Total Maximum Daily Load (TMDL) for Phosphorus in Blind Sodus Bay

Wayne County, New York

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Prepared for:

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1.0 INTRODUCTION

1.1. Background

In April of 1991, the United States Environmental Protection Agency (EPA) Office of Water's Assessment and Protection Division published "Guidance for Water Quality-based Decisions: The Total Maximum Daily Load (TMDL) Process." In July 1992, EPA published the final "Water Quality Planning and Management Regulation" (40 CFR Part 130). Together, these documents describe the roles and responsibilities of EPA and the states in meeting the requirements of Section 303(d) of the Federal Clean Water Act (CWA) as amended by the Water Quality Act of 1987, Public Law 100-4. Section 303(d) of the CWA requires each state to identify those waters within its boundaries not meeting water quality standards for any given pollutant applicable to the water's designated uses.

Further, Section 303(d) requires EPA and states to develop TMDLs for all pollutants violating or causing violation of applicable water quality standards for each impaired waterbody. A TMDL determines the maximum amount of pollutant that a waterbody is capable of assimilating while continuing to meet the existing water quality standards. Such loads are established for all the point and nonpoint sources of pollution that cause the impairment at levels necessary to meet the applicable standards with consideration given to seasonal variations and margin of safety. TMDLs provide the framework that allows states to establish and implement pollution control and management plans with the ultimate goal indicated in Section 101(a)(2) of the CWA: "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water, wherever attainable" (USEPA, 1991).

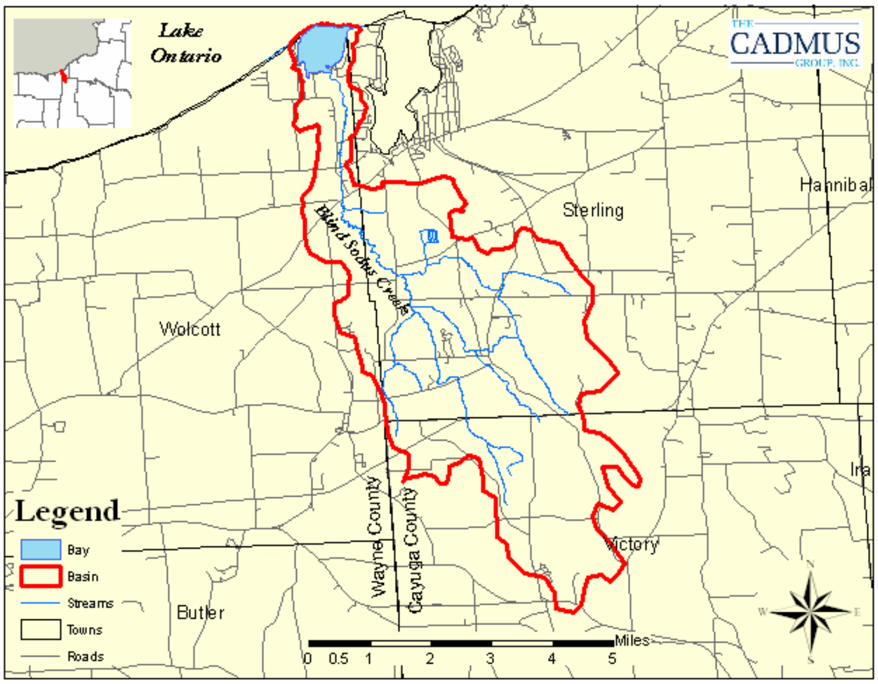
1.2. Description of Waterbody and Drainage Basin

Blind Sodus Bay (WI/PWL ID 0302-0021) is a 235 acre (0.95 km^2) waterbody situated in the Town of Wolcott, within Wayne County, New York at an elevation of about 246 feet (75 meters) above mean sea level (AMSL) (Figure 1). The majority of Blind Sodus Bay's watershed is within Cayuga County. The bay has a direct drainage area of 10,209 acres (41.3 km^2) excluding the surface area of the bay.

Blind Sodus Bay is approximately 4,998 feet (1,523 meters) long, 3,185 feet (971 meters) wide at the widest point, and has a shoreline perimeter of approximately 15,883 feet (4,841 meters). Bathymetric map calculations suggest that the bay has an approximate mean depth of 14 feet (4.3 meters) and an estimated maximum depth of 24 feet (7.3 meters) (Figure 2). The topography of the Blind Sodus Bay drainage basin exhibits gently rolling, irregularly-shaped hills and valleys. Elevation in the basin ranges from approximately 591 feet (180 meters) AMSL in the hills of the upper drainage basin to as low as 246 feet (75 meters) AMSL at the surface of Blind Sodus Bay.

Blind Sodus Creek flows into Blind Sodus Bay from the south and is the only tributary draining into the bay. There are four unnamed stream reaches in the upper drainage basin that coalesce to feed Blind Sodus Creek. Water exits the bay and enters into Lake Ontario through a narrow outlet located at the northwest corner of the bay.

