Wasa Lake Preliminary
Water Quality and Sediment Quality Assessment

Prepared for Wasa Lake Land Improvement District
Winter 2026

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Executive Summary

Wasa Lake is a small (105 ha) lake situated on the traditional and unceded territory of the Ktunaxa Nation, less than 1 km from the Kootenay River. The lake is a popular tourist destination that experiences abundant boating activity throughout the summer.

Limited sampling during 2025 indicated that water quality in Wasa Lake is suitable for recreational use; British Columbia's Recreational Water Quality Guidelines were infrequently exceeded. Water quality results exceeded recreational guidelines for pH in the Central and South bays of Wasa Lake during May 2025 sampling. This periodic exceedance is common in BC lakes but should be monitored if pH exceeds 9 units regularly. Additionally, recorded *E. coli* concentrations exceeded recreational guidelines for the first time during 2025.

Water quality in Wasa Lake can support invasive mussels. Invasive mussels threaten Wasa Lake's ecological integrity, aquatic infrastructure, and recreational values. Wasa Lake's direct connection to the Kootenay River increases the need to prevent invasive mussel introductions, as microscopic offspring can transfer between hydrologically connected water bodies.

Algae samples were comprised of green algae and cyanobacteria during May and August 2025. Green algae communities were dominated by species that favor shallow water with high nutrient concentrations. Cyanobacteria were present in low densities, and health risks associated with cyanobacteria were negligible in 2025 samples.

Wasa Lake is susceptible to sediment resuspension. A boat trial conducted by WLLID demonstrated that sediment resuspension occurs when boating in the shallows of Wasa Lake. Lab analyzed sediment samples indicated widespread contamination of petroleum-based hydrocarbons in Wasa Lake's sediment. Alongside petroleum contamination and sediment resuspension, drone footage highlighted the severity of boat propeller strikes on the sediment. Extreme sediment scouring in Wasa Lake provided visual evidence of ecological degradation through powerboating. Alongside negative ecological impacts, propellor strikes to the sediment also degrades water quality. Additionally, unrestricted boating can:

- deteriorate water quality through sediment resuspension that can increase turbidity plumes and mobilize nutrients, metals, contaminants and *E. coli* into the water column
- negatively influence fish and their food chain
- contribute to increased algae through nutrient release from resuspended sediments
- contaminate sediments with petroleum and metals
- increase risk of invasive mussel introduction

Wasa Lake was rated in a Lake Suitability Index for powerboating and was designated as "high risk". This result estimates that powerboating in Wasa Lake has significant negative consequences on water quality and lake health. The blue box below discusses powerboating in Wasa Lake:

This study found that Wasa Lake is unsuitable for unrestricted lake-wide powerboating and wake surfing:

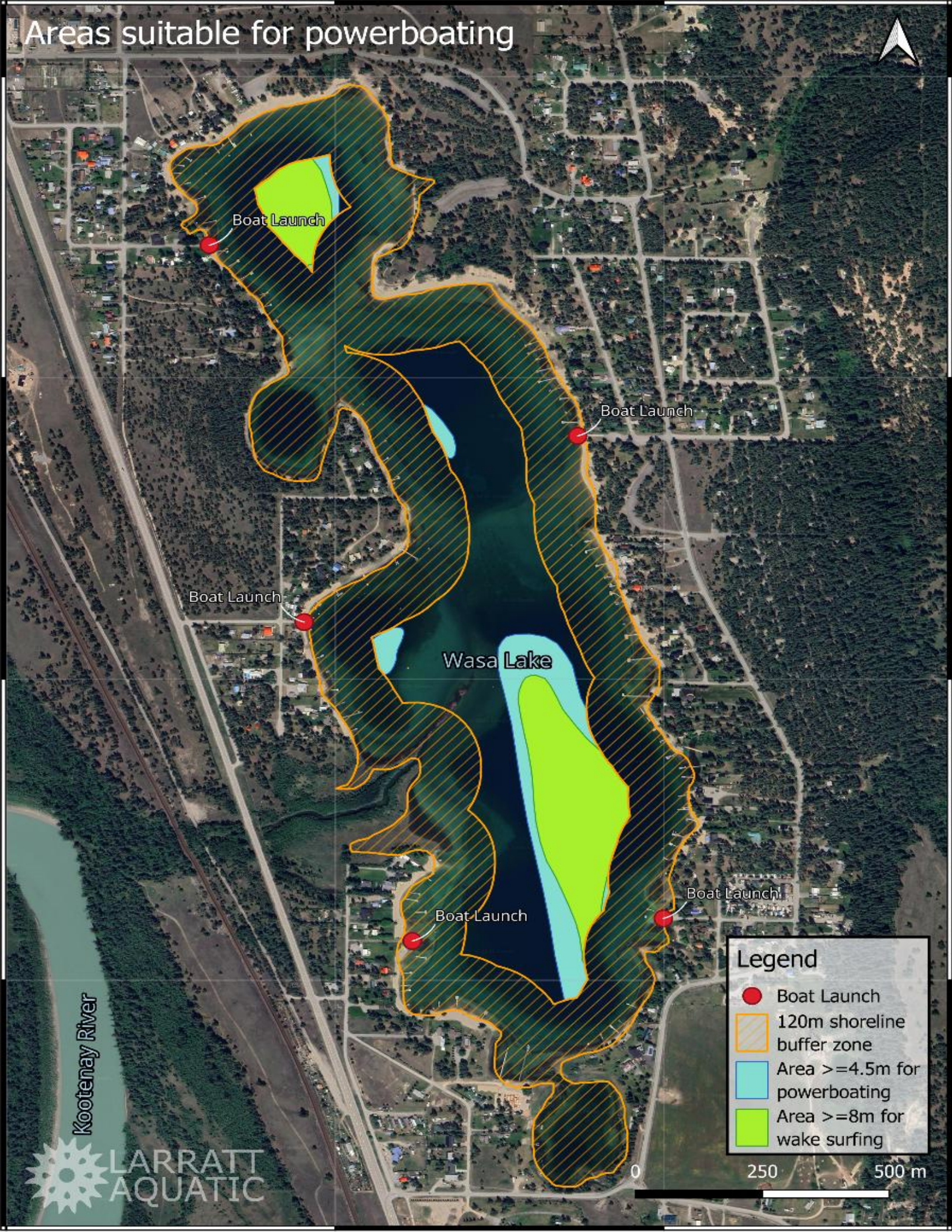
- naturally variable water levels present significant risk of boats impacting lake sediments during low water periods, a pattern well established by the damage to the bottom of the lake

- to prevent environmental and water quality degradation, recommended depth for power boating and wake surfing is over 4.5 m
    - only 21 % of Wasa Lake is > 4.5 m deep

- to prevent erosion of riparian areas, recommended distance from shore for powerboating and wake surfing is over 120 m
    - only 13 % of Wasa Lake is > 4.5 m deep and 120 m from the shoreline

- Wasa Lake has a theoretical maximum simultaneous carrying capacity of 2 concurrent powerboats/wake surfing boats when depth and distance to shoreline are considered
    - number increases to 13 powerboats when water quality and environmental factors are not considered

- Figure below shows areas where powerboating and wake surfing can occur without degrading water quality


Areas suitable for powerboating
Boat Launch
Boat Launch
Boat Launch
Wasa Lake
Boat Launch
Boat Launch
Kootenay River
Legend
Boat Launch
120m shoreline buffer zone
Area >=4.5m for powerboating
Area >=8m for wake surfing
0
250
500 m
LARRATT AQUATIC

Preferred Citation

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Definitions

Glossary: Following terms are defined as they are used in this report

Term	Definition
Cyanobacteria	Bacteria-like algae having cyanochrome as the main photosynthetic pigment
Green Algae	Photosynthetic algae that contains chlorophyll-a
Diatoms	Algae that have hard, silica-based "shells" frustules
Phytoplankton	Algae suspended in water
Secchi Depth	Depth where a 20 cm secchi disk can be seen; measures water transparency
Turbidity	Quality of being cloudy, opaque, or thick with suspended matter
Boating Terminology	
Powerboat	A boat with > 50 HP engine, particularly speed, wake surfing, and waterskiing boats
Personal watercraft	Seadoos, skidoos, and fishing boats
Wake surfing boat	A powerboat specifically designed for wake surfing and creates a large wake

Abbreviations

Acronyms	Parameters
BC = British Columbia	EPHs = Extractable Petroleum Hydrocarbons
CCME = Canadian Council of Ministers of the Environment	*E. coli* = Escherichia coli
IH = Interior Health	
LAC = Larratt Aquatic Consulting Ltd.	
OBWB = Okanagan Basin Water Board	
RWQG = Recreational Water Quality Guidelines	

Study Context

Wasa Lake Land Improvement District (WLLID) contracted Larratt Aquatic Consulting Ltd. (LAC) to provide understanding on current sediment and water quality at Wasa Lake. This small study was designed to be collaborative between WLLID and LAC to accommodate budget restrictions.

