The Black River Watershed Restoration and Protection Plan

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Completed by the
Rutgers Cooperative Extension
Water Resources Program
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Rutgers
New Jersey Agricultural
Experiment Station

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1. Introduction

There are two basic components to managing our valuable water resources through watershed management in New Jersey. Restoration is one component, while protection and conservation is the other component. Both of these components or elements of watershed management build on information gathered from a thorough assessment of the watershed. The following report presents a thorough assessment of the water resources within the Black River Watershed, as well as recommendations for the restoration, protection, and conservation of the Black River Watershed.

The Black River Watershed is located in Morris County, New Jersey and contains portions of Washington Township, Chester Township, Chester Borough, Roxbury, Randolph and Mine Hill. The Black River Wildlife Management Area in Chester Township is a significant ecological and recreational resource that occurs within this watershed. A significant portion of the land area is noted as Environmentally Sensitive in the New Jersey State Plan, and an even greater portion of the watershed is located within the Highlands Preservation Area.

The Rutgers Cooperative Extension (RCE) Water Resources Program has undertaken the task of performing water quality testing, land surveillance, and geographic information systems (GIS) analysis to provide stakeholders within the Black River Watershed with a Watershed Restoration and Protection Plan to ensure the quality of the water resources within the watershed for the future. The Raritan Highlands Compact, along with the Association of New Jersey Environmental Commissions (ANJEC) and the municipalities, has retained the RCE Water Resources Program for this purpose.

1.1 Project Background and the TMDL Development Process

Section 303 of the Federal Clean Water Act (CWA) requires New Jersey to prepare and submit to the United States Environmental Protection Agency (USEPA) a report that identifies waters that do not meet or are not expected to meet state surface water quality standards and criteria. This report is commonly referred to as the 303(d) list. Those waterbodies, which are listed on the 303(d) list, are water quality limited waterbodies and therefore a total maximum daily load (TMDL) must be developed for each individual pollutant in these water bodies based on an agreed upon schedule between the state and USEPA.

A TMDL is a calculation of the maximum amount of a single pollutant that a waterbody can receive and still meet state water quality standards. It quantitatively assesses water quality problems, contributing sources, and load reductions or control actions needed to restore and protect individual water bodies. The ultimate goal of the TMDL process is to meet the water quality standards and ultimately improve the water resources within a watershed.

A TMDL establishes Waste Load Allocations and Load Allocations for point and nonpoint sources (NPS), respectively. These allocations together, with a margin of safety, are used to calculate the TMDL value. Point source pollution can come from the wastewater of various industries, federal, state, county, and municipal facilities, private companies, private residential developments, hospitals, and schools. These point sources are all regulated. NPS pollution, on the other hand, comes from many diffuse sources that enter waterways from stormwater runoff. Some sources of NPS pollution are excess fertilizers, sediment from streets or land that is not stable, and bacteria from pet wastes or faulty septic systems.

Within the Integrated List of Waterbodies (NJDEP, 2006) for New Jersey (a.k.a. the 303(d) list) are lists that indicate the presence and level of impairment for each waterbody monitored. The lists are defined as follows:

- **Sublist 1** suggests that the waterbody is meeting water quality standards.
- **Sublist 2** states that a waterbody is attaining some of the designated uses, and no use is threatened. Furthermore, Sublist 2 suggests that data are insufficient to declare if other uses are being met.
- **Sublist 3** maintains a list of waterbodies where no data or information are available to support an attainment determination.
- **Sublist 4** lists waterbodies where use attainment is threatened and/or a waterbody is impaired; however, a TMDL will not be required to restore the waterbody to meet its use designation.
    - **Sublist 4a** includes waterbodies that have a TMDL developed and approved by the USEPA, that when implemented, will result in the waterbody reaching its designated use.
    - **Sublist 4b** establishes that the impaired reach will require pollutant control measurements taken by local, state, or federal authorities that will result in full attainment of designated use.
    - **Sublist 4c** states that the impairment is not caused by a pollutant, but is due to factors such as instream channel condition and so forth. It is recommended by the USEPA that this list be a guideline for water quality management actions that will address the cause of impairment.
- **Sublist 5** clearly states that the water quality standard is not being attained and requires a TMDL.

The Black River is on the Integrated List of Waterbodies for 2004 and 2006. The listings for the Black River Watershed are as follows:

- The entire length of the Black River, together with its major tributary, Tanners Brook, is under a TMDL Implementation Priority for Fecal Coliform. This document was approved in September of 2003 and calls for a 90% reduction in the wasteload allocation of Fecal Coliform.

- The Furnace Road to Hillside Road (Black River Subbasin 1, See Figure 1) section of the Lamington River has been placed on the two-year TMDL schedule for temperature impairment. This area has also been listed on Sublist 5 for aquatic life (trout) and Sublist 4a for primary contact recreation. The Hillside Road to Route 10 section (Subbasins 2 and 3, See Figure 1) of the Lamington River has also been listed on Sublist 5 for aquatic life (trout) and Sublist 4a for primary contact recreation. These impairments are from the 2006 Integrated List which categorizes the waters based on use attainment.

- A TMDL for phosphorus on the Lamington River near Ironia Road is currently under development and should be completed in 2008.

2. Watershed Characterization

2.1 The Delineation of the Black River Watershed

A delineation of the Black River Watershed is provided in Figure 1. The watershed was delineated using the 7.5 minute digital elevation model data (DEM) (10-meter X 10-meter data spacing) provided by the United States Geological Survey (USGS) and the functionality of the preprocessing in the ArcHydro modeling software. The outlet of the delineated basin was positioned at the Black River crossing of Old Route 24 in Chester Township. The outlet of the basin or watershed corresponds with New Jersey Department of Environmental Protection (NJDEP) Ambient Biological Monitoring Network (AMNET) site AN0358.

Using the ArcHydro extension of ArcGIS v. 9.2, the entire Black River Watershed was subdivided into four subbasins (See Figure 1). The outlets of these subbasins correspond to the four water quality sampling stations within the watershed. The stations and subbasins were numbered from the outlet of Subbasin 1 (Site 1 – most downstream) to the outlet of Subbasin 4 (Site 4 – most upstream) in the headwaters. (See Figure 1).

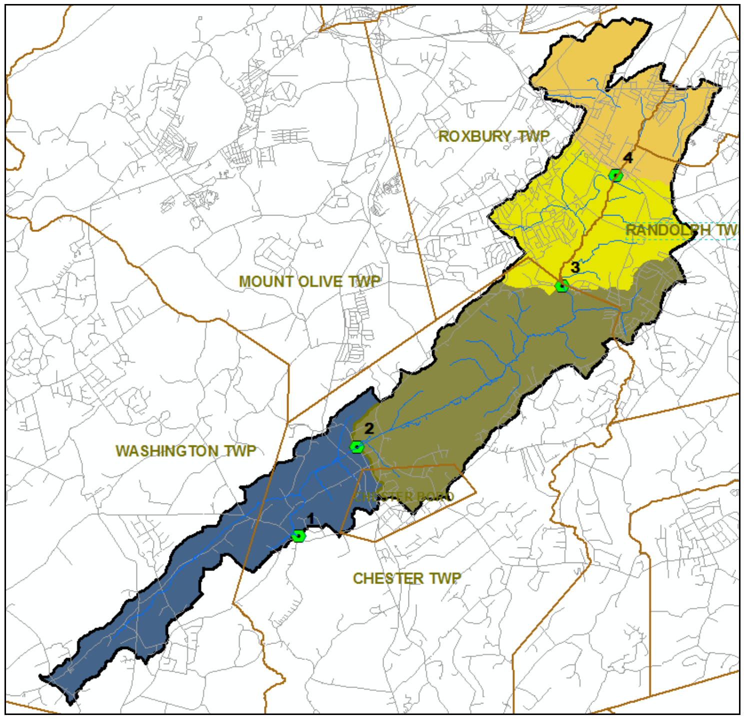

Figure 1: The Black River's Subbasins and Municipalities

2.2 Location, Area and Stream Length

The Black River Watershed is part of the North Branch of the Raritan River Watershed, located within New Jersey Watershed Management Area 8 (WMA 8). The Black River Watershed covers 21 square miles in the western portion of Morris County, New Jersey (See Figure 2).

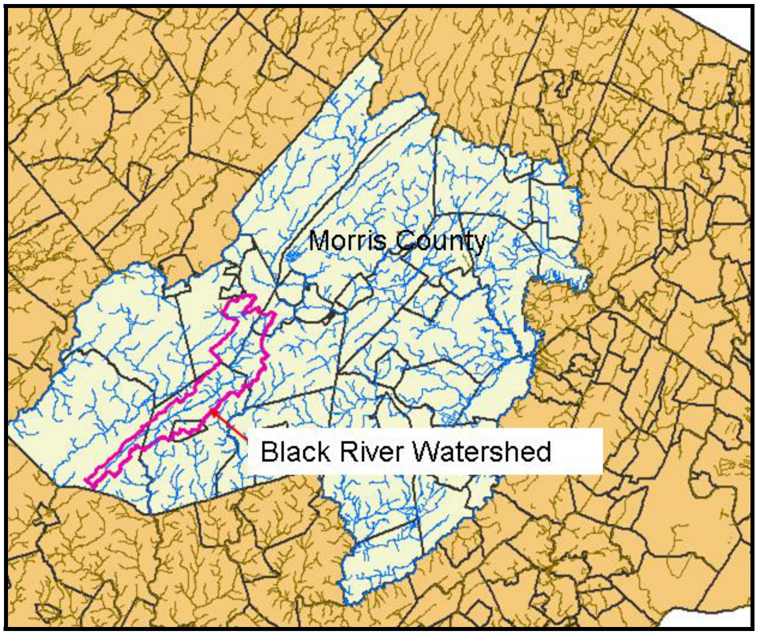

Figure 2: The Location of the Black River Watershed within Morris County

The main stem of the stream, including the Tanners Brook tributary, is approximately 13 miles long. When all mapped tributaries are included (NJDEP GIS stream layer), the total stream length extends to over forty miles. The stream winds its way from the headwaters in Mine Hill and Roxbury Township, through Randolph Township, Chester Township and Washington Township. The northwest section of Chester Borough contributes to the drainage area of the watershed.

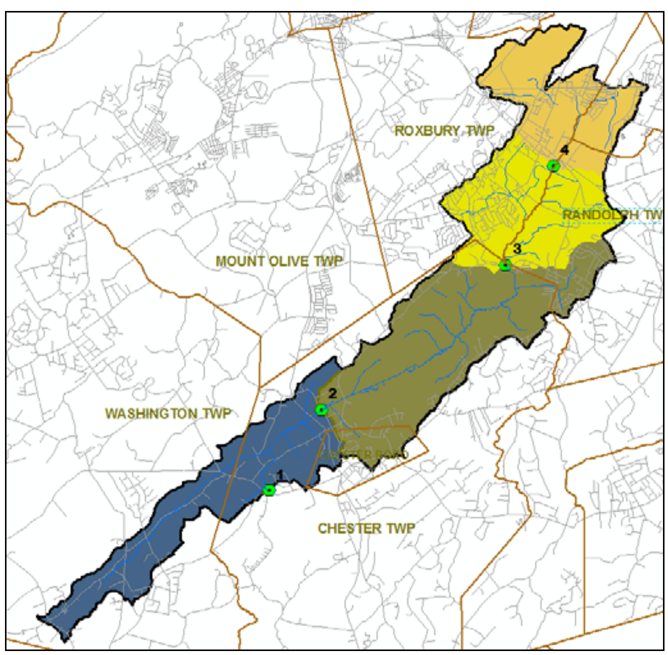

Figure 3: The Municipalities of the Black River Watershed

2.3 Stream Classification

The Black River portion of the Lamington River is designated as FW2; "FW2" means the general surface water classification applied to those fresh waters that are not designated as FW1 or Pinelands Waters. The Black River is further subcategorized into a FW2-TM (trout maintenance) section within Washington Township and Chester Township. "Trout maintenance waters" means waters designated at N.J.A.C. 7:9B-1.15(b) through (g) for the support of trout throughout the year. Above Hillside Road in Chester Township the classification changes to FW2-NT (non-trout) waters. "Nontrout waters" means fresh waters that have not been designated in N.J.A.C. 7:9B-1.15(b) through (h) as trout production or trout maintenance. These waters are generally not suitable for trout because of their physical, chemical, or biological characteristics, but are suitable for a wide variety of other fish species. One mile of FW2-TP (trout production) streams are present in Randolph Township within the Black River Watershed. "Trout production waters" means waters designated at N.J.A.C. 7:9B-1.15(b) through (g) for use by trout for spawning or nursery purposes during their first summer. These classifications aid in determining use related water quality standards. (See Appendix A, Map 1 and Figure 4).

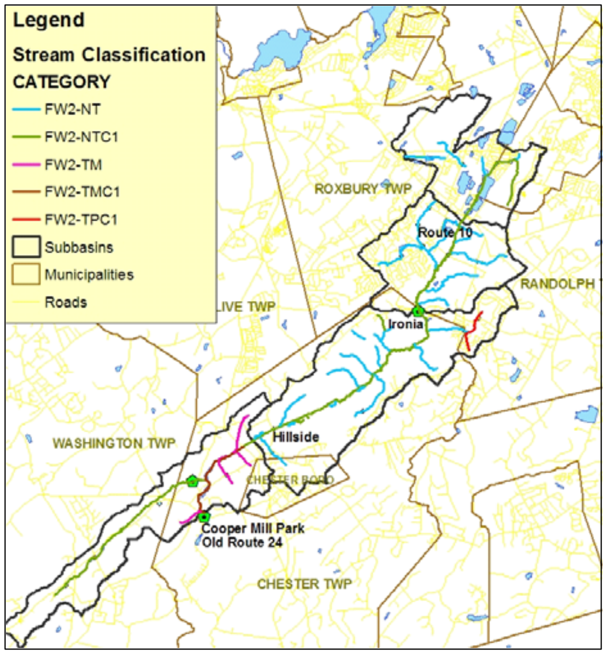

Figure 4: Stream Classification

In addition to these classifications, a Category One (C1) anti-degradation level of protection is in place for the entire main stem and the larger tributaries of the Black River, including Tanners Brook. C1 waters are protected from any measurable change in water quality because of their exceptional ecological significance, exceptional recreational significance, exceptional water supply significance, or exceptional fisheries resources.

2.4 Land Use

Land use in the Black River Watershed is primarily urban and forested lands. Three land uses combined, wetlands, water and forests, make up over 58% of the watershed (Table 1).

Table 1: Land Use in the Black River Watershed

	Total Acres	Percentage of Total
Agriculture	828.96	6.16
Barren Land	132.96	0.99
Forest	4965.85	36.92
Urban	4651.23	34.58
Water	260.24	1.93
Wetlands	2610.36	19.41
Total Acres	**13449.61**	**100%**
Square Miles	21.02	

Slightly over one-third of the Black River Watershed is characterized as "urban" land use. This urban land use includes residential, commercial, roadways and low cover forests (Table 2)

Table 2: Urban Land Use Types in the Black River Watershed

Urban Land Use, Label 2002	Acres	Percent of total urban
ATHLETIC FIELDS (SCHOOLS)	46.3	1.0
CEMETERY	35.1	0.8
COMMERCIAL/SERVICES	340.4	7.3
INDUSTRIAL	139.4	3.0
INDUSTRIAL/COMMERCIAL COMPLEXES	9.6	0.2
MAJOR ROADWAY	23.9	0.5
MIXED URBAN OR BUILT-UP LAND	1.0	0.0
OTHER URBAN OR BUILT-UP LAND	247.0	5.3
RECREATIONAL LAND	198.5	4.3
RESIDENTIAL, HIGH DENSITY OR MULTIPLE DWELLING	28.2	0.6
RESIDENTIAL, RURAL, SINGLE UNIT	1367.8	29.4
RESIDENTIAL, SINGLE UNIT, LOW DENSITY	897.7	19.3
RESIDENTIAL, SINGLE UNIT, MEDIUM DENSITY	1051.6	22.6
STORMWATER BASIN	13.6	0.3
TRANSPORTATION/COMMUNICATION/UTILITIES	28.4	0.6
UPLAND RIGHTS-OF-WAY DEVELOPED	1.7	0.0
UPLAND RIGHTS-OF-WAY UNDEVELOPED	221.0	4.8
Total	**4651.2**	**100.0**

Land Use by Subbasin

In an effort to prioritize areas for restoration and protection, the land use of the drainage area was divided into four subbasins as discussed in Section 2.1. A map of the land use can be found in Appendix A, Map B. The land use for these subbasins varies and is shown in Figure 5.