Figure 1. Maps of Blind Sodus Bay Direct Drainage Basin



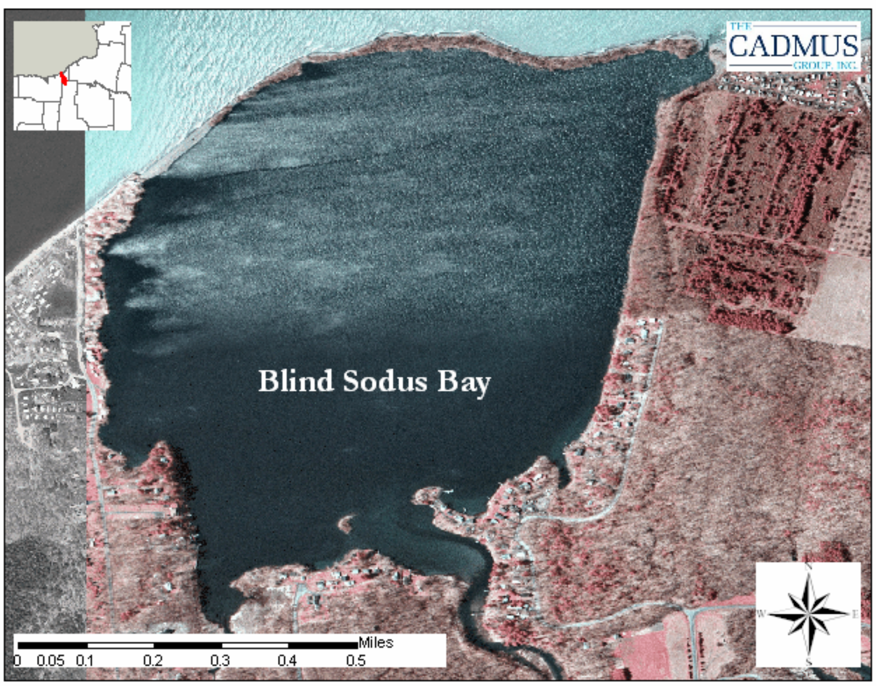
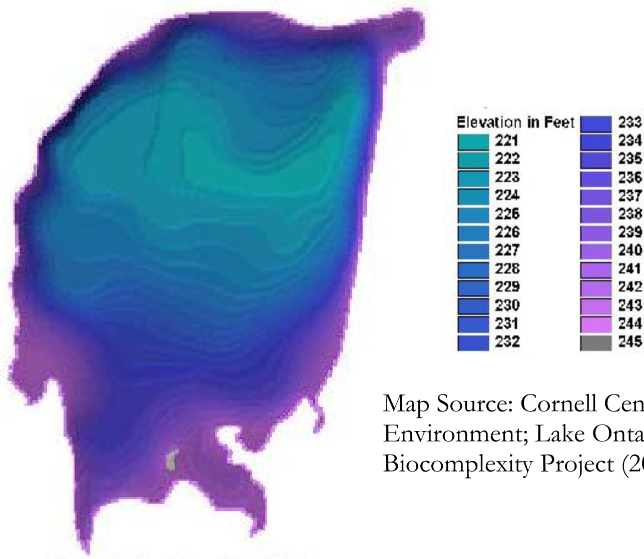


Figure 2. Bathymetric Map of Blind Sodus Bay



Map Source: Cornell Center for the Environment; Lake Ontario Biocomplexity Project (2001)

Existing land use and land cover in the Blind Sodus Bay drainage basin was determined from digital aerial photography and geographic information system (GIS) datasets. Digital land use/land cover data were obtained from the 2001 National Land Cover Dataset (Homer, 2004). The NLCD is a consistent representation of land cover for the conterminous United States generated from classified 30-meter resolution Landsat thematic mapper satellite imagery data. High-resolution color orthophotos were used to manually update and refine land use categories for portions of the drainage basin to reflect current conditions in the drainage basin. Appendix A provides additional detail about the refinement of land use for the drainage basin. Land use categories in Blind Sodus Bay's drainage basin include agriculture, developed land, forests, wetlands, and open water (Table 1 and Figures 3 and 4).

Table 1. Land Use Acres and Percent in Blind Sodus Bay Drainage Basin

Land Use Category	Acres	% of Basin
Open Water (excluding bay)	72	1%
Agriculture	3,042	30%
Hay & Pasture	*1,374*	*14%*
Cropland	*1,667*	*16%*
Developed Land	442	4%
Low Intensity	*438*	*4%*
High Intensity	*3*	*0%*
Forest	6,199	61%
Wetlands	454	4%
TOTAL	**10,209**	**100%**

Figure 3. Distribution of Land Use in Blind Sodus Bay Drainage Basin

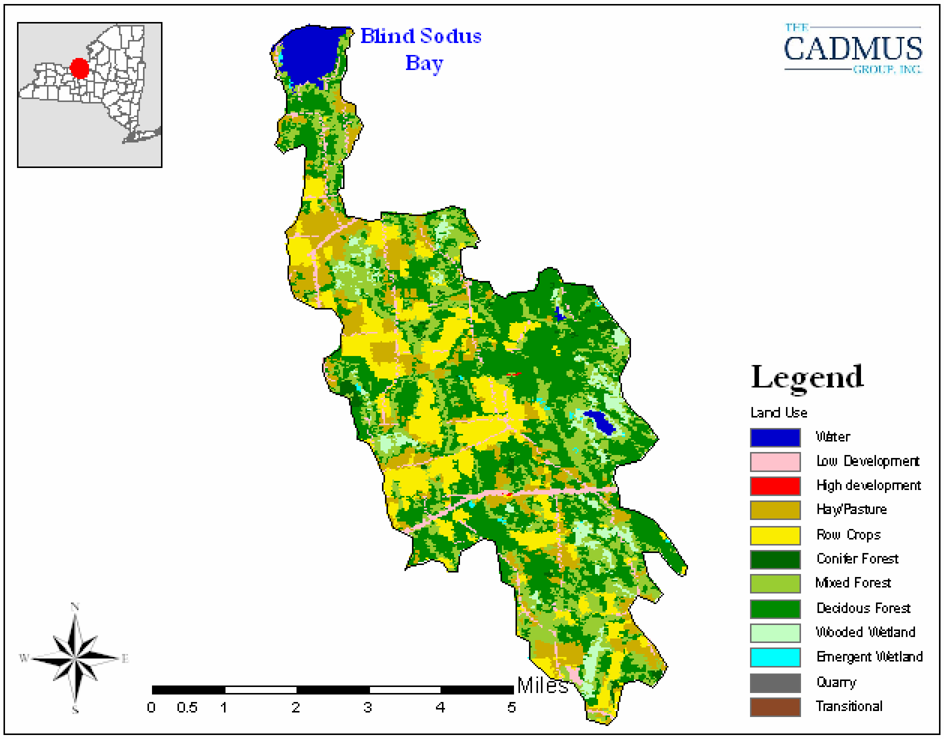
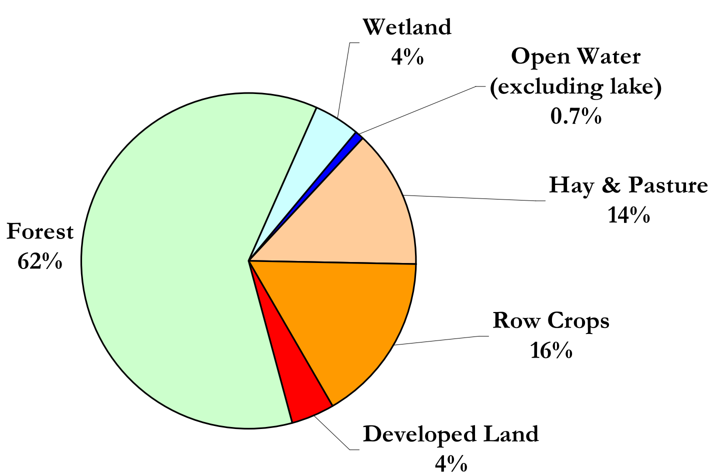


