MADAWASKA LAKE

Aroostook County - Maine

TOTAL MAXIMUM DAILY (ANNUAL) LOAD

TOTAL PHOSPHORUS

FINAL LAKES TMDL REPORT

DEPLW 2000 - 112

Maine Department of Environmental Protection

20 June 2000

MADAWASKA Lake TMDL, Aroostook County, Maine

Final Report: June 20, 2000 ME-DEP, DEA, Lakes Assessment Section

1. Description of Waterbody, Priority Ranking, Pollutant of Concern, and Pollutant Sources - in Relation to Natural Background Levels

Description of Waterbody

Madawaska Lake (MIDAS #1802) is a 1,564 acre/6.4 km^2, dual true basin waterbody (upper north basin 1 = 1,054 surface acres/4.3 km^2 and lower south basin 2 = 510 surface acres/2.1 km^2) located in T16R4WELS and Westmanland TWPs in Aroostook County, Maine (DeLorme Atlas page 68).

Both basins are fairly shallow with maximum depths of 38 feet (12 m) and mean depths of 16 feet (5 m). These waters are lightly colored (34-36 SPUs), while annual lake flushing rates vary considerably between the two basins (upper basin = 1.5 and lower basin = 4.7). The direct drainage areas for the basins are 21.8 sq. mi. for the upper and 8.0 sq. mi. for the lower (total = 30 sq. mi.).

Drainage System – Johnson Brook and the Cary Pond-Brook and Black Brook complex drain into the upper (northern) lake basin, while a low-head dam, equipped with a fishway-spillway, exists on the outlet of the lower (southern) lake basin (Figure 1). The outlet is directly east of the confluence of McCluskey Brook and feeds into Little Madawaska River, which eventually drains into the Aroostook River in the vicinity of Caribou.

A public boat launch is located on the north end of the upper basin off of Route 161, the major thoroughfare between Caribou and Fort Kent in northern Maine. The major use of Madawaska Lake is recreational, which includes boating, fishing, and beach/residential use (ME-DEP 1994). There are two heavily used privately owned picnic/beach areas situated on the shores of Madawaska Lake.

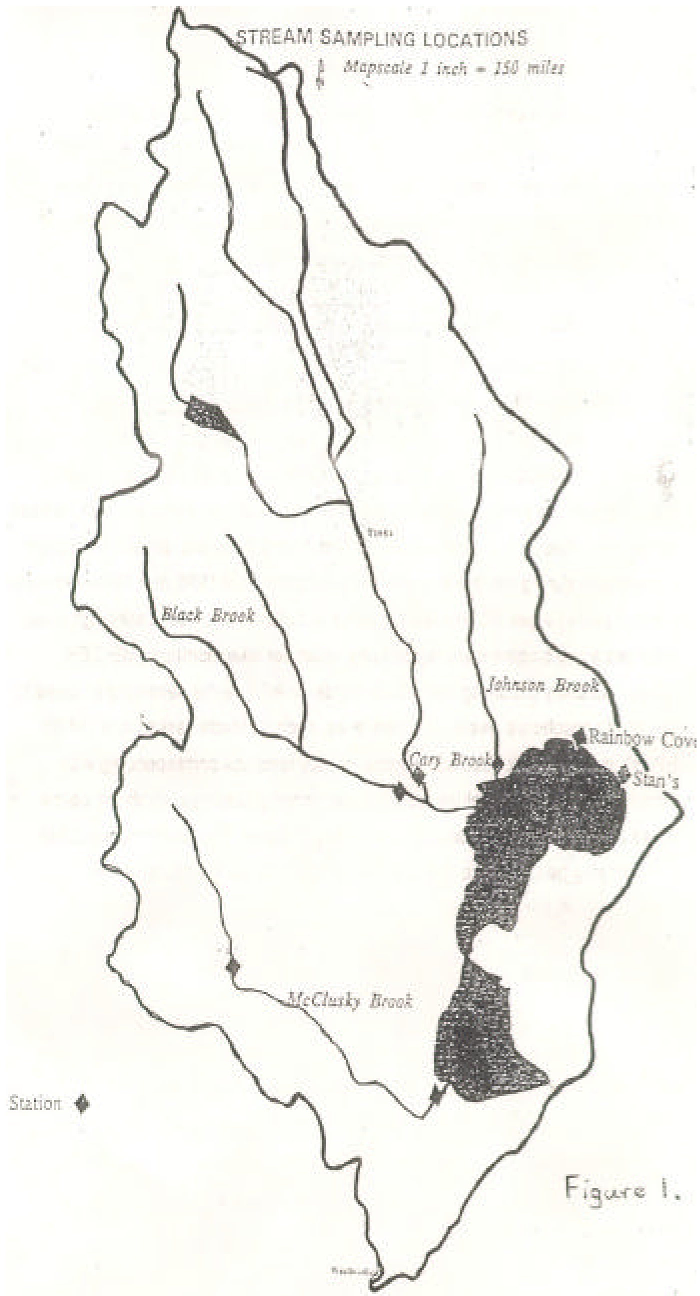
STREAM SAMPLING LOCATIONS
Mapscale 1 inch = 150 miles
Black Brook
Johnson Brook
Rainbow Cov
Stan's
Cary Brook
McClusky Brook
Station

Figure 1.

Human Development – Madawaska Lake is highly developed, with both seasonal camps and year-round residences (MDIFW 1990, ME-LURC 1990). Based on early-1990s statistics, there are 312 lots, 217 on the northern basin and 95 on the southern basin, while a total population of approximately 57,600 people reside within a 50 km radius of the lake (ME-DEP 1994).

Priority Ranking, Pollutant of Concern, and Algae Bloom History

Madawaska Lake is listed as targeted (high priority) on the 303(d) list and the Madawaska Lake TMDL has been developed for total phosphorus, which has been determined to be the major limiting nutrient to algae growth in this system. According to ME-DEP (1994), Madawaska Lake experienced a nuisance algae bloom for the first time in early to mid-July through early September 1987. Based on minimum Secchi disk transparencies less than 2.0 meters, algae blooms were also present during the late summer-early fall periods of 1988 and 1991. Intense (i.e., nuisance) algae blooms did not occur in 1989-90 and 1992, although small, localized algae blooms were reported by volunteer lake monitors (ME-DEP 1994). Naturally occurring water color tends to reduces the sensitivity of lakes to elevated phosphorus levels. Colored lakes, such as Madawaska Lake (34-36 SPUs), may have reduced water transparency readings corresponding with increased phosphorus values, despite chlorophyll-a readings which are below those expected in less colored waters. In such cases, it is recommended that chlorophyll-a be used as a more sensitive and accurate measure of lake productivity (Potvin and Bacon 1998).

Pollutant Sources

This current water quality assessment is based on over 20 years of Secchi disk water transparency measures (1974-98), combined with 5 years of in-lake monitoring data (1980-97), including chlorophyll-a, and 10 years of total phosphorus data (1976-97). In-depth Madawaska Lake water quality data (spring through fall) were collected during a three-year (1990 to 1992) period and reported through a Diagnostic/Feasibility study conducted by ME-DEP (1994).

