PHOSPHORUS CONTROL ACTION PLAN

and Total Maximum Daily (Annual Phosphorus) Load Report

LILLY POND - Rockport and Camden

Knox County, Maine

Lilly Pond PCAP - TMDL Report

Maine DEPL 2005 - 0734

Maine Department of Environmental Protection

and Maine Association of Conservation Districts

FINAL EPA REVIEW DOCUMENT - December 2005

LILLY POND - Rockport and Camden

Phosphorus Control Action Plan (PCAP)

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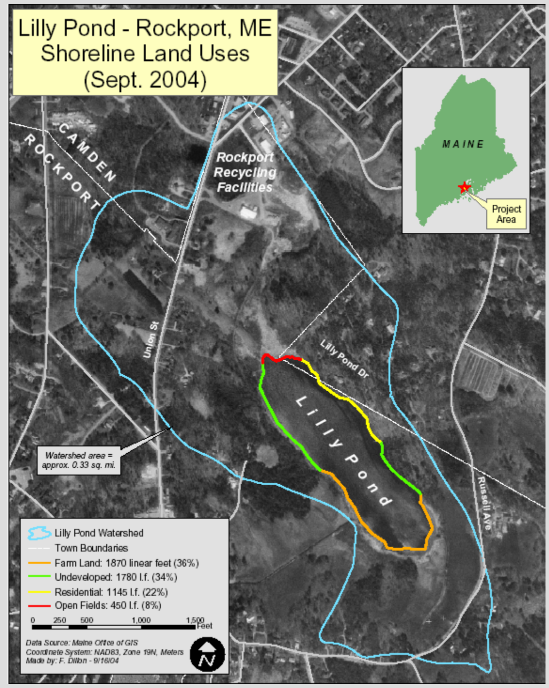
LILLY POND - ROCKPORT AND CAMDEN PHOSPHORUS CONTROL ACTION PLAN SUMMARY FACT SHEET

Background

LILLY POND (MIDAS No. 0083) is a 30-acre (12 ha) lightly-colored waterbody located in the Towns of Rockport and Camden in Knox County, Maine. Lilly Pond has a direct drainage area (see map at right and on pg. 8) of approximately 0.33 square miles (0.86 sq. km); a maximum depth of 24 feet (7 meters), a mean depth of 13 feet (4 meters); and an annual **flushing rate** of 1.2.



Historical Information

Lilly Pond has a long history of supporting persistent nuisance algae blooms. Nutrient contamination of Lilly Pond has been documented since 1979, with the main source coming from Jacobs Quarry via an unnamed brook on the north end of the pond. Interest in this pond's water quality status by both the town of Rockport and the pond association in the 1980's prompted studies to find the major source of pollutants to Lilly Pond. Maine DEP reported approximately 50 million gallons of leachates per year were being discharged from the quarry into Lilly Pond. One major impact of special concern was the high **phosphorus** inputs and the accumulation in pond bottom sediments which caused persistent algae blooms in Lilly Pond. This study also examined other sources of pollutants to Lilly Pond, including soil erosion from the surrounding **watershed** and stormwater runoff from area roads, which effectively transport phosphorus, serving to "fertilize" the pond and decreases water clarity. Excess phosphorus can also harm fish habitat and lead to nuisance algae blooms-floating mats of green scum- or dead and dying algae. Studies have shown that as lake water clarity decreases, lakeshore residential property values also decline.

Recent water quality data show that dump closure and removal of the old leachate from the quarry has improved the water quality and restored the natural color in Lilly Pond (VLMP 2004) waters, however, deepwater dissolved oxygen limitations are still prevalent.

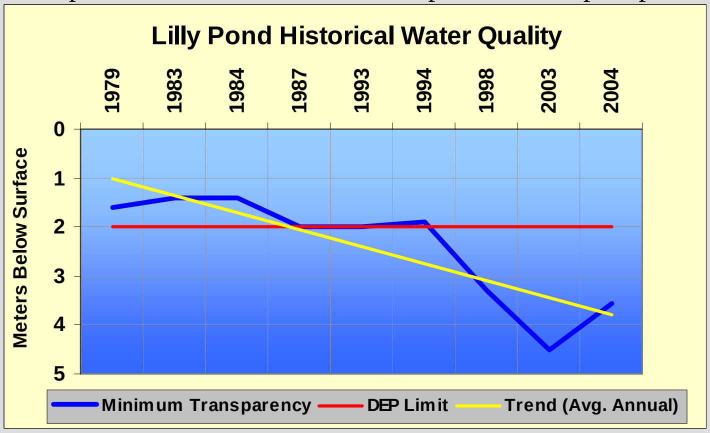
What We Learned

A land use assessment was conducted for the Lilly Pond watershed to determine any current potential sources of phosphorus that may run off from land areas during

Key Terms

- ***Watershed*** *is a drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.*
- ***Flushing rate*** *refers to how often the water in the entire lake is replaced on an annual basis..*
- ***Phosphorus****: is one of the major nutrients needed for plant growth. It is naturally present in small amounts and limits the plant growth in lakes. Generally, as phosphorus increases, the amount of algae also increases.*

storm events and springtime snow melt. This assessment utilized many resources, including generating and interpreting maps, inspecting aerial photos, and conducting field surveys. An estimated <u>28</u> kg of phosphorus is exported annually to Lilly Pond from the direct watershed. The bar chart (below right) illustrates the land area representative land uses as compared to the phosphorus export load for each land use. During recent years, the amount of total phosphorus being recycled internally (<u>8.5</u> kg/year) from Lilly Pond bottom sediments during the summer-time (2004-05) is well in excess of the pond's natural capacity (<u>1.7</u> kg/year) for in-lake phosphorus assimilation (<u>15</u> ppb target goal).



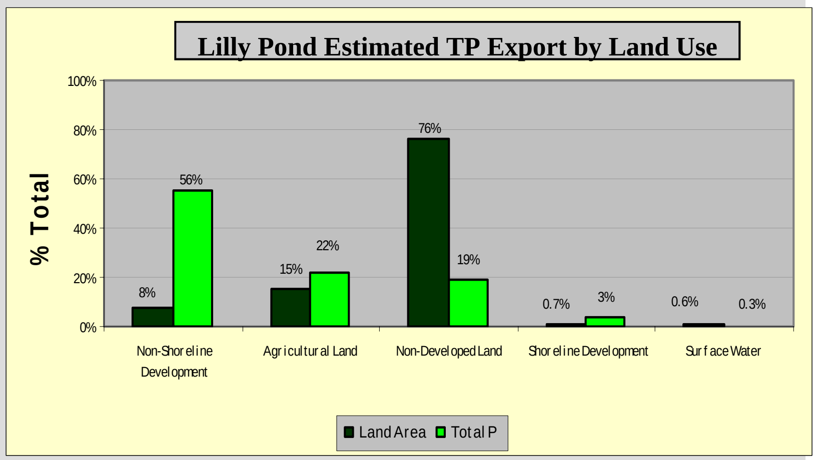
Lilly Pond's water clarity leveled off between 1987 and 1994 following dump closure and has greatly improved in recent years.

Phosphorus Reduction Needed

Lilly Pond's average summertime TP concentration approximates 20 ppb - equal to an additional 0.60 kg (5 ppb x 0.12 kg). Including a 0.06 kg allocation for future development, the total <u>annual</u> amount of phosphorus needed to be reduced to support Maine water quality standards (algal bloom-free total phosphorus concentrations of 15 ppb or less) in Lilly Pond is <u>0.66</u> kg.

<u>What You Can Do To Help!</u>

As a watershed resident, there are many things you can do to protect the water quality of Lilly Pond. Lakeshore owners can use phosphorus-free fertilizers and maintain natural vegetation adjacent to the lake. Agricultural and commercial land users can consult the Knox-Lincoln County Soil and Water Conservation District or Maine Department of Environmental Protection for information regarding **Best Management Practices** (BMPs) for reducing phosphorus loads. Watershed residents can always become involved by volunteering to join the Lilly Pond Association and by participating in events sponsored by State agencies and local organizations. The estimated phosphorus loading to Lilly Pond originates from both shoreline and non-shoreline areas, so all watershed residents must take ownership of maintaining suitable water quality.



Lake stakeholders and watershed residents can learn more about their lake and the many resources available, including review of the Lilly Pond Phosphorus Control Action Plan and **TMDL** report. Following final EPA approval, copies of this detailed report, with recommendations for future NPS/BMP work, will be available online at www.maine.gov/dep/blwq/docmonitoring/tmdl2.htm, or can be viewed and/or copied (at cost) at Maine DEP offices in Augusta (Bureau of Land and Water Quality, Ray Building, AMHI Campus).

