TOTAL MAXIMUM DAILY LOAD TO ADDRESS THE PHOSPHORUS IMPAIRMENT TO BELLEVILLE PONDS AND BELLEVILLE UPPER POND INLET

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Best Management Practices (BMP) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of and impacts upon waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

CFR is the Code of Federal Regulations.

Clean Water Act (CWA) refers to the Federal Water Pollution Control Act (33 U.S.C. § 1251) et seq. and all amendments thereto.

DEM or RIDEM refers to the Rhode Island Department of Environmental Management.

Designated uses are those uses specified in water quality standards for each waterbody or segment whether or not they are being attained. In no case shall assimilation or transport of pollutants be considered a designated use.

DOT or RIDOT refers to the Rhode Island Department of Transportation.

EPA refers to the United States Environmental Protection Agency.

Hypolimnion means the bottom waters of a thermally stratified lake.

Load allocation (LA) is the portion of a receiving water's loading capacity that is attributed either to one of its nonpoint sources of pollution or to natural background sources.

Loading Capacity means the maximum amount of loading that a surface water can receive without violating water quality standards.

mg/L is a concentration unit of milligrams (one-thousandth of a gram) pollutant (e.g. total phosphorus) per liter solution.

MS4 is a municipal separate storm sewer system. The Town of North Kingstown and RIDOT are operators of MS4s.

MOS refers to the Margin of safety.

Nonpoint Source (NPS) means any discharge of pollutants that does not meet the definition of Point Source in section 502.(14). of the Clean Water Act and these regulations. Such sources are diffuse, and often associated with land-use practices, and carry pollutants to the waters of the State, including but not limited to, non-channelized land runoff, drainage, or snowmelt; atmospheric deposition; precipitation; and seepage.

Point source means any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation or vessel, or other floating craft, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture.

Rhode Island Pollutant Discharge Elimination System (RIPDES) is the Rhode Island system for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing point source discharge permits and imposing and enforcing pretreatment requirements pursuant to Title 46, Chapter 12 of the General Laws of Rhode and the Clean Water Act.

Runoff means water that drains from an area as surface flow.

Storm water is that portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes and other features of a stormwater drainage system into a defined surface waterbody, or a constructed infiltration facility. Stormwater can also refer to rainwater that hits the ground, does not infiltrate at that location and travels to local surface waters without entering a stormwater conveyance system, and 2) rainwater that is collected in stormwater collection systems (pipes or ditches) and is then conveyed to local surface waters.

SWMPP is a storm water management project plan.

Total Maximum Daily Load (TMDL) means the amount of a pollutant that may be discharged into a waterbody and still maintain water quality standards. The TMDL is the sum of the individual waste load allocations for point sources and the load allocations for nonpoint sources and natural background taking into account a margin of safety.

Waste load allocation is the portion of a receiving water's loading capacity that is allocated to point sources of pollution, including stormwater discharges regulated under the NPDES.

Water quality criteria means elements of the State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use.

Water quality standard means provisions of State or Federal law, which consist of designated use(s) and water quality criteria for the waters of the State. Water Quality Standards also consist of an antidegradation policy.

ABSTRACT

This TMDL addresses the phosphorus impairment to Belleville Ponds and Belleville Upper Pond Inlet (the major tributary to Belleville Pond). Both waterbodies are located in North Kingstown. Belleville Ponds is 53 hectares in area and has a mean depth of 1.5 meters. Belleville Ponds are comprised of a main upper basin and much smaller lower basin. The basins form a single waterbody, but narrow to a 40-foot wide bottleneck where they join. The watershed of Belleville Ponds is approximately 1500 hectares and is dominated by undeveloped land classified as forest, wetland, and water.

The goals of this TMDL are to assess total phosphorus concentrations within Belleville Ponds and Belleville Upper Pond Inlet, to identify and assess sources of the impairment, and to determine necessary pollutant reductions and mitigation measures to restore all designated uses. The upper basin of Belleville Ponds has consistently higher phosphorus levels than the lower basin. The upper basin had a mean phosphorus concentration of 0.037 mg/l, significantly higher than the Rhode Island Water Quality Standard of 0.025 mg/l. The mean chlorophyll-a concentration in the upper basin was 0.040 mg/l.

The major sources of phosphorus to Belleville Ponds and Belleville Upper Pond Inlet are the discharge from the Lafayette Trout Hatchery, stormwater, and possibly, waterfowl and internal cycling of phosphorus released from sediments. The Lafayette Trout Hatchery, a state facility, is the only identified point source, other than stormwater outfalls. It was determined that the Lafayette Trout Hatchery annually contributes 212 kg/yr of total phosphorus to Belleville Ponds, which comprises 51% of the total current load to the ponds. Although there are no culverts discharging directly into Belleville Ponds, thirty four (34) identified storm drains discharge to its tributaries or hydrologically connected wetlands. Most of these outfalls conduct highway discharge associated with Colonel Rodman Highway (Route 4) and Ten Rod Road (Route 102). The remaining outfalls are associated with residential areas. Only seven outfalls are 2 feet in diameter or greater. Although only small numbers of waterfowl were observed on the pond during the brief shoreline survey, the pond provides excellent habitat to support a significant population of waterfowl. The release of phosphorus from the pond sediments may be a significant source to Belleville Ponds, however there is no conclusive evidence to support this. Phosphorus cycling may be dominated by the growth and decay of the dense aquatic vegetation that forms a dense mat throughout the entire pond.

The current phosphorus load to Belleville Ponds was calculated from in-pond total phosphorus concentrations using the Reckhow model. The allowable load (TMDL) was back-calculated using the Reckhow model and the numeric water quality target. A ten percent margin of safety was then subtracted from this value to determine the allowable load or TMDL for Belleville Ponds. The current and target load (TMDL) were then used to calculate the necessary load reduction. Belleville Ponds require a load reduction of 39% to meet the state water quality criteria of 0.025 mg/l. The allowable phosphorus load for Belleville Ponds is inclusive of reductions needed to address Belleville Upper Pond Inlet's phosphorus impairment.

The load allocation, assigned to Lafayette Trout Hatchery, was based on the criteria concentration and permitted flow. The allowable load assigned to the Lafayette Trout Hatchery was set so as not to cause an exceedance of the 0.025 mg/l total phosphorus criteria for the Belleville Upper Pond Inlet, at the point it enters Belleville Ponds, under the most adverse conditions (defined as the lowest average 7 consecutive day low flow with an average recurrence frequency of once in 10 years by Rule 8 (E)(1) of Rhode Island's Water Quality Regulations). The allocation of loads between stormwater WLAs (point sources) and LAs (non-point sources) was established using the estimate of percent impervious area within the watershed.

Eliminating the phosphorus-related impairments to Belleville Ponds requires a reduction in external and perhaps internal sources of phosphorus. Preliminary data appear to indicate that the phosphorus load from the Lafayette Trout Hatchery has been significantly reduced with implementation of various Best Management Practices there. A year-long pilot study, involving removal of solid waste from hatchery raceways, was initiated, significantly reducing the quantity of hatchery sludge being discharged to the headwaters of the Belleville Upper Pond Inlet. Additional BMP's will likely be required to achieve the necessary load reductions.

Other recommended implementation activities to address external sources to the Belleville Ponds focus primarily on the control of stormwater runoff to the ponds. The implementation of Phase II Stormwater Management Program Plans (SMPP) including illicit discharge detection and elimination, and the construction of stormwater BMPs at selected locations is expected to help reduce nutrient loadings to Belleville Ponds. To realize water quality improvements in Belleville Ponds, both phosphorus concentrations in storm water *and* the volume of storm water discharged to the ponds must be reduced. While the Town of North Kingstown and RIDOT must implement the Phase II minimum measures town-wide, they should prioritize implementation of Phase II minimum measures in the Belleville Ponds watershed and should target the construction of stormwater BMPs for priority outfalls. The Town of North Kingstown and RIDOT should conduct BMP feasibility studies to identify locations and technologies for installing infiltration basins or equivalent BMPs in the priority catchments. This study should evaluate the feasibility of distributing infiltration or other treatment structures throughout the drainage area of priority outfalls as an alternative to end-of-pipe technologies. The Town of North Kingstown and RIDOT should also consider increasing the frequency of street sweeping and/or stormwater system maintenance and acquiring vacuum-assisted street sweeping trucks because of their increased efficiency in removing plant debris and soil. The public education program, required by the Six Minimum Measures, should also focus on both water quality and water quantity concerns within the watershed. Examples include minimizing the adverse effects of lawn fertilizers, disposing of pet waste properly, and promoting infiltration.

The control of loading due to a potentially excessive population of waterfowl may also be necessary to achieve the allowable phosphorus load to Belleville Ponds. However, the control of waterfowl may be difficult due to the natural and relatively remote setting of the pond. Some reductions in loading may be possible through the control of geese and swan populations.

Control of external sources of phosphorus may not produce immediate or expected water quality benefits to the ponds unless internal loading is also addressed in a timely fashion. Furthermore, reducing phosphorus loads to the ponds is expected to reduce native plant densities however have little effect on invasive plant species which are known to thrive in even nutrient poor waters. Thus, in addition to reducing external sources of phosphorous discharged to the pond, it is strongly recommended that a lake management study be done to determine the most effective and environmentally safe method to reduce internal phosphorus loading and to control invasive aquatic plants. A Freshwater Wetlands permit from the Office of Water Resources would be required prior to harvesting aquatic vegetation.

Monitoring of the Belleville Ponds should continue so that the effectiveness of ongoing remedial activities can be gauged. Continuing monitoring efforts by University of Rhode Island Watershed Watch volunteers will help track water quality trends, and monitoring by RIDEM Division Fish and Wildlife as part of their RIPDES permit will evaluate pollution control efforts at the hatchery.

1.0 INTRODUCTION

Section 303(d) of the federal Clean Water Act requires the State of Rhode Island to prepare a list of all surface waters in the state for which beneficial uses of the water are impaired by pollutants. Waterbodies placed on the 303(d) list require the preparation of Total Maximum Daily Loads (TMDLs) to identify and quantify sources of the impairments and establish acceptable pollutant loads from both point and nonpoint sources of pollution which allow the impaired waterbody to meet water quality standards. TMDLs prepared by RIDEM also include implementation strategies for reducing these point and nonpoint source pollution loads.

This TMDL addresses the phosphorus impairment to Belleville Ponds and Belleville Upper Pond Inlet as identified on the 2008 Integrated Water Quality Report and the Draft 2010 Integrated Water Quality Report. The Belleville Ponds watershed is dominated by undeveloped land classified as forest, wetland, and water. The pond receives storm water runoff from both point and nonpoint conveyances discharged into tributaries and hydrologically connected wetlands. The Lafayette Trout Hatchery discharges into the pond via the Belleville Upper Pond Inlet, a stream that extends from the hatchery area to the upper basin of Belleville Ponds. Additional external sources of phosphorus likely include waterfowl, pet waste, and lawn fertilizers.

RIDEM has employed an approach consistent with that in an EPA Region 1 document detailing a procedure for developing lake phosphorus TMDLs (Basile and Voorhees, 1999). The document uses a practical and simplistic approach for lake phosphorus TMDL development. A core component of this methodology is the use of an empirical loading-response model derived by Reckhow, which balances external loadings against the in-lake mean phosphorus concentration. A major benefit of the methodology is that data acquisition and analysis are minimal compared to other widely used techniques. An empirical model was used to relate annual phosphorus load and steady-state in-pond concentration of total phosphorus.

1.1 Scope and Purpose of the Belleville Ponds and Belleville Upper Pond Inlet TMDL

This TMDL will address the phosphorus impairment to Belleville Ponds and Belleville Upper Pond Inlet (Table 1.1). The phosphorus impairments to Belleville Ponds and Belleville Upper Pond Inlet were identified through sampling conducted by volunteers with the University of Rhode Island Watershed Watch Program. The Belleville Upper Pond Inlet is also on the Draft 2010 303(d) List for enterococci, however the enterococci impairment is not addressed by this TMDL.

Table 1.1 Water Quality Classification and 2010 303(d) Impairments Addressed by this TMDL.

Waterbody	Waterbody ID	Size (ha or km)	WQ Classification	Impairment(s) Draft 2010 303(d) List
Belleville Ponds	RI0007027L-02	52.7	B	Phosphorus
Belleville Upper Pond Inlet	RI0007027R-02	4.8	B	Phosphorus

The phosphorus impairment is an indicator of a nutrient enriched system, better known as a eutrophic system. In freshwater systems the primary nutrient known to accelerate eutrophication is phosphorus. Therefore, in order to prevent further degradation of water quality and to ensure that Belleville Ponds meets state water quality standards, the TMDL will establish a phosphorus limit for the pond and will outline corrective actions to achieve that goal. The phosphorus limit assigned to the pond will require reductions that also address the phosphorus impairment to Belleville Upper Ponds Inlet.

1.2 Pollutants of Concern and Applicable Criteria

The pollutant of concern for Belleville Ponds and Belleville Upper Ponds Inlet is phosphorus. Total phosphorus is typically the limiting nutrient to algal growth in the freshwater environment.

The following criteria for nutrients, which include total phosphorus and nitrogen, excerpted from Table 1 8.D.(2). Class-Specific Criteria - Fresh Waters of RIDEM's Water Quality Regulations (RIDEM, 2009), apply to the subject ponds:

10(a). Average Total phosphorus shall not exceed 0.025 mg/l in any lake, pond, kettle hole, or reservoir, and average Total P in tributaries at the point where they enter such bodies of water shall not cause exceedance of this phosphorus criteria, except as naturally occurs, unless the Director determines, on a site-specific basis, that a different value for phosphorus is necessary to prevent cultural eutrophication.

10(b). None [nutrients] *in such concentration that would impair any usages specifically assigned to said Class, or cause undesirable or nuisance aquatic species associated with cultural eutrophication, nor cause exceedance of the criterion of 10(a) above in a downstream lake, pond, or reservoir. New discharges of wastes containing phosphates will not be permitted into or immediately upstream of lakes or ponds. Phosphates shall be removed from existing discharges to the extent that such removal is or may become technically and reasonably feasible.*

Criterion 10(b) states that nutrient concentrations in a waterbody (and hence loadings to the water body) shall not cause undesirable aquatic species (e.g. chlorophyll-a) associated with cultural vegetation. This narrative standard is designed to prevent the occurrence of excessive algal or plant growth as is the case for Belleville Ponds. The Department will follow guidelines set by the Nurnberg (1996) Trophic State Index to establish a limit for algal concentrations in the subject pond.

Belleville Ponds are classified as warm water fish habitat in the Rhode Island Water Quality Regulations (Amended May 2009). The Belleville Upper Pond Inlet is classified as a cold water fish habitat. The following standards apply for dissolved oxygen for each condition:

Warm Water Fish Habitat - Dissolved oxygen content of not less than 60% saturation, based on a daily average, and an instantaneous minimum dissolved oxygen concentration of at least 5.0 mg/l. The 7-day mean water column dissolved oxygen concentration shall not be less than 6 mg/l.

Cold Water Fish Habitat - Dissolved oxygen content of not less than 75% saturation, based on a daily average, and an instantaneous minimum dissolved oxygen concentration of at least 5 mg/l, except as naturally occurs. For the period from October 1st to May 14th, where in areas identified by the RI Division of Fish and Wildlife as cold water fish spawning areas the following criteria apply: For species whose early life stages are not directly exposed to the water column (ie, early life stages are intergravel), the 7 day mean water column dissolved oxygen concentration shall not be less than 9.5 mg/l and the instantaneous minimum dissolved oxygen concentration shall not be less than 8mg/l. For species that have early life stages exposed directly to the water column, the 7 day mean water column dissolved oxygen concentration shall not be less than 6.5 mg/l and the instantaneous minimum dissolved oxygen concentration shall not be less than 5.0 mg/l.

1.3 Priority Ranking

Belleville Ponds is listed in Category 5 of the state's 2008 Integrated Report (also known as the 2008 303(d) List of Impaired Waters) and is scheduled for TMDL development in 2008. Category 5 waters are those that are impaired or threatened for one or more designated uses by a pollutant(s), and requires a TMDL.

1.4 Antidegradation Policy

Rhode Island's antidegradation policy requires that, at a minimum, the water quality necessary to support existing uses be maintained (see Rule 18, Tier 1 in the State of Rhode Island's Water Quality Regulations). If water quality for a particular parameter is of a higher level than necessary to support an existing use, that improved level of quality should be maintained and protected (see Rule 18, Tier 2 in the State of Rhode Island's Water Quality Regulations).

2.0 WATERSHED/WATERBODY DESCRIPTIONS

Belleville Ponds are located in the Annaquatucket River Watershed, in the Town of North Kingstown (Figure 2.1). Belleville Ponds are comprised of a main upper basin and much smaller lower basin. The basins form a single waterbody, but narrow to a 40-foot wide bottleneck where they join. The Belleville Ponds area is bounded by Ten Rod Road (Route 102) to the north, Tower Hill Road (Route 1) to the east, and Colonel Rodman Highway (Route 4) to the west. There is no development in the immediate vicinity of the ponds. Belleville Ponds have a surface area of approximately 52.7 hectares (RIGIS). The ponds have an average and maximum depth of 1.5 and 2.4 meters, respectively (Guthrie and Stolgitis, 1977). The estimated volume of Belleville Ponds is 7.91×10^5 m^3. Inflow to the pond, listed in no particular order of significance, consists of groundwater, surface water runoff, stormwater runoff, discharge from the Lafayette Trout Hatchery via tributary inflow, and direct precipitation.

The Belleville Ponds watershed, including both the upper and lower basins, encompasses approximately 1495 hectares. The watershed is not sewered. The Belleville Ponds watershed is relatively undeveloped, with forest, wetland, and water accounting for approximately 65% of the watershed (Figure 2.2). Medium density residential development makes up only 15% of the watershed. Mixed urban landuse accounts for approximately 7% of the watershed. High density residential and agriculture comprise approximately 5% and 4% of the watershed, respectively. The remaining portion of the watershed is made up of commercial and low-density residential development.

The area immediately surrounding the pond is characterized by upland forests, wetlands, and open fields. Most of this surrounding area is comprised of Ryan Park, a 176-hectare park that offers a boat ramp at the southeast end of the lower basin, recreational fields, and an extensive system of hiking trails. The area contiguous to Belleville Ponds is largely made up of an extensive system of marshes and swamps. Belleville Ponds are also characterized by extremely dense growth of aquatic macrophytes. These aquatic plants cover nearly 100% of the pond's bottom. Native macrophytes largely consist of coontail (*Ceratophyllum spp.)*, white water lily (*Nymphaea odorata*), water-shield (*Brasenia schreberi*), yellow water lily (*Nuphar spp*), macrophytic algae, and occasionally duckweed (*Lemna spp.*). In addition to total phosphorus, Belleville Ponds are on the 2008 303(d) List for non-native aquatic plants, including fanwort, variable milfoil, and water chestnut. The water in one southeast cove of the main basin was characterized by iron oxide staining, a somewhat milky appearance, and a sheen of what appeared to be oil or manganese.

Belleville Ponds are naturally occurring, although a low earthen dam at the eastern shore of the lower basin, has somewhat enlarged the waterbodies. The main inlet into the upper basin is the Belleville Upper Pond Inlet, a perennial stream approximately 4.8 kilometers long and originating near the Lafayette Trout Hatchery, a state-owned facility. Water for hatchery operations is supplied exclusively by three groundwater wells, which pump at a combined rate of approximately 1.8 MGD. Discharge from the hatchery comprises the majority of flow at the headwaters to the stream. Belleville Upper Pond Inlet bisects a large marsh/shrub wetland located to the immediate west of Route 4, prior to discharging into the northern end of the upper basin of Belleville Ponds.

In addition to Belleville Upper Pond Inlet, another tributary, Himes Brook, flows into an impoundment to the immediate west of Oak Hill Road, southwest of the upper basin of Belleville Ponds. Approximately half of the flow, exiting the impoundment, discharges into the upper basin of Belleville Ponds, at its southern end. The other half of the flow discharges to a manmade ditch that discharges to Secret Lake, which is located to the immediate south of Oak Hill Road. A short unnamed ditch, originating from

Secret Lake discharges into the lower basin of Belleville Ponds, at its southeastern end, only 100 meters from the origin of the Annaquatucket River, the sole outlet of the pond. A fish ladder at the outlet allows for access of andronomous fish into Belleville Ponds. The Annaquatucket River eventually discharges to Bissel Cove and Narragansett Bay.

There are thirty four (34) identified storm drains discharging to the tributaries of Belleville Ponds or hydrologically connected wetlands. A map and a list of identified stormwater point sources are provided in Appendix B and Appendix C, respectively.

Figure 2. 1. The Belleville Ponds Watershed, Tributaries, and Sampling Stations.