Figure 4. Percent Land Use in Blind Sodus Bay Drainage Basin



1.3. Water Quality Data

The New York State Department of Environmental Conservation's (NYS DEC) Citizens Statewide Lake Assessment Program (CSLAP) is a cooperative volunteer monitoring effort between NYS DEC and the New York Federation of Lake Association (FOLA). The goal of the program is to establish a volunteer lake monitoring program that provides data for a variety of purposes, including establishment of a long-term database for NYS lakes, identification of water quality problems on individual lakes, and geographic and ecological groupings of lakes, and education for data collectors and users. The data collected in CSLAP are fully integrated into the state database for lakes, have been used to assist in local lake management and evaluation of trophic status, spread of invasive species, and other problems seen in the state's lakes.

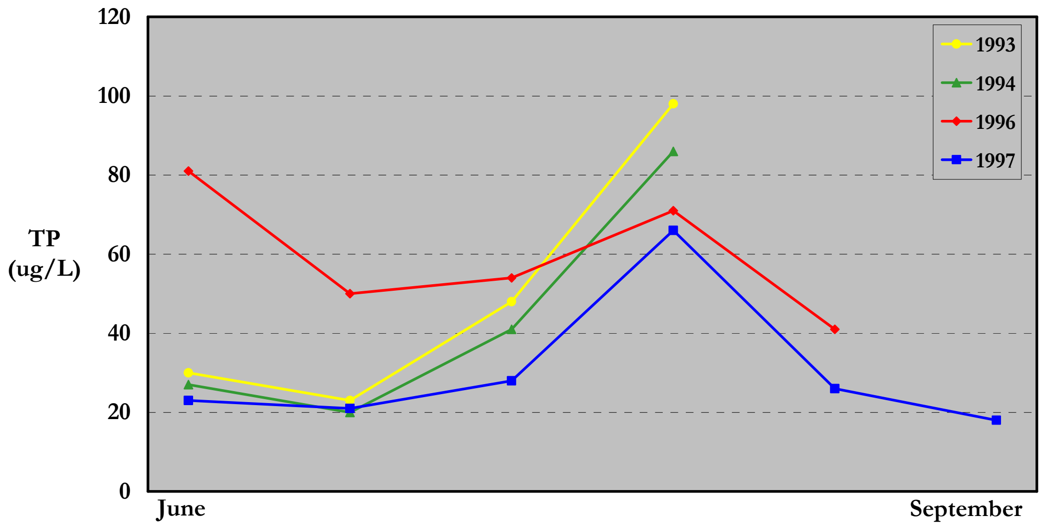
Volunteers undergo on-site initial training and follow-up quality assurance and quality control sessions are conducted by NYS DEC and trained NYS FOLA staff. After training, equipment, supplies, and preserved bottles are provided to the volunteers by NYS DEC for bi-weekly sampling for a 15 week period between May and October. Prior to 2002, water samples, field data, and observation forms were transported to the NYS Department of Health (NYS DOH) for analysis. Water samples are analyzed for standard lake water quality indicators, with a focus on evaluating eutrophication status-total phosphorus, nitrogen (nitrate, ammonia, and total), chlorophyll *a,* pH, conductivity, color, and calcium. Field measurements include water depth, water temperature, and Secchi disk transparency. Volunteers also evaluate use impairments through the use of field observation forms, utilizing a methodology developed in Minnesota and Vermont. Aquatic vegetation samples, deepwater samples, and occasional tributary samples are also collected by sampling volunteers at some lakes. Data are sent from the laboratory to NYS DEC and annual interpretive summary reports are developed and provided to the participating lake associations and other interested parties.

CSLAP monitors several parameters related to the trophic (extent of eutrophication) state of a lake, including phosphorus. Figure 5 shows the epilimnetic concentrations for phosphorus data collected during all sampling seasons and years in which Blind Sodus Bay was sampled as part of CSLAP. Table 2 provides the annual summer mean epilimnetic phosphorus concentrations for these data.

Table 2. Annual Summer Mean Epilimnetic Total Phosphorus Concentrations in Blind Sodus Bay

Year	Total Phosphorus (μg/L)
1993	50
1994	44
1996	59
1997	30

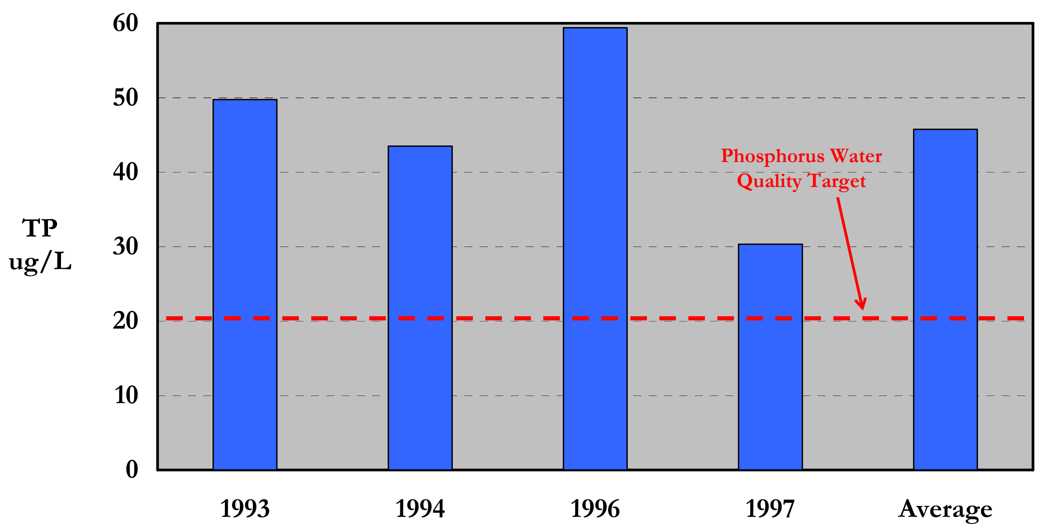
Figure 5. Epilimnetic Phosphorus Concentrations For Blind Sodus Bay



1.4. Problem Definition

As part of CSLAP, a limited number of water quality samples were collected in Blind Sodus Bay during the summers of 1993, 1994, 1996, and 1997. The results from these sampling efforts show eutrophic conditions in Blind Sodus Bay, with the concentration of phosphorus in the bay violating the state guidance value for phosphorus (20 μg/L or 0.020 mg/L, applied as the mean summer, epilimnetic total phosphorus concentration), which increases the potential for nuisance summertime algae blooms (Figure 6).