Key Terms

- ***<u>Best Management Practices</u>*** *are techniques to reduce sources of polluted runoff and their impacts. BMP's are low cost, common sense approaches to reduce storm runoff and velocity to keep soil out of lakes and tributaries.*
- ***<u>TMDL</u>****, an acronym for Total Maximum Daily Load, represents the total amount of a pollutant (e.g., phosphorus) that a waterbody can receive on an annual basis and still meet water quality standards.*

Project Premise

This lakes PCAP-TMDL project, funded through a Clean Water Act Section 319-grant from the United States Environmental Protection Agency (EPA), was directed and administered by the Maine Department of Environmental Protection (Maine DEP) under contract with the Maine Association of Conservation Districts (MACD), from the summer of 2004 thru the fall of 2005.

The objectives of this project were twofold: First, a comprehensive land use inventory was undertaken to assist Maine DEP in developing a Phosphorus Control Action Plan (PCAP) and a Total Maximum Daily Load (TMDL) report for the Lilly Pond watershed. Simply stated, a TMDL is the total amount of phosphorus that a lake can receive without harming water quality. Maine DEP, with assistance from the MACD, will fully address and incorporate public comments before final submission to the US EPA. *(For more specific information on the TMDL process and results, refer to the Appendices or contact Dave Halliwell at the Maine DEP Augusta Office at 287-7649 or at david.halliwell@maine.gov*).

Secondly, watershed assessment work, including a shoreline survey was conducted by the Maine DEP-MACD project team to help assess **total phosphorus** reduction techniques that would be beneficial for the Lilly Pond watershed. The results of this assessment report include recommendations for future conservation work in the watershed to help citizens, organizations, and agencies restore and protect Lilly Pond. **Note:** *To protect the confidentiality of landowners in the Lilly Pond watershed, site-specific information has not generally been provided as part of this PCAP-TMDL report.*

Total Phosphorus (TP) - *is one of the major nutrients needed for plant growth. It is generally present in small amounts and limits the plant growth in lakes. Generally, as the amount of lake phosphorus increases, the amount of algae also increases.*

This Phosphorus Control Action Plan (PCAP) report compiles and refines land use data derived from various sources, including the Maine Office of Geographic Information Systems, the Knox-Lincoln Soil & Water Conservation District (KL-SWCD), and the Maine Forest Service (MFS). Local citizens, active and/or developing watershed organizations, and conservation agencies will benefit from this compilation of both historical and recently collected data as well as the watershed assessment and the NPS Best Management Practice (BMP) recommendations. Above all, this document is intended to help Lilly Pond stakeholder groups to effectively prioritize future BMP work in order to obtain the funding resources necessary for further **NPS pollution** mitigation work in their watershed - if and when they become organized.

Nonpoint Source (NPS) Pollution *- is polluted runoff that cannot be traced to a specific origin or starting point, but accumulates from overland flow from many different watershed sources*

Study Methodology

Lilly Pond background information was obtained using several methods, including a review of previous studies of the pond and watershed, numerous phone conversations and personal interviews with municipal officials, regional organizations and state agencies, and several field tours of the watershed, including boat reconnaissance of the lake and shoreline area.

> ***GIS**—or **geographic information system** combines layers of information about a place to give you a better understanding of that place. The information is often represented as computer generated maps.*

> ***Ground-truthing** involves conducting field reconnaissance in a watershed to confirm the relative accuracy of computer generated maps.*

Land use data were determined using several methods, including (1) **Geographic Information System (GIS)** map analysis, (2) analysis of topographic maps, (3) analysis of aerial photographs and (4) **ground-truthing**. Much of the non-developed land use area (i.e., forest, wetland, grassland) was determined using a GIS layer which is a combination of Maine Gap Analysis (GAP) landcover and USGS Multi Resolution Landcover Characterization (MRLC) landcover layers. It was created at the request of Maine DEP Bureau of Land and Water Quality (BLWQ) staff. It includes those classes in each layer which are best suited to calculating impermeability of watersheds. Both MRLC and GAP (and so Maine COMBO) are based on 1995 LandSat imagery. The developed land use areas were obtained using the best possible information available through analysis of methods 1 through 4 listed above.

Final adjusted phosphorus loading numbers (see Table 2, page 23) were modeled using overlays of soils, slope, and installed Best Management Practices. All of the land use coverage data for agricultural areas was re-configured using aerial overlays in conjunction with ground-truthing throughout the watershed.

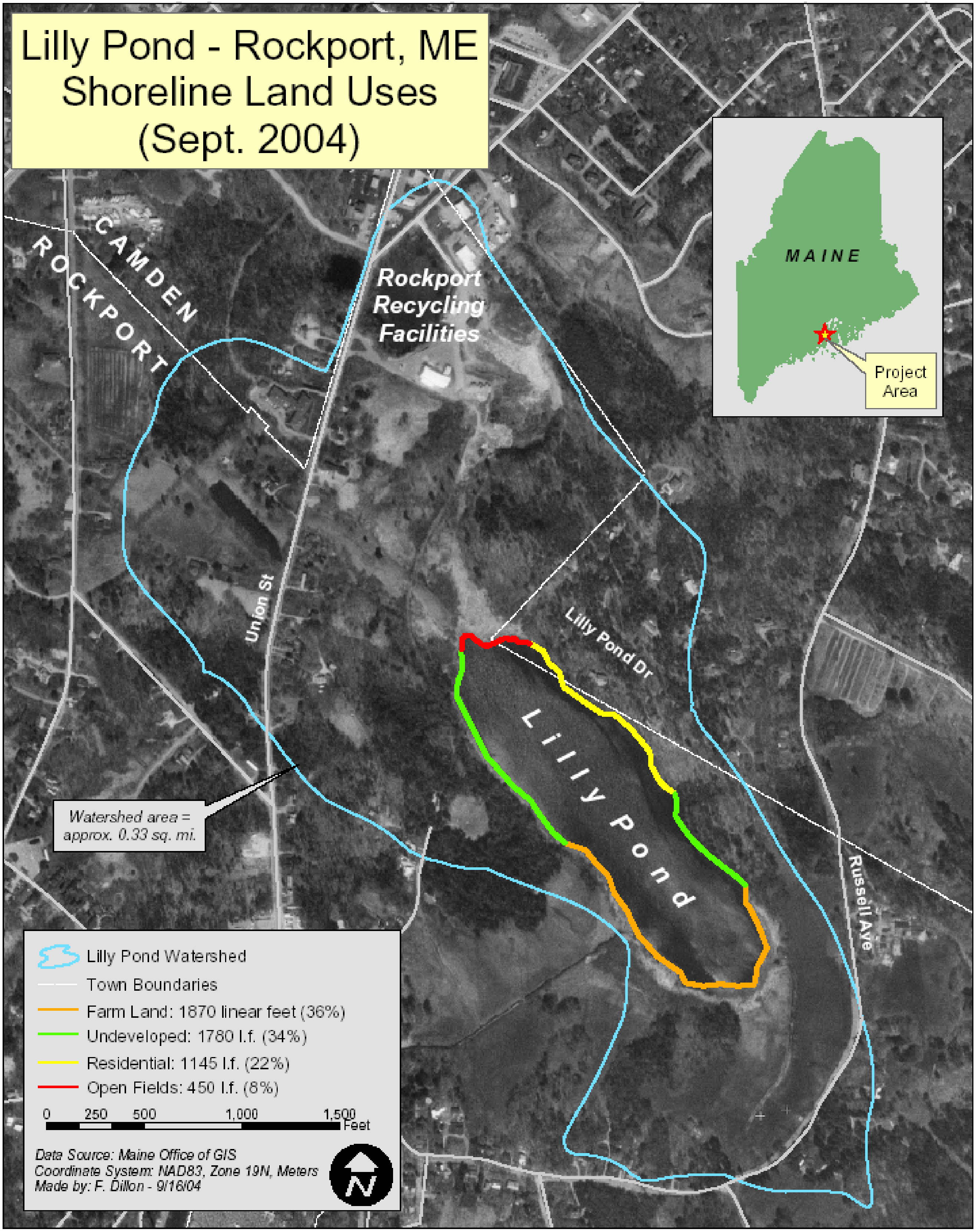
Roadway widths were estimated from previous PCAP reports where actual measurements were made for the various road types. In general, town-owned roads were found to be 12 meters wide; and privately-owned roads were found to be 6 meters wide. GIS was used to calculate total road surface area.

Agricultural information within the Lilly Pond watershed was reviewed by the Knox-Lincoln Soil and Water Conservation District (KL-SWCD). Information regarding forest harvest operations were reviewed by the Maine Forest Service, Department of Conservation.

Study Limitations

Land use data gathered for the Lilly Pond watershed is as accurate as possible given all of the available information and resources utilized. However, final numbers for the land use analysis and phosphorus loading numbers are approximate, and should be viewed as carefully researched estimations.

Figure 1. Map of Lilly Pond Direct Watershed and Shoreline Land Uses



LILLY POND Phosphorus Control Action Plan

DESCRIPTION of WATERBODY (MIDAS Number 0083) and WATERSHED

LILLY POND is a 30-acre, single-basin, lightly-colored, 12-hectare waterbody, located in the Towns of Rockport and Camden (DeLorme Atlas, Map 14), in Knox County, Maine. Lilly Pond has a direct watershed area (see Figure 1) of approximately 178 acres (0.33 square miles) including lake surface area. The Lilly Pond direct watershed is located within the towns of Rockport (85%) and Camden (15%). Lilly Pond has a maximum depth of 24 ft (7 m), overall mean depth of 13 ft (4 m), and an annual flushing rate of 1.2 times.