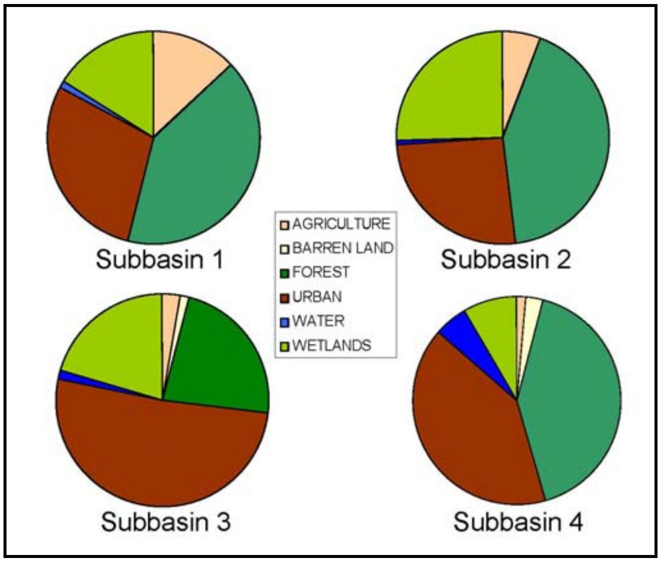

Figure 5: Black River Land Use Percentages per Subbasin

Aerial Loading Analysis

NPS pollutant loading varies with land use. Loading coefficients have been developed through the study of stormwater runoff from the various types of land uses. These coefficients can be used to estimate the impact of potential NPS pollution from the individual subbasins to the waterway. The pollutant loading coefficients (L_c) that were used for this report were compiled from the New Jersey Best Management Practices (BMP) Manual and from current literature sources, (NJDEP, 2004b) (See Appendix B).

Annual NPS loads for each subbasin were calculated using the loading equation:

$$Load = UL_c \times Area.$$

Load is expressed as pounds of pollutant per year (lbs/yr), UL_c is expressed as pounds per acre per year (lbs/acre/yr) for each specific land use, and *Area* is in acres for each specific land use. The loading equation provides an approximation for annual NPS loads on a subbasin basis. This allows for the comparison of pollutant loading between subbasins and provides a method to prioritize subbasins for restoration and/or preservation. When the area between subbasins differs to a great extent, it may be useful to normalize the load to the total area of the subbasin to compare only the land use effect.

The following two tables provide estimates of NPS pollution related to land use in the Black River Watershed. Table 3 provides the overall, total NPS loading per subbasin. To correct for the size of the subbasins, the total loading was normalized to the area of the subbasin in Table 4.

Table 3: NPS Loading (kg/yr)

	TN	NH3-N	NO2+NO3	TSS	TP
Subbasin 1	16659.3	429	1468.5	318287.2	678.8
Subbasin 2	22698.3	586.8	2241.5	363630.2	800.5
Subbasin 3	20483.1	974.3	2585.6	264094.8	825.3
Subbasin 4	24917.7	1378.5	3437.9	281689.0	942.3

Table 4: NPS Loading Normalized to Area (kg/yr/acre)

	TN	NH3-N	NO2+NO3	TSS	TP
Subbasin1	5	0.13	0.44	95.4	0.2
Subbasin 2	4.66	0.12	0.46	74.5	0.2
Subbasin 3	7.24	0.34	0.91	93.0	0.3
Subbasin 4	10.3	0.57	1.42	116.4	0.4

2.5 Water Quality Data Analysis

2.5.1 Existing Studies

Omni Environmental Corporation collected data in the Black River as part of a TMDL study for the Raritan River Watershed. Two of Omni's sampling stations were located within the Black River Watershed (See Figure 6). Data from these sites have produced valuable information that could aid in identifying problem areas that affect not only the Black River Watershed, but the larger Raritan River Watershed. Data taken during this study relating to the phosphorus and the dissolved oxygen concentration will be discussed in Sections 2.5.4 and 2.5.8, below.

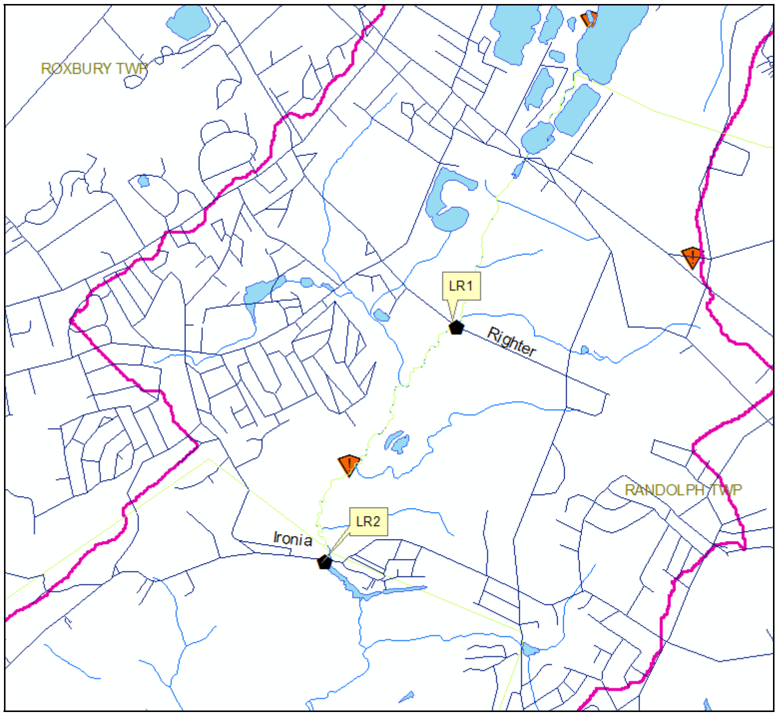

Figure 6: Location of Sampling Points within the Black River Watershed for Raritan River Phase I TMDL Report

2.5.2 Water Quality Sampling

The RCE Water Resources Program conducted water quality sampling in September and October of 2007. Sampling sites were chosen to represent the outlet of each subbasin delineated, which correlates to subtle land use changes. The four sites that were chosen can be seen in Figure 7 and in Appendix A, Map 3. Flow through the watershed generally moves toward the southwest from Site 4 to the outlet of the watershed at Site 1. Tanners Brook, a tributary to the Black River, flows in a northeast direction to join the main stem of the Black River, just above the outlet of the watershed at Old Route 24 in Chester Township. The headwaters that drain to Site 4 incorporate the effects of the more densely developed land together with many water quality ponds. The area draining to Site 3 provides insight on an area with some dense development, but also characterizes the runoff from an area that is a critical recharge area. Moving downstream, the land that characterizes the stream water quality at Site 2 is comprised largely of the Black River Wildlife Management Area. At the final water quality sampling site, Site 1, the effects of the input from the tributary, Tanners Brook, along with loosely developed lands of Washington Township and Chester Township and the farms contained within these areas are characterized.

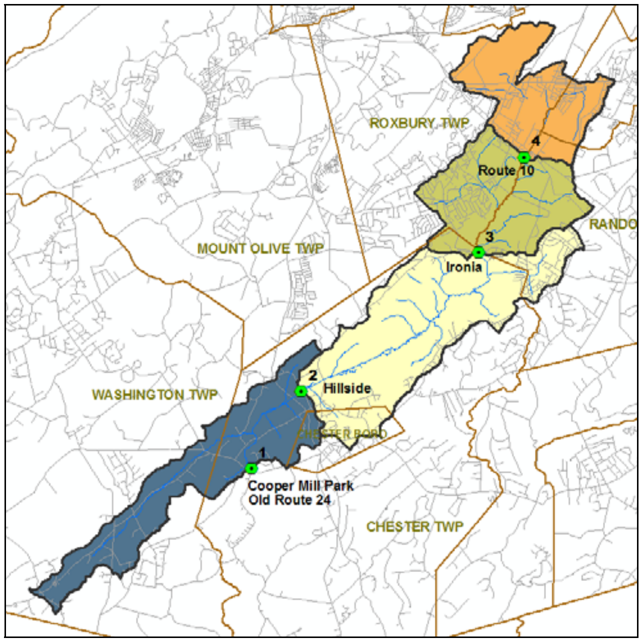

Figure 7: Black River Sampling Station Locations

2.5.1 Overview of Sampling Dates and Parameters

Ten sampling events were performed in 2007. The scheduling of the sampling events began in September of 2007 and continued through the end of October 2007. Sampling events were planned to follow a five-sample in thirty-day regimen to produce a geometric mean of the bacteria data found to be representative of the indicator organism, as required by NJDEP for bacteria monitoring. Sampling was performed without regard to weather conditions to produce results that would capture the variability of water quality in relation to precipitation conditions.

The water quality parameters included in the sampling events were as follows: pH, dissolved oxygen, temperature, fecal coliform, *E. Coli*, total phosphorus, dissolved orthophosphate and total suspended solids. All analyses were performed at a NJDEP certified lab, as referenced in the Quality Assurance Project Plan.

One sampling event was preceded by rain. Precipitation amounts are reported as the total, in inches, of rain that fell in the 24-hour period before the sampling event began. The sampling event on October 12, 2007 was preceded by 0.85 inches of rain and allowed evaluation of added NPS pollution from direct runoff.

2.5.2 Fecal Coliform

The Black River is contained within the Lamington River Watershed and varies in land use composition and pollutant sources. The Lamington River has a "Priority

Implementation" rating at the State level and has been calculated as requiring a 90% reduction of fecal coliform concentration. This TMDL was based upon the fecal coliform surface water quality criteria:

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

It is important to note that the NJDEP has replaced the fecal coliform criteria with *Escherichia coli* (*E. coli)* criteria. *E. coli* data will be discussed later in this plan.

Samples were collected at four locations on ten different days over a two month period. These data are shown in Table 5.

Table 5: Fecal Coliform concentrations (CFU/100ml)

	Fecal Coliform (CFU/100ml)			
	Site 4	**Site 3**	**Site 2**	**Site 1**
09/19/07	66	56	44	44
09/24/07	56	72	200	72
09/27/07	60	84	150	150
10/01/07	16	32	100	64
10/04/07	32	120	160	110
10/08/07	20	200	200	52
10/12/07	720	900	780	810
10/15/07	520	68	220	120
10/18/07	100	88	56	32
10/24/07	20	28	56	24

Table 6 and Table 7 provide the data separated by the season collected, as defined by NJDEP, 2003 and by sampling group of five samples within a thirty day period. The TMDL document specifies that summer is defined as May through September.

Table 6: Summer Fecal Coliform Data

September 19, 2007 through October 4, 2007						
	Fecal Coliform (col/100 ml)			***E. coli* (col/100 ml)**		
	Min	Max	Geometric Mean	Min	Max	Geometric Mean
Site 4	16	66	40.83	12	66	27.94
Site 3	32	120	66.50	36	130	70.94
Site 2	44	200	116.13	84	250	130.75
Site 1	44	150	80.33	32	120	63.04

Table 7: Fall Fecal Coliform and *E. coli* Data

October 8, 2007 through October 24, 2007						
	Fecal Coliform (col/100 ml)			***E. coli* (col/100 ml)**		
	Min	Max	Geometric Mean	Min	Max	Geometric Mean
Site 4	20	720*	108.41	4	320*	27.94
Site 3	28	900*	124.71	20	500*	84.47
Site 2	56	780*	160.84	44	690*	107.18
Site 1	24	810*	82.76	32	720*	72.15

Note 1: Asterisk denotes sampling after precipitation event

The geometric mean of all the data is 90.6 CFU/100 ml, which does not exceed the State criteria of 200 CFU/100 ml. In comparing the data to the 400 CFU/100 ml criteria, twenty-five percent of the samples in October did exceed the 400 CFU/100 ml criteria. This is mainly due to samples collect on October 12, 2007 after a storm event. Therefore, these data clearly show that a fecal coliform impairment still exists. Using these data, a new percent reduction can be determined for each of the sub-watersheds within the study area.

A review of the TMDL indicates that TMDL computations were necessary for the two criteria and resulted in percent reductions for both of these criteria. For the Black River, NJDEP applied the higher percent reduction value in the TMDL so that both the 200 CFU/100 ml and 400 CFU/100 ml criteria were satisfied. This resulted in a required fecal coliform reduction of 90% for the Black River (including Tanners Brook).

The TMDL provides two equations to determine the percent reductions: one for the geometric mean and one for the summer geometric mean. The TMDL document specifies summer data as including May through September. The geometric mean of the data that were collected for this study from September 19, 2007 through October 4, 2007 was inserted into the summer equation, and the geometric mean of the data collected from October 8, 2007 through October 24, 2007 was entered into the general equation. Using a 90% confidence interval, load reductions specific to the Black River Watershed were calculated and can be seen in Table 8 below. The load reductions required to achieve the general criteria have been determined to be more stringent than the load reductions needed to satisfy the summer criteria, and therefore are the target reductions for this plan. The detailed calculation is presented in Appendix C.

Table 8: Load Reductions Specific to the Black River Subbasins

	Load Reduction Required	
	Summer Criteria (400org/100ml)	General Criteria (200 org/100ml)
Site 4	12%	67%
Site 3	46%	71%
Site 2	69%	78%
Site 1	55%	56%

2.5.3 *E. coli*

Revised water quality criteria have been set for bacteria levels using *E. coli* as the indicator organism for pathogens. According to the surface water quality standards found in N.J.A.C. 7:9B October 2006:

> *E. coli levels for FW2 waters shall not exceed a geometric mean of 126 CFU/100ml or a single sample maximum of 235 CFU/100ml.*

Samples were collected at four locations on ten different days over a two month period. These data are shown in Table 9.

Table 9: *E. coli* concentration (CFU/100ml)

Date	Precip	Site 4	Site 3	Site 2	Site 1
09/19/07		66	36	84	36
09/24/07		32	130	100	120
09/27/07		28	80	140	120
10/01/07		24	60	250	32
10/04/07		12	80	130	60
10/08/07		4	160	160	48
10/12/07	0.85	320	500	690	720
10/15/07		32	20	44	34
10/18/07		64	56	52	32
10/24/07		32	48	56	52

The geometric mean of these data is 67.1 CFU/100 ml, which does not exceed the surface water quality criteria of 126 CFU/100 ml. In comparing the data to the 235 CFU/100 ml criteria, five out of the forty samples did exceed the 235 CFU/100 ml criteria. The wet weather event on October 12, 2007 corresponded with an increase in the concentration of *E. coli*, bringing all sites out of compliance with the single sample maximum (See Table 7). During the dry weather sampling events, Site 2 exceeded the geometric mean criteria during the summer sampling session and also had one sample that exceeded the single sample criteria. Therefore, these data clearly show that *E. coli* impairment still exists.

2.5.4 Phosphorus

Total Phosphorus

According to the New Jersey 2004 and 2006 Integrated Water Quality Monitoring and Assessment Report, segments of the Black River do no meet the criteria for total phosphorus. This impairment is based on sampling data exceeding the 0.1 mg/L phosphorus surface water quality criteria for streams. A TMDL for the Raritan River Watershed including Black River is currently being prepared by NJDEP to address this impairment.

The data from water quality sampling events on the Black River is shown in Table 10. This data shows water quality criteria exceedances during dry weather at Site 3. The instream total phosphorus concentration at this location is below the criteria after the wet weather event on October 12, 2007. High instream concentration during dry events and low concentration during wet events is indicative of a point source located upstream of Site 3, but downstream of Site 4. A permitted wastewater treatment plant is located just upstream of Site 3 and has been identified by NJDEP in their TMDL study as the source of the total phosphorus impairment at this location. This exceedence does, however, rebound to areas of compliance by Site 2, suggesting that a sink may exist between Site 3 and Site 2.

Table 10: Total Phosphorus (mg/L)

Date	Precip	Site 4	Site 3	Site 2	Site 1
09/19/07		ND	0.10	0.04	0.03
09/24/07		0.02	0.14	0.04	0.03
09/27/07		0.03	0.16	0.06	0.05
10/01/07		0.03	0.21	0.06	0.05
10/04/07		0.04	0.19	0.04	0.05
10/08/07		0.03	0.24	0.05	0.06
10/12/07	0.85	0.03	0.05	0.07	0.07
10/15/07		0.03	0.07	0.04	0.04
10/18/07		0.03	0.11	0.05	0.05
10/24/07	0.07	0.03	0.23	0.07	0.06

Dissolved Orthophosphate

Dissolved Orthophosphate is one component of total phosphorus. It is the most biologically available component of phosphorus. Orthophosphate concentrations reported are detailed in Table 11.

