

**PHOSPHORUS CONTROL ACTION PLAN**  
and Total Maximum Daily (Annual Phosphorus) Load Report

**UPPER NARROWS POND**  
Kennebec County, Maine



**Upper Narrows Pond PCAP-TMDL Report**

Maine DEPLW 2004 - 0680



**Maine Department of Environmental Protection**

**COBBOSEE WATERSHED DISTRICT and  
Maine Association of Conservation Districts**

**Final EPA Submittal - December 20, 2004**

# UPPER NARROWS POND Phosphorus Control Action Plan (PCAP)

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# UPPER NARROWS POND PHOSPHORUS CONTROL ACTION PLAN - SUMMARY FACT SHEET

## Background

**Upper Narrows Pond** is a 222-acre waterbody located in the town of Winthrop in Kennebec County, south central Maine. Upper Narrows Pond has a direct watershed (see map) area of 2,729 acres or 4.26 square miles; a maximum depth of 59 feet, a mean depth of 26 feet; and a **flushing rate** of 1.5 flushes per year.



Upper Narrows Pond has experienced a gradual decline in water quality, in terms of a significant depletion in dissolved oxygen in deep areas of the lake over the past three decades. The average dissolved oxygen in the lake's lower layer has declined to minimum levels that threaten the lake's cold water fishery. This decline is due in large part to the contribution of **phosphorus** that is prevalent in area soils and effectively transported via storm flows. Excessive soil erosion in lake watersheds can have far-reaching water quality consequences. Soil particles transport phosphorus, which essentially "fertilizes" the lake and decreases water clarity. Studies on lakes in general have also shown that as lake water clarity decreases, lakeshore property values decline.

## Stakeholder Involvement

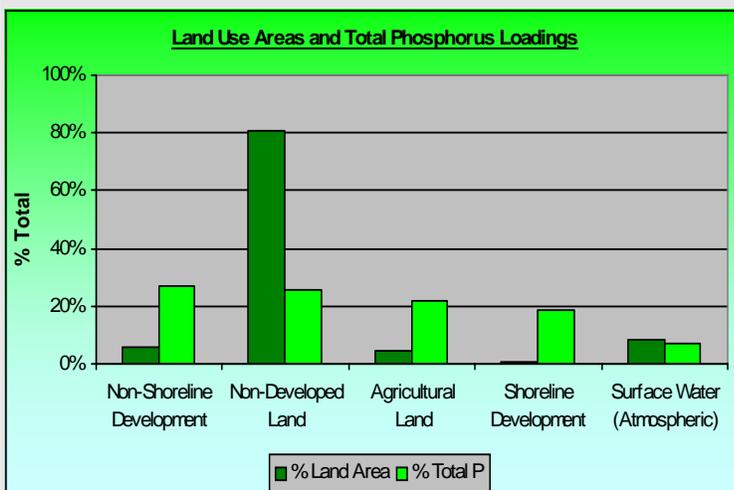
Federal, state, county, and local groups have been working together to effectively address this nonpoint source water pollution problem. In 2002-03, the Maine Department of Environmental Protection funded a project in cooperation with the Cobbossee Watershed District (CWD), Maine Association of Conservation Districts (MACD) and the Kennebec County Soil and Water Conservation District (KC-SWCD) to identify and quantify the potential sources of phosphorus and identify the **Best Management Practices** needed to be installed in the watershed. A final report, completed in the late fall of 2004, is entitled "Upper Narrows Pond Phosphorus Control Action Plan" and doubles as a **TMDL** report, to be submitted to the U.S. Environmental Protection Agency, New England Region, for their final review and approval.

## What We Learned

A land use assessment was conducted for the Upper Narrows Pond watershed to determine potential sources of phosphorus that may run off from land areas during storm events and springtime snow melting.

This assessment utilized many resources, including generating and interpreting maps, inspecting aerial photos, and conducting field surveys.

An estimated 207 kilograms (kg) of phosphorus per year is exported to Upper Narrows Pond from the direct watershed. The bar chart illustrates the land area for each land use vs. its total phosphorus export load.



The total phosphorus contribution from upstream Carlton Pond was estimated at 50

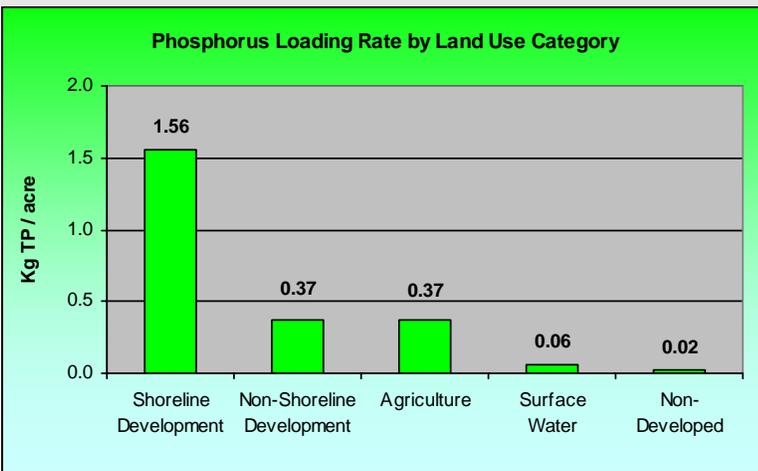
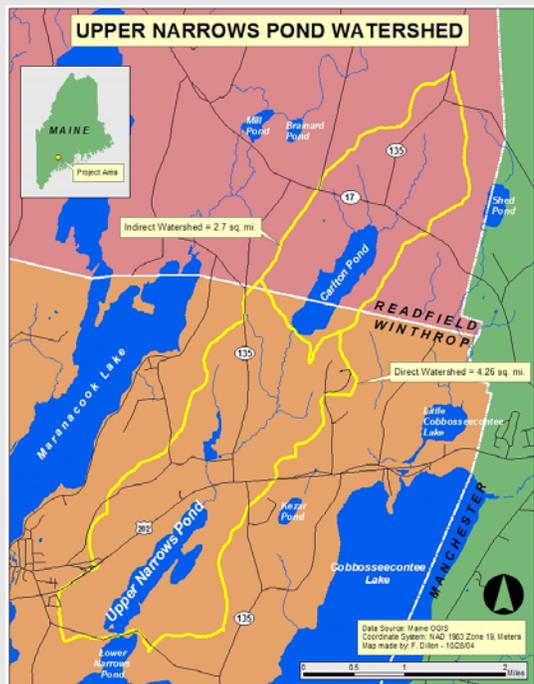
kg/yr. During the past several years, the amount of phosphorus being recycled internally from the bottom sediments of Upper Narrows Pond do not represent a significant net positive component to the annual phosphorus budget of the pond.

### Phosphorus Reduction Needed

Upper Narrows Pond has a natural capacity to effectively process up to 177 kg of phosphorus annually without harming water quality. This amount equates to an in-lake phosphorus concentration of 9 ppb. Upper Narrows Pond's actual in-lake average annual TP concentration is 10 ppb, corresponding to an annual phosphorus loading of 197 kg TP. Taking into account a 15 kg allocation for potential future watershed development, the total phosphorus reduction needed to restore water quality standards in Upper Narrows Pond approximates 35 kg.

### What You Can Do To Help!

As a watershed resident, there are many things you can do to protect the water quality of Upper Narrows Pond. Lakeshore owners can use phosphorus-free fertilizers and maintain natural vegetation adjacent to the lake. Agricultural and commercial land users can consult Cobbossee Watershed District, Kennebec County Soil and Water Conservation District, or the 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 help Cobbossee Watershed District and participating in events sponsored by the Friends of the Cobbossee Watershed.



All stakeholders and watershed residents can learn more about their lake and the many resources available, including review of the Upper Narrows Pond Phosphorus Control Action Plan. Following final EPA approval, copies of this detailed report, with recommendations for future NPS/BMP work, will be available online at [www.state.me.us/dep/blwq/docmonitoring/tmdl2.htm](http://www.state.me.us/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**

- **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.
- **Best Management Practices** are techniques to reduce sources of polluted runoff and their impacts. BMPs are low cost, common sense approaches to reduce storm runoff and velocity to keep soil out of lakes and tributaries.
- **TMDL** is an acronym for **Total Maximum Daily Load**, representing the total amount of a pollutant (e.g., phosphorus) that a waterbody can annually receive and still meet water quality standards.

## Project Premise

This project, funded through a Clean Water Act section 319 grant from the United States Environmental Protection Agency (US-EPA), was directed and administered by the Maine Department of Environmental Protection (Maine DEP) under separate contracts with the Cobbossee Watershed District (CWD) and the Maine Association of Conservation Districts (MACD), from the summer of 2002 through the late fall of 2004.

