpoint sources of pathogen impairment by including sanitary sewer overflows (SSOs) as a nonpoint source of pathogen impairment. The Department contends that nonpoint sources include "inputs" that are not dependent on precipitation events including Sanitary Sewer Overflows (SSOs), (NWWR TMDL, p. 16). (1)

Response 5.

The commenter is correct that sanitary sewer overflows are point sources. However, there are no legally existing SSOs in New Jersey. Any discharge from a sanitary sewer line would be an event that is subject to compliance and enforcement action, and is, therefore, not characterized as an on-going point source. To avoid any confusion, the Department has revised the language in the TMDL document.

Comment 6.

The NWWR TMDL does not provide any location-specific sources of pathogen impairment in the 10 stream segments, nor does the NWWR TMDL provide a sufficient level of detail of the specific land uses and land cover present within the impaired stream watersheds. The Department has identified the following possible sources of pathogen impairment; failing sewage conveyances systems, SSOs, failing or inappropriately located septic systems, geese, wildlife, farms and domestic pets (NWWR TMDL, p.13). The Department does not discuss where or to what extent these sources are located within the impaired watersheds or spatially related to the rivers themselves. The Department should use a more detailed land use breakdown in the TMDL. (1)

Response 6.

The Department disagrees. Location specific information regarding sources is provided in the Segment Specific Recommendations section of the TMDL document. Further, the implementation plan describes the process by which, through the watershed restoration plans for priority segments, more detailed work plans for restoration will be developed. The land use classification system used in the TMDL document contains the most current land use information to assess sources. Land use is not used in these TMDLs to quantify pollutant loadings and, therefore, a more detailed analysis is not warranted.

Comment 7.

The Department does not discuss whether domestic or industrial wastewater sludge or other solid wastes are being land applied within the impaired watersheds. (1)

Response 7.

No dedicated domestic or industrial wastewater sludge land application sites are present within the impaired watersheds.

Comment 8.

The Department defines stormwater point sources, and distinguishes NJPDES permitted stormwater discharges from nonpoint sources, but does not indicate if any NJPDES stormwater point sources are within any of the 10 stream segments. The Department states, "stormwater discharged to the impaired segments through 'small municipal separate storm sewer systems' (MS4s) are regulated under the Department's Phase II Municipal Stormwater Regulation Program" (NWWR TMDL, p. 26-27). The Department has failed to identify the location of these MS4s within the impaired watersheds. In addition, the Department indicates does not specify when Phase II measures will be effective. The MS4 program should be fast tracked for these ten areas in order to actually implement the reductions through MS4 permits. (1)

Response 8.

With regard to MS4s, the Department has supplied the Tier A and Tier B classifications for the municipalities within the areas affected by the TMDLs as an appendix. All 566 municipalities within the State are assigned regulated as either Tier A or Tier B. Tier A municipalities are located within the more densely populated regions of the state or have drainage to the coast. Tier B municipalities are more rural and in non-coastal regions. Both Tier A and Tier B municipalities have NJPDES permits, but only Tier A municipalities are considered point sources under the Clean Water Act. This is explained in the TMDL report. Also explained are Statewide Basic Requirements (SBRs) applicable to each tier. More detail regarding the municipal stormwater permitting program can be found at the Department's website at njstormwater.org. The TMDL report explains that stormwater point sources are addressed by assigning a percent reduction as a WLA to land uses that are deemed equivalent to the areas regulated as point sources. Therefore, the location of these point sources is the urban land use area given in Figures 2, 3, 4, 5, 6, 8, 9, and 10 in the TMDL report. The implementation schedule for the municipal stormwater permitting program has already been set forth in rules and can be found at www.njstormwater.org. The Department

believes that this schedule is sufficiently aggressive and would note that the requirements, such as street sweeping and inlet cleanout, are now operative.

Comment 9.

The Department contends, "[r]elating 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" (NWWR TMDL, p. 16). The Department further contends the above facts warrant using "a concentration set to meet the state water quality standard" to express load capacity (NWWR TMDL, p. 17). The Department is essentially proposing to establish the loading capacity for the 10 streams as the SWQS. This is inadequate because the purpose of the TMDL is to ensure compliance with the SWQS. In addition, this method requires a less detailed analysis of the sources of pathogen impairment, and broader, less specific, decision-making regarding reductions in the identified sources of pathogen impairment. This is evidenced by the broad, generalized nature of the NWWR TMDL as a whole. The Department should allocate more resources to the source assessment portion of the TMDL.

(1)

Response 9.

While the purpose of a TMDL is to identify the load of a pollutant that can be assimilated by a waterbody and still attain surface water quality standards and support designated uses, allocate that loading capacity to point sources, nonpoint sources and a margin of safety, the means to achieve the standards is through implementation of management measures that will result in the necessary load reductions. The Department believes that the technical approach used to establish the loading capacity should consider the uncertainties (gaps and variability) in the data, the ability to model and predict concentration response relative to loadings, and the predictability of achieving a load reduction from applying a given management measure. The approach used in these TMDLs is appropriate to the parameter being addressed, including the variability and unpredictability of sources and effectiveness of management measures. The inclusion of both an implicit and explicit Margin of Safety (MOS) as part of the TMDL calculation is a reflection of the uncertainties and provides for reasonable assurance that the standard will be met. EPA has accepted this TMDL approach in over 170 previously approved TMDLs. With regard to identification and implementation of management measures, the Department has gathered information on the impaired segments. Detailed stream characterization information has been gathered from many useful sources including: solicited public input, stream-walks conducted by Department-trained AmeriCorps members, and field visits. This information, as well as the generic approaches that apply to source types wherever they are found to exist, is the basis for the preliminary implementation plan, which includes a plan for source trackdown and identification, as needed. Through its watershed management initiative, the Department is developing detailed watershed restoration workplans for each stream segment with a TMDL, on a priority basis. These workplans take the preliminary implementation plan to the next level and are the basis for targeting available funds, as discussed in the TMDL report, to effect specific projects to achieve load reductions. The Department believes it is more effective in

achieving water quality improvement to devote resources to implementation measures than to attempt to precisely quantify and model fecal coliform loads.

Comment 10.

The Department does not provide a discussion regarding why it chose to focus solely on bacteria when discussing the load capacity being expressed as a concentration (NWWR TMDL, p. 17). The Department does not discuss viruses or protozoa, generally grouped under the pathogen heading. (1)

Response 10.

Waterbodies are listed as impaired when a water quality standard or designated use is not attained. TMDLs are then prepared to determine the load reductions of a pollutant necessary to attain the standard/designated use. The TMDL for fecal coliform does not discuss other pathogens, such as viruses or protozoa, because the SWQS are expressed in terms of fecal coliform and there are no standards for specific pathogens, such as viruses or protozoa. The Department assesses streams for sanitary quality by using fecal coliform because it is a widely accepted indicator of the sanitary quality of the water. As stated in EPA Protocol for Developing Pathogen TMDLs, pathogenic organisms present in polluted water are few and difficult to isolate; therefore, an indicator organism is chosen because it is more easily sampled and measured. Indicator organisms are assumed to indicate the presence of all human pathogenic organisms.

Comment 11.

The Department does not provide sufficient detail on the relationship between the proposed percent reductions, the assigned WLAs and LAs and the eight source categories listed in Table 5 (NWWR TMDL, p. 24). In addition, the Department does not adequately explain how the percent reductions, the assigned WLAs and LAs and the calculated MOS will result in the ten stream segments meeting the SWQS in the future. The implementation plan proposed by the Department for the NWWR TMDL is insufficient because it lacks the specificity required to implement the purpose of the TMDL process, which is to ensure the attainment of the established water quality standards. (1)

Response 11.

The TMDL approach employed here does not attempt to model the relationship between load and concentration as previously explained. The Department's strategy is to reduce the nonpoint and stormwater point sources to the extent practicable using BMPs, based on the reasonable initial assumption that, if sources are controlled, SWQS will be attained. If, through follow up monitoring, it is determined that SWQS are not met, then, in accordance with the adaptive management paradigm, the Department will identify additional measures, such as stormwater management retrofits, that will be implemented in order to attain SWQS.

Comment 12.

There is no information provided regarding where the 115 monitoring stations in the Ambient Stream Monitoring Network (ASMN) program are in relation to the impaired stream segments.

In addition, the Department does not provide a link between the follow-up monitoring and the verification of attainment of the established percent reductions for the identified sources of pathogen impairment. (1)

Response 12.

Figures 1 and 2 in the TMDL report identify the locations of the monitoring stations within the impaired segments that were used to assess the segments, resulting in placement on Sublist 5 of the Integrated List. The ASMN program was used to compile the list of impaired waterbodies and will be used to evaluate SWQS attainment in the future. If the ASMN monitoring data demonstrates compliance with the SWQS, then TMDL implementation will be deemed successful and the waterbody will be placed on Sublist 1. The follow-up monitoring discussed in the implementation section is intended for relative source identification to inform targeting management measures, not for effectiveness evaluation.

Comment 13.

The Department does not indicate why it has not been identifying and preventing unauthorized discharges from the wastewater collection systems in the impaired watersheds prior to the proposal of this TMDL. (1)

Response 13.

While the Department does not explicitly state it in the document, the Department and the entities maintaining the wastewater collection systems routinely respond to unauthorized discharges as they are identified.

Comment 14.

The Department offers no timeframe when they intend to implement the proposed management strategies in the impaired watersheds or when the fecal coliform SWQS for the impaired streams will be attained. (1)

Response 14.

The elements of the plan for attaining the SWQS will proceed over time and may be adjusted, as needed, through adaptive management, to respond to results of the ambient monitoring program, which will be assessed at least every two years, until attainment of SWQS is demonstrated. The Department is currently engaged in source track down efforts for the fecal coliform TMDLs established in 2003. Plans are being developed to expand this project to carry out the track down monitoring for the current suite of proposed fecal coliform TMDLs. Once the data are available from the current and expanded monitoring projects they will be assessed and will inform further development and/or refinement of management measures to implement the TMDLs. In addition, it should be noted that the measures required under the municipal stormwater permitting program are currently operative. Further, the Department is continually working through its watershed management initiative to implement nonpoint source reduction strategies within the 20 watershed management areas, consistent with established TMDLs, using available resources. The TMDL documents provide the basis upon which regulatory action can be taken to implement management strategies. The Department has been and continues to target available resources, like the

319(h) grant program, Corporate Business Tax (CBT) revenues, and allied grant programs for agricultural areas (EQIP, CRP and CREP) to address fecal coliform sources in the impaired segments for which TMDLs were completed. Follow up monitoring will determine where efforts need to be stepped up or redirected to attain SWQS. For example, if it is determined that additional measures are needed to address stormwater sources subject to the municipal stormwater permitting rules, these measures will become requirements under the general permits issued by the Department. Finally, the TMDL process and adoption of the TMDLs as amendments to the applicable area-wide Water Quality Management Plans (WQMPs) is significant because it assures that plan amendments and permitting throughout the Department are consistent with the TMDLs. For example, implementation of septic management districts may be required through wastewater management plan updates where septic system sources are identified.

Comment 15.

It is unclear why the segment specific sources of pathogen impairment were not identified and discussed under section 4.0 "Source Assessment". The Department should have identified these sources under that section, and allocated WLAs or LAs to them as appropriate. The Department states, "[e]fforts to identify sources include visual assessments and planned track-down monitoring, where appropriate" (NWWR TMDL, p. 29). The Department does not provide an explanation as to its rationale for not conducting these activities prior to proposing the NWWR TMDL. In addition, the Department will need to elaborate on its course of action, if the source track-down efforts result in findings contrary to the NWWR TMDL or shows the NWWR TMDL is inadequate. (1)

Response 15.

WLAs and LAs have been established for each category of source, by land use. As the management measures to be applied are land use related, this is the appropriate level of detail for the WLAs and LAs. Detailed stream characterization information was gathered from many useful sources including: solicited public input, stream-walks conducted by Department-trained AmeriCorps members, and field visits. The Department relied on these information resources to tailor the segment specific recommendations in the implementation section. The data collected through track-down monitoring is intended and will be evaluated and used to inform implementation decisions. The Department's ambient monitoring network will be an on-going means to determine if SWQS have been and continue to be maintained or if adaptive management will direct refinement/enhancement of management measures.

Comment 16.

There is too much focus on birds and wildlife as the polluters, when the pollution should be attributed to the large human population in this state, and on factories and farming practices. Stormwater inlets should be cleaned up and pet waste collected. Wildlife and birds should be removed from this TMDL. (2)

Response 16.

The Department agrees that human sources, stormwater, pet waste and agriculture are among the sources of fecal coliform found in the waterbodies and has included them in the TMDL, but cannot ignore the wildlife sources as contributing to the fecal coliform present in the waterbodies. Wildlife populations in general are not a focus of implementation strategies. Overpopulation of certain wildlife species resulting from human activities, such as populations of Canada Geese, is a locally significant source of fecal contamination.

Comment 17. The Department should provide a greater level of detail as to why, “strategies for source reduction will apply equally well to new development as to existing development”, in particular, the Department needs to discuss how it intends to implement the source reductions to new development in the impaired watersheds. (1)

Response 17. New development is expected to contribute a de minimus load relative to the existing land use it replaces. This is because stormwater associated with newly developed areas will be controlled by the new stormwater management control requirements, and, in MS4 regulated areas, by the requirements in the municipal stormwater permitting rules. This is expected to effectively avoid increases in storm driven sources.

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Appendix A: NJPDES Permitted Surface Discharges Located in the TMDLs' Project Areas

WMA	Station #	NJPDES	Facility Name	Discharge Type^a	Receiving waterbody	WLA: de minimus source
1	DRBCNJ0028	NJ0004049	Phillipsburg Commerce Park	IMJ	Lopatcong Creek via unnamed trib	0% reduction
1	DRBCNJ0028	NJ0024716	Phillipsburg STP	MMJ	Lopatcong Creek	0% reduction
1	1455801	NJ0127850	Certified Aggregates Inc	IMI	Musconetcong River via ditch	0% reduction
1	1443250	NJ0024163	Big 'N' Shopping Center STP	MMI	Paulins Kill via unnamed trib	0% reduction
1	1443250	NJ0050580	Hampton Commons Wastewater Facility	MMI	Paulins Kill River via unnamed trib	0% reduction
1	1443250	NJ0020184	Town of Newton	MMJ	Moores Creek	0% reduction
1	DRBCNJ0027	NJ0020711	Warren Co Technical School STP	MMI	Pohatcong Creek	0% reduction
1	DRBCNJ0027	NJ0021113	Washington Borough WWTP	MMI	Pohatcong Creek	0% reduction
11	DRBCNJ0023	NJ0021890	Milford Sewer Utility	MMI	Hakihokake Creek	0% reduction
11	DRBCNJ0023	NJ0140619	Holland Twp Municipal Garage	IMI	Hakihokake Creek via unnmd trib & strm swr	0% reduction
11	01461220, 01461300 & DRBCNJ0012, 01461282	NJ0027561	Delaware Twp MUA	MMI	Wickecheoke Creek via unnamed trib	0% reduction

^a "MMI" indicates a Municipal Minor discharge and "MMJ" indicates a Municipal Major discharge. "IMI" indicates a Industrial Minor discharge and "IMJ" indicates a Industrial Major discharge.

Appendix B: TMDL Calculations

Load Allocation (LA) and Margin of Safety (MOS)															
				200 FC/100ml Standard					400 FC/400ml Standard						
WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	N (# of values)	Geometric mean CFU/100ml	MOS as a percentage of the target concentration	Percent reduction without MOS	Percent reduction with MOS	Summer N	Summer geometric mean CFU/100 ml	MOS as a percentage of the target concentration	Percent reduction without MOS	Percent reduction with MOS	Wasteload Allocation (WLA)	Period of records used in analysis
1	01445900	01445900	Honey Run near Hope	10	570	51%	65%	83%	10	570	51%	88%	94%	94%	8/1/01-8/7/02
1	DRBCNJ0028	DRBCNJ0028	Lopatcong Creek at Main St in Phillipsburg	8	198	66%	-1%	66%	8	198	66%	66%	88%	88%	7/22/99-6/7/00
1	01455801	01455801	Musconetcong River at Lockwood	86	131	27%	-53%	-12%	46	256	27%	73%	81%	81%	7/14/76-10/17/91
1	01443250	01443250	Paulins Kill at Warbasse Junction Rd near Lafayette	10	831	42%	76%	86%	10	831	42%	92%	95%	95%	7/5/01-6/5/02
1	DRBCNJ0027	DRBCNJ0027	Pohatcong Creek at River Rd Bridge	29	544	41%	63%	78%	29	544	41%	88%	93%	93%	7/1/99-9/25/02
11	DRBCNJ0023	DRBCNJ0023	Hakihokake Creek at Bridge St Bridge in Milford	8	86	74%	-132%	40%	8	86	74%	21%	80%	80%	8/2/99-9/28/00
11	DRCBNJ0003	DRBCNJ0003	Jacobs Creek above Rt. 29	7	196	45%	-2%	44%	7	196	45%	65%	81%	81%	7/20/99-6/5/00
11	01461220, 01461300 & DRBCNJ0012, 01461282	01461220, 01461300, DRBCNJ0012, 01461282	Wickecheoke Creek at Croton, Wickecheoke Creek at Stockton, Wickecheoke	10	126	23%	-59%	-23%	77	167	23%	59%	69%	69%	2/6/80-8/6/02

			Creek near Sergenstville												
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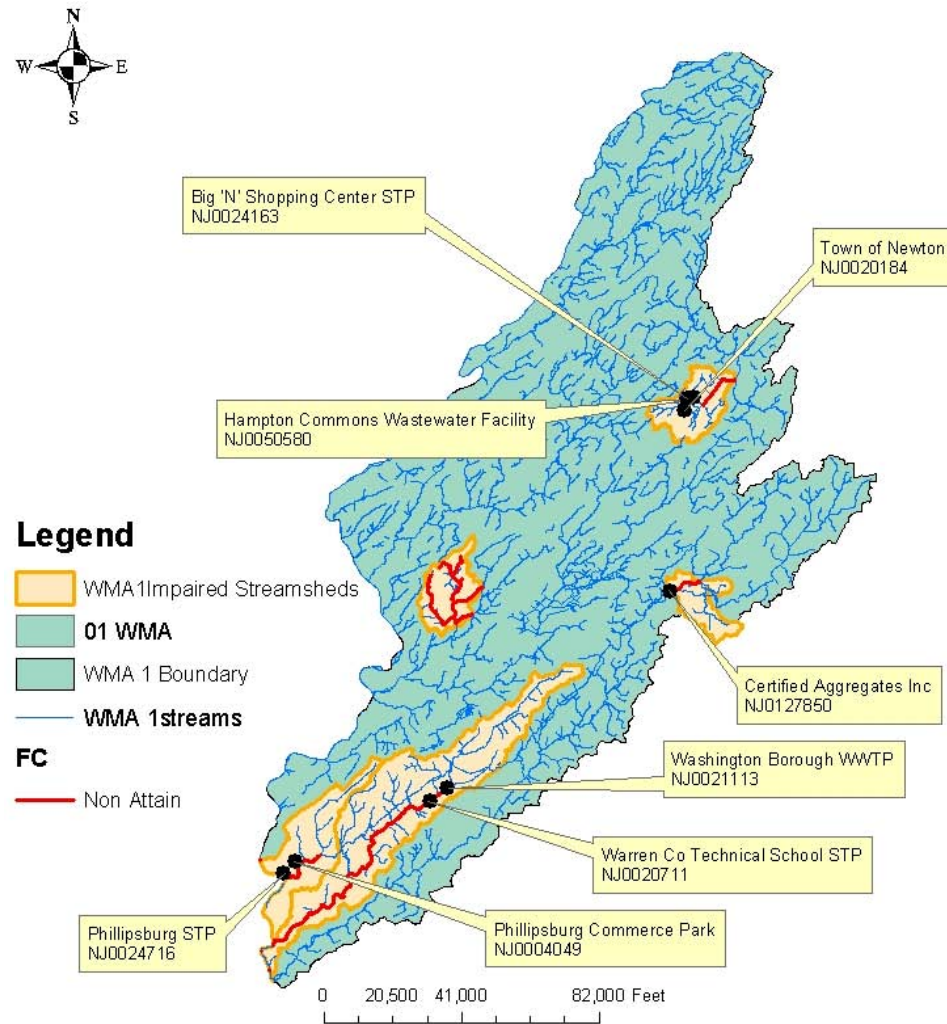
Appendix C: Tier A / Tier B Municipalities in Affected Drainage Areas

Station Name	Municipality	Discharge Type	NJPDES Permit No.
Honey Run near Hope	Blairstown	Tier B	NJG0153648
	Hope	Tier B	NJG0153001
	Knowlton	Tier B	NJG0153621
Lopatcong Creek at Main St in Phillipsburg	Harmony	Tier B	NJG0153061
	Lopatcong	Tier A	NJG0148881
	Phillipsburg	Tier A	NJG0149128
	Pohatcong	Tier A	NJG0149420
	Alpha Boro	Tier A	NJG0148334
	Greenwich	Tier A	NJG0151009
Musconetcong River at Lockwood	Byram	Tier A	NJG0149209
	Mount Olive	Tier A	NJG0148326
	Roxbury	Tier A	NJG0152641
	Stanhope	Tier A	NJG0151301
	Netcong	Tier A	NJG0151084
Paulins Kill at Warbasse Junction Rd near Lafayette	Hampton	Tier B	NJG0154644
	Lafayette	Tier B	NJG0151939

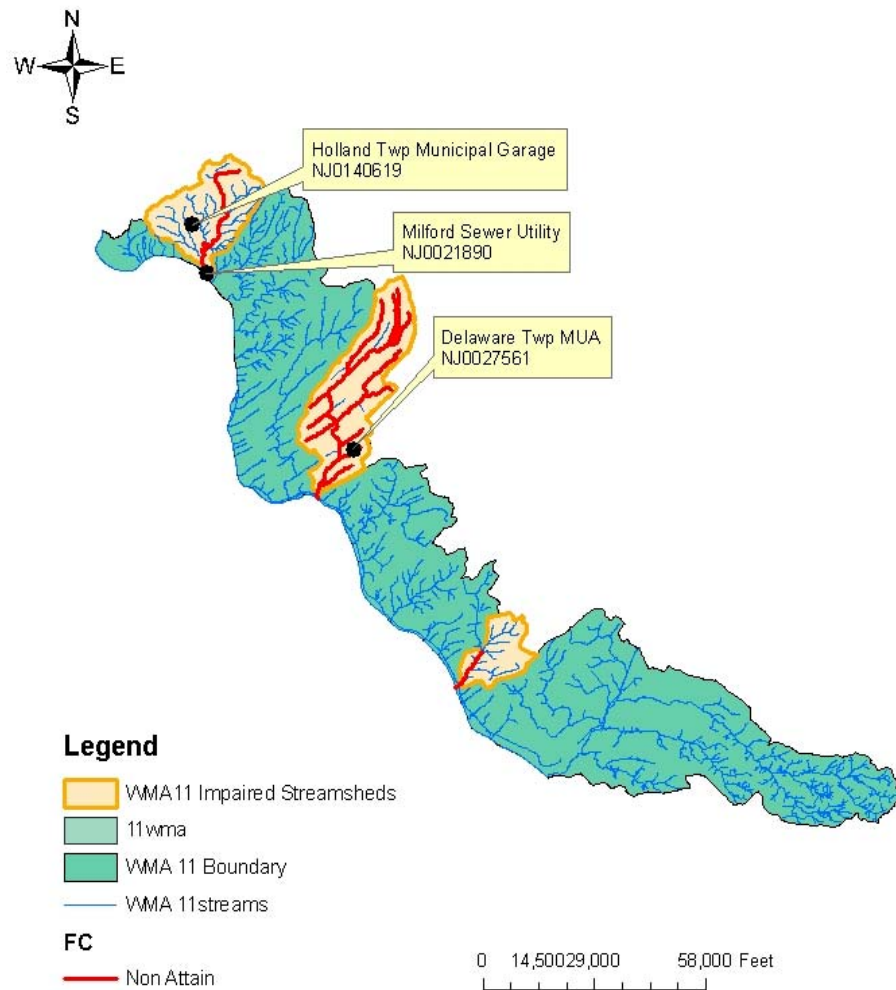
	Fredon	Tier B	NJG0152790
	Andover Twp	Tier A	NJG0153290
	Newton	Tier A	NJG0149969
Pohatcong Creek at River Rd Bridge	Pohatcong	Tier A	NJG0149420
	Alpha Boro	Tier A	NJG0148334
	Greenwich	Tier A	NJG0151009
	Harmony	Tier B	NJG0153061
	Lopatcong	Tier A	NJG0148881
	Franklin	Tier A	NJG0151025
	Washington	Tier A	NJG0149004
	Washington Boro	Tier B	NJG0147729
	Mansfield	Tier A	NJG0152633
	Independence	Tier A	NJG0153087
	White Twp	Tier B	NJG0149683
Hakihokake Creek at Bridge St Bridge in Milford	Alexandria	Tier B	NJG0149659
	Holland	Tier B	NJG0148024
	Union	Tier B	NJG0152978
	Bethlehem	Tier B	NJG0153010
	Milford Boro	Tier B	NJG0148211
Jacobs Creek above Rt. 29	Hopewell	Tier A	NJG0150622
	Ewing	Tier A	NJG0154393
	Pennington	Tier A	NJG0153141
Wickecheoke Creek at Croton	Franklin	Tire A	NJG0151025
	Raritan	Tier A	NJG0149241

	Kingwood	Tier B	NJG0152706
	Delaware	Tier B	NJG0150673
Wickecheoke Creek at Stockton	Franklin	Tier A	NJG0151025
	Raritan	Tier A	NJG0149241
	Kingwood	Tier B	NJG0152706
	Delaware	Tier B	NJG0150673
Wickecheoke Creek near Sergenstville	Franklin	Tier A	NJG0151025
	Raritan	Tier A	NJG0149241
	Kingwood	Tier B	NJG0152706
	Delaware	Tier B	NJG0150673

Appendix D: Dischargers in WMA 1 that are of interest for fecal coliform



Appendix E: Dischargers in WMA 11 that are of interest for fecal coliform



Appendix F: Sampling Data

Honey Run near Hope fecal coliform data (01445900)

USGS	Sampling Station	Date	Time	Results CFU/10 0 ml
USGS	1445900	8/1/2001	10:10	50
USGS	1445900	8/8/2001	9:15	490
USGS	1445900	8/15/2001	11:00	790
USGS	1445900	8/22/2001	10:30	700
USGS	1445900	8/29/2001	10:20	5400
USGS	1445900	7/10/2002	10:10	300
USGS	1445900	7/17/2002	10:22	230
USGS	1445900	7/24/2002	10:20	3000
USGS	1445900	7/31/2002	10:20	1400
USGS	1445900	8/7/2002	10:20	170

Lopatcong Creek at Main St in Phillipsburg fecal coliform data (DRBCNJ0028)

DRBC	Sampling Station	Date	Year	Results CFU/100 ml
DRBC	DRBCNJ0028	07/22/99	1999	80.0
DRBC	DRBCNJ0028	07/01/99	1999	13.0
DRBC	DRBCNJ0028	08/05/99	1999	
DRBC	DRBCNJ0028	08/19/99	1999	196.0
DRBC	DRBCNJ0028	07/26/00	2000	2000.0
DRBC	DRBCNJ0028	08/09/00	2000	
DRBC	DRBCNJ0028	09/13/00	2000	1480.0
DRBC	DRBCNJ0028	09/29/00	2000	
DRBC	DRBCNJ0028	06/21/00	2000	420.0
DRBC	DRBCNJ0028	07/12/00	2000	460.0
DRBC	DRBCNJ0028	08/23/00	2000	20.0
DRBC	DRBCNJ0028	06/07/00	2000	

Musconetcong River at Lockwood fecal coliform data (01455801)

USGS	Sampling Station	Date	Time	Results
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	Station			CFU/10 0 ml
USGS	1455801	7/14/1976	10:00	230
USGS	1455801	8/9/1976	11:15	50
USGS	1455801	9/15/1976	12:00	330
USGS	1455801	10/18/1976	11:30	20
USGS	1455801	11/30/1976	11:30	50
USGS	1455801	8/1/1977	11:45	20
USGS	1455801	9/19/1977	11:40	1100
USGS	1455801	10/31/1977	12:00	9200
USGS	1455801	1/30/1978	12:30	1300
USGS	1455801	3/21/1978	11:45	630
USGS	1455801	4/17/1978	11:40	20
USGS	1455801	5/8/1978	11:55	16000
USGS	1455801	6/12/1978	11:20	2530
USGS	1455801	1/23/1979	12:10	70
USGS	1455801	3/27/1979	11:45	20
USGS	1455801	5/24/1979	11:45	5400
USGS	1455801	10/9/1979	12:45	20
USGS	1455801	2/28/1980	9:00	50
USGS	1455801	4/21/1980	13:00	20
USGS	1455801	6/4/1980	10:40	490
USGS	1455801	7/15/1980	11:00	230
USGS	1455801	8/13/1980	10:45	110
USGS	1455801	9/30/1980	11:40	170
USGS	1455801	1/29/1981	11:15	20
USGS	1455801	3/24/1981	11:30	20
USGS	1455801	5/20/1981	12:30	20
USGS	1455801	7/7/1981	12:30	110
USGS	1455801	8/3/1981	12:00	20
USGS	1455801	10/5/1981	11:45	330
USGS	1455801	1/27/1982	12:30	20
USGS	1455801	4/5/1982	12:00	20
USGS	1455801	6/9/1982	11:00	1300
USGS	1455801	7/13/1982	11:30	170

USGS	1455801	8/16/1982	11:45	70
USGS	1455801	10/27/1982	12:20	20
USGS	1455801	1/18/1983	11:45	20
USGS	1455801	3/17/1983	12:15	20
USGS	1455801	5/18/1983	12:15	170
USGS	1455801	7/12/1983	12:15	70
USGS	1455801	8/2/1983	12:00	130
USGS	1455801	9/22/1983	12:45	1100
USGS	1455801	1/25/1984	11:45	80
USGS	1455801	3/21/1984	11:45	20
USGS	1455801	5/16/1984	11:45	20
USGS	1455801	7/11/1984	12:00	20
USGS	1455801	8/7/1984	12:00	330
USGS	1455801	9/27/1984	12:00	700
USGS	1455801	1/24/1985	11:45	20
USGS	1455801	3/19/1985	12:15	20
USGS	1455801	5/22/1985	11:45	70
USGS	1455801	7/8/1985	12:00	170
USGS	1455801	8/12/1985	11:45	490
USGS	1455801	11/20/1985	12:00	80
USGS	1455801	2/5/1986	12:15	20
USGS	1455801	3/24/1986	12:00	20
USGS	1455801	5/21/1986	12:30	490
USGS	1455801	7/15/1986	12:15	170
USGS	1455801	8/5/1986	12:00	220
USGS	1455801	10/15/1986	12:15	110
USGS	1455801	2/25/1987	12:15	20
USGS	1455801	4/1/1987	12:15	790
USGS	1455801	5/26/1987	12:30	330
USGS	1455801	7/16/1987	12:00	330
USGS	1455801	8/26/1987	12:15	80
USGS	1455801	11/4/1987	13:00	20
USGS	1455801	2/3/1988	12:00	20
USGS	1455801	5/12/1988	10:45	230
USGS	1455801	6/2/1988	12:45	230
USGS	1455801	7/5/1988	12:00	460

USGS	1455801	8/15/1988	12:00	1300
USGS	1455801	10/26/1988	11:00	130
USGS	1455801	1/24/1989	12:00	220
USGS	1455801	4/20/1989	13:30	80
USGS	1455801	6/20/1989	10:45	70
USGS	1455801	7/18/1989	12:15	170
USGS	1455801	8/31/1989	11:15	3500
USGS	1455801	11/28/1989	10:30	220
USGS	1455801	3/1/1990	12:15	20
USGS	1455801	7/24/1990	13:30	1300
USGS	1455801	8/7/1990	12:00	5400
USGS	1455801	10/29/1990	13:20	130
USGS	1455801	2/6/1991	12:30	40
USGS	1455801	3/26/1991	12:45	20
USGS	1455801	6/24/1991	12:30	230
USGS	1455801	8/7/1991	10:45	80
USGS	1455801	10/17/1991	12:30	5400

Paulins Kill at Warbasse Junction Rd near Lafayette fecal coliform data (01443250)

USGS	Sampling Date	Time	Results
	Station		CFU/10 0 ml
USGS	1443250	7/5/2001	10:40 490
USGS	1443250	7/11/2001	11:05 2200
USGS	1443250	7/18/2001	10:50 790
USGS	1443250	7/25/2001	11:30 460
USGS	1443250	8/1/2001	11:15 790
USGS	1443250	5/8/2002	10:45 400
USGS	1443250	5/15/2002	10:15 3000
USGS	1443250	5/22/2002	11:35 170
USGS	1443250	5/29/2002	10:25 5000
USGS	1443250	6/5/2002	10:45 500

Pohatcong Creek at River Rd Bridge fecal coliform data (DRBCNJ0027)

DRBC	Sampling Station	Date	Year	Results CFU/10 0 ml
DRBC	DRBCNJ0027	07/01/99	1999	880.0
DRBC	DRBCNJ0027	07/22/99	1999	2400.0
DRBC	DRBCNJ0027	08/05/99	1999	
DRBC	DRBCNJ0027	08/19/99	1999	320.0
DRBC	DRBCNJ0027	08/09/00	2000	
DRBC	DRBCNJ0027	07/12/00	2000	30.0
DRBC	DRBCNJ0027	07/26/00	2000	550.0
DRBC	DRBCNJ0027	09/13/00	2000	1180.0
DRBC	DRBCNJ0027	06/21/00	2000	510.0
DRBC	DRBCNJ0027	08/23/00	2000	380.0
DRBC	DRBCNJ0027	06/07/00	2000	
DRBC	DRBCNJ0027	09/29/00	2000	
DRBC	DRBCNJ0027	07/26/01	2001	21200.0
DRBC	DRBCNJ0027	06/21/01	2001	770.0
DRBC	DRBCNJ0027	08/09/01	2001	355.0
DRBC	DRBCNJ0027	08/22/01	2001	550.0
DRBC	DRBCNJ0027	09/12/01	2001	310.0
DRBC	DRBCNJ0027	09/26/01	2001	3910.0
DRBC	DRBCNJ0027	07/12/01	2001	1380.0
DRBC	DRBCNJ0027	05/24/01	2001	3500.0
DRBC	DRBCNJ0027	06/07/01	2001	760.0
DRBC	DRBCNJ0027	05/10/01	2001	300.0
DRBC	DRBCNJ0027	07/26/01	2001	22320.0
DRBC	DRBCNJ0027	05/09/02	2002	400.0
DRBC	DRBCNJ0027	05/23/02	2002	600.0
DRBC	DRBCNJ0027	06/04/02	2002	300.0
DRBC	DRBCNJ0027	06/20/02	2002	620.0
DRBC	DRBCNJ0027	07/10/02	2002	40.0
DRBC	DRBCNJ0027	07/24/02	2002	460.0
DRBC	DRBCNJ0027	08/07/02	2002	280.0
DRBC	DRBCNJ0027	08/21/02	2002	230.0

DRBC	DRBCNJ0027	09/12/02	2002	420.0
DRBC	DRBCNJ0027	09/25/02	2002	4.0

Hakihokake Creek at Bridge St Bridge in Milford (DRBCNJ0023)

DRBC Sampling Station	Date	Year	Results CFU/10 0 ml
DRBC DRBCNJ0023	08/02/99	1999	
DRBC DRBCNJ0023	08/24/99	1999	1.0
DRBC DRBCNJ0023	07/06/99	1999	264.0
DRBC DRBCNJ0023	07/27/99	1999	9.0
DRBC DRBCNJ0023	07/11/00	2000	190.0
DRBC DRBCNJ0023	09/12/00	2000	40.0
DRBC DRBCNJ0023	08/08/00	2000	
DRBC DRBCNJ0023	07/25/00	2000	760.0
DRBC DRBCNJ0023	06/20/00	2000	670.0
DRBC DRBCNJ0023	08/22/00	2000	330.0
DRBC DRBCNJ0023	09/28/00	2000	

Jacobs Creek above Rt. 29 (DRBCNJ0003)

DRBC Sampling Station	Date	Year	Results CFU/10 0 ml
DRBC DRBCNJ0003	07/20/99	1999	1240.0
DRBC DRBCNJ0003	08/17/99	1999	228.0
DRBC DRBCNJ0003	06/29/99	1999	144.0
DRBC DRBCNJ0003	08/02/99	1999	
DRBC DRBCNJ0003	09/11/00	2000	140.0
DRBC DRBCNJ0003	07/10/00	2000	240.0
DRBC DRBCNJ0003	07/24/00	2000	50.0
DRBC DRBCNJ0003	08/21/00	2000	160.0
DRBC DRBCNJ0003	08/07/00	2000	
DRBC DRBCNJ0003	09/27/00	2000	
DRBC DRBCNJ0003	06/05/00	2000	

Wickecheoke Creek at Croton fecal coliform data (01461220)

Sampling Station	Date	Results CFU/10 0 ml
01461220	06/08/99	170
01461220	06/16/99	2400
01461220	06/22/99	170
01461220	06/24/99	330

Wickecheoke Creek at Stockton fecal coliform data (01461300)

USGS Station	Sampling Date	Time	Results CFU/10 0 ml
USGS 1461300	2/6/1980	11:00	20
USGS 1461300	4/29/1980	10:30	1700
USGS 1461300	6/4/1980	12:45	700
USGS 1461300	7/16/1980	13:00	1800
USGS 1461300	8/20/1980	13:00	9200
USGS 1461300	10/1/1980	11:15	330
USGS 1461300	2/2/1981	12:30	24000
USGS 1461300	3/26/1981	13:30	20
USGS 1461300	6/3/1981	12:00	790
USGS 1461300	7/23/1981	11:00	490
USGS 1461300	8/26/1981	12:00	50
USGS 1461300	9/29/1981	9:45	130
USGS 1461300	2/25/1982	10:30	20
USGS 1461300	3/25/1982	13:45	20
USGS 1461300	6/2/1982	12:00	790
USGS 1461300	7/26/1982	11:30	60
USGS 1461300	8/26/1982	11:00	170
USGS 1461300	10/13/1982	13:15	20
USGS 1461300	1/27/1983	12:15	20
USGS 1461300	4/13/1983	11:30	50
USGS 1461300	6/9/1983	14:00	20
USGS 1461300	7/28/1983	11:00	20

USGS	1461300	8/24/1983	11:45	20
USGS	1461300	10/13/1983	10:15	490
USGS	1461300	1/18/1984	10:15	20
USGS	1461300	4/9/1984	11:30	20
USGS	1461300	5/21/1984	13:30	460
USGS	1461300	7/19/1984	13:45	2400
USGS	1461300	8/8/1984	13:45	230
USGS	1461300	9/24/1984	12:30	330
USGS	1461300	2/7/1985	12:00	20
USGS	1461300	4/17/1985	12:15	20
USGS	1461300	6/13/1985	11:20	20
USGS	1461300	7/24/1985	12:30	130
USGS	1461300	8/15/1985	11:45	130
USGS	1461300	10/24/1985	13:30	2400
USGS	1461300	2/4/1986	13:30	170
USGS	1461300	3/20/1986	13:30	20
USGS	1461300	5/20/1986	13:30	110
USGS	1461300	7/24/1986	11:45	80
USGS	1461300	8/7/1986	13:30	50
USGS	1461300	10/8/1986	14:00	40
USGS	1461300	1/29/1987	13:30	90
USGS	1461300	5/21/1987	12:30	20
USGS	1461300	7/28/1987	14:15	20
USGS	1461300	8/17/1987	11:00	330
USGS	1461300	10/8/1987	12:30	60
USGS	1461300	2/18/1988	12:15	60
USGS	1461300	3/30/1988	12:00	80
USGS	1461300	5/18/1988	11:00	1400
USGS	1461300	7/11/1988	12:30	170
USGS	1461300	8/22/1988	10:30	20
USGS	1461300	10/11/1988	11:30	20
USGS	1461300	2/8/1989	12:15	20
USGS	1461300	4/4/1989	11:45	130
USGS	1461300	5/22/1989	12:15	40
USGS	1461300	7/10/1989	12:30	130
USGS	1461300	8/2/1989	13:00	50

USGS	1461300	11/15/1989	13:30	20
USGS	1461300	3/1/1990	10:30	20
USGS	1461300	7/31/1990	11:45	110
USGS	1461300	8/16/1990	12:00	90
USGS	1461300	11/14/1990	13:00	140
USGS	1461300	2/4/1991	14:00	20
USGS	1461300	4/8/1991	12:00	20
USGS	1461300	5/20/1991	14:00	20

Wickecheoke Creek at Stockton fecal coliform data (DRBCNJ0012)

DRBC	Sampling Station	Date	Year	Results CFU/100 ml
DRBC	DRBCNJ0012	07/06/99	1999	128.0
DRBC	DRBCNJ0012	07/27/99	1999	200.0
DRBC	DRBCNJ0012	08/02/99	1999	
DRBC	DRBCNJ0012	08/24/99	1999	57.0
DRBC	DRBCNJ0012	07/10/00	2000	80.0
DRBC	DRBCNJ0012	06/19/00	2000	90.0
DRBC	DRBCNJ0012	08/07/00	2000	
DRBC	DRBCNJ0012	08/21/00	2000	330.0
DRBC	DRBCNJ0012	09/11/00	2000	310.0
DRBC	DRBCNJ0012	07/24/00	2000	1360.0
DRBC	DRBCNJ0012	06/05/00	2000	
DRBC	DRBCNJ0012	09/27/00	2000	
DRBC	DRBCNJ0012	08/07/01	2001	160.0
DRBC	DRBCNJ0012	09/25/01	2001	1040.0
DRBC	DRBCNJ0012	07/24/01	2001	65.0
DRBC	DRBCNJ0012	05/08/01	2001	54.0
DRBC	DRBCNJ0012	06/19/01	2001	500.0
DRBC	DRBCNJ0012	08/21/01	2001	50.0
DRBC	DRBCNJ0012	05/22/01	2001	7820.0
DRBC	DRBCNJ0012	07/10/01	2001	200.0
DRBC	DRBCNJ0012	09/17/01	2001	130.0
DRBC	DRBCNJ0012	06/05/01	2001	580.0

DRBC	DRBCNJ0012	07/10/01	2001	250.0
DRBC	DRBCNJ0012	05/07/02	2002	76.0
DRBC	DRBCNJ0012	05/21/02	2002	140.0
DRBC	DRBCNJ0012	06/05/02	2002	48.0
DRBC	DRBCNJ0012	06/18/02	2002	92.0
DRBC	DRBCNJ0012	07/09/02	2002	12.0
DRBC	DRBCNJ0012	07/23/02	2002	190.0
DRBC	DRBCNJ0012	08/06/02	2002	110.0
DRBC	DRBCNJ0012	08/20/02	2002	0.0
DRBC	DRBCNJ0012	09/10/02	2002	72.0
DRBC	DRBCNJ0012	09/24/02	2002	12.0

Wickecheoke Creek near Sergenstville fecal coliform data (01461282)

USGS	Station	Sampling Date	Time	Results CFU/100 ml
USGS	1461282	7/12/2001	9:30	490
USGS	1461282	7/19/2001	11:00	1100
USGS	1461282	7/26/2001	9:00	20
USGS	1461282	7/26/2001	10:00	3500
USGS	1461282	7/26/2001	10:30	790
USGS	1461282	7/26/2001	11:00	130
USGS	1461282	8/2/2001	9:30	50
USGS	1461282	8/9/2001	10:30	1700
USGS	1461282	7/9/2002	10:06	230
USGS	1461282	7/16/2002	10:31	110
USGS	1461282	7/25/2002	10:20	70
USGS	1461282	8/6/2002	11:07	500

**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:

**New Jersey Department of Environmental Protection
Division of Watershed Management
P.O. Box 418
Trenton, New Jersey 08625-0418**

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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

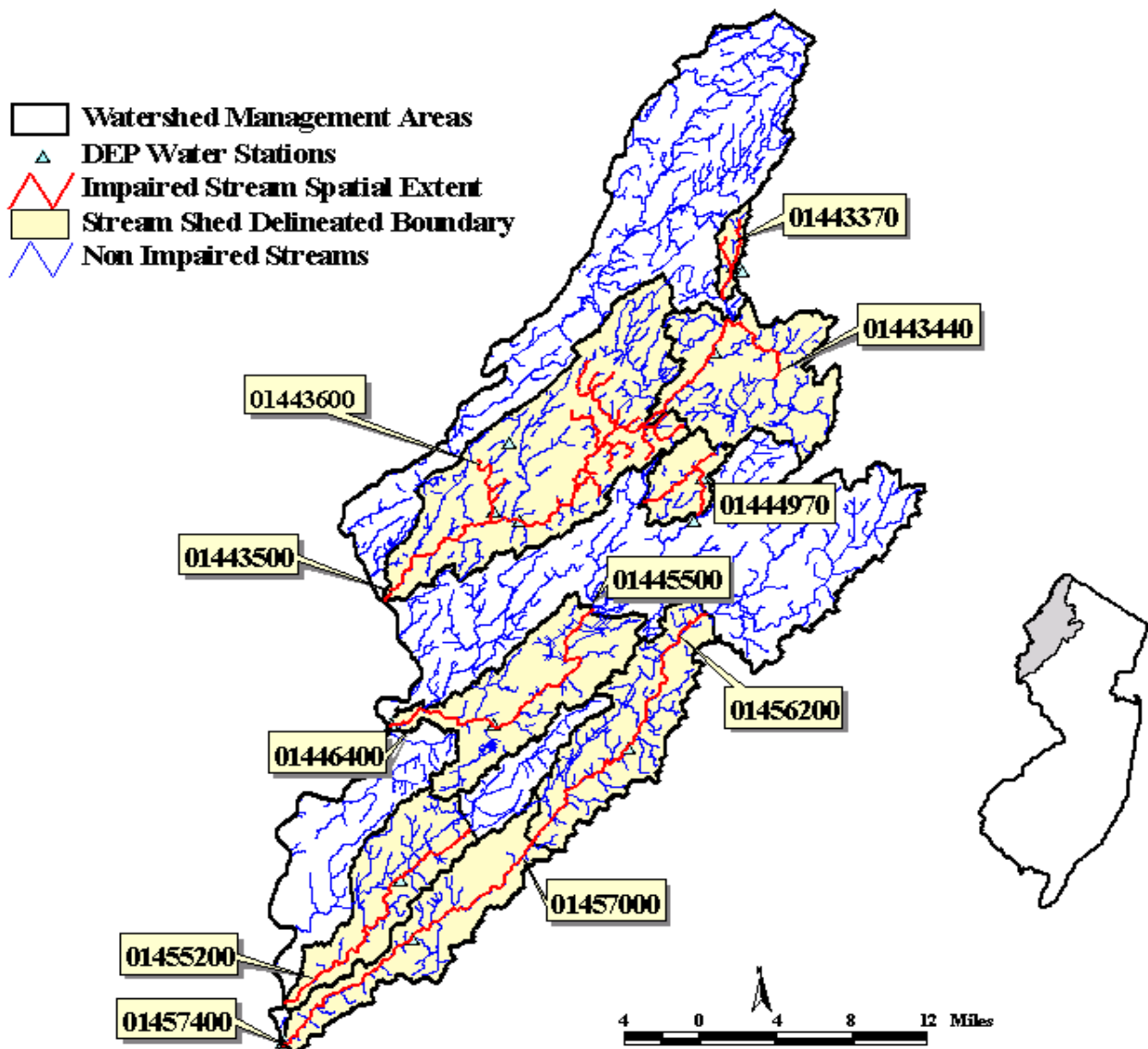


Table 3 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 1.

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**

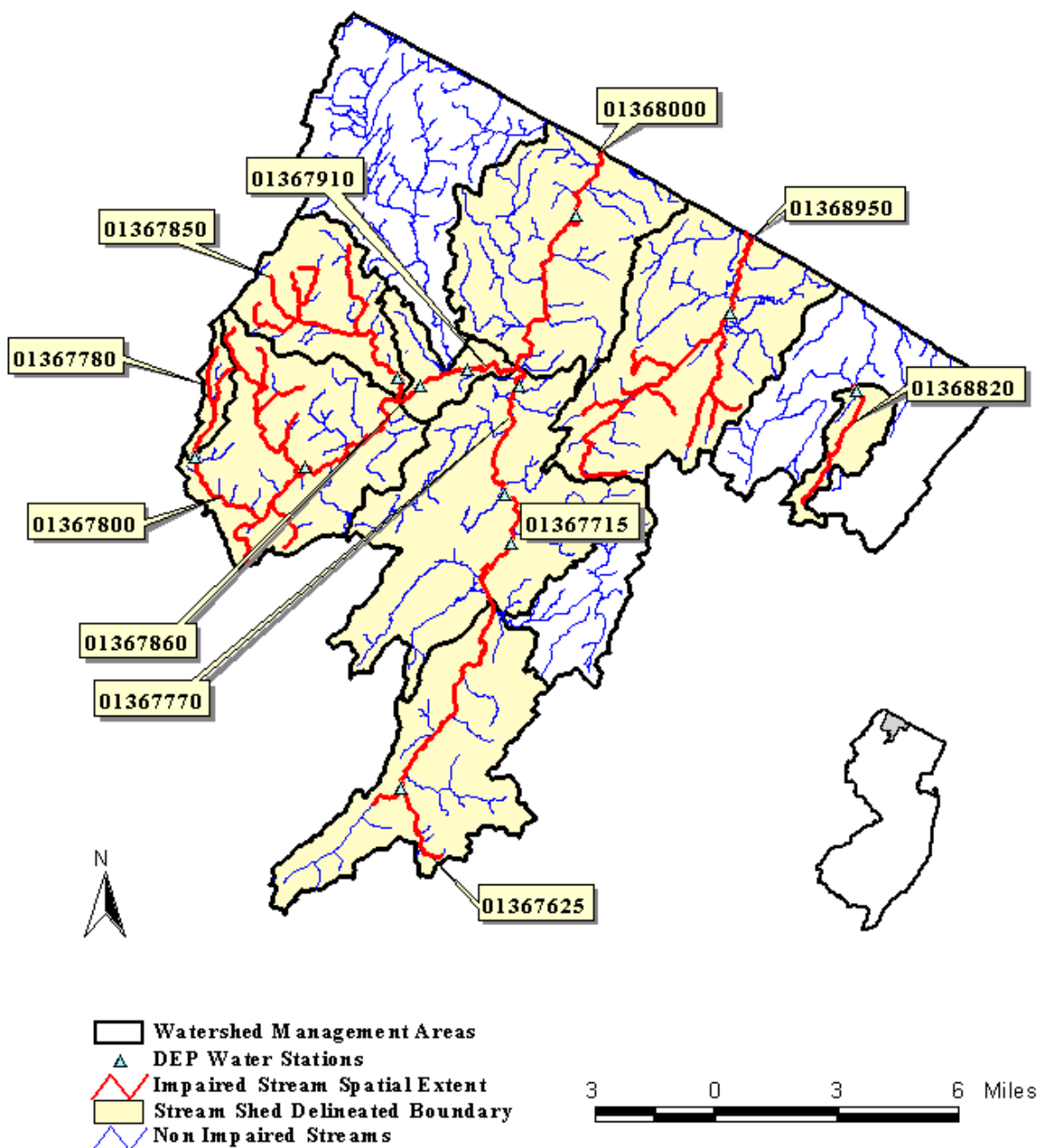


Table 5 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 2.

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								
	01367715			01367860					
	01367625	01367770	01367780	01367800	01367850	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

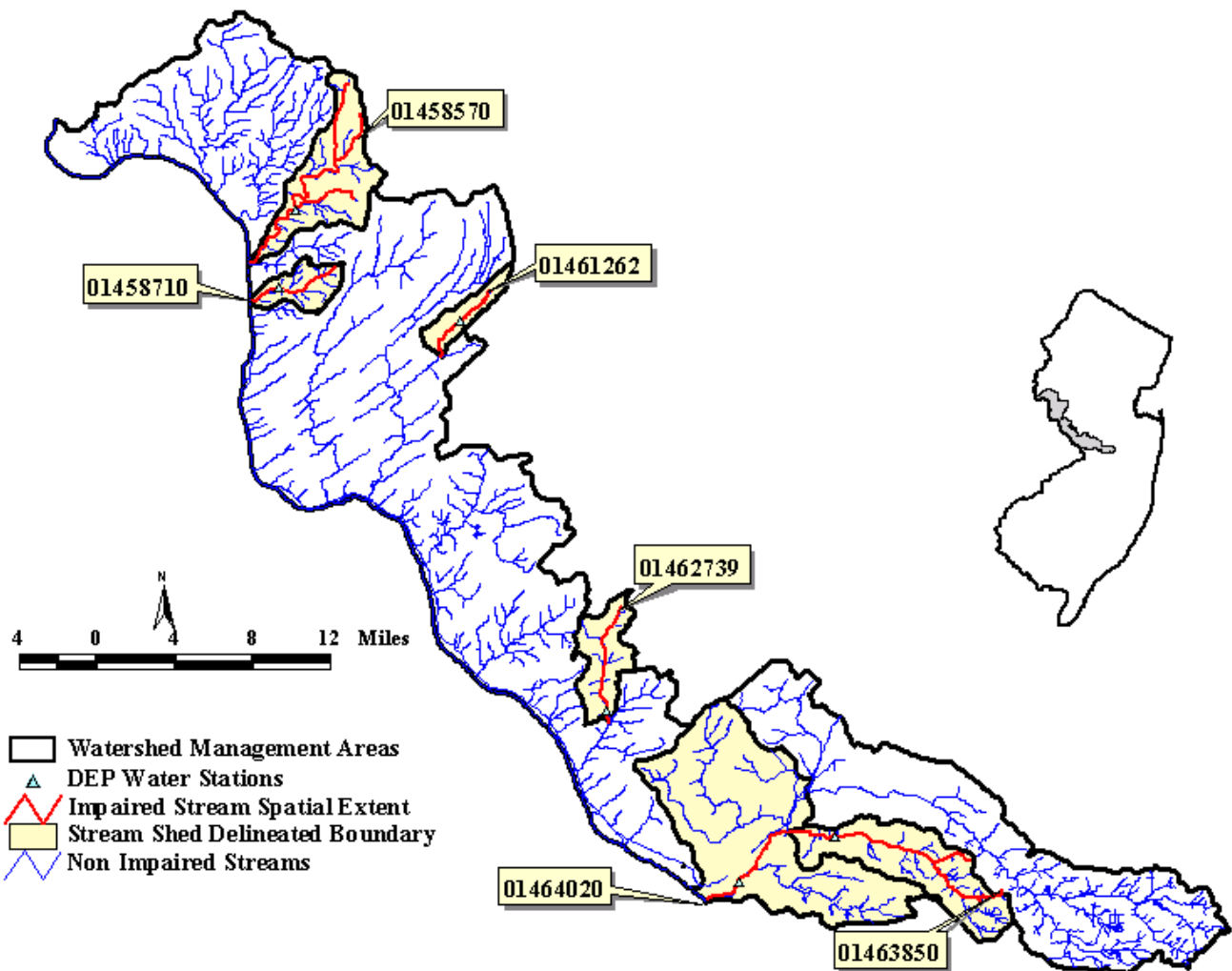


Table 7 Description of the spatial extent for each Sublist 5 segment, listed for fecal coliform, in WMA 19.

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
<u>Land use/Land cover</u>						
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.

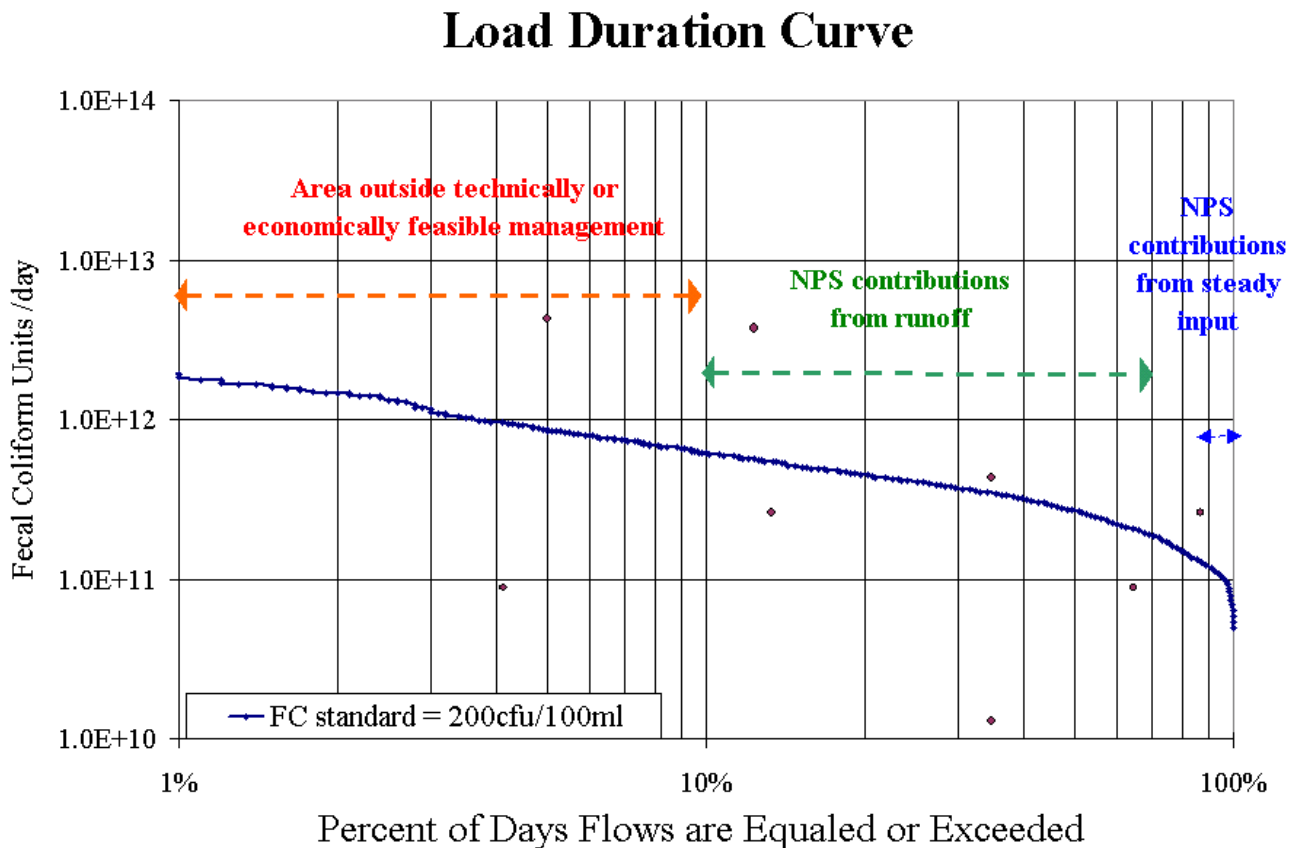
Since sewage treatment plants routinely achieve essentially complete disinfection (less than 20 CFU/100ml), the requirement to disinfect results in fecal coliform concentrations well below the criteria and permit limit. The percent of the total point source contribution is an insignificant fraction of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

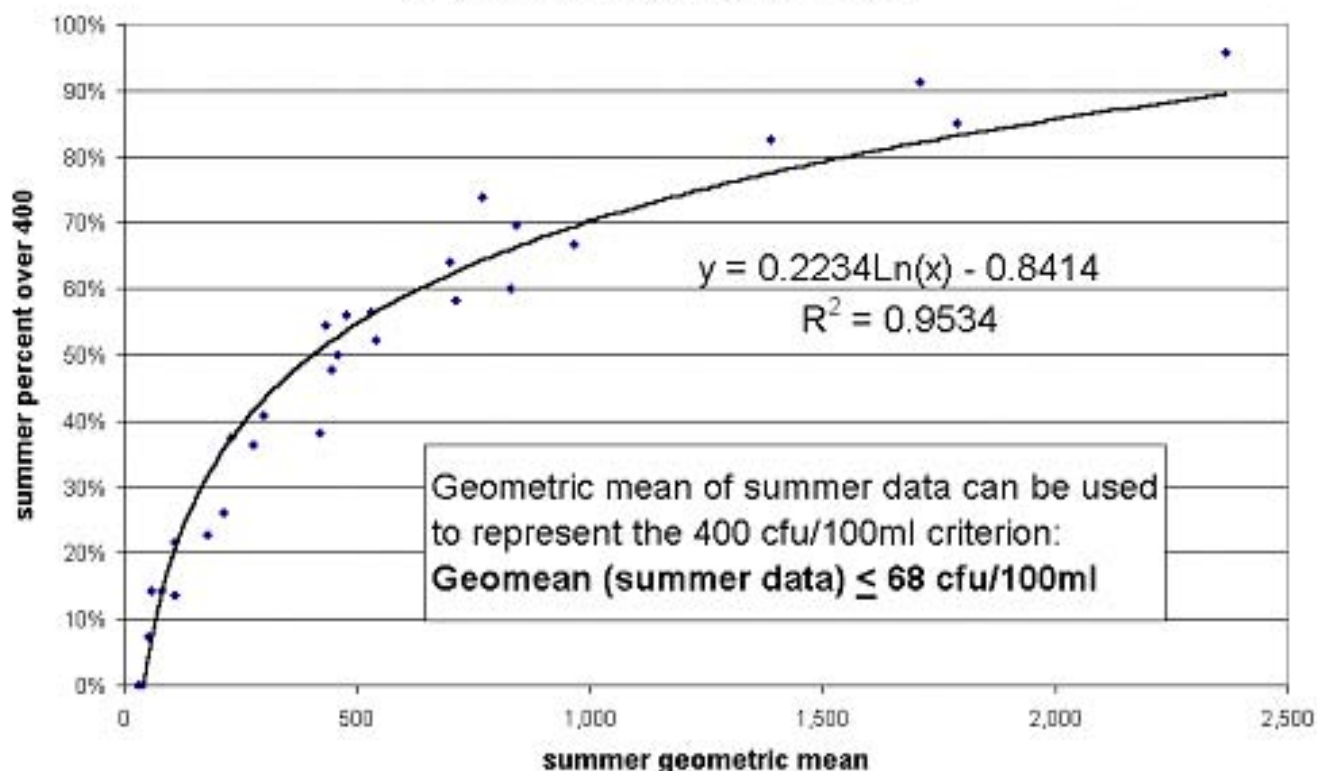
Given the two criteria of 200 CFU/100 ml and 400 CFU/100 ml in FW2 waters, computations were necessary for both criteria and resulted in two- percent reduction values. The higher

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**

Percent of Summer Values over 400 CFU/100ml vs. Summer Geometric Mean



$$y = 0.2234\ln(x) - 0.8414$$

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.