Figure 6. Summer Mean Epilimnetic Total Phosphorus Levels in Blind Sodus Bay



A variety of nonpoint sources of phosphorus contribute to poor water quality in Blind Sodus Bay. The water quality of the bay is influenced by runoff events from the drainage basin, as well as loading from nearby residential septic tanks. In response to precipitation, nutrients such as phosphorus – naturally found in New York soils – drain into the bay from the surrounding drainage basin by way of streams, overland flow, and subsurface flow. Nutrients are then deposited and stored in the bay's bottom sediments. Phosphorus is often the limiting nutrient in temperate lakes, ponds, and bays and can be thought of as a fertilizer; a primary food for plants, including algae. When bays receive excess phosphorus, it "fertilizes" the bay by feeding the algae. Too much phosphorus can result in algae blooms, which can damage the ecology/aesthetics of a bay, as well as the economic well-being of the surrounding community. Blind Sodus Bay is listed on the New York State CWA Section 303(d) list of waterbodies that do not meet water quality standards due to phosphorus impairments (NYS DEC, 2004). Based on this listing, a TMDL for phosphorus is being developed for the bay.

1.5. Numeric Water Quality Target

The TMDL target is a numeric endpoint specified to represent the level of acceptable water quality that is to be achieved by implementing the TMDL. The water quality classification for Blind Sodus Bay is Class *B*, which means that the best usages of the bay are primary and secondary contact recreation and fishing. The bay must also be suitable for fish propagation and survival. New York State has a narrative standard for nutrients -- none in amounts that will result in growths of algae, weeds, and slimes that will impair the waters for their best usages (6 NYSCRR Part 703.2). As part of its Technical and Operational Guidance Series (TOGS 1.1.1 and accompanying fact sheet, NYS, 1993), NYS DEC has suggested that for waters classified as ponded (i.e., lakes, reservoirs and ponds, excluding Lakes Erie, Ontario and Champlain), the epilimnetic summer mean total phosphorus level shall not exceed 20 μg/L (or 0.02 mg/L), based on biweekly sampling, conducted from June 1 to September 30. This guidance value of 20 μg/L is the TMDL target for Blind Sodus Bay.

2.0 SOURCE ASSESSMENT

2.1. Estimating Phosphorus Loading Using AVGWLF

The ArcView Generalized Watershed Loading Function (AVGWLF) model was used in combination with BATHTUB to develop the Blind Sodus Bay TMDL. This approach consists of using AVGWLF to determine mean annual phosphorus loading to the bay, and then using BATHTUB to define the extent to which this load must be reduced to meet the water quality target. This approach required no additional data collection thereby expediting the modeling efforts.

The GWLF model was developed by Haith and Shoemaker (1987). GWLF simulates runoff and stream flow by a water-balance method based on measurements of daily precipitation and average temperature. The complexity of GWLF falls between that of a detailed, process-based simulation model and a simple export coefficient model that does not represent temporal variability. The GWLF model was determined to be appropriate for this TMDL analysis because it simulates the important processes of concern, but does not have onerous data requirements for calibration. AVGWLF was developed to facilitate the use of the GWLF model via an ArcView interface (Evans, 2002). Appendix A discusses the setup, calibration, and use of the AVGWLF model for TMDL assessments in New York.

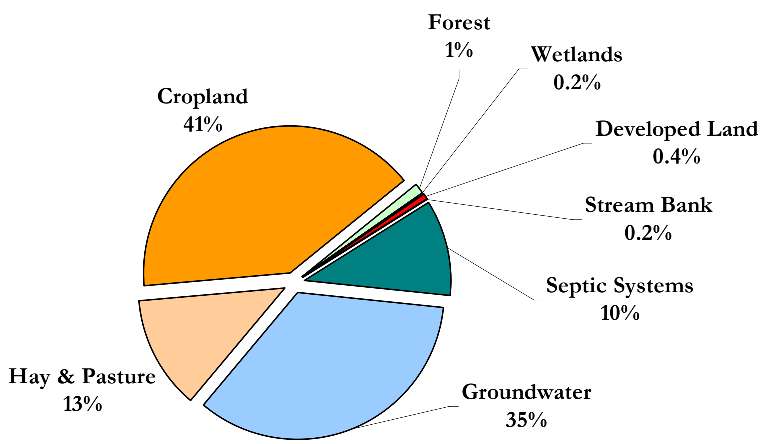
2.2. Sources of Phosphorus Loading

AVGWLF was used to estimate long-term (1990-2004) mean annual phosphorus loading to Blind Sodus Bay. Appendix A provides the detailed simulation results from AVGWLF. The estimated mean annual load of 2,216 lbs/yr of total phosphorus that enters the bay comes primarily from the sources listed in Table 3 and shown in Figure 7.

Table 3. Estimated Sources of Phosphorus Loading to Blind Sodus Bay

Source Category	Total Phosphorus (lbs/yr)
Hay/Pasture	277
Cropland	898
Forest	27
Wetlands	5
Developed Land	9
Stream Bank	5
Groundwater	765
Septic Systems	230
TOTAL	**2,216**

Figure 7. Estimated Sources of Total Phosphorus Loading to Blind Sodus Bay



Residential On-Site Septic Systems

Residential on-site septic systems contribute an estimated 230 lbs/yr of phosphorus to Blind Sodus Bay, which is about 10% of the total loading to the bay. Residential septic systems contribute dissolved phosphorus to nearby waterbodies due to system malfunctions. Septic systems treat human waste using a collection system that discharges liquid waste into the soil through a series of distribution lines that comprise the drain field. In properly functioning (normal) systems, phosphates are adsorbed and retained by the soil as the effluent percolates through the soil to the shallow saturated zone. Therefore, normal systems contribute very little phosphorus loads to nearby waterbodies. A septic system (ponding) malfunction occurs when there is a discharge of waste to the soil surface (where it is available for runoff); as a result, malfunctioning septic systems can contribute high phosphorus loads to nearby waterbodies. Short-circuited systems (those systems in close proximity to surface waters where there is limited opportunity for phosphorus adsorption to take place) also contribute significant phosphorus loads.

