Total Maximum Daily Loads (TMDLs) for Phosphorus in Buck, Long, and Cranberry Ponds

Monroe 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" (USEPA 1991b). 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 water body. A TMDL determines the maximum amount of pollutant that a water body 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, 1991a).

1.2. Problem Statement

Buck, Long, and Cranberry Ponds (WI/PWL IDs 0301-0017, 0301-0015, and 0301-0016, respectively) are located along the Lake Ontario shoreline in the Town of Greece, within Monroe County, New York. Over the past couple of decades, the ponds have experienced degraded water quality that has reduced the ponds' recreational and aesthetic value. In particular, recreational suitability has become less favorable due to excessive weed growth in the ponds. All three ponds have high concentrations of total phosphorus. Long Pond has the highest concentrations followed by Cranberry and then Buck Pond.

A variety of phosphorus sources contribute to the poor water quality in Buck, Long, and Cranberry Ponds. Water quality in the ponds is influenced by runoff events from the drainage basin, as well as loading from residential septic tanks positioned close to stream segments and pond shorelines. In response to precipitation, nutrients, such as phosphorus – naturally found in New York soils – drain into the ponds from the surrounding drainage basin by way of streams, overland flow, and subsurface flow. Nutrients are then deposited and stored in the bottom sediments of the ponds. Phosphorus is often the limiting nutrient in temperate lakes and ponds and can be thought of as a fertilizer; a primary food for plants, including algae. When ponds receive excess phosphorus, it "fertilizes" the pond by feeding the algae. Too much phosphorus can result in algae blooms, which can damage the ecology and aesthetics of a pond, and in turn, the economic well-being of the surrounding drainage basin community.

The results from sampling efforts confirm eutrophic conditions in Buck, Long, and Cranberry Ponds, with the concentration of phosphorus in the ponds exceeding the state guidance value for phosphorus (20 μg/L or 0.02 mg/L, applied as the mean summer, epilimnetic total phosphorus concentration), which increases the potential for nuisance summertime algae blooms. In 2002, Buck, Long, and Cranberry Ponds were added to the New York State Department of Environmental Conservation (NYS DEC) CWA Section 303(d) list of impaired water bodies that do not meet water quality standards due to phosphorus impairments and identified as high priorities for TMDL development (NYS DEC, 2010). Based on this listing, TMDLs for phosphorus are being developed for the ponds to address the impairment.

2.0 WATERSHED AND POND CHARACTERIZATION

2.1. History of the Ponds and Watershed

Buck, Long, and Cranberry Ponds are three of many small, shallow embayments along the southern edge of Lake Ontario. These ponds are an important recreational resource and also support wildlife habitat. In recent decades, Long Pond has become hypereutrophic as a result of excess nutrients transported to the pond by Northrup Creek from sources within the drainage basin. Similarly, Buck Pond has become hypereutrophic as a result of nutrients transported to the pond by Larkin Creek from sources within the drainage basin. Cranberry Pond has become hypereutrophic as a result of excess nutrients transported from the surrounding drainage basin and atmospheric deposition of phosphorus.

2.2. Watershed Characterization

The drainage basins for Buck, Long, and Cranberry Ponds are shown in Figure 1. Buck Pond has a direct drainage basin area of 10,791 acres excluding the surface area of the pond. Long Pond has a direct drainage basin area of 14,438 acres excluding the surface area of the pond. Cranberry Pond has a direct drainage basin area of 645 acres excluding the surface area of the pond. Elevations in the ponds' basins range from approximately 659 feet above mean sea level (AMSL) to as low as 245 feet AMSL at the surface of Long Pond, 246 feet AMSL at the surface of Cranberry Pond, and 250 feet AMSL at the surface of Buck Pond. The Larkin and Northrup Creek Watersheds drain into Buck Pond and Long Pond, respectively.

Existing land use and land cover in the Buck, Long, and Cranberry Ponds' drainage basins 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 (NLCD, 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 (Figure 2). Appendix A provides additional detail about the refinement of land use for the drainage basin. Land use categories (including individual category acres and percent of total) in the Buck, Long, and Cranberry Ponds' drainage basins are listed in Tables 1 - 3 and presented in Figures 3 - 8.

Figure 1. Direct Drainage Basins for Buck, Long, and Cranberry Ponds

Figure 2. Aerial Image of Buck, Long, and Cranberry Ponds

Table 1. Land Use Acres and Percent in Buck Pond Drainage Basin

Land Use Category	Acres	% of Drainage Basin
Open Water	101.0	0.9%
Agriculture	2,027.6	18.8%
Hay & Pasture	1,130.9	10.5%
Row Crops	896.7	8.3%
Developed Land*	4,434.5	41.1%
Low Density Mixed	678.9	6.3%
Med Density Mixed	242.8	2.2%
High Density Mixed	126.4	1.2%
Low Density Residential	379.9	3.5%
Med Density Residential	3,006.5	27.9%
Turf Grass	116.6	1.1%
Forest	3,307.8	30.7%
Wetlands	780.6	7.2%
Quarry	22.9	0.2%
TOTAL	**10,791.0**	**100.0%**

* All of the developed land resides within a Municipal Separate Storm Sewer System (MS4)

Figure 3. Percent Land Use in Buck Pond Drainage Basin

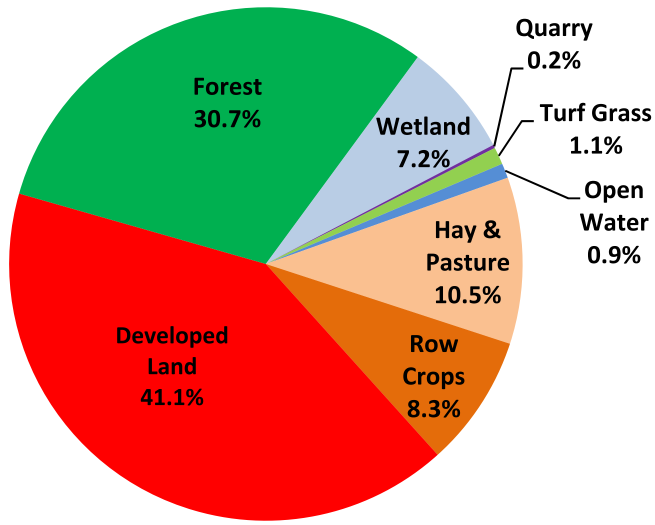


Figure 4. Land Use in Buck Pond Drainage Basin

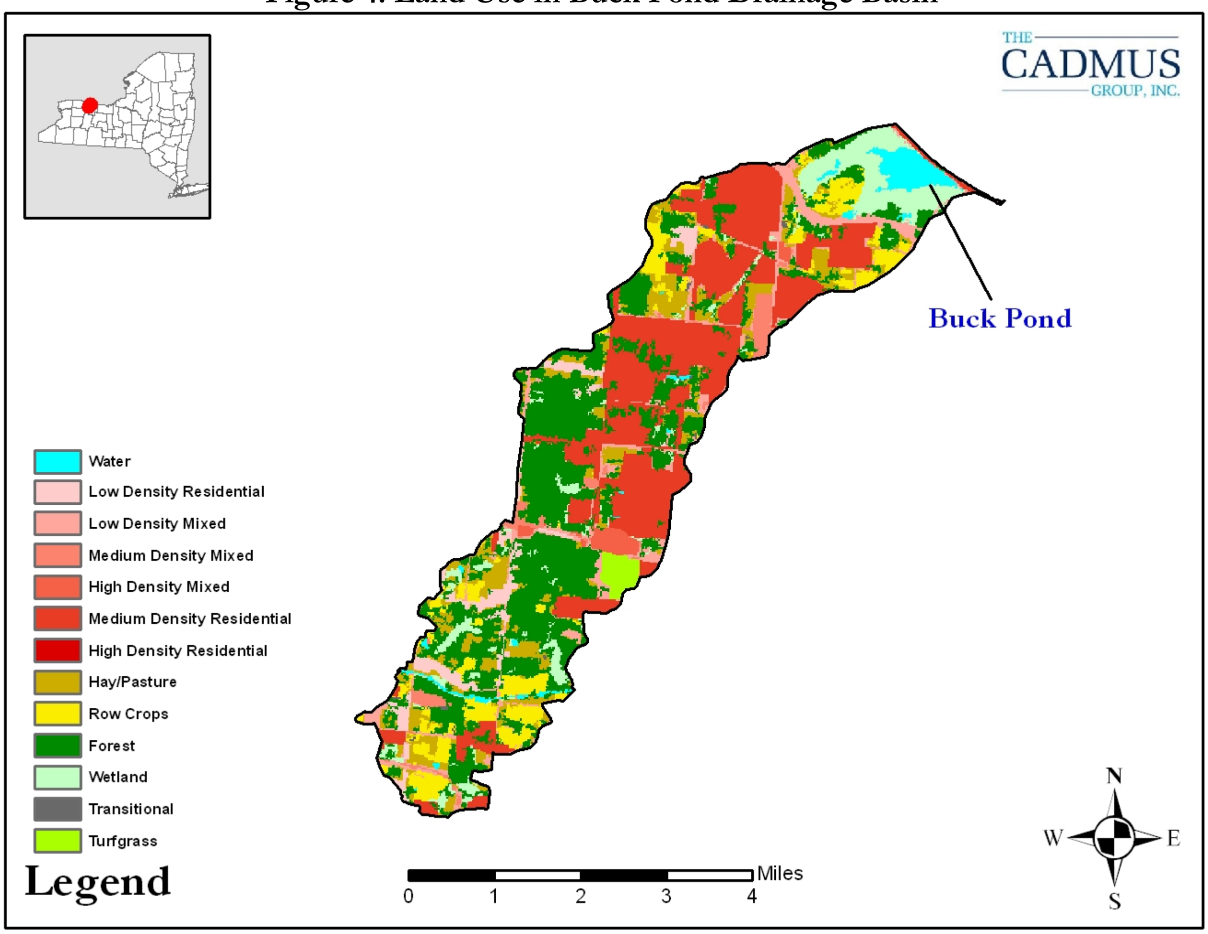


Table 2. Land Use Acres and Percent in Long Pond Drainage Basin

Land Use Category	Acres	% of Drainage Basin
Open Water	20.4	0.1%
Agriculture	5,544.7	38.4%
Hay & Pasture	2,970.8	20.6%
Row Crop	2,573.9	17.8%
Developed Land*	3,508.8	24.3%
Low Density Mixed	1,033.6	7.16%
Med Density Mixed	300.7	2.08%
High Density Mixed	42.0	0.29%
Low Density Residential	1,192.7	8.26%
Med Density Residential	939.8	6.51%
Turf Grass	105.7	0.7%
Forest	4,396.5	30.5%
Wetlands	840.3	5.8%
Quarry	22.0	0.2%
TOTAL	**14,438.4**	**100.0%**

* All of the developed land resides within a Municipal Separate Storm Sewer System (MS4)