Study Outline

Field sampling is described in Table 1 and sampling methods are detailed in Appendix 1: Methods. Surface water was collected for chemical and biological analysis at in-lake sample sites (Figure 1; Table 1).

Table 1: Study features, 2025

LAC Feature	Function	Frequency
Lake sampling	*E. coli* and calcium samples collected in-lake on May 30, 2025 (Figure 1) – sampled North, South, and Central lake basins – single one-off sampling performed by WLLID Secchi depth recordings were taken by WLLID throughout summer 2025	9 samples
Weekly Lake Log	Performed by WLLID to record boating related observations	Nearly weekly from June to August
Phytoplankton	Surface algae samples collected in-lake on May 30, 2025 (Figure 1) – occasional one-off sampling performed by WLLID – sampled North, South, and Central lake basins	4 samples with full taxonomy 4 samples with simple taxonomy
Meter profiles	Dissolved oxygen, temperature, pH, and turbidity profiles on May 30, 2025 (Figure 1) - taken at North, South, and Central lake basins	3 profiles
Sediment traps	Sediment traps measured local sediment accumulation rates for one summer season – increases understanding of sediment resuspension – submitted to CARO for analysis: total weight, total volatile solids – Traps deployed in North, South, and Central lake basins	Spring-Fall 3 samples
Sediment samples	Measured total metals and EPHs within sampled sediment – collect sediment from southern, central, and northern basins – submitted to CARO Analytical Services, Kelowna, BC, for analysis	3 samples
Boating Trial	Captured sediment disturbance events during boating	1 event
Aerial drone	To identify scouring from boats on the lake-bottom - increases understanding of boating-influence on the beach - performed pre and post boating season	2 events

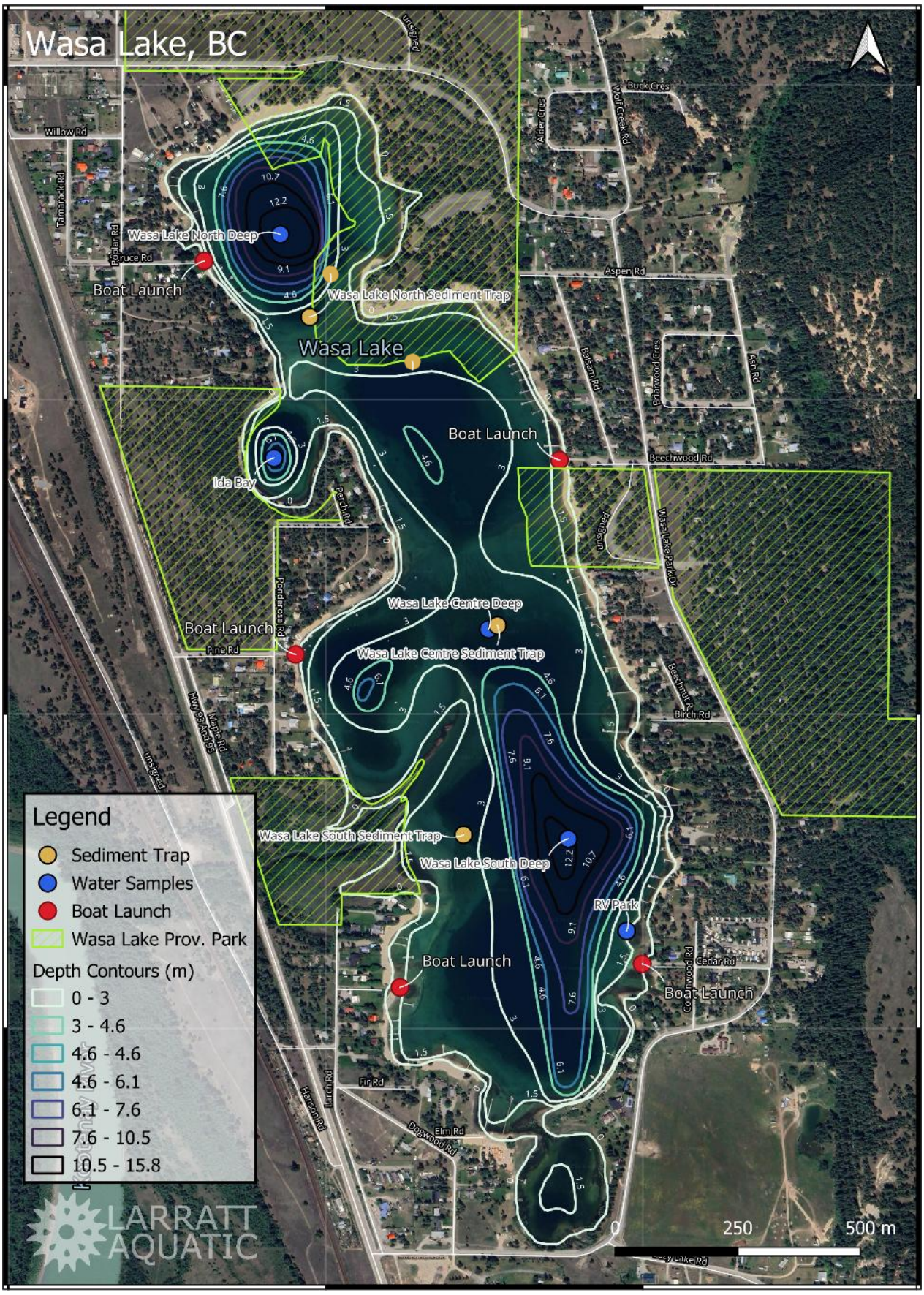

Figure 1: Wasa Lake including, sampling sites, bathymetry, and boat launches, 2025

Study Background

Wasa Lake is a small lake in eastern British Columbia located on the traditional and unceded territory of the Ktunaxa Nation.

Wasa Lake is advertised as one of the warmest lakes in BC and attracts recreators from British Columbia and Alberta (WLLID, 2025b). Wasa Lake Provincial Park surrounds the lake in four distinct sections and maintains a provincially regulated boat launch (Figure 2). Five unregulated boat launches on Wasa Lake provide additional accessibility for motorized recreation (Figure 1).

Figure 2: Wasa Lake Provincial Park (Photo credits: Trip Advisor)

Physical, Chemical and Biological Results

This section discusses water and biological samples collected by LAC and WLLID on May 30, 2025. Chemistry analyses were submitted to CARO Analytical Services in Kelowna, BC (Figure 1; Table 1).

Water Level

Maximum surface water levels in Wasa Lake vary by over 1 m each year (Figure 3). Natural drawdowns can exceed 2 m over the summer season.