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 Upper Narrows Pond watershed. Simply stated, a TMDL is the total amount of phosphorus that a lake can receive without harming water quality. Maine DEP, with the assistance of the MACD Project Team, will 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 survey work, including a shoreline survey, was conducted by the Cobbossee Watershed District to help assess **total phosphorus** reduction techniques that would be beneficial for the Upper Narrows Pond watershed. Watershed survey work included assessing direct drainage **nonpoint source (NPS) pollution** sites. This project involved identifying NPS pollution sites through field surveys, and BMPs were recommended to help mitigate potential phosphorus and sediment loading to Upper Narrows Pond.

**Note:** *To protect the confidentiality of landowners in the Upper Narrows Pond watershed, site-specific information is not provided as part of this 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.

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

This Phosphorus Control Action Plan (PCAP) report compiles and refines land use data derived from various sources, including the municipality of Winthrop, the Cobbossee Watershed District, the Maine Office of GIS, and the Kennebec County Soil and Water Conservation District (KC-SWCD). Local citizens, watershed organizations, and conservation agencies should benefit from this compilation of data as well as the watershed assessment and the NPS Best Management Practice (BMP) recommendations. Above all, this document is intended to help Upper Narrows Pond stakeholder groups to effectively prioritize future BMP work in order to obtain the funding resources necessary for NPS pollution mitigation work in their watershed.

## Study Methodology

Upper Narrows Pond background information was obtained using several methods, including review of a previous study of the lake and watershed area, 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.

Land use data were determined using several methods, including (1) **Geographic Information System (GIS)** map analysis, (2) analysis of topographic maps, (3) analysis of town property tax maps and tax data, (4) analysis of aerial photographs (1998 and 1992) and (5) field visits. Much of the undeveloped land use area (i.e., forest, wetland, scrub shrub) was determined using GIS maps utilizing data from the Maine Gap Program/MRLC compiled by Maine DEP. The developed land use areas were obtained using the best possible information available through analysis of methods 2 through 5 listed above. Necessary adjustments to the GIS data were made using best professional judgment.

*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.*

Roadway data were gathered by taking actual road width measurements of the various types of roads (state, town, private/camp) in the watershed. Roads were measured between the two outer edges of the roadside ditches or berms. Final measurements for all roadways within the watershed were extrapolated using GIS and USGS topographical maps. The roadway area was determined using linear distances and average widths for each of the three main road types.

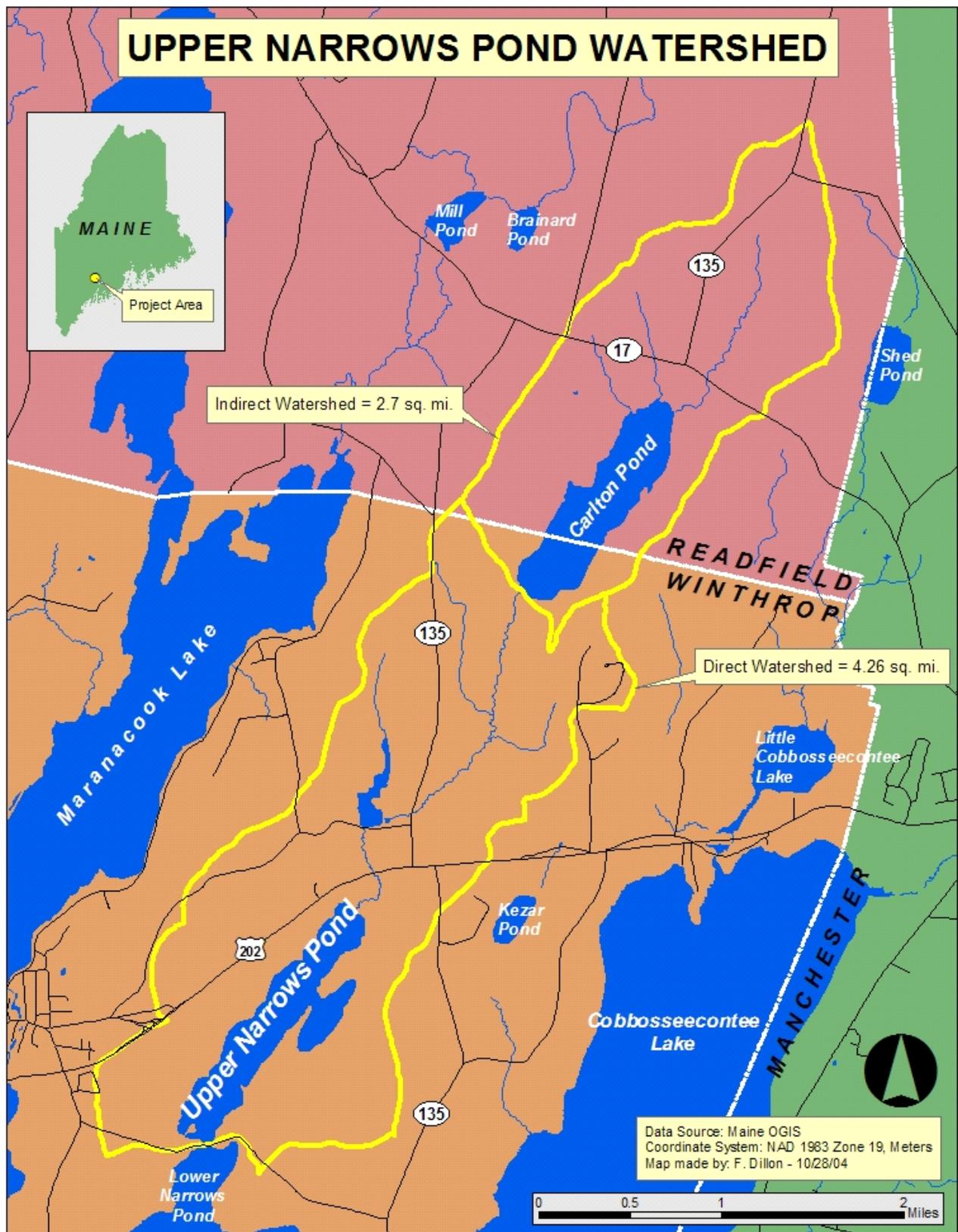
Additional land use data (i.e. non-shoreline residential, commercial) were determined using GIS cover mapping, aerial photos, topographic and property tax maps as well as personal consultation and, when necessary, field visits.

The agricultural (individual farmer) survey for the Upper Narrows Pond watershed was conducted solely by Cobbossee Watershed District (CWD) staff.

## Study Limitations

Land use data gathered for the Upper Narrows Pond watershed is as accurate as possible given available information and resources utilized. However, the 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 Upper Narrows Pond Direct Watershed**



# UPPER NARROWS POND Phosphorus Control Action Plan

## DESCRIPTION of WATERBODY (MIDAS Number 0098) and WATERSHED

**UPPER NARROWS POND** is a 222-acre single-basin waterbody, located within the Town of Winthrop (DeLorme Atlas, Map 12), in Kennebec County, located in south-central Maine. Upper Narrows Pond has a **direct watershed** area (see Figure 1) of 2,729 acres or 4.26 square miles within the Kennebec River drainage system. Upper Narrows Pond has a maximum depth of 59 feet (18 meters), an overall mean depth of 26 feet (8 meters) and has a flushing rate of 1.5 times per year (CWD).

*The **direct watershed** refers to the land area that drains to the lake without first passing through another lake or pond.*

**Drainage System** – Along the northernmost portion of Upper Narrows Pond, the lone tributary to the pond discharges from a large wetland system. The tributary is the product of the confluence of several unnamed streams, one of which represents the outfall of Carlton Pond, the only upstream lake in the watershed. Carlton Pond is the primary drinking water source for the City of Augusta. Upper Narrows Pond serves as the primary drinking water source for the Town of Winthrop and portions of the Town of Monmouth.

Upper Narrows Pond shares the same water level elevation as Lower Narrows Pond which lies immediately downstream. Upper and Lower Narrows ponds are hydraulically connected via a large culvert beneath a causeway supporting Narrows Pond Road. A non-adjustable earthen dam at the outlet of Lower Narrows Pond controls the elevations of both ponds.

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

### **Water Quality Information**

Upper Narrows Pond is listed on the Maine DEP's Clean Water Act section 303(d) list of lakes that do not meet State water quality standards as well as the State's Nonpoint Source Priority Watersheds list; hence, the preparation of a Phosphorus Control Action Plan (and TMDL) was prepared, publicly reviewed, and completed in the late fall of 2004.

***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.*

Water quality monitoring data for Upper Narrows Pond, including temperature, oxygen, **Secchi disk transparency**, color, pH, conductivity, alkalinity and **chlorophyll-a** has been collected since 1976.