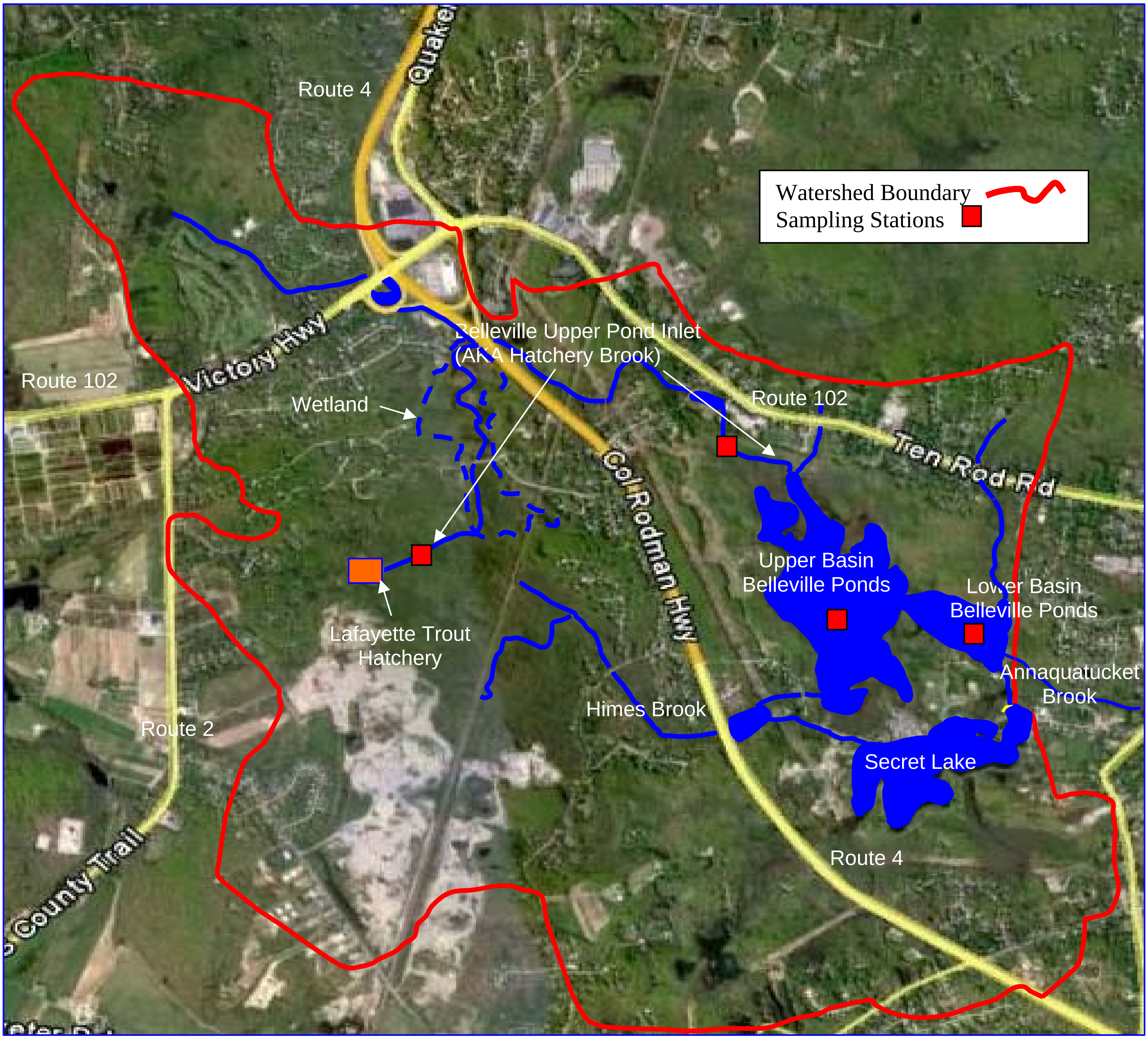
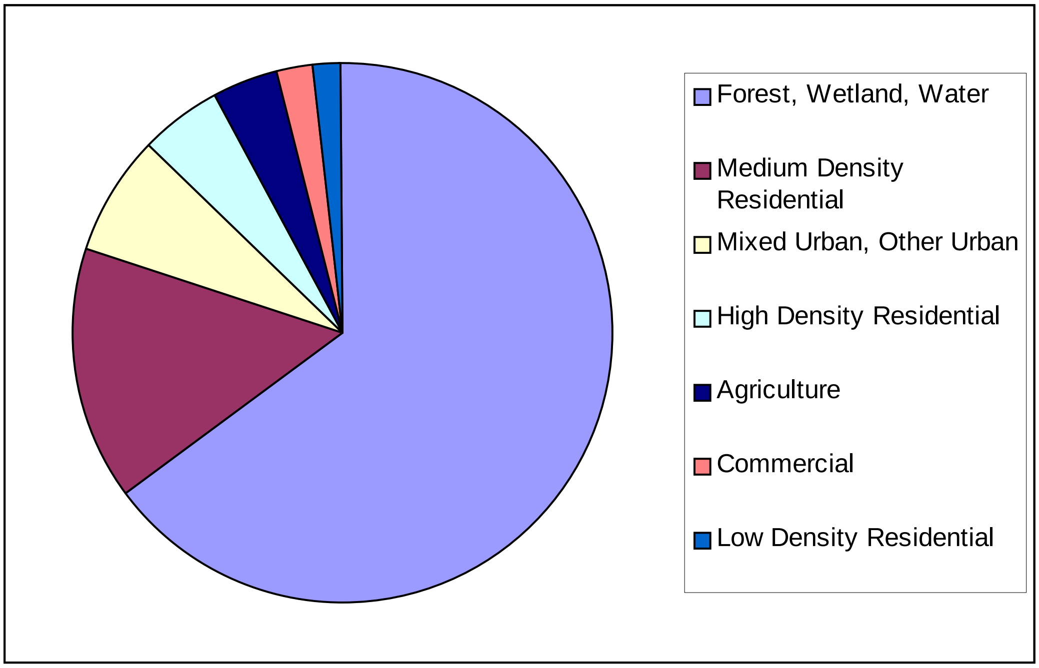


Figure 2.2 Percent Land Use within the Belleville Ponds Watershed.



3.0 CURRENT WATER QUALITY CONDITIONS

Most of the water quality data utilized in this study was provided by the University of Rhode Island Watershed Watch program (URIWW). The Watershed Watch Program, initiated in 1986, is led by URI's Cooperative Extension and Department of Natural Resources Science (NRS). The URIWW program is an institutional collaboration between URI, the Cooperative State Research Education Extension Services (CSREES), the Rhode Island Department of Environmental Management (RIDEM), the Narragansett Bay Estuary Restoration Program, municipalities, environmental and sporting organizations, the Narragansett Indian Tribe, lakeside residents and organizations, and various other local, regional, and national partnerships. Program goals are to encourage active citizen participation in water quality protection, to educate the public about water quality issues, and to obtain multi-year surface water quality information. Water quality information is used to ascertain current water quality conditions and to detect trends in order to encourage successful, cost-effective management.

The program is based on the work of volunteers, who conduct the sampling after they receive training for the appropriate field procedures. The sampling schedules are centrally coordinated at URI. The aim of the program is to establish a long-term monitoring program for water bodies all over Rhode Island. The URIWW program typically samples for alkalinity, bacteria, chloride, chlorophyll, ammonium, nitrate, total nitrogen, pH, dissolved phosphorus, total phosphorus and measures secchi depths as well. Through comparison of bi-weekly or monthly sampling over the summer season, long-term changes in the water quality may be detected. All data represented below is available at the URIWW website at: http://www.uri.edu/ce/wq/ww/. The URIWW program assures the quality of its data through its Quality Assurance Plan (QAPP), which was approved by RIDEM and USEPA. The QAPP is available at: the URIWW website cited above.

The URIWW program samples for phosphorus three times a year, analyzing for both total and dissolved phosphorus. Waterbodies are typically sampled for phosphorus in May, July, and October. Samples are collected 1 meter below the surface.

The URIWW program typically samples for chlorophyll-a once every two weeks, from May through October. Samples are taken 1 meter below the surface at the deepest part of the waterbody. Duplicate samples for the same day are averaged.

Although RIDEM considers Belleville Ponds as a single waterbody with a single identification number, it is made up of two separate basins. URI Watershed Watch (URIWW) volunteers have monitored the pond since 1993 – maintaining monitoring stations in both basins. URIWW staff have also sampled the Belleville Upper Pond Inlet since 2000 (identified on its website as Belleville @ RR Xing), near the point it enters Belleville Ponds. Himes Brook, at Lafayette Road, was sampled by URIWW staff six times in 2004. The Division of Fish and Wildlife has contracted ESS Laboratory (A Division of Thielsch Engineering) to sample discharge from the hatchery at the headwaters to the Belleville Upper Pond Inlet. ESS Laboratory has a comprehensive Quality Assurance/Quality Control program that meets and often exceeds the strict requirements established by the EPA and RIDEM. The hatchery discharge has been sampled for phosphorus as well as several other constituents since at least 2003, as required by their RIPDES permit.

As previously discussed in section 2.0, approximately half of the flow from Himes Brook discharges to the southern end of the upper basin of Belleville Ponds. The mean total phosphorus concentration in Himes Brook was 0.026 mg/l. The minimum and maximum concentrations were 0.002 and 0.045 mg/l, respectively.

Figure 3.1 shows total phosphorus concentration data for Belleville Ponds and two stations in its major tributary, the Belleville Upper Pond Inlet. The Belleville Upper Pond Inlet stations are located at its headwaters at the terminus of a former hatchery raceway (approximately 100 m downstream of current hatchery operations), and at a former railroad bed approximately 335 m upstream of the inlet to the upper basin of Belleville Ponds. The last five years of Watershed Watch data (2003-2007) is shown for the Belleville Pond stations and the Belleville Upper Pond Inlet station near the point it enters the upper basin of Belleville Ponds. The data for the station located at the headwaters of the Belleville Upper Pond Inlet at the hatchery outfall was collected by DEM Division of Fish & Wildlife as part of their RIPDES permit and is from September 2006 through June 2009, during which time BMPs were initiated at the hatchery (Appendix A). Another reason for using this time period is that prior to July 2006 TP analytical precision for samples collected by Division of Fish & Wildlife resulted in many "non-detects" making TP levels difficult to accurately quantify. There is an evident trend of decreasing total phosphorus levels downstream of the hatchery discharge. The mean and median TP concentrations of the hatchery discharge were 0.084 and 0.072 mg/l, respectively. The mean and median drop to 0.054 and 0.038 mg/l at the Belleville upper Pond Inlet near the point it enters Belleville Ponds. The mean and median TP concentrations in the upper basin of Belleville Ponds fell further to 0.037 and 0.030 mg/l. The mean TP concentration in the lower basin of Belleville Ponds was 0.023 mg/l, below the State criteria of 0.025 mg/l. The trend of decreasing TP levels downstream of the hatchery is probably due to both dilution and attenuation in wetlands. There is a very large wetland complex associated with the Belleville Upper Pond Inlet, downstream of the hatchery. The wetland straddles Hatchery Road, and consists of marsh north of the roadway and shrub wetland to its south. The marsh is inundated with surface water for the entire year while the shrub wetland is inundated for perhaps 10 to 11 months of the year. The wetland is an area of significant groundwater discharge, which dilute TP concentrations. There is also probably significant attenuation of phosphorus taking place within the wetland as well as smaller wetlands, located further downstream. However, research on phosphorus retention and release in wetlands (Richardson, C & Qian, S, 1999 and Surridge, B et al, 2007) suggests that there are likely episodes when the wetlands release large quantities of historic phosphorus originating from the hatchery as well as from other sources within the watershed.

In addition to decreasing mean and median TP concentrations, Figure 3.1 also shows a trend of decreasing variability. Variability was highest at the hatchery outfall, with TP levels as high as 0.460 mg/l, and several higher than 0.150 mg/l. Variability at the hatchery could be related to biomass or hatchery operations at the time of sampling. For instance, cleaning, feeding, or the removal of fish for stocking could result in the resuspension of fish waste and elevated levels at the hatchery outfall. Total phosphorus concentrations were as high as 0.180 and 0.211 mg/l in the Belleville Upper Pond Inlet, near the point it enters the upper basin of Belleville Ponds. TP levels within the upper basin of Belleville Ponds reached a maximum of 0.125 mg/l. There is little variability of TP levels within the lower basin of Belleville Ponds.

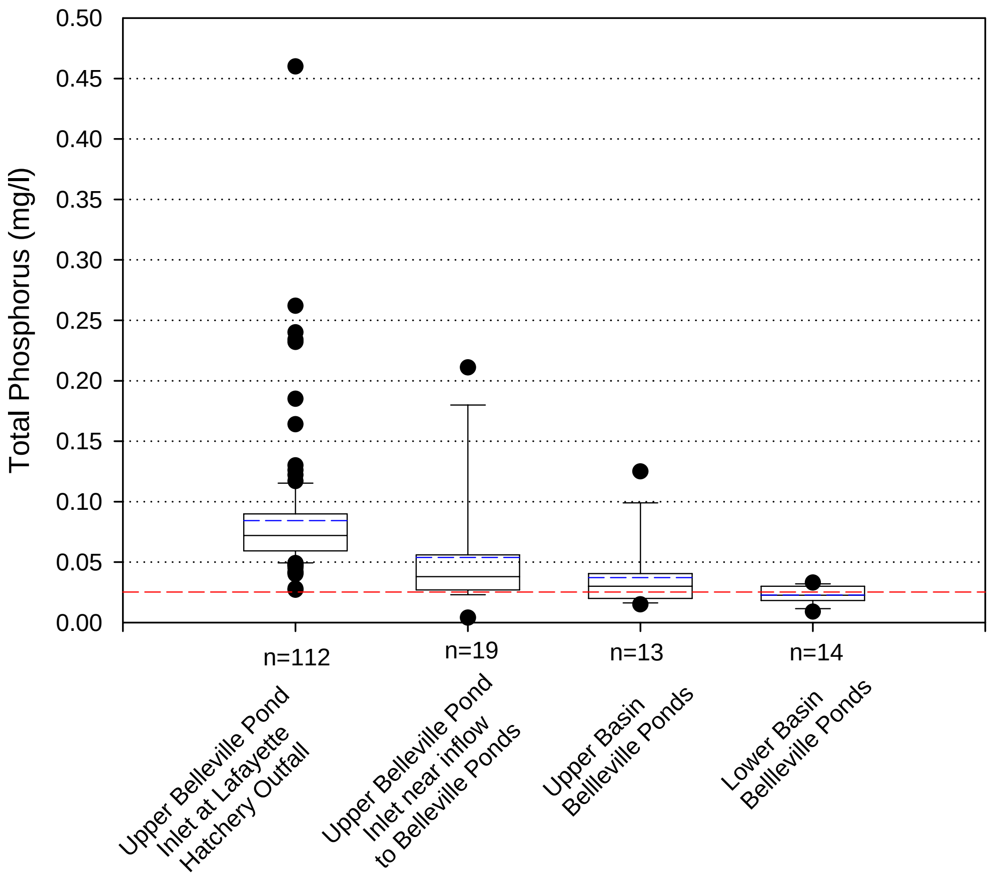
Figures 3.2 through 3.4 show seasonal total phosphorus concentrations for Belleville Ponds and the Belleville Upper Pond Inlet near the point it enters the upper basin of Belleville Ponds. The figures show TP concentrations at the beginning of the growing season, mid-growing season, and at the end of the growing season. Although the data is grouped in two or three month intervals, the vast majority of data for each time period occurs during a single month (May, July, or October). Figure 3.2 shows TP concentrations in the late spring and mimics the annual trend displayed in the previous figure, with progressively decreasing values and variability from the Belleville Upper Pond Inlet to the lower basin of Belleville Ponds. This pattern of decreasing TP values and variability is probably the result of vegetative uptake of phosphorus during the early spring, as well as dilution from direct groundwater discharge into the ponds, and dilution from inflow from other tributaries with lesser levels of phosphorus than the Belleville Upper Pond Inlet. Figure 3.3 shows TP values during mid summer. Although the median TP concentration dropped from the Belleville Upper Pond Inlet to the upper basin of Belleville Pond during this time period, the variability at the higher end was greater in the pond. Higher values within the upper basin of Belleville Ponds could be the result of several factors including: the release of phosphorus from anoxic lake sediments occurring during periods of stagnant summer weather patterns, resuspension of lake sediment during periods of high winds, or because of a high phosphorus load entering the pond from another tributary. Total phosphorus concentrations in the early fall are shown in Figure 3.4. Again there is a significant reduction in phosphorus levels from the Belleville Upper Pond Inlet to Belleville Ponds. During the early fall sampling period, both phosphorus levels and variability are low within the upper basin of the pond. These low levels occur during a period when the water column is well mixed and aerated and also during a period when marsh soils contiguous to the pond are probably aerobic due to lower seasonal water levels. Examination of Figures 3.2 through 3.4 shows that phosphorus levels and variability are low within the lower basin of Belleville Ponds during all sampling periods.

As previously mentioned in section 2.0, almost 100% of the bottom of Belleville Ponds is covered by submergent aquatic vegetation. Most of the phosphorus within the pond system is probably tied up in these plants, at least during the growing season. Inspection of aerial photographs, from 1970 to 2008, shows that significant areas of the ponds that were formerly open water have been transformed to marsh. This sedimentation is especially evident at the northern and western ends of the upper basin of Belleville Ponds. Although some sedimentation can be expected over time in any lake basin, it appears that the rate of sedimentation of Belleville Ponds far exceeds that which would be expected from natural processes (and may be due in part to the excessive vegetative growth occurring in the pond).

Although chlorophyll-a is not listed as an Observed Effect on the 2008 303(d) List, there are periods as evidenced by the Watershed Watch data, when the chlorophyll-a levels in Belleville Ponds are elevated (greater than 0.009 mg/l). The chlorophyll-a concentrations in the lower basin ranged from 0.001-0.027 mg/l. The mean and median chlorophyll levels in the lower basin were 0.007 and 0.006 mg/l, respectively. Chlorophyll levels in the upper basin ranged from 0.001-0.650 mg/l, with a mean and median of 0.040 and 0.006 mg/l respectively. The assimilation of phosphorus by dense aquatic and emergent macrophytic vegetation may account for the absence of higher mean chlorophyll-a concentrations in the upper basin.

The presence of nuisance aquatic vegetation including both native and invasive species and algal blooms diminishes the value of the ponds for virtually all uses and may potentially foster hypoxic conditions in the bottom waters of the ponds during the summer months. Recreational use is made less appealing, aesthetic enjoyment is impaired, and habitat value is reduced. Reducing total phosphorus to the criterion concentration is expected to reduce densities of native species of aquatic vegetation and the frequency and duration that the chlorophyll levels are above the nuisance level of 0.009mg/l. Invasive aquatic plant species, however, are known to grow in even nutrient poor waters and thus separate management efforts will be needed to control the invasive plant species.

Figure 3.1 Multi-year (2003 – 2007) Phosphorus Concentrations in Belleville Ponds and the Belleville Upper Pond Inlet.



Box Plot Legend

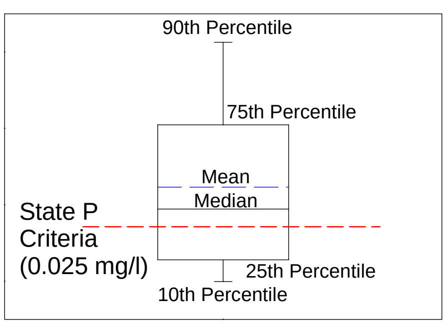


Figure 3.2 May-June Total Phosphorus Concentrations in the Belleville Ponds System.

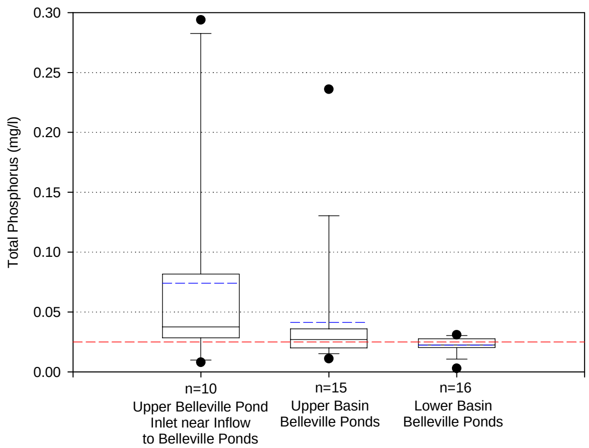


Figure 3.3 July-August Phosphorus Concentrations in the Belleville Ponds System.