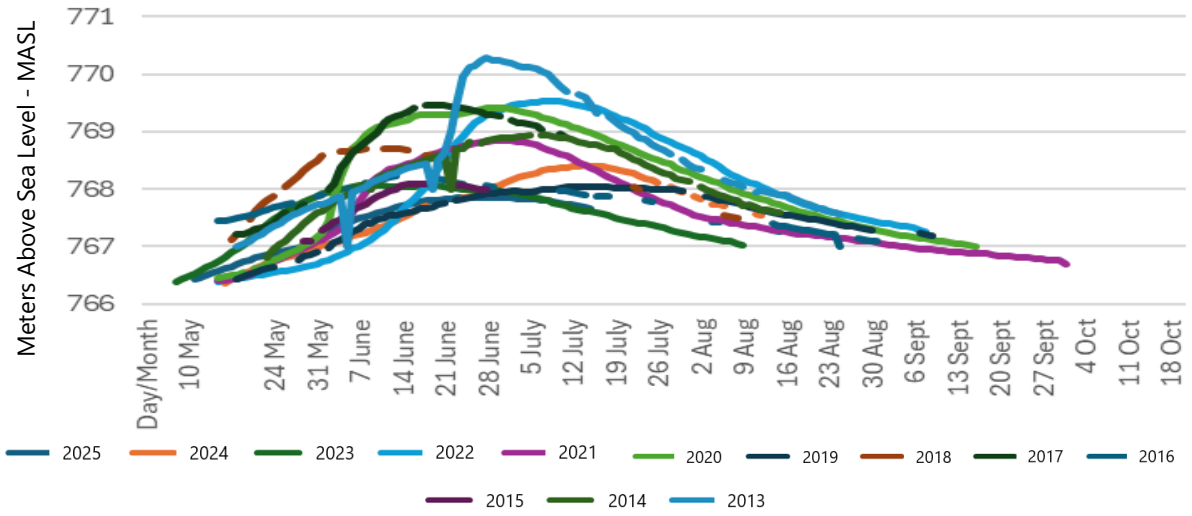

Figure 3: Annual water level (MASL) in Wasa Lake, 2013-2025

Note: Y-axis represents elevation in m not depth of Wasa Lake

Temperature and Oxygen

BC Recreational Water Quality Guidelines (BC RWQG) do not apply to water temperatures or oxygen concentrations. Wasa Lake's shallow depth facilitates warm water conditions in the summer with water temperatures exceeding 18 °C at all sites by late May 2025 (Figure 4).

Surface water in Wasa Lake was super saturated with oxygen at all sites, reflecting algae contributing oxygen to the water column during sampling (> 10 mg/L of oxygen; see algae section). Deep water oxygen concentrations were low and measured 1 mg/L at the bottom of the deepest site (Figure 4).

pH

BC RWQG designated pH values between 5 and 9 as acceptable for recreation. Water column pH values were within recreational guidelines in the North Bay, averaging 8.62 ± 0.19 on May 30, 2025. pH recordings exceeded 9 units in Central and South Bay's surface water.

Turbidity and Secchi Depth

Aesthetic objectives under BC RWQG state 50 NTU as a maximum acceptable turbidity recording. This guideline was not exceeded during LAC sampling. Turbidity and secchi depth recordings were collected in-situ with a multi-parameter sonde and secchi disc respectively. The maximum turbidity value was 2.10 NTU at the South sampling site. Secchi recordings measured 1.5 m at all sites on May 30, 2025.

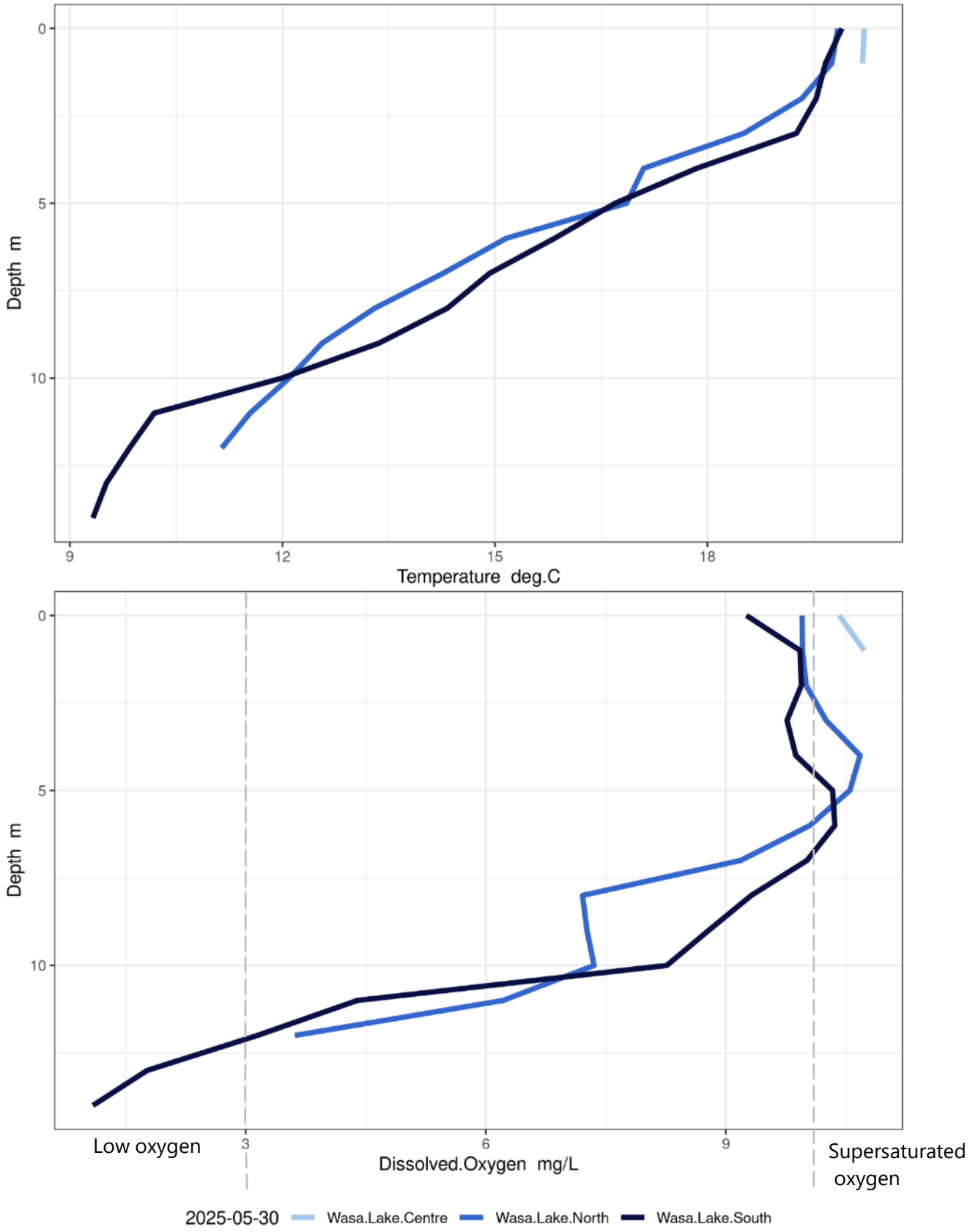

Figure 4: Wasa Lake temperature (top) and oxygen (bottom) profiles, May 30, 2025

Total and Dissolved Calcium (Invasive Mussels)

British Columbia is one of the last jurisdictions in North America without invasive mussels. Invasive mussels devastate ecosystems by out competing native species, degrading habitat and water quality, depleting food for fish, and increasing algae blooms. Lakes infested with invasive mussels undergo significant economic losses in recreation and lake-front property value. Beaches of infested lakes become dominated by razor sharp shell fragments, increasing recreational hazards. Docks and drinking water intakes are also damaged by invasive mussels. Fish populations decrease following invasive mussel introductions as juveniles are starved and spawning habitats are destroyed. Boating is the primary transportation method of invasive mussels in North America (Department of Fisheries and Oceans Canada, 2026; Figure 5)

A lake's vulnerability to invasive mussels is influenced by the concentration of calcium available in the water column[1]. Water quality results confirmed Wasa Lake can host invasive mussels (Table 2). BC's Invasive Mussel Defense Program detected 4 mussel-fouled watercrafts at their inspection stations during 2025. Documents detailing invasive mussel protection and information are provided in Appendix 2: Documents Regarding Invasive Mussel Information.

Wasa Lake's proximity and direct connection to the Kootenay River increases the importance of preventing invasive mussel introductions. If Wasa Lake becomes infested with invasive mussels, discharges into the Kootenay River could risk transportation of mussels downstream.