Table 11: Dissolved Orthophosphate (mg/L)

Date	Weather	Site 4	Site 3	Site 2	Site 1
09/19/07		nd	0.09	0.02	0.02
09/24/07		0.01	0.16	0.03	0.02
09/27/07		nd	0.07	0.02	0.01
10/01/07		nd	0.1	0.01	0.01
10/04/07		0.02	0.12	0.02	0.02
10/08/07		nd	0.16	0.02	0.02
10/12/07	0.85	nd	0.04	0.05	0.05
10/15/07		nd	0.06	0.02	0.02
10/18/07		nd	0.05	0.02	0.01
10/24/07	0.07	nd	0.15	0.03	0.03

nd = non-detect

The data collect for this study confirms the finding in the "The Raritan River Basin TMDL Phase I Data Summary and Analysis Report" (TRC Omni Environmental Corporation, 2005) that the Lamington River exceeds the 0.1 mg/L total phosphorus surface water quality criteria in Chester, downstream of Roxbury Township STP (Ajax Terrace), but returns to a low phosphorus condition downstream in Pottersville and near Whitehouse (sites downstream of the delineated Black River Watershed).

2.5.5 Total Suspended Solids

Two criteria for total suspended solids (TSS) exist for FW2-TM and FW2-NT classified waters. Since all sampling was performed on the main stem of the Black River, the stricter trout maintenance criteria of 24 mg/L of TSS applies. The level of total suspended solids allowed before exceeding criteria is 24 mg/L. All samples taken on the Black River, including samples collected following the precipitation event, fell well below the criteria, as can be seen in Table 12.

Table 12: Total Suspended Solids (mg/L)

Date	Site 4	Site 3	Site 2	Site 1
09/19/07	0.5	0.5	2.5	nd
09/24/07	1.5	1.0	1.0	0.5
09/27/07	1.5	2.5	0.3	1.5
10/01/07	2.0	2.5	3.0	1.5
10/04/07	1.5	1.0	1.5	1.5
10/08/07	nd	nd	0.5	1.0
10/12/07	3.0	1.0	2.0	2.5
10/15/07	4.0	0.5	nd	1.0
10/18/07	1.0	1.0	1.5	1.5
10/24/07	2.0	1.5	1.0	1.5

nd = non-detect

2.5.6 pH

The pH level of all waters should be within a range of 6.5 to 8.5 Standard Units (S.U.). Values less than 7 are considered "acidic" and values over 7 are considered "basic." A value of 7 would be considered neutral.

The measurements for the Black River can be found in Table 13. Twenty-two of the forty total samples collected exceeded the surface water quality criteria. The Black River is not currently listed as impaired for this pH.

Table 13: pH (S.U.)

Date	Site 4	Site 3	Site 2	Site 1
09/19/07	7.06	~~4.02~~	6.47	6.70
09/24/07	6.61	~~3.89~~	6.49	6.46
09/27/07	6.82	6.89	6.77	7.29
10/01/07	6.42	7	6.40	6.68
10/04/07	6.83	6.35	6.31	6.82
10/08/07	7.01	6.30	6.25	6.36
10/12/07	6.95	6.02	6.32	6.50
10/15/07	5.89	6.03	5.86	5.84
10/18/07	7.24	6.63	6.24	6.65
10/24/07	6.56	5.98	6.06	6.24

Note: Strikethrough indicates statistical outliers

2.5.7 Temperature

There are three criteria applied to the various classifications of surface waters for temperature. For FW2-TP and TM waters, the surface water quality criteria is "no thermal alterations which would cause temperatures to exceed 20 °C (68 °F) summer seasonal average." For FW2-NT (small mouth bass and yellow perch waters), the surface water quality criteria is "no thermal alterations which would cause temperatures to exceed 27.8 °C (82 °F) summer seasonal average." For FW2-NT waters, the surface water quality criteria are "no thermal alterations which would cause temperatures to exceed 30 °C (86 °F) summer seasonal average." Portions of the Black River have been noted to be impaired for temperature, according to the 2004 and 2006 Integrated Report.

Only the main stem of the stream that passes through Subbasin 1, to the outlet of the delineated Black River Watershed, would need to adhere to the criteria of 20 °C (68 °F) summer seasonal average. All other data reported for the outlets of Subbasins 4 through 2 would need to adhere to the criteria of 30 °C (86 °F) summer seasonal average.

All temperature readings taken for Subbasins 2 and above fell within the limits of the criteria, not approaching 30 °C during the sampling periods. With the increased stringency of the criteria for Site 1, one data point taken on October 8, 2007, exceeded the criteria and one data point, taken on September 27, 2007, met that criteria with a reading of 20.0 °C. Temperature fluctuations throughout the sampling period can be seen in Figure 8.

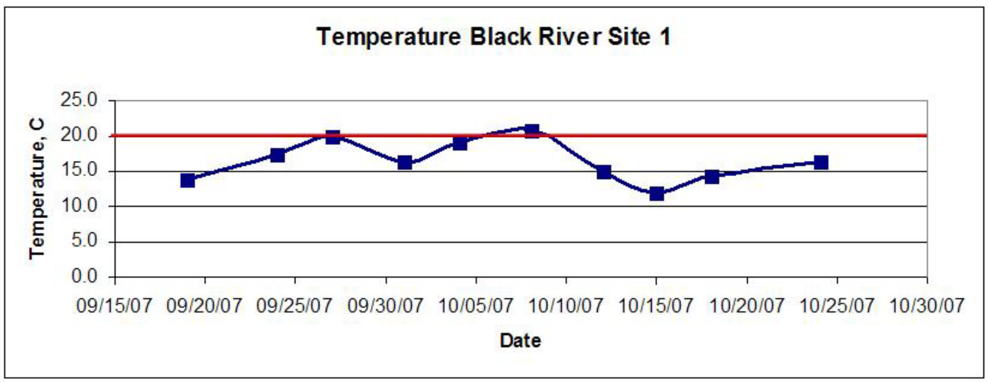

Figure 8: Temperature Site 1

2.5.8 Dissolved Oxygen

Dissolved oxygen concentrations can fluctuate over a 24-hour period, with concentrations increasing during daylight hours from photosynthesis and decreasing during the night from respiration. Typically the highest concentrations of dissolved oxygen occur in the hours approaching dusk, and the lowest concentrations of dissolved oxygen occur in the hours approaching dawn. Dissolved oxygen concentrations are also highly dependent on water temperature, being lower at higher temperatures.

According to New Jersey's surface water quality criteria, both TM and NT waters posses a criteria based on a 24-hour average, and a one time point minimum. For the trout maintenance section of the Black River, the criteria is a twenty-four average not less than 6.0 mg/L and no less than 5.0 mg/L at any time. The criteria for the non trout section, Subbasin 2 and above, is a 24-hour average no less than 5.0 mg/L but not less than 4.0 at any time.

Table 14: Dissolved Oxygen (mg/L)

Date	Site 4	Site 3	Site 2	Site 1
	FW2-NT	FW2-NT	FW2-NT	FW2-TM
09/19/07	4.82	5.66	6.26	6.70
09/24/07	4.50	5.75	5.49	10.30
09/27/07	4.50	4.94	5.30	7.93
10/01/07	3.93	6.4	5.13	7.59
10/04/07	4.64	4.21	4.16	8.66
10/08/07	4.24	3.57	3.77	7.18
10/12/07	5.27	4.35	3.80	7.92
10/15/07	5.57	7.06	5.25	10.07
10/18/07	6.87	7.38	5.15	7.16

Since only single measurements of the dissolved oxygen were gathered during the sampling events on the Black River, only the single point criteria can be assessed without making large assumptions about averages. As the data reported in Table 14 show, Site 4, the most upstream site, is below the acceptable level consistently through early October. Site 3 and Site 2 also have dissolved oxygen below the required level, on four and three occasions, respectively. For Site 1 with the increased stringency of the trout maintenance criteria, dissolved oxygen was at desirable levels during all sampling events.

Additional dissolved oxygen data were collect by Omni Environmental Corporation and are presented in the "The Raritan River Basin TMDL Phase I Data Summary and Analysis Report" (TRC Omni Environmental Corporation, 2005). For this study, Omni Environmental Corporation conducted 24-hour dissolved oxygen monitoring. Extreme diurnal swings in dissolved oxygen concentration as high as 10 mg/L exacerbate the low dissolved oxygen, causing the stream to violate the 4.0 mg/L minimum dissolved oxygen criteria and even become apparently anoxic during the night under extreme low flows. This is the only impairment designated by the NJDEP for dissolved oxygen in the Raritan River.

2.5.9 Benthic Macroinvertebrates

In the Black River Watershed, three active biomonitoring stations exist (See Figure 9). These stations are among approximately 800 stations monitored by the NJDEP's Bureau of Freshwater & Biological Monitoring as part of the Ambient Biomonitoring Network (AMNET) (NJDEP, 2000). Data collected from these monitoring locations are used to evaluate streams for biological impairment as indicated by the New Jersey Impairment Score (NJIS).

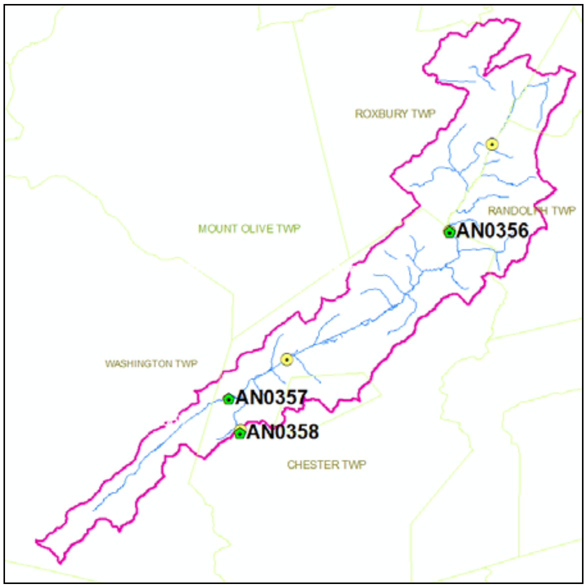

Figure 9: Location of AMNET Stations in the Black River Watershed

Table 15 lists these AMNET locations within the Black River Watershed and the assessment results. Assessment results can be defined as non-impaired, moderately impaired, and severely impaired.

Non-impaired is defined by a benthic community comparable to other undisturbed streams within the region. The community is characterized by maximum taxa richness, balanced taxa groups, and good representation of intolerant individuals.

Moderately impaired describes a macroinvertebrate community whose richness has been reduced, in particular pollutant-intolerant species. There may also be a reduced community balance and numbers of pollutant-intolerant taxa.

Severely impaired refers to a benthic community dramatically different from those in less impaired situations; macroinvertebrates are dominated by a few taxa with many individuals and only pollutant-tolerant individuals are present (NJDEP, 2000).

Table 15: AMNET Stations in the Black River Watershed

Site ID	Station Name	1994 Result	1999 Result	2004 Result
AN0356	Lamington River at Ironia Road	Moderate	Moderate	Moderate
AN0357	Tanners Brook	Moderate	Non-impaired	Non-impaired
AN0358	Lamington River at Rt. 24 (Cooper Mill Park)	Non-impaired	Non-impaired	Moderate

The 2006 Integrated Water Quality Monitoring and Assessment Report notes Subbasin 1 is on Sublist 5 for Aquatic Life-Trout, and Subbasins 2 and 3 are on Sublist 5 for both Aquatic Life-Trout and General. Sublist 5 states that these waterways clearly do not meet designated uses and require a TMDL.

2.5.10 Stream Visual Assessment Protocol

Twenty-two Stream Visual Assessment Protocol (SVAP) data points were collected during June and July of 2007 by members of the Raritan Highlands Compact. For the details of the protocol and data, please go to http://www.water.rutgers.edu/SVAP/SVAP.htm. The protocol used is based on the USDA Stream Visual Assessment Protocol, revised by the RCE Water Resources Program (previous edits completed by TRC Omni Environmental and the Delaware Riverkeeper Network).

Using the SVAP, impaired reaches of stream are rated as to their degree of degradation. Using several parameter categories (e.g., bank stability, water appearance, channel condition, riparian zone, etc.) and a scoring range as indicated in the USDA Stream Visual Assessment Protocol, a score is given for each parameter and averaged to yield an overall score. The following range and description is used:

< 6.0 Poor
6.1-7.4 Fair
7.5-8.9 Good
>9.0 Excellent

Map 4 in Appendix A shows all the sites that SVAP data was collected and the resultant average score per site.

2.6 Discussion of Black River Data

Although the aerial loading analysis (Section 2.4) indicates that Subbasin 4, the most urbanized of the four subwatersheds, contributes the highest NPS loads for total phosphorus and total suspended solids on a per acre basis, the water quality data suggest that the on-line impoundments located in this subwatershed are effectively functioning as BMPs and reducing the downstream water quality impacts from the urbanized land use. However, if the lakes are functioning as a sink for water quality contaminants, then it is likely that the water quality of the lake and its sediments are impacted. The nutrients that are accumulating in these waterways can create eutrophic conditions represented by algal growth, consumption of dissolved oxygen, and lake filling. The sedimentation of the lakes can become a concern, and ultimately dredging may be necessary.

In evaluating the data collected for this study, the instream bacteria concentrations were found to increase during rainfall events, thereby indicating that the source is nonpoint in nature. The percent reduction in fecal coliform loading was calculated for each of the subbasins based upon the data collected for this study (Section 2.5.2). These calculations suggest that a lower load reduction is needed than specified in the TMDL for the Black River.

Total phosphorus concentrations were high at Site 3 immediately downstream of the wastewater treatment plant. This is the only monitored location in this watershed where phosphorus was not meeting the surface water quality criteria. This confirms the preliminary findings of the Raritan Basin TMDL. The wastewater treatment plant's impact on the Black River will be addressed in the TMDL and ultimately, could receive lower effluent limitations for total phosphorus. The elevated phosphorus concentrations decrease to below the surface water quality criteria by Site 2. This is most likely due to the settling of inorganic phosphorus and plant uptake of organic phosphorus. Between Site 3 and Site 2, the Black River is a slow meandering stream through a marshy area.

Another suspected effect of the discharge coming from the Roxbury Ajax wastewater treatment facility, is a large diurnal dissolved oxygen swing possibly indicating excessive algal activity (respiration and photosynthesis). In diurnal data collected for the phosphorus TMDL, dissolved oxygen levels were found to dip below the minimum surface water quality criteria of 4 mg/L.

For this project, dissolved oxygen was measured *in situ* once during each sampling event at each location. On four occasions, dissolved oxygen dipped to below the minimum criteria during the sampling events (once at Site 4, once at Site 3 and twice at Site 2). Since samples were always collected in the morning, if algal activity was impacting the instream dissolved oxygen, concentrations would be expected to be lower in the early morning hours and higher in the later afternoon hours due to oxygen production through photosynthesis. The Raritan Basin TMDL study did collect diurnal dissolved oxygen at Site 3 which indicated that dissolved oxygen goes to zero at this location. Similar data should be collected at Site 2 where dissolved oxygen was measured to be below the standard minimum during this study.

Summary:

- The Black River is not meeting the designated use for primary contact recreation. This is due to high fecal coliform concentrations for which a TMDL has been developed. This TMDL requires a 90% reduction. This reduction was recalculated using the data collected for this study.

- Portions of the Black River are not meeting the designated use for aquatic life (trout). This is due to documented high temperatures during the warmer summer months. On one occasion, the temperature did exceed the surface water quality criteria during this study. These data were collected in September and October; it would be expected that temperature exceedences occur in the warmer months (July and August).

- Portions of the Black River are not meeting the designated use for aquatic life (general). This listing is due to a moderately impaired benthic community as measured in the AMNET survey by NJDEP. Further study is needed to determine the causes of the impairment.

- Portions of the Black River are also not meeting water quality standards for total phosphorus.

3.0 Identification of Causes of Impairment and Pollutant Sources

The Raritan Basin TMDL presents a broad identification of the causes of the fecal coliform impairments that may be affecting the watershed. For the watershed of the Lamington River near Ironia, the report suggests that land use sources including suburban development and geese provide a source that is negatively impacting the waterway. The TMDL recommends that Environmental Quality Incentive Program (EQIP) funds be used to install agricultural BMPs, to develop goose management programs for local communities, and to implement the Phase II stormwater program (NJDEP, 2006).