*The **direct watershed** refers to the land area that drains to a waterbody without first passing through an associated lake or pond.*

Drainage System: Lilly Pond has two inflows. The primary inflow is a small unnamed brook that enters Lilly Pond from the north. The second source of inflow is a drainage canal at the southern end of the pond. Lilly Pond's only outflow is a man-made drainage canal on the southwest side of the pond. This outlet canal flows through the center of Rockport, and eventually discharges into Rockport Harbor.

Water Quality Information

Lilly Pond is listed on the Maine DEP's section 303(d) list of lakes that did not historically meet State water quality standards. Therefore, a Phosphorus Control Action Plan (and TMDL) was prepared during the fall and winter of 2005.

***Secchi Disk Transparency** - a vertical measure of the transparency of water (ability of light to penetrate water) obtained by lowering a black and white disk into the water until it is no longer visible.*

***Chlorophyll-a** is a measurement of the green pigment found in all plants including microscopic plants such as algae. It is used as an estimate of algal biomass; the higher the Chl-a number, the higher the amount of algae in the lake.*

***Trophic state** - the degree of eutrophication of a lake. Transparency, chlorophyll a levels, phosphorus concentrations, amount of macrophytes, and quantity of dissolved oxygen in the hypolimnion can be used to assess trophic state.*

Based on historical **sechhi disk transparency** and current measures of both TP and **chlorophyll-a**, the water quality of Lilly Pond is considered to be poor and the potential for nuisance algae blooms is high (Maine VLMP 2004). Together, these water quality data document a trend of increasing **trophic state,** in direct violation of the Maine DEP Class GPA water quality criteria requiring a stable or decreasing trophic state.

Historically, poor water quality in Lilly Pond is attributed to leachate from the nearby Rockport Dump (Jacob's Quarry). Removal of leachate and dump closure has helped improve water quality (lower TP and chlorophyll-a) and restored natural color levels. Earlier pre-dump closure color measures averaged 38 SPU's (1979-94), while color levels of 17 SPU's represent average measures in recent years (1998-2004).

However, other nonpoint sources of pollution may also be contributing to the poor water quality in Lilly Pond. During storm events, nutrients such as phosphorus – naturally found in Maine soils - drain into the pond from the surrounding watershed by way of streams and overland flow, eventually being deposited and stored in pond sediments (8.5 kg annual average, based on 2004-05 measures). The potential for TP to leave bottom sediments and become available to algae in the water column is high.

Phosphorus is naturally limited in lakes and can be thought of as a fertilizer, a primary food for plants, including algae. When lakes receive excess phosphorus from NPS pollution, it "fertilizes" the lake by feeding the algae. Too much phosphorus can result in nuisance algae blooms, which can damage the ecology and aesthetics of a lake, as well as the economic well-being of the entire lake watershed.

One major impact of special concern was the high inputs which was causing persistent algae blooms in Lilly Pond as a result of years of disposal and burning of municipal solid waste into Jacob's quarry since the 1930's by the surrounding Towns of Camden, Hope, Lincolnville and Rockport.

Covering an area of approximately 12 acres north of Lilly Pond, Jacob's Quarry was formed between 1817 and 1907 by the removal of limestone. The outlet of the quarry discharges to an unnamed brook that enters Lilly Pond, while the outlet of Lilly Pond feeds directly to Rockport Harbor.

From the early 1930's through the 1970's, Jacob's quarry was also used for disposal of unburned municipal solid waste, tannery waste, construction and demolition debris, land clearing debris and inert fill, and later for shredded municipal solid waste adjacent to the quarry until 1982. The DEP reported approximately 50 million gallons of leachates per year were being discharged from the quarry into the brook which feeds Lilly Pond. One major impact of special concern was the high phosphorus inputs and accumulations in pond sediments that annually fed persistent algae blooms in Lilly Pond.

In 1982, the four towns using the quarry hired an outside engineer to assess the quarry's effects on the Lilly Pond watershed (C.E.S. Inc. 1982). The following year, the towns set up a transfer station, and the quarry was no longer used to landfill municipal solid waste, although the quarry continued to receive trees, brush, construction debris and other wood waste (C.E.S. Inc. 1988). This latter follow-up study included an assessment of additional inputs to Lilly Pond. This study showed that the primary surface inflow to Lilly Pond was from the quarry area which was contaminated with landfill leachate.

Principle Uses & Human Development: The prevalent human uses of the Lilly Pond shoreline are agricultural and residential (Figure 2). NPS pollution is a significant concern for the watershed. Consequently, Lilly Pond is on the State's 303(d) list due primarily to excessive phosphorus (sediments), lake enrichment and the historical prevalence of nuisance algal blooms. Although water quality has improved in recent years, dissolved oxygen deficiencies are still prevalent in the deeper portions of the water column.

Lilly Pond Fish Assemblage & Fisheries Status

Based on records provided by the Maine Department of Inland Fisheries and Wildlife (Maine DIFW) and recent conversations with fisheries biologist Bill Woodward (Region B, Sidney DIFW office), 30-acre (maximum depth 24 feet) Lilly Pond (Town of Rockport - harbor-coastal drainage) is managed as a warmwater (largemouth bass and chain pickerel) fishery. Lilly Pond was originally surveyed by Maine DIFW in 1950 and resurveyed in 1993 (REMAP), while their lake fisheries report was last revised in 2001. A total of **8** fish species were originally listed, including: **7** native indigenous fishes (catadromous American eel, golden shiner, white sucker, chain pickerel, brown bullhead, white perch, and pumpkinseed); and **1** previously introduced fish (largemouth bass).

Largemouth bass

Chain pickerel

A massive fish kill, due to **anoxic conditions**, occurred in Lilly Pond during the latter 1980's, when large numbers of recently introduced smallmouth bass perished. This species is no longer a member of the Lilly Pond fish assemblage. There is some question whether other resident fish species still occur. Despite use of a wide array of fishing gears (gill nets, fyke nets, minnow traps, and angling), no fish were seen nor captured during the 1993-94 REMAP (Maine DEP-IFW survey). Largemouth bass and pumpkinseed, electrofished from Branch Lake (Palermo), were subsequently stocked into Lilly Pond during May-June 1996. During July 1999, Maine DIFW sampled several age classes of largemouth bass, including young-of-year, juveniles, and 7 adults (210-380 mm, 2-6 years old). Maine DIFW note that **dissolved oxygen** deficiencies in the cooler water at depths below ten feet eliminate the possibility of managing this waterbody for cold-water (salmonid) fish, hence, no trout stocking is recommended.

Future improvements in water quality may serve to enhance fisheries conditions in Lilly Pond. Given that the trophic state of Lilly Pond has been disturbed by cumulative human impacts over the past several decades, then a significant reduction in the total phosphorus load in the Lilly Pond watershed may lead to maintaining in-lake nutrient levels within the natural assimilative capacity of this lake to effectively process total phosphorus - and possibly enhance existing largemouth bass fisheries.

> ***Anoxia****—a condition of no oxygen in the water. Often occurs near the bottom of fertile, stratified lakes in the summer and under ice in late winter.*

> ***Dissolved Oxygen****—refers to the amount of oxygen measured in the water. It is used by aquatic organisms for respiration. The higher the temperature, the less oxygen the water can hold. Oxygen will naturally decline during the summer months as water temperatures rise.*

General Soils Description (Source: USDA SCS 1987)

The Lilly Pond Watershed is characterized by the following general soil associations: Peru-Swanville-Lyman (100%) which is: deep and shallow, gently sloping to steep, moderately well drained and somewhat excessively drained soils; formed in glacial till; and deep, nearly level, poorly drained soils; formed in marine and lacustrine sediments.

All general soil associations fall within the C and D hydrologic soil groups, which have slow and very slow infiltration rates, allowing for high runoff potential and leading to greater amounts of surface runoff.

Land Use Inventory

The results of the Lilly Pond watershed land use inventory are depicted in Table 1 (p.13), and categorized by developed land vs. non-developed land. The developed land area comprises approximately 24% of the watershed and the undeveloped land including the water surface area of Lilly Pond, comprises the remaining 76% of the watershed. These numbers may be used to help make future planning and conservation decisions relating to the Lilly Pond watershed. The information in Table 1 was also used as a basis for preparing the Total Maximum Daily (Annual Phosphorus) Load report (see Appendices).

Descriptive Land Use and Phosphorus Export Estimates

Agriculture: Agricultural land is estimated to comprise 16 acres (7.8%) of the watershed area and contribute nearly 6 kg (21.5%) of the total phosphorus loading to Lilly Pond. These data were mapped using GIS software and verified by aerial photography.

Shoreline Residential (House and Camp Lots): Shoreline lake residences can have a comparatively large total phosphorus loading impact to lakes in comparison to their relatively small percentage of the total land area in the watershed. This is not the case for Lilly Pond, given the sparse extent of shoreline development. Shoreline residential land use is estimated to consist of only 0.3% of the total watershed land area and contribute approximately 0.6% of the total phosphorus load to Lilly Pond.

