Hutchinson
Environmental Sciences Ltd.

Lakeshore Capacity Assessment of Shallow Lake

Prepared for: Municipality of Mattice-Val Côté
Job #: 240074

October 28, 2024

FINAL REPORT

93 Kimberley Avenue, Bracebridge ON P1L 1Z8 | 705-645-0021

Hutchinson
Environmental Sciences Ltd.

93 Kimberley Avenue, Bracebridge, ON P1L 1Z8 │705-645-0021
www.environmentalsciences.ca

October 28, 2024 Project No. 240074

Guylaine Coulombe
CAO/Clerk
Municipality of Mattice-Val Côté
P.O. Box 129
500, Highway 11
Mattice, ON P0L 1T0

Dear Ms. Coulombe:

Re: Shallow Lake Lakeshore Capacity Assessment

We have assessed the shoreline-development capacity of Shallow Lake based on its phosphorus concentration relative to the Provincial Water Quality Objective, which was determined using the Lakeshore Capacity Model. In addition, we compared shoreline-development density to a threshold intended to ensure sufficient recreational capacity. Both of these measures indicate that Shallow Lake has no capacity for additional shoreline development.

Thank you for the opportunity to complete this interesting project for Mattice-Val Côté.

Sincerely,
Per. Hutchinson Environmental Sciences Ltd.

Joel Harrison, Ph.D.
Aquatic Scientist
joel.harrison@environmentalsciences.ca

Signatures

Report Prepared by:

Joel Harrison, Ph.D.
Aquatic Scientist

Report Reviewed by:

Brent Parsons, M.Sc.
Principal and Senior Aquatic Scientist

Executive Summary

HESL has been retained by the Municipality of Mattice-Val Côté to assess the shoreline development capacity of Shallow Lake. The Province of Ontario recommends the use of their Lakeshore Capacity Model (LCM) to determine the interim Provincial Water Quality Objective (PWQO) for total phosphorus (TP) and the amount of shoreline development that can occur while maintaining the TP concentration below 150% of the modelled background (pre-development) concentration. 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 in the context of lake dynamics to predict TP concentration in lakes.

In addition to the phosphorus-based capacity assessment performed using the LCM, the "recreational capacity" of Shallow Lake was also assessed as part of a multiple-lines-of-evidence approach to shoreline development planning. The shoreline development density was calculated and compared to thresholds adopted by the Township of Seguin in its official plan.

Based on existing data and a field investigation performed by HESL, it is concluded that Shallow Lake has a relatively modest TP concentration (oligotrophic, bordering on mesotrophic status), especially given its appreciable concentration of dissolved organic carbon.

The accuracy of the LCM was found to be very good, with only a 1.9% difference between predicted (9.08 µg/L) and observed (9.25 µg/L) spring TP concentrations. The modelled background TP concentration for Shallow Lake is 5.07 µg/L. The PWQO is 150% of this value, which is 7.60 µg/L. Based on the modelled data, the expected average TP concentration for the ice-free period is 8.44 µg/L, which is above the PWQO of 7.60 µg/L; thus, there is no capacity for additional lakeshore development based on the LCM results.

The offshore lake area (i.e., that beyond a 30-m-wide nearshore zone) is 104 ha, which is less than the area required for recreation (154 ha) for the current level of development if the criteria of Seguin Township are adopted (1 residential unit per 1.6 ha and 1 tourist accommodation unit per 0.8 ha); thus, there is no recreational capacity for additional development on Shallow Lake.

Whether assessed based on water quality or recreational density, there is no capacity for additional development on Shallow Lake. Proper septic system maintenance and the establishment/expansion of shoreline vegetation "buffer zones" can help to mitigate water quality degradation from existing development.

We recommend the following:

1. Do not approve additional development on the lake's shoreline apart from the development of vacant lots of record.
2. Vegetative shoreline buffers should be encouraged and enforced through education and the development of relevant planning policy.
3. Appropriate septic system design should be required and enforced through a permitting and enforcement process while maintenance should be encouraged through education.
4. The Porcupine Health Unit and MECP should be circulated this study to ensure that relevant Best Management Practices described through sewage or other approvals (e.g., Environmental Compliance Approval) are being implemented at both existing campgrounds/resorts on Shallow Lake.

Table of Contents

List of Figures

List of Tables

Appendices

1. Introduction

HESL has been retained by the Municipality of Mattice-Val Côté to assess the shoreline development capacity of Shallow Lake. This northern Ontario lake is located approximately midway between Kapuskasing and Hearst, just north of Highway 11 and west of the Missinaibi River. As its name suggests, Shallow Lake has a small volume, with a deep location of approximately 9 m in the southern embayment but depths of only 2–3 m throughout the majority of the lake (MNRF 2023; Appendix A). Shoreline development, including two campgrounds, is currently restricted to the southern half of the lake; the northern shoreline is completely forested. The lake's drainage basin is very small and much of it is wetland. Among the fish species present in Shallow Lake (MNRF 2020) are northern pike (*Esox lucius*), walleye (*Sander vitreus*), yellow perch (*Perca flavescens*), and smallmouth bass (*Micropterus dolomieu*).

The Province of Ontario recommends the use of their Lakeshore Capacity Model (LCM) to determine the interim Provincial Water Quality Objective (PWQO) for total phosphorus (TP) and the amount of shoreline development that can occur while maintaining the TP concentration below 150% of the modelled background (pre-development) concentration. 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 in the context of lake dynamics to predict TP concentration in lakes.

