Hutchinson

Environmental Sciences Ltd.

Lakeshore Capacity and Fish Habitat Impact Assessment for Horn Lake

Prepared for: Mr. Chris Noll
Job #: J170058

May 1, 2018

1-5 Chancery Lane, Bracebridge, ON P1L 2E3 | 705-645-0021

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HESL Job #: J170058

Mr. Chris Noll
125 Bermondsey Road
Toronto, ON M4A 1X3

Dear Mr. Noll:

Re: Lakeshore Capacity and Fish Habitat Impact Assessment for Horn Lake

Hutchinson Environmental Sciences Ltd. was retained to complete a Lakeshore Capacity Assessment and Fish Habitat Impact Assessment as part of a proposed land severance application on Horn Lake, in the Municipality of Magnetawan, Ontario.

Horn Lake is not over capacity in terms of total phosphorus, recreational capacity or average Mean Volume-Weighted Hypolimnetic Dissolved Oxygen (MVWHDO) concentrations. Modelled total phosphorus (TP) results indicate that the model does not properly represent existing conditions and capacity remains for additional development in relation to the interim Provincial Water Quality Objective guidelines of 10 µg/L or to Background + 50% if a 72% sewage-related total phosphorus retention coefficient is applied to existing development. With sewage treatment using Waterloo Biofilter Systems with EC-P units, the proposed development of 4 lots is modelled to potentially increase TP by <0.01 µg/L and decrease MVWHDO by <0.01 mg/L, increases which are well below regulatory guidelines and are immeasurable through standard laboratory procedures.

Most of the fish habitat fronting the subject property is not critical or sensitive to development of docks. We identified a groundwater seepage area that drains into nursery habitat and potential spawning habitat for some residential species, so this area was afforded a 10m buffer from shoreline structures and development should take place outside of this area.

Sincerely,

per Hutchinson Environmental Sciences Ltd.

Brent Parsons, M.Sc.
Senior Aquatic Scientist
brent.parsons@environmentalsciences.ca

Signatures

Report prepared by:

Brent Parsons, M.Sc.
Senior Aquatic Scientist

Report reviewed by:

Neil Hutchinson, Ph.D.
Principal Scientist

Executive Summary

Hutchinson Environmental Sciences Ltd. (HESL) was retained to complete a Lakeshore Capacity Assessment and Fish Habitat Impact Assessment as part of a proposed land severance application on Horn Lake, in the Municipality of Magnetawan, Ontario. The subject property (Part of Lot 10, Concession 1) is located at the south end of the lake (Figure 1) and the development proposal is to sever the property to create four lots.

Horn Lake supports Lake Trout (*Salvelinus namaycush*), is listed as a natural Lake Trout lake by the Ontario Ministry of Natural Resources and Forestry (MNRF 2015) and is listed as at "capacity" in the Municipality of Magnetawan's Official Plan.

The Lakeshore Capacity Model was not able to predict TP concentrations to within 20% of the measured value and so does not accurately reflect existing conditions. MOE (2010) recommends use of the interim PWQO of 10 µg/L of TP as an upper limit to protect against algal blooms instead of "Background + 50%". In this case, the modelled values of 3.68 µg/L to 3.94 µg/L (depending on % of TP retention and inclusion of vacant lots of record) are well below 10 ug/L and Horn Lake is not considered over capacity for TP.

Although Horn Lake is well below the Interim PWQO of 10 ug/L we do not recommend that 10 ug/L serve as a management limit. Instead, we refined the model to bring the management goals closer in line to the preferred objective of Background + 50%, which corresponds to a lower and more protective TP concentration of 4.51 µg/L. We utilized a scientifically-defensible sewage-related TP retention coefficient of 72% in the model for existing development to better align the model with existing conditions instead of utilizing the 10 µg/L of TP guideline, and the results indicate that capacity does exist on Horn Lake for the 4 proposed lots following this methodology. With sewage treatment using Waterloo Biofilter Systems with EC-P units, the proposed development of 4 lots is modelled to potentially increase TP by <0.01 µg/L and decrease MVWHDO by <0.01 mg/L, increases which are well below regulatory guidelines and are immeasurable through standard laboratory procedures.

Most of the fish habitat fronting the subject property is not critical or sensitive to development of docks. We identified a groundwater seepage area that drains into a nursery habitat and potential spawning habitat for some residential species, so this area was afforded a 10m buffer from the development of shoreline structures. A number of mitigation measures were also recommended in Section 5.3 that will protect fish habitat and ensure that the development follows municipal and federal regulations related to fish habitat.

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1. Introduction

Hutchinson Environmental Sciences Ltd. (HESL) was retained to complete a Lakeshore Capacity Assessment and Fish Habitat Impact Assessment as part of a proposed land severance application on Horn Lake, in the Municipality of Magnetawan, Ontario. The subject property (Part of Lot 10, Concession 1) is located at the south end of the lake (Figure 1) and the development proposal is to sever the property to create four lots. The exact orientation of each lot has yet to be determined so the Fish Habitat Impact Assessment focused on identifying opportunities and constraints to shoreline development across the entire subject property.

Horn Lake supports Lake Trout (*Salvelinus namaycush*), and is listed as a natural Lake Trout lake by the Ontario Ministry of Natural Resources and Forestry ((MNRF) 2015). Lake Trout have stringent habitat requirements including cold-water temperatures and high dissolved oxygen concentrations, and various policies have been adopted to protect this sensitive habitat. Waterfront development and the potential influx of sewage-related phosphorus to an adjacent waterbody has been identified as a stressor on Lake Trout habitat because increased phosphorus concentrations can lead to decreased dissolved oxygen concentrations.

Ontario's Lakeshore Capacity Model (MOE 2010) was developed to determine suitable development capacity on lakes through an assessment of phosphorus and the associated modelling procedure of Molot et al (1992) for dissolved oxygen concentrations, and in the case of Horn Lake, it has been determined that the lake is over capacity in terms of Provincial guidelines (Meridian Planning Consultants Inc. 2012). For recreational lakes on the Precambrian Shield, phosphorus and dissolved oxygen concentrations are the parameters of concern for water quality. The revised Provincial Water Quality Objective (PWQO) for inland lakes on the Precambrian Shield (MOE 2010) allows for a 50% increase in phosphorus concentration from development over levels that would occur in the absence of any development on the lake (i.e., "Background" + 50%) to a maximum concentration of 20 µg/L. The dissolved oxygen guideline for protection of lake trout habitat is 7 mg/L of Mean End-of-Summer Volume-Weighted Hypolimnetic Dissolved Oxygen (MVWHDO).

The Province of Ontario recommends the use of the Lakeshore Capacity Model to determine the interim PWQO for phosphorus and the amount of shoreline development that can occur to maintain phosphorus levels within the phosphorus threshold (MOE 2010). The LCM is a steady-state mass balance model that estimates hydrologic and phosphorus loading from natural (watershed runoff and atmospheric deposition) and human (septic systems and land disturbance) sources and links them together considering lake dynamics to predict total phosphorus concentrations in lakes. Dissolved oxygen is modelled on the basis of lake morphometry and total phosphorus concentrations using the techniques described in Molot et al. (1992) and Clark et al. (2002)

Fish habitat impact assessments are commonly completed in support of waterfront development applications to ensure that impacts to fish habitat are minimized to suitable levels in terms of relevant policies such as the federal Fisheries Act. Habitat is characterized, compared to habitat requirements of resident fish species, and suitable locations for the establishment of shoreline structures, such as boathouses and docks, are determined. Selection of appropriate locations and implementation of mitigation measures to minimize impacts typically results in regulatory approval.

The following assessments were completed to verify whether or not Horn Lake is currently over threshold for additional development, determine suitable locations for the establishment of shoreline structures, and to identify mitigation measures that would minimize any associated impacts to acceptable levels as described by relevant policy.

Legend

- Rivers
- Roads
- Subject Property
- Lakes

Project Lead: Brent Parsons
Prepared by: Kris Hadley
Data Source: HESL,Ontario Land, ESRI
Coordinate System: NAD 1983 UTM Zone 17N

Figure 1:
Study Area

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2. Policy Context

2.1 Municipality of Magnetawan Official Plan

The Municipality of Magnetawan Official Plan (Meridian Planning Consultants Inc. 2012) contains a number of relevant policies which helped define the scope of this study. These policies include those listed under sections 4.3, 4.4 and 5.4.2.

4.3 Surface Water Quality

Preservation of water quality is a significant consideration in reviewing any development proposal adjacent to a watercourse or lake. Septic systems shall be located at least 30 metres from a watercourse or waterbody, and in the case of lakes at or near capacity, including Horn Lake, lot creation and land use changes which would result in a more intensive use will not be permitted except under one of the following special circumstances:

1) to separate existing habitable dwellings, each of which is on a lot that is capable of supporting a class 4 sewage system, provided that the land use would not change and there would be not net increase in phosphorus loading to the lake;

2) where all new tile fields would be located such that they would drain into a drainage basin which is not at capacity;

3) where all new tile fields would be set back at least 300 metres from the shoreline of lakes, or such that drainage from the tile fields would flow at least 300 metres to the lake; and

4) where the proposed site can meet the additional site-specific soils criteria in the Lake Capacity Assessment Handbook and where certain municipal planning tools and agreements are in place such as a Development Permit System under the Planning Act, and/or site plan control under the Planning Act, and site alteration and tree-cutting by-laws under the Municipal Act to implement those criteria.

5) There is an additional criterion accepted by MOE for situations where there are deep soils native to the site (undisturbed and over 3m depth), meeting a specific chemical composition and hydrologic condition. This approach requires site-specific soils investigations by a qualified professional and, if meeting the criteria, would require long-term monitoring and use of planning tools that would ensure long-term maintenance of specified conditions. The MNR and MOE will be consulted if this criterion is considered for Horn Lake.

As a condition of development approval, a natural shoreline vegetation buffer shall be preserved within at least 20 metres of all watercourses and waterbodies wherever possible except for the removal of hazardous trees and a narrow area to allow a pathway to the shoreline. Council may require a wider buffer depending on site-specific conditions and the sensitivity of the adjacent natural heritage features.

Where development would result in a significant increase in storm water run-off, the Municipality shall require the proponent to complete storm water management works that will ensure that off-site surface water quality and quantity is not adversely impacted by the development. Direct outfalls to surface waters should be avoided and wherever possible developments shall utilize infiltration as a method for storm water management.