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

Equation 2

Where:

y = sample measurement

n = total number of samples

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

Equation 3

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

Equation 4

where:

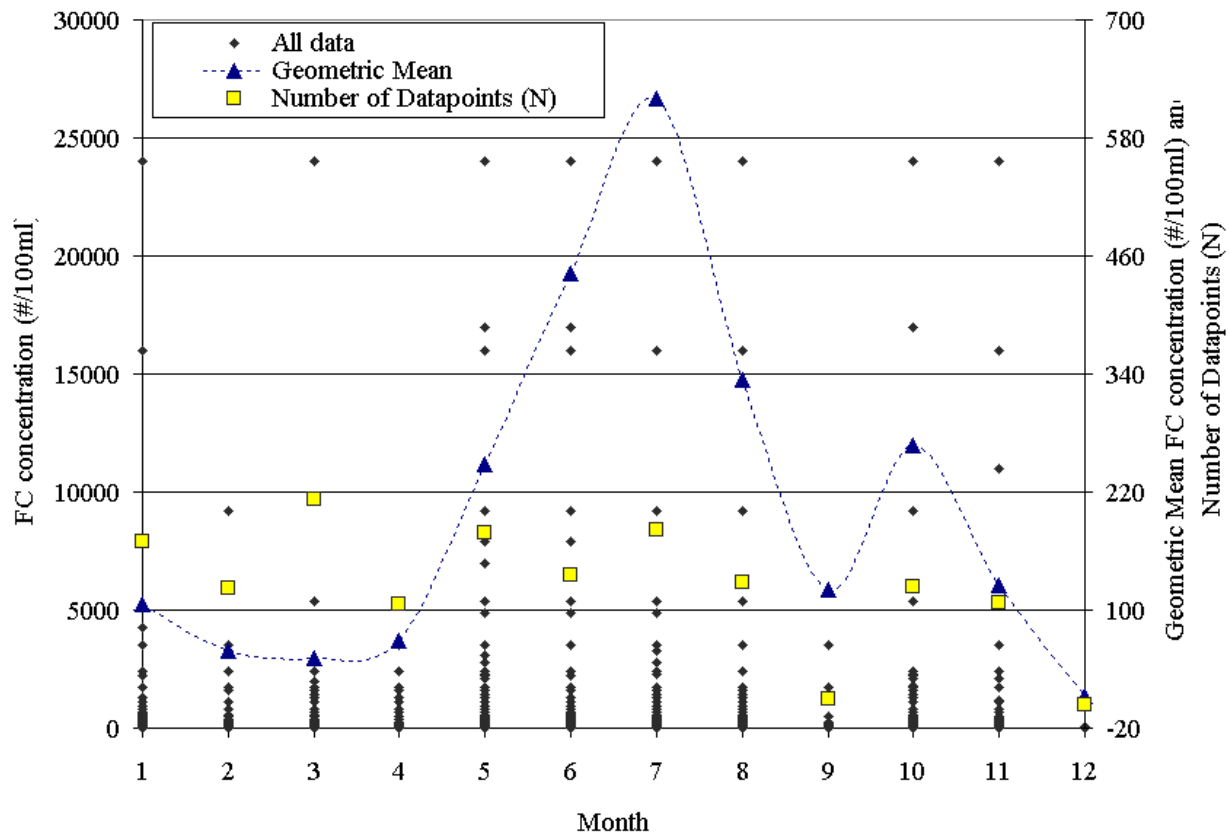
e = (margin of safety)

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

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

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 coliform 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, Pequest 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: $\frac{e}{200 \text{ CFU} / 100\text{ml}}$ or $\frac{e}{68 \text{ CFU} / 100\text{ml}}$ 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 area 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	Municipality, 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, septic, 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 septic/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 Wallkill 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 are 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 sewerage. 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 where 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 *Escherichia 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 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 on the 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	Moore's 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 unnmtd 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

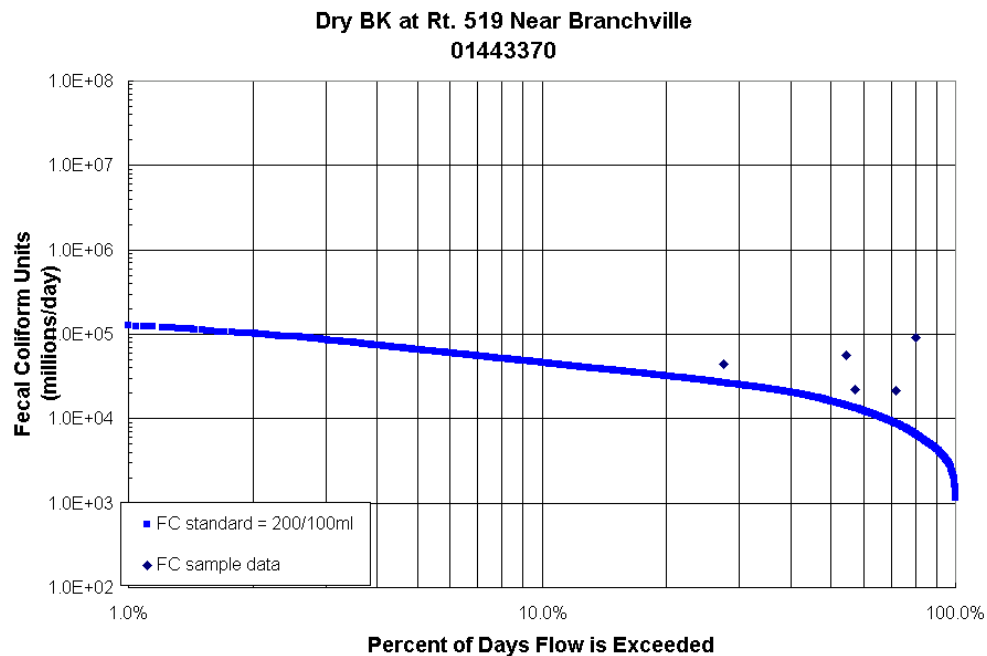
^a “MMI” indicates a Municipal Minor discharge and “MMJ” indicates Municipal Major discharge.

Appendix C: TMDL Calculations

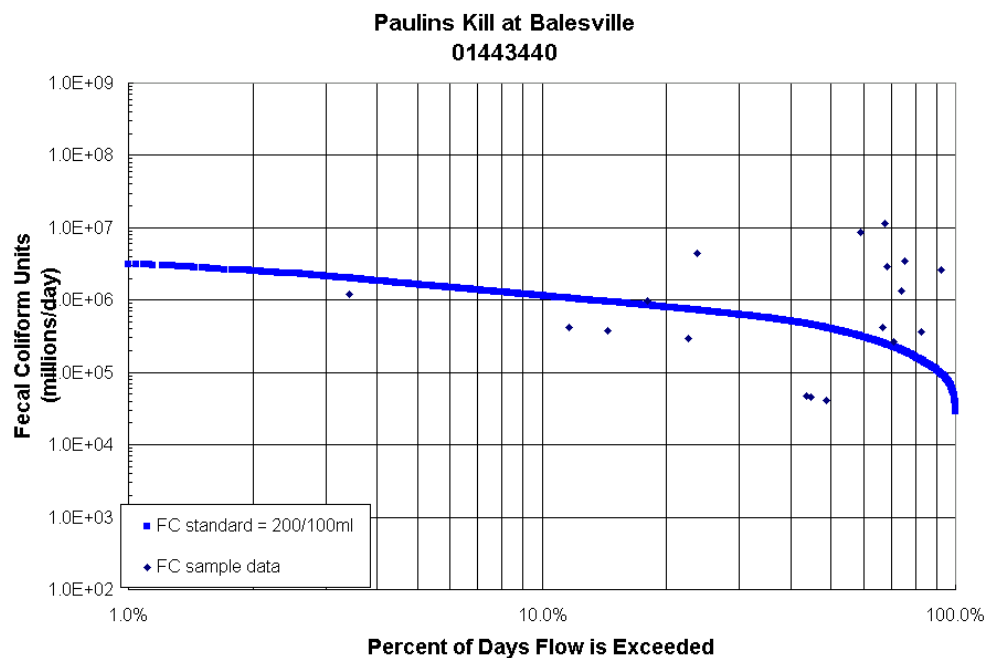
WMA	303(d) Category 5 Segments	Water Quality Stations	Station Names	Load Allocation (LA) and Margin of Safety (MOS)										Wasteload Allocation (WLA)	Period of record used in analysis
				200 FC/100ml Standard					400 FC/100ml Standard						
				N (# of values)	Geometric Mean CFU/100ml	MOS as a Percent 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, Pequest 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

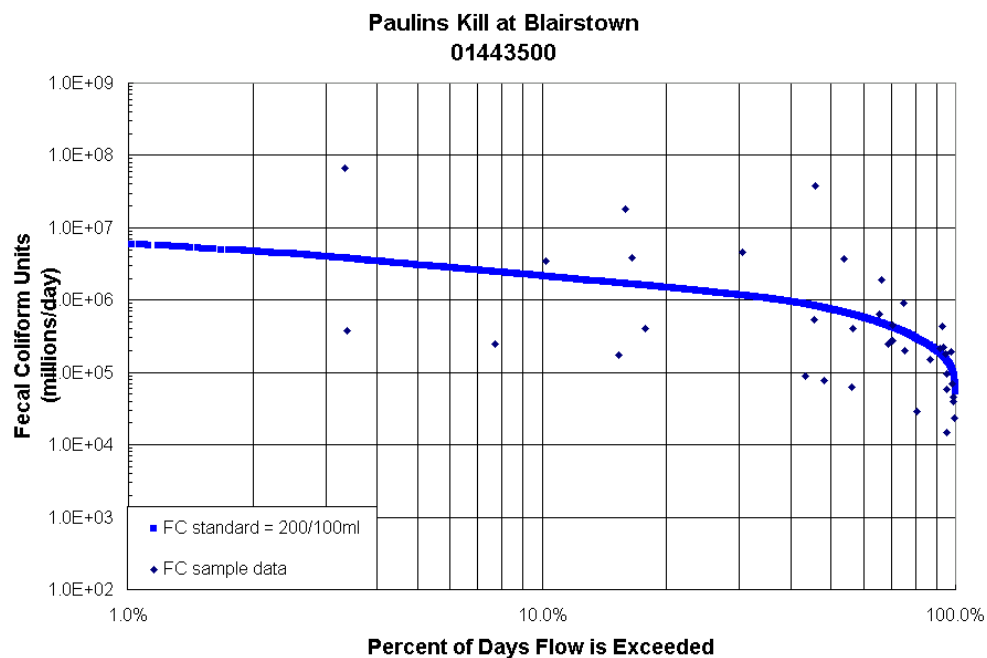
Appendix D: Load Duration Curves for selected listed waterbodies



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.



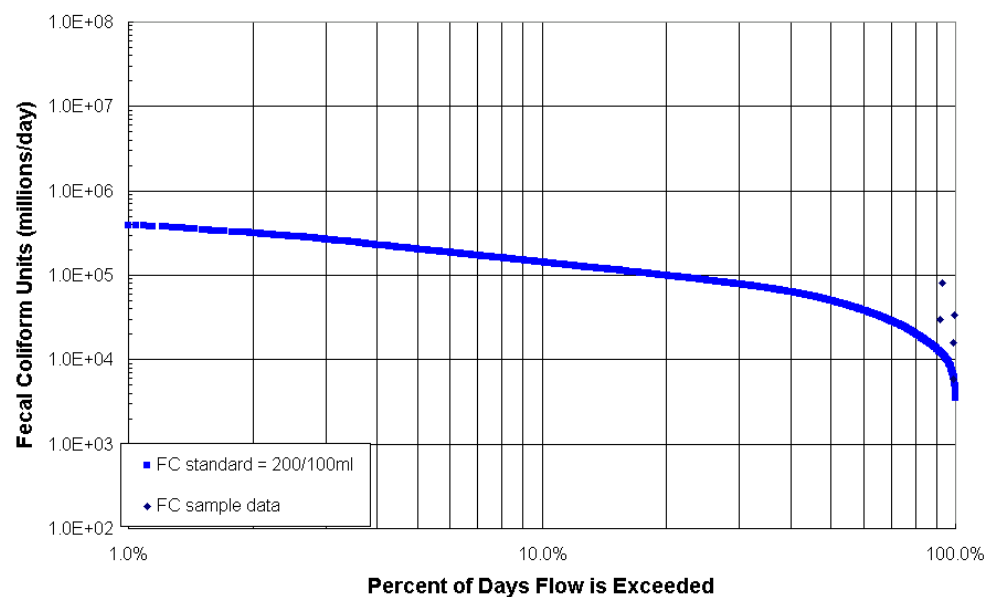
Load Duration Curve for Paulins Kill at Balesville. Fecal coliform data from USGS station # 01443440 during the period 2/7/94 through 8/4/97. Water years 1970-2000 from USGS station # 01443500 (Paulins Kill at Blairstown) were used in generating the FC standard curve.



Load Duration Curve for Paulins Kill at Blirstown. 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.

W.Q. data 6/21/99-7/21/99
Flow data from station 01443500
1970-2000

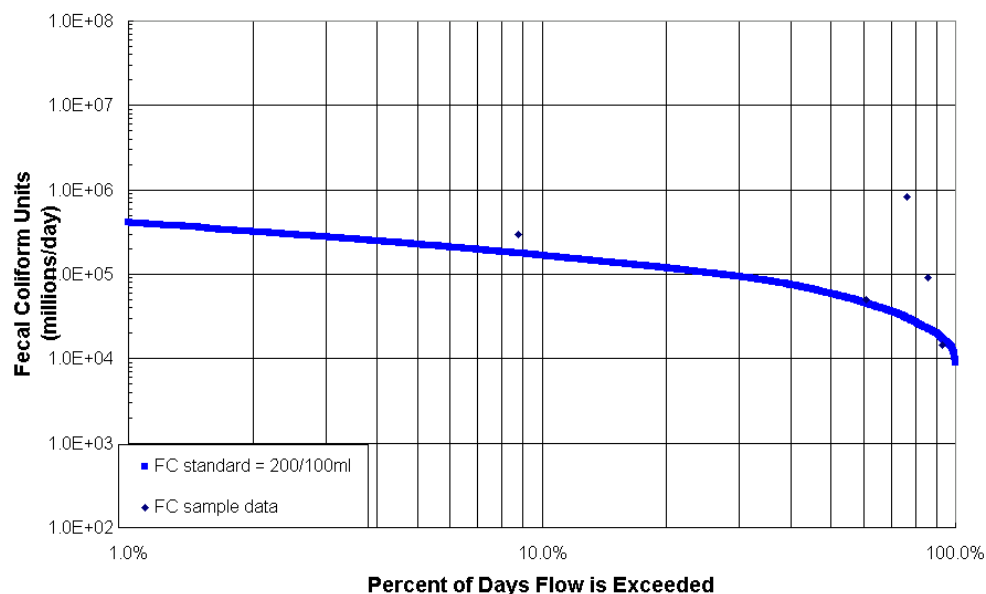
**Jacksonburg Creek Near Blirstown
01443600**



Load Duration Curve for Jacksonburg Creek near Blirstown. 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 Blirstown) were used in generating the FC standard curve.

W.Q data 6/17/98-8/26/98
Flow data station #01445500
1970-2000

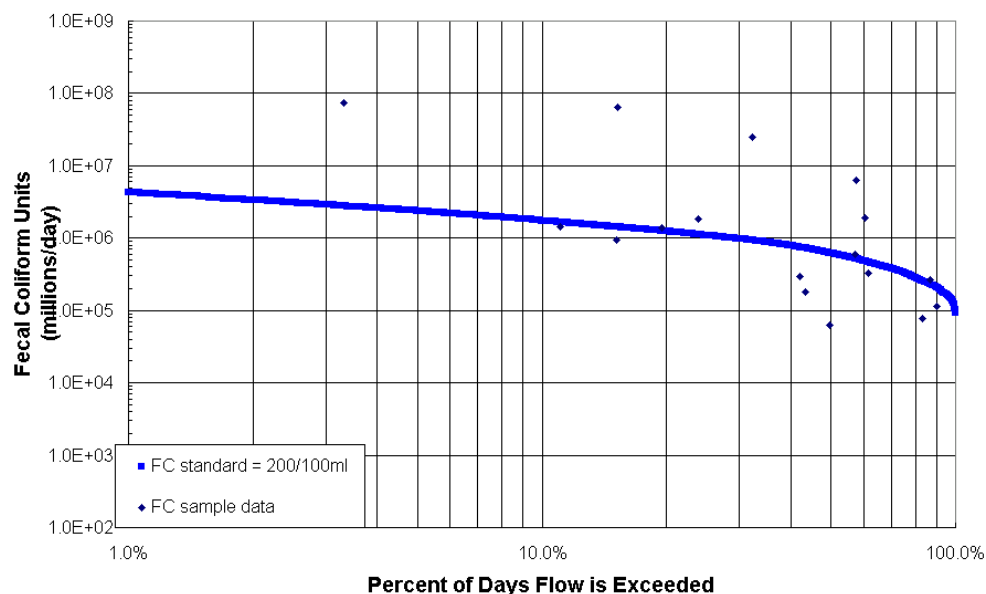
Pequest River at Rt. 206 below Springdale 01444970



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.

W.Q data 2/14/94-8/4/97
Flow data 1970-2000

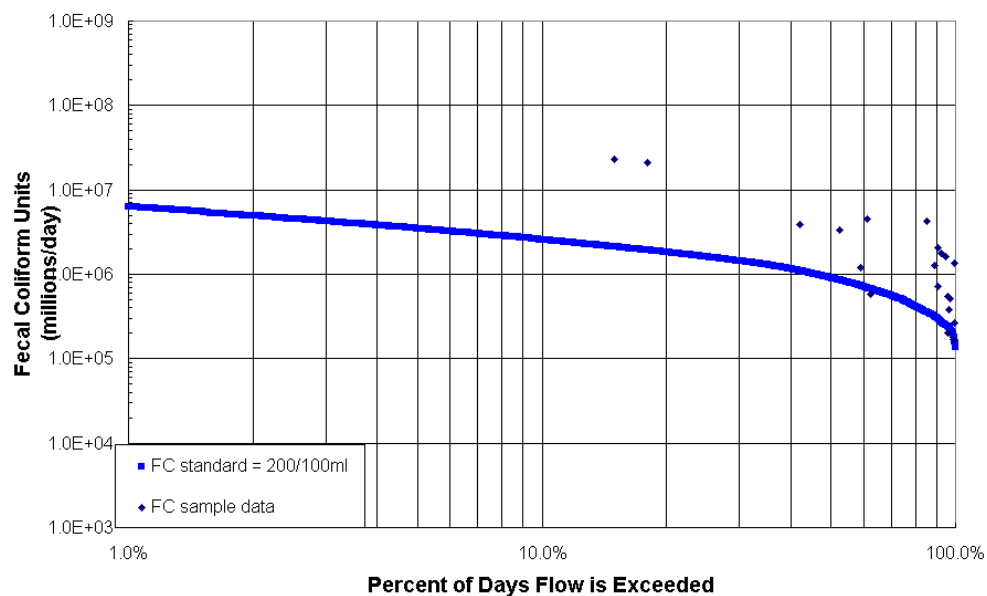
Pequest River at Pequest 01445500



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.

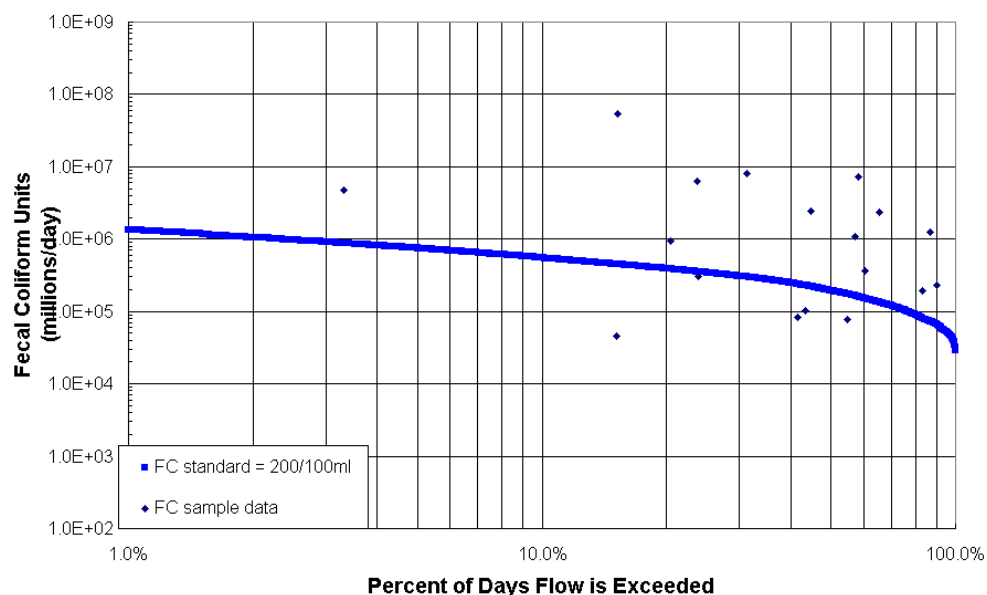
W.Q data 6/11/98-8/29/01
Flow data from station #01445500
1970-2001

Pequest River at Belvidere 01446400



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.

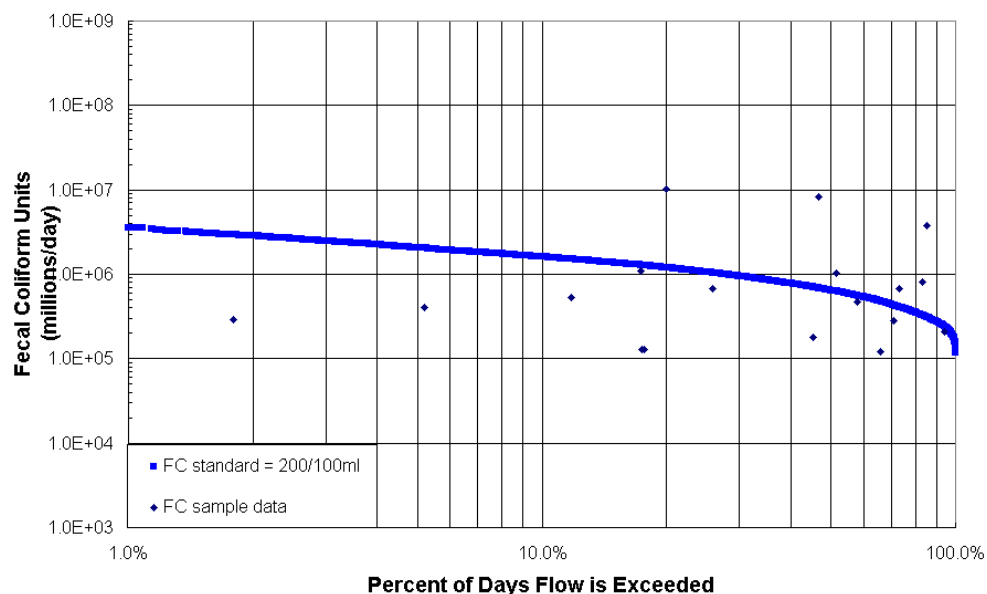
Pohatcong Ck at New Village 01455200



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.

W.Q data 2/7/94-8/11/97
Flow data from station #01457000
during 1970-2000

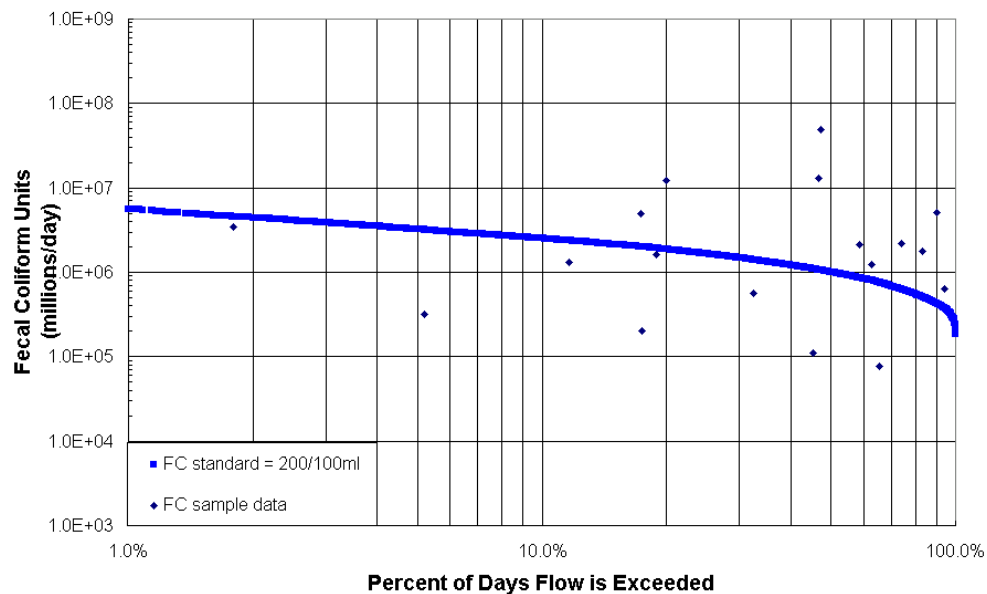
Musconetcong River at Beattystown 01456200



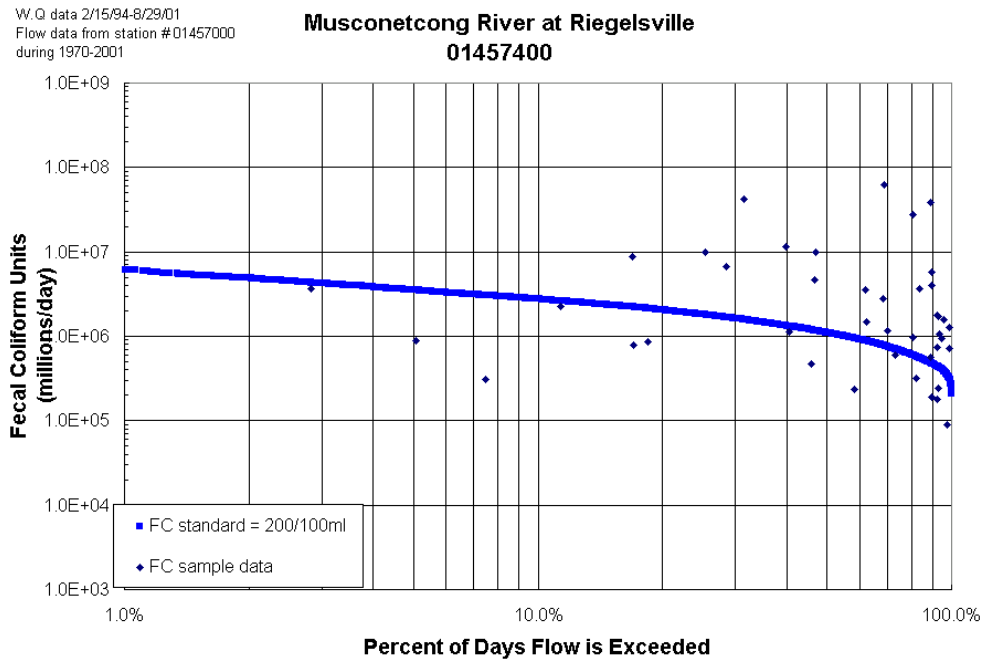
Load Duration Curve for Musconetcong River at Beattystown. Fecal coliform data from USGS station # 01456200 during the period 2/7/94 through 8/11/97. Water years 1970-2000 from USGS station # 01457000 (Musconetcong River near Bloomsbury) were used in generating the FC standard curve.

W.Q data 2/7/94-8/11/97
Flow data 1970-2000

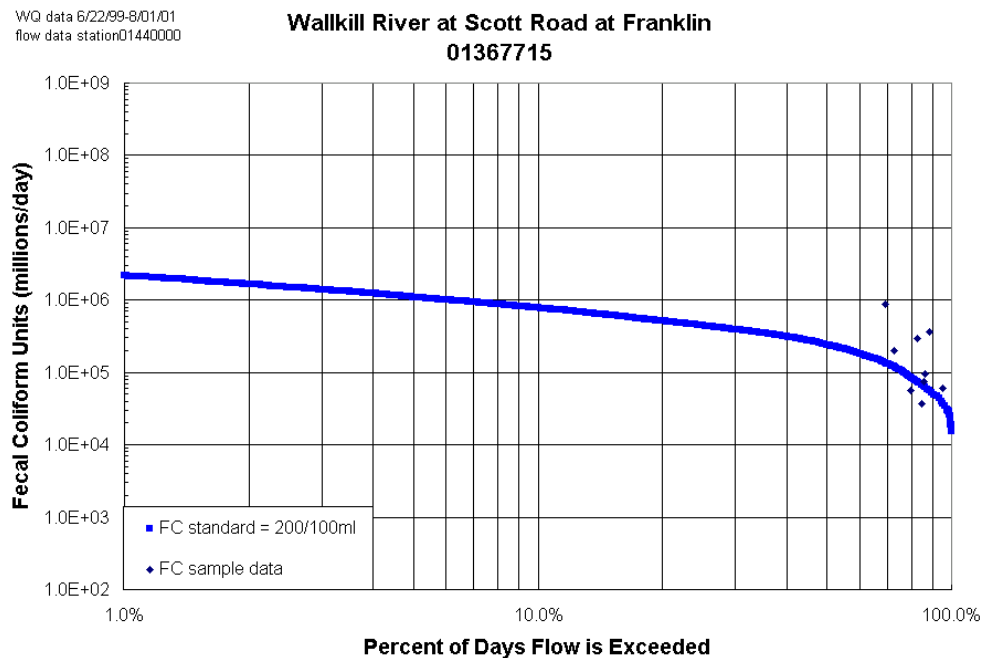
Musconetcong River near Bloomsbury 01457000



Load Duration Curve for Musconetcong 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.



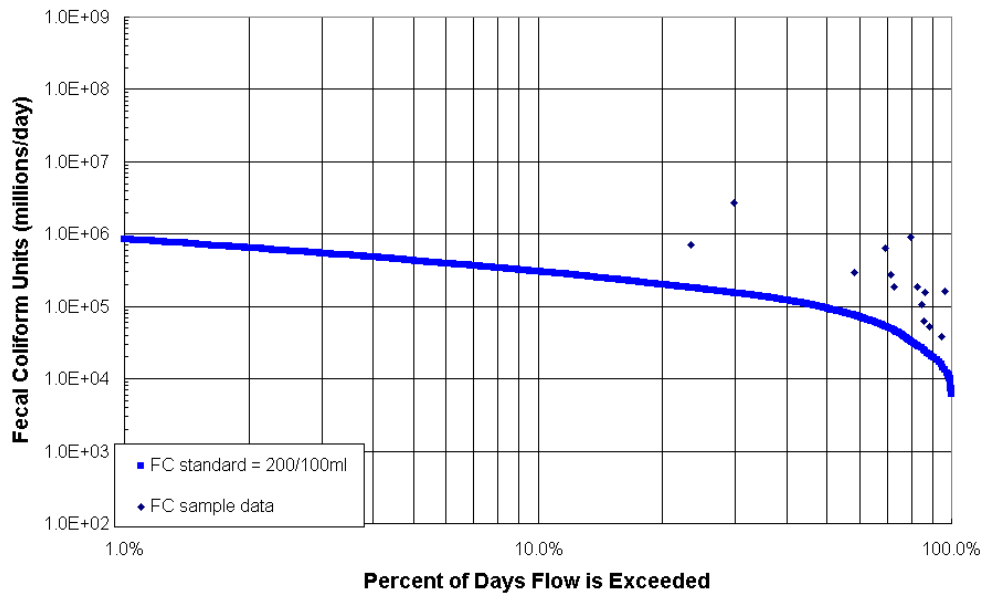
Load Duration Curve for Musconetcong River at Riegelsville. Fecal coliform data from USGS station # 01457400 during the period 2/15/94 through 8/29/01. Water years 1970-2001 from USGS station # 01457000 (Musconetcong River near Bloomsbury) were used in generating the FC standard curve.



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.

W/Q data 6/22/99-8/1/01
flow data station 01440000

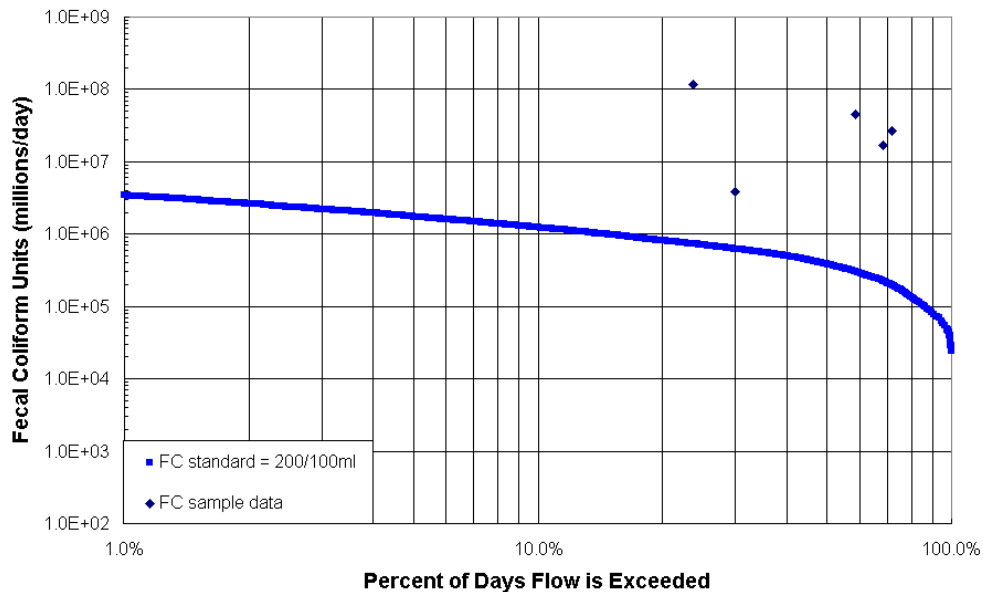
Papakating Creek at Pelletown 01367800



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.

W/Q data 6/28/00-7/24/00
flow data station 01440000

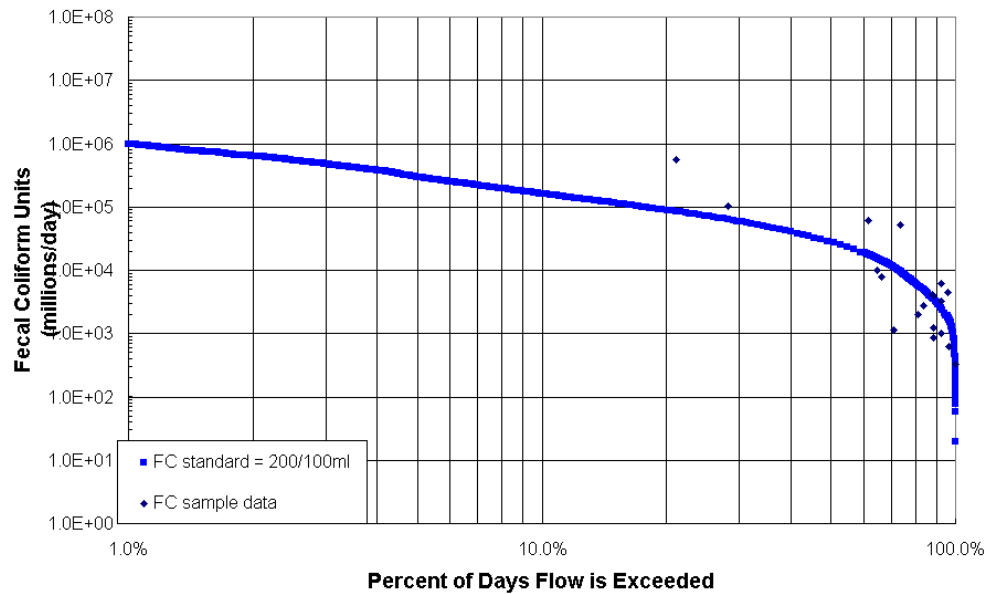
WB Papakating Ck at McCoys Corner 01367850



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.

W.Q data 6/8/98-8/9/01
Flow data from station #01398000
during 1970-2001

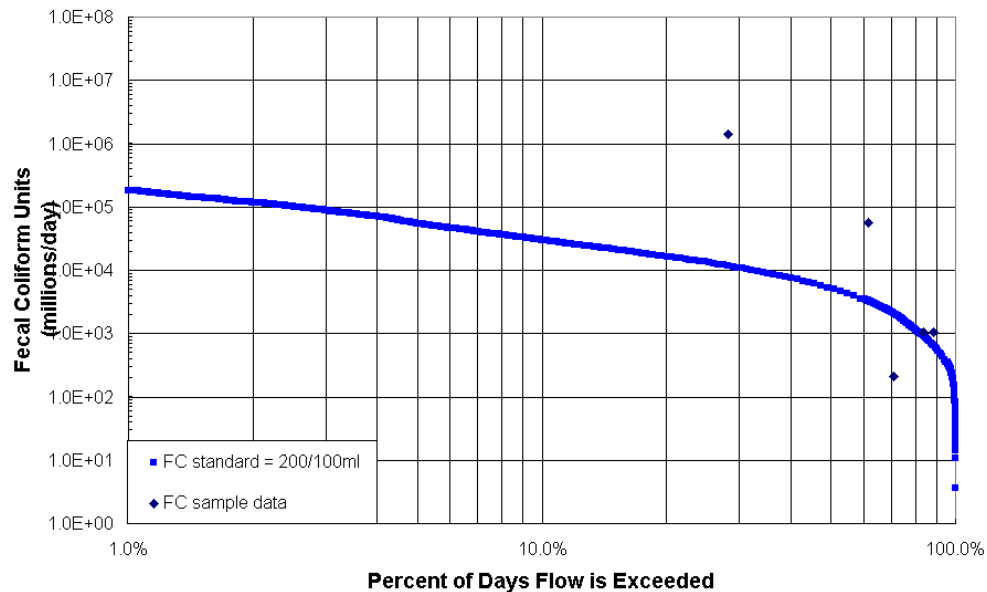
Nishisakawick Ck Near Frenchtown 01458570



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.

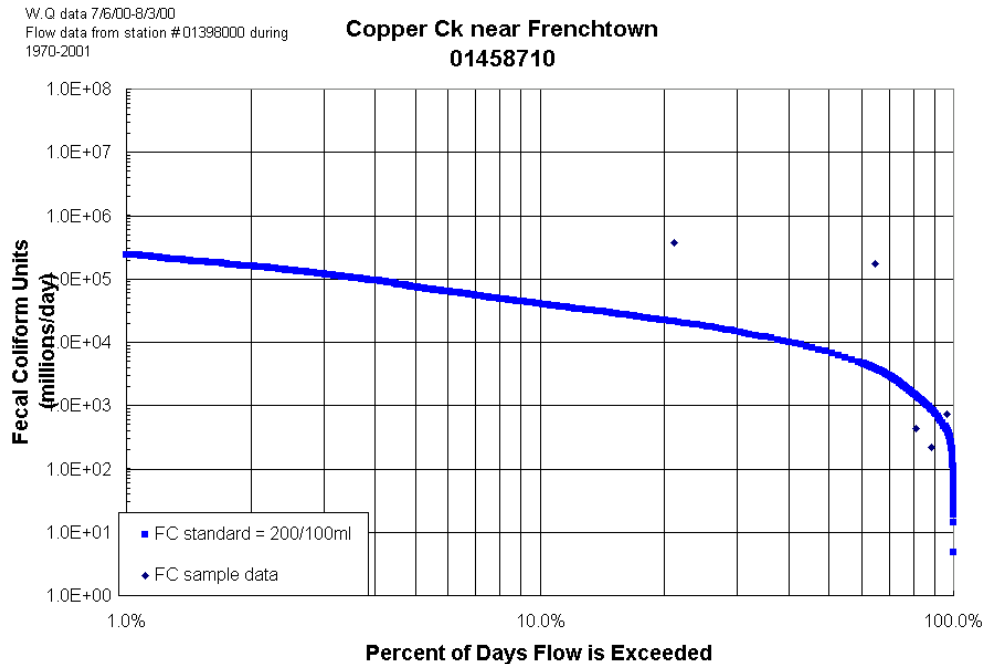
W.Q data 6/8/98-7/21/98
Flow data from station #01398000
during 1970-2001

Plum Brook Near Locktown 01461262

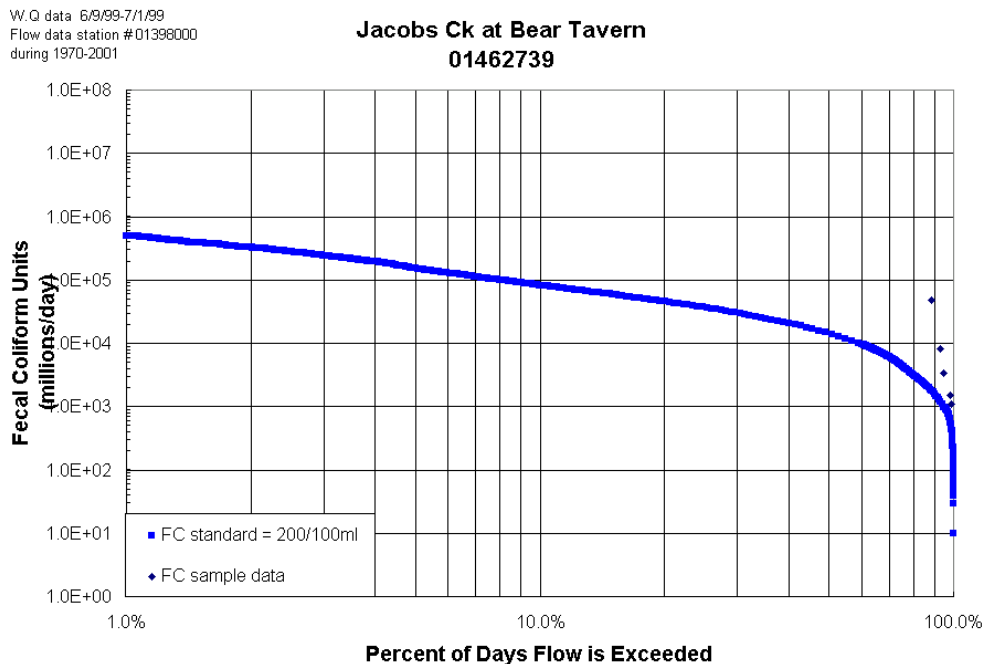


Load Duration Curve for Plum Brook near Locktown. Fecal coliform data from USGS station # 01461262 during the 6/8/98 through 7/21/98. Water years 1970-2001 from USGS station #

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



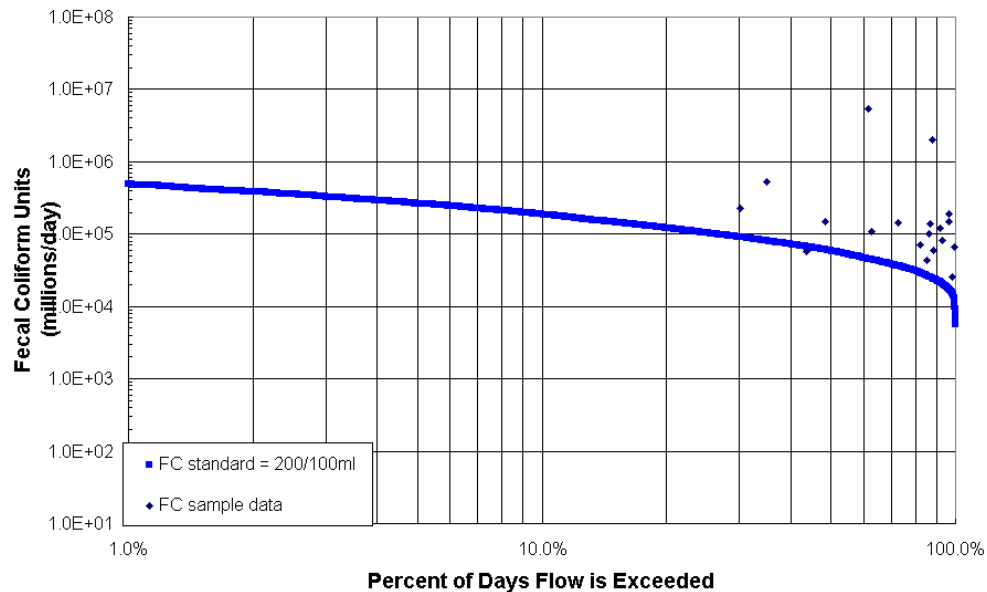
Load Duration Curve for Copper Ck near Frenchtown. Fecal coliform data from USGS station # 01458710 during the period 7/6/00 through 8/3/00. Water years 1970-2001 from USGS station # 01398000 (Neshanic River at Reaville) were used in generating the FC standard curve.



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.

W.Q data 6/8/98-6/11/01
Flow data station #01464000
1970-2001

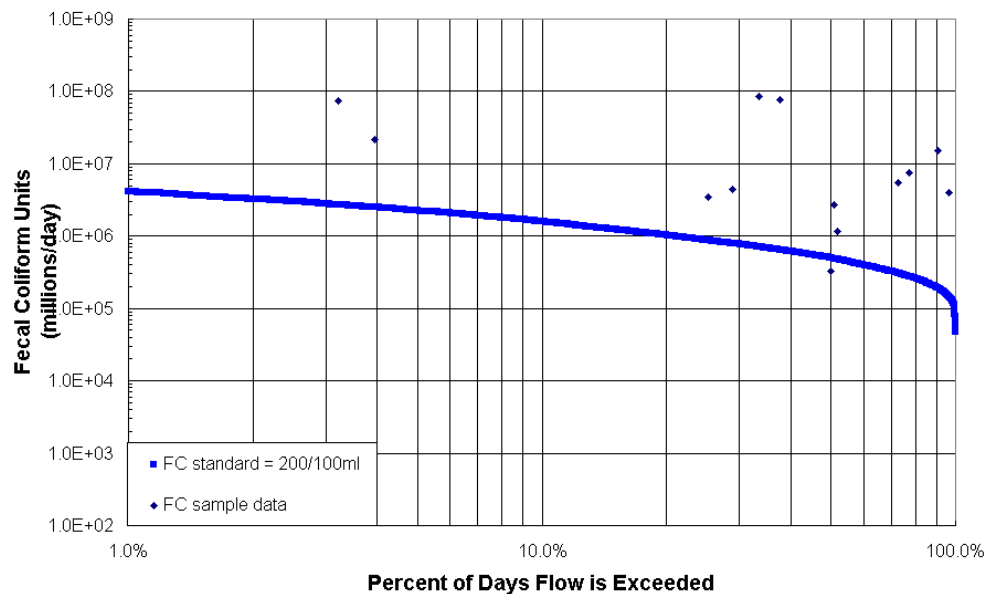
Miry Run at Route 533 at Mercerville 01463850



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.

W.Q data 2/15/94-8/8/96
Flow data 1970-2001

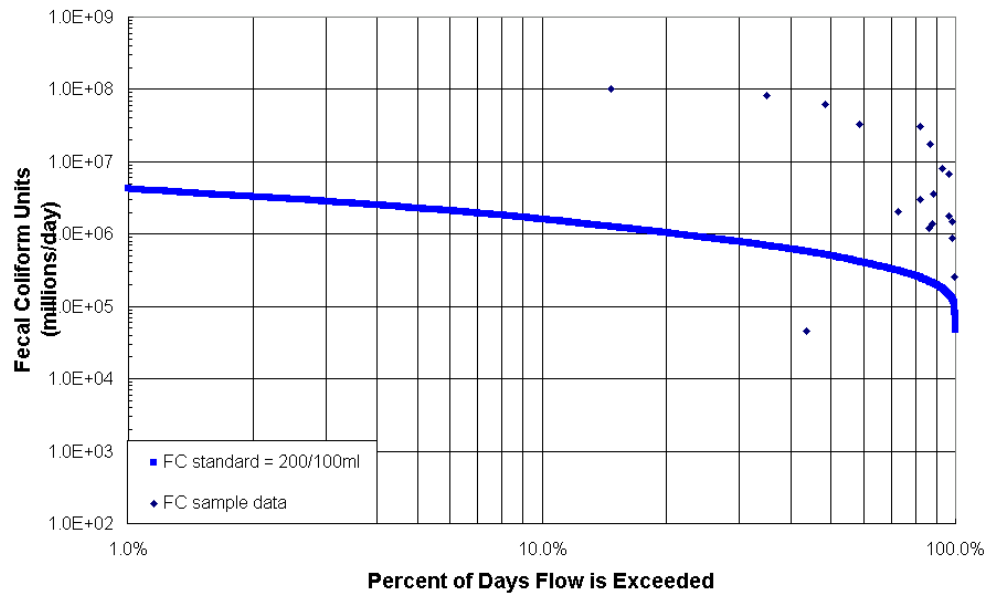
Assunpink Creek at Trenton 01464000



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.

W.Q. data 6/8/98-6/11/01
Flow data station #01464000
during 1970-2001

**Assunpink Creek at Peace St. at Trenton
01464020**



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.

**Amendment to the Atlantic, Cape May,
Lower Delaware, Lower Raritan-Middlesex,
Mercer, Monmouth, Northeast, Ocean,
Sussex, Tri-County, Upper Delaware and
Upper Raritan Water Quality Management
Plans**

**Total Maximum Daily Load for
Mercury Impairments Based on
Concentration in Fish Tissue Caused Mainly
by Air Deposition
to Address 122 HUC 14s Statewide**

Proposed: June 15, 2009
Established: September 10, 2009
Approved: September 25, 2009
Adopted: June 10, 2010

**New Jersey Department of Environmental Protection
Division of Watershed Management
P.O. Box 418
Trenton, New Jersey 08625-0418**

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Executive Summary

In accordance with Section 305(b) and 303(d) of the Federal Clean Water Act (CWA), the State of New Jersey, Department of Environmental Protection (Department or NJDEP) published the *2008 Integrated Water Quality Monitoring and Assessment Report*, which provides information on water quality conditions and trends, and various management strategies and actions being employed to protect and improve water quality. The report includes the List of Water Quality Limited Waters, also known as the 303(d) List, which identifies waters that do not attain an applicable designated use because of a known pollutant and for which a TMDL must be established. On March 3, 2008, the Department proposed the *2008 List of Water Quality Limited Waters* (40NJR4835(c)) as an amendment to the Statewide Water Quality Management Plan, pursuant to the Water Quality Planning Act at N.J.S.A.58:11A-7 in accordance with the Water Quality Management Planning rules at N.J.A.C. 7:15-6.4(a). The Environmental Protection Agency has approved this list. The *2008 List of Water Quality Limited Waters* identifies 256 waters as impaired with respect to mercury, as indicated by the presence of mercury concentrations in fish tissue in excess of New Jersey fish consumption advisories and/or not complying with the Surface Water Quality Standards (SWQS) for mercury at N.J.A.C. 7:9B.

A TMDL has been developed to address mercury impairment in 122 waters identified in Table 1 below. These are waters whose main source of contamination is air deposition. Waters that are tidal, where there are other significant sources of mercury or where cooperative efforts have been or are expected to be undertaken are not addressed in this TMDL pending additional study.