GIS analysis of orthoimagery for the basin shows approximately 29 houses within 50 feet of the shoreline and 89 houses between 50 and 250 feet of the shoreline; all of the houses are assumed to have septic systems. To convert the estimated number of septic systems to population served, an average household size of 2.61 people per dwelling was used based on the circa 2000 USCB census estimate for number of persons per household in New York State. All of the septic systems within 50 feet of the shoreline and 25% of systems between 50 and 250 feet of the shoreline were categorized as short-circuiting systems. Approximately 10% of septic systems beyond 250 feet of the shoreline (up to the drainage basin boundary) were categorized as ponding systems. All remaining systems in the basin (including those beyond 250 feet of the shoreline) were categorized as normal. To account for seasonal variations in population, data from the 2000 census were used to estimate the percentage of seasonal homes for the town(s) surrounding the bay. Approximately 84% of the homes around the bay are assumed to be year-round residences, while 16% are seasonally occupied (i.e., June through August only). Additional details about the process for estimating the population served by normal and malfunctioning systems within the bay drainage basin is provided in Appendix A. The estimated population in the Blind Sodus Bay drainage basin served by normal and malfunctioning systems is summarized in Table 4.

Table 4. Population Served by Septic Systems in the Blind Sodus Bay Drainage Basin

	Normally Functioning	Malfunctioning		Total
		Short-Circuit	Ponded	
September - May	590	119	46	755
June - August (Summer)	590	141	46	777

Agriculture

Agricultural land encompasses 3,042 acres (30%) of the bay drainage basin and includes hay and pasture land (14%) and row crops (16%). Overland runoff from agricultural land is estimated to contribute 1,175 lbs/yr of phosphorus loading to Blind Sodus Bay, which is about 53% of the total phosphorus loading to the bay. Row crops are the largest agricultural contributor, accounting for approximately 41% of the total phosphorus load to Blind Sodus Bay.

In addition to the contribution of phosphorus to the bay from overland agriculture runoff, additional phosphorus originating from agricultural lands is leached in dissolved form from the surface and transported to the bay through subsurface movement via groundwater. The process for estimating subsurface delivery of phosphorus originating from agricultural land is discussed in the Groundwater section (below). Phosphorus loading from agricultural land originates primarily from soil erosion and the application of manure and fertilizers. Implementation plans for agricultural sources will require voluntary controls applied on an incremental basis.

Forests

Forested land is estimated to comprise 6,199 acres (61%), of the bay drainage basin. Forested land is estimated to contribute 27 lbs/yr of phosphorus loading to Blind Sodus Bay, which is less than 2% of the total phosphorus loading to the bay. Phosphorus loading from forested land is typically considered a component of natural background loading.

Urban and Residential Development

Developed land comprises 442 acres (4%) of the bay drainage basin and contributes 9 lbs/yr of phosphorus loading to Blind Sodus Bay, which is less than 1% of the total phosphorus loading to the bay. This load does not account for contributions from malfunctioning septic systems.

In addition to the contribution of phosphorus to the bay from overland urban runoff, additional phosphorus originating from developed lands is leached in dissolved form from the surface and transported to the bay through subsurface movement via groundwater. The process for estimating subsurface delivery of phosphorus originating from developed land is discussed in the Groundwater section (below).

Phosphorus runoff from developed areas originates primarily from human activities, such as fertilizer applications to lawns. Shoreline development, in particular, can have a large phosphorus loading impact to nearby waterbodies in comparison to its relatively small percentage of the total land area in the drainage basin.

Groundwater

In addition to nonpoint sources of phosphorus delivered to the bay by overland surface runoff, a portion of the phosphorus load from nonpoint sources seeps into the ground and is transported to the bay via groundwater. Groundwater is estimated to transport 765 lbs/yr (35%) of the total phosphorus load to Blind Sodus Bay. With respect to groundwater, there is typically a small "background" concentration owing to various natural sources. In the Blind Sodus Bay drainage basin, the model-estimated groundwater phosphorus concentration is 0.021 mg/L. The GWLF manual provides estimated background groundwater phosphorus concentrations for ≥90% forested land in the eastern United States, which is 0.006 mg/L. Consequently, about 29% of the groundwater load (219 lbs/yr) can be attributed to natural sources, including forested land and soils.

The remaining amount of the groundwater phosphorus load (about 546 lbs/yr) likely originates from agricultural and developed land sources (i.e., leached in dissolved form from the surface). The portion originating from developed land was estimated using the following equation from the final report for the Lake George Nationwide Urban Runoff Program (NURP) Study (Sutherland, 1983):

> $\mathbf{L_{AP} = -0.149 + 0.241 * \ln(\%D)}$, where L_{AP} is the areal phosphorus loading from developed land and % D is the percent developed land in the basin

Based on the NURP study, the estimated phosphorus loading from urban land is approximately 179 lbs/yr. AVGWLF estimates that 9 lbs/yr of phosphorus is delivered from surface urban runoff. Therefore, it is assumed that the remaining phosphorus originating from developed land is transported via groundwater. Using the NURP study and accounting for the 9 lbs/yr from surface runoff, it is estimated that approximately 170 lbs/yr of phosphorus loading from developed land is transported to the bay via groundwater. The remaining amount of the groundwater phosphorus load (377 lbs/yr) is estimated to originate from agricultural sources. Table 5 summarizes this information.

Table 5. Sources of Phosphorus Transported in the Subsurface via Groundwater

	Total Phosphorus (lbs/yr)	% of Total Groundwater Load
Natural Sources	219	29%
Agriculture	377	49%
Developed Land	170	22%
Total	**765**	**100%**

Other Sources

Wildlife, waterfowl, and domestic pets may also be a potential source of phosphorus loading to the bay. Atmospheric deposition, while a small contributor, is also another source of phosphorus. All of these small sources of phosphorus are incorporated into the land use loadings as identified in the TMDL analysis (and therefore accounted for).