4.4 Natural Heritage and Resource Management

New development or alterations shall have no negative impact on the natural features or ecological functions of significant habitat of endangered or threatened species, other significant wildlife habitat, fish habitat, a provincially significant wetland or other significant natural heritage feature or function.

5.4.2 Development Standards

Horn Lake has been identified as a lake trout lake that is at capacity. New development including additional lot creation or redevelopment of existing developed lots that would result in more intensive use, shall generally not be permitted except as provided for in Section 4.3 (see above).

The at "capacity" status of Horn Lake in the Magnetawan OP was determined based on an old assessment of optimal Lake Trout habitat in the early 1990s (Sein, R. (MOECC) "Re: Horn Lake" Message to B. Parsons. January 15, 2018. Email). The approach has changed considerably over the last 30 years and is now based on a MVWHDO of 7 mg/L. MOECC has not, however, provided an updated assessment of capacity for Horn Lake on the basis of the newer MVWHDO criterion.

2.2 Fisheries Act

Regulation of fish habitat is carried out under the federal Fisheries Act enforced by Fisheries and Oceans Canada (DFO, Government of Canada, 2015). Section 35(1) of the Act states: "No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery." Furthermore the definition of "serious harm" is "the death of fish, or a permanent alteration to, or destruction of fish habitat", while fish habitat is defined as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes."

Fisheries and Oceans Canada now has a self-assessment process that includes criteria for no DFO review (i.e. if the required footprint of a dock or boat house is less than 20 m^2) and measures to avoid causing harm, both of which are addressed later in the report.

3. Site Description

Horn Lake is a 472 ha lake located on the Precambrian Shield, approximately 10 km east of the Town of Magnetawan (Figure 1). It has a watershed area of 1922 ha, a mean depth of 11.3 m and a maximum depth of 34.7 m (MNR 2010). Shoreline development around the lake consists of 32 year-round residences, 1 resort, 1 mobile home park with 29 trailers, and 138 seasonal properties in both the Municipality of

Magnetawan and Ryerson Township. The subject property proposed development site is in the southwestern portion of the lake.

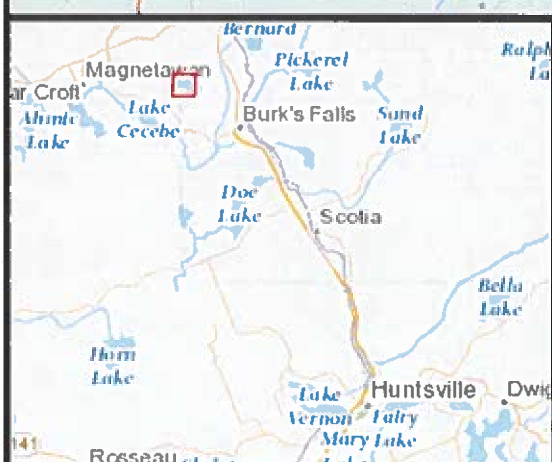
4. Lakeshore Capacity Assessment

4.1 Input Data

The Lakeshore Capacity Assessment used the assumptions and recommended coefficients and constants provided by the MOE (MOE 2010), and data gathered from assessment of satellite imagery, the MNRF's Flow Assessment Tool and Lake Fact Sheet, the Ministry of Environment and Climate Change's (MOECC) Lake Partner Program and Runoff Lookup Database, and water quality sampling as listed in Table 1. Water quality sampling locations are presented on Figure 2. Sampling locations utilized by HESL staff overlapped those used by MNRF during dissolved oxygen sampling and those used by the Lake Partner Program for sampling of total phosphorus.

Table 1. Information on the data used in the Lakeshore Capacity Assessment.

Type of Data	Inputs	Source
Physical	Lake area and depth	Lake Fact Sheet (MNR 2010)
	Catchment and wetland area	Ontario Flow Assessment Tool (MNRF 2017)
Development	Lots and occupancies	Municipality of Magnetawan, Ryerson Township and satellite imagery
Water chemistry	Total phosphorus	Field sampling by HESL staff
		MOECC Lake Partner Program
	Dissolved oxygen	MNRF
		Field sampling by HESL staff
Hydrological	Annual runoff	MOECC Runoff Lookup Database



Legend

- Rivers
- Roads
- Subject Property
- Lakes
- Sampling Locations

Project Lead: Brent Parsons
Prepared by: Kris Hadley
Data Source: HESL,Ontario Land, ESRI
Coordinate System: NAD 1983 UTM Zone 17N

Figure 2:
Water Sampling Locations

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4.2 Measured Total Phosphorus Data

Measured Total Phosphorus (TP) data were compared with modelled TP results to determine the ability of the Lakeshore Capacity Model to accurately estimate TP concentrations. The Province recommends that differences between measured and modelled results be less than 20% to confidently use the model to assess capacity (MOE 2010).

Phosphorus samples have been collected from a central part of Horn Lake since 1994 as part of MOECC's Lake Partner Program (Figure 2). Our assessment focused on data from 2003 onwards because of improvements in collection methodologies since that time such as field filtering and sampling directly into glass tubes that are later used during laboratory analysis (Clark et al. 2010). Total phosphorus sampling is often best completed during spring turnover when the water column is mixed to assess whole lake conditions for studies of lake capacity. Spring overturn phosphorus data were collected in Horn Lake from 2002 to 2016 following improved sampling methodology through the MOECC's Lake Partner program but 2002 data (average = 10.6 µg/L) was not included as it was more than 2.5 standard deviations outside of the mean value of 5 µg/L and the highest average value recorded since that time was 5.3 µg/L in 2007. The average spring overturn phosphorus concentration in Horn Lake between 2003 and 2016 was 4.62 +/- 0.7 µg/L (Table 2).

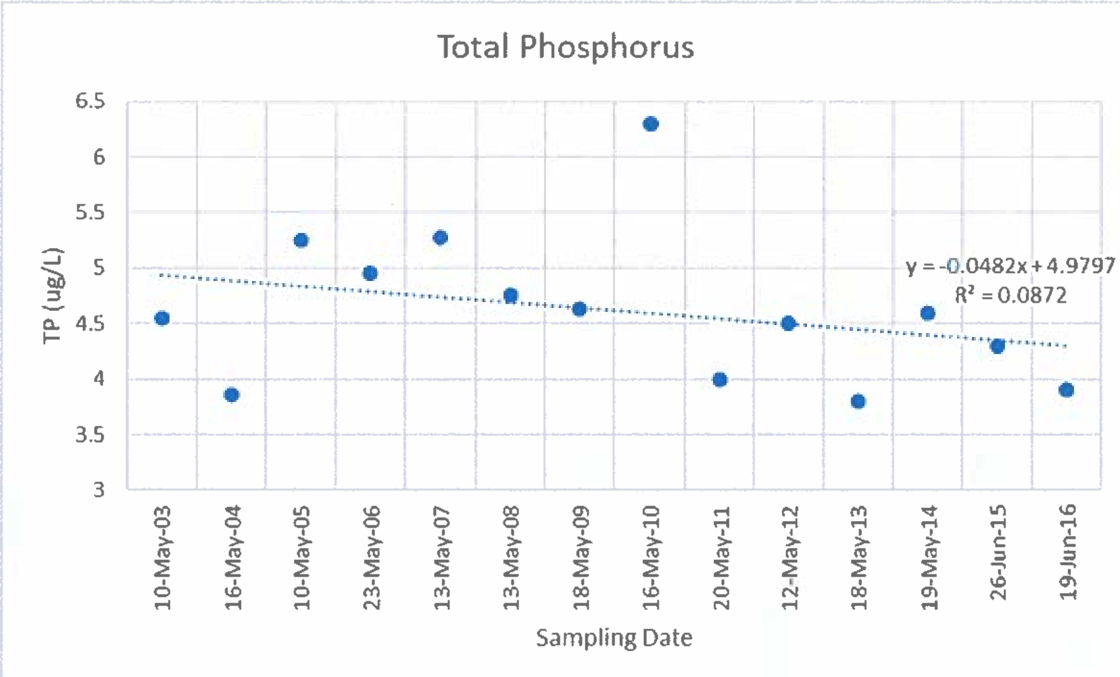
TP results were also plotted over time on Figure 3 to determine if any trends stand-out. Phosphorus concentrations declined between 2003 and 2016 ($y = -0.0482x + 4.9797$; $R^2 = 0.0872$), with a magnitude of change of 0.075 µg/L per year but the trend is not significant ($p = 0.11$).

Table 2. Phosphorus measurements from Horn Lake 2003-2016 (all samples collected from station 2015 in mid lake, deep spot through MOECC's Lake Partner Program).

Date	Phosphorus Concentration (µg/L)	Average Annual Phosphorus Concentration (µg/L)
May 10, 2003	4.2	4.6
	4.9	
May 16, 2004	3.8	3.9
	3.9	
May 10, 2005	4.9	5.3
	5.6	
May 23, 2006	5.3	5.0
	4.6	
May 13, 2007	5.8	5.3
	4.8	

May 13, 2008	5.3	4.8
	4.3	
May 18, 2009	4.5	4.6
	4.7	
May 16, 2010	6.8	6.3
	5.8	
May 20, 2011	4.0	4.0
	4.0	
May 12, 2012	4.4	4.5
	4.6	
May 18, 2013	3.8	3.8
	3.8	
May 19, 2014	4.4	4.6
	4.8	
June 26, 2015	4.0	4.3
	4.6	
June 19, 2016	3.8	3.9
	4.0	
Average		4.62

Figure 3. MOE Lake Partner Program Total Phosphorus Results Over Time



4.3 Measured Mean Volume Weighted Hypolimnetic Dissolved Oxygen

Dissolved oxygen was measured by MNRF throughout the water column in Horn Lake in 1999, 2000, 2001, 2003, 2004, 2006, 2007, 2009 and 2013, and by HESL in 2017 in Basin 1 and 2 (Figure 2). We noted two issues with MNRF data after review.