Table 2: Invasive Mussel Survival Risk Matrix and Wasa Lake Risk Assessment

Parameter	Risk Threshold	Wasa Lake Values
Calcium	>12 mg/L	22.6 to 29.3
pH	7.0 to 9.5	7.9 to 9.3
Temperature	0 to 33 °C	9.3 to 20.2
Salinity	< 10%	< 10 %
Oxygen limit	> 3 mg/L	> 3 mg/L*

Note: Based on in-situ data collected on May 30, 2025
* = Wasa Lake has < 3 mg/L in the deepest water only
Modified from (Okanagan Basin Water Board, 2024)

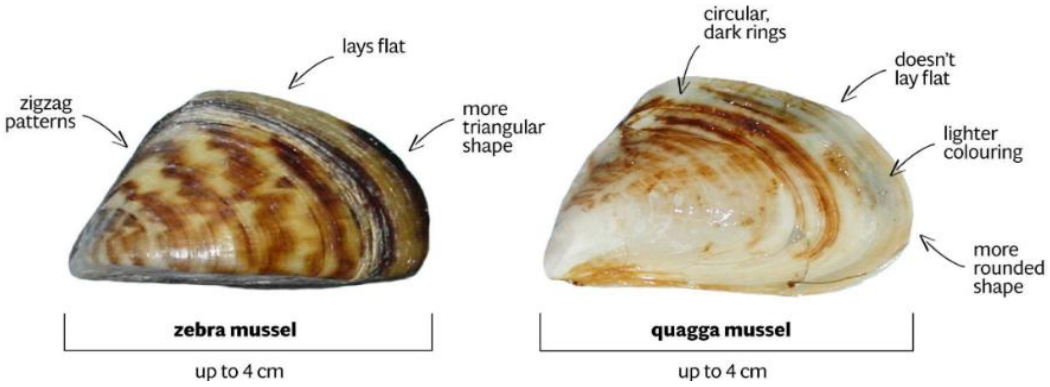

Figure 5: Zebra and quagga mussel comparison (Invasive Species Centre Canada, 2025)

[1] Calcium is required for shell development

Microbiology

Two types of BC RWQG exist for *E. coli* (Table 3). No sample collected by LAC exceeded short-term RWQGs on May 30, 2025. The highest *E. coli* concentration detected during May 2025 sampling was in front of the RV park in the South Bay of Wasa Lake (Figure 6; 68 CFU/100 mL).

High *E. coli* concentrations are not common at Wasa Lake, and *E. coli* concentrations have surpassed 200 CFU/100 mL only three times in 20 years (WLLID, 2025a). High *E. coli* concentrations were recorded for the first time in 2025 at the Campers Beach at the BC provincial park. *E. coli* measured 7,300 CFU/100 mL and 1000 CFU/ 100 ML on June 16 and July 19 respectively. These samples exceeded short-term RWQGs and the source of *E. coli* was not identified by WLLID or Interior Health.

Table 3: BC Recreational Water Quality Guidelines for E. coli

Type	Guideline	Description
Long-term	≤ 200 CFU /100 mL	Geometric mean of a minimum of 5 samples in 30 days
Short-term	≤ 400 CFU /100 mL	Single sample maximum concentration

(Ministry of Environment and Climate Change Strategy, 2019)

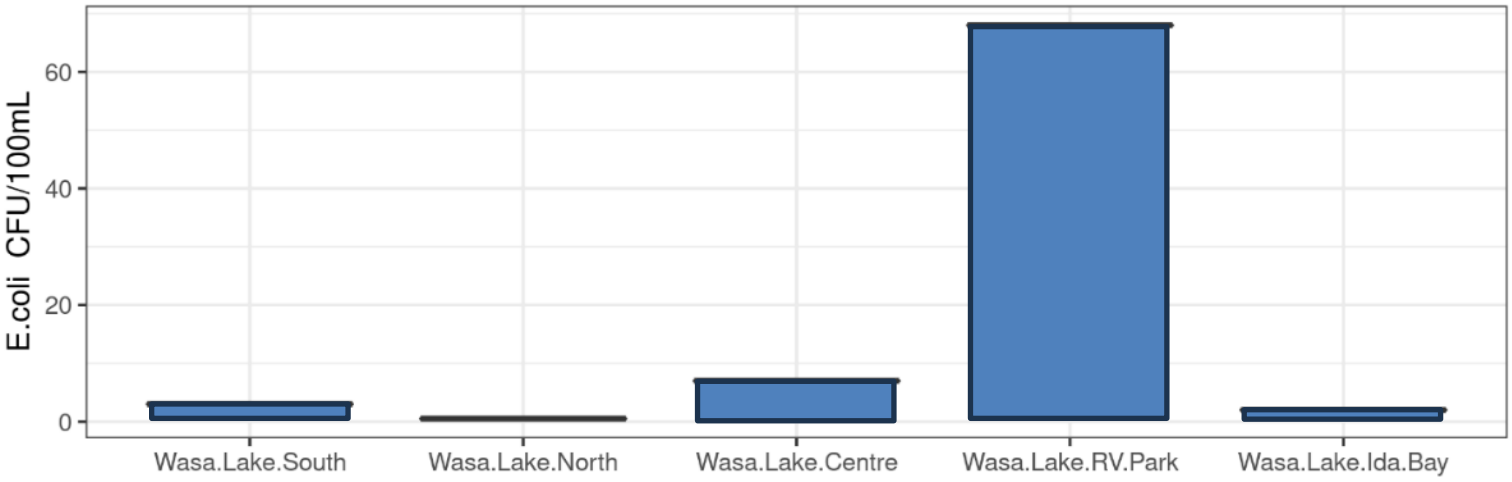

Figure 6: Wasa Lake E. coli concentrations, May 30, 2025

Phytoplankton

Eight algae samples were collected between May and August 2025. Of the samples collected only four could be enumerated into cells/mL, the other four were evaluated into percentage-based community composition (Table 4). Algal community composition represents the identity and relative abundance of all algae from each taxonomic category (diatom, green, yellow-brown, cyanobacteria and flagellates; Figure 8).

Table 4: Wasa Lake Algae Samples, 2025

Date (2025)	Cyanobacteria	Green	Diatoms	Other
Samples enumerated to cells/mL				
May 30 (South Bay)	1985	1490	400	570
May 30 (North Bay)	1070	850	140	450
May 30 (Central Bay)	1280	1200	460	760
June 15	590	120	30	230
Samples evaluated to percentage (%)				
August 10	88		12	
August 11	92		7	
August 23	99			
August 25	Could not be analyzed to percent			

May 30 samples contained dense colonies of *Ophrydium* ciliates forming a gelatinous mucilage. *Ophrydium* is a freshwater protozoan commonly found in wetlands and lakes, where it forms large colonies that appear as gel spheres in the water column. These spheres are typically clear, but *Ophrydium* appeared green in Wasa Lake because green algae were symbiotically within the gel spheres (Figure 7; Table 4). *Ophrydium* gel spheres do not pose a risk to recreator health.

Cyanobacteria were present in May 30, 2025, samples but densities did not pose health risks to recreators (Table 4).

Figure 7: Ophrydium cell under the microscope with green algae within it and Ophrydium colonies visible to the naked eye

Samples were low in algae density and dominated by cyanobacteria and green algae numerically on June 15, 2025. Cyanobacterial cells are much smaller than green algae and only represented a fraction of total biomass (Figure 8; Table 4). *Oocystsis sp.* was the dominant algae type and categorized as green algae. *Oocystsis sp.* is typical for shallow, clear lakes with moderate to high nutrient concentrations. Although green algae are not toxic, excessive growth can cause oxygen depletion in the water column, decrease lake aesthetic, and produce odors.

August Samples were dominated by cyanobacteria, but densities could not be evaluated (Table 4). Cyanobacteria typically increase in concentration during late summer due to their ecological preference of warm water.