Table 1. Assessment Units Covered by this TMDL

Watershed Management Area (WMA)	Assessment Unit ID	Waterbody Name	2006 Integrated list	2008 Integrated list
01	02040104090020	Clove Brook (Delaware R)	Sublist 5	Sublist 5
01	02040104130010	Little Flat Brook (Beerskill and above)	Sublist 5	Sublist 5
01	02040104140010	Big Flat Brook (above Forked Brook)	Sublist 5	Sublist 5
01	02040105030020	Swartswood Lake and tribs	Sublist 5	Sublist 5
01	02040105030030	Trout Brook	Sublist 5	Sublist 5
01	02040105050040	Yards Creek	Sublist 3	Sublist 3*
01	02040105090040	Mountain Lake Brook	Sublist 5	Sublist 5
01	02040105140040	Merrill Creek	Sublist 5	Sublist 5
01	02040105140060	Pohatcong Ck (Springtown to Merrill Ck)	Sublist 3	Sublist 3*
01	02040105150020	Lake Hopatcong	Sublist 5	Sublist 5
01	02040105150060	Cranberry Lake / Jefferson Lake & tribs	Sublist 5	Sublist 5
02	02020007040040	Highland Lake/Wawayanda Lake	Sublist 5	Sublist 5
03	02030103050020	Pacock Brook	Sublist 5	Sublist 5
03	02030103050030	Pequannock R (above OakRidge Res outlet)	Sublist 5	Sublist 5
03	02030103050040	Clinton Reservoir/Mossmans Brook	Sublist 5	Sublist 5

03	02030103050060	Pequannock R(Macopin gage to Charl'brg)	Sublist 5	Sublist 5
03	02030103050080	Pequannock R (below Macopin gage)	Sublist 5	Sublist 5
03	02030103070030	Wanaque R/Greenwood Lk(aboveMonks gage)	Sublist 5	Sublist 5
03	02030103070050	Wanaque Reservior (below Monks gage)	Sublist 5	Sublist 5
03	02030103110020	Pompton River	Sublist 5	Sublist 5
06	02030103010170	Passaic R Upr (Rockaway to Hanover RR)	Sublist 5	Sublist 5
06	02030103020040	Whippany R(Lk Pocahontas to Wash Val Rd)	Sublist 5	Sublist 5
06	02030103020080	Troy Brook (above Reynolds Ave)	Sublist 5	Sublist 5
06	02030103030030	Rockaway R (above Longwood Lake outlet)	Sublist 5	Sublist 5
06	02030103030040	Rockaway R (Stephens Bk to Longwood Lk)	Sublist 5	Sublist 5
06	02030103030070	Rockaway R (74d 33m 30s to Stephens Bk)	Sublist 5	Sublist 5
06	02030103030090	Rockaway R (BM 534 brdg to 74d 33m 30s)	Sublist 5	Sublist 5
06	02030103030110	Beaver Brook (Morris County)	Sublist 5	Sublist 5
06	02030103030140	Rockaway R (Stony Brook to BM 534 brdg)	Sublist 5	Sublist 5
06	02030103030150	Rockaway R (Boonton dam to Stony Brook)	Sublist 5	Sublist 5
06	02030103030170	Rockaway R (Passaic R to Boonton dam)	Sublist 5	Sublist 5
08	02030105010030	Raritan River SB(above Rt 46)	Sublist 5	Sublist 5
08	02030105010040	Raritan River SB(74d 44m 15s to Rt 46)	Sublist 3	Sublist 3*
08	02030105010050	Raritan R SB(LongValley br to 74d44m15s)	Sublist 3	Sublist 3*
08	02030105010060	Raritan R SB(Califon br to Long Valley)	Sublist 3	Sublist 3*
08	02030105020040	Spruce Run Reservior / Willoughby Brook	Sublist 5	Sublist 5
08	02030105020090	Prescott Brook / Round Valley Reservior	Sublist 5	Sublist 5
08	02030105020100	Raritan R SB(Three Bridges-Prescott Bk)	Sublist 3	Sublist 3*
08	02030105040010	Raritan R SB(Pleasant Run-Three Bridges)	Sublist 3	Sublist 3*
08	02030105040040	Raritan R SB(NB to Pleasant Run)	Sublist 3	Sublist 3*
09	02030105080020	Raritan R Lwr (Rt 206 to NB / SB)	Sublist 3	Sublist 3*
09	02030105080030	Raritan R Lwr (Millstone to Rt 206)	Sublist 3	Sublist 3*
09	02030105120080	South Fork of Bound Brook	Sublist 3	Sublist 3*
09	02030105120100	Bound Brook (below fork at 74d 25m 15s)	Sublist 3	Sublist 3*
09	02030105120140	Raritan R Lwr(I-287 Piscatway-Millstone)	Sublist 5	Sublist 5
09	02030105130050	Lawrence Bk (Church Lane to Deans Pond)	Sublist 3	Sublist 3*
09	02030105130060	Lawrence Bk (Milltown to Church Lane)	Sublist 3	Sublist 3*

09	02030105140020	Manalapan Bk(incl LkManlpn to 40d16m15s)	Sublist 3	Sublist 3*
09	02030105140030	Manalapan Brook (below Lake Manalapan)	Sublist 5	Sublist 5
09	02030105160030	Duhernal Lake / Iresick Brook	Sublist 3	Sublist 3*
10	02030105090050	Stony Bk(Province Line Rd to 74d46m dam)	Sublist 3	Sublist 3*
10	02030105100130	Bear Brook (below Trenton Road)	Sublist 3	Sublist 5
10	02030105110020	Millstone R (HeathcoteBk to Harrison St)	Sublist 3	Sublist 5
10	02030105110110	Millstone R (BlackwellsMills to BedenBk)	Sublist 3	Sublist 3*
10	02030105110140	Millstone R(AmwellRd to BlackwellsMills)	Sublist 3	Sublist 3*
10	02030105110170	Millstone River (below Amwell Rd)	Sublist 3	Sublist 3*
12	02030104060020	Matawan Creek (above Ravine Drive)	Sublist 3	Sublist 3*
12	02030104060030	Matawan Creek (below Ravine Drive)	Sublist 5	Sublist 5
12	02030104070070	Swimming River Reservior / Slope Bk	Sublist 3	Sublist 3*
12	02030104070090	Nut Swamp Brook	Sublist 3	Sublist 5
12	02030104090030	Deal Lake	Sublist 3	Sublist 3*
12	02030104090080	Wreck Pond Brook (below Rt 35)	Sublist 3	Sublist 5
12	02030104100050	Manasquan R (gage to West Farms Rd)	Sublist 5	Sublist 5
13	02040301030040	Metedeconk R SB (Rt 9 to Bennetts Pond)	Sublist 5	Sublist 5
13	02040301060050	Dove Mill Branch (Toms River)	Sublist 5	Sublist 5
13	02040301070010	Shannae Brook	Sublist 5	Sublist 5
13	02040301070030	Ridgeway Br (Hope Chapel Rd to HarrisBr)	Sublist 5	Sublist 5
13	02040301070040	Ridgeway Br (below Hope Chapel Rd)	Sublist 5	Sublist 5
13	02040301070080	Manapaqua Brook	Sublist 3	Sublist 5
13	02040301070090	Union Branch (below Blacks Br 74d22m05s)	Sublist 5	Sublist 5
13	02040301080030	Davenport Branch (above Pinewald Road)	Sublist 3	Sublist 5
13	02040301090050	Cedar Creek (GS Parkway to 74d16m38s)	Sublist 5	Sublist 5
13	02040301130030	Mill Ck (below GS Parkway)/Manahawkin Ck	Sublist 3	Sublist 3*
13	02040301130050	Westecunk Creek (above GS Parkway)	Sublist 5	Sublist 5
13	02040301140020	Mill Branch (below GS Parkway)	Sublist 3	Sublist 3*
13	02040301140030	Tuckerton Creek (below Mill Branch)	Sublist 3	Sublist 3*
14	02040301150080	Batsto R (Batsto gage to Quaker Bridge)	Sublist 5	Sublist 5
14	02040301160030	Mullica River (Rt 206 to Jackson Road)	Sublist 5	Sublist 5
14	02040301160140	Mullica River (39d40m30s to Rt 206)	Sublist 5	Sublist 5
14	02040301160150	Mullica R (Pleasant Mills to 39d40m30s)	Sublist 5	Sublist 5
14	02040301180060	Oswego R (Andrews Rd to Sim Place Resv)	Sublist 3	Sublist 3*
14	02040301180070	Oswego River (below Andrews Road)	Sublist 5	Sublist 5

14	02040301190050	Wading River WB (Jenkins Rd to Rt 563)	Sublist 5	Sublist 5
14	02040301200010	Beaver Branch (Wading River)	Sublist 5	Sublist 5
14	02040301200050	Bass River EB	Sublist 3	Sublist 3*
15	02040302030020	GEHR (AC Expressway to New Freedom Rd)	Sublist 5	Sublist 5
15	02040302040050	Collings Lakes trib (Hospitality Branch)	Sublist 5	Sublist 5
15	02040302040130	GEHR (Lake Lenape to Mare Run)	Sublist 5	Sublist 5
15	02040302050120	Middle River / Peters Creek	Sublist 3	Sublist 3*
16	02040206210050	Savages Run (above East Creek Pond)	Sublist 5	Sublist 5
16	02040206210060	East Creek	Sublist 5	Sublist 5
17	02040206030010	Salem River (above Woodstown gage)	Sublist 5	Sublist 5
17	02040206070030	Canton Drain (above Maskell Mill)	Sublist 5	Sublist 5
17	02040206080050	Cohansey R (incl CornwellRun - BeebeRun)	Sublist 3	Sublist 5
17	02040206090030	Cohansey R (Rocaps Run to Cornwell Run)	Sublist 5	Sublist 5
17	02040206100060	Nantuxent Creek (above Newport Landing)	Sublist 3	Sublist 3*
17	02040206130010	Scotland Run (above Fries Mill)	Sublist 5	Sublist 5
17	02040206130040	Scotland Run (below Delsea Drive)	Sublist 5	Sublist 5
17	02040206140010	MauriceR(BlkwtrBr to/incl WillowGroveLk)	Sublist 5	Sublist 5
17	02040206150050	Muddy Run (incl ParvinLk to Palatine Lk)	Sublist 3	Sublist 3*
17	02040206180050	Menantico Creek (below Rt 552)	Sublist 3	Sublist 3*
18	02040202100020	Pennsauken Ck NB (incl StrwbrdgLk-NJTPK)	Sublist 3	Sublist 5
18	02040202110030	Cooper River (above Evesham Road)	Sublist 5	Sublist 5
18	02040202110040	Cooper R (Wallworth gage to Evesham Rd)	Sublist 5	Sublist 5
18	02040202110050	Cooper River (Rt 130 to Wallworth gage)	Sublist 5	Sublist 5
18	02040202120010	Big Timber Creek NB (above Laurel Rd)	Sublist 5	Sublist 5
18	02040202120020	Big Timber Creek NB (below Laurel Rd)	Sublist 5	Sublist 5
18	02040202120030	Big Timber Creek SB (above Lakeland Rd)	Sublist 5	Sublist 5
18	02040202120040	Big T Ck SB(incl Bull Run to LakelandRd)	Sublist 5	Sublist 5
18	02040202120050	Big Timber Creek SB (below Bull Run)	Sublist 5	Sublist 5
18	02040202120060	Almonesson Creek	Sublist 5	Sublist 5
18	02040202120090	Newton Creek (LDRV-Kaighn Ave to LT Ck)	Sublist 5	Sublist 5
18	02040202120100	Woodbury Creek (above Rt 45)	Sublist 5	Sublist 5
18	02040202130030	Chestnut Branch (above Sewell)	Sublist 5	Sublist 5
18	02040202150020	Raccoon Ck (Rt 45 to/incl Clems Run)	Sublist 3	Sublist 3*
18	02040202150040	Raccoon Ck (Russell Mill Rd to Rt 45)	Sublist 5	Sublist 5
19	02040202030050	Bucks Cove Run / Cranberry Branch	Sublist 5	Sublist 5
19	02040202050050	Friendship Ck (below/incl Burrs Mill Bk)	Sublist 3	Sublist 3*

19	02040202050060	Rancocas Creek SB(above Friendship Ck)	Sublist 3	Sublist 3*
19	02040202050080	Rancocas Ck SB (Vincetown-FriendshipCk)	Sublist 3	Sublist 3*
19	02040202050090	Rancocas Ck SB (BobbysRun to Vincetown)	Sublist 3	Sublist 3*
20	02040201090030	LDRV tribs (Assiscunk Ck to Blacks Ck)	Sublist 5	Sublist 5

* Data became available in these assessment units after the 2008 list was approved indicating fish tissue levels that would result in listing of these waters in accordance with the current listing methodology; therefore, these assessment units will also be addressed in this TMDL.

The target for the TMDL is a concentration of 0.18 µg/g in fish tissue, which is the concentration at which the recommended rate of fish consumption for the high risk population is not more than 1 meal per week of top trophic level fish. At this concentration unlimited consumption is appropriate for the general population. An overall reduction of 84.3% in existing mercury loads is required to achieve the target. In its *New Jersey Mercury Reduction Plan*, the Department outlines measures needed to achieve these reductions.

The TMDLs in this report were proposed on June 15, 2009 and, having completed the public participation process, shall be adopted by the Department as amendments to the Atlantic, Cape May, Lower Delaware, Lower Raritan-Middlesex, Mercer, Monmouth, Northeast, Ocean, Sussex, Tri-County, Upper Delaware and Upper Raritan Water Quality Management Plans in accordance with N.J.A.C. 7:15-6.4. This TMDL report was developed consistent with the United States Environmental Protection Agency's (USEPA or EPA) May 20, 2002 guidance document entitled, "Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992" (Sutfin, 2002), which describes the general statutory and regulatory requirements for approvable TMDLs, as well as EPA's more specific guidance memo for the subject type of TMDL, dated September 29, 2008 and entitled "Elements of Mercury TMDLs Where Mercury Loadings are Predominantly from Air Deposition" (Hooks, 2008).

1.0. Introduction

Mercury is a persistent, bio-accumulative toxin that can be found in solid, liquid, or vapor form. Mercury can cause a variety of harmful health effects including damage to the brain, central nervous system, and kidneys and is particularly harmful to children and pregnant and nursing women. Mercury comes from various natural and anthropogenic sources, including volcanic activity, burning of some forms of coal, use in dental procedures and manufacturing, use and disposal of products containing mercury. Most often, mercury enters the environment in gas or particulate form and is deposited on surfaces, often through precipitation, which washes deposited mercury into waterways. There it undergoes a natural chemical process and is converted to a more toxic form – methyl mercury. The methyl mercury builds up in the tissues of fish and animals, increasing its concentration as it moves up through the food chain, which results in high levels of mercury in some of the foods we eat. At certain levels, fish consumption advisories are triggered.

Mercury contamination in the environment is ubiquitous, not only in New Jersey, but worldwide. Mercury contamination is a global issue because the overwhelming source of mercury is air deposition. Consequently, mercury pollution will not be abated on a state by state basis alone, but must be controlled by regional, national and international efforts. In recognition of this, the New England Interstate Water Pollution Control Commission (NEIWPCC) established the *Northeast Regional Mercury Total Maximum Daily Load* dated October 24, 2007 (Northeast Regional TMDL), a regional TMDL for the states of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island and Vermont which addressed impairments due to mercury contamination of waterbodies where the main source of mercury contamination is air deposition. It was approved by EPA on December 20, 2007. As EPA has approved establishment of regional TMDLs for mercury impairments where the primary source is air deposition using the NEIWPCC approach, the Department has determined that it is appropriate for New Jersey to develop a similar TMDL for comparable impairments in New Jersey, not only to recommend a course of action to reduce mercury contamination in New Jersey, but to further emphasize that substantial source reductions from outside New Jersey will be needed to achieve water quality objectives. Therefore, New Jersey has developed a statewide TMDL that will complement the Northeast Regional TMDL developed for the northeast states.

In accordance with Section 303(d) of the Federal Clean Water Act (CWA) (33 U.S.C. 1315(B)), the State of New Jersey is required biennially to prepare and submit to the USEPA a report that identifies waters that do not meet or are not expected to meet 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 accordance with Section 305(b) of the CWA, the State of New Jersey is also required biennially to prepare and submit to the USEPA a report addressing the overall water quality of the State's waters. This report is commonly referred to as the 305(b) Report or the Water Quality Inventory Report. The Department combines these reports into the Integrated Water Quality Monitoring and Assessment Report and assigns each designated use within the assessment unit to one of five sublists. An assessment unit is listed as Sublist 1 if all designated uses are assessed and attained. (The Department does not include the fish consumption use for this sublist.) If some but not all uses are attained, an assessment unit is placed on Sublist 2 for attained uses. If the Department

did not have data to assess a use, the assessment unit is placed on Sublist 3 for that use. If a use is not attained, the assessment unit will be placed on Sublist 5, or Sublist 4 if there is an approved TMDL, there are other enforceable management measures in effect or the impairment is due to pollution, not a pollutant. Sublist 5 constitutes the list of waters for which a TMDL may be required, also known as the 303(d) list. In accordance with the *2008 Integrated Water Quality Monitoring and Assessment Methods*, although there is a State-wide fish consumption advisory for mercury, only waters with actual fish tissue monitoring data that exceed the threshold which results in a consumption restriction (greater than 0.07 mg/kg) are placed on Sublist 5. All other assessment units are listed on Sublist 3 for this use. Based on the TMDL analysis, which demonstrates that reduction of natural sources of mercury would be needed in order to achieve the level necessary to allow unlimited consumption for high risk populations, the Department intends to revise its Assessment Method when developing future Integrated Water Quality Monitoring and Assessment Reports to allow that a limit of 1 meal per week for the high risk population would be considered as attaining the use with respect to mercury-based fish consumption (listing threshold would be results greater than 0.18 µg/g).

The *2008 List of Water Quality Limited Waters* currently identifies 256 Assessment Units as impaired due to mercury in surface water and/or fish tissue. This report establishes 122 TMDLs for mercury contamination based on fish tissue concentration whose source is largely air deposition. Waters where there are other significant sources of mercury in a waterbody, as indicated by a water column concentration in excess of the Surface Water Quality Standards, documentation of high levels of mercury in ground water or the presence of hazardous waste sites where mercury is a contaminant of concern, are deferred at this time, pending additional study. Tidal waters are also excluded because the approach used in this TMDL is intended for waters not affected by tidal dynamics. In addition, areas that are included in the spatial extent of the on-going interstate effort to address mercury impairments in the New York/New Jersey Harbor are excluded from this TMDL. A similar interstate effort is an appropriate means of addressing mercury impairments in the shared waters of the Atlantic Ocean and the Delaware River and Estuary, and these waters are deferred as well.

A TMDL represents the assimilative or carrying capacity of a waterbody, taking into consideration point and nonpoint sources of pollutants of concern, natural background and surface water withdrawals. A TMDL quantifies the amount of a pollutant a 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 waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and a margin of safety (MOS).

EPA guidance (Sutfin, 2002) describes the statutory and regulatory requirements for approvable TMDLs, as well as additional information generally needed for EPA to determine if a submitted TMDL fulfills the legal requirements for approval under Section 303(d) and EPA regulations. EPA has also issued guidance for the development of TMDLs for mercury impairments that are due primarily to air deposition (Hooks, 2008).

2.0. Pollutant of Concern, Applicable Surface Water Quality Standards, and Area of Interest

2.1 Pollutant of Concern

The pollutant of concern for these TMDLs is mercury. According to the current assessment methodology, an assessment unit is listed as impaired for mercury if the data show water column concentrations in excess of the Surface Water Quality Standards (SWQS) or fish tissue concentrations that would result in any limitations on fish consumption. These advisories are not SWQS, but they do indicate a limitation on the use of the waters. As previously discussed, this TMDL is limited to assessment units where impairment is attributed to fish tissue in excess of advisory thresholds, where the mercury is primarily from air deposition. The assessment units addressed are identified in Table 1. These listings have a medium priority ranking in the *2008 List of Water Quality Limited Waters* (40NJR4835(c)).

2.2 Applicable Surface Water Quality Standards and Fish Consumption Advisory Criteria

Most of the waters addressed in this report are classified in the Surface Water Quality Standards (SWQS) at N.J.A.C. 7:9B as Fresh Water 2 (FW2), either Non-Trout (NT), Trout Maintenance (TM) or Trout Production (TP). Some waters are classified as Pinelands (PL) or Freshwater 1 (FW1). A few Assessment Units include waters classified as FW2-NT/SE1 or FW2-NT/SE2. If the measured salinity is less than 3.5 parts per thousand at mean high tide, the FW2-NT classification applies. The TMDL does not apply to fresh or saline tidal waters. If the majority of the waters in the HUC 14 subwatershed are fresh and non-tidal, that assessment unit was included in this TMDL. Therefore, even though portions of some assessment units are noted as including the SE (Saline Estuarine) designation, these designations are not affected and are not discussed below. Table 2 below lists the surface water classifications for the assessment units addressed in this document and Table 3 provides the numeric criteria for mercury.

Table 2. Surface Water Classifications for the Assessment Units Addressed Under this TMDL

WMA	Assessment Unit ID	Waterbody Name	Surface Water Classifications
01	2040104090020	Clove Brook (Delaware River)	FW1, FW1-TP, FW2-TPC1, FW2-TPMC1
01	2040104130010	Little Flat Brook (Beerskill And Above)	FW1, FW2-TP, FW2-TPC1, FW2-NTC1
01	2040104140010	Big Flat Brook (Above Forked Brook)	FW1, FW2-NTC1
01	2040105030020	Swartswood Lake And Tributaries	FW2-TM, FW2-TMC1, FW2-NT, FW2-NTC1
01	2040105030030	Trout Brook	FW2-TPC1, FW2-NT
01	2040105050040	Yards Creek	FW2-TPC1, FW2-NT
01	2040105090040	Mountain Lake Brook	FW2-TM, FW2-NT

01	2040105140040	Merrill Creek	FW2-TPC1, FW2-TM
01	2040105140060	Pohatcong Creek (Springtown To Merrill Creek)	FW2-TPC1, FW2-TMC1
01	2040105150020	Lake Hopatcong	FW2-TM, FW2-NT
01	2040105150060	Cranberry Lake / Jefferson Lake & Tributaries	FW2-TMC1, FW2-NT, FW2-NTC1
02	2020007040040	Highland Lake/Wawayanda Lake	FW2-NT, FW2-NTC1
03	2030103050020	Pacock Brook	FW1, FW1-TP, FW2-NTC1
03	2030103050030	Pequannock River (Above Oak Ridge Reservoir Outlet)	FW1-TP, FW1-TM, FW2-TP, FW2-TPC1, FW2-TMC1, FW2-NT
03	2030103050040	Clinton Reservoir/Mossmans Brook	FW1, FW2-TPC1, FW2-TP, FW2-TMC1, FW2-NTC1
03	2030103050060	Pequannock River (Macopin Gage To Charl'brg)	FW1-TM, FW2-TPC1, FW2-TP, FW2-TM, FW2-TMC1, FW2-NT
03	2030103050080	Pequannock River (Below Macopin Gage)	FW2-TPC1, FW2-TP, FW2-NTC1, FW2-TM, FW2-NT
03	2030103070030	Wanaque River /Greenwood Lake (Above Monks Gage)	FW2-TPC1, FW2-TM, FW2-TMC1, FW2-NT, FW2-NTC1
03	2030103070050	Wanaque Reservoir (Below Monks Gage)	FW2-TPC1, FW2-TMC1, FW2-NTC1
03	2030103110020	Pompton River	FW2-NT
06	2030103010170	Passaic River Upper (Rockaway To Hanover Rr)	FW2-NT
06	2030103020040	Whippany River(Lake Pocahontas To Washington Valley Rd)	FW2-TM, FW2-NT
06	2030103020080	Troy Brook (Above Reynolds Ave)	FW2-NT
06	2030103030030	Rockaway River (Above Longwood Lake Outlet)	FW2-NTC1
06	2030103030040	Rockaway River (Stephens Brook To Longwood Lake)	FW2-NTC1
06	2030103030070	Rockaway RIVER (74d 33m 30s To Stephens Brook)	FW1, FW2-NTC1, FW2-TPC1, FW2-TMC1
06	2030103030090	Rockaway River (BM 534 Bridge To 74d 33m 30s)	FW2-NTC1, FW2-NT
06	2030103030110	Beaver Brook (Morris County)	FW2-TPC1, FW2-TMC1, FW2-NTC1
06	2030103030140	Rockaway River (Stony Brook To BM 534 Bridge)	FW2-NTC1
06	2030103030150	Rockaway River (Boonton Dam To Stony Brook)	FW2-TMC1, FW2-NTC1, FW2-NT
06	2030103030170	Rockaway River (Passaic River To Boonton Dam)	FW2-NT
08	2030105010030	Raritan River South Branch (Above Route 46)	FW2-NT, FW2-TM, FW2-NTC1
08	2030105010040	Raritan River South Branch(74d 44m 15s To Route 46)	FW2-NTC1, FW2-TPC1, FW2-NT, FW2-TMC1

08	2030105010050	Raritan River South BRANCH(Longvalley Brook To 74d44m15s)	FW2-TPC1, FW2-NT
08	2030105010060	Raritan River South Branch(Califon Brook To Long Valley)	FW2-TPC1, FW2-NT
08	2030105020040	Spruce Run Reservior / Willoughby Brook	FW2-TPC1, FW2-TMC1, FW2-TM, FW2-NT
08	2030105020090	Prescott Brook / Round Valley Reservoir	FW2-TPC1, FW2-TM, FW2-NT
08	2030105020100	Raritan River South Branch(Three Bridges-Prescott Brook)	FW2-TM, FW2-NT
08	2030105040010	Raritan River South Branch(Pleasant Run-Three Bridges)	FW2-NT
08	2030105040040	Raritan River South Branch(North Branch To Pleasant Run)	FW2-NT
09	2030105080020	Raritan River Lower (Route 206 To North Branch / South Branch)	FW2-NT
09	2030105080030	Raritan River Lower (Millstone To Route 206)	FW2-NT
09	2030105120080	South Fork Of Bound Brook	FW2-NT
09	2030105120100	Bound Brook (Below Fork At 74d 25m 15s)	FW2-NT
09	2030105120140	Raritan River Lwr(I-287 Piscatway-Millstone)	FW2-NT
09	2030105130050	Lawrence Brook (Church Lane To Deans Pond)	FW2-NT
09	2030105130060	Lawrence Brook (Milltown To Church Lane)	FW2-NT
09	2030105140020	Manalapan Brook(Incl Lakemanlpn To 40d16m15s)	FW2-NT
09	2030105140030	Manalapan Brook (Below Lake Manalapan)	FW2-NT
09	2030105160030	Duhernal Lake / Iresick Brook	FW2-NT
10	2030105090050	Stony Brook(Province Line Rd To 74d46m Dam)	FW2-NT
10	2030105100130	Bear Brook (Below Trenton Road)	FW2-NT
10	2030105110020	Millstone River (Heathcotebk To Harrison St)	FW2-NT
10	2030105110110	Millstone River (Blackwellsmills To Beden Brook)	FW2-NT
10	2030105110140	Millstone River(Amwellrd To Blackwellsmills)	FW2-NT
10	2030105110170	Millstone River (Below Amwell Rd)	FW2-NT
12	2030104060020	Matawan Creek (Above Ravine Drive)	FW2-NT/SE1
12	2030104060030	Matawan Creek (Below Ravine Drive)	FW2-NT/SE1
12	2030104070070	Swimming River Reservoir / Slope Brook	FW2-NTC1
12	2030104070090	Nut Swamp Brook	FW2-NT/SE1
12	2030104090030	Deal Lake	FW2-NT/SE1
12	2030104090080	Wreck Pond Brook (Below Route 35)	FW2-NT, FW2-NT/SE1
12	2030104100050	Manasquan River (Gage To West Farms Road)	FW2-TMC1, FW2-NTC1

13	2040301030040	Metedeconk River South Branch (Rt 9 To Bennetts Pond)	FW2-TMC1, FW2-NTC1
13	2040301060050	Dove Mill Branch (Toms River)	FW2-NTC1, PL
13	2040301070010	Shannae Brook	FW2-NT, PL
13	2040301070030	Ridgeway Brook (Hope Chapel Rd To Harrisbrook)	PL
13	2040301070040	Ridgeway Brook (Below Hope Chapel Rd)	PL, FW2-NT/SE1
13	2040301070080	Manapaqua Brook	PL, FW2-NT/SE1
13	2040301070090	Union Branch (Below Blacks Brook 74d22m05s)	PL, FW2-NT/SE1
13	2040301080030	Davenport Branch (Above Pinewald Road)	PL
13	2040301090050	Cedar Creek (GS Parkway To 74d16m38s)	PL
13	2040301130030	Mill Creek (Below Gs Parkway)/Manahawkin Creek	PL, FW2-NT, FW2-NTC1/SE1
13	2040301130050	Westecunk Creek (Above Garden State Parkway)	PL
13	2040301140020	Mill Branch (Below Garden State Parkway)	FW2-NT/SE1
13	2040301140030	Tuckerton Creek (Below Mill Branch)	PL, FW2-NTC1/SE1, FW2-NT/SE1
14	2040301150080	Batsto River (Batsto Gage To Quaker Bridge)	FW1, PL
14	2040301160030	Mullica River (Route 206 To Jackson Road)	PL
14	2040301160140	Mullica River (39d40m30s To Rt 206)	PL
14	2040301160150	Mullica RIVER (Pleasant Mills To 39d40m30s)	PL
14	2040301180060	Oswego River (Andrews Rd To Sim Place Reservoir)	PL
14	2040301180070	Oswego River (Below Andrews Road)	PL
14	2040301190050	Wading River West Branch (Jenkins Road To Route 563)	PL
14	2040301200010	Beaver Branch (Wading River)	PL
14	2040301200050	Bass River East Branch	PL, FW1
15	2040302030020	Great Egg Harbor (Atlantic City Expressway To New Freedom Road)	PL, FW2-NT
15	2040302040050	Collings Lakes Tributary (Hospitality Branch)	PL
15	2040302040130	Great Egg Harbor (Lake Lenape To Mare Run)	PL
15	2040302050120	Middle River / Peters Creek	FW1, /SE1 C1, FW2-NTC1/SE1
16	2040206210050	Savages Run (Above East Creek Pond)	FW1, PL,
16	2040206210060	East Creek	FW1, PL, FW2-NTC1/SE1, FW2-NT/SE1
17	2040206030010	Salem River (Above Woodstown Gage)	FW2-NTC1, FW2-NT
17	2040206070030	Canton Drain (Above Maskell Mill)	FW2-NT/SE1

17	2040206080050	Cohansey River (Including Cornwell Run – Beebe Run)	FW2-NT/SE1
17	2040206090030	Cohansey R (Rocaps Run To Cornwell Run)	FW2-NT/SE1
17	2040206100060	Nantuxent Creek (Above Newport Landing)	FW1, FW2-NTC1/SE1, FW2-NT/SE1
17	2040206130010	Scotland Run (Above Fries Mill)	FW2-NT
17	2040206130040	Scotland Run (Below Delsea Drive)	FW2-NT
17	2040206140010	Mauriceriver(Blackwater Book To Include Willow Grovelake)	FW2-NT, FW2-NTC1
17	2040206150050	Muddy Run (Including Parvin Lake To Palatine Lake)	FW2-NT, FW2-NTC1
17	2040206180050	Menantico Creek (Below Route 552)	FW2-NT, FW2-NTC1
18	2040202100020	Pennsauken Creek North Branch (Including Strawbridge Lake-Njtpk)	FW2-NT
18	2040202110030	Cooper River (Above Evesham Road)	FW2-NT
18	2040202110040	Cooper River (Wallworth Gage To Evesham Road)	FW2-NT
18	2040202110050	Cooper River (Route 130 To Wallworth Gage)	FW2-NT
18	2040202120010	Big Timber Creek North Branch (Above Laurel Road)	FW2-NT
18	2040202120020	Big Timber Creek North Branch (Below Laurel Road)	FW2-TPC1, FW2-NT
18	2040202120030	Big Timber Creek South Branch (Above Lakeland Road)	FW2-NT
18	2040202120040	Big Timber Creek South Branch(Including Bull Run To Lakeland Road)	FW2-NT
18	2040202120050	Big Timber Creek South Branch (Below Bull Run)	FW2-NT
18	2040202120060	Almonesson Creek	FW2-NT
18	2040202120090	Newton Creek (Ldrv-Kaighn Ave To Lt Creek)	FW2-NT
18	2040202120100	Woodbury Creek (Above Rt 45)	FW2-NT/SE2
18	2040202130030	Chestnut Branch (Above Sewell)	FW2-NT/SE2
18	2040202150020	Raccoon Creek (Rt 45 To/Include Clems Run)	FW2-NT/SE2
18	2040202150040	Raccoon Creek (Russell Mill Road To Route 45)	FW2-NT/SE2
19	2040202030050	Bucks Cove Run / Cranberry Branch	PL
19	2040202050050	Friendship Creek (Below/Including Burrs Mill Brook)	PL
19	2040202050060	Rancocas Creek South Branch(Above Friendship Creek)	PL
19	2040202050080	Rancocas Creek South Branch (Vincentown-Friendship Creek)	PL, FW2-NT
19	2040202050090	Rancocas Creek South Branch (Bobbys Run To Vincentown)	FW2-NT
20	2040201090030	Lower Delaware River Tributaries (Assiscunk Creek To Blacks Creek)	FW2-NT

C1 refers to Category One, a specific category of water relevant with respect to the antidegradation policies in the SWQS.

In all FW1 waters, the designated uses are (NJAC 7:9B-1.12):

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 (NJAC 7:9B-1.12):

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

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

1. Cranberry bog water supply and other agricultural uses;
2. Maintenance, migration and propagation of the natural and established biota indigenous to this unique ecological system;
3. 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;
4. Primary and secondary contact recreation; and
5. Any other reasonable uses.

Table 3. Mercury Water Column Criteria (µg/l)

Toxic substance	Fresh Water (FW2) Criteria		
	Aquatic		Human Health
	Acute	Chronic	
Mercury	1.4(d) (s)	0.77(d) (s)	0.05(h)(T)

d = criterion expressed as a function of the water effects ratio

T = total

h = noncarcinogenic effect-based human health criteria

s = dissolved

Surface water quality criteria for FW1 waters are that they shall be maintained as to quality in their natural state. PL waters shall be maintained as to quality in their existing state or that quality necessary to attain or protect the designated uses, whichever is more stringent.

In addition N.J.A.C. 7:9B-1.5(a) 4 includes the requirement that “Toxic substances in water shall not be at levels that are toxic to humans or the aquatic biota so as to render them unfit for human consumption.”

Fish consumption advisories are jointly issued by the New Jersey Department of Environmental Protection and the New Jersey Department of Health and Senior Services. They provide advice to the general population and high-risk individuals (for example, women of childbearing age and children) concerning the number of meals that represent safe levels of consumption of recreational fish from New Jersey waters. Fish consumption advisories for mercury include information on how to limit risk by providing guidance on the types and sizes of fish and the number of meals to eat. They are not promulgated standards, but they are used for determining whether the fish consumption use is met. Where fish tissue levels exceed the advisory thresholds, a waterbody is listed on the 303(d) list. The New Jersey fish consumption advisories are as follows:

**Table 4. New Jersey Fish Consumption Advisory Thresholds
(from Toxics in Biota Committee 1994)**

Advisories for the high risk population*	
Mercury (TR) Concentration in Fish Tissue	Advisory
Greater than 0.54 µg/g (ppm)	Do not eat
Between 0.19 and 0.54 µg/g (ppm)	One meal per month
Between 0.08 and 0.18 µg/g (ppm)	One meal per week
0.07 µg/g (ppm) or less	Unlimited consumption
Advisories for the general population	
Mercury (TR) Concentration in Fish Tissue	Advisory
Greater than 2.81 µg/g (ppm)	Do not eat
Between 0.94 and 2.81 µg/g (ppm)	One meal per month
Between 0.35 and 0.93 µg/g (ppm)	One meal per week
0.34 µg/g (ppm) or less	Unlimited consumption

TR – Total Recoverable Mercury

* The high risk population consists of women of childbearing years, pregnant and nursing mothers and children.

Under the current assessment methodology, an assessment unit was listed as not attaining the fish consumption use if fish tissue data indicated that any restriction of consumption would be necessary, in other words if the fish tissue concentration was above 0.07 µg/g. However, based on this TMDL analysis, this level in fish tissue can be caused solely by natural sources of mercury in some waters (see Section 5 *TMDL Calculations* below). Therefore, the Department intends to revise the assessment methodology in the development of future lists (2010) to reflect a minimal level of consumption advisory for the high risk population. It is expected that the

future assessment method will use a tissue concentration of greater than 0.18 µg/g as the listing threshold, which would allow consumption by the high risk population of one meal per week. Therefore, the target for this TMDL is 0.18 µg/g total mercury fish tissue concentration. Big Timber Creek would not have been listed using this listing threshold, however, because it is listed on the 2008 303(d) list, it will be included in this TMDL document. All other waters included in this TMDL exceed the 0.18 ug/g fish tissue target.

Because fish consumption advisories are not SWQS and a TMDL must demonstrate attainment of the applicable SWQS, it is necessary to demonstrate that using this fish tissue target will also attain the applicable SWQS for mercury. This is done using bioaccumulation factors (BAFs), to convert the levels found in the fish tissue to a water column value so there can be a direct comparison with the State's current water quality criterion of 0.050 µg/L as total mercury. There is no numerical standard for waters classified as PL or FW1. The 0.18 ug/g fish tissue target is a human health endpoint which is protective of all waters, regardless of a waterbody's designation. NJAC 7:9B-1.5(a) 4's narrative standard regarding toxic substances is applicable to all waters. Absent a numeric standard for FW1 and PL waters, the narrative standard was applied and implemented using the 0.18 ug/g mercury fish tissue target. In addition the target of 0.18 µg/L requires the reduction of mercury to near natural background levels (see TMDL calculations in section 5 below) and as such is protective of waters with PL and FW1 designations.

New Jersey is engaged in an ongoing effort to develop regional BAFs. As this work is not complete, the EPA national default values will be used for this TMDL. A BAF of 1,690,000 L/kg was selected, which is based on the averaging of EPA national default values for trophic level 3 and trophic level 4 fish of 2,700,000 and 680,000 L/kg, respectively. Averaging the two values assumes a diet of 50% of these higher trophic level fish. This BAF is for methyl mercury. A further conversion to a corresponding total mercury concentration in the water column can be calculated by using the ratio of dissolved methyl mercury to total mercury. Data available from the various regions of New Jersey show that the ratios range from 0.059 to 0.005 (pers. comm. G. A. Buchanan, NJDEP, May 5, 2009). A ratio of 0.055 can be calculated from national data (EPA, 1997). The water column mercury concentration, 0.021 ug/L, expressed as total mercury using the selected BAF and the most conservative conversion factor (0.005) is lower than the mercury surface water criterion of 0.050 ug/L. Therefore, the use of a fish tissue criterion as a TMDL target ensures that the SWQS will be met if the TMDL fish tissue target is met.

The following formula was used for this comparison:

WCV (µg/L)=[Fish Tissue Value (mg/kg)/BAF (L/kg) x 1000 µg/mg] / dissolved MeHg to total Hg

Where:

WCV = water column mercury concentration

Fish Tissue Value = 0.18 mg/kg

BAF = 1,690,000 L/kg

Therefore:

WCV (µg/L)(as total Hg) = $[0.18 \text{ mg/Kg}/1,690,000 \text{ L/kg} \times 1000 \text{ µg/mg}] / 0.005 = \mathbf{0.021 \text{ µg/L total Hg}}$

In other words, when a fish tissue target of 0.18 mg/kg is met, the water column mercury concentration would be 0.021 µg/L, which is below the surface water quality criterion of 0.050 µg/L).

2.3 Area of Interest

In accordance with the *2008 Integrated Water Quality Monitoring and Assessment Methods*, although there is a State-wide fish consumption advisory for mercury, only waters with actual fish tissue monitoring data that exceed the threshold which results in a consumption restriction (greater than 0.07 mg/kg) are placed on Sublist 5. All other assessment units are listed on Sublist 3 for this use.

The *2008 List of Water Quality Limited Waters* currently identifies 256 assessment units as impaired due to mercury in surface water and/or fish tissue. This report establishes 122 TMDLs for mercury contamination based on fish tissue concentration whose source is largely air deposition. Waters where there are other significant sources of mercury in a waterbody, as indicated by a water column concentration in excess of the Surface Water Quality Standards (61 listings), documentation of high levels of mercury in ground water (15 listings) or the presence of hazardous waste sites where mercury is a contaminant of concern (8), are deferred at this time, pending additional study. Tidal waters (35) are also excluded because the approach used in this TMDL is intended for waters not affected by tidal dynamics. In addition, areas that are included in the spatial extent of the on-going interstate effort to address mercury impairments in the New York/New Jersey Harbor are excluded from this TMDL (6). A similar interstate effort is an appropriate means of addressing mercury impairments in the shared waters of the Atlantic Ocean (37) and the Delaware River and Estuary (9) and these waters are deferred as well. See Appendix A for a listing of the deferred assessment units.

Additional fish tissue data not available when the *2008 List of Water Quality Limited Waters* was developed were evaluated and 37 additional assessment units were found to have fish tissue concentrations that would have resulted in listing of those assessment units under the current assessment methodology (see those indicated with an asterisk in Table 1). These assessment units also meet the other criteria for being addressed under this TMDL (no other significant sources, non-tidal, outside the spatial extent of interstate study). Therefore, these assessment units will be addressed under this TMDL.

As additional fish tissue data is obtained, it is expected that other assessment units will be identified that conform to the parameters established for this TMDL approach and would appropriately be addressed by this TMDL, had the data been available. Therefore, in addition to the impaired waters listed Table 1, this TMDL may, in appropriate circumstances, also apply to waterbodies that are identified in the future as being impaired for mercury. For such waterbodies, this TMDL may apply if, after listing the waters for mercury impairment and taking into account all relevant comments submitted on the Impaired Waters List, the Department determines, with EPA approval of the list, that this TMDL should apply to future mercury impaired waterbodies. Under these circumstances, the assessment units will be placed on Sublist 4.

The assessment units addressed in this TMDL are listed in Table 1 and depicted in Figure 1. The assessment units encompass 724,236 acres throughout the state.

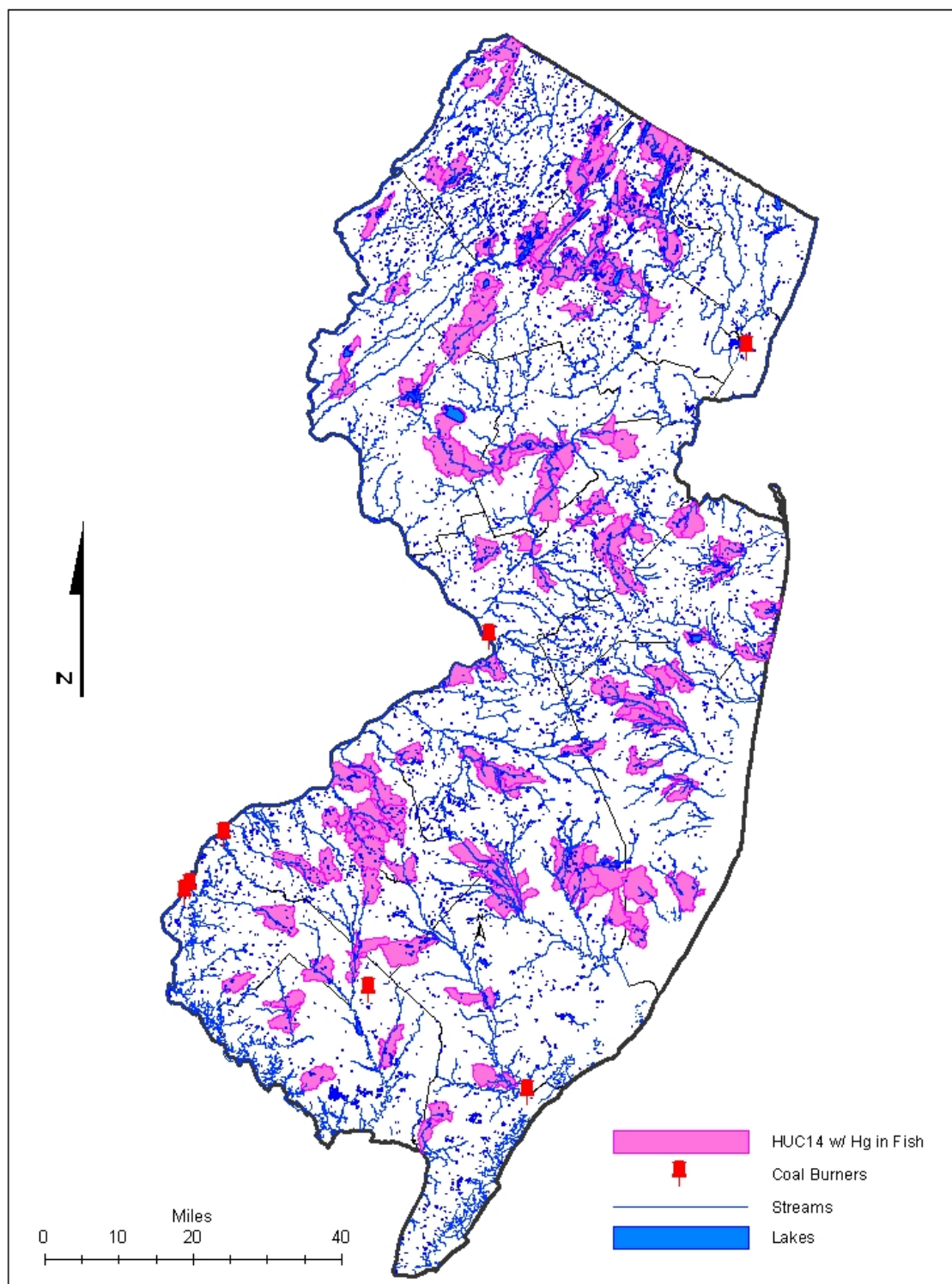


Figure 1. Assessment Units Addressed in this TMDL

3.0. Data Analysis

3.1 Fish Tissue Data

Beginning in 1994, research on freshwater fish found mercury concentrations exceeding the risk-based health advisories established by the State of New Jersey. Additional data were developed and reported in Academy of Natural Sciences, Philadelphia (ANSP) (1999), Ashley and Horwitz (2000), Horwitz et al. (2005) and Horwitz et al. (2006). The Department's Routine Monitoring Program for fish tissue began in 2002. The purpose of this monitoring program is to enhance waterbody assessments; amend existing advisories or, if necessary, develop new advisories; assist the NJDEP in evaluating trends in contaminant concentrations of these selected species; and to determine the need for additional research and monitoring studies. The sampling program is based on a rotating assessment of contamination in five regions of the state on a 5-year cycle. The regions consist of:

1. Passaic River Region;
2. Marine/Estuarine Coastal Region;
3. Raritan River Region;
4. Atlantic Coastal Inland Waterways Region; and
5. Upper and Lower Delaware River Region.

Sampling in the Passaic Region was conducted in 2002-2003 and the Marine/Estuarine Region in 2004-06. The results were reported in Horwitz, et al. (2005 and 2006). In the third year of the cycle, the Raritan River Region was sampled for freshwater fish, blue crabs and marine fish. In 2006-2007, species important to recreational anglers in the Raritan estuaries and adjacent oceanic waters and in two southern New Jersey coastal bays were sampled.

The initial data set consulted included 2,474 samples that had been analyzed for mercury in fish tissue in the waters of New Jersey collected through the above sampling programs and from localized investigations. All fish were analyzed using microwave digestion and cold vapor atomic absorption. Based on an evaluation of data quality, all samples before 1990 were excluded because of issues with background contamination in the labs analyzing samples. A small number of fish tissue samples were derived from whole fish samples. Only samples where the fillets were analyzed were retained to ensure a consistent basis for comparison. Locations with known mercury contamination from other sources were eliminated to avoid influences beyond air deposition (water column exceedances, presence of hazardous sites with mercury, groundwater levels with elevated mercury). All tidal areas were excluded, including those from the areas of on-going or anticipated interstate studies (New York/New Jersey Harbor, Atlantic Ocean and Delaware River and Bay). The final data set used for this TMDL analysis included 1,368 samples from 26 different species (see Appendix B).

This TMDL is based on the linear relationship between mercury levels in the air and water and that a BAF can relate fish tissue concentration to water column concentration. This means that if the existing load is responsible for the observed mercury levels in fish, then one can calculate the load that will result in the target concentration in fish and the associated water column

concentration using the BAF, to ensure the SWQS are attained. The steady state bioaccumulation equation is:

$$C_{\text{fish } t1} = \text{BAF} * C_{\text{water } t1}$$

where:

$C_{\text{fish } t1}$ and $C_{\text{water } t1}$ represent methyl mercury concentration in fish and water at time t_1 , respectively;

BAF represents the bioaccumulation factor, which is constant for a given age and length fish in a specific water body.

For a future time, t_2 , when mercury concentrations have changed, but all other parameters remain constant, the following equation applies:

$$C_{\text{fish } t2} = \text{BAF} * C_{\text{water } t2}.$$

Combining both equations produces the following:

$$C_{\text{fish } t1} / C_{\text{fish } t2} = C_{\text{water } t1} / C_{\text{water } t2}.$$

Then, with methyl mercury water column concentrations being proportional to mercury air deposition load, therefore:

$$C_{\text{fish } t1} / C_{\text{fish } t2} = L_{\text{air } t1} / L_{\text{air } t2}$$

where:

$L_{\text{air } t1}$ and $L_{\text{air } t2}$ represent mercury loads from the air deposition at time 1 and time 2.

Mercury concentration in fish increases with both age and length (see Figure 2). In order to derive a representative existing fish tissue concentration as a basis to calculate the load reduction required to achieve the target concentration, it is necessary to statistically standardize the data. The fish tissue mercury concentrations were statistically adjusted to a “standard-length fish”. Because many fish are larger than the standard length and therefore higher in mercury, the TMDL analysis targets the 90th percentile mercury tissue concentration of the distribution of all length-standardized fish evaluated. This will provide an implicit margin of safety and be more protective than using a mean or median concentration value. In addition, because growth rates and levels of mercury accumulation will vary between waterbodies, using the 90th percentile tissue concentration will be protective of waterbodies with higher levels of accumulation.

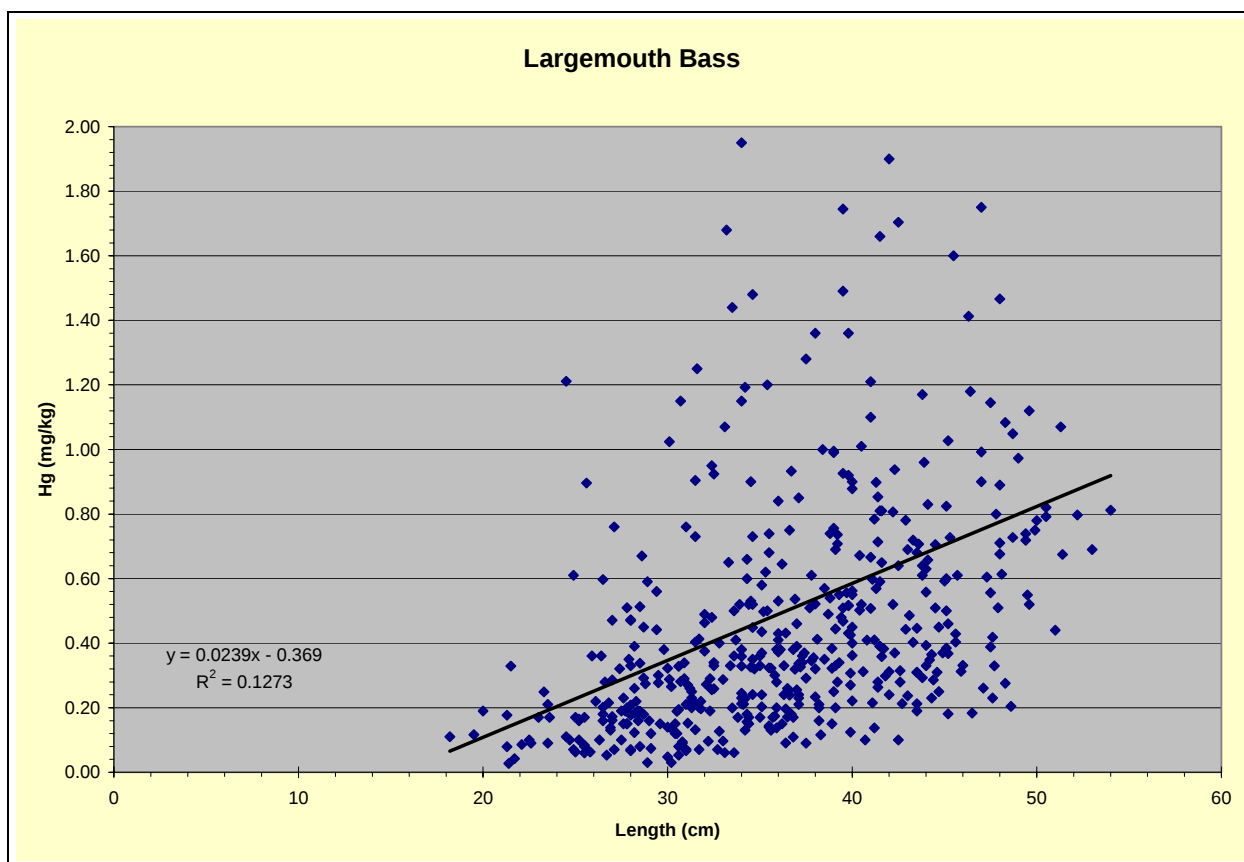


Figure 2. Relationship Between Length and Mercury Concentration in Fish Tissue

The Northeast Regional TMDL analyzed four different species of top trophic level fish, comparing the mean, 80th and 90th percentile concentrations. The authors chose the smallmouth bass (*Micropterus dolomieu*), because of the rate of bioaccumulation of mercury and its ubiquitous distribution throughout the Northeast States. The smallmouth bass is not well distributed throughout New Jersey, therefore it was not an appropriate indicator species for this TMDL. However, the largemouth bass (*Micropterus salmoides*), of the same genus and with the same diet of crayfish, frogs and fish, is well distributed throughout New Jersey. Samples are available from 69% of the listed assessment areas. The chain pickerel was also considered because it is represented by the second largest number of samples in the data set and has a high average mercury concentration (see tables 5 and 6 below). Its diet consists of invertebrates and fish. However, it is not as well distributed throughout New Jersey. Because of the larger sample size and better distribution, the largemouth bass was chosen to be the indicator for this TMDL effort. Using either fish yields a similar reduction factor.

Table 5. Data on Methyl Mercury Concentration in Fish Fillet Samples (n = number of samples, Average = arithmetic mean concentration)

Species List	2000-2007		1990-1999	
	n	Average	n	Average
American Eel	72	0.4	6	0.47
Black Crappie	15	0.15	32	0.19
Bluegill	75	0.14	2	0.03
Bluegill Sunfish	3	0.07	20	0.18
Brown Bullhead	32	0.07	79	0.19
Brown Trout	2	0.08	1	0.2
Chain Pickerel	82	0.658	166	0.685
Channel Catfish	9	0.22	10	0.15
Common Carp	36	0.11	5	0.04
Hybrid Striped Bass	0		6	0.27
Lake Trout	5	0.14	12	0.46
Largemouth Bass	152	0.54	224	0.56
Mud sunfish	0		3	1.01
Northern Pike	6	0.29	6	0.24
Pike	0		3	0.39
Pumpkinseed Sunfish	0		19	0.37
Rainbow Trout	0		6	0.11
Redbreast Sunfish	16	0.16	4	0.24
Rock Bass	19	0.33	4	0.46
Smallmouth Bass	13	0.34	22	0.47
Striped x White Bass Hybrid	5	0.29	0	
Walleye	10	0.4	6	0.74
White Catfish	8	0.19	15	0.27
White perch	12	0.18	22	0.42
White Sucker	3	0.23	0	
Yellow Bullhead	33	0.23	32	0.63
Yellow Perch	27	0.36	28	0.51

An analysis of covariance model was used to estimate the length-adjusted concentrations of mercury in largemouth bass. Scatter plots indicated that a log transformation for mercury would approximately linearize the relationship between mercury and length, so the model used the log to the base 10 of mercury as the dependent variable. The independent variables were length and water body. Water bodies were considered to be fixed effects. The result of this analysis was to create a length-adjusted mercury concentration for each water body.

A model was also run in order to determine whether the length-adjusted concentrations changed over time. In order to do this, an independent variable defining the decade in which the sample was taken (1992 – 1999 vs. 2000 – 2007) was included in the model along with length and water body. This model was significant ($p < 0.001$) with an R-square of 82%. Mercury concentrations varied significantly ($p < 0.001$) with length, waterbody and the decade in which the samples were taken.

Because decade was a significant effect, the two decades were analyzed separately. The adjusted estimates were calculated at the mean length of 35.11cm for data collected from 1992-1999 and 39.78 cm for data collected from 2000-2007.

For the 1992-1999, the data set included 49 water bodies. The number of fish sampled from each water body ranged from 1 to 12. The independent variables included length and water body. This model run was significant ($p < 0.001$) with an R-square of 89%. Mercury concentration varied significantly ($p < 0.001$) with both length and waterbody. The 90th percentile of the length-adjusted mercury concentration is $10^{(0.0448)} = 1.109 \mu\text{g/g}$.

The 2000-2007 dataset included 46 water bodies. The number of fish sampled from each water body ranged from 3 to 5. The independent variables included length and water body. This model run was significant ($p < 0.001$) with an R-square of 85%. Mercury concentration varied significantly ($p < 0.001$) with both length and waterbody. The 90th percentile of the length adjusted mercury concentration is $10^{(0.0607)} = 1.150 \mu\text{g/g}$.

The statistical analyses were performed in SAS version 9.1.3.

Because the mercury concentration varies with the waterbody, the 90th percentile fish tissue concentration is used to calculate the reduction factor. This will be protective of all the waterbodies, even those with higher fish tissue mercury concentrations.

Table 6. Mercury Concentrations Related to Fish Length for 2000-2007 Data

Species	Standard Length (cm)	Mean Hg Concentration (ppm) at Standard Length	80th percentile Hg Concentration (ppm) at Standard Length	90th percentile Hg Concentration (ppm) at Standard Length
Largemouth bass	35.11	0.531	0.64	1.15
Chain pickerel	41.61	0.59	1.26	1.29

Figure 3 shows the distribution of methyl mercury concentrations in all species in the 2000–2007 data set and concentrations in the largemouth bass for the same period. The graph shows that targeting the 90th percentile concentration in largemouth bass corresponds to the 93rd percentile concentration for all fish species. Therefore, targeting the concentration of 90th percentile for largemouth bass, means that approximately 93% of all fish populations tested will comply with

the TMDL target concentration. There is much environmental variability. Some lakes will show decreases in mercury more quickly, some more slowly. Both the Minnesota and the Northeast States regional TMDLs were based on the 90th percentile concentration. Therefore the 90th percentile target is in keeping with mercury TMDLs EPA has previously approved.

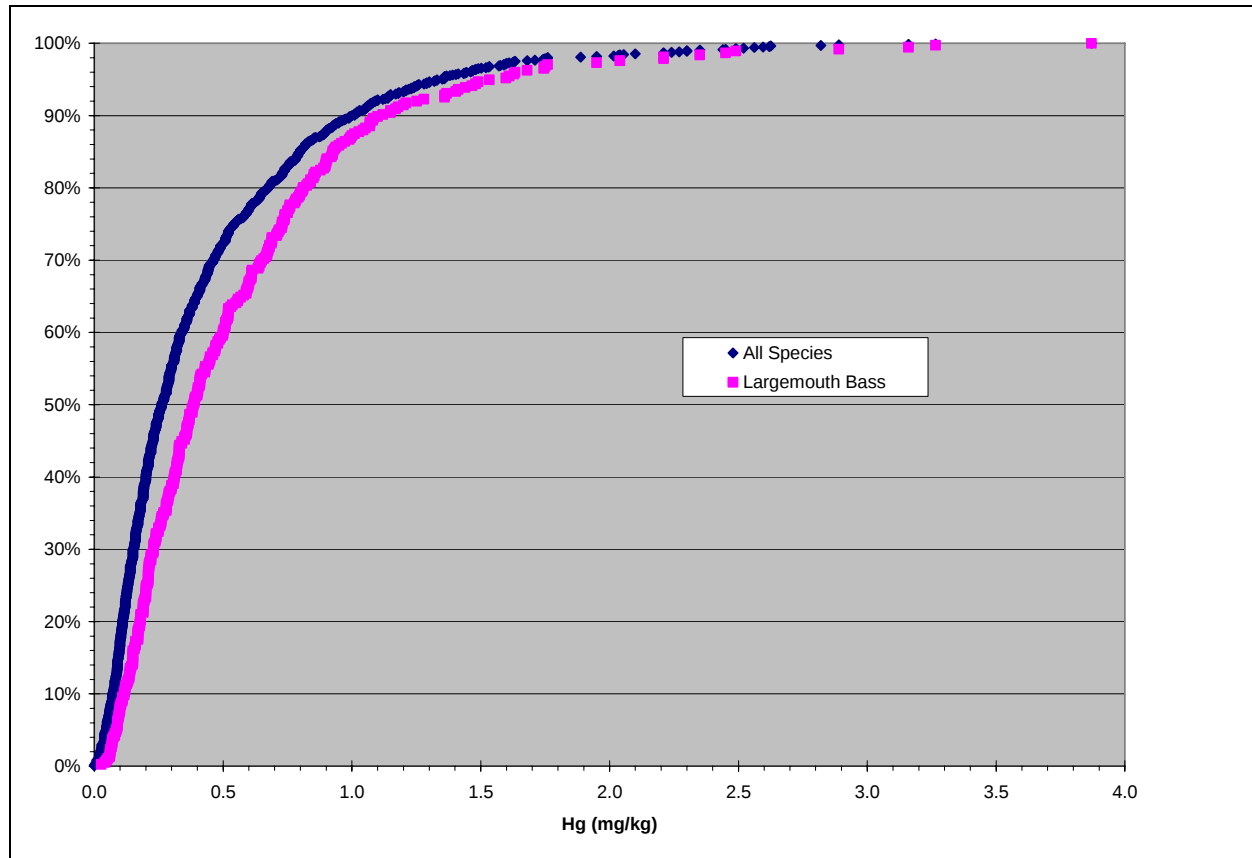


Figure 3. Cumulative Distribution of Mercury Concentrations in Fish Tissues

Based on the linear relationship premise, a Reduction Factor (RF) based on the existing and target fish tissue concentrations is calculated as follows:

$$RF = (EFMC - TFMC) / EFMC$$

where:

EFMC = the existing fish mercury concentration for the selected fish species.

TFMC = target fish mercury concentration

or:

$$0.84 = (1.15 \mu\text{g/g} - 0.18 \mu\text{g/g}) / 1.15 \mu\text{g/g}$$

As discussed above, the EFCM for this study is 1.15 µg/g, which represents the 90th percentile concentration based on standard length for largemouth bass. The target fish tissue concentration is 0.18 µg/g, which will allow a consumption rate of 1 meal per week for the high risk population. For unlimited consumption of fish for the high risk population, the reduction factor would need to be 0.94. As discussed below, natural sources of mercury, which cannot be reduced, make this reduction factor unattainable. However, the TMDL calculation includes an implicit margin of safety based on a number of conservative assumptions. Therefore, it is possible that unlimited consumption for the high risk population may be attainable if the identified anthropogenic reductions are achieved. In any case, although this TMDL target will not allow unlimited consumption of top trophic level fish for high risk groups using the multiple conservative assumptions in this analysis, mercury will be reduced at all trophic levels, allowing greater options for safe consumption of fish at the lower trophic levels and one meal per week of the top trophic levels by the high risk population.

4.0. Source Assessment

In order to evaluate and characterize mercury loadings on a statewide basis source assessments are critical. Source assessments include identifying the types of sources and their relative contributions to mercury loadings and are necessary to develop proper management responses to reduce loadings and attain water quality targets.

Air deposition is the primary source of the mercury impairments addressed in this TMDL. A recent study was undertaken in partnership with the states and USEPA Regional Air and Water Offices to use atmospheric deposition modeling to quantify contributions of specific sources and source categories to mercury deposition within each of the lower 48 states (ICF, 2008). The annual simulation was performed based on data that represented late 90's emission profiles for most source categories. The primary modeling system used for this study is the Regional Modeling System for Aerosols and Deposition (REMSAD). REMSAD is a three-dimensional grid model designed to calculate the concentrations of pollutants by simulating the physical and chemical processes in the atmosphere that affect pollutant concentrations. REMSAD simulates both wet and dry deposition of mercury. REMSAD also includes algorithms for the reemission of previously deposited mercury (originating from anthropogenic and natural sources) into the atmosphere from land and water surfaces. The Particle and Precursor Tagging Methodology (PPTM) feature allows the user to tag or track emissions from selected sources or groups of sources, and quantify their contribution to mercury deposition throughout the modeling domain and simulation period. Results from the Community Multiscale Air Quality (CMAQ) modeling system were used to enhance the analysis of the effects of global background on mercury deposition. The outputs from three global models were used to specify the boundary conditions for both REMSAD and CMAQ and thus represent a plausible range of global background contributions based on current scientific understanding.

Preparation and quality assurance of the mercury emissions inventory were critical for the air deposition load modeling. Based on the emissions data utilized by USEPA in the Clean Air Mercury Rule (CAMR) modeling, detailed summaries of the top emitters in the CAMR mercury inventory for each state were prepared and provided to the appropriate EPA regional offices and

state agencies for review. An effort was made to update emissions to the 2001 timeframe in addition to the general QA/QC that performed by the states and EPA regions. Then based on the state's input, any errors in the data were corrected. Table 7 lists New Jersey's emission inventory as it was used in the model. This inventory was developed based on the Department's 2001 mercury emission estimates (ICF, 2008). For the total of the three forms of mercury emission load, approximately 60% was due to air point sources and 40% from air nonpoint sources. Air point sources include fuel combustion-electric utilities, industrial facilities and other combustion facilities. Air nonpoint sources include human cremation, fluorescent lamp breakage, miscellaneous volatilization and other non-stationary sources.