In addition to the phosphorus-based capacity assessment performed using the LCM, the "recreational capacity" of Shallow Lake was also assessed as part of a multiple-lines-of-evidence approach to shoreline development planning. The shoreline development density was calculated and compared to thresholds adopted by the Township of Seguin in its official plan.

2. Methods

2.1 Background Review

2.1.1 Water Quality

Phosphorus and calcium data were obtained from the Ministry of Environment, Conservation and Parks (MECP)'s online database for the Lake Partner Program (LPP). MECP staff were contacted directly to request any additional historical water quality data for Shallow Lake.

2.1.2 Current Lakeshore Development

Shoreline development data were provided to HESL by the Municipality (Pers. Comm.; Guylaine Coulombe; 18 September 2024). Residences identified as seasonal were split equally between the LCM categories of "Extended Seasonal" and "Seasonal". The two campsites were categorized as "Campgrounds/Tent trailers/ RV parks". The 5 cabins associated with the campsite on Shallow Lake Rd E were categorized as "Resort" units.

2.2 Field Survey

Shallow Lake was sampled at two locations (HESL-1–"Middle" and HESL-2–"South"; Figure 1) by HESL (accompanied by Guylaine Coulombe) on 24 May 2024. Conditions on the day prior to sampling and the day of sampling were windy and rainy. At each site, the water column was profiled using a calibrated YSI sonde to determine water temperature (Temp), specific conductance (SpCond), pH, and dissolved oxygen (DO) concentration at various depths from the surface to the bottom of the water column. A second profile was recorded using a field fluorometer (bbe FluoroProbe) to estimate the vertical distribution of the biomass of different phytoplankton groups (as chlorophyll-*a* concentrations). Water samples were collected from the upper portion of the water column (surface to Secchi depth) using a weighted glass bottle. Samples were shipped in a cooler to ALS Global in Waterloo for determination of TP, total suspended solids (TSS), total Kjeldahl nitrogen (TKN), nitrite (NO_2), nitrate (NO_3), and dissolved organic carbon (DOC) concentrations. Duplicate samples were submitted for TP for consistency with the LPP methodology. DOC samples were filtered immediately after collection using a 0.45-µm pore-size polycarbonate filter in a plastic syringe.

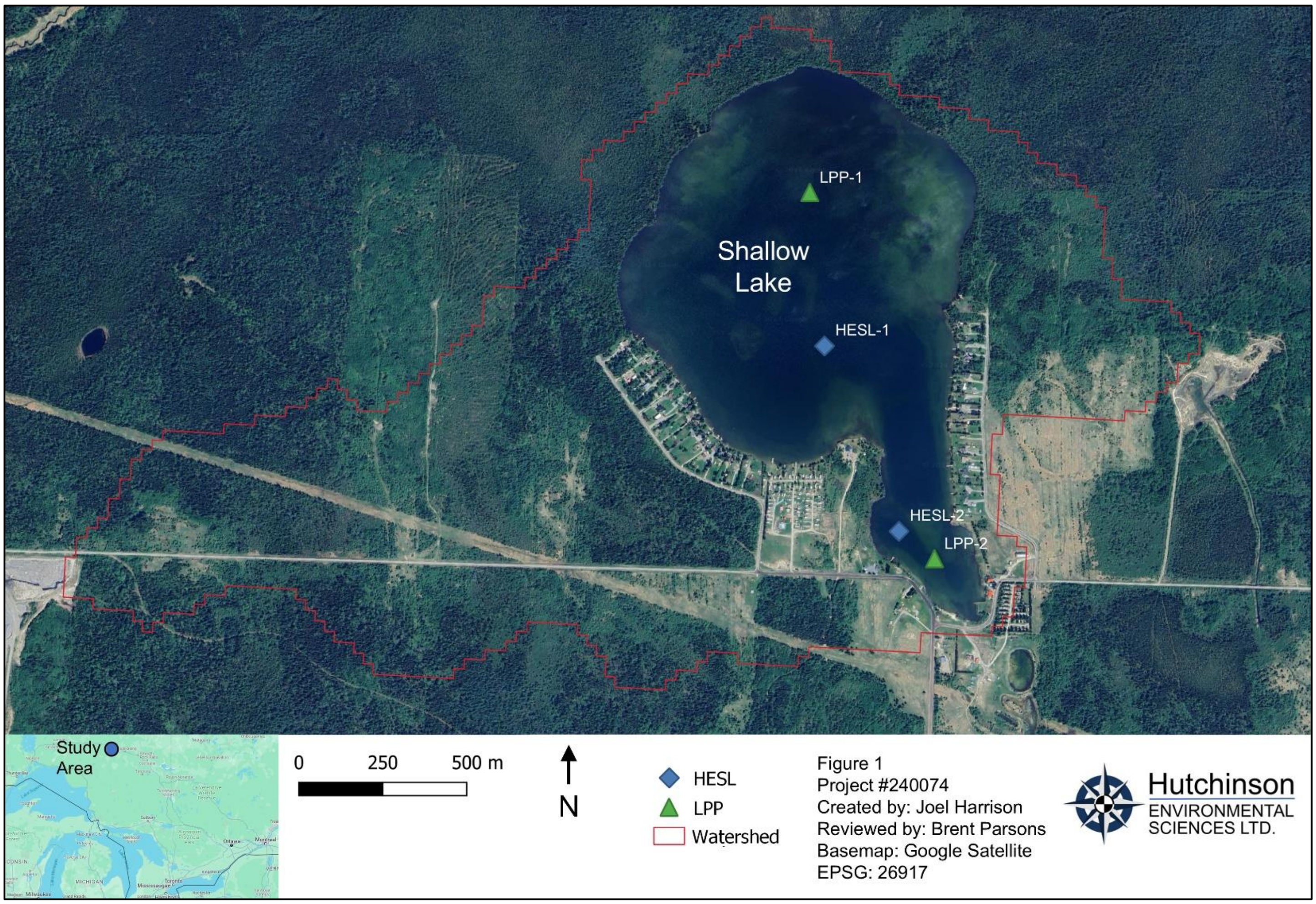

Figure 1. Shallow Lake, its watershed, and sampling locations.