The existing phosphorus load was estimated and allocated among the combined-basin Madawaska Lake watershed land-use classes and atmospheric deposition. The relative contribution of alternative sources of phosphorus loading (e.g., internal recycling, waterfowl droppings) were addressed (ME-DEP 1994) and dismissed as being insignificant (however, not "assumed" to be negligible – Mattson and Isaac 1999) to the overall phosphorus budget of the Madawaska Lake watershed. In short, the total phosphorus load (both internal and external) are intrinsically addressed through use of the empirically derived Dillon and Rigler model. Indeed, an accounting of external total phosphorus loadings to Madawaska Lake, via major tributary monitoring efforts during 1992 (see Table 1 for calculated tributary phosphorus loadings and Figure 1 for locale), showed estimated P-loads large enough to account for the observed in-lake TP increase (ME-DEP 1994).

Natural Background - levels 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).

Descriptive land use information (used as a basis for Table 2)

Estimates of total phosphorus export from different land uses in the Madawaska Lake watershed are presented in Table 2 and represent the extent of external phosphorus loading to the lake, expressed as a range to reflect a degree of uncertainty associated with such estimates (ME-DEP 1994). The watershed total phosphorus loadings were determined using literature-derived export coefficients (Reckhow et al. 1980, US-EPA 1980, ME-DEP 1981 and 1989, Dennis et al. 1992, and Bouchard et al. 1995) for forest (managed, state-owned, and non-managed); agriculture (rotation crops and CRP); suburban (residential lots/camps, shoreline erosion, and septic systems), commercial-public property, and road-types (logging, highway, private) land use categories.

Table 1. Calculated Phosphorus Loadings from Tributaries.

	Phosphorus kg (lbs)	Area ha (acre)	kg/ha	lb/acre
McKluskey Brook	118 (261)	484 (1,197)	.244	.218
Black Brook	122 (268)	1,326 (3,276)	.091	.082
Cary Brook	123 (271)	2,969 (7,336)	.041	.037
Johnson Brook	92 (203)	795 (1,965)	.116	.103
Rainbow Cove	27 (59)	104 (257)	.257	.230
Boat Landing	4 (9)	13 (33)	.306	.273
TOTAL Phosphorus:	**486 (1,071)**	[for five month sample period]		

Table 2. Estimated total phosphorus export by land use category

Land Use Class & Subclass Non-Point Pollution Sources	Land Area Hectares	Percent Watershed	Total-Phosphorus kg/year	Exp.Coeffic. kg/ha/yr	Percent P-Load
Managed Forest	1,448		724 - 1,086	0.5 - 0.75	
Unmanaged Forest	5,785		202 - 289	.035 - .05	
State Forest	405		14 - 20	.035 - .05	
TOTAL FOREST	**7,638**	**90.2**	**940 - 1,395**		**59 - 63**
Rotation Crops	59		89 - 207	1.5 - 3.5	
USDA CRP*	5		0.5 - 1.5	0.1 - 0.3	
TOTAL AGRICULTURE	**64**	**0.8**	**90 - 209**		**6 - 9**
Residential Lots	49		12 -17	0.25 - 0.35	
Shoreline Erosion	--		87		
Septic Systems	--		57 - 223	2.0 - 4.0**	
TOTAL CAMP/HOME	**49**	**0.6**	**156 - 327**		**10 - 14**
COMMERCIAL	2	--	7	3.5	0.3 - 0.5
PUBLIC	1	--	0.2 - 0.3	0.2 - 0.3	
Logging Roads	52		182 - 281	3.5	
Public Highway	23		64 - 81	3.5	
Camp/Private Roads	10		35 - 48	3.5	
TOTAL ROADS	**85**	**1.0**	**281 - 410**		**17 - 19**
ATMOSPHERIC	**627**	**7.4**	**25 - 31**	**0.04 - 0.05**	**1 - 2**
GRAND TOTALS	**8,466**	**100.0**	**1,499 - 2,379**		**93 - 107**
AVERAGE			**1,939 kg/TP/yr**		

*CRP = USDA Conservation Reserve Program (Bouchard et al. 1995)

*Coefficients adjusted for soil attenuation in final calculation (ME-DEP 1994)

The phosphorus loading from atmospheric deposition was estimated by using a literature derived export coefficient for watersheds dominated by forested land (Reckhow et al. 1980). Of the total land area within the Madawaska Lake watershed, 90.8 percent (7,690 ha) is forested, most of which (88.7 percent or 6,819 ha) is owned and actively managed as a commercial forest by the Van Buren-Madawaska Corporation (ME-DEP 1994).

FOREST – the coefficient range chosen for use in commercial forests (0.5 – 0.75) within the Madawaska Lake watershed reflects the intensity of the forest practices in use (13.5 percent clearcuts and 8.3 percent selective cuts) and are within the range of 0.19 to 0.83 as cited by Reckhow et al. (1980). The coefficient range for non-managed and State forests of 0.035 to 0.05 are similar to those used in the China Lake study (ME-DEP 1989) from central Maine, and generally reflect the high proportion of the forest in softwoods, which have a high precipitation interception rate and evapotranspiration potential. Both of these total phosphorus export coefficient ranges are considered to be conservatively high estimates (ME-DEP 1994), particularly when contrasting the wet, steep sloped West Coast terrain (Reckhow et al. 1980) with the gentle to low slopes of the Madawaska Lake watershed. A combined total range of 59 to 63 percent of the total phosphorus load is estimated to be derived from forested watersheds.

AGRICULTURE – the impact of agricultural practices upon Madawaska Lake is relatively small. As of the early 1990s, there were only 2 active farms in the watershed with a total area of 64 ha (ME-DEP 1994). Most of this farm acreage is rotated 1-1 in potatoes and grain (cover crop) and was assigned a coefficient range of 1.5 – 3.5 (Bouchard et al. 1995). Five hectares are in the Conservation Reserve Program (CRP) and is planted as a close growing and erosion resistant grass and legume mix, which is not intended for harvest over a ten-year period. Land in the CRP was assigned a reduced range of 0.1 – 0.3 kg/ha/yr. Although agriculture, as a land use, comprised less than one percent of the watershed area, its estimated total phosphorus load of 90 – 209 kg accounted for 6.0 – 8.8 percent of the total phosphorus load (ME-DEP 1994). Presently, there are no active/operational farms located in the Madawaska Lake watershed (personal communication, Kathy Hoppe, ME-DEP, Presque Isle office).

CAMP and HOME LOTS – have one of the largest estimated impacts, in terms of total phosphorus loading to the lake, in comparison to its percentage of the watershed. Camp and home lots comprise less than 1 percent of the watershed, however, contribute 156 – 327 kg of total phosphorus, which equals 10 to 14 percent of the estimated total phosphorus load (ME-DEP 1994).

This land-use category was divided into three sub-classes: houselot, shoreline erosion, and septic systems. The range of total phosphorus loading coefficients used for houselots (0.25 – 0.35 kg/ha/yr) is similar to those used for China Lake in Kennebec County, Maine (ME-DEP 1989) and Long Lake, Aroostook County, Maine (Bouchard et al. 1995). The total phosphorus export from shoreline erosion was calculated by the Central Aroostook Soil and Water Conservation District (CASWCD) using data relating to the extent of erosion, and phosphorus concentrations found in shoreline soils, which yielded an estimate of 87 kg/yr.

Total phosphorus loading coefficients for the septic field component are based on the numbers of camps and homes, and the extent of their use. This information was obtained from a sanitary survey conducted by the Madawaska Lake Association during the 1987-88 time period.