Table 7. Summary of Emissions Inventory of New Jersey in Tons per Year (tpy) (ICF, 2008)

Facility Name	HG0* (tpy)	HG2* (tpy)	HGP* (tpy)	Total (tpy)
B.L. England	0.094	0.016	0.004	0.114
Hudson*	0.011	0.028	0.003	0.041
Mercer	0.030	0.015	0.011	0.057
Deepwater	0.002	0.004	0.000	0.006
Logan Generating Company - L.P.	0.001	0.000	0.000	0.002
Chambers Cogeneration - L.P.	0.010	0.006	0.004	0.021
Co Steel Raritan	0.090	0.011	0.011	0.112
Atlantics States Cast Iron Pipe	0.033	0.004	0.004	0.041
U.S. Pipe & Fndy. Co	0.019	0.011	0.000	0.030
Co Steel Sayreville*	0.178	0.022	0.022	0.222
Essex County RRF*	0.047	0.123	0.042	0.212
Camden RRF*	0.011	0.029	0.010	0.050
Union County RRF	0.003	0.008	0.003	0.014
Gloucester County	0.002	0.005	0.002	0.009
Warren Energy RF	0.001	0.001	0.001	0.003
Howarddown	0.002	0.001	0.001	0.004
Hoeganese	0.005	0.003	0.002	0.010
Camden County Muassi	0.005	0.003	0.002	0.010
Stony Brook Regional Sewerage Authority	0.011	0.007	0.005	0.023
Bayshore Regional Sewerage Authority	0.004	0.002	0.002	0.008
Somerset Raritan Valley Sewerage Authority	0.007	0.004	0.003	0.014
Northwest Bergen County Utilities Authority	0.005	0.003	0.002	0.010
Parsippany – Troy Hills Township WWTP	0.004	0.003	0.002	0.009
Atlantic County Utilities Authority	0.003	0.002	0.001	0.006
Gloucester County Utilities Authority	0.001	0.001	0.000	0.002
Point Source Total	0.579	0.312	0.137	1.030
Non-point Source	0.464	0.096	0.055	0.613
Total	1.043	0.408	0.192	1.643

*HG0 - elemental mercury vapor; HG2 - divalent mercury compounds in gas phase; HGP - divalent mercury compounds in particulate phase.

As summarized in Table 8 below, a total of 594 kg of annual mercury load due to air deposition was estimated for New Jersey. “Background” refers to the effects of initial and boundary concentrations and embodies the effects of global emissions, altogether, about 52% of the total

load. Emissions from New Jersey are contributing 12.5% of the total load. The emissions from five surrounding states contribute 26% of the total load.

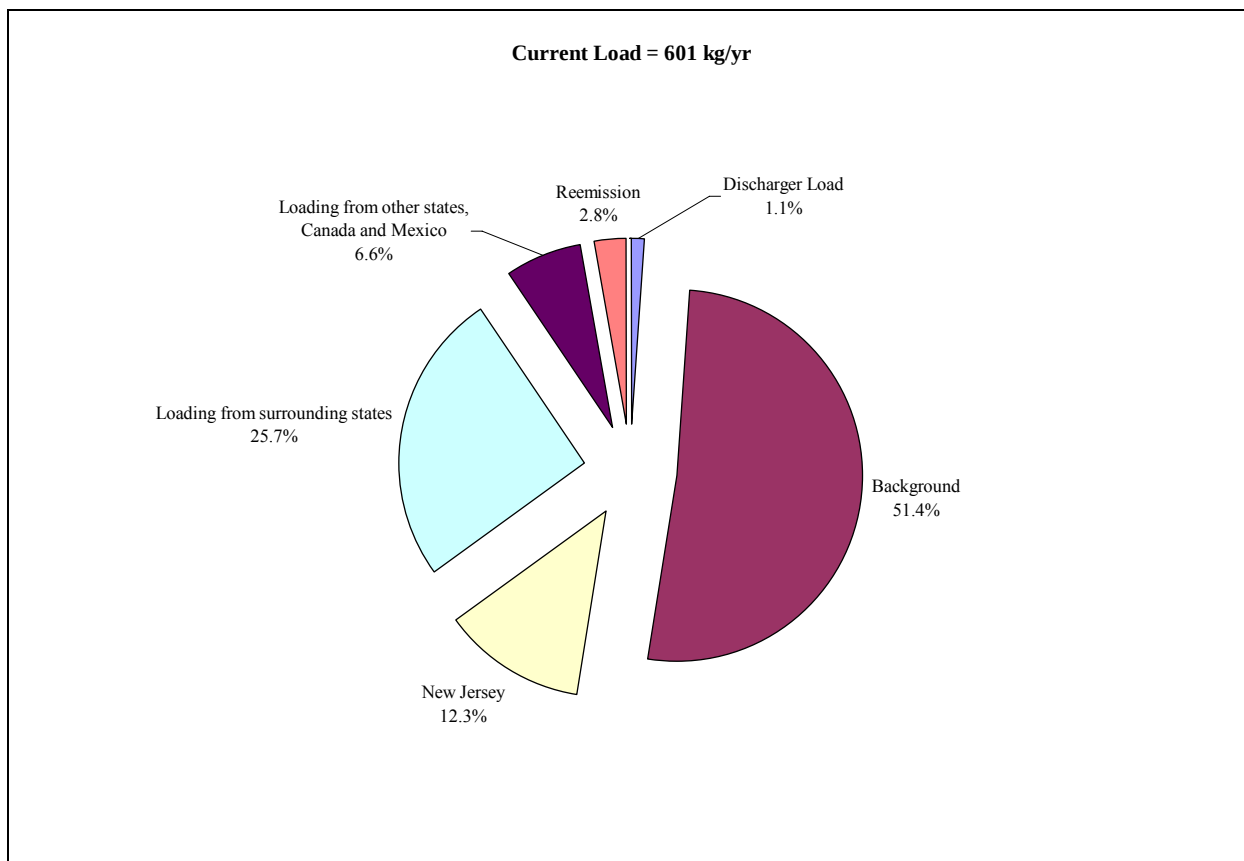
Table 8. Mercury Air Deposition Load for New Jersey (pers. com. D. Atkinson, March 26, 2009, see Appendix D)

Category	Load (kg/yr)	Percent of Total Load
Background	309.0	52.0%
Background-reemission	16.9	2.8%
New Jersey	74.1	12.5%
Loading from the surrounding state (Total)	154.6	26.0%
Pennsylvania	102.8	17.3%
Maryland	25.1	4.2%
New York	13.7	2.3%
Delaware	11.1	1.9%
Connecticut	1.8	0.3%
Loading from other states, Canada and Mexico	39.6	6.7%
Total	594.2	100%

Under the Clean Water Act (CWA), air deposition is a nonpoint source of mercury. Mercury deposited from air sources reaches the surface water as the result of direct deposition on the water surface and through stormwater runoff. Under the CWA, stormwater discharges subject to regulation under the National Pollutant Discharge Elimination System (NPDES) are a point source. In New Jersey, this includes facilities with individual or general industrial stormwater permits and Tier A municipalities and state and county facilities regulated under the New Jersey Pollutant Discharge Elimination System (NJPDES) municipal stormwater permitting program. Stormwater discharges that are not subject to regulation under NPDES, such as Tier B municipalities regulated under the NJPDES municipal stormwater permitting program, and direct stormwater runoff from land surfaces are nonpoint sources. Stormwater point sources derive their pollutant load from runoff from land surfaces and the necessary load reduction for this TMDL will be accomplished in the same way as for stormwater that is a nonpoint source, that is by reducing the air deposition load. The distinction is that, under the Clean Water Act stormwater point sources are assigned a WLA while nonpoint sources are assigned a LA. For this TMDL, the proportion of the air deposition loading attributed to stormwater point sources has been estimated by determining the amount of urban land located within Tier A municipalities. Based on NJDEP's 2002 land use coverage, the area of urban land use within the Tier A municipalities is about 25.6% of the entire state. Applying this percentage to the entire load due to air deposition is the best approximation of the air deposition load subject to stormwater regulation and this proportion of the air deposition load will be assigned a WLA.

Surface water discharges of sanitary and industrial wastewater that have the potential to discharge mercury are the other potential point source category which must be assigned a WLA. The Department reviewed over 240 existing major and minor municipal surface water discharge locations. Industrial surface water dischargers with mercury limits in their permits regulated under the New Jersey Pollutant Discharge Elimination System (NJPDES) were also included as the potential point sources for this TMDL. Since this TMDL is limited to non-tidal water, facilities discharging to coastal water were excluded. By examining the locations of the outfall pipes, approximately two-thirds of initially identified municipal and industrial surface water discharge facilities were used to estimate the point source loading from them.

Various sources of data were assessed in order to estimate an appropriate loading to attribute to discharge facilities. Due to the high detection limit of the standard method for analyzing the samples collected from the dischargers, mercury concentrations reported to date were generally listed as non-detected in the Monitoring Report Forms. Dental facilities are believed to be the largest source of mercury reaching wastewater treatment plants. Through the recently adopted New Jersey Pollutant Discharge Elimination System, Requirements for Indirect Users – Dental Facilities rules, N.J.A.C. 7:14A-21.12, dental facilities that generate amalgam waste are required to comply with best management practices and install amalgam separators. The amalgam separators will allow the mercury containing amalgam to be collected and recycled, thereby reducing the amount entering the environment through sludge incineration. The Department required major wastewater treatment facilities to carryout baseline monitoring of their effluent to determine mercury levels prior to implementation of the new dental requirements. However, the data from this monitoring effort are not yet available for use in this TMDL. As part of the New York-New Jersey Harbor TMDL development, in 2000 and 2001 a total of 30 samples were collected from 11 Publicly Owned Treatment Works (POTWs) in New Jersey which discharge to the Harbor (GLEC, 2008). Total recoverable mercury concentrations ranged from 8.32 to 74.9 ng/L, with a mean of 30.09 ng/L and a median of 19.75 ng/L. The Department believes that the mercury effluent concentrations found in these facilities will serve as an appropriate representation of effluent quality in the state. Therefore, the median concentration of 19.75 ng/L was used as a typical mercury concentration for treatment facilities. The total permitted flows for selected facilities is about 250 MGD. Using that flow and the selected median concentration, the total mercury load from these facilities is estimated to be 6.8 kg/year. This loading (6.8 kg/yr) is also a conservative assumption of the existing point source load since the permitted flow was used instead of the actual flow. The loading attributed to discharge facilities is insignificant at approximately 1% of the total load. Figure 4 shows the distribution of the current total load of mercury.



Note: Load from stormwater is not distinguished because it is derived from and is a subset of the air deposition load from the different air sources identified.

Figure 4. Distribution of the Current Mercury Load

5.0. TMDL Calculation

Methods similar to those used in the *Northeast Regional TMDL* (2007) are employed below to calculate the TMDL. A total source load (TSL), described in Section 4, and reduction factor (RF), as described in Section 3, are used to define the TMDL by applying the reduction factor to the total source load, as shown in Equation 1 below.

$$\text{TMDL} = \text{TSL} \times (1 - \text{RF})$$

where:

- TMDL is the total maximum daily load (kg/yr) that is expected to result in attainment of the target fish tissue mercury concentration.
- TSL is the existing total source load (kg/yr), and is equal to the sum of the existing point source load and the existing nonpoint source load
- RF is the reduction factor required to achieve the target fish mercury concentration.

To allow a consumption rate for the high risk population of one meal per week, the required reduction is 84.3 % ($1 - 0.18/1.15 = 84.3\%$). The total existing loading from air deposition and the treatment facilities discharging into non-tidal waters is 601.kg/yr. In this load, 6.8 kg/yr (about 1%) comes from NJPDES regulated facilities with discharges to surface water in non-tidal waters. Due to the insignificant percentage contribution from this source category, reductions from this source category are not required in this TMDL. Therefore, individual WLAs are not being assigned to the various facilities through this TMDL. Individual facilities have been and will continue to be assessed to determine if a water quality based effluent limit should be assigned to prevent localized exceedances of SWQS and to ensure that the aggregate WLA is not exceeded. As discussed above and in the Reasonable Assurance section below, the recently implemented dental amalgam rules are expected to significantly reduce the amounts of mercury entering wastewater treatment facilities. At this time, it is not known what effect this will have on effluent concentrations. The post-implementation monitoring will be assessed to determine the effect of best management practices (BMPs) for the handling of dental amalgam waste and installation and proper operation of amalgam separators and the need for adaptive management with regard to this source in air deposition impacted waterbodies. Waterbodies that may be impacted by NJPDES regulated facilities with discharges to surface water (those with water column exceedances of the SWQS) have been excluded from the TMDL and will be addressed individually at a later date.

Based on results of several paleolimnological studies (NEIWPC, et.al. 2007) in the Northeast, the natural mercury deposition is estimated to range between 15 % and 25 % of deposition fluxes for circa 2000. Natural sources cannot be controlled and are expected to remain at the same long-term average. It is assumed, in this study, that 25% of the background and background reemission is due to natural sources and can not be reduced (Ruth Chemerys and John Graham Pers. Comm. April 28, 2009). Twenty-five percent of the background and background reemission load is about 81.5 kg/yr, which is 13.6% of the total existing load. Including the load of 6.8 kg/yr attributed to surface water dischargers, the portion of the existing load that is not expected to be reduced is about 14.7%. If 0.07 ug/g (the fish concentration for unlimited consumption by the high risk population) were used as the TMDL target, the required reduction would be 93.9% of the existing load, which is greater than the entire anthropogenic load of 85.3% ($1-14.7\%$) and clearly unattainable. For this reason, the concentration level (0.18 ug/g) that allows the high risk population to consume fish once per week was used as the target for this TMDL and will also be used as the threshold in future assessments of impairment. In order to achieve the overall 84.3% reduction of the existing load to attain the target of 0.18 mg/kg in fish tissue, a reduction of 98.8% of the anthropogenic source load would be needed. An implicit margin of safety (MOS) is used in this study, therefore, the MOS term of the TMDL equation is set to zero. Figure 5 presents the distribution of the TMDL to achieve the target concentration that will allow one meal per week by the high risk population.

Table 9. Mercury TMDL for One Meal per Week by High Risk Population

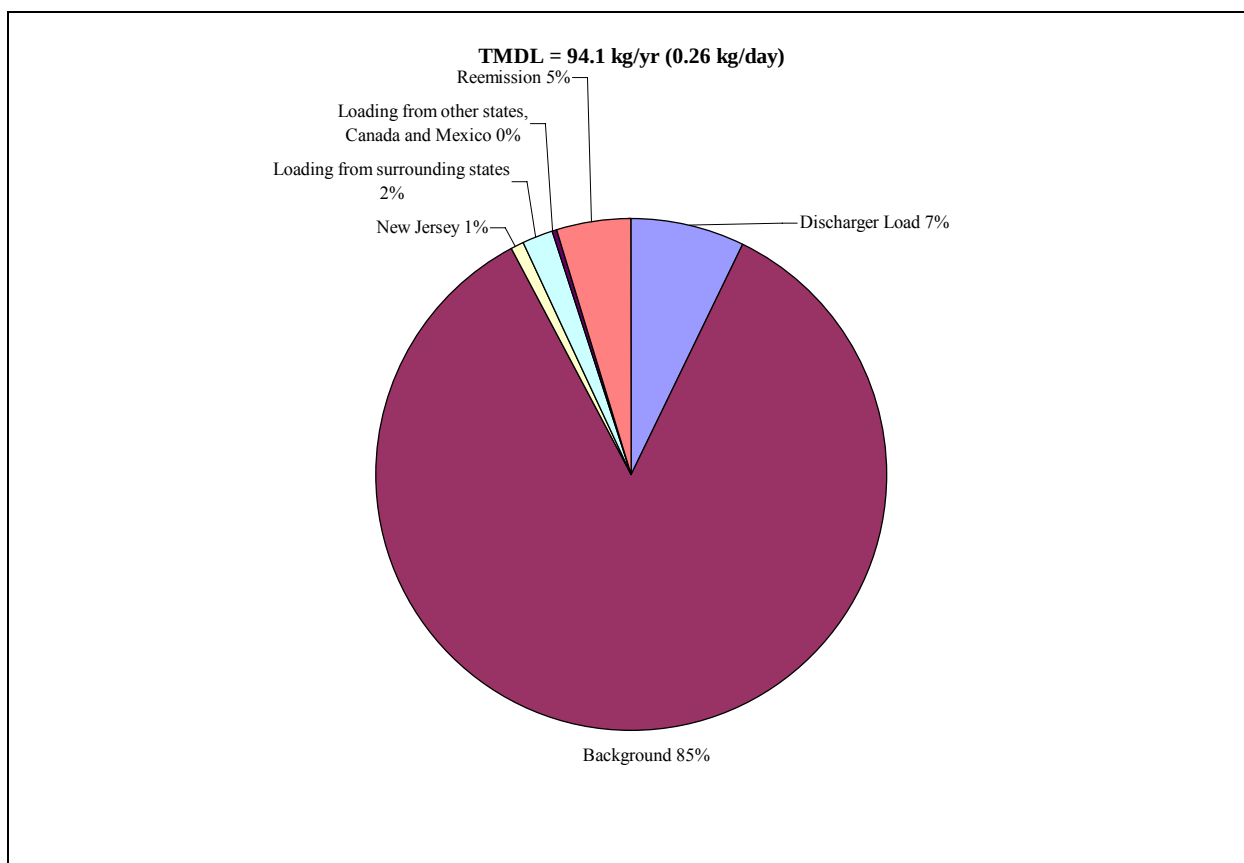
Category	Existing Load (kg/yr)	TMDL Load		Percent Reduction
		kg/yr	kg/day	
Total Annual Load	601.0	94.1	0.26	84.3%
Discharger Load (WLA)	6.8	6.8	0.02	-
Air Deposition Load (LA/WLA)	594.2	87.3	0.24	85.3%
Background due to natural source	77.3	77.3	0.21	-
Background due to anthropogenic sources	231.8	2.6	0.01	98.9%
New Jersey	74.1	0.8	0.002	98.9%
Loading from surrounding states	154.6	1.8	0.005	98.9%
Loading from other states, Canada and Mexico	39.6	0.4	0.001	98.9%
reemission due to natural source	4.2	4.2	0.01	-
Reemission due to anthropogenic source	12.7	0.1	0.0004	98.9%

Note: The TMDL loadings presented in the above table were rounded to 0.1 kg/yr. Percents of required reductions were calculated based on values with more significant digits. Using the values from the table to calculate the percent reduction may generate inaccurate results.

Table 10. Distribution of Air Deposition Load between LA and WLA under the TMDL Condition

Air Deposition Load	Annual Load (kg/yr)	Daily Load (kg/day)	Percent of Loading Capacity
Total	87.3	0.24	92.8%
WLA	22.3	0.06	23.7%
LA	65.0	0.18	69.1%

The urban storm water WLA portion of the air deposition load is derived by applying the percentage of urban land within Tier A municipalities (25.6%) to the overall air deposition load (87.3 kg/yr) based on the assumption that this load reaches the water bodies through regulated stormwater sources (see discussion in Section 4). Thus, under the TMDL conditions the WLA has been approximated to be 22.3 kg/yr (87.3×0.256), equivalent to 0.06 kg/day (Table 10). The air deposition rate under the TMDL condition is not available to conduct a more precise calculation of the stormwater WLA. More accuracy in developing this WLA is not necessary because the major source of mercury in stormwater is air deposition. Mercury in stormwater must be reduced by reducing air deposition and not through the usual stormwater measures. Therefore a WLA that represents an approximation of the total stormwater load is sufficient for the purposes of this TMDL. Individual stormwater WLAs would not change the response.



Note: Load from stormwater is not distinguished because it is derived from and is a subset of the air deposition load from the different air sources identified.

Figure 5. Distribution of TMDL for One Meal per Week by High Risk Population

As discussed in Section 5.2, multiple conservative assumptions have been made so that the calculated TMDL includes an implicit Margin of Safety (MOS). Therefore, the MOS term of the TMDL equation is set equal to zero. As explained above, a reduction of 85.3% ($1 - 88.3/601$) is the highest possible overall reduction that can be expected. The required reduction to achieve unlimited consumption for the high risk population is higher, ($1 - 0.07/1.15 = 93.9\%$). Nevertheless, given the multiple conservative assumptions, this reduction may be achievable. Data gathered following implementation of the TMDL will be used to evaluate success in achieving goals.

5.1. Seasonal Variation/Critical Conditions

40 CFR 130.7(c)(1) requires that “TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical WQS with seasonal variations”. Calculated TMDLs shall take into account critical conditions for stream flow, loading, and water quality parameters.”

The relative contribution of local, regional, and long-range sources of mercury to fish tissue levels in a waterbody are affected by the speciation of natural and anthropogenic emission sources. The amount of bioavailable methyl mercury in water and sediments is a function of the relative rates of mercury methylation and demethylation. Factors such as pH, length of the aquatic food chain, temperature and dissolved organic carbon can affect bioaccumulation. (EPA, 2009). These factors influence the extent to which mercury bioaccumulates in fish and may vary seasonally and spatially. However, mercury concentrations in fish tissue represent accumulation of the life span of a fish. Use of a fish tissue target integrates spatial and temporal variability, making seasonal variation and critical conditions less significant. In addition, the TMDL fish target value is human health-based, reflecting a longer-term exposure.

In New Jersey, data show levels of mercury in some species of fish in the Pinelands sampling region are generally higher compared to fish in other sampling regions of the state. The reductions called for in this TMDL will attain the target fish tissue concentration in the Pinelands, thereby ensuring that the target is met statewide, within the areas addressed by the TMDL.

5.2. Margin of Safety

A TMDL must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA 303(d)(1)(C), 40C.F.R.130.7(c)(1)). EPA's 1991 TMDL Guidance explains that the MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described.

The MOS included in this TMDL is implicit because of the following conservative assumptions:

- The 90th percentile fish mercury concentration based on the largemouth bass, *Micropterus salmoides*. This species of fish has the highest concentration of the species that are ubiquitous throughout the state
- The percent reduction does not account for additional reductions in methyl mercury that may occur as a result of the implementation of ongoing state and federal programs to reduce sulfur emissions. Reductions in sulfur deposition and sulfate-reducing bacterial activity will decrease the rate of mercury methylation. This TMDL does not account for potential mercury reductions associated with decreased sulfur deposition.

6.0. Monitoring

The Department has engaged in various monitoring efforts that have provided significant insight into mercury contamination issues, some of which are described below. In order to effectively assess progress toward achieving mercury reduction objectives, several monitoring programs are recommended, including:

- A primary monitoring strategy for measuring the levels of mercury and calculating trends is the previously mentioned Routine Fish Monitoring Program for Toxics in Fish. This comprehensive program divides the State's waters into five regions that are sampled on a rotating basis for contaminants in fish. Since mercury is persistent in the environment, accumulates in biological tissue, and biomagnifies in the food chain, adverse impacts to non-aquatic, piscivorous (fish eating) organisms may arise from very low surface water concentrations. Fish tissue sampling provides a cost-effective measure to understanding the effects of mercury in the food chain and the environment.
- A mercury water monitoring program is needed to understand the extent and magnitude of the State's mercury contamination and its effect on aquatic organisms. Such a program must have a comprehensive scope and long-term sampling period. Recent mercury studies from the United State Geological Survey (USGS) have suggested the use of screening tools to target areas where elevated concentrations of mercury may occur. These studies have suggested looking at the presence of wetlands within watersheds, dissolved organic carbon and suspended sediment concentrations, and stream flow. High dissolved oxygen content (DOC) and suspended sediment concentrations, increased stream flow, and larger wetland areas may point to elevated mercury concentrations. The sampling requirements would consist of total and methyl mercury in the water column as well as methyl mercury in fish tissue. The locations would extend to all regions of the state such as the Pinelands, Northern New Jersey, Delaware Estuary, and Atlantic Estuary. Each region would have at least five randomized sampling locations as well as a reference site, which are small undeveloped watersheds with no known sources of mercury contamination other than air deposition. This sampling is not needed on a yearly basis, but quarterly sampling once every 2-5 years is appropriate. An ongoing project, that is targeting local air source reduction by sampling for mercury in fish, water column, and leaves at four locations from 2007 to 2013, is expected to impact the development of the statewide mercury monitoring program by refining sampling frequencies, protocols, and objectives. In addition, an ongoing study in collaboration with USGS involves establishing a baseline for natural background levels for mercury in surface waters to discern the location of impairments that may have anthropogenic sources in addition to atmospheric deposition e.g. mercurial pesticides on orchard, crops and golf courses and which may have other natural sources, e.g. geologic. This evaluative monitoring has been completed in the Inner and Outer Coastal Plain, Raritan River Basin, Papakating and Wallkill River Watersheds. The investigation is ongoing in the Millstone River Basin, Crosswicks Creek Watershed and Passaic River Basin.
- One hundred POTWs in New Jersey submitted baseline data on mercury concentrations in their treatment plant effluent. These samples were analyzed using the most sensitive analytical method for mercury in wastewater, Method 1631E. This baseline data will be used to determine the effectiveness of the implementation of the dental BMPs and the installation of the amalgam separators. These POTWs are

required to conduct additional mercury sampling and analyses, using the same analytical method, after amalgam separator installation.

- In-stream monitoring to evaluate effectiveness of the dental amalgam rule is required at target locations upstream and downstream of the POTW discharge. The monitoring sites will be sampled semi-annually to evaluate ambient water quality before and after the rule's implementation to observe the significance of the reductions. Currently, only one site has been targeted. This project needs to expand by selecting suitable locations based on reviewing the POTW effluent data.
- Air sampling under the National Mercury Monitoring Deposition Network is required to continue to monitor long-term loadings and trends from atmospheric deposition. This program currently has only one site in the New Brunswick area. Additional sites in southern and northern portions of the state this network are needed to improve knowledge of depositional rates for different regions of the state and assist in atmospheric deposition source track down.

Monitoring studies already carried out have provided the following information:

- The Department's Air Program has collected speciated ambient mercury concentration data from several Tekran units that can be used to estimate dry deposition. To date, over two years' data from units at two locations, Elizabeth and New Brunswick have been checked for quality and are in the process of being evaluated. Data on wet deposition is being collected in New Brunswick and is analyzed by the National Mercury Deposition Network.
- Water monitoring data collected by NJDEP/USGS in the Ambient and Supplemental Surface Water Networks show that of the 1,752 results since 1997, nearly 67% had concentrations less than the detection levels. None of the total mercury values exceeded the current acute freshwater aquatic life criterion for dissolved mercury of 1.4 microgram per liter (ug/l) or the chronic criterion of 0.77 ug/l, but 3% of the samples exceeded the human health criterion of 0.05 ug/l. Other mercury studies and projects by NJDEP and USGS over the years show similar results, the majority of mercury concentrations are below detection levels. Detection levels have improved since 1997 with detection levels between 0.04 and 0.1 ug/l to detection levels between 0.01 and 0.02 ug/l since 2004.
- In response to the need for detection of low levels of mercury, the Department initiated a preliminary study of low level mercury occurrence in surface waters. Using EPA's method 1631E, the project consisted of 33 filtered samples with accompanying field blanks at 23 unique stations across the state. The detection level at the Wisconsin laboratory being used was 0.04 ppt. Results did not exceed any of the existing surface water quality criteria. Mercury concentrations did not appear to be influenced by land use, but did appear to increase with stream flow. The findings suggest that air deposition is a major influence on in-stream mercury concentrations. In 2007, the Department conducted a follow-up study to determine seasonal

variability in total and methyl mercury concentrations at 7 reference stations, small undeveloped watersheds with no known sources of mercury contamination other than air deposition. Although total mercury showed no seasonal patterns, methyl mercury had elevated levels during the summer due to higher methylation rates during the warmer months. In addition, the project verified new sampling protocols that allow one person to conduct low level mercury sampling, thereby reducing manpower requirements and allowing this sampling to be incorporated into an ambient or routine program.

- A 150 well, statewide, shallow Ground Water Quality Monitoring Network, which was stratified as a function of land use, has been established and is sampled on a 5 year cycle for mercury and other contaminants. During the first 5 year sampling cycle from 1999 to 2004, mercury concentrations were found to range from <0.01 to 1.7 ug/L in ground water from 148 wells and only 5 of those were detectable above the laboratory reporting limits. In addition, other ground water data has been collected under the Private Well Testing Act that required private wells in 9 Southern New Jersey counties to test for mercury. A total of 25,270 wells were tested with a concentration range of 114.2 ug/l to “not detected”. Approximately 1% had concentrations above the drinking water maximum contaminate level (MCL) of 2 ug/l. An analysis of the data showed no obvious geographic or land use patterns for the elevated mercury results.

7.0. Reasonable Assurance

New Jersey has a long history of working toward the reduction of mercury contamination within the state and working with interstate organizations to reduce the mercury both coming into and leaving the state. Much progress has been made. Because of New Jersey’s past successes in the reduction of mercury, the actions New Jersey has underway and its commitment to implementing further actions as necessary, including working with neighboring states to reduce sources originating from outside the state, there is reasonable assurance that the goals of the TMDL will be met.

New Jersey began working to reduce mercury releases to the environment in 1992 with the formation of a Mercury Task Force. That Task Force examined the many routes and sources of mercury exposure and found air emissions to be the number one source of mercury contamination in New Jersey. The Task Force identified the largest source of mercury air emissions in New Jersey as Municipal Solid Waste (MSW) Incinerators. The Task Force recommended a statewide mercury emission standard for MSW Incinerators, which was implemented in 1996. In addition to the MSW incinerator standards, New Jersey passed the “Dry Cell Battery Management Act” in 1992, banning the use of mercury in certain batteries. These two efforts reduced MSW incinerator mercury emissions by 97% between 1992 and 2006.

In 1998, New Jersey convened a second Mercury Task Force. The second Task Force consisted of representatives from government, emission sources, public interest groups, academia, and fishing organizations. This Task Force was charged with reviewing the current science on

mercury impacts on human health and ecosystems, inventorying and assessing mercury sources, and developing a comprehensive mercury reduction plan for NJ. The “New Jersey Mercury Task Force Report” published in December 2001 established a goal of the virtual elimination of anthropogenic sources of mercury and provided recommendations and targets for further reducing mercury emissions in New Jersey. The Task Force Report is available at http://www.nj.gov/dep/dsr/mercury_task_force.htm

In 2007 the Department’s Mercury Workgroup evaluated New Jersey’s progress towards meeting the goals and recommendations of the Task Force and began putting together a Mercury Reduction Plan to identify the necessary additional actions to continue to reduce mercury emissions in New Jersey. The reduction plan will serve as the implementation plan for these TMDLs.

Below is a summary of actions that have been taken to reduce New Jersey’s mercury loadings.

- To participate in and support regional, national, and global efforts to reduce mercury uses, releases, and exposures New Jersey is a member of the Interstate Mercury Education and Reduction Clearinghouse (IMERC), a member of the Northeast Waste Management Officials Association (NEWMOA), the Quicksilver Caucus, Northeast States for Consolidated Air Use Management (NESAUM), Environmental Council of the States (ECOS), and Toxics in Packaging.
- In conjunction with NEWMOA, informational brochures were developed for tanning salons and property managers concerning the management of mercury containing fluorescent lamps. The brochures were sent to every tanning salon and property management company in the state.
- New Jersey works with interstate organizations to assist in the development of federal legislation that minimizes the use of mercury in products. The Department is a member of and works with the Northeast Waste Management Officials Association (NEWMOA) on mercury issues. The Department will participate in any effort conducted by NEWMOA or other interstate organization to develop federal legislation to minimize the use of mercury in products.
- On December 6, 2004, New Jersey adopted regulations to establish new requirements for coal-fired boilers, in order to decrease emissions of mercury. These rules are located at <http://www.state.nj.us/dep/aqm/Sub27-120604.pdf>.
- On December 6, 2004, New Jersey adopted regulations to establish new requirements for iron or steel melters in order to decrease emissions of mercury. The Department provided three years to reduce mercury contamination of scrap through elimination and separation measures. If the source reduction measures do not achieve emission reduction, the rule requires the installation and operation of mercury air pollution control and requires achieving mercury standard starting 1/2010. These rules are located at <http://www.state.nj.us/dep/aqm/Sub27-120604.pdf>.

- On December 6, 2004, New Jersey adopted regulations to establish new requirements for Hospital/medical/infectious waste (HMIW) incinerators in order to prevent or decrease emissions of mercury by ensuring that the mercury emissions from HMIW incinerators will be maintained at low levels. These rules are located at <http://www.state.nj.us/dep/aqm/Sub27-120604.pdf>.
- The Department has closely monitored mercury sewage sludge levels and has taken action where existing authority would allow the imposition of a sewage sludge limit or a discharge limitation. For example, the POTW with the highest sewage sludge mercury concentrations was identified and the industry responsible voluntarily agreed to shut down all production of mercury-containing diagnostic kits. Increased focus on removing mercury from products, as well as the proposed dental rule noted above, should continue the decreasing trend of detectable concentrations of mercury found in sewage sludge.
- On December 6, 2004, New Jersey adopted revised regulations to establish new requirements for municipal solid waste (MSW) incinerators in order to prevent or decrease emissions of mercury by requiring MSW incinerators to further reduce their mercury emissions. These rules are located at <http://www.state.nj.us/dep/aqm/Sub27-120604.pdf>.
- The Department has included all mercury containing products in the Universal Waste Rule which allows generators of waste mercury containing products to manage the waste under less stringent regulations than the Hazardous Waste Regulations. In addition, every county in the state holds at least one household hazardous waste (HHW) collection per year. Most counties hold multiple collections and 3 counties (Burlington, Monmouth, and Morris) have permanent collection sites. Households generating mercury containing products can properly dispose of the items at their county's collection.
- Legislation banning the sale of mercury thermometers was passed in April 2005.
- The New Jersey Legislature passed the Mercury Switch Removal Act of 2005 requiring automobile recycling facilities to remove mercury auto switches from vehicles prior to sending the vehicles for recycling. Automobile recyclers located in New Jersey were required to begin removing the mercury auto switches in May 2006. Manufacturers have stopped using mercury switches in convenience lighting.
- The Department adopted new rules on October 1, 2007 to curtail the release of mercury from dental facilities into the environment. The new rules, under most circumstances, exempt a dental facility from the requirement to obtain an individual permit for its discharge to a POTW, if it implements best management practices (BMPs) for the handling of dental amalgam waste and installs and properly operates an amalgam separator. Dental facilities were required to implement the BMPs by October 1, 2008 and must install and operate an amalgam separator by October 1, 2009. These measures are expected to prevent at least 95 percent of the mercury wastes from being sent to the

POTW and result in approximately 2,550 pounds of mercury removed from the environment each year.

- The Department participated in the Quicksilver Caucus, which developed methods for the retirement and sequestering of mercury.

The out of state contributions to the depositional load of mercury are too great for New Jersey to eliminate mercury contamination of fish tissue by reducing sources originating within its borders alone. New Jersey will work with EPA and other states to eliminate mercury sources nationwide. EPA's efforts to issue MACT (Maximum Achievable Control Technology) standards for utilities to reduce the depositional load of mercury are supported by New Jersey. In October 2008, the New England Interstate Water Pollution Control Commission (NEIWPCC), on behalf of seven states, submitted a petition under the Clean Water Act Section 319(g) requesting EPA to convene an interstate conference to address mercury deposition to the Northeast from upwind states. The petition builds on the Northeast States' regional mercury TMDL (approved by EPA in 2007), which indicates that reductions in mercury deposition from outside the region are needed to meet water quality standards. New Jersey will participate actively in this conference when it is held.

8.0. Implementation Plan

The implementation actions below are the recommendations of the Department's Mercury Task Force (NJDEP, 2009) intended to reduce anthropogenic sources of mercury:

- 1) Consider developing legislation that reflects the provisions of the Mercury Education and Reduction Model Act prepared by the Northeast Waste Management Officials' Association (NEWMOA), as part of the New England Governors' Mercury Action Plan. This plan addresses mercury-containing products and limits the sale of mercury for approved purposes. Provisions of the model legislation have been adopted by 16 states, including all of the New England states.
- 2) Continue monitoring of mercury in environmental media. Needed follow-up monitoring is described in Section 6 and is essential for determining the effectiveness of the mercury Total Maximum Daily Load (TMDL).
- 3) New Jersey contributes only 12.5% to the state mercury deposition; 52% is background deposition (natural and anthropogenic) and the remaining percentage comes from surrounding states, Mexico, and Canada. Reductions required in this TMDL can not be achieved from the New Jersey anthropogenic air sources alone. Mercury reductions on the nationwide and global scales are necessary to meet the TMDL targets set up above.
- 4) The Department plans to update its mercury water quality criteria based upon the EPA recommended Clean Water Act Section 304(a) for methyl mercury in fish tissue. This criterion requires the development of regional bioaccumulation factors (BAFs) to address differences in the rate of methylation based on other water quality parameters such as pH and

dissolved organic carbon. While the EPA's recommended Clean Water Act Section 304(a) water quality criterion is based on a methyl mercury fish tissue concentration value of 0.3 mg/kg, New Jersey plans to develop criteria based upon a methyl mercury fish tissue concentration of 0.18 mg/kg which is based upon consumption of 1 meal per week by high risk individuals. Updating the mercury criteria based on EPA's recommendation will require calculating BAFs for New Jersey that involves additional surface water and fish tissue sampling. This information will also be used to reevaluate the previously proposed wildlife mercury criteria using updated regional BAFs. The revised mercury criteria will be used to develop TMDLs for areas of the State not covered by the Total Maximum Daily Load for Mercury Impairments Based on Concentration in Fish Tissue Caused Mainly by Air Deposition. In calculating an updated, revised mercury SWQS for human health and wildlife, the Department will divide the state into four regional waters: Pinelands, Non-Pinelands, Delaware Estuary tidal waters, and Atlantic tidal waters. Surface water and fish tissue data will be collected and used to develop new BAFs for each region of the state. The data results will then be applied in calculating the mercury criteria for each region. In 2009, the Department expects to begin data collection in the Pinelands region with plans to continue collection in non-Pinelands water the following year. The next action is to collect data for the Delaware Estuary and Atlantic tidal waters.

- 5) The existing regulations concerning mercury will continue to be implemented, enforced, and evaluated for effectiveness. This includes the regulations on mercury emissions from air sources, the removal of automobile mercury switches and the dental amalgam regulations.

9.0. Public Participation

There have been various efforts to inform and educate the general public as well as the regulated community about the effects of mercury and the need to reduce anthropogenic sources. The regulatory controls regarding mercury are described in Section 7 and some of the outreach to the general public are noted below.

Over the years the Department, in cooperation with the Department of Health and Senior Services has conducted a great deal of public outreach to the fishing community to inform them of the fish consumption advisories. Surveys were done to determine how best to reach the public. As a result the fish advisories are posted in both Spanish and English. Brochures have been developed and are distributed to doctors and WIC (the federal Women, Infants and Children nutrition program) centers. The Department of Health seafood inspectors distribute and check for postings as part of their inspections.

Currently the Department's Urban Fishing Program educates children from the Newark Bay Complex and throughout New Jersey about their local watershed. Children learn about how people's actions affect the water and human health, and what they can do to help. The NJDEP's Divisions of Watershed Management and Science, Research and Technology in conjunction with the Division of Fish and Wildlife, the Hackensack RiverKeeper, the City of Bayonne and the Municipal Utilities Authority of Bayonne have offered the program for over 10 years. The first several years of the Urban Watershed Program were conducted only in the Newark Bay

Complex. The program has now expanded to other urban areas around the state. Trenton and Camden have participated over the last three years, and we hope to add several more cities in the future.

In conjunction with NEWMOA, informational brochures were developed for tanning salons and property managers concerning the management of mercury containing fluorescent lamps. The brochures were sent to every tanning salon and property management company in the state.

There has been additional public outreach and opportunity for comment for the TMDL itself. In accordance with N.J.A.C. 7:15–7.2(g), this TMDL was proposed by the Department as an amendment to the Atlantic, Cape May, Lower Delaware, Lower Raritan-Middlesex, Mercer, Monmouth, Northeast, Ocean, Sussex, Tri-County, Upper Delaware and Upper Raritan Water Quality Management Plans.

Notice proposing this TMDL was published on June 15, 2009 in the New Jersey Register and in newspapers of general circulation in the affected area in order to notify the public of the opportunity to review the TMDL and submit comments. In addition, an informational presentation followed by a public hearing for the proposed TMDL was held on July 15, 2009. Notice of the proposal and the hearing was also provided to affected Designated Planning Agencies and dischargers in the affected watersheds. One member of the public attended the hearing and declined to comment. No comments were submitted during the public comment period. Various minor edits to the proposal document have been made for clarification.

10.0. Data Sources

Geographic Information System (GIS) data from the Department was used extensively to describe the areas addressed in this document.

- State Boundary of New Jersey, Published by New Jersey Office of Information Technology (NJOIT), Office of Geographic Information Systems (OGIS), May 20, 2008. On line at: https://njgin.state.nj.us/NJ_NJGINExplorer/jviewer.jsp?pg=DataDownloads
- Watersheds (Subwatersheds by name - DEPHUC14), Drainage basins are delineated from 1:24,000-scale (7.5-minute) USGS quadrangles. The delineations have been developed for general purpose use by USGS District staff over the past 20 years. Arc and polygon attributes have been included in the coverage with basin names and ranks of divides, and 14-digit hydrologic unit codes. *Originator:* U.S. Geological Survey, William H. Ellis, Jr. *Publication_Date:* 19991222
<http://www.state.nj.us/dep/gis/digidownload/zips/statewide/dephuc14.zip>
- NJDEP 2002 Waters of New Jersey (Lakes and Ponds), *Edition* 2008-05-01. The data was created by extracting water polygons which represented lakes and ponds from the 2002 land use/land cover (LU/LC) layer from NJ DEP's geographical information systems (GIS) database <http://www.state.nj.us/dep/gis/digidownload/zips/statewide/njwaterbody.zip>

- NJDEP 2002 Waters of New Jersey (Rivers, Bays and Oceans), *Version* 20080501; *Edition:* 20080501. The data was created by extracting water polygons which represented Rivers, Bays and Oceans from the 2002 land use/land cover (LU/LC) layer from NJ DEP's geographical information systems (GIS) database. *Online Linkage*
<http://www.state.nj.us/dep/gis/digidownload/zips/statewide/njarea.zip>

- NJPDES Surface Water Discharges in New Jersey, (1:12,000), *Version* 20090126, *Edition:* 2009-01-26. This is a 2009 update of the 2002 data. New Jersey Pollutant Discharge Elimination System (NJPDES) surface water discharge pipe GIS point coverage compiled from GPSed locations, NJPDES databases, and permit applications. This coverage contains the surface water discharge points and the receiving waters coordinates for the active as well as terminated pipes. *Online Linkeage:*
<http://www.state.nj.us/dep/gis/digidownload/zips/statewide/njpdesswd.zip>

- NJDEP Surface Water Quality Standards of New Jersey *Edition:* 200812. This data is a digital representation of New Jersey's Surface Water Quality Standards in accordance with "Surface Water Quality Standards for New Jersey Waters" as designated in N.J.A.C. 7:9 B. The Surface Water Quality Standards (SWQS) establish the designated uses to be achieved and specify the water quality (criteria) necessary to protect the State's waters. Designated uses include potable water, propagation of fish and wildlife, recreation, agricultural and industrial supplies, and navigation. These are reflected in use classifications assigned to specific waters. When interpreting the stream classifications and anti-degradation designations, the descriptions specified in the SWQS at N.J.A.C. 7:9B-1.15 always take precedence. The GIS layer reflects the stream classifications and anti-degradation designations adopted as of June 16, 2008, and it is only supplemental to SWQS and is not legally binding. <http://www.state.nj.us/dep/gis/digidownload/zips/statewide/swqs.zip>

- “Water Management Areas”, created 03/2002 by NJDEP, Division of Watershed Management, the last update January, 2009. *Online Linkage.*
<http://www.state.nj.us/dep/gis/digidownload/zips/statewide/depwmas.zip>

- NJDEP Known Contaminated Site List for New Jersey, 2005, *Edition:* 200602; The Known Contaminated Sites List for New Jersey 2005 are those sites and properties within the state where contamination of soil or ground water has been identified or where there has been, or there is suspected to have been, a discharge of contamination. This list of Known Contaminated Sites may include sites where remediation is either currently under way, required but not yet initiated or has been completed.
<http://www.state.nj.us/dep/gis/digidownload/zips/statewide/kcsl.zip>

- Groundwater Contamination Areas (CKE); this data layer contains information about areas in the state which are specified as the Currently Known Extent (CKE) of ground water pollution. CKE areas are geographically defined areas within which the local ground water resources are known to be compromised because the water quality exceeds drinking water and ground water quality standards for specific contaminants. NJDEP Currently Known Extent of Groundwater Contamination (CKE) for New Jersey, 2007. *Edition:* 200703. *Online Linkage:* <http://www.state.nj.us/dep/gis/digidownload/zips/statewide/cke.zip>

11.0. References

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Appendix A

Listed Assessment units that were excluded from the Statewide TMDL

Waterbody	Name	Reason for Exclusion from TMDL
02030103120070-01	Passaic River Lwr (Fair Lawn Ave to Goffle)	Mercury in surface water
02030103120080-01	Passaic River Lwr (Dundee Dam to F.L. Ave)	Mercury in surface water
02030103120090-01	Passaic River Lwr (Saddle R to Dundee Dam)	Mercury in surface water
02030103150030-01	Passaic River Lwr (Second R to Saddle R)	Mercury in surface water
02030103150040-01	Passaic River Lwr (4th St br to Second R)	Mercury in surface water
02030103150050-01	Passaic River Lwr (Nwk Bay to 4th St brdg)	Mercury in surface water
02030103170030-01	Hackensack River (above Old Tappan gage)	Mercury in surface water
02030103170060-01	Hackensack River (Oradell to Old Tappan gage)	Mercury in surface water
02030103180030-01	Hackensack River (Ft Lee Rd to Oradell gage)	Mercury in surface water
02030103180080-01	Hackensack River (Rt 3 to Bellmans Ck)	Mercury in surface water
02030103180090-01	Hackensack River (Amtrak bridge to Rt 3)	Mercury in surface water
02030103180100-01	Hackensack River (below Amtrak bridge)	Mercury in surface water
02030104010020-01	Kill Van Kull West	Mercury in surface water
02030104010020-02	Newark Bay / Kill Van Kull (74d 07m 30s)	Mercury in surface water
02030104010030-01	Kill Van Kull East	Mercury in surface water
02030104010030-02	Upper NY Bay / Kill Van Kull (74d07m30s)	Mercury in surface water
02030104020030-01	Arthur Kill North	Mercury in surface water
02030104030010-01	Arthur Kill South	Mercury in surface water
02030104050120-01	Arthur Kill waterfront (below Grasselli)	Mercury in surface water
02040105210060-01	Jacobs Creek (above Woolsey Brook)	Mercury in surface water
02040105230050-01	Assunpink Creek (Shipetaukin to Trenton Rd)	Mercury in surface water
02040201050040-01	Crosswicks Creek (Walnford to Lahaway Ck)	Mercury in surface water
02040201050050-01	Crosswicks Creek (Ellisdale trib - Walnford)	Mercury in surface water
02040201050070-01	Crosswicks Creek (Doctors Ck-Ellisdale trib)	Mercury in surface water
02040206140040-01	Blackwater Branch (above/incl Pine Br)	Mercury in surface water
02040206140050-01	Blackwater Branch (below Pine Branch)	Mercury in surface water
02040206200010-01	Middle Branch / Slab Branch	Mercury in surface water
02040206200020-01	Muskee Creek	Mercury in surface water
02040301020040-01	Muddy Ford Brook	Mercury in surface water
02040301070080-01	Manapaqua Brook	Mercury in surface water
02040301170010-01	Hammonton Creek (above 74d43m)	Mercury in surface water
02040301170020-01	Hammonton Creek (Columbia Rd to 74d43m)	Mercury in surface water
02040302020020-01	Absecon Creek SB	Mercury in surface water
02040302020030-01	Absecon Creek (AC Reserviors) (gage to SB)	Mercury in surface water
02030103010180-01	Passaic River Upr (Pine Bk br to Rockaway)	Mercury in surface water
02030103040010-01	Passaic River Upr (Pompton R to Pine Bk)	Mercury in surface water
02030103120100-01	Passaic River Lwr (Goffle Bk to Pompton R)	Mercury in surface water
02030103180060-01	Berrys Creek (above Paterson Ave)	Mercury in surface water
02030103180070-01	Berrys Creek (below Paterson Ave)	Mercury in surface water
02030105160070-01	South River (below Duhernal Lake)	Mercury in surface water
02040202020030-01	Rancocas Creek NB (incl Mirror Lk-Gaunts Bk)	Mercury in surface water
02040202020040-01	Rancocas Creek NB (NL dam to Mirror Lk)	Mercury in surface water
02040202100060-01	Pennsauken Creek (below NB / SB)	Mercury in surface water
02040301020050-01	Metedeconk River NB (confluence to Rt 9)	Mercury in surface water
02040301040020-01	Metedeconk River (Beaverdam Ck to confl)	Mercury in surface water
02040302050060-01	Great Egg Harbor River (Miry Run to Lake Lenape)	Mercury in surface water

02040302050130-01	Great Egg Harbor River (GEH Bay to Miry Run)	Mercury in surface water
Delaware River 1	Delaware River 1C2	Mercury in surface water
Delaware River 2	Delaware River 1C3	Mercury in surface water
Delaware River 3	Delaware River 1C4	Mercury in surface water
Delaware River 4	Delaware River 1D1	Mercury in surface water
Delaware River 5	Delaware River 1D2	Mercury in surface water
Delaware River 6	Delaware River 1D3	Mercury in surface water
Delaware River 7	Delaware River 1D4	Mercury in surface water
Delaware River 8	Delaware River 1D5	Mercury in surface water
Delaware River 9	Delaware River 1D6	Mercury in surface water
Delaware River 10	Delaware River 1E1	Mercury in surface water
Delaware River 11	Delaware River 1E2	Mercury in surface water
Delaware River 12	Delaware River 1E3	Mercury in surface water
Delaware River 13	Delaware River 1E4	Mercury in surface water
Delaware River 14	Delaware River 1E5	Mercury in surface water
Delaware River 15	Delaware River 2	Mercury in surface water
Delaware River 16	Delaware River 3	Mercury in surface water
Delaware River 17	Delaware River 4	DRBC
Delaware River 18	Delaware River 5A	DRBC
Delaware River 19	Delaware River 5B	DRBC
Delaware River 20	Delaware River 5C	DRBC
02040204910010-02	Delaware Bay (Cape May Pt to Dennis Ck) offshore	DRBC
02040204910010-01	Delaware Bay (CapeMay Pt to Dennis Ck) inshore	DRBC
02040204910040-01	Delaware Bay (Cohansey R to FishingCk)	DRBC
02040204910020-02	Delaware Bay (Dennis Ck to Egg Islnd Pt) offshore	DRBC
02040204910020-01	Delaware Bay (DennisCk to Egg Islnd Pt) inshore	DRBC
02040301200030-02	Wading River (below Rt 542)	Tidal
02040301200080-02	Mullica River (GSP bridge to Turtle Ck)	Tidal
02040301210010-02	Mullica River (below GSP bridge)	Tidal
02030104020030-02	Elizabeth River (below Elizabeth CORP BDY)	Tidal
02030104030010-02	Morses Creek / Piles Creek	Tidal
02030104080040-01	Shrewsbury River (above Navesink River)	Tidal
02030104090040-01	Shark River (above Remsen Mill gage)	Tidal
02030104090060-01	Shark River (below Remsen Mill gage)	Tidal
02030104910020-01	Sandy Hook Bay (east of Thorns Ck)	Tidal
02040201030010-01	Duck Creek and UDRV to Assunpink Ck	Tidal
02030104060010-01	Cheesequake Creek / Whale Creek	Tidal
02030104070110-01	Navesink River (below Rt 35) / Lower Shrewsbury	Tidal
02040301080060-01	Toms River Lwr (Rt 166 to Oak Ridge Pkwy)	Tidal
02030104070110-01	Navesink River (below Rt 35) / Lower Shrewsbury	Tidal
02030104060060-01	Pews Creek to Shrewsbury River	Tidal
02040301080060-01	Toms River Lwr (Rt 166 to Oak Ridge Pkwy)	Tidal
02040301200030-02	Wading River (below Rt 542)	Tidal
02030104080010-01	Little Silver Creek / Town Neck Creek	Tidal
02040301200080-02	Mullica River (GSP bridge to Turtle Ck)	Tidal
02040301210010-02	Mullica River (below GSP bridge)	Tidal
02040302020010-01	Absecon Creek NB	Tidal
02040302020040-01	Absecon Creek (below gage)	Tidal

02030104080010-01	Little Silver Creek / Town Neck Creek	Tidal
02030104080020-01	Parkers Creek / Oceanport Creek	Tidal
02030104080030-01	Branchport Creek	Tidal
02040201070030-01	Shady Brook / Spring Lake / Rowan Lake	Tidal
02040202120080-01	Big Timber Creek (below NB/SB confl)	Tidal
02040202130040-01	Mantua Creek (Edwards Run to rd to Sewell)	Tidal
02040202140040-01	Moss Branch / Little Timber Creek (Repaupo)	Tidal
02040202140050-01	Repaupo Creek (below Tomlin Sta Rd) / Cedar Swamp	Tidal
02040202160020-01	Oldmans Creek (Rt 45 to Commissioners Rd)	Tidal
02040206090080-01	Cohansey River (Greenwich to 75d17m50s)	Tidal
02040206090100-01	Cohansey River (below Greenwich)	Tidal
02030104010010-01	Newark Airport Peripheral Ditch	Tidal
02040206100040-01	Cedar Creek (above Rt 553)	Tidal
02040206160030-01	Maurice River (Union Lake to Sherman Ave)	Other sources of Hg
02030103030070-01	Rockaway River (74d 33m 30s to Stephens Bk)	Other sources of Hg
02030103100070-01	Ramapo River (below Crystal Lake bridge)	Other sources of Hg
02040201050060-01	Ellisdale Trib (Crosswicks Creek)	Other sources of Hg
02040201070020-01	Crosswicks Creek (below Doctors Creek)	Other sources of Hg
02030103100060-01	Crystal Lake / Pond Brook	Other sources of Hg
02030104060040-01	Chingarora Creek to Thorns Creek	Other sources of Hg
02030104060050-01	Waackaack Creek	Other sources of Hg
02030105160090-01	Red Root Creek / Crows Mill Creek	Hg in groundwater
02030105160100-01	Raritan River Lwr (below Lawrence Bk)	Hg in groundwater
02040105230020-01	Assunpink Creek (New Sharon Br to/incl Lake)	Hg in groundwater
02040105230030-01	New Sharon Branch (Assunpink Creek)	Hg in groundwater
02040105230040-01	Assunpink Creek (Trenton Rd to New Sharon Br)	Hg in groundwater
02040105240010-01	Shabakunk Creek	Hg in groundwater
02040105240050-01	Assunpink Creek (below Shipetaukin Ck)	Hg in groundwater
02040201030010-01	Duck Creek and UDRV to Assunpink Ck	Hg in groundwater
02040201040040-01	Jumping Brook (Monmouth Co)	Hg in groundwater
02040301160020-01	Mullica River (above Jackson Road)	Hg in groundwater
02040301170040-01	Mullica River (Batsto R to Pleasant Mills)	Hg in groundwater
02040301170060-01	Mullica River (Rt 563 to Batsto River)	Hg in groundwater
02040301170080-01	Mullica River (Lower Bank Rd to Rt 563)	Hg in groundwater
02040301170130-01	Mullica River (Turtle Ck to Lower Bank Rd)	Hg in groundwater
02040301190050-01	Wading River WB (Jenkins Rd to Rt 563)	Hg in groundwater
02040301200020-01	Wading River (Rt 542 to Oswego River)	Hg in groundwater
02030103180040-01	Overpeck Creek	HEP
02030103180050-01	Hackensack River (Bellmans Ck to Ft Lee Rd)	HEP
02030104050060-01	Rahway River (Robinsons Br to Kenilworth Blvd)	HEP
02030104050100-01	Rahway River (below Robinsons Branch)	HEP
02030105120170-01	Raritan River Lwr (Lawrence Bk to Mile Run)	HEP
02030105160100-01	Raritan River Lwr (below Lawrence Bk)	HEP
02040302940010-01	Atlantic Ocean (34th St to Corson Inl) inshore	Tidal
02040302940010-02	Atlantic Ocean (34th St to Corson Inl) offshore	Tidal
02040302920010-01	Atlantic Ocean (Absecon In to Ventnor) inshore	Tidal
02040302920010-02	Atlantic Ocean (Absecon In to Ventnor) offshore	Tidal
02040301920010-02	Atlantic Ocean (Barnegat to Surf City) offshore	Tidal
02040301920010-01	Atlantic Ocean (Barnegat to Surf City) inshore	Tidal

02040302940050-01	Atlantic Ocean (CM Inlet to Cape May Pt) inshore	Tidal
02040302940050-02	Atlantic Ocean (CM Inlet to Cape May Pt) offshore	Tidal
02030902940020-01	Atlantic Ocean (Corson to Townsends Inl) inshore	Tidal
02030902940020-02	Atlantic Ocean (Corson to Townsends Inl) offshore	Tidal
02040302930010-01	Atlantic Ocean (Great Egg to 34th St) inshore	Tidal
02040302930010-02	Atlantic Ocean (Great Egg to 34th St) offshore	Tidal
02040301920030-01	Atlantic Ocean (Haven Bch to Lit Egg) inshore	Tidal
02040301920030-02	Atlantic Ocean (Haven Bch to Lit Egg) offshore	Tidal
02040302940040-01	Atlantic Ocean (Hereford to Cape May In) inshore	Tidal
02040302940040-02	Atlantic Ocean (Hereford to Cape May In) offshore	Tidal
02040301910020-01	Atlantic Ocean (Herring Is to Rt 37) inshore	Tidal
02040301910020-02	Atlantic Ocean (Herring Is to Rt 37) offshore	Tidal
02040302910010-01	Atlantic Ocean (Ltl Egg to Absecon In) inshore	Tidal
02040302910010-02	Atlantic Ocean (Ltl Egg to Absecon In) offshore	Tidal
02040301910010-01	Atlantic Ocean (Manasquan/Herring Is) inshore	Tidal
02040301910010-02	Atlantic Ocean (Manasquan/Herring Is) offshore	Tidal
02030104920020-01	Atlantic Ocean (Navesink R to Whale Pond) inshore	Tidal
02030104920020-02	Atlantic Ocean (Navesink R to Whale Pond) offshore	Tidal
02040301910030-01	Atlantic Ocean (Rt 37 to Barnegat Inlet) inshore	Tidal
02040301910030-02	Atlantic Ocean (Rt 37 to Barnegat Inlet) offshore	Tidal
02030104920010-01	Atlantic Ocean (Sandy H to Navesink R) inshore	Tidal
02030104920010-02	Atlantic Ocean (Sandy H to Navesink R) offshore	Tidal
02030104930020-01	Atlantic Ocean (Shark R to Manasquan) inshore	Tidal
02030104930020-02	Atlantic Ocean (Shark R to Manasquan) offshore	Tidal
02040301920020-01	Atlantic Ocean (Surf City to Haven Be) inshore	Tidal
02040301920020-02	Atlantic Ocean (Surf City to Haven Be) offshore	Tidal
02030902940030-01	Atlantic Ocean (Townsends to Hereford In) inshore	Tidal
02030902940030-02	Atlantic Ocean (Townsends to Hereford In) offshore	Tidal
02040302920020-01	Atlantic Ocean (Ventnor to Great Egg) inshore	Tidal
02040302920020-02	Atlantic Ocean (Ventnor to Great Egg) offshore	Tidal
02030104930010-01	Atlantic Ocean (Whale Pond to Shark R) inshore	Tidal