2.3 Lakeshore Capacity Model

The LCM was used to predict the background (pre-development) TP concentration of Shallow Lake. The shoreline development capacity is then defined as the amount of additional development that can occur without the lake's TP concentration exceeding 150% of the background concentration.

2.3.1 Lake Area and Watershed Information

Catchment characteristics (watershed area and land cover) were determined using the Ministry of Natural Resources and Forestry (MNRF)'s Ontario Watershed Information Tool (OWIT). The area of Shallow Lake was determined by manual tracing at a scale of 1:1000 using QGIS (v. 3.28). Annual runoff was determined from the MECP's runoff database based on the lake's outlet location (49.6574, -83.2810), as determined using OWIT.

2.3.2 Lake Phosphorus Concentrations

LCM accuracy was assessed by comparing predictions of the spring-overturn TP concentration to the average of measured values from LPP monitoring and the HESL survey (i.e., all available TP data). The model results are assumed to be reliable if the relative difference between the measured and predicted spring TP (i.e., the error) is 20% or less (MOE 2010).

2.3.3 Phosphorus and Water Loading

The phosphorus loading to Shallow Lake was calculated as the sum of natural and anthropogenic inputs, estimated using the standard LCM coefficients (Paterson et al. 2006). The TP loading to each lake comprised direct atmospheric deposition (16.7 mg/m^2/y), watershed runoff, lot runoff (0.04 kg/lot/y), and shoreline septic system inputs (0.66 kg/capita/y; see Section 3.3 for assumed occupancies). Water loading was calculated based on catchment area and the mean annual runoff estimate for the lake obtained from the MECP's provincial runoff database (376 mm/y). The areal TP loading from watershed runoff was assumed to be 10.3 mg/m^2/y, as recommended by MMA (1986) for sedimentary watersheds with <15% cleared land and as discussed in Section 2.3.4. It should be noted that the utilization of a runoff coefficient based on % wetland on the Precambrian Shield (in this case 58%) resulted in a vast overprediction of phosphorus concentration.

2.3.4 Phosphorus Retention by Soil

The coefficient for phosphorus retention by soil was selected based on the geology of the study area and a scientific understanding of phosphorus attenuation. Decades of research 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 (Willman et al. 1981; Zanini et al., 1998; Robertson et al. 1998; Robertson 2003) show strong adsorption of phosphate on charged soil surfaces and mineralization of phosphate with iron and aluminum. Mineralization reactions appear to be favoured in acidic and mineral-rich groundwater in Precambrian Shield settings (Robertson et al. 1998; Robertson 2003), typically resulting in over 90% immobilization of septic-system phosphorus. The mineralization reactions appear to be permanent (Isenbeck-Schroter et al. 1993) and many studies conclude that most septic phosphorus is stable within 0.5–1 m of the tile drains in a septic field (Robertson et al. 1998; Robertson 2003; Robertson 2012). A recent review (Robertson et al. 2019) reported an average phosphorus attenuation of 97% between the septic tank and lake in non-calcareous soils and 69% in areas of calcareous soils.

Based on mapping provided by the Ontario Geological Survey (Figure 2), the quaternary geology of the catchment is predominantly glaciofluvial ice-contact deposits (sand, gravelly sand and gravel, nearshore and beach deposits) with some bedrock (undifferentiated igneous and metamorphic rock, exposed at surface or covered by a discontinuous, thin layer of drift) and glaciolacustrine deposits (gravel and sand, minor till, includes esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits). Based on data from Land Information Ontario, the dominant soil type within the catchment of Shallow Lake is clay loam (Figure 3). According to provincial and federal data sources, the soils of the Shallow Lake catchment are predominantly calcareous (Table 1) which is consistent with the lake's moderately high calcium concentration and pH >7 (see Section 3.1).

In addition to catchment geology, LCM predictive accuracy was considered in determining the soil retention coefficient; preliminary model runs assuming no phosphorus retention by soil, as recommended by the MECP in the absence of site-specific soils data (MOE 2010), resulted in unacceptably low predictive accuracy (i.e., absolute error >> 20%). Based on the catchment soil conditions and phosphorus geochemistry, a retention co-efficient of 69% was chosen, consistent with the aforementioned findings of Robertson et al. (2019).