ROADS – are divided into three sub-classes: logging, public highway, and camp roads, all of which were estimated at total phosphorus loading rates of 3.5 kg/ha/yr (Dennis et al. 1992). Apparently, there is very little data regarding total phosphorus export from roads, and it is generally believed that the 3.5 kg/ha/yr estimate is probably conservatively high (J. Dennis, ME-DEP, personal communication). Similar to camp and home lots, the roads category of land use accounted for a greater percentage of the total phosphorus load (281 to 410 kg, or 17 – 19%) versus its percentage of the watershed (1.0).

COMMERCIAL and PUBLIC PROPERTIES – there are only two commercial and two (State-owned) public properties located in the Madawaska Lake watershed, which together comprise only 3 ha and approximately 0.5 percent of the total phosphorus load. Differences in export coefficients between these two types of land use generally reflect the relative presence and absence of major foot traffic and auto traffic (commercial parking lots) and associated levels of soil erosion problems.

ATMOSPHERIC DEPOSITION and DRY FALLOUT – is estimated to account for an estimated 25 – 31 kg of total phosphorus, representing 1 to 2 percent of the total load entering Madawaska Lake, with a lake surface comprised of 7.4 percent of the watershed area (ME-DEP 1994). The coefficient range (0.04 to 0.05 kg/ha/yr) used reflects a watershed which is over 90 percent forested, with no large urban or agricultural areas. In contrast, similar studies of Webber Pond and China Lake (more disturbed areas) located in central Maine have used AD/DF estimates of 0.08 to 1.00 (ME-DEP 1981 and 1989), while Reckhow et al. (1980) cites a range of coefficients of 0.07 to 0.54 kg/ha/yr for estimating atmospheric deposition.

A total of 98 percent of the phosphorus loading to Madawaska Lake is estimated to have been derived from the cumulative effects of the preceding four land use classes: forests (61), roads (18), camp and home lots (12), and agricultural practices (7), as depicted in Table 2. It is our professional opinion, based upon ME-DEP experience with other lakes in the Aroostook county region, that the selected export coefficients are appropriate for the Madawaska Lake watershed. Results of this land use analysis indicate that a best estimate of the present total phosphorus loading from nonpoint pollution sources in the watershed is an average of 1,939 kg TP/yr, ranging from 1,499 to 2,379 kg/yr. This loading estimate may be considered somewhat high, as these numbers reflect a period of active farming, and currently there are no active farms in operation (personal communication, Kathy Hoppe, ME-DEP/NRO).

A cross-check of Madawaska Lake total phosphorus loadings with actual data from 1991 algae bloom conditions show the upper end of the pollutant loading

(2,379 kg/yr) to be very similar to the 2,230 kg/yr, corresponding to an average in-lake TP of 17 ppb under algae bloom conditions.

2. Description of Applicable MAINE DEP WATER QUALITY STANDARDS And Determination of Appropriate NUMERIC WATER QUALITY TARGET

Maine State Water Quality Standard – standards 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 tropic 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."

ME-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. Madawaska Lake is a lightly-colored lake (34-36 SPUs), with characteristically low late summer minimal SDT readings (1.0-1.4 meters) accompanied by elevated chlorophyll a levels (17 to 26 ppb) during years in which nuisance algae blooms were evident (1987-88 and 1991-92), as previously discussed in Section 1, page 4 of this report.

From a functional perspective, ME-DEP views clearly negative trends in seasonal SDT means or minima as an indication of increasing trophic state condition. This interpretation 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, we have determined that episodic, non-cyanophyte based algae blooms, limited to the fall or spring periods only, are not considered as non-attainment for GPA waters.

Designated Uses and Antidegradation Policy

Madawaska Lake is designated as a GPA (Great Pond Class A) water in the ME-DEP state water quality regulations. Designated uses for GPA waters in general include: water supply (after disinfection); primary/secondary contact recreation (swimming and fishing); hydroelectric power generation; navigation; and fish and wildlife habitat. According to Maine antidegradation statutes, 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 the characteristics and designated uses of downstream GPA waters or cause an increase in their trophic state. Summertime algae blooms are usually considered to interfere with primary contact recreational pursuits (i.e., swimming).

Numeric Water Quality Target

The numeric (in-lake) water quality target for Madawaska Lake is set at 14 (13-15) ppb total phosphorus. Since numeric criteria for phosphorus do not exist in Maine's state water quality regulations, we used Best Professional Judgement (BPJ) to select a target in-lake phosphorus concentration that would attain the narrative water quality standard. Attainment of Maine state water quality standards were violated during the late summers of 1987 to 1988 and 1991 to 1992 – when late August, in-lake water column total phosphorus concentrations of 17 to 19 ppb were evident, in direct correspondence to elevated levels (16 to 27 ppb) of chlorophyll-a. Corresponding springtime total phosphorus levels in Madawaska Lake averaged 12 to 14 ppb during these time periods (Table 2). Notably, Maine water quality standards were not violated in 1990, when TP values were 14 to 16 ppb throughout much of the summer period (14 ppb in spring) and relatively low chlorophyll-a measures were recorded (2.6 to 7.1 ppb).

In summary, the numeric water quality target goal for total phosphorus in Madawaska Lake (14 ppb) was based on available water quality data (average epilimnion grab/core samples) 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).

3. LOADING CAPACITY and Linking Water Quality and Pollutant Sources

Loading Capacity - the combined basin loading capacity is set at 1,836 kg/yr of total phosphorus. As indicated, the Madawaska Lake 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 Madawaska Lake TMDL as an annual load because the Madawaska Lake basins have relatively long hydraulic residence times (flushes once every 9 months in upper basin and once every 3-4 months in lower basin). Generally, nutrients that enter a lake in the fall or winter may still be available for algae growth the following summer, variable with lake bottom sedimentation loading and release rates (Rippey et al. 1997).

Linking Pollutant Loading to a Numeric Target - the combined-basins loading capacity was set at 1,836 kg/yr of total phosphorus to meet the numeric water quality target of 14 (13-15) ppb of total phosphorus. A phosphorus retention model, calibrated to in-lake phosphorus data, was used to link phosphorus loading to the numeric target (see below). Although flushing rates differ between the two basins of Madawaska Lake, a single target was chosen based on similar levels of phosphorus and timing of algae blooms within lake basins.

Supporting Documentation for the Madawaska Lake TMDL Analysis – includes the following: ME-DEP and VLMP water quality monitoring data, watershed/landuse maps, literature derived export coefficients, specification of phosphorus retention model – including both empirical models and observed retention coefficients.

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

$$L = P\ (A\ \ z\ \ p)\ /\ (1-R)$$

Where, **L** = external total phosphorus load (kg/year)

P = spring overturn total phosphorus concentration (ppb)

A = lake basin surface area (km^2)

z = mean depth of lake basin (m)

p = annual flushing rate (flushes/year)

R = phosphorus retention coefficient, where:

R = 1 / (1+ sq.rt. p) (Larsen and Mercier 1976)

	Upper Basin	**Lower Basin**
P	14 ppb	14 ppb
A	4.3 km^2	2.1 km^2
z	5.0 m	5.0 m
p	1.51/year	4.67/year
R	0.45	0.32
A z p	32.5	49.0
L	**827 kg P/yr**	**1,009 kg P/yr**

Total L (both basins combined) **1,836 kg P/yr**

Previous use of the Vollenwieder, Dillon and Rigler type empirical model (e.g., Cobbossee Lake TMDL, Monagle 1995) has shown this approach to be effective in linking total watershed phosphorus loadings to existing in-lake phosphorus concentrations. Additionally, the hydraulic and morphometric features of Madawaska Lake are within the bounds of the model development data set, following the modifications of Larsen and Mercier (1976). Results of this assessment show that the empirically predicted in-lake spring-time total phosphorus concentration (14 ppb) to be not significantly different from the range of in-lake monitoring data (13 to 15 ppb), indicating that sources other than watershed variables and atmospheric loading are not important contributors to the overall total phosphorus budget.