- MOE (2010) policy dictates that sampling is completed between August 15 and September 15 to capture the time of year when oxygen stress in the hypolimnion is the greatest. It should be noted that data collected by MNRF was outside of this range in 2001, 2009 and 2013, which could potentially misrepresent long-term average conditions.
- The hypolimnion must be determined to calculate MVWHDO. The hypolimnion is the bottom section of a stratified lake and the upper boundary of the hypolimnion is determined based on a temperature gradient between two depth strata that is <1°C/m (Wetzel 2001). MNRF routinely selected the bottom layer of the temperature gradient as the upper limit of the hypolimnion when in fact, the upper layer boundary of this temperature gradient should be used, so that the layer in which temperature first declines <1°C is included in the hypolimnetic volume. We therefore corrected the MVWHDO values to account for inclusion of the entire hypolimnion.

Original and corrected MVWHDO are presented in Table 3, while dissolved oxygen/temperature profiles from HESL sampling on August 18, 2017 are presented in Figures 4 and 5. Corrected MVWHDO concentrations ranged from 6.43 mg/L to 9.61 mg/L, with the four lowest concentrations measured following September 15th (September 18, 2001 = 6.94 mg/L (Basin 1), 7.08 mg/L (Basin 2), September 17, 2009 = 6.71 mg/L (Basin 1), 6.43 (Basin 2)). MVWHDO concentrations were similar in Basin 1 (7.97 mg/L) and 2

(7.70 mg/L). HESL recorded higher MVWHDO (Basin 1 = 8.94 mg/L; Basin 2 = 8.98 mg/L) in 2017 and, as can be seen in Figures 4 and 5, dissolved oxygen remained >4 mg/L near bottom.

Table 3. MVWHDO Results as part of MNRF and HESL Sampling

Source	Date	Basin	MVWHDO (mg/L)	
			Original	Corrected
MNRF	August 31, 1999	1	7.79	9.07
	August 31, 2000	1	7.35	7.69
	August 31, 2000	2	7.40	7.66
	September 18, 2001	1	6.41	6.94
	September 18, 2001	2	6.72	7.08
	September 3, 2003	1	7.41	7.78
	September 3, 2003	2	7.63	8.00
	September 14, 2004	1	8.72	9.61
	September 14, 2004	2	8.05	8.36
	September 14, 2006	1	7.57	7.70
	September 14, 2006	2	7.36	7.58
	September 14, 2007	1	7.50	7.81
	September 14, 2007	2	8.32	8.68
	September 17, 2009	1	6.64	6.71
	September 17, 2009	2	6.37	6.43
	September 23, 2013	1	8.15	8.38
	September 23, 2013	2	7.78	7.83
HESL	August 18, 2017	1	8.94	

	August 18, 2017	2	8.98	
Average (all years)			7.48	7.84
Average (data collected between August 15th and September 15th)			7.73	8.18
Average (Basin 1)			7.50	7.97
Average (Basin 2)			7.45	7.70

Figure 4. Dissolved oxygen and water temperature profile at Basin 1.

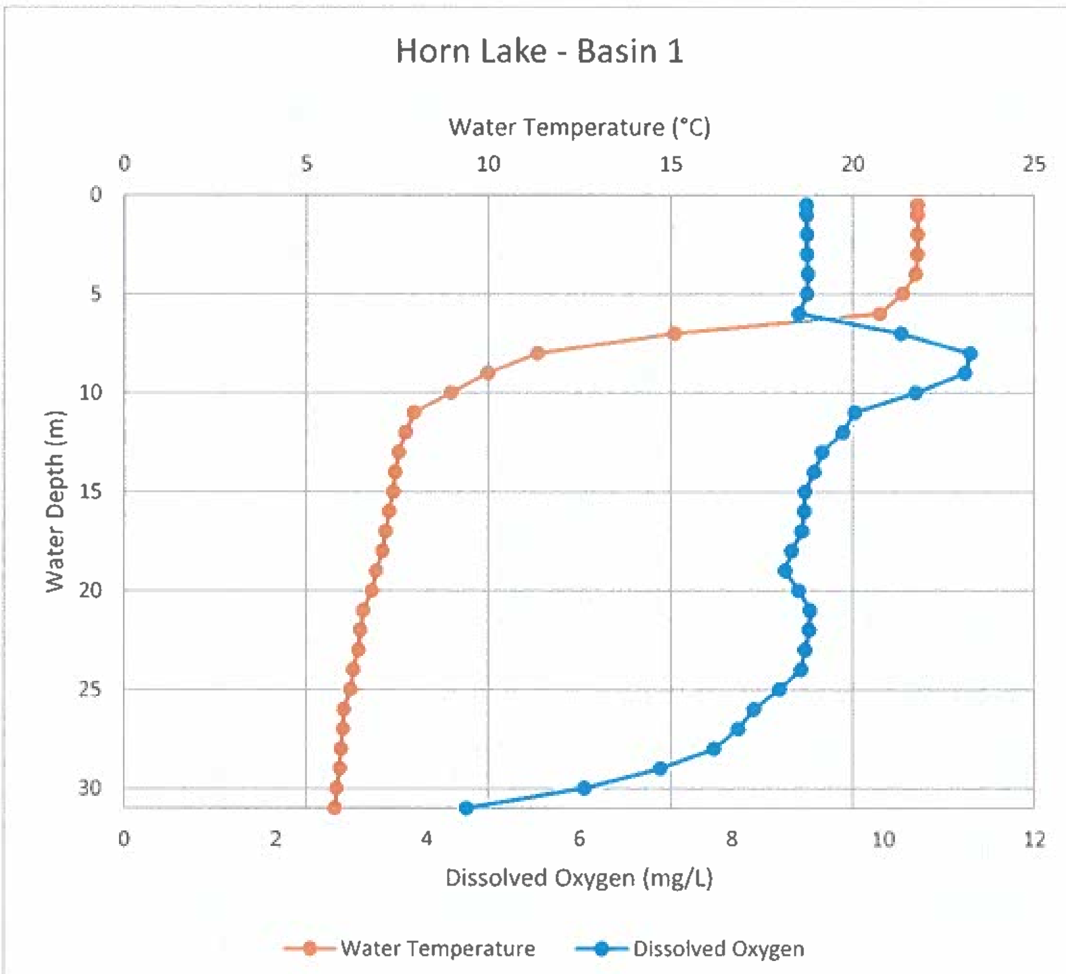
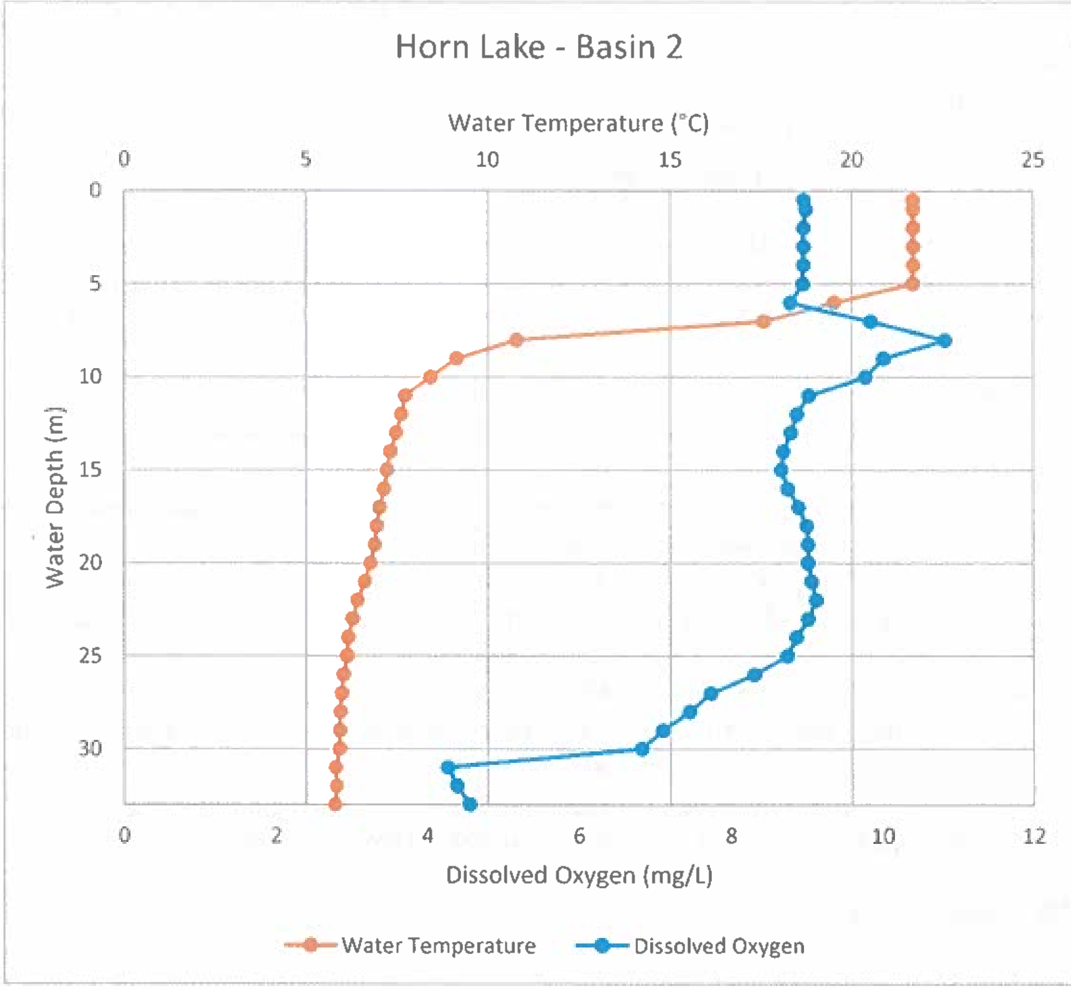


Figure 5. Dissolved oxygen and water temperature profile at Basin 2.



These analyses clearly show that Horn Lake is not at "capacity" in terms of oxygenated hypolimnetic Lake Trout habitat, as average MVWHDO concentrations collected by HESL and by MNRF exceeded 7 mg/L whether corrected or uncorrected.