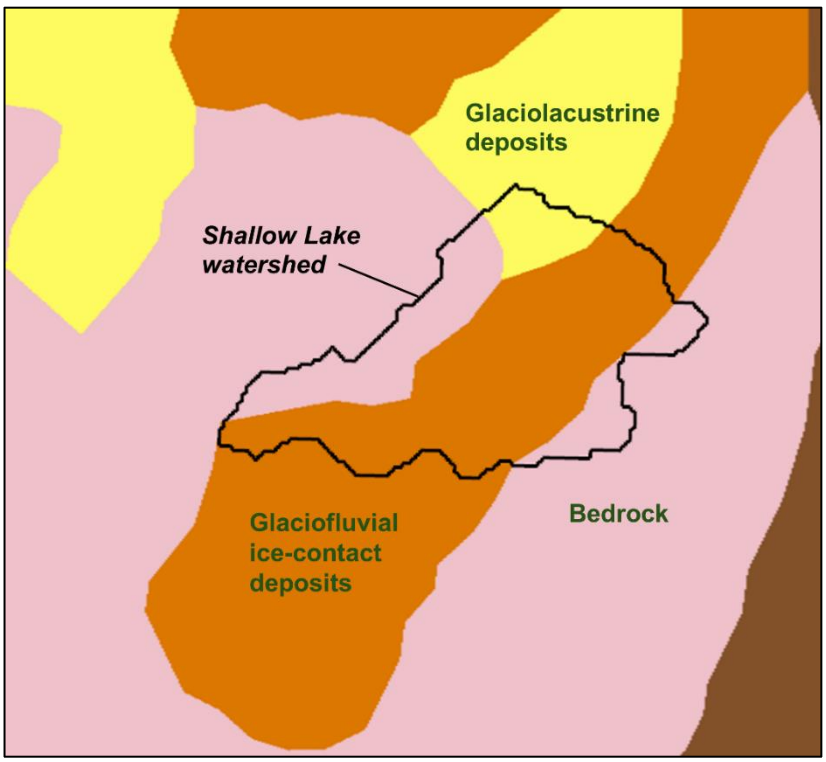

Figure 2. Surficial geology of the study area according to the Ontario Geological Survey.

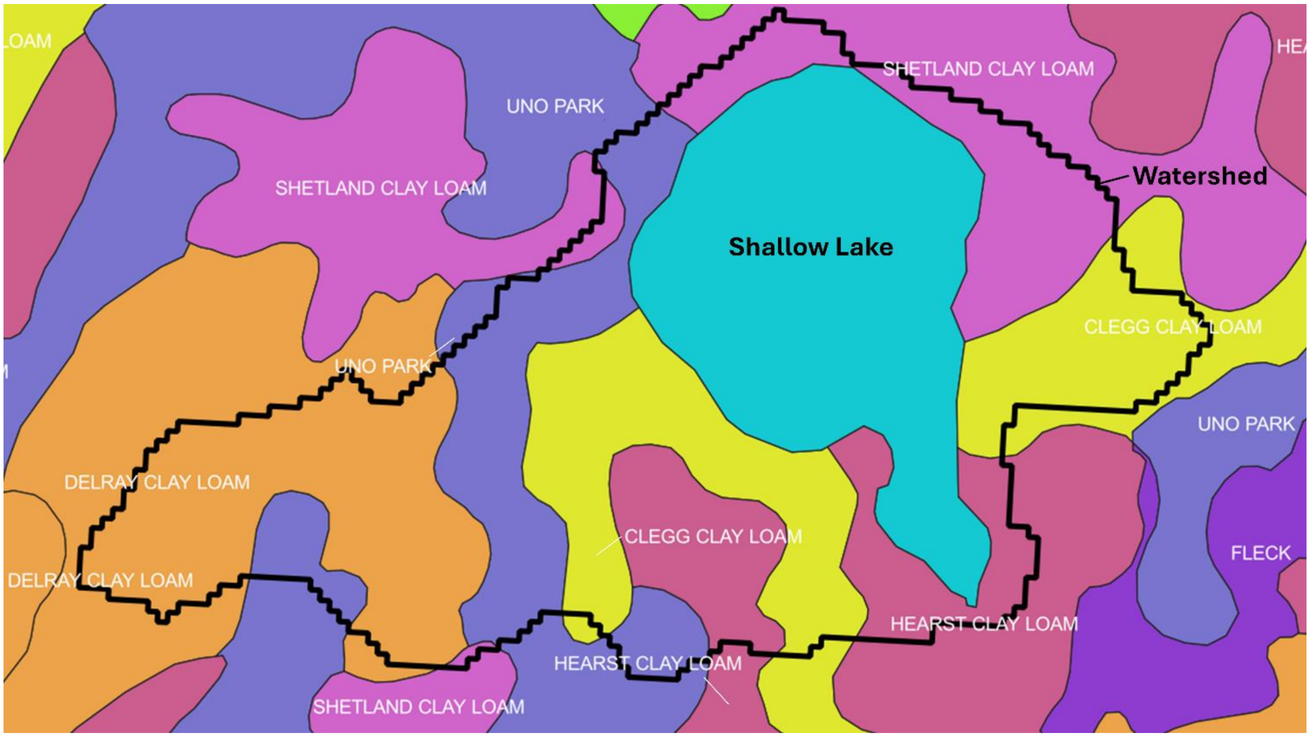

Figure 3. Soil types of the Shallow Lake watershed (data from Land Information Ontario).

Table 1. Characteristics of watershed soils and parent material.

Land Information Ontario (https://geohub.lio.gov.on.ca/datasets/ontarioca11::soil-survey-complex)			National Soil Database (https://sis.agr.gc.ca/cansis/soils/on/soils.html)					
Soil Type	**Code**	**Parent Material**	**Name**	**Class**	**Kind of material**	**Mode of Deposition**	**Texture**	**Chemical properties**
Clegg Clay Loam	ONCGG	calcareous clay to silty clay lacustrine	CLEGG	Brunisolic Gray Brown Luvisol	Mineral	Lacustrine	Fine	*Calcareous
Delray Clay Loam	ONDRY	calcareous clay to silty clay lacustrine	———— Not listed in National Soil Database. ————					
Hearst Clay Loam	ONHST	calcareous silty clay to clay lacustrine	HEARST	Brunisolic Gray Brown Luvisol	Mineral	Lacustrine	Fine	*Calcareous
Shetland Clay Loam	ONSHN	calcareous silty clay to clay lacustrine	———— Not listed in National Soil Database. ————					
Uno Park	ONUPK	fibric organic (30 cm) over mesic organic (30-90 cm) over clay	———— Not listed in National Soil Database. ————					