***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.*

Trout and other coldwater fish require oxygen levels greater than 5 parts per million (ppm) to survive and even higher levels (7-8 ppm) to grow and reproduce. Since dissolved oxygen levels in Upper Narrows Pond's **hypolimnion** fall far below this level during most summers, it is possible that the lake has experienced a moderate to severe reduction in coldwater fish habitat. Nonpoint source pollution is the main reason for

***Hypolimnion**—lower, cooler layer of a lake during summertime thermal stratification.*

declining water quality in Upper Narrows Pond. During storm events phosphorus - naturally found in Maine soils - drain into the lake from the surrounding watershed by way of streamflow and overland drainage.

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 algae blooms, which can damage the ecology/aesthetics of a lake, as well as the economic well-being of the entire affected watershed community.

**Principle Uses:** The dominant human uses of the Upper Narrows Pond shoreline are residential (both seasonal and year-round occupancy) and recreational - including low-intensity boating, fishing and swimming. A state-operated public boat launch is located along the north side of the pond along Route 202 in the Town of Winthrop. Public access is restricted to carry-in watercraft only. There are no other public access facilities on the pond.

**Human Development:** The shoreline of Upper Narrows Pond is lightly to moderately developed in comparison to other regional lakes and ponds within the Cobbossee Watershed District (CWD). The eastern shoreline is much more intensely developed than the west shore. Much of the land along the western shore of the pond is under ownership of the Winthrop Utilities District for the purpose of source protection. There are 74 structures located along the approximate 4.2-mile shoreline; of these, 36 percent are seasonal camps and 64 percent are year-round dwellings (CWD, personal communication 2002).

The direct watershed of Upper Narrows Pond is located primarily within the town of Winthrop with a small fraction (less than one percent) located within the Town of Readfield. The Town of Winthrop is an industrial and suburban center, located about 10 miles west of Augusta on Route 202 (Kennebec County Council of Governments 2004). The population of the watershed of Upper Narrows Pond is approximately 700 people (CWD).

Upper Narrows Pond is on the State’s **Nonpoint Source Priority Watersheds** list due primarily to a declining trend for dissolved oxygen levels (see next page: fisheries assessment).

*Waterbodies within designated NPS **priority watersheds** have significant value from a regional or statewide perspective and have water quality that is either impaired or threatened to some degree due to NPS water pollution. This list helps to identify watersheds where state and federal agency resources for NPS water pollution prevention or restoration should be targeted.*

## Upper Narrows Pond Fish Assemblage & Fisheries Status

Based on records provided by the Maine Department of Inland Fisheries and Wildlife (Maine DIFW) and a recent conversation with fish biologist Bill Woodward (Maine DIFW Region B, Sidney), **Upper Narrows Pond** (Town of Winthrop - Kennebec River drainage) is currently managed as a mixed cold-warm water fishery (salmon, trout, perch and bass) and was last surveyed in 1976 (Maine DIFW fisheries report last revised in 2000). A total of **17** fish species are found to inhabit the Upper-Lower Narrows pond system, including: **12** native indigenous fishes (American eel, golden shiner, fallfish, white sucker, brook and lake trout, brown bullhead, chain pickerel, slimy sculpin, pumpkinseed, redbreast sunfish and yellow perch); **4** previously introduced/stocked fishes (white perch, smallmouth bass, landlocked Atlantic salmon and rainbow smelt); and **1** illegally introduced top predator, northern pike - emigrants from downstream Annabessacook Lake via Lower Narrows Pond. According to Maine DIFW, landlocked Atlantic salmon are stocked in the Narrows Pond complex once every three years while brook trout are stocked on an annual basis. In contrast to Lower Narrows Pond, the lake trout fishery in Upper Narrows Pond is limited to individual fish which migrate from the Lower Narrows Pond fishery.

Historically, Upper Narrows Pond had excellent water quality for salmonids, with a large band of cold, oxygenated water present to a depth of 60 feet (18 meters). Today, due to increasing nutrient levels, lake sediment organic matter deposition and subsequent decomposition by aerobic microbes, hypolimnetic oxygen depletion (under 5 parts per million and down to 2 ppm and below **dissolved oxygen**) is apparent within 50% of the water column (9-18 meters) in the deep hole sampling station of Upper Narrows Pond. Morphometrically expanded for the entire lake, these numbers translate into a loss of 21 percent on the basis of lake volume. In-lake oxygen levels below 5 ppm stress coldwater fish and a persistent loss of oxygen may further eliminate suitable habitat for both warm- and cold-water fish species.

***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.*

**Watershed Topography and Characteristic Soils** (Source: USDA SCS 1978): The majority of the soils within Upper Narrows Pond drainage area can be categorized in two general soil associations:

The majority of the eastern, western, and southern portions of the Upper Narrows Pond watershed fall within the **Hollis-Paxton-Charlton-Woodbridge** soil association. These soils are shallow and deep, somewhat excessively drained to moderately well drained soils. A majority of the shoreline areas fall within the Paxton-Charlton soil series which can have limitations for septic system placement.

Much of the northern portions of the Upper Narrows Pond watershed falls within the **Scantic-Ridgebury-Buxton** soil association. These soils are deep, poorly drained soils to moderately well drained soils. The shoreline areas of the tributary to the north of the pond contain a large amount of Ridgebury series. These poorly drained soils fall within the "C" hydrologic soil class and high amounts of runoff during storm events can be anticipated.

### **Land Use Inventory**

The results of the Upper Narrows Pond watershed land use inventory are depicted in Table 1. The various land uses are categorized by developed land vs. non-developed land. The developed land area comprises approximately 11% of the watershed and the non-developed land including the water surface area of Upper Narrows Pond, comprises the remaining 89% of the watershed. These numbers may be used to help make future planning and conservation decisions relating to the Upper Narrows 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:** The CWD has been working with various farmers in the Upper Narrows Pond watershed since the 1970s. Little activity has occurred in the Upper Narrows Pond watershed, due to the minimal amount of land dedicated to agricultural use. Historically, apple orchards were a major form of agriculture in the watershed, but during the past 10 to 20 years, the majority of the orchards were either converted to pasture or hayland or have simply become inactive.

In the Upper Narrows Pond watershed, there is a single farming operation solely dedicated to livestock. This farm in the northern portion of the watershed is primarily a low intensity mix of beef cattle and dairy farm. The herd size ranges occasionally but rarely exceeds 50 head and there are an estimated 30 acres of pasture and 53 acres of hayland on this farm. This farm also has a constructed manure facility capable of accommodating all on-site waste production.

In summary, the extent of land used for agricultural purposes in the watershed is minimal when compared to other culturally based land uses. The amount of land used for agriculture in the watershed of Upper Narrows Pond accounted for just 4.5% of the total direct watershed area and 22% of the total phosphorus loading to the lake. Of the various agricultural practices, hayland is estimated to contribute the most phosphorus (11.7%), with pasture (4.7%), manure storage (2.2%), and inactive orchards (2.9%) contributing the remainder of the annual agriculture-related TP load.

**Table 1. Upper Narrows Direct Watershed - Land Use Inventory and P-Loads.**

<u>LAND USE CATEGORY</u>	Total Land Area Acres	Total Land Area %	TP Export Total %
<b><u>Agricultural Land</u></b>			
Hayland - Manured	43	1.6	10.4
Hayland - Non-Manured	10	0.4	1.3
Pasture	30	1.1	4.7
Manure Storage	0.1	0.0	2.2
Inactive Orchard	37	1.4	2.9
<b><u>Sub-Totals</u></b>	<b><u>120</u></b>	<b><u>4.5%</u></b>	<b><u>22%</u></b>
<b><u>Shoreline Development</u></b>			
Low Impact Residential	6.7	0.2	1.6
Medium Impact Residential	8.0	0.3	2.4
High Impact Residential	2.3	0.1	0.7
Septic Systems	—	—	10.9
Private and Camp Roads	8.1	0	3.2
<b><u>Sub-Totals</u></b>	<b><u>25</u></b>	<b><u>1%</u></b>	<b><u>19%</u></b>
<b><u>Non-Shoreline Development</u></b>			
Low Density Residential	81.5	3.0	8.0
Parks, Cemeteries	3.8	0.1	0.6
Commercial	28.3	1.0	7.7
State Roads	21.1	0.8	6.2
Town Roads	11.6	0.4	3.4
Institutional (Public)	1.3	0.0	0.4
Sand/Salt Storage	2.5	0.1	0.7
<b><u>Sub-Totals</u></b>	<b><u>150</u></b>	<b><u>5.5%</u></b>	<b><u>27%</u></b>
<b>Total: <u>DEVELOPED Land</u></b>	<b><u>295</u></b>	<b><u>11%</u></b>	<b><u>67%</u></b>
<b><u>Non-Developed Land</u></b>			
Inactive/Passively Managed Forest	1,762	65	13.8
Scrub Shrub	222.6	8.2	4.3
Grassland/Reverting Fields	194.2	7.1	7.6
Wetlands	33	1.2	0.1
<b>Total: <u>NON-DEVELOPED Land</u></b>	<b><u>2,212</u></b>	<b><u>81%</u></b>	<b><u>26%</u></b>
<b>Total: <u>Surface Water (Atmospheric)</u></b>	<b><u>222</u></b>	<b><u>8%</u></b>	<b><u>7%</u></b>
<b>TOTAL: <u>DIRECT WATERSHED</u></b>	<b><u>2,729</u></b>	<b><u>100%</u></b>	<b><u>100%</u></b>