4.4 Modelling Approach

Horn Lake was modelled using the Lakeshore Capacity Model following the Province's guidance in the Lakeshore Capacity Assessment Handbook (MOE 2010). Input parameters and calculation results used to model TP concentrations in Horn Lake are provided in Appendix A. Detailed methods and assumptions of the model are provided in MOE (2010). The following provides a description and brief rationale for the selection of various coefficients and assumptions used in the modelling of Horn Lake:

- The lake and catchment area of Horn Lake are 472 ha and 1922 ha, respectively.
- TP loading from land area in the Horn Lake watershed was determined using the following equation because % wetland in the catchment was greater than 3.5% and cleared or pastured land was less than 15%:
  - TP (kg/yr) = catchment area (km^2) * (0.47 * % wetland area +3.82)
- A TP loading rate of 0.167 kg/ha/yr was used to calculate TP loads to the surface of the lake from atmospheric deposition.
- Mean annual runoff value from 0.527 m/yr was determined from the runoff look up table provided by the MOECC and used to calculate water loads from the lake basin.
- TP loads from septic systems located within 300 m of the shoreline of the lake were calculated assuming a loading rate of 0.66 kg/capita/yr for each septic system. For existing conditions, a septic usage rate of 0.69 capita yrs/yr for seasonal residences was used.
- All lots included an overland runoff load of 0.04 kg of TP/lot/yr.
- For full build-out of the 4 proposed lots, TP loads were conservatively calculated assuming an extended seasonal usage rate of 1.27 capita years/yr[1].
- A settling velocity of 12.4 m/yr was used to indicate that oxic conditions are present in the hypolimnion of Horn Lake in accordance with dissolved oxygen measurements.

4.5 Capacity Assessment

4.5.1 Total Phosphorus

4.5.1.1 Existing Conditions

The modelled spring-overturn mean TP concentration under existing conditions was 5.73 µg/L; 24% above the measured value of 4.62 µg/L, indicating that the Lakeshore Capacity Model overestimates TP concentration and that the error exceeds the Provincial guidance of acceptable accuracy of +/- 20%. Provincial guidance (MOE 2010) recommends using the interim PWQO of 10 µg/L for TP as a water quality objective where the model is inaccurate.

A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10 µg/L or less. This should apply to all lakes naturally below this value (MOE 2010).

[1] *Usage rates of existing lots were provided by the Municipality of Magnetawan and Ryerson Township. An extended seasonal usage rate for the proposed lots was applied as part of a conservative assessment.*

This results in an additional 378 extended seasonal residences before ice-free TP concentrations are modelled to be greater than 10 µg/L. We therefore adjusted the Lakeshore Capacity Model inputs and assumptions to better reflect actual conditions to produce a better fit with measured values and allow use of the more conservative criterion. The model assumes that all sewage-related phosphorus is transported to the lake and it is most likely this assumption that caused the model to overestimate TP concentrations in Horn Lake.

Research over the past 20 years has consistently shown that septic system phosphorus is immobilized in PreCambrian Shield soils. Mechanistic evidence (Stumm and Morgan, 1970; Jenkins et al., 1971; Isenbeck-Schroter et al., 1993) and direct observations made in septic systems (Willman et al., 1981; Zanini et al., 1997; Robertson et al., 1998; Robertson, 2003) all show strong adsorption of phosphate on charged soil surfaces and mineralization of phosphate with iron (Fe) and aluminum (Al) in soil. The mineralization reactions, in particular, appear to be favoured in acidic and mineral rich groundwater in Precambrian Shield settings (Robertson et al., 1998; Robertson, 2003), such that over 90% of septic phosphorus may be immobilized. The mineralization reactions appear to be permanent (Isenbeck-Schroter et al., 1993). Recent studies conclude that most septic phosphorus may be stable within 0.5 m – 1m of the tile drains in a septic field (Robertson et al., 1998, Robertson, 2003, Robertson 2012).

Trophic status modelling also supports the mechanistic and geochemical evidence. Dillon et al. (1994) reported that only 28% of the potential loading of phosphorus from septic systems around Harp Lake, Muskoka, could be accounted for in the measured phosphorus budget of the lake. The authors attributed the variance between measured and modelled estimates of phosphorus to retention of septic phosphorus in tills that were found in the catchment of Harp Lake, within the geological classifications of Ground Moraine over bedrock, Glaciolacustrine Delta and Outwash Plain (Mollard et al. 1980, Gartner Lee Ltd. 2005).

Hutchinson (2002) recommended that the TP contribution from sewage septic systems be reduced by 74%[2] for lakes with suitable soils in their catchments. Bedrock with undifferentiated igneous and metamorphic rock, exposed at surface or covered by a discontinuous, thin layer of drift is predominant in the Horn Lake catchment (Ontario Geological Survey 2000). These geological formations typically result in acidic soils that are known to retain TP, such as those noted by Robertson (2012) and Hutchinson (2002). We therefore applied a 72% retention coefficient to existing development to determine if this improved the model response.

The modelled spring-overturn ice-free mean TP concentration under existing conditions with 72% retention of sewage related TP was 4.28 µg/L; 7% different than the measured value of 4.62 µg/L, indicating that the Lakeshore Capacity Model does accurately model concentrations in Horn Lake within acceptable limits (i.e. 20%) when a science-based retention coefficient is implemented to account for attenuation of phosphorus from existing development by soils in the catchment (Table 4).

The Lakeshore Capacity Model includes an equation to determine spring overturn TP based on ice-free concentrations as follows:

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[2] *The Hutchinson (2002) citation represents an error – Dillon et al (1994) reported that 28% of septic phosphorus was accounted for in the lake budget (=72% retention) and not 26% (74% retention).*

Spring-overturn TP = (ice-free TP – (-0.563)/0.992

The interim PWQO of Background + 50% to protect against nuisance algal blooms (Table 4; MOE (2010)) was calculated based on the modelled background ice-free mean TP concentration for Horn Lake (3.00 µg/L). The revised PWQO derived from background plus 50% was 4.51 µg/L. Modelled ice-free TP concentrations were 3.68 µg/L, indicating that Horn Lake is currently 0.83 µg/L under capacity in terms of the interim PWQO, or is currently at Background + 23%.

Table 4. Modelled and measured spring overturn TP concentrations for Horn Lake.

Scenario	TP
Modelled Background Total Phosphorus (µg/L) - Ice-Free Conditions	3.00
Revised PWQO of Background + 50% (µg/L) - Ice-Free Conditions	4.51
Existing Modelled Total Phosphorus (µg/L) - Ice Free Conditions - Spring Overturn	3.68 4.28
Existing Measured Total Phosphorus (µg/L) - Spring Overturn	4.62
% difference between modelled and measured:	*-7%*

Horn Lake is currently under capacity for development in terms of TP following existing Provincial guidance. Previous modelling conducted in the early 1990s is what is reflected in the Magnetawan OP policies but this pre-dated the Province's recommended approach for both TP and MVWHDO as described in the Lakeshore Capacity Handbook (Sein, R. (MOECC) Re: Horn Lake. January 15, 2018. Email) and so the previous assessment is no longer valid.

Although Horn Lake has additional capacity we have recommended a number of mitigation measures as described in Section 4.6 as precautionary measures since a) the LCM did not accurately predict existing conditions and b) to protect sensitive Lake Trout habitat. The assessment of Future Conditions in the following section includes implementation of one recommended, optional mitigation measure - septic systems designed to retain sewage-related TP, since the amount of retention helps inform future modelled TP and MVWHDO concentrations.

4.5.1.2 Future Conditions

Many sewage systems have been shown to mitigate phosphorus loads to lakes. These include: the use of phosphorus retaining "B" horizon soils rich in aluminum and iron in septic bed construction, the Ecoflo + DpEC Self-Cleaning Phosphorus Removal Unit, and the Waterloo Biofilter EC-P unit. MOECC have recognized the phosphorus removal capabilities of Waterloo Biofilter System and Ecoflo Biofilter and note that each system should be able to reliably and consistently reduce 88% of sewage related phosphorus before the effluent enters the leaching field (Castro 2015), with further retention likely in the leaching field. The use of phosphorus retaining "B" horizon soils is well documented in the works of Robertson et al. (1998)

and was tested as part of an OMB decision for Kushog Lake and shown to be effective (letter: Castro to Newhook, Oct. 29. 2013).

Altered TP concentrations in Horn Lake associated with the proposed development of 4 extended seasonal lots plus the vacant lots of record were assessed using the Lakeshore Capacity Model under three scenarios of varying TP retention: 0% TP retention, 72% TP retention (as described above) and 88% TP retention (via mitigation technologies) for the additional lots. The build-out of the 4-proposed extended seasonal residences resulted in ice-free TP concentrations ranging from 3.68 µg/L to 3.74 µg/L, depending on the level of TP retention (Table 5). These concentrations represent an increase of <0.01 µg/L to 0.08 µg/ from existing modelled concentrations. Build-out of the proposed 4 lots as well as the vacant lots of record resulted in TP concentrations of 3.75 µg/L to 3.94 µg/L or increases of 0.06 µg/L to 0.26 µg/L from modelled existing conditions. All future predicted concentrations are below the interim PWQO of 4.51 µg/L.

Table 5. Future modelled TP concentrations.

Scenario	TP (µg/L)		
	0% retention	72% retention	88% retention
With build-out of 4 additional extended seasonal residences (µg/L)	3.74	3.70	3.68
With build-out of 4 additional extended seasonal residences and 16 vacant lots of record as extended seasonal residences (µg/L)	3.94	3.76	3.75

4.5.1.3 TP Loads

Phosphorus loads under existing and build-out scenarios were calculated to be less than 26% over the background loads (Table 6) further supporting the conclusion that Horn Lake is under capacity for shoreline development in terms of phosphorus levels.

Table 6. Summary of TP loads to Horn Lake.

Scenario	Horn Lake
Background TP load (kg/yr)	204.3
Existing TP load with 72% retention of sewage-related TP (kg/yr)	250.5
% Increase over Background:	*22.5%*
With build-out of 4 additional extended seasonal residences and 72% retention of sewage-related TP (kg/yr)	251.6
% Increase over Background:	*23.1%*

With build-out of 4 additional extended seasonal residences and 16 vacant lots of record as extended seasonal residences and 72% retention of sewage-related TP (kg/yr)	256.0
% Increase over Background:	*25.3%*

4.5.2 Dissolved Oxygen

MVWHDO can be predicted for individual lakes based on spring overturn TP concentrations following the methods of Molot et al. (1992) and Clark et al. (2002). MNRF used contour volumes from two distinct basins when calculating MVWHDO. We utilized contour volumes from Basin 2 when predicting changes to MVWHDO concentrations since that basin is located closer to the subject property and the terrain indicates that drainage flows roughly towards that area.