<u>Strengths and Weaknesses in the Overall TMDL Analytical Process</u>

The Madawaska Lake TMDL was developed using existing water quality monitoring data (Table 1: ME-DEP 1974-1999), derived watershed export coefficients (Reckhow et al. 1980, ME-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) 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-NES) provides a more accurate model for northeastern regional lakes (US-EPA 2000).

Strengths:

- Approach is commonly accepted practice in lake management
- Made best use of available water quality monitoring data (Table 1)
- Export coefficients were derived from extensive data bases,

  and were determined to be appropriate for the application lake.
- 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:

- Greater uncertainty when compared to studies with extensive multi-year water quality monitoring data (e.g., 10-20 years).

<u>Critical Conditions</u>

Critical conditions in Madawaska Lake occur during the summertime, when the potential (frequency and occurrence) of nuisance algae blooms are greatest. The loading capacity of 13-15 ppb of total phosphorus was set to achieve desired water quality standards during this critical time period, and will also provide protection throughout the year (see 'Seasonal Variation,' page 15).

APPENDIX A LOAD ALLOCATIONS (LA's)

The load allocation for all existing and future nonpoint pollution sources for Madawaska Lake is 1,836 kg/yr, as derived from the empirical phosphorus retention model (see 'Loading Capacity' discussion). As previously mentioned, it was not possible to separate natural background from nonpoint pollution sources in this watershed because of the limited and general nature of the available information. Reductions in nonpoint source phosphorus loadings are expected from the implementation of best management practices for roads and shoreline stabilization, as well as replacement of outdated septic systems (see projected implementation plan summary, page 16).

5. WASTE LOAD ALLOCATIONS (WLA's)

As there are no known existing point sources in the Madawaska Lake watershed, the waste load allocation for all existing and future point sources is set at 0 (zero) kg/yr of total phosphorus.

6. MARGIN OF SAFETY (MOS)

An implicit margin of safety was incorporated into the Madawaska Lake TMDL through the conservative selection of the numeric water quality target. Based on a summary of statewide Maine lakes water quality data for colored or >26 SPU lakes, the target of 14 ppb (1,836 kg TP/yr in Madawaska Lake) represents a fairly conservative goal to assure attainment of Maine DEP water quality goals of non-sustained and repeated blue-green summer-time algae blooms due to NPS pollution or cultural eutrophication. The state-wide data base for naturally colored Maine lakes indicate that nuisance algae blooms (plankton growth of algae which causes Secchi disk transparency to be less than 2 meters) are more likely to occur at 17 ppb or above. A range of 14 to16 ppb (1,836 to 2,099 kg TP/yr in Madawaska Lake) is unlikely to result in nuisance algae blooms, particularly in a colored lake. The difference between the in-lake target of 14 ppb and 16 ppb represents a 12.5% (263 kg TP/yr) implicit margin of safety.

7. SEASONAL VARIATION

The Madawaska Lake 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 average hydraulic retention times of 3 to 9 months, the average annual phosphorus loading is most critical to the overall water quality in Madawaska Lake. Madawaska Lake comprises two basins with varying flushing rates: Upper basin 1.5/yr and Lower basin 4.7/yr. ME-DEP lake biologists, as a general rule-of-thumb, use more than five to six flushes annually (bi-monthly) as the cutoff for considering seasonal variation as a major factor in the evaluation of lake total phosphorus loadings to lakes in Maine. Also, the Best Management Practices (BMPs) proposed for the Madawaska Lake watershed have been designed to address total phosphorus loading during all seasons.

APPENDIX A TMDL WATER QUALITY MONITORING PLAN

Historically, the water quality of Madawaska Lake has been monitored via measures of Secchi disk transparencies during the open water months since 1974 (VLMP 1999: Dana Hallowell 1988-present; Connie Bondeson 1998-present, alternate volunteer). Water chemistry data (pH, total alkalinity, specific conductance, color, dissolved oxygen and temperature/depth profiles, and chlorophyll-a) were collected periodically during 5 to 8 (20-30%) of the 24 years of record.

Continued long-term water quality monitoring within the northern and southern drainage basins of Madawaska Lake will be conducted during the open water months (May-October) through the VLMP in cooperation with ME-DEP. Beginning in the late spring – early summer of 2000, deep hole basin parameters will be measured on a monthly basis, including: Secchi disk transparency, dissolved oxygen/temperature/depth profiles, total phosphorus, and chlorophyll-a. Under the planned 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 Madawaska Lake.

APPENDIX A IMPLEMENTATION PLAN and REASONABLE ASSURANCES

Madawaska Lake is a waterbody whose water quality is impaired solely by nonpoint sources (see LA's and WLA's), hence, reasonable assurances that total phosphorus load reductions will be achieved are not required for the TMDL to be approved by EPA (U.S. EPA 1999). However, States are strongly encouraged to provide reasonable assurances regarding achievement of load allocations in their implementation planning efforts.

According to ME-DEP (1994), external sources of total phosphorus account for the majority, if not all, of in-lake TP (loadings). A listing of high priority non-point source (NPS) problem sites found during the watershed survey is available from the Central Aroostook Soil and Water Conservation District (CASWCD).

Specific recommendations (Best Management Practices or BMPs) and actions taken for the reduction of external total phosphorus loadings to improve water quality conditions in Madawaska Lake are as follows (ME-DEP 1994 – also see Appendix A, re. Land Use Recommendations):

(1) Forestry (940 – 1,395 kg TP/yr, + logging roads, 182 – 281 kg TP/yr): Upgrading and proper road maintenance by commercial forestry land holders (i.e., Van Buren-Madawaska Corporation or VB-MC). This would include proper grading (crowning), ditching, and associated seeding, mulching, and stabilization of culvert faces. In addition, VB-MC should make the closing of abandoned logging roads a priority, using acceptable BMPs to put yard areas, tote roads, and skidder trails to bed (seeding and mulching), including proper placement of water bars and diversions.

(2) Non-Forested Roads (99 – 129 kg TP/yr): upgrading and proper road maintenance by both lakeshore residents. This would include proper grading (crowning), ditching, and associated seeding, mulching, and stabilization of culvert faces. Some of this BMP-type roadwork was done by Madawaska Lake shoreline residents during the mid-to-late 1990s (personal communication, Roy Bouchard, ME-DEP).

(3) Septic Systems (57 – 223 kg TP/yr): completion of the septic system sanitary survey by lake shore residents, with the assistance of Presque Isle offices of DEP and Land Use Regulatory Commission (LURC), followed by efforts to renovate and replace outdated systems through landowner assistance programs (e.g., DEP's Small Community Grants program). To date, a fair number of residential septic systems around Madawaska Lake have been updated through year-round use conversions (personal communication, Roy Bouchard, ME-DEP).