**Shoreline Residential (House and Camp Lots):** There are 74 dwellings along the shoreline of this 222-acre lake, constituting less than 1% of the total land area in the watershed (2,729 acres). In order to evaluate the impact of these dwellings, CWD project staff conducted a shoreline survey in the summer and fall of 2002. The shoreline survey was conducted via boat and the results represent subjective determinations of potential impact ratings based on best professional judgment and a residential structure tally. To help characterize shoreline development, each lot was assigned an NPS pollution impact rating using best professional judgment. The ratings range from 1 to 5, with 1 being very low impact (natural - best case scenario) and 5 being high impact (unnatural – worst case scenario). Table 2 outlines the impact ratings assigned to each shoreline lot during the survey. Lots receiving a rating of 1 have a full, naturally vegetated buffer.

Conversely, a lot given a score of 5 would have little or no vegetative buffer and support bare (eroding) soil – a visible source of phosphorus input to the lake. A grass covered mowed lawn leading down to a rip-rapped shoreline or beach would receive a rating of 4 – but, only if there was no evidence of bare soil, in which case a rating of 5 would be assigned.

In addition to the impact rating, project staff estimated the residency status of the dwelling (seasonal vs. year-round), the distance of the dwelling to the lake, the percent slope of the lot, the presence or lack of vegetated buffers, presence of bare soils, existing rip rap, and other notable features such as retaining walls or boat launches. A similar rating system for vegetated buffer status was established. A summary of the findings of the survey on Upper Narrows Pond appears below:

<b>Table 2. <u>Upper Narrows Pond</u> Shoreline Survey Results (2002)</b>			
<b>NPS Pollution Potential Severity Score</b>	<b>Impact rating characterized by one or more of the following:</b>	<b>Number of shoreline sites identified within each category</b>	<b>% of sites within each category</b>
1 = very low impact	All natural vegetation—great buffer; good setback from lake	29	39%
2 = low impact	Good natural vegetation; good setback from lake	19	26%
3 = moderate impact	Lack of adequate buffer; close to lake	16	22%
4 = moderately high impact	Lack of buffer; steep slopes; close to lake	5	7%
5 = high impact	Lack of buffer; steep slopes; close to lake; bare soils	5	7%

Relevant findings of the shoreline survey include the moderate percentage (36%) of inadequate shoreline buffers on lakefront lots. There were no discernable extended areas of shoreline considered to be either moderate or severely eroded. Inadequate vegetated shoreline buffers contribute most of the number of sites categorized as moderate to severe non-point source (pollution) contributors. Of the 74 dwellings, it is estimated that 47 are year-round residences and 27 are seasonal.

To estimate phosphorus loading from residential shoreline use on Upper Narrows Pond, the shoreline lots were rated as low, medium or high impact. Phosphorus loading coefficients were assigned corresponding to a residential lot with clearing limits of 10,000 square feet as presented in PHOSPHORUS CONTROL IN LAKE WATERSHEDS: *A Technical Guide to Evaluation New Development* (Maine DEP 1992). In total, seasonal and year-round camp and home lots on Upper Narrows Pond comprise less than 1% of the land area and a total of 9.7 kg of total phosphorus annually, which approximates 5% of the estimated total phosphorus load.

- *To convert kg of total phosphorus to pounds—multiply by 2.2046*
- *To convert kg/hectare to lbs/acre—multiply by .892*

**Shoreline Septic Systems:** It is important to consider the potential for phosphorus loading from septic systems around the immediate vicinity of Upper Narrows Pond. Antiquated and/or poorly designed and installed septic systems within the shoreland zone may contribute substantially to the annual total phosphorus load to adjacent lake water, adding to the cumulative phosphorus load to Upper Narrows Pond. While Upper Narrows Pond septic systems – when properly sited, constructed, maintained, and set back from the water – should have a minimal effect on lake water quality, systems that do not meet all of these criteria have the potential to contribute phosphorus and other contaminants to lake water. Systems around Upper Narrows Pond which are sited in coarse, sandy soils with minimal filtering capacity, and which are situated in zones where groundwater in-seepage is significant, are especially likely to contribute nutrients to lake waters. This is particularly true for old systems which pre-date Maine’s 1974 Plumbing Code.

In order to estimate total phosphorus loading from shoreline septic systems, a simple model was used based on an estimate of 2.7 persons per household and export coefficients of 0.05 and 0.15 kg/P per capita for seasonal and year-round residences, respectively. Export coefficients were taken from Dennis and McPhedran (1991), and applied to this recent shoreline survey. The total phosphorus load to Upper Narrows Pond from shoreline septic systems is estimated at 23 kg TP annually, or about 11% of the total phosphorus load to the pond.

**Private/Camp Roadways:** Common problems associated with camp roads include erosion of the road surface, insufficient road crown, and presence of shoulder berms. CWD staff conducted an inspection of more than one half of the camp roads in the vicinity of the pond during the summer of 2003. During this investigation, the roads appeared to be very well designed and maintained with few areas that may require slight modifications and/or maintenance.

The CWD will continue to offer technical assistance to local camp/private road associations regarding proper road design and maintenance. Recommendations generally include the installation of typical roadside BMPs such as reshaping of ditches, culvert maintenance, proper crowning of roads, and proper draining including installing plunge pools and turnouts.

The average road width for private roads in the Upper Narrows Pond watershed is 16.7 feet. There are 4 linear miles of camp roads within the watershed. When multiplied by the average road width, camp roads cover 8 acres in the watershed. In total, camp roads contribute an estimated 3.2% (6.5 kg/TP) to the total annual phosphorus load to Upper Narrows Pond.

## Other Development and Land Uses

**Non-Shoreline Development** consists of all lands outside the immediate shoreline area of Upper Narrows Pond. Included in this category are residential and commercial areas, state and town roads, and other land uses such as institutional (public) areas.

**Residential Homes:** Aerial photos and GIS mapping tools provided by Maine DEP were used in combination with ground-truthing to determine the number of residential dwellings outside of the shoreland zone but within the Upper Narrows Pond watershed. Non-shoreline residential areas, characterized by dispersed, low-density single-family homes, account for 8% (16.5 kg/TP) of the total phosphorus load to Upper Narrows Pond and 3% of the total watershed land area.

**State/Town Roadways:** There are 33 acres of public roadways within the Upper Narrows Pond watershed. Phosphorus loading estimates for state (21.1 acres) and town roads (11.6 acres) were calculated using the same methods as camp roads (see previous section). The combined total loading for state and town roadways is about 10% of the total phosphorus load to Upper Narrows Pond. The major state road is U.S. Route 202, which contributes an estimated 12.8 kg TP annually or 6.2% of the annual load. Roadways account for a much greater percentage of the total phosphorus load (9.6%) versus land area (1.2%) in the Upper Narrows Pond watershed.

**Other Non-Shoreline Land Uses include** a few commercial enterprises, a municipal sand and salt storage facility, a small cemetery, a municipal water treatment facility, and little league baseball field. The total phosphorus loading of these combined land uses is 19.5 kg TP/yr or 9.4% of the total phosphorus loading to Upper Narrows Pond.

## Phosphorus Loading from Non-Developed Lands and Surface Water Area

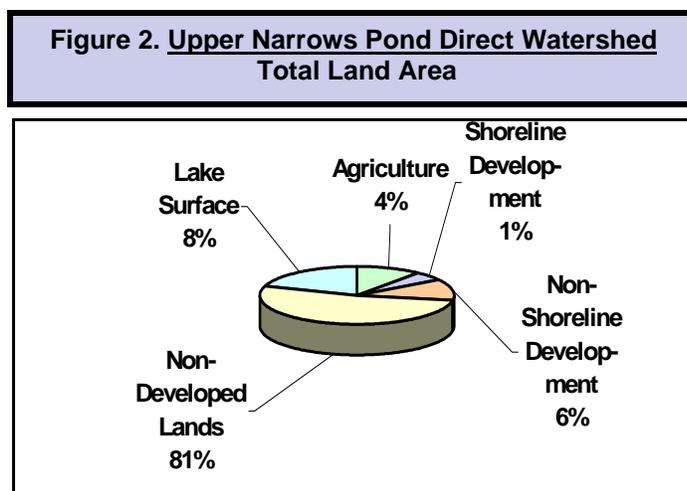
**Inactive/Passively Managed Forests:** Of the total land area within the Upper Narrows Pond watershed, 65% (1,762 acres) is forested, characterized by privately-owned non-managed deciduous and mixed forest plots (CWD 2004). About 13.8% of the phosphorus load is estimated to be derived from non-commercial forested areas within Upper Narrows Pond direct drainage area. Figure 2 depicts the percentage of total land area covered by each land use.