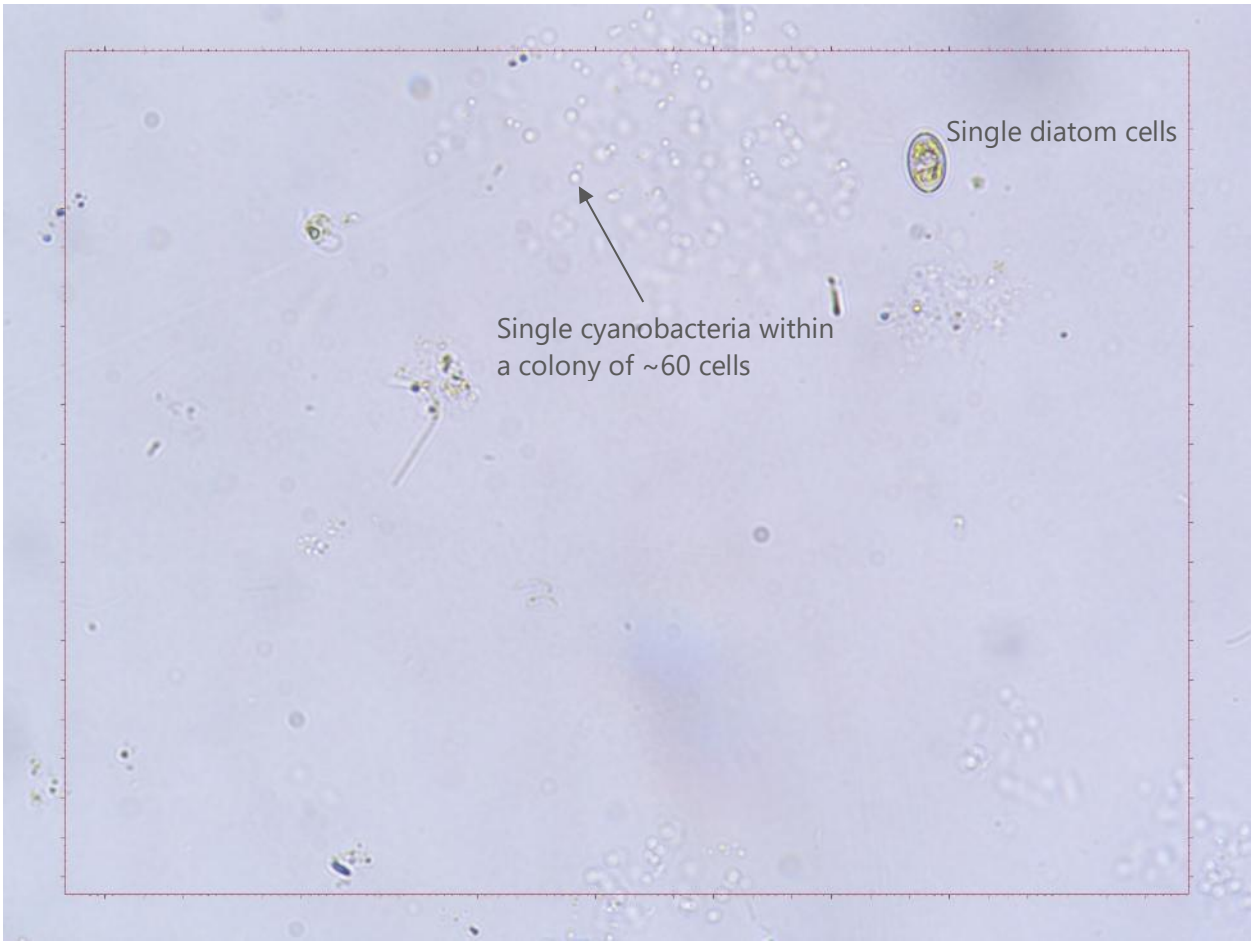

Figure 8: Microscope frame of a Wasa Lake sample, June 16, 2025

Sediment Quality

Lake sediments from the North, South and Central bays were analyzed for extractable petroleum hydrocarbons (EPHs) and total metals[2] (Figure 1). Sediment samples across all sites were similar in composition, appearing grey in colour and containing hydrocarbon and sulfur odors (Figure 9).

Figure 9: Sediment sample from Wasa Lake's South Bay, May 30, 2025

Petroleum-based Compounds

EPHs represent contaminants from petroleum and are commonly broken into two groups: compounds with 10-19 carbons or 19-32 carbons (Table 5). Sediment quality guidelines are not set for EPHs because it is a broad category including both natural biogenic hydrocarbons from decomposition of algae and human-caused petroleum hydrocarbons.

Results indicated wide-spread hydrocarbon contamination in Wasa Lake (Table 5). EPHs 19-32 are associated with motor oil and were detected in higher concentrations than EPHs 10-19 (Table 5).

Table 5: EPH concentrations in Wasa Lake sediment, May 30, 2025

EPH Type	North Bay (mg/kg)	Central Bay (mg/kg)	South Bay (mg/kg)
EPH 10-19	<210 (RL)	140	160
EPH 19-32	590	260	310
	Characteristics		
EPH 10-19	- Associated with jet fuel, diesel, and light lubricating oils - More soluble, mobile in soil, and more bio-available		
EPH 19-32	- Associated with motor oil, hydraulic oil, heavy lubricating oil - Less soluble, remains in soil for longer, binds to organic matter		

Note: sediment was analyzed with silica gel cleanup for increased accuracy of petroleum contamination detection
RL = reporting limit (210 mg/kg)

[2] One sample from Horseshoe Beach was submitted for sediment *E. coli* analysis (9.6 MPN/g)

Total Metals

Calcium, strontium, and sulfur concentrations surpassed regional averages at all sites (Table 6). These metals are not commonly associated with boating and likely represent local geology[3]. Above average sulfur concentrations reflected sulfurous odors detected during sediment sampling and are associated with anoxic, highly organic sediments.

North and South bays contained metals exceeding BC and/or CCME guidelines (Table 6). Lead and nickel are metals associated with boat operations and maintenance (An & Kampbell, 2003; Bighiu et al., 2017). Iron and manganese exceedances at the South Site, likely reflected low-no oxygen conditions that influence these metals. These exceedances may represent contamination related to boating or local geology; additional sampling is required to confirm.

Table 6: Earth metals, transition metals, and reactive non-metal exceedances, May 30, 2025

Regional Comparison			
Sampling Site	**Metal of interest**	**Regional average (mg/kg)**	**Wasa Lake Value (mg/kg)**
North	Calcium	77,470	96,300
	Strontium	96.48	191
	Sulfur	4077	8010
Central	Barium	97.37	432
	Calcium	77,470	256,000
	Strontium	96.48	1340
	Sulfur	4077	5180
South	Aluminum	9,630	11,400
	Calcium	77,470	103,000
	Strontium	96.48	238
	Sulfur	4077	6600
Guideline Exceedances			
Sampling Site	**Metal of interest**	**Guideline (mg/kg)**	**Wasa Lake Value (mg/kg)**
North	Lead **	CCME Sediment (35)	40.1
		BC Working Sediment (35)	
South	Iron	BC Working Sediment (21,200)	21,300
	Manganese	BC Working Sediment (460)	464
	Nickel **	BC Working Sediment (16)	18.3

Note: Central Bay did not exceed BC, CCME, or Canadian sediment guidelines
Averages from K. Reiberger, Metal Concentrations in Bottom Sediments from Uncontaminated BC Lakes, 1992
- Wasa Lake considered part of "Southern Rocky Mountain Tectonic Sub-region" for regional averages
** = metals associated with boating operations and maintenance

[3] Control sites were not sampled for regional reference due to limited budget

Sediment Traps

Sediment traps estimate sediment accumulation rates and sediment resuspension. Accumulation rates vary significantly between lakes and even within the same lake depending on proximity to inflows, sediment disturbances, and position within the lake.

Five sediment traps were deployed on the lake bottom by each sampling location, Boaters Beach and near Horseshoe Beach (Figure 1; Table 7). Sediment traps were placed in 1-3 m deep water to mimic average water depth in Wasa Lake and only 3 were retrieved at the study's conclusion (Table 7). Traps were deployed for approximately three months.

The South Bay's sediment trap was outside of typical boating routes and contained the lowest sediment accumulation rate of 0.14 mm/year.

Sediment trap located near Horseshoe Beach contained the second highest concentration of sediment. Reflecting sediment resuspension in an area frequented by personal watercraft (Jet-Skis and Seadoos) and non-motorized recreation (Table 7).

The Boaters Beach sediment trap contained the highest sediment accumulation rate of 1.45 mm/year (Table 7). This trap was placed within a popular boating location and its high sediment concentrations reflected regular boat usage in the area (Table 7).

Disturbances from summer boating presumably caused resuspension of sediment at Boaters Beach, increasing accumulation rates. Powerboat sediment disturbance studies conducted in the Okanagan Valley concluded that in water (Schleppe et al., 2016; Self and Larratt, 2020):

- 3 m or less deep, major sediment disturbances are caused by power boating
- 4 – 6 m deep, moderate sediment disturbances are caused by power boating
- 7-8 m depth, minor sediment disturbances are caused by power boating

Table 7: Wasa Lake sediment results, 2025

Analysis	Near Horseshoe Beach	Boaters Beach	South Bay
Dry g/trap	2.07	6.14	0.58
g/m^2/day	1.34	3.99	0.38
mm/yr	0.49	1.46	0.14
Depth of trap (m)	2-3	1-1.5	2-3

Note: Wasa Lake's water level is highly variable, influencing sediment trap depth during the study

Aerial Drone Footage

Aerial drone footage collected for this study by Bailey Repp recorded evidence of abundant boat impacts to Wasa Lake's sediment (Appendix 3: Drone Footage). Wasa Lake's average depth of only 3.8 m increases the risk of sediment disturbances caused by boating. Extreme sediment disturbances caused by boating can cause deep scours/trenches in a lake's bottom (Figure 10). Wasa Lake's sediment contained deep trenches and scours caused by boat propellors in each bay (Figure 11).