Appendix B

Fish Tissue Data

Location	Species	Field (or lab) Total Length (cm)	Hg (mg/kg) ug/g wet wt	Year
Alcyon Lake	Largemouth Bass	28.6	0.67	1992
Alcyon Lake	Largemouth Bass	33.7	0.41	1992
Batsto Lake	Yellow Bullhead	23.7	0.23	1992
Batsto Lake	Brown Bullhead	26.5	0.18	1992
Batsto Lake	Chain Pickerel	57.3	1.06	1992
Batsto Lake	Largemouth Bass	27.1	0.76	1992
Batsto Lake	Largemouth Bass	35.4	1.20	1992
Batsto Lake	Largemouth Bass	37.5	1.28	1992
Big Timber Creek	Black Crappie	15.5	0.07	1992
Big Timber Creek	Brown Bullhead	29.4	0.05	1992
Big Timber Creek	Brown Bullhead	31	0.06	1992
Big Timber Creek	Channel Catfish	42.3	0.09	1992
Big Timber Creek	White Catfish	33.4	0.08	1992
Big Timber Creek	White Catfish	29.6	0.09	1992
Big Timber Creek	Largemouth Bass	33.0	0.10	1992
Big Timber Creek	Largemouth Bass	28.2	0.12	1992
Big Timber Creek	Largemouth Bass	25.5	0.06	1992
Clementon Lake	Chain Pickerel	35.5	0.14	1992
Clementon Lake	Chain Pickerel	33	0.16	1992
Clementon Lake	Chain Pickerel	40	0.16	1992
Clementon Lake	Chain Pickerel	50.5	0.32	1992
Clementon Lake	Chain Pickerel	48.6	0.37	1992
Clementon Lake	Chain Pickerel	47.6	0.38	1992
Clementon Lake	Largemouth Bass	35.9	0.28	1992
Clementon Lake	Largemouth Bass	38.7	0.49	1992
Clinton Reservoir	Largemouth Bass	28.2	0.39	1992
Clinton Reservoir	Largemouth Bass	34.3	0.60	1992
Clinton Reservoir	Largemouth Bass	34.6	0.73	1992
Clinton Reservoir	Largemouth Bass	44.1	0.83	1992
Clinton Reservoir	Largemouth Bass	36.0	0.84	1992
Clinton Reservoir	Largemouth Bass	37.1	0.85	1992
Cooper River Park Lake	Black Crappie	16.7	0.04	1992
Cooper River Park Lake	Black Crappie	18.1	0.10	1992
Cooper River Park Lake	Black Crappie	18.4	0.12	1992
Cooper River Park Lake	Largemouth Bass	19.5	0.12	1992
Cooper River Park Lake	Largemouth Bass	21.4	0.03	1992
Cooper River Park Lake	Largemouth Bass	21.7	0.04	1992
Cooper River Park Lake	Largemouth Bass	25.5	0.08	1992
Cooper River Park Lake	Largemouth Bass	28	0.07	1992
Cooper River Park Lake	Largemouth Bass	30.8	0.09	1992

Cooper River Park Lake	Largemouth Bass	32.2	0.10	1992
Cooper River Park Lake	Largemouth Bass	32.8	0.13	1992
Cooper River Park Lake	Largemouth Bass	35.5	0.14	1992
Cooper River Park Lake	Largemouth Bass	43.5	0.31	1992
Cooper River Park Lake	Largemouth Bass	44	0.56	1992
Cooper River Park Lake	Largemouth Bass	22.1	0.09	1992
Cooper River Park Lake	Largemouth Bass	25.5	0.08	1992
Cooper River Park Lake	Largemouth Bass	28	0.07	1992
Cooper River Park Lake	Largemouth Bass	30.8	0.09	1992
Cooper River Park Lake	Largemouth Bass	35.5	0.14	1992
Cooper River Park Lake	Largemouth Bass	43.5	0.31	1992
Cranberry Lake	Chain Pickerel	42.4	0.27	1992
Cranberry Lake	Chain Pickerel	56.9	0.37	1992
Cranberry Lake	Chain Pickerel	55.5	0.37	1992
Cranberry Lake	Hybrid Striped Bass	38.2	0.29	1992
Cranberry Lake	Hybrid Striped Bass	37	0.31	1992
Cranberry Lake	Hybrid Striped Bass	52	0.43	1992
Crystal Lake	Brown Bullhead	19.8	0.02	1992
Crystal Lake	Brown Bullhead	20	0.05	1992
Dundee Lake	Brown Bullhead	27.1	0.19	1992
Dundee Lake	Brown Bullhead	29.3	0.20	1992
East Creek Lake	Chain Pickerel	31.5	0.79	1992
East Creek Lake	Chain Pickerel	34.5	1.03	1992
East Creek Lake	Chain Pickerel	41.4	1.33	1992
East Creek Lake	Chain Pickerel	39	1.33	1992
East Creek Lake	Chain Pickerel	51	1.59	1992
East Creek Lake	Chain Pickerel	40	1.76	1992
East Creek Lake	Chain Pickerel	50	2.30	1992
East Creek Lake	Chain Pickerel	46.2	2.44	1992
East Creek Lake	Chain Pickerel	52.5	2.82	1992
East Creek Lake	Yellow Bullhead	26.8	1.29	1992
East Creek Lake	Yellow Bullhead	27.4	1.47	1992
Evans Lake	Largemouth Bass	27.8	0.15	1992
Evans Lake	Largemouth Bass	21.5	0.33	1992
Harrisville Lake	Chain Pickerel	40	0.99	1992
Harrisville Lake	Chain Pickerel	33.5	1.21	1992
Harrisville Lake	Chain Pickerel	28.3	1.71	1992
Harrisville Lake	Chain Pickerel	45.7	1.74	1992
Harrisville Lake	Chain Pickerel	51.4	2.10	1992
Harrisville Lake	Yellow Bullhead	27.5	1.36	1992
Lake Carasaljo	Chain Pickerel	34.9	0.28	1992
Lake Hopatcong	Chain Pickerel	35.1	0.19	1992
Lake Hopatcong	Chain Pickerel	48	0.22	1992
Lake Hopatcong	Chain Pickerel	47.3	0.35	1992
Lake Hopatcong	Chain Pickerel	45	0.37	1992
Lake Hopatcong	Chain Pickerel	53	0.64	1992
Lake Hopatcong	Largemouth Bass	39.9	0.27	1992
Lake Hopatcong	Largemouth Bass	41.4	0.28	1992
Lake Hopatcong	Largemouth Bass	29.5	0.30	1992

Lake Nummy	Chain Pickerel	35	1.36	1992
Lake Nummy	Yellow Bullhead	26.7	0.32	1992
Lake Nummy	Yellow Bullhead	27.8	0.32	1992
Lake Nummy	Yellow Bullhead	28.1	0.32	1992
Lenape Lake	Chain Pickerel	35.5	0.25	1992
Lenape Lake	Chain Pickerel	44.8	0.54	1992
Lenape Lake	Chain Pickerel	49.7	0.89	1992
Marlton Lake	Largemouth Bass	38	1.36	1992
Maskells Mill Lake	Chain Pickerel	28	0.37	1992
Merrill Creek	Rainbow Trout	25.3	0.04	1992
Merrill Creek	Rainbow Trout	24.7	0.08	1992
Merrill Creek Reservoir	Rainbow Trout	32.1	0.14	1992
Merrill Creek Reservoir	Rainbow Trout	37.5	0.14	1992
Merrill Creek Reservoir	Rainbow Trout	38.6	0.24	1992
Merrill Creek Reservoir	Lake Trout	51.3	0.44	1992
Merrill Creek Reservoir	Lake Trout	51.6	0.77	1992
Merrill Creek Reservoir	Lake Trout	53.2	0.79	1992
Merrill Creek Reservoir	Lake Trout	56.4	0.69	1992
Merrill Creek Reservoir	Largemouth Bass	30.9	0.29	1992
Merrill Creek Reservoir	Largemouth Bass	43.9	0.96	1992
Merrill Creek Reservoir	Largemouth Bass	41.0	1.21	1992
Monksville Reservoir	Chain Pickerel	39.3	0.21	1992
Monksville Reservoir	Chain Pickerel	42.4	0.36	1992
Monksville Reservoir	Chain Pickerel	64	1.14	1992
Monksville Reservoir	Largemouth Bass	28.7	0.45	1992
Monksville Reservoir	Largemouth Bass	33.9	0.52	1992
Monksville Reservoir	Largemouth Bass	38.4	1.00	1992
Mountain Lake	Largemouth Bass	31.8	0.22	1992
Mountain Lake	Largemouth Bass	37.4	0.37	1992
Mountain Lake	Largemouth Bass	47.0	0.90	1992
New Brooklyn Lake	Chain Pickerel	18.7	0.10	1992
New Brooklyn Lake	Chain Pickerel	37.7	0.23	1992
New Brooklyn Lake	Chain Pickerel	46.6	0.79	1992
Newton Creek, North	Brown Bullhead	29	0.02	1992
Newton Creek, North	Brown Bullhead	34.4	0.03	1992
Newton Creek, North	Brown Bullhead	32.3	0.03	1992
Newton Creek, North	Brown Bullhead	32.4	0.03	1992
Newton Creek, North	Channel Catfish	36.5	0.08	1992
Newton Creek, North	Channel Catfish	47.1	0.12	1992
Newton Creek, South	Brown Bullhead	25.9	0.04	1992
Newton Creek, South	Brown Bullhead	26.1	0.06	1992
Newton Creek, South	Brown Bullhead	29.5	0.18	1992
Newton Creek, South	Chain Pickerel	25.3	0.10	1992
Newton Creek, South	Largemouth Bass	37.1	0.23	1992
Newton Creek, South	Largemouth Bass	36.6	0.24	1992
Newton Creek, South	Largemouth Bass	30.7	1.15	1992
Newton Lake	Black Crappie	18.4	0.09	1992
Newton Lake	Black Crappie	19.4	0.11	1992
Newton Lake	Black Crappie	20.4	0.13	1992

Newton Lake	Largemouth Bass	30	0.05	1992
Newton Lake	Largemouth Bass	30.6	0.05	1992
Newton Lake	Largemouth Bass	33.6	0.06	1992
Newton Lake	Largemouth Bass	33.1	0.06	1992
Newton Lake	Largemouth Bass	25.8	0.06	1992
Newton Lake	Largemouth Bass	25.0	0.06	1992
Newton Lake	Largemouth Bass	31.0	0.07	1992
Newton Lake	Largemouth Bass	31.0	0.07	1992
Newton Lake	Largemouth Bass	29.1	0.07	1992
Newton Lake	Largemouth Bass	45.2	0.18	1992
Newton Lake	Largemouth Bass	41.1	0.22	1992
Newton Lake	Largemouth Bass	45.6	0.40	1992
Rancocas Creek	Channel Catfish	45.6	0.11	1992
Rockaway River	Brown Bullhead	31	0.12	1992
Rockaway River	Chain Pickerel	34	0.15	1992
Rockaway River	Chain Pickerel	30.6	0.15	1992
Rockaway River	Chain Pickerel	38.8	0.25	1992
Rockaway River	Chain Pickerel	40.7	0.29	1992
Rockaway River	Chain Pickerel	44.7	0.31	1992
Rockaway River	Rainbow Trout	53.6	0.04	1992
Rockaway River	Yellow Bullhead	21.2	0.15	1992
Rockaway River near Whippany	Largemouth Bass	26.4	0.36	1992
Rockaway River near Whippany	Largemouth Bass	28.9	0.59	1992
Rockaway River near Whippany	Largemouth Bass	31.5	0.73	1992
Round Valley Reservoir	Lake Trout	40	0.06	1992
Round Valley Reservoir	Lake Trout	54.4	0.14	1992
Round Valley Reservoir	Lake Trout	75.5	0.14	1992
Saw Mill Lake	Brown Bullhead	36.5	0.05	1992
Saw Mill Lake	Brown Bullhead	33.1	0.06	1992
Saw Mill Lake	Brown Bullhead	39.5	0.07	1992
Saw Mill Lake	Brown Bullhead	37.9	0.07	1992
Saw Mill Lake	Northern Pike	53.4	0.27	1992
Shadow Lake	Largemouth Bass	29.1	0.12	1992
Shadow Lake	Largemouth Bass	30.4	0.15	1992
Shadow Lake	Largemouth Bass	36.7	0.18	1992
Shadow Lake	Largemouth Bass	31.2	0.26	1992
Spring Lake	Largemouth Bass	37.1	0.21	1992
Spring Lake	Largemouth Bass	49.9	0.75	1992
Spring Lake	Largemouth Bass	47.8	0.80	1992
Spruce Run Reservoir	Hybrid Striped Bass	33.1	0.17	1992
Spruce Run Reservoir	Hybrid Striped Bass	37.1	0.19	1992
Spruce Run Reservoir	Hybrid Striped Bass	38.2	0.22	1992
Spruce Run Reservoir	Largemouth Bass	25.2	0.10	1992
Spruce Run Reservoir	Largemouth Bass	28.4	0.19	1992
Spruce Run Reservoir	Largemouth Bass	41.2	0.41	1992
Spruce Run Reservoir	Largemouth Bass	43.8	0.64	1992
Stafford Forge Main Line	Chain Pickerel	26.6	0.59	1992
Stafford Forge Main Line	Chain Pickerel	27.7	0.63	1992
Stafford Forge Main Line	Chain Pickerel	29.9	0.85	1992

Strawbridge Lake	Black Crappie	15.3	0.13	1992
Strawbridge Lake	Black Crappie	14.8	0.24	1992
Strawbridge Lake	Black Crappie	14.3	0.24	1992
Swartswood Lake	Chain Pickerel	39.6	0.09	1992
Swartswood Lake	Chain Pickerel	43.3	0.10	1992
Swartswood Lake	Chain Pickerel	42.3	0.12	1992
Swartswood Lake	Smallmouth Bass	30.8	0.12	1992
Swartswood Lake	Smallmouth Bass	35.5	0.18	1992
Swartswood Lake	Smallmouth Bass	37.5	0.29	1992
Wading River	Chain Pickerel	39.4	0.66	1992
Wading River	Chain Pickerel	40.8	0.68	1992
Wading River	Chain Pickerel	34.3	0.82	1992
Wading River	Chain Pickerel	37.3	1.09	1992
Wading River	Chain Pickerel	43.6	1.23	1992
Wanaque Reservoir	Chain Pickerel	38.7	0.33	1992
Wanaque Reservoir	Chain Pickerel	55.5	0.93	1992
Wanaque Reservoir	Smallmouth Bass	27.5	0.34	1992
Wanaque Reservoir	Smallmouth Bass	37.9	0.51	1992
Wanaque Reservoir	Largemouth Bass	32.8	0.40	1992
Wanaque Reservoir	Largemouth Bass	37.8	0.61	1992
Wanaque Reservoir	Largemouth Bass	36.6	0.75	1992
Wanaque Reservoir	Largemouth Bass	40.5	1.01	1992
Wanaque Reservoir	Largemouth Bass	43.8	1.17	1992
Wanaque Reservoir	Largemouth Bass	46.4	1.18	1992
Wilson Lake	Chain Pickerel	37.8	0.24	1992
Wilson Lake	Chain Pickerel	36.3	0.38	1992
Wilson Lake	Chain Pickerel	50.6	1.06	1992
Wilson Lake	Chain Pickerel	34.4	1.53	1992
Woodstown Memorial Lake	Black Crappie	17.5	0.08	1992
Woodstown Memorial Lake	Largemouth Bass	24.5	0.11	1992
Woodstown Memorial Lake	Largemouth Bass	27.8	0.20	1992
Woodstown Memorial Lake	Largemouth Bass	27.6	0.23	1992
Woodstown Memorial Lake	Largemouth Bass	39.3	0.34	1992
Woodstown Memorial Lake	Largemouth Bass	45.1	0.50	1992
Big Timber Creek	Channel Catfish	42.3	0.09	1993
Budd Lake	White Catfish	33.8	0.17	1993
Budd Lake	Northern Pike	54.8	0.11	1993
Budd Lake	Northern Pike	64	0.11	1993
Budd Lake	Northern Pike	68.5	0.14	1993
Canistear Reservoir	Largemouth Bass	36	0.41	1993
Canistear Reservoir	Largemouth Bass	42.2	0.52	1993
Canistear Reservoir	Largemouth Bass	40	0.55	1993
Canistear Reservoir	Largemouth Bass	45.7	0.61	1993
Canistear Reservoir	Largemouth Bass	43.5	0.68	1993
Canistear Reservoir	Largemouth Bass	39.1	0.69	1993
Canistear Reservoir	Largemouth Bass	38.8	0.74	1993
Carnegie Lake	Largemouth Bass	39.1	0.20	1993
Carnegie Lake	Largemouth Bass	32.3	0.29	1993
Carnegie Lake	Largemouth Bass	35.1	0.37	1993

Carnegie Lake	Largemouth Bass	44.7	0.45	1993
Carnegie Lake	Largemouth Bass	35.1	0.58	1993
Carnegie Lake	Largemouth Bass	51.3	1.07	1993
Corbin City Impoundment #3	Brown Bullhead	26.7	0.07	1993
Crystal Lake	Black Crappie	19.1	0.04	1993
Crystal Lake	Black Crappie	20.7	0.18	1993
Crystal Lake	Largemouth Bass	23.5	0.09	1993
Crystal Lake	Largemouth Bass	30.0	0.14	1993
Crystal Lake	Largemouth Bass	42.6	0.28	1993
Manasquan Reservoir	Largemouth Bass	31	0.76	1993
Manasquan Reservoir	Largemouth Bass	38.9	2.35	1993
Manasquan Reservoir	Largemouth Bass	36.4	2.45	1993
Manasquan Reservoir	Largemouth Bass	40	2.49	1993
Manasquan Reservoir	Largemouth Bass	38	2.89	1993
Manasquan Reservoir	Largemouth Bass	41.1	3.16	1993
Manasquan Reservoir	Largemouth Bass	40.3	3.87	1993
Maskells Mill Lake	Black Crappie	20.8	0.20	1993
Maskells Mill Lake	Black Crappie	26.3	0.29	1993
Maskells Mill Lake	Brown Bullhead	25.4	0.23	1993
Maskells Mill Lake	Brown Bullhead	28.9	0.31	1993
Maskells Mill Lake	Brown Bullhead	28.9	0.47	1993
Maskells Mill Lake	Largemouth Bass	25.9	0.36	1993
Maskells Mill Lake	Largemouth Bass	32.4	0.48	1993
Mullica River	Chain Pickerel	40.7	1.21	1993
New Brooklyn Lake	Chain Pickerel	46.2	0.82	1993
New Brooklyn Lake	Chain Pickerel	59.7	1.30	1993
Round Valley Reservoir	Largemouth Bass	25.2	0.16	1993
Round Valley Reservoir	Largemouth Bass	37.1	0.24	1993
Round Valley Reservoir	Largemouth Bass	35.1	0.24	1993
Spruce Run Reservoir	Northern Pike	63.2	0.41	1993
Spruce Run Reservoir	Northern Pike	64.2	0.39	1993
Woodstown Memorial Lake	Black Crappie	19.5	0.10	1993
Woodstown Memorial Lake	Black Crappie	37.3	0.22	1993
Batsto Lake	Bluegill sunfish	18.5	0.31	1994
Batsto Lake	Bluegill sunfish	22	0.33	1994
Batsto Lake	Bluegill sunfish	20	0.56	1994
Batsto Lake	Brown bullhead	30.5	0.16	1994
Batsto Lake	Brown bullhead	30	0.16	1994
Batsto Lake	Brown bullhead	28	0.16	1994
Batsto Lake	Brown bullhead	30	0.21	1994
Batsto Lake	Brown bullhead	30	0.25	1994
Batsto Lake	Chain pickerel	29	0.38	1994
Batsto Lake	Chain pickerel	29.5	0.43	1994
Batsto Lake	Chain pickerel	28.5	0.44	1994
Batsto Lake	Chain pickerel	30	0.44	1994
Batsto Lake	Chain pickerel	38	0.79	1994
Batsto Lake	Largemouth bass	27	0.47	1994
Batsto Lake	Largemouth bass	26.5	0.60	1994
Batsto Lake	Largemouth bass	31.5	0.90	1994

Batsto Lake	Largemouth bass	32.5	0.92	1994
Batsto Lake	Largemouth bass	34	1.15	1994
Carnegie Lake	Bluegill sunfish	16.2	0.06	1994
Carnegie Lake	Bluegill sunfish	16.8	0.02	1994
Carnegie Lake	Bluegill sunfish	17.5	0.05	1994
Carnegie Lake	White perch	20	0.13	1994
Carnegie Lake	White perch	20.5	0.19	1994
Carnegie Lake	White perch	21.1	0.11	1994
Carnegie Lake	White perch	21.2	0.20	1994
Carnegie Lake	White perch	21.4	0.19	1994
Carnegie Lake	Largemouth bass	43.0	0.24	1994
Carnegie Lake	Largemouth bass	45.2	0.37	1994
Carnegie Lake	Largemouth bass	43.5	0.45	1994
Carnegie Lake	Largemouth bass	48.0	0.68	1994
Carnegie Lake	Largemouth bass	54.0	0.81	1994
Merrill Creek Reservoir	Largemouth bass	41.0	0.67	1994
Merrill Creek Reservoir	Largemouth bass	39.5	0.93	1994
Merrill Creek Reservoir	Largemouth bass	36.7	0.93	1994
Merrill Creek Reservoir	Largemouth bass	41.0	1.10	1994
Merrill Creek Reservoir	Largemouth bass	49.6	1.12	1994
Monksville Reservoir	Largemouth bass	31.3	0.20	1994
Monksville Reservoir	Largemouth bass	31.2	0.21	1994
Monksville Reservoir	Largemouth bass	28.5	0.51	1994
Monksville Reservoir	Largemouth bass	41.2	0.78	1994
Monksville Reservoir	Largemouth bass	39	1.00	1994
Wilson Lake	Pumpkinseed sunfish	20.4	0.26	1994
Wilson Lake	Pumpkinseed sunfish	18.5	0.60	1994
Wilson Lake	Pumpkinseed sunfish	18.2	1.52	1994
Wilson Lake	Yellow perch	22	0.48	1994
Wilson Lake	Yellow perch	24.5	0.65	1994
Wilson Lake	Yellow perch	26.1	0.72	1994
Wilson Lake	Yellow perch	30	1.08	1994
Wilson Lake	Yellow perch	2.95	1.23	1994
Wilson Lake	Largemouth bass	35.5	0.74	1994
Wilson Lake	Largemouth bass	40.0	0.88	1994
Wilson Lake	Largemouth bass	25.6	0.90	1994
Wilson Lake	Largemouth bass	34.5	0.90	1994
Wilson Lake	Largemouth bass	47.0	1.75	1994
Carnegie Lake	Brown bullhead	30.1	0.03	1995
Carnegie Lake	Brown bullhead	31.1	0.05	1995
Carnegie Lake	Brown bullhead	28.2	0.06	1995
Carnegie Lake	Brown bullhead	28.5	0.10	1995
Carnegie Lake	Brown bullhead	29.4	0.12	1995
Carnegie Lake	Channel catfish	56.6	0.12	1995
Carnegie Lake	Channel catfish	61.8	0.16	1995
Carnegie Lake	Channel catfish	56.2	0.18	1995

Carnegie Lake	Channel catfish	41.2	0.44	1995
East Creek Lake	Brown bullhead	33.2	2.62	1995
East Creek Lake	Chain pickerel	31.2	0.65	1995
East Creek Lake	Chain pickerel	33.5	0.78	1995
East Creek Lake	Chain pickerel	35	0.99	1995
East Creek Lake	Chain pickerel	33.3	1.14	1995
East Creek Lake	Chain pickerel	33.7	1.35	1995
East Creek Lake	Pumpkinseed sunfish	11.3	0.35	1995
East Creek Lake	Pumpkinseed sunfish	11.4	0.43	1995
East Creek Lake	Pumpkinseed sunfish	11.4	0.53	1995
East Creek Lake	Yellow bullhead	11.7	0.30	1995
East Creek Lake	Yellow bullhead	22.3	0.73	1995
East Creek Lake	Yellow perch	18	0.67	1995
East Creek Lake	Yellow perch	20	0.82	1995
East Creek Lake	Yellow perch	22	0.90	1995
East Creek Lake	Yellow perch	24	0.95	1995
East Creek Lake	Yellow perch	20.1	1.01	1995
East Creek Lake	Largemouth bass	33.1	1.07	1995
East Creek Lake	Largemouth bass	33.5	1.44	1995
East Creek Lake	Largemouth bass	34	1.95	1995
East Creek Lake	Largemouth bass	38	2.04	1995
East Creek Lake	Largemouth bass	42	2.21	1995
Harrisville Lake	Chain pickerel	27.5	0.90	1995
Harrisville Lake	Chain pickerel	24.5	0.94	1995
Harrisville Lake	Chain pickerel	25	1.20	1995
Harrisville Lake	Chain pickerel	33.5	1.48	1995
Harrisville Lake	Chain pickerel	45	2.27	1995
Harrisville Lake	mud sunfish	11.1	0.76	1995
Harrisville Lake	mud sunfish	17.5	0.95	1995
Harrisville Lake	mud sunfish	18.5	1.32	1995
Harrisville Lake	Yellow bullhead	15.5	0.96	1995
Harrisville Lake	Yellow bullhead	32.5	2.52	1995
Lake Nummy	Chain pickerel	33.3	0.47	1995
Lake Nummy	Chain pickerel	33.3	0.49	1995
Lake Nummy	Chain pickerel	33.6	0.60	1995
Lake Nummy	Chain pickerel	33.7	0.63	1995
Lake Nummy	Chain pickerel	33.2	0.64	1995
Lake Nummy	Yellow bullhead	25.7	0.21	1995
Lake Nummy	Yellow bullhead	11	0.23	1995
Lake Nummy	Yellow bullhead	25.5	0.31	1995
Lake Nummy	Yellow bullhead	25.1	0.34	1995
Lake Nummy	Yellow perch	22.3	0.52	1995
Lake Nummy	Yellow perch	20	0.53	1995
Lake Nummy	Yellow perch	22.3	0.53	1995
Lake Nummy	Yellow perch	22.3	0.54	1995
Lake Nummy	Yellow perch	22.1	0.59	1995

Manasquan Reservoir	Black crappie	17.5	0.35	1995
Manasquan Reservoir	Black crappie	16.5	0.51	1995
Manasquan Reservoir	Black crappie	16.5	0.53	1995
Manasquan Reservoir	Bluegill sunfish	15	0.16	1995
Manasquan Reservoir	Bluegill sunfish	15.5	0.22	1995
Manasquan Reservoir	Bluegill sunfish	16.8	0.22	1995
Manasquan Reservoir	Bluegill sunfish	16.5	0.31	1995
Manasquan Reservoir	Bluegill sunfish	16.5	0.37	1995
Manasquan Reservoir	Brown bullhead	24	0.06	1995
Manasquan Reservoir	Brown bullhead	21.5	0.11	1995
Manasquan Reservoir	Brown bullhead	22	0.12	1995
Manasquan Reservoir	Brown bullhead	26	0.15	1995
Manasquan Reservoir	Brown bullhead	24	0.16	1995
Manasquan Reservoir	Chain pickerel	21.6	0.08	1995
Manasquan Reservoir	Chain pickerel	20	0.13	1995
Manasquan Reservoir	Chain pickerel	24.1	0.15	1995
Manasquan Reservoir	Chain pickerel	39.8	0.48	1995
Manasquan Reservoir	Yellow perch	19.5	0.11	1995
Manasquan Reservoir	Yellow perch	18	0.12	1995
Manasquan Reservoir	Yellow perch	21	0.17	1995
Manasquan Reservoir	Largemouth bass	27	0.29	1995
Manasquan Reservoir	Largemouth bass	28	0.47	1995
Manasquan Reservoir	Largemouth bass	39.5	1.49	1995
Manasquan Reservoir	Largemouth bass	39.5	1.75	1995
Manasquan Reservoir	Largemouth bass	44.5	2.21	1995
Merrill Creek Reservoir	Black crappie	25.3	0.09	1995
Merrill Creek Reservoir	Black crappie	26.1	0.12	1995
Merrill Creek Reservoir	Bluegill sunfish	14.6	0.05	1995
Merrill Creek Reservoir	Bluegill sunfish	172	0.09	1995
Merrill Creek Reservoir	Bluegill sunfish	25.4	0.16	1995
Merrill Creek Reservoir	Brown bullhead	26	0.12	1995
Merrill Creek Reservoir	Brown bullhead	27.9	0.14	1995
Merrill Creek Reservoir	Brown bullhead	29.5	0.14	1995
Merrill Creek Reservoir	Brown bullhead	25.4	0.16	1995
Merrill Creek Reservoir	Brown bullhead	25.1	0.17	1995
Merrill Creek Reservoir	Lake trout	56.7	0.38	1995
Merrill Creek Reservoir	Lake trout	56.5	0.44	1995
Merrill Creek Reservoir	Lake trout	60	0.46	1995
Merrill Creek Reservoir	Lake trout	58.6	0.51	1995
Merrill Creek Reservoir	Lake trout	64	0.73	1995
Merrill Creek Reservoir	Smallmouth bass	38.5	0.44	1995
Merrill Creek Reservoir	Smallmouth bass	40.1	0.44	1995
Merrill Creek Reservoir	Smallmouth bass	42.5	0.49	1995
Merrill Creek Reservoir	Smallmouth bass	39.3	0.63	1995
Merrill Creek Reservoir	Smallmouth bass	43.3	0.68	1995
Merrill Creek Reservoir	Yellow perch	31.2	0.20	1995
Merrill Creek Reservoir	Yellow perch	30.1	0.22	1995
Merrill Creek Reservoir	Yellow perch	34	0.32	1995
Monksville Reservoir	Brown bullhead	31.8	0.04	1995

Monksville Reservoir	Brown bullhead	31	0.06	1995
Monksville Reservoir	Brown bullhead	29	0.06	1995
Monksville Reservoir	Brown bullhead	28.5	0.09	1995
Monksville Reservoir	Brown bullhead	29.2	0.13	1995
Monksville Reservoir	Brown trout	45	0.20	1995
Monksville Reservoir	Pumpkinseed sunfish	19.2	0.09	1995
Monksville Reservoir	Pumpkinseed sunfish	18.1	0.14	1995
Monksville Reservoir	Pumpkinseed sunfish	18	0.25	1995
Monksville Reservoir	Smallmouth bass	31.6	0.26	1995
Monksville Reservoir	Smallmouth bass	27	0.28	1995
Monksville Reservoir	Smallmouth bass	37	0.33	1995
Monksville Reservoir	Walleye	35.5	0.30	1995
Monksville Reservoir	Walleye	41.4	0.42	1995
Monksville Reservoir	Walleye	42	0.48	1995
Monksville Reservoir	Walleye	47.6	0.80	1995
Monksville Reservoir	Walleye	45.9	0.98	1995
Monksville Reservoir	Walleye	52.2	1.44	1995
Monksville Reservoir	White perch	24.5	0.19	1995
Monksville Reservoir	White perch	26.8	0.55	1995
Monksville Reservoir	White perch	27	0.58	1995
Monksville Reservoir	White perch	28.5	0.74	1995
Monksville Reservoir	White perch	32.1	0.79	1995
Mullica River	Brown bullhead	25.5	0.26	1995
Mullica River	Brown bullhead	24.5	0.28	1995
Mullica River	Brown bullhead	22	0.40	1995
Mullica River	Chain pickerel	23.5	0.25	1995
Mullica River	Chain pickerel	30	0.45	1995
Mullica River	Chain pickerel	33.2	0.49	1995
Mullica River	Chain pickerel	46	0.62	1995
Mullica River	Chain pickerel	50.5	0.92	1995
Mullica River	Pumpkinseed sunfish	13	0.12	1995
Mullica River	Pumpkinseed sunfish	13	0.21	1995
Mullica River	Pumpkinseed sunfish	17	0.52	1995
Mullica River	White catfish	29.6	0.23	1995
Mullica River	White catfish	29	0.25	1995
Mullica River	White catfish	29	0.35	1995
Mullica River	White perch	18.3	0.34	1995
Mullica River	White perch	17.4	0.35	1995
Mullica River	White perch	20	0.36	1995
Mullica River	White perch	19	0.36	1995
Mullica River	White perch	21	0.51	1995
New Brooklyn Lake	Black crappie	21	0.08	1995
New Brooklyn Lake	Black crappie	21.8	0.16	1995
New Brooklyn Lake	Black crappie	21.5	0.19	1995

New Brooklyn Lake	Chain pickerel	20.5	0.13	1995
New Brooklyn Lake	Chain pickerel	29.7	0.20	1995
New Brooklyn Lake	Chain pickerel	34	0.25	1995
New Brooklyn Lake	Chain pickerel	43.9	0.48	1995
New Brooklyn Lake	Chain pickerel	32.5	0.64	1995
New Brooklyn Lake	Pumpkinseed sunfish	15.4	0.22	1995
New Brooklyn Lake	Pumpkinseed sunfish	16	0.28	1995
New Brooklyn Lake	Pumpkinseed sunfish	16.5	0.30	1995
New Brooklyn Lake	Yellow bullhead	20	0.05	1995
New Brooklyn Lake	Yellow bullhead	24.1	0.06	1995
New Brooklyn Lake	Yellow bullhead	23.8	0.08	1995
New Brooklyn Lake	Yellow bullhead	25.9	0.09	1995
New Brooklyn Lake	Yellow bullhead	26.9	0.20	1995
New Brooklyn Lake	Largemouth bass	23.3	0.25	1995
New Brooklyn Lake	Largemouth bass	27.4	0.32	1995
New Brooklyn Lake	Largemouth bass	31.7	0.41	1995
Wading River	Brown bullhead	31.5	0.62	1995
Wading River	Chain pickerel	42.5	0.46	1995
Wading River	Chain pickerel	35.1	0.49	1995
Wading River	Chain pickerel	28.5	0.55	1995
Wading River	Chain pickerel	22.3	0.55	1995
Wading River	Chain pickerel	32	0.71	1995
Wading River	White catfish	30.3	0.49	1995
Wading River	White catfish	30	0.60	1995
Wading River	Yellow bullhead	20.2	1.01	1995
Wading River	Yellow bullhead	30.3	1.59	1995
Wanaque Reservoir	Bluegill sunfish	17.2	0.07	1995
Wanaque Reservoir	Brown bullhead	35.8	0.01	1995
Wanaque Reservoir	Brown bullhead	36.2	0.03	1995
Wanaque Reservoir	Brown bullhead	34	0.07	1995
Wanaque Reservoir	Chain pickerel	51	0.12	1995
Wanaque Reservoir	Chain pickerel	47.5	0.18	1995
Wanaque Reservoir	Chain pickerel	50.5	0.37	1995
Wanaque Reservoir	Chain pickerel	47	0.41	1995
Wanaque Reservoir	Chain pickerel	50.6	0.43	1995
Wanaque Reservoir	Chain pickerel	56	0.73	1995
Wanaque Reservoir	Smallmouth bass	38.5	0.27	1995
Wanaque Reservoir	Smallmouth bass	29.6	0.29	1995
Wanaque Reservoir	Smallmouth bass	46.2	0.36	1995
Wanaque Reservoir	White catfish	41.5	0.12	1995
Wanaque Reservoir	White catfish	40.5	0.17	1995
Wanaque Reservoir	White catfish	37.1	0.17	1995
Wanaque Reservoir	White catfish	37.7	0.28	1995
Wanaque Reservoir	White catfish	42.9	0.33	1995
Wanaque Reservoir	White perch	27.2	0.35	1995
Wanaque Reservoir	White perch	30.7	0.63	1995

Wanaque Reservoir	White perch	36.8	0.65	1995
Wanaque Reservoir	White perch	32.1	0.75	1995
Wanaque Reservoir	White perch	33.9	1.18	1995
Wanaque Reservoir	Yellow bullhead	23.9	0.03	1995
Wanaque Reservoir	Largemouth bass	37.9	0.36	1995
Wanaque Reservoir	Largemouth bass	34.6	0.45	1995
Wanaque Reservoir	Largemouth bass	39.5	0.51	1995
Wanaque Reservoir	Largemouth bass	41.4	0.71	1995
Wanaque Reservoir	Largemouth bass	41.4	0.85	1995
Wilson Lake	Chain pickerel	29.5	0.66	1995
Wilson Lake	Chain pickerel	30.5	0.88	1995
Wilson Lake	Chain pickerel	25.7	0.91	1995
Wilson Lake	Chain pickerel	47	1.14	1995
Wilson Lake	Chain pickerel	47	1.30	1995
Boonton Reservoir	Brown Bullhead	30.5	0.01	1996
Boonton Reservoir	Brown Bullhead	32.8	0.02	1996
Boonton Reservoir	White Catfish	40	0.54	1996
Boonton Reservoir	Largemouth Bass	35	0.33	1996
Boonton Reservoir	Largemouth Bass	45.1	0.60	1996
Boonton Reservoir	Largemouth Bass	41.6	0.81	1996
Butterfly Bogs	Brown Bullhead	30.6	0.08	1996
Butterfly Bogs	Chain Pickerel	33.9	0.78	1996
Cedar Lake	Brown Bullhead	31.5	0.06	1996
Cedar Lake	Chain Pickerel	47.9	0.24	1996
Cedar Lake	Chain Pickerel	49.6	0.31	1996
Cedar Lake	Chain Pickerel	64.7	0.76	1996
Cedar Lake	Largemouth Bass	39	0.25	1996
Cedar Lake	Largemouth Bass	41.5	0.59	1996
Cedar Lake	Largemouth Bass	43.8	0.61	1996
Crater Lake	Brown Bullhead	30	0.39	1996
Crater Lake	Yellow Perch	21.6	0.29	1996
Crater Lake	Yellow Perch	19.9	0.43	1996
Crater Lake	Yellow Perch	27.9	0.58	1996
DeVoe Lake	Brown Bullhead	27	0.09	1996
DeVoe Lake	Chain Pickerel	41.5	0.14	1996
DeVoe Lake	Chain Pickerel	43	0.25	1996
DeVoe Lake	Chain Pickerel	48.5	0.27	1996
DeVoe Lake	Largemouth Bass	31.7	0.07	1996
DeVoe Lake	Largemouth Bass	34.1	0.21	1996
DeVoe Lake	Largemouth Bass	36.5	0.26	1996
Double Trouble Lake	Chain Pickerel	18.1	0.74	1996
Double Trouble Lake	Chain Pickerel	37.7	1.24	1996
Double Trouble Lake	Chain Pickerel	46.7	1.60	1996
Double Trouble Lake	Chain Pickerel	52.4	2.24	1996
Double Trouble Lake	Chain Pickerel	57.6	2.30	1996
Double Trouble Lake	Yellow Bullhead	26.1	0.82	1996
Double Trouble Lake	Yellow Bullhead	28.3	1.09	1996
Double Trouble Lake	Yellow Bullhead	26.6	1.18	1996
Echo Lake Reservoir	Largemouth Bass	30.4	0.12	1996

Echo Lake Reservoir	Largemouth Bass	34.4	0.15	1996
Echo Lake Reservoir	Largemouth Bass	29	0.16	1996
Echo Lake Reservoir	Largemouth Bass	35	0.17	1996
Green Turtle Lake	Chain Pickerel	28.1	0.11	1996
Green Turtle Lake	Chain Pickerel	44.7	0.14	1996
Green Turtle Lake	Chain Pickerel	44.6	0.15	1996
Green Turtle Lake	Yellow Perch	20.8	0.09	1996
Green Turtle Lake	Yellow Perch	24.6	0.10	1996
Green Turtle Lake	Largemouth Bass	23.6	0.17	1996
Green Turtle Lake	Largemouth Bass	26.1	0.22	1996
Green Turtle Lake	Largemouth Bass	34.7	0.32	1996
Greenwood Lake	White perch	18.3	0.00	1996
Greenwood Lake	White perch	19.2	0.02	1996
Greenwood Lake	Largemouth Bass	36.2	0.15	1996
Greenwood Lake	Largemouth Bass	34.3	0.18	1996
Greenwood Lake	Largemouth Bass	31.4	0.21	1996
Greenwood Lake	Largemouth Bass	36.3	0.24	1996
Greenwood Lake	Largemouth Bass	40	0.40	1996
Grovers Mill Pond	Brown Bullhead	33	0.08	1996
Grovers Mill Pond	Brown Bullhead	32.2	0.40	1996
Grovers Mill Pond	Chain Pickerel	35.3	0.12	1996
Grovers Mill Pond	Chain Pickerel	35.2	0.16	1996
Grovers Mill Pond	Chain Pickerel	37.2	0.16	1996
Grovers Mill Pond	Chain Pickerel	36.5	0.18	1996
Grovers Mill Pond	Largemouth Bass	31.3	0.25	1996
Grovers Mill Pond	Largemouth Bass	35.8	0.30	1996
Grovers Mill Pond	Largemouth Bass	35	0.36	1996
Grovers Mill Pond	Largemouth Bass	41.5	0.39	1996
Grovers Mill Pond	Largemouth Bass	28	0.47	1996
Hainesville Pond	Chain Pickerel	39.3	0.14	1996
Hainesville Pond	Chain Pickerel	36.6	0.14	1996
Hainesville Pond	Chain Pickerel	36.5	0.15	1996
Hainesville Pond	Largemouth Bass	30.3	0.13	1996
Hainesville Pond	Largemouth Bass	31.0	0.21	1996
Hainesville Pond	Largemouth Bass	31.3	0.23	1996
Malaga Lake	Chain Pickerel	32	0.73	1996
Malaga Lake	Chain Pickerel	29.3	0.88	1996
Malaga Lake	Chain Pickerel	36.2	0.97	1996
Malaga Lake	Chain Pickerel	31	0.99	1996
Malaga Lake	Chain Pickerel	34	1.38	1996
Malaga Lake	Largemouth Bass	32.4	0.95	1996
Passaic River at Hatfield Swamp	Pumpkinseed Sunfish	12.4	0.08	1996
Passaic River at Hatfield Swamp	Pumpkinseed Sunfish	12.6	0.09	1996
Passaic River at Hatfield Swamp	Black Crappie	18.1	0.30	1996
Passaic River at Hatfield Swamp	Black Crappie	18.9	0.32	1996
Passaic River at Hatfield Swamp	Bluegill Sunfish	18.9	0.19	1996
Passaic River at Hatfield Swamp	Black Crappie	20	0.21	1996

Passaic River at Hatfield Swamp	Black Crappie	20	0.22	1996
Passaic River at Hatfield Swamp	Yellow Bullhead	21.4	0.11	1996
Passaic River at Hatfield Swamp	Largemouth Bass	23	0.17	1996
Passaic River at Hatfield Swamp	Largemouth Bass	23.5	0.21	1996
Passaic River at Hatfield Swamp	Largemouth Bass	36	0.53	1996
Pompton River at Lincoln Park	Pike	27.8	0.17	1996
Pompton River at Lincoln Park	Pike	42	0.41	1996
Pompton River at Lincoln Park	Pike	66.6	0.59	1996
Pompton River at Lincoln Park	Yellow Perch	21	0.21	1996
Pompton River at Lincoln Park	Yellow Perch	24	0.26	1996
Pompton River at Lincoln Park	Largemouth Bass	35.4	0.50	1996
Pompton River at Lincoln Park	Largemouth Bass	35.5	0.68	1996
Raritan River at Millstone River	Brown Bullhead	25.4	0.06	1996
Raritan River at Millstone River	Brown Bullhead	27.5	0.07	1996
Raritan River at Millstone River	Channel Catfish	39.8	0.15	1996
Raritan River at Millstone River	Largemouth Bass	32.5	0.33	1996
Raritan River at Millstone River	Largemouth Bass	36.3	0.33	1996
Raritan River at Millstone River	Largemouth Bass	44.9	0.37	1996
Raritan River at Millstone River	Largemouth Bass	37	0.46	1996
Ridgeway Branch of Tom's River	Brown Bullhead	26.4	0.17	1996
Ridgeway Branch of Tom's River	Brown Bullhead	27	0.44	1996
Ridgeway Branch of Tom's River	Brown Bullhead	22.8	1.15	1996
Ridgeway Branch of Tom's River	Brown Bullhead	25.6	1.57	1996
Ridgeway Branch of Tom's River	Chain Pickerel	36	1.22	1996
Rockaway River near Whippany	Black Crappie	17.9	0.21	1996
Rockaway River near Whippany	Bluegill Sunfish	14.5	0.12	1996
Rockaway River near Whippany	Largemouth Bass	39.8	0.92	1996
South Branch Raritan River at Neshanic Station	Brown Bullhead	17.2	0.08	1996
South Branch Raritan River at Neshanic Station	Redbreast Sunfish	15.7	0.09	1996
South Branch Raritan River at Neshanic Station	Redbreast Sunfish	15.9	0.15	1996
South Branch Raritan River at Neshanic Station	Rock Bass	15	0.09	1996
South Branch Raritan River at Neshanic Station	Smallmouth Bass	20.7	0.18	1996
South Branch Raritan River at Neshanic Station	Largemouth Bass	18.2	0.11	1996
Speedwell Lake	Bluegill Sunfish	18.3	0.12	1996
Speedwell Lake	Bluegill Sunfish	19.7	0.13	1996
Speedwell Lake	Brown Bullhead	21	0.01	1996
Speedwell Lake	Largemouth Bass	27.5	0.10	1996
Speedwell Lake	Largemouth Bass	32.5	0.34	1996
Speedwell Lake	Largemouth Bass	36.1	0.38	1996
Steenykill Lake	Largemouth Bass	26.5	0.16	1996
Steenykill Lake	Largemouth Bass	27.5	0.19	1996
Steenykill Lake	Largemouth Bass	27.7	0.19	1996
Steenykill Lake	Largemouth Bass	27.8	0.15	1996
Steenykill Lake	Largemouth Bass	28.3	0.22	1996

Steenykill Lake	Largemouth Bass	29.6	0.15	1996
Sunset Lake	Bluegill Sunfish	11.2	0.05	1996
Sunset Lake	Chain Pickerel	30.7	0.09	1996
Sunset Lake	Largemouth Bass	22.5	0.10	1996
Sunset Lake	Largemouth Bass	33.8	0.17	1996
Sunset Lake	Largemouth Bass	38.2	0.21	1996
Sunset Lake	Largemouth Bass	38.5	0.35	1996
Sunset Lake	Largemouth Bass	53	0.69	1996
Wawayanda Lake	Chain Pickerel	35	0.25	1996
Wawayanda Lake	Chain Pickerel	39.5	0.28	1996
Wawayanda Lake	Chain Pickerel	40.5	0.29	1996
Wawayanda Lake	Chain Pickerel	37.9	0.31	1996
Wawayanda Lake	Chain Pickerel	42	0.34	1996
Wawayanda Lake	Chain Pickerel	42.4	0.44	1996
Oak Ridge Reservoir	Yellow Bullhead	24.5	0.25	1997
Oak Ridge Reservoir	Chain Pickerel	25	0.24	1997
Oak Ridge Reservoir	Chain Pickerel	28	0.29	1997
Oak Ridge Reservoir	Chain Pickerel	30.6	0.30	1997
Oak Ridge Reservoir	Brown Bullhead	33	0.02	1997
Oak Ridge Reservoir	Brown Bullhead	34.5	0.02	1997
Oak Ridge Reservoir	Smallmouth Bass	40.2	0.49	1997
Oak Ridge Reservoir	Chain Pickerel	58	0.30	1997
Oak Ridge Reservoir	Largemouth Bass	36.8	0.38	1997
Oak Ridge Reservoir	Largemouth Bass	42.5	0.64	1997
Oak Ridge Reservoir	Largemouth Bass	48	0.71	1997
Oak Ridge Reservoir	Largemouth Bass	48	0.89	1997
Pompton River at Pequannock River	Black Crappie	19.3	0.24	1997
Pompton River at Pequannock River	Pumpkinseed Sunfish	14.5	0.35	1997
Pompton River at Pequannock River	Pumpkinseed Sunfish	14.1	0.78	1997
Pompton River at Pequannock River	Redbreast Sunfish	13.7	0.32	1997
Pompton River at Pequannock River	Redbreast Sunfish	15.8	0.41	1997
Pompton River at Pequannock River	Rock Bass	19.2	0.54	1997
Pompton River at Pequannock River	Rock Bass	21.1	0.54	1997
Pompton River at Pequannock River	Rock Bass	22	0.68	1997
Pompton River at Pequannock River	Smallmouth Bass	29.6	0.57	1997
Pompton River at Pequannock River	Smallmouth Bass	36.8	1.02	1997
Pompton River at Pequannock River	Smallmouth Bass	25.4	1.10	1997
Pompton River at Pequannock River	Smallmouth Bass	27.8	1.14	1997
Pompton River at Pequannock River	Yellow Bullhead	26.2	0.80	1997
Pompton River at Pequannock River	Largemouth Bass	39	0.99	1997
Pompton River at Pequannock River	Largemouth Bass	39.8	1.36	1997
Whitesbog Pond	Chain Pickerel	23	0.43	1997
Whitesbog Pond	Chain Pickerel	31.5	0.58	1997
Whitesbog Pond	Chain Pickerel	34.3	0.74	1997
Whitesbog Pond	Chain Pickerel	32.5	0.76	1997
Whitesbog Pond	Chain Pickerel	39.6	1.02	1997
Willow Grove Lake	Brown Bullhead	33	0.23	1997

Willow Grove Lake	Brown Bullhead	32.4	0.28	1997
Willow Grove Lake	Chain Pickerel	31	0.76	1997
Willow Grove Lake	Chain Pickerel	48.1	1.03	1997
Willow Grove Lake	Chain Pickerel	36.5	1.13	1997
Willow Grove Lake	Chain Pickerel	45.2	1.26	1997
Willow Grove Lake	Chain Pickerel	53	1.29	1997
Willow Grove Lake	White Catfish	43	0.17	1997
Willow Grove Lake	Yellow Bullhead	28	0.82	1997
Willow Grove Lake	Yellow Bullhead	30.5	0.91	1997
Willow Grove Lake	Largemouth Bass	33.2	1.68	1997
Mullica River @ Green Bank	American Eel	45.7	0.51	1999
Mullica River @ Green Bank	American Eel	69	0.49	1999
Mullica River @ New Gretna	American Eel	42.5	0.3	1999
Mullica River, below dam @ Batsto Village	American Eel	29.7	0.65	1999
Mullica River, below dam @ Batsto Village	American Eel	39.5	0.04	1999
Mullica River, below dam @ Batsto Village	American Eel	46.3	0.8	1999
Stewart Lake (Woodbury)	Bluegill	15.9	0.03	1999
Stewart Lake (Woodbury)	Bluegill	16.4	0.03	1999
Stewart Lake (Woodbury)	Black Crappie	18.3	0.1	1999
Stewart Lake (Woodbury)	Brown Bullhead	25.4	0.01	1999
Stewart Lake (Woodbury)	Brown Bullhead	27.3	0.01	1999
Stewart Lake (Woodbury)	Brown Bullhead	31.1	0.04	1999
Stewart Lake (Woodbury)	Common Carp	43.8	0.01	1999
Stewart Lake (Woodbury)	Common Carp	49.3	0.04	1999
Stewart Lake (Woodbury)	Common Carp	54.5	0.08	1999
Stewart Lake (Woodbury)	Common Carp	59.8	0.03	1999
Stewart Lake (Woodbury)	Common Carp	65.8	0.03	1999
Stewart Lake (Woodbury)	Largemouth Bass	35.9	0.2	1999
Stewart Lake (Woodbury)	Largemouth Bass	38.9	0.15	1999
Stewart Lake (Woodbury)	Largemouth Bass	43.5	0.19	1999
Boonton Reservoir	rock bass	20.7	0.13	2002
Boonton Reservoir	rock bass	22.2	0.27	2002
Boonton Reservoir	rock bass	22.3	0.22	2002
Boonton Reservoir	rock bass	22.3	0.26	2002
Boonton Reservoir	smallmouth bass	38.9	0.39	2002
Boonton Reservoir	smallmouth bass	41.0	0.39	2002
Boonton Reservoir	smallmouth bass	43.4	0.52	2002
Boonton Reservoir	smallmouth bass	48.4	0.75	2002
Boonton Reservoir	largemouth bass	41.6	0.36	2002
Boonton Reservoir	largemouth bass	45.0	0.59	2002
Boonton Reservoir	largemouth bass	48.3	1.08	2002
Boonton Reservoir	largemouth bass	48.7	0.73	2002
Boonton Reservoir	largemouth bass	52.2	0.80	2002
Branch Brook Park	bluegill	14.5	0.16	2002
Branch Brook Park	bluegill	15.3	0.15	2002
Branch Brook Park	bluegill	15.5	0.24	2002

Branch Brook Park	common carp	60.5	0.10	2002
Branch Brook Park	common carp	69.0	0.19	2002
Branch Brook Park	common carp	69.5	0.19	2002
Branch Brook Park	common carp	72.5	0.07	2002
Canistear Reservoir	bluegill	18.5	0.11	2002
Canistear Reservoir	yellow perch	20.5	0.29	2002
Canistear Reservoir	bluegill	21.0	0.10	2002
Canistear Reservoir	bluegill	21.8	0.11	2002
Canistear Reservoir	yellow bullhead	24.5	0.12	2002
Canistear Reservoir	yellow bullhead	25.1	0.17	2002
Canistear Reservoir	yellow perch	25.3	0.18	2002
Canistear Reservoir	yellow perch	27.5	0.22	2002
Canistear Reservoir	yellow bullhead	27.6	0.16	2002
Canistear Reservoir	yellow bullhead	28.6	0.19	2002
Canistear Reservoir	chain pickerel	41.5	0.19	2002
Canistear Reservoir	chain pickerel	41.8	0.25	2002
Canistear Reservoir	chain pickerel	44.0	0.14	2002
Canistear Reservoir	chain pickerel	47.2	0.16	2002
Canistear Reservoir	bluegill	21.2	0.23	2002
Canistear Reservoir	largemouth bass	41.7	0.38	2002
Canistear Reservoir	largemouth bass	43.8	0.29	2002
Canistear Reservoir	largemouth bass	44.5	0.51	2002
Canistear Reservoir	largemouth bass	51.4	0.67	2002
Clinton Reservoir	redbreast sunfish	12.7	0.25	2002
Clinton Reservoir	redbreast sunfish	13.2	0.19	2002
Clinton Reservoir	redbreast sunfish	13.8	0.16	2002
Clinton Reservoir	redbreast sunfish	14.1	0.16	2002
Clinton Reservoir	rock bass	15.8	0.18	2002
Clinton Reservoir	rock bass	15.9	0.19	2002
Clinton Reservoir	rock bass	18.2	0.65	2002
Clinton Reservoir	yellow bullhead	28.2	0.43	2002
Clinton Reservoir	yellow bullhead	28.3	0.74	2002
Clinton Reservoir	yellow bullhead	28.4	0.44	2002
Clinton Reservoir	yellow bullhead	29.7	0.45	2002
Clinton Reservoir	white sucker	44.5	0.25	2002
Clinton Reservoir	chain pickerel	45.2	0.61	2002
Clinton Reservoir	white sucker	45.5	0.19	2002
Clinton Reservoir	white sucker	46.8	0.24	2002
Clinton Reservoir	chain pickerel	53.0	0.43	2002
Echo Lake Reservoir	bluegill	16.4	0.10	2002
Echo Lake Reservoir	bluegill	17.9	0.06	2002
Echo Lake Reservoir	bluegill	18.5	0.11	2002
Echo Lake Reservoir	bluegill	19.0	0.11	2002
Echo Lake Reservoir	yellow bullhead	22.4	0.09	2002
Echo Lake Reservoir	yellow bullhead	22.9	0.14	2002
Echo Lake Reservoir	yellow bullhead	26.4	0.16	2002
Echo Lake Reservoir	yellow bullhead	28.6	0.07	2002
Echo Lake Reservoir	chain pickerel	43.5	0.20	2002
Echo Lake Reservoir	chain pickerel	45.6	0.27	2002

Echo Lake Reservoir	chain pickerel	62.8	0.37	2002
Echo Lake Reservoir	largemouth bass	45.6	0.43	2002
Echo Lake Reservoir	largemouth bass	48.1	0.61	2002
Echo Lake Reservoir	largemouth bass	49.4	0.72	2002
Echo Lake Reservoir	largemouth bass	50.5	0.79	2002
Green Turtle Lake	bluegill	17.7	0.07	2002
Green Turtle Lake	bluegill	17.9	0.09	2002
Green Turtle Lake	bluegill	18.6	0.14	2002
Green Turtle Lake	bluegill	19.9	0.58	2002
Green Turtle Lake	largemouth bass	31.7	0.20	2002
Green Turtle Lake	largemouth bass	32.5	0.26	2002
Green Turtle Lake	largemouth bass	38.9	0.32	2002
Green Turtle Lake	largemouth bass	40.0	0.36	2002
Green Turtle Lake	largemouth bass	49.4	0.74	2002
Greenwood Lake	bluegill	19.0	0.08	2002
Greenwood Lake	bluegill	19.1	0.13	2002
Greenwood Lake	bluegill	19.2	0.07	2002
Greenwood Lake	bluegill	20.1	0.09	2002
Greenwood Lake	yellow bullhead	21.4	0.06	2002
Greenwood Lake	yellow bullhead	23.6	0.09	2002
Greenwood Lake	yellow bullhead	23.7	0.07	2002
Greenwood Lake	yellow bullhead	23.8	0.11	2002
Greenwood Lake	walleye		0.18	2002
Greenwood Lake	walleye		0.28	2002
Greenwood Lake	walleye		0.28	2002
Greenwood Lake	walleye		0.30	2002
Greenwood Lake	walleye		0.47	2002
Greenwood Lake	largemouth bass	39.9	0.31	2002
Greenwood Lake	largemouth bass	42.0	0.31	2002
Greenwood Lake	largemouth bass	42.6	0.31	2002
Greenwood Lake	largemouth bass	42.7	0.21	2002
Greenwood Lake	largemouth bass	44.4	0.29	2002
Monksville reservoir	bluegill	17.8	0.11	2002
Monksville reservoir	bluegill	18.5	0.08	2002
Monksville reservoir	yellow bullhead	19.4	0.11	2002
Monksville reservoir	bluegill	19.8	0.17	2002
Monksville reservoir	bluegill	19.9	0.13	2002
Monksville reservoir	yellow bullhead	23.0	0.13	2002
Monksville reservoir	yellow perch	27.6	0.17	2002
Monksville reservoir	yellow perch	34.9	0.17	2002
Monksville reservoir	chain pickerel	35.5	0.15	2002
Monksville reservoir	chain pickerel	38.4	0.19	2002
Monksville reservoir	walleye	44.4	0.44	2002
Monksville reservoir	walleye	47.8	0.55	2002
Monksville reservoir	chain pickerel	51.1	0.31	2002
Monksville reservoir	walleye	51.6	0.42	2002
Monksville reservoir	walleye	54.0	0.35	2002
Monksville reservoir	walleye	59.8	0.78	2002
Monksville Reservoir	Largemouth bass	26.5	0.20	2002