### **Other Non-Developed Land Areas:**

Combined wetlands, scrub and shrub fields and grassland/reverting fields account for the remaining 16.5% of the land area and 12% of the non-developed total phosphorus export load.

### **Atmospheric Deposition (Open Water):**

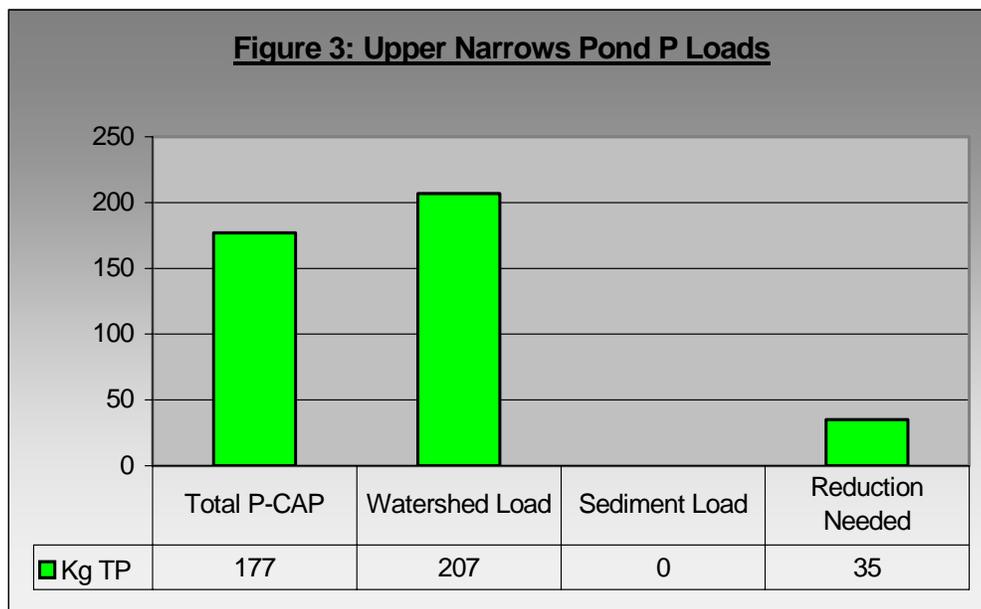
Upper Narrows Pond surface waters (222 acres) comprise 8% of the total watershed area, representing 7% of the total phosphorus load entering Upper Narrows Pond.



## 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, CWD and the Volunteer Lake Monitoring Program, and the development of a phosphorus retention model (see [Appendices](#) for detailed information).

- Total phosphorus loadings to **Upper Narrows Pond** originate from a combination of watershed and lake sediment sources. Watershed total phosphorus sources, totaling 207 kg annually have been identified and accounted for by land use (See Table 3 - page 26).
- Total phosphorus loading from associated upstream **Carlton Pond** accounts for an indirect watershed average load of 50 kg TP annually, determined on the basis of *flushing rate x volume x TP concentration*, representing typical area gauged streamflow calculations.
- The contribution of annually accumulated internal sources of total phosphorus recycled within Upper Narrows Pond sediments is minimal and does not substantially contribute to the annual total phosphorus load at this time.
- The annual total phosphorus contribution to account for future development for Upper Narrows Pond approximates 15 kg.
- The lake's assimilative capacity for all existing and future non-point pollution sources for Upper Narrows Pond is 177 kg of total phosphorus per year, based on a target goal of 9 ppb.
- A change of 1 ppb in phosphorus concentration in Upper Narrows Pond is equivalent to 20 kg. The difference between the target goal of 9 ppb and the measured average summertime total phosphorus concentration (10 ppb) is 1 ppb or 20 kg.
- Given a 15 kg allocation for future development ( $20 \times 0.75$ ), the total amount of phosphorus needed to be reduced, on an annual basis, to maintain water quality standards in Upper Narrows Pond is estimated to be 35 kg ( $20 + 15$ ).



# UPPER NARROWS POND

## PHOSPHORUS CONTROL ACTION PLAN

### Recent and Current NPS/BMP Efforts

A formal watershed survey of Upper Narrows Pond has not been performed since the mid-1970's. The earlier survey was part of a collaborative effort between the CWD and the Southern Kennebec Regional Planning Commission as part of a region-wide Section 208 planning grant. Since that time the CWD has provided extensive land use reviews for the Winthrop Planning Board and the Winthrop Utilities District (WUD). These reviews include several stormwater and phosphorus control plans for the major new commercial development projects and proposed subdivisions as well as expansions to pre-existing developments. Also, the CWD has, on a case-by-case basis, inspected portions of camp roads in the vicinity of Upper Narrows Pond to provide technical support to local landowners.

### Recommendations for Future Work

Specific recommendations regarding recent and current efforts in the watershed, best management practices (BMPs), and actions to reduce external watershed total phosphorus loadings in order to improve water quality conditions in Upper Narrows Pond are as follows:

**Watershed Management:** The CWD has been working cooperatively for several years with the Winthrop Utilities District, Friends of the Cobbossee Watershed, Maine DEP, the Town of Winthrop and, in previous years, the Narrows Pond Improvement Association (NPIA). The NPIA has not been active for several years. It is important for lake associations to stay organized and active in order to take a proactive role as opposed to simply reacting when water quality declines or the resource is threatened. Active participation by those who benefit the most from sustained water quality (maintaining property values and recreation opportunities) sends a clear message to the local and state organizations charged with water quality protection that its shoreline and watershed residents are willing to help protect and enhance the resource as well.

<b>Action Item # 1: Activate the Narrows Pond Improvement Association</b>		
<u>Activity</u>	<u>Participants</u>	<u>Time Schedule</u>
Organize and Activate the NPIA	Shorefront landowners, CWD, WUD, and concerned direct watershed citizens	Immediately

**Shoreline Residential** areas have the greatest potential to negatively impact the water quality of Upper Narrows Pond. The CWD shoreline survey noted that more than one-third of shorefront lots have a moderate to high impact on water quality due to a lack of an adequately vegetated shoreline buffer. In order to mitigate phosphorus export from shoreline residential lots, landowners should be encouraged to implement appropriate shorefront BMPs.

## Action Item # 2: Provide Incentives for Buffer Plantings

<u>Activity</u>	<u>Participants</u>	<u>Schedule &amp; Cost</u>
Encourage shorefront landowners to implement BMPs such as establishing and maintaining vegetative buffers	Shorefront landowners, CWD, <i>Friends</i> , WUD, Winthrop, local contractors, NPIA, and Maine	Ongoing

**Shoreline Septic Systems:** Available options for reducing septic system-related phosphorus loading to Upper Narrows Pond include seeking the replacement of pre-Plumbing Code septic systems and other poorly functioning systems within the shoreland zone of Upper Narrows Pond. Identification of potential problem systems can be accomplished through a combination of shorefront property owner questionnaire surveys and/or formal sanitary surveys (e.g., dye testing). Educational efforts should make residents aware of impending problems and possible cost-effective solutions.

## Action Item # 3: Promote Public Education About Septic System Impacts

<u>Activity</u>	<u>Participants</u>	<u>Schedule &amp; Cost</u>
Distribute educational materials for shoreline residents re: septic systems and water quality	Shorefront landowners, CWD, NPIA, <i>Friends</i> , and the Town of Winthrop.	2005—\$1,500

**Roadways:** The CWD has maintained close communication with local camp road owners in the watershed of Upper Narrows Pond. The majority of camp road surfaces are well maintained by private road owners and pose a limited threat to water quality when compared other similar road networks within the Cobbossee Watershed District. It is anticipated that camp/private road owners will continue to maintain their respective roads out of concern for the water quality.

State and town roads also were determined to represent limited NPS problems. One state road (Route 202) site was noted as a high priority by virtue of its close proximity to the northern end of the pond. No significant problems have been identified that warrant attention at this time.

## Action Item # 4: Continue Monitoring Watershed Roadways

<u>Activity</u>	<u>Participants</u>	<u>Schedule &amp; Cost</u>
Continue monitoring of all watershed roadways for potential NPS impacts and continue to offer technical	Camp road associations, private landowners, CWD, KC-SWCD, Town of Winthrop, Maine DOT,	Ongoing

When erosion or drainage-related problems arise on town roads, the Town of Winthrop has cooperated with the CWD to correct these issues, and CWD will continue to seek this cooperation.