(4) Shoreline Erosion (87 kg TP/yr): implementation of a shoreline stabilization buffer strip vegetative cover planting program, with technical assistance from CASWCD and NCRS (formerly SCS), along with active enforcement of the Westmanland shoreland zoning ordinance. To date, no shoreline buffer projects have been completed in the Madawaska Lake watershed (personal communication, Kathy Hoppe, ME-DEP, Presque Isle office).

Maine DEP is confident that a combination of these NPS/BMPs will have a very good chance of achieving the necessary reduction in phosphorus loading (103 kg TP/yr) to Madawaska Lake. This contention is strongly supported by Maine DEP's existing Nonpoint Source Pollution (NPS) Control Program Upgrade and 15 Year Strategy Plan, which was approved by EPA-New England on October 13, 1999. This plan, recognized by the EPA Washington office as "among the best" in the nation, outlines many realistic, yet aggressive, short and long-range goals and actions aimed at reducing pollution from major nonpoint source categories, including transportation, forestry, agriculture, and development. This statewide NPS/BMP plan relies on strong partnerships and offers a commitment to providing outreach and technical assistance in priority NPS watersheds. Madawaska Lake is on both the 1998 303(d) TMDL list and Maine's NPS priority watersheds list, and has been given priority for funding under the implementation of Maine's 319 portion of the NPS program.

10. PUBLIC PARTICIPATION

Adequate ('full and meaningful') public participation in the Madawaska Lake TMDL development process was ensured through the following avenues:

1. Draft TMDL prepared and paper and electronic forms made available, including 'legal' advertising in local newspapers, posting on the ME-DEP Internet Web site, and through normal ME-DEP advertising procedures (information and education). The following ad was printed in the Aroostook Republican (weekly, March 15 and 22, 2000) and The Bangor News (weekend, March 18 and 25, 2000).

   Per requirement (Section 303(d) of the Clean Water Act, 40 CFR Part 130), the Maine Department of Environmental Protection has prepared a Total Maximum Daily-Annual Load (TMDL) nutrient report for total phosphorus for Madawaska Lake, located in Westmanland and T16R4WELS TWPs in Aroostook County. This report identifies non-point source total phosphorus loadings within the Madawaska Lake watershed and reductions required to establish and maintain acceptable water quality standards via adoption of (recommended) Best Management Practices. A draft of the report may be viewed at the ME-DEP Northern Maine Regional Offices in Presque Isle or on-line at: http://www.state.me.us/dep/blwq/update.htm. Click on "Public Comment." Send any comments, in writing by April 12, 2000, to David Halliwell, Lakes TMDL Project Leader, ME-DEP, State House Station #17, Augusta, ME 04333.   207-287-7649 or e-mail: david.halliwell@state.me.us.

2. Solicited public comments received by project staff included requests for the draft TMDL report to: Dr. Ogden Small (multiple copies to send to the various Madawaska Lake road associations and their boards), George Neilson (Chair, Madawaska Lake Campers Association), Steve Miller (First Select-person, Westmanland), Dana Hallowell (Volunteer Lake Monitoring Program – Madawaska Lake representative), Sam Collins, Connie Bondeson, and Bill Sheehan. In addition, Peter Paiette (Reporter from Aroostook Republican) made telephone contact and was provided information.

3. Kathy Hoppe (ME-DEP NRO) was a guest speaker at a June 13, 2000 South Shore Road (and Madawaska Lake Campers) association meeting, attended by an estimated 60 people at the Stockholm School in Madawaska. This meeting was convened to discuss 'road issues' and Kathy provided a briefing on the draft TMDL and past lake studies (i.e., ME-DEP 1994 Diagnostic-Feasibility). She also presented and discussed NPS pollution sources at lakeshore camps and provided BMP remedial approaches.

4. <u>Miscellaneous Notes</u>: Apparently, and according to Kathy Hoppe (February 28, 2000 correspondence), there is no lake association for Madawaska Lake. As referred to above, there are a several 'road associations.' The Little Lake Road in the town of Westmanland has the most 'gravel' road problems in close proximity to Madawaska Lake (lower basin). This road is privately owned by Maine Department of Conservation and Irving Company, and has a road association. Roads along the northern (larger) basin of Madawaska Lake are paved.

5. A one-page Maine Lake TMDL fact sheet was written and a back-page specific Madawaska Lake fact sheet was prepared (see Appendix B). This brief document was designed primarily for non-technical people who are interested in knowing the why, how, and where of lake TMDLs

in Maine. This fact sheet is available and resides adjacent to the draft and final lake TMDLs on the ME-DEP Internet Web Site/home page.

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APPENDIX A

LAND USE RECOMMENDATIONS

From

Maine DEP (1994)

Diagnostic/Feasibility Report

LAND USE RECOMMENDATIONS

This section outlines watershed recommendations. Cooke et al. (1993) states that the first step in lake restoration is to remove or treat inputs of external sources. Data indicate that the majority of phosphorus affecting Madawaska Lake is from external sources. For this reason, (we) concentrate (our) discussion of recommendations on Best Management Practices (BMPs) that can be applied to the watershed to reduce this load. Some of these recommendations are being implemented to some degree at this time. The State of Maine has developed several BMP manuals. These include: forestry (ME Forest Service 1991); erosion and sediment control (Cumberland County Soil and Water Conservation District and State of Maine Department of Environmental Protection 1991); agriculture (ME NPS Agricultural Task Force 1991); and phosphorus control from new development (ME DEP 1992). Copies of these manuals are available from the local DEP office in Presque Isle. Many of the recommendations will require a permit from either the DEP, LURC, or under certain circumstances - the Town of Westmanland. Before (implementing) any recommendations, check with the appropriate agency, or town. Cost estimates are provided when known, otherwise, individual sites or options will differ greatly.

FORESTRY

Although export models indicate that forest lands, excluding roads, produce one of the lowest ratios of kilgograms of phosphorus exported per hectare of watershed, commercial (forest) harvests have been suggested by local residents as having a major effect on the water quality of the lake. Since most discussions have centered around this issue, (we) will discuss it in detail. While the effects of forestry operations on water quality and stream ecology are well documented (Bormann et al. 1974; Martin et al. 1981; and Skille 1991), very few studies have looked directly at phosphorus, and only a few have been conducted in the North-east. Martin et al. (1981) states that timber harvesting reduces nutrient uptake, accelerates mineralization, nitrification, and organic matter breakdown, while increasing soil moisture and water yield. All these factors can lead to a greater nutrient leaching and increases in concentrations in streams. However, Martin et al. (1981) concluded that clearcutting - including the large whole-tree harvests of Maine, alters stream chemistry very little. Phosphorus, however, was not one of the elements studied.

Several factors will effect the amount of nutrients released from a logging site. Smith et al. (1986) found that whole-tree harvesting removed four times the amount of phosphorus that would be removed in bole-only harvests. This study showed that 16 percent of the phosphorus found in above stump biomass was located in roadside slash piles from limbing operations. The authors suggest that forest managers leave these residues scattered on-site, since nutrients released by residue decomposition will help replenish supplies of exchangeable soil nutrients. By leaving the limbed residue on-site instead of piled along the roads and associated ditches, phosphorus export could be reduced. This is supported by a study by MacDonald et al. (1991), which states that microbial decomposition will release unbound phosphate ions, and that dissolved phosphorus can be readily transported to the drainage network. Forest soils have a high capacity to bind dissolved phosphorus through a variety of cation exchange reactions.