Figure 5. Percent Land Use in Long Pond Drainage Basin

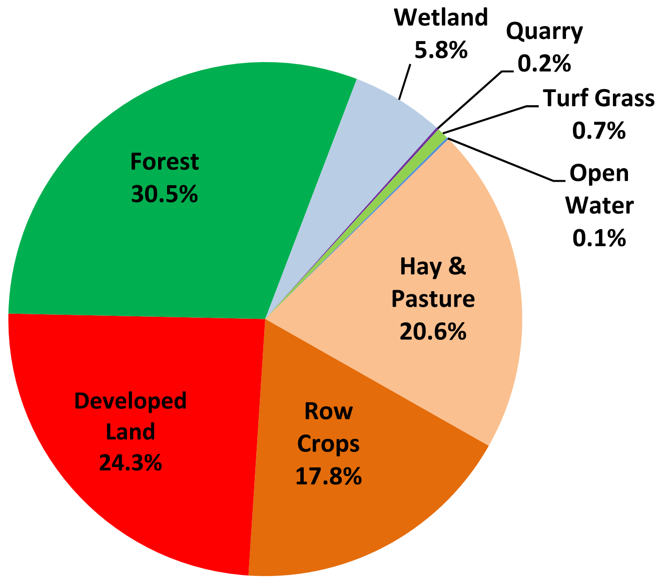


Figure 6. Land Use in Long Pond Drainage Basin

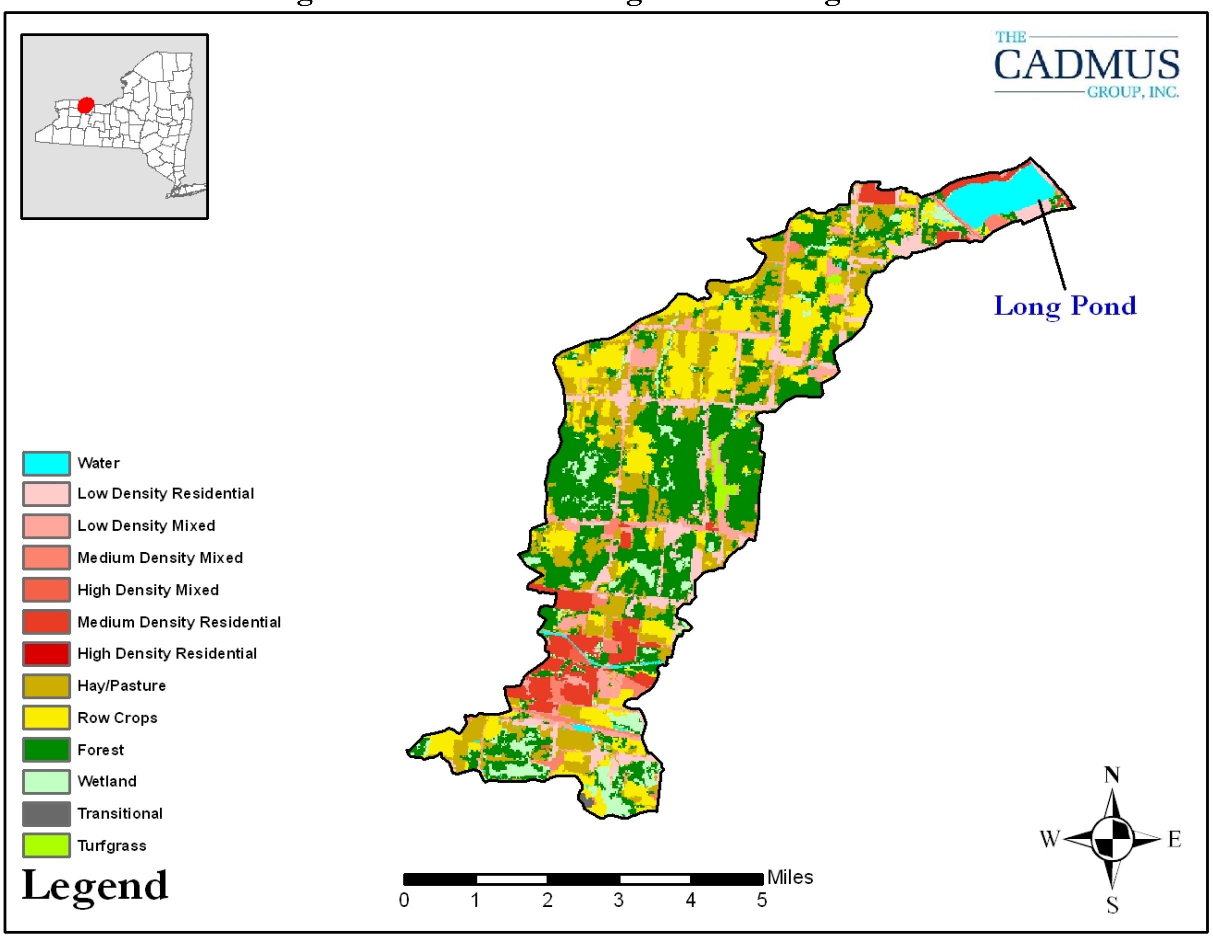


Table 3. Land Use Acres and Percent in Cranberry Pond Drainage Basin

Land Use Category	Acres	% of Drainage Basin
Agriculture	61.6	9.6%
Hay & Pasture	38.8	6.0%
Row Crops	22.8	3.6%
Developed Land*	218.1	33.8%
Low Density Mixed	69.0	10.7%
Med Density Mixed	16.0	2.5%
Low Density Residential	30.9	4.8%
Med Density Residential	102.2	15.8%
Forest	146.1	22.6%
Wetlands	219.6	34.0%
TOTAL	**645.4**	**100%**

* All of the developed land resides within a Municipal Separate Storm Sewer System (MS4)

Figure 7. Percent Land Use in Cranberry Pond Drainage Basin

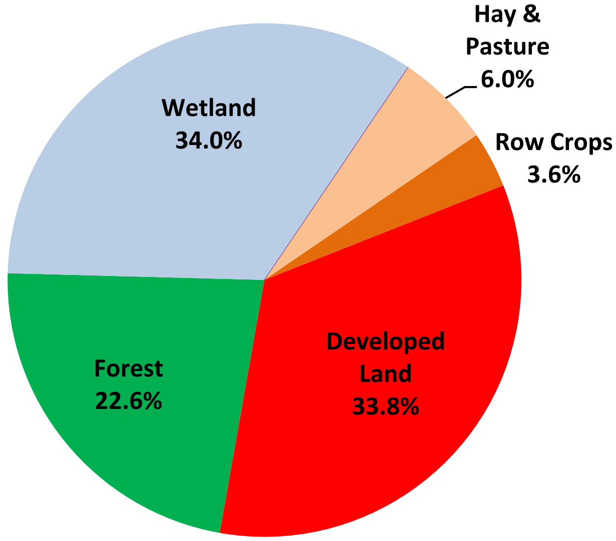
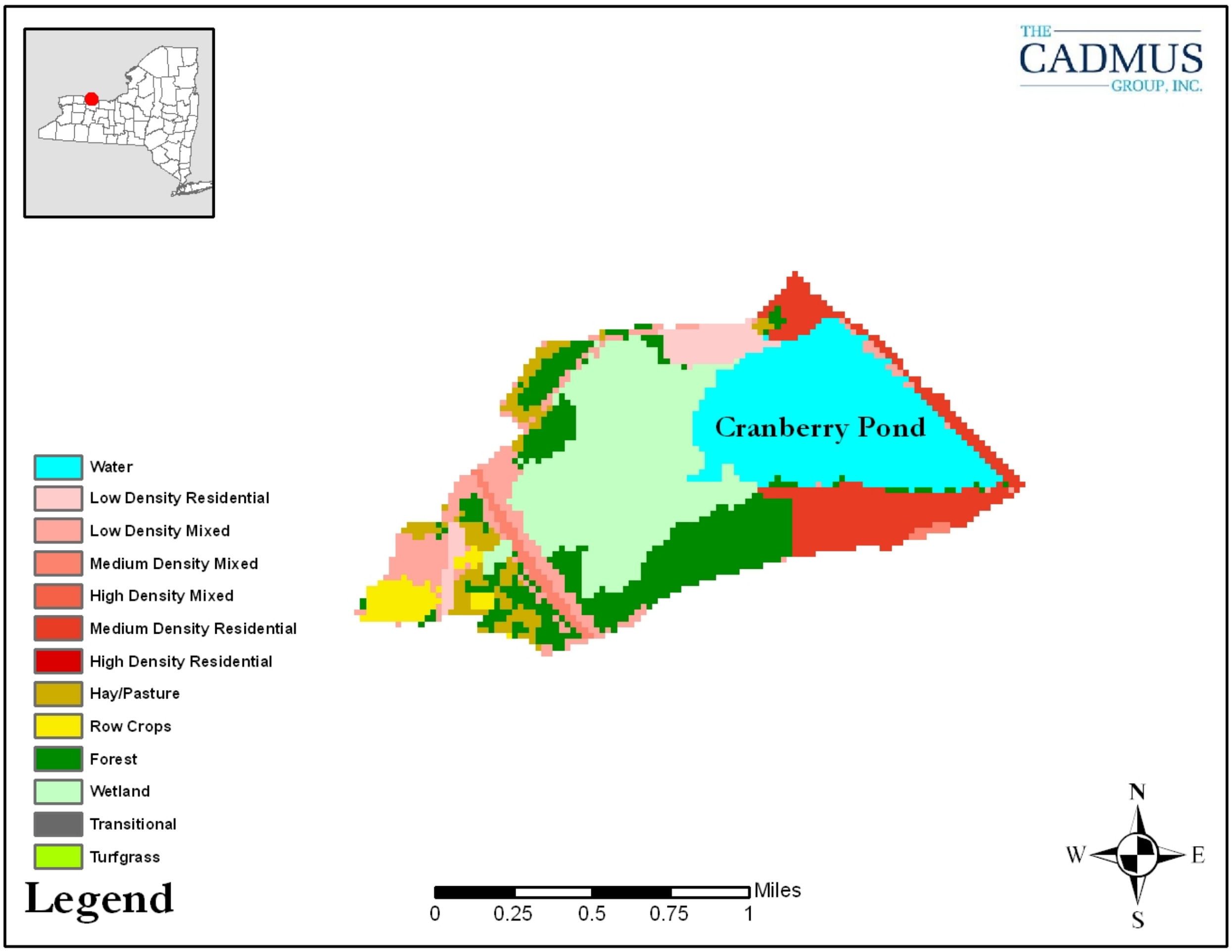


Figure 8. Land Use in Cranberry Pond Drainage Basin



2.3. Pond Morphometry

Buck Pond is a 171 acre water body at an elevation of about 250 feet AMSL. Figure 9 shows a bathymetric map developed by The Cadmus Group, Inc. for Buck Pond using data collected by the Upstate Freshwater Institute during the summer of 2007. Table 4 summarizes key morphometric characteristics for Buck Pond.

Figure 9. Bathymetric Map of Buck Pond

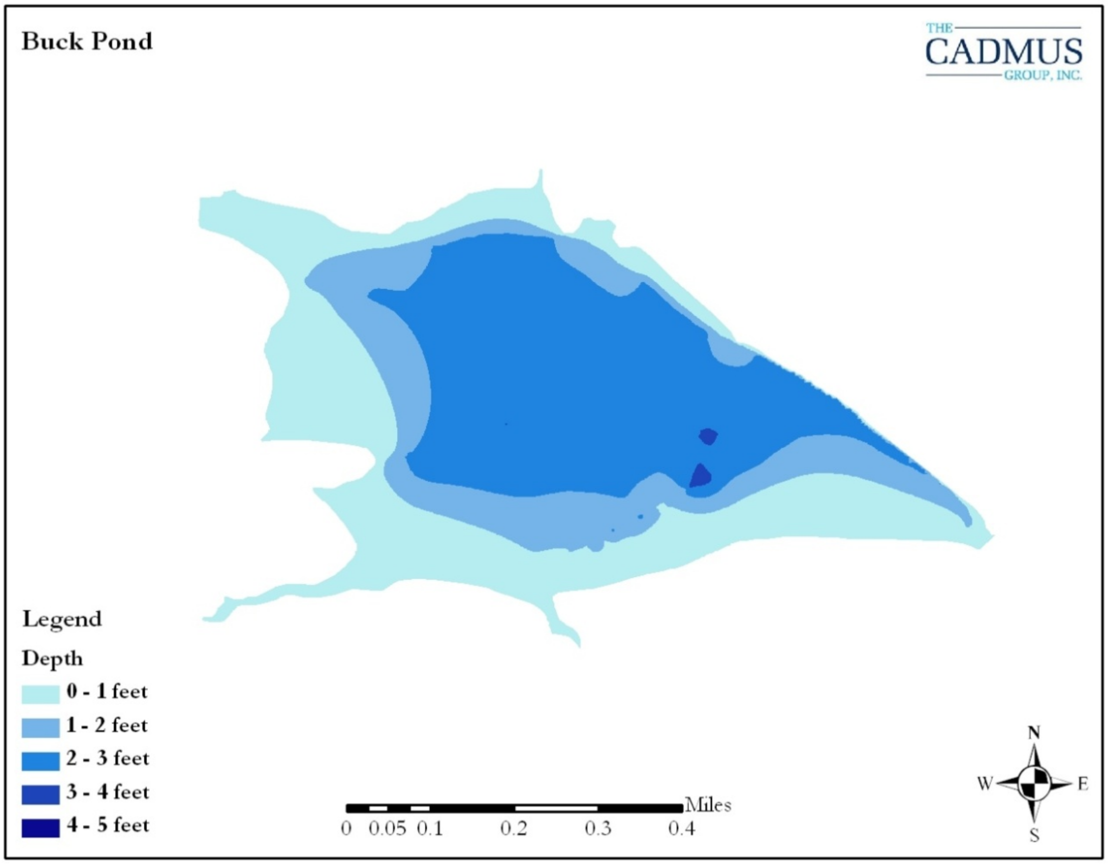


Table 4. Buck Pond Characteristics

Surface Area (acres)	171
Elevation (ft AMSL)	250
Maximum Depth (ft)	5
Mean Depth (ft)	1.6
Length (ft)	5,455
Width at widest point (ft)	2,813
Shoreline perimeter (ft)	17,244
Direct Drainage Area (acres)	10,791
Watershed: Pond Ratio	63:1
Mass Residence Time (years)	0.02
Hydraulic Residence Time (years)	0.02

Long Pond is a 481 acre water body at an elevation of about 245 feet AMSL. Figure 10 shows a bathymetric map for Long Pond based on a map obtained from Makarewicz et al. (1990). Table 5 summarizes key morphometric characteristics for Long Pond.