Monksville Reservoir	Largemouth bass	28.0	0.18	2002
Monksville Reservoir	Largemouth bass	31.5	0.13	2002
Monksville Reservoir	Largemouth bass	36.9	0.32	2002
Monksville Reservoir	Largemouth bass	44.0	0.39	2002
Oak Ridge Reservoir	bluegill	17.5	0.15	2002
Oak Ridge Reservoir	bluegill	18.1	0.11	2002
Oak Ridge Reservoir	bluegill	19.9	0.24	2002
Oak Ridge Reservoir	bluegill	20.0	0.28	2002
Oak Ridge Reservoir	yellow bullhead	23.8	0.10	2002
Oak Ridge Reservoir	yellow bullhead	28.5	0.23	2002
Oak Ridge Reservoir	largemouth bass	41.3	0.90	2002
Oak Ridge Reservoir	largemouth bass	41.6	0.65	2002
Oak Ridge Reservoir	largemouth bass	42.2	0.81	2002
Oak Ridge Reservoir	largemouth bass	45.1	0.82	2002
Pompton River at Lincoln Park	black crappie	17.5	0.19	2002
Pompton River at Lincoln Park	black crappie	20.3	0.29	2002
Pompton River at Lincoln Park	rock bass	20.8	0.64	2002
Pompton River at Lincoln Park	black crappie	21.4	0.15	2002
Pompton River at Lincoln Park	rock bass	21.5	0.60	2002
Pompton River at Lincoln Park	rock bass	23.7	0.83	2002
Pompton River at Lincoln Park	common carp	49.5	0.22	2002
Pompton River at Lincoln Park	common carp	49.9	0.47	2002
Pompton River at Lincoln Park	common carp	57.5	0.28	2002
Pompton River at Lincoln Park	common carp	58.7	0.39	2002
Pompton River at Lincoln Park	largemouth bass	34.6	0.35	2002
Pompton River at Lincoln Park	largemouth bass	35.2	0.50	2002
Pompton River at Lincoln Park	largemouth bass	39.2	0.74	2002
Rockaway River at Powerville	bluegill	15.8	0.11	2002
Rockaway River at Powerville	bluegill	16.0	0.11	2002
Rockaway River at Powerville	bluegill	16.1	0.13	2002
Rockaway River at Powerville	yellow bullhead	16.6	0.10	2002
Rockaway River at Powerville	yellow bullhead	22.5	0.28	2002
Rockaway River at Powerville	rock bass	23.3	0.29	2002
Rockaway River at Powerville	yellow bullhead	23.5	0.14	2002
Rockaway River at Powerville	rock bass	23.9	0.41	2002
Rockaway River at Powerville	rock bass	24.1	0.34	2002
Rockaway River at Powerville	rock bass	24.5	0.32	2002
Shepherds lake	redbreast sunfish	14.6	0.19	2002
Shepherds lake	rock bass	15.3	0.20	2002
Shepherds lake	redbreast sunfish	15.6	0.18	2002
Shepherds lake	redbreast sunfish	15.9	0.20	2002
Shepherds lake	rock bass	20.9	0.15	2002
Shepherds lake	brown bullhead	28.9	0.06	2002
Shepherds lake	brown bullhead	29.5	0.13	2002
Shepherds lake	brown bullhead	36.1	0.07	2002
Shepherds lake	largemouth bass	39.0	0.76	2002
Shepherds Lake	largemouth bass	39.2	0.71	2002
Shepherds Lake	largemouth bass	39.7	0.56	2002
Shepherds Lake	largemouth bass	40.4	0.67	2002

Shepherds Lake	largemouth bass	41.1	0.60	2002
Speedwell Lake	bluegill	15.4	0.10	2002
Speedwell Lake	bluegill	15.8	0.10	2002
Speedwell Lake	bluegill	18.6	0.13	2002
Speedwell Lake	bluegill	20.5	0.16	2002
Speedwell Lake	chain pickerel	25.9	0.09	2002
Speedwell Lake	chain pickerel	31.8	0.11	2002
Speedwell Lake	common carp	57.7	0.13	2002
Speedwell Lake	chain pickerel	59.6	0.26	2002
Speedwell Lake	common carp	61.7	0.10	2002
Speedwell Lake	common carp	62.5	0.14	2002
Speedwell Lake	common carp	63.6	0.05	2002
Split Rock Reservoir	bluegill	21.2	0.13	2002
Split Rock Reservoir	bluegill	21.4	0.21	2002
Split Rock Reservoir	bluegill	22.0	0.10	2002
Split Rock Reservoir	bluegill	22.6	0.12	2002
Split Rock Reservoir	yellow perch	26.2	0.10	2002
Split Rock Reservoir	yellow perch	29.5	0.15	2002
Split Rock Reservoir	yellow perch	30.0	0.13	2002
Split Rock Reservoir	yellow perch	30.0	0.34	2002
Split Rock Reservoir	brown bullhead	30.7	0.04	2002
Split Rock Reservoir	brown bullhead	39.0	0.04	2002
Split Rock Reservoir	chain pickerel	46.8	0.30	2002
Split Rock Reservoir	chain pickerel	49.0	0.32	2002
Split Rock Reservoir	chain pickerel	54.5	0.30	2002
Split Rock Reservoir	chain pickerel	57.0	0.32	2002
Split Rock Reservoir	chain pickerel	61.0	0.26	2002
Split Rock Reservoir	largemouth bass	35.5	0.32	2002
Split Rock Reservoir	largemouth bass	35.9	0.38	2002
Split Rock Reservoir	largemouth bass	38.0	0.32	2002
Split Rock Reservoir	largemouth bass	39.4	0.48	2002
Split Rock Reservoir	largemouth bass	40.5	0.52	2002
Wanaque Reservoir	yellow bullhead	18.8	0.10	2002
Wanaque Reservoir	yellow bullhead	19.9	0.08	2002
Wanaque Reservoir	bluegill	20.2	0.22	2002
Wanaque Reservoir	bluegill	20.4	0.23	2002
Wanaque Reservoir	bluegill	20.6	0.27	2002
Wanaque Reservoir	bluegill	21.2	0.41	2002
Wanaque Reservoir	yellow bullhead	22.2	0.16	2002
Wanaque Reservoir	yellow bullhead	22.9	0.17	2002
Wanaque Reservoir	largemouth bass	30.7	0.28	2002
Wanaque Reservoir	largemouth bass	34.2	0.23	2002
Wanaque Reservoir	largemouth bass	45.2	1.03	2002
Wanaque Reservoir	largemouth bass	48.0	1.47	2002
Wawayanda Lake	bluegill	17.9	0.14	2002
Wawayanda Lake	bluegill	18.2	0.21	2002
Wawayanda Lake	bluegill	18.3	0.21	2002
Wawayanda Lake	chain pickerel	26.4	0.23	2002
Wawayanda Lake	chain pickerel	27.1	0.23	2002
Wawayanda Lake	yellow bullhead	27.1	0.30	2002

Wawayanda Lake	chain pickerel	28.0	0.23	2002
Wawayanda Lake	yellow bullhead	28.3	0.45	2002
Wawayanda Lake	yellow bullhead	29.9	0.36	2002
Wawayanda Lake	chain pickerel	33.9	0.50	2002
Wawayanda Lake	chain pickerel	44.5	0.44	2002
Wawayanda Lake	largemouth bass	33.0	0.29	2002
Wawayanda Lake	largemouth bass	33.4	0.33	2002
Wawayanda Lake	largemouth bass	42.9	0.78	2002
Wawayanda Lake	largemouth bass	44.1	0.66	2002
Wawayanda Lake	largemouth bass	45.3	0.73	2002
Weequachic Lake	bluegill	16.4	0.12	2002
Weequachic Lake	bluegill	17.3	0.15	2002
Weequachic Lake	bluegill	17.4	0.09	2002
Weequachic Lake	white perch	17.7	0.10	2002
Weequachic Lake	white perch	17.9	0.08	2002
Weequachic Lake	white perch	18.0	0.09	2002
Weequachic Lake	brown bullhead	27.2	0.03	2002
Weequachic Lake	brown bullhead	30.0	0.03	2002
Weequachic Lake	brown bullhead	31.0	0.03	2002
Weequachic Lake	common carp	50.5	0.04	2002
Weequachic Lake	common carp	56.2	0.08	2002
Weequachic Lake	common carp	71.0	0.10	2002
Weequachic Lake	largemouth bass	34.0	0.21	2002
Weequachic Lake	largemouth bass	35.1	0.20	2002
Weequachic Lake	largemouth bass	45.9	0.31	2002
Weequachic Lake	largemouth bass	47.5	0.39	2002
Mullica River	American Eel	49.5	0.29	2004
Mullica River	American Eel	63.5	0.33	2004
Mullica River	American Eel	64.9	0.18	2004
Mullica River	American Eel	73.2	0.2	2004
Mullica River	American Eel	77	0.2	2004
Below New Market Pond Dam	American eel	68.2	0.08673	2006
Below New Market Pond Dam	American eel	69.9	0.11418	2006
Bound Brook @ Shepard Rd.	American eel	51.3	0.08569	2006
Bound Brook @ Shepard Rd.	American eel	54.3	0.08921	2006
Bound Brook @ Shepard Rd.	American eel	61.3	0.20208	2006
Budd Lake	bluegill	17.8	0.09949	2006
Budd Lake	bluegill	18.2	0.1561	2006
Budd Lake	bluegill	18.8	0.12716	2006
Budd Lake	brown bullhead	25.6	0.02337	2006
Budd Lake	brown bullhead	27.2	0.0193	2006
Budd Lake	brown bullhead	31.5	0.01034	2006
Budd Lake	white catfish	34.3	0.18067	2006
Budd Lake	white catfish	35.6	0.21846	2006
Budd Lake	white catfish	42.1	0.27947	2006
Budd Lake	northern pike	74.1	0.30651	2006
Budd Lake	northern pike	78.4	0.45883	2006
Budd Lake	northern pike	81	0.19917	2006
Budd Lake	largemouth bass	35.7	0.16964	2006
Budd Lake	largemouth bass	36.4	0.43134	2006

Budd Lake	largemouth bass	36.9	0.53606	2006
Budd Lake	largemouth bass	43.1	0.48615	2006
Budd Lake	largemouth bass	47.6	0.41803	2006
Carnegie Lake	Bluegill sunfish	16.7	0.06306	2006
Carnegie Lake	Bluegill sunfish	17.9	0.05655	2006
Carnegie Lake	Bluegill sunfish	19	0.10097	2006
Carnegie Lake	white perch	20.8	0.23403	2006
Carnegie Lake	white perch	20.8	0.14171	2006
Carnegie Lake	white perch	21	0.16152	2006
Carnegie Lake	largemouth bass	34.3	0.15636	2006
Carnegie Lake	largemouth bass	38.3	0.11614	2006
Carnegie Lake	largemouth bass	43.3	0.40243	2006
Carnegie Lake	largemouth bass	44.3	0.36529	2006
Carnegie Lake	largemouth bass	49.6	0.51996	2006
Davidson Mill Pond	bluegill	18.1	0.18292	2006
Davidson Mill Pond	bluegill	19	0.0504	2006
Davidson Mill Pond	bluegill	20.3	0.14941	2006
Davidson Mill Pond	chain pickerel	43.5	0.27161	2006
Davidson Mill Pond	chain pickerel	43.9	0.24405	2006
Davidson Mill Pond	chain pickerel	48.3	0.35285	2006
Davidson Mill Pond	American eel	75.2	0.20145	2006
Davidson Mill Pond	American eel	79	0.20049	2006
Davidson Mill Pond	largemouth bass	37.7	0.5091	2006
Davidson Mill Pond	largemouth bass	40.4	0.50194	2006
Davidson Mill Pond	largemouth bass	41.3	0.56886	2006
DeVoe Lake	brown bullhead	30.9	0.07703	2006
DeVoe Lake	brown bullhead	32.5	0.12689	2006
DeVoe Lake	brown bullhead	35.7	0.16058	2006
DeVoe Lake	chain pickerel	45.8	0.26277	2006
DeVoe Lake	chain pickerel	50	0.38873	2006
DeVoe Lake	chain pickerel	50.5	0.50737	2006
Duhernal Lake	bluegill	18.4	0.04042	2006
Duhernal Lake	bluegill	20.2	0.07774	2006
Duhernal Lake	bluegill	22.3	0.16006	2006
Duhernal Lake	brown bullhead	31.6	0.03663	2006
Duhernal Lake	brown bullhead	33.5	0.02588	2006
Duhernal Lake	brown bullhead	34.5	0.05482	2006
Duhernal Lake	largemouth bass	36.4	0.19646	2006
Duhernal Lake	largemouth bass	36.5	0.1712	2006
Duhernal Lake	largemouth bass	39.2	0.2798	2006
Farrington Lake	bluegill	17.2	0.09828	2006
Farrington Lake	bluegill	17.8	0.1512	2006
Farrington Lake	bluegill	18.7	0.11982	2006
Farrington Lake	yellow perch	20.6	0.17985	2006
Farrington Lake	yellow perch	20.7	0.22166	2006
Farrington Lake	yellow perch	25.7	0.41141	2006
Farrington Lake	brown bullhead	29.8	0.03402	2006
Farrington Lake	brown bullhead	34.7	0.04048	2006
Farrington Lake	brown bullhead	36.5	0.01656	2006
Farrington Lake	chain pickerel	43.2	0.19105	2006

Farrington Lake	chain pickerel	45.8	0.20378	2006
Farrington Lake	chain pickerel	48.8	0.48139	2006
Farrington Lake	largemouth bass	39.8	0.51737	2006
Farrington Lake	largemouth bass	41	0.50762	2006
Farrington Lake	largemouth bass	42.3	0.93764	2006
Farrington Lake	largemouth bass	46.3	1.41272	2006
Farrington Lake	largemouth bass	49	0.97277	2006
Lamington River @ Lamington	redbreast sunfish	15.8	0.12666	2006
Lamington River @ Lamington	redbreast sunfish	16.1	0.16744	2006
Lamington River @ Lamington	redbreast sunfish	16.6	0.14858	2006
Lamington River @ Lamington	smallmouth bass	18.6	0.13566	2006
Lamington River @ Lamington	smallmouth bass	20.6	0.18452	2006
Lamington River @ Lamington	smallmouth bass	22	0.12535	2006
Lamington River @ Lamington	brown trout	23.7	0.07503	2006
Lamington River @ Lamington	brown trout	26.1	0.08884	2006
Lamington River @ Lamington	American eel	53.7	0.18808	2006
Lamington River @ Lamington	American eel	60.2	0.39376	2006
Lamington River @ Lamington	American eel	63.2	0.24738	2006
Manalapan Lake	bluegill	18.4	0.04791	2006
Manalapan Lake	bluegill	18.4	0.07113	2006
Manalapan Lake	bluegill	18.6	0.04947	2006
Manalapan Lake	black crappie	21	0.09823	2006
Manalapan Lake	black crappie	21.4	0.10733	2006
Manalapan Lake	black crappie	22.8	0.14389	2006
Manalapan Lake	American eel	49.5	0.07662	2006
Manalapan Lake	American eel	53.4	0.12536	2006
Manalapan Lake	American eel	59.7	0.17554	2006
Manalapan Lake	largemouth bass	38	0.23315	2006
Manalapan Lake	largemouth bass	39.1	0.32996	2006
Manalapan Lake	largemouth bass	40.8	0.40945	2006
New Market Pond	bluegill	16.5	0.06683	2006
New Market Pond	bluegill	17	0.06511	2006
New Market Pond	bluegill	17.3	0.0888	2006
New Market Pond	black crappie	20.6	0.05647	2006
New Market Pond	black crappie	22.5	0.08984	2006
New Market Pond	black crappie	24.1	0.05213	2006
New Market Pond	brown bullhead	33.3	0.02354	2006
New Market Pond	brown bullhead	33.5	0.00063	2006
New Market Pond	American eel	34	0.02819	2006
New Market Pond	brown bullhead	34.5	0.00419	2006
New Market Pond	American eel	46.6	0.04004	2006
New Market Pond	American eel	48.5	0.10651	2006
New Market Pond	common carp	50.7	0.04819	2006
New Market Pond	common carp	52.7	0.05352	2006
New Market Pond	common carp	53	0.03293	2006
New Market Pond	largemouth bass	35.9	0.13736	2006
New Market Pond	largemouth bass	36.8	0.10944	2006
New Market Pond	largemouth bass	41.4	0.26315	2006
Raritan River @ Millstone River	redbreast sunfish	18.2	0.13396	2006
Raritan River @ Millstone River	redbreast sunfish	18.2	0.16323	2006

Raritan River @ Millstone River	redbreast sunfish	19.3	0.10685	2006
Raritan River @ Millstone River	smallmouth bass	30.9	0.29331	2006
Raritan River @ Millstone River	smallmouth bass	31	0.33445	2006
Raritan River @ Millstone River	white catfish	32.6	0.20333	2006
Raritan River @ Millstone River	white catfish	35.7	0.21395	2006
Raritan River @ Millstone River	smallmouth bass	37.3	0.26906	2006
Raritan River @ Millstone River	white catfish	40.1	0.23869	2006
Raritan River @ Millstone River	channel catfish	48.7	0.35862	2006
Raritan River @ Millstone River	channel catfish	53	0.17138	2006
Raritan River @ Millstone River	American eel	57.6	0.10876	2006
Raritan River @ Millstone River	common carp	57.9	0.12682	2006
Raritan River @ Millstone River	common carp	59.7	0.15017	2006
Raritan River @ Millstone River	channel catfish	63.7	0.16402	2006
Raritan River @ Millstone River	common carp	65.9	0.00431	2006
Raritan River @ Millstone River	American eel	70.6	0.24336	2006
Raritan River @ Millstone River	American eel	71	0.29174	2006
Raritan River at Millstone River	largemouth bass	32.4	0.25569	2006
Raritan River at Millstone River	largemouth bass	37.2	0.32619	2006
Raritan River at Millstone River	largemouth bass	43	0.6896	2006
Rosedale Lake in Pennington	bluegill	18.4	0.05062	2006
Rosedale Lake in Pennington	bluegill	18.7	0.06377	2006
Rosedale Lake in Pennington	bluegill	20.2	0.10783	2006
Rosedale Lake in Pennington	black crappie	24.1	0.10195	2006
Rosedale Lake in Pennington	black crappie	25.7	0.11855	2006
Rosedale Lake in Pennington	black crappie	30.8	0.12335	2006
Rosedale Lake in Pennington	common carp	62.2	0.11683	2006
Rosedale Lake in Pennington	common carp	64.1	0.10668	2006
Rosedale Lake in Pennington	common carp	66.8	0.10278	2006
Rosedale Lake in Pennington	largemouth bass	40	0.22114	2006
Rosedale Lake in Pennington	largemouth bass	47.6	0.22991	2006
Rosedale Lake in Pennington	largemouth bass	47.7	0.3298	2006
Round Valley Reservoir	bluegill	21.5	0.11044	2006
Round Valley Reservoir	bluegill	21.9	0.11996	2006
Round Valley Reservoir	bluegill	22	0.09508	2006
Round Valley Reservoir	white catfish	36.8	0.08206	2006
Round Valley Reservoir	white catfish	40	0.0991	2006
Round Valley Reservoir	lake trout	43.9	0.08773	2006
Round Valley Reservoir	channel catfish	50.2	0.11492	2006
Round Valley Reservoir	lake trout	52.2	0.10409	2006
Round Valley Reservoir	lake trout	53.7	0.2057	2006
Round Valley Reservoir	lake trout	54.9	0.12745	2006
Round Valley Reservoir	channel catfish	58.7	0.4599	2006
Round Valley Reservoir	channel catfish	61.8	0.06823	2006
Round Valley Reservoir	lake trout	66.5	0.18896	2006
Round Valley Reservoir	largemouth bass	30.6	0.19463	2006
Round Valley Reservoir	largemouth bass	41.8	0.2981	2006
Round Valley Reservoir	largemouth bass	45.1	0.38514	2006
South Branch Raritan River at Neshanic Station	redbreast sunfish	16.9	0.10381	2006

South Branch Raritan River at Neshanic Station	redbreast sunfish	17.7	0.09302	2006
South Branch Raritan River at Neshanic Station	redbreast sunfish	17.9	0.12138	2006
South Branch Raritan River at Neshanic Station	rock bass	20.4	0.24498	2006
South Branch Raritan River at Neshanic Station	rock bass	20.6	0.16647	2006
South Branch Raritan River at Neshanic Station	rock bass	21.1	0.2056	2006
South Branch Raritan River at Neshanic Station	smallmouth bass	34.9	0.31523	2006
South Branch Raritan River at Neshanic Station	common carp	37.2	0.05298	2006
South Branch Raritan River at Neshanic Station	smallmouth bass	41.1	0.38035	2006
South Branch Raritan River at Neshanic Station	common carp	42.7	0.05706	2006
South Branch Raritan River at Neshanic Station	common carp	46.1	0.04491	2006
South Branch Raritan River at Neshanic Station	smallmouth bass	49.9	0.39461	2006
South Branch Raritan River at Neshanic Station	American eel	63	0.29096	2006
South Branch Raritan River at Neshanic Station	American eel	69.9	0.22739	2006
South Branch Raritan River at Neshanic Station	American eel	72.5	0.25548	2006
South Branch Raritan River at Neshanic Station	largemouth bass	20	0.18969	2006
South Branch Raritan River at Neshanic Station	largemouth bass	21.3	0.17653	2006
South Branch Raritan River at Neshanic Station	largemouth bass	26.9	0.1382	2006
Spring Lake	common carp	48.3	0.04448	2006
Spring Lake	common carp	54.5	0.00202	2006
Spring Lake	common carp	64.6	0.0799	2006
Spruce Run Reservoir	channel catfish	41	0.06091	2006
Spruce Run Reservoir	striped x white bass hybrid	42.4	0.14346	2006
Spruce Run Reservoir	striped x white bass hybrid	48	0.18523	2006
Spruce Run Reservoir	striped x white bass hybrid	49.2	0.22875	2006
Spruce Run Reservoir	striped x white bass hybrid	53.6	0.39913	2006
Spruce Run Reservoir	striped x white bass hybrid	54.3	0.51704	2006
Spruce Run Reservoir	channel catfish	55.6	0.22611	2006
Spruce Run Reservoir	channel catfish	56.3	0.32477	2006
Spruce Run Reservoir	common carp	57.8	0.12598	2006
Spruce Run Reservoir	common carp	58.1	0.12418	2006
Spruce Run Reservoir	common carp	58.3	0.13401	2006
Spruce Run Reservoir	northern pike	65.5	0.31375	2006

Spruce Run Reservoir	northern pike	68.5	0.24939	2006
Spruce Run Reservoir	northern pike	76.8	0.20958	2006
Spruce Run Reservoir	largemouth bass	28.7	0.17957	2006
Spruce Run Reservoir	largemouth bass	35.8	0.17422	2006
Spruce Run Reservoir	largemouth bass	39.8	0.43026	2006
Spruce Run Reservoir	largemouth bass	42.9	0.44294	2006
Spruce Run Reservoir	largemouth bass	47.3	0.60489	2006
Weston Mill Pond	bluegill	17.7	0.06793	2006
Weston Mill Pond	bluegill	18.6	0.11264	2006
Weston Mill Pond	bluegill	18.9	0.2196	2006
Weston Mill Pond	yellow perch	25.3	0.27386	2006
Weston Mill Pond	black crappie	25.8	0.19928	2006
Weston Mill Pond	yellow perch	26.3	0.14497	2006
Weston Mill Pond	black crappie	26.9	0.28312	2006
Weston Mill Pond	black crappie	26.9	0.22769	2006
Weston Mill Pond	brown bullhead	27.1	0.01612	2006
Weston Mill Pond	brown bullhead	28.2	0.05252	2006
Weston Mill Pond	yellow perch	29.3	0.39874	2006
Weston Mill Pond	brown bullhead	35.7	0.0256	2006
Weston Mill Pond	chain pickerel	38.9	0.16182	2006
Weston Mill Pond	chain pickerel	45.9	0.28877	2006
Weston Mill Pond	chain pickerel	48	0.48049	2006
Weston Mill Pond	American eel	49.8	0.10278	2006
Weston Mill Pond	American eel	50.2	0.11332	2006
Weston Mill Pond	American eel	55.1	0.13674	2006
Weston Mill Pond	largemouth bass	38	0.52104	2006
Weston Mill Pond	largemouth bass	38.1	0.41189	2006
Weston Mill Pond	largemouth bass	39.5	0.46808	2006
Atsion Lake	American eel	31.2	0.33	2007
Atsion Lake	American eel	32.1	0.27	2007
Atsion Lake	American eel	51.7	0.52	2007
Atsion Lake	chain pickerel	33.2	0.47	2007
Atsion Lake	chain pickerel	39.6	0.69	2007
Atsion Lake	chain pickerel	44.7	0.82	2007
Batsto Lake	brown bullhead	32.9	0.29	2007
Batsto Lake	brown bullhead	33.4	0.22	2007
Batsto Lake	brown bullhead	36.18	0.16	2007
Batsto Lake	chain pickerel	23.7	0.30	2007
Batsto Lake	chain pickerel	35	0.78	2007
Batsto Lake	chain pickerel	35.5	0.85	2007
Batsto Lake	chain pickerel	35.9	0.44	2007
Batsto Lake	largemouth bass	35.5	1.25	2007
Batsto Lake	largemouth bass	35.6	1.07	2007
Batsto Lake	largemouth bass	36.7	0.85	2007
Batsto Lake	largemouth bass	37.2	0.10	2007
Cedar Lake	American eel	48.7	0.16	2007
Cedar Lake	American eel	54.2	0.18	2007
Cedar Lake	American eel	63.9	0.22	2007
Cedar Lake	largemouth bass	32.8	0.18	2007
Cedar Lake	largemouth bass	38.8	0.31	2007

Cedar Lake	largemouth bass	47	1.63	2007
Cedar Lake	white perch	30.7	0.33	2007
Cedar Lake	white perch	31.8	0.22	2007
Cedar Lake	white perch	37.4	0.51	2007
Cedarville Ponds	chain pickerel	30.6	0.65	2007
Cedarville Ponds	chain pickerel	32.5	0.46	2007
Cedarville Ponds	chain pickerel	34.4	0.53	2007
Cedarville Ponds	chain pickerel	35.4	0.54	2007
Cedarville Ponds	chain pickerel	43.1	0.69	2007
Cedarville Ponds	yellow perch	28	0.31	2007
Cedarville Ponds	yellow perch	28.8	0.33	2007
Cedarville Ponds	yellow perch	29.8	0.35	2007
Deal Lake	American eel	31	0.30	2007
Deal Lake	American eel	60	0.05	2007
Deal Lake	largemouth bass	38	0.09	2007
Deal Lake	largemouth bass	39.8	0.12	2007
Deal Lake	largemouth bass	40.2	0.14	2007
Deal Lake	white perch	16.3	0.02	2007
Deal Lake	white perch	18.1	0.04	2007
Deal Lake	white perch	20.2	0.18	2007
East Creek Lake	American eel	43.2	1.05	2007
East Creek Lake	American eel	51.8	1.02	2007
East Creek Lake	American eel	53.9	1.24	2007
East Creek Lake	chain pickerel	33.6	1.14	2007
East Creek Lake	chain pickerel	41.1	1.46	2007
East Creek Lake	chain pickerel	42.9	1.05	2007
East Creek Lake	largemouth bass	30.5	1.05	2007
East Creek Lake	largemouth bass	39.4	1.40	2007
East Creek Lake	largemouth bass	44.6	1.37	2007
Harrisville Lake	American eel	27.4	0.47	2007
Harrisville Lake	American eel	40.5	0.58	2007
Harrisville Lake	American eel	54.1	0.73	2007
Harrisville Lake	chain pickerel	27.6	1.05	2007
Harrisville Lake	chain pickerel	29.4	0.61	2007
Harrisville Lake	chain pickerel	30.4	0.91	2007
Harrisville Lake	chain pickerel	31.3	1.05	2007
Lake Absegami	American eel	31.6	0.36	2007
Lake Absegami	American eel	32.7	0.29	2007
Lake Absegami	American eel	47.5	0.80	2007
Lake Absegami	chain pickerel	35.3	1.32	2007
Lake Absegami	chain pickerel	35.4	1.26	2007
Lake Absegami	chain pickerel	43.5	1.24	2007
Lake Absegami	chain pickerel	47.6	1.62	2007
Lake Absegami	chain pickerel	58.7	1.39	2007
Lake Manahawkin	American eel	46.3	1.50	2007
Lake Manahawkin	American eel	56.1	1.43	2007
Lake Manahawkin	American eel	79.6	1.89	2007
Lake Manahawkin	largemouth bass	33.6	1.08	2007
Lake Manahawkin	largemouth bass	35.2	0.93	2007

Lake Manahawkin	largemouth bass	45.1	1.76	2007
Lake Nummy	yellow bullhead	29.2	0.44	2007
Lake Nummy	yellow bullhead	29.7	0.26	2007
Lake Nummy	yellow bullhead	33.4	0.79	2007
Lake Nummy	chain pickerel	46.2	1.07	2007
Lake Nummy	chain pickerel	56	2.56	2007
Lake Oswego	American eel	49.6	0.70	2007
Lake Oswego	American eel	60.5	0.46	2007
Lake Oswego	chain pickerel	26.6	0.82	2007
Lake Oswego	chain pickerel	27.7	0.76	2007
Lake Oswego	chain pickerel	42.1	0.42	2007
Lake Oswego	chain pickerel	46.8	2.05	2007
Lefferts Lake	brown bullhead	27.8	0.07	2007
Lefferts Lake	brown bullhead	28.8	0.10	2007
Lefferts Lake	brown bullhead	29.1	0.10	2007
Lefferts Lake	chain pickerel	43.9	0.11	2007
Lefferts Lake	chain pickerel	44.7	0.19	2007
Lefferts Lake	chain pickerel	46.7	0.21	2007
Lefferts Lake	yellow perch	23.8	0.10	2007
Lefferts Lake	yellow perch	24.4	0.12	2007
Lefferts Lake	yellow perch	25.3	0.09	2007
Lenape Lake	American eel	53	0.42	2007
Lenape Lake	American eel	58.7	1.06	2007
Lenape Lake	American eel	62.4	0.89	2007
Lenape Lake	largemouth bass	40	1.60	2007
Lenape Lake	largemouth bass	44.6	1.04	2007
Lenape Lake	largemouth bass	45.9	1.61	2007
Manasquan Reservoir	American eel	54.2	0.08	2007
Manasquan Reservoir	American eel	58	0.05	2007
Manasquan Reservoir	American eel	82.4	0.17	2007
Manasquan Reservoir	largemouth bass	40.1	0.10	2007
Manasquan Reservoir	largemouth bass	44.5	0.21	2007
Manasquan Reservoir	largemouth bass	49.2	0.40	2007
Maple Lake	American eel	44.1	0.81	2007
Maple Lake	American eel	48.6	0.81	2007
Maple Lake	American eel	53.6	1.02	2007
Maple Lake	largemouth bass	33.1	0.43	2007
Maple Lake	largemouth bass	33.7	0.84	2007
Maple Lake	largemouth bass	34.7	0.86	2007
Maple Lake	largemouth bass	38	1.48	2007
Marlu Lake	common carp	64.4	0.04	2007
Marlu Lake	common carp	66.6	0.04	2007
Marlu Lake	common carp	67.9	0.04	2007
Marlu Lake	largemouth bass	34.5	0.08	2007
Marlu Lake	largemouth bass	41.4	0.09	2007
Marlu Lake	largemouth bass	44.2	0.14	2007
Parvin Lake	American eel	63.1	0.12	2007
Parvin Lake	American eel	64.9	0.12	2007
Parvin Lake	chain pickerel	45.7	0.24	2007
Parvin Lake	chain pickerel	47.7	0.21	2007

Parvin Lake	chain pickerel	51.4	0.19	2007
Parvin Lake	largemouth bass	35.9	0.16	2007
Parvin Lake	largemouth bass	39.5	0.21	2007
Parvin Lake	largemouth bass	43.3	0.26	2007
Parvin Lake	largemouth bass	44.6	0.19	2007
Parvin Lake	largemouth bass	49	0.27	2007
Pohatcong Lake	American eel	44.3	0.44	2007
Pohatcong Lake	American eel	45.3	0.95	2007
Pohatcong Lake	American eel	66.2	0.72	2007
Pohatcong Lake	largemouth bass	41.7	0.78	2007
Pohatcong Lake	largemouth bass	41.7	0.69	2007
Pohatcong Lake	largemouth bass	42.7	0.61	2007
Pohatcong Lake	largemouth bass	43	0.64	2007
Pohatcong Lake	yellow perch	26.5	0.14	2007
Pohatcong Lake	yellow perch	31.2	0.36	2007
Pohatcong Lake	yellow perch	34.6	0.83	2007
Shenandoah Lake	American eel	46.8	0.42	2007
Shenandoah Lake	American eel	47.9	0.24	2007
Shenandoah Lake	American eel	75.5	0.42	2007
Shenandoah Lake	chain pickerel	35.3	0.34	2007
Shenandoah Lake	chain pickerel	41.2	0.23	2007
Shenandoah Lake	chain pickerel	41.4	0.32	2007
Shenandoah Lake	largemouth bass	40.5	0.37	2007
Shenandoah Lake	largemouth bass	41.6	0.46	2007
Shenandoah Lake	largemouth bass	43.2	0.65	2007
Swimming River Reservoir	American eel	42.2	0.04	2007
Swimming River Reservoir	American eel	66.1	0.07	2007
Swimming River Reservoir	American eel	68.9	0.08	2007
Swimming River Reservoir	largemouth bass	40	0.09	2007
Swimming River Reservoir	largemouth bass	42.7	0.09	2007
Swimming River Reservoir	largemouth bass	50.1	0.15	2007
Wading River	chain pickerel	36.3	2.60	2007
Wading River	chain pickerel	37.5	2.63	2007
Wading River	chain pickerel	40.7	2.03	2007
Wilson Lake	chain pickerel	34.7	1.58	2007
Wilson Lake	chain pickerel	37	1.36	2007
Wilson Lake	chain pickerel	54.7	2.02	2007
Wilson Lake	largemouth bass	35.4	1.53	2007
Wilson Lake	largemouth bass	38.9	1.63	2007
Wilson Lake	largemouth bass	40.9	3.27	2007
Wilson Lake	yellow perch	28	1.25	2007
Wilson Lake	yellow perch	28	1.46	2007
Wilson Lake	yellow perch	30	0.87	2007

Appendix C

Non-Tidal Surface Water NJPDES Facility List to Quantify Potential Hg Load

NJPDES Permit Number	Facility Name	Permitted Flow	Description
NJ0000876	HERCULES INC - KENVIL	0.7	Industrial
NJ0020036	DEPT OF VETERANS AFFAIRS	0.08	Municipal minor
NJ0020184	NEWTOWN WASTEWATER TREATMENT PLANT	1.4	Municipal major
NJ0020206	ALLENTOWN BORO WWTP	0.238	Municipal minor
NJ0020281	CHATHAM HILL STP	0.03	Municipal minor
NJ0020290	CHATHAM TWP MAIN STP	1	Municipal minor
NJ0020354	BRANCBURG NESHANIC STP	0.055	Municipal minor
NJ0020389	CLINTON TOWN WWTP	2.03	Municipal major
NJ0020419	LONG POND SCHOOL WTP	0.01	Municipal minor
NJ0020427	CALDWELL WASTEWATER TREATMENT PLANT	4.5	Municipal major
NJ0020532	HARRISON TOWNSHIP TREATMENT PLANT	0.8	Municipal minor
NJ0020605	ALLAMUCHY SEWERAGE TREATMENT PLANT	0.6	Municipal minor
NJ0020711	WARREN CO TECHNICAL SCHOOL STP	0.012	Municipal minor
NJ0021083	VETERANS AFFAIRS NJ HEALTH CARE SYSTEM- LYONS	0.4	Municipal minor
NJ0021091	JEFFERSON TWP HIGH-MIDDLE SCHOOL	0.0275	Municipal minor
NJ0021105	ARTHUR STANLICK SCHOOL	0.013	Municipal minor
NJ0021113	WASHINGTON BORO WWTP	1.5	Municipal major
NJ0021253	INDIAN HILLS HIGH SCHOOL	0.0336	Municipal minor
NJ0021326	MEDFORD LAKES BOROUGH STP	0.55	Municipal minor
NJ0021334	MENDHAM BORO	0.45	Municipal minor
NJ0021342	SKYVIEW/HIBROOK WTP	0.023	Municipal minor
NJ0021369	HACKETTSTOWN MUA	3.48	Municipal major
NJ0021571	SPRINGFIELD TWP ELEM SCH STP	0.0075	Municipal minor
NJ0021636	NEW PROVIDENCE WWTP	1.5	Municipal major
NJ0021717	BUENA BOROUGH MUA	0.4	Municipal major
NJ0021865	FIDDLER'S ELBOW CTRY CLUB WWTP	0.03	Municipal minor
NJ0021890	MILFORD SEWER UTILITY	0.4	Municipal minor
NJ0021954	CLOVERHILL STP	0.5	Municipal minor
NJ0022047	RARITAN TOWNSHIP MUA STP	3.8	Municipal major
NJ0022063	SUSSEX COUNTY HOMESTEAD WTP	0.05	Municipal minor
NJ0022101	BLAIR ACADEMY	0.05	Municipal minor
NJ0022110	EDUCATIONAL TESTING SERVICE	0.08	Municipal minor
NJ0022144	HAGEDORN PSYCHIATRIC HOSPITAL	0.052	Municipal minor
NJ0022250	WOODSTOWN WASTEWATER TREATMENT PLANT	0.53	Municipal minor
NJ0022276	STONYBROOK SCHOOL	0.01	Municipal minor
NJ0022349	ROCKAWAY VALLEY REG SA	12	Municipal major
NJ0022381	NORTHERN BURLINGTON COUNTY	0.0135	Municipal minor
NJ0022390	NPDC SEWAGE TREATMENT PLANT	0.5	Municipal minor
NJ0022438	HELEN A FORT MIDDLE SCHOOL	0.05	Municipal minor

NJ0022489	WARREN TWP SEWERAGE AUTH STAGE I-II STP	0.47	Municipal minor
NJ0022497	WARREN STAGE IV STP	0.8	Municipal minor
NJ0022586	MARLBORO PSYCHIATRIC HOSP STP	1	Municipal major
NJ0022675	ROXBURY TOWNSHIP	2	Municipal major
NJ0022764	RIVER ROAD STP	0.1172	Municipal minor
NJ0022781	POTTERSVILLE STP	0.048	Municipal minor
NJ0022845	HARRISON BROOK STP	2.5	Municipal major
NJ0022918	ROOSEVELT BORO WTP	0.25	Municipal minor
NJ0022985	WRIGHTSTOWN BOROUGH STP	0.337	Municipal minor
NJ0023001	SALVATION ARMY CAMP TECUMSEH	0.018	Municipal minor
NJ0023124	MONTGOMERY HIGH SCHOOL STP	0.035	Municipal minor
NJ0023175	ROUND VALLEY MIDDLE SCHOOL	0.009	Municipal minor
NJ0023311	KINGWOOD TWP SCHOOL	0.0048	Municipal minor
NJ0023493	WASHINGTON TOWNSHIP MUA WTP	0.5	Municipal minor
NJ0023540	NAVAL WEAPONS STATION EARLE	0.37	Municipal minor
NJ0023663	CARRIER FOUNDATION WTP	0.04	Municipal minor
NJ0023698	POMPTON LAKES BORO MUA	1.2	Municipal major
NJ0023728	PINE BROOK STP	8.8	Municipal major
NJ0023736	PINELANDS WASTEWATER COMPANY	0.5	Municipal minor
NJ0023787	EAST WINDSOR WATER POLLUTION CONTROL PLANT	4.5	Municipal major
NJ0023841	LOUNSBERRY HOLLOW MIDDLE SCH STP	0.032	Municipal minor
NJ0023949	LEGENDS RESORT & COUNTRY CLUB	0.35	Municipal minor
NJ0024031	ELMWOOD WTP	2.978	Municipal major
NJ0024040	WOODSTREAM STP	1.7	Municipal major
NJ0024091	UNION TWP ELEMENTARY SCHOOL	0.011	Municipal minor
NJ0024104	UNITED WATER PRINCETON MEADOWS	1.64	Municipal major
NJ0024163	BIG `N` SHOPPING CENTER STP	0.02	Municipal minor
NJ0024414	WEST MILFORD SHOPPING CENTER STP	0.02	Municipal minor
NJ0024457	OUR LADY OF THE MAGNIFICAT	0.0012	Municipal minor
NJ0024465	LONG HILL TOWNSHIP OF STP	0.9	Municipal minor
NJ0024490	VERONA TWP WTP	4.1	Municipal major
NJ0024511	LIVINGSTON WATER POLLUTION CONTROL FACILITY	4.6	Municipal major
NJ0024716	PHILLIPSBURG TOWN STP	3.5	Municipal major
NJ0024759	EWING-LAWRENCE SA WTP	16	Municipal major
NJ0024791	RIDGEWOOD VILLAGE WPC FACILITY	5	Municipal major
NJ0024813	NORTHWEST BERGEN CNTY UA	16.8	Municipal major
NJ0024821	PEMBERTON TOWNSHIP MUA STP	2.5	Municipal major
NJ0024864	SOMERSET RARITAN VALLEY SA	21.3	Municipal major
NJ0024902	HANOVER SEWERAGE AUTHORITY	4.61	Municipal major
NJ0024911	BUTTERWORTH WATER POLLUTION CONTROL UTILITY	3.3	Municipal major
NJ0024929	WOODLAND WATER POLLUTION CONTROL UTILITY(WPCU	2	Municipal major
NJ0024937	MOLITOR WATER POLLUTION CONTROL FACILITY	5	Municipal major
NJ0024970	PARSIPPANY TROY HILLS	16	Municipal major
NJ0025160	HAMMONTON WTPF	1.6	Municipal major
NJ0025330	CEDAR GROVE STP	2	Municipal major

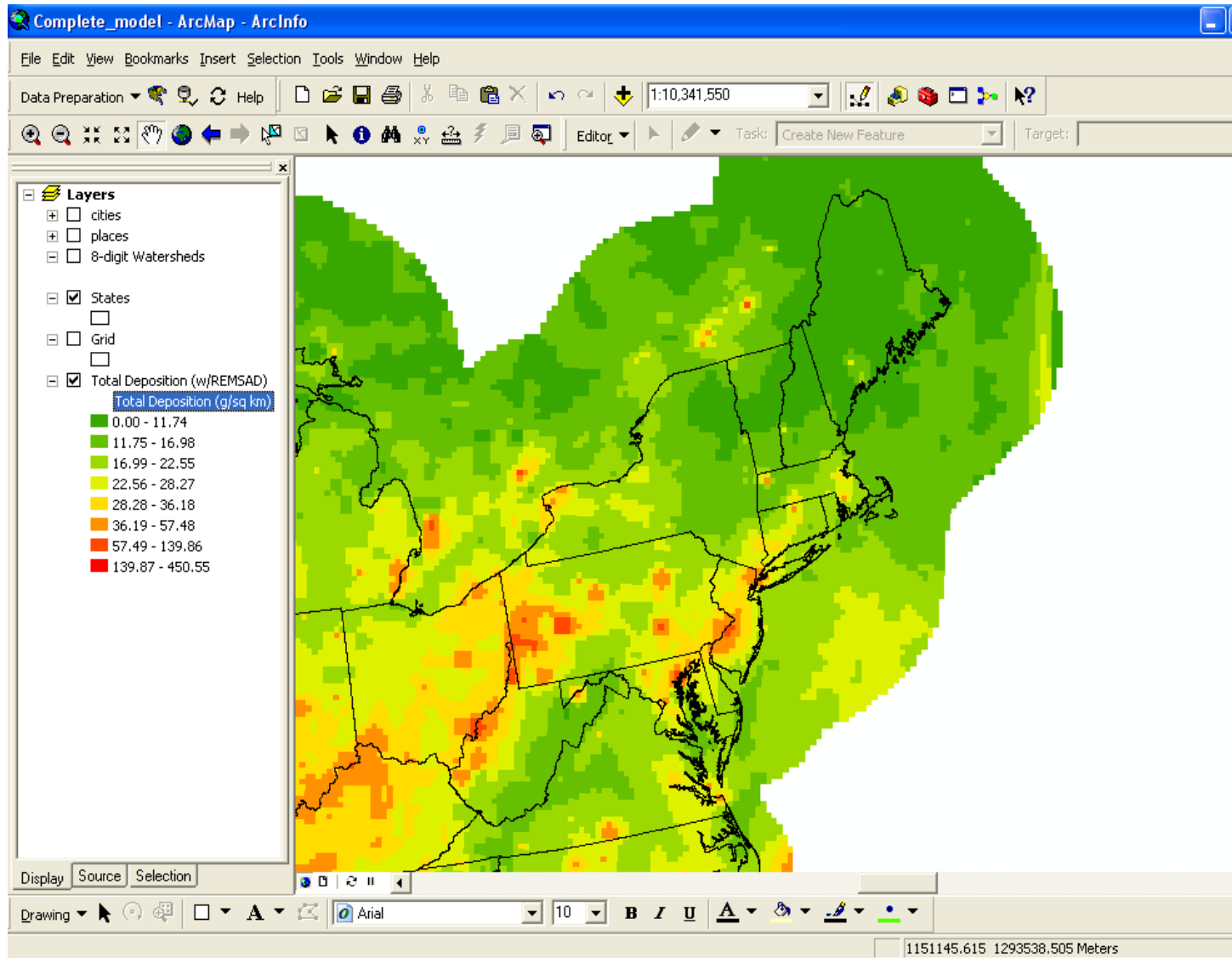
NJ0025496	MORRISTOWN SEWER UTILITY	6.3	Municipal major
NJ0025518	FLORHAM PARK SEWERAGE AUTH	1.4	Municipal major
NJ0026174	CRESCENT PARK STP	0.064	Municipal minor
NJ0026387	BERNARDSVILLE STP	0.8	Municipal minor
NJ0026689	GREYSTONE PARK PSYCH HOSPITAL	0.4	Municipal minor
NJ0026697	READINGTON TWP PUBLIC SCHOOL	0.017	Municipal minor
NJ0026719	ALBERT C WAGNER YOUTH CORRECTIONAL FACILITY	1.3	Municipal minor
NJ0026727	COLORADO CAFE WTP	0.0175	Municipal minor
NJ0026824	CHESTER SHOPPING CENTER	0.011	Municipal minor
NJ0026832	MEDFORD TWP WASTEWATER TREATMENT PLANT	1.75	Municipal major
NJ0026867	WHITE ROCK STP	0.1295	Municipal minor
NJ0026891	BURNT HILL TREATMENT PLANT #1	0.0153	Municipal minor
NJ0026905	STAGE II TREATMENT PLANT	0.48	Municipal minor
NJ0027006	RINGWOOD ACRES TREATMENT PLANT	0.036	Municipal minor
NJ0027031	HOLMDEL BD OF ED VILLAGE SCHOOL STP	0.01	Municipal minor
NJ0027049	POPE JOHN XXIII HIGH SCH WTP	0.022	Municipal minor
NJ0027057	SPARTA PLAZA WTP	0.05	Municipal minor
NJ0027065	SPARTA ALPINE SCHOOL	0.025	Municipal minor
NJ0027227	TRUMP NATIONAL GOLF COURSE	0.0005	Municipal minor
NJ0027464	HANOVER MOBILE VILLAGE ASSOC	0.02	Municipal minor
NJ0027511	CALIFORNIA VILLAGE SEWER PLANT	0.032	Municipal minor
NJ0027529	CAREONE @HOLMDEL	0.025	Municipal minor
NJ0027553	LESTER D. WILSON ELEM SCHOOL	0.0075	Municipal minor
NJ0027561	DELAWARE TOWNSHIP MUA	0.065	Municipal minor
NJ0027596	SPARTAN VILLAGE MOBILE HOME PK	0.038	Municipal minor
NJ0027669	AWOSTING STP	0.045	Municipal minor
NJ0027677	OLDE MILFORD ESTATES STP	0.172	Municipal minor
NJ0027685	HIGHVIEW ACRES STP	0.2	Municipal minor
NJ0027715	MERCER CO CORRECTION CTR STP	0.09	Municipal minor
NJ0027731	PRINCETON HEALTHCARE SYSTEM	0.296	Industrial
NJ0027774	OAKWOOD KNOLLS WWTP	0.035	Municipal minor
NJ0027821	MUSCONETCONG SEWERAGE AUTHORITY	5.79	Municipal major
NJ0027961	BERKELEY HEIGHTS WPCF	3.1	Municipal major
NJ0028002	MOUNTAIN VIEW STP	13.5	Municipal major
NJ0028304	QUALITY INN OF LEDGEWOOD	0.04	Municipal minor
NJ0028436	RARITAN TWP MUA-FLEMINGTON	2.35	Municipal major
NJ0028479	NJ TRAINING SCHOOL FOR BOYS	0.15	Municipal minor
NJ0028487	MOUNTAINVIEW CORRECTIONAL INSTITUTION	0.26	Municipal minor
NJ0028541	BIRCH HILL PARK STP	0.02	Municipal minor
NJ0028665	MOBILE ESTATES OF SOUTHAMPTON INC	0.06	Municipal minor
NJ0028894	KITTATINNY REG HS BD OF ED	0.045	Municipal minor
NJ0029041	REGENCY @ SUSSEX APT	0.08	Municipal minor
NJ0029386	TWO BRIDGES WASTEWATER TREATMENT PLANT	10	Municipal major
NJ0029432	ROBERT ERSKINE SCHOOL STP	0.008	Municipal minor
NJ0029475	HIGHTSTOWN BORO AWWTP	1	Municipal major

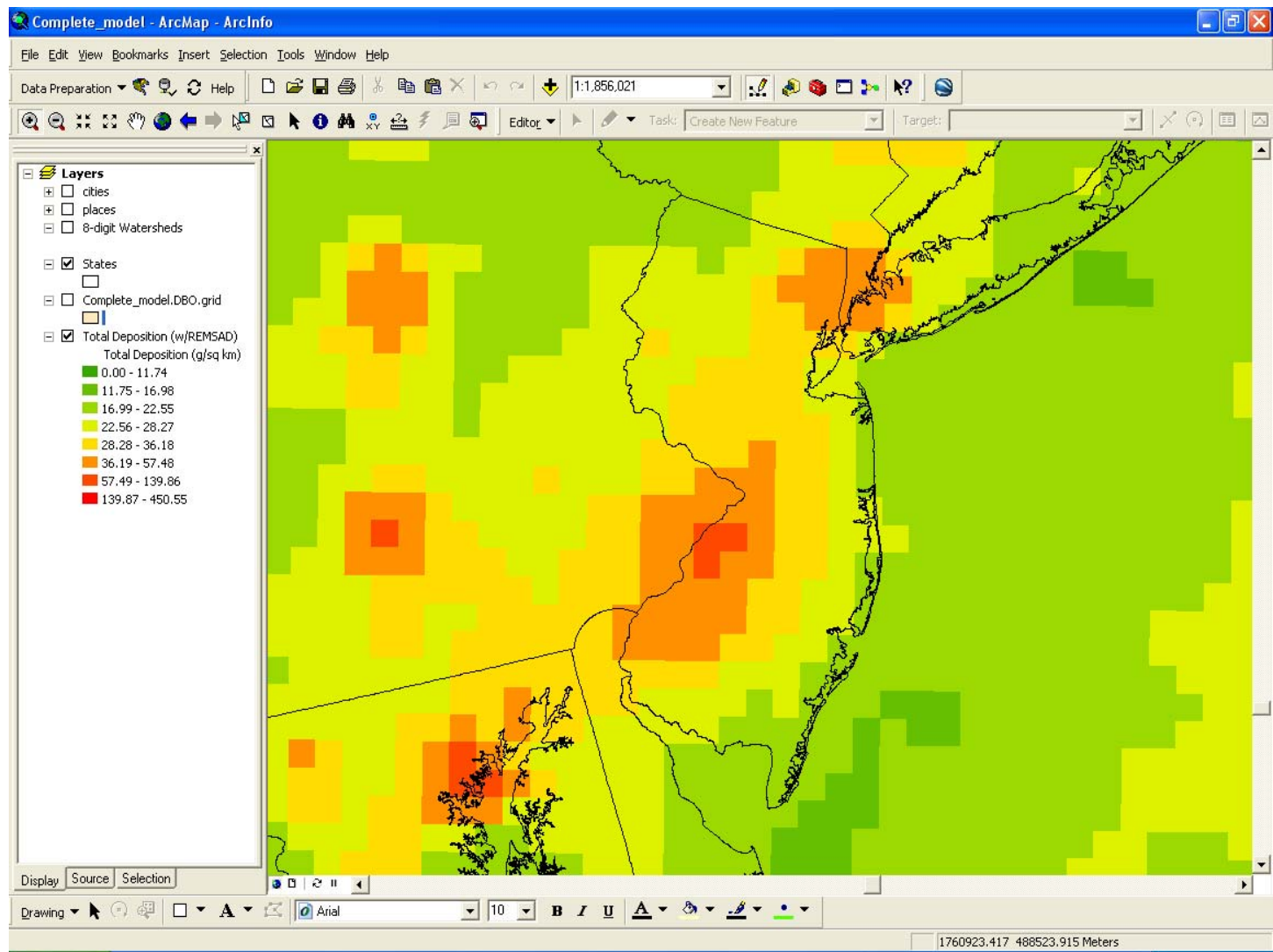
NJ0029831	FRENCHTOWN WASTEWATER TREATMENT PLANT	0.15	Municipal minor
NJ0029858	OAKLAND CARE CENTER INC	0.03	Municipal minor
NJ0031046	NORTH WARREN REG SCH DIST WTF	0.02	Municipal minor
NJ0031119	STONY BROOK RSA- RIVER ROAD STP	13.06	Municipal major
NJ0031585	HIGH POINT REGIONAL HS	0.03	Municipal minor
NJ0031615	CAMDEN COUNTY VOC & TECH SCHOOL	0.058	Municipal minor
NJ0031674	REMINGTON'S RESTAURANT	0.028	Municipal minor
NJ0031771	COLTS NECK INN HOTEL	0.006	Municipal minor
NJ0032395	RINGWOOD PLAZA STP	0.01168	Municipal minor
NJ0033995	ENVIRONMENTAL DISPOSAL CORP	2.1	Municipal major
NJ0035084	EXXONMOBIL RESEARCH & ENGINEERING CO	0.22	Industrial
NJ0035114	BELVIDERE AREA WWTF	0.5	Municipal minor
NJ0035301	STONY BROOK RGNL SEWERAGE AUTH	0.3	Municipal minor
NJ0035319	STONY BROOK RSA	0.3	Municipal minor
NJ0035483	OXFORD AREA WTF	0.5	Municipal minor
NJ0035670	ALEXANDRIA MIDDLE SCHOOL	0.011	Municipal minor
NJ0035718	HOLMDEL WASTEWATER TREATMENT FACILITY	0.04	Municipal minor
NJ0050130	RIVERSIDE FARMS STP	0.145	Municipal minor
NJ0050369	WARREN STAGE V STP	0.38	Municipal minor
NJ0050580	HAMPTON COMMONS WASTEWATER FACILITY	0.05	Municipal minor
NJ0052256	CHATHAM GLEN STP	0.155	Municipal minor
NJ0053112	CHAPEL HILL ESTATES STP	0.01	Municipal minor
NJ0053350	SUSSEX CNTY MUA UPPER WALLKILL FACILITY	3	Municipal major
NJ0053759	WANAQUE VALLEY REGIONAL SEWERAGE AUTHORITY	1.25	Municipal major
NJ0055395	BURLINGTON CNTY RESOURCE RECOVERY COMPLEX	2.075	Industrial
NJ0060038	PIKE BROOK STP	0.67	Municipal minor
NJ0067733	OXBRIDGE WASTEWATER TREATMENT PLANT	0.16	Municipal minor
NJ0069523	CHERRY VALLEY STP	0.286	Municipal minor
NJ0080811	RAMAPO RIVER RESERVE WWTP	0.1137	Municipal minor
NJ0098663	HOMESTEAD TREATMENT UTILITY	0.25	Municipal minor
NJ0098922	READINGTON-LEBANON SA	0.8	Municipal minor
NJ0100528	GLEN MEADOWS/TWIN OAKS STP	0.025	Municipal minor
NJ0102270	EVOINK DEGUSSA CORP	0.015	Industrial
NJ0102563	ROUTE 78 OFFICE AREA WWTF	0.09653	Municipal minor
NJ0109061	LONG VALLEY VILLAGE WTP	0.244	Municipal minor
NJ0136603	MORRIS LAKE WTP	0.2	Municipal minor
NJG0005134	HERCULES GROUNDWATER TREATMT AT GEO SPEC CHEM	0.432	Industrial

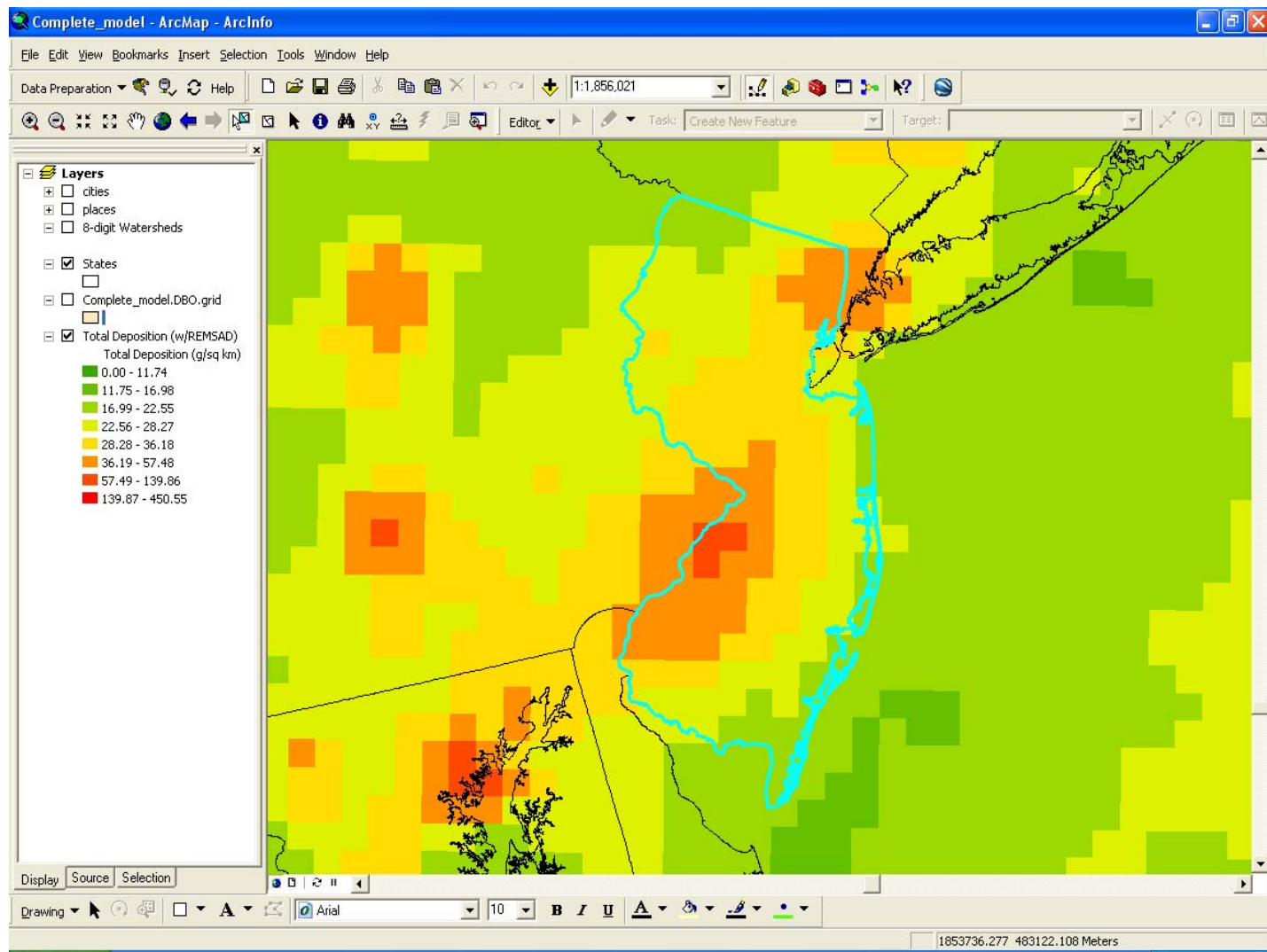
Footnote: TMDL Section 4.0 - Source Assessment describes list construction.