MACD project staff determined the lakeside residential phosphorus load estimate by conducting a general shoreline survey in the fall of 2004. This visual survey was carried out while observing the Lilly Pond shoreline from a boat and using best professional judgment to create a shoreline land-use map (Figure 1, page 8).

- *To convert kilograms (kg) of total phosphorus to pounds - multiply by 2.2046*

Private/Camp Roads: NPS pollution associated with shoreline roads can vary widely, depending upon road type, slope and proximity to a surface water resource. Routine maintenance of unimproved roads and associated drainage structures is often inadequate. For Lilly Pond, total phosphorus loading from shoreline roads was estimated using GIS land use data to determine the

Table 1. Lilly Pond Direct Watershed—Land Use Inventory and Phosphorus Loads

LAND USE CLASS	Land Area (Acres)	Land Area (% Total)	Total Phosphorus Export (% of Total)
Agricultural Land			
Pasture	16.4	7.8%	21.5%
Sub-Totals	**16.4**	**7.8%**	**21.5%**
Shoreline Development			
Private/Camp Roads	0.9	0.4%	2.8%
Low Density Residential	0.6	0.3%	0.6%
Sub-Totals	**1.5**	**0.7%**	**3.4%**
Non-Shoreline Development			
Commercial - Industrial	9.8	4.7%	28.4%
Roads	5.7	2.7%	13.8%
Low Density Residential	15.9	7.6%	13.5%
Sub-Totals	**31.4**	**15.0%**	**55.7%**
Total: DEVELOPED LAND	**49**	**24%**	**80.5%**
Non-Developed Land			
Scrub-Shrub	45.9	21.9%	11.7%
Grassland/Reverting Fields	16.9	8.1%	4.1%
Inactive/Passively Managed Forest	51.2	24.4%	3.4%
Wetlands	45.3	21.6%	0.0%
Total: NON-DEVELOPED LAND	**159**	**76%**	**19.2%**
Total: Surface Water (Atmospheric)	**1.2**	**0.6%**	**0.3%**
TOTAL: DIRECT WATERSHED	**210**	**100%**	**100%**

overall area occupied by this category. The average width for shoreline roads in the Lilly Pond watershed was estimated to be about 6 meters (based on the findings from previous PCAP reports). Based on these factors, shoreline roads were determined to cover about 0.9 acres and contribute less than 3% (0.2 kg/yr) of the total phosphorus load to the direct watershed.

Overall, shoreline development comprises less than 1% of the total watershed area and contributes approximately 1kg of total phosphorus annually, which is 3.4% of the estimated phosphorus load.

Non-Shoreline Development and Land Uses

Non-Shoreline Development consists of all lands outside the immediate shoreline of Lilly Pond - including public roads, low density residential areas and commercial/industrial areas. The total land area covered by these land-uses were calculated with GIS land use data.

Public Roads: Public road widths were estimated from previous PCAP reports and from on-screen viewing of aerial photography (town roads were estimated to be 12 meters average width) to determine the amount of total phosphorus loading from this land use category. Based on these factors, public roads contribute an estimated 3.9 kg/year (13.8%) of the total phosphorus load to Lilly Pond's direct watershed.

Low Density Residential: Low density residential land use consists of approximately 16 acres and contributes an estimated 3.8 kg/year (13.5%) of the total phosphorus loading to the Lilly Pond direct watershed.

Commercial/Industrial: Though covering a relatively small land area (9.8 acres and 7.6% of the total watershed), the commercial/industrial area in the Lilly Pond watershed contributes 28.4% of the total phosphorus load to Lilly Pond. This is more than any other land use, and more than half of the total phosphorus delivered by non-shoreline development.

Phosphorus Loading from Non-Developed Lands and Water

Inactive/Passively Managed Forests: Of the total land area within the Lilly Pond watershed, 51 acres are forested, characterized by privately-owned non-managed deciduous and mixed forest plots. Approximately 3.4% of the phosphorus load (1 kg/year) is estimated to be derived from non-commercial forested areas within Lilly Pond's direct drainage area.

Other Non-Developed Land Areas: Combined wetlands, grasslands/reverting fields and scrub-shrub account for the remaining 51.6% of the land area and less than 15.8% of the total phosphorus export load.

Atmospheric Deposition (Open Water): Surface waters for Lilly Pond's direct watershed comprise 0.6% of the total land area (1.2 acres) and accounts for an estimated 0.1 kg of total phosphorus per year, representing 0.3% of the total direct watershed load entering Lilly Pond. The lower total phosphorus loading coefficient chosen (0.11 kg/ha) is similar to that used for nearby central Maine lakes in Kennebec County, while the upper range (0.21 kg/ha) generally reflects a watershed that is 50 percent forested, combined with agricultural areas interspersed with urban/suburban land uses (Reckhow et al. 1980).

PHOSPHORUS LOADS – Watershed, Sediment and In-Lake Capacity

Supporting documentation for the phosphorus loading analysis includes the following: water quality monitoring data from Maine DEP and the Volunteer Lake Monitoring Program, and the development of a phosphorus retention model (see Appendices for detailed information). Please note that two methods were used in our total phosphorus loading analysis to assist with the preparation of this report: 1) a GIS-based land use and indirect load models; and 2) an in-lake phosphorus concentration model. However, the phosphorus reduction needed for the Lilly Pond TMDL was determined using only the in-lake phosphorus concentration model.

1. GIS-Based Land Use Method

Watershed Land Uses: Total phosphorus loadings to Lilly Pond originate from a combination of external watershed and internal lake sediment sources. Watershed total phosphorus sources, totaling approximately 28 kg annually (corrected GIS) have been identified and accounted for by land use (See Table 2 - page 23). In contrast, average annual internal lake sediment P-loadings of 8.5 kg were estimated to be present during the 2004-05 growing season.

2. In-Lake Concentration Method (TMDL)

Pond Capacity: The assimilative capacity for all existing and future non-point pollution sources for Lilly Pond is 1.7 kg of total phosphorus per year, based on a target goal of 15 ppb (See Phosphorus Retention Model - page 25).

Target Goal: A change in 1 ppb in phosphorus concentration in Lilly Pond is equivalent to 0.12 kg. The difference between the target goal of 15 ppb and the measured average summertime total phosphorus concentration (20 ppb) is 5 ppb or 0.60 kg (5 x 0.12).

Future Development: The annual total phosphorus contribution to account for future development for Lilly Pond is 0.06 kg (0.50 x 0.12) (see page 25 for more information).

Reduction Needed: Given the target goal and a 0.06 kg allocation for future development, the total amount of phosphorus needed to be reduced, on an annual basis, to eventually restore water quality standards in Lilly Pond is estimated to be 0.66 kg (0.60 + 0.06).

PHOSPHORUS CONTROL ACTION PLAN

Recent and Current NPS/BMP Efforts

The Knox-Lincoln Natural Resources Conservation Service (NRCS) has an ongoing relationship with land owners in the Lilly Pond watershed and has helped them establish voluntary conservation management plans to reduce nutrient export from agricultural operations.

In addition, the Town of Rockport recently (10/05) submitted a Stormwater Compensation Fund grant to improve the roads around Lilly Pond. Implementation is based on availability of the funding.

Recommendations for Future NPS/BMP Work

Lilly Pond has impaired water quality due mostly to historically high phosphorus inputs from Jacob's quarry as well as nonpoint source (NPS) pollution and resultant internal lake sediment recycling of phosphorus. Specific recommendations regarding recent and current efforts in the watershed, Best Management Practices (BMPs), and actions to reduce (1) external watershed and (2) accumulated bottom sediment phosphorus total phosphorus loadings in order to improve water quality conditions in Lilly Pond are as follows:

Watershed Management: Several agencies (i.e., Maine DEP, KL-SWCD, USDA/NRCS) have been involved in attempting to restore the water quality of Lilly Pond. This PCAP-TMDL report will serve as a compilation of existing information about the past and present restoration projects that have been undertaken in order to adequately assess future NPS BMP needs in the watershed.

Action Item # 1: Coordinate existing watershed management efforts		
Activity	**Participants**	**Schedule & Cost**
Continue efforts to develop a Lilly Pond Restoration Steering Team.	KL-SWCD, NRCS, Maine DEP, towns of Camden and Rockport, interested watershed citizens - stakeholders.	Annual Roundtable Meetings beginning in Summer 2006 - minimal cost.

Agriculture: Agricultural land encompass the greatest land area of the land-uses in the watershed, and contributes the second greatest phosphorus load behind commercial and industrial development. BMP recommendations for agricultural land uses include providing education on conservation practices and planning assistance. The Natural Resources Conservation Service provides technical assistance for using proper agricultural BMPs. For more information contact the NRCS office in Knox-Lincoln County (273-2005).