**Individual Actions:** An educational campaign conducted by the CWD in partnership with the *Friends of the Cobbossee Watershed* should be implemented to include a watershed-wide outreach program. Actions that should be encouraged include use of non-phosphate cleaning detergents, establishing or maintaining vegetated buffer strips down-gradient of developed areas, changing lawn practices to include the use of phosphorus-free fertilizer, and practicing proper erosion control during any construction activities, however minor. Also, watershed residents should continue to seek technical assistance through the CWD, KC-SWCD and Maine DEP non-point source pollution prevention programs.

**Agriculture:** The CWD has been in contact with the single farm in the Upper Narrows Pond direct watershed. At this point in time, it is not clear what changes, if any, would be warranted concerning the farm operations. Certainly, continued maintenance of the farm's manure storage facility and vigilance with regard to manure spreading practices, should continue. Additional recommendations will be developed after further farm-specific information is gathered.

**Municipal Action:** The CWD has for years offered technical assistance to the Planning Boards of District towns regarding the review of proposed subdivisions and commercial uses within the Upper Narrows Pond direct watershed. The CWD frequently reviews development proposals for the Town of Winthrop Planning Board to ensure that phosphorus control is adequate to protect the current status of Upper Narrows Pond. The CWD will continue to work cooperatively with the Town of Winthrop in this capacity.

### **WATER QUALITY MONITORING PLAN**

Historically, the water quality of Upper Narrows Pond has been monitored via Secchi disk transparencies, temperature and oxygen profiles, and pH readings during the open water months since 1976. Chlorophyll-a, total phosphorus and associated water chemistry has been monitored on the lake intermittently from 1976 to the present (CWD). Continued long-term water quality monitoring of Upper Narrows Pond for the above-noted parameters will be conducted monthly, from May to October of each year by the CWD. The data are augmented by monthly Secchi disk transparency data provided by a VLMP certified lake monitor. Under this planned, post-TMDL water quality-monitoring scenario, sufficient data will be acquired to adequately track seasonal and inter-annual variation and long-term trends in water quality in Upper Narrows Pond. A post-TMDL adaptive management status report will be prepared five to ten years following EPA approval.

### **PCAP CLOSING STATEMENT**

The Cobbossee Watershed District (CWD) has worked diligently since the early to mid-1970's addressing nonpoint source pollution in the watershed of Upper Narrows Pond and upstream Carlton Pond. Technical assistance by the CWD is available to all District towns to mitigate phosphorus export from existing NPS pollution sources and the prevention of excess loading from future sources through the CWD's technical advice to local planning boards. The CWD towns, including the Town of Winthrop, as well as the Winthrop Utilities District, have long recognized the value of local water resources to the local way of life, the local economy and as a primary source of

drinking water, and thus provide strong support to lake restoration and protection efforts. The Town of Winthrop should be commended for their continued support and cooperation with the CWD in the pursuit of water quality protection and improvement.

The CWD also works closely with the Natural Resources Conservation Service (USDA-NRCS) to collaboratively address agricultural based nutrient loading. The Kennebec County Soil and Water Conservation District regularly joins forces with the CWD to identify NPS sites and develop effective mitigation strategies. The CWD has also worked closely with the recently-formed *Friends of the Cobbossee Watershed*, a watershed made up of 28 waterbodies, of which Upper Narrows Pond is one. This regional watershed group is taking an aggressive and innovative approach to water quality education and outreach, which includes a newsletter, a website, an Education Vessel, and educational workshops for kids as well as a seasonal conservation corps.

Based on the teamwork approach to water quality protection and improvement demonstrated over the past 30 years, there is a very high probability that the CWD will continue to garner support from the local community, regional agencies, and the Maine DEP to maintain the Upper Narrows Pond water quality protection efforts.

# APPENDICES

## UPPER NARROWS POND

### Total Maximum Daily (Annual Phosphorus) Load

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## Introduction to 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 33 lakes in Maine which do not meet water quality standards due to excessive amounts of in-lake total phosphorus.

**The first Maine lake TMDL** was developed (1995) for Cobbossee Lake by the Cobbossee Watershed District (CWD) - under contract with Maine DEP and US-EPA. TMDLs have been approved by US-EPA for Madawaska Lake (Aroostook County), Sebasticook Lake, East Pond (Belgrade Lakes), China Lake, Webber, Threemile and Threecornered ponds (Kennebec County), Mousam and Highland (Duck) lakes in Cumberland County, Annabessacook Lake and Pleasant Pond (Cobbossee Watershed District), and Sabattus, Highland (Bridgton), Unity and Toothaker ponds. PCAP-TMDLs are presently being prepared by Maine DEP, with assistance from the Maine Association of Conservation Districts (MACD) and County Soil and Water Conservation Districts (SWCDs) for Long Lake (Naples & Harrison), Togus, Duckpuddle and Lovejoy ponds, in addition to Little Cobbossee Lake - under separate contract with CWD.

**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 intended by Maine DEP to be used for regulatory purposes.*

For further information, you may contact Dave Halliwell, Maine Department of Environmental Protection, Lakes PCAP-TMDL Program Manager, SHS #17, Augusta, ME 04333 (287-7649).

**Water Quality Monitoring:** (Source: CWD-VLMP 2003) Water quality monitoring data for Upper Narrows Pond has been collected annually since 1976. This water quality assessment is based on 28 years of Secchi disk transparency (SDT) measures, combined with 17 years of epilimnion core total phosphorus (TP) data, and 22 years of water chemistry and chlorophyll-a monitoring data.

**Water Quality Measures:** (Source: CWD and VLMP 2003) Upper Narrows Pond is a non-colored lake (average color 18 SPU's) with an average Secchi disk transparency (SDT) of 5.9 m (19.5 ft). The range of epilimnetic water column total phosphorus (TP) (from epilimnion core samples only) for Upper Narrows Pond is 5-17 parts per billion (ppb) with an average of 9 ppb, while chl-a ranges from 1.2 -15.4 ppb with an average of 4.1 ppb. Recent dissolved oxygen (DO) profiles show moderate depletion in deep areas of the lake. The potential for TP to enter the water column from the bottom sediments and become available to algae (internal loading) is apparently quite low (CWD 2004). Oxygen levels below 5 parts per million (ppm) stress certain cold-water fish and a persistent loss of oxygen may eliminate habitat for sensitive cold-water species.

**Priority Ranking, Pollutant of Concern and Algal Bloom History:** Upper Narrows Pond is listed on the State's 2002 303(d) list of waters in non-attainment of Maine state water quality standards and was moved up in the priority development order due to stakeholder interest and EPA partnership need to complete an accelerated approach to lakes TMDL development. The Upper Narrows Pond TMDL has been developed for total phosphorus, the major limiting nutrient to algae growth in freshwater lakes in Maine.

**Natural Environmental Background Levels** for Upper Narrows Pond were not separated from the total nonpoint source load because of the limited and general nature of available information. Without more and detailed site-specific information on nonpoint source loading, it is very difficult to separate natural background from the total nonpoint source load (US-EPA 1999). There are no known point sources of pollutants to Upper Narrows 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 (<26 SPU) and for higher color lakes where low SDT readings are accompanied by elevated chlorophyll a levels. Upper Narrows Pond is a non-colored lake (average color 22 SPUs), with an average Secchi disk transparency (SDT) of 5.9 m (19.5 ft). The range of epilimnetic water column total phosphorus (TP) (from core samples only) for Upper Narrows Pond is 5-17 parts per billion (ppb) with an average of 9 ppb, while Chl-a ranges from 1.2 -15.4 ppb with an average of 4.1 ppb.

This water quality assessment uses historic documented conditions as the primary basis for comparison. Given the context of "impaired use and enjoyment," along with a realistic interpretation of Maine's goal-oriented Water Quality Standards (WQS), Maine DEP has determined that episodic, non-cyanobacteria based algae blooms (e.g. diatoms), limited to the fall or spring periods only, are in WQS attainment for GPA waters.

**Designated Uses and Antidegradation Policy:** Upper Narrows 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 Upper Narrows Pond, to meet this goal, is conservatively set at 9 ppb total phosphorus (177 kg TP/yr). Since numeric criteria for phosphorus do not exist in Maine's 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 phosphorus concentration that would attain the narrative water quality standard. Spring-time (late April – late May) total phosphorus levels in Upper Narrows Pond approximated 9-12 ppb during 2002. In-lake (epilimnion core) total phosphorus measures during summer and fall periods ranged from 8 to 12 ppb. In summary, the numeric water quality target goal of 9 ppb for total phosphorus in Upper Narrows Pond was based on observed late spring – early summer mixed water column data, corresponding to continued maintenance of 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 3 details the numeric land use data used to determine external phosphorus loading for the Upper Narrows Pond watershed. The key below explains the columns and the narrative that follows the table (pages 27-29) relative to each of the representative land use classes.