** Moderately / Very Strongly Calcareous (6–40% $CaCO_3$ equivalent).*

2.3.5 Phosphorus Sedimentation Rate

No vertical profiles of dissolved oxygen are available for Shallow Lake for the summer stratified period. However, based on the evidence of stratification and hypolimnetic oxygen depletion observed in 2024 during windy conditions early in the season (see Section 3.1), it is considered very likely that the lake is typically strongly stratified and the hypolimnion anoxic in late summer when surface-water temperatures would be much higher, and wind speeds generally lower, than during the May 2024 survey. Therefore, the lake was modelled with a settling velocity of 7.2 m/y, as recommended for lakes that undergo hypolimnetic anoxia (MOE 2010).

2.4 Shoreline Development Density Calculation

The recreational carrying capacity of the lake was determined based on the offshore area and the criterion for maximum recreational density adopted by the Township of Seguin for lake management (i.e., 1 residential unit per 1.6 ha and 1 tourist accommodation unit per 0.8 ha; Township of Seguin 2022). The offshore area of the lake, defined as the area greater than 30 m from shore, was determined using QGIS. The number of residential units was calculated as the sum of permanent, extended seasonal, and seasonal residences (see data in Section 3.3). The number of tourist accommodation units was calculated as the sum of Campgrounds/Tent trailers/RV parks and resort residences. The existing recreational density for Shallow Lake was calculated based on offshore area and shoreline residency information.

3. Results

3.1 Water Quality

Water quality sampling through the MECP's LPP has been conducted in 2005, 2008, 2013, and 2024, with spring TP concentrations ranging from 7.6 to 11.3 µg/L based on samples collected in 2005 and 2024 (

Table 2).

Surface water temperature was ~13°C at both sites on 24 May 2024; surprisingly, the water column was already stratified at the deep sampling location in the southern part of the lake (HESL-2), with a difference of >2°C between 6 m and 7 m (Figure 4). Consistent with the thermal stratification of the water column at site HESL-2, the DO concentration and pH were lower and the SpCond higher below 6 m relative to the surface mixed layer above (Figure 4).

The average TP concentration based on the May 2024 sampling by HESL (9.83 µg/L) is similar to the average TP concentration determined by LPP sampling in spring of 2005 and 2024 (9.58 µg/L). Based on the limited available data, it is concluded that Shallow Lake has a relatively modest TP concentration (oligotrophic, bordering on mesotrophic status), especially given the appreciable DOC concentration (Table 3); TP is generally higher in lakes with more DOC as the dissolved organic matter, originating chiefly from decomposed wetland vegetation and soils, contains both carbon and phosphorus. TSS was above the laboratory's detection limit, indicating measurable suspended solids in the water column. This is consistent with the presence of some sediment from the lakebed resuspended into the water column, as would be expected during the high-wind conditions on the date of the May 2024 survey. The relatively low Secchi depths (avg. = 1.36 m) is indicative of modest water clarity and is consistent with the presence of suspended particles (which absorb and scatter light) and DOC (which absorbs light).

Concentrations of NO_3 and NO_2 were below the laboratory's limit of detection (i.e., very low). If it is thus assumed that the total nitrogen (TN) on 24 May 2024 was equivalent to the TKN (avg. = 0.59 mg/L), the TN:TP molar ratio would equal 133, indicative of phosphorus limitation of phytoplankton growth (Guildford and Hecky 2000). Estimates of the chlorophyll-*a* concentration based on *in situ* fluorescence (i.e., measured directly in the lake) by a field fluorometer were surprisingly high (~12–14 µg/L; Figure 5) relative to the TP concentrations; it is possible that the fluorescence-based chlorophyll-*a* estimates were affected by the moderately high DOC concentration of Shallow Lake. The FluoroProbe data suggest that the phytoplankton community was made up of chlorophytes ("green algae"), diatoms, chrysophytes ("golden algae"), and dinoflagellates, all of which are eukaryotes (i.e., true algae not cyanobacteria or "blue-green algae").

Table 2. Water quality as assessed through Lake Partner Program sampling.

Site	Lat.	Lon.	Date	Parameter	Abbr.	Value	Rep1	Rep2
1	49.6547	-83.2839	2005-05-31	Phosphorus, total (µg/L)	TP	7.6	7.2	8.0
2	49.6450	-83.2783	2005-05-31	Phosphorus, total (µg/L)	TP	8.4	8.2	8.7
1	49.6547	-83.2839	2008-07-03	Phosphorus, total (µg/L)	TP	6.9	6.8	7.0
1	49.6547	-83.2839	2013-05-09	Calcium (mg/L)	Ca	28.1	–	–
1	49.6547	-83.2839	2024-05-14	Phosphorus, total (µg/L)	TP	11.3	10.3	12.3
2	49.6450	-83.2783	2024-05-14	Phosphorus, total (µg/L)	TP	11.0	11.1	10.8

Table 3. Water quality as assessed by HESL on 24 May 2024.

Parameter	Abbr.	Average	Middle (HESL-1)	South (HESL-2)
Carbon, dissolved organic (mg/L)	DOC	6.32	6.18	6.46
Kjeldahl nitrogen, total (mg/L)	TKN	0.590	0.574	0.611
Nitrate (mg-N/L)	NO_3	<0.02	<0.02	<0.02
Nitrite (mg-N/L)	NO_2	<0.01	<0.01	<0.01
*Phosphorus, total (µg/L)	TP	9.83	9.10 (9.10, 9.10)	10.55 (10.20, 10.90)
Secchi depth (m)	Zsd	1.36	1.45	1.27
Solids, total suspended (mg/L)	TSS	4.2	3.8	4.6

* Average values with duplicates in parentheses.