Other factors which could effect export of nutrients are the size of clearcut and buffer widths, and the use of herbicides. Martin and Pierce (1980) indicated that clearcutting part of a watershed and leaving buffers substantially reduced nutrient losses from these watersheds. Martin et al. (1981) concluded that clear-cutting practices that maximize the edge effect, such as strip clearcutting, small patch cuts, buffer strips, and (leaving) islands of unmerchantable trees - (all) should reduce the quantity of nutrients reaching streams. These concerns are (also) addressed in the Maine Forest Service standards regarding forest regen-eration and clearcutting, which limits size of clearcuts and establishes buffer zones (Maine Forest Service 1990). The State of Maine Department of Conser-vation Land Use Regulation Commission's Land Use District and Standards (ME

LURC 1991) has set stream buffer strip widths at 22.9 m (75 ft) for flowing waters draining less than 129.5 km^2 (50 mi^2), and 30.5 m (100 ft) buffers for flowing waters draining more than 129.5 km^2. Similar regulations are in place for organized towns. Unless strengthened by individual towns, there is a 22.9 m buffer along all streams, with a 30.5 m buffer on rivers draining more than 64.8 km^2 (25 mi^2), flowing into a Great Pond or along any Great Pond (ME DEP 1993e). There is harvesting allowed in these buffers: 40 percent can be removed over a ten-year period as long as an even distribution of trees remain. Briggs et al. (1989) state that current State of Maine regulations for stream buffer zones seem adequate to minimize adverse changes in (water) temperature or from erosion, and may also be effective for minimizing the movement of nutrients and pesticides from upland to adjacent streams. This view is supported by MacDonald et al. (1991), who states studies from the Pacific Northwest (which) indicate that forest management activities are unlikely to substantially increase phosphorus concentrations in aquatic ecosystems.

Bormann et al. (1974) found that particulate matter increased exponentially after three successive years of herbicide use following a complete de-vegetation clearcut harvest. They suggest (that) the increase was due to biotic control of erodibility being weakened by three years of herbicide spray. It is important to note, however, that the methods employed in this study were purely academic.

Specific site recommendations will not be discussed here, as they are listed in the BMP manual (ME Forest Service 1991), however, from the previous cited studies, several general recommendations for forest practices in the water-shed would include:

1) Maintain buffer strips - minimums would be widths mandated by law. If wind throw is a problem - wider buffer strips would possibly alleviate this situation.
2) Employ winter cuts, or other methods of harvest that will reduce the amount of erosion or mineralization.
3) Limit the use and duration of herbicides. If regeneration can occur unaided, then herbicides should not be used. If substantial re-growth has occurred

within two years of harvest (following) herbicide application - then, (further) application should cease.

4) Minimize yard areas, tote roads, and skidder trails, or any un-vegetated site. Consideration of topography of the intended cut area should be taken into account. The design and location of tote and haul roads, yard areas, and cuts should be such as to minimize impact and reduce erosion as much as possible.
5) Yard areas, tote roads, and skidder trails should be put to bed (seeded and mulched), including water bars and diversions - when the cut is finished. Several types of mixes are available including: Soil Conservation Service mix and Maine Department of Transportation erosion control mix. Estimated cost for hand broadcast and mulching - excluding labor, are: \$4.04 per 10 m^2 (\$3.75/100 ft^2). Estimated cost for hydroseeding - excluding labor and major capital, are: \$22.60 per 100 m^2 (\$21.00/1,000 ft^2).
6) Site considerations and runoff potential should be addressed before clear cutting practices are employed.
7) Water crossings should be kept to a minimum. When made, select sites with firm approaches, and make approaches at right angles to the stream. Temporary culverts or bridges should be used on tote roads and removed when the cut is complete.

NOTE: The major impact of any forestry operation = ROADS, will be discussed under the section entitled Roads.

AGRICULTURE

This land use is not a large portion of the watershed - and most of its load is estimated to come from lands in rotation crops. Again (see Forestry), specific site recommendations will not be discussed here, as they are listed in the agricultural BMP manual (ME NPS Agricultural Task Force 1991). General non-point source reduction practices include:

1) Farms should be under Soil Conservation Service farm plans, which currently all are (Gary Pangburn, personal communication). Part of this plan should address water quality.
2) USDA Conservation Reserve Program (CRP) lands should remain in this program, with additional land added as they become available and economics allow. Estimated cost: $20.25 per hectare ($50.00 per acre).

CAMP/HOME LOTS

As with other land uses, camp lot owners are urged to follow advice given in the erosion and sediment control (manual: Cumberland County Soil and Water Conservation District and State of Maine DEP 1991), and other phosphorus run-off publications - such as phosphorus control for new development (ME DEP 1992). Individuals should contact the regional offices of the DEP or LURC, located in Presque Isle, before performing any ground work within 250-feet (76 meters) of the normal high water mark - as a permit is required. Technical assistance can be obtained from the United States Department of Agriculture Soil Conservation Service (SCS = NRCS), and CASWCD at no, or minimal costs. This category will be divided into three main sub-sections, including: (house) lots, septic systems, and shoreline erosion.

House LOTS

1) Remove private boat launches. There is a state boat ramp, located with easy access, on the big basin (of Madawaska Lake). The lake is small enough that this ramp can service the entire lake. The private launches should be put to bed - this would include leveling the area, installing water bars or diversions if necessary, and seeding and mulching the area. Trees and shrubs should be planted, as this would greatly improve shoreline stabilization, while lowering the water table to allow greater percolation of storm water. Estimated costs, excluding labor, or if done by hand-broadcast and mulching: $4.04/100 m^2 ($3.75/100 ft^2). Average cost for coniferous seedlings are $1 each, shrubs $4 to $6 each, and 1.2 to 1.8 meter (4-6 foot) deciduous trees: $2 each.

2) Diverting rain water and snow melt away from slopes, i.e., driveways and boat launches, to a more stable, vegetated (wooded) area is preferred. This allows water to pool in an area where phosphorus will filter into the soil rather than entering directly into the lake. As the water runs down a driveway, or (boat) launch, it often accelerates and picks up additional soil and associated phosphorus - on its way towards the lake. Estimated cost would be minimal, if done by hand.
3) Plan improvements and new developments to reduce the (total) amount of impervious areas, drives, walkways, outbuildings, etc., as much as possible. This will allow for (greater) percolation and reduce the potential for (soil) erosion. Estimated cost, minimal.
4) Plant more trees and shrubs on the (house) lots. The canopy will intercept rainfall and decrease the amount of soil directly impacted, loosened and transported by rain. In addition, with the increased depth of the root zone (versus planting grass) - the water table will decrease allowing more water to percolate (through the soil). Trees and shrubs can be purchased from local Soil Conservation Service (NRCS) offices. Average cost for coniferous seedlings are $1 each, shrubs $4 to $6 each, and 1.2 to 1.8 meter (4-6 foot) deciduous trees $20 each.