#### Key for Columns in Table 3

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

**TP Coeff. Value kg TP/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 (BMPs) installed.

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

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

**Table 3. Upper Narrows Pond Direct Watershed - Phosphorus Export by Land Use Class**

Upper Narrows Pond LAND USE	Land Area Acres	Land Area %	TP Coeff. Range kg/P/ha	TP Coeff. Value kg/TP/ha	Land Area Hectares	TP Exp. Avg. kg TP	TP Exp Total %
<b><u>Agriculture</u></b>			<b><u>Upper</u></b>	<b><u>Narrows</u></b>			
Hayland - Manured	43.0	1.6%	0.65 - 1.81	1.24	17.4	21.6	10.4%
Hayland - Non-Manured	10.0	0.4%	0.35 - 1.81	0.64	4.0	2.6	1.3%
Pasture	30.0	1.1%	0.14 - 4.90	0.81	12.1	9.8	4.7%
Manure Storage	0.1	0.0%	21 - 795	224	0.020	4.5	2.2%
Inactive Orchard	37.1	1.4%	0.06 - 0.75	0.40	15.0	6.0	2.9%
<b>Sub-totals</b>	<b>120</b>	<b>4%</b>	<b><u>Upper</u></b>	<b><u>Narrows</u></b>	<b>49</b>	<b>44.5</b>	<b>22%</b>
<b><u>Shoreline Development</u></b>							
Low Impact Residential	6.7	0.2%	0.25 - 1.75	1.21	2.7	3.3	1.6%
Medium Impact Residential	8.0	0.3%	0.4 - 2.2	1.50	3.3	4.9	2.4%
High Impact Residential	2.3	0.1%	0.56 - 2.7	1.66	0.9	1.5	0.7%
Residential Septic Systems	<i>Septic</i>	<i>System</i>	<i>Model</i>		0	22.6	10.9%
Private and Camp Roads	8.1	0.3%	0.60 - 10.0	2.00	3.3	6.5	3.2%
<b>Sub-totals</b>	<b>25</b>	<b>1%</b>	<b><u>Upper</u></b>	<b><u>Narrows</u></b>	<b>10</b>	<b>39</b>	<b>19%</b>
<b><u>Non-Shoreline Development</u></b>							
Low Density Residential	81.5	3.0%	0.25 - 1.75	0.50	33.0	16.5	8.0%
Parks, Cemeteries	3.8	0.1%	0.25 - 0.98	0.80	1.5	1.2	0.6%
Commercial	28.3	1.0%	0.8 - 4.20	1.40	11.4	16.0	7.7%
State Roads	21.1	0.8%	0.60 - 10.0	1.50	8.5	12.8	6.2%
Town Roads	11.6	0.4%	0.60 - 10.0	1.50	4.7	7.1	3.4%
Institutional	1.3	0.0%	0.8 - 4.20	1.50	0.5	0.8	0.4%
Sand/Salt Storage	2.5	0.1%	0.8 - 4.20	1.50	1.0	1.5	0.7%
<b>Sub-totals</b>	<b>150</b>	<b>5.5%</b>	<b><u>Upper</u></b>	<b><u>Narrows</u></b>	<b>61</b>	<b>56</b>	<b>27%</b>
<b>Total: <u>Developed Land</u></b>	<b>295</b>	<b>11%</b>			<b>119</b>	<b>139</b>	<b>67%</b>
Inactive/Passively Managed Forest	1,762	64.6%	0.01 - 0.2	0.04	713.1	28.5	13.8%
Scrub-Shrub	222.6	8.2%	0.01 - 0.2	0.10	90.1	9.0	4.3%
Grassland/Reverting Fields	194.2	7.1%	0.01 - 0.2	0.20	78.6	15.7	7.6%
Wetlands	33	1.2%	0.02 - 0.83	0.02	13.4	0.3	0.1%
<b>Total: <u>Non-Developed</u></b>	<b>2,212</b>	<b>81%</b>	<b><u>Upper</u></b>	<b><u>Narrows</u></b>	<b>895</b>	<b>54</b>	<b>26%</b>
<b>Total: <u>Surface Water</u></b>	<b>222</b>	<b>8%</b>	<b>0.11 - 0.21</b>	<b>0.16</b>	<b>90</b>	<b>14</b>	<b>7%</b>
<b>Total: <u>DIRECT WATERSHED</u></b>	<b>2,729</b>	<b>100%</b>			<b>1,104</b>	<b>207</b>	<b>100%</b>

## Total Phosphorus Land Use Loads

Estimates of total phosphorus export from different land uses found in the Upper Narrows Pond are presented in Table 3, representing the extent of the current direct watershed phosphorus loading to the lake (207 kg TP/yr). Annual total phosphorus loading from the associated upstream Carlton Pond (50 kg TP) accounts for loading from the indirect watershed, determined on the basis of *flushing rate x volume x TP concentration*, representing typical area gauged streamflow calculations.

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 loadings 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., institutional, commercial).

In some cases (primarily roads and shoreline residential) selected phosphorus loading coefficients were reduced to account for the estimated bioavailability of the soil runoff sources according to available literature (Lee et al. 1980 and Sonzogni et al. 1982) and to better account for algal available-P export values as reflected in Dennis et al. (1992). These adjustments accounted not only for the readily available SRP (soluble-reactive-phosphorus) in the runoff, but also a substantial portion of the particulate inorganic component, particularly the P which is weakly adsorbed on the surface of soil particles (relative to discussion in Chapra 1997, pg. 524). **Note:** *These adjustments in P-load coefficients did not effectively alter the overall conclusions and final recommendations of the Upper Narrows Pond PCAP-TMDL report regarding identified needs and NPS/BMP implementation plans for the Upper Narrows Pond watershed.*

**Agricultural and Forest Operational Lands:** Phosphorus loading coefficients as applied to agricultural land uses were adopted, in part, from Reckhow et al. 1980: (orchard 0.40) Dennis and Sage 1981: low-intensity hayland 0.64 kg TP/ha; and from past Maine DEP 1982 studies.

**Shoreline Residential Lots (House and Camp):** The range of phosphorus loading coefficients used (0.25 – 2.70 kg ha/yr) were developed using information on residential lot stormwater export of algal available phosphorus as derived from Dennis et al (1992).

**Private Camp Roads:** The total phosphorus loading coefficient for private camp roads (2.00 kg/ha) was chosen, in part, from previous studies of rural Maine highways (Dudley et al. 1997), as well as proximity to the waterbody.

### Non-Shoreline Development

**Residential:** Non-shoreline residential areas in the watershed are best characterized as low density residential as reflected in the 0.50 TP loading coefficient.

**Public Roadways:** Town and state roadways (13 ha) were assigned a total phosphorus loading rate of 1.50 kg per hectare per year. This coefficient was chosen, in part, from previous studies of rural Maine highways (Dudley et al. 1997).

**Total Developed Lands Phosphorus Loading:** A total of 70% (139 kg) of the total phosphorus loading to Upper Narrows Pond is estimated to have been derived from the cumulative effect of the preceding cultural land use classes: agriculture (22% - 44.5 kg); non-shoreline development (27% - 56 kg) and shoreline development (19.5% - 39 kg), including septic systems (11% - 23 kg) and camp/private roads (3% - 6.5 kg) – as depicted in Table 3.

**Non-Developed Lands Phosphorus Loading:** The phosphorus export coefficient for forested land (0.04) is based on a New England regional study (Likens et al 1977). The lower total phosphorus loading coefficient chosen for atmospheric deposition (0.16 kg TP/ha) is similar to that

used for the Pleasant Pond TMDL (Kennebec County), while the upper range (0.21 kg TP/ha) generally reflects a watershed that is 50 percent forested, combined with agricultural areas interspersed with urban/suburban land uses (Reckhow et al. 1980).

**Non-Developed Land Uses:** Forested land, wetlands, old field scrub shrub and grassland/reverting fields account for 26% (54 kg) of the total non-cultural or non-developed land total phosphorus export load as depicted in Table 3.

**Atmospheric Deposition (Open Water):** Upper Narrows Pond surface waters (90 ha) comprise 8% of the total watershed area (2,729 ha) and account for an estimated 14 kg of total phosphorus, representing 7% of the total phosphorus load entering Upper Narrows Pond.

### **Phosphorus Load Summary**

It is our professional opinion that the selected export coefficients are appropriate for the Upper Narrows Pond watershed. Results of the land use analysis indicate that a best estimate of the present total phosphorus loading from external (both direct and indirect watershed generated) nonpoint source nutrient pollution approximates 257 kg TP/yr. This annual external watershed generated loading to Upper Narrows Pond equates to a total phosphorus loading modeled at 13 ppb (257 kg TP/year) - 80 kg above the total phosphorus based TMDL target goal of 9 ppb (177 kg TP/year).