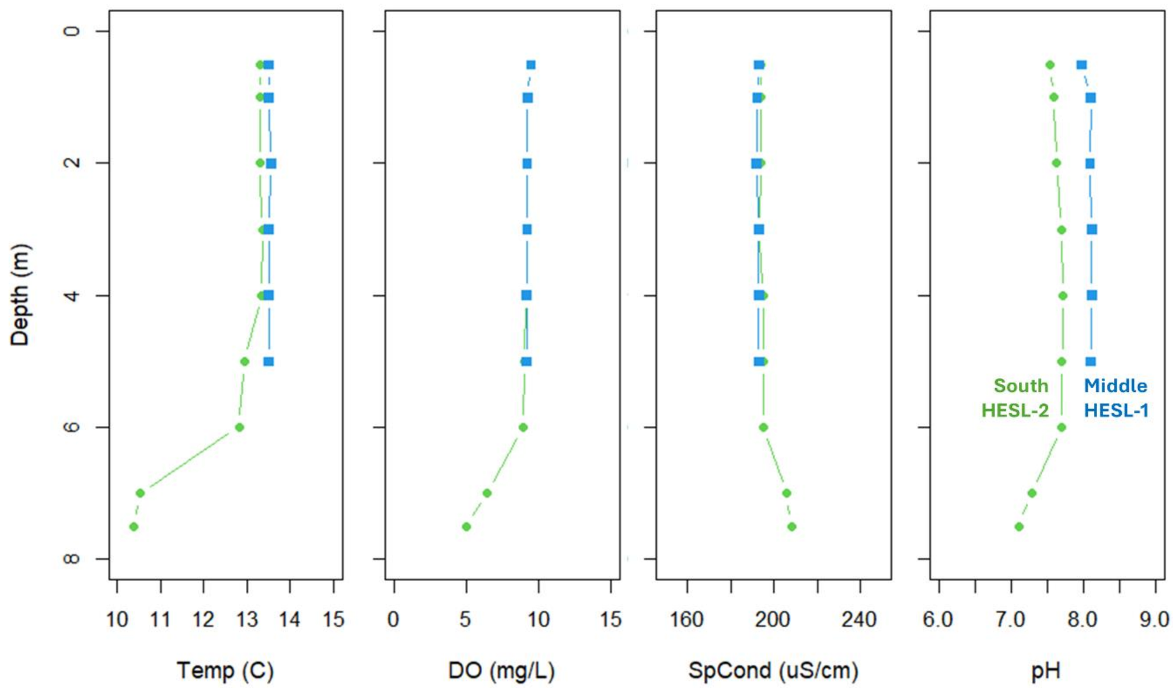

Figure 4. Water column properties on 24 May 2024 as measured by HESL using a YSI sonde.

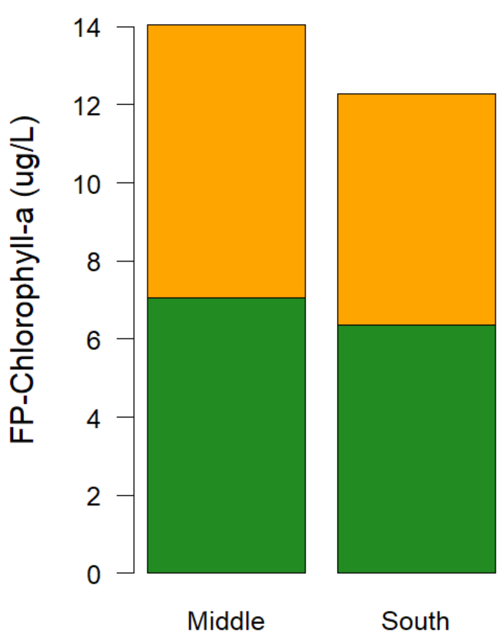

Figure 5. Portion of the estimated total chlorophyll-a concentration contributed by green algae (green) vs. diatoms, dinoflagellates, and chrysophytes (orange) in the top 5 m of the water column, as estimated from *in situ* fluorescence measured using a FluoroProbe.

3.2 Lake and Catchment Charactertistics

Using QGIS, the area of Shallow Lake was determined to be 104.2 ha. The offshore area, defined as the area beyond a 30-m-wide nearshore zone, was determined to be 89.9 ha. Based on the watershed delineation performed using OWIT, the total catchment area (including the lake) was determined to be 3.499 km^2 which implies a drainage area of 245.7 ha for the lake. The land-cover characteristics of the catchment based on provincial mapping are provided below (Table 4).

Table 4. Land cover composition of the Shallow Lake drainage basin.

Land Cover Type	Relative Area (%)
Swamp	33.7
Fen	18.3
Mixed Treed	14.9
Deciduous Treed	13.1
Coniferous Treed	6.9
Community/Infrastructure	6.2
Bog	2.8
Disturbance	2.4
Sparse Treed	1.8

3.3 Current Shoreline Development

Based on the information provided (Appendix B), the current level of shoreline development (Table 5) includes 15 permanent dwellings, 29 seasonally occupied residences (split between “Extended Seasonal” and “Seasonal” for the LCM), 5 cabins associated with a campground (assigned to the “Resort” LCM category), and 100 campground units (62 units at the Boudrias Campground and 38 units at Mamie & Papie’s Family Resort). There were 4 vacant lots of record reported (i.e., 81 Tanguay Rd E, 87 Tanguay Rd E, 141 Tanguay Rd W, and 103 Tanguay Rd W).