Action Item # 2: Conduct workshops for agricultural landowners		
Activity	**Participants**	**Schedule & Cost**
Conduct workshops encouraging the use of phosphorus control measures within the Lilly Pond watershed.	KL-SWCD, NRCS, agricultural landowners and watershed municipalities (Rockport & Camden).	Annually beginning in 2006 Variable cost depending on type of activities.

Non-Shoreline Development: Combined, these types of land uses are estimated to contribute nearly 56% of the total phosphorus load to Lilly Pond. Therefore, particular attention should be given to properties adjacent to Lilly Pond watershed brooks and streams.

Action Item # 3: Develop stewardship initiatives for Lilly Pond tributaries		
Activity	**Participants**	**Schedule & Cost**
"Adopt" local streams to promote stewardship efforts including education and water quality	Maine DEP, KL-SWCD, Stream Team, local schools and watershed citizens	Annually beginning in 2006 $1,500/yr

Roadways: A common cause of NPS pollution in lake watersheds is often related to roads, which if not properly designed and maintained can be a major source of erosion and sedimentation into ponds, lakes and streams. This PCAP report estimates that public and private roads combined contribute slightly more than 16% of the total phosphorus load per year to Lilly Pond. As such, efforts should be undertaken to identify pollution sources from roads so that appropriate BMPs can be designed and installed to remediate problem areas.

Action Item # 4: Implement roadway best management practices		
Activity	**Participants**	**Schedule & Cost**
Conduct survey of public and private roads in watershed to determine NPS pollution sources and establish / implement roadway BMPs.	Maine DEP, KL-SWCD, Towns of Rockport and Camden, interested watershed citizens.	Annually beginning in 2006 $5,000

Commercial/Industrial Runoff: Stormwater generated from impervious surfaces such as rooftops and parking areas contribute elevated concentrations of phosphorus, to local streams, and lakes. The small amount of commercial and industrial land (7.6% of the total watershed) in the Lilly Pond watershed contributes more phosphorus than any other land use (28.4%), and more than half of the phosphorus delivered by non-shoreline development..

Action Item # 5: Develop a stormwater education campaign for businesses		
Activity	**Participants**	**Schedule & Cost**
Provide stormwater management education to small business owners and industrial facilities in the Watershed.	Maine DEP, KL-SWCD, Towns of Rockport and Camden.	Begin immediately— $2,000

Septic Systems: Older, poorly designed and installed septic systems within the shoreland zone may contribute significantly to water quality problems, adding to the cumulative phosphorus load to Lilly Pond. While Lilly Pond septic systems – when properly sited, constructed, maintained, and set back from the water – should not affect water quality, many septic systems may not meet all of these criteria and thus have the potential to contribute phosphorus and other contaminants to lake water. Examples include septic systems sited in coarse, sandy soils with minimal filtering capacity, as well as soils that are shallow to bedrock - such as the Lyman soil series (personal communication, Dave Rocque, Maine Department of Agriculture). Septics that are inadequately separated from fractured bedrock provide direct conduits that are especially likely to contribute nutrients to lake waters, as are older septic systems which pre-date Maine's 1974 Plumbing Code. Recommendations for reducing existing phosphorus inputs to lakes include seeking replacement of pre-Plumbing Code septic systems and other poorly functioning systems within the shoreland zone of Lilly Pond.

Individual Action: All watershed residents should be encouraged through continued education and outreach efforts, including: retention or planting of natural vegetation of buffer strips, use of non-phosphate cleaning detergents, elimination of phosphorus-containing fertilizers, adequate maintenance of septic systems.

Action Item # 6: Expand homeowner education and technical assistance programs		
Activity	**Participants**	**Schedule & Cost**
Increase outreach and education efforts to watershed citizens including technical assistance to landowners.	KL-SWCD, Maine DEP, Lilly Pond Association.	Annually beginning in 2006 $2,500/yr includes printing of educational materials.

Municipal Action: Should include ensuring public compliance with local and state water quality laws and ordinances (Shoreland Zoning, Erosion and Sedimentation Control Law, plumbing code) through education and enforcement action, when necessary.

WATER QUALITY MONITORING PLAN

Historically, the water quality of Lilly Pond has been monitored via measures of Secchi disk transparencies during the open water months since 1979 (Maine DEP and VLMP). Continued long-term water quality monitoring (water transparencies) for Lilly Pond will be conducted monthly, from May to October, through the continued efforts of Maine DEP and VLMP. Under this planned, post-TMDL water quality-monitoring plan, sufficient data will be acquired to adequately track seasonal and inter-annual variation and long-term trends in water quality in Lilly Pond. A post-TMDL adaptive management status report will be prepared 5 to 10 years following EPA approval.

PCAP CLOSING STATEMENT

The Maine Association of Conservation Districts and Knox-Lincoln Soil and Water Conservation District (KL-SWCD), in cooperation with lake stakeholders, have initiated the process of addressing nonpoint source pollution in the Lilly Pond watershed. Technical assistance by KL-SWCD is available to both watershed towns (Rockport and Camden) to mitigate phosphorus export from existing NPS pollution sources and to prevent excess loading from future sources. It is critical that the Towns of Rockport and Camden recognize the inherent value of Lilly Pond and its vital link to the community by providing strong support to restoration efforts. Both towns should cooperate with KL-SWCD and NRCS in the pursuit of local and regional lake protection and improvement strategies. This teamwork approach should result in an eventual and overall improvement in Lilly Pond through NPS-BMP implementation and increased public involvement and awareness.

APPENDICES

LILLY POND (Rockport and Camden)

Total Maximum Daily (Annual Phosphorus) Load

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Maine Lake TMDLs and Phosphorus Control Action Plans (PCAPs)

You may be wondering what the acronym 'TMDL' represents and what it is all about. TMDL is actually short for 'Total Maximum Daily Load.' This information, no doubt, does little to clarify TMDLs in most people's minds. However, when we think of this as an annual phosphorus load (*Annual Total Phosphorus Load),* it begins to make more sense.

Simply stated, excess nutrients or phosphorus in lakes promote nuisance algae growth/blooms - resulting in the violation of water quality standards as measured by water clarity depths of less than 2 meters. A lake TMDL is prepared to estimate the total amount of total phosphorus that a lake can accept on an annual basis without harming water quality. Historically, development of TMDLs was first mandated by the Clean Water Act in 1972, and was applied primarily to *point sources* of water pollution. As a result of public pressure to further clean up water bodies, lake and stream TMDLs are now being prepared for watershed-generated *Non-Point Sources* (NPS) of pollution.

Nutrient enrichment of lakes through excess total phosphorus originating from watershed soil erosion has been generally recognized as the primary source of NPS pollution. Major land use activities contributing to the external phosphorus load in lakes include residential-commercial developments, roadways, agriculture, and commercial forestry. Statewide, there are 32 lakes in Maine which do not meet water quality standards due to excessive amounts of in-lake total phosphorus - the great majority of which are located in south-central Maine.

The first Maine lake TMDL was developed (1995) for Cobbossee Lake by the Cobbossee Watershed District (CWD) - under contract with Maine DEP and U.S. EPA. TMDLs have been approved by U.S. EPA for Madawaska Lake (Aroostook County), Sebasticook Lake, East Pond (Belgrade Lakes), China Lake, Webber, Threemile and Threecornered ponds (Kennebec County), Mousam Lake, the Highland lakes in Falmouth and Bridgton, Annabessacook Lake, Pleasant Pond, Upper Narrows Pond and Little Cobbossee Lake (under contract with CWD), Sabattus, Toothaker, and Unity ponds and Long Lake (with assistance from Lakes Environmental Association), as well as Togus, Duckpuddle, and Lovejoy ponds. PCAP-TMDL studies have also been initiated for Sewell and Hermon-Hammond ponds, as well as several of the remaining seven 2004 303(d) listed PCAP-TMDL waterbodies in Aroostook County.

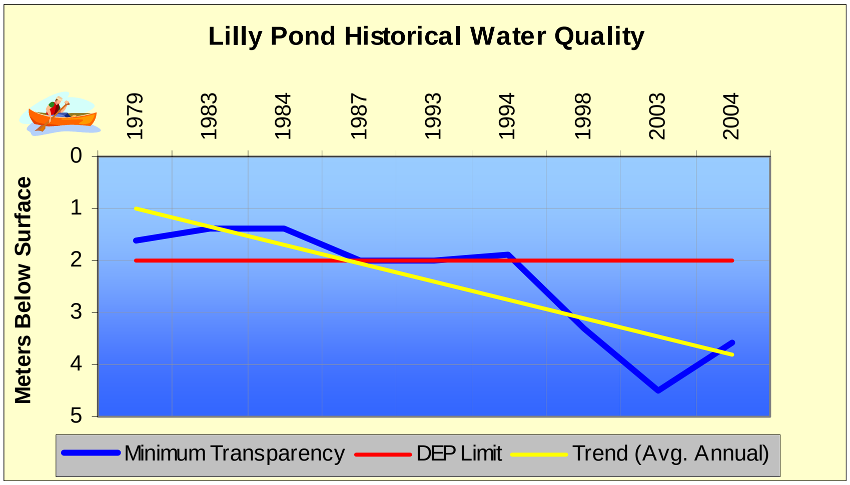
Lake PCAP-TMDL reports are based in part on available water quality data, including seasonal measures of total phosphorus, chlorophyll-a, Secchi disk transparencies, and dissolved oxygen-water temperature profiles. Actual reports include: a lake description; watershed GIS assessment and estimation of NPS pollutant sources; selection of a total phosphorus target goal (acceptable amount); allocation of watershed/land-use phosphorus loadings, and a public participation component to allow for stakeholder review.