Formation of trenches causes large-scale sediment disturbances, increased turbidity, and mobilization of contaminants, nutrients and *E. coli* from the sediment into the water column, degrading water quality. Sediment resuspension negatively influences aquatic life by reducing light penetration, influencing fish feeding and schooling, causing gill irritation and damage to fish's protective eye mucous, disturbing fish eggs, and dislodging benthic invertebrates from the sediment (Environment and Climate Change Canada, 2017). Disturbed sediments also influence ecological dynamics and can stimulate algae growth from increased nutrient availability in the water column (Dillon et al. 1990; Nedohin and Elefsiniotis 1996).

Extensive sediment scouring revealed Wasa Lake is unsuitable for motorized recreation and power boating's influence on ecological integrity and water quality (Figure 10; Figure 11; Figure 12; Figure 13). Sediment scouring was most prevalent in the Central Bay, reflecting high powerboat usage (Figure 10).

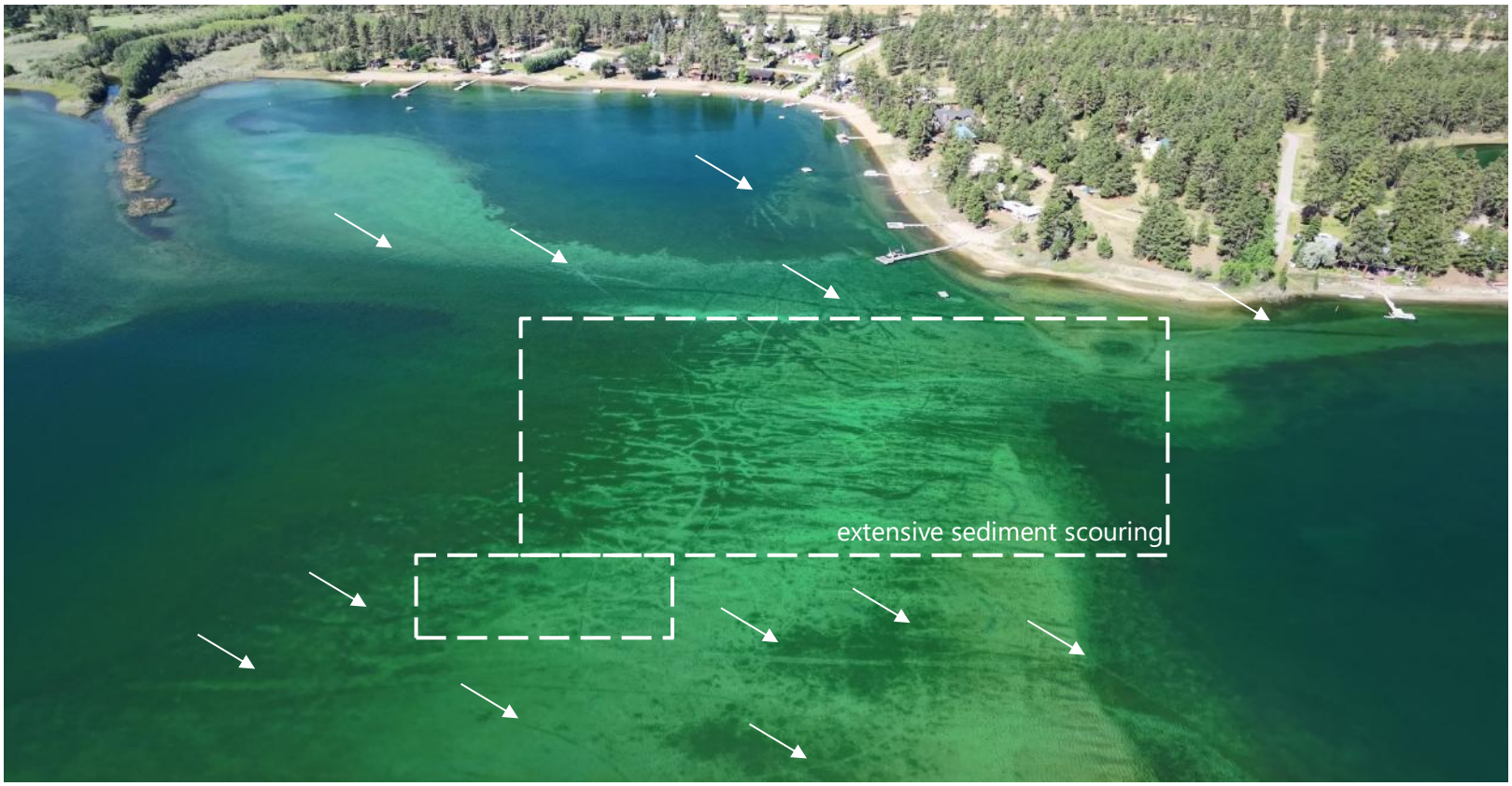

Figure 10: Sediment scours caused by boating between the South and Central Bays, May 30, 2025
Note: Arrows and boxes indicate some scours/trenches

Figure 11: Extensive sediment scouring caused by boating, May 30, 2025

Figure 12: Extensive sediment scouring caused by boating in the North Bay, May 30, 2025

Figure 13: Sediment scouring at Wasa Lake Provincial Park's boat launch, 2025
Note: Arrows and boxes indicate some scours/trenches

Boat Trial

A boat trial was conducted to demonstrate sediment resuspension with a 220 HP powerboat in Wasa Lake (August 2025; Figure 14). Sediment was easily disturbed during this trial and large plumes remained visible in the water column for over half an hour (Figure 15). Images from this trial can be used to provide public education and awareness of boating in shallow water. In the shallowest depths, sediment resuspension was most evident. In sections where water becomes deeper and where macrophytes were dense, sediment resuspension was reduced (Figure 15). Wasa Lake can conduct a measured boat trial to determine depth ranges with the highest risk of sediment suspension specific to Wasa Lake.

2025 boat trials demonstrated that boat activity caused sediment resuspension in shallow water (Figure 14; Figure 15).