A review of the data and a detailed inspection of the land use/cover in the watershed have yielded several potential sources of bacteria. NJDEP is correct that geese are an issue in this watershed. Waterfowl have been seen in the ponds/lakes of the watershed. Also, large open spaces of turf grass provide habitat for geese, and evidence of geese was seen at several of these sites within the watershed. The watershed does contain agricultural land uses, many of which are equine operations. Although many of these farms have buffers along the stream, they are still a potential source of pollution. Due to the large contiguous areas of forest, wetlands, and waterways, wildlife is expected to be a contributing factor in bacteria impairments. Evidence of raccoon was found in the stream. These raccoon have been known to live in stormwater piping. Additionally, deer and turkeys are commonly found within the watershed. Both of these species can be contributing to the bacteria impairments. Finally, urbanization is a contributing factor. Pet waste, septic systems and garbage dumpsters can all be contributing to the bacteria impairment.

As discussed above, potential sources of bacteria contamination have been identified throughout the Black River Watershed. Additional studies need to be conducted to better quantify these sources. Various microbial source tracking (MST) techniques have been successfully used throughout the country to identify sources of bacteria, but very few of these techniques can be used to quantify the sources. In New Jersey, Rutgers University has applied quantitative polymerase chain reaction (qPCR) with *Bacteroidetes* spp. in the Salem River Watershed with known fecal impairment. The qPCR effort in this watershed successfully quantified the input of human, bovine, and other sources of *Bacteroidetes* at ten locations on several occasions. A similar effort should be conducted in the Black River Watershed to better quantify the sources, which will allow the stakeholders in the watershed to better prioritize restoration efforts.

Regarding the total phosphorus impairment, the Roxbury Ajax Wastewater Treatment Plant, located upstream of sampling location 3, is most likely the main cause of the elevated phosphorus levels observed in the system. The Raritan Basin Phosphorus TMDL will address the impacts of the Roxbury Ajax Wastewater Treatment Plant. Other sources of phosphorus include geese, domestic pets, highly fertilized lawns and driveways, agriculture fields, farm animals, and wildlife. BMPs that are designed to remove bacteria will also be effective at removing phosphorus attributed to these nonpoint sources.

4.0 Management Measures

A. Watershed Wide Management Measures

1. Septic Management Program (Onsite Wastewater Treatment Systems)

Throughout the site surveillance portion of this study, it became apparent that many areas within the Black River Watershed service their wastewater onsite with septic systems (i.e., Onsite Wastewater Treatment Systems (OWTS)). Mounded septic systems, those that have replaced older, failing systems, were specifically identified in Subbasin 4. These systems themselves are not the primary concern, but it is the fact that older systems that are failing may still be in place and may not be being detected. Failing onsite wastewater treatment systems have the ability to emit not only bacteria and associated viruses, but may also contribute to the excess nutrient pollution within a watershed.

OWTSs may be the best option in many areas because of relatively low construction and maintenance costs and successful treatment of domestic wastewater when functioning properly. Because impaired and failing systems are costly to fix and replace and can endanger public health and water quality, proper maintenance of OWTS is essential. Furthermore, management of OWTS systems can help ensure proper maintenance and aid in discovering malfunctioning systems before the problem becomes larger and more expensive to repair. Thus, the EPA has developed a voluntary OWTS management program consisting of five models based upon varying levels of management. These management models should be considered for the municipalities in the Black River Watershed. See the attached Fact Sheet on the Five Levels of OWTS Management located in Appendix D.

A detailed survey needs to be conducted to identify the location of homes with OWTSs. Education efforts need to be targeted at these homeowners to ensure that their OWTSs are being maintained. Additionally, an analysis should be conducted to determine the risk to nearby waters that is associated with these systems. The soil suitability, depth to groundwater, and the proximity to nearby waterways needs to be considered in this analysis. If the risk for environmental impact from these systems is great, a more advanced management level should be considered.

2. Dumpster Leachate Management Program

The bacterial contamination noted could have a potential source in the discharge of leachate from open dumpsters containing food waste and child or adult waste products. For this reason, the development of a comprehensive plan to address the proper containment of dumpster related leachate should be considered for the watershed.

The program should begin with a review of currently held waste ordinances for each municipality and advance to provide educational materials to all businesses that have dumpsters on their property. Educational materials would need to include information on preventing precipitation from reaching the contents of a dumpster. Additional information on the ideal drainage of the dumpster area, including draining area to a pervious surface and avoiding the direct discharge to a catch basin should be provided to businesses that utilize this type of waste disposal option.

3. Equine Operations Technical Assistance Program

The watershed is home to a variety of equine operations. These facilities can be potential sources of bacteria contamination. Technical assistance is necessary for the equine operators to provide them information on how to better manage their facility to minimize their impact on the surrounding waterways. Additionally, this program should work with these farmers to take advantage for Farm Bill funding that is available from Natural Resources Conservation Service (NRCS) to implement environmental controls and conservation practices. RCE has the potential to develop and implement this program. Traditionally, RCE has provided twilight training sessions at local farms to address county-wide agricultural and environmental issues. Also, RCE County Agents have been working one-on-one with farmers across the state to help them adopt agricultural management practices for their farms.

The Technical Assistance Program will build upon North Jersey Resource Conservation and Development Council's (North Jersey RC&D) Farmer Friendly Program and the Rutgers Equine Science Center Sustainable Agriculture Research and Education's program on equine pasture management. Additionally, the RCE of Salem County's Agricultural Agent, Dave Lee, developed a program where RCE County Staff would visit local farms and help them identify farm issues that could adversely impact the nearby waterways and solutions for these issues. The information collected and lessons learned from these other efforts will be incorporated into this Technical Assistance Program.

4. Goose Management Programs

The non-migratory Canada goose has been identified as contributing nutrient and bacteria pollution to lands and waterways throughout New Jersey. The Morris County Parks Commission has found success in implementing a long term program to remove geese and addle their eggs before they hatch. This program also encourages habitat enhancement that discourages the nesting of these animals. For the purposes of this plan, this program should be confidently supported and extended into municipal arenas, industrial complexes and educational facility complexes that have lands identified as being attractive to the activities of the goose.

5. The Disconnection of Stormwater Runoff from Impervious Surfaces

The development of land increases the impervious footprint. Rainwater from these surfaces, be it rooftop, driveway, road or compacted dirt parking area, often require a conveyance system to move the excess water away from the developed area. This routing of excess rainwater removes an essential resource from recharging into the groundwater aquifers. This conveyance may also create a quicker rise in the stream flow during storms and tends to carry the pollutants that it passes over directly to the stream. This "directly connected" stormwater routing short circuits recharge and pollutant attenuation and can be remedied by "disconnection and infiltration" of excess rainwater from these impervious sites.

The disconnection of impervious area and the infiltration of the excess stormwater can take place in various scenarios, from the routing of sheet flow off an industrial parking lot to a vegetated swale, to the capture of roof runoff in a small bioretention system known as a rain garden.

Municipalities can incorporate recommendations that provide development or re-development with guidance on how to achieve maximum infiltration from their impervious footprint. Education efforts discussed in Section 7 aimed at residents can incorporate this agenda. The RCE Water Resources Program offers a "RU Disconnected?" manual that supports this endeavor for use with residential programs and commercial applications, as well. In addition, the municipalities may find an ideal opportunity to work with ANJEC and other agencies on developing new ordinances to promote disconnection and infiltration.

6. Microbial Source Tracking Study

Additional data need to be collected to quantify the sources of bacteria within the watershed. A sampling program should be implemented to collect samples during dry weather and wet weather conditions. Samples should be analyzed for *E. coli*. Furthermore, qPCR with *Bacteroidetes* should be used to determine the contribution of each of the identified sources at each of the locations. This will provide data to help prioritize the implementation of BMPs to address bacteria impairments.

B. Best Management Practices

This plan has presented five general practices that need to be considered to benefit the quality of the Black River Watershed. For locations of recommendations, refer to the GIS ID number noted in the text and cross reference with Map 5 in Appendix A.

Subbasin 4, Headwaters

Overview of Subbasin 4

Subbasin 4 is the northern most subbasin of the Black River Watershed. The headwaters of the Black River originate here in portions of Roxbury, Mine Hill and Randolph.

Within the Highlands Planning Area, Subbasin 4 contains approximately 40% urban/developed areas and 40% forested areas, of which the Hercules Kenvil Works facility is a part.

This subbasin has several impoundments that accept drainage from land area that is primarily urban and forested. These lakes or ponds, whether they are designed for recreational use, stormwater detention or for another historical reason, provide for the settling of pollutants as the stream flow slows and passes through. So although Subbasin 4 has 40% of the land as developed, urban land, these waterbodies will aid in reducing the runoff pollutants to downstream sections of the watershed. However, as these runoff pollutants settle, they will decrease the water and sediment quality within the lakes itself. Therefore, reducing the concentration of contaminants in the stormwater runoff within Subbasin 4 will be directly beneficial in protecting the resources that are present in Subbasin 4.

A water quality sampling station at the outlet of Subbasin 4 was located off of Route 10 immediately downstream of a driving range and an impoundment (See Figure 7). The data from this site should aid in quantifying the land use effects on the water quality for this subbasin.

Sampling Station 4 at the outlet of Subbasin 4 show slightly elevated fecal coliform and *E. coli* concentrations immediately after the rainfall event on October 12, 2007. The dissolved oxygen dipped below the minimum of 4 mg/l once during the ten sampling events. The pH was below 6.5 on two of the ten sampling events. Temperature was never above the required minimum of 30 °C. At this location, the fecal coliform criterion of 200 org/100ml was satisfied but the 400 org/100ml was violated by 20% of the samples. At station 4, the total phosphorus criterion was consistently satisfied.

The New Jersey BMP Manual reports a 50-90% total suspended solid removal efficiency for wet detention ponds. This physical removal process would extend to bacteria removal, but detention time and the volume of the pond would determine removal efficiency. These ponds and lakes already in place in Basin 4 are expected to have reduced bacteria concentration to low levels at Station 4, but concern for the lakes themselves should be considered. Additional measures that will reduce contaminant concentrations to stormwater runoff will benefit the water quality of those ponds and for other tributaries upstream of the ponds.

Listed below are specific sites where management measures can be implemented to reduce bacteria loads to the Black River Watershed.

<u>B.4.a. Commercial Development north of Route 46 (BJ’s Shopping Center) (GIS ID3)</u>
This shopping center contains large expanses of impervious cover that can be better addressed with stormwater systems that disconnect these impervious surfaces and capture and infiltrate runoff from these surfaces. Bacteria loading has been correlated to impervious cover (Mallin et al., 2000; Schoover, et al., 2006), with loading tending to increase with increases in impervious cover. Bioretention systems may be appropriate for

this area to capture, treat and infiltrate runoff. Bioretention systems tend to reduce bacteria loading by 95% (Rusciano and Obropta, 2007). The effects of this shopping center may not be significant on the bacteria loading to the Black River since the runoff from this site drains to an existing pond. Although it is expected that this pond will remove 70 to 90% of the bacteria load, thereby protecting the Black River downstream from this location, the bacteria concentration in the pond may increase due to this runoff and efforts should be put in place to minimize bacteria loading to the existing pond.

B.4.b. Shoreline Restoration at Pond East of Commerce Boulevard (Lake 515_08) (GIS ID4)

Located east of Commerce Boulevard in Roxbury, this pond receives drainage from a large area that includes residential and commercial development. Upon site visitation, it appears that this pond has been well maintained with a great portion of its circumference protected by vegetated buffers. It appears that only a section of the northern portion of the lake requires a more substantial buffer to deter goose occupation.

Figure 10: Pond East of Commerce Blvd.

B.4.c. Lincoln and Roosevelt Educational Complex in Roxbury (GIS ID5)

This educational complex on Meeker Street and Hillside in Roxbury contains two schools and the Board of Education Building.

This educational complex with two schools (Lincoln and Roosevelt) and a Board of Education Building has very little stormwater infrastructure on this site. Most of the stormwater runs off on to the athletic fields. Initial investigation finds little opportunities for this site. The picture below suggests that there may be a possibility of a buffer but this site does not seem optimal. Additional investigations are required.

Figure 11: Educational Complex in Roxbury

B.4.d. Triple Lakes Parking Lot (Mark and Green) (GIS ID2)

The lake located by Mark and Green in Roxbury is used recreationally and needs to attain all water quality standards for this purpose. Given that the area possesses a combination of septic systems and possibly geese, the potential for elevated bacterial concentrations is a concern. Municipal officials should regularly conduct water quality testing to ensure compliance with water quality standards. The lakes appear to be in good condition. One parking lot drains directly to the catch basins that outlet to the lake and could contribute nonpoint source pollution directly to lake during rain events. It is recommended that this area be disconnected from the entering the lake. This can be accomplished by creating curb cuts that rout flow to areas designed for bioretention and infiltration.

Figure 12: Triple Lakes Parking Lot

Subbasin 3

Overview of Subbasin 3

This area of the Black River Watershed in Roxbury and Randolph Townships is considered just over 50% urban, with forest and wetlands making up a large part of the remaining tracts of land. The northern portion of this subbasin falls within the Highlands

Planning Area, while the southern portion is contained within the Highlands Preservation Area.

Areas of Subbasin 3 contain large well maintained residential areas with large expanses of lawn. This Subbasin contains the Alamatong well field, a wetland area that is an important primary water source for over 470,000 residents in Morris County. This area is currently well protected and this protection should continue to preserve an important resource. The current C1 designation aids in maintaining this level of protection.

The Roxbury Ajax Wastewater Treatment Plant has a reported discharge downstream of the well field.

<u>B.3.a. Stoney Brook Day Camp (GIS ID10)</u>

The Stoney Brook Day Camp contains a large play yard and an in-line pond at the headwaters of a tributary to the Black River on Randolph public lands. The site set up appears to attract a large number of geese which are expected to increase the bacterial contamination of the waterways.

A comprehensive program that re-establishes the buffer while minimizing the turf grass areas around the pond should be implemented. The restoration of the pond’s buffer is expected to make the pond less attractive to the geese and will educate the children in stormwater management while creating a cleaner area to enjoy.

<u>B.3.b. Sussex Business Park (GIS ID 11)</u>

The Sussex Business Park has a large impervious footprint in Randolph. Existing stormwater infrastructure includes grated collection/infiltration boxes outletting to stormwater detention basins with turfgrass. The basins show evidence of geese occupation, with the turfgrass providing forage and safe haven for them.

The boxes that appear to have been designed to capture and infiltrate runoff from the parking lots seem to be providing some benefit, but may be failing in some instances due to poor design or lack of maintenance.

Recommendations for this site include naturalize the basins with native vegetation. This would diminish goose habitat as well as decrease maintenance requirements such as mowing. A second recommendation would be to have the capture/infiltration boxes surveyed for effectiveness during and after a storm event. A properly implemented maintenance plan is also required.

<u>B.3.c. Horseshoe Lake (GIS ID 12)</u>

Horseshoe Lake appears to be a well visited recreational area. Several observations were made regarding potential projects that would help to maintain or improve the water quality of this area.

Contamination with bacteria is always a concern with water bodies that are used for swimming, and all attempts to reduce potential inputs should be considered. Limited riparian buffers surround the lake, and evidence of geese was observed. Also, although "pick up after your pet" signs were posted, it is obvious that certain visitors to the parks have been ignoring.

Concerning the runoff of total suspended solids or other contaminants found on the land surface, the compaction of earth in areas surrounding the lake were noted. Soil compaction was noted where it appears parking for vehicles is allowed. This compaction prevents infiltration and promotes direct stormwater runoff which carries nonpoint source pollution directly to recreational waterways.

The building for the bathroom facilities could be retrofitted with a demonstration rain garden that could be used to promote disconnection of impervious surfaces and infiltration of rain water.

Recommendations include: restoring the areas where the buffer is deficient, enforcing pet waste ordinances, restoring and resurfacing compacted parking lots with pervious pavers or stone, and disconnecting all impervious surfaces while routing the runoff to bioretention areas/rain gardens.

<u>B. 3. d. Ponds off Condit (GIS ID 30)</u>

There are a series of three ponds that are located southwest of Condit Street in Roxbury. The upper portion of the lower pond, the entire middle pond, and portions of the upper pond are all lacking in riparian buffer making them ideal habitat for Canada geese. There is not only area for the geese to occupy, but there is direct access to the water. At a site visit in early spring, algae were already evident.

Figure 13: Ponds off Condit and Rivendel

The recommendation for this site would be to reestablish the riparian buffers thereby eliminating goose habitat and reducing bacterial contamination.

<u>B.3.e. Roxbury School off Mapledale (GIS ID31)</u>

This is another large educational complex containing a typical parking lot with minimal low impact development stormwater facilities. Although there appears to be little potential options for retrofitting on this site, the parking lot does appear to be in need of repaving.