PCAP-TMDLs are important tools for maintaining and protecting acceptable lake water quality and are designed to 'get a handle' on the magnitude of the NPS pollution problem and to develop plans for implementing Best Management Practices (BMPs) to effectively address the lake's water pollution problem. Landowners and watershed groups are eligible to receive technical and financial assistance from state and federal natural resource agencies to reduce watershed total phosphorus loadings to the lake. **Note:** for non-stormwater regulated lake watersheds, the *development of phosphorus-based lake PCAP-TMDLs are not generally intended by Maine DEP to be used for regulatory purposes*.

For further information, contact Dave Halliwell, Maine Department of Environmental Protection, Lakes PCAP-TMDL Program Manager, SHS #17, Augusta, ME 04333 (287-7649). E-mail: david.halliwell@maine.gov

Water Quality, Priority Ranking, and Algae Bloom History

Water Quality Monitoring: (Source: Maine DEP and VLMP 2004) Water quality monitoring data for Lilly Pond (station 1, deep hole) has been collected sporadically since 1979 (83-84,87,93-94,98,03-04). Hence, this present water quality assessment is based on nine years of water quality data including 9 years of Secchi disk transparency (SDT) measures, combined with 6 years of epilimnion core total phosphorus (TP) data, 8 years of water chemistry and 9 years of chlorophyll-a measures.



Lilly Pond water quality leveled off between 1987 and 1994, following dump closure. Since that time, water clarity has greatly improved, with water transparency measurements that exceed Maine DEP's 2.0 meter minimum transparency standards.

Water Quality Measures: (Source: Maine DEP and VLMP 2004) Historically, Lilly Pond has had a range of SDT measures from 1.4 to 5.5 m, with an average of 3.1 m; an epilimnion core TP range of 20 to 57 with an average of 37 parts per billion (ppb), and chlorophyll-a measures ranging from 1.7 to 30.4 ppb, with an average of 18.3 ppb. Recent dissolved oxygen (DO) profiles indicate excessively low levels of DO in deep areas of the lake. Late summer dissolved oxygen levels in 2003 and 2004 showed improvement (2 to 4 meters) with only 25% of the water column (lower 2 meters) unsuitable for fish in contrast to 50% (lower 4 meters) during the 1980's and 1990's. The potential for total phosphorus to leave the bottom sediments and become available to algae in the water column (internal loading) is high (Maine DEP 2002).

Priority Ranking, Pollutant of Concern and Algae Bloom History: Lilly Pond is listed on the State's 2004 303(d) list of historical waters in non-attainment of Maine State water quality standards and was moved up in the priority development order due to the need to complete an accelerated approach to lakes TMDL development. This Lilly Pond TMDL has been developed for total phosphorus, the major limiting nutrient to algae growth in freshwater lakes in Maine.

Water quality in Lilly Pond during the summers of 1998-2004 appears to be greatly improved in contrast to 1979-1987, when minimum transparencies of 2 meters or less were prevalent and total phosphorus (43 ppb) and chlorophyll-a (mean 21.1 ppb) levels were fairly high. On the basis of measured water transparencies below 2 meters in the summertime, nuisance algae blooms were prevalent during at least 6 out of the 9 years of record, with the most suitable minimal measure of 4.5 meters observed in the summer of 2003.

Natural Environmental Background levels for Lilly Pond were not separated from the total non-point source load because of the limited and general nature of available information. Without more and detailed site-specific information on non-point source loading, it is very difficult to separate natural background from the total non-point source load (US-EPA 1999). There are no known point sources of pollutants to Lilly Pond.

WATER QUALITY STANDARDS & TARGET GOALS

Maine State Water Quality Standard for nutrients which are narrative, are as follows *(July 1994 Maine Revised Statutes Title 38, Article 4-A*): "Great Ponds Class A (GPA) waters shall have a stable or decreasing trophic state (based on appropriate measures, e.g., total phosphorus, chlorophyll a, Secchi disk transparency) subject only to natural fluctuations, and be free of culturally induced algae blooms which impair their potential use and enjoyment."

Maine DEP's functional definition of nuisance algae blooms include episodic occurrence of Secchi disk transparencies (SDTs) < 2 meters for lakes with low levels of apparent color (<30 SPU) and for higher color lakes where low SDT readings are accompanied by elevated chlorophyll a levels. Lilly Pond is a lightly-colored lake (average color 31 SPUs), with relatively low late summer SDT readings (annual average of 3.1 meters), in association with moderate/high chlorophyll a levels (18.3 ppb annual average). Removal of leachate and dump closure has helped improve water quality (lower TP and chlorophyll-a) and restored natural color levels. Earlier pre-dump closure color measures averaged 38 SPU's (1979-94), while color levels of 17 SPU's represent average measures in recent years (1998-2004). Lilly Pond currently does not meet water quality standards due to a historical (pre-1994) decline in water transparency trends over time, combined with existing annual summertime hypolimnetic dissolved oxygen deficiencies (25% of water column). This water quality assessment uses historic documented conditions as the primary basis for comparison.

Designated Uses and Antidegradation Policy: Lilly Pond is designated as a GPA (Great Pond Class A) water in the Maine DEP state water quality regulations. Designated uses for GPA waters in general include: water supply; primary/secondary contact recreation (swimming and fishing); hydro-electric power generation; navigation; and fish and wildlife habitat. No change of land use in the watershed of a Class GPA water body may, by itself or in combination with other activities, cause water quality degradation that would impair designated uses of downstream GPA waters or cause an increase in their trophic state. Maine's anti-degradation policy requires that "existing in-stream water uses, and the level of water quality necessary to sustain those uses, must be maintained and protected."

Numeric Water Quality Target: The numeric (in-lake) water quality target for Lilly Pond is set at 15 ppb total phosphorus (1.7 kg/yr). Since numeric criteria for phosphorus do not exist in Maine's state water quality regulations - and would be less accurate targets than those derived from this study - we employed best professional judgment to select a target in-lake total phosphorus concentration that would attain the narrative water quality standard. Spring-time (late May - June) total phosphorus levels in Lilly Pond historically approximated 15-16 ppb during 2004, while summertime-early fall levels ranged from 14-26, averaging 20 ppb.

In summary, the numeric water quality target goal of 15 ppb for total phosphorus in Lilly Pond was based on observed late spring - early summer pre-water column stratification measures, generally corresponding to non-bloom conditions, as reflected in suitable (water quality attainment) measures of both Secchi disk transparency (> 2.0 meters) and chlorophyll-a (< 8.0 ppb).

ESTIMATED PHOSPHORUS EXPORT BY LAND USE CLASS

Table 2 details the numerical data used to determine external phosphorus loading for the Lilly Pond watershed. The key below Table 2 on the next page explains the columns and the narrative that follows (page 24) relative to each of the representative land use classes.

Table 2. Lilly Pond Direct Watershed - Estimated Phosphorus Export by Land Use

LAND USE CLASS	Land Area Acres	Land Area %	TP Coeff. Range kg TP/ha	TP Coeff. Value kg TP/ha	Land Area Hectares	TP Export Load kg TP	GIS Adjusted* kg TP	TP Export Total %
Agricultural Land								
Pasture	16.4	7.8%	0.14-4.9	0.81	6.7	5.4	6.0	21.5%
Sub-Totals	**16.4**	**7.8%**			**6.7**	**5.4**	**6.0**	**21.5%**
Shoreline Development								
Private/Camp Roads	0.9	0.4%	0.60 - 10.0	2	0.4	0.7	0.8	2.8%
Low Density Residential	0.6	0.3%	0.25 - 1.75	0.5	0.3	0.1	0.2	0.6%
Sub-Totals	**1.5**	**0.7%**			**0.6**	**0.9**	**0.9**	**3.4%**
Non-Shoreline Development								
Commercial - Industrial	9.8	4.7%	0.77 - 4.18	1.92	4.0	7.6	7.9	28.4%
Roads	5.7	2.7%	0.60 - 10.0	1.5	2.3	3.5	3.9	13.8%
Low Density Residential	15.9	7.6%	0.25 - 1.75	0.5	6.4	3.2	3.8	13.5%
Sub-Totals	**31.4**	**15.0%**			**12.7**	**14.3**	**15.5**	**55.7%**
Total: DEVELOPED LAND	**49**	**24%**			**20.0**	**20.6**	**22.5**	**80.5%**
Non-Developed Land								
Scrub-Shrub	45.9	21.9%	0.1 - 0.2	0.15	18.6	2.8	3.3	11.7%
Grassland/Reverting Fields	16.9	8.1%	0.1 - 0.2	0.15	6.8	1.0	1.1	4.1%
Inactive/Passively Managed Forest	51.2	24.4%	0.01-0.08	0.04	20.7	0.8	1.0	3.4%
Wetlands	45.3	21.6%	0-0.05	0	18.3	0.0	0.0	0.0%
Total: NON-DEVELOPED LAND	**159**	**76%**			**64.5**	**4.6**	**5.4**	**19.2%**
Total: Surface Water (Atmospheric)	**1.2**	**0.6%**	**0.11- 0.21**	**0.16**	**0.5**	**0.1**	**0.1**	**0.3%**
TOTAL: DIRECT WATERSHED	**210**	**100%**			**84.9**	**25.3**	**27.9**	**100%**

Key for Columns in Table 2

Land Use Class: The land use category that was analyzed for this report

Land Area in Acres: The area of each land use as determined by GIS mapping, aerial photography, Delorme Topo USA software, and field reconnaissance.