SEPTIC SYSTEMS

This could be one of the most readily fixed non-point sources in the watershed. Many of the Madawaska Lake camp owners (38.7%) - like those on other lakes - do not know where the waste disposal systems are located, while only 18.5% of (septic) systems with known locations meet the minimum setback. Individuals should contact the ME DEP/LURC regional offices located in Presque Isle, before performing any ground work within 250 feet (76 meters) of the normal high water mark. A permit will often, but not always, be needed. Many of the recommendations are listed in the DEP educational pamphlet entitled "Septic Systems, How They Work and How to Keep Them Working" (ME DEP, unpublished). Another excellent source of information is the local plumbing inspector. Some general recommendations include:

1) Place all septic systems back to at least the minimum standard of 100 feet (30.5 meters) from the normal high water mark. In many situations, this would require a lease of additional land or a legal easement. In organized towns, the Department of Human Services will require a legal easement, while in unorganized territories, the Land Use Regulation Commission will accept a legal easement or systems built on leased land. It could become important in the future to allow septic systems installed on leased lands in organized (towns), especially if this is the only alternative to (maintaining) a faulty (septic) system. The lake association should contact the local plumbing inspectors for technical assistance. Estimated cost, excluding buying or leasing land: $5,000 per system.

   For those camps that meet certain criteria, the State of Maine DEP has a program known as "The Small Community Grants" that provides matching funds for the replacement of faulty septic systems. The lake association should contact the DEP's Presque Isle office for more information.

2) Develop a maintenance and pump-out schedule for all septic systems and holding tanks. The ME DEP recommends a 2 to 3 year schedule for year-round residences, and a 4 to 5 year schedule for seasonal camps. The local plumbing inspectors can help determine when pumping is necessary. This action could reduce phosphorus loading as well as (transport of) potential pathogens to the lake. Estimated costs range from $80 to $125 per pumpout.
3) Limit the stress on a septic system. This includes keeping grease and food out of the system, along with chemicals.
4) Do not use chemical or biological septic system cleaners - which can plug leach fields and ruin the (septic) system.
5) Twenty percent of the surveyed camps stated that gray water - from sink and showers - is disposed of in dry wells or on the ground. This practice should stop. Gray water can have just as much, if not more, phosphorus as septic system wastes. Gray water systems should be attached to the septic system.

A properly designed, installed, and functioning (septic) system can easily handle this additional (phosphorus) load.

SHORELINE EROSION

The issue of shoreline erosion at Madawaska Lake has been a source of controversy for several years. The potential solutions to shore erosion comes in two forms: actual shoreline stabilization; and changes in the dam and associated (resultant) water level. Lake water level manipulation will be discussed in the in-lake recommendation flushing section (see below). Individuals should contact the regional offices of the ME DEP or LURC, located in Presque Isle - before performing any ground work within 250 feet (76 meters) of the normal high water mark, as a permit may be required.

Shoreline stabilization must start with the realization that most shoreline erosion is due to human activites, including land clearing. A tour around any lake, including Madawaska, will reveal (that) the greatest shore erosion occurs in front of camps - while most naturally vegetated shores show little to no signs of erosion. It is important to note that shore stabilization is not only the planting of trees and shrubs along the crest or slope of the shore, but is also having plantings back and throughout the camp lot. There are two main options to control shoreline erosion: vegetative and mechanical. These options include:

1) Vegetative shoreline stabilization requires the planting of trees and shrubs along the shoreline in order to hold soil in place. Several willow species (Salix sp.) or dogwoods (Cornus sp.) have been suggested - as they are hardy, water-tolerant, and relatively fast growing (species). In general, cuttings are spaced approximately 18 inches (46 cm) apart, while live stakes are spaced 1 to 3 feet (31 to 91 cm) apart. Technical assistance can be obtained from the SCS (NRCS) or CASWCD. This service is provided free or at minimal cost. Estimated costs for un-rooted cuttings are $0.25 to $0.50 each, while rooted cuttings and live stakes are $1 each.
2) Other new bio-engineering techniques include (both) emergent and wetland herbaceous plant, coconut, and other natural or manufactured fibers - used in

conjunction with woody plants. Herbaceous plants include sedges, rushes, and grasses. Technical assistance can be obtained from the SCS (NRCS), or the CASWCD. This service is provided free or at minimal cost. It is important to note that the market for bio-engineered solutions to shoreline erosion is just evolving, therefore, supply could at times be low and subject (to wide) price swings (Dickerson, personal communication). Estimated costs for peat pots: $0.65 to $1.50 each; bare roots $0.25 to $1 each; rootstock $0.50 to $1.50 each; plant plugs $0.75 to $1.25 each; fiber rolls with installation averages $10 to $11 per linear foot ($33 to $36 per meter); and Biologs (fiber roll, with plants), including installation, averages $10 to $17 per linear foot ($33 to $56 per linear meter).

3) Geotextile fabrics can be used on 3:1 or flatter slopes. It is recommended that geotextile fabric be used with planting, versus use of the fabric alone - as the fabric is not a long-term solution, (but) will disintegrate (over) time. Estimated cost, excluding labor and plantings: $50 per linear foot ($164 per linear meter).

4) Rip-Rap is probably the most commonly used, and best known of the shoreline applied solutions (for stabilization). If installed properly, rip-rap has been found to greatly reduce (shoreline) erosion - even in higher sloped areas and locations with increased wave activity. Under ME DEP standards, rip-rap may only be used on shoreline areas where erosion exists - and it cannot be effectively controlled by vegetation. Costs of rip-rap will vary with the size of the project, length of shoreline, and height of the bank. Estimated cost: $28 per linear foot ($92 per linear meter) of 12-foot (3.7 meter) embankment.

COMMERCIAL PROPERTY

BMPs for commercial and urban development are available from ME DEP. Commercial properties undergo heavy foot and vehicular traffic. Many of the observed (soil erosion) problems can be attributed to a combination of location of the property and nearby roads, including a state highway which acts as a conduit to funnel runoff quickly to the lake. Recommendations include:

1) Divert water from flowing (off) roads to parking areas and redesign parking lots to divert runoff into woody vegetation. Keep impervious surface to a minimum. Cost will be dependent on the extent of (existing) problems.
2) Disperse foot traffic areas in order to discourage the formation of easily eroded foot paths. Estimated cost minimal, if done by hand.
3) If foot traffic can not be dispersed, limit the number of paths and keep them seeded and maintained. Estimated cost, if done by hand, including seeding and mulching: \$3.75 per 100 ft^2 (\$4.04 per 10 m^2).
4) (Limit) vehicle access to the lake to the designated public boat ramp. Although not a major problem, it is one that can be easily rectified by planting a few trees. This would have the added benefit of stabilizing the shoreline areas. Average cost for shrubs \$4 to \$6 each, and 4-6 foot (1.2 to 1.8 meter) deciduous trees: \$20 each.

PUBLIC PROPERTY

Public use in the Madawaska Lake watershed is very minor and does not add a large amount of phosphorus to the lake on a yearly basis. However, there are a few recommendations that, if implemented, could reduce the (total) phosphorus export - including:

1) Seed and mulch all exposed soil and divert foot traffic so as to not develop paths. Estimated costs, if done by hand, including seeding and mulching: \$3.75 per 100 ft^2 (\$4.04 per 10 m^2).
2) Plant shrubs and trees along the banks by Johnson Brook, which transects the public use area on Route 161. This would not only stabilize the bank, but (would also) protect the bank from foot traffic. Average estimated cost for shrubs: \$4 to \$6 each.