Table 5. Shoreline development data used for LCM.

Shoreline Development Type	Number	Usage (capita-yr/yr)
Permanent	15	2.56
Extended Seasonal	15	1.27
Seasonal	14	0.69
Resort	5	1.18
Trailer Parks	0	0.69
Youth Camps	0	0.125
Campgrounds/Tent trailers/RV parks	100	0.37
Vacant Lots of Record	4	1.27

3.4 Lakeshore Capacity Model Results

The accuracy of the LCM was quite good, with only a 1.9% difference between predicted (9.08 µg/L) and observed (9.25 µg/L) spring TP concentrations; this is well within the 20% limit of model error deemed acceptable by the MECP (MOE 2010).

The modelled background (pre-development) TP concentration for Shallow Lake is 5.07 µg/L. The PWQO is 150% of this value, which is 7.60 µg/L. Based on the modelled data, the expected average TP concentration for the ice-free period is 8.44 µg/L, which is above the PWQO of 7.60 µg/L; thus, there is no capacity for additional lakeshore development based on the LCM results (i.e., based on modelled phosphorus concentrations and loadings). The model inputs and outputs are included as Appendix C.

3.5 Shoreline Density

The offshore lake area (i.e., that beyond a 30-m-wide nearshore zone) is 104 ha, which is less than the area required for recreation (154 ha) for the current level of development if the criteria of Seguin Township are adopted (1 residential unit per 1.6 ha and 1 tourist accommodation unit per 0.8 ha); thus, there is no recreational capacity for additional development on Shallow Lake (Table 6).

Table 6. Recreational density data for Shallow Lake.

Lake Area (ha)	104.2
Offshore Area (ha)	89.9
Residences (#)	44
Residential Area (ha)	70.4
Tourist Units (#)	105
Tourist Area (ha)	84
Used Recreational Area (ha)	154.4

4. Recommendations

Whether assessed based on water quality or recreational density, **there is no capacity for additional development on Shallow Lake**. It is recommended that no additional development be permitted on the lake's shoreline except for on the vacant lots of record (i.e., there should be no new lot creation around Shallow Lake).

Proper septic-system maintenance and the establishment/expansion of strips of shoreline vegetation ("shoreline buffers") can help to mitigate water quality degradation from existing development.

4.1 Shoreline Buffers

A shoreline buffer is an area along the shoreline of a developed lot that is naturally vegetated or re-vegetated. Shoreline buffers are a well-studied mitigation measure associated with waterfront development. Buffers provide wildlife habitat, a visual screen, and filter sediment and other pollutants and absorb nutrients from runoff, thereby helping to mitigate impacts of stormwater (Zhang et al., 2010; Beacon Environmental, 2012). Vegetative buffers mitigate social density by screening the view of the shoreline from the lake and providing a buffer for view and noise between lots to help maintain a wilderness perspective. Shoreline vegetative buffers can also provide riparian protection and habitat for songbirds and wildlife. Zhang et al.

(2010) found that buffer width can explain 35–60% of variance in removal efficacy for sediment, pesticides, nitrogen and phosphorus. Most studies demonstrate that buffers from 9–30 m provide more effective attenuation than smaller buffers and 30-m buffers provide effective water quality protective functions (Dillaha *et al.* 1985; Magette *et al.* 1986; Environmental Law Institute 2008; Wenger 1999).

4.2 Septic Systems

Sewage effluent from sewage treatment systems can negatively impact adjacent waterbodies through transmission of nutrients and bacteria. Research over the past several decades has consistently shown that a large proportion of septic-system phosphorus is immobilized in soils, as discussed in Section 2.3.4. Proper septic system design and maintenance is important to maximizing phosphorus attenuation in on-site soils and minimizing impacts to Shallow Lake.

A variety of sewage treatment systems are available that are aimed at reducing the impacts of septic effluent on water quality through retention of nutrients in wastewater such as the Waterloo EC-P or Ecoflow DpEC units. The use of “B” horizon soils in the leaching bed has also proven to effectively retain septic-related phosphorus through the adsorption of phosphate on charged soil surfaces and mineralization of phosphate with iron and aluminum can immobilize septic phosphorus (Robertson et al., 1998; Robertson, 2003).

We recommend the following

1) Do not approve additional development on the lake’s shoreline apart from the development of vacant lots of record.
2) Vegetative shoreline buffers should be encouraged and enforced through education and the development of relevant planning policy.
3) Appropriate septic system design should be required and enforced through a permitting and enforcement process while maintenance should be encouraged through education.
4) The Porcupine Health Unit and MECP should be circulated this study to ensure that relevant Best Management Practices described through sewage or other approvals (e.g., Environmental Compliance Approval) are being implemented at both existing campgrounds/resorts on Shallow Lake.