3.0 DETERMINATION OF LOAD CAPACITY

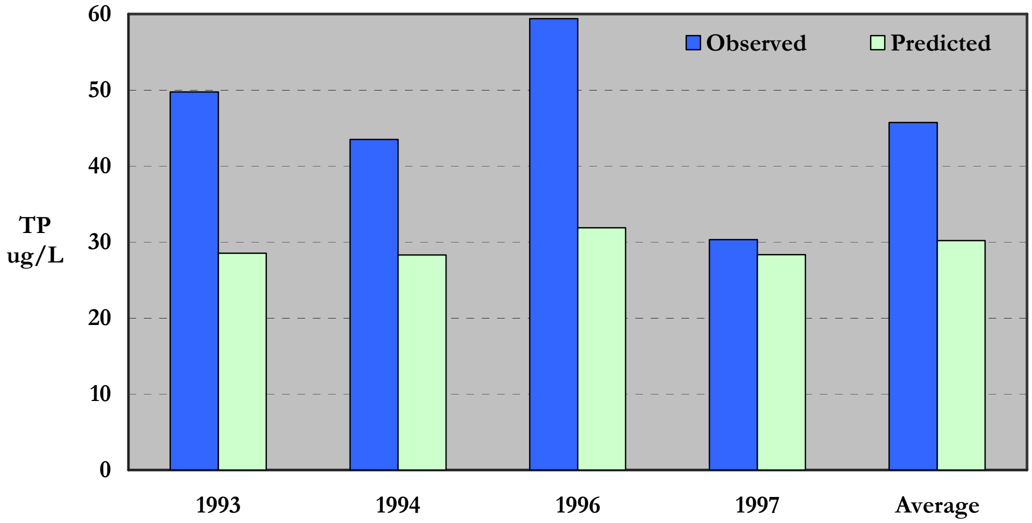
3.1. Bay Modeling Using the BATHTUB Model

BATHTUB was used to define the relationship between phosphorus loading to the bay and the resulting concentrations of total phosphorus in the bay. The U.S. Army Corps of Engineers' BATHTUB model predicts eutrophication-related water quality conditions (e.g., phosphorus, nitrogen, chlorophyll a, and transparency) using empirical relationships previously developed and tested for reservoir applications (Walker, 1987). BATHTUB performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network. Appendix B discusses the setup, calibration, and use of the BATHTUB model.

3.2. Linking Total Phosphorus Loading to the Numeric Water Quality Target

In order to estimate the loading capacity of the bay, simulated phosphorus loads from AVGWLF were used to drive the BATHTUB model to simulate water quality in Blind Sodus Bay. AVGWLF was used to derive a mean annual phosphorus loading to the bay for the period 1990-2004. Using this load as input, BATHTUB was used to simulate water quality in the bay. The results of the BATHTUB simulation were compared against the average of the bay's observed summer mean phosphorus concentrations for the years 1993, 1994, 1996, and 1997. Year-specific loading was also simulated with AVGWLF, run through BATHTUB, and compared against the observed summer mean phosphorus concentration for that particular year. The combined use of AVGWLF and BATHTUB provided a good fit to the observed data for Blind Sodus Bay (Figure 8).

Figure 8. Observed vs. Simulated Summer Mean Epilimnetic Total Phosphorus Concentrations (μg/L) in Blind Sodus Bay



The BATHTUB model was used as a "diagnostic" tool to derive the total phosphorus load reduction required to achieve the phosphorus target of 20 μg/L. The loading capacity of Blind Sodus Bay was determined by running BATHTUB iteratively, reducing the concentration of the drainage basin phosphorus load until model results demonstrated attainment of the water quality target. The maximum concentration that results in compliance with the TMDL target for phosphorus is used as the basis for determining the bay's loading capacity. This concentration is converted into a loading rate using simulated flow from AVGWLF.

The maximum annual phosphorus load (i.e., the annual TMDL) that will maintain compliance with the phosphorus water quality goal of 20 μg/L in Blind Sodus Bay is a mean annual load of 1,271 lbs/yr. The daily equivalent TMDL of 3.5 lbs/d was calculated by dividing the annual load by the number of days in a year. Lakes and reservoirs store phosphorus in the water column and sediment, therefore water quality responses are generally related to the total nutrient loading occurring over a year or season. For this reason, phosphorus TMDLs for lakes and reservoirs are generally calculated on an annual or seasonal basis. The use of annual loads, versus daily loads, is an accepted method for expressing nutrient loads in lakes and reservoir. This is supported by EPA guidance such as *The Lake Restoration Guidance Manual* (USEPA, 1990) and *Technical Guidance Manual for Performing Waste Load Allocations, Book IV, lakes and Impoundments, Chapter 2 Eutrophication* (USEPA, 1986). While a daily load has been calculated, it is recommended that the annual loading target be used to guide implementation efforts since the annual load of total phosphorus as a TMDL target is more easily aligned with the design of best management practices (BMPs) used to implement nonpoint source and stormwater controls for bays than daily loads. Ultimate compliance with the water quality standards for the TMDL will be determined by measuring the bay's water quality to determine when the phosphorus guidance value is attained.

4.0 POLLUTANT LOAD ALLOCATIONS

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources so that appropriate control measures can be implemented and water quality standards achieved. Individual waste load allocations (WLAs) are assigned to discharges regulated by State Pollutant Discharge Elimination System (SPDES) permits (commonly called point sources) and unregulated loads (commonly called nonpoint source) are contained in load allocations (LAs). A TMDL is expressed as the sum of all individual WLAs for point source loads, LAs for nonpoint source loads, and an appropriate margin of safety (MOS), which takes into account uncertainty (Equation 1).

Equation 1. Calculation of the TMDL

$$TMDL = \sum WLA + \sum LA + MOS$$

4.1. Wasteload Allocation (WLA)

There are no point source discharges of treated wastewater effluent in the Blind Sodus Bay drainage basin. There are also no Municipal Separate Storm Sewer Systems in the basin. Therefore, the WLA is set at 0 (zero), and all of the loading capacity is allocated as a gross allotment to the load allocation.

4.2. Load Allocation (LA)

The LA is set at 1,144 lbs/yr. Nonpoint sources that contribute total phosphorus to Blind Sodus Bay on an annual basis include loads from developed land, agricultural land, and malfunctioning septic systems. Table 6 lists the current loading for each source and the load allocation needed to meet the TMDL; Figure 9 provides a graphical representation of this information. Phosphorus originating from forested land is assumed to be a minor source of loading that is unlikely to be further reduced and therefore the load allocation is set at the current loading levels. If the lakeshore were sewered as part of a regional wastewater treatment solution (as further discussed in Section 5, Implementation), most of the load from septic systems could be eliminated from the watershed. Septic systems remote from the lakeshore and not replaced by sanitary sewers would have to be corrected individually. Loads from developed land were assigned a twenty percent reduction, which is believed to be reasonable and practical. The bulk of the reductions need to come from agricultural land, which account for most of the estimated load in the watershed.