A recommendation for this site would be to explore pervious pavement options to resurface the parking area.

<u>B.3.f. Construction Site (GIS ID32)</u>
This site drains directly to a wetland area and has impervious area connected to the stream. The stormwater infrastructure is clogged and damaged. There are many open dumpsters. It is expected that future changes in this site will address the current source problems.

Figure 14: Dumpsters on construction site

Subbasin 2

Overview of Subbasin 2

Subbasin 2 is the largest delineated subbasin in the Black River Watershed and it includes the Black River Wildlife Management Area. The majority of the area within Subbasin 2 is in the Township of Chester, but a section in the northeast corner of the subbasin is in Randolph. It is in this section that Randolph has two tributaries, together under one mile in length, that are designated as trout production streams. These two tributaries coalesce at Bryant Pond off of Park Avenue.

Given that the entire watershed is home to many horse farms, it should be noted that the Larrison horse farms located at the lower portion of Subbasin 2 is a good example of stormwater management and should be encouraged to continue and possibly even educate other farm owners in the area.

This subbasin contains portions of the Alamatong well field and is in the Highlands Preservation Area.

B.2.a. Ironia Road Horse Farms (GIS ID 16)

Several equine operations exist in subbasin 2. Although no obvious impact from these sites was observed, they are a potential source of bacteria contamination. In many cases there are simple management practices that can be implemented that could minimize this impact such as rerouting barn roof runoff around paddock areas, installing fencing to keep animals out of direct contact with stream water, and installing vegetated buffers between the equine operation and the waterway. As previously discussed for watershed wide management measures, the Equine Operators Technical Assistance Program would help operators identify problem areas and identify management measures.

B.2.b. Linabury, Prides Crossing, Selma Road Pond, and other small ponds (GIS ID 14, 15 and 19)

Several small ponds in the watershed were observed. Many of these ponds exhibited excessive algal growth most likely resulting from an overabundance of nutrients. These ponds also provide habitat for geese, providing a partial explanation for the nutrient load. Many of these ponds receive direct runoff from fertilized, residential areas. Attempts need to be made to limit the phosphorus entering these systems. If towns contained within this watershed have not already adopted a no/low phosphorus fertilizer ordinance, they should do so as soon as possible. NJDEP has recently signed a Memorandum of Understanding (MOU) with the fertilizer companies to reduce phosphorus by 50% in their residential lawn care products. This will make low phosphorus and phosphorus free fertilizers readily available in the local retail stores.

Additionally, riparian buffers around the pond need to be reestablished to reduce geese habitat.

Another method to protect the ponds is to disconnect impervious surfaces from discharging directly to ponds. This requires identifying sources of runoff that have been routed from impervious surfaces such as roadways, driveways and rooftops that could be routed to areas of bioretention for treatment and infiltration. Infiltration trenches and cisterns (rain barrels) can also be an effective method of capturing the runoff from disconnected impervious surfaces.

Subbasin 1, Outlet

Overview of Subbasin 1

Chester Township and Washington Township

B.1.a. Chester DPW Furnace Road (GIS ID 20)

The expanse of land at the Chester Department of Public Works is largely composed of turfgrass, again providing adequate habitat for Canada geese. This is an opportunity to provide an example for the watershed of exchanging turfgrass for native vegetation. This would create a reduction in water requirements, fertilizer requirement and mowing. This would also reduce the foraging possibilities for the geese.

B.1.b. Tanners Brook Road, bridge #1150, Carlisle Court (GIS ID 21)

Sediment deposits were observed at the bridge on Tanners Brook Road. Raccoon tracks were observed at this location. Raccoons could be a source of bacteria contamination in this watershed. The sediment at this location is most likely coming from the surrounding wetlands. A residential development located on Carlisle Court slightly upstream of this location does have a stormwater detention facility, primarily vegetated with turfgrass. Although this facility appears to be effective at capturing stormwater runoff from the development, the detention basin outlet may need additional armoring to reduce exit velocities from this detention basin. This high exit velocity may be causing erosion of the forested wetlands between the basin and the bridge at Tanners Brook Road. The site should be further investigated to ensure these high exit velocities exist as a chronic condition and could be remedied.

Detention basins, such as the one on Carlisle Court, that are vegetated with turfgrass are attractive to geese. With the additional geese located at these basins, this increases the potential for bacterial contamination. Naturalizing the basin with native vegetation can increase aesthetics, reduce maintenance and increase the pollutant removal capacity related to that stormwater facility.

The detention basin on Carlisle Court contains a cement low flow channel that was a design intended to reduce mosquito habitat. This was found not to be the case in practice and these low flow channels are no longer recommended. This basin has had the channel disconnected at certain areas which allow for infiltration of the low flow and the reduction of standing water.

This newly developed residential neighborhood by Carlisle Court possesses a long vegetated swale that collects runoff from the roadways and provides infiltration to the groundwater. This serves to reduce peak flow while reducing nonpoint source pollution to the stream. The combination of no curbs and roadside swales can serve as an example to the watershed as a optimal stormwater management system.

B.1.c. Valley Brook County Day School (GIS ID 25)

The headwaters of the Tanners Brook tributary consist of large tracts of land that were previously agricultural land. An analysis of the land use GIS layer showed that many acres that are currently low density residential have been converted from farmland since 1995. These residential lawns can be attractive to geese that are a source of nutrient enrichment at the ponds at the Valley Brook Day School. In addition, these lawns provide nutrient input from excessive fertilization. Although high phosphorus concentrations were not found in Tanners Brook, excessive algal growth was detected at the ponds at Valley Country Day School, indicating phosphorus uptake. This algae can ultimately reduce dissolved oxygen, harming aquatic life.

There are small pockets of agricultural land that may be contributing sediment and nutrients to the runoff, contributing to decreased water quality entering the ponds.

There are also opportunities at the VCDS itself to environmental curriculum into their educational programs. Students can be encouraged to participate in remediating negative effects on their waterways. This may be an ideal opportunity to train the next generation of volunteers from the Raritan Highlands Compact and ANJEC.

<u>B.1.d. Valley Brook Road Horse Farms (GIS ID 23)</u>
Valley Brook Road and East Valley Brook Road have horse farms and have evidence of septic systems that are currently in operation. Both of these cases could contribute bacteria to the watershed. A septic management program and the Equine Operations Technical Assistance Program would be beneficial for this area.

<u>B.1.e.Ponds at Hillside and Larrison (GIS ID 33)</u>
This is typical of many residential areas in the watershed. These small ponds are prime locations for geese to populate, and they appear to be eutrophic. These ponds were found with little or no buffer to deter runoff and goose access.

Figure 15: Pond at Hillside and Larrison

5.0 Estimate Load Reduction (expected from management measures)

Since the Black River Watershed currently has a TMDL requiring a 90% reduction in the loading of fecal coliform to the watershed, the recommended BMPs should focus on the removal of bacteria. Current bacterial loading should be quantified first. Several entities have tried to quantify bacterial loading from mixed land use watersheds (Mallin et al., 2000; Schoonover, et al., 2006; Tufford and Marshall, 2002). These studies have reported the concentrations (CFU/100ml) of bacteria that have been detected in their watersheds and the correlations to various aspects of land use.

Loading calculations require multiplying the instream bacterial concentration by the flow rate. To provide an accurate annual loading rate, the concentrations with concurrent flow rates must be determined for a range of flow rates. This requires taking into consideration low flows and the range of flows following storm events as well as concentration data taken along the hydrograph as the stream is rising. This will provide a loading rate (lbs/acre/year) for the entire subbasin and cannot differentiate between land uses.

Bacteria are difficult to characterize because the amount of bacteria is highly variable between sites. Areal loading rates for a specific watershed and contained land uses are difficult to extrapolate to other watersheds unless sources are well identified and similarly spatially located.

All pollution is a function of source, but bacterial pollution is not a well distributed, diffuse source, so it is even more difficult to assign a land use coefficient that best represents the potential pollution emanating from a particular land use. It is possible to have the entire load of the bacterial contamination in a watershed coming from a few discrete sources. Given this fact, one of two methods can be employed to estimate load reductions that can be expected from management measures. First, a complete survey of potential bacteria sources and their location to the stream should be measured. This survey would include not only a count and spatial identification of each farm animal, but a best estimate of wildlife in the area. Among the few spreadsheet models that have attempted this is the "Bacterial Source Load Calculator" developed by the Biological Systems Engineering Department at Virginian Polytechnic Institute and State University. This model requires a count of each farm and wild animal per subbasin, the time that the farm animals spend outside, the number and age of all septic systems and sewered residences, as well as access to the streams for all of the animals. This information would likely provide a reasonable estimate of bacterial loading to the watershed.

Since the input data needed for the use of the "Bacterial Source Load Calculator" are not readily available, it cannot be used for the Black River Watershed. Additionally, one factor that this accomplished model does not account for is the presence of dumpsters. As stated previously, dumpsters are beginning to be identified as contributors of bacterial pollution in runoff. Being receptacles for trash, these structures attract many animals, such as rodents and birds. These structures are generally located on impervious areas, often having the runoff directly connected to conduits for stormwater that create a direct slug of bacteria to fresh water systems. While the quantification of these units is currently being identified, these sources need to be considered.

When this level of analysis is not possible, a trained professional can provide expertise on effectively identifying and reducing nonpoint bacterial pollution. The estimated quantification of results may depend on extrapolation of previously collected data and may not accurately depict results. This method has a reasonable expectation of providing positive results and to move efficiently into the implementation and reduction mode to quantify results post-implementation.

This plan has identified potential sources of nonpoint source pollution that may be contributing to the bacterial concentrations that have lead to the water quality impairment (Section 4.0). For the purpose of presenting a relative effect that remediation of these sites may have on the watershed, loading can be roughly estimated from either a runoff concentration value (assigned to several common land use types) derived from NURP data (Pitt, 1998), which is 20,000 CFU/100ml with average flow from Black River sampling areas. Another surrogate for bacterial concentrations can be determined from the predictive equation that uses percent impervious in the subbasins (Mallin, 2000). The use of this equation provided negative numbers for the lower two subbasins because the percent impervious area is below the threshold for the use of the equation.

Table 16: Bacteria Predictive Loading Analysis

Site	Average Flow (cfs)	Area (acres)	Per Cent Impervious	Mallin predictive equation using % Impervious (CFU/100ml)	Pitt,1998 NURP data (CFU/100ml)	Mallin aerial loading CFU/acre/year	Pitt aerial loading CFU/acre/year
4	2.3	2420	16.5	60	20000	5.10E+08	1.69856E+11
3	3.6	2841	14	46.5	20000	5.27E+08	2.26465E+11
2	5.6	4879	5	-2.1	20000	-2.15E+07	2.05129E+11
1	9	3335	4.4	-5.34	20000	-1.29E+08	4.82299E+11

This plan has also determined the percent reduction allocation that the Black River Watershed is estimated to require to improve water quality to satisfy standards (Section 2.5.2 and Table 8).

6.0 Estimation of Technical and Financial assistance/cost/sources and authorities to implement plan

As stated in the TMDL document for the Raritan Water Region, the Environmental Quality Incentive Program (EQIP) is intended to provide technical, financial, and educational assistance to farmers/producers for conservation practices that address natural resource concerns, such as water quality. Practices that have been acceptable 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 wste management facilities and irrigation systems.

The TMDL document also offers information on the Conservation Reserve Program (CRP) which 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. BMPs that achieve these improvements can be considered viable options for implementation through this program.

The Soil and Water conservation Cost-Sharing Program is available to participants in a Farmland Preservation Program. Eligible practices include erosion control, animal waste control facilities, and water management practices. Cost sharing can be provided for up to 50% of the cost to establish these practices.

Other potential funding sources include the NJDEP's 319(h) program, NJDEP's Corporate Business Tax for Watershed Projects, NJDEP Environmental Services Program, USDA's Wildlife Habitat Incentive Program, NJ Green Acres, along with private foundations and county open space preservation programs.

7.0 New Jersey Educational Programs

The programs listed below are a sample of educational programs that are available in New Jersey. The educational programs that will create true change in the actions of people must provide stakeholders with hands on activities and contain a strong outreach component. It is for this reason that the RCE programs play an important role and offers programs that can be delivered at the municipality and work with the local stakeholders to educate them on specific concerns in their area.

The United States Environmental Protection Agency (USEPA) and the NJDEP offer newsletters, brochures and other outreach materials and these can be used by the watershed groups to educate stakeholders. However, priority should be given to hands on instruction.

Rutgers Cooperative Extension Water Resources Program Stormwater Management in Your Backyard Program

This program provides a detailed overview of stormwater management. It introduces the factors that affect stormwater runoff, point and nonpoint source pollution, the impact of development (particularly impervious cover) on stormwater runoff, and the pollutants found in stormwater runoff. An overview of New Jersey's stormwater regulations is presented including who must comply and what they are required to do. Additionally, the concept of TMDLs is introduced along with various other requirements of the Federal Clean Water Act that have serious implications on New Jersey. A thorough discussion of different types of BMPs that can be implemented to control stormwater runoff is presented and how these BMPs can be used to achieve the quality, quantity and groundwater recharge requirements of New Jersey regulations. The BMPs discussed include bioretention systems (i.e., rain gardens), sand filters, stormwater wetlands, extended detention basins, infiltration basins, manufactured treatment devices, vegetated filters, and wet ponds. The program also discusses the various management practices that the homeowner can install including dry wells, rain gardens, rain barrels, and alternative landscaping. The protocol for designing these systems is reviewed in detail with real world examples provided. A step by step guide is worked through for designing a rain garden so that homeowners can actually construct one on their property. The students have an opportunity to bring in sketches of their property for the class to review and discuss various BMP options for each site. The course also provides a discussion of BMP maintenance focusing on the homeowner BMPs. The course concludes with a discussion of larger watershed restoration projects and how the students can lead these restoration efforts in their community. The course is very interactive, and ample time is set aside for question and answer sessions.

For more information, please contact Christopher Obropta at 732-932-9800 x 6209 or obropta@envsci.rutgers.edu.

Rutgers Cooperative Extension's Environmental Steward Program

RCE has formed a partnership with Duke Farms to create a statewide Environmental Steward certification program. Participants learn land and water stewardship, BMPs, environmental public advocacy, and leadership. Each group meets twenty times for classroom and field study. They are taught by experts from Rutgers and its consortium partners. Students are certified as Rutgers Environmental Stewards when they have completed sixty hours of classroom instruction *and* sixty hours of volunteer internship. Classes are held throughout New Jersey including the Essex County Environmental Center in Roseland, Duke Farms in Hillsborough, Somerset County and the Rutgers EcoComplex in Bordentown, Burlington County. Consortium partners can ask students to provide volunteer assistance to complete their internship requirements.

Graduates of this program become knowledgeable about the basic processes of earth, air, water, and biological systems. They increase awareness of techniques and tools used to monitor and assess the health of the environment. They gain an understanding of the research and regulatory infrastructure of state and federal agencies operating in New Jersey that relate to environmental issues. Unlike some programs, they are also given an introduction to group dynamics and community leadership. Participants are taught to recognize the elements of sound science and public policy based in science while acquiring a sense of the limits of the current understanding of the environment. The goal of the Rutgers Environmental Stewards program is to give graduates knowledge to expand public awareness of scientifically based information related to environmental issues and facilitate positive change in their community.

For more information please log on to: http://envirostewards.rutgers.edu/.

Rutgers Cooperative Extension Water Resources Program Restore-A-Waterway Program

Restore-a-Waterway is a technical service provider program offered by the RCE Water Resources Program. The Program is funded jointly by the United States Department of

Agriculture Cooperative State Research, Education, and Extension Service (USDA CSREES), New Jersey Sea Grant, and the New Jersey Agricultural Experiment Station (NJAES). The goal of the program is to provide technical assistance to citizen groups that want to take action in restoring the condition of a waterway. RCE provides expertise to these groups to assist them in their efforts. Forms of technical assistance include helping these groups to:

- perform physical waterway characterizations,
- develop and implement chemical and biological quality assurance project plans (i.e., QAPPs),
- interpret and analyze of data,
- identify problems and sources of those problems within a watershed,
- design solutions to mitigate the identified problems,
- secure funds to implement the designed solutions,
- implement the solutions.

In addition to offering workshops to help educate citizen groups on these technical issues, Restore-a-Waterway can be adapted for municipal officials to address their specific needs. The implementation of solutions after monitoring and analysis is an important focus of this program.