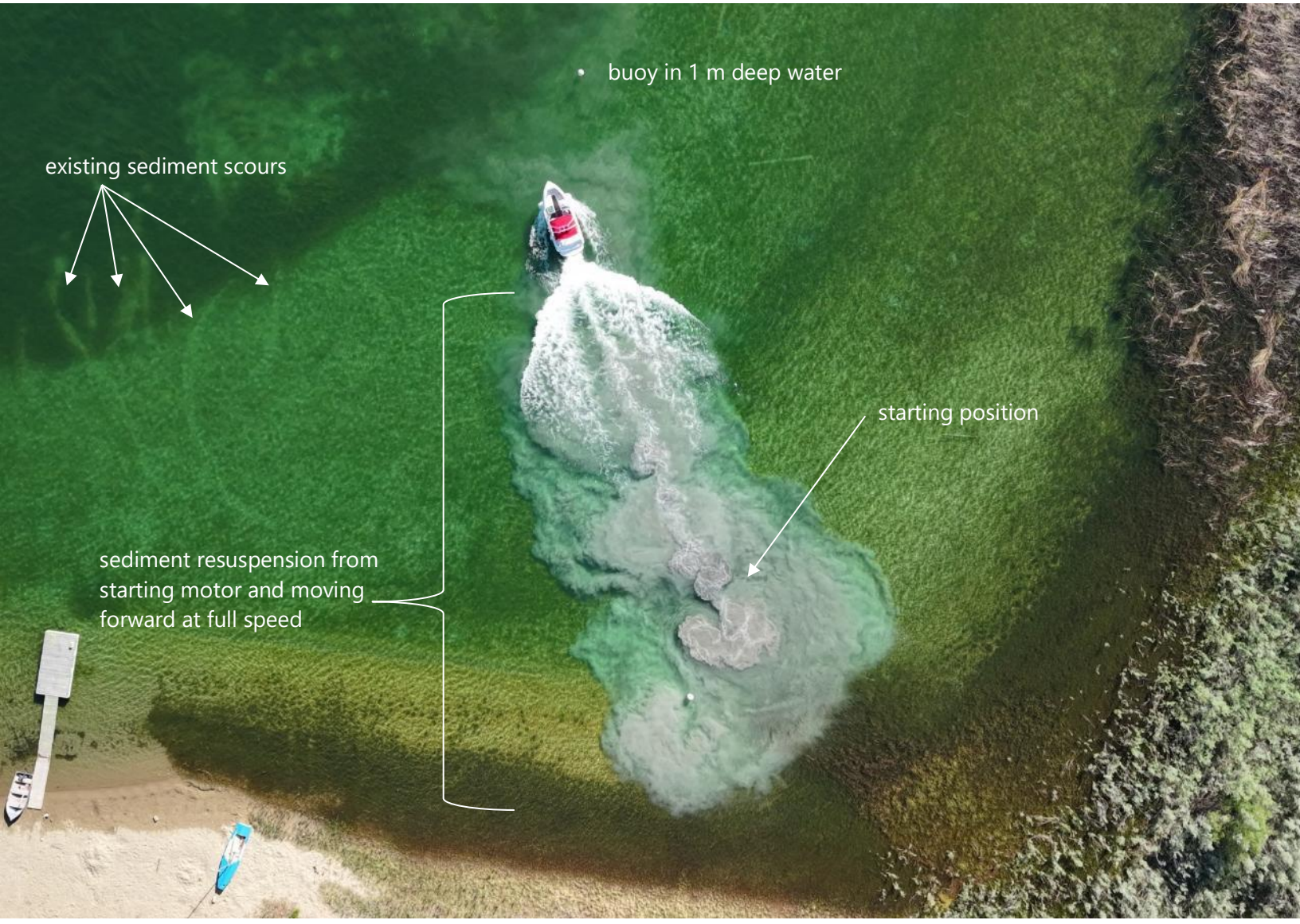

Figure 14: Boat trial initiation in shallow water, August 2025

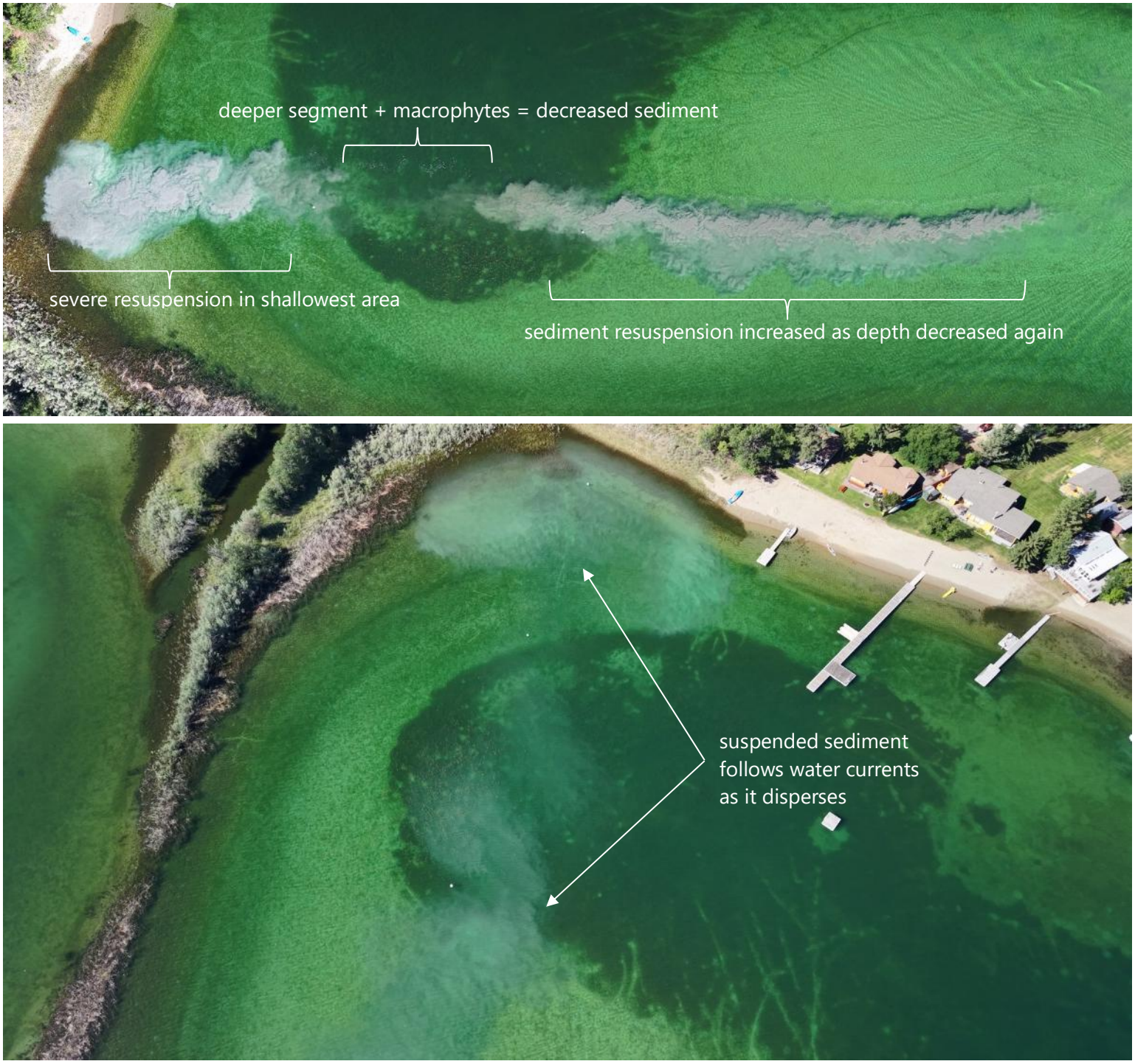

Figure 15: Sediment resuspension 2 minutes after trial (top) and approximately 30 minutes after trial (bottom), August 2025

Discussion

Public Use

Historically, Wasa Lake was a small community comprised of foreshore cabins with minimal riparian disturbances. As popularity grew for its recreational value, the introduction of larger homes, shoreline structures, and provincial parks altered Wasa Lake's natural foreshore. Currently, the entire Wasa Lake foreshore is owned either by residents (66 %) or parks (34 %) with natural habitat comprising only 40% of the shoreline (Mcpherson et al., 2009).

Wasa Lake's recreational use is supported by provincial parks, privately groomed beaches, and infrastructure for watercrafts. Two beaches are buoyed off for safety between motorized and non-motorized recreators. The 2008 FIM study identified segments of Wasa Lake containing 16 to 28 docks per kilometer demonstrating high motorized recreation among residents. Docks within these high-density ranges have potential to degrade sensitive habitats, introduce pollutants from motors, and damage the sediment causing scours (Figure 16; Mcpherson et al., 2009).