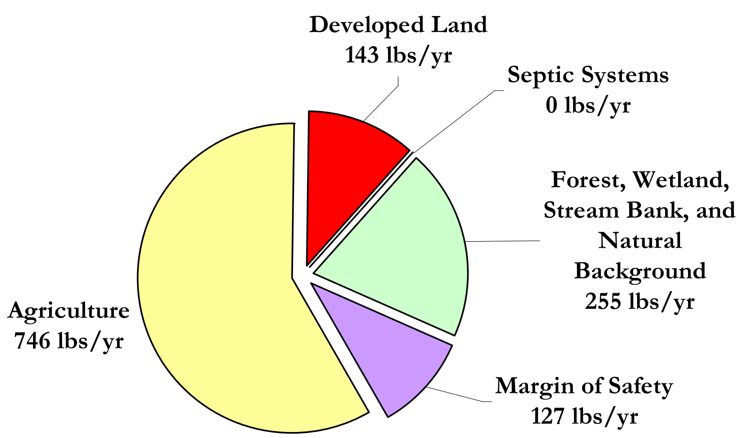
Table 6. Total Annual Phosphorus Load Allocations for Blind Sodus Bay[1]

Source	Total Phosphorus Load (lbs/yr)			% Reduction
	Current	Allocated	Reduction	
Agriculture*	1,552	746	806	52%
Developed Land*	179	143	36	20%
Septic Systems	230	0	230	100%
Forest, Wetland, Stream Bank, and Natural Background	255	255	0	0%
LOAD ALLOCATION (subtotal)	**2,216**	**1,144**	**1,072**	**48%**
Point Sources	0	0	0	0%
WASTELOAD ALLOCATION (subtotal)	**0**	**0**	**0**	**0%**
LA + WLA	**2,216**	**1,144**	**1,072**	**48%**
Margin of Safety	---	127	---	---
TOTAL	**2,216**	**1,271**	**n/a**	**n/a**

1 - Note: The values reported in Table 6 are the annually integrated values. The daily equivalent values are provided in Appendix C.

* Includes phosphorus transported through surface runoff and subsurface (groundwater)

Figure 9. Total Phosphorus Load Allocations for Blind Sodus Bay (lbs/yr)



4.3. Margin of Safety (MOS)

The margin of safety (MOS) can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. For the Blind Sodus Bay TMDL, the MOS is explicitly accounted for during the allocation of loadings. An implicit MOS could have been provided by making conservative assumptions at various steps in the TMDL development process (e.g., by selecting conservative model input parameters or a conservative TMDL target). However, making conservative assumptions in the modeling analysis can lead to errors in projecting the benefits of BMPs and in projecting bay responses. Therefore, the recommended method is to formulate the mass balance using the best scientific estimates of the model input values and keep the margin of safety in the "MOS" term.

The TMDL contains an explicit margin of safety (MOS) corresponding to 10% of the loading capacity, or 127 lbs/yr. The 10% MOS is appropriate based on the generally good agreement between the AVGWLF loading model and the observed loading and flow data, and good agreement between the BATHUB water quality model and the observed bay water quality data. Since these models reasonably reflect the conditions in the drainage basin, a 10% MOS is considered to be adequate to address the uncertainty in the TMDL. The MOS can be reviewed in the future as new data become available.

4.4. Critical Conditions

TMDLs must take into account critical environmental conditions to ensure that the water quality is protected during times when it is most vulnerable. Critical conditions were taken into account in the development of this TMDL. In terms of loading, spring runoff periods are considered critical because wet weather events transport significant quantities of nonpoint source loads to bays. However, the water quality ramifications of these nutrient loads are most severe during middle or late summer. Therefore, BATHTUB model simulations were compared against observed data for the summer period only. Furthermore, AVGWLF takes into account loadings from all periods throughout the year, including spring loads.

4.5. Seasonal Variations

Seasonal variation in nutrient load and response is captured within the models used for this TMDL. In BATHTUB, seasonality is incorporated in terms of seasonal averages for summer. Seasonal variation is also represented in the TMDL by taking 14 years of daily precipitation data when calculating runoff through AVGWLF, as well as by estimating septic system loading inputs based on residency (i.e., seasonal or year-round). This takes into account the seasonal effects the bay will undergo during a given year.

5.0 IMPLEMENTATION

Coordination with state agencies, federal agencies, local governments, and stakeholders, the general public, environmental interest groups, and representatives from nonpoint pollution sources will ensure that the proposed management alternatives are technically and financially feasible. NYS DEC, in coordination with these local interests, will address the sources of impairment, using primarily non-regulatory tools in this watershed, matching management strategies with sources, and aligning available resources to effect implementation.

NYS DEC recognizes that TMDL designated load reductions alone may not be sufficient to restore eutrophic lakes and bays. The TMDL establishes the required nutrient reduction targets and provides some regulatory framework to effect those reductions. However, the nutrient load only affects the eutrophication potential of a lake or bay. The implementation plan therefore calls for the collection of additional monitoring data, as discussed in Section 5.2, and consideration of in-lake measures that need to be taken to supplement the nutrient reduction measures required by the TMDL. For example, the shallow portion of the bay supports macrophytes that, at some density levels, are a natural component of a healthy, clear-water lake ecology. However, because of density or location, these macrophytes ultimately interfere with boating. Phosphorus reductions alone may not address this issue and biological controls of macrophytes or other measures may be a long-term maintenance measure needed in certain areas to facilitate boating use.

5.1. Reasonable Assurance for Implementation

Because agricultural load is estimated to be the primary source of load in the Blind Sodus Bay watershed, restoration depends on significant reductions from that source. Reductions would be attempted by a voluntary, incentive-based approach to installing management practices that reduce phosphorus losses; however the level of reduction necessary to restore Blind Sodus Bay is beyond what could be anticipated from installing these practices. Some of the agricultural land may need to be taken out of production or converted to crops that result in less phosphorus losses, as is described in detail below.