Target communities would be those that are mentioned and prioritized in this document. Selection, design and implementation of BMPs recommended within this document can be optimized through the use of this program.

If you are interested in participating in Restore-a-Waterway, please contact: Gregory Rusciano at (732) 932-9800 x 6130 or greg.rusciano@rutgers.edu.

Community-Project-Based Learning Educational Program

The RCE Water Resources Program has joined forces with Research in Education Applied to Learning (R.E.A.L.) Science to create a new method of science instruction called "Community-Project-Based Learning." R.E.A.L. Science is a nonprofit organization that provides a support system for innovative standards-based authentic science projects along with effective teacher in-service training programs in science education. Community-Project-Based Learning incorporates the authentic practice of real scientists into the regular classroom setting. Community-Project-Based Learning identifies a real environmental problem in the community and works with the students to address these driving questions: Is there a real problem with our watershed? What is our contribution to the problem? If there is pollution in our watershed, how can we fix it? The project objectives include the students investigating various aspects of the natural environment on and around the school grounds, students documenting findings, and students communicating these findings to fellow classmates and the community. Working in teams, the students design a solution to a problem and present these solutions to their classmates. The best solutions are selected and built on the school grounds.

These projects expose students to the actual practice of scientists in the fields of ecology and environmental science and cover issues in geology, biology, chemistry, and applied mathematics. Lessons and activities are designed with classroom teachers to instruct students within the state standards-based curriculum. The students work together to address relevant environmental problems in their community.

Students participate as legitimate members of a scientific community. They work with their teachers, parents, local scientists, and other knowledgeable members of the community to create a solution to a relevant environmental problem in their community. As scientists, the students assemble existing data, collect new data, and work with professionals from the community to fully understand the problem, while honing their skills and learning within the guidelines of the New Jersey State Core Curriculum Content Standards.

For more information, please contact Christopher Obropta at 732-932-9800 x 6209 or obropta@envsci.rutgers.edu.

Best Management Practices in Landscaping (under development)

Landscapers contribute to the application of fertilizer, the removal of yard waste, the construction of gardens and the maintenance of the grounds surrounding the streams and lakes within a watershed. For these reasons, a program that will be aimed at teaching the BMPs of landscaping could be required as a part of the licensing processes of landscapers.

As yet undeveloped, this program has the potential to be administered through the Environmental Steward or the Restore–A-Waterway programs. After initial development of the program, it is possible for the municipality to offer it or have it offered through the box stores that carry lawn maintenance equipment and fertilizers. Key aspects of this educational program will be soil testing and the subsequent application of necessary nutrients; the design, implementation and maintenance of rain gardens; buffer establishment and maintenance, and the BMPs of waste disposal.

Addressing the large number of landscaping professionals can have a strong impact on stormwater management and will best be served by a general registration of landscapers. Registration is one recommendation that could be undertaken by the individual municipalities. Requirements for using the BMPs can then be more efficiently delivered to the interested parties.

Other Programs

The Raritan Highlands Compact and ANJEC have conducted educational programs throughout the region. The Raritan Highlands Compact is currently conducting a rain garden education program. ANJEC regularly conducts educational programs for municipal officials that focus on stormwater education. Efforts within the Black River

Watershed should be coordinated between the Raritan Highlands Compact, ANJEC and RCE.

8.0 Schedule for implementation of management measures

Obviously implementation of the projects listed herein will require some level of funding. The Raritan Highlands Compact, ANJEC, RCE, local environmental commissions, local municipalities, and citizen action groups need to work together to begin the implementation of this plan. The following is a schedule for implementation provided funding is available.

The following initiative should begin in Year 1 and continue through Year 3:

1. Microbial Source Tracking Program: In Year 1, develop a sampling plan and implement the sampling plan. Continue to monitor in Years 2 and 3. Use data to further prioritize sources.
2. Equine Operations Technical Assistance Program: In Year 1 develop program tools to conduct on-farm surveys with RCE and North Jersey RC&D. Conduct a pilot program to test these survey tools. Implement demonstration BMPs on several farms that can be used in future sessions as educational tools. Continue efforts in Years 2 and 3.
3. Stormwater Management in Your Backyard Program: In Year 1 expand the Raritan Highland Compact's rain garden efforts through this program. Deliver programming with local support from environmental commissions and Raritan Highlands Compact. Continue to work with stakeholders to construct more rain gardens in the watershed.
4. Goose Management Program: In Year 1 develop a goose management program for small ponds in the watershed and for publicly owned lands. In Years 2 and 3 implement the management program.
5. The Disconnection of Stormwater Runoff from Impervious Surfaces: In Years 1 and 2 work with municipalities to modify municipal ordinances to contain impervious cover disconnection requirements. In Years 2 and 3 implement several demonstration projects that disconnect impervious surfaces from small commercial sites.
6. Dumpster Leachate Management Program: In Year 1 develop a sample ordinance that can be adopted by the municipalities in the watersheds. In Years 2 and 3 implement several dumpster leachate management designs.
7. Septic Management Program: Begin in Year 1 by conducting a detailed survey of locations of septic systems and begin educational programs in these areas. In Years 2 and 3 continue educational programs and work with municipalities to implement septic system tracking programs where needed.
8. Specific projects in the four subbasins: In Year 1 begin implementing these specific projects as part of 1-7 discussed above. Prioritize the projects in these four subbasins based upon MST data.

9.0 Description of interim measurable milestones

Five years after the commencement of the implementation of management measures, a detailed evaluation will be conducted to quantify the water quality improvements attained in the watershed. Based upon this evaluation, practices can be modified to further refine the recommendations for management measures, which are needed to ultimately attain the goal of the plan.

10.0 Monitoring component

The implementation of the management measures will result in water quality improvements while minimizing flooding and promoting groundwater recharge or reuse. Both modeling and monitoring can be conducted to quantify these improvements.

Monitoring can be conducted to also quantify the improvements to the Black River and its watershed that result from the implementation of the Plan. NJDEP does maintain three ambient biomonitoring sites on the Black River. These sites can provide information on improvement in the effects of water quality on aquatic biota. Moreover, water quality samples can be collected throughout the system and analyzed for various pollutants that are a concern within the watershed such as nutrients and bacteria.

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Appendices:

Appendix A: MAPS
- Map 1 Stream Classification
- Map 2 Land Use
- Map 3 Sampling Sites
- Map 4 Average SVAP scores
- Map 5 BMP Recommendation Locations

Appendix B: Pollutant Loading Coefficients

Appendix C: Calculation of Load Reductions

Appendix D: Fact Sheet, “Onsite Wastewater Treatment Systems: Five Levels of Protection”

Appendix E: Engineering Concept Drawings
- (Large files, available as printed versions only)
- Plan 1: Dumpster remediation concept plan
- Plan 2: Valley Brook Road Horse Equine Bioretention
- Plan 3: Valley Brook Road Vegetated Swale

Appendix A:

MAPS

Appendix A: MAPS

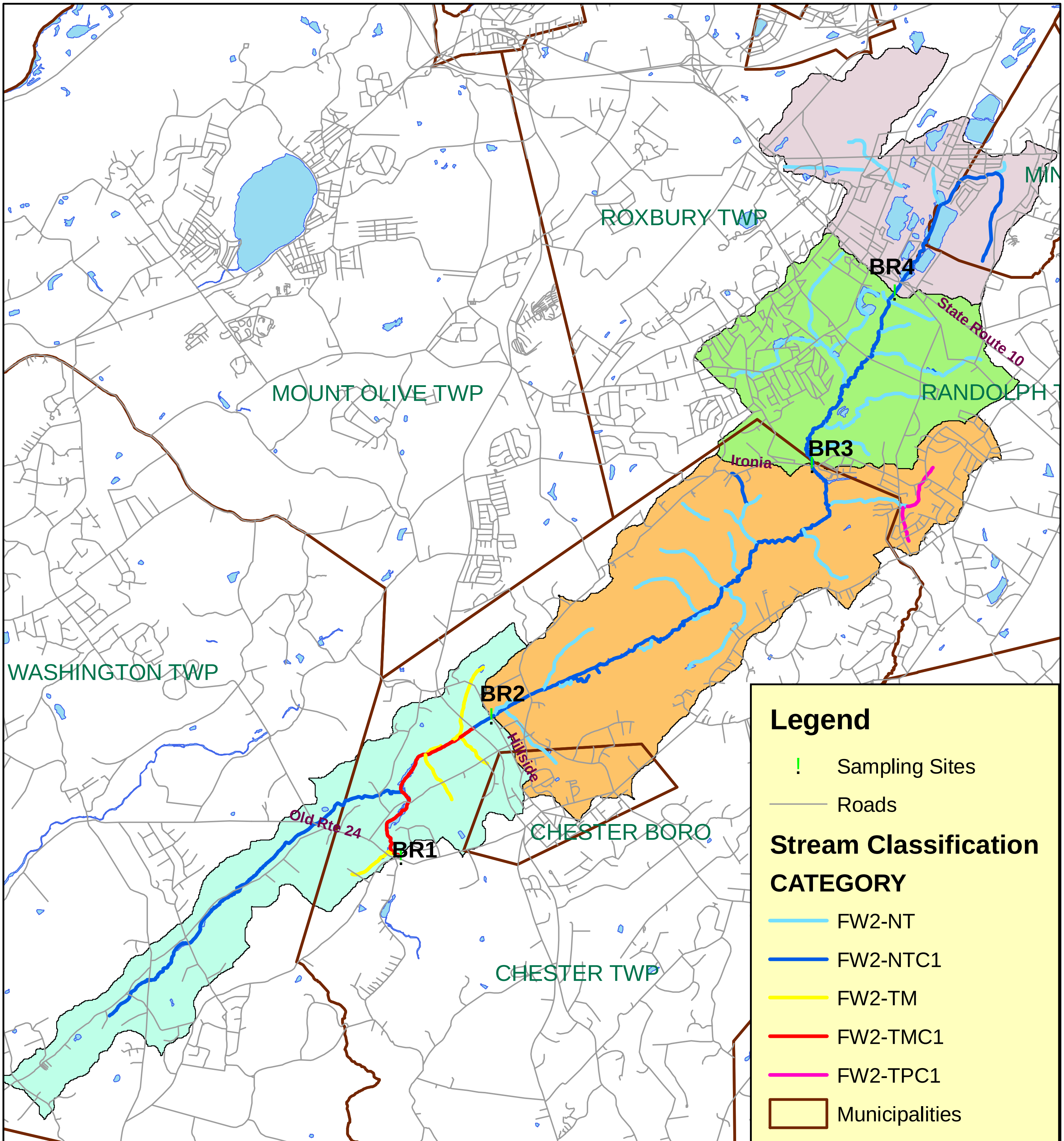
Map 1 Stream Classification

Map 2 Land Use

Map 3 Sampling Sites

Map 4 Average SVAP scores

Map 5 BMP Recommendation Locations



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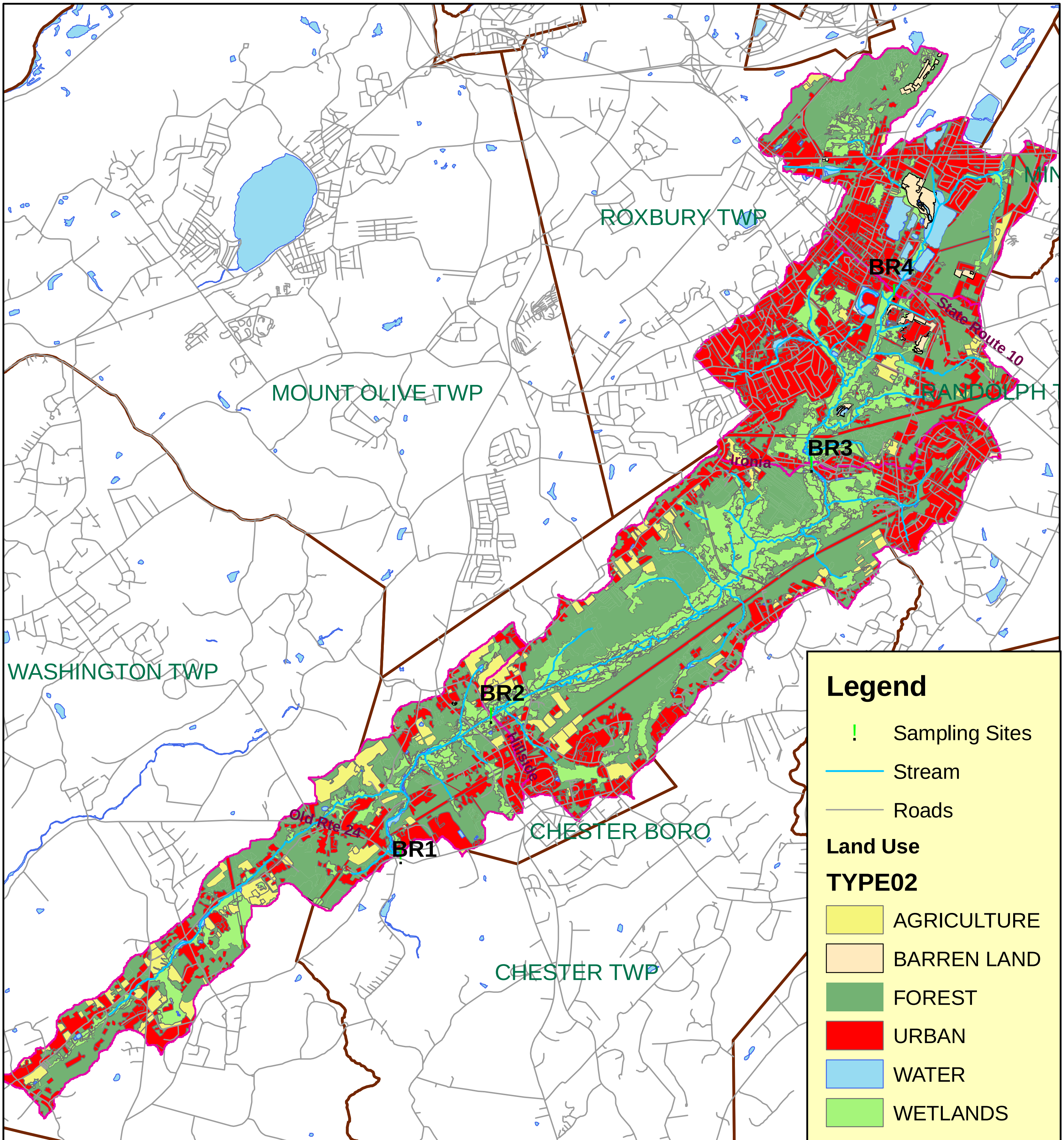
BLACK RIVER WATERSHED
Stream Classifications
MAP 1