### **LINKING WATER QUALITY and POLLUTANT SOURCES**

**Assimilative Loading Capacity:** The Upper Narrows 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 Upper Narrows Pond TMDL as an annual load because the lake basin has an annual flushing rate of 1.50 flushes/year, equaling the average flushing rate for Maine lakes.

The Upper Narrows Pond lake assimilative capacity is capped at 177 kg TP/yr, as derived from the empirical phosphorus retention model based on a target goal of 9 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 9 ppb.

**Future Development:** In order to effectively meet the stated goal of maintaining current trophic state conditions, further reductions in existing watershed phosphorus loading is necessary for two important reasons. First, Upper Narrows Pond has a flushing rate of only 1.5 times per year and is a well-mixed waterbody. Hence, much of the phosphorus laden water in the lake entered from 2 to 5 years ago. Some development has occurred in the watershed over the past 5 years, no doubt resulting in an increase in annual phosphorus loading from the watershed. Given the lag time in lake response to this additional P-load, existing annual watershed phosphorus loads should be reduced by at least the amount of increase in P-load over the past 5 years. The unmitigated rate of increase in Upper Narrows Pond's annual phosphorus load due to new development approximates 15 kg TP/yr (Dennis et al. 1992 application).

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.

This projected amount is a conservative estimate, since most of the development during this period (1999-2003) did in fact incorporate measures to mitigate phosphorus export from the Upper

Narrows Pond watershed. The second reason for the need to further reduce existing watershed P-loads is that growth will, no doubt, continue to occur in the Upper Narrows Pond watershed, contributing new sources of phosphorus to the lake. Previously unaccounted P-loading from anticipated future development on the Upper Narrows Pond watershed is 15 kg (1 ppb change in trophic state = 20 kg x 0.75). Hence, existing phosphorus source loads must be reduced by at least 15 kg/yr to allow for anticipated new sources of phosphorus to Upper Narrows Pond. Reductions already underway in non-point source total phosphorus loadings are expected from the continued implementation of best management practices - primarily from improvements to roadways and residential shoreline vegetative buffer plantings (see NPS/BMP Implementation Plan and PCAP Summary, pp. 18-21).

**Internal Lake Sediment Phosphorus Mass:** The relative contribution of internal sources of total phosphorus within Upper Narrows 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 from late April until mid-November 2002. Estimated in-lake total phosphorus concentrations for this 2-year period ranged from a low of 8.2 ppb on September 6 to a high of 12.5 ppb on November 12. During the spring thru summer monitoring period, in-lake phosphorus levels decreased in Upper Narrows Pond through the growing season. Internal recycling of TP in Upper Narrows Pond does not appear to represent a significant net positive component of the annual total phosphorus budget.

**Linking Pollutant Loading to a Numeric Target:** The basin loading assimilative capacity for Upper Narrows Pond was set at 177 kg/yr of total phosphorus to meet the numeric water quality target of 9 ppb of total phosphorus. A phosphorus retention model, calibrated to in-lake phosphorus data was used to link phosphorus loading to a numeric target.

**Supporting Documentation for the Upper Narrows Pond TMDL Analysis** includes the following: CWD, VLMP, and Maine DEP 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)

$$L = P (A z p) / (1-R) \text{ where: } (1 \text{ ppb change} = 20 \text{ kg})$$

- 177 = L = external total phosphorus load capacity (kg TP/year)
- 9.0 = P = spring overturn total phosphorus concentration (ppb)
- 0.09 = A = lake basin surface area (km<sup>2</sup>)
- 8.00 = z = mean depth of lake basin (m) **A z p = 10.8**
- 1.50 = p = annual flushing rate (flushes/year)
- 0.55 = 1- R = phosphorus retention coefficient, where:
- 0.45 = 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, Sebecook, East, and China Lake TMDLs (2000-2001), and Highland, Webber-Threemile-Threecornered pond complex, Mousam, Annabessacook, Pleasant, Sabattus, Highland (Bridgton), Unity and Toothaker pond PCAP-TMDLs (Maine DEP 2003-2004) have shown this approach to be effective in linking watershed total phosphorus (external) loadings to existing in-lake total P-concentrations.

**Strengths and Weaknesses in the Overall TMDL Analytical Process:** The Upper Narrows 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** - have not yet been observed to occur in Upper Narrows Pond to date. Anoxic conditions in hypolimnetic water occurs during late summer and early autumn, when the potential (frequency and occurrence) of nuisance algae blooms is greatest. However, this has not translated into a significant increase, via entrainment, in the phosphorus concentration in surface water to a level capable of supporting nuisance algal bloom conditions. The total phosphorus loading capacity of 9 ppb was set to achieve desired water quality protection during this critical period, and will also provide protection throughout the year (see Seasonal Variation section).

**LOAD ALLOCATIONS (LA's)** The load allocation for Upper Narrows Pond equals 177 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 3). Direct external TP sources (totaling 207 kg) have been identified and accounted for in the land-use breakdown portrayed in Table 3. Further reductions in non-point source phosphorus loadings are expected from the continued implementation of NPS best management practices (see PCAP pages 19-22). 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 Webber-Threemile-Threecorner Pond TMDLs), in-lake nutrient (phosphorus) loadings in Upper Narrows Pond originate from a combination of direct and indirect external (watershed + Carlton Pond) 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 Upper Narrows 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 Upper Narrows 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 3). Based on both the Upper Narrows Pond historical records and a summary of statewide Maine lakes water quality data for non-colored (< 26 SPU lakes) - the target of 9 ppb (177 kg TP/yr in Upper Narrows Pond) represents a highly conservative goal to assure 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 non-colored Maine lakes indicate that summer nuisance algae blooms (growth of algae which causes Secchi disk transparency to be less than 2 meters) are more likely to occur at 18 ppb or above. The 160 kg difference between the in-lake target of 9 ppb (177 kg) and 17 ppb (337 kg) represents a 47% implicit margin of safety for Upper Narrows Pond.

**SEASONAL VARIATION:** This Upper Narrows 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 1.5 flushes/year, the average annual phosphorus loading is most critical to the water quality in Upper Narrows 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. Nonpoint source best management practices (BMPs) proposed for the Upper Narrows Pond watershed have been designed to address total phosphorus loading during all seasons.

**PUBLIC PARTICIPATION:** Adequate ('full and meaningful') public participation in the Upper Narrows Pond TMDL developmental process was ensured - during which land use and total phosphorus load reductions were discussed - through the following avenues from summer 2002-spring 2004:

1. On July 20, 2004, CWD Project Manager, Bill Monagle met with the Board of Trustees of the Winthrop Utilities District to explain the TMDL process, and the scope of services that the CWD would be providing in the preparation of an Upper Narrows Pond TMDL.
2. CWD Project Manager, Bill Monagle, explained the Upper Narrows Pond TMDL to the CWD Board of Trustees on several occasions beginning with the commencement of the project. The CWD Board of Trustees has two municipally-appointed members from the Town of Winthrop. The meetings of the CWD are held monthly and are publicly noticed.
3. On May 3, 2004, Bill Monagle addressed the Winthrop Town Council to explain CWD's programs and current efforts regarding the Town's lake resources, including the Upper Narrows Pond TMDL.

### **Stakeholder and Public Review Process**

A near final Upper Narrows Pond public draft was reviewed by the primary stakeholder group - Cobbossee Watershed District staff - during the week of November 11-17, 2004. The following advertisement was placed in the ***Kennebec Journal*** (November 27-28 and December 10-11, 2004) and (Winthrop-based) ***Community Advertiser*** over a one-month period (November 19 to December 19, 2004). 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 for the Upper Narrows Pond (DEPLW 2004-0680) watershed, located within the town of Winthrop. This PCAP-TMDL report identifies and provides best estimates of non-point source phosphorus loads for all representative land use classes in the Upper Narrows Pond watershed and the total phosphorus reductions required to establish 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.state.me.us/dep/blwq/comment.htm>. Please send all comments, in writing - by December 19, 2004, to Dave Halliwell, Lakes TMDL Program Manager, Maine DEP, State House Station #17, Augusta, ME 04333. 207-287-7649 or e-mail: david.halliwell@maine.gov.

Comments received by Maine DEP during the Public Review process were limited to a telephone call from an interested lakeshore resident who wanted an explanation (in simple, non-technical language) of what the report was all about, after reading the notification in the Winthrop *Community Advertiser*. The draft two-page project summary report (pp. 4-5) was sent to this individual, with a note to Cobbossee Watershed District manager Bill Monagle to contact for further information.

The *Winthrop Utilities District* also expressed their concerns stressing the importance of Upper Narrows Pond as the primary drinking water supply for the town (CWD communication).

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