The Wayne County Water and Sewer Authority is conducting a study to determine sewer needs for Blind Sodus Bay and adjacent impaired bays. Sewage from these areas would be treated at a regional facility that discharges to Lake Ontario. A systematic approach, such as the formation of a sewer district, would be essential to achieving the load reductions specified above. A regional sewage treatment plan could also address the need for phosphorus reduction in Little Sodus Bay, immediately to the east, that has been identified in a TMDL for that watershed.

Load reductions from stormwater, although relatively less than agriculture and septic systems, should be addressed through reasonable management applied through the programs outlined below.

Measures for Agriculture

The New York State Agricultural Environmental Management (AEM) Program was codified into law in 2000. Its goal is to support farmers in their efforts to protect water quality and conserve natural resources, while enhancing farm viability. AEM provides a forum to showcase the soil and water conservation stewardship farmers provide. It also provides information to farmers about Concentrated Animal Feeding Operation (CAFO) regulatory requirements, which helps to assure compliance. Details of the AEM program can be found at the New York State Soil and Water Conservation Committee (SWCC) website, http://www.nys-soilandwater.org/aem/index.html.

Using a voluntary approach to meet local, state, and national water quality objectives, AEM has become the primary program for agricultural conservation in New York. It also has become the umbrella program for integrating/coordinating all local, state, and federal agricultural programs. For instance, farm eligibility for cost sharing under the SWCC Agricultural Non-point Source Abatement and Control Grants Program is contingent upon AEM participation.

AEM core concepts include a voluntary and incentive-based approach, attending to specific farm needs and reducing farmer liability by providing approved protocols to follow. AEM provides a locally led, coordinated and confidential planning and assessment method that addresses watershed needs. The assessment process increases farmer awareness of the impact farm activities have on the environment and by design, it encourages farmer participation, which is an important overall goal of this implementation plan.

The AEM Program relies on a five-tiered process:

Tier 1 – Survey current activities, future plans and potential environmental concerns.

Tier 2 – Document current land stewardship; identify and prioritize areas of concern.

Tier 3 – Develop a conservation plan, by certified planners, addressing areas of concern tailored to farm economic and environmental goals.

Tier 4 – Implement the plan using available financial, educational and technical assistance.

Tier 5 – Conduct evaluations to ensure the protection of the environment and farm viability.

Because the Blind Sodus Bay extends into two counties, both the Wayne and Cayuga County Soil and Water Conservation Districts should be encouraged to implement the AEM program on farms in the watershed that will lead to identification of management practice to reduce phosphorus loads. These practices would be eligible for state or federal funding and because they address a water quality impairment associated with this TMDL, should score well.

Tier 1 could be used to identify farmers that for economic or personal reasons may be changing or scaling back operations, or contemplating selling land. These farms would be candidates for conservation easements, or conversion of cropland to hay, as would farms identified in Tier 2 with highly-erodible soils and/or needing stream management. Tier 3 should include a Comprehensive Nutrient Management Plan with phosphorus indexing, and perhaps include a nutrient mass balance to identify excessive phosphorus input to the farm (feed management). These efforts could identify the need to export manure outside of the Blind Sodus Bay watershed. Several practices could be implemented in Tier 4 to reduce phosphorus loads, such as conservation tillage, stream fencing, rotational grazing and cover crops. Also, riparian buffers reduce losses from upland fields and stabilize stream banks in addition to the reductions from taking the land in buffers out of production.

Measures for Septic Systems

Until sanitary sewers are installed, the testing of septic systems should be expanded and failing systems must be upgraded in accordance with the State Sanitary Code. Property owners should be educated on proper maintenance of their septic systems and encouraged to make preventative repairs.

Measures for Stormwater

In March 2002, NYS DEC issued SPDES general permits GP-02-01 for construction activities, and GP-02-02 for stormwater discharges from municipal separate stormwater sewer system (MS4s) in response to the federal Phase II Stormwater rules. GP-02-02 applies to urbanized areas of New York State, so it does not cover the Blind Sodus Bay watershed.

Stormwater management in rural areas can be addressed through the Nonpoint Source Management Program. There are several measures, which, if implemented in the watershed, could directly or indirectly reduce phosphorus loads in stormwater discharges to the Bay or watershed:

- Public education regarding:
  - Lawn care, specifically reducing fertilizer use or using phosphorus-free products, now commercially available.
  - Cleaning up pet waste.
  - Discouraging waterfowl congregation by restoring natural shoreline vegetation.
- Management practices to address any significant existing erosion sites.
- Construction site and post construction stormwater runoff control ordinance and inspection and enforcement programs.
- Pollution prevention practices for road and ditch maintenance.

Protection Measures

Measures to further protect water quality and limit growth of phosphorus load that would otherwise offset load reduction efforts should be considered. The basic protections afforded by local zoning ordinances could be enhanced to limit non-compatible development and preserve natural vegetation along shorelines. Identification of wildlife habitats, sensitive environmental areas, and key open spaces within the shoreline area could lead to their preservation or protection by way of conservation easements or other voluntary controls, which would supplement the regulated wetlands in the watershed.

5.2. Follow-up Monitoring

A targeted post-assessment monitoring effort will be initiated to determine the effectiveness of the implementation plan associated with the TMDL. Blind Sodus Bay will be sampled in 2008 at its deepest location (approx. 6-7 m), during the warmer part of the year (May through September) on 8 sampling dates. Dissolved oxygen and temperature profiles will be done at 1 meter intervals at the "deep hole." Grab samples will be collected at 1.5 meters and in the hypolimnion, if thermal stratification is present (but this is not expected). The samples will be analyzed for the phosphorus series (total phosphorus, total soluble phosphorus, and soluble reactive phosphorus), the nitrogen series (nitrate, ammonia and total nitrogen), and chloride. The epilimnetic samples will be analyzed for chlorophyll *a* and the Secchi disk depth will be measured. A simple macrophyte survey will also be conducted one time during mid summer.

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Depending on the speed and extent of implementation, the sampling will be repeated at a regular interval. The initial plan will be to set the interval at 5 years. In addition, as the information on the DEC GIS system is updated (land use, BMPs, etc.), these updates will be applied to the input data for the models BATHTUB and AVGWLF. The information will be incorporated into the NY 305(b) report as needed.

6.0 PUBLIC PARTICIPATION

Notice of availability of the Draft TMDL was made to local government representatives and interested parties. This Draft TMDL was public noticed in the Environmental Notice Bulletin on July 11, 2007. A 30-day public review period was established for soliciting written comments from stakeholders prior to the finalization and submission to the TMDL for USEPA approval. No comments were received.

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