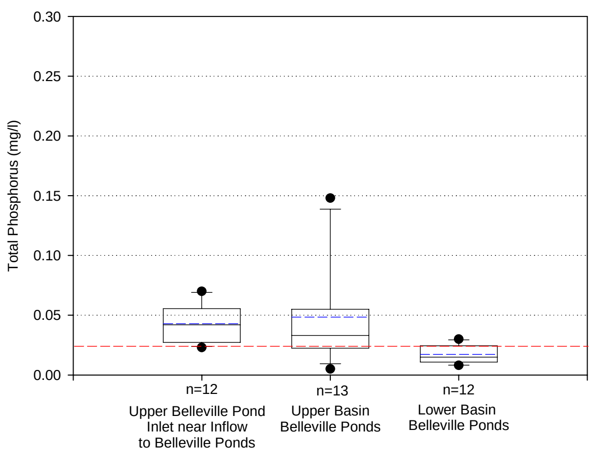
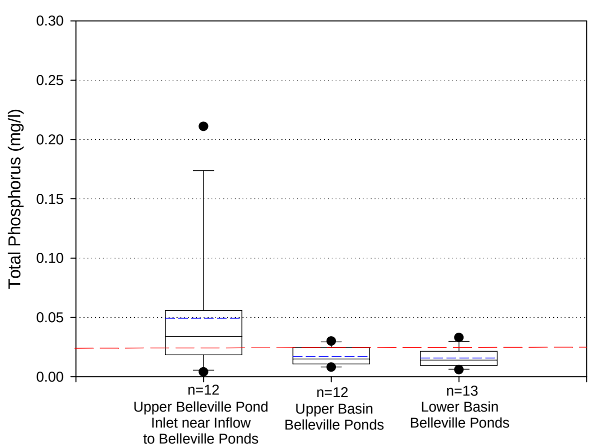


Figure 3.4 September-November Phosphorus Concentrations in the Belleville Ponds System.



4.0 POLLUTION SOURCES

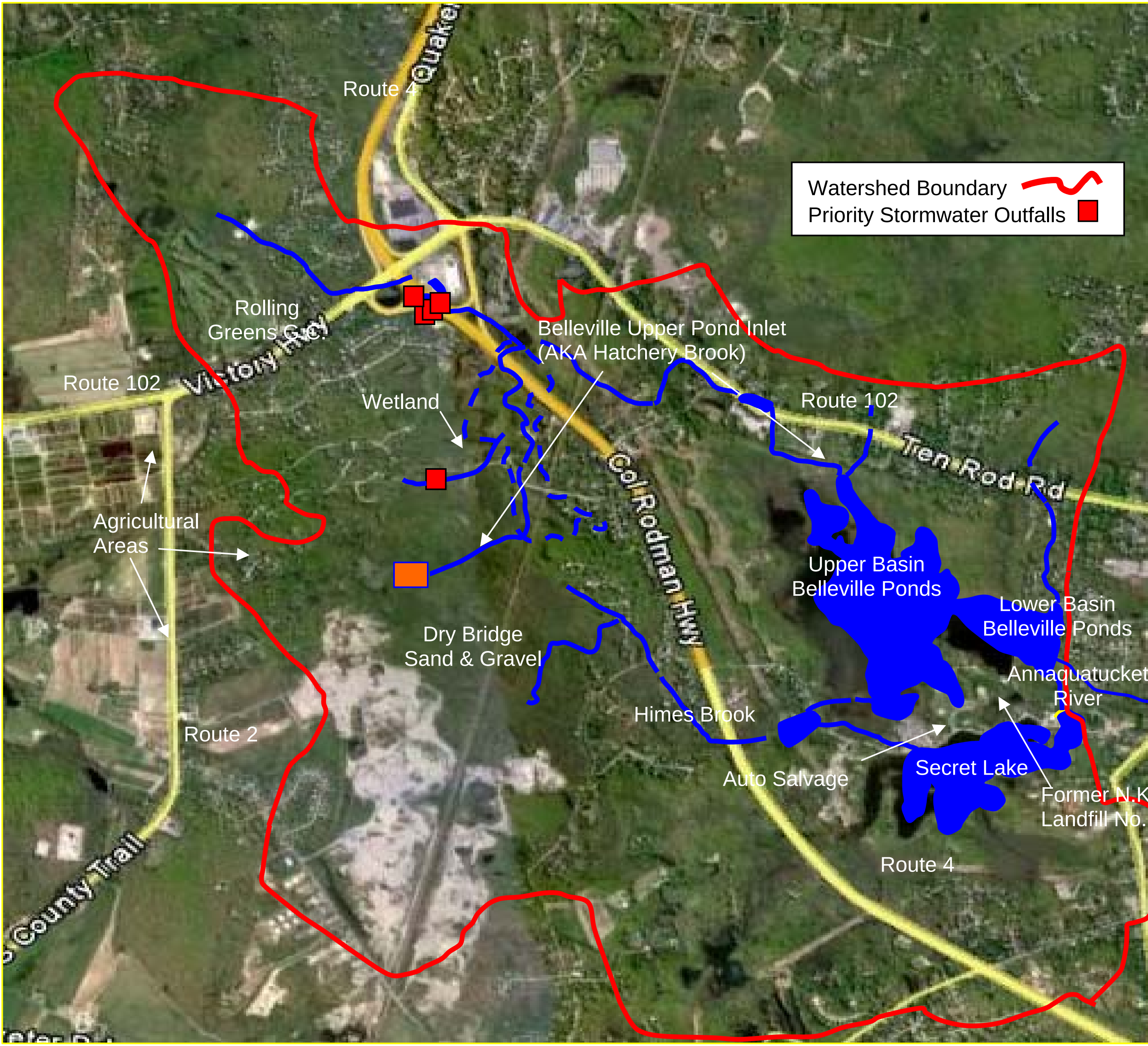
4.1 Overview

Sources of phosphorus are both external and internal (nutrient recycling from the decay of aquatic macrophytes or from the release of phosphorus from lake sediment). The major sources of phosphorus to Belleville Ponds, not necessarily in order of significance, are discharge from the Lafayette Trout Hatchery, stormwater, waterfowl, release of phosphorus from wetlands sediments and internal cycling within the pond itself. Priority stormwater sources as well as potential and actual non-stormwater sources are displayed in Figure 4.1. Sections 4.2 through 4.7 present an overview of likely sources of phosphorus to Belleville Ponds.

4.2 Lafayette Trout Hatchery

The Lafayette Trout Hatchery, a state facility, is the only non-stormwater point source within the Belleville Ponds watershed. The facility pumps groundwater for hatchery operations. The mean daily flow from the facility, from September 2006 to June 2009, was 1.82 MGD. This flow comprises the vast majority of flow to the headwaters of the Belleville Upper Pond Inlet. The Belleville Upper Pond Inlet discharges into the upper basin of Belleville Ponds approximately 3 km downstream of the Lafayette Trout Hatchery. The brook bisects a large wetland complex, located to the west of Route 4, that research suggests would alternately serve as both a sink and source of pollutants generated from hatchery operations. The RIDEM RIPDES (Rhode Island Pollutant Discharge Elimination System) program has issued an permit regulating the hatchery's effluent (Permit No. RI0110035). The hatchery's RIPDES program requires that the hatchery discharge be sampled for total phosphorus, as well as for several other pollutants. The "hatchery outfall" sampling point is located approximately 350 ft downstream of the operational concrete raceways, at the confluence of an abandoned gravel raceway and a naturalized stream. The RIPDES permit requires that phosphorus be sampled monthly from April through September and quarterly from October through March. The hatchery outfall was sampled more frequently than required by the RIPDES permit. Although the outfall was sampled quarterly prior to May 2007, after May 2007 the outfall was sampled monthly. Each month or quarter, the outfall was sampled three times over the course of a day, totaling 112 samples. Sample results are shown Figure 3.1 and in Appendix A. During the September 2006 through June 2009 time period, total phosphorus concentrations ranged from 0.027-0.460 mg/l. The mean and median sampling concentrations were 0.084 and 0.073 mg/l, respectively.

Figure 4.1. The Belleville Ponds Watershed and Potential and Actual Sources.



4.3 Stormwater Runoff

Stormwater runoff is a major source of total phosphorus in urban environments. Lee and Jones-Lee (1995) stated that urban stormwater runoff contains about 100 times the total concentrations of phosphorus that are typically derived from stormwater runoff from forested areas. Sampling conducted as part of a TMDL for Mashapaug Pond, located in Providence, found that stormwater was a significant source of total phosphorus. Total phosphorus concentrations measured from six stormwater outfalls discharging to Mashapaug Pond ranged from maximum values at first flush of between 17 and 205 mg/l.

In another study, mean total phosphorus concentrations in stormwater runoff in two urban southern Wisconsin watersheds were measured between 0.140 and 2.370 mg/l (Waschbusch et al., 1999; Browman et al., 1979). Waschbusch et al. (1999) determined that lawns and streets were the largest sources of total phosphorus in the watersheds, with lawns contributing more than streets. The street fraction of the phosphorus load was associated with sediment, and to a lesser extent leaf litter. Browman et al. (1979) found that the highest dissolved phosphorus concentrations occurred in the fall and spring, coinciding with leaf and tree seed fall, respectively.

As part of this TMDL, all stormwater outfalls discharging directly to the pond, tributaries, and hydrologically connected wetlands were identified. A shoreline survey of Belleville Ponds was also conducted. Roadways adjacent to the waterbody, any tributaries, and hydrologically connected wetlands were also investigated to identify low-lying catch basins. Each of these catch basins was inspected to determine if there was an associated outlet to the waterbody. Outfalls were located with a handheld GPS unit and pipe diameters were measured. Outfalls were prioritized for implementation mainly by pipe diameter, deducing that the culverts were sized according to their drainage areas and the amount of impervious area within the associated catchments. Therefore, the outfalls targeted as significant sources are greater than 24 inches in diameter. The presence of sedimentation, scouring, dry weather flows, odor, staining, and raccoon sign elevated the prioritization of any given outfall. The prioritization was downgraded if there was evidence that the pipe conveyed significant flow from a tributary or wetland in contrast to stormwater or if the outfall was connected to a water quality structure. Appendix B shows outfall locations mapped on aerial photographs of the Belleville Pond watershed. Appendix C lists all the outfalls and provides outfall diameters, latitude and longitude, location descriptions, and any comments associated with the outfalls, including the prioritization factors mentioned above and also provides information on blockages of culverts or nearby catch basins. Areas of concentrated surface flows from parking lots and roadways into tributaries, or hydrologically connected wetlands are shown in Appendix B and are also listed in Appendix C.

Although there are no culverts discharging directly into Belleville Ponds, thirty four (34) identified storm drains discharge to its tributaries or hydrologically connected wetlands (Appendix B and Appendix C). Two culverts discharge directly to the Belleville Upper Pond Inlet. Most of the outfalls conduct highway discharge associated with Colonel Rodman Highway (Route 4) and Ten Rod Road (Route 102). The remaining outfalls are associated with residential areas. In addition to the 34 stormwater culverts that discharge to tributaries to Belleville Ponds, there are twenty three (23) areas of concentrated surface flow that discharge into the Belleville Ponds system. These areas of concentrated flow are generally either curb cutouts of asphalt swales but may be naturalized swales or rills that arise from concentrated surface flow off the roadways. Most of the areas of concentrated surface flow are located in residential areas, with the remaining ones associated with highway runoff. Many are clustered along short segments of roadway. For instance, eight areas of concentrated surface flow are located on Lafayette Road in the vicinity of its intersection with Audubon Road and another three are located on Hatchery Road at the Belleville Upper Pond Inlet bridge.

There are only seven outfalls that are 2 feet in diameter or greater. Two of the seven outfalls (BeP-D and BeP-G) conduct discharge from streams in addition to conveying stormwater. Since the majority of flow in these two pipes appears to be associated with the streams, they were not selected as priority outfalls. The most significant culverts are listed in Table 4.1. Four of the five priority outfalls appear to be owned by RIDOT. RIDEM's RIPDES program regulates stormwater from RIDOT-owned stormwater drainage systems under permit no. RIR040036. The remaining priority outfall is owned by the Town of North Kingstown. The RIPDES program regulates stormwater associated with the Town of North Kingstown's stormwater drainage systems under permit RIR040028. The highest priority outfall (BeP-H) is a 36-inch pipe, which discharges from a residential area to a tributary at Beacon Drive (Table 4.1). Three priority culverts (BeP-X, BeP-Y, BeP-Z) drain Route 102, discharging to a sedimentation basin located to the immediate southwest of the intersection of Routes 4 and 102. Although these culverts drain to a sedimentation basin, the basin may not provide adequate treatment of stormwater because a stream discharges to same area of the basin. The flow through the basin, associated with the stream, may preclude the settling out of fine sediments within the basin resulting in inadequate treatment of stormwater. A 24-inch outfall culvert (BeP-AA) conducts highway runoff to a roadside ditch at a Route 4 off ramp to Route 102.

Table 4.1 Priority Outfalls for Belleville Ponds.

Outfall ID	Diameter (in)	Location	Ownership *
BeP-H	36	Beacon Dr.	Town of North Kingstown
BeP-X	24	Route 4/102 Intersection	RIDOT
BeP-Y	24	Route 4/102 Intersection	RIDOT
BeP-Z	30	Route 4/102 Intersection	RIDOT
BeP-AA	24	Route 4/102 Intersection	RIDOT

- Ownership inferred from proximity to state or local roadways.

4.3.1 Potential Stormwater Sources

Most of the stormwater-phosphorus, adversely impacting the water quality of Belleville Ponds and the Belleville Upper Pond Inlet, probably originates from residential areas of the watershed, and activities such as lawn fertilization. However a few other areas have been identified that have the potential to be significant sources of phosphorus. These areas were identified either due to activities often associated with phosphorus, or because of their close proximity to Belleville Ponds.

Rolling Greens Golf Course is located at the northwest end of the watershed, just north of Route 102 (Ten Rod Road) and west of Route 4. It has been identified as a potential source because golf courses typically fertilize intensively. The western edge of the golf course lies within close proximity to an intermittent stream, which is a tributary to the Belleville Upper Pond Inlet.

Dry Bridge Sand and Stone Inc. is located off Dry Bridge Road, at the western end of the watershed. The company runs a sand and gravel mining operation that encompasses approximately 69 hectares of land. Excavated sand and gravel is washed onsite to remove fines. Surface water in the washing area is confined by an earthen impoundment. Under normal operating conditions, no surface water is discharged from the facility. However, in 2004, the impoundment failed, releasing a large amount of sediment into an adjacent wetland, at the headwaters of Himes Brook, itself a tributary to the upper basin of Belleville Ponds. The company reported the incident to DEM's Office of Compliance and Inspection (OCI). The company removed much of the coarse sediment from the wetlands as required by OCI, but was allowed to leave fine-grained sediment, east of the Amtrak railroad line, within the wetland, since it was feared that the removal of the fines would cause additional physical damage to the wetlands. It is likely that sediment-borne phosphorus from this incident was released into surface waters and impacted the water quality of Belleville Ponds. Assuming there are proper controls in place to contain wash waters, and there is no future impoundment failure or stockpiling of phosphorus-rich materials on the bare sand and gravel substrate, normal mining operations are not anticipated to have a significant negative impact of the surface water quality of Belleville Ponds.

D&K Pitcher's Autosalvage and Belleville Autosalvage share a large auto salvage yard, located on Oak Hill Road, to the immediate south of the upper basin of Belleville Ponds. The perimeter of the junkyard is surrounded by wetlands, which have a direct surface hydrologic connection to the upper Basin of Belleville Ponds. A mobile car crusher operates onsite. Fluids are removed from the vehicles prior to crushing, however some residual fluids probably remain. The mobile car crusher apparently has a containment system for any fluids, but there is no secondary containment system onsite. Fluids are stored indoors in sealed containers. Although originally evaluated as a potential source based solely on proximity to the pond, the autosalvage yards have been excluded from further consideration as a source of phosphorus to the pond, because there are no known activities or materials that would result in phosphorus export.

4.4 Waterfowl and Other Wildlife

Animal waste derived nutrients have the potential to enrich surface water and thus contribute to the process of eutrophication. There have been a significant number of papers published examining how nutrients from both migratory and resident bird populations can effect water quality and speed the process of cultural eutrophication (Manny et al, 1994; Moore et al. 1998; Purcell, 1999; Portnoy, 1990; Kitchel et al., 1999, and Bland et al., 1996). Even in small numbers, larger waterfowl like geese are likely a significant source of phosphorus. However, studies have shown that the impact of animal derived nutrient loadings to waterbodies from birds varies with: bird species, bird population density, feeding habits, dilution capacity of the waterbody, and time of year.

In urban and suburban areas throughout Rhode Island a lack of natural predators, limited hunting, and supplemental feeding have created an explosion in resident waterfowl numbers. Resident and migratory waterfowl can create many problems including excessive nutrient loading to lakes and ponds. Most of the nutrient problems are derived from excessive populations of Canada geese, but swans, ducks, and gulls, may be a significant source in some areas.

Manny et al. (1994) estimated that an individual waterfowl contributed approximately 8.2×10^{-3} kg/yr to a lake in southwestern Michigan, mostly during their migration. This is equivalent to 70% of all P that entered the lake from external sources. Manny et al. estimated the annual phosphorus loading per individual Canada goose. This estimate ranged from 0.028 kg/yr (Manny et al., 1975) to 0.179 kg/yr (Manny et al., 1994). At this loading rate, they thought it reasonable to assume that 2100 Canada geese were a significant source of phosphorus to a 15-hectare pond. Portnoy (1990) determined that approximately 42% of phosphorus loading in a Cape Cod pond was attributable to gulls. Migrating geese increased the total phosphorus loading rate in some wetland ponds at the Bosque del Apache National Wildlife Refuge in New Mexico by as much as 75% (Kitchel et al.). Chlorophyll levels increased in proportion to bird densities. J.K. Bland (1996) reported that 52% of the annual phosphorus budget of Green Lake in Seattle could be traced to waterfowl.

Canada geese were observed on several different occasions congregating at a small impoundment in the Belleville Upper Pond Inlet, to the immediate east of Lafayette Road. Twenty to forty birds were often observed at any one time. Grassed areas on both sides of the impoundment offer easy access to the water at this location.

It is difficult to estimate the waterfowl population that frequent Belleville Pond. Only small numbers of waterfowl were observed on the pond during the brief shoreline survey. However, the actual population may differ significantly from the population that was observed on that particular day. It is likely that significantly more waterfowl utilize the pond since it provides excellent waterfowl habitat. Waterfowl hunting is allowed in portions of the pond. The shoreline of Belleville Pond is undeveloped and the only open area for large numbers of waterfowl to congregate on the shoreline is the public boat ramp on the southern side of Lower Belleville Pond. If the waterfowl population is significantly higher than the numbers that were observed and assuming the more conservative estimate of phosphorus loading of 0.179 kg/yr (Manny et al., 1994) and assuming that all the water birds observed at Belleville Pond contributed loads equivalent to geese and that all birds were year-round residents, it is reasonable to assume that water fowl and other birds may be a significant source of phosphorus to the ponds.

4.5 Atmospheric

Atmospheric phosphorus loads are typically divided into wet and dry deposition. Observations of concentrations in rainwater are frequently available, and dry deposition is usually estimated as a fraction of the wet deposition. Wet deposition is typically associated with dissolved substances in rainfall. The settling of particulate matter during non-rainfall events contributes to dry deposition. Ullman et al. (2005) reported that the atmospheric phosphorus load was approximately 3-5% of the total annual phosphorus load to Delaware's inland bays. Wet and dry deposition phosphorus loads were 1.2-1.9 mg/m^2/year and 2.6-5.4 mg/m^2/year, respectively. The atmospheric deposition rates for phosphorus were reported in the Long Island Sound Study (Hydro Qual, 1991) and the Chesapeake Bay Model Study (Cerco and Cole, 1993). The dry atmospheric deposition was 26.7 mg/m^2/year and the wet deposition concentration was 0.061 mg/l.

4.6 Groundwater

In the past, it was generally thought that phosphorus is typically adsorbed to soil particles and is not transported in groundwater. However, recent research has demonstrated that phosphorus is indeed transported in groundwater in some instances (McCobb et al., 2003; SNIFFER, 2008).

4.6.1 Lafayette Trout Hatchery

Elevated levels of phosphorus have been observed in groundwater at the Lafayette Trout Hatchery, located in the western portion of the watershed, south of Hatchery Road. Groundwater, pumped for hatchery operations, was sampled 69 times between September 2006 and June 2009. The mean and median total phosphorus concentrations in the groundwater was 0.039 and 0.028 mg/l, respectively. Iron levels at the hatchery appear to be very low, which would facilitate the transport of phosphorus, since iron bonds with phosphorus, forming a complex that is immobile.

It is not known whether elevated groundwater levels at the Lafayette Hatchery are the result of contamination upgradient of the hatchery (e.g. agricultural practices) or whether there is a local source of contamination on hatchery grounds. Inspection of historic photographs shows that the hatchery maintained a fish pond on the premises from at least 1939 to at least 1999. The pond was filled in to allow for the construction of modern concrete raceways. The pond was dredged multiple times prior to it being filled in. Given the fish pond's 60 years of use, and considering the substrate below the pond is clean sand and there is a pumping well less than 100 feet from the former pond, it is possible that the former pond is causing the elevated phosphorus levels observed in the groundwater at the hatchery. Sampling groundwater, upgradient of both the former fish pond and actively pumping wells, would answer the question of whether or not the groundwater contamination is localized or regional.

Specifically, there is an existing monitoring well located on State property, approximately 350 ft southwest of the hatch house.