Appendix D

Mercury Air Deposition Load for New Jersey (provided by Mr. Dwight Atkinson of EPA)



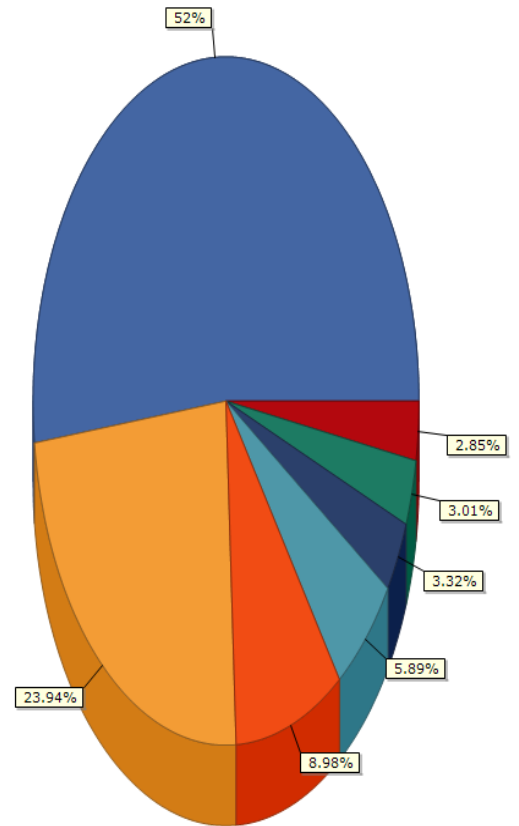




Legend	
BG_Avg_of_REMSAD_CTM-GRAHM-GEOSCHEM_Boundary	309,020
Other sources	142,260.25
PA_Other_Sources	53,361.17
NJ_Other_Sources	34,986.96
PA_Other_utilities	19,755.74
NJ_Counties_bordering_NY/NJ_Harbor	17,915.12
BG_Re-emission	16,921.27

New Jersey (grams)

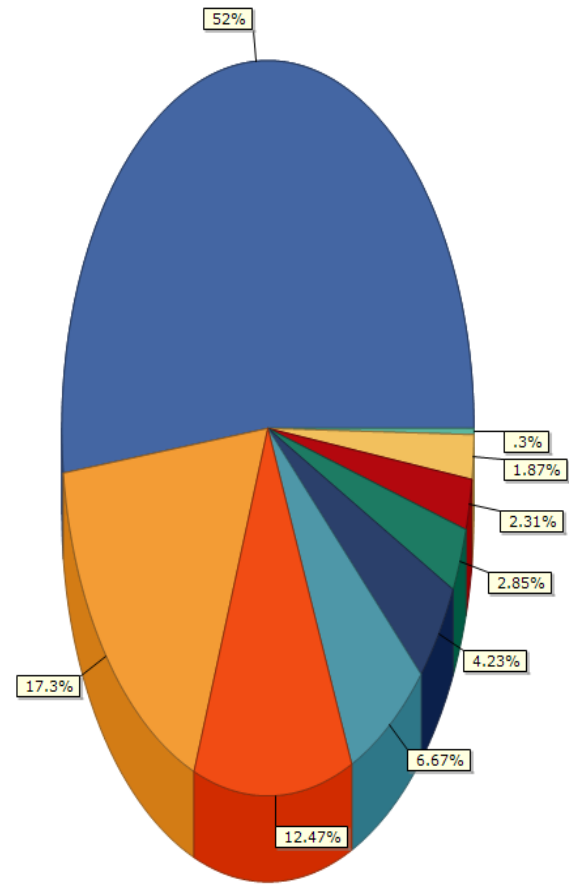
Total mercury = 594,220.5 g. Total Area = 19,309.69 Sq km.

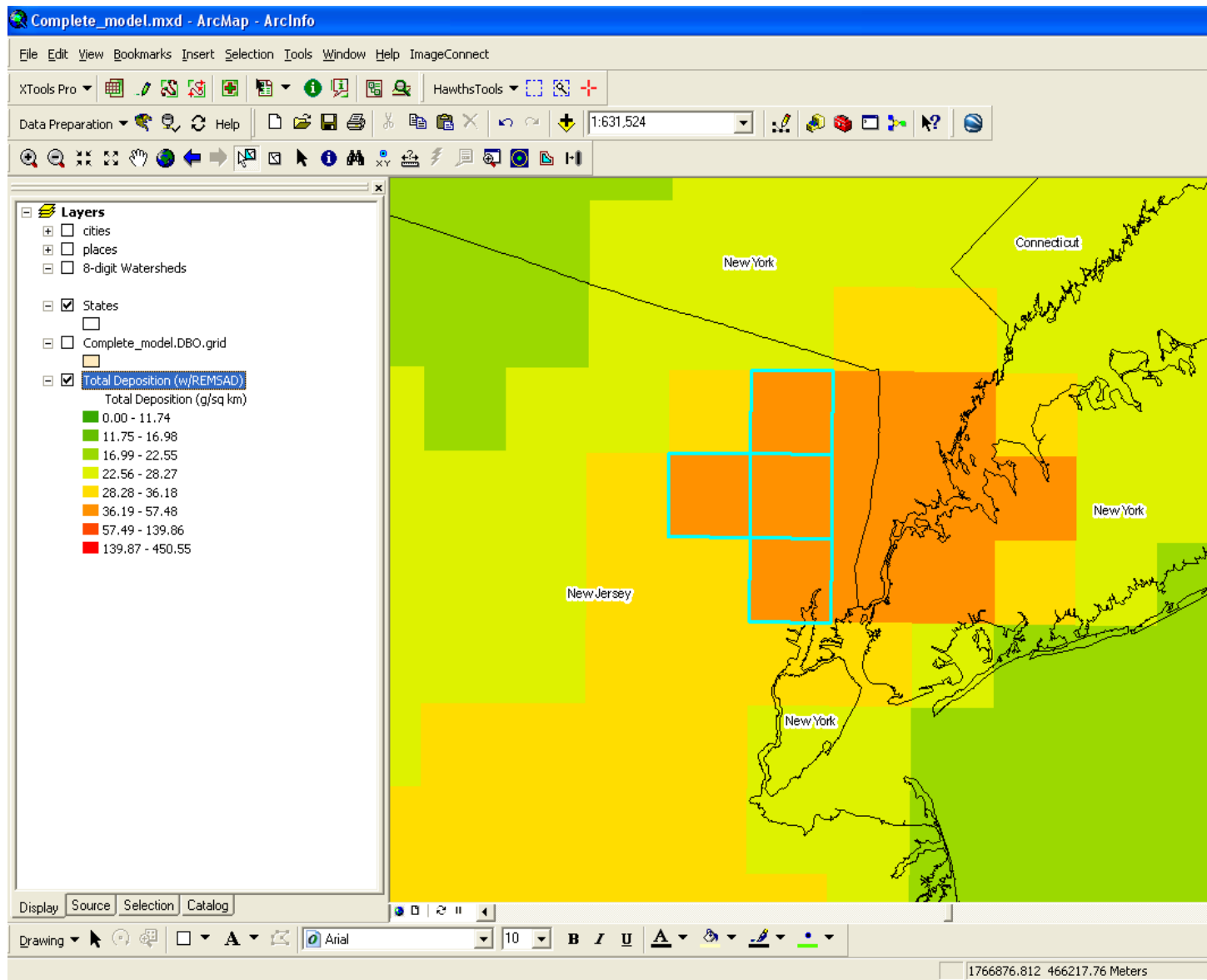


Legend	
BG_Avg_of_REMSAD_CTM-GRAHM-GEOSCHEM_Boundary	309,020
Pennsylvania	102,777.71
New Jersey	74,073.49
Other sources	39,646.2
Maryland	25,150.66
BG_Re-emission	16,921.27
New York	13,726.24
Delaware	11,117.46
Connecticut	1,787.49

New Jersey (surrounding states) (grams)

Total mercury = 594,220.5 g. Total Area = 19,309.69 Sq km.

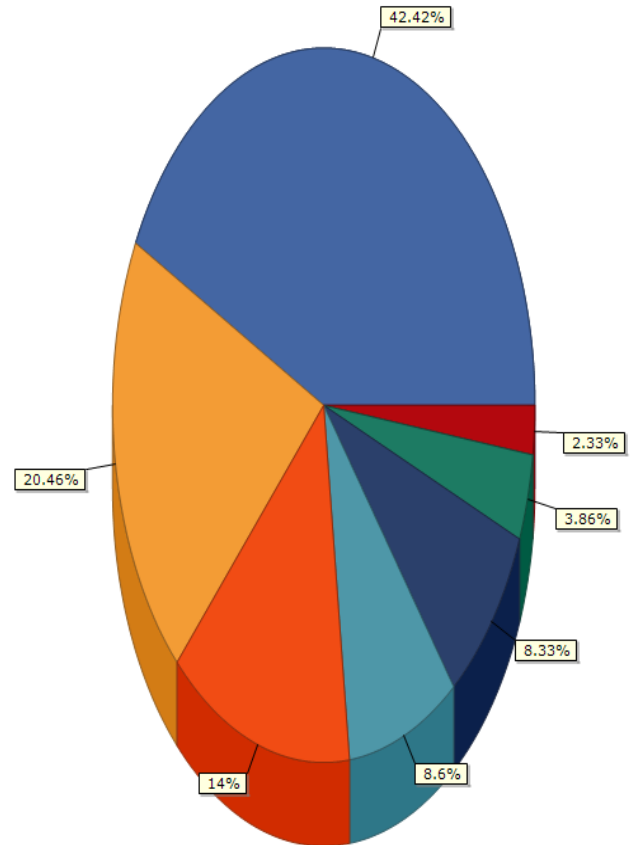


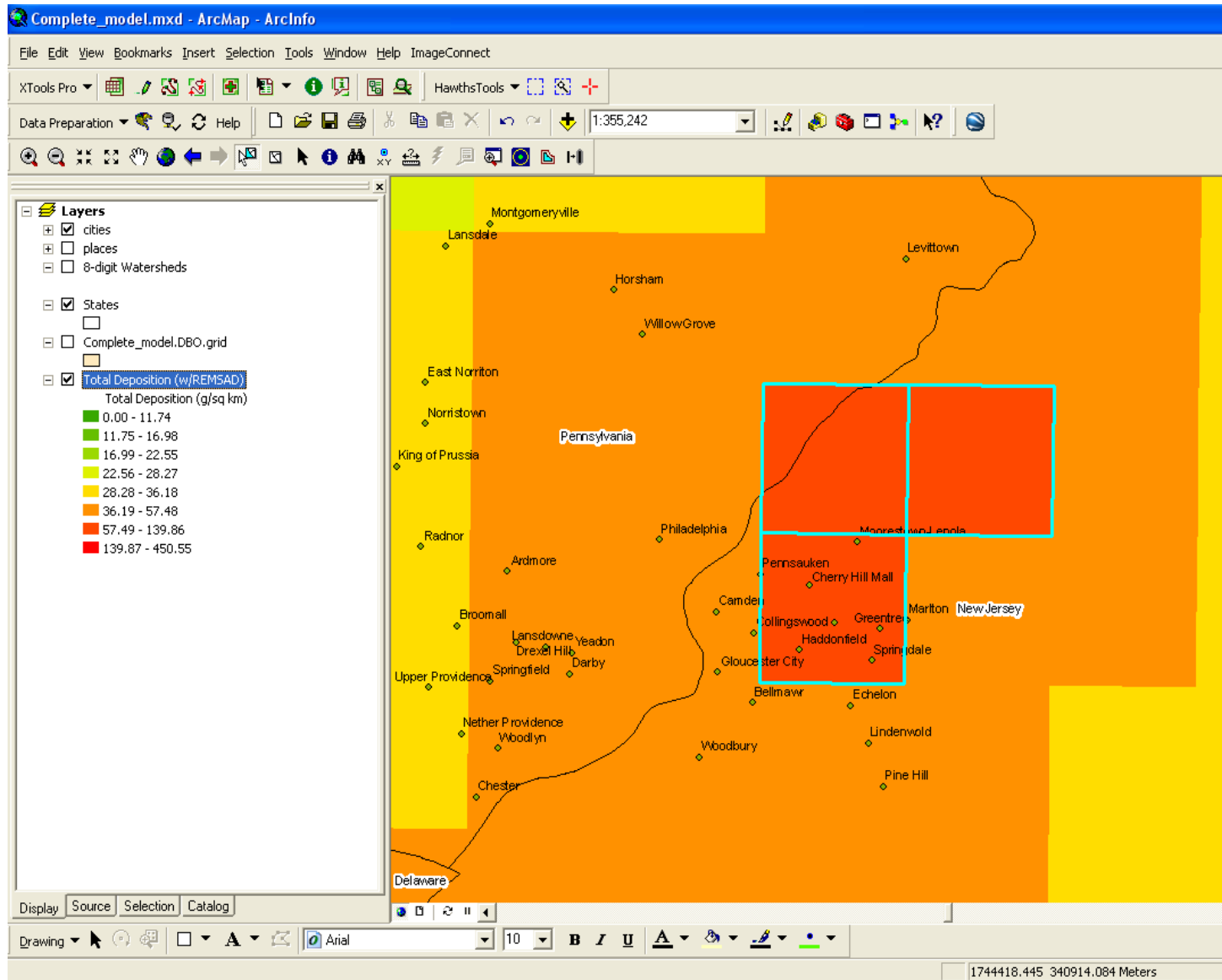


Legend	
BG_Avg_of_REMSAD_CTM-GRAHM-GEOSCHEM_Boundary	9,359.18
Other sources	4,513.44
NJ_Counties_bordering_NY/NJ_Harbor	3,089.05
NJ_Other_Sources	1,896.45
NJ_Essex_Co._RRF	1,838.06
NY_Counties_bordering_NY/NJ_Harbor	851.89
BG_Re-emission	513.02

NJ High Dep (NE corner) (grams)

Total mercury = 22,061.1 g. Total Area = 576.00 Sq km.

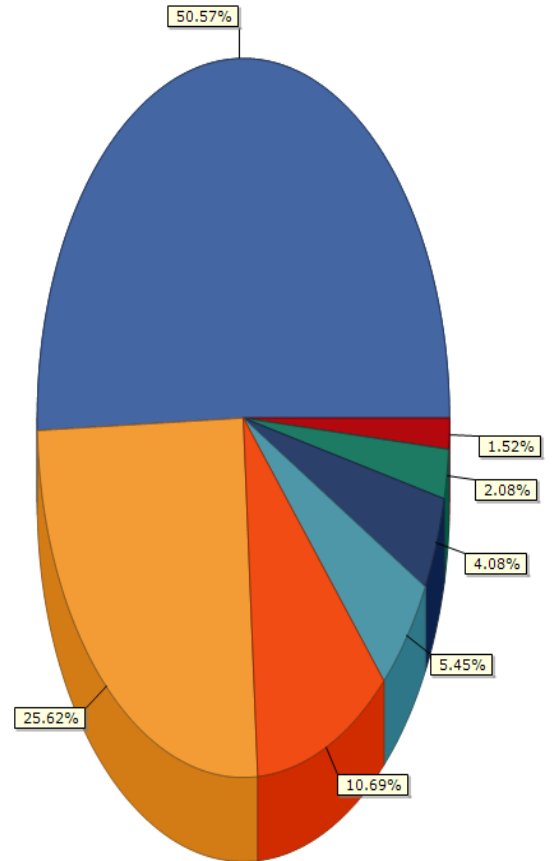




Legend	
PA_Other_Sources	17,204.32
BG_Avg_of_REMSAD_CTM-GRAHM-GEOSCHEM_Boundary	8,716.55
Other sources	3,637.35
NJ_Other_Sources	1,854.19
NJ_Camden_RRF	1,387.27
PA_Other_utilities	706.37
BG_Re-emission	515.65

NJ High Dep (Camden area) (grams)

Total mercury = 34,021.7 g. Total Area = 432.00 Sq km.



**Amendment to the
Upper Delaware Water Quality Management Plan
Northeast Water Quality Management Plan
Upper Raritan Water Quality Management Plan
Sussex County Water Quality Management Plan**

**Total Maximum Daily Loads for Phosphorus
To Address 4 Eutrophic Lakes in the
Northwest Water Region**

**CRANBERRY LAKE, SUSSEX COUNTY
GHOST LAKE, WARREN COUNTY
LAKE HOPATCONG, SUSSEX COUNTY
LAKE MUSCONETCONG, SUSSEX COUNTY**

**Watershed Management Area 1
(Upper Delaware River Watershed)**

Proposed: January 21, 2003
Established: March 28, 2003
Approved (by EPA Region 2): September 17, 2003
Adopted:

**New Jersey Department of Environmental Protection
Division of Watershed Management
P.O. Box 418
Trenton, New Jersey 08625-0418**

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1.0 Executive Summary

The State of New Jersey's 2002 *Integrated List of Waterbodies* identified several lakes in the Northwest Water Region as being eutrophic. This report establishes total maximum daily loads (TMDLs) for total phosphorus (TP) that address eutrophication of the lakes listed in Table 1.

Table 1 Eutrophic Lakes for which Phosphorus TMDLs are being established

TMDL Number	Lake Name	Municipality	WMA	Acres
1	Cranberry Lake	Byram Township, Sussex County	01	190
2	Ghost Lake	Independence Township, Warren County	01	18.3
3	Lake Hopatcong	Hopatcong Borough, Sussex County; Mt. Arlington Borough, Jefferson & Roxbury Townships; Morris County	01	2,410
4	Lake Musconetcong	Stanhope, Byram, Netcong and Roxbury Townships; Sussex County	01	314

These TMDLs serve as the foundation on which restoration plans will be developed to restore eutrophic lakes and thereby attain applicable surface water quality standards. 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 Surface Water Quality Standards (SWQS). The pollutant of concern for these TMDLs is phosphorus, since phosphorus is generally the nutrient responsible for overfertilization of inland lakes leading to cultural eutrophication. The Department's Geographic Information System (GIS) was used extensively to describe the lakes and lakesheds (drainage basins of the lakes).

In order to prevent excessive primary productivity¹ and consequent impairment of recreational, water supply and aquatic life designated uses, the SWQS define both numerical and narrative criteria that address eutrophication in lakes due to overfertilization. Phosphorus sources were characterized on an annual scale (kg TP/yr) for both point and nonpoint sources. Runoff from land surfaces comprises a substantial source of phosphorus into lakes. An empirical model was used to relate annual phosphorus load and steady-state in-lake concentration of total phosphorus. To achieve the TMDLs, overall load reductions were calculated for at least eight source categories. In order to track effectiveness of remediation measures (including TMDLs) and to develop baseline and trend information on lakes, the Department will augment its ambient monitoring program to include lakes on a rotating schedule. The implementation plan also calls for the collection of additional monitoring data and the development of a Lake Restoration Plan for each lake for which TMDLs are being established. These plans will consider what specific measures are necessary to achieve the nutrient reductions required by the TMDL, as well as what in-lake measures need to be taken to supplement the nutrient reductions required by the TMDL.

¹ Primary productivity refers to the growth rate of primary producers, namely algae and aquatic plants, which form the base of the food web.

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

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

2.0 Introduction

Sublist 5 (also known as List 5 or, traditionally, the 303(d) List) of the State of New Jersey's 2002 *Integrated List of Waterbodies* identified several lakes in the Northwest Water Region (WMAs 1, 2, and 11) as being eutrophic, as evidenced by elevated total phosphorus (TP), elevated chlorophyll-*a*, and/or macrophyte density that impairs recreational use (a qualitative assessment). Total phosphorus was used as the pollutant of concern, since this "independent" causal pollutant causes "dependent " responses in chlorophyll-*a* concentrations and/or macrophyte density. This report establishes four total maximum daily loads (TMDLs) that address total phosphorus loads to the identified lakes. These TMDLs serve as the foundation on which management approaches or restoration plans will be developed to restore eutrophic lakes and thereby attain applicable surface water quality standards. Several of the lakes are listed on Sublist 5 for impairments caused by other pollutants. These TMDLs address only the impairment of lakes due to eutrophication. Separate TMDL evaluations will be developed to address the other pollutants of concern. The waterbodies will remain on Sublist 5 until such time as TMDL evaluations for all pollutants have been completed and approved by the United States Environmental Protection Agency (USEPA).

A TMDL is considered "proposed" when NJDEP publishes the TMDL Report as a proposed Water Quality Management Plan Amendment in the New Jersey Register (NJR) for public review and comment. A TMDL is considered to be "established" when NJDEP finalizes the TMDL Report after considering comments received during the public comment period for the proposed plan amendment and formally submits it to EPA Region 2 for thirty (30)-day review and approval. The TMDL is considered "approved" when the NJDEP-established TMDL is approved by EPA Region 2. The TMDL is considered to be "adopted" when the EPA-approved TMDL is adopted by NJDEP as a water quality management plan amendment and the adoption notice is published in the NJR.

3.0 Background

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

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

Environmental Protection Agency (USEPA) a report addressing the overall water quality of the State's waters. This report is commonly referred to as the 305(b) Report or the Water Quality Inventory Report.

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

Scenario 1: A TMDL is established for the pollutant of concern;

Scenario 2: A determination is made that the waterbody is meeting water quality standards (no TMDL is required); or

Scenario 3: A determination is made that a TMDL is not the appropriate mechanism for achieving water quality standards and that other control actions will result in meeting standards.

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

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

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

3.2 Total Maximum Daily Loads (TMDLs)

A TMDL represents the assimilative or carrying capacity of a waterbody, taking into consideration point and nonpoint source 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 sources in the form of wasteload allocations (WLAs), nonpoint sources in the form of 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 SWQS.

Once one of the three possible delisting scenarios, noted above, is completed, states have the option to remove the waterbody and specific pollutant of concern from the 303(d) List or maintain the waterbody on the 303(d) list until SWQS are achieved. The State of New Jersey will be removing lakes from the 303(d) List for eutrophication once their TMDLS are approved by USEPA.

3.3 Integrated List of Waterbodies

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

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

4.0 Pollutant of Concern and Area of Interest

Lakes were designated as eutrophic on Sublist 5 of the *2002 Integrated List of Waterbodies* as a result of evaluations performed through the State's Clean Lakes Program. Indicators used to determine trophic status included elevated total phosphorus (TP), elevated chlorophyll-*a*, and/or macrophyte density. The pollutant of concern for these TMDLs is total phosphorus. The mechanism by which phosphorus can cause use impairment is via excessive primary productivity. Phosphorus is an essential nutrient for plants and algae, but is considered a pollutant because it can stimulate excessive growth (primary production). Phosphorus is

most often the major nutrient in shortest supply relative to the nutritional requirements of primary producers in freshwater lakes; consequently, phosphorus is frequently a prime determinant of the total biomass in a lake. Furthermore, of the major nutrients, phosphorus is the most effectively controlled through engineering technology and land use management (Holdren *et al*, 2001). Eutrophication has been described as the acceleration of the natural aging process of surface waters. It is characterized by excessive loading of silt, organic matter, and nutrients, causing high biological production and decreased basin volume (Cooke *et al*, 1993). Symptoms of eutrophication (primary impacts) include oxygen supersaturation during the day, oxygen depletion during night, and high sedimentation (filling in) rate. Algae and aquatic plants are the catalysts for these processes. Secondary biological impacts can include loss of biodiversity and structural changes to communities. Phosphorus is generally the nutrient responsible for overfertilization of inland lakes leading to eutrophication.

As reported in the 2002 *Integrated List of Waterbodies*, the Department identified the following lakes in Northwest Water Region as being eutrophic for a total of 3,480 acres. These four TMDLs will address 2,930 acres or 84.2% of the total impaired acres in this region (Table 2). Lake Hopatcong is listed for both trophic status and aquatic life, which is based on a fishery assessment performed by the Department's Bureau of Freshwater Fisheries; secondary impacts of eutrophication include poorer fish quality and diversity, often due to oxygen depressions and fluctuations. Therefore, it is likely that management actions directed at addressing eutrophication impairments would also address aquatic life impairments based on fishery assessment. However, the exact causes of the aquatic life impairment have not been determined, therefore it is not certain that a TMDL for eutrophication will address the aquatic life impairment completely. Both eutrophic lakes and aquatic life impairments are ranked as Low Priority in the 2002 *Integrated List of Waterbodies* because they are not directly related to human health issues; however, both issues are environmentally important.

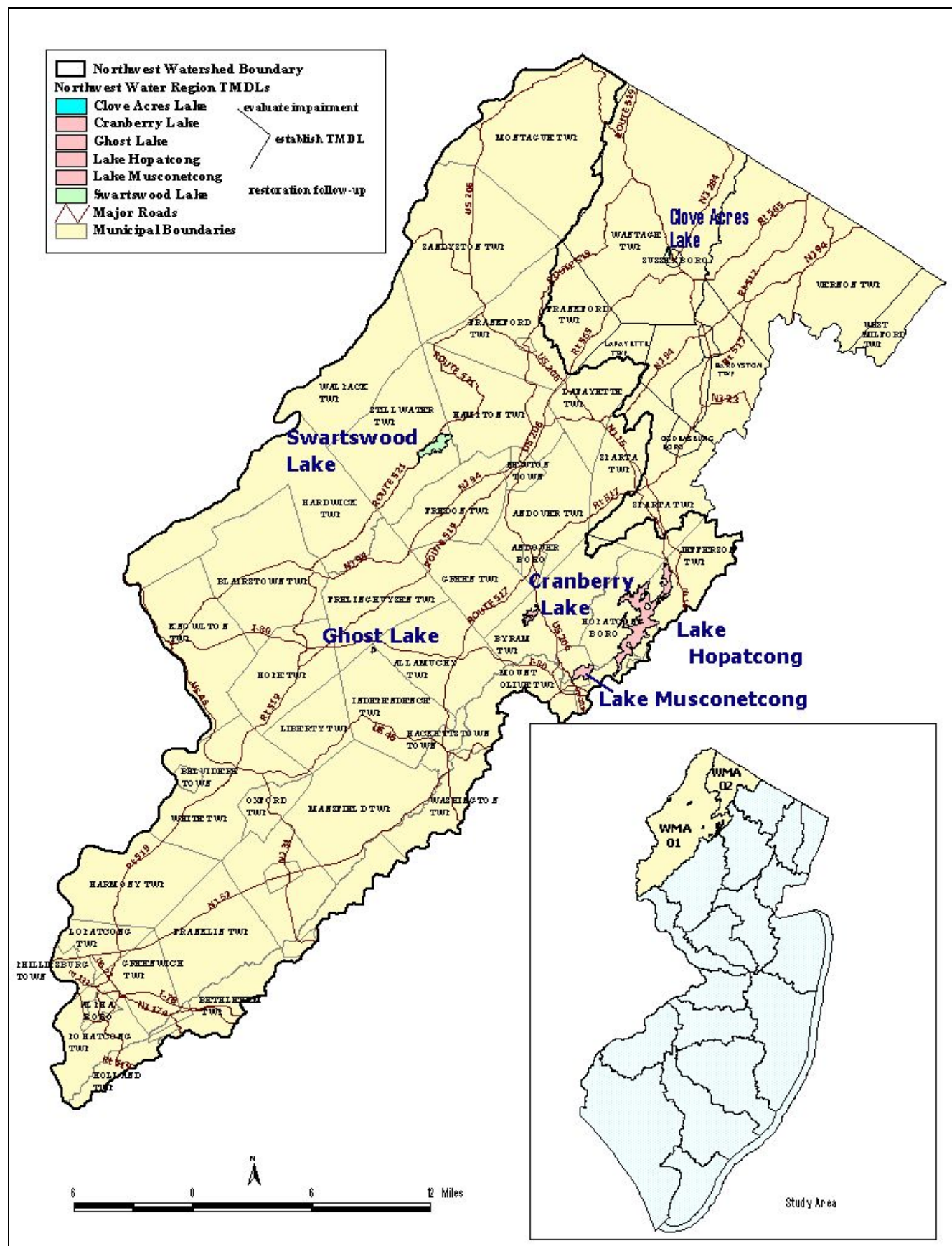
Table 2 Abridged Sublist 5 of the 2002 Integrated List of Waterbodies, eutrophic lakes

No.	WMA	Lake ^a	Lake Acres	Lakeshed Acres	Management Response
1	01	Cranberry Lake	1890	1,740	establish TMDL
2	01	Ghost Lake	18.3	212	establish TMDL
3	01	Lake Hopatcong	2,410	16,200	establish TMDL
4	01	Lake Musconetcong	314	2,980 ^b	establish TMDL
5	01	Swartswood Lake	521	6,410	restoration follow-up
6	02	Clove Acres Lake	28.6	12,500	evaluate impairment

a All of the waterbodies covered under these TMDLs have a FW2 classification.

b To avoid "double-counting," watershed area of Lake Musconetcong does not include Lake Hopatcong and its watershed.

Figure 1 Eutrophic lakes in the Northwest Water Region on Sublist 5 of 2002 Integrated List



These TMDLs will address a total of 2,930 acres of lakes with a corresponding total of 21,110 acres of land. Traditionally, land use has been dictated by the topography and transportation system of the area. The Upper Delaware Watershed (WMA-01) exhibits an accelerated pattern of growth, especially around its lakes. In spite of the area's relatively low population density and numerous protected lands, these development trends are likely to negatively impact surrounding water quality and quantity.

The Department's Geographic Information System (GIS) was used extensively to describe the lakes and lakesheds (watersheds of the lakes), specifically the following data coverages:

- 1995/97 Land use/Land cover Update, published 12/01/2000 by NJDEP Bureau of Geographic Information and Analysis, delineated by watershed management area.
- NJDEP Statewide Lakes (Shapefile) with Name Attributes (from 95/97 Land Use/Land Cover) in New Jersey, published 7/13/2001 by NJDEP - Bureau of Freshwater and Biological Monitoring,
<http://www.state.nj.us/dep/gis/digidownload/zips/statewide/njlakes.zip>.
- Lakesheds were delineated based on 14-digit hydrologic unit code coverage (HUC-14) elevation contours, and 10 meter digital elevation model grids.
 - NJDEP 14 Digit Hydrologic Unit Code delineations (DEPHUC14), published 4/5/2000 by New Jersey Geological Survey,
<http://www.state.nj.us/dep/gis/digidownload/zips/statewide/dephuc14.zip>.
 - Statewide Elevation Contours (10 Foot Intervals), unpublished, auto-generated from: 7.5 minute Digital Elevation Models, published 7/1/1979 by U.S. Geological Survey.
 - NJDEP Statewide Elevation Contours (20 Foot Intervals), published 1987 by Bureau of Geographic Information and Analysis (BGIA),
<http://www.state.nj.us/dep/gis/digidownload/zips/statewide/stcon.zip>.
 - NJDEP 10-meter Digital Elevation Grids, published 06/01/2002 by Bureau of Geographic Information and Analysis (BGIA), delineated by watershed management area.
- 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).

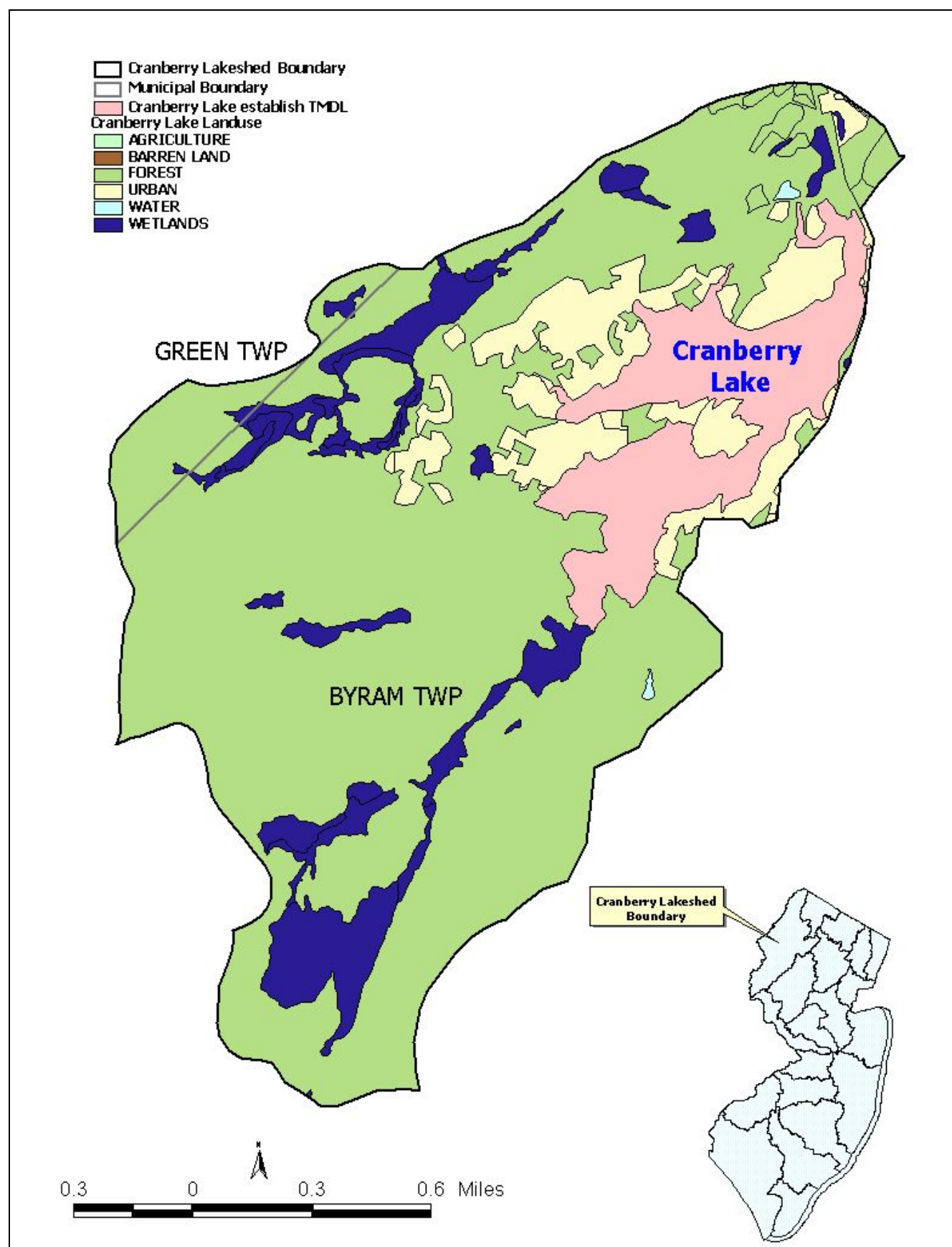
4.1 Cranberry Lake

Cranberry Lake is a 190-acre public lake located in Byram Township, Sussex County, and drains a lakeshed of 1744 acres almost completely within Byram Township. The lakeshed is 9.2 times the area of the lake, making it moderately sized². The lake consists of two basins, each with numerous coves, separated by a large peninsula (Strawberry Point). Tributaries of Lubber's Run feed both basins. Mean depth (2.13m) and total inflow (3,783,000 m³/yr) were obtained from the Diagnostic Feasibility Study for Cranberry Lake (Coastal Environmental Services, 1992).

² A lakeshed seven times the area of its lake is considered small, whereas a lakeshed ten times the area of its lake is considered large (Holdren *et al*, 2001).

Cranberry Lake is a shallow lake within the Musconetcong Watershed, having a mean depth of seven feet and a maximum depth of 15 feet. The lakeshed of Cranberry Lake primarily consists of 1,219 acres of forest, or 70 percent of the entire lakeshed. Approximately half of the land adjacent to the lakeshore is used for medium density residential development, while the remainder is undeveloped (forest cover). Cranberry Lake offers fishing and boating services at the northern end of the lake, where there are boat launch areas (including one trailer launch ramp) and a floating dock. Swimming is available at Cranberry Lake Rose Beach and the Cranberry Lake Club House. The lake is known to have a major septic problem, as indicated in the Phase I Inventory of Current EPA Efforts to Protect Ecosystems report. New Jersey received a Clean Lakes Program Phase II Restoration/Implementation grant in 1992 for Cranberry Lake. The ongoing project entails implementation of in-lake restoration work as well as critical nonpoint source pollution control activities. In 2000 the Weaver House Cove dredging project, which required the lake to be lowered five feet, was nearing completion. In 2001 the Cranberry Lake community was battling watermilfoil vegetation with the herbicide SONAR.

Figure 2 Lakeshed of Cranberry Lake

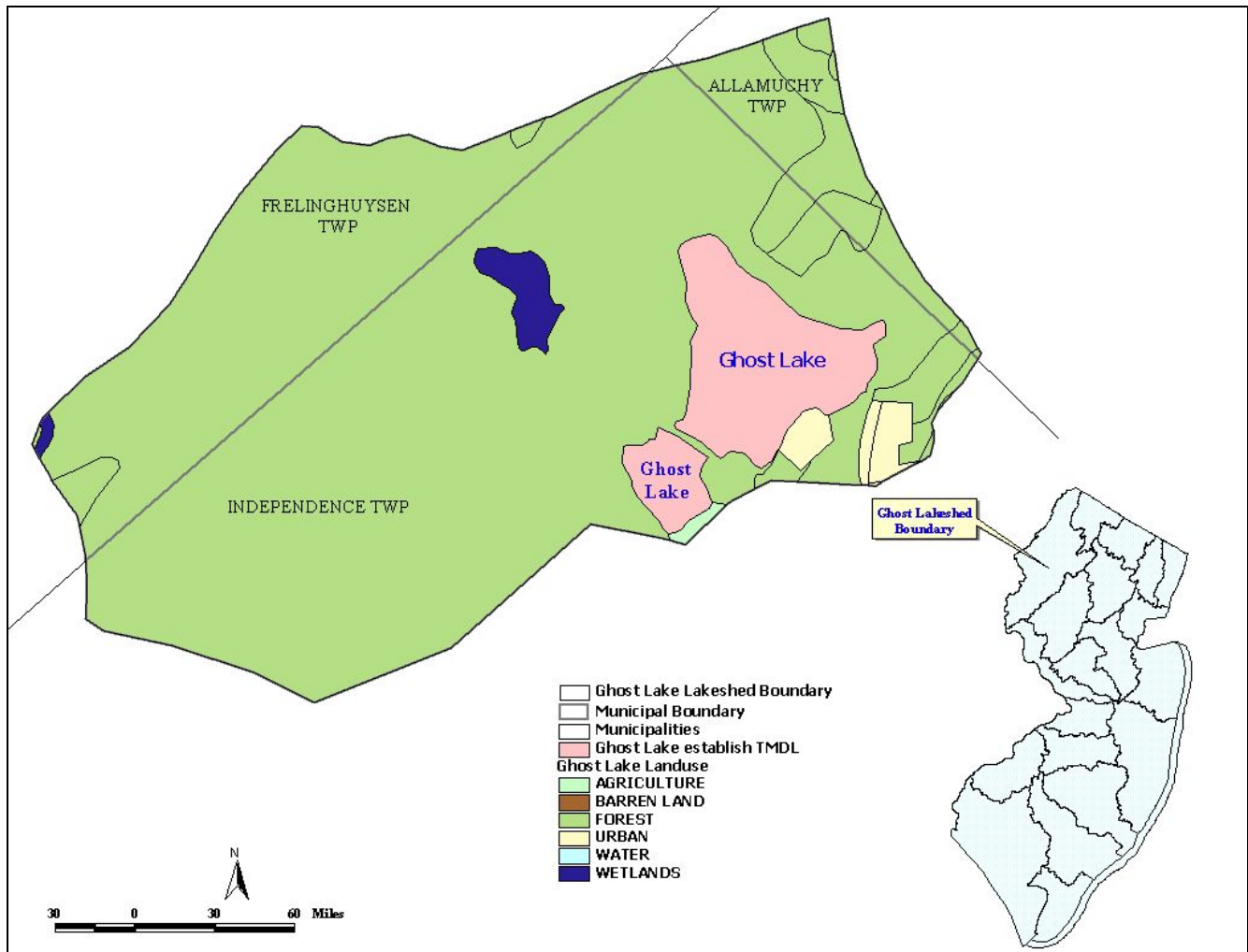


4.2 Ghost Lake

Ghost Lake is located within Jenny Jump State Forest in Independence Township, Warren County, and drains a lakeshed of 212 acres that extends into parts of Frelinghuysen and Allamuchy Townships. The lakeshed is 11.5 times the area of the lakes, making it somewhat large. Ghost Lake has no tributaries; most of the lake's inflow is comprised of groundwater and surface runoff. Mean depth (1.34m) and total inflow (449,000 m³/yr) were obtained from the Phase 1 Diagnostic / Feasibility Study of Ghost Lake (Princeton Hydro, 2002).

This man-made, shallow lake is 18 acres in size and part of the Pequest River Watershed. A narrow band of land separates the larger upper portion of the lake from the much smaller lower portion. The lakeshed is heavily forested and consists of 187 acres of forest (88 percent). However, in the southeast quadrant of the lakeshed, there are two small clusters of low density/rural development, comprising three acres. Ghost Lake offers fishing and boating (car-top launch only) services at the north end of the lake. Although phosphorus loading to Ghost Lake is currently not excessive, a TMDL is being established to ensure that phosphorus levels do not increase in the future and to establish in-lake measures necessary to restore the lake. To that end, the Department plans to implement as appropriate the recommendations in USEPA Clean Lakes Project Phase I Diagnostic/Feasibility Study, dated February 2002.

Figure 3 Lakeshed of Ghost Lake



4.3 Lake Hopatcong

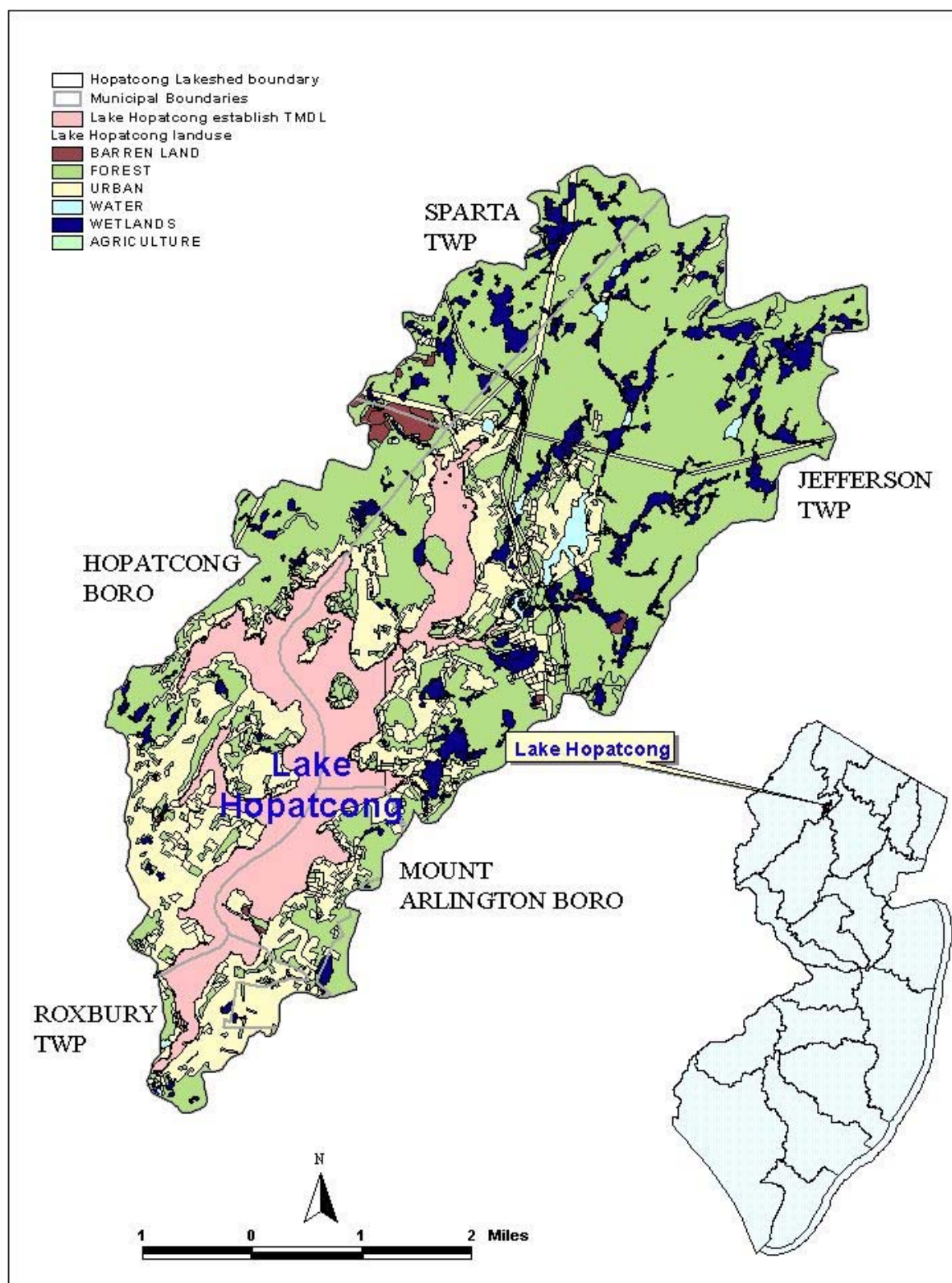
Lake Hopatcong is a 2,406-acre public lake located on the border of Morris and Sussex counties in the municipalities of Mount Arlington Borough, Hopatcong Borough, Jefferson Township, and Roxbury Township. The lake drains a lakeshed of 16,216 acres within the headwaters of the Musconetcong River Watershed. The lakeshed is 6.7 times the area of the lakes, making it fairly small relative to the size of the lake. Lake Hopatcong is a large, irregularly shaped lake composed of many shallow coves around the perimeter. About 50% of the flow into the lake is provided through headwater tributaries of the Musconetcong River, while groundwater inflow comprises about 25% of the flow. Mean depth (5.5m) and total inflow (39,700,000 m³/yr) were obtained from the Clean Lakes Report for Lake Hopatcong (Princeton Aqua Science, 1983).

Lake Hopatcong is the largest freshwater lake in New Jersey and measures 9.5 miles long with a maximum depth of 58 feet. Originally, Hopatcong consisted of two separate lakes, but a dam built in what is now Lake Hopatcong State Park for the Morris Canal Company linked them together in 1837 to form one large lake. Lake Hopatcong was the major source of water

for the 90-mile waterway that stretched from Newark to Phillipsburg. (The lake is also currently a designated emergency source of drinking water.) The predominant land uses in this lakeshed consist of 9,671 acres of forest and wetlands (including bodies of water other than Lake Hopatcong) and 3,974 acres urban, or 60% and 25%, respectively. About 90% of the land adjacent to the 40-mile lake shore is developed, with the majority in seasonal and year-round low, medium, and high density residential land uses. An estimated 500,000 visitors use Lake Hopatcong's recreational facilities each year for fishing, boating, swimming, sailing, jet skiing, and passive recreation. The lake is known to have some good size fish, with largemouth bass averaging two to five pounds. However, several of its beaches are impaired for fecal coliform, and nonpoint source pollution into the lake has become a critical problem.

The Lake Hopatcong Commission is the entity that has taken control of the lake's improvement and was created in January 2001 under a \$3 million startup grant from the State of New Jersey. The Commission's mandate is to safeguard the lake as a natural, scenic, and recreational resource. Some of the tools available to the Commission to accomplish this mandate are monitoring the lake's water quality and quantity; evaluating land use impacts; developing plans, strategies, policies, ordinances, and funding mechanisms; conducting lake management projects; and educating the public on how to protect the lake. A major component of the Lake Hopatcong Commission's protection effort is mechanical harvesting of the overgrowth of aquatic vegetation caused by the influx of phosphorus in the lake. The activity of aquatic plant harvesting began in Lake Hopatcong by the Lake Hopatcong Regional Planning Board and was transferred to the Lake Hopatcong Commission upon its creation. In 2002, the Commission removed over 4.8 million pounds of vegetation from the lake. The Commission has been engaged in a cooperative research effort with the U.S. Geological Survey to conduct a water budget study of Lake Hopatcong. The Commission has initiated plans to address stormwater discharges into Lake Hopatcong, because discharges from such nonpoint sources and catch basins are believed to be a major source of phosphorus in the lake. The Commission also has prepared a geomorphological report describing the Lake Hopatcong area.

Figure 4 Lakeshed of Lake Hopatcong

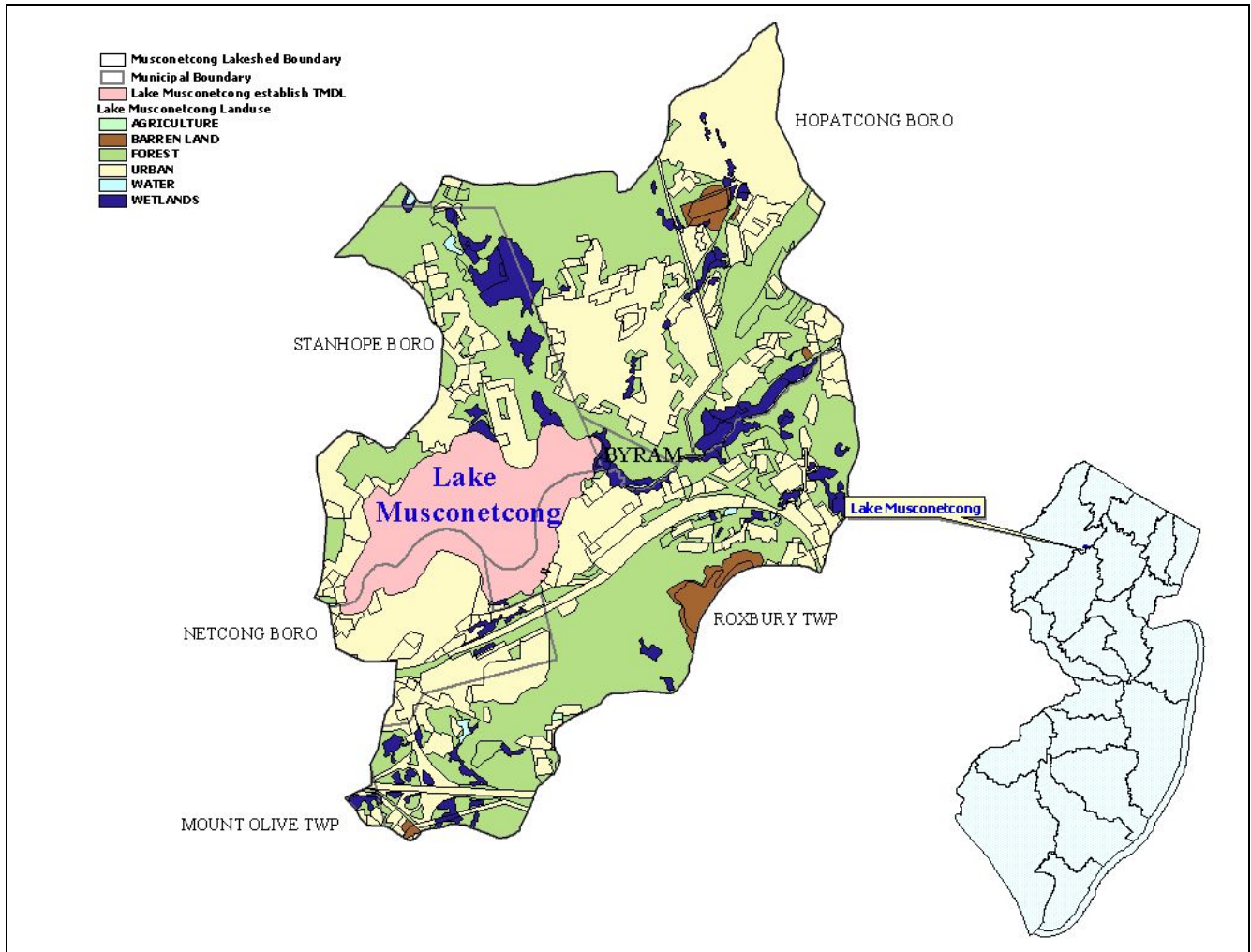


4.4 Lake Musconetcong

Lake Musconetcong is a 314-acre public lake located on the border of Morris and Sussex counties in the municipalities of Netcong, Stanhope, Byram and Roxbury. The lake drains an immediate lakeshed of 2,977 acres within the headwaters of the Musconetcong River Watershed. In addition, Lake Hopatcong drains into the immediate Lake Musconetcong lakeshed, adding 12,091 acres to the total lakeshed. Including the Lake Hopatcong lakeshed, the total lakeshed of Lake Musconetcong is 48 times the area of the lake, making it very large relative to the size of the lake. Over 80% of the total flow into the lake consists of inflow from Lake Hopatcong through the Musconetcong River. Mean depth (1.5m) and total inflow (48,400,000 m³/yr) were obtained from the Diagnostic / Feasibility Study for Lake Musconetcong (Coastal Environmental Services, 1993).

By far, the predominant land uses in the Lake Musconetcong lakeshed are forest, with 1,199 acres (40%), and urban, with 1,222 acres (41%). Low and medium density residential land uses surround most of the lakeshore itself. Fishing and boating accommodations are offered at the southern end of Lake Musconetcong. There are several municipal and State park areas on the lake available for fishing, one having a boat launch area. Several dozen private docks, but no public ones, can be found on the lake. Stanhope Beach was dredged several years ago, but it is used for fishing only, due to water conditions. The lake is being aided by two entities, the Musconetcong Regional Planning Board, which advises on land use matters affecting the lake, and the Musconetcong Watershed Association. As a result of the Phase I Clean Lakes project, the area immediately around the lake has been sewered and they have implemented weed harvesting, dredging, and various nonpoint source pollution controls. Lake Musconetcong has received Clean Water Act Section 319(h) funding for best management practices.

Figure 5 **immediate Lakeshed of Lake Musconetcong**



4.5 Swartswood Lake

This glacier lake, with a mean depth of 22 feet (deep lake) and a maximum depth of 42 feet, is 505 acres in size and located at Swartswood State Park in the Paulins Kill Watershed. Fishing and boating services are available on the east and south sides of the lake, and a swimming area is located on the border of the eastern shore and the State Park. The Swartswood Lakes and Watershed Association has been involved in stormwater projects funded by the Clean Water Act Section 319(h) grants to improve water quality, such as the recently completed five-unit hypolimnetic aeration system to halt deterioration and save the trout fishery. The lake had been suffering from large growths of aquatic weeds, algae, and low dissolved oxygen in deeper waters. Now that this public lake is being restored as a result of remediation projects involving weed harvesting, aeration, and nonpoint source controls, the Department agrees to follow up on its restoration to determine whether uses are still impaired. Malcolm Pirnie is currently performing a diagnostic/feasibility study of Swartswood Lake.

4.6 Clove Acres Lake

Clove Acres Lake is located in Wantage Township and Sussex Borough, Sussex County within the Wallkill River Watershed. The initial water quality evaluation for this shallow lake was completed approximately 20 years ago. Subsequently, the dam broke and the 28-acre lake drained. The lake has not been filled for most of the last fifteen years, during which time a limited amount of dredging took place. The dam was rebuilt and, during the summer of 2002, the lake started to refill. The Department will collect information and determine if the new lake is impaired. It should be noted that, based on the previous morphological and hydrological conditions and land use characteristics as of 1995, the Department estimates that the overall nonpoint source load of total phosphorus would have to be reduced by at least 64%. Currently, a consultant Fred Yoerg/ Associates has been engaged to begin working on a lake management plan.

5.0 Applicable Surface Water Quality Standards

In order to prevent excessive primary productivity and consequent impairment of recreational, water supply and aquatic life designated uses, the Surface Water Quality Standards (SWQS, N.J.A.C. 7:9B) define both numerical and narrative criteria that address eutrophication in lakes due to overfertilization. The total phosphorous (TP) criterion for freshwater lakes at N.J.A.C. 7:9B – 1.14(c)5 reads as follows:

For freshwater 2 classified lakes, Phosphorus as total phosphorus shall not exceed 0.05 mg/l in any lake, pond or reservoir or in a tributary at the point where it enters such bodies of water, except where site-specific criteria are developed to satisfy N.J.A.C. 7:9B-1.5(g)3.

N.J.A.C. 7:9B-1.5(g)3 states:

The Department may establish site-specific water quality criteria for nutrients in lakes, ponds, reservoirs or stream, in addition to or in place of the criteria in N.J.A.C. 7:9B-1.14, when necessary to protect existing or designated uses. Such criteria shall become part of the SWQS.

Presently, no site-specific criteria apply to any of these lakes.

Also at N.J.A.C. 7:9B-1.5(g)2, the following is discussed:

Except as due to natural conditions, nutrients shall not be allowed in concentrations that cause objectionable algal densities, nuisance aquatic vegetation, or otherwise render the waters unsuitable for the designated uses.

These TMDLs are designed to meet both numeric and narrative criteria of the SWQS.

All of the waterbodies covered under these TMDLs have a FW2 classification. The designated uses, both existing and potential, that have been established by the Department for waters of the State classified as such are as stated below:

In all FW2 waters, the designated uses are (N.J.A.C. 7:9B-1.12):

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

6.0 Source Assessment

Phosphorus sources were characterized on an annual scale (kg TP/yr). Long-term pollutant loads are typically more critical to overall lake water quality than the load at any particular short-term time period (e.g. day). Storage and recycling mechanisms in the lake, such as luxury uptake and sediments dynamics, allow phosphorus to be used as needed regardless of the rate of delivery to the system. Also, empirical lake models use annual loads rather than daily or monthly loads to estimate in-lake concentrations.

6.1 Assessment of Point Sources other than Stormwater

Point sources of phosphorus other than stormwater were identified using the Department's GIS as all Major Municipal (MMJ), Minor Municipal (MMI), and Combined Sewer Overflow (CSO) discharges within each lakeshed. Other types of discharges, such as Industrial, were not included because their contribution, if any, is negligible compared to municipal discharges and runoff from land surfaces. No municipal point sources exist anywhere within the lakesheds of Cranberry Lake or Ghost Lake. One MMI, Arthur Stanlick School, discharges within the Lake Hopatcong lakeshed. The current annual TP load was estimated by multiplying the monthly average TP concentration of 0.314 mg TP/l by the average flow of 0.0014 million gallons per day (MGD), and converting to units of kg/yr. Average flow and concentration were calculated from data submitted to the Department as required in the form of Discharge Monitoring Reports. Similarly, the currently permitted annual TP load was estimated by multiplying the current TP concentration limit of 1.0 mg TP/l by the permitted flow of 0.013 MGD, and converting to units of kg/yr. Since Lake Hopatcong discharges into the Lake Musconetcong lakeshed, the point source was included only indirectly as part of the tributary load into Lake Musconetcong.

Table 3 Point Source Phosphorus Loads

Lake	NJPDES #	Facility Name	receiving water	current P load (kg TP/yr)	permitted P load (kg TP/yr)
Lake Hopatcong	NJ0021105	Arthur Stanlick School	Lake Shawnee	0.6	18.0

6.2 Assessment of Nonpoint Sources and Stormwater

Runoff from land surfaces comprises most of the nonpoint and stormwater sources of phosphorus into lakes. Watershed loads for total phosphorus were therefore estimated using the Unit Areal Load (UAL) methodology, which applies pollutant export coefficients obtained from literature sources to the land use patterns within the watershed, as described in USEPA's Clean Lakes Program guidance manual (Reckhow,1979b). Land use was determined using the Department's GIS system using the 1995/1997 land use coverage. The Department reviewed phosphorus export coefficients from an extensive database (Appendix B) and selected the land use categories and values shown in Table 4.