Predicted MVWHDO concentrations ranged from 8.02 mg/L to 8.03 mg/L for build-out of the 4 proposed lots, representing a maximum decrease of 0.012 mg/L from the existing modelled concentration of 8.03 mg/L from Basin 2. Predicted MVWHDO concentrations ranged from 7.98 mg/L to 8.02 mg/L for build-out of the 4 proposed lots and 16 vacant lots of record, representing a maximum decrease of 0.055 mg/L from the existing modelled concentration.

Table 7. Modelled spring overturn TP and resulting MVWHDO concentrations.

Scenario	Spring Overturn TP (µg/L)			MVWHDO (mg/L)		
Modelled existing conditions	4.28			8.03		
TP Retention	0% Retention	74% Retention	88% Retention	0% Retention	74% Retention	88% Retention
With build-out of 4 additional extended seasonal residences (kg/yr)	4.34	4.30	4.28	8.02	8.03	8.03
With build-out of 4 additional extended seasonal residences and 16 vacant lots of record as extended seasonal residences (kg/yr)	4.54	4.36	4.35	7.98	8.02	8.02

Modelled existing MVWHDO concentrations (8.03 mg/L) are higher than the majority of average measured values presented in Table 3 but the same magnitude of predicted change can be applied to measured MVWHDO concentrations in Basin 2. Full build-out of the 4 proposed lots and 16 vacant lots of record with 0% retention of septic-related TP resulted in a 0.04 mg/L change (8.02 mg/L → 7.98 mg/L) in modelled MVWHDO concentrations. The uncorrected measured MVWHDO concentration of 7.45 mg/L in Basin 2 would therefore be modelled to decrease to 7.41 mg/L under that conservative scenario; all other measured values would be even greater than the guidance value MVWHDO of 7 mg/L.

4.5.3 Recreational Carrying Capacity

Recreational Carrying Capacity is another component of lake management that is used in some jurisdictions (i.e. Seguin Township) to manage development to control overcrowding. A development density of 1 lot/1.62 ha of lake surface area is used in Seguin Township as a "filter" for "crowding" or social density to reflect recreational use of lake surface areas, an approach which was upheld in an OMB decision of December 22, 2016. This filter equates to a Recreational Carrying Capacity of 291 lots for Horn Lake which is much higher than the 222 seasonal, permanent, resort units, mobile trailer lots and vacant lots of record (Section 3). The proposed addition of 4 lots development would therefore not result in over-crowding based on this metric.

4.6 Mitigation Measures

Horn Lake is not at capacity but a variety of mitigation measures should still be utilized during waterfront development to minimize short and long-term impacts associated with water quality as a precautionary measure since the LCM did not accurately predict existing conditions and to protect sensitive Lake Trout habitat. Mitigation measures #1 - #3 are already required through the Municipality of Magnetawan Official Plan and we recommend two additional approaches.

1. Septic systems shall be located at least 30 metres from a watercourse or waterbody.

2. As a condition of development approval, a natural shoreline vegetation buffer shall be preserved within at least 20 metres of all watercourses and waterbodies wherever possible except for the removal of hazardous trees and a narrow area to allow a pathway to the shoreline.

3. Where development would result in a significant increase in storm water run-off, the Municipality shall require the proponent to complete storm water management works that will ensure that off-site surface water quality and quantity is not adversely impacted by the development. Direct outfalls to surface waters should be avoided and wherever possible developments shall utilize infiltration as a method for storm water management.

    - We recommend discharging of roof leaders, use of soak away pits and other measures to promote infiltration. Other specific design options for consideration include: grassed and vegetated swales, filter strips, roof leaders and French drains which have all proven to be effective at mitigating impacts associated with stormwater.

4. We recommend implementation of an Erosion and Sediment Control plan during construction, which should (CISEC Canada 2012):

- Utilize a multi-barrier approach;
- Retain existing vegetation;
- Minimize land disturbance area;
- Slow down and retain runoff to promote settling;
- Divert runoff from problem areas;
- Minimize slope length and gradient of disturbed areas;
- Maintain overland sheet flows and avid concentrate flows; and
- Store/stockpile soil away from watercourses, drainage features, and tops of steep slopes.

5. Utilize Waterloo Biofilter Systems with EC-P units to minimize sewage related-TP.

Additional information regarding waterfront development Best Management Practices can be found in "Protect Your Waterfront Investment" (Muskoka Watershed Council; Appendix B).

4.7 Discussion

MNRF has a criterion of 7 mg/L of MVWHDO for the protection of Lake Trout habitat. The Province recommends that generally there will be no new development within 300 metres of Lake Trout lakes where MVWHDO has been measured to be at or below 7 mg/L. This recommendation also applies to lakes where modelling has determined that development would reduce MVWDHO to 7 mg/L or less. Although MVWDO concentrations less than 7 mg/L were recorded on September 18, 2001 and September 17, 2009, both of those dates lie outside of the MOECC-determined sampling window of August 15th to September 15th. Average MVWHDO concentrations were greater than 7 mg/L in both basins and the focus should be on the long-term average values because of issues related to inter-annual variability, including equipment and user error, in accordance with MOE (2010):

"When attempting to characterize lakes in this manner, it is preferable to use average profiles which are derived from several years of data to offset the effects of inter-annual variation. This approach will allow the description of average conditions in a lake's hypolimnion at the end of summer and compare between-lake differences under similar conditions."

The Lakeshore Capacity Model was not able to predict TP concentrations to within 20% of the measured value and so does not accurately reflect existing conditions. MOE (2010) recommends use of the interim PWQO of 10 µg/L of TP as an upper limit to protect against algal blooms instead of "Background + 50%". In this case, the modelled values of 3.68 µg/L to 3.94 µg/L (depending on % of TP retention and inclusion of vacant lots of record) are well below 10 ug/L and Horn Lake is not considered over capacity for TP.

Although Horn Lake is well below the Interim PWQO of 10 ug/L we do not recommend that 10 ug/L serve as a management limit. Instead, we refined the model to bring the management goals closer in line to the preferred objective of Background + 50%. We utilized a scientifically-defensible sewage-related TP retention coefficient of 72% in the model for existing development to better align the model with existing conditions instead of utilizing the 10 µg/L of TP guideline, and the results indicate that capacity does exist on Horn Lake for the 4 proposed lots following this methodology. The proposed development of the 4 lots is modelled to increase TP by <0.01 µg/L and decrease MVWHDO by <0.01 mg/L with implementation of Waterloo Biofilter Systems with a EC-P units, both of which result in concentrations well below regulatory guidelines and are immeasurable through standard laboratory procedures. Mitigation measures listed in 4.6 further ensure that impacts to water quality will be minimized to acceptable levels in accordance with relevant municipal and provincial policy.

5. Fish Habitat Impact Assessment

MNRF fish habitat mapping did not indicate Type 1 habitat fronting the subject property but a Fish Habitat Impact Assessment (FHIA) was completed because such mapping is not always accurate as it was based on air photo interpretation. Documentation and an understanding of site-specific conditions allowed for the development of recommendations that will ensure shoreline development will adhere to policies outlined in the Municipality of Magnetawan Official Plan and the Fisheries Act.

Fish habitat was characterized in the littoral environment and compared to the habitat requirements of various resident fish species to classify the environment in terms of functionality (e.g. spawning) and resiliency per MNRF guidelines. The assessment was completed based on the proposed development of docks, the characterization of fish habitat features and functions, and the incorporation of a number of short and long-term mitigation measures.

The assessment of the subject properties' littoral and riparian environments was completed through a review of background material and a field investigation undertaken on August 18, 2017.

5.1 Background Review

A fish species list for Horn Lake and MNRF fish habitat mapping were reviewed to determine the perceived habitat value of the nearshore environment of the study area (MNR 2010).

5.1.1 Fish Habitat Mapping

The MNRF has developed three categories or habitat types to standardize the assessment of fish habitat (MNR 1994). Below is a summary of the characteristics of each habitat type and its sensitivities.

Type 1 Habitat

Habitats are rare or highly sensitive to the potential impacts of development or limit fish productivity either directly or indirectly in a specified water body or portion of a water body. Where these habitats are limiting, productivity would be expected to diminish if they are harmed.

Type 2 Habitat

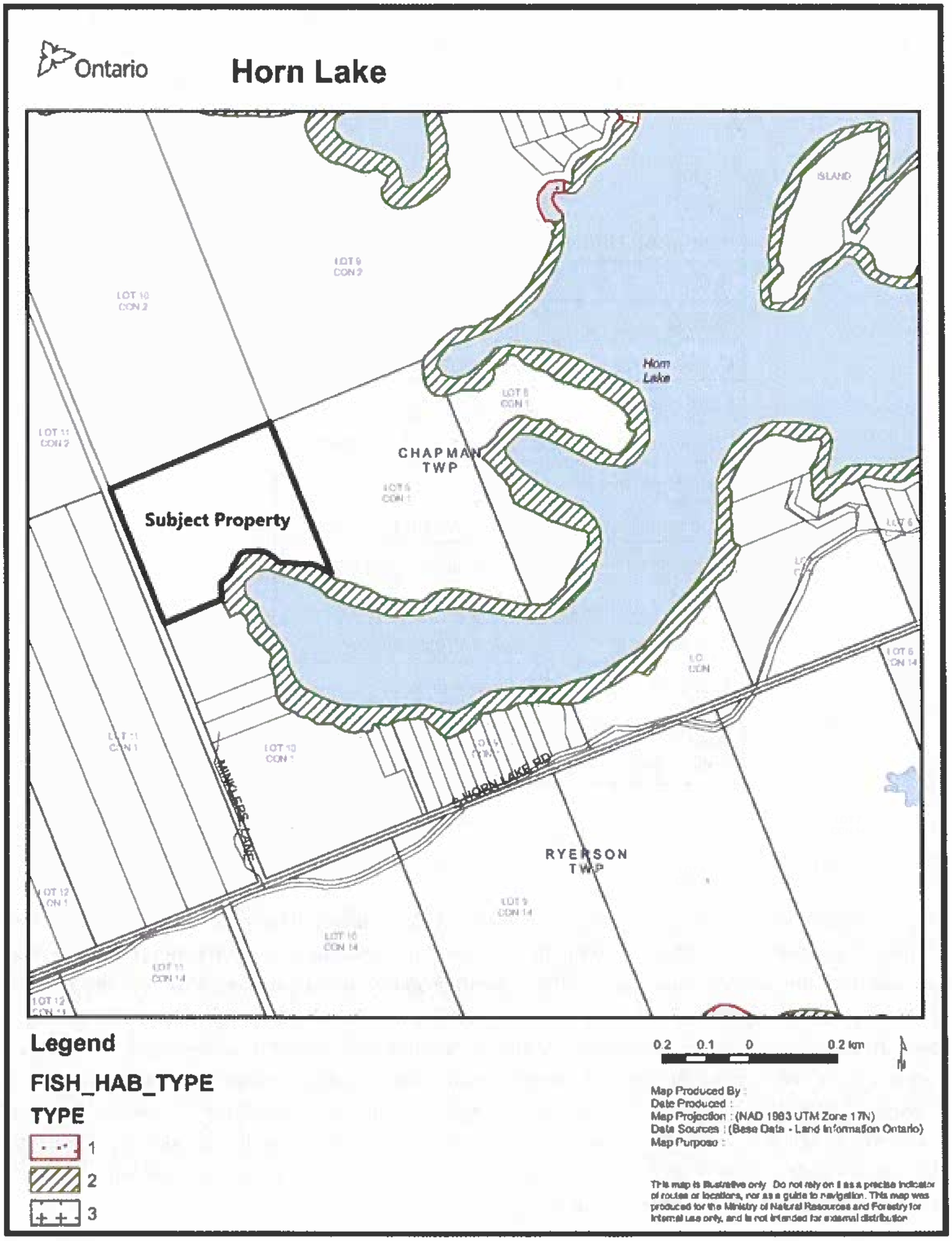
Habitats that are moderately sensitive to the potential impacts of development and although important to fish populations, do not limit the productivity of fish either directly or indirectly. These habitats are usually abundant and another habitat component is the limiting factor in fish production.