Land Area %: The percentage of the watershed covered by the land use.

TP Coeff. Range kg/ha: The range of the total phosphorus coefficient values listed in the literature associated with the corresponding land use.

TP Coeff. Value kg/ha: The selected coefficient for each land use category. The total phosphorus coefficient is determined from previous research – usually the median value, if listed by the author. The coefficient is often adjusted using best professional judgment based on conditions including soil type, slope, and best management practices (BMP's) installed.

Land Area in Hectares: Conversion, 1.0 acre = 0.404 hectares

TP Export Load kg P: Total hectares x applicable total phosphorus coefficient

TP Export Total %: The percentage of estimated phosphorus exported by the land use.

Total Phosphorus Land Use Loads

Estimates of total phosphorus export from different land uses found in the Lilly Pond watershed as presented on the previous page in Table 2 represent the extent of the current direct watershed phosphorus loading to the lake (28 kg/yr).

Total phosphorus loading measures are provided as a range of values to reflect the degree of uncertainty generally associated with such relative estimates (Walker 2000). The watershed total phosphorus loading values were primarily determined using literature and locally-derived export coefficients as found in Schroeder (1979), Reckhow et al. (1980), Dennis (1986), Dennis et al. (1992), and Bouchard et al. (1995) for residential properties, roadways, agriculture and other types of land uses (e.g., recreational, commercial).

Agriculture: Phosphorus loading coefficients as applied to agricultural land uses were adopted from past Maine DEP 1982 studies for non-manured hayland (0.64 kg/ha/yr). This coefficient was used for all hayland in the watershed and may actually underestimate its impact since some hayland receives manure or commercial fertilizer.

Residential Lots (House and Camp): The range of phosphorus loading coefficients used (0.25 – 2.70 kg/ha/yr) was developed from information on residential lot stormwater export of phosphorus as derived from Dennis et al (1992). Phosphorus loading coefficients for low density residential development was estimated to be 0.50 kg/ha/yr.

Private and Public Roads: The total phosphorus loading coefficient for private/camp and public roads (2.0 kg/ha/yr for private/camp roads and 1.50 kg/ha/yr for public roads) was chosen, in part, from previous studies of rural Maine highways (Dudley et al. 1997) and phosphorus research by Jeff Dennis (Maine DEP).

Total Developed Lands Phosphorus Loading: A total of 80.5% (22.5 kg) of the phosphorus loading to Lilly Pond is estimated to have been derived from the cumulative effect of the preceding cultural land use classes: agriculture (21.5% - 6 kg); shoreline development (3.4% - 0.9 kg); and non-shoreline development (55.7% - 15.5 kg) as depicted in Table 2.

Non-Developed Lands Phosphorus Loading: The phosphorus export coefficient for inactive/ passively managed forest land (0.04 kg/ha/yr) is based on a New England regional study (Likens et al 1977) and phosphorus availability recommendation by Jeff Dennis. The phosphorus export coefficient for grassland/reverting fields (0.20 kg/ha/yr) and scrub/shrub (0.10 kg/ha/yr) is based on research by Bouchard in 1995 (0.20 kg/ha/yr). The export coefficient for wetlands is based on research by Bouchard 1995 and Monagle 1995 (0.0 kg/ha/yr). The phosphorus loading coefficient chosen for surface waters (atmospheric deposition) was (0.16 kg/ha/yr), as was originally used in the China Lake TMDL (Kennebec County), and subsequent PCAP-TMDL lake studies in Maine.

Shoreline Erosion: Undeveloped areas of the lake shoreline that may be eroding due to natural causes (i.e., wind, wave and ice action) are not included as a source of phosphorus due to the difficulty in quantifying impact area and assigning suitable phosphorus loading coefficients.

Phosphorus Load Summary

It is our professional opinion that the selected export coefficients are appropriate for the Lilly Pond watershed. Results of the land use analysis indicate that a best estimate of the present total phosphorus loading from external nonpoint source nutrient pollution approximates 28 kg/yr.

LINKING WATER QUALITY and POLLUTANT SOURCES

Assimilative Loading Capacity: The Lilly Pond TMDL is expressed as an annual load as opposed to a daily load. As specified in 40 C.F.R. 130.2(i), TMDLs may be expressed in terms of either mass per unit time, toxicity, or other appropriate measures. It is thought appropriate and justifiable to express the Lilly Pond TMDL as an annual load because the lake basin has an annual flushing rate of 1.2, quite similar to the 1.5 overall average flushing rate for Maine lakes.

The Lilly Pond basin lake assimilative capacity is capped at 1.7 kg TP/yr, as derived from the empirical phosphorus retention model based on a target goal of 15 ppb. This value reflects the modeled annual phosphorus loading responsible for current trophic state conditions, based on a long term goal of maintaining average phosphorus concentrations at or below 15 ppb.

Future Development: The Maine DEP water quality goal of maintaining a stable trophic state includes a reduction of current P-loading which accounts for both recent P-loading as well as potential future development in the watershed. The methods used by Maine DEP to estimate future growth (Dennis et al. 1992) are inherently conservative, as they provide for relatively high-end regional growth estimates and largely non-mitigated P-export from new development. This provides an additional non-quantified margin of safety to ensure the attainment of state water quality goals. Previously unaccounted P-loading from anticipated future development on Lilly Pond watershed approximates 0.06 kg annually (0.5 x 1 ppb change in trophic state or 0.12 kg).

Human growth will continue to occur in the Lilly Pond watershed, contributing new sources of phosphorus to the lake. Hence, existing phosphorus source loads must be reduced by at least 0.06 kg to allow for anticipated new sources of phosphorus to Lilly Pond.

Overall, the presence of nuisance algae blooms in Lilly Pond may be reduced, along with halting the trend of increasing trophic state, if the existing phosphorus loading is reduced by approximately 0.66 kg TP/yr.

Internal Lake Sediment Phosphorus Mass: The relative contribution of internal sources of total phosphorus within Lilly Pond - in terms of sediment TP recycling - were analyzed (using lake volume-weighted mass differences between early and late summer) and estimated on the basis of water column TP data. The only years for which adequate lake profile TP concentration was available to derive reliable estimates of internal lake mass was in 2004-05, estimated at 7.6 and 9.3 kg respectively, for an average annual value of 8.5 kg.

Linking Pollutant Loading to a Numeric Target: The basin loading assimilative capacity for lightly- colored Lilly Pond was set at 1.7 kg/yr of total phosphorus to meet the numeric water quality target of 15 ppb of total phosphorus. A phosphorus retention model, calibrated to in-lake phosphorus data, was used to link phosphorus loading to numeric target.

Supporting Documentation for the Lilly Pond TMDL Analysis includes the following: Maine DEP and VLMP water quality monitoring data, and specification of a phosphorus retention model – including both empirical models and retention coefficients.

Total Phosphorus Retention Model (after Dillon and Rigler 1974 and others)

L = P (A z p) / (1-R) where, **1 ppb change = 0.12 kg**

1.67 = **L** = external total phosphorus load capacity (kg TP/year)
15 = **P** = total phosphorus concentration (ppb) = Target Goal = **15 ppb**
.012 = **A** = lake basin surface area (km^2)=12.0 ha or 29.7 acres
4.0 = **z** = mean depth of lake basin (m) **A z p = 0.058**
1.20 = **p** = annual flushing rate (flushes/year)
0.52 = **1- R** = phosphorus retention coefficient, where:
0.48 = **R = 1 / (1+ sq. rt. p)** (Larsen and Mercier 1976)

Previous use of the Vollenwieder (Dillon and Rigler 1974) type empirical model for Maine lakes, e.g., Cobbossee, Madawaska, Sebasticook, East, China, Mousam, Highland (Falmouth), Webber, Threemile, Threecornered, Annabessacook, Pleasant, Sabattus, Toothaker, Unity, Upper Narrows, Highland (Bridgton), Little Cobbossee, Long (Bridgton), Togus, Duckpuddle, and Lovejoy PCAP-TMDL reports (Maine DEP 2000-2005) have all shown this approach to be effective in linking watershed total phosphorus (external) loadings to existing in-lake total phosphorus concentrations.