4.6.2 Agriculture

There are nurseries and other agricultural areas located on South County Trail (Route 2), at the western end of the watershed. These areas are located directly upgradient of the hatchery wells. While Office of Water Resources does not have direct evidence, over-fertilizing of these agricultural lands and/or improper storage of fertilizers could be a potential source of the high phosphorus concentrations recorded at the Lafayette Trout Hatchery. It should be noted that the aquifer in this area is confined, and the groundwater boundary may extend beyond (to the west of) the watershed boundary.

4.6.3 Failed Septic Systems

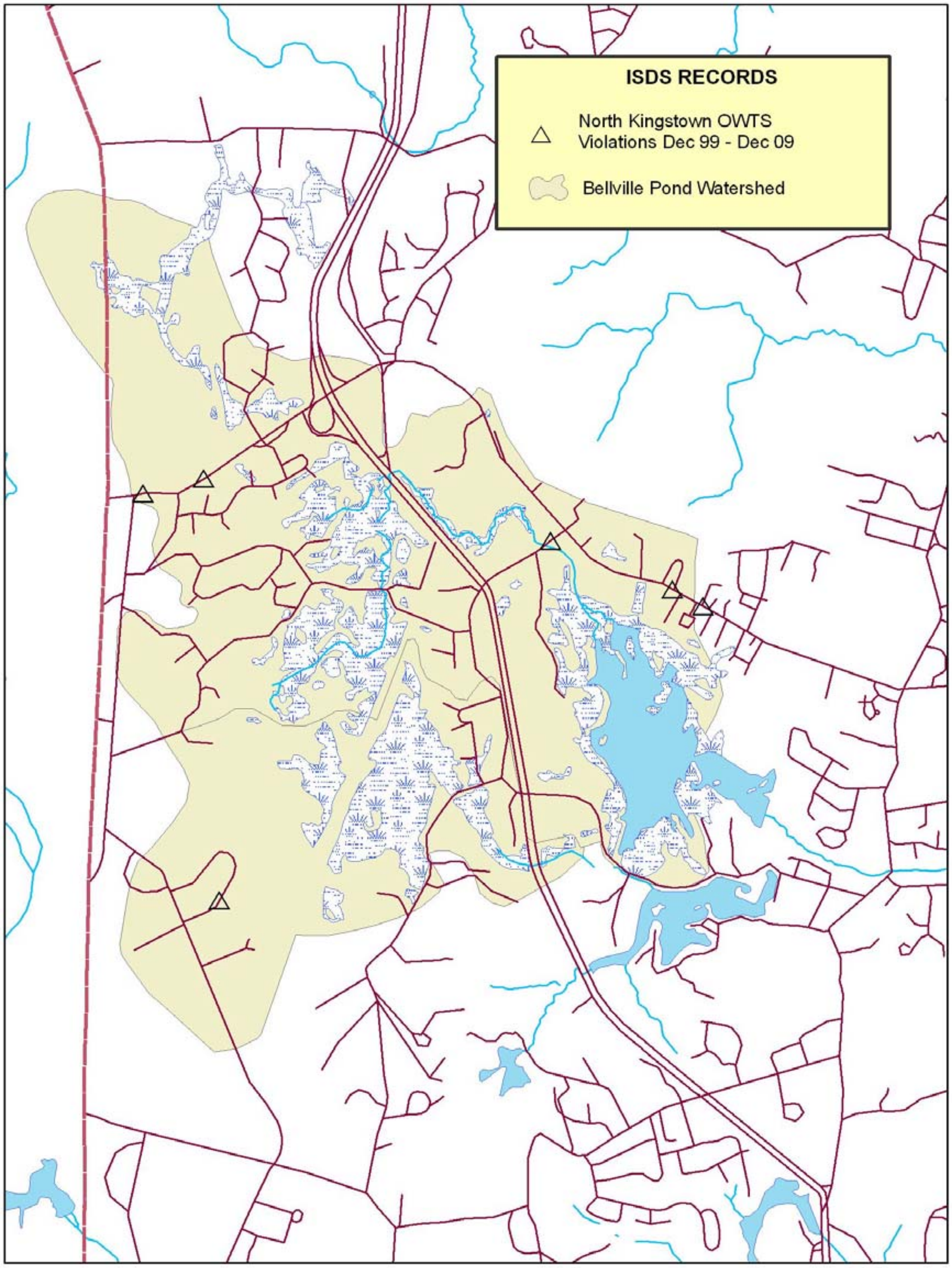
Septic systems, when properly designed, installed, and maintained, provide an effective and efficient means for treating wastewater. However, they are prone to failure with age, overuse, poor soil conditions, high water tables, or improper installation, repair, and/or maintenance. Failed or non-conforming septic systems could be a significant contributor of phosphorus to Belleville ponds. Wastes from failing septic systems enter surface waters either as direct overland flow or via groundwater. Wet weather events typically increase the rate of transport of pollutant loadings from failing septic systems to surface waters because of the wash-off effect from runoff and the increased rate of groundwater recharge.

Figure 4.2 shows septic system-related violations in the Belleville Ponds watershed between December 1999 and December 2009, including Notices of Violation (NOVs) and Notices of Intent (NOIs). NOIs are written notification by RIDEM's Office of Compliance & Inspection (OCI) to private or public property owners that a violation of state environmental law has occurred and that the infraction must be corrected or further enforcement action will be taken. NOVs are written notification by OCI to owners that enforcement action is pending. NOVs are issued for more serious violations or after there has been an inadequate response to a NOI. The vast majority of NOVs and NOIs displayed in Figure 4.2 are associated with septic system failures. The displayed NOVs and NOIs may also include illegal tie-ins to storm drain systems (including both illicit septic and/or laundry connections), illegal direct discharges, and System Suitability Determination Infractions (SSDIs). SSDIs are issued when owners make significant upgrades to residences, such as adding bedrooms, without submitting an application to the Office of Water Resources to determine if the existing system is adequate to service additional demands. There have been six documented violations in the watershed in the last 10-year period. Most of the violations have occurred on Ten Rod Road, with the remaining violations taking place on Lafayette Rd, and Vista Dr.

4.6.4 North Kingstown Landfill No. 2

There is a 5-acre former landfill (North Kingstown Landfill # 2), located to the immediate south of the lower basin of Belleville Ponds, east of a large auto salvage operation. The Ryan Park Athletic Complex now occupies the site. From 1940 to 1970, the Town of North Kingstown operated a landfill at the property and accepted an estimated 19,000 tons of household waste and demolition materials annually. A majority of landfilled materials were covered with varying depths of sand and loam and the Ryan Park Athletic Complex was constructed on the site. A slight groundwater mound exists below the landfill causing leachate from the property to flow to the north and northwest towards Belleville Ponds. Analytical analyses of subsurface soil samples collected in 1990 indicated the presence of one volatile organic compound (VOC), 17 semivolatile organic compounds (SVOCs), one polychlorinated biphenyl (PCB), and four metals, including lead. Analytical results of groundwater samples collected from three on-site monitoring wells in 1990 indicated the presence of two VOCs and one metal. Analytical results of

Figure 4. 2. Septic System Violations in the Belleville Ponds Watershed



sediment samples collected from Belleville Pond and nearby wetlands in 1990 indicated the presence of three VOCs, one SVOC, and four metals. Analytical results of surface water samples collected in 1990 indicated the presence of two SVOCs, three pesticides, and seven metals, including lead. Based upon the analytical results, the USEPA has concluded that Belleville Ponds and its associated fishery appear to be impacted.

A narrow cove at the southeastern end of the upper basin and a small pond located to the immediate south of the lower basin have water quality characteristics that could be the result of contaminated groundwater from the closed landfill. Both the cove and small pond had a slight milky appearance. Iron flocculent and manganese films were also commonly observed in the waterbodies as well as in nearby wetlands. These characteristics are consistent with anaerobic conditions, which could be the result of groundwater with a high BOD. Anaerobic conditions within the sediment generally causes the release of phosphorus, because iron becomes reduced and soluble and is no longer able to bind with phosphorus. Phosphorus could also be leaching directly from the former landfill site.

4.7 Internal Loading

Internal loading, the release of phosphorus from lake sediments and/or aquatic vegetation, can play an important role in the phosphorus dynamics of lentic systems. Internal phosphorus loading originates from a pool of phosphorus accumulated in the sediment or in aquatic vegetation within the lake. The ultimate source of most of the sediment-bound phosphorus is external (e.g. stormwater). Under certain conditions this sediment-bound phosphorus can be released into the water column resulting in elevated phosphorus concentrations and algal blooms. In some cases, the majority of the phosphorus load to a waterbody can be due to internal loading.

The decay of organic matter in the sediment and also the decay of recent algal die-off or aquatic macrophytes may cause anoxic conditions in pond sediments. Anoxic conditions in the pond sediments favor the release of phosphorus. Søndergaard et al. (1993) found that in a Danish lake phosphorus release mainly occurred from April to October, with little or no phosphorus release occurring during the winter. As previously discussed, stratification results in anoxic conditions in the bottom waters that are conducive to the release of phosphorus from lake sediments. Stratified lake waters cause dissolved phosphorus, released from the sediment, to build up in the hypolimnion.

Two different mechanisms have to occur nearly simultaneously to result in the release of phosphorus from the sediment. Firstly, phosphorus bound to particles or aggregates in the sediment must be mobilized by being transferred to the pool of dissolved phosphorus (primarily phosphate) in the pore water. Secondly, processes which transport the dissolved phosphorus to the lake water must function. Important mobilization processes are desorption, dissolution, ligand exchange mechanisms, and enzymatic hydrolysis. These processes are affected by a number of environmental factors, of which redox potential, pH and temperature are the most important. Essential transport mechanisms include diffusion, wind-induced turbulence, bioturbation (the disturbance of the bottom sediments by aquatic organisms) and gas convection. Redox-controlled dissolution and diffusion are considered as the dominant mechanisms for phosphorus release from stagnant hypolimnetic bottom areas of deep lakes. All the mobilization and transport processes can theoretically contribute to the overall phosphorus release from sediments in shallow lakes.

Significant amounts of phosphorus in lake sediments may be bound to redox-sensitive iron compounds or fixed in more or less labile organic forms (Søndergaard, 2003). Jensen and Anderson (1992) have shown that iron-bound phosphorus, when present in significant proportions in the sediment, may be a major source for internal phosphorus loading in shallow, eutrophic lakes, just as it may be in deeper, stratified lakes. These phosphorus compounds are potentially mobile and may eventually be released to the lake water once bottom waters become anoxic in the summer, although phosphorus release from the sediment has also been recorded in oxic waters.

Pore water chemistry, especially the Fe:P ratio, can have a significant effect upon the mobility of sediment-bound phosphorus. Jensen et al. (1992) found that internal cycling from aerobic sediments from fifteen Danish lakes was suppressed by Fe:P ratios above 15 (by weight). No correlation was found between the water total phosphorus concentration and sediment phosphorus concentration alone. Conversely, very high internal loading rates (20-50 mg/m^2/d) have been observed in shallow lakes with low Fe:P ratios, wind mixing/resuspension and high pH (Welch and Cooke, 1995). Phillips et al. (1994) measured higher phosphorus release rates during periods when sulfide from sulfate reduction removed iron [FE(II)] from the sediment pore water.

While shallow lakes are generally well mixed, they may become weakly or intermittently stratified, resulting in anoxic conditions in the bottom waters. Riley and Prepas (1984) studied two shallow intermittently-stratified lakes in Alberta and found that during periods of stratification water directly overlying sediments was anoxic and total phosphorus increased in deep water, with the sediments being the major source of total phosphorus. After eight of nine mixing events that immediately followed stratified periods, total phosphorus in the surface water increased by 3-52%.

Although the release of sediment-bound phosphorus is enhanced by anoxic bottom conditions, phosphorus is also released from lake sediments to well aerated water more typical of shallow lakes. Holdren and Armstrong (1980) per Fricker (1981) quoted literature values of sediment phosphorus release rates from several lakes in the United States for aerobic (0 to 13 mg/m^2/day) and anaerobic conditions (0 to 50 [max. 150] mg P mg/m^2/day). Welch and Cooke (1995) reported very high internal loading rates (20-50 mg/m^2/d) in shallow lakes characterized by wind mixing/resuspension. Søndergaard et al. (1992) reported that the rate of phosphorus release from the undisturbed sediment of a shallow eutrophic Danish lake during the summer was 4-12 mg/m^2/day. This rate increased to 150 mg/m^2/day during simulated resuspension events. Phillips et al. (1994) recorded sediment phosphorus release rates as high as 278 mg/m^2/d, in very shallow lakes in the United Kingdom.

The level of phosphorus concentrations in the water column influences the length of time that phosphorus is released from the sediment. Søndergaard et al. (1999) found that in shallow eutrophic Danish lakes, with total phosphorus concentrations below 0.100 mg/l, phosphorus was retained in lake sediments for most of the year, except July and August when mean internal loading accounted for 10-30% of external loading. In lakes with total phosphorus above 0.100 mg/l, phosphorus was retained in lake sediments during the winter but released from April to September.

Experience gained in various lake restoration projects suggests that the history of accelerated eutrophication, that is, the length of time the lake has been eutrophied, has an important bearing on lake behavior with respect to internal loading and phosphorus retention in the sediments. Sediments remain oligotrophic and only become gradually eutrophic, long after the water mass becomes highly eutrophic (Schindler *et al*). Conversely, the highly eutrophic sediment would remain eutrophic long after the external load is reduced and would thus delay the recovery of the lake. In some shallow highly eutrophied lakes with a long history with eutrophication (Ryding and Forsberg, 1976), 22 to 400% of the external phosphorus load was released from the sediments after reduction of the external load.

The contribution of internal loading to the total phosphorus load has been quantified in several studies. Keyes Associates et al. (1982) reported that the sediment was the major source of phosphorus to Gorton Pond located in Warwick, contributing 54% of the phosphorus load. In 14 of 17 Washington lakes, where phosphorus budgets were available and internal loading was measurable, internal loading averaged 68% of the total phosphorus loading during the summer (Welch and Jacoby, 2001). Internal phosphorus loads accounted for between 56 and 66% of the total phosphorus load to Spring Lake in southwestern Michigan (Steinman and Rediske, 2003).

Indirect evidence also indicates that the release of sediment phosphorus is also a significant source in other shallow ponds located in the State of Rhode Island (RIDEM, 2007). These shallow urban ponds, showed significant increases in water column total phosphorus from the spring to the summer. Urban runoff, the main source of external phosphorus to most of the lakes, is typically highest in the spring and lowest in the summer. If internal cycling was not a significant source of phosphorus to the urban ponds, one would expect the total phosphorus concentrations to drop in the summer. Therefore the increase of lake total phosphorus during summer is an indirect indication that internal cycling is a significant source of phosphorus to the lake. Søndergaard et al. (1999) measured the seasonal phosphorus concentrations of 265 shallow, mainly eutrophic Danish lakes and found that total phosphorus concentrations during summer were two to four times higher than winter values in lakes with a mean summer total phosphorus concentration above 0.200mg/l.

There is no conclusive evidence to indicate that phosphorus is released from the sediment in Belleville Ponds. Although total phosphorus concentrations are highest in the summer, they are also relatively high in the spring. Elevated concentrations in the spring may be due to increased productivity at the Lafayette Trout Hatchery and may mask any increase in the summer due to internal cycling. Phosphorus concentrations may also be high in the spring because aquatic plants have not yet begun the uptake of phosphorus. It is also possible that phosphorus released from the hatchery may be absorbed by a large wetland complex associated with the Belleville Upper Pond Inlet, approximately 2 km upstream of Belleville Ponds. This phosphorus may be released from the wetlands in the summer months when the wetlands turn anoxic and may contribute to elevated phosphorus concentrations in the summer along with any potential release from the pond sediments themselves.

Phosphorus release from pond sediments may also be somewhat mitigated by uptake by rooted aquatic plants, which are found in the ponds in great abundance. The aquatic vegetation within the pond may be the important phosphorus sink, rather than the soil. Oxygen is present in a thin film around the roots of plants. This oxygen can lead to the oxidation of ferrous iron around the roots forming iron crusts. These crusts contain phosphorus in high quantities (Hupner and Dollan, 2003). Phosphorus may also be stored in the above-substrate portion of the aquatic macrophytes.

The importance of addressing internal phosphorus loading should be clear. The focus of this TMDL's implementation section is the control of identified sources of phosphorus discharged to these lakes. However, it must be understood that even if external loading is significantly reduced, little improvement may be seen in water quality for decades, because of continued internal loading. Even after wastewater treatment was installed reducing 80% of the external load to Shagawa Lake in Minneapolis, Minnesota, modeling indicates that it would take 80 years to achieve a 90% reduction in summer lake phosphorus, due to internal cycling (Chapra and Canale, RP.1991). Søndergaard et al. (1993) estimated that, even after an 80–90% reduction in external phosphorus loading to a shallow hypereutrophic Danish Lake, phosphorus would continue to be released from the sediment for approximately 20 years. One year after the drastic reduction in external phosphorus loading in 1982, net internal phosphorus loading was 8 $g/m^2/y$. This rate decreased slowly to 2 $g/m^2/y$ in 1990, 15 years after the reduction in external phosphorus loading. Therefore the more immediate achievement of water quality improvements may also entail use of in-lake management techniques to control the internal cycling of phosphorus.

5.0 TMDL ANALYSIS

As described in EPA guidelines, a TMDL identifies the pollutant loading that a waterbody can assimilate per unit of time without violating water quality standards (40 C.F.R. 130.2). The TMDL is often defined as the sum of loads allocated to point sources (i.e. waste load allocation, WLA), loads allocated to nonpoint sources, including natural background sources (i.e. load allocation, LA), and a margin of safety (MOS). The loadings are required to be expressed as mass per time, toxicity, or other appropriate measures (40 C.F.R. 130.2[I]).

5.1 Margin of Safety (MOS)

The MOS may be incorporated into the TMDL in two ways. One can implicitly incorporate the MOS using conservative assumptions to develop the allocations or explicitly allocate a portion of the TMDL as the MOS . This TMDL uses the latter approach of allocating an additional 10 percent reduction in allowable total phosphorus loading as an adequate MOS.

5.2 Critical Conditions and Seasonal Variation

Critical conditions for phosphorus occur during the growing season, which in most waterbodies occurs from May though October, when the frequency and occurrence of nuisance algal blooms, low dissolved oxygen, and macrophyte growth are usually greatest. Since this TMDL is based on information collected during the most environmentally sensitive period (i.e., the growing season) and was developed to be protective of this critical time period, it will also be protective of water quality during all other seasons.

5.3 Numeric Water Quality Target

The primary goal of this Total Phosphorus TMDL is to address the water quality impairments in Belleville Ponds and the Belleville Upper Pond Inlet. Belleville Ponds are dominated by both submergent and emergent aquatic vegetation. An extremely dense growth of submergent vegetation covers the entire lake bottom. The near-shoreline is dominated by common reed (*Phragmites australis*). Inspection of aerial photographs, from 1970 to 2008, shows that significant areas of the ponds that were formerly open water have been transformed to marsh. This sedimentation is especially evident at the northern and western ends of the upper basin of Belleville Ponds. Although some sedimentation can be expected over time in any lake basin, it appears that rate of sedimentation of Belleville Ponds far exceeds that which would be expected from natural processes. In addition to total phosphorus, Belleville Ponds are on the 2008 303(d) List for non-native aquatic plants, including fanwort, variable milfoil, and water chestnut. Although chlorophyll-a is not listed as an Observed Effect on the 2008 303(d) List, there are periods as evidenced by the Watershed Watch data, when the chlorophyll-a levels in Belleville Ponds are elevated. As previously discussed in section 1.2, the Belleville Upper Pond Inlet is on the draft 2010 303(d) List because average phosphorus concentrations in this tributary have caused an exceedance of the phosphorus criteria at the point where the tributary enters Belleville Ponds in violation of Section 8.D.

Reducing phosphorus is the most effective way to reduce densities of aquatic vegetation and to reduce algal abundance, because the growth of aquatic plants and algae in freshwater environments is typically constrained by the availability of phosphorus. The presence of nuisance aquatic vegetation and algal blooms diminishes the value of the ponds for virtually all uses and may potentially foster hypoxic conditions in the bottom waters of the ponds during the summer months. Recreational use is made less appealing, aesthetic enjoyment is impaired, and habitat value is reduced. To support these designated uses, reducing total phosphorus to the criterion concentration will reduce densities of nuisance aquatic vegetation and will also reduce the frequency and duration that the chlorophyll levels are above a nuisance level of 0.009 mg/l. Additional in-lake controls will likely be needed to manage the non-native nuisance vegetation, since high densities of non-native species may persist even at lower in-pond phosphorus concentrations.

With algal and aquatic weed densities under control, the variability in dissolved oxygen levels (high daytime values, low nighttime values, and depressed oxygen levels following bloom crashes) will be reduced. As previously discussed, the natural process of density stratification due to a vertical temperature gradient can produce low dissolved oxygen concentrations even in shallow lakes and ponds. Low DO conditions are most likely to occur during stagnant weather patterns during the summer months. The current Rhode Island water quality criteria for warm water fish habitat are an instantaneous DO concentration of at least 5.0 mg/L at any point in the water column except as naturally occurs and a 7-day mean water column concentration of at least 6.0 mg/L.

RIDEM has set a total phosphorus concentration of 0.025 mg/l as the numeric target for Belleville Ponds. For Belleville Upper Pond Inlet, Total Phosphorus concentrations must not cause an exceedance of the 0.025 mg/l criteria in the pond at its point of entry and during the critical condition of 7Q10 flow when the hatchery discharge comprises all of the stream’s flow. These numerical and narrative targets are consistent with the State’s water quality criteria for total phosphorus. Compliance points of shallow ponds such as Belleville Ponds are based on historic surface sampling stations.

The objective of this TMDL is to restore Belleville Ponds to a condition that supports their designated uses and protects them from future degradation. In summary, the goals of this TMDL are to:

- Reduce total phosphorus levels in the ponds to an average level of 0.025 mg/L;
- Reduce total phosphorus levels in the Belleville Upper Pond Inlet such that they do not cause an exceedance of the 0.025 mg/L criteria at the point that the tributary enters Belleville Ponds;
- Reduce nuisance densities of both native and non-native aquatic plants in Belleville Ponds;
- Reduce algal abundance in Belleville Ponds to levels consistent with designated uses, by reducing the frequency and duration of chlorophyll-a levels exceeding 0.009 mg/L;

5.4 Existing Load To the Upper Basin of Belleville Ponds

5.4.1 Reckhow Model Estimate

The existing load was calculated for the upper basin of Belleville Ponds alone, rather than for the combined basins, since the mean phosphorus concentration of the upper basin of Belleville Ponds (0.037 mg/l) was significantly higher than the mean phosphorus concentration of the lower basin (0.023 mg/l). Therefore calculating necessary load reductions, based on the existing loads to the upper basin will assure that the upper basin will meet state criteria for phosphorus (0.025 mg/l), which is already the case for the lower basin.

The current annual mean phosphorus load to the upper basin of Belleville Ponds was based on the average TP concentration and areal water loading (see below equation) using the Reckhow model (1979). The Reckhow model was developed from a database of lakes within a north temperate setting, thereby making it applicable for waterbodies within southern New England. The Reckhow model expresses phosphorus concentration (TP in mg/l) as a function of phosphorus loading (L, in g/m^2-yr), areal water loading (q_s, in m/yr), and apparent phosphorus settling velocity (v_s, in m/yr) in the form:

$$\mathbf{TP = L/(v_s + q_s)}$$

Using a least squares regression, it was found that the apparent settling velocity could be fit using a weak function of q_s. This resulted in the fitted model:

$TP = L/(11.6 + 1.2q_s)$
Where:
L = Existing Load; and
q_s = Areal Water Load.

The existing annual load (*L*) was calculated by substituting the observed total phosphorus concentration, averaged over the sampling period, into the Reckhow equation. The mean annual total phosphorus concentration was derived from URIWW data. The last five years of available URIWW data (2003-2007) was used. Generally three total phosphorus measurements were taken each year, typically in May, July, and October/November.

The estimation of Areal Water Load (q_s) was calculated in the following manner:

$q_s = Q/Ao$
Where:
Q = Inflow Water Volume; and
A_o = Lake Surface Area.

$Q = (A_d \times r) + (A_o \times Pr)$

Where:
q_s = Areal water loading (m/yr);
Q = Inflow water volume (m^3/yr);
A_d = Watershed area (m^2);
A_o = Waterbody surface area (m^2);
r = total annual unit runoff (m/yr); and
P_r = mean annual net precipitation (m/yr).

Ideally, Q should be determined from direct measurement of inflow or outflow. Since data for Q are not available, it was estimated by regressing mean annual inflows, based on long-term records of gauged streams in Rhode Island against drainage area. This resulted in a value of 2.0 cfs per square mile, which was converted into the value Q in m^3/yr. There is a subwatershed in the Belleville Ponds area that discharges directly to both the upper and lower basins of Belleville Ponds. Based on two sets of flow measurements, approximately one half of the flow from the Himes Brook watershed discharges to the upper basin, and the remaining half discharges to the lower basin. Accordingly, to estimate the mean annual inflow (Q) to the upper basin of Belleville Ponds, one half of the subwatershed area was assigned to the subwatershed that discharges exclusively to the upper basin. The estimated annual inflow (Q) was then divided by the waterbody surface area (A_o) in order to obtain a value of q_s for the waterbody.

The estimated mean annual inflow, the mean phosphorus concentration, and the current total phosphorus load to the upper basin of Belleville Ponds is summarized in Table 5.1. The estimated mean annual inflow to the upper basin of Belleville Ponds was 6.26 cfs (5.59×10^6 m^3/yr). The mean annual phosphorus concentration for the upper basin of Belleville Ponds was 0.037 mg/l. The annual total phosphorus load to Belleville Ponds was 417 kg/yr.

Table 5.1 Summary of estimated current total phosphorus loads, mean total phosphorus concentrations, and mean annual inflows to the upper basin of Belleville Ponds.

Watershed Area (ha)	Estimated Mean Annual Inflow (m^3/yr)	Mean Annual Total Phosphorus Concentration (mg/l)	Current Load (kg/yr)
810	5.59 x 10^6	0.037	417

5.4.2 AVGWLF Model Estimate

The AVGWLF model was used to quantify and categorize non-point nutrient sources within the watershed of the upper basin of Belleville Ponds. The main reason for running the AVGWLF model was to compare loading estimates with those predicted by the Reckhow model. The Reckhow model, not the AVGWLF model, was used for all loading calculations utilized in this study, including the calculations for the necessary reductions to meet State criteria. The AVGWLF model utilizes GIS software and has been endorsed by EPA as a good mid-level model with the capacity to simulate most mechanisms controlling nutrient fluxes within a watershed. The model uses daily weather data and a soil layer to simulate runoff. Sediment and nutrient loads are simulated according to runoff and land use. The AVGWLF predicts runoff, erosion, and sediment yields; subsurface and surface nutrient loads are also calculated. As discussed in the previous section, approximately half of the flow from the Himes Brook watershed discharges into the upper basin of Belleville Ponds. The AVGWLF model was run for both the watershed that drains exclusively to the upper basin and for the Himes brook watershed (Figure 5.1 shows land use patterns within both subwatersheds). Accordingly half of the load from the Himes Brook watershed was added to the exclusive upper basin watershed to estimate the load for the upper basin of Belleville Ponds. The estimated load was 208 kg/yr. This estimation does not include the load from the Lafayette Trout hatchery (212 kg/yr), discussed in the section below. The total phosphorus load, to the upper basin of Belleville Ponds, predicted by the AVGWLF model, was 420 kg/yr compared to 417 kg/yr predicted by the Reckhow Model. The fact that the current load predicted by the AVGWLF model is almost identical to the load predicted by the Reckhow model, lends credence to the accuracy of both models in this case. A summary of results of the AVGWLF, and estimated loads from individual land uses are shown in Tables 5.2 and 5.3.

5.5 Existing Loads from Lafayette Trout Hatchery

As previously discussed in section 4.2, the Lafayette Trout Hatchery is the only point source within the Belleville Ponds watershed for which there is effluent data available. The mean daily flow from the facility, from September 2006 to June 2009, was 1.82 MGD. Total phosphorus concentrations ranged from 0.027-0.460 mg/l. The loading rate was calculated by multiplying the mean effluent concentration (0.084 mg/l) by the average flow rate (1.82 MGD). The mean annual load from the Lafayette Trout Hatchery was 212 kg/yr, which comprises 51% of the total current load to the upper basin of Belleville Ponds.

Currently there is no effluent-based limit on total phosphorus required of the hatchery as there are for some other pollutants such as TSS. With respect to total phosphorus, only monitoring of the hatchery discharge is currently required. The RIPDES permit requires that phosphorus be sampled monthly from April through September and quarterly from October through March.

It is possible that actual loads from the hatchery are significantly higher than estimated above, dependent upon whether the improved raceway cleaning practices are consistently followed and upon the timing of the sampling in relation to raceway cleaning and if waste is flushed into the Brook.

Figure 5.1. Land Use within the Watershed of the Upper Basin of Belleville Ponds.

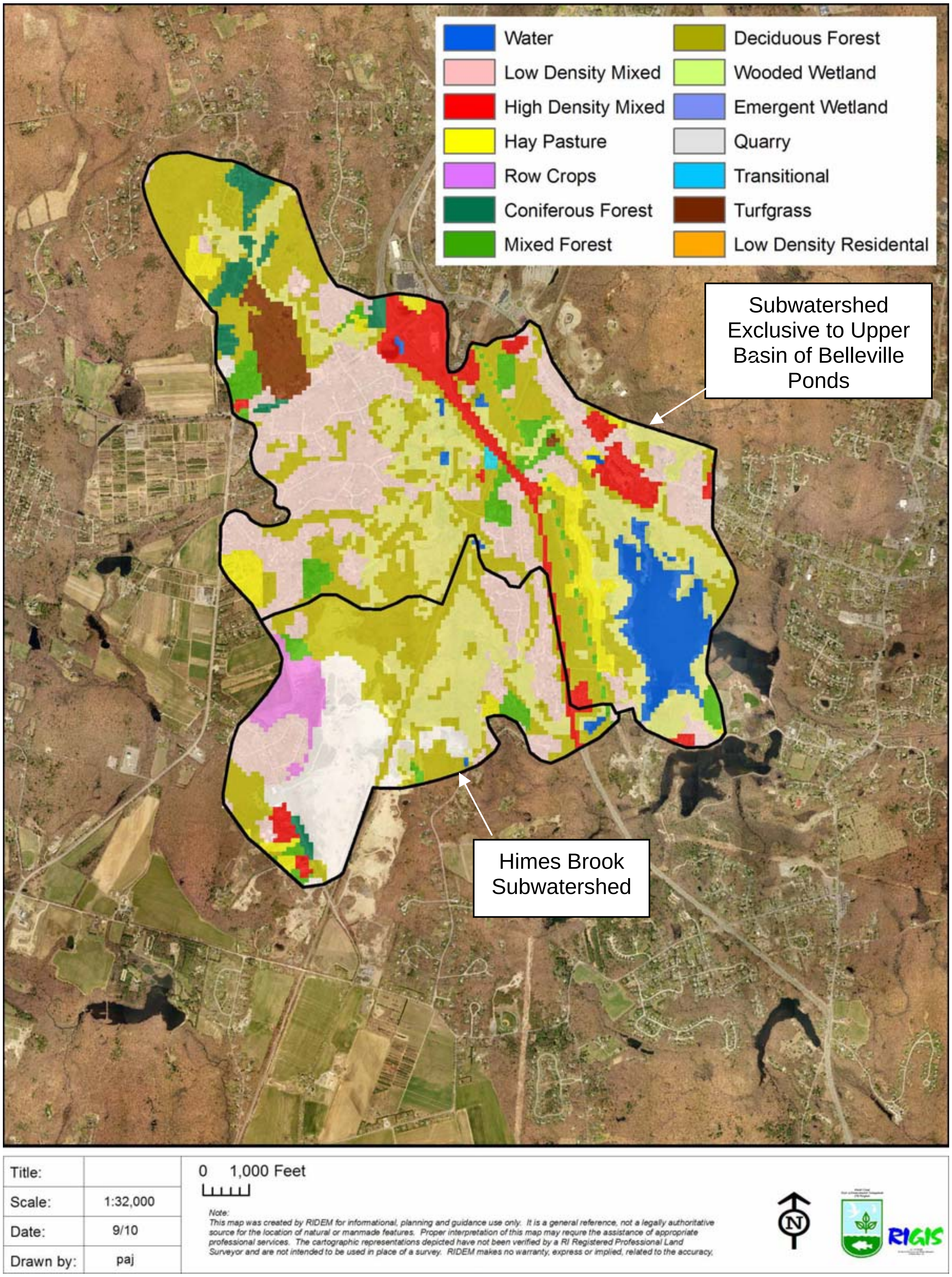


Table 5.2 AVGWLF Predicted Existing Loads from the Watershed Exclusive to the Upper Basin of Belleville Ponds

Source	Area (Ha)	Total Phosphorus Load (Kg/yr)
Hay/Pasture	32	4.6
Forest	251	0.9
Wetland	128	1.3
Quarry	2	0.0
Turf Grass	22	0.6
Transition	1	1.0
Low-Intensity Development	168	16.5
High-Intensity Development	56	42.8
Stream Bank Erosion		3.1
Groundwater		77.3
Total	**660**	**148.2**

Table 5.3 AVGWLF Predicted Existing Loads from the Himes Brook Watershed

Source	Area (Ha)	Total Phosphorus Load (Kg/yr)
Hay/Pasture	4	0.1
Cropland	17	9.8
Forest	98	0.4
Wetland	54	0.6
Quarry	67	1.3
Low-Intensity Development	53	5.2
High-Intensity Development	7	5.4
Stream Bank Erosion		0.3
Groundwater		36.8
Total	**300**	**59.7**

It is also likely that current effluent loads underestimate the historic sediment load discharged to the Belleville Upper Pond Inlet system (wetlands and surface water bodies) during cleaning operations at the hatchery. It is expected that these historically released solids have, at least in part, settled in the wetlands and pond bottoms, and that these sediments under certain environmental conditions, release phosphorus to the water column. Given that the predominant land use in the watershed is forest and wetland, it is likely that a significant portion of the load ascribed to the non-point load allocation is ultimately derived from the historic release of solids from the hatchery.

In addition to Belleville Ponds, there is concern about the ability of the wetland complex, located downstream of the hatchery and to the immediate west of Route 4, to assimilate the phosphorus load from the hatchery without negative impacts upon the wetland. Richardson and Qian (1999) performed a statistical analysis of the North American Wetland Database (NAWDB) and developed a mass loading model to separate Phosphorus Assimilative Capacity or PAC (defined as P absorption with no significant ecosystem change and no elevated P output) from storage capacity (maximum storage in wetlands). Richardson and Qian determined that the average PAC in North American wetlands is approximately

1 g/m^{2}·yr. The flooded portion of wetland complex downstream of the hatchery, which is most likely to be impacted by hatchery discharge, is approximately 15.63 hectares in area. Based on the mean PAC and this wetland area, the wetland complex is able to assimilate 157 kg/yr, without a significant ecosystem change. This figure is significantly less than the existing load from hatchery operations of 212 kg/yr. If the entire load from the hatchery spreads out over the entire flooded area of the wetlands, it is likely that there is a significant negative impact on the wetlands downstream.

5.6 Existing Stormwater Point Source and Non-point Source Loads

The existing load attributable to the hatchery based on historic effluent monitoring (212 kg/yr) was subtracted from the total current load predicted by the Reckhow Model (417 kg/yr) to determine the portion of the load attributable to other pollution sources (205 kg/yr). The point source stormwater load and non-point source load were determined using the estimate of percent of impervious area within the watershed. The values of percent impervious cover, assigned to each separate land use, were taken from a study conducted by the Center for Watershed Protection (CWP). Percent impervious area within each of the land use categories was multiplied by the corresponding percent of each land use category within the watershed in order to calculate a percent impervious value (Table 5.4). The percent impervious area within the watershed of the upper basin of the Belleville Ponds is 15%. This 15% impervious area was used to parse out the stormwater point source and nonpoint source portions of the load (Table 5.5)

Table 5.4 Impervious cover (%) for land uses within the Belleville Pond Watershed.[1]

Land Use Category	Impervious cover (%)
High density residential	55
Medium density residential	36
Low density- rural residential	22
Commercial	85
Mixed urban- other urban	46
Agriculture	2
Forest, wetland, water	0

1. Data taken from URI NEMO Program and the Center for Watershed Protection.

Table 5.5 Current Phosphorus Loads for Belleville Ponds.

Percent Impervious Area in Watershed	Total Current Load (kg/yr)	Non-Stormwater (Hatchery) Point Source Current Load (kg/yr)	Stormwater Point Source Current Load (kg/yr)	Nonpoint Source Load
15	417	212	31	174

In section 5.4.1, current loads were calculated from in-pond total phosphorus concentrations using the Reckhow model. Allowable loadings (TMDLs) were back-calculated using the Reckhow model and the 25 mg/l numeric water quality target as the load (L). A ten percent margin of safety was then subtracted from this value to determine the Target Load for the waterbody. The necessary load reductions are calculated as follows:

Percent Reduction (%) = [(Current Load – Target Load)/ Current Load] x 100

The allowable phosphorus load, required load reduction in kg/yr and the percent reduction in load for the upper basin of Belleville Ponds is presented below in Table 5.6.

The allowable pollutant load, or TMDL for the pond can be expressed as follows (EPA, 2002):

TMDL = WLAS + WLANS + LA + MOS

Where:

TMDL = Allowable Pollutant Load
WLAS = Waste Load Allocation (Stormwater)
WLANS= Waste Load Allocation (Non-Stormwater)
LA = Load Allocation, and
MOS = 10% Margin of Safety.

Table 5.6 Loading Capacity and Allocation of Allowable Loading

Current Load (kg/yr)	TMDL * (kg/yr)	Required Load Reduction (kg/yr)	Required Loading Reduction (% Present Value)
417	254	163	39

*Includes a 10% Margin of Safety.

As shown in Table 5.6, the existing total phosphorus load to the upper basin of Belleville Ponds must be reduced by 39%, from 417 to 254 kg/yr, to meet water quality standards within the upper basin. Rule 8 (D)(2)(Table 1) of Rhode Island's Water Quality Regulations requires that the average total phosphorus shall not exceed 0.025 mg/l in any lake, pond, kettlehole or reservoir, and the average total phosphorus in tributaries at the point where they enter such bodies of water shall not cause exceedance of this phosphorus criteria. Therefore, to ensure that the total phosphorus levels in tributaries that discharge into Bellville Pond do not cause an exceedance of this water quality criteria, the 0.025 mg/l criteria is applied to the tributaries, including the Belleville Upper Pond Inlet at the point where it enters the upper basin. The allowable phosphorus load for Belleville Ponds is inclusive of reductions needed to address Belleville Upper Pond Inlet's phosphorus impairment.

Since the Lafayette Trout Hatchery is the only permitted point source discharge into the Belleville Upper Pond Inlet, the allowable load assigned to the hatchery, must be protective of the water quality standards applied to the tributary at its point of entry into the upper basin of Belleville Ponds. In other words, the discharge from the Lafayette Trout Hatchery must not cause an exceedance of the 0.025 mg/l total phosphorus criteria for the Belleville Upper Pond Inlet under the most adverse conditions. Rule 8 (E)(1) of Rhode Island's Water Quality Regulations identifies the most adverse conditions for freshwater aquatic life criteria as not being exceeded at or above the lowest average 7 consecutive day low flow with an average recurrence frequency of once in 10 years (7Q10). It is evident that under 7Q10 conditions, the Belleville Upper Pond Inlet not only is an effluent-dominated stream, but that wastewater discharged from the hatchery effectively comprises all of the flow within the stream at the point where it enters the upper basin of Belleville Ponds. As previously discussed, the hatchery discharges approximately 1.8

MGD, consistently throughout the year. USGS staff measured flow in the Belleville Upper Pond Inlet at Lafayette Road in September and October 1996, and discharge was 0.75 and 0.88 MGD, respectively. Since wastewater discharge from the hatchery accounts for all streamflow at the Belleville Upper Pond Inlet during 7Q10 conditions, the allowable load assigned to the hatchery must be based on an effluent concentration that is set to the total phosphorus water quality criteria concentration of 0.025 mg/l. Based on the criteria concentration of 0.025 mg/l and the permitted discharge of 2.5 MGD, the allowable load for the Lafayette Trout Hatchery is set to 86 kg/yr.

The hatchery allocation of 86 kg/yr was then subtracted from the TMDL of 254 kg/yr to determine the allocation for other point and non-point sources in the watershed. The allocation of loads between stormwater WLAs (point sources) and LAs (non-point sources) was established according to estimates of percent impervious and pervious land cover. As previously discussed, the percent impervious area within the watershed of the upper basin of the Belleville Ponds is 15%. This separation between stormwater WLAs and LAs based on impervious area within land use categories represents the best estimate defined as narrowly as the data allow. If a significant portion of the load is due to birds and internal cycling, this methodology of allocating between WLA and LA will over estimate the portion of the total load assigned to point sources. The stormwater portion of the waste load allocation is 25 kg/yr and the load allocation is 143 kg/yr (Table 5.7). A zero load allocation is given to the sand and gravel mining operation, operated by Dry Bridge Sand and Stone Inc. located off Dry Bridge Road, at the western end of the watershed.

Table 5.7 Allocation of Phosphorus Loads for Belleville Ponds.

TMDL[1, 2] (kg/yr)	WLA Non-stormwater (kg/yr)	WLA Stormwater (kg/yr)	LA (kg/yr)
254	86	25	143

Allowable loads (TMDL) are rounded to the nearest whole number and include a 10% explicit Margin of Safety.
The daily load is the annual load divided by 365.