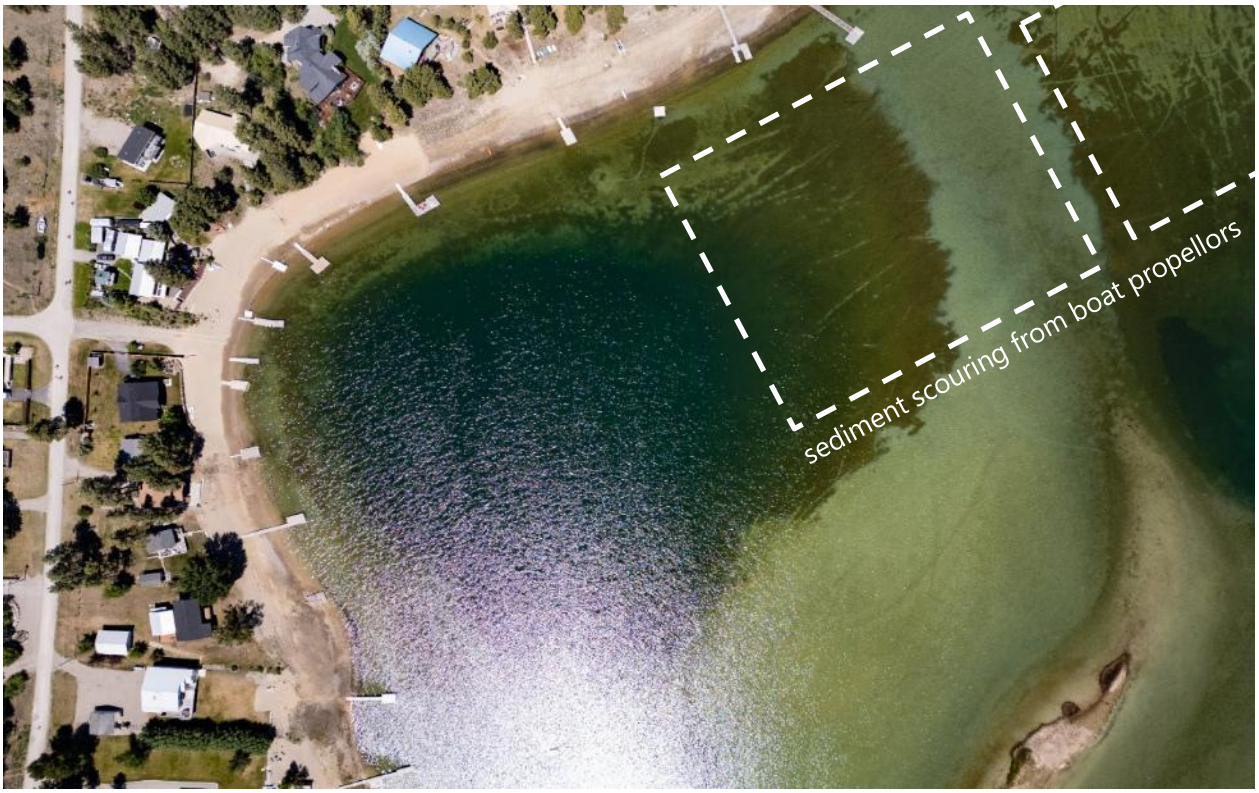

Figure 16: High dock density on Wasa Lake, May 2025

Motorized Recreation and Wasa Lake

Motors of powerboats create vertical turbulence in the water column that can reach a depth of 3 m (Gucinski 1982; Keller 2017). Motors from wake surfing boats are stronger and generate vertical wakes that can reach 4.5 – 8 m depths depending on power (Self and Larratt 2020; Raymond and Galvez-Cloutier 2015; Francis et al. 2023; Asplund 2000; Mastran et al. 1994; Schleppe et al. 2017; Mercier-Bliase and Prairie 2014; Raymond and Galvez-Cloutier 2015; Francis et al. 2023). These vertical wakes can cause sediment resuspension in the water column decreasing recreational aesthetic value, water quality, and environmental integrity. Wasa Lake monitoring demonstrated that this lake is vulnerable to ecological and water quality degradation caused by boating in shallow water (see: Sediment Traps, Aerial Drone Footage, Boat Trial, and Appendix 4).

Wasa Lake's shallow depth is unsuitable for wake surfing with only 11 % of the lake containing depth over 8 m and 21 % over 4.5 m at full pool (Figure 17). Sediment traps and extensive lake bottom scouring identified in this study revealed the large influence of motorized recreation on the substrate. The boat trial conducted by WLLID in 2025 also revealed that sediment in Wasa Lake is easily resuspended and can degrade water quality (Figure 15).

Alongside sediment resuspension, wake surfing boats and large watercrafts accelerate shoreline erosion. Studies have indicated that wake surfing boats require distances of 120-310 m to minimally impact shorelines (Francis et al. 2023). Only 13 % of Wasa Lake contains depth over 4.5 m and a 120 m minimum distance from shore at full pool (13.7 ha).

Boating studies conducted on Kalamalka Lake and Windermere Lake identified 1 powerboat/8 hectares[4] as a sustainable carrying capacity based on existing research (Schleppe et al. 2017; Larratt et al. 2024). Using this method, Wasa Lake's carrying capacity[5] at full pool is 13 powerboats at one time when ecological and water quality factors are not considered (full pool = maximum water depth).

Carrying capacity is reduced to 2 powerboats at one time when considering suitable areas that have depths over 4.5 m and boating distances 120 m from shore at full pool (Figure 17). Because Wasa Lake's water level is highly variable, this carrying capacity is expected to decrease throughout the summer. The carrying capacity refers to powerboats and wake surfing boats but does not include personal water craft like small fishing boats (see definitions).

[4] Details regarding carrying capacity can be found in Schleppe et al. 2017 study "Kalamalka and Wood Lake Boat Capacity Study on Source Waters"

[5] A carrying capacity specific to Wasa Lake was not determined in this study due to restricted budget

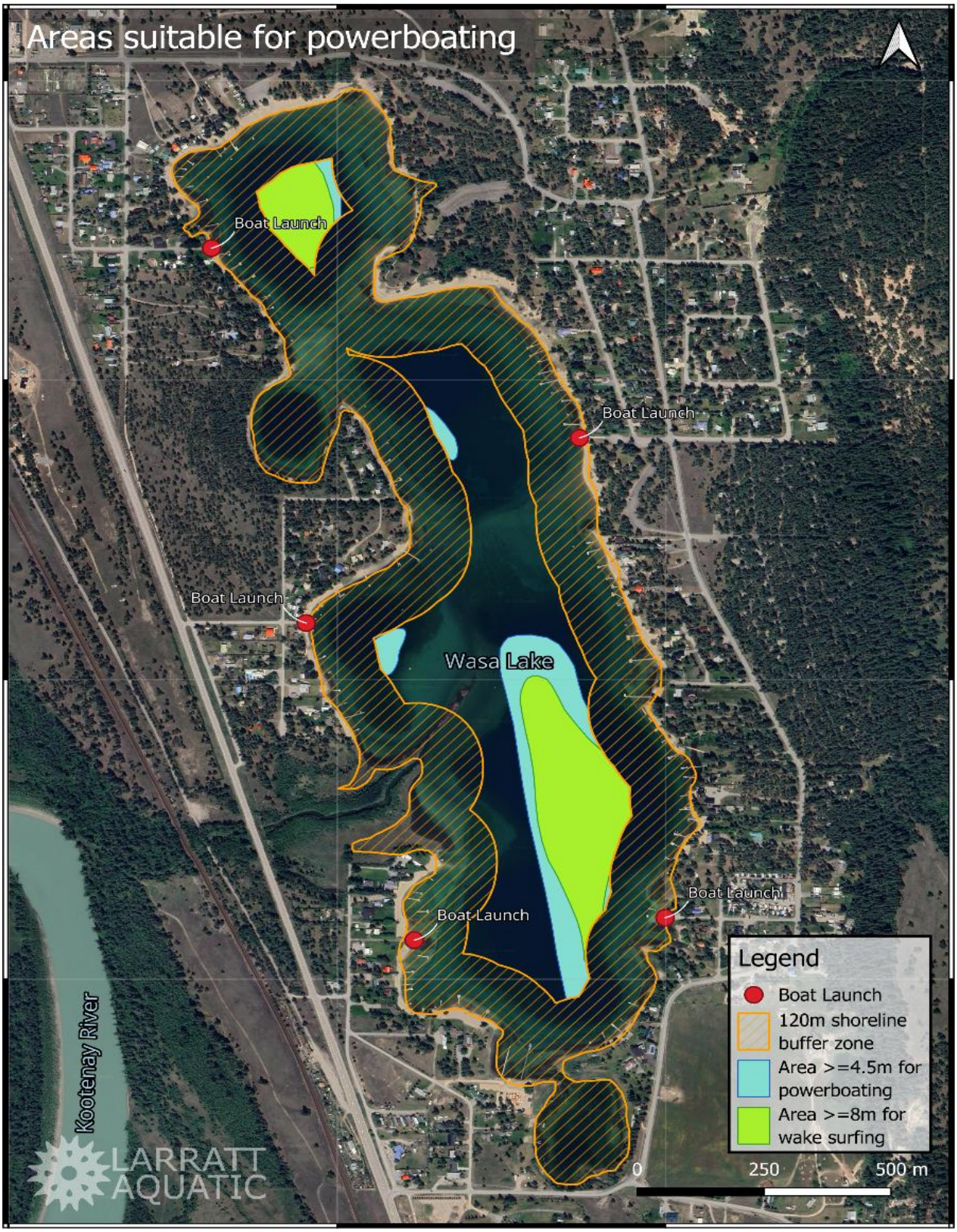

Figure 17: Estimated areas suitable for powerboating (≥4.5m) and wake surfing (≥8m)

Note: Depth contours extracted from 1960 survey by British Columbia Department of Recreation and Travel Industry – Fish and Wildlife Branch; an updated bathymetric map should be produced to refine these estimated areas

Lake Suitability Index

LAC, Lