Amendment to the
Upper Raritan Water Quality Management Plan

Total Maximum Daily Loads for Pathogens to Address 4 Lakes in the Raritan Water Region

Watershed Management Area 8
(Budd Lake, Randolph Park Lake, Ravine Lake, and Sunset Lake)

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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 four lakes as impaired with respect to pathogens in the Raritan 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 four lakes that are impaired with respect to pathogens in the Raritan 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 Raritan Water Region impaired for pathogens for which TMDLs are adopted.

TMDL Number	WMA	Lake Assessment Unit Name	County(s)*
1	8	Budd Lake	Morris
2	8	Randolph Park Lake	Morris
3	8	Ravine Lake	Somerset
4	8	Sunset Lake	Somerset

*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 four 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 Upper Raritan Water Quality Management Plan 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 Raritan Water Region, the *2006 Integrated List of Waterbodies* currently identifies four 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 four TMDLs for pathogens to address the impaired lakes in the Raritan 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, Budd Lake was listed for mercury on the *2006 Integrated List*. This pollutant will be addressed in future TMDL efforts.

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 both 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	County(s)*	Proposed Action
1	8	Budd Lake	Budd Lake-08	Morris	Adopt TMDL
2	8	Randolph Park Lake	Randolph Park Lake-08	Morris	Adopt TMDL
3	8	Ravine Lake	Ravine Lake-08	Somerset	Adopt TMDL
4	8	Sunset Lake	Sunset Lake-08	Somerset	Adopt TMDL

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

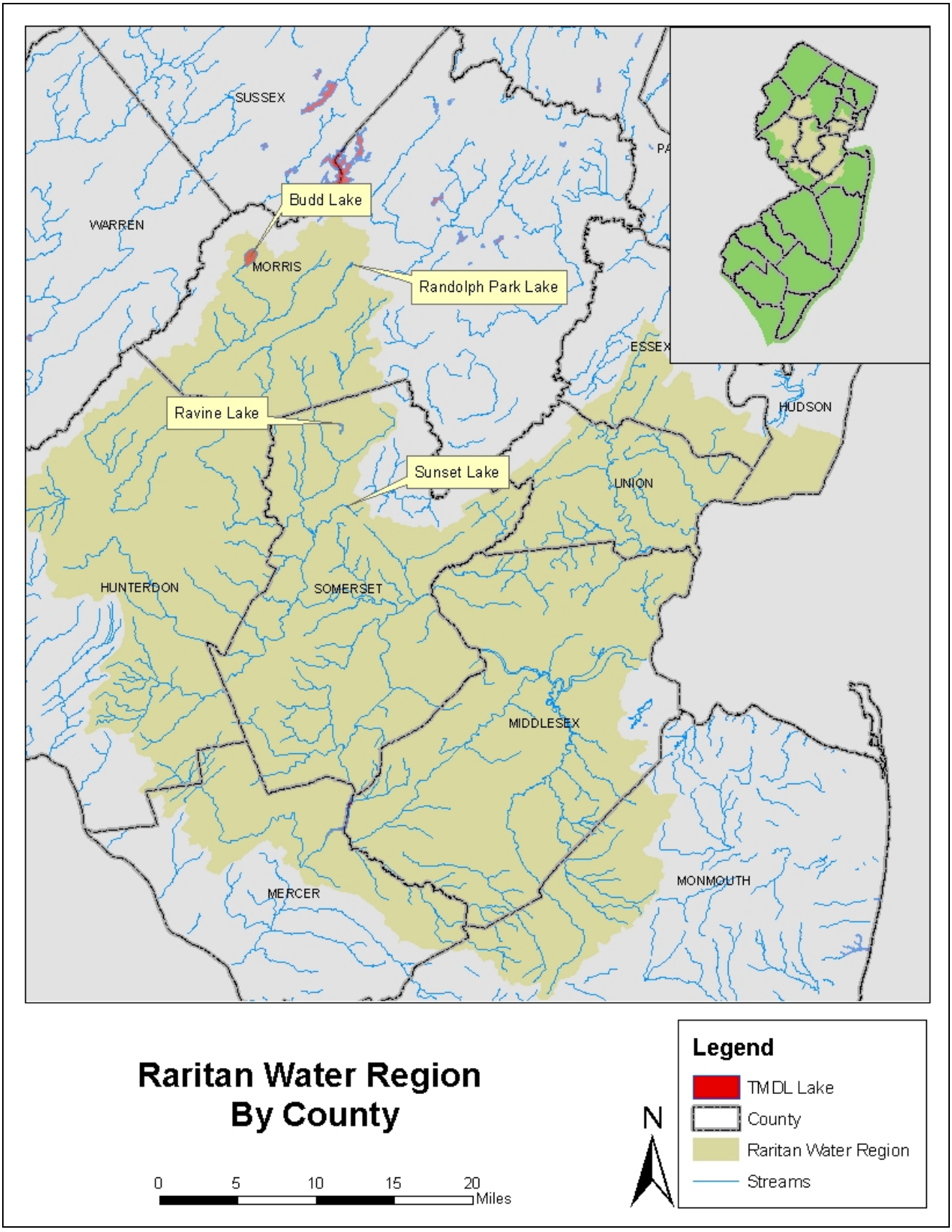

Figure 1. Pathogen impaired lakes in the Raritan Water Region by county.

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

All the impaired lakes addressed in this document are classified as Fresh Water 2 (FW2), Non-Trout (NT), except for Ravine Lake which is FW2, Trout Maintenance (TM).

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 Raritan 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 for each impaired lake was delineated and land uses assessed as 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 Raritan Water Region.

WMA	Lake Assessment Unit ID	Agriculture		Barren Land		Forest		Urban		Water		Wetland		Total Area
		km²	%	km²	%	km²	%	km²	%	km²	%	km²	%	km²
8	Budd Lake-08	0.09	0.7	0.22	1.8	4.48	36.1	4.25	34.2	1.58	12.8	1.79	14.4	12.42
8	Randolph Park Lake-08	0.00	0.0	0.03	5.6	0.26	44.9	0.21	37.4	0.06	10.8	0.01	1.4	0.57
8	Ravine Lake-08	6.10	8.9	0.39	0.6	33.33	48.6	23.87	34.8	0.78	1.1	4.15	6.1	68.61
8	Sunset Lake-08	0.05	1.0	0.00	0.0	1.62	30.1	3.36	62.4	0.06	1.1	0.29	5.4	5.38

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 – TMDL target conc./max conc.) x 100
Load Capacity = (1 – percent reduction) * overall current load (using WTM)
MOS = 5% * Load capacity
Overall percent reduction = 1 – (Load capacity – MOS) / overall current load
Overall current load = agricultural and urban land use loads + forest, wetlands and barren land loads

When $1 - \frac{LoadCapacity - MoS - Forestedbarrenlandload}{ControllableLandUseLoad} \geq 99.5\%$,

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

Otherwise,

Zero percent reduction on Forest, Wetlands 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.

<u>Lakeshed connected with the Fecal Coliform TMDL established streamshed</u>

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 Raritan 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
8	Budd Lake-08	3.47E+03	2.13E+02	1.94E+02	3.88E+03	98.94%	5.00%	
8	Randolph Park Lake-08	4.43E+02	1.67E+01	2.42E+01	4.84E+02	98.10%	5.00%	
8	Ravine Lake-08[a]	4.32E+04	6.71E+03	2.62E+03	5.25E+04	94.57%	5.00%	69%
8	Sunset Lake-08	5.89E+03	1.99E+02	3.21E+02	6.41E+03	96.78%	5.00%	

a. Nested with a stream watershed, NB Raritan River near Chester (NJDEP, 2003). The stream shed is part of the lake shed and required a reduction of 69%. Since the required reduction for the lake is much higher (94.57%), the entire lake shed is ruled by the lake reduction.

Table 7. Raritan 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)
8	Budd Lake-08	99%	8.90E+02	99%	9.39E+00	6.51E+02	99%	6.87E+00	1.86E+04	99%	1.96E+02	3.29E+05	99%	3.47E+03	0.00E+00	99%	0.00E+00
8	Randolph Park Lake-08	98%	0.00E+00	98%	0.00E+00	9.44E+01	98%	1.79E+00	7.85E+02	98%	1.49E+01	2.33E+04	98%	4.43E+02	0.00E+00	98%	0.00E+00
8	Ravine Lake-08	95%	4.69E+04	95%	2.55E+03	5.56E+02	95%	3.02E+01	7.27E+04	95%	3.94E+03	7.95E+05	95%	4.32E+04	3.56E+03	95%	1.93E+02
8	Sunset Lake-08	97%	4.99E+02	97%	1.61E+01	0.00E+00	97%	0.00E+00	5.68E+03	97%	1.83E+02	1.83E+05	97%	5.89E+03	0.00E+00	97%	0.00E+00

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 permit)
- 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 Comodity 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. Raritan Outreach and Restoration Projects

WMA	FY	Funding Source	Recipient	Project Title	Grant Amount
08	2005	319	Mount Olive Township	Budd Lake Watershed Restoration, Protection and Regional Stormwater Management Plan	$428,994

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 proposed 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. 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 Upper Raritan Water Quality Management Plan in accordance with New Jersey's Water Quality Management Planning Rules at N.J.A.C. 7:15-3.4 (g).

APPENDIX A: REFERENCES

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

Raritan Water Region Wastewater Treatment Facilities

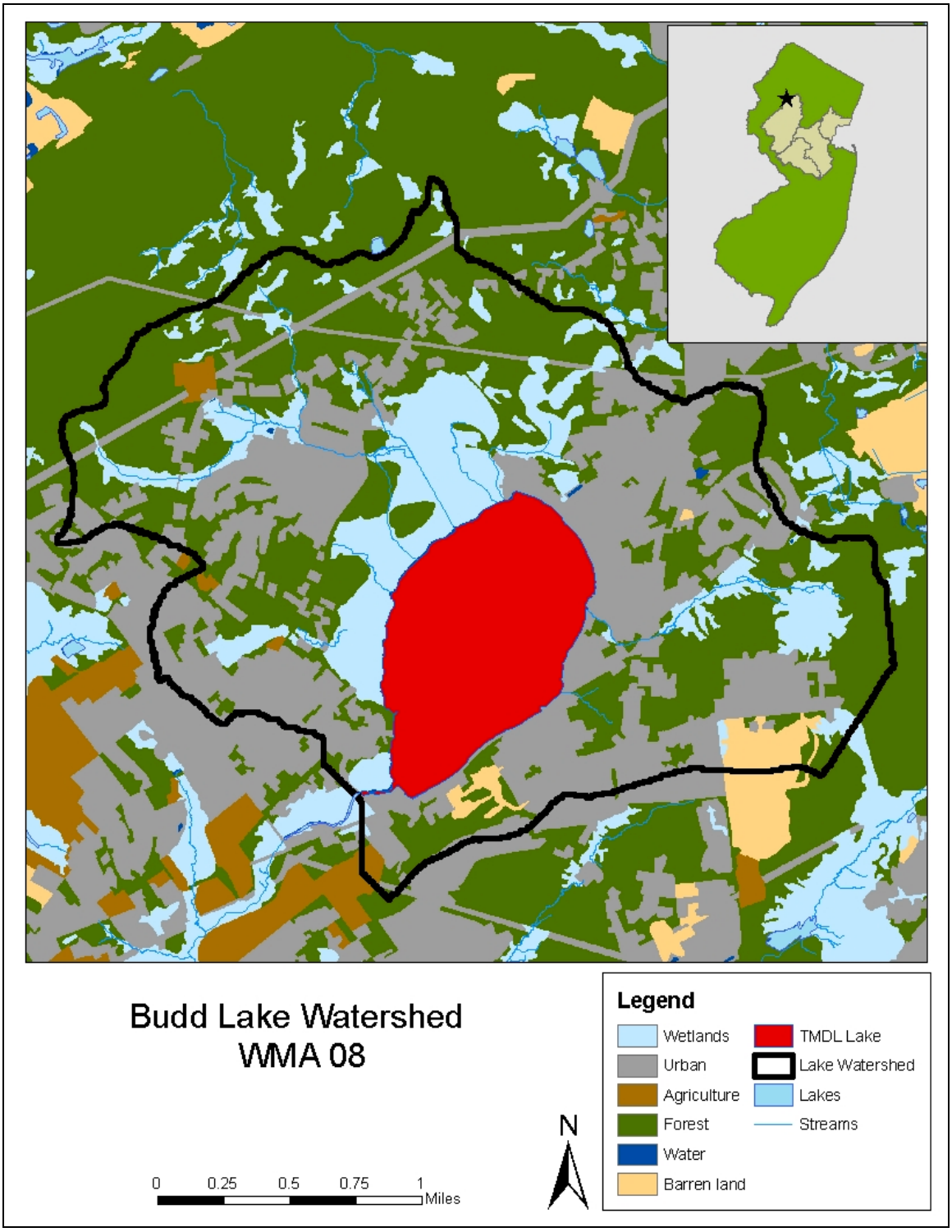
NJPDES ID	Facility Name	Pipe	FC Limit	Permit Category*	Receiving Waters/ Associated Lake
NJ0021334	Mendham Boro	001A	NA	A	India Brook (Raritan River NB)/Ravine Lake

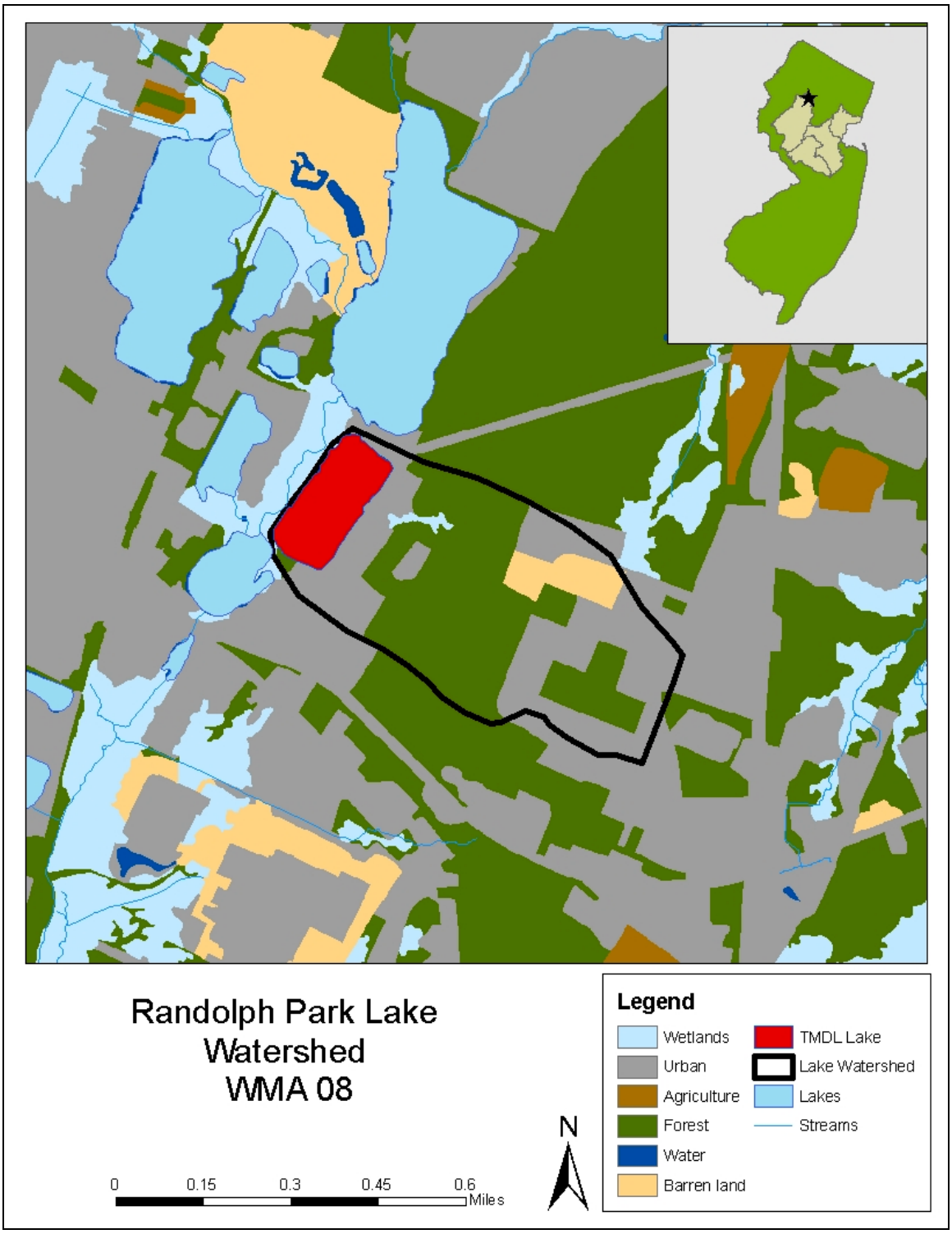
*Permit Categories: A = Sanitary Surface Water Discharge

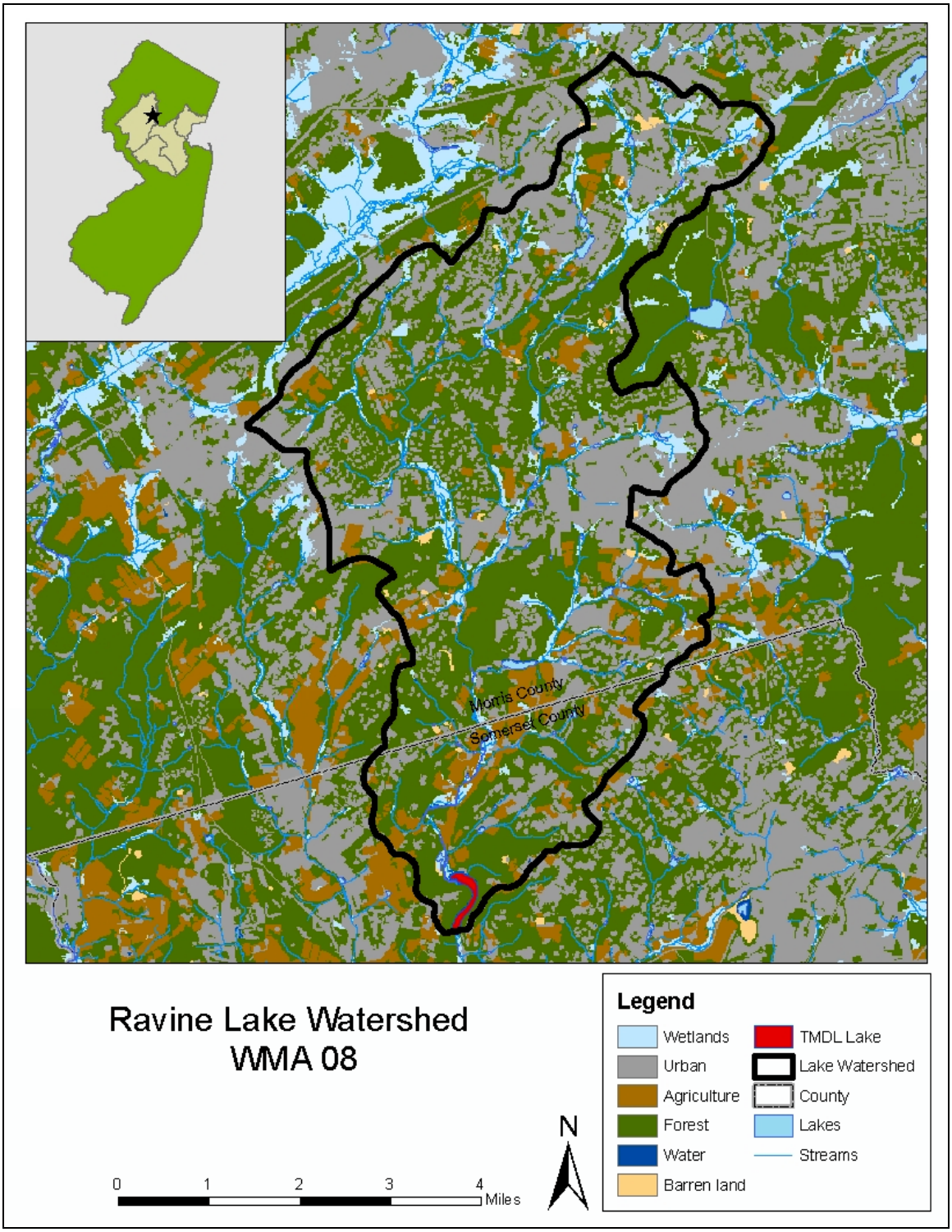
Raritan Water Region Tier A and Tier B Municipalities

Tier	Watershed	Municipality	WMA	Permit #
A	Budd Lake	Mount Olive Twp	8	NJG0148326
	Ravine Lake	Randolph Twp	8	NJG0152501
		Chester Twp	8	NJG0151238
		Mendham Twp	8	NJG0150819
		Chester Boro	8	NJG0151467
		Mendham Boro	8	NJG0151483
		Bernardsville Boro	8	NJG0151068
		Peapack Gladstone Boro	8	NJG0153711
	Sunset Lake	Bernards Twp	8	NJG0148661
		Bridgewater Twp	8	NJG0147893
	Randolph Park Lake	Mine Hill Twp	8	NJG0153133
		Randolph Twp	8	NJG0152501
B	Ravine Lake	Far Hills Boro	8	NJG0151599

APPENDIX C: LAKE WATERSHED MAPS




Randolph Park Lake
Watershed
WMA 08
0
0.15
0.3
0.45
0.6
Miles
N
Legend
Wetlands
Urban
Agriculture
Forest
Water
Barren land
TMDL Lake
Lake Watershed
Lakes
Streams


Morris County
Somerset County
Ravine Lake Watershed
WMA 08
Legend
Wetlands
Urban
Agriculture
Forest
Water
Barren land
TMDL Lake
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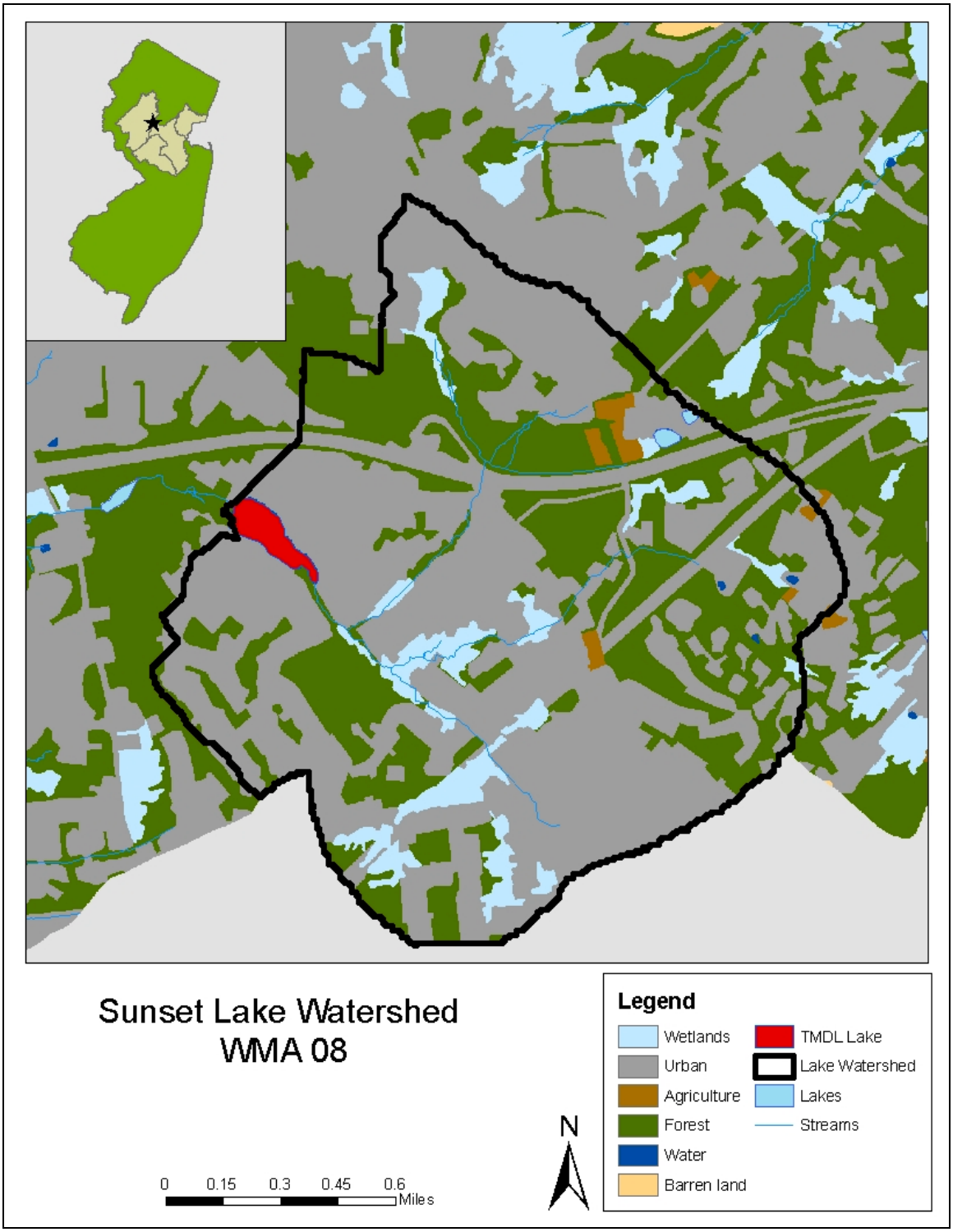
County
Lakes
Streams
N
0
1
2
3
4
Miles


Sunset Lake Watershed
WMA 08
Legend
Wetlands
Urban
Agriculture
Forest
Water
Barren land
TMDL Lake
Lake Watershed
Lakes
Streams
N
0
0.15
0.3
0.45
0.6
Miles

APPENDIX D: RARITAN WATER REGION WATER QUALITY DATA

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

WMA 08

Budd Lake			
count	185	mean+3stdev	4346
median	46	%Reduction	99%
max	18000		
stdev	1362	**no data excluded**	
mean	261		
mean+3stdev	4346		

Station	**Date**	**Value**	**Remarks**
MOL1	05/19/98	220	L
MOL1	05/21/98	1	K
MOL1	05/26/98	120	K
MOL1	06/02/98	99	K
MOL1	06/09/98	94	K
MOL1	06/16/98	79	K
MOL1	06/23/98	26	K
MOL1	06/30/98	800	L
MOL1	07/01/98	142	K
MOL1	07/07/98	4	K
MOL1	07/14/98	150	K
MOL1	07/21/98	21	K
MOL1	07/28/98	22	K
MOL1	08/04/98	1	K
MOL1	08/11/98	68	K
MOL1	08/18/98	380	L
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MOL1	09/08/98	36	K
Municipal Beach	05/25/99	421	L
Municipal Beach	05/28/99	3	K
Municipal Beach	06/02/99	6	K
Municipal Beach	06/08/99	17	K
Municipal Beach	06/15/99	20	K
Municipal Beach	06/22/99	787	L
Municipal Beach	06/24/99	4	K
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Municipal Beach	07/06/99	20	K
Municipal Beach	07/13/99	2	K
Municipal Beach	07/20/99	2	K
Municipal Beach	07/27/99	30	K
Municipal Beach	08/03/99	10	K
Municipal Beach	08/10/99	1	K
Municipal Beach	08/16/99	2340	L
Municipal Beach	08/17/99	2550	L
Municipal Beach	08/18/99	1160	L
Municipal Beach	08/19/99	108	K
Municipal Beach	08/23/99	46	K
Municipal Beach	08/24/99	48	K
Municipal Beach	08/25/99	24	K
Municipal Beach	08/30/99	4	K
Municipal Beach	08/31/99	160	K
Municipal Beach	09/01/99	154	K
Municipal Beach	09/02/99	34	K
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Municipal Beach	09/14/99	616	L
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MOL 1	03/30/00	44	K
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MOL 1	06/12/00	84	K
MOL 1	06/20/00	8	K
MOL 1	06/27/00	26	K
MOL 1	07/05/00	124	K
MOL 1	07/11/00	8	K
MOL 1	07/18/00	28	K
MOL 1	07/25/00	8	K
MOL 1	08/01/00	154	K
MOL 1	08/08/00	344	L
MOL 1	08/10/00	24	K resample
MOL 1	08/15/00	100	K
MOL 1	08/22/00	52	K
MOL 1	08/29/00	88	K
	05/15/01	102	K
	05/23/01	1040	L
	05/25/01	130	Resample K
	05/29/01	158	K
	06/05/01	96	K
	06/12/01	2	K
	06/19/01	88	K
	06/26/01	2	K
	07/03/01	8	K
	07/10/01	50	K
	07/17/01	56	K
	07/24/01	20	K
	07/31/01	30	K
	08/07/01	28	K
	08/15/01	10	K
	08/21/01	2	K
	08/28/01	2	K
	07/31/01	306	L
	08/08/01	246	L
	07/31/01	16	K
	08/08/01	16	K
	07/31/01	182	K
	08/08/01	183	K
	05/15/02	88	K
	05/21/02	14	K
	05/28/02	110	K
	06/04/02	10	K
	06/11/02	20	K
	06/18/02	20	K
	07/01/02	50	K
	07/09/02	30	K
	07/16/02	270	L, CLOSURE
	07/18/02	40	K, RESAMPLE
	07/23/02	10	K
	07/30/02	20	K
	08/06/02	30	K
	08/13/02	10	K
	08/20/02	150	K
	08/27/02	90	K
	09/09/02	10	K
	09/10/02	10	K
	09/18/02	50	K
	07/18/02	360	L
	09/03/02	2300	L
	09/09/02	40	K,RESAMPLE
	09/10/02	10	K
	09/18/02	70	K
	09/03/02	18000	L
	09/09/02	140	K,RESAMPLE
	09/10/02	380	L
	09/18/02	590	L
	09/03/02	840	L
	09/09/02	40	K,RESAMPLE
	09/10/02	10	K
	09/18/02	60	K
	09/09/02	30	K
	09/10/02	100	K
	07/18/02	10	K
	09/09/02	10	K
	09/10/02	20	K
	09/09/02	10	K
	09/10/02	140	K
	07/18/02	270	L
	09/09/02	140	
	09/10/02	690	L
	09/09/02	40	K
	09/09/02	10	K
	09/09/02	10	K
	09/09/02	10	K

Mt. Olive Beach	05/20/03	20	
	05/27/03	30	
	06/03/03	20	
	06/10/03	20	
	06/17/03	20	
	06/24/03	10	
	07/01/03	40	
	07/08/03	10	
	07/15/03	20	
	07/22/03	20	
	07/29/03	70	
	08/05/03	70	
	08/19/03	220	
	08/20/03	120	
Mt. Olive Beach	05/18/04	2	k
	05/25/04	48	
	06/01/04	216	
	06/03/04	194	
	06/08/04	20	
	06/16/04	8	
	06/23/04	168	
	06/24/04	14	
	06/25/04	30	
	06/30/04	64	
	07/06/04	26	
	07/14/04	192	
	07/21/04	66	
	07/27/04	166	
	08/03/04	94	
	08/10/04	160	
	08/17/04	160	
	08/24/04	194	
Mt. Olive Beach	06/09/05	8	
	06/14/05	8	
	06/21/05	36	
	06/29/05	88	
	07/06/05	108	
	07/12/05	96	
	07/19/05	196	
	07/26/05	42	
	08/02/05	216	closed
	08/04/05	8	resample
	08/10/05	254	closed
	08/11/05	1800	closed
	08/15/05	700	closed
	08/18/05	700	closed
	08/23/05	22	
	08/31/05	100	

Randolph Park Lake			
count	366	mean+3stdev	11744
median	60	%Reduction	98%

max	73000		
stdev	3720	**1 value excluded (73000)**	
mean	583	**Excluded. Incredibly high value (possibly data entry error)**	
mean+3stdev	11744		

STATION	**DATE**	**VALUE**	**REMARK**
MOL1	05/20/98	50	
MOL1	05/27/98	6,800	RESAMPLE
MOL1	05/29/98	10	
MOL1	06/03/98	10	
MOL1	06/10/98	10	
MOL1	06/17/98	20	
MOL1	06/22/98	10	
MOL1	07/01/98	10	
MOL1	07/06/98	10	
MOL1	07/13/98	260	RESAMPLE
MOL1	07/16/98	10	
MOL1	07/20/98	73,000	RESAMPLE
MOL1	07/22/98	20	
MOL1	07/27/98	670	RESAMPLE
MOL1	08/03/98	1000	RESAMPLE
MOL1	08/05/98	40	
MOL1	08/10/98	10	
MOL1	08/17/98	70	
MOL1	08/24/98	40	
MOL1	08/31/98	40	
MOL1	09/09/98	70	CLOSED FOR SEASON
MOL2	05/20/98	10	
MOL2	05/27/98	20	
MOL2	06/03/98	10	
MOL2	06/10/98	10	
MOL2	06/17/98	30	
MOL2	06/22/98	30	
MOL2	07/01/98	10	
MOL2	07/06/98	10	
MOL2	07/13/98	20	
MOL2	07/20/98	1,000	RESAMPLE
MOL2	07/22/98	10	
MOL2	07/27/98	430	RESAMPLE
MOL2	07/29/98	190	
MOL2	08/03/98	1500	RESAMPLE
MOL2	08/05/98	200	
MOL2	08/10/98	10	
MOL2	08/17/98	310	RESAMPLE
MOL2	08/19/98	150	
MOL2	08/24/98	50	
MOL2	08/31/98	30	
MOL2	09/09/98	250	CLOSED FOR SEASON
MOL3	05/20/98	10	
MOL3	05/27/98	60	
MOL3	06/03/98	10	
MOL3	06/10/98	10	
MOL3	06/17/98	50	
MOL3	06/22/98	10	
MOL3	07/01/98	10	
MOL3	07/06/98	40	
MOL3	07/13/98	10	
MOL3	07/16/98	10	
MOL3	07/20/98	40	
MOL3	07/22/98	160	
MOL3	07/27/98	290	RESAMPLE
MOL3	07/29/98	30	
MOL3	08/03/98	220	RESAMPLE
MOL3	08/05/98	10	
MOL3	08/10/98	10	
MOL3	08/17/98	50	
MOL3	08/24/98	40	
MOL3	08/31/98	10	
MOL3	09/09/98	10	CLOSED FOR SEASON
MOL 1	05/26/99	10	K
MOL 1	06/02/99	10	K
MOL 2	06/02/99	10	K
MOL 1	06/16/99	10	K
MOL 2	06/16/99	10	
MOL 1	06/23/99	10	K
MOL 2	06/23/99	10	K
MOL 1	06/30/99	10	K
MOL 2	06/30/99	60	
MOL 1	07/07/99	10	K
MOL 2	07/07/99	10	K
MOL 1	07/14/99	40	
MOL 2	07/14/99	70	
MOL 1	07/28/99	80	
MOL 2	07/28/99	20	
MOL 1	07/30/99	350	
MOL 2	07/30/99	90	
MOL 1	08/02/99	60	
MOL 2	08/02/99	310	
MOL 1	08/04/99	10	K
MOL 2	08/04/99	10	K
MOL 1	08/11/99	10	
MOL 2	08/11/99	10	
MOL 1	08/18/99	190	
MOL 2	08/18/99	190	
MOL 1	08/25/99	320	
MOL 2	08/25/99	100	
MOL 1	09/01/99	200	
MOL 2	09/01/99	170	
MOL 2	09/08/99	70	
MOL 3	06/02/99	10	K
MOL 3	06/16/99	90	
MOL 3	06/23/99	10	
MOL 3	06/30/99	80	
MOL 3	07/07/99	10	K

MOL 3	07/14/99	10	K
MOL 3	07/28/99	20	
MOL 3	07/30/99	860	
MOL 3	08/02/99	20	
MOL 3	08/04/99	10	K
MOL 3	08/11/99	10	K
MOL 3	08/18/99	20	
MOL 3	08/25/99	40	
MOL 3	09/01/99	200	
MOL 3	09/08/99	30	
MOL 1	06/07/00	330	
MOL 1	06/14/00	10	
MOL 1	06/21/00	10	K
MOL 1	06/28/00	10	
MOL 1	07/05/00	660	
MOL 1	07/07/00	10	K
MOL 1	07/12/00	30	
MOL 1	07/19/00	30	
MOL 1	07/26/00	40	
MOL 1	07/28/00	100	
MOL 1	08/02/00	470	
MOL 1	08/04/00	160	
MOL 1	08/07/00	210	
MOL 1	08/09/00	130	
MOL 1	08/16/00	3,800	
MOL 1	08/18/00	40	
MOL 1	08/23/00	940	
MOL 1	07/29/98	160	
MOL 2	06/07/00	270	
MOL 2	06/14/00	10	K
MOL 2	06/21/00	10	K
MOL 2	06/28/00	200	
MOL 2	07/05/00		
MOL 2	07/12/00	60	
MOL 2	07/19/00	50	
MOL 2	07/26/00	30	
MOL 2	07/28/00	40	
MOL 2	08/02/00	870	
MOL 2	08/04/00	950	
MOL 2	08/07/00	320	
MOL 2	08/09/00	10	
MOL 2	08/16/00	130	
MOL 2	08/18/00	10	K
MOL 2	08/23/00	20	
MOL 3	06/14/00	10	
MOL 3	06/21/00	20	
MOL 3	06/28/00	100	
MOL 3	07/05/00	60	
MOL 3	07/12/00	20	
MOL 3	07/19/00	10	K
MOL 3	07/26/00	10	K
MOL 3	07/28/00	100	
MOL 3	08/02/00	100	

MOL 3	08/09/00	30	
MOL 3	08/16/00	120	
MOL 3	08/23/00	100	
Left Beach	05/23/01	120	
Left Beach	05/30/01	10	
Left Beach	06/06/01	10	K
Left Beach	06/13/01	10	K
Left Beach	06/20/01	70	
Left Beach	06/27/01	100	
Left Beach	07/03/01	10	
Left Beach	07/11/01	100	
Left Beach	07/17/01	100	
Left Beach	07/24/01	20	
Left Beach	07/30/01	20	
Left Beach	08/14/01	860	Resample
Left Beach	08/17/01	10	
Left Beach	08/21/01	810	Resample
Left Beach	08/23/01	10	K
Left Beach	08/28/01	20	
Right Beach	05/23/01	120	
Right Beach	05/30/01	10	
Right Beach	06/06/01	80	
Right Beach	06/13/01	10	
Right Beach	06/20/01	10	
Right Beach	06/27/01	80	
Right Beach	07/03/01	150	
Right Beach	07/11/01	30	
Right Beach	07/17/01	10	
Right Beach	07/24/01	590	
Right Beach	07/26/01	5200	
Right Beach	07/30/01	120	
Right Beach	08/14/01	120	
Right Beach	08/21/01	2,500	
Right Beach	08/23/01	70	
Right Beach	08/28/01	80	
Swim Lane	05/23/01	90	
Swim Lane	05/30/01	100	
Swim Lane	06/06/01	30	
Swim Lane	06/13/01	10	
Swim Lane	06/20/01	10	
Swim Lane	06/27/01	10	
Swim Lane	07/03/01	10	K
Swim Lane	07/11/01	80	
Swim Lane	07/17/01	80	
Swim Lane	07/24/01	10	K
Swim Lane	07/30/01	20	
Swim Lane	08/14/01	10	K
Swim Lane	08/21/01	50	
Swim Lane	08/28/01	10	K
Left Beach	05/17/02	10	k
Left Beach	05/22/02	10	k
Left Beach	05/29/02	10	k
Left Beach	06/04/02	10	k

Left Beach	06/12/02	70	
Left Beach	06/18/02	10	
Left Beach	06/25/02	40	
Left Beach	07/01/02	260	
Left Beach	07/09/02	70	
Left Beach	07/15/02	280	
Left Beach	07/16/02	250	resample
Left Beach	07/18/02	40	resample
Left Beach	07/22/02	10	
Left Beach	07/29/02	250	
Left Beach	07/31/02	80	resample
Left Beach	08/01/02	190	
Left Beach	08/06/02	410	
Left Beach	08/07/02	10	k, resample
Left Beach	08/12/02	6,900	
Left Beach	08/14/02	40	resample
Left Beach	08/19/02	10	
Left Beach	08/21/02	130	
Left Beach	08/26/02	1,700	
Left Beach	08/28/02	9,300	resample
Left Beach	08/30/02	3,100	resample
Right Beach	02/05/17	10	k
Right Beach	05/22/02	10	k
Right Beach	05/29/02	10	k
Right Beach	06/04/02	10	k
Right Beach	06/12/02	80	
Right Beach	06/18/02	30	
Right Beach	06/25/02	80	
Right Beach	07/01/02	750	
Right Beach	07/09/02	9,000	
Right Beach	07/11/02	2,300	resample
Right Beach	07/15/02	600	
Right Beach	07/16/02	210	resample
Right Beach	07/18/02	200	resample
Right Beach	07/22/02	40	
Right Beach	07/29/02	3,400	
Right Beach	07/31/02	160	resample
Right Beach	08/01/02	2,400	
Right Beach	08/05/02	2,400	resample
Right Beach	08/07/02	150	resample
Right Beach	08/12/02	2,500	
Right Beach	08/14/02	250	resample
Right Beach	08/19/02	460	resample
Right Beach	08/21/02	50	resample
Right Beach	08/26/02	20	
Right Beach	08/28/02	10,000	
Right Beach	08/30/02	2,000	resample
Swim Lane	05/17/02	10	
Swim Lane	05/22/02	10	
Swim Lane	05/29/02	10	
Swim Lane	06/04/02	10	
Swim Lane	06/12/02	10	
Swim Lane	06/18/02	10	

Swim Lane	06/25/02	10	
Swim Lane	07/01/02	10	
Swim Lane	07/09/02	30	
Swim Lane	07/15/02	20	
Swim Lane	07/22/02	30	
Swim Lane	07/29/02	1,500	
Swim Lane	07/31/02	60	resample
Swim Lane	08/01/02	10	
Swim Lane	08/05/02	20	
Swim Lane	08/12/02	70	
Swim Lane	08/21/02	70	
Swim Lane	08/26/02	940	
Swim Lane	08/28/02	1,800	resample
Swim Lane	08/30/02	50	resample/closed for season
Inlet	05/16/02	160	
Inlet	05/22/02	90	
Inlet	05/29/02	190	
Inlet	06/04/02	360	
Inlet	06/12/02	310	
Inlet	06/18/02	200	
Inlet	06/25/02	240	
Inlet	07/01/02	10	
Inlet	07/09/02	90	
Inlet	07/15/02	110	
Inlet	07/22/02	350	
Inlet	07/29/02	260	
Inlet	08/05/02	320	
Inlet	08/12/02	270	
Beach	05/16/02	100	
Beach	05/22/02	20	
Beach	05/29/02	10	k
Beach	06/04/02	70	
Beach	06/12/02	10	
Beach	06/18/02	10	k
Beach	06/25/02	40	
Beach	07/01/02	170	
Beach	07/09/02	10	
Beach	07/15/02	470	
Beach	07/16/02	160	resample
Beach	07/22/02	120	
Beach	07/29/02	20	
Beach	08/05/02	10	
Beach	08/20/02	90	
Swim Lanes	05/29/02	10	
Swim Lanes	06/18/02	20	
Swim Lanes	06/25/02	10	
Swim Lanes	07/01/02	10	
Swim Lanes	07/09/02	30	
Swim Lanes	07/15/02	10	
Swim Lanes	07/22/02	10	
Swim Lanes	07/29/02	10	
Swim Lanes	08/05/02	10	
Swim Lanes	08/12/02	40	Closed for

			season
Lanes	05/14/03	10	K
	05/19/03	10	K
	05/27/03	30	
	06/02/03	10	
	06/16/03	20	
	06/26/03	90	
	06/30/03	20	
	07/07/03	120	
	07/14/03	10	K
	07/21/03	20	
	07/28/03	20	
	08/04/03	60	
	08/11/03	20	
	08/18/03	10	K
	08/25/03	10	
Rt. Beach	05/14/03	10	K
	05/19/03	10	K
	05/27/03	140	
	06/02/03	40	
	06/16/03	10	
	06/23/03	1,800	
	06/25/03	10	K; resample
	06/30/03	200	
	07/07/03	150	
	07/14/03	50	
	07/21/03	500	
	07/23/03	480	resample; **closed**
	07/25/03	2,000	resample
	07/28/03	400	resample
	07/30/03	4,600	resample
	08/01/03	200	resample; **reopened**
	08/04/03	2,000	
	08/06/03	390	resample; **closed**
	08/08/03	90	resample; **reopened**
	08/11/03	100	
	08/18/03	3,500	
	08/20/03	560	resample; **closed**
	08/22/03	580	resample
	08/25/03	290	resample
	08/27/03	840	resample
Left Beach	05/14/03	10	K
	05/19/03	10	K
	05/27/03	40	
	06/02/03	90	
	06/16/03	50	
	06/23/03	660	
	06/25/03	170	resample
	07/07/03	30	
	07/14/03	50	

	07/21/03	70	
	07/28/03	70	
	07/30/03	6,200	
	08/01/03	220	resample; **closed**
	08/04/03	140	resample; **reopened**
	08/06/03	2,100	
	08/08/03	210	resample; **closed**
	08/11/03	90	resample; **reopened**
	08/15/03	290	
	08/18/03	200	resample
	08/20/03	1,200	
	08/22/03	2,700	resample; **closed**
	08/25/03	820	resample
	08/29/03	10	resample; **reopened**
		6,600	
	05/25/04	290	Not open for season
	05/25/04	220	Not open for season
	05/25/04	160	
	05/27/04	110	
	05/27/04	260	
	05/27/04	70	
	06/02/04	10	K
	06/02/04	50	
	06/02/04	30	
	06/07/04	10	K
	06/07/04	10	
	06/07/04	10	
	06/14/04	10	K
	06/14/04	20	
	06/14/04	10	
	06/21/04	10	K
	06/21/04	30	
	06/21/04	10	
	06/28/04	360	
	06/28/04	10	
	06/28/04	10	K
	06/30/04	10	K; resample
	06/30/04	170	
	07/06/04	120	
	07/06/04	330	
	07/08/04	7200	K; closed
	07/12/04	10	
	07/12/04	30	
	07/12/04	20	K; reopened
	07/19/04	130	
	07/19/04	200	
	07/19/04	70	

	07/26/04	10	
	07/26/04	60	
	07/26/04	50	
	08/02/04	160	
	08/02/04	30	
	08/02/04	90	
	08/09/04	5300	
	08/09/04	730	
	08/09/04	130	
	08/11/04	30	resample
	08/11/04	40	resample
	08/11/04	80	
	08/17/04	40	
	08/17/04	790	
	08/17/04	1200	
	08/19/04	40	
	08/19/04	100	resample
	08/19/04	150	resample
	08/23/04	20	
	08/23/04	40	
	08/23/04	130	
	08/30/04	20	facility closed for season
	08/23/04	5600	
	08/23/04	430	

Ravine Lake			
count	55	mean+3stdev	3023
Median	73	%reduction	94%
Max	3500		
stdev	869	**no data excluded**	
mean	416		
mean+3stdev	3023		

Station	**Date**	**Value**	**Remark**
Somerset Lake and Gun Club	05/22/03	200	
	05/27/03	3500	
	06/02/03	3300	
	06/09/03	2100	
	06/12/03	2800	
	06/16/03	300	
	06/18/03	100	L
	06/26/03	500	
	07/03/03	47	
	07/09/03	100	
	07/17/03	25	
	07/25/03	800	
	07/31/03	1700	
	08/15/03	3100	
	05/21/01	98	
	05/31/01	69	

	06/05/01	2	
	06/11/01	60	
	06/26/01	160	
	07/03/01	45	
	07/31/01	54	
	08/15/01	400	
	08/22/01	98	
	08/28/01	9	
	05/24/02	800	
	05/28/02	40	
	06/05/02	27	
	06/10/02	103	
	06/18/02	119	
	06/25/02	63	
	07/02/02	62	
	07/09/02	30	
	07/16/02	19	
	07/23/02	14	
	07/30/02	73	
	08/07/02	27	
	08/13/02	41	
	08/20/02	400	
	08/28/02	100	
Somerset Lake and Gun Club	05/20/04	10	L
	05/25/04	30	
	05/28/04	50	
	06/04/04	20	
	06/11/04	60	
	06/18/04	40	
	06/25/04	90	
	07/01/04	10	
	07/08/04	10	
	07/16/04	120	
	07/30/04	190	
	08/04/04	140	
	08/11/04	430	
	08/19/04	120	
	08/18/04	40	
	08/25/04	30	

Sunset Lake			
count	73	mean+3stdev	4280
median	100	%reduction	97%
Max	5900		
Stdev	1231	**no data excluded**	
Mean	587		
mean+3stdev	4280		

Station	**Date**	**Value**	**Remark**
	09/03/98	96	

	08/27/98	40	
	08/20/98	84	
	08/10/98	36	
	08/07/98	20	
	07/28/98	20	
	07/21/98	80	
	07/06/98	200	
	06/29/98	8	
	06/22/98	140	
	06/17/98	160	
	06/11/98	80	
Sunset Lake	06/23/00	400	
Sunset Lake	06/27/00	88	
Sunset Lake	07/05/00	200	
Sunset Lake	07/11/00	151	
Sunset Lake	07/21/00	1500	
Sunset Lake	07/25/00	200	
Sunset Lake	08/03/00	79	
Sunset Lake	08/08/00	200	
Sunset Lake	08/17/00	10	
Sunset Lake	09/01/00	1	
Sunset Lake	05/25/01	900	
Sunset Lake	06/05/01	200	
Sunset Lake	06/07/01	600	
Sunset Lake	06/11/01	200	
Sunset Lake	06/13/01	12	
Sunset Lake	06/28/01	200	
Sunset Lake	07/02/01	5	
Sunset Lake	07/06/01	1800	
Sunset Lake	07/12/01	22	
Sunset Lake	07/19/01	157	
Sunset Lake	08/02/01	9	
Sunset Lake	08/09/01	200	
Sunset Lake	08/17/01	60	
Sunset Lake	08/24/01	5	
Sunset Lake	06/21/02	41	
Sunset Lake	07/02/02	100	
Sunset Lake	07/11/02	44	
Sunset Lake	07/16/02	16	
Sunset Lake	07/24/02	77	
Sunset Lake	08/01/02	300	
Sunset Lake	08/08/02	5200	
Sunset Lake	08/12/02	30	
Sunset Lake	08/20/02	2800	
Sunset Lake	08/23/02	35	
Sunset Lake	08/27/02	200	
Sunset Lake	09/20/02	267	
Sunset Lake	09/24/02	125	
	06/05/03	5900	
	06/09/03	4300	
	06/16/03	3900	
	07/03/03	2500	
	07/11/03	300	

	07/15/03	100	
	07/25/03	100	
	07/31/03	1500	
	05/25/04	50	
	05/28/04	30	
	06/04/04	100	
	06/11/04	60	
	06/18/04	50	
	06/25/04	10	K
	07/01/04	40	
	07/08/04	10	K
	07/16/04	30	
	07/30/04	3200	
	08/04/04	420	
	08/04/04	180	
	08/11/04	500	
	08/18/04	2000	
	08/20/04	40	
	08/25/04	160	