6.0 IMPLEMENTATION

The major sources of phosphorus to Belleville Ponds are discharge from the Lafayette Trout Hatchery, stormwater, waterfowl, and other nonpoint sources of pollution including internal cycling from the decay of aquatic plants or from lake sediments and the release of phosphorus from the wetlands down gradient of the hatchery. Eliminating the phosphorus impairment to Belleville Ponds will likely require a reduction in both external and internal sources of phosphorus. Recommended implementation activities for Belleville Ponds are detailed in the following sections. These implementation activities focus primarily on the control of discharge from the Lafayette Trout Hatchery, the control of stormwater runoff, internal cycling/aquatic weed harvesting and to a lesser extent on the control of loadings from waterfowl and other non point sources.

In addition to implementation of BMPs and /or other treatment technologies at the hatchery, achieving standards requires that both the volume of storm water and its phosphorus concentration be reduced. The implementation of Phase II Stormwater Management Program Plans (SWMPP) including construction of stormwater BMPs at selected locations is expected to, in time, help reduce the nutrient impairment to Belleville Ponds. However, control of external sources of phosphorus may not produce immediate or expected water quality benefits unless internal loading is also addressed in a timely fashion.

Monitoring of the Belleville Ponds should continue so that the effectiveness of ongoing remedial activities can be gauged. Continuing monitoring efforts by University of Rhode Island Watershed Watch volunteers will help track water quality trends, and monitoring by RIDEM Division Fish and Wildlife as part of their RIPDES permit will evaluate pollution control efforts at the hatchery.

DEM will continue to respond to environmental complaints, conduct inspections, and issue RIPDES permits as part of its responsibilities under state and federal laws and regulations. As resources allow, RIDEM will continue to work with RIDOT, the Town of North Kingstown and any watershed groups to identify funding sources and evaluate locations and designs for stormwater control BMPs throughout the watershed.

6.1 Storm Water Management

6.1.1 Phase II – Six Minimum Measures

Although impervious area makes up only 15% of the Belleville Ponds watershed, stormwater is probably a significant source of wet weather impairments to the pond. Significant stormwater is generated from residential areas within the Town of North Kingstown and from RIDOT-owned roadways.

The Town North Kingstown and the RI Dept. of Transportation operate small Municipal Separate Storm Sewer Systems (MS4s) that discharge to the tributaries of Belleville Ponds. RIDEM's RIPDES program regulates stormwater from RIDOT-owned stormwater drainage systems under permit no. RIR040036. The RIPDES program regulates stormwater associated with the Town of North Kingstown's stormwater drainage systems under permit RIR040028. RIDOT and the Town of North Kingstown have applied for and obtained coverage under the RIPDES General Permit and have developed and submitted the required Storm Water Management Program Plans (SWMPPs). The plans contain implementation schedules that include interim milestones, frequency of activities and reporting of results. The SWMPPs describe BMPs for the six minimum measures and include measurable goals and schedules for each measure:

- A public education and outreach program to inform the public about the impacts of stormwater on surface water bodies,

- A public involvement/participation program,
- An illicit discharge detection and elimination program,
- A construction site storm water runoff control program for sites disturbing 1 or more acres,
- A post construction storm water runoff control program for new development and redevelopment sites disturbing 1 or more acres, and
- A municipal pollution prevention/good housekeeping operation and maintenance program.

Storm sewers and ditches associated with stormwater runoff frequently have multiple interconnections between MS4s. DEM encourages cooperation between operators of MS4s (including RIDOT) in developing and implementing the six minimum measures and constructing Best Management Practices throughout the drainage area contributing to a discharge, by the way of inter-agency agreements. Communities affected by the Phase II program are encouraged to cooperate on any portion of, or an entire minimum measure when developing and implementing their stormwater programs.

Post-construction storm water management in areas undergoing new development or redevelopment is necessary because runoff from these areas has been shown to significantly effect receiving waterbodies. To meet the requirements of the Phase II minimum control measure relating to Post Construction Runoff Control, the operator of a regulated small MS4 will need to at a minimum:

- Develop and implement strategies which include a combination of structural and/or nonstructural BMPs;
- Develop an ordinance or other regulatory mechanism requiring the implementation of post-construction runoff controls to the extent allowable under State or local law;
- Ensure adequate long-term operation and maintenance of controls;
- Determine appropriate best management practices (BMPs) and measurable goals for this minimum control measure.

6.1.2 Required Amendments to Phase II Stormwater Management Program Plans

Part IV.D of the General Permit states that the operator must address the TMDL provisions in the SWMPP if a TMDL has been approved for any waterbody into which storm water discharges from the MS4 contribute directly or indirectly the pollutants(s) of concern (Part II.C3).
Accordingly, upon notification by RIDEM of US EPA approval of the TMDL, the RIDOT and Town of North Kingstown are required to amend their Storm Water Management Program Plans (SWMPPs) to address the TMDL provisions as required by Rule 31 (f)(8)(iii) of the Rhode Island Pollutant Discharge Elimination System (RIPDES) Regulations. The DEM is in the process of re-issuing the Rhode Island Pollutant Discharge Elimination System (RIPDES) General Permit for Storm Water Discharge from Small Municipal Separate Storm Sewer Systems (MS4 GP). It is anticipated that the MS4 GP will be effective by January 2011 and will establish a deadline (e.g. 90 days from effective date of permit) for the MS4s to submit a new SWMPPP for the next 5 year permit term. Therefore, the RIDOT and the Town will be allowed to submit the required SWMPP amendments and the proposed TMDL Implementation Plans at the same time it submits the SWMPP required by the re-issued MS4 GP.

More specifically, the SWMPPs must be revised to describe the six minimum measures and other additional controls that are or will be implemented to address the phosphorus-related impairments including any specific provisions described herein. The operators must provide measurable goals for the development and/or implementation of the six minimum measures and additional structural and non-structural BMPs that will be necessary to address provisions for the control of storm water identified in this TMDL including an implementation schedule, which includes all major milestone deadlines including the start and finish calendar dates, the estimated costs and proposed or actual funding sources, and the anticipated improvement(s) to water quality. If no structural BMPs are recommended, the operator must evaluate whether the six minimum measures alone (including any revisions to ordinances) are sufficient to meet the TMDL's specified pollutant reduction targets. The revised SWMPP must specifically address the following:

1. Determine the land areas contributing to the discharges identified in TMDL using sub-watershed boundaries as determined from USGS topographic maps or other appropriate means;

2. Address all contributing areas and the impacts identified by the Department;

3. Assess the six minimum control measure BMPs and additional controls currently being implemented or that will be implemented in the SWMPP and describe the rationale for the selection of controls including the location of the discharge(s), receiving waters, water quality classification and other relevant information;

4. Identify and provide tabular description of the discharges identified in the TMDL including:

    - the location of discharge (latitude/longitude and street or other landmark;
    - size and type of conveyance (e.g. 15" diameter concrete pipe);
    - any existing discharge data (flow data and water quality monitoring data);
    - impairment of concern and any suspected sources(s);
    - interconnections with other MS4s within the system;
    - TMDL provisions specific to the discharge;
    - any BMP(s) that have or will be implemented to address TMDL provisions and phosphorus-related impairments;
    - schedule for construction of structural BMPs including those for which a Scope of Work (SOW) is to be prepared, as described below.

Among the six minimum measures described earlier is the requirement for operators to establish post construction storm water runoff control programs for new land development and redevelopment sites disturbing one or more acres. Given the relatively rural nature of the watershed and potential for expanded urban development, it is imperative that land development and re-development projects utilize best management practices if Belleville Pond is to be successfully restored. To ensure consistency with the goals and recommendations of the TMDL, the revised SWMPP must also address revisions to the local ordinances to ensure that:

- new land development employ stormwater controls to prevent any net increase in phosphorus and;

- redevelopment projects employ stormwater controls to reduce phosphorus to the maximum extent feasible.

This TMDL has determined that structural BMPs are necessary, therefore all operators of MS4s identified herein must also prepare and submit a Scope of Work describing the process and rationale that will be used to select BMPs and measurable goals to ensure that the TMDL provisions will be met. The Scope of Work must also be accompanied with a schedule prioritizing outfalls for the construction of structural stormwater BMPs. A targeted approach to construction of stormwater retrofit best management practices (BMPs) at state and locally-owned stormwater outfalls is recommended. Priority outfalls have been identified in section 4.3. Operators of MS4s must work to identify other outfalls that contribute the greatest pollutants loads and prioritize these for BMP construction, as detailed in the following sections.

The Scope of Work must:

Describe the tasks necessary to design and construct BMPs that reduce loads of phosphorus and stormwater volumes to the maximum extent feasible consistent with pollution reduction targets specified in the TMDL including:

- the delineation of the drainage or catchment area,

- determination of interconnnections within the system and the approximate percentage of contributing area served by each operator’s drainage system, as well as a description of efforts to cooperate with owners of the interconnected system, and

- completion of catchment area feasibility analyses to determine drainage flow patterns (surface runoff and pipe connectivity), groundwater recharge potentials(s), upland and end-of-pipe locations suitable for siting BMPs throughout the catchment area, appropriate structural BMPs that address the pollutants(s) of concern, any environmental (severe slopes, soils, infiltration rates, depth to groundwater, wetlands or other sensitive resources, bedrock) and other siting (e.g. utilities, water supply wells, etc.) constraints, permitting requirements or restrictions, potential costs, preliminary and final engineering requirements.

- Establish a schedule to identify and assess all remaining discharges not identified in the TMDL (owned by the operator) contributing to the impaired waters addressed by the TMDL, to delineate the drainage or catchment areas to these discharges, and as needed to address water quality impairments, to design and construct structural BMPS. To determine the prioritization for BMP construction, the assessment of identified discharges shall determine the relative contribution of phosphorus taking into consideration pollutant loads (i.e. concentrations and flows) as indicated by drainage area, pipe size, land use, known hot spots and/or sampling data.

6.1.3 Specific Storm Water Measures

To realize water quality improvements in Belleville Ponds, both phosphorus concentrations in storm water and the volume of storm water discharged to the ponds must be reduced. The impervious area within the watershed contributes substantial increases in the amount of runoff and phosphorus entering the ponds during and immediately after rain events. As the amount of impervious area in a watershed increases, the peak runoff rates and runoff volumes generated by a storm increases because developed lands have lost much or all of their natural capacity to delay, store, and infiltrate water. As a result, phosphorus from streets, lawns, wildlife, and domestic pets quickly wash off during storm events and discharge into the nearby waterbodies. In some cases increased runoff rates also result in the transport of eroded phosphorus-rich sediment and organic matter such as leaf litter.

While the Town of North Kingstown and RIDOT must implement the Phase II minimum measures town-wide, they should prioritize implementation of Phase II minimum measures in the Belleville Ponds watershed and should target the construction of stormwater BMPs for priority outfalls, identified in section 4.3. Addressing priority outfalls would of course first entail the identification of each of the catchments associated with each of these outfalls. Illicit discharge detection and elimination, required by the General Permit, should focus on the outfalls that discharge to tributaries of Belleville Ponds or wetlands that have a surface hydrologic connection to the pond.

The Town of North Kingstown and RIDOT should conduct BMP feasibility studies to identify locations and technologies for installing infiltration basins or equivalent BMPs in these priority catchments. These studies should evaluate the feasibility of distributing infiltration throughout the drainage area of priority outfalls as an alternative to end-of-pipe technologies. This concept is particularly important in developed areas where rain events increase the storm water flows and pollutant loads as a result of the large amount of impervious surfaces and there is a small amount of undeveloped land available for BMP construction. Water quality improvements identified through ongoing water quality monitoring may result in modifications to the schedule and/or the need for additional BMPs.

Five stormwater outfalls were identified as the most significant potential sources of stormwater-related phosphorus to Belleville Ponds (Table 4.1). These outfalls, in order of significance, are located at Beacon Drive (BeP-H) and near the intersection of Routes 4 and 102 (BeP-X, BeP-Y, BeP-Z, and BeP-AA) (Figure 4.1, Appendix A and Appendix B). As discussed in Section 6.1, the catchments associated with each of the priority outfalls must be identified and a feasibility study must be conducted to determine the types and locations of BMPs that will be most effective in reducing stormwater volumes and phosphorus loading to the pond to the maximum extent feasible. RIDEM recommends infiltration, filtration and/or retention BMPs throughout the identified subwatersheds to reduce runoff volume and phosphorus loading of stormwater reaching the pond, rather than end-of-pipe solutions.

A wide range of BMPs are available to control both the quality and quantity of urban storm water runoff entering receiving waters. BMPs should be incorporated into a comprehensive storm water management program. Without proper selection, design, construction, and maintenance, BMPs will not be effective in managing storm water runoff. There are a number of competing factors that must be addressed when selecting the appropriate BMP or suite of BMPs for an area. Site suitability and other factors are crucial in effective BMP selection. Several considerations for BMP selection include: drainage area, land uses, runoff volumes and flow rates, soil types, site slopes, water table elevation, land availability, susceptibility to freezing, community acceptance, maintenance accessibility, long-term maintenance needs, cost, and aesthetics. The combination of these factors make BMP selection difficult, requiring the involvement of an experienced storm water practitioner.

There are many opportunities to address both water quality and water quantity and tailor efforts to the local concerns in the SWMPP as further described in the following sections.

6.1.3.1 Public Education/Public Involvement

The public education program should focus on both water quality and water quantity concerns within the watershed. Public education material should target the particular audience being addressed. For example, the residential community should be educated about the water quality impacts from residential use and activities and the measures they can take to minimize and prevent these impacts. Examples include minimizing the adverse effects of lawn fertilizers (minimizing use, applying more frequent applications of smaller quantities of fertilizer if current overall quantities are to be maintained, and avoiding fertilizing immediately before anticipated storm events), disposing of pet waste properly, discouraging large waterfowl populations by eliminating human feeding of waterfowl and utilizing plantings and/or fencing adjacent to large tracts of open land near waterbodies where waterfowl congregate (see section 6.3), prohibiting illegal tie-ins to storm drains from failing septic systems or washing machines, and informing residents about disposing wastes improperly (i.e. discouraging the disposal of yard waste immediately adjacent to a tributary). Public involvement programs should actively involve the community in addressing these concerns. Involvement activities may include posting signs informing the public not to feed waterfowl, stenciling storm drains with Do Not Dump labels, and designating and maintaining areas with pet waste bags and containers. Lawn care companies should also be targeted in the case of fertilizer application, by providing educational brochures and/or classes.

The residential community should also be informed about water quantity impacts as a result of large areas of impervious surfaces and what measures they can take to minimize or help offset these impacts. Measures include the infiltration of roof runoff where feasible (green roofs, dry wells, and roof drains redirecting drainage to lawns and forested areas) and landscaping choices that allow runoff to be attenuated on-site thus minimizing runoff. Some examples of landscaping measures include grading the site to minimize runoff and to promote storm water attenuation and infiltration, the creation of rain gardens, reducing paved areas such as driveways, and use of porous driveways (cost effective options may include crushed shells or stone). Runoff can also be slowed by buffer strips and swales that add filtering capacity through vegetation. These examples can also be targeted to residential land developers and landscapers.

Other potential audiences include commercial property owners, land developers, and landscapers. BMPs that minimize runoff and promote infiltration should be encouraged when redeveloping or re-paving a site. Examples include minimizing road widths, porous pavement, infiltrating catch basins, breaking up large tracts/areas of impervious surfaces, sloping surfaces towards vegetated areas, and incorporating buffer strips and swales where possible.

6.1.3.2 Construction/Post Construction

As noted previously, the Town of North Kingstown must revise its post construction stormwater ordinance to require that new land development employ stormwater controls to prevent any net increase in phosphorus and that redevelopment projects employ stormwater controls to reduce phosphorus to the maximum extent feasible. Low Impact Development (LID) techniques provide an essential means to accomplish these objectives. The primary goal of LID is to reduce runoff and mimic the predevelopment site hydrology by using site planning and design strategies to store, infiltrate, evaporate, and detain runoff as close as possible to the point where precipitation reaches the ground. The revised RI Stormwater Design and Installation Manual (Public Review Draft, May 2009) provides guidance for stormwater management on new development and redevelopment projects and, most importantly, incorporates LID as the “industry standard” for all sites. Consistent with Rhode Island General Law, Section 45, Chapter 61.2, entitled “The Smart Development for a Cleaner Bay Act of 2007” (hereafter, the Bay Act of 2007), RIDEM and CRMC have amended the RI Stormwater Design and Installation Manual to a) maintain groundwater recharge to predevelopment levels; b) maintain post-development peak discharge rates to not exceed pre-development rates; and c) use LID techniques as the primary method of stormwater control to the maximum extent practicable.

As mentioned previously, examples of acceptable reduction measures include reducing impervious surfaces, sloping impervious surfaces to drain towards vegetated areas, using porous pavement, and installing infiltration catch basins where feasible. Other runoff reduction measures to consider are the establishment of buffer zones, vegetated drainage ways, use of cluster zoning, or conservation development or low impact development techniques, transfer of development rights, and overlay districts for sensitive areas.

6.1.3.3 Good Housekeeping/Pollution Prevention

The Storm Water General Permit (see Part IV.B.6.a.2 and Part IV.B.6.b.1) extends storm water volume reduction requirements to operator-owned facilities and infrastructure (RIDEM, 2003a). Similarly, municipal and state facilities could incorporate measures such as reducing impervious surfaces, sloping impervious surfaces to drain towards vegetated areas, incorporating buffer strips and swales, using porous pavement and infiltration catch basins where feasible. In addition, any new municipal construction project or retrofit should incorporate BMPs that reduce storm water and promote infiltration such as the before-mentioned measures: buffer strips, swales, vegetated drainage ways, infiltrating catch basins, porous roads etc.

As part of its Good Housekeeping/Pollution Prevention requirements, the Town of North Kingstown and RIDOT must investigate the feasibility of increased street sweeping and/or stormwater system maintenance to address sediments loads to Belleville Pond. Street sweeping in priority areas within the watershed must be conducted more frequently than the required once-annual schedule. These prioritized areas include catchments that are associated with priority outfalls listed in section 4.3 and also with those outfalls associated with flooding problems, blocked culverts, blocked catch basins and/or sediment deltas. For those outfalls having evidence of sediment deposition, Phase II plans must document that twice-annual street sweeping is sufficient to prevent further sediment accumulation and certify that there are no active eroding areas contributing to the sediment buildup. The Town of North Kingstown and RIDOT should also consider acquiring vacuum-assisted street sweeping trucks because of their increased efficiency in removing plant debris and soil. The Town of North Kingstown and RIDOT should also make efficient removal of debris and litter on streets a priority and tailor street sweeping activities accordingly. Catch basin and storm drain system cleaning is also an important activity in controlling phosphorus loads to Belleville Ponds, by preventing the accumulation of sediment that could hamper settling or cause flooding and erosion. Several culverts within the Belleville Ponds watershed were observed to be at least partially blocked with sediment. Sedimentation deltas were observed at other outfalls. Two areas of concentrated flow were observed to have caused erosion along the shoulder of a roadway. With the exception of a single outfall associated with a town road, all of these sediment-impacted culverts are associated with Routes 4 and 102. All culverts and areas of concentrated surface flow associated with sediment problems are listed in Table 6.1. These culverts need to be cleaned and properly maintained. Erosion control BMPs must also be installed at the outfall of the areas of concentrated flow listed below.

Table 6.1 Sediment Impacted Storm Water Culverts Within the Belleville Ponds Watershed.

Outfall/Surface Discharge ID	Culvert Diameter (in.)	Location	Comments	Ownership
BeP-I	12	Hatchery Rd. By-Pass	Mostly blocked with sediment	Town of North Kingstown
BeP-K	18	Route 4	Almost completely blocked with sediment	RIDOT
BeP-M	12	Route 4	Half blocked with sediment	RIDOT
BeP-O	18	Route 4	Half blocked with sediment	RIDOT
BeP-U	12	Route 4/102 Intersection	Sedimentation delta; mostly blocked with sediment	RIDOT
BeP-W	12	Route 4/102 Intersection	Sedimentation delta	RIDOT
BeP-X	24	Route 4/102 Intersection	Sedimentation delta	RIDOT
BeP-Y	24	Route 4/102 Intersection	Sedimentation delta	RIDOT
BeP-AB	18	Route 4/102 Intersection	Half blocked with sediment	RIDOT
BeP-AD	12	Route 4/102 Intersection	Almost completely blocked	RIDOT
BeP-AE	18	Route 4/102 Intersection	Almost completely blocked	RIDOT
BeP-5	NA	Route 4	Erosion causing rills on highway shoulder	RIDOT
BeP-6	NA	Route 4	Erosion causing rills on highway shoulder	RIDOT

6.2 Controls at the Lafayette Trout Hatchery

As previously discussed in section 5.7, the Lafayette Trout Hatchery was assigned a required load reduction of 126 kg/yr to achieve the criteria concentration of 0.025 mg/l at the point where the Belleville Upper Pond inlet discharges into the upper basin of Belleville Ponds. The existing load of 212 kg/yr must be reduced to 86 kg/yr. Table 1. 8.D.(2). of Rhode Island’s Water Quality Regulations require that phosphates be removed from existing discharges to the extent that such removal is or may become technically and reasonably feasible (RIDEM, 2009). A draft RIPDES permit renewal for Lafayette Trout Hatchery (Permit No. RI0110035), consistent with the recommendations of this TMDL, has been developed and was public noticed concurrent with the public comment period for the TMDL.

The raceway system at Lafayette Trout Hatchery consists of a series of two parallel raceways. Each of the raceways is divided into segments by the use of splashboards. Each segment has a sump associated with it and can be drained individually. The Division of Fish & Wildlife initiated a pilot study from July, 2006 through February, 2008. The pilot study was initiated to reduce the pollutant load discharged from the facility, including the phosphorus load. Prior to the pilot study, all waste cleaned from the bottom and sides of the raceways was flushed directly to the headwaters of the Belleville Upper Pond Inlet. The pilot study completely revised the method of raceway cleaning employed at the hatchery. The terminal 100 feet of both raceways are now permanently devoid of fish and are used as sedimentation basins (personal communication; Peter Angelone; Lafayette Trout Hatchery). The splashboards and screens of each segment of the raceways were cleaned on a daily basis. Prior to the cleaning, all flow was diverted into the adjacent runway so that suspended sediments were not flushed through the system during the cleaning. Next the sump valve was opened draining most of the water and waste into the terminal section of the raceway. The waste was then allowed to settle out in the terminal section of the raceway before flow was returned to the raceway. This procedure was then repeated for each segment of the raceways, except for the terminal segments being used as sedimentation basins. Once every two to four weeks flow was diverted from the terminal segment of the raceways and the accumulated waste in each of these segments was vacuumed out into a truck. The waste was then applied to agricultural fields offsite. Peter Angelone reported that 6 inches of waste, accumulated over a two- week period, was removed from the terminal segment of each raceway. Since each raceway measures 100 x 8 ft, approximately 800 ft^3 of waste was removed from the system during a two to four-week period. Since this waste was previously flushed directly to the headwaters of the Belleville Upper Pond Inlet, it is expected that the phosphorus load from the hatchery was greatly reduced due to these new cleaning procedures. Unfortunately the pilot study was curtailed because of staff reductions at the hatchery. Between March 2008 and April 2009, the cleaning frequency was reduced to approximately once every three months. From May 2009 to the present time (October 2009), the raceways have not been cleaned at all.

In addition to the new cleaning procedures, the Lafayette Trout Hatchery initiated a new fish diet and feeding regime. Starting March 1, 2007, a new low-phosphorus diet was initiated. The new feed contains 0.9% phosphorus vs. 1.1 % phosphorus for the existing feed (personal communication, Lafayette Trout Hatchery staff), an 18% reduction in phosphorus. A new feeding regime, involving more frequent feedings of smaller quantities of feed will also be introduced. It is believed that this new feeding regime has resulted in less wasted feed.

It is anticipated that the Hatchery will have to implement additional controls beyond the increased cleaning frequencies and revised feeding procedures to meet the required load reductions. Initial research by the DEM's Office of Water Resources indicates that total phosphorus levels on the order of 0.025 mg/l are achievable through the use of wastewater filters at trout hatcheries. Therefore, it is anticipated that the Hatchery will have to install wastewater treatment upgrades in order to meet the required load reductions. The DEM's RIPDES Program will work with the Hatchery, subsequent to issuance of a revised RIPDES permit, to ensure that the necessary treatment system improvements are made to meet the required load reductions.

6.3 Waterfowl Control

Although only small numbers of waterfowl were spotted during Belleville Ponds shoreline survey, it is likely that significantly numbers of waterfowl utilize the pond since it provides excellent waterfowl habitat. Most of the waterfowl probably congregate in the open waters of the pond or in the many isolated and densely vegetated coves that characterize the pond. The shoreline of Belleville pond is undeveloped and the only open area for large numbers of waterfowl to congregate on the shoreline is the public boat ramp on the southern side of Lower Belleville Pond. However, there was no waterfowl sign at this location. If there is future evidence of public feeding of birds either at the boat ramp or the trail system that skirts the eastern edge of the lower basin, then signage should be installed at these locations. Many of the bird-control strategies listed in this section may not be feasible or applicable along the shoreline of Belleville Ponds due to the pond's relatively remote location and natural setting. However, some of these techniques may be applied to other areas along tributaries to the pond. One such area is a mill pond surrounded by a maintained lawn area where waterfowl has been known to congregate. This small mill pond was formed by a dam across the Belleville Upper Pond Inlet and is located to the immediate east of Lafayette Road. A barrier, preferably a vegetative barrier, could be installed to block access to this waterbody.

There are many ways to discourage waterfowl and especially geese from settling adjacent to a nutrient impaired waterbody. No single technique to prevent the congregation of excessive numbers of nuisance waterfowl is universally effective and feasible in a suburban setting. Persistent application of a combination of methods is usually necessary and yields the best results. Some methods for controlling goose populations include the following: discontinuing feeding, modifying habitat, installing fencing, using visual scaring devices, applying repellents, using dogs to chase geese, and controlling goose nesting and capturing and removing geese (RIDEM Division of Fish & Wildlife and U.S. Department of Agriculture, written communication). Although the preceding methods pertain to the control of goose populations, many of the methods may also work for other waterfowl and gulls.

6.4 Internal Phosphorus/Aquatic Weed Control

Control of external sources of phosphorus may not produce immediate or expected water quality benefits to the ponds unless internal loading is also addressed in a timely fashion. Furthermore, reducing phosphorus loads to the ponds is expected to reduce native plant densities however have little effect on invasive plant species which are known to thrive in even nutrient poor waters. Thus, in addition to reducing external sources of phosphorous discharged to the pond, it is strongly recommended that a lake management study be done to determine the most effective and environmentally safe method to reduce internal phosphorus loading and to control invasive aquatic plants.

Much of the phosphorus load within Belleville Ponds is likely locked up in the aquatic plants which are found in great densities. These nutrients may be released from the plants as they die back and decompose in the fall and winter months, and become available for uptake again in future growing seasons. Removal of aquatic vegetation prior to the die-back disrupts this internal phosphorus cycling and may significantly reduce the internal phosphorus load over time. Thus, harvesting may be the most effective means of both controlling invasive aquatic plants and reducing the internal phosphorus load. There is currently an ongoing effort to manually harvest water chestnut from Belleville Ponds, which has been highly successful. Unfortunately water chestnut accounts for a relatively small percentage of the aquatic weed biomass and its removal has probably resulted in a limited decrease in phosphorus available for internal cycling. Special care must be taken with the harvesting of invasive species such as milfoil, which is common in Belleville Ponds, since milfoil can reproduce from fragments, with the potential to make the problem worse. Treating Belleville Ponds with herbicide may reduce excessive aquatic plant densities however since phosphorus from decaying herbicide-treated plants would just be released back into the system, the problems associated with elevated phosphorus would be expected to continue. For these reasons along with the preference to not introduce additional chemicals into the environment, herbicide treatments are the less desirable treatment option. A permit from the Wetlands Permitting office of RIDEM must be obtained for any harvesting of aquatic plants, and a permit from the Division of Agriculture must be obtained prior to any chemical treatment.

6.5 Septic System Maintenance

The Belleville Ponds watershed is not sewered. The Town of North Kingstown has a Wastewater Management District Ordinance, which went into effect in 1999. The ordinance requires that property owners have their onsite wastewater treatment system inspected once every three years and pumped when the volume of solids in the septic tank reaches 50%.

6.6 IMPLEMENTATION SUMMARY

The recommended implementation measures for Belleville Ponds are summarized in Table 6.2. As discussed previously, implementation of these BMPs is anticipated to address the ponds' phosphorus and phosphorus-related impairments.

Table 6.2 Summary of Recommended Implementation Measures and Responsible Parties.

Abatement Measure	Responsible Party	Notes
Point Source Controls	State of RI Lafayette Trout Hatchery	It is anticipated that the Hatchery will have to install wastewater treatment upgrades in order to meet the required load reductions.
Stormwater Phase II Minimum Measures	Town of North Kingstown &RIDOT	Revised Plans submitted to RIDEM as required.
Stormwater BMPs	Town of North Kingstown & RIDOT	Recommend BMP feasibility studies to identify locations and technologies for installing infiltration basins or equivalent BMPs in priority catchments.
Internal Phosphorus/Aquatic Weed Controls	RIDEM & Town of North Kingstown	It is strongly recommended that a lake management study be done to determine the most effective and environmentally safe method to reduce internal phosphorus loading and control excessive aquatic plant growth
Septic System Maintenance	Town of North Kingstown	The Town should enforce the existing Wastewater Management District Ordinance
Waterfowl Controls	Town of North Kingstown& Private Property Owners	Waterfowl controls are recommended at an impoundment east of Lafayette Road and at Belleville Ponds if needed.

7.0 PUBLIC PARTICIPATION

RIDEM held a public meeting upon the completion of the draft TMDL to discuss the water quality assessment and restoration plan. The plan was presented to the general public and stakeholders, including public officials and other agencies, including the Division of Fish & Wildlife at a meeting held on July 29, 2010 at the Town of North Kingstown's Public Library. Notification was sent to key stakeholders in advance of the meeting. In addition, the meeting was publicized in a press release, and public notices were posted at the Town Hall, Public Library as well as RIDEM offices in Providence. The draft Belleville Ponds TMDL was made available to the public on the RIDEM's website approximately two weeks prior to the public meeting.

8.0 FUTURE MONITORING

Future monitoring should be designed to track water quality improvements as remedial actions are accomplished. Monitoring of Belleville Ponds has been historically conducted by URI Watershed Watch (URIWW) volunteers. URIWW has monitored both the upper and lower basins of Belleville Ponds, as well as the Belleville Upper Pond Inlet just below the former railroad bed. RIDEM encourages URIWW to continue monitoring at these stations. Continued monitoring of the Belleville Upper Pond Inlet is especially critical in gauging future water quality improvements resulting from upgrades to the Lafayette Trout Hatchery. RIDEM also encourages URIWW to initiate the monitoring of Himes Brook, near its inlet to the southern portion of the upper basin of Bellville Ponds. Currently URIWW has two monitoring stations in the general area of the Himes Brook Inlet. These two stations consist of Oak Hill Brook East and Oak Hill Brook West. Oak Hill Brook is a tributary to Secret Lake. The eastern station is located near the inlet to Secret Lake and the other station is located approximately 200 m to the west. Perusal of the URIWW data shows that the water quality data at the two stations appears very similar. Resources may be better marshaled by keeping the Oak Hill Brook East station and substituting the Oak Hill Brook West station with a new station at Himes Brook, located near Telephone Pole No. 15 on Oak Hill Road.

9.0 REASONABLE ASSURANCES

EPA guidance calls for reasonable assurances when TMDLs are developed for waters impaired by both point and nonpoint sources. In a waterbody impaired by both point and nonpoint sources, where a point source is given a less stringent wasteload allocation based on an assumption that nonpoint source load reductions will occur, reasonable assurance that the nonpoint source reductions will happen must be explained in order for the TMDL to be approvable. This information is necessary for EPA to determine that the load and wasteload allocations will achieve water quality standards.

For this TMDL, reasonable assurance is not required because point sources are not given less stringent wasteload allocations based on the assumption of future nonpoint source load reductions. The existing hatchery point source load (212 kg/yr) comprised approximately 51% of the total existing load of 417 kg/r. However, the hatchery was assigned a waste load allocation of 86 kg/yr, a required reduction of approximately 59%. Similarly, the existing stormwater portion of the point source load (31 kg/yr) comprised approximately 7% of the total existing load. However, stormwater was assigned a waste load allocation of 25 kg/yr, a required reduction of approximately 19%.

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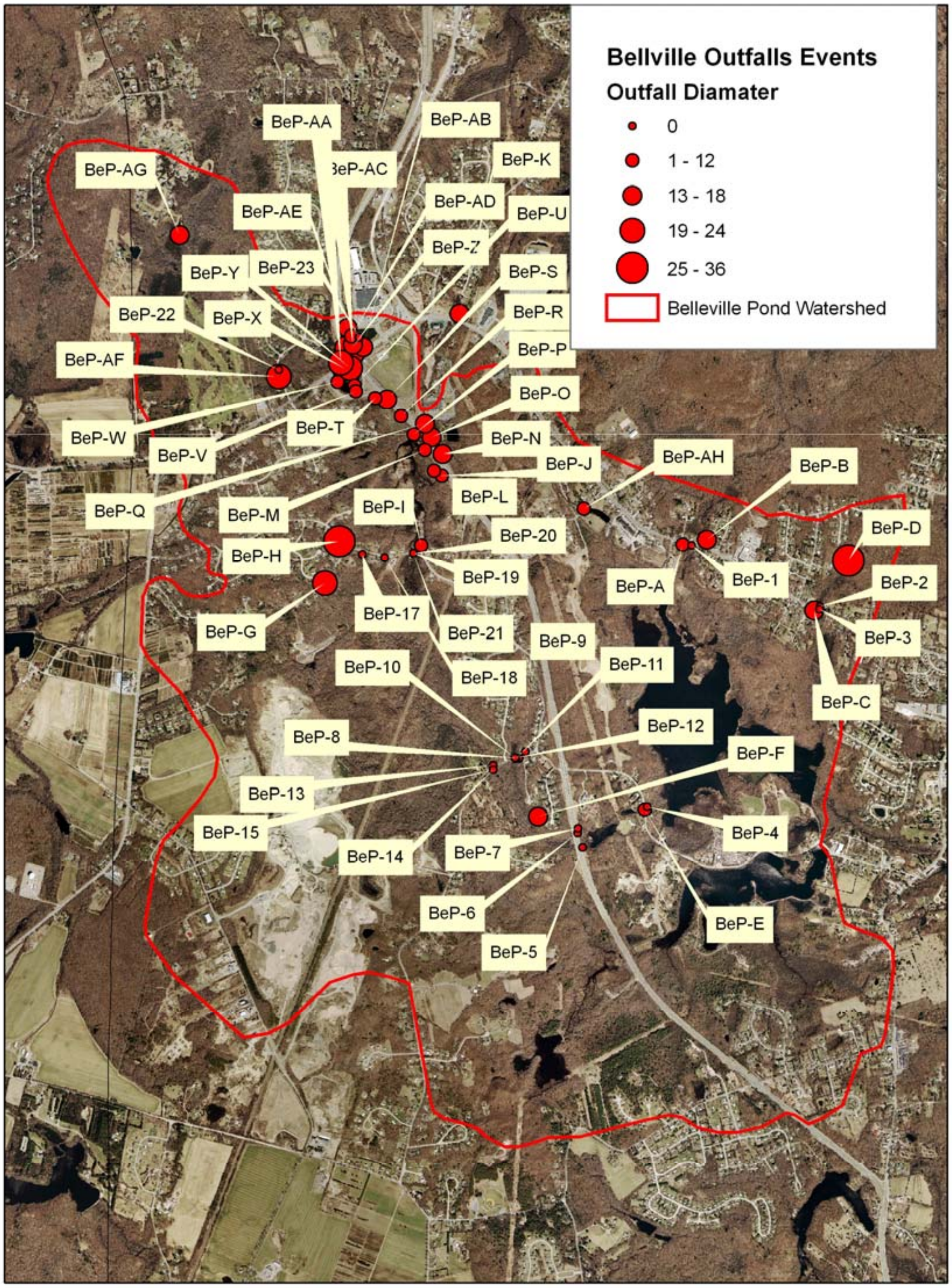
APPENDIX A. LAFAYETTE HATCHERY OUTFALL PHOSPHORUS CONCENTRATIONS (COLLECTED AT BELLEVILLE UPPER POND INLET)

Date	Time	Total Phosphorus Concentration (mg/l)
6/23/2006	9:45	0.1
	11:45	0.1
	13:40	0.1
9/28/2006	8:30	0.060
	10:50	0.070
	13:05	0.060
12/27/2006	9:00	0.080
	11:30	0.080
	13:45	0.100
3/15/2007	9:40	0.090
3/15/2007	8:45	0.130
	12:30	0.080
	14:00	0.080
5/30/2007	8:15	0.460
	9:15	0.100
	10:15	0.100
6/15/2007	8:00	0.100
	8:45	0.100
	9:30	0.100
7/27/2007	9:10	0.067
	11:30	0.067
	13:10	0.069
7/27/2007	9:10	0.065
	11:30	0.059
	13:20	0.060
8/10/2007	8:30	0.061
	9:30	0.057
	10:30	0.041
9/14/2007	8:30	0.079
	9:30	0.081
	10:30	0.078
10/16/2007	11:40	0.232
	12:40	0.164
	13:40	0.185
11/27/2007	10:31	0.087
	12:40	0.070
	14:45	0.065
11/27/2007	10:26	0.089
	12:42	0.087
	14:40	0.089
12/20/2007	10:27	0.262
	11:29	0.234
	12:30	0.240
1/23/2008	10:00	0.042
	11:00	0.045
	12:00	0.040
2/22/2008	8:00	0.073

Date	Time	Total Phosphorus Concentration (mg/l)
	9:00	0.061
	10:01	0.072
3/27/2008	8:00	0.076
	10:30	0.060
	13:00	0.051
3/27/2008	8:10	0.054
	10:40	0.053
	13:25	0.055
4/25/2008	10:00	0.058
	11:00	0.050
	12:00	0.051
5/9/2008	8:15	0.054
	9:15	0.057
	10:15	0.052
6/13/2008	7:45	0.063
	10:15	0.061
	12:50	0.056
6/13/2008	7:45	0.063
	10:15	0.062
	12:35	0.052
7/11/2008	7:50	0.074
	8:50	0.071
	9:50	0.073
8/26/2008	9:40	0.049
	10:40	0.048
	11:40	0.047
9/25/2008	8:00	0.054
	10:40	0.060
	12:45	0.061
9/25/2008	7:50	0.028
	10:30	0.027
	12:42	0.049
10/20/2008	11:45	0.082
	12:45	0.062
	13:45	0.063
11/10/2008	10:15	0.098
	10:21	0.081
	10:30	0.085
12/16/2008	8:40	0.074
	11:07	0.081
	13:03	0.087
12/16/2008	8:45	0.071
	11:02	0.100
	12:57	0.072
1/12/2009	11:15	0.054
	12:17	0.122
	13:20	0.047
2/9/2009	10:10	0.070
	11:12	0.060
	12:15	0.051
3/20/2009	8:01	0.126
	10:11	0.109

Date	Time	Total Phosphorus Concentration (mg/l)
	12:07	0.073
3/20/2009	7:57	0.117
	10:07	0.111
	12:03	0.083
4/6/2009	10:50	0.109
	11:52	0.090
	12:55	0.082
5/15/2009	10:02	0.081
	11:04	0.071
	12:05	0.071
6/5/2009	8:11	0.087
	10:09	0.097
	12:07	0.086
6/5/2009	8:07	0.095
	10:04	0.100
	12:03	0.104

APPENDIX B BELLEVILLE PONDS WATERSHED AND OUTFALLS



APPENDIX C BELLEVILLE PONDS OUTFALLS

Outfall/Surface Discharge ID[1]	**Culvert Diameter (in.)**	**GPS Coordinates**	**Location**	**Comments [2]**
BeP-A	12	41.57192° 71.48183°	Discharges to hydrologically connected wetland south of Ten Rod Rd. (Route 102); approximately 100 ft east of Hendrick Av.	Not flowing
BeP-B	18	41°34.329' 71°28.814'	Discharges to hydrologically connected wetland 150 ft west of Queen St.; approximately 250 ft northwest of its intersection with Route 102	Outfall not found; private property
BeP-C	18	41°34.119' 71°28.392'	Discharges to swale north of Ten Rod Rd.; approximately 300 ft east of its intersection with Angel Av.	No flow; drains to tributary via short swale
BeP-D	36	41°34.267' 71°28.258'	Discharges to tributary approximately 250 ft southeast of the cul-de-sac of Ponte La.	No flow; carries discharge from ditches in undeveloped area in addition to street runoff
BeP-E	12	41.55884° 71.48432°	Discharges to tributary south of Oak Hill Rd.; approximately 1300 ft east of Route 4	No flow
BeP-F	18	41.55851° 71.49131°	Discharges to detention basin approximately 100 ft west of Inez Dr.; approximately 800 ft south of its intersection with Oak Hill Rd.	No flow; eventually discharges to tributary
BeP-G	24	41.57001 ° 71.50528°	Discharges to tributary at Hatchery Road; opposite Stone Hill Rd.	Flowing; culverted stream with combined street runoff
BeP-H	36	41.57207° 71.50433°	Discharges to tributary east of Beacon Dr.; approximately 250 ft northwest of its intersection with Hatchery Rd.	Flowing slightly

Outfall/Surface Discharge ID[1]	**Culvert Diameter (in.)**	**GPS Coordinates**	**Location**	**Comments [2]**
BeP-I	12	41.57187° 71.49898°	Discharges to the Belleville Upper Pond Inlet west of Hatchery Rd. By-Pass; approximately 50 ft south of its intersection with Hatchery Rd.	No flow; mostly blocked with sediment
BeP-J	12	41°34.518’ 71°29.858	Discharges to a hydrologically connected wetland west of Route 4; approximately 750 ft south of the Belleville Upper Pond Inlet	Mostly blocked; no sign of recent flow
BeP-K	18	41°34.997’ 71°29.788’	Discharges to swale east of Route 4; approximately 2500 ft south of Route 102	No flow; almost completely blocked with sediment
BeP-L	12	41°34.553’ 71°29.888’	Discharges to a hydrologically connected wetland west of Route 4; approximately 450 ft south of the Belleville Upper Pond Inlet	No flow
BeP-M	12	41°34.595’ 71°29.924’	Discharges to hydrologically connected wetland west of Route 4; approximately 200 ft south of the Belleville Upper Pond Inlet	No flow; half blocked with sediment
BeP-N	18	41°34.582’ 71°29.854’	Discharges to swale east of 4; approximately 2000 ft south of Route 102	No flow
BeP-O	18	41°34.632’ 71°29.898’	Discharges to swale east of Route 4; approximately 1750 ft south of Route 102	No flow; half blocked with sediment
BeP-P	12	41°34.641’ 71°29.967’	Discharges to tributary west of Route 4; approximately 200 ft north of the Belleville Upper Pond Inlet	No flow
BeP-Q	18	41°34.672’ 71°29.924’	Discharges to swale east of Route 4 off ramp; approximately 1600 ft south of Route 102	No flow
BeP-R	12	41°34.696’ 71°30.018’	Discharges to tributary west of Route 4; 1400 south of Route 102	No flow
BeP-S	18	41°34.745’ 71°30.072’	Discharges to tributary west of Route 4; 1100 ft south of Route 102	No flow

Outfall/Surface Discharge ID[1]	**Culvert Diameter (in.)**	**GPS Coordinates**	**Location**	**Comments [2]**
BeP-T	12	41°34.748’ 71°30.119’	Discharges to tributary 350 ft west of Route 4; 800 south of Route 102; south of ramp and immediately east of tributary	**No flow**
BeP-U	12	41°34.785’ 71°30.200’	Discharges to east end of sedimentation basin; west of Route 4; approximately 400 ft south of Route 102;	No flow; small sedimentation delta; mostly blocked with sediment
BeP-V	12	41°34.769’ 71°30.195’	Discharges to north end of sedimentation basin; 450 ft south of Route 102; approximately 600 ft west of Route 4	No flow
BeP-W	12	41°34.797’ 71°30.267’	Discharges to west end of sedimentation basin; 200 ft south of Route 102; approximately 500 ft west of Route 4	No flow; small sedimentation delta
BeP-X	24	41°34.837’ 71°30.239’	Discharges to northeast end of sedimentation basin; south of Route 102; approximately 150 ft west of Route 4	No flow; small sedimentation delta
BeP-Y	24	41°34.838’ 71°30.218’	Discharges to northeast end of sedimentation basin; south of Route 102; approximately 125 ft west of Route 4	No flow; small sedimentation delta
BeP-Z	30	41°34.839’ 71°30.216’	Discharges to northeast end of sedimentation basin; south of Route 102; approximately 100 ft west of Route 4	No flow
BeP-AA	24	41.58089° 71.50424°	Discharges to swale north of Ten Rod Rd. (Route 102), at Route 4 South off ramp	Not flowing; discharges to tributary
BeP-AB	18	41°34.900’ 71°30.166’	Discharges to highway ditch north of Route 102; approximately 200 ft. east of its intersection with Route 102	No flow; half blocked with sediment
BeP-AC	18	41°34.907’ 71°30.207’	Discharges to highway ditch 200 ft north of Route 102 and 100 ft east of Route 4; west of on ramp	No flow

Outfall/Surface Discharge ID[1]	**Culvert Diameter (in.)**	**GPS Coordinates**	**Location**	**Comments [2]**
BeP-AD	12	41°34.932' 71°30.214'	Discharges to highway ditch 300 ft north of Route 102 and 100 ft east of Route 4; west of on ramp	No flow; almost completely blocked
BeP-AE	18	41°34.955' 71°30.228'	Discharges to highway ditch 400 ft north of Route 102 and 100 ft east of Route 4; west of on ramp	No flow; almost completely blocked
BeP-AF	18	41.58021° 71.50831°	Discharges to swale east of Lang Dr.; approximately 600 ft north of Route 102	Not flowing; discharges to tributary via short swale
BeP-AG	18	41°35.231' 71°30.889'	Discharges to tributary approximately 500 ft southeast of the southern end of Cassandra La.	Flowing; discharge from detention basin
BeP-AH	12	41.57369° 71.48831°	Discharges to Belleville Upper Pond Inlet northwest of Lafayette Rd.; approximately 500 ft southwest of Route 102	Not flowing
BeP-1	NA	41.57188° 71.48123°	Discharges to tributary south of Ten Rod Rd. (Route 102); approximately 200 ft east of Hendrick Av.	Curb cutout
BeP-2	NA	41.56886° 71.47283°	Discharges to tributary; south of Ten Rod Rd. (Route 102); approximately 200 ft east of its intersection with Angel Av.; at telephone pole no. 25	Curb cutout
BeP-3	NA	41.56871° 71.47285°	Discharges to tributary; opposite side of road from BeP-2	Curb cutout
BeP-4	NA	41.55899° 71.48415°	Discharges to tributary north of Oak Hill Rd.; approximately 1300 ft east of Route 4; opposite BeP-E	Asphalt swale
BeP-5	NA	41°33.419' 71°29.303'	Discharges to hydrologically connected wetland east of Route 4; approximately 1400 ft south of Oak Hill Rd.	Concentrated flow from highway as evidenced by rills

Outfall/Surface Discharge ID[1]	**Culvert Diameter (in.)**	**GPS Coordinates**	**Location**	**Comments [2]**
BeP-6	NA	41°33.461’ 71°29.323’	Discharges to hydrologically connected wetland east of Route 4; approximately 1200 ft south of Oak Hill Rd.	Concentrated flow from highway as evidenced by rills
BeP-7	NA	41°33.475’ 71°29.322’	Discharges to hydrologically connected wetland east of Route 4; approximately 1150 ft south of Oak Hill Rd.	Curb Cutout
BeP-8	NA	41.56135° 71.49255°	Discharges to hydrologically connected wetland north of Lafayette Rd.; approximately 350 ft west of its intersection with Oak Hill Rd.	Curb cutout
BeP-9	NA	41.56168° 71.49213°	Discharges to hydrologically connected wetland south of Lafayette Rd.; approximately 450 ft west of its intersection with Oak Hill Rd.	Curb cutout
BeP-10	NA	41.56133° 71.49276°	Discharges to hydrologically connected wetland north of Lafayette Rd.; approximately 450 ft west of its intersection with Oak Hill Rd.	Curb cutout
BeP-11	NA	41.56136° 71.49273°	Discharges to hydrologically connected wetland south of Lafayette Rd.; approximately 550 ft west of its intersection with Oak Hill Rd.	Curb cutout
BeP-12	NA	41.56138° 71.49281°	Discharges to hydrologically connected wetland north of Lafayette Rd.; approximately 550 ft west of its intersection with Oak Hill Rd.	Curb cutout
BeP-13	NA	41.56102° 71.49425°	Discharges to hydrologically connected wetland south of Lafayette Rd.; approximately 800 ft west of its intersection with Oak Hill Rd.	Curb cutout

Outfall/Surface Discharge ID[1]	**Culvert Diameter (in.)**	**GPS Coordinates**	**Location**	**Comments** [2]
BeP-14	NA	41.56079° 71.49426°	Discharges to tributary south of Lafayette Rd.; east side of bridge, approximately 900 ft west of the intersection of Lafayette Rd. and Oak Hill Rd.	Curb cutout
BeP-15	NA	41.56079° 71.49426°	Discharges to tributary south of Lafayette Rd.; west side of bridge, approximately 900 ft west of the intersection of Lafayette Rd. and Oak Hill Rd.	Curb cutout
BeP-16	NA	41. 57001 ° 71. 50528°	Discharges to tributary at Hatchery Road; opposite Stone Hill Rd.; adjacent to Culvert BeP-G	Asphalt swale
BeP-17	NA	41.57144° 71.50282°	Discharges to hydrologically connected wetland south of Hatchery Rd.; approximately 300 ft east of its intersection with Beacon Dr.	Asphalt swale
BeP-18	NA	41.57127° 71.50136°	Discharges to tributary north of Hatchery Rd.; approximately 700 ft east of Beacon Dr.	Naturalized swale
BeP-19	NA	41.57150° 71.49947°	Discharges to Belleville Upper Pond Inlet south of Hatchery Rd.; west side of bridge	Curb cutout
BeP-20	NA	41.57150° 71.49947°	Discharges to Belleville Upper Pond Inlet south of Hatchery Rd.; east side of bridge	Curb cutout
BeP-21	NA	41.57150° 71.49947°	Discharges to Belleville Upper Pond Inlet north of Hatchery Rd.; east side of bridge	Curb cutout
BeP-22	NA	41.58055° 71.50830°	West of Lang Dr.; approximately 650 ft north of Route 102, immediately north of bridge	Short swale discharging to tributary
BeP-23	NA	41°34.928' 71°30.183'	Discharges from detention basin approximately 400 ft northeast of the intersection of Route 4 and Route 102	Outflow from weir of sedimentation basin

1. Letters represent culvert outfalls; numbers represent discharge points of concentrated surface water flows.
2. Flow was assessed during dry weather unless otherwise indicated.

APPENDIX D RESPONSE TO WRITTEN COMMENTS ABOUT TMDL FINAL DRAFT

FROM: Steven Winnett

TO: Scott Ribas, Elizabeth Scott

RE: Review of draft nutrient TMDL for Belleville Ponds and Inlet

Thank you for the opportunity to review DEM's draft nutrient TMDLs for Belleville Ponds and the Belleville Upper Pond Inlet. Our comments are listed below.

* A map is needed that shows and labels the various water body segments referred to in the text, including the impaired segments and connected water bodies, such as Himes Brook, Secret Lake, Annaquatucket River, and various ditches. The hatchery should be located and identified, along with the residential neighborhoods and other features referred to in the text, such as wetlands, golf course, and industrial facilities. Another map should show the land uses in the Ponds' watershed, similar to other Rhode Island TMDLs. Figure 4.1 and the outfall map in Appendix B are insufficient to gain an understanding of the watershed.

RIDEM Response
A map (Figure 2.1) showing various tributaries and waterbodies was inserted on page 4. Another map (Figure 4.1), showing potential and actual sources cited in the text, was added on page 12. A third map (Figure 5.1 on page 25) was added to show land use within the watershed of the Upper Basin of Belleville Ponds.

* On page 6, you discuss the various sampling and monitoring efforts. Please discuss how these efforts are covered by quality assurance plans.

RIDEM Response
Page 6 was revised as requested. Sampling was conducted by URI's Watershed Watch (URIWW) and ESS Laboratories. URIWW has a Quality Assurance Project Plan approved by RIDEM and USEPA. ESS Laboratories has a Quality Assurance Quality /Quality Control program that meets USEPA requirements. ESS Laboratories used approved methodologies for analysis of total phosphorus (EPA 365.3). Their SOP for total phosphorus was previously approved by EPA (Sampling Plan; Surface Water Monitoring in the Ten Mile River Watershed; Year 2007).

* On page 6, you cite a phosphorus measurement for Himes Brook of 26 ug/l. While only slightly above criteria, this segment appears to not meet WQ standards. You may want to consider including this segment in the TMDL and calculating a TMDL for it.

RIDEM Response
The mean total phosphorus concentration in Himes Brook was determined to be 0.026 mg/l (26 ug/l). However, this mean was calculated from six samples collected from May through October 2004, by URIWW. It is DEM's position that there is not an adequate number of samples or a significant sampling period to list Himes Brook as impaired for phosphorus. In addition, an impoundment at Dry Bridge Sand & Gravel failed in 2004, washing a large amount of sediment into the headwaters of Himes Brook. This event may have had a significant yet temporary effect on phosphorus levels within Himes Brook. Ordinarily there is no surface water discharge from the sand and gravel operation.

* The graphs in figures 3.1 through 3.4 are helpful. Can you include under each vertical set of data (perhaps in the labels under the horizontal axis) the number of data points represented (N = ?)? That would also help to clarify the relative percentage of measurements represented by those points outside the 10^{th} and 90^{th} percentile marks.

RIDEM Response
Figures 3.1 through 3.4 were revised as requested. Please note that the original Figure 3.1 inadvertently included 2008 data in the data set for Upper Belleville Inlet near the inflow to Belleville Ponds. The 2008 data was removed from the revised chart. All sampling stations in Figure 3.1 include 2003-2007 data, as indicated in the text.

* At the bottom of page 10 you discuss chlorophyll-a concentrations. Please discuss what a healthy/acceptable level of chlorophyll-a is, or what concentration would be associated with meeting criteria. You reveal that later in the document but it would be very helpful to include here.

RIDEM Response
Page 10 has been revised as requested.

* In Chapter 4, you discuss sources of pollution, including RIPDES and other sources. Please include permit numbers for all point sources, including MS4s, MSGPs, and so forth. You note later in Chapter 6 that the two auto salvage operations are MSGPs; are the golf course and sand and stone operations also permittees? If not, how are they regulated? Is the North Kingston landfill no. 2 a permittee or covered by any type of effluent regulation?

RIDEM Response
The RIPDES permit numbers for the Lafayette Trout hatchery, RIDOT, and the Town of North Kingstown have been added to sections 4.2, 4.3,6.1.1, and 6.2.

As previously discussed in section 4.3.1, D&K Pitcher's Autosalvage and Belleville Autosalvage were identified as potential sources because of their close proximity to the pond, however there are no known activities or materials at this site that would generate phosphorus export. Section 4.3.1 was revised to further clarify this point. It was our original intention to remove any requirements for the Autosalvage yards to revise their SWMPPs. There appears to be no reason to require the facilities to submit revised SWMPPs, when it does not appear that there is the potential for phosphorus export. Unfortunately section 6.1.4, addressing revisions to multi-sector general permits, was inadvertently left in the document. Section 6.1.4 has now been removed.

Stormwater from golf courses is not regulated in the State of Rhode Island, unless part of a Freshwater Wetlands Permit. The Nonpoint source pollution generated form the golf course is assumed to be part of the waste load allocation.

Daily activities at the Dry Bridge Sand & Gravel operation is not regulated by the RIPDES program. Under normal operating conditions, there is no surface water discharge from the sand and gravel operation.

North Kingstown Landfill No. 2 is not regulated by the RIPDES program. Under normal situations, there is no surface water discharged from the former landfill area. RIDEM 's Office of Waste Management is working with the Town of North Kingstown to address any groundwater issues. The Office of Waste Management approved a Site Investigation Work Plan in May, 2005.

* Depending on your answer to the question, above, you should include these permittees in your discussion of controls in Chapter 6.

* At the end of Chapter 5, you set a TMDL load and reduction for the Belleville Ponds segment but do not set one for the Inlet segment. It appears that the TMDL you've calculated for the Pond segment is supposed to cover the Inlet segment, too ("The allowable phosphorus load for Belleville Ponds in inclusive of reductions needed to address Belleville Pond Inlet's phosphorus impairment.")

While we see your reasoning, we prefer having a TMDL for each segment, as is the case with all other Rhode Island TMDLs we are aware of. It is to the State's advantage in your TMDL program to get credit for the work for each segment that you invest in.

There are a couple of options and we leave it to you to decide how you want to address the issue. (1) DEM could apportion the load to each segment based upon some reasonable calculation. Perhaps you could look to the water body data to pull out an approach that you'd be comfortable with. (2) The entire Belleville Ponds system (pond and inlet) can be approved with one TMDL for 254 kg/year.

Our strong preference is to have a TMDL for each segment. It's the unusual case where each segment does not have a TMDL calculated for it. Please let us know how you wish to proceed.

* Vis a vis the TMDL allocation, please clarify where the golf course and auto salvage operations fit into the TMDL. The zero allocation of the sand and stone operation is specified on page 28.

RIDEM Response
RIDEM has opted to maintain one TMDL for the entire Belleville Pond system (pond and inlet). As previously discussed, stormwater from golf courses is not regulated in the State of Rhode Island. Non point source pollution from the golf course is considered as part of the waste load. Also as previously discussed the autosalvage yards have been excluded as potential sources since there are no known activities or materials that would generate phosphorus export from these facilities. The sand and gravel operation was given a zero allocation because there is no surface water discharge from the operation under normal circumstances.

* On page 38, 2nd to last paragraph, you cite a concentration of 25 ug/l. As you've used the 0.025 mg/l in most other places in the document, it would be good to pick one set of units and use it consistently throughout the document, including, for instance, the Himes Brook concentration discussed above.

RIDEM Response
All concentration units throughout the document have been changed to mg/l.

* Please include a discussion of reasonable assurances. In a mixed point source and nonpoint source TMDL, EPA requires the states to address reasonable assurances that point sources are not given less stringent WLAs based on the assumption of future nonpoint source load reductions.

RIDEM Response
A discussion of reasonable assurances was added to the document (section 9.0).

Town of North Kingstown, Rhode Island
Department of Public Works
2050 Davisville Road
North Kingstown, RI 02852-1799
Phone: (401) 268-1500
Fax: (401) 267-9036
Web: www.northkingstown.org

August 25, 2010
Mr. Scott Ribas
RIDEM Office of Water Resources
235 Promenade Street
Providence, RI 02908-5767

RE: Belleville Ponds draft TMDL report

Dear Mr. Ribas:

The Town of North Kingstown has specific comments regarding the findings, requirements and recommendations of the above report. These are the following.

1. Page vi: The MS4 definition lists Providence, North Providence, Smithfield and Johnston as well as RIDOT. The MS4 for Belleville Ponds is the Town of North Kingstown and RIDOT.

RIDEM Response:
Page vi has been revised as requested.

2. Page 12: BeP-AF, an outfall along Lang Drive has been identified as a priority outfall of concern. The outfall does not meet the description given in the report for priority outfalls. Storm water outfalls were prioritized by pipe diameter, specifically greater than 24 inches, drainage area, amount of impervious area, presence of scouring, dry weather flows, odor, staining and raccoon sign.

RIDEM Response:
Upon further investigation, it is agreed that BeP-AF should not have been classified as a priority outfall. The subject culvert has been removed from the priority list. See responses below for more details.

The Town has mapped the entire drainage system, identifying outfalls and all storm water detention or retention basins. The outfalls have been inspected for blockage, scouring, odor and dry weather flow. As noted in the report, the Town also did not find any dry weather flows at BeP-AF. There is no scouring or odors. (No definition of “raccoon sign” was given, so we are unable to address that parameter.)The outfall pipe is 18 inches in diameter, not 24 inches. The area draining to the outfall is approximately 320 feet of road, with a narrow strip of woods on either side. Only one small strip of lawn is included in the subcatchment. An aerial photograph showing the drainage area is attached. The subcatchment area is minor.

RIDEM Response:
An additional field inspection revealed that the subject flared pipe is indeed 18 inches in diameter, not 24 inches. It has also been confirmed that the catchment area associated with BeP-AF includes approximately 320 of Lang Drive and only receives runoff from one or two lawns. Given these new findings BeP-AF has been removed from the list of priority outfalls. Sections 4 and 6 of the document have been revised accordingly.

Note that the subdivision to the north up Lang Drive drains separately to a storm water detention basin.

RIDEM Response:
It is noted that the much of the neighborhood drains to an infiltration basin, south of West Ridge Court. It appears that there is surface water outflow from the basin only during extreme rain events, as evidenced by upland herbaceous and woody vegetation growing throughout the bottom of the basin. Such outfalls, that generally do not have a surface hydrological connection to Belleville Ponds, were not identified in the study.

Table 6.2, the Summary of Recommended Implementation Measures and Responsible Parties would require that the Town address the above outfall. We request the outfall labeled BeP-AF be removed from the list of Priority Outfalls for Belleville Ponds in Table 4.1.

RIDEM Response:
BeP-AF has been removed from the list of priority outfalls.

3. The above mentioned summary recommends that the Town perform a lake management study to reduce internal phosphorus loading. The internal loading is an accumulation of phosphorus in the sediments over the decades. The most significant source of those historic sediments appears to be from the hatchery (Table 5.5). Sources under the control of the Town contribute much less. The Town requests that RIDEM Fish & Wildlife conduct the lake management study and take responsibility for the implementation of any aquatic weed control program.

RIDEM Response:
The DEM acknowledges that based upon available information that the hatchery is a significant source of phosphorus to the pond, however the pond's aquatic weed problem is not just related to the phosphorus levels but in part to the presence of the invasive plant species. Given that both the Town and DEM have responsibility and interest in the overall management of the pond, a joint effort in conducting a lake management study and controlling aquatic weeds is recommended. The TMDL document has been revised accordingly.

4. The required amendments to address the TMDL provisions are to be completed within 180 days of the written notice from the RIPDES Program. The Town requests one year in order to obtain funding and/ or be able to use a student intern.

RIDEM Response:
The deadline for amendments to the Storm Water Management Program Plans has been extended. Section 6.1.3 has been revised accordingly.

We appreciate the work to compile this report and look forward to your response to our comments.

Sincerely,

Phil Bergeron, P.E.
Public Works Director

Enclosure
Copies: Michael Embury, Town Manager
Kim Wiegand, Town Engineer
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