ROADS and ASSOCIATED DITCHES

Roads and ditches can, and are estimated in this study - to be large contributors to water quality problems, depending upon construction material, maintenance, traffic, etc. Proper construction, maintenance, and repair are all important in reducing phosphorus loading. Persons involved in road work should implement Best Management Practices. Recommendations made in this section are directed at all three major types of roads: forestry, State, and camp or private. Technical assistance can be obtained from SCS (NRCS) and CASWCD. If a specific type of road is singled out for (further) discussion - it will be noted. General recommendations include:

1) Minimize the size (length and width) of all roads as much as possible, while maintaining safety standards.
2) Roads should be crowned and maintained with material containing a low amount of fine (materials).
3) All (roadside) ditches should be trapezoid in shape (not "V-shaped"), and should be well-vegetated - with adequate turnouts and cross drains. Estimated cost will be site specific. In general, several types of seed mixes are available, including Soil Conservation Service mix and Maine Department of Transportation erosion control mix. Estimated cost for hydroseeding, excluding labor and major capital: \$21.00 per 1,000 ft^2 (\$22.60 per 100 m^2).
4) Culverts should be properly sized, stabilized on both ends with rip-rap, and maintained (on a regular basis).
5) Water crossings should be minimized, and stabilized on both upstream and downstream ends.
6) On steep slopes, place enough water turnouts and cross culverts to reduce (water flow) head pressure and (soil) erosion potential. Since each site has unique qualities, it is possible that certain sites will require more of these measures than called for in the BMPs.
7) Anyone working on, or maintaining roads, should be provided with continual training and education (re. soil and water conservation practices). The State

of Maine Department of Transportation provides training. In addition, there are several education opportunities available - such as the New England Regional Council on Forest Engineering's two-day 'roads and structures' workshop.

8) Dirt roads (located) near the lake should be treated with calcium chloride to prevent the aerial transport of fines and associated phosphorus. Treatment might be required once or twice per year, depending on traffic patterns. Estimated cost: $200 per ton, with application rates of approximately 6 to 7 tons per mile (10 to 11 tons per km).

The next two recommendations are made in regard to the commercial forestry roads, but the first also applies to all roads in the watershed.

1) Reduce the area of exposed soils next to the roads. After a new road as been built, the area next to the road - where excavated road material was obtained, should be leveled, seeded, and mulched. If this area is to be planted in trees, include mulching to reduce phosphorus export. The use of silt fences and hay bales should also be used to contain possible runoff. Work should (be planned to) be done during the dry season (if at all possible).
2) All abandoned logging roads should be put to bed. This would include leveling the area, roads and ditches - including pulling culverts, pulling and stabilizing water crossings, and the installation of water bars and water diversions on long slopes. The whole area should be seeded and mulched, then replanted - if feasible and economical. This (activity) should be done on a continual basis, as more minor logging roads become abandoned.

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APPENDIX B

General

Lakes TMDLs "Fact Sheet"

And

Madawaska Lake

Summary Page

Understanding *LAKE TMDLs* in Maine – Answer's To Questions

What does the acronym 'TMDL' stand for and what does it mean?

'TMDL' is short for 'Total Maximum Daily Load' and is the loading capacity (pollutant budget) of a waterbody, or total amount of a specific pollutant a waterbody can accept and still meet water quality standards. Lake TMDLs are usually nutrient-based and operationally, for lakes - we are primarily interested in accounting for annual total phosphorus loadings originating from non-point sources in the watershed.

How long have TMDLs been around and why the recent interest?

Congress originally included development of TMDLs in the Clean Water Act of 1972 in Section 303(d) to further clean-up waterways that were in non-compliance with existing pollution controls. States are now required to develop prioritized listings of all waters which do not attain water quality standards, and to prepare TMDLs for their impaired waters. Recent interest in non-attainment lists and TMDLs is primarily due to increased public concern over the pace at which water pollution is being addressed.

What are TMDLs based on and what does a TMDL report include?

TMDLs are primarily based on available water quality data (i.e., total phosphorus, chlorophyll-a, Secchi disk transparencies, and dissolved oxygen profiles) and related past reports (e.g., Lake Diagnostic Feasibility studies). TMDL reports include: (1) waterbody description and nature of the water quality problem, with applied nutrient retention models; (2) land-use assessment of the relative contribution of pollutant sources; (3) identification of a numeric target goal (total phosphorus load) to ensure attainment of water quality standards; (4) allocation of pollutant loadings among point (wasteload), non-point (watershed) sources, and natural background conditions, while addressing 'margin of safety' concerns and seasonal variation; and (5) a public participation component to facilitate public review and receipt of comments on TMDLs.

How many waterbodies are actually listed and for what pollutants?

In Maine, there are 53 lakes identified on the 303(d) listing for waters not meeting water quality standards. One lake is listed as a point-source violator, eleven lakes are limited primarily for hydrological/habitat (flow-level) concerns, and three are identified as having dissolved oxygen limitations. The remaining 38 non-attainment lakes have problems with excess total phosphorus and nuisance algal blooms. To date, two lake TMDLs (Cobbossee and Madawaska lakes) have been submitted and approved through US-EPA. Sebasticook Lake is currently under final review (Fall 2000) and will be followed by East Pond (Winter 2001), China Lake (Spring 2001), Mousam Lake (Summer 2001), and Unity Pond (Fall 2001).

***Prepared by Dave Halliwell, ME-DEP with US-EPA and NWF source material.**

MADAWASKA Lake TMDL for Total Phosphorus (TP) 3-2000

Contact: Dave Halliwell, ME-DEP, 207-287-7649, david.halliwell@state.me.us

Lake Characteristics

- Surface Area = 1, 564 acres (6.4 km^2)
- Average Depth = 16 feet (5 meters)
- Maximum Depth = 38 feet (12 meters)
- Average Flushing Rate = 3.1 (3 times per year, 1.5 to 4.7)
- Primary use recreational (swimming/boating/fishing)

Watershed Characteristics

- Direct Drainage Area = 20,920 acres or 8,466 ha (29.8 mi^2)
- Forest is the dominant landcover (90.8 percent) and landuse activity

Total Phosphorus In-Lake Concentrations

- 14 ppb target goal to meet water quality standards
- 17 ppb nuisance algae bloom conditions (1991)

Impairments (from ME-DEP 1994 Diagnostic Feasiblility Report)

- Excess Algal Growth – high total phosphorus, high chlorophyll-a, low transparency

Primary Pollutant Sources (from ME-DEP 1994 D/F Report) 86-96% Acc't.

- Forestry Practices – primarily managed (940-1,395 kg/TP/year, 59-63%)
- Roads – logging, private camps (281-410 kg/TP/yr, 17-19% of TP-Load)
- Residential (camps)/Shoreline Erosion (156-327 kg/TP/yr, 10-14%)

Total Phosphorus Reductions Due to Proposed BMPs

- Forestry Practices (putting to bed/seeding & mulching yard areas, ...
- Roads (logging and private) .....tote roads and skidder trails)
- Residential and Shoreline Erosion (stabilization, vegetated buffer strips)

Other Possible Sources of Future TP Load Reductions

- Local ordinance requiring watershed residents to upgrade septic systems
- Upgrading and proper road maintenance (crowning, ditching, seed/mulch)

SUMMARY: Based on 25 years of water quality monitoring (1974-99), state water quality standards (GE. 2.0 m SDT) were violated in 1987-88 and 1991-92. Since then, marginal water quality conditions have existed, variable with rainfall and extent of soil erosion and transport of phosphorus laden sediments.