Figure 10. Bathymetric Map of Long Pond

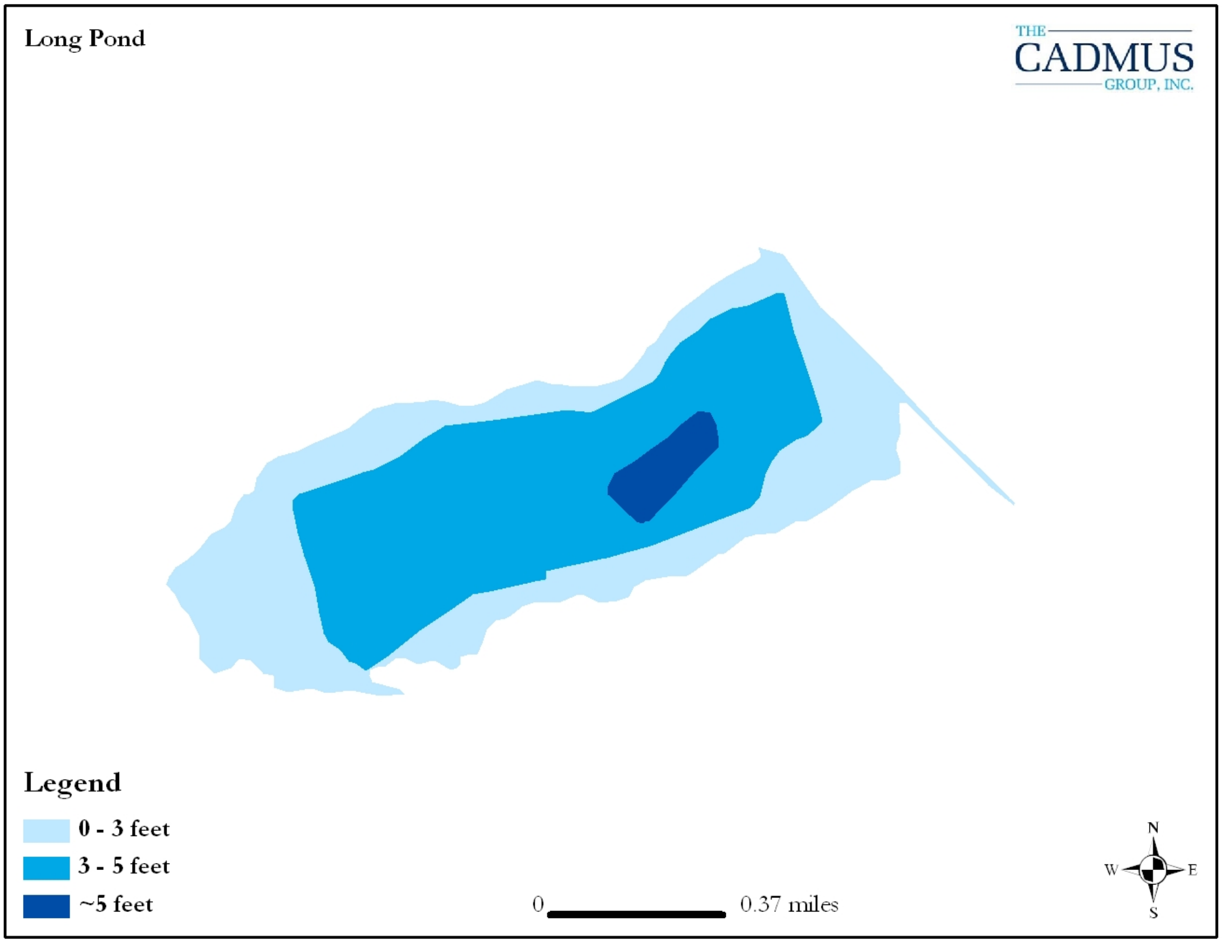


Table 5. Long Pond Characteristics

Surface Area (acres)	481
Elevation (ft AMSL)	245
Maximum Depth (ft)	8
Mean Depth (ft)	7
Length (ft)	8,045
Width at widest point (ft)	3,413
Shoreline perimeter (ft)	36,396
Direct Drainage Area (acres)	14,438
Watershed: Pond Ratio	30:1
Mass Residence Time (years)	0.2
Hydraulic Residence Time (years)	0.2

Cranberry Pond is a 224 acre water body at an elevation of about 246 feet AMSL. A bathymetric map was not available for Cranberry Pond and efforts to collect bathymetric data failed due to lack of boat access to the pond. The estimated mean depth was obtained from a report prepared by Makarewicz and Lampman (1994). Table 6 summarizes key morphometric characteristics for Cranberry Pond.

Table 6. Cranberry Pond Characteristics

Surface Area (acres)	224
Elevation (ft AMSL)	246
Maximum Depth (ft)	7
Mean Depth (ft)	4
Length (ft)	5,245
Width at widest point (ft)	2,884
Shoreline perimeter (ft)	17,843
Direct Drainage Area (acres)	645
Watershed: Pond Ratio	3:1
Mass Residence Time (years)	0.9
Hydraulic Residence Time (years)	1.0

2.4. Water Quality

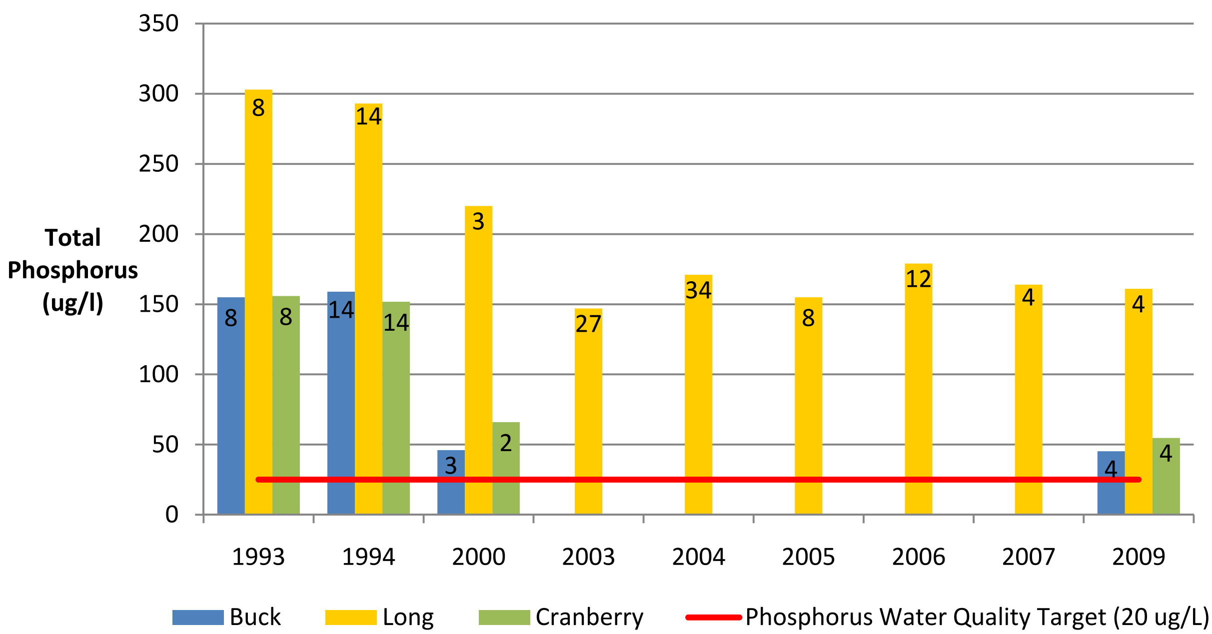
NYS DEC's Lake Classification and Inventory (LCI) program was initiated in 1982 and is conducted by NYS DEC staff. Each year, approximately 10-25 water bodies are sampled in a specific geographic region of the state. The waters selected for sampling are considered to be the most significant in that particular region, both in terms of water quality and level of public access. Samples are collected for pH, ANC, specific conductance, temperature, oxygen, chlorophyll *a*, nutrients and plankton at the surface and with depth at the deepest point of the lake, 4-7 times per year (with stratified lakes sampled more frequently than shallow lakes). Sampling generally begins during May and ends in October.

The LCI effort had been suspended after 1992, due to resource (mostly staff time) limitations, but was resumed again in 1996 on a smaller set of lakes. Since 1998, this program has been geographically linked with the Rotating Integrated Basin Sampling (RIBS) stream monitoring program conducted by the NYS DEC Bureau of Watershed Assessment. LCI sites are chosen within the RIBS monitoring basins (Susquehanna River basin in 1998, Long Island Sound/Atlantic Ocean and Lake Champlain basins in 1999, Genesee and Delaware River basins in 2000, and the Mohawk and Niagara Rivers basins in 2001, Upper Hudson River and Seneca/Oneida/Oswego Rivers basins in 2002, and the Lake Champlain, Lower Hudson River, and Atlantic Ocean/Long Island Sound basin in 2003) from among the water bodies listed on the NYS Priority Waterbodies List for which water quality data are incomplete or absent, or from the largest lakes in the respective basin in which no water quality data exists within the NYS DEC database.

As part of the LCI program and through water quality sampling efforts by the State University of New York, water quality samples were collected in Buck, Long, and Cranberry Ponds during the summers of 2000, 2003-2007, and 2009. Additional data were obtained for the years 1993 and 1994

(Makarewicz and Lampman, 1994) and 2009 (unpublished data provided via DEC personal communication with Dr. Joseph Makarewicz, 10/19/09). The results from these sampling efforts show eutrophic conditions in Buck, Long, and Cranberry Ponds, with the concentration of phosphorus in the ponds violating the 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 11 shows the summer mean epilimnetic phosphorus concentrations for phosphorus data collected during all sampling seasons and years in which Buck, Long, and Cranberry Ponds were sampled. The number annotations on the bars indicate the number of data points included in each summer mean.

Figure 11. Summer Mean Epilimnetic Total Phosphorus Levels in Buck, Long, and Cranberry Ponds



3.0 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 Buck, Long, and Cranberry Ponds is *B*, which means that the best usages of the ponds are primary and secondary contact recreation and fishing. The ponds 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 was derived based on user perceptions of water quality at a wide range of recreational lakes in New York State (Kishbaugh, 1994). The dataset contained only a very limited number of shallow ponded waters, with heavily developed watersheds.

Although the use of the 20 μg/L recreational phosphorus guidance value serves as an endpoint for the proposal of these TMDLs, NYS DEC is presently revising its nutrient guidance values, which may present a reason to revise these TMDLs in the future.

Also, analysis of recently collected data and the modeling outputs suggests that there is uncertainty in the relationship between the phosphorus endpoint and typical indicators of eutrophication in these ponds. The reason is that observed total phosphorus level in these three ponds is actually a surrogate for the broad optical properties of the ponds (total suspended solids, turbidity, etc.), rather than a variable that accurately describes the trophic state of each water body. As such, any subsequent revision of these TMDLs will need to use as an endpoint, either a revised State-wide phosphorus guidance value developed specifically for shallow, urban water bodies, or site-specific endpoints tailored to the use and user perception of Long, Cranberry and Buck Ponds. For these reasons, NYS DEC is proposing to stage the implementation of the TMDLs for these ponds. The staging specifics and summary of the data and conclusions drawn from these studies is provided in the Implementation Section of this report.

4.0 SOURCE ASSESSMENT

4.1. Analysis of Phosphorus Contributions

The MapShed watershed model was used in combination with the BATHTUB lake response model to develop the Buck, Long, and Cranberry Ponds TMDLs. This approach consists of using MapShed to determine mean annual phosphorus loading to the ponds, and BATHTUB to define the extent to which this load must be reduced to meet the water quality target.

MapShed incorporates an enhanced version of the Generalized Watershed Loading Function (GWLF) model developed by Haith and Shoemaker (1987) and the RUNQUAL model also developed by Haith (1993). GWLF and RUNQUAL simulate runoff and stream flow by a water-balance method based on measurements of daily precipitation and average temperature. The complexity of the two models falls between that of detailed, process-based simulation models and simple export coefficient models that do not represent temporal variability. The GWLF and RUNQUAL models were determined to be appropriate for this TMDL analysis because they simulate the important processes of concern, but do not have onerous data requirements for calibration. MapShed was developed to facilitate the use of the GWLF and RUNQUAL models via a MapWindow interface (Evans, 2009). Appendix A discusses the setup, calibration, and use of the MapShed model for lake TMDL assessments in New York.

4.2. Sources of Phosphorus Loading

MapShed was used to estimate long-term (1990-2007) mean annual phosphorus (external) loading to Buck, Long, and Cranberry Ponds. Additionally, estimates for internal loading were calculated (see Section 4.2.7). The mean annual total load of 1,931 lbs/yr of total phosphorus that enters Buck Pond comes from the sources listed in Table 7 and shown in Figure 12. The mean annual total load of 29,014 lbs/yr of total phosphorus that enters Long Pond comes from the sources listed in Table 8 and shown in Figure 13. The mean annual total load of 272 lbs/yr of total phosphorus that enters Cranberry Pond comes from the sources listed in Table 9 and shown in Figure 14. Appendix A provides the detailed simulation results from MapShed.

Table 7. Estimated Sources of Total Phosphorus Loading to Buck Pond

Source	Phosphorus (lbs/yr)
Hay/Pasture	49.47
Cropland	178.86
Forest	2.89
Wetland	5.78
Developed Land	805.28
Stream Bank	4.59
Septic Systems	409.57
Groundwater	474.60
TOTAL	**1,931.04**

Figure 12. Estimated Sources of Total Phosphorus Loading to Buck Pond

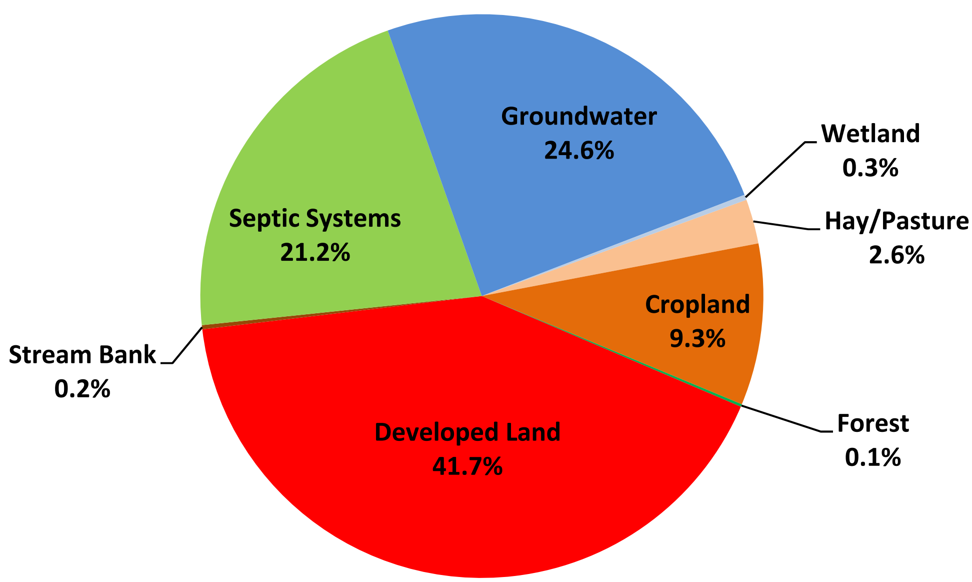


Table 8. Estimated Sources of Phosphorus Loading to Long Pond

Source	Phosphorus (lbs/yr)
Point Sources	2,832.0
NYS Barge Canal Discharge	443.8
Hay/Pasture	213.6
Cropland	833.1
Forest	13.7
Wetlands	4.1
Developed Land	1174.9
Stream Bank	7.2
Septic Systems	1,499.7
Groundwater	1,603.5
Internal Loading	20,388.5
TOTAL	**29,014.1**

Figure 13. Estimated Sources of Phosphorus Loading to Long Pond

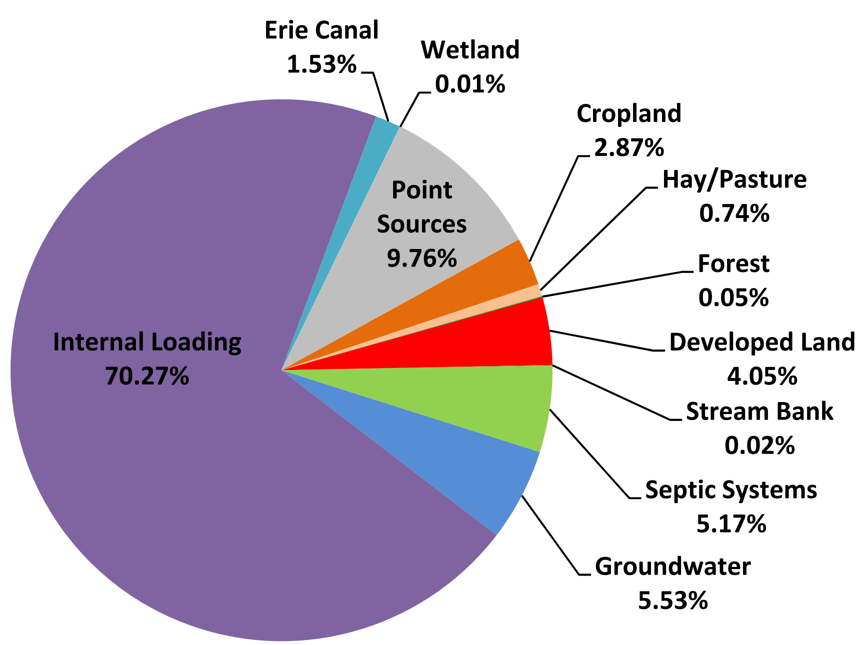
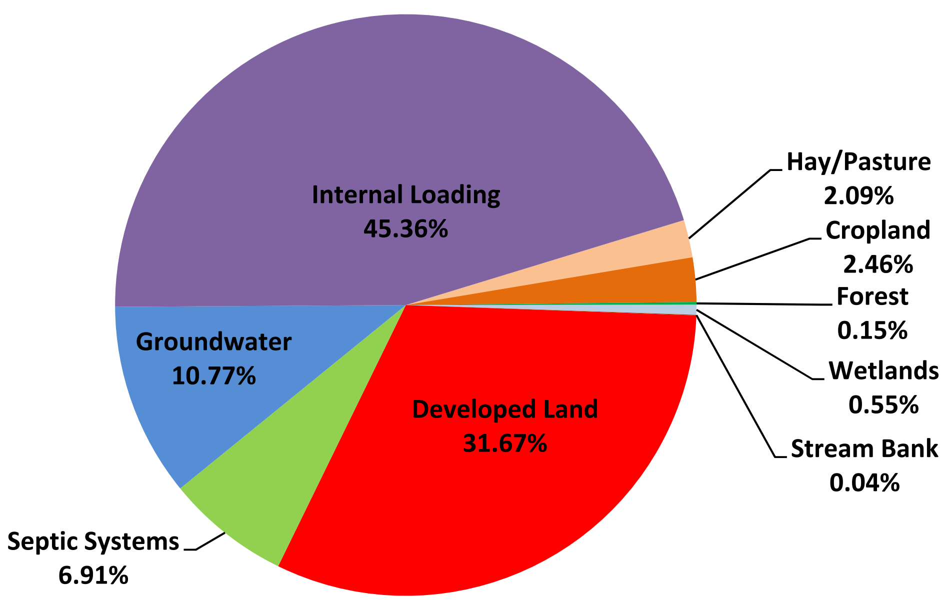


Table 9. Estimated Sources of Phosphorus Loading to Cranberry Pond

Source	Phosphorus (lbs/yr)
Hay/Pasture	5.7
Cropland	6.7
Forest	0.4
Wetlands	1.5
Stream Bank	0.1
Developed Land	86.2
Septic Systems	18.8
Groundwater	29.3
Internal Loading	123.5
TOTAL	**272.2**

Figure 14. Estimated Sources of Phosphorus Loading to Cranberry Pond



4.2.1. ***Wastewater Treatment Plants***

The following seven wastewater treatment plants were identified in the Long Pond drainage basin: 1) Spencer Port Wastewater Treatment Facility, 2) Northwood School, 3) Kirby's Courtyard Inn, 4) September Place & Gates Trailer Park, 5) Hess Mobile Home Park, 6) Braemar Country Club, and 7) Maier Autohaus. Estimated monthly total phosphorus concentration and flow was estimated by NYS DEC for these facilities; these estimates are provided in Appendix D. These data are used in MapShed to calculate phosphorus loading from wastewater treatment facilities. Estimated total phosphorus loading from the wastewater treatment facilities (combined) is 2,832 lbs/yr (33% of the total external loading to Long Pond).

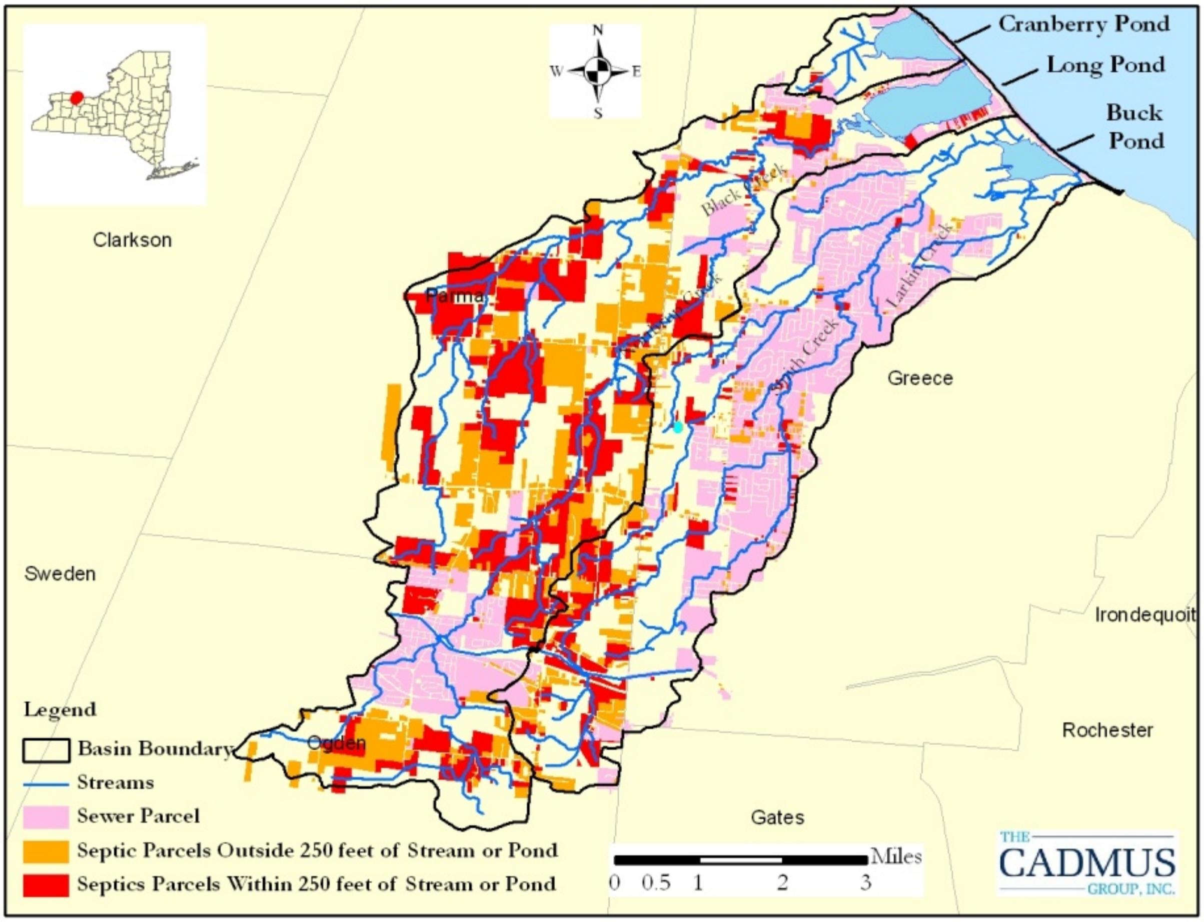
There are no wastewater treatment plants in the drainage basins for Buck and Cranberry Ponds.

4.2.2. ***Residential On-Site Septic Systems***

Residential septic systems contribute dissolved phosphorus to nearby water bodies 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 water bodies. A ponding septic system 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 water bodies. 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; septic systems within 250 feet of the lake are subject to potential short-circuiting, with those closer to the lake more likely to contribute greater loads. Additional details about the process for estimating the population served by normal and malfunctioning systems within the lake drainage basin is provided in Appendix A.

In addition to phosphorus contributions from septic systems surrounding the ponds, past studies have indicated that septic systems within close proximity to stream segments in the ponds' drainage basins are also a significant contributor of phosphorus to the ponds. The number of septic parcels within 250 feet of the shoreline of the ponds and within 250 feet of stream segments draining to the ponds was estimated using septic parcel spatial data from Monroe County (Figure 15). To convert the estimated number of septic systems in each basin 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. 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 ponds.

Figure 15. Septic Parcel Distribution in Buck, Long, and Cranberry Pond Drainage Basins



<u>Buck Pond</u>

Residential on-site septic systems contribute an estimated 409.6 lbs/yr of phosphorus to Buck Pond, which is about 21.2% of the total loading to the pond. GIS analysis of orthoimagery for the basin shows approximately 2 septic parcels within 50 feet of the shoreline of the pond and approximately 222 septic parcels between 250 feet of the streams draining to the pond. 25% of septic systems were categorized as short-circuiting, 10% were categorized as ponding systems, and 65% were categorized as normal systems. Approximately 97% of the homes around the pond are assumed to be year-round residences, while 3% are seasonally occupied (i.e., June through August only). The estimated population in the Buck Pond drainage basin served by normal and malfunctioning systems is summarized in Table 10.

Table 10. Population Served by Septic Systems in the Buck Pond Drainage Basin

	Normally Functioning	Ponding	Short Circuiting	Total
September – May	226	56	282	564
June – August (Summer)	380	58	146	584

Long Pond

Residential on-site septic systems contribute an estimated 1,499.7 lbs/yr of phosphorus to Long Pond, which is about 17.4% of the external loading to the pond. GIS analysis of orthoimagery for the basin shows approximately 34 septic parcels within 50 feet of the shoreline of the pond and approximately 491 septic parcels between 250 feet of the streams draining to the pond. 50% of septic systems were categorized as short-circuiting, 10% were categorized as ponding systems, and 40% were categorized as normal systems. Approximately 97% of the homes around the pond are assumed to be year-round residences, while 3% are seasonally occupied (i.e., June through August only). The estimated population in the Long Pond drainage basin served by normal and malfunctioning systems is summarized in Table 11.

Table 11. Population Served by Septic Systems in the Long Pond Drainage Basin

	Normally Functioning	Ponding	Short Circuiting	Total
September – May	528	132	660	1,320
June – August (Summer)	547	137	684	1,368

Cranberry Pond

Residential on-site septic systems contribute an estimated 18.8 lbs/yr of phosphorus to Cranberry Pond, which is about 12.8% of the external loading to the pond. GIS analysis of orthoimagery for the basin shows 1 septic parcel within 250 feet of the shoreline of the pond and about 5 septic parcels between 250 feet of the streams draining to the pond. 50% of septic systems were categorized as short-circuiting, 10% were categorized as ponding systems, and 40% were categorized as normal systems. Approximately 97% of the homes around the pond are assumed to be year-round residences, while 3% are seasonally occupied (i.e., June through August only). The estimated population in the Cranberry Pond drainage basin served by normal and malfunctioning systems is summarized in Table 12.

Table 12. Population Served by Septic Systems in the Cranberry Pond Drainage Basin

	Normally Functioning	Ponding	Short Circuiting	Total
September – May	6	2	8	16
June – August (Summer)	6	2	8	16

4.2.3. *Agricultural Runoff*

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. The estimated phosphorus loading from overland agricultural runoff in each pond's drainage basin is provided below. In addition to the contribution of phosphorus to the ponds from overland agriculture runoff, additional phosphorus originating from agricultural lands is leached in dissolved form from the surface and transported to the ponds through subsurface movement via groundwater. The process for estimating subsurface delivery of phosphorus originating from agricultural land is discussed in the Groundwater Seepage section (below).

Buck Pond

Agricultural land encompasses 2,027.6 acres (18.8%) of the Buck Pond drainage basin and includes hay and pasture land (10.5%) and row crops (8.3%). Overland runoff from agricultural land is estimated to contribute 228.3 lbs/yr of phosphorus loading to Buck Pond, which is 11.9% of the total phosphorus loading to the pond.

Long Pond

Agricultural land encompasses 5,544.7 acres (38.4%) of the Long Pond drainage basin and includes hay and pasture land (20.6%) and row crops (17.8%). Overland runoff from agricultural land is estimated to contribute 1046.7 lbs/yr of phosphorus loading to Long Pond, which is 12.1% of the external phosphorus loading to the pond.

Cranberry Pond

Agricultural land encompasses 61.6 acres (9.6%) of the Cranberry Pond drainage basin and includes hay and pasture land (6.0%) and row crops (3.6%). Overland runoff from agricultural land is estimated to contribute 12.4 lbs/yr of phosphorus loading to Cranberry Pond, which is 8.4% of the external phosphorus loading to the pond.

4.2.4. *Urban and Residential Development Runoff*

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 water bodies in comparison to its relatively small percentage of the total land area in the drainage basin. The estimated phosphorus loading from overland urban runoff in each pond's drainage basin is provided below. In addition to the contribution of phosphorus to the ponds from overland urban runoff, additional phosphorus originating from developed lands is leached in dissolved form from the surface and transported to the ponds through subsurface movement via groundwater. The process for estimating subsurface delivery of phosphorus originating from developed land is discussed in the Groundwater Seepage section (below).

Buck Pond

Developed land comprises 4,434.5 acres (41.1%) of the Buck Pond drainage basin. Stormwater runoff from developed land contributes 805.28 lbs/yr of phosphorus to Buck Pond, which is about 41.7% of the total phosphorus loading to the pond. This load does not account for contributions from malfunctioning septic systems. The developed land within the Buck Pond drainage basin is all part of Municipal Separate Storm Sewer Systems (MS4s).

Long Pond

Developed land comprises 3,508.8 acres (24.3%) of the Long Pond drainage basin. Stormwater runoff from developed land contributes 1,174.9 lbs/yr of phosphorus to Long Pond, which is about 13.6% of the external phosphorus loading to the pond. This load does not account for contributions from malfunctioning septic systems. The developed land within the Long Pond drainage basin is all part of MS4s.

Cranberry Pond

Developed land comprises 218.1 acres (33.8%) of the Cranberry Pond drainage basin. Stormwater runoff from developed land contributes 86.2 lbs/yr of phosphorus to Cranberry Pond, which is about 58.0% of the external phosphorus loading to the pond. This load does not account for contributions from malfunctioning septic systems. The developed land within the Cranberry Pond drainage basin is all part of MS4s.

4.2.5. ***Forest Land Runoff***

Buck Pond

Forested land comprises 3,307.8 acres (30.7%) of the Buck Pond drainage basin. Runoff from forested land is estimated to contribute about 2.89 lbs/yr of phosphorus loading to Buck Pond, which is about 0.1% of the total phosphorus loading to the pond. Phosphorus contribution from forested land in the Buck Pond basin is considered a component of background loading.

Long Pond

Forested land comprises 4,396.5 acres (30.5%) of the Long Pond drainage basin. Runoff from forested land is estimated to contribute about 13.7 lbs/yr of phosphorus loading to Long Pond, which is less than 0.2% of the external phosphorus loading to the pond. Phosphorus contribution from forested land in the Long Pond is considered a component of background loading.

Cranberry Pond

Forested land comprises 146.1 acres (22.6%) of the Cranberry Pond drainage basin. Runoff from forested land is estimated to contribute less than 0.5 lb/yr of phosphorus loading to Cranberry Pond, which is less than 0.5% of the external phosphorus loading to the pond. Phosphorus contribution from forested land in the Cranberry Pond is considered a component of background loading.

4.2.6. ***Groundwater Seepage***

In addition to nonpoint sources of phosphorus delivered to the ponds by surface runoff, a portion of the phosphorus loading from nonpoint sources seeps into the ground and is transported to the ponds via groundwater. With respect to groundwater, there is typically a small "background" concentration owing to various natural sources. The GWLF manual provides estimated background groundwater phosphorus concentrations for ≥90% forested land in the eastern United States, which is 0.006 mg/L.

Buck Pond

Groundwater is estimated to transport 474.6 lbs/yr (24.6%) of the total phosphorus load to Buck Pond. The model-estimated groundwater phosphorus concentration is 0.03 mg/L in the Buck Pond drainage basin. Consequently, about 20% of the groundwater load (94.9 lbs/yr) can be attributed to natural sources, including forested land and soils, in the Buck Pond drainage basin. It is estimated that the remaining 379.70 lbs/yr of phosphorus transported to the pond through groundwater originates from developed land (295.8 lbs/yr) and agricultural sources (83.9 lbs/yr), proportional to their respective surface runoff loads. Table 13 summarizes this information.

Table 13. Sources of Phosphorus Transported in the Subsurface via Groundwater

	Total Phosphorus (lbs/yr)	% of Total Groundwater Load
Natural Sources	94.9	20%
Developed Land	295.8	62%
Agricultural Land	83.9	18%
TOTAL	**474.6**	**100%**

<u>Long Pond</u>

Groundwater is estimated to transport 1,603.5 lbs/yr (18.6%) of the external phosphorus load to Long Pond. The model-estimated groundwater phosphorus concentration is 0.05 mg/L in the Long Pond drainage basin. Consequently, about 12% of the groundwater load (192.4 lbs/yr) can be attributed to natural sources, including forested land and soils, in the Long Pond drainage basin. It is estimated that the remaining 1,411.1 lbs/yr of phosphorus transported to the pond through groundwater originates from developed land (746.3 lbs/yr) and agricultural sources (664.8 lbs/yr), proportional to their respective surface runoff loads. Table 14 summarizes this information.

Table 14. Sources of Phosphorus Transported in the Subsurface via Groundwater

	Total Phosphorus (lbs/yr)	% of Total Groundwater Load
Natural Sources	192.4	12%
Developed Land	746.3	47%
Agricultural Land	664.8	41%
TOTAL	**1,603.5**	**100%**

<u>Cranberry Pond</u>

Groundwater is estimated to transport 29.3 lbs/yr (19.70%) of the external phosphorus load to Cranberry Pond. The model-estimated groundwater phosphorus concentration is 0.03 mg/L in the Cranberry Pond drainage basin. Consequently, about 20% of the groundwater load (5.86 lbs/yr) can be attributed to natural sources, including forested land and soils, in the Cranberry Pond drainage basin. It is estimated that the remaining 23.44 lbs/yr of phosphorus transported to the pond through groundwater originates from developed land (20.48 lbs/yr) and agricultural sources (2.96 lbs/yr), proportional to their respective surface runoff loads. Table 15 summarizes this information.

Table 15. Sources of Phosphorus Transported in the Subsurface via Groundwater

	Total Phosphorus (lbs/yr)	% of Total Groundwater Load
Natural Sources	5.86	20%
Developed Land	20.48	70%
Agricultural Land	2.96	10%
TOTAL	**29.30**	**100%**

4.2.7. *Internal Loading*

Both Cranberry and Long Ponds have been exposed to nutrient loading that is much higher than their assimilative capacity. Over time, much of this excess phosphorus has been deposited into the bottom sediments. Internal phosphorus loading from lake sediments can be an important component of the phosphorus budget for lakes, especially shallow lakes. Excess phosphorus in a lake's bottom sediments is available for release back into the water column when conditions are favorable for nutrient release. Such conditions can include re-suspension of sediments by wind mixing or rough fish activity (e.g., feeding off bottom of lake), sediment anoxia (i.e., low dissolved oxygen levels near the sediment water interface), high pH levels, die-offs of heavy growths of curly-leaf pond weeds, and other mechanisms that result in the release of poorly bound phosphorus.

Accurate simulation of internal phosphorus loading is an uncertain science and a generally applicable method has yet to be identified. Several existing methods were considered for estimating internal loading in Cranberry or Long Ponds. However, none of these methods were able to accurately simulate the internal loading process in Cranberry or Long Ponds. Therefore, once all external sources of phosphorus loading were identified, it is assumed that the remaining load originates from internal sources (i.e., lake bottom sediments). Based on this determination, internal loading is estimated to contribute about 123.5 lbs/yr of phosphorus (45.36% of the total load) to Cranberry Pond and 20,388.5 lbs/yr of phosphorus (70.27% of the total load) to Long Pond.

4.2.8. *Other Sources*

Atmospheric deposition, wildlife, waterfowl, and domestic pets are also potential sources of phosphorus loading to the ponds. All of these small sources of phosphorus are incorporated into the land use loadings as identified in the TMDL analysis (and therefore accounted for). Further, the deposition of phosphorus from the atmosphere over the surface of the ponds is accounted for in the lake model.

The NYS Barge Canal discharges approximately 443.8 lbs/year of phosphorus (1.53% of the total phosphorus load) to Northrup Creek, which is a tributary to Long Pond (Monroe County, personal communication). The TMDL for Long Pond has been developed assuming no reductions in phosphorus loading from the Barge Canal.

5.0 DETERMINATION OF LOAD CAPACITY

5.1. Pond Modeling Using the BATHTUB Model

BATHTUB was used to define the relationship between phosphorus loading to the pond and the resulting concentrations of total phosphorus in the pond. 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.

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

In order to estimate the loading capacity of the ponds, simulated phosphorus loads from MapShed and calculated internal loads were input to the BATHTUB model, which was then used to simulate water quality in Buck, Long, and Cranberry Ponds. MapShed was used to derive a mean annual external phosphorus loading to the ponds for the period 1990-2007. Using this external load and the calculated internal load as input, BATHTUB was used to simulate water quality in the ponds. The results of the BATHTUB simulation were compared against the average of the ponds' observed summer mean phosphorus concentrations. Year-specific loading was also simulated with MapShed for external loading and calculated for internal loading. The load was run through BATHTUB and compared against the observed summer mean phosphorus concentration for years with observed in-pond data. The combined use of MapShed, BATHTUB, and internal loading estimates provide a good fit to the observed data for Buck, Long, and Cranberry Ponds (Figures 16-18).

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 capacities of Buck, Long, and Cranberry Ponds were determined by running BATHTUB iteratively, reducing the concentration of the drainage basin phosphorus load (which in turn reduced the internal 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 ponds' loading capacity. This concentration is converted into a loading rate using simulated flow from MapShed.

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 Buck Pond is a mean annual load of 784.99 lbs/yr. The daily TMDL for Buck Pond of 2.149 lbs/day was calculated by dividing the annual load by the number of days in a year. 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 Long Pond is a mean annual load of 1,361.7 lbs/yr. The daily TMDL for Long Pond is 3.728 lbs/day. 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 Cranberry Pond is a mean annual load of 50.23 lbs/yr. The daily TMDL for Cranberry Pond is 0.138 lbs/day.

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, ponds, 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 reservoirs. 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 lakes and ponds than daily loads. Ultimate compliance with water quality standards for the TMDL will be determined by measuring the ponds' water quality to determine when the phosphorus guidance value is attained.

Figure 16. Observed vs. Simulated Summer Mean Epilimnetic Total Phosphorus Concentrations (μg/L) in Buck Pond

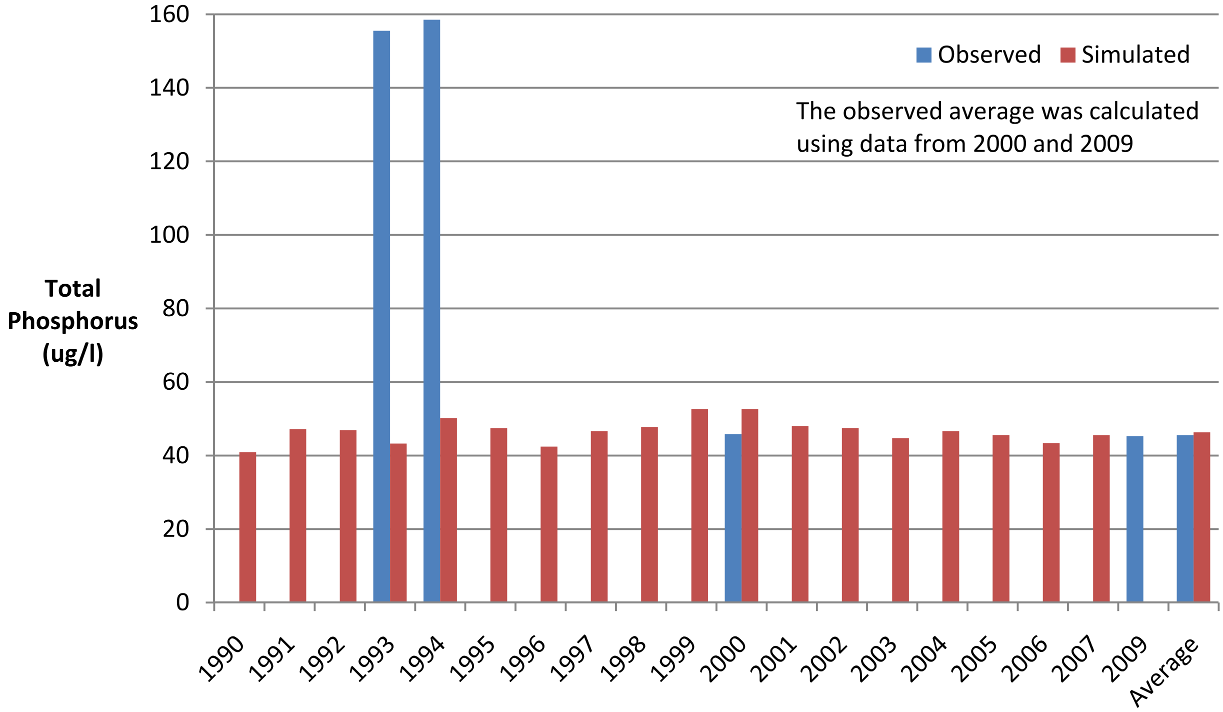


Figure 17. Observed vs. Simulated Summer Mean Epilimnetic Total Phosphorus Concentrations (μg/L) in Long Pond

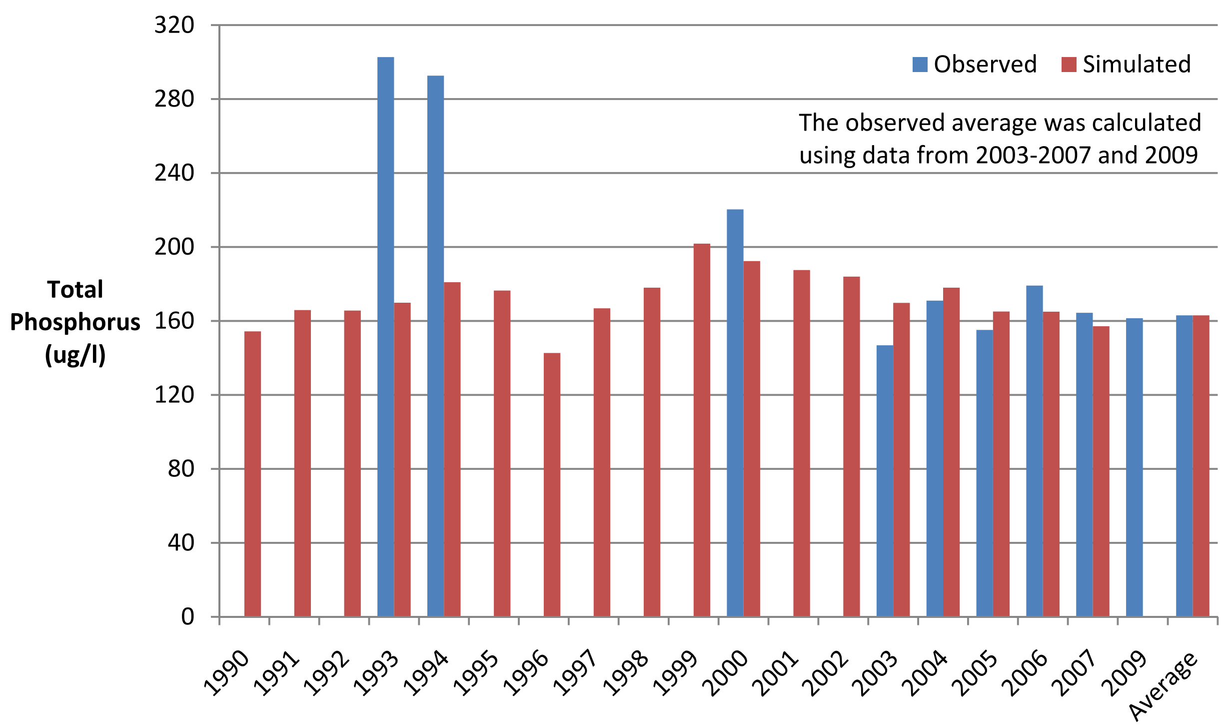
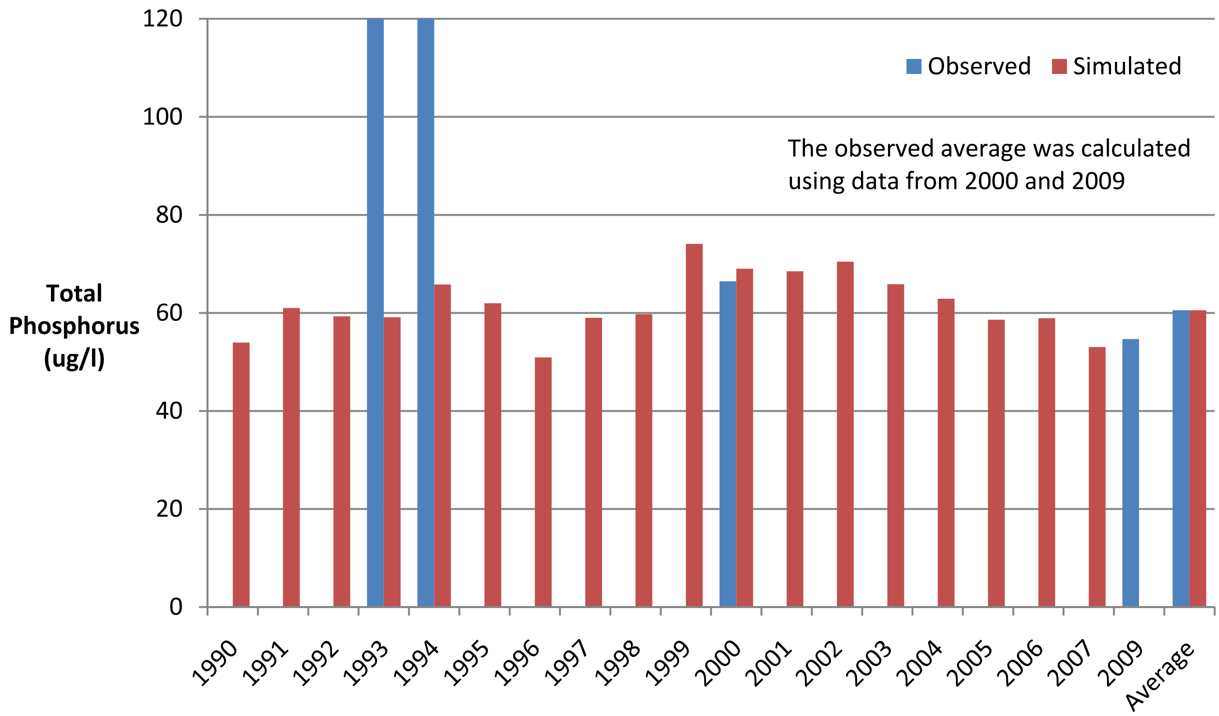


Figure 18. Observed vs. Simulated Summer Mean Epilimnetic Total Phosphorus Concentrations (μg/L) in Cranberry Pond



6.0 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 sources) 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

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

6.1. Wasteload Allocation (WLA)

The WLA for Buck Pond is set at 805.28 lbs/yr. There are no permitted wastewater treatment plant dischargers in the Buck Pond basin; however, the MS4s within the basin are subject to permits issued by NYS DEC.

The WLA for Long Pond is set at 216.7 lbs/yr. There are seven permitted wastewater treatment plant dischargers in the Long Pond basin. Wasteload allocations for wastewater treatment plants are shown in Table 17. The WLAs for the small dischargers to Long Pond are based on an effluent concentration of 0.5 mg/l, at permitted discharge (flow) for the entire year. The WLA for the Spencerport WWTP is zero because it was diverted out of the watershed in 2008. In addition to wastewater treatment plant dischargers, there are also MS4s within the basin, which are subject to permits issued by NYS DEC.

The WLA for Cranberry Pond is set at 17.10 lbs/yr. There are no permitted wastewater treatment plant dischargers in the Cranberry Pond basin; however, the MS4s within the basin are subject to permits issued by NYS DEC.

6.2. Load Allocation (LA)

The LA for Buck Pond is set at 1,125.76 lbs/yr. Nonpoint sources that contribute total phosphorus to Buck Pond on an annual basis include loads from developed land (groundwater), agricultural land, and malfunctioning septic systems. Table 16 lists the current loading for each source and the load allocation needed to meet the TMDL; Figure 19 provides a graphical representation of this information. Phosphorus originating from natural sources in the Buck Pond basin (including forested land, wetlands, and stream banks) is assumed to be a minor source of loading that is unlikely to be reduced further and therefore the load allocation is set at current loading.

The LA for Long Pond is set at 1,008.8 lbs/yr. Nonpoint sources that contribute total phosphorus to Long Pond on an annual basis include loads from developed land (groundwater), agricultural land, and malfunctioning septic systems. Table 17 lists the current loading for each source and the load allocation needed to meet the TMDL; Figure 20 provides a graphical representation of this information. Phosphorus originating from natural sources in the Long Pond basin (including forested land, wetlands, and stream banks) is assumed to be a minor source of loading that is unlikely to be reduced further and therefore the load allocation is set at current loading.

The LA for Cranberry Pond is set at 28.11 lbs/yr. Nonpoint sources that contribute total phosphorus to Cranberry Pond on an annual basis include loads from developed land, agricultural land, and malfunctioning septic systems. Table 18 lists the current loading for each source and the load allocation needed to meet the TMDL; Figure 21 provides a graphical representation of this information. Phosphorus originating from natural sources in the Cranberry Pond basin (including forested land, wetlands, and stream banks) is assumed to be a minor source of loading that is unlikely to be reduced further and therefore the load allocation is set at current loading.

6.3. 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 Buck, Long, and Cranberry Pond TMDLs, 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 pond 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 TMDLs contain an explicit margin of safety corresponding to 10% of the loading capacity, or 78.499 lbs/yr, 136.17 lbs/yr, and 5.023 lbs/yr for Buck, Long, and

Cranberry Ponds, respectively. The MOS can be reviewed in the future as new data become available.

6.4. 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 ponds. 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, MapShed takes into account loadings from all periods throughout the year, including spring loads.

6.5. 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 18 years of daily precipitation data when calculating runoff through MapShed, 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 ponds will undergo during a given year.

Table 16. Total Annual Phosphorus Load Allocations for Buck Pond*

Source	Total Phosphorus Load (lbs/yr)			% Reduction
	Current	Allocated	Reduction	
Agriculture**	312.21	62.44	249.77	80%
Developed Land (non-regulated groundwater)	295.81	177.48	118.33	40%
Septic Systems	409.57	0.00	409.57	100%
Forest, Wetland, Stream Bank, and Natural Background**	108.17	108.17	0.00	0%
LOAD ALLOCATION	**1,125.76**	**348.09**	**777.67**	**69%**
Point Sources	0.00	0.00	0.00	---
Developed Land (regulated MS4 stormwater)	805.28	358.40	446.88	55%
WASTELOAD ALLOCATION	**805.28**	**358.40**	**446.88**	**55%**
LA + WLA	**1,931.04**	**706.49**	**1,224.55**	**63%**
Margin of Safety	---	78.499	---	---
TOTAL	**1,931.04**	**784.99**	---	---

* The values reported in Table 16 are annually integrated. Daily equivalent values are provided in Appendix C.
** Includes phosphorus transported through surface runoff and subsurface (groundwater)

Figure 19. Total Phosphorus Load Allocations for Buck Pond (lbs/yr)

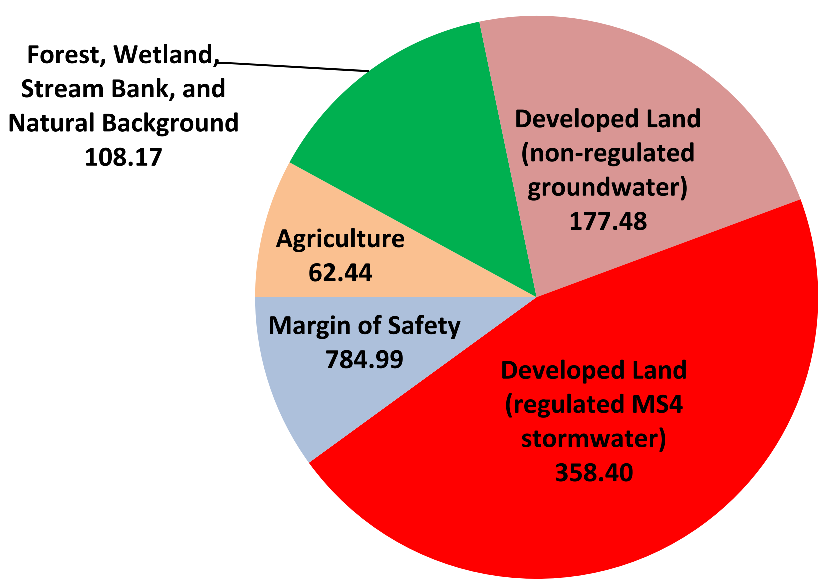


Table 17. Total Annual Phosphorus Load Allocations for Long Pond*

Source	Total Phosphorus Load (lbs/yr)			% Reduction
	Current	Allocated	Reduction	
Agriculture**	1,711.5	176.2	1,535.3	90%
Developed Land (non-regulated groundwater)	746.3	171.4	574.9	77%
Septic Systems	1,499.7	0.0	1,499.7	100%
NYS Barge Canal	443.8	443.8	0.0	0%
Forest, Wetland, Stream Bank, and Natural Background**	217.4	217.4	0.0	0%
Internal Loading	20,388.5	0.0	20,388.5	100%
LOAD ALLOCATION	**25,007.2**	**1,008.8**	**23,998.4**	**96%**
Spencerport (V) WWTP	2,235.0	0.0	2,235.0	100%
Northwood School	219.4	36.5	182.9	83%
Kirby's Courtyard Inn	111.6	18.6	93.0	83%
September Place & Gates Trailer Park	145.4	24.1	121.3	83%
Hess Mobile Home Park	73.2	12.2	61.0	83%
Braemar Country Club	44.8	7.4	37.4	84%
Maier Autohaus	2.7	0.4	2.3	85%
Developed Land (regulated MS4 stormwater)	1,174.9	117.5	1,057.4	90%
WASTELOAD ALLOCATION	**4,007.0**	**216.7**	**3,790.3**	**95%**
LA + WLA	**29,014.2**	**1225.5**	**27,788.7**	**96%**
Margin of Safety	---	136.17	---	---
TOTAL	**29,014.2**	**1,361.7**	**---**	**---**

* The values reported in Table 17 are annually integrated. Daily equivalent values are provided in Appendix C.
** Includes phosphorus transported through surface runoff and subsurface (groundwater)

Figure 20. Total Phosphorus Load Allocations for Long Pond (lbs/yr)

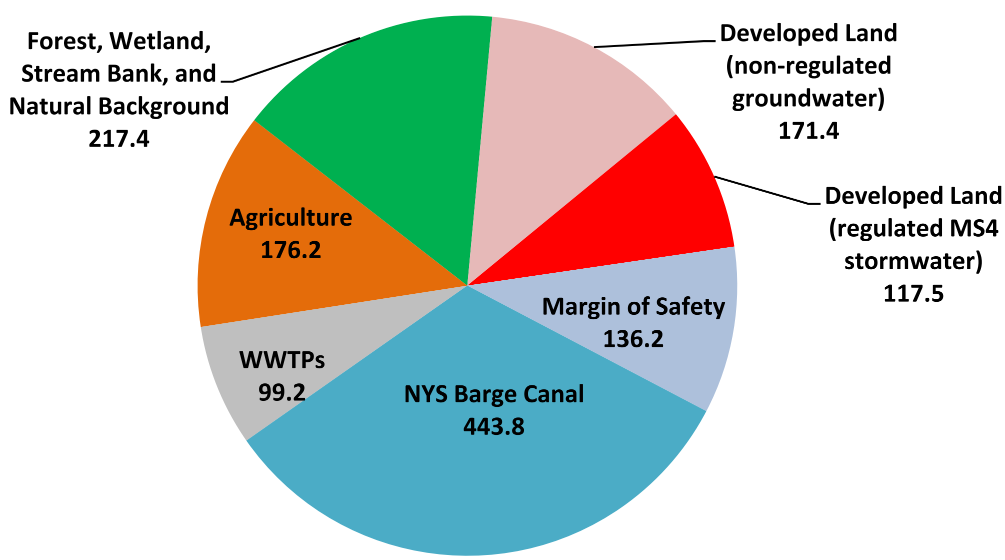
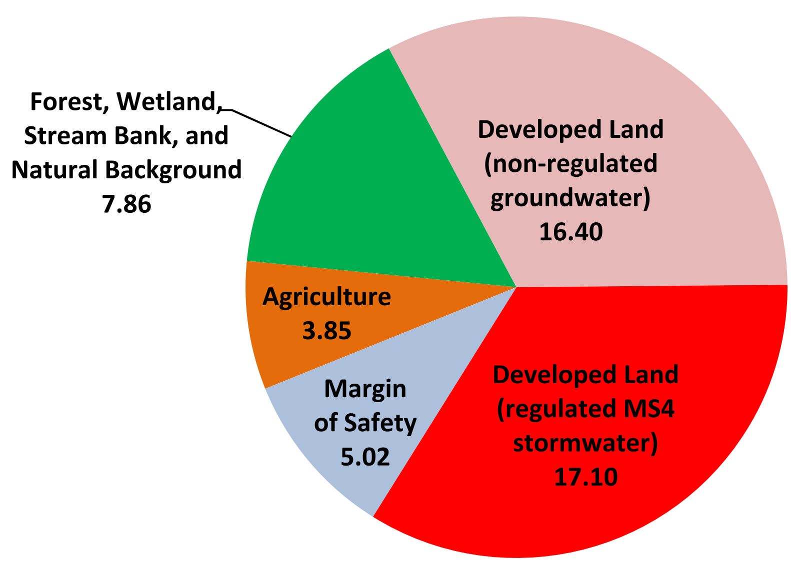


Table 18. Total Annual Phosphorus Load Allocations for Cranberry Pond*

Source	Total Phosphorus Load (lbs/yr)			% Reduction
	Current	Allocated	Reduction	
Agriculture**	15.39	3.85	11.54	75%
Developed Land (non-regulated groundwater)	20.48	16.40	4.08	20%
Septic Systems	18.78	0.00	18.78	100%
Forest, Wetland, Stream Bank, and Natural Background**	7.86	7.86	0.00	0%
Internal Loading	123.46	0.00	123.46	100%
LOAD ALLOCATION	**185.97**	**28.11**	**157.86**	**85%**
Point Sources	0.00	0.00	0.00	---
Developed Land (regulated MS4 stormwater)	86.21	17.10	69.11	80%
WASTELOAD ALLOCATION	**86.21**	**17.10**	**69.11**	**80%**
LA + WLA	**272.18**	**45.21**	**226.97**	**83%**
Margin of Safety	---	5.023	---	---
TOTAL	**272.18**	**50.23**	**---**	**---**

* The values reported in Table 18 are annually integrated. Daily equivalent values are provided in Appendix C.
** Includes phosphorus transported through surface runoff and subsurface (groundwater)

Figure 21. Total Phosphorus Load Allocations for Cranberry Pond (lbs/yr)



7.0 IMPLEMENTATION

One of the critical factors in the successful development and implementation of TMDLs is the identification of potential management alternatives, such as BMPs in collaboration with the involved stakeholders. NYS DEC, in coordination with these local interests, will address the sources of impairment, using regulatory and non-regulatory tools in this watershed, matching management strategies with sources, and aligning available resources to effect implementation.

Monroe County and its individual towns, cities and villages have been historically proactive in protecting its water bodies. The County has been at the forefront of water quality management efforts and centralization of sanitary wastewater treatment. It has also had an active program of implementing urban and agricultural BMPs and an effective water quality monitoring effort.

NYS DEC recognizes that TMDL designated load reductions alone may not be sufficient to restore eutrophic lakes. 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. The implementation plan therefore calls for the collection of additional monitoring data, as discussed in Section 7.2, to determine the effectiveness of nutrient reduction management practices.

As mentioned in the Water Quality Standards section of this report, several uncertainties have been identified related to the modeling analysis and the relationship between total phosphorus and eutrophication indicators. For these reasons, NYSDEC is proposing to stage the implementation of these TMDLs, so that compliance with the WLA-based permits and nonpoint source reductions are not required to be met until 2030. Staged implementation allows for proceeding with the most technically achievable load reductions, while additional data and site-specific analyses are used to gain further understanding of in-lake processes and refine the TMDLs, as necessary.

Examination of data from both Northrup Creek (USGS, 2010) and Long Pond (unpublished data provided via DEC personal communication with Dr. Joseph Makarewicz, 10/19/09), show the following:

1. During the period 1995-1996, when the Spencerport WWTF improved its phosphorus removal capabilities, the soluble reactive phosphorus (SRP) in Northrup Creek declined significantly. SRP is a measure of orthophosphate, the filterable (soluble, inorganic) fraction of phosphorus, the form directly taken up by plant cells
2. During the period 2008-2009, when the Spencerport wastewater was diverted out of the Long Pond watershed, the SRP appears to have declined even further. The USGS continues to monitor Northrup Creek, in order to confirm this short term pattern.
3. However, during the entire sampling period for Northrup Creek (1989-2009), there is no pattern in total phosphorus levels versus time. Further, there is no trend in (Total P – SRP) in Northrup Creek either. This value (Total P – SRP), is a rough measure of the particulate P fraction, since total dissolved phosphorus, TDP, was not analyzed.
4. There is no relationship between growing season chlorophyll a levels and total phosphorus in Long Pond. There is however, a good relationship between (Total P – SRP) and total suspended sediment (TSS) in Long Pond.

All of this taken collectively indicates that there is no clear correlation between the phosphorus loading to Long Pond and the response variable chlorophyll a, and there may be other factors influencing the eutrophication potential in these Lakes. There are a number of possible reasons for this, including:

1. Much of the phosphorus loading not only to Long Pond, but also to Buck and Cranberry ponds is in the particulate form. Although all of the SRP and somewhere between 25% and 33% of the particulate P is available for algal growth (Sonzogni et. al, 1982), the high loading of particulate P is accounting for much of the Total P in Long Pond, rather than conversion of bioavailable P to algal P.
2. Since the ponds are relatively shallow, wind induced turbulence may resuspend additional non-algal particles from the bottom muds (Sherwood, 1999).
3. The presence of detectable levels of SRP is a good indication that phosphorus may not always be the limiting factor in the three ponds (Corell, 1998). Further, the high levels of turbidity in the ponds may indicate that light may occasionally be limiting to algal growth.

7.1. Reasonable Assurance for Implementation

As noted above, the TMDL implementation builds upon previous accomplishments of local governments to protect Buck, Long and Cranberry Ponds. An example of this, is the diversion of the Spencerport WWTP in 2008. As noted on Table 17, the "existing" loads for Long Pond include the load from the Village of Spencerport wastewater treatment plant discharge, which was connected to the Monroe County Pure Waters WWTP, located outside of the watershed. The WLA accounts for the elimination of the Village of Spencerport wastewater treatment plant load. All of these TMDLs are based on further sewering, diversion and the virtual elimination of on-site septic systems. Even then, significant load reductions are needed from agriculture and developed land. Meeting the necessary load reductions, using staged implementation, is necessary in the Long Pond and Cranberry Pond TMDLs, because the allocations are based on an estimation of internal load and a response of that load to external load reductions. It will likely take years to see the response in water quality from attempts to reduce watershed phosphorus loads. Also, the form of phosphorus and the timing of its delivery to receiving waters also affects its bio-availability.

The proposed load reductions include reasonable assurance that designated uses for Buck Pond will be met, because a significant portion of the reduction responsibility is required of the regulated MS4s. Staged implementation is also necessary for the TMDL for Buck Pond to allow time to address uncertainties. The allocations do not include an objective quantification of internal load for that pond. Similar mechanisms of internal load (resuspension of bottom sediments, for example) to those for Long and Cranberry ponds are probably at work in Buck Pond to some degree. If so, water quality in Buck Pond will respond better than predicted to external load reductions.

NYS DEC is re-evaluating its nutrient criteria for ponded waters, based on scientific information that a different phosphorus guidance value may be appropriate to protect swimming uses. If a less stringent guidance value is subsequently adopted for Class *B* ponded waters, some of the actions to reduce loads in later stages of implementation may not be needed. Also, the level of reduction required by this TMDL would require implementation beyond what is presently considered technically feasible. In the future, the design and subsequent availability of new technologies may change this situation. Staged implementation provides opportunity to re-evaluate these TMDLs with future information and to consider the attainability of achieving the designated uses of these lakes.

The TMDL implementation strategy is divided into three stages. Stage 1 would be completed by the end of 2020, and would be based primarily upon implementation of stormwater control provisions in permits now in effect, as described below. Additional watershed load reductions are attributed to the estimated benefits of both incentive-based voluntary nutrient management on farms and the recent passage of Chapter 205 of the laws of 2010, the Household Detergent and Nutrient Runoff Law (amending section 35-105 and adding a new Title 21 to Article 17of the Environmental Conservation Law) which was signed into law by the Governor on July 15, 2010. This law restricts the sale and application of fertilizers containing phosphorus for lawns and limits the phosphorus content of automatic dishwashing detergent (NY State, 2010). Stage 2 would be implemented by the end of 2025, and would be based on more significant load reductions from both agriculture and developed land. Stage 3 would be implemented by the end of 2030, and would be based on the 1) elimination of the septic system load by connection to sewers 2) extensive implementation of management and other conservation practices on agricultural lands, as well as 3) further significant load reductions from developed land. For reasons stated above, the waste load allocations in these TMDLs would not be expected to be met until the end of Stage 3 in 2030.

7.1.1. *Recommended Phosphorus Management Strategies for Septic Systems*

An enhanced surveying and testing program should be implemented to document the location of septic systems and verify failing systems, requiring replacement in accordance with the NY State Sanitary Code. State funding is presently available for either a voluntary septic system inspection and maintenance program or a septic system local law requiring system inspection and repair. Property owners should be educated on proper maintenance of their septic systems and encouraged to make preventative repairs. The recently passed legislation will reduce phosphorus in dishwashing detergents sold in NY State and this should reduce the phosphorus contribution from on-site wastewater systems, especially those in substandard condition.

This TMDL recommends eliminating phosphorus loading from septic systems by either sewering and diverting all the developed areas in the watersheds or institution of a management system to assure design and operation of remaining individual systems. The TMDL implementation plan schedules this load reduction for Stage 3, with a target date of 2030.

7.1.2 *Recommended Phosphorus Management Strategies for Wastewater Treatment Plants*

There are numerous private, commercial and institutional (PCI) dischargers in the Long Pond watershed. In order to provide reasonable assurance that the TMDL will be met, stringent wasteload allocations for the SPDES dischargers have been adopted. The wasteload allocations are then translated into permit limits for each of the facilities. When the SPDES permits are modified, they will contain a compliance schedule for completing facility upgrades necessary to meet these new phosphorus limits. Minor reductions will be realized due to the passage of Environmental Conservation Law Bill S3780A. Facilities should be encouraged to tie into the municipal sewer system, where available.

7.1.3 *Recommended Phosphorus Management Strategies for Agricultural Runoff*

There are no farms in the TMDL watersheds that are large enough to be categorized as a Concentrated Animal Feeding Operation (CAFO), which is regulated under the Federal Clean Water Act CAFO Permit. It is recognized that some agricultural management has already been implemented, even though these practices are not credited by the watershed model in estimating load. The staged implementation plan for this TMDL allows for reductions of loads from agriculture to proceed on a rationale basis, proportionally to other load reductions, needed to meet water quality targets in the ponds.

The New York State Agricultural Environmental Management (AEM) Program was established by 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, which the agricultural community provides. The AEM 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.

Monroe County Soil and Water Conservation District should continue to implement the AEM program on farms in the watershed, focusing on identification of management practices that reduce phosphorus loads. These practices would be eligible for state or federal funding and because they address a water quality impairment associated with these TMDLs, 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. Additional practices could be fully 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.

Stage 2 of this implementation plan is based on bringing all agricultural operations through Tier 4 of AEM, thus implementing conservation plans by 2025. Levels of phosphorus reductions to achieve Stage 3 load allocations, could only be achieved with significant changes in agricultural operations, such as converting cropland to pasture or conservation easements. It should be noted that all of the actions outlined would be voluntary on the part of farmers.

7.1.4 *Recommended Phosphorus Management Strategies for Stormwater Runoff*

NYS DEC issued SPDES general permits GP-0-10-001 for construction activities and GP0-10-002 for stormwater discharges from MS4s in response to the federal Phase II Stormwater rules (Table 19). GP0-10-002 which remains in effect until 2015, extended boundaries beyond urbanized area to municipal boundaries, occupying all three watersheds shown on Figure 1.

Table 19. Stormwater Permits

SPDES #	Permittee	Date Notice of Intent (NOI) Submitted
NYR20A054	Town of Ogden	3/3/2003
NYR20A133	Town of Greece	3/5/2003
NYR20A263	Village of Spencerport	3/10/2003
NYR20A266	Monroe County	3/10/2003
NYR20A460	Town of Gates	5/20/2003
NYR20A475	Town of Parma	10/14/2003
NYR20A288	NYNYSDOT	3/10/2003

GP0-10-002 requires MS4s to institute minimum measures, including:

- Public education, more specifically:
    - Sensible lawn care, specifically reducing fertilizer use or using phosphorus-free products, now readily available to consumers. The previously mention phosphorus legislation, restricts the sale and application of fertilizers containing phosphorus.
    - Cleaning up pet waste, and
    - Discouraging waterfowl congregation, by restoring natural shoreline vegetation.
- Illicit discharge and detection requirements, such as mapping the sanitary sewersheds;
- Construction site and post construction stormwater runoff control:
    - Ordinance, inspection and enforcement programs, and

- Assurance of no net increase of pollutants from the MS4 taking into account construction.

Implementation of stormwater controls through the MS4 permit will be staged as follows:

- Stage 1 (through 2020) reductions are based on continuation of the GP0-10-002, and adoption of the preventive management practices listed above. This stage would include some pilot retrofits and correction of significant illicit discharges.
- Stage 2 (2025) would be based on practical limits for infiltration of stormwater from developed areas through green infrastructure and likely inclusion of some implementation of practices to address any significant existing erosion sites.
- Stage 3 (2030) would take complete implementation of erosion control practices and stormwater retrofits, and would require implementation beyond what is now considered feasible.

7.1.5 *Additional Protection Measures*

Measures to further protect water quality and limit the 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, preserve natural vegetation along shorelines and tributaries and promote smart growth. Identification of wildlife habitats, sensitive environmental areas, and key open spaces within the watershed could lead to their preservation or protection by way of conservation easements or other voluntary controls.

7.2 Follow-up Monitoring

A targeted post-assessment monitoring effort is necessary to determine the effectiveness of the implementation plan associated with the TMDL. Annual growing season monitoring of the pond and watersheds would inform the implementation process. At a minimum, Buck, Long and Cranberry Ponds will be sampled in 2015 at their deepest location during the warmer part of the year (June through September) on 8 sampling dates. Grab samples will be collected at a 1.5 meter depth and in the hypolimnion (if thermally stratified). 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 recorded. A simple macrophyte survey will also be conducted one time during midsummer. A special study will be conducted, sometime in the first five years post-TMDL, to determine the relatively contributions of phosphorus from the watershed and resuspension of bottom material in each pond.

The USGS will be encouraged to continue its long-term monitoring of Northrup Creek, as this information is invaluable to understanding both the impacts of the Spencerport WWTP diversion and the response of Northrup Creek water quality to the Implementation Plan, continued herein.

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 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 MapShed/RUNQUAL and may be used to modify the TMDL or implementation plan as needed. The information will be incorporated into the NY 305(b) report as needed.

8.0 PUBLIC PARTICIPATION

NYSDEC met with representatives of local government, several Monroe County agencies, and an academic institution with interests in the watersheds on March 4, 2010 to discuss TMDL development, refine data and to receive local input. 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 28, 2010. A 30-day public review period was established for soliciting written comments from stakeholders prior to the finalization and submission of the TMDL for EPA approval.

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