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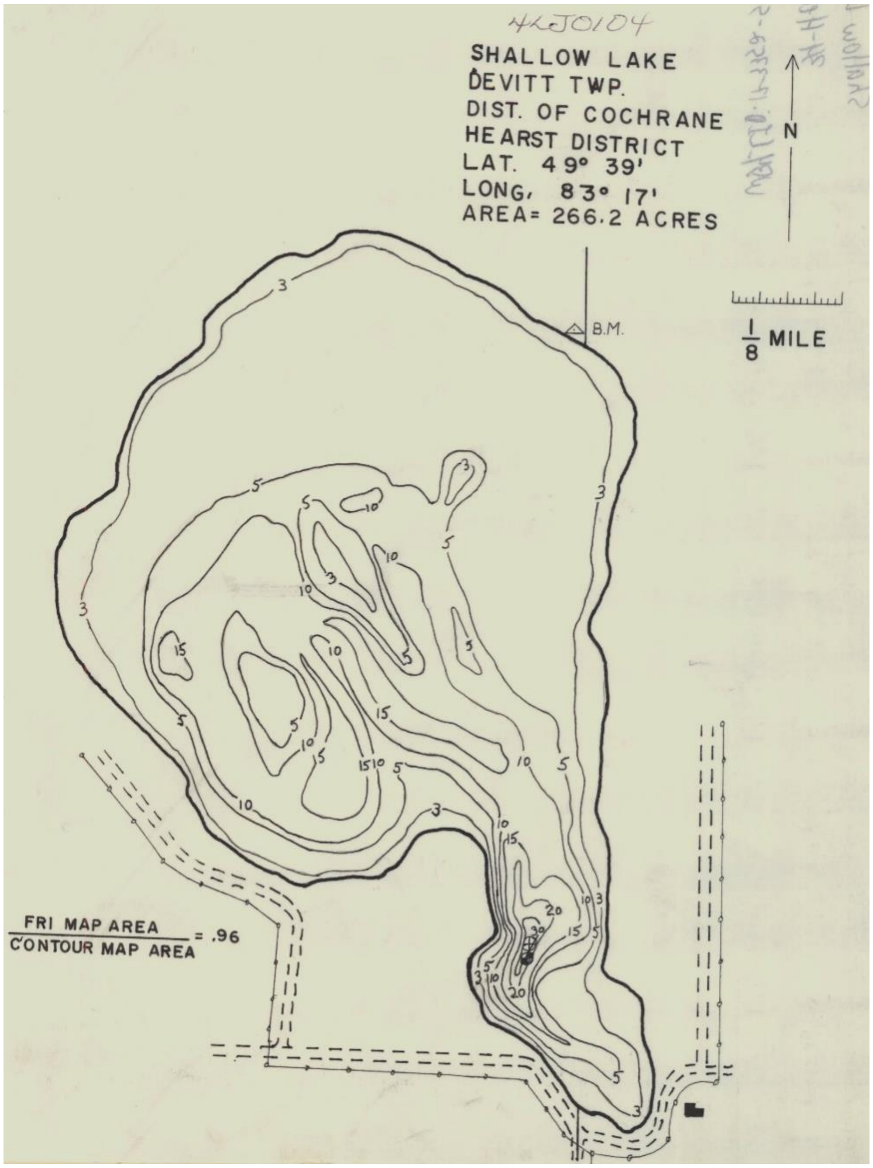
Appendix A. Shallow Lake Bathymetry



Source: MNRF (2023).

Appendix B. Lakeshore Capacity Model

Lakeshore Capacity Model — Shallow Lake

Anthropogenic Supply			
Shoreline Development Type	Number	Usage (capita years/yr)	
Permanent	15	2.56	
Extended Seasonal	15	1.27	
Seasonal	14	0.69	
Resort	5	1.18	
Trailer Parks	0	0.69	
Youth Camps	0	0.125	kg/capita/yr
Campgrounds/Tent trailers/RV parks	100	0.37	
Vacant Lots of Record	4	1.27	
Retention by soil (Rs) (0-1)	0.69		
Catchment			**Upstream Lakes**
Lake Area (Ao)	104.2	ha	
Catchment Area (Ad)	245.7	ha	
Wetland		%	
Cleared	0.0	%	
Hydrological Flow			
Mean annual runoff	0.376	m/yr	
Lake outflow discharge (Q)	1315624	m3/yr	
Areal water loading rate (qs)	1.26	m/yr	
Inflow 1		m3/yr	
Inflow 2		m3/yr	
Inflow 3		m3/yr	
Natural Loading			
Atmospheric Load	17.40	kg/yr	
Runoff Load	25.31	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	
Current Total Upstream Load 2		kg/yr	
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	28.47	kg/yr	
Future Anthropogenic Load	29.67	kg/yr	
Areal Load Rate			
Current Total Areal Loading Rate (L_T)	68.31	mg/m2/yr	
Future Total Areal Loading Rate (L_{FT})	69.46	mg/m2/yr	

Sedimentation		
Is the lake anoxic?	y	
Settling velocity (v)	7.2	m/yr
In lake retention (Rp)	0.85	
Monitoring Data		
Years of spring TP data	3	
Average Measured TPso	9.25	µg/L
Measured vs. Predicted TPso	-1.9	%
Is the model applicable?	y	
Over or under predicted?	under	
Modeling Results		
TPlake	8.44	µg/L
TPout	8.07	µg/L
TPso	9.08	µg/L
TPfuture	8.59	µg/L
Phosphorus Thresholds		
TPbk	5.07	µg/L
TPbk+40	7.09	µg/L
TPbk+50	7.60	µg/L
TPbk+60	8.11	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	at capacity	
# Extended seasonal OR	at capacity	
# Seasonal cottages OR	at capacity	
Loads		
Natural Load w/no developmer	42.71	kg/yr
Background + 50% Load	64.06	kg/yr
Current Load	71.18	kg/yr
Future Load	72.38	kg/yr
Outflow Loads		
Background Outflow Load	6.37	kg/yr
Current Outflow Load	10.62	kg/yr
Future Outflow Load	10.80	kg/yr

* Note that no value was supplied for %wetlands because the areal TP loading from watershed runoff was assumed to be 10.3 mg/m²/y, as recommended by MMA (1986) for sedimentary watersheds with <15% cleared land.