Type 3 Habitat

Habitats that are marginal or highly degraded, and currently do not contribute directly to fish productivity, based on fish community management objectives. Type 3 habitats can often be improved significantly, thereby providing a net gain of productive capacity.

Fish habitat classified in front of the subject property was entirely Type 2 (Figure 6).

Figure 6. MNRF Fish Habitat Mapping



5.1.2 Fish Species List

MNRF has recorded 13 fish species in Horn Lake, including the following game fish species: Lake Trout, Smallmouth Bass (*Micropterus dolomieu*), Walleye (*Sander vitreus*), Yellow Perch (*Perca flavescens*), Rainbow Trout (*Oncorhynchus mykiss*), and Brook Trout (*Salvelinus fontinalis*; Table 8). The lake was stocked for Lake Trout and Brook Trout between 1945 and 2000 (MNR 2010).

Table 8. Fish species in Horn Lake.

Common Name	Scientific Name
Brown Bullhead	*Ameiurus nebulosus*
Burbot	*Lota lota*
Creek Chub	*Semotilus atromaculatus*
Lake Trout	*Salvelinus namycush*
Lake Whitefish	*Coregonus clupeaformis*
Rainbow Smelt	*Osmerus mordax*
Rainbow Trout	*Oncorhynchus mykiss*
Rock Bass	*Ambloplites rupestris*
Smallmouth Bass	*Micropterus dolomieu*
Brook Trout	*Salvelinus fontinalis*
Walleye	*Sander vitreus*
White Sucker	*Catostomus commersonii*
Yellow Perch	*Perca flavescens*

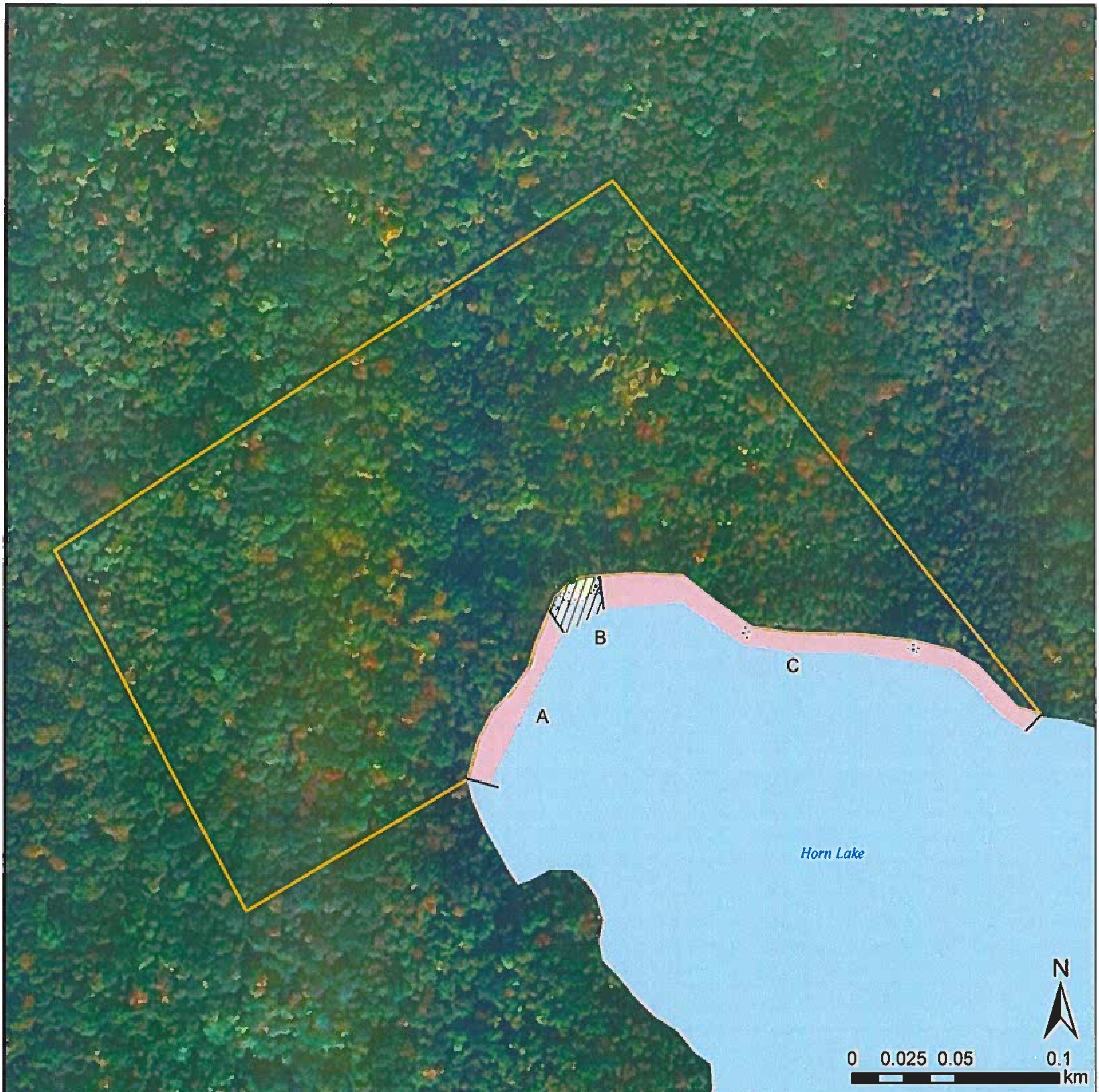
5.2 Existing Conditions

The nearshore environment fronting the subject property was relatively heterogeneous but can be best broken into three study areas with similar aquatic habitat features for descriptive purposes (Figure 7). Study Area A stretches from the western boundary of the subject property, approximately 110 m to the northeast before transitioning into Study Area B (Photograph 1). Riparian slopes were approximately 10% throughout Study Area A. In-water slopes were also relatively steep, ranging from 2:1 (2 m water depth 1 m offshore) to 3:1. Woody debris was abundant in the littoral environment, aquatic vegetation was sparse, and substrates were dominated by periphyton-covered large cobbles and boulders. Riparian vegetation includes mixed forest which overhung most of the nearshore environment, and the understory consisted of Sweet Gale (*Myrica gale*), Blue Flag Iris (*Iris versicolor*), Bracken Fern (*Pteridium aquilinum*), Sensitive Fern (*Onoclea sensibilis*), and Grass (*Poaceae spp.*).

Study Area B was a more depository area with shallower 4:1 in-water slopes and a variety of substrates, including: organic debris, sand, periphyton-covered boulders and some gravel. Patches of the following aquatic vegetation species were noted in the area: Pipewort (*Eriocaulon aquaticum*), Broad Leaf Arrowhead

(*Sagittaria latifolia*), and Pondweed (*Potamoegeton spp.*, Figure 6). Woody debris was also abundant in the study area. A small, seepage area was observed in the middle of the study area and cold-water temperatures indicated that it was of groundwater origin. The riparian environment in Study Area B contained similar vegetation as Study Area A and similar slopes, apart from a flatter transition from the shore.

Study Area C encompassed the eastern half of the subject property. The area contained steep in-water slopes (2:1), lots of woody debris, and sparse accumulations of Milfoil (*Myriophyllum spp.*) and Pipewort. Periphyton-covered large cobbles, boulders and exposed bedrock were dominant throughout the littoral environment. The riparian environment was similar to Study Area 1 in terms of vegetation and slope.



Legend

- Study Areas
- Mixed Substrates
- Groundwater Seepage
- Aquatic Vegetation
- Subject Property
- Cobbles/Boulders
- Lakes

Project Lead: Brent Parsons
Prepared by: Kris Hadley
Data Source: HESL,Ontario Land, ESRI
Coordinate System: NAD 1983 UTM Zone 17N

Figure 7:
Fish Habitat Features

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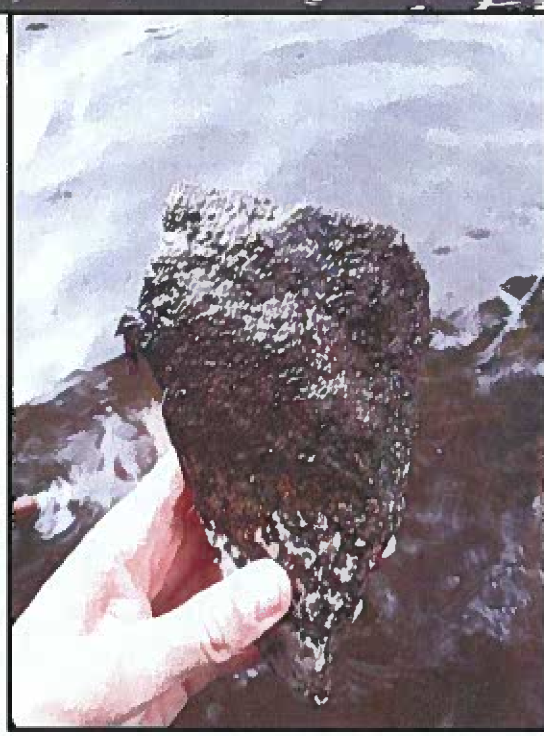
Hutchinson
Environmental Sciences Ltd.

Photographs 1 and 2. A view of the nearshore environment fronting the western portion of the subject property, highlighting Study Area A (above) and Study Area B (below).



Photographs 3 and 4. A view of the heterogeneous shoreline fronting the eastern portion of the subject property (above), and periphyton covered rocks (below), which were abundant throughout the littoral environment.

5.2.1 Assessment of Fish Habitat

The assessment of fish habitat was completed by comparing site-specific features to the requirements of resident fish species so that critical habitats such as nursery or spawning habitats could be defined. Study Area B contains mixed substrates and vegetation that could provide spawning opportunities for Rock Bass, Smallmouth Bass, Yellow Perch and Brook Trout. The area also provides nursery habitat for various species because of cover provided by aquatic vegetation and woody debris, and the presence of the groundwater seepage area which provides a continuous influx of oxygen and nutrients to the area.

Study Areas A and C provide potential spawning opportunities for Lake Whitefish but the areas are not suitable for Lake Trout spawning. Lake Trout typically seek out clean, wave-swept cobble substrates where ample dissolved oxygen allows their eggs to develop in the interstitial spaces between the cobble (Fitzsimons 1994). Ubiquitous periphyton on the angular cobble and boulders has the potential to impact dissolved oxygen concentrations through photosynthesis, respiration and decomposition, and the location of the subject property on the western side of Horn Lake within a secluded embayment, limits the wave action (as seen by the accumulation of woody debris).

Table 9. Resident Fish Species that could use the Study Areas for Spawning Purposes.

Species	Tolerance[1]	Spawning Habitat	Study Area
Lake Whitefish	Intolerant	Rocky shoals, boulders, rubble and cobble	A and C
Rock Bass	Intermediate	Rocky or vegetated shallows of lakes	B
Smallmouth Bass	Intermediate	Rocky and sandy areas or lakes	B
Yellow Perch	Intermediate	Rooted vegetation, sand or gravel	B
Brook Trout	Intolerant	Groundwater upwellings, rocky substrates	B

Note : [1]Tolerances from Eakins (2015).

The majority of the littoral environment represents Type 2 habitat as it does not limit the productivity of resident fish species and is not sensitive to impacts generally associated with the development of docks. The groundwater seepage area and adjacent accumulation of macrophytes and woody debris represents a unique combination of fish habitat features in the study area, is appropriately classified as Type 1 habitat, and should be avoided to protect nursery habitat and spawning habitat for select resident fish species.

5.3 Mitigation Measures

The incorporation of appropriate mitigation measures will minimize impacts to fish habitat to acceptable levels in accordance with policies in the Fisheries Act and the Municipality of Magnetawan Official Plan.

The majority of the following mitigation recommendations were gathered from the "Measures to Avoid Causing Harm to Fish and Fish Habitat" (Fisheries and Oceans Canada 2015) and should be implemented:

- Avoid construction of shoreline structures on or within 10m of the groundwater seepage area identified on Figure 6. A 10 m buffer is sufficient to protect the functionality of the seepage area from adjacent development of docks or boardwalks since 10 m is a suitable base buffer width for water quality, screening of human disturbance and core habitat protection (Beacon Environmental Ltd. 2012).

- Implement a timing window of March 15th to July 15th and October 15th to May 31st to protect spring and fall spawning species, that is dock construction should be completed outside of that timing window (July 16th to October 14th).

- Utilize a dock design that has a small footprint on the lakebed such as a floating, cantilever or a pole supported dock. If a larger footprint is used (i.e. cribs) then the cribs should be constructed in an open- faced manner and filled with large rocks to provide accessible crevices for fish and other small organisms. Cribs should be spaced (2 m) and located at least 2 m from the high-water mark to allow nearshore water to circulate.

- Develop and implement an Erosion and Sediment Control Plan for the site that minimizes risk of sedimentation of the waterbody during all phases of the project. For dock construction this includes:

    - Installation of effective erosion and sediment control measures before starting work to prevent sediment from entering the water body.

- Clearing of riparian vegetation should be kept to a minimum.

- Minimize the removal of natural woody debris, rocks, sand or other materials from the banks, the shoreline or the bed of the waterbody below the ordinary high water mark. If material is removed from the waterbody, set it aside and return it to the original location once construction activities are completed.

- Immediately stabilize shoreline or banks disturbed by any activity associated with the project to prevent erosion and/or sedimentation, preferably through re-vegetation with native species suitable for the site.

- Restore bed and banks of the waterbody to their original contour and gradient; if the original gradient cannot be restored due to instability, a stable gradient that does not obstruct fish passage should be restored.

- If replacement rock reinforcement/armouring is required to stabilize eroding or exposed areas, then ensure that appropriately-sized, clean rock is used; and that rock is installed at a similar slope to maintain a uniform bank/shoreline and natural stream/shoreline alignment.

- Remove all construction materials from site upon project completion.

- Ensure that all in-water activities, or associated in-water structures, do not interfere with fish passage, constrict the channel width, or reduce flows.

5.4 Discussion

The impact assessment was guided by the Fisheries Act and relevant Municipality of Magnetawan Official Plan policies, and completed based on the sensitivity of the fish habitat and implementation of various mitigation measures. In terms of the Fisheries Act, if a dock is constructed with a footprint of less than 20m^2 on the lake bed, no review is required by Fisheries and Oceans Canada, but if a footprint is larger than 20m^2 it is necessary to complete a self-assessment using information that is provided in this report.

Incorporation of the mitigation measures listed in Section 5.3 will provide assurance that fish habitat will be protected during the construction of docks on the subject property and the project will be in compliance with the Fisheries Act due to the self-assessment process described here-in.

The FHIA also addresses all requirements of an Environmental Impact Assessment as defined by the Municipality of Magnetawan Official Plan by ensuring that new developments shall have no negative impact on fish habitat (Policy 4.4).

6. Conclusions

6.1 Lakeshore Capacity Assessment

Horn Lake is not over capacity in terms of total phosphorus, recreational capacity or average MVWHDO concentrations. Modelled TP results indicate that the model does not properly represent existing conditions and capacity remains for additional development in relation to the interim PWQO guidelines of 10 µg/L or to Background + 50% if a 72% sewage-related TP retention coefficient is applied to existing development. Additionally, McIntyre (2006) noted that Lake Trout abundance slightly improved between 1998 and 2005, TP declined between 2003 and 2016, and there have been no algal blooms reported to the North Bay Parry Sound District Health Unit (Environmental Health Program, personal communication, January 4, 2017), so water quality and Lake Trout habitat appear healthy in Horn Lake.

The proposed development of the 4 lots is modelled to increase TP by <0.01 µg/L and decrease MVWHDO by <0.01 mg/L with implementation of Waterloo Biofilter Systems with EC-P units, both of which remain well below regulatory guidelines and are immeasurable through standard laboratory or field procedures. Mitigation measures listed in 4.6 further ensure that impacts to water quality will be minimized to acceptable levels in accordance with relevant municipal and provincial policy.

6.2 Fish Habitat Impact Assessment

Most of the fish habitat fronting the subject property is not critical or sensitive to development of docks. We identified a groundwater seepage area that drains into a nursery habitat and potential spawning habitat for some residential species, so this area was afforded a 10 m buffer and development should take place outside of this area. A number of mitigation measures were also recommended in Section 5.3 that will protect fish habitat and ensure that the development follows municipal and federal regulations related to fish habitat.

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Appendix A. Lakeshore Capacity Model

Lakeshore Capacity Model

Horn Lake

Anthropogenic Supply			
Shoreline Development Type	Number	Usage (capita years/yr)	
Permanent	32	2.56	
Extended Seasonal		1.27	
Seasonal	138	0.69	
Resort	7	1.18	
Trailer Parks	29	0.69	
Youth Camps	0	0.125	kg/capita/yr
Campgrounds/Tent trailers/RV parks	0	0.37	
Vacant Lots of Record	16	1.27	
		206	
Retention by soil (Rs) (0-1)	0.72		
Catchment			Upstream Lakes
Lake Area (Ao)	471.8	ha	
Catchment Area (Ad)	1922.3	ha	
Wetland	5.8	%	
Cleared	0.0	%	
Hydrological Flow			
Mean annual runoff	0.527	m/yr	
Lake outflow discharge (Q)	12616907	m3/yr	
Areal water loading rate (qs)	2.67	m/yr	
Inflow 1		m3/yr	
Inflow 2		m3/yr	
Inflow 3		m3/yr	
Natural Loading			
Atmospheric Load	78.79	250.46	
Runoff Load	125.47	kg/yr	
Upstream Loading			
Background Upstream Load 1		kg/yr	
Background Upstream Load 2		kg/yr	
Background Upstream Load 3		kg/yr	
Current Total Upstream Load 1		kg/yr	142.3
Current Total Upstream Load 2		kg/yr	0.696524719
Current Total Upstream Load 3		kg/yr	
Future Upstream Load 1		kg/yr	
Future Upstream Load 2		kg/yr	
Future Upstream Load 3		kg/yr	
Anthropogenic Loading			
Current Anthropogenic Load	46.20	kg/yr	
Future Anthropogenic Load	46.20	kg/yr	
Areal Load Rate			
Current Total Areal Loading Rate (L_T)	53.09	mg/m2/yr	
Future Total Areal Loading Rate (L_{FT})	53.09	mg/m2/yr	

Sedimentation		
Is the lake anoxic?	n	
Settling velocity (v)	12.4	m/yr
In lake retention (Rp)	0.82	
Monitoring Data		
Years of spring TP data	17	
Average Measured TPso	4.62	µg/L
Measured vs. Predicted TPso	-7.4	%
Is the model applicable?	y	
Over or under predicted?	under	
Modeling Results		
TPlake	3.68	µg/L
TPout	3.52	µg/L
TPso	4.28	µg/L
TPfuture	3.68	µg/L
Phosphorus Thresholds		
TPbk	3.00	µg/L
TPbk+40	4.21	µg/L
TPbk+50	4.51	µg/L
TPbk+60	4.81	µg/L
*if TPbk+40% < TPlake < TPbk+60% cell is orange		
*if TPlake > TPbk+60% cell is red		
No. of allowable residences to reach capacity:		
# Permanent OR	32	
# Extended seasonal OR	64	
# Seasonal cottages OR	116	
Loads		
Natural Load w/no developme	204.26	kg/yr
Background + 50% Load	306.39	kg/yr
Current Load	250.46	kg/yr
Future Load	250.46	kg/yr
Outflow Loads		
Background Outflow Load	36.24	kg/yr
Current Outflow Load	44.43	kg/yr
Future Outflow Load	44.43	kg/yr

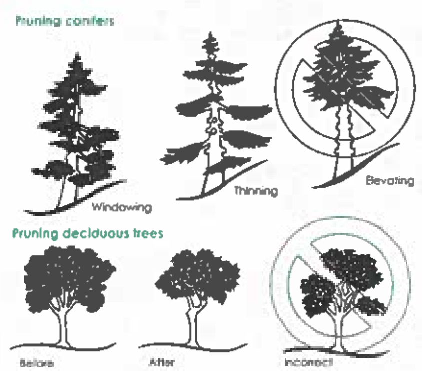
Appendix B. Protect Your Waterfront Investment, Muskoka Watershed Council, Best Practices Series

Your shoreline insurance policy

Before you cut down trees or remove understory vegetation, think about how it will affect your investment.

1) *PLAN FOR NATURAL SUCCESSION* - young plants tend to be more resilient and will grow into your future trees so leave a healthy mix of young and old trees.

2) *PLAN YOUR VIEWS* - with proper pruning, you can obtain good views of the water while maintaining your shoreline buffer and your privacy. Improper pruning can weaken trees. If you are in any doubt, hire a tree specialist to prune and protect your investment.



3) *PROTECT YOUR SOIL* - native grasses and groundcover can be established in less shaded or more active areas to further enhance your buffer zone, reduce runoff and immobilize pollutants.

4) *INVEST IN YOUR PROPERTY* - manures, compost and fertilizers, should only be applied carefully or by qualified individuals and used only as a last resort to maintain optimum plant health.

Without a buffer zone, nutrients and toxic chemicals can be carried into your lake and contribute to water quality issues such as algae blooms. This decrease in water quality can reduce the value of your property by as much as 8.5%!

Where to find more information

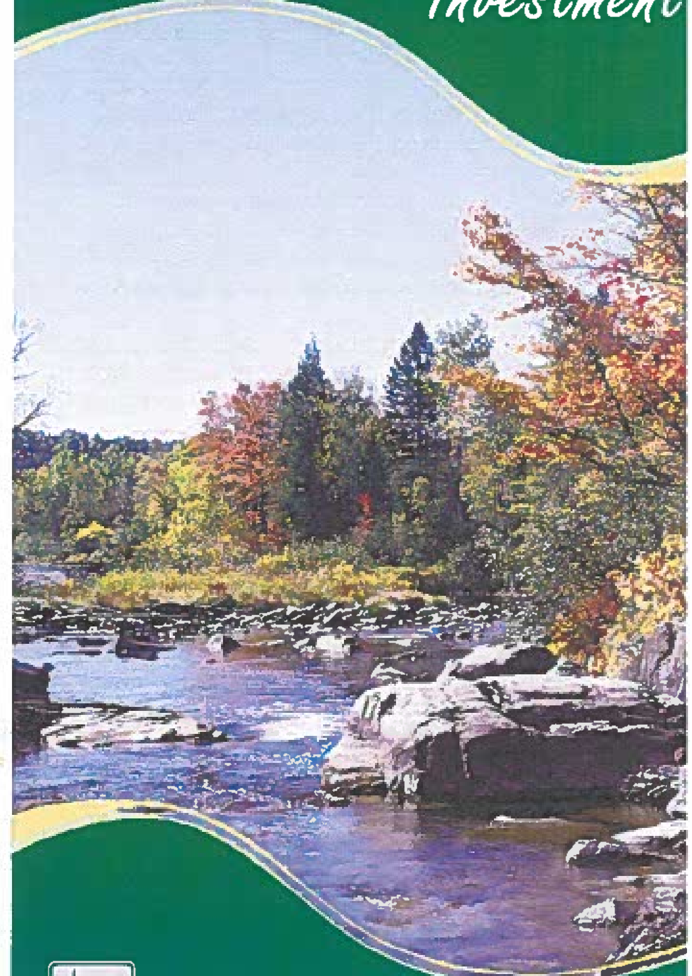
- Muskoka Watershed Council
  www.muskokaheritage.org/mwc
- District Municipality of Muskoka
  www.muskoka.on.ca
- Parry Sound-Muskoka Stewardship Network
  www.ontariostewardship.org/councils/parrysound-muskoka
- Muskoka Water Web
  www.muskokawaterweb.ca
- Ontario Professional Forester's Association
  www.opfa.ca
- Ontario Ministry of Agriculture and Food
  www.omafra.gov.on.ca
- Ontario Ministry of Environment
  www.ene.gov.on.ca/environment
- Ontario Ministry of Natural Resources
  www.mnr.gov.on.ca
- *On the Living Edge*: Your Handbook for Waterfront Living published by the Living By Water Project. Available from the Muskoka Heritage Foundation at (705) 645-7393.

Muskoka Watershed Council
11-B Taylor Road, Box 482
Bracebridge, ON P1L 1T8

Phone: (705) 645-7393 Fax: (705) 645-7888
Email: watershed@muskokaheritage.org

Brought to you by:

Protect your Waterfront Investment



Muskoka WATERSHED COUNCIL

Best Practices Series

Help your investment grow!

Reduced water clarity can result in an 8.5% decrease in your property value!

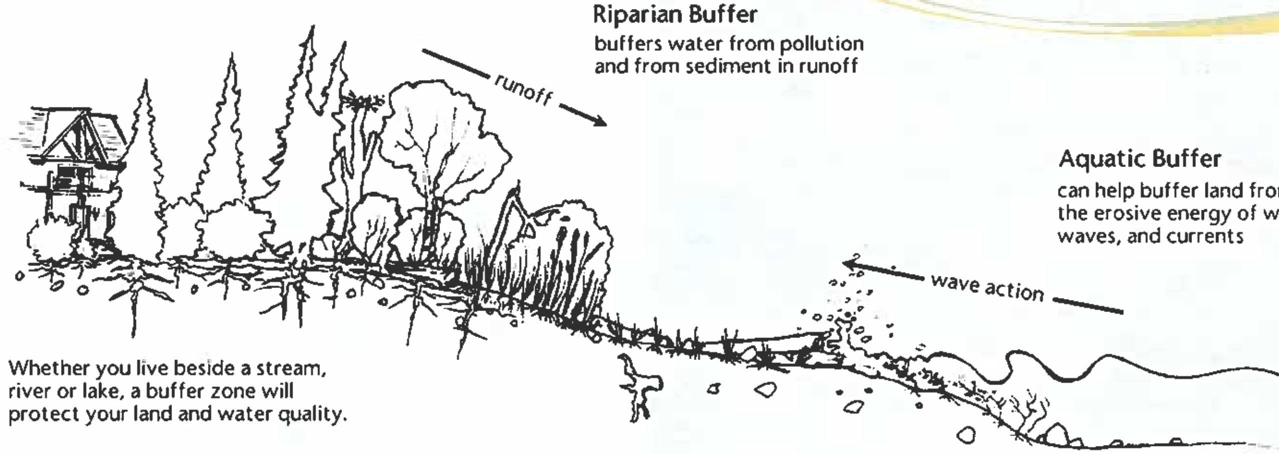
Studies demonstrate that property values decrease as water quality declines. The single most important thing you can do to protect the value of your waterfront investment is to maintain the water quality in your lake.

The natural vegetation on your property, especially that located along your shoreline, is an excellent and low cost way to maintain the quality of your water and protect your land from erosion. Think of the natural vegetation on your property as a free shoreline insurance policy.

Protect your investment

- Maintain or re-establish a shoreline buffer using species native to Muskoka.
- Get to know your property. Look at the vegetation on your property and make note of what species are present and in what numbers.
- Inspect the shoreline buffer area in all four seasons and take notes to compare one season to the next. Certified foresters, horticulturalists, and/or arborists can help you in this process.
- Use this information to gauge the health of your shoreline and plan accordingly.
- Have many different native plant species on your property with varied ages. By doing so, you can account for any unforeseen disturbances, such as wind or ice storms, and/or environmental changes that may occur in the future.

Your buffer zone



Whether you live beside a stream, river or lake, a buffer zone will protect your land and water quality.

From On the Living Edge

Your buffer zone is an area of natural vegetation, including fallen trees, branches and washed up logs, and natural rocks or pebbles, that runs along the length of your shoreline. It includes the areas upland of the high water mark (your riparian buffer) as well as the area below the high water mark, right down into the water (your aquatic buffer).

Ideally, a buffer zone contains vegetation that would normally grow in Muskoka. These native species might include trees, shrubs, wildflowers, grasses and native aquatic plants.

When a shoreline is cleared, the buffer area has the potential to become an erosion zone. Alterations to shorelines can also result in:

- silted up spawning beds
- pollution from runoff
- increased flooding

Your buffer zone is in a constant state of change.

Dead, dying, diseased, and dangerous material can be removed in order to improve the health, safety and aesthetics of your property.

Common shoreline species in Muskoka:
TREES: White cedar, White pine, Hemlock
SHRUBS: Red-osier dogwood, Meadowsweet
WILDFLOWERS: Cardinal flower, Blue flag iris
AQUATIC PLANTS: Pickerelweed, Coontail

Whether you are planning a major construction project or just maintaining what you have, it is important to:

- *MINIMIZE* the types and amount of traffic your buffer area receives. Simple foot traffic can drive oxygen out of the soil and allow for water runoff.
- *MAINTAIN* natural forest floor coverings and keep natural areas as large as possible.
- *INCORPORATE* a woodchip-style mulch approximately 2-4" thick in high traffic areas to condense traffic flow and minimize damage.
- *LEAVE* some dead or dying material on your property, if it isn't a hazard, to enhance wildlife habitat.
- *CHECK* with local authorities before removing vegetation from your property so you don't contravene any laws.