0 0.5 1 2 Miles

Data Source: NJDEP GIS DataCD ROM 1996;
NJDEP Surface Water Quality Standards, 2005

sg 5/08



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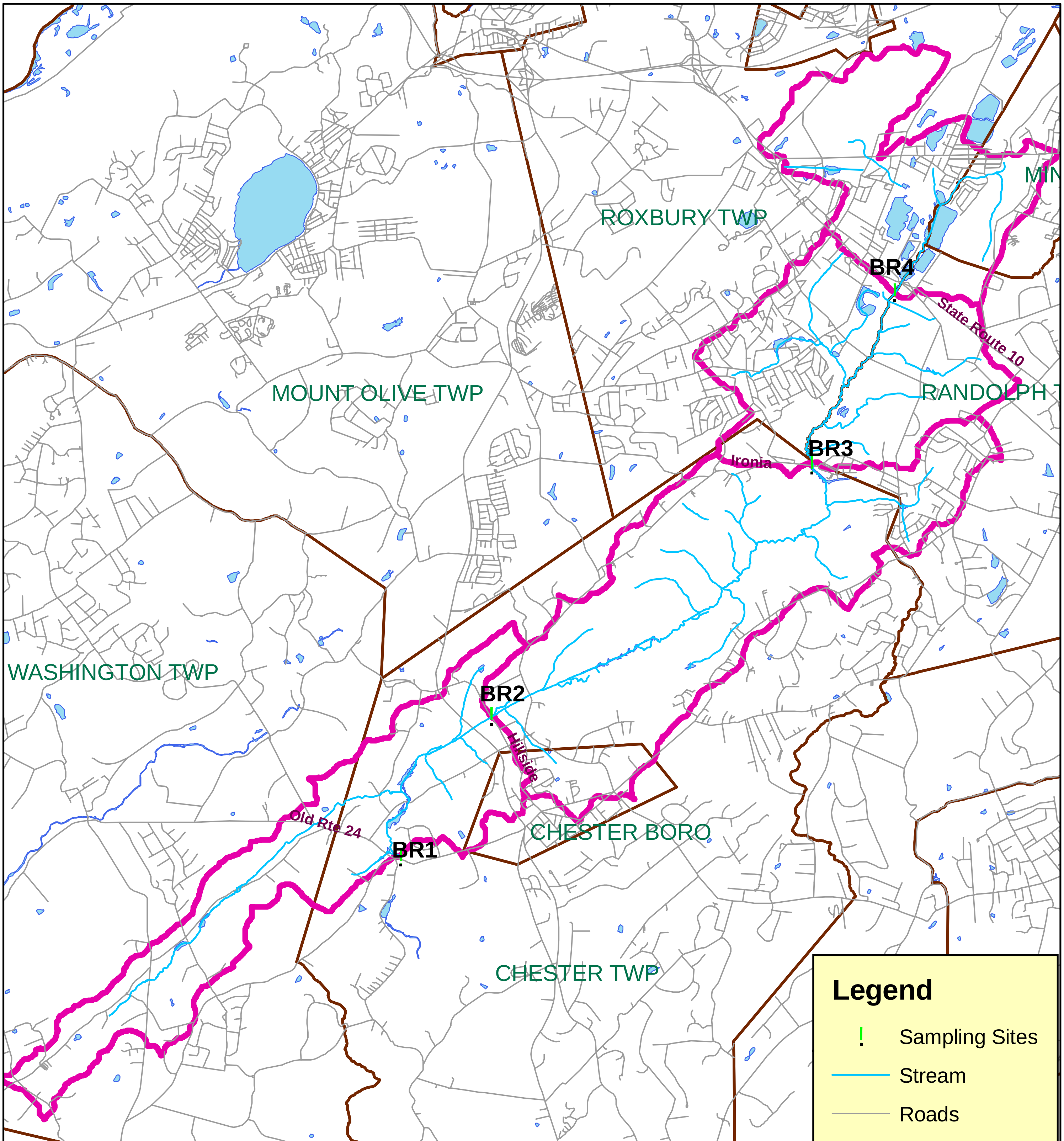
BLACK RIVER WATERSHED
Land Use
MAP 2

0 0.5 1 2 Miles

Data Source: NJDEP GIS DataCD ROM 1996;
NJDEP Surface Water Quality Standards, 2005

sg 5/08



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BLACK RIVER WATERSHED
Sampling Sites
Map 3

0 0.5 1 2 Miles

Data Source: NJDEP GIS DataCD ROM 1996;
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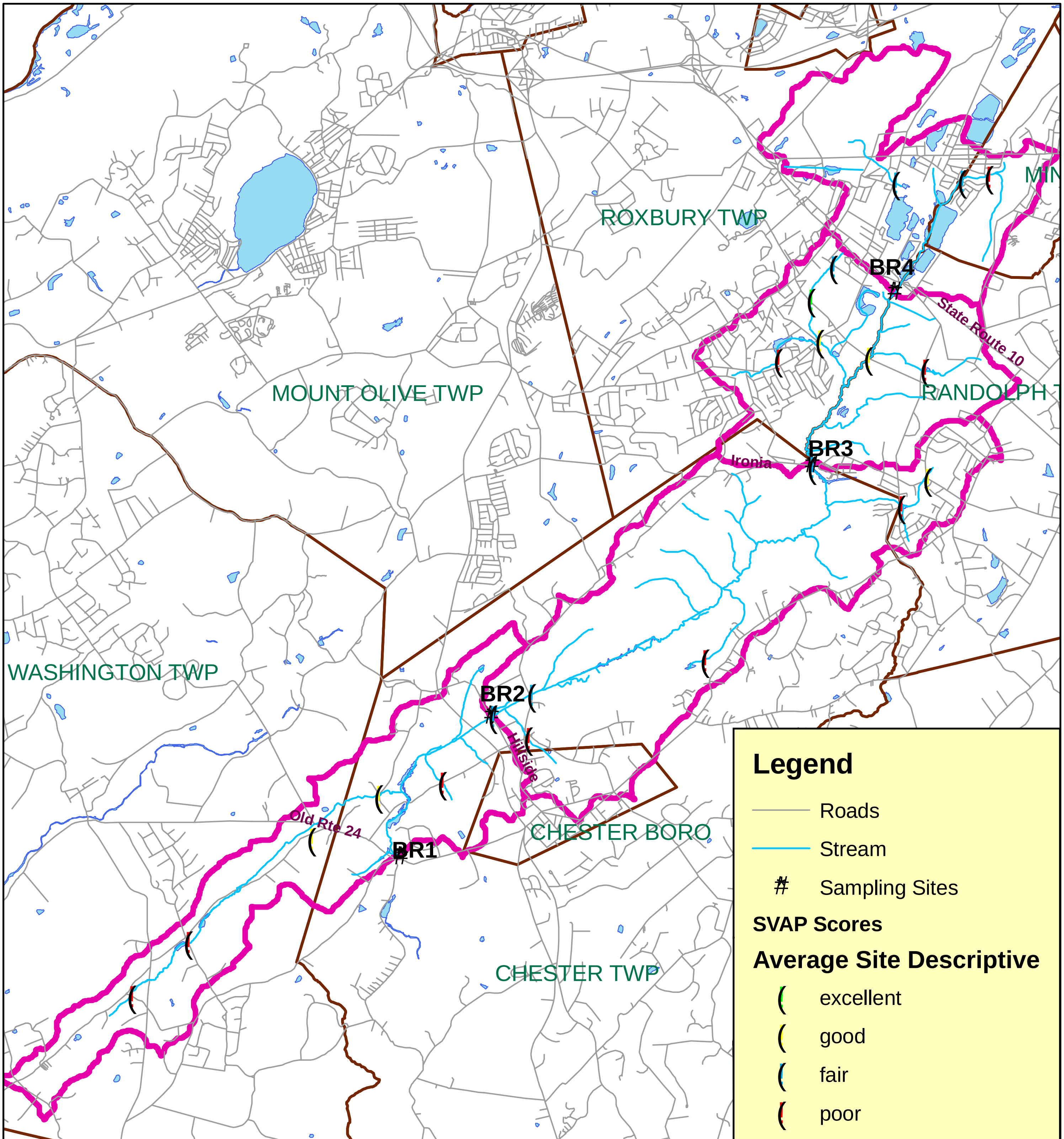
sg 5/08



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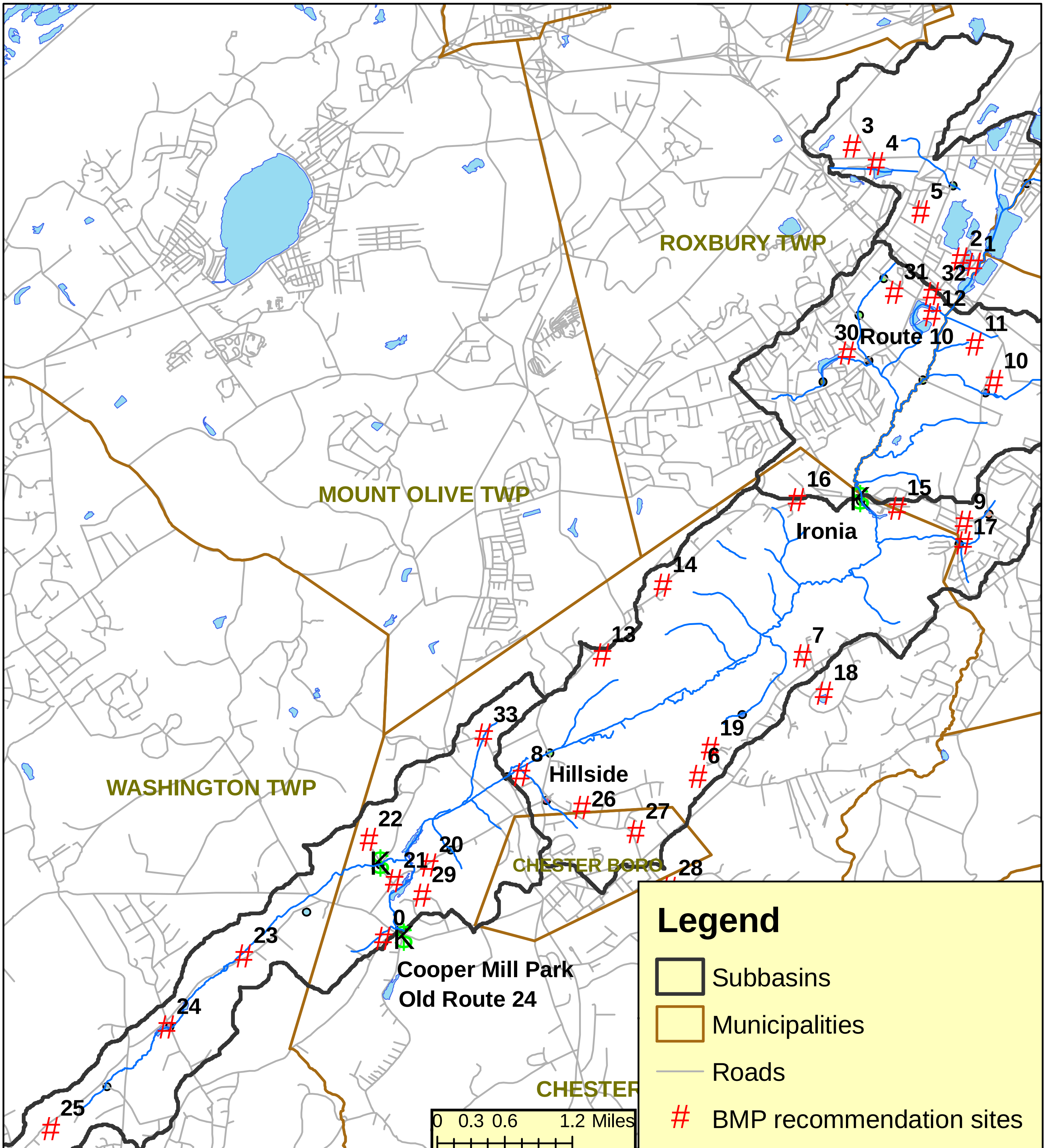
BLACK RIVER WATERSHED
Stream Visual Assessment Protocol Scores
Map 4

0 0.5 1 2 Miles

Data Source: NJDEP GIS DataCD ROM 1996;
NJDEP Surface Water Quality Standards, 2005

sg 5/08



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MAP 5
BLACK RIVER WATERSHED
BMP Recommendation Locations

0808sg

Appendix B:

Pollutant Loading Coefficients

NJDEP 1995/97 Land Use Type	**Aerial Loading Source Analysis: Loading Rate Coefficients**										
	TP *(lbs/ac/yr)*	*TN* *(lbs/ac/yr)*	*TSS* *(lbs/ac/yr)*	*NH3-N* *(lbs/ac/yr)*	*LEAD* *(lbs/ac/yr)*	*ZINC* *(lbs/ac/yr)*	*COPPER* *(lbs/ac/yr)*	*CADMIUM* *(lbs/ac/yr)*	*BOD* *(lbs/ac/yr)*	*COD* *(lbs/ac/yr)*	*NO2+NO3* *(lbs/ac/yr)*
High/Med Residential	1.4	15	140	0.65	0.2965	0.335	0.453	N/A	25.6	152.6	1.7
Low/Rural Residential	0.6	5	100	0.02	0.217	0.172	0.19	N/A	N/A	N/A	0.1
Commercial	2.1	22	200	1.9	0.955	0.873	0.784	0.002	42.1	662.6	3.1
Industrial	1.5	16	200	0.2	1.409	1.598	0.93	0.003	31.4	N/A	1.3
Mixed Urban	1	10	120	1.75	3.215	1.743	1.529	0.0025	67.2	184.8	3.55
Agriculture	1.3	10	300	N/A	0.071	0.089	0.027	N/A	15.45	N/A	N/A
Forest, Water, Wetlands	0.1	3	40	N/A	0.009	0.018	0.027	N/A	9.2	2	0.3
Barren Land	0.5	5	60	N/A	N/A	0.002	N/A	N/A	3.1	N/A	N/A
N/A: Data not available from sources used.											
The loading coefficients used in this table have been provided by the NJDEP in the "New Jersey Stormwater Best Management Practices Manual," February 2004.											

Appendix C:

Calculation of Load Reductions

This page has been excerpted from the NJDEP 2003 Raritan Region TMDL document. This explains the method by which the final load reduction is quantified. This was used to calculate a more specific reduction that is pinpointed at the Black River Watershed.

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

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

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

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

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

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

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

Appendix C, Table 1: Excerpt from Table 11 in 2003 Raritan Water Region TMDL document, "TMDLs for fecal coliform-impaired stream segments in the Raritan Water Region as identified in Sublist 5 of the 2002 Integrated List of Waterbodies.

	Load Allocation (LA) and Margin of Safety (MOS)(400 FC/100ml standard)					
Station Names	Summer N (number of values)	Summer Geo Mean (CFU/100ml)	MOS as a percent of the target concentration	Percent Reduction without MOS	Percent reduction with MOS	Wasteload Allocation
Lamington River near Ironia**	48	531	25%	87%	90%	90%

**only 01399200 is within The Black River Watershed. This site has no continuous stream flow data.

Appendix C, Table 2: Fecal coliform concentrations (sampled for this plan)

	Site 4	Site 3	Site 2	Site 1
09/19/07	66	56	44	44
09/24/07	56	72	200	72
09/27/07	60	84	150	150
10/01/07	16	32	100	64
10/04/07	32	120	160	110
10/08/07	20	200	200	52
10/12/07	720	900	780	810
10/15/07	520	68	220	120
10/18/07	100	88	56	32
10/24/07	20	28	56	24

Appendix C, Table 3: Log Transformed and averaged data used for calculations

			y bar	
	66	1.8195	1.957355	0.01899188
	56	1.7482	1.957355	0.04375082
	60	1.7782	1.957355	0.03211398
	16	1.2041	1.957355	0.56736297
	32	1.5051	1.957355	0.20448937
	20	1.3010	1.957355	0.43076249
	720	2.8573	1.957355	0.80995952
	520	2.7160	1.957355	0.57554733
	100	2.0000	1.957355	0.0018186
	20	1.3010	1.957355	0.43076249
	56	1.7482	1.957355	0.04375082
	72	1.8573	1.957355	0.0100045
	84	1.9243	1.957355	0.001094
	32	1.5051	1.957355	0.20448937
	120	2.0792	1.957355	0.01484164
	200	2.3010	1.957355	0.11811251
	900	2.9542	1.957355	0.99378474
	68	1.8325	1.957355	0.01558654
	88	1.9445	1.957355	0.0001657
	28	1.4472	1.957355	0.26030093
	44	1.6435	1.957355	0.09853466
	200	2.3010	1.957355	0.11811251
	150	2.1761	1.957355	0.04784556
	100	2.0000	1.957355	0.0018186
	160	2.2041	1.957355	0.06089296
	200	2.3010	1.957355	0.11811251
	780	2.8921	1.957355	0.87373816
	220	2.3424	1.957355	0.14827713
	56	1.7482	1.957355	0.04375082
	56	1.7482	1.957355	0.04375082
	44	1.6435	1.957355	0.09853466
	72	1.8573	1.957355	0.0100045
	150	2.1761	1.957355	0.04784556
	64	1.8062	1.957355	0.02285388
	110	2.0414	1.957355	0.00706234
	52	1.7160	1.957355	0.05825061
	810	2.9085	1.957355	0.90464834
	120	2.0792	1.957355	0.01484164
	32	1.5051	1.957355	0.20448937
	24	1.3802	1.957355	0.3330949
average=	167.55			
	y bar=	1.9574		8.03414971
	N-1=	39		

Appendix C, Table 4: Black River Watershed MOS calculation

#3	Standard deviation of the log transformed data		S(sub y)=		0.453876
#4	Geometric mean of the FC data				
#5	Standard error of the mean			0.071764	
#6	For the 200 standard ($X_{standard}$), ($y_{standard}$)=2.301, 90% confidence			90% confid limits	
	alph=0.1			3.045357	1.556643
	stan dev=	232.419377			
	size	40			
	there for the lower confidence limit=			-1.64	
		y(target)=	**3.04535739**		
#7	X target=10^(y target)	**x(target)=**	**36.0282**		
#8	MOS (*e*)	$(e)_{200}$= 163.97	X_{target},200	36.03	
		$(e)_{400}$= 31.97	X_{target}, 400	368.03	