Table 4 Phosphorus export coefficients (Unit Areal Loads)

land use / land cover	LU/LC codes³	UAL (kg TP/ha/yr)
medium / high density residential	1110, 1120, 1150	1.6
low density / rural residential	1130, 1140	0.7
Commercial	1200	2.0
Industrial	1300, 1500	1.7
mixed urban / other urban	other urban codes	1.0
Agricultural	2000	1.5
forest, wetland, water	4000, 6000, 5000	0.1
barren land	7000	0.5

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

For all lakes in this TMDL document, a UAL of 0.07 kg TP/ha/yr was used to estimate air deposition of phosphorus directly onto the lake surface. This value was developed from statewide mean concentrations of total phosphorus from the New Jersey Air Deposition Network (Eisenreich and Reinfelder, 2001). For Lake Musconetcong, land use runoff loads were only calculated for the immediate watershed downstream of Lake Hopatcong. An additional annual tributary load from Lake Hopatcong into Lake Musconetcong was estimated by multiplying the annual discharge from the lake by the mean phosphorus concentration as calculated under Current Condition in section 7.1 below. Land uses and calculated runoff loading rates for each of the lakes are shown in Table 5. Also included in Table 5 are estimates of loading rates from septic systems and from internal sources (sediment regeneration, macrophyte decomposition, and/or groundwater) developed

³ LU/LC code is an attribute of the land use coverage that provides the Anderson classification code for the land use. The Anderson classification system is a hierarchical system based on four digits. The four digits represent one to four levels of classification, the first digit being the most general and the fourth digit being the most specific description.

previously (Coastal Environmental Services, 1992; Princeton Aqua Science, 1983; Coastal Environmental Services, 1993; Princeton Hydro, 2002) for each of the lakes.

Table 5 Nonpoint and Stormwater Sources of Phosphorus Loads*

Nonpoint Source	Cranberry Lake		Lake Hopatcong		Lake Musconetcong		Ghost Lake	
	acres	Kg TP/yr	acres	Kg TP/yr	acres	Kg TP/yr	acres	Kg TP/yr
medium / high density residential	156	101	2,790	1,800	759	492	0.0	0.0
low density / rural residential	9.0	2.5	423	120	116	32.9	3.2	0.9
commercial	1.5	1.2	237	192	107	86.9	0.0	0.0
industrial	0.0	0.0	7.7	5.3	37.1	25.6	0.0	0.0
mixed urban / other urban	0.0	0.0	521	211	207	83.7	0.0	0.0
agricultural	0.4	0.2	0	0	0.9	0.5	0.4	0.3
forest, wetland, water	1,380	55.9	9,670	391	1,360	55.2	190	7.7
barren land	6.8	1.4	165	33.3	72.6	14.7	0.0	0.0
Direct air deposition on lake surface	190	5.4	2,410	68.2	314	8.9	18.3	0.5
septic systems	n/a	731	n/a	1,600	n/a		n/a	
internal load	n/a	104	n/a	595	n/a	151	n/a	12.4
tributary load	n/a		n/a		n/a	1,240	n/a	
TOTAL	1,740	1,000	16,200	5,020	2,980	2,190	211	21.8

* all figures rounded to not more than three significant digits

7.0 Water Quality Analysis

Empirical models were used to relate annual phosphorus load and steady-state in-lake concentration of total phosphorus. These empirical models consist of equations derived from simplified mass balances that have been fitted to large datasets of actual lake measurements. The resulting regressions can be applied to lakes that fit within the range of hydrology, morphology and loading of the lakes in the model database. The Department surveyed the commonly used models in Table 6.

Table 6 Empirical models considered by the Department

reference	steady-state TP concentration in lake (mg/l)	Secondary term	Application
Rast, Jones and Lee, 1983	$1.81 \times NPL^{0.81}$	$NPL = \left(\frac{P_a \times DT / D_m}{1 + \sqrt{DT}} \right)$	expanded database of mostly large lakes
Vollenweider and Kerekes, 1982	$1.22 \times NPL^{0.87}$	$NPL = \left(\frac{P_a \times DT / D_m}{1 + \sqrt{DT}} \right)$	mostly large natural lakes
Reckhow, 1980	$\frac{P_a}{13.2}$	none	Upper bound for closed lake
Reckhow, 1979a	$\frac{P_a}{(11.6 + 1.2 \times Q_a)}$	$Q_a = \frac{Q_i}{A_i}$	General north temperate lakes, wide range of loading concentration, areal loading, and water load

reference	steady-state TP concentration in lake (mg/l)	Secondary term	Application
Walker, 1977	$\frac{P_a \times DT / D_m}{(1 + 0.824 \times DT^{0.454})}$	none	oxic lakes with $D_m / DT < 50$ m/yr
Jones and Bachmann, 1976	$\frac{0.84 \times P_a}{(D_m \times (0.65 + DT^{-1}))}$	none	may overestimate P in shallow lakes with high D_m / DT
Vollenweider, 1975	$\frac{P_a}{(D_m \times (DT^{-1} + S))}$	$S = 10 / D_m$	Overestimate P lakes with high D_m / DT
Dillon-Kirchner, 1975	$\frac{P_a}{(13.2 + D_m / DT)}$	none	low loading concentration range
Dillon-Rigler, 1974	$P_a \times DT / D_m \times (1 - R)$	R = phosphorus retention coefficient	general form
Ostrofsky, 1978	Dillon-Rigler, 1974	$R = 0.201 \times e^{(-0.0425 \times Q_a)} + 0.5743 \times e^{-0.00949 \times Q_a}$	lakes that flush infrequently
Kirchner-Dillon, 1975	Dillon-Rigler, 1974	$R = 0.426 \times e^{(-0.271 \times D_m / DT)} + 0.5743 \times e^{-0.00949 \times D_m / DT}$	general application
Larsen-Mercier, 1975	Dillon-Rigler, 1974	$R = \frac{1}{1 + \sqrt{1 / DT}}$	Unparameterized form

where:

- NPL = normalized phosphorus loading
- P_a = areal phosphorus loading (g/m²/yr)
- DT = detention time (yr)
- D_m = mean depth (m)
- Q_a = areal water load (m/yr)⁴
- Q_i = total inflow (m³/yr)
- A_l = area of lake (m²)
- S = settling rate (per year)

Reckhow (1979a) model was selected because it has the broadest range of hydrologic, morphological and loading characteristics in its database. Also, the model includes an uncertainty estimate that was used to calculate a Margin of Safety. The Reckhow (1979a) model is described in USEPA Clean Lakes guidance documents: Quantitative Techniques for the Assessment of Lake Quality (Reckhow, 1979b) and Modeling Phosphorus Loading and Lake Response Under Uncertainty (Reckhow *et al*, 1980). The derivation of the model is

⁴ Areal water load is defined as the annual water load entering a lake divided by the area of the lake. Since, under steady-state conditions, the water coming in to the lake is equal to the water leaving the lake, either total inflow or total outflow can be used to calculate areal water load. If different values were reported for total inflow and total outflow, the Department used the higher of the two to calculate areal water load.

summarized in Appendix C. The model relates TP load to steady state TP concentration, and is generally applicable to north temperate lakes, which exhibit the following ranges of characteristics (see Symbol definitions after Table 5):

$$\begin{aligned} \text{phosphorus concentration: } & 0.004 < P < 0.135 \text{ mg/l} \\ \text{average influent phosphorus concentration: } & P_a * DT / D_m < 0.298 \text{ mg/l} \\ \text{areal water load: } & 0.75 < Q_a < 187 \text{ m/yr} \\ \text{areal phosphorus load: } & 0.07 < P_a < 31.4 \text{ g/m}^2/\text{yr} \end{aligned}$$

For comparison, Table 7 below summarizes the characteristics for each lake based on their current and target conditions as described below. While the target concentration for each lake (section 7) is well within the range, the areal phosphorus load provides a better representation of a lake's intrinsic loading characteristics. Also, it is the model's prediction of target condition that is being used to calculate the TMDL; if current loads are higher than the range that can produce reliable model results, this has no affect on the model's reliability to predict target condition under reduced loads. It should also be noted that no attempt was made to recalibrate the Reckhow (1979a) model for lakes in New Jersey or in this Water Region, since sufficient lake data were not available to make comparisons with model predictions of steady-state in-lake concentration of total phosphorus. The model was already calibrated to the dataset on which it is based, and is generally applicable to north temperate lakes that exhibit the range of characteristics listed previously.

Table 7 Hydrologic and loading characteristics of lakes

Lake	Current Avg Influent [TP] (mg/l)	Target Avg Influent [TP] (mg/l)	Current Areal TP load (g/m²/yr)	Target Areal TP load (g/m²/yr)	Areal Water Load (m/year)
Cranberry Lake	0.265	0.071	1.31	0.35	4.9
Ghost Lake	0.049	0.049	0.19	0.19	6.0
Lake Hopatcong	0.126	0.080	0.52	0.33	4.1
Lake Musconetcong	0.045	0.030	1.73	1.14	38.1

7.1 Current Condition

Using these estimated physical parameters and current loads, the predicted steady-state phosphorus concentration of each lake was calculated using the Reckhow (1979a) formulation and listed in Table 8. The current phosphorus load distribution for each lake is shown in Figures 6 to 9 below.

Figure 6 **Current distribution of phosphorus load for Cranberry Lake**

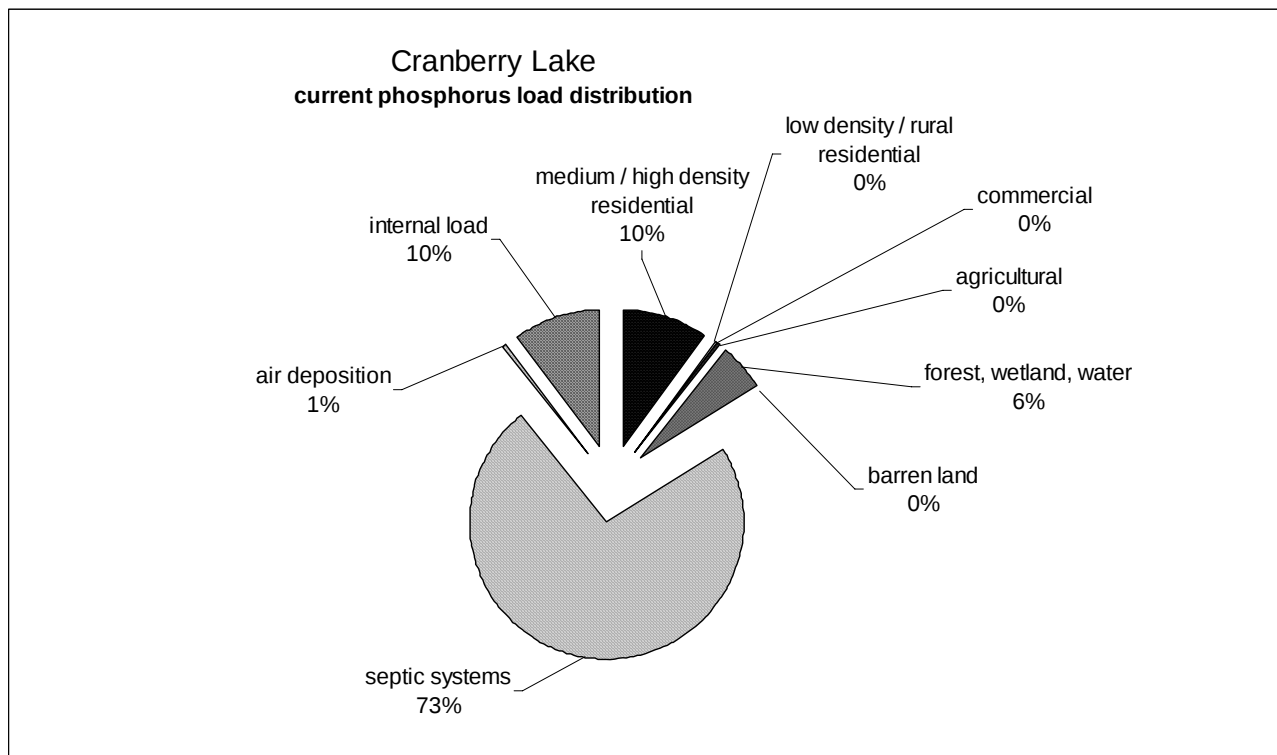


Figure 7 **Current distribution of phosphorus load for Ghost Lake**

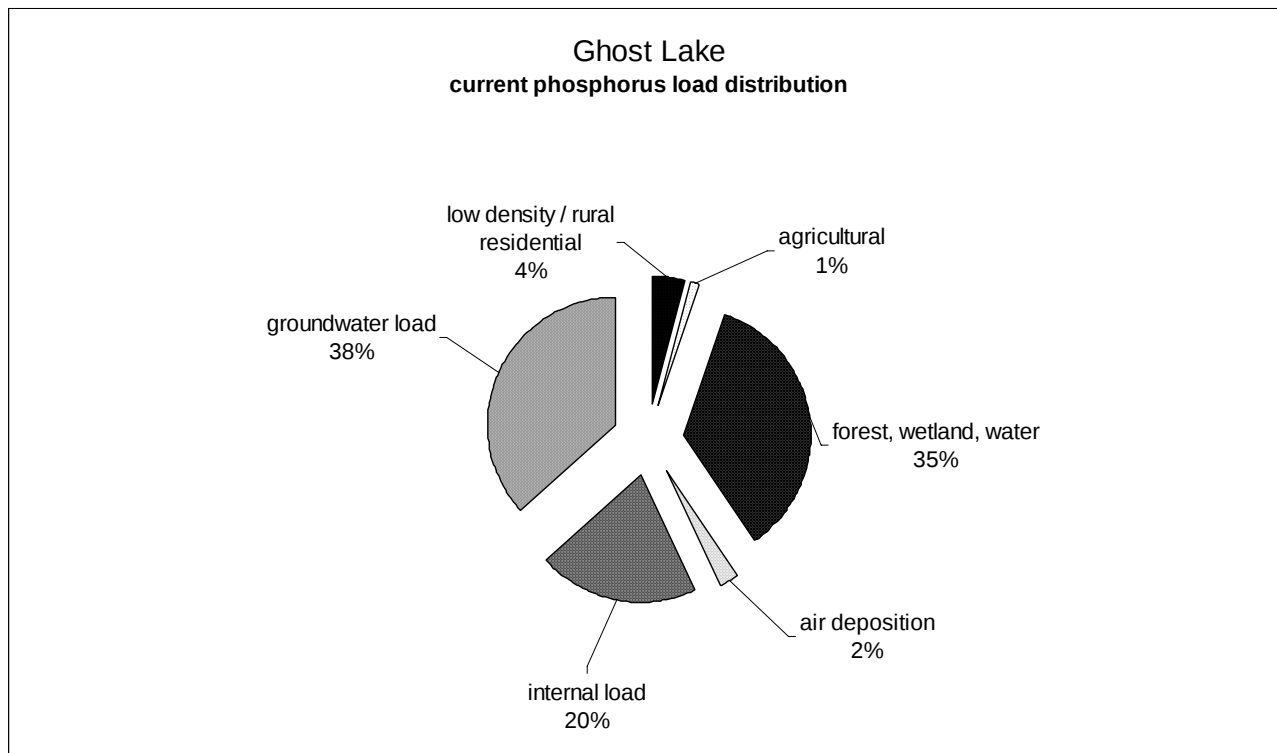


Figure 8 **Current distribution of phosphorus load for Lake Hopatcong**

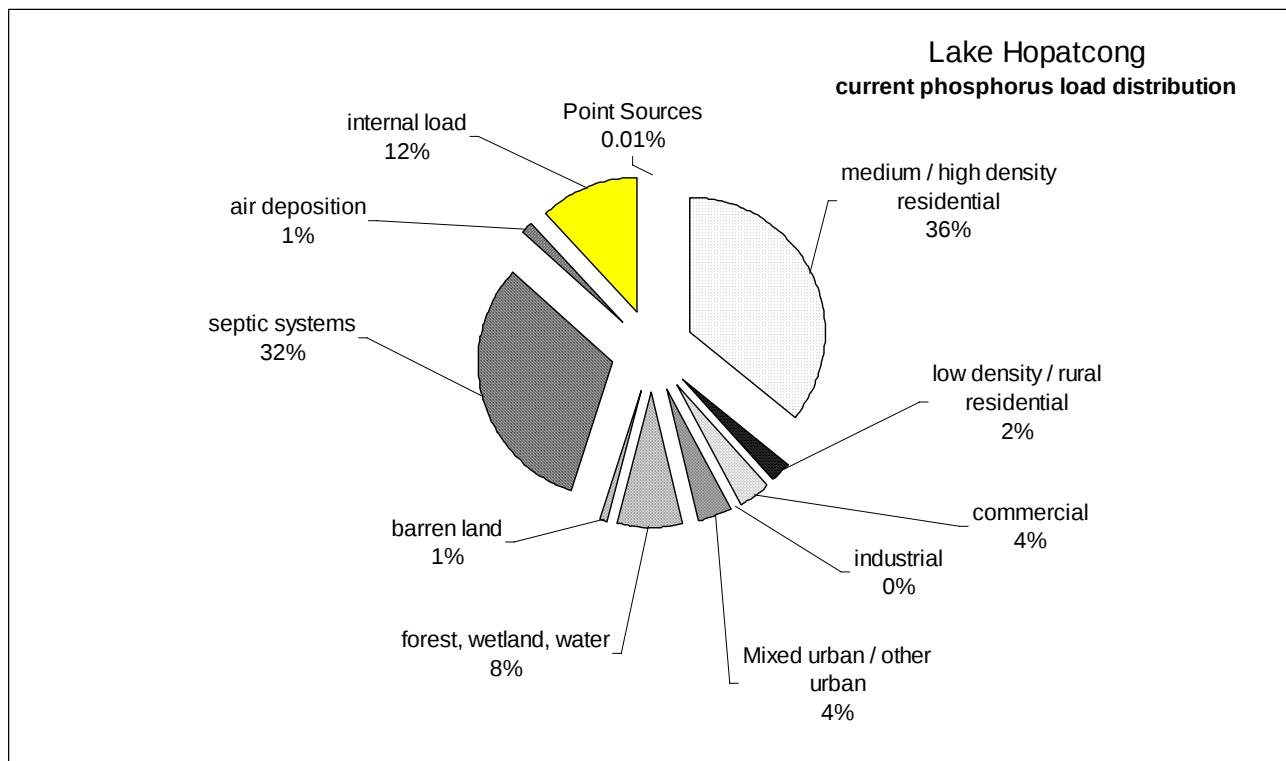
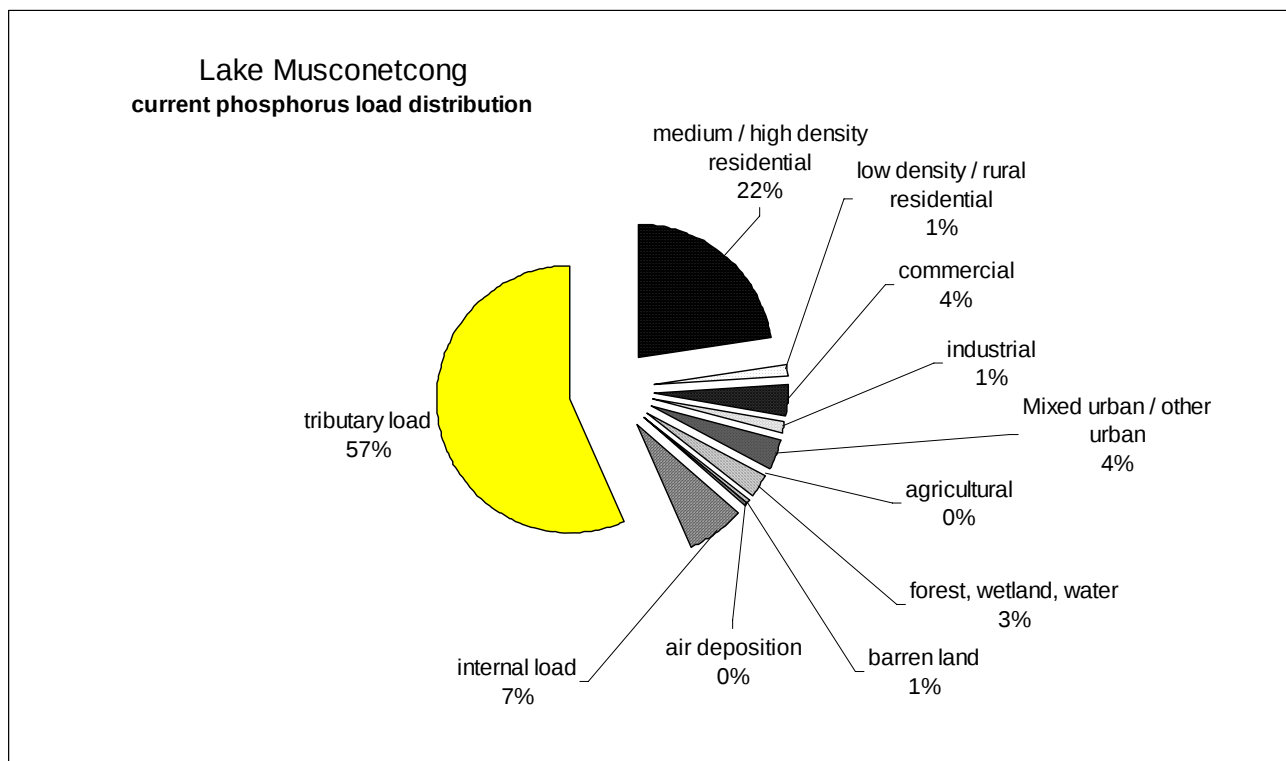


Figure 9 **Current distribution of phosphorus load for Lake Musconetcong**



7.2 Reference Condition

A reference condition for each lake was estimated by calculating external loads as if the land use throughout the lakeshed were completely forest and wetlands. Using the same physical parameters and external loads from forest and wetlands, a reference steady-state phosphorus concentration was calculated for each lake using the Reckhow (1979a) formulation and listed in Table 8.

7.3 Seasonal Variation/Critical Conditions

These TMDLs will attain applicable surface water quality standards year round. The Reckhow model predicts steady-state phosphorus concentration. To account for data variability, the Department generally interprets threshold criteria as greater than 10% exceedance for the purpose of defining impaired waterbodies. Data from two lakes in New Jersey for which the Department had ready access to data (Strawbridge Lake, NJDEP 2000a; Sylvan Lake, NJDEP 2000b) exhibit peak (based on the 90th percentile) to mean ratios of 1.56 and 1.48, resulting in target phosphorus concentrations of 0.032 and 0.034 mg TP/l, respectively. Since the peak to mean ratios were close and the target concentration not very sensitive to differences in peak to mean ratios, the Department determined that a target phosphorus concentration of 0.03 mg TP/l is reasonably conservative. The seasonal variation was therefore assumed to be 67%, resulting in a target phosphorus concentration of 0.03 mg TP/l. Since it is the annual pollutant load rather than the load at any particular time that determines overall lake water quality (section 6), the target phosphorus concentration of 0.03 mg TP/l accounts for critical conditions.

7.4 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)). A MOS is required in order to account for uncertainty in the loading estimates, physical parameters and the model itself. The margin of safety, as described in USEPA guidance (Sutfin, 2002), can be either explicit or implicit (i.e., addressed through conservative assumptions used in establishing the TMDL). For these TMDL calculations, an implicit as well as explicit Margin of Safety (MOS) is provided.

These TMDLs contain an implicit margin of safety by using conservative critical conditions, over-estimated loads, and total phosphorus. Each conservative assumption is further explained below.

Critical conditions are accounted by comparing peak concentrations to mean concentrations and adjusting the target concentration accordingly (0.03 mg TP/l instead of 0.05 mg TP/l). In addition to the conservative approach used for critical conditions, the land use export methodology does not account for the distance between the land use and the lake, which will result in phosphorus reduction due to adsorption onto land surfaces and in-stream kinetic processes. Furthermore, the lakesheds are based on topography without accounting for the

diversion of stormwater from lakes, which is common in urban areas. Neither are any reductions assumed due to the addition of lakeside vegetative buffer construction or other management practices aimed at minimizing phosphorus loads. Finally, the use of total phosphorus, as both the endpoint for the standard and in the loading estimates, is a conservative assumption. Use of total phosphorous does not distinguish readily between dissolved orthophosphorus, which is available for algal growth, and unavailable forms of phosphorus (e.g. particulate). While many forms of phosphorus are converted into orthophosphorus in the lake, many are captured in the sediment, for instance, and never made available for algal uptake.

In addition to the multiple conservative assumptions built in to the calculation, an additional explicit margin of safety was included to account for the uncertainty in the model itself. As described in Reckhow *et al* (1980), the Reckhow (1979a) model has an associated standard error of 0.128, calculated on log-transformed predictions of phosphorus concentrations. Transforming the terms in the model error analysis from Reckhow *et al* (1980) yields the following (Appendix D):

$$MoS_p = \sqrt{\frac{1}{(1-\rho)*4.5}} \times (10^{0.128} - 1),$$

where: MoS_p = margin of safety as a percentage over the predicted phosphorus concentration;
 ρ = the probability that the real phosphorus concentration is less than or equal to the predicted phosphorus concentration plus the margin of safety as a concentration.

Setting the probability to 90% yields a margin of safety of 51% when expressed as a percentage over predicted phosphorus concentration or estimated external load. The external load for each lake was therefore multiplied by 1.51 to calculate an "upper bound" estimate of steady-state phosphorus concentration. An additional explicit margin of safety was included in the analyses by setting the upper bound calculations equal to the target phosphorus concentration of 0.3 mg TP/l, as described in the next section and shown in Table 8. Note that the explicit Margin of Safety is equal to 51% when expressed as a percentage over the predicted phosphorus concentration; when expressed as a percentage of total loading capacity, the Margin of Safety is equal to 34%:

$$\left(MoS_{lc} = \frac{MoS_p \times P}{P + (MoS_p \times P)} = \frac{MoS_p}{1 + MoS_p} = \frac{0.51}{1.51} = 0.34 \right),$$

where: MoS_p = margin of safety expressed as a percentage over the predicted phosphorus concentration or external load;
 MoS_{lc} = margin of safety as a percentage of total loading capacity;
 P = predicted phosphorus concentration (or external load).

7.5 Target Condition

As discussed above, the current steady state concentration of phosphorus in each lake must be reduced to a steady state concentration of 0.03 mg/l to avoid exceeding the 0.05 mg/l phosphorus criterion. Using the Reckhow (1979a) formulation, the target conditions were calculated by reducing the loads as necessary to make the upper bound predictions (which incorporate the Margin of Safety) equal to the target phosphorus concentration of 0.03 mg TP/l. The target condition for Ghost Lake was set equal to the current condition, since the upper bound prediction assuming current loads is already less than the target phosphorus concentration of 0.03 mg TP/l. The target condition for Lake Hopatcong was used to calculate the tributary load for the target condition of Lake Musconetcong. Overall reductions necessary to attain the target steady state concentration of total phosphorus in each lake were calculated by comparing the current condition to the target condition (Table 8).

Table 8 Current condition, reference condition, target condition and overall percent reduction for each lake

Lake	current condition [TP] (mg/l)	reference condition [TP] (mg/l)	upper bound target condition [TP] (mg/l)	target condition [TP] (mg/l)	% overall TP load reduction
Cranberry Lake	0.075	0.005	0.030	0.020	73%
Ghost Lake	0.016	0.006	0.024	0.016	0%
Lake Hopatcong	0.031	0.004	0.030	0.020	36%
Lake Musconetcong	0.030	0.011	0.030	0.020	34%

8.0 TMDL Calculations

8.1 Loading Capacity

The Reckhow (1979a) model was used to solve for loading rate given the upper bound target concentration of 0.03 mg/l (which incorporates the Margin of Safety). Reducing the current loading rates by the percentages in Table 8 yields the same results. The acceptable loading capacity for each lake is provided in Table 10.

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. Therefore, the loading capacities and accompanying WLAs and LAs must be attained in consideration of any new sources that may accompany future development. The primary means by which future growth could increase phosphorus load is through the development of forest land within the lakesheds. The implementation plan includes the development of Lake Restoration Plans that require the collection of more detailed information about each lakeshed. If the development of forest with the watershed of a particular lake is planned, the issue of reserve capacity to account for the additional runoff load of phosphorus may be revisited.

8.3 Allocations

USEPA regulations at 40 CFR § 130.2(i), state that “pollutant loadings may be expressed in terms of either mass per time, toxicity, or other appropriate measure.” For lake nutrient TMDLs, it is appropriate to express the TMDL on a yearly basis. Long-term average pollutant loadings are typically more critical to overall lake water quality due to the storage and recycling mechanisms in the lake. Also, most available empirical lake models, such as the Reckhow model used in this analysis, use annual loads rather than daily loads to estimate in-lake concentrations.

The TMDLs for total phosphorus are therefore calculated as follows (Table 10):

$$\begin{aligned}\text{TMDL} &= \text{loading capacity} \\ &= \text{Sum of the wasteload allocations (WLAs) + load allocations (LAs) + margin of} \\ &\quad \text{safety + reserve capacity.}\end{aligned}$$

WLAs are hereby established for all NJPDES-regulated point sources within each source category, while LAs are established for stormwater sources that are not subject to NJPDES regulation and for all nonpoint sources. This distribution of loading capacity between WLAs and LAs is consistent with recent EPA guidance that clarifies existing regulatory requirements for establishing WLAs for stormwater discharges (Wayland, November 2002). Stormwater discharges are captured within the runoff sources quantified according to land use, as described previously. Distinguishing between regulated and unregulated stormwater is necessary in order to express WLAs and LAs numerically; however, "EPA recognizes that these allocations might be fairly rudimentary because of data limitations and variability within the system." (Wayland, November 2002, p.1) While the Department does not have the data to actually delineate lakesheds according to stormwater drainage areas subject to NJPDES regulation, the land use runoff categories previously defined can be used to estimate between them. Therefore allocations are established according to source categories as shown in Table 9. This demarcation between WLAs and LAs based on land use source categories is not perfect, but it represents the best estimate defined as narrowly as data allow. The Department acknowledges that there may be stormwater sources in the residential, commercial, industrial and mixed urban runoff source categories that are not NJPDES-regulated. Nothing in these TMDLs, including Table 9, shall be construed to require the Department to regulate a stormwater source under NJPDES that would not already be regulated as such, nor shall anything in these TMDLs be construed to prevent the Department from regulating a stormwater source under NJPDES. WLAs are hereby established for all NJPDES-regulated point sources, including stormwater, according to their source category. Quantifying WLAs and LAs according to source categories provides the best estimation defined as narrowly as data allow. However it is clearly noted that WLAs are hereby established for all NJPDES-regulated point sources within each source category, while LAs are established for stormwater sources that are not subject to NJPDES regulation and for all nonpoint sources. The WLAs and LAs in Table 9 are not themselves "Additional Measures" under proposed N.J.A.C. 7:14A-25.6 or 25.8.

Table 9 **Distribution of WLAs and LAs among source categories**

Source category	TMDL allocation
Point Sources other than Stormwater	WLA
Nonpoint and Stormwater Sources	
medium / high density residential	WLA
low density / rural residential	WLA
commercial	WLA
industrial	WLA
Mixed urban / other urban	WLA
agricultural	LA
forest, wetland, water	LA
barren land	LA
air deposition onto lake surface	LA
septic systems	LA
internal load	LA
tributary load	LA

In order to attain the TMDLs, the overall load reductions shown in Table 8, or those determined through additional monitoring, must be achieved. Since loading rates have been defined for at least eight source categories, countless combinations of source reductions could be used to achieve the overall reduction target. The selected scenarios focus on land use and septic sources that can be affected by BMP implementation or NJPDES regulation, requiring equal percent reductions from each in order to achieve the necessary overall load reduction (Table 10). The Lake Restoration Plans developed for each lake as part of the TMDL implementation (section 10) may revisit the distribution of reductions among the various sources in order to better reflect actual implementation projects. The resulting TMDLs, rounded to two significant digits, are shown in Table 10 and illustrated in Figures 10 to 13.

The WLA of 5.5 kg TP/yr for Arthur Stanlick School was calculated by multiplying the current TP concentration limit of 1.0 mg TP/l by the 20-year planned flow of 0.004 MGD, and converting to units of kg/yr. This WLA represents about a 70% decrease from currently permitted annual TP load of 18 kg/yr; however, the actual current annual TP load is only 0.6 kg/yr (section 6.1). Since the WLA represents only 0.1% of the loading capacity for Lake Hopatcong, reduction of the currently permitted concentration limit is not justified. However a WLA was established for this facility in order to prevent the source from becoming significant by incorporating the 20-year planned flow into the next permit. The resulting TMDLs, rounded to two significant digits, are shown in Table 10 and illustrated in Figures 10 to 13.

Table 10 TMDL calculations for each lake (annual loads and percent reductions^a)

lake	Cranberry Lake		% reduction	Ghost Lake		% reduction
	kg TP/yr	% of LC		kg TP/yr	% of LC	
loading capacity (LC)	400	100%	n/a	33	100%	n/a
Point Sources other than Stormwater	n/a			n/a		
Nonpoint and Stormwater Sources						
medium / high density residential	12	3.0%	88%	0.00	0.0%	n/a
low density / rural residential	0.30	0.08%	88%	0.91	2.8%	0%
commercial	0.15	0.04%	88%	0.00	0.0%	n/a
industrial	0.00	0.00%	n/a	0.00	0.0%	n/a
Mixed urban / other urban	0.00	0.00%	n/a	0.00	0.0%	n/a
agricultural	0.23	0.06%	0%	0.27	0.81%	0%
forest, wetland, water	56	14%	0%	7.7	23%	0%
barren land	1.4	0.34%	0%	0.00	0.0%	n/a
air deposition onto lake surface	5.4	1.3%	0%	0.52	1.6%	0%
septic systems	87	22%	88%			
internal load	100	26%	0%	12	38%	0%
Other Allocations						
explicit Margin of Safety	140	34%	n/a	11	34%	n/a
Reserve Capacity	n/a			n/a		

lake	Lake Hopatcong		% reduction	Lake Musconetcong		% reduction
	kg TP/yr	% of LC		kg TP/yr	% of LC	
loading capacity (LC)	4800	100%	n/a	2200	100%	n/a
Point Sources other than Stormwater	5.5	0.11%	69% ^b	n/a		
Nonpoint and Stormwater Sources						
medium / high density residential	960	20%	47%	290	13%	41%
low density / rural residential	64	1.3%	47%	20	0.89%	41%
commercial	100	2.1%	47%	52	2.4%	41%
industrial	2.8	0.06%	47%	15	0.69%	41%
Mixed urban / other urban	110	2.3%	47%	50	2.3%	41%
agricultural	0.0	0.0%	n/a	0.52	0.02%	0%
forest, wetland, water	390	8.1%	0%	55	2.5%	0%
barren land	33	0.69%	0%	15	0.67%	0%
air deposition onto lake surface	68	1.4%	0%	8.9	0.41%	0%
septic systems	850	18%	47%	n/a		
internal load	600	12%	0%	150	6.9%	0%
tributary load	n/a			790	36%	36%
Other Allocations						
explicit Margin of Safety	1600	34%	n/a	740	34%	n/a
Reserve Capacity	n/a			n/a		

a Percent reductions shown for individual sources are necessary to achieve overall reductions in Table 7.

b Percent reduction for point source is compared to currently permitted annual load, not actual current load.

Figure 10

Phosphorus allocations for Cranberry Lake TMDL

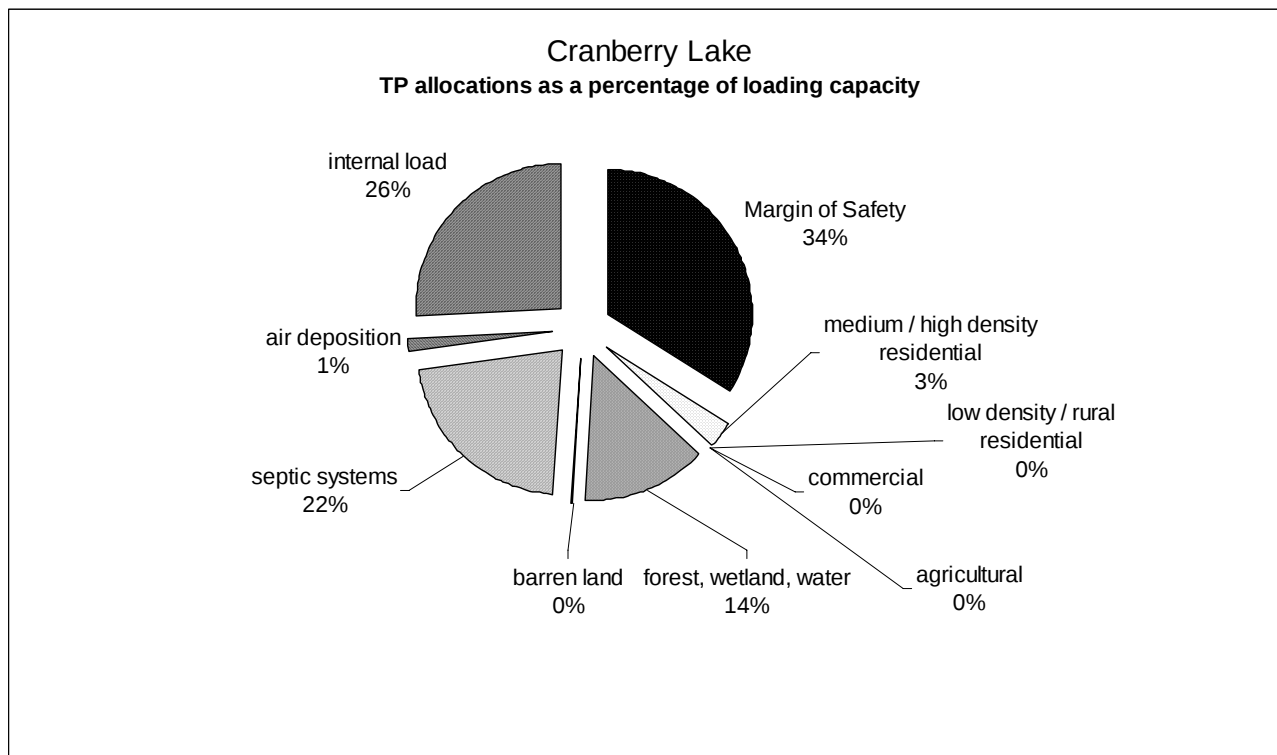


Figure 11

Phosphorus allocations for Ghost Lake

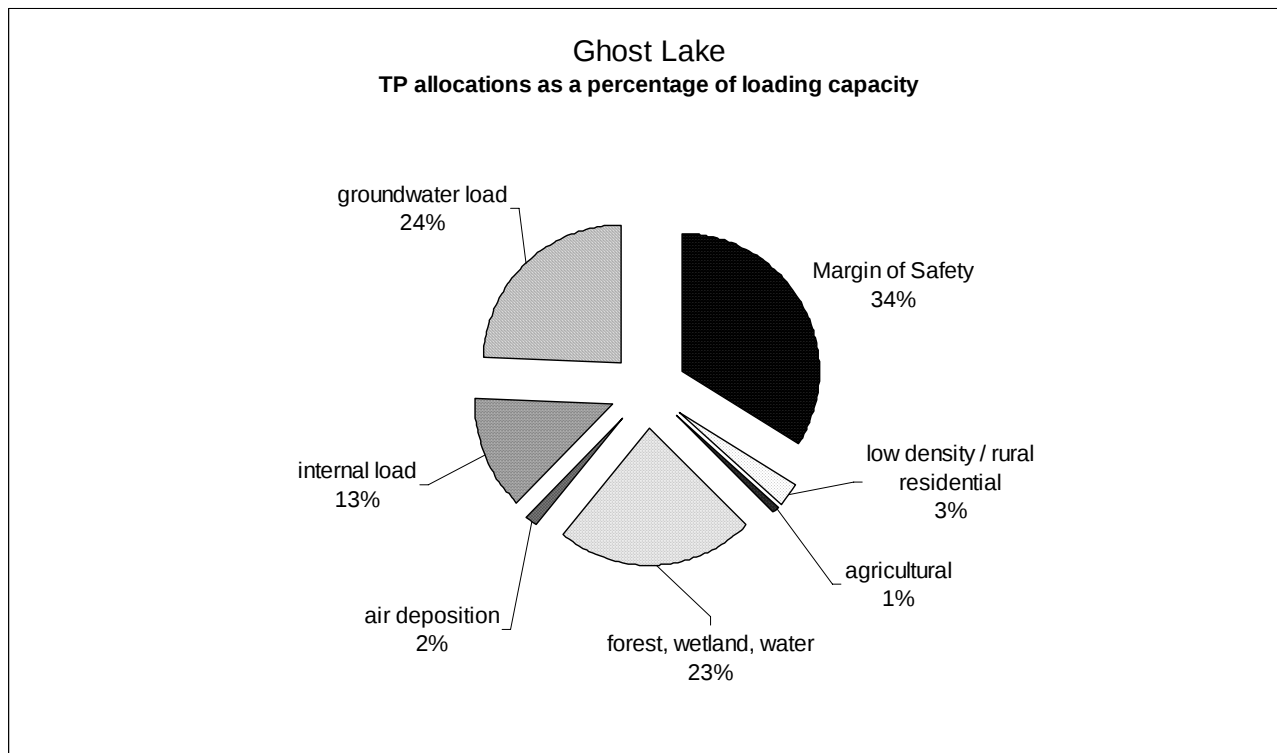


Figure 12

Phosphorus allocations for Lake Hopatcong TMDL

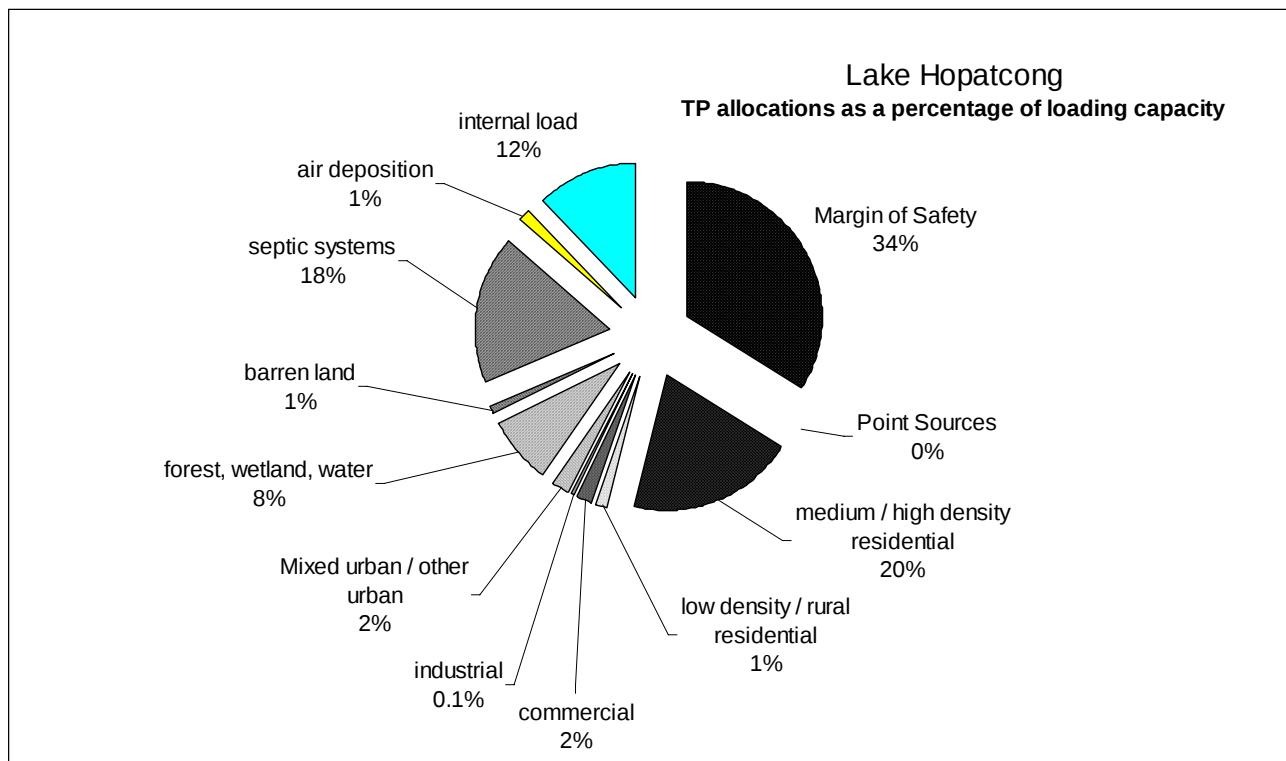
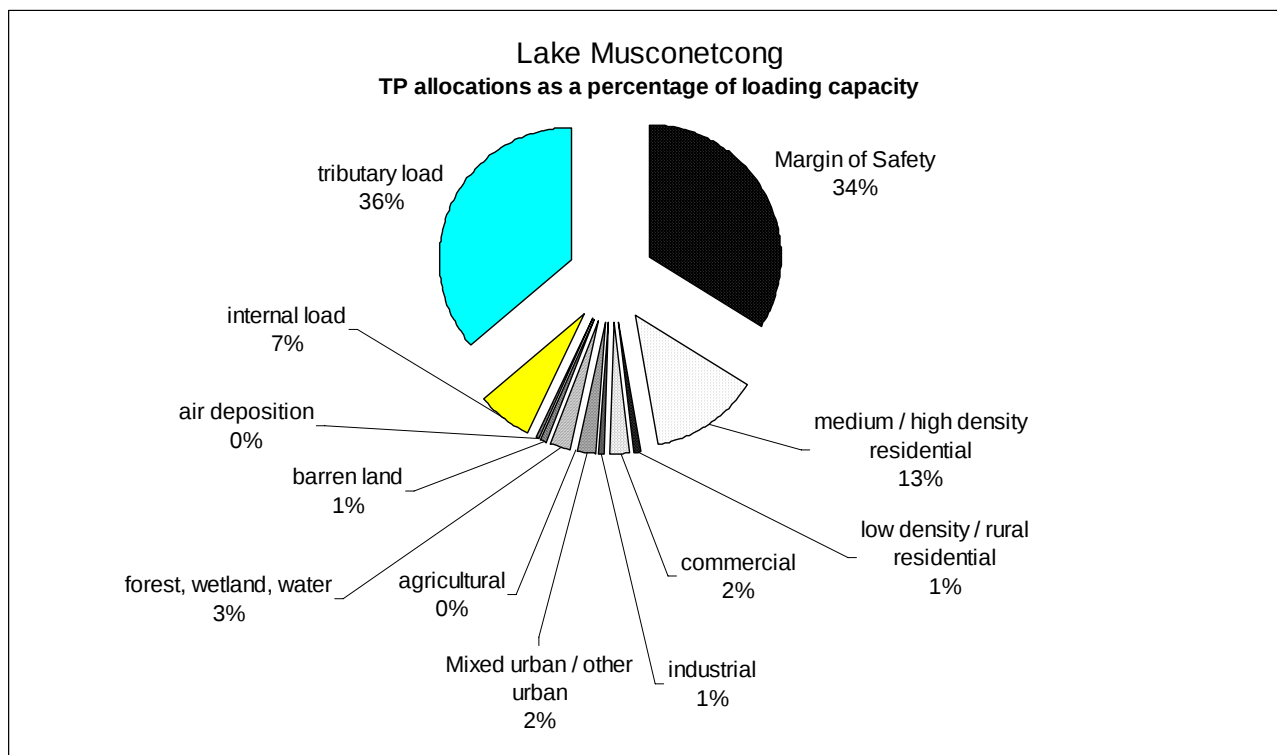


Figure 13

Phosphorus allocations for Lake Musconetcong TMDL



9.0 Follow-up Monitoring

In order to track effectiveness of remediation measures (including TMDLs) and to develop baseline and trend information on lakes, the Department will augment its ambient monitoring program to include lakes on a rotating schedule. The details of a new Lakes Monitoring Network will be published by December 31, 2003. Lakes for which remediation measures have been performed will be given top priority on whatever rotating schedule is developed.

Follow-up monitoring will include evaluations (qualitative using a field index or quantitative) of algal blooms (presence, severity, extent) and aquatic vegetation (density, extent, diversity). Measurements such as secchi depths, nutrient concentrations, and chlorophyll-*a* will be included, in addition to dissolved oxygen, temperature and pH profiles. Basic hydrologic and morphometric information will be measured as necessary to obtain current data, including discharge and bathymetry. The details as to what data will be collected by the Lakes Monitoring Network will be included in the network description.

10.0 Implementation

The next steps toward implementation are preparation of lake characterizations and lake restoration plans, where they have not already been developed. In the development of these plans, the loads by source will be revised, as necessary, to reflect refinements in source contributions. It will be on the basis of refined source estimates that specific strategies for reduction will be developed. These will consider issues such as cost and feasibility when specifying the reduction target for any source or source type. As appropriate, WLAs or other measures to be applied to traditional or stormwater point sources through NJPDES permits will be adopted by the Department as amendments to the applicable areawide Water Quality Management Plan.

The Department recognizes that TMDLs alone are not sufficient to restore eutrophic lakes. The TMDL establishes the required nutrient reduction targets and provides the regulatory framework to effect those reductions. However, the nutrient load only affects the eutrophication potential of a lake. The implementation plan therefore calls for the collection of additional monitoring data and the development of a Lake Restoration Plan for each lake. The plans will consider in-lake measures that need to be taken to supplement the nutrient reduction measures required by the TMDL. In addition, the plans will consider the ecology of the lake and adjust the eutrophication indicator target as necessary to protect the designated uses.

For instance, with the exception of Lake Hopatcong, all of these lakes are shallow lakes, as defined by having a mean depth less than 3 meters. Even Lake Hopatcong includes many basins that behave like shallow lakes, such as Woodport Bay. For a lake to be shallow means that most of the lake volume is within the photic zone and therefore more able to support aquatic plant growth (Holdren *et al*, 2001). Shallow lakes are generally characterized by either

abundant submerged macrophytes and clear water or by abundant phytoplankton and turbid water. From an aquatic life and biodiversity perspective, it is desirable for shallow lakes to be dominated by aquatic plants rather than algae, especially phytoplankton. While lower nutrient concentrations favor the clear/plant state, either state can persist over a wide range of nutrient concentrations. Shallow lakes have ecological stabilizing mechanisms that tend to resist switches from clear/plant state to turbid/algae state, and vice-versa. The clear/plant state is more stable at lower nutrient concentrations and irreversible at very low nutrient concentrations; the turbid/algae state is more stable at higher nutrient concentrations. The Lake Restoration Plans for each lake will need to consider the ecological nuances of shallow and deep lakes.

The State of New Jersey has adopted a watershed approach to water quality management. That plan divides the state into five watershed management regions, one of which is the Northwest Region. The Department recognizes that lake restoration requires a watershed approach. Lake Restoration Plans will be used as a basis to address overfertilization and sedimentation issues in watersheds that drain to these sensitive lakes. In addition, the Department will direct research funds to understand and demonstrate biomanipulation and other techniques that can be applied in New Jersey lakes to promote the establishment of healthy and diverse aquatic plant communities in shallow lakes. Finally, public education efforts will focus on the benefits of aquatic plants in shallow lakes and the balance of aquatic life uses with recreational uses of these lakes. With the combination of New Jersey's strong commitment to the collection and use of high quality data to support environmental decisions and regulatory programs, including TMDLs, the Department is reasonably assured compliance with the total phosphorus criteria applicable to these eutrophic lakes.

10.1 Lake Characterization

Additional monitoring may be performed in order to develop the Lake Restoration Plans to implement these TMDLs. The level of characterization necessary to plan restoration will be specific to individual lakes depending on the remedial options being considered. During at least one or two summer trips, the following information may be collected as necessary.

- for shallow lakes, vegetation mapping using shore to center transects, measuring density and composition (emergents, rooted floaters, submergents, free-floating plants, submerged macro-algae)
- 1-5 mid-lake sampling stations as needed to characterize the lake
 - at least 2 samples per station per day; min 4 samples per trip
 - secchi depths
- chemistry (nutrients, chlorophyll-*a*, etc.)
 - surface, metalimnion, hypolimnion, and bottom if stratified
 - otherwise surface and bottom
- biology (integrated sample from mixed surface layer)
 - algal abundance and composition (greens, diatoms, blue-greens)
 - zooplankton abundance, composition and size ranges
- DO, temperature and pH profiles (hourly throughout day)

Where necessary, flow and water quality measurements of influent and effluent streams will be taken periodically from Spring to Fall, and fish abundance and composition will be assessed in early autumn.

The schedules for lake characterization and development of Lake Restoration Plans to implement these TMDLs are provided in Table 11.

Table 11 Implementation Schedule

Lake	Lake Characterization	Lake Restoration Plan
Cranberry Lake ^a	Summer 2004	Spring 2005
Ghost Lake ^b	Completed 2000 and 2001	Completed February 2002
Lake Hopatcong	Summer 2003	Spring 2004
Lake Musconetcong	Summer 2003	Spring 2004

a While Phase 2 remediation of Cranberry Lake is already underway, the TMDL implementation will focus on how successful the nutrient reduction efforts have been, and what additional measures are necessary to restore the lake.

b The Diagnostic / Feasibility study for Ghost Lake (Princeton Hydro, 2002) fulfills the TMDL requirements for lake characterization and lake restoration planning. While nutrient reductions are not required, the report specifies a management plan to restore the lake, including biomanipulation through fishery management.

10.2 Reasonable Assurance

Reasonable assurance for the implementation of these TMDLs has been considered for point and nonpoint sources for which phosphorus load reductions are necessary. These TMDLs obligate the Department to routinely monitor lake water quality as well as characterize and develop specific restoration plan for these particular lakes according to the schedule in Table 11. Moreover, stormwater sources for which WLAs have been established will be regulated as NJPDES point sources.

With the implementation of follow-up monitoring and development of Lake Restoration Plans through watershed management process, the Department is reasonably assured that New Jersey's Surface Water Quality Standards will be attained for these lakes. Activities directed in the watersheds to reduce nutrient loadings shall include a whole host of options, included but not limited to education projects that teach best management practices, approval of projects funded by CWA Section 319 Nonpoint Source (NPS) Grants, recommendations for municipal ordinances regarding feeding of wildlife, and pooper-scooper laws, and stormwater control measures.

11.0 Public Participation

Presently, the Upper Delaware Watershed public participation process is being managed by the Department under a contract with the North Jersey Resource Conservation and Development Council. It is comprised of the Project Work Group, an Action Now Committee, an Education and Outreach Committee, an Open Space and Farmland Preservation Committee, and a Characterization and Assessment Committee. It holds regular meetings and relies on its diverse partners and the general public to work on

watershed tasks and issues. In June 2002 the Department gave a presentation to the Upper Delaware Watershed Project Work Group on the New Jersey 2002 Integrated List of Waterbodies and the Water Quality Monitoring and Assessment Methodology, and also encouraged submittal of any comments.

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

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

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

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Appendix B: Database of Phosphorus Export Coefficients

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

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

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Appendix C: Summary of Reckhow (1979a) model derivation

The following general expression for phosphorus mass balance in lake assumes the removal of phosphorus from a lake occurs through two pathways, the outlet (M_o) and the sediments (ϕ):

$$V \cdot \frac{dP}{dt} = M_i - M_o - \phi \quad \text{Equation 1}$$

where:

- V = lake volume (10^3 m^3)
- P = lake phosphorus concentration (mg/l)
- M_i = annual mass influx of phosphorus (kg/yr)
- M_o = annual mass efflux of phosphorus (kg/yr)
- ϕ = annual net flux of phosphorus to the sediments (kg/yr).

The sediment removal term is a multidimensional variable (dependent on a number of variables) that has been expressed as a phosphorus retention coefficient, a sedimentation coefficient, or an effective settling velocity. All three have been shown to yield similar results; Reckhow's formulation assumes a constant effective settling velocity, which treats sedimentation as an areal sink.

Assuming the lake is completely mixed such that the outflow concentration is the same as the lake concentration, the phosphorus mass balance can be expressed as:

$$V \cdot \frac{dP}{dt} = M_i - v_s \cdot P \cdot A - P \cdot Q \quad \text{Equation 2}$$

where:

- v_s = effective settling velocity (m/yr)
- A = area of lake (10^3 m^2)
- Q = annual outflow ($10^3 \text{ m}^3/\text{yr}$).

The steady-state solution of Equation 2 can be expressed as:

$$P = \frac{P_a}{v_s + \frac{z}{T}} = \frac{P_a}{v_s + Q_a} \quad \text{Equation 3}$$

where:

- P_a = areal phosphorus loading rate ($\text{g}/\text{m}^2/\text{yr}$)
- z = mean depth (m)
- T = hydraulic detention time (yr)
- $Q_a = \frac{Q}{A}$ = areal water load (m/yr).

Using least squares regression on a database of 47 north temperate lakes, Reckhow fit the effective settling velocity using a function of areal water load: $P = \frac{P_a}{11.6 + 1.2 \cdot Q_a}$. **Equation 4**

Appendix D: Derivation of Margin of Safety from Reckhow *et al* (1980)

As described in Reckhow *et al* (1980), the Reckhow (1979a) model has an associated standard error of 0.128, calculated on log-transformed predictions of phosphorus concentrations. The model error analysis from Reckhow *et al* (1980) defined the following confidence limits:

$$P_L = P - h \cdot (10^{(\log P - 0.128)} - P)$$

$$P_U = P + h \cdot (10^{(\log P + 0.128)} - P)$$

$$\rho \geq 1 - \frac{1}{2.25 \cdot h^2}$$

where:

P_L = lower bound phosphorus concentration (mg/l);

P_U = upper bound phosphorus concentration (mg/l);

P = predicted phosphorus concentration (mg/l);

h = prediction error multiple

ρ = the probability that the real phosphorus concentration lies within the lower and upper bound phosphorus concentrations, inclusively.

Assuming an even-tailed probability distribution, the probability (ρ_u) that the real phosphorus concentration is less than or equal to the upper bound phosphorus concentration is:

$$\rho_u = \rho + \frac{1 - \rho}{2} = \rho + \frac{1}{2} - \frac{\rho}{2} = \rho \cdot \left(1 - \frac{1}{2}\right) + \frac{1}{2} = \frac{1}{2} \cdot \rho + \frac{1}{2}$$

Substituting for ρ as a function of h :

$$\rho_u = \frac{1}{2} \cdot \left(1 - \frac{1}{2.25 \cdot h^2}\right) + \frac{1}{2} = \frac{1}{2} - \frac{1}{4.5 \cdot h^2} + \frac{1}{2} = 1 - \frac{1}{4.5 \cdot h^2}$$

Solving for h as a function of the probability that the real phosphorus concentration is less than or equal to the upper bound phosphorus concentration:

$$\frac{1}{4.5 \cdot h^2} = 1 - \rho_u$$

$$h^2 = \frac{1}{4.5(1 - \rho_u)}$$

$$h = \sqrt{\frac{1}{4.5(1 - \rho_u)}}$$

Expressing Margin of Safety (MoS_p) as a percentage over the predicted phosphorus concentration yields:

$$MoS_p = \frac{P_U}{P} - 1 = \frac{P_U - P}{P}$$

Substituting the equation for P_U :

$$MoS_p = \frac{P + h \cdot (10^{(\log P + 0.128)} - P) - P}{P} = \frac{h \cdot (10^{(\log P + 0.128)} - P)}{P}$$

$$P \cdot MoS_p = h \cdot (10^{(\log P + 0.128)} - P)$$

$$\frac{P \cdot MoS_p}{h} = 10^{(\log P + 0.128)} - P$$

$$\frac{P \cdot MoS_p}{h} + P = 10^{(\log P + 0.128)}$$

Taking the log of both sides and solving for margin of safety:

$$\log\left(\frac{P \cdot MoS_p}{h} + P\right) = \log P + 0.128$$

$$\log\left(\frac{P \cdot MoS_p}{h} + P\right) - \log P = 0.128$$

$$\log\left(P\left(\frac{MoS_p}{h} + 1\right)\right) - \log P = 0.128$$

$$\log P + \log\left(\frac{MoS_p}{h} + 1\right) - \log P = 0.128$$

$$\log\left(\frac{MoS_p}{h} + 1\right) = 0.128$$

$$\frac{MoS_p}{h} + 1 = 10^{0.128}$$

$$\frac{MoS_p}{h} = 10^{0.128} - 1$$

$$MoS_p = h(10^{0.128} - 1)$$

Finally, substituting for h yields Margin of Safety (MoS_p) as a percentage over the predicted phosphorus concentration, expressed as a function of the probability (ρ_u) that the real phosphorus concentration is less than or equal to the upper bound phosphorus concentration:

$$MoS_p = \sqrt{\frac{1}{((1 - \rho_u) * 4.5)}} \times (10^{0.128} - 1)$$