Strengths and Weaknesses in the Overall TMDL Analytical Process: The Lilly Pond TMDL was developed using existing lake water quality monitoring data, derived watershed export coefficients (Reckhow et al. 1980, Maine DEP 1981 and 1989, Dennis 1986, Dennis et al. 1992, Bouchard et al. 1995, Soranno et al. 1996, and Mattson and Isaac 1999) and a phosphorus retention model which incorporates both empirically derived and observed retention coefficients (Vollenwieder 1969, Dillon 1974, Dillon and Rigler 1974 a and b, and 1975, Kirchner and Dillon 1975). Use of the Larsen and Mercier (1976) total phosphorus retention term, based on localized data (northeast and north-central U.S.) from 20 lakes in the US-EPA National Eutrophication Survey (US-EPA-New England) provides a more accurate model for northeastern regional lakes.

Strengths:

- Approach is commonly accepted practice in lake management
- Makes best use of available water quality monitoring data
- Based upon experience with other lakes in the northeastern U.S. region, the empirical phosphorus retention model was determined to be appropriate for the application lake.

Weaknesses:

- Inherent uncertainty of TP load estimates (Reckhow 1979, Walker 2000) and associated variability and generality of TP loading coefficients.

Critical Conditions occur in Lilly Pond during the summertime, when the potential (both occurrence and frequency) of nuisance algae blooms are greatest. The loading capacity of 15 ppb of total phosphorus was set to achieve desired water quality standards during this critical time period, and will also provide adequate protection throughout the year (see Seasonal Variation).

LOAD ALLOCATIONS (LA’s) - The load allocation for Lilly Pond equals 1.7 kg TP on an annual basis and represents, in part, that portion of the lake’s assimilative capacity allocated to non-point (overland) sources of phosphorus (from Table 2). Direct external TP sources (totaling 28 kg annually) have been identified and accounted for in the land-use breakdown portrayed in Table 2 (corrected GIS). Further reductions in non-point source phosphorus loadings are expected from the continued implementation of NPS best management practices (see summary, pages 15-18). As previously mentioned, it was not possible to separate natural background from non-point pollution sources in this watershed because of the limited and general nature of the available information. As in other Maine TMDL lakes (see Sebasticook Lake, East Pond, China Lake, and subsequent TMDLs), in-lake nutrient loadings in Lilly Pond originate from a combination of direct and internal (lake sediment) sources of total phosphorus.

WASTE LOAD ALLOCATIONS (WLA's): There are no known existing point sources of pollution (including regulated storm-water sources) in the Lilly Pond watershed, hence, the waste load allocation for all existing and future point sources is set at 0 (zero) kg/year of total phosphorus.

MARGIN OF SAFETY (MOS): An implicit margin of safety was incorporated into the Lilly Pond TMDL through the conservative selection of the numeric water quality target, as well as the selection of relatively conservative phosphorus export loading coefficients for cultural pollution sources (Table 2). Based on both the Lilly Pond historical records and a summary of statewide Maine lakes water quality data for colored (> 30 SPU) lakes - the target of 15 ppb (1.7 kg/yr in Lilly Pond) represents a highly conservative goal to assure future attainment of Maine DEP water quality goals of non-sustained and non-repeated blue-green summer-time algae blooms due to NPS pollution or cultural eutrophication and stable or decreasing trophic state. The statewide data base for colored Maine lakes indicate that summer nuisance algae blooms (growth of algae which causes water transparency to be less than 2 meters) are more likely to occur at 18 ppb or above.

SEASONAL VARIATION: The Lilly Pond TMDL is protective of all seasons, as the allowable annual load was developed to be protective of the most sensitive time of year – during the summer, when conditions most favor the growth of algae and aquatic macrophytes. With an average flushing rate of 1.2 flushes/year, the average annual phosphorus loading is most critical to the water quality in Lilly Pond. Maine DEP lake biologists, as a general rule, use more than six flushes annually (bi-monthly) as the cutoff for considering seasonal variation as a major factor (to distinguish lakes vs. rivers) in the evaluation of total phosphorus loadings in aquatic environments in Maine. Furthermore, nonpoint source best management practices (BMPs) proposed for the Lilly Pond watershed have been designed to address total phosphorus loading during all seasons.

PUBLIC PARTICIPATION: Adequate (‘full and meaningful’) public participation in the Lilly Pond PCAP-TMDL development process was ensured - during which land use and phosphorus load reductions were discussed - through the following avenues:

1. **December 2003:** A Memorandum of Agreement was signed between the Knox-Lincoln SWCD (KL-SWCD) and the Maine Association of Conservation Districts (MACD) to coordinate staff for assistance completing the Lilly Pond TMDL.

2. **June 2004:** MACD staff member Fred Dillon met with the manager of Aldemere Farms to discuss public access to the pond.

3. **September 2004:** MACD staff members Fred Dillon and Jodi Michaud-Federle met with the Rockport Town Assessor to acquire high resolution digital imagery for the GIS analysis.

4. **September 2005:** MACD staff Jennifer Jespersen contacted the KL-SWCD staff Mary Tiel and NRCS staff Mary Thompson to discuss historical information about Lilly Pond.

5. **October 2005:** Mary Thompson (NRCS) spoke with Tom Ford from the Town of Rockport regarding the upcoming Stormwater Compensation Fund Grant to be submitted for improving town roads around Lilly Pond.

6. **November 2, 2005:** MACD staff contacted the Town of Rockport Sewer District, and the Department and the Town of Camden Public Works Department to determine the number of Lilly Pond shoreline residences on septic vs. sewer.

7. **November 4, 2005:** MACD staff contacted the VLMP program coordinator and former President of the Lilly Pond Association to determine if the Association is still active and if local volunteers are currently monitoring water quality measures.

The combined Stakeholder and Public Review process for Lilly Pond covered the 4-week period November 21, 2005 through December 16, 2005 - with legal advertisements (see following page 28) posted in the Kennebec Journal on the weekend of December 3 and 10th.

Combined STAKEHOLDER AND PUBLIC REVIEW PROCESS

LILLY POND - Rockport and Camden

In accordance with Section 303(d) of the Clean Water Act, and implementation regulations in 40 CFR Part 130 - the Maine Department of Environmental Protection has prepared a combined Phosphorus Control Action Plan (PCAP) and Total Maximum Daily Load (TMDL) nutrient report (DEPLW 2005-0734) for the **LILLY POND** watershed, located within the Town of Rockport and Camden. This PCAP-TMDL report identifies and provides best estimates of non-point source phosphorus loads for all representative land use classes in the **LILLY POND** direct watershed and the total phosphorus reductions required to restore and maintain acceptable water quality conditions. A Public Review draft of this report may be viewed at Maine DEP Central Offices in Augusta (Ray Building, Hospital Street - Route 9, Land & Water Bureau) or on-line: http://www.maine.gov/dep/blwq/comment.htm. Please send all comments, in writing by December 16, 2005 to Dave Halliwell, Lakes TMDL Program Manager, Maine DEP, State House Station #17, Augusta, ME 04333. or e-mail: david.halliwell@maine.gov

PUBLIC REVIEW Comments Received

COMMENT From: Dave Rocque (Maine Department of Agriculture)
Sent: Monday, **November 28, 2005**
To: 'info@fbenvironmental.com'
Cc: Halliwell, David
Subject: RE: **Lilly Pond TMDL Public Review Document**

Couple of comments you may want to consider for this and future TMDL's. You indicate concern with septic system impact on ponds in sandy soils which is correct. Of equal or even greater concern is septic systems on shallow to bedrock soils. When a septic system is inadequately separated from fractured bedrock, there is a direct conduit to the pond. The Lyman soils indicated as being present in this watershed are subject to this problem. It isn't as much a problem for post 1974 systems but is a big problem for pre-1974 systems. I have seen more problems with septic systems and fractured bedrock than I have with sandy soils.

The other comment is about estimating P loads from AG land based on Reckhow 1980 numbers. Is that study still applicable today? Not only do we have new BMP's today but even the nutrient content of animal waste and nutrient applications to AG land should be different, particularly if a nutrient management plan is being followed. Are those numbers as valid today as they were in 1980?

RESPONSE - from Jennifer Jespersen, MACD (Lilly Pond Project Manager)

Thank you for your comments regarding the Lilly Pond TMDL. You are absolutely right about the shallow to bedrock soils. Both the Lyman and Tunbridge soils on the east side of the Pond are poorly suited for septic systems due to the shallow depth to bedrock. We will definitely incorporate this information into this report and future reports.

Your second point regarding potentially outdated P-loading estimates for agricultural BMPs is something that we have been looking into. Dave Halliwell at Maine DEP is taking the lead on this, and has recently found some good leads in the literature. We will continue to ensure that we are using the best available information for calculating P-loads to these ponds and lakes.

COMMENTS - Bill Woodward (Maine DIFW) reviewed the draft Fisheries section during the Public Review period, and provided new information, or the lack thereof, which leads to questioning the current presence of historically recorded fish species in Lilly Pond (see Pg. 11).

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