Appendix C, Table 5: Black River Calculated Load Reduction

#9	Load Reduction		-	-	-	-	-				
	200 criteria	Load reduction=	GM	X target,200	load reduction, 200		X target, 400	load reduction, 400		% reduc w/o MOS	
	(also known as		40.8	36.028	11.8		36.028	11.77			
	equation#3 on pg34		66.5	36.028	45.8		36.028	45.82			
	of TMDL doc)		116.1	36.028	69.0		36.028	68.98			
			80.3	36.028	55.2		36.028	55.15			
		Site 4	108.4	36.028	66.8	%	36.028	66.77		-0.84	-84.48
		Site 3	124.7	36.028	71.1	%	36.028	71.11		-0.60	-60.38
		Site 2	160.8	36.028	77.6	%	36.028	77.60		-0.24	-24.35
		Site 1	82.8	36.028	56.5	%	36.028	56.47		-1.42	-141.67
	400 criteria		40.8	36.028	11.8	Site 4	36.028	11.77	%	-4.78	-477.70
	(also known as		66.5	36.028	45.8	Site 3	36.028	45.82	%	-0.48	-48.40
	equation#4 on pg34		116.1	36.028	69.0	Site 2	36.028	68.98	%	0.01	1.41
	of TMDL doc)		80.3	36.028	55.2	Site 1	36.028	55.15	%	-0.23	-23.30
			108.4	36.028	66.8		36.028	66.77			
			124.7	36.028	71.1		36.028	71.11			
			160.8	36.028	77.6		36.028	77.60			
			82.8	36.028	56.5		36.028	56.47			

Appendix C, Table 6: Load Reduction per Black River Site

	Load Reduction Required	
	Summer Criteria (400org/100ml)	Fall Criteria (200 org/100ml)
Site 4	12%	67%
Site 3	46%	71%
Site 2	69%	78%
Site 1	55%	56%

Appendix D:

Fact Sheet

“Onsite Wastewater Treatment Systems: Five Levels of Protection”

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Fact sheet

Onsite Wastewater Treatment Systems: Five Levels of Protection

Christopher C. Obropta, Ph.D., Extension Specialist in Water Resources & David Berry, Student in Bioresource Engineering

The Importance of OWTS Management

Onsite Wastewater Treatment Systems (OWTS) have been identified by the U.S. Environmental Protection Agency (USEPA) as a long-term solution to wastewater treatment. Twenty-five percent of U.S. homes and 33% of new construction utilize OWTS (USEPA, 2002). These systems may be the best option in many areas because of relatively low construction and maintenance costs and effective treatment of domestic wastewater. Because impaired and failing systems are costly to repair and replace and can endanger public health and water quality, proper maintenance of OWTS is essential. Furthermore, management of OWTS can help ensure proper maintenance and early detection of malfunctioning systems before problems become larger and more expensive to repair. Thus, the USEPA has developed a voluntary OWTS management program consisting of five models based upon varying levels of management.

The Incentives of OWTS Management

- Protection of public health and local water resources;
- Increase in property values;
- Avoidance of expensive repairs;
- Groundwater aquifer replenishment;
- No costly infrastructure to install unlike public sewerage;
- Long-term savings through proper maintenance (longer system life means less replacement costs).

Management Considerations

The management model that a community chooses to use should be based upon the potential for system failure, environmental sensitivity, and potential public health risks in the area (see Figure 1). The density of development, soil type, water table depth, limiting horizons (clay lens or bedrock), important ecological areas, and receiving water use are among the many factors affecting environmental sensitivity. Advanced technology and rigorous management may be suitable for areas at a high risk for system failure, whereas, homeowner awareness and education programs combined with regular pumping and inspections may be the best option for non-sensitive areas.

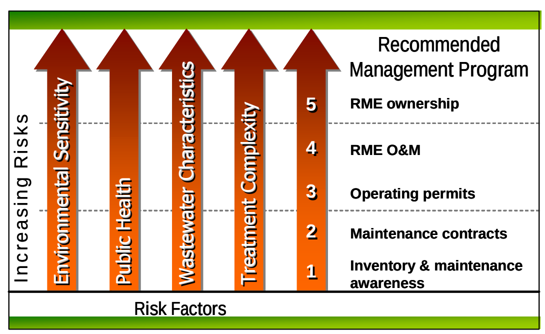

Figure 1. Risk Levels Determine Management Program (USEPA, 2003).

The Five Management Levels

LEVEL 1 – Homeowner Awareness:

The homeowner awareness model is appropriate for areas where conventional systems function properly, and there are no critical environmental issues of concern. The purpose of this model is to educate the homeowner on the proper operation and maintenance of their systems. In doing so, a regulatory agency (typically, the township engineer or local health department) issues permits for system construction and keeps a comprehensive database of OWTS. The agency is advised by the USEPA to send reminders to homeowners when a pump-out or inspection is due. The reminder, combined with community "refresher" classes in maintenance and care, will ensure an educated and aware homeowner.

This model has the advantage of compiling comprehensive information about onsite systems within a region, which may be useful in monitoring and future planning. The possible disadvantage of the model is that maintenance and system operation fall in the hands of the homeowner, who is responsible for proper care of their system.

LEVEL 2 – Maintenance Contracts:

The maintenance contract level is an additional step above Level 1, the Homeowner Awareness Model. In this program, homeowners must have OWTS maintenance contracts with licensed septic technicians. This model is appropriate for areas that require additional treatment and more advanced technologies, which may require more maintenance and understanding. Typically, pretreatment (removing excess solids) is used in conjunction with conventional systems. These advanced technologies require maintenance levels agreed upon by the owner and operator.

Advantages of this model include the ability to implement technology, to treat wastewater to a higher level, and to ensure that regular inspections will occur by a licensed service provider. The limitation of this system is that the regulatory agency depends on the homeowner or the service provider to alert them if there has been a breach of contract. In this model, there is no mechanism that ensures that the contracts are being upheld.

LEVEL 3 – Operating Permits:

The operating permit model guarantees regular inspections by a licensed service provider through mandatory compliance of municipal regulations. Limited-term operating permits are issued to the owner upon satisfying the terms of the permit agreement. When the permit expires, the homeowner must demonstrate that the system is still in accordance with permit specifications. This model ensures long-term commitment from the homeowner and fewer impaired systems. The degree of management afforded by operating permits promotes greater property values and fewer repair costs in the long run. This model is appropriate for areas where high levels of treatment are crucial, in particular, areas that are concerned with excessive nutrient inputs into local water bodies. This model is also appropriate for places where systems may have been installed in marginally appropriate areas such as areas with a high water table or areas having soils with low permeability.

Level 3 gives regulatory agencies a mechanism for regulating consistent and proper operation of OWTS. Because implementation of this program level is fully dependent on the support of the community, proper steps must be taken to raise awareness among residents. Currently, some municipalities have approved ordinances that only require new systems to enter the program. Unfortunately, allowing existing systems to operate unregulated may reduce the effectiveness of the program, particularly if the unregulated systems are much older and possibly failing (see Figure 2).

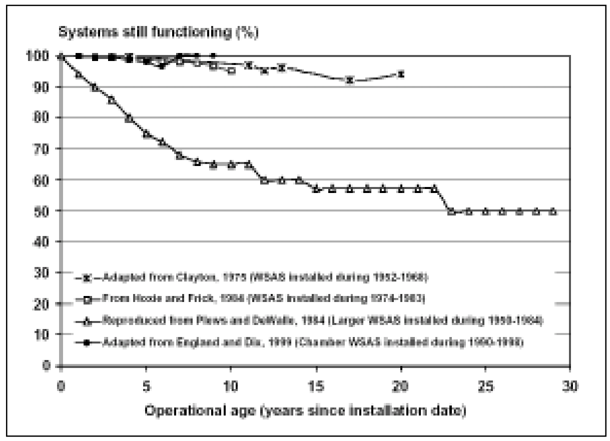

Figure 2. System Functionality with Respect to Age (USEPA, 2003).

LEVEL 4 – Responsible Management Entity (RME) Operation and Maintenance:

This model grants operating permits to RME organizations. The RME is then responsible for timely and concise operation and maintenance of OWTS. While operation and maintenance is a responsibility of the RME, the homeowner owns the OWTS and is responsible for any repair or replacement costs. This is appropriate for areas of moderately high environmental sensitivity or with large concentrations of OWTS. Particularly, this management level is applicable for developments that utilize clustered OWTS technology.

In this program, the RME, not the homeowner, is responsible for the permit and the maintenance of the system. Thus, responsibility lies in the hands of knowledgeable professionals. However, potential for conflict between the RME and the homeowner exists when there is a disagreement over repair or system replacement. Accordingly, the RME must also have a legal easement to the OWTS to access the system.

LEVEL 5 – RME Ownership:

In this model, the RME owns the OWTS and is responsible for all aspects of operation, maintenance, repair, and replacement of failing systems. This is the decentralized analog to public sewerage. Level 5 has the greatest amount of management and allows for technologically advanced systems that treat wastewater to a very high level. This management level is ideal for very sensitive areas and clustered systems that require a high level of monitoring and maintenance. It also provides a form of insurance to the homeowner for repairing or replacing malfunctioning systems. In New Jersey, these costs can be excessive, and the homeowner typically delays repairing or replacing a failing system, resulting in unpleasant smells, human health concerns, and environmental impacts until the system is repaired. A potential impediment is the unwillingness of homeowners to pay an annual fee to a RME. Some homeowners will relate this fee as an additional tax for a service that they have been financially responsible for on their own. Homeowners may object to the establishment of an RME if the annual RME fee is significantly greater than the cost homeowners incurred with their system before the creation of the RME.

Existing New Jersey Management Programs

In New Jersey, all municipalities are required by regulation to implement management programs similar to a Level 1 program. For example, the Standards for Individual Subsurface Sewage Disposal Systems (N.J.A.C. 7:9A) requires all system construction and repairs to be designed by a Professional Engineer (P.E.) and to be approved by the appropriate health department. In addition, N.J.A.C. 7:9A-3.14 requires health departments to notify homeowners on a triennial basis of proper operation and maintenance practices. Furthermore, when people buy homes with septic systems, it is standard practice for them to hire the services of a qualified septic inspector.

Of 566 New Jersey municipalities, eight have implemented more comprehensive OWTS management programs based on the USEPA's voluntary guidelines (see Table 1). The management programs have been spurred, in many instances, by a need to protect shared resources such as recreational and potable waterbodies. To fully establish a Level 5 management strategy, years of planning may be necessary. Figure 3 depicts an approximate timeline for program establishment.

These eight New Jersey municipalities have instituted management programs to the EPA's Level 3. OWTS owners are required to apply for and maintain a license for operation, which is typically a three year agreement. At the end of this time, the owner is required to apply for a new license and prove that the terms of the license have been fulfilled. This usually means that the tank has been

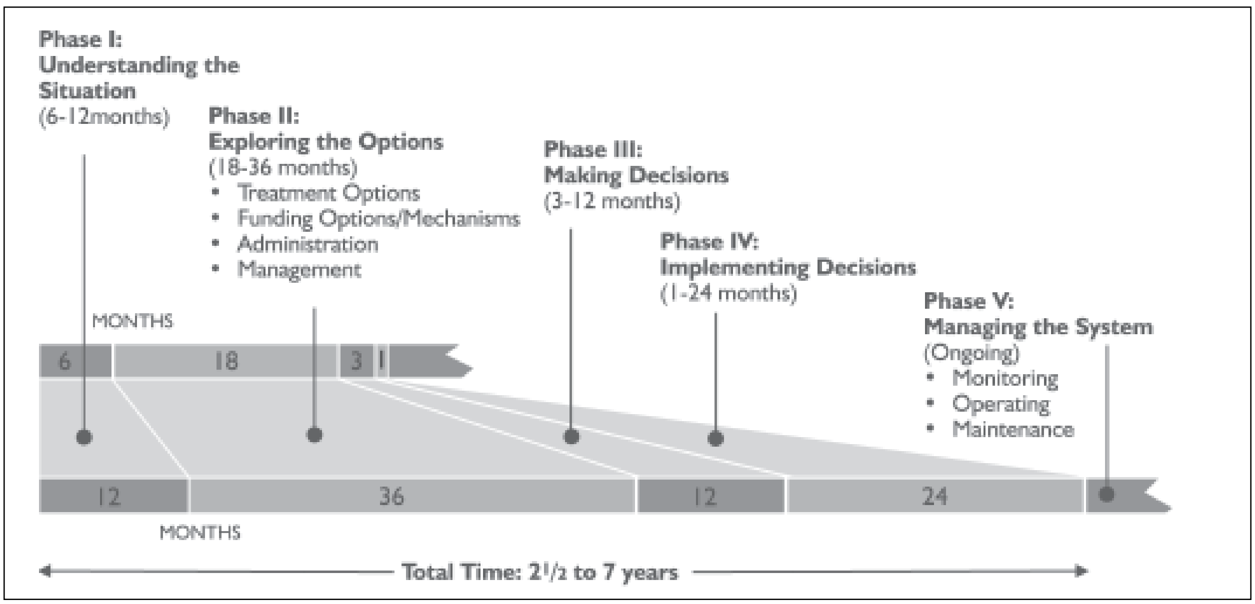

Figure 3. Typical Timetable for a Wastewater Treatment Project (Olson et al., 2002).

inspected and pumped in the last three years and that any necessary repairs have been made. These measures can reduce the number of failing systems, aid the municipality in tracking the frequency and location of system failures, and ensure that non-working systems will be repaired.

Table 1. New Jersey Municipalities with OWTS Management Programs.

County	Municipality	Level	"Grand-fathering"
Morris	Chatham Township	3	No
Morris	Montville Township	3	Yes
Morris	Mount Olive Township	3	Yes
Somerset	Montgomery Township	3	Yes
Sussex	Byram Township	3	No
Sussex	Frankford Township	3	Yes
Sussex	Borough of Hopatcong	3	No
Sussex	*Sparta Township	3	No

*Lake Mohawk Watershed only.

Fifty percent of the municipalities requiring operating permits for septic systems included a "grandfather clause" allowing homeowners with existing systems the option of not entering the program. This means that a failing system may continue to fail until such time as there is new construction. This can limit the effectiveness of the program, and should be considered during program design.

All OWTS that have flow greater than 2,000 gallons per day are required to obtain permits to operate from the NJDEP. These NJDEP permits require frequent maintenance inspections and monitoring to ensure ongoing compliance with ground water and surface water quality standards. This level of management corresponds to USEPA Level 3, 4, or 5.

Funding Sources

- Clean Water State Revolving Fund (USEPA). www.epa.gov/owm/cwfinance/cwsrf.
- Environmental Finance Program (USEPA). www.epa.gov/efinpage/.
- Nonpoint Source Pollution Program (USEPA). www.epa.gov/owow/nps/319hfunds.html.
- U.S. Department of Agriculture, Rural Development. www.rurdev.usda.gov.
- U.S. Department of Housing and Urban Development, Office of Community Planning and Development. www.hud.gov/cpd/cdbg.html.
- The National Decentralized Water Resources Capacity Development Project. www.ndwrcdp.org/funding.cfm.

For More Information

- Rutgers Cooperative Research & Extension. www.rcre.rutgers.edu.
- *A Guide to Public Management of Private Septic Systems*. www.cardi.cornell.edu/clgp/septics_index.cfm.
- *U.S. Environmental Protection Agency, Septic Systems, Guidelines, and General Guidance*. http://cfpub.epa.gov/owm/septic/guidelines.cfm#7479.

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Olson K., Chard B.I., Hickman, D., Malchow, D. 2002. *Small Community Wastewater Solutions: A Guide to Making Treatment, Management and Financing Decisions.*

U.S. Environmental Protection Agency (USEPA). 2002. *Onsite Wastewater Treatment Systems Manual*. EPA/625/R-00/008. Office of Research and-Development. Cincinnati, OH.

U.S. Environmental Protection Agency (USEPA). 2003. *Draft: Handbook for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*. EPA 832-D-03-001. Office of Research and Development. Cincinnati, OH.

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Appendix E:

Engineering Concept Drawings

Appendix E: Engineering Concept Drawings

Plan 1: Dumpster remediation concept plan

Plan 2: Valley Brook Road Horse Equine Bioretention

Plan 3: Valley Brook Road Vegetated Swale

These AutoCAD drawings are too large for this format and will be provided in hard copy format to stakeholders the NJDEP. Other interested parties can make a request for the full 36X24 Concept Plans if there is a need. The plans will be available for viewing on our website: http://www.water.rutgers.edu/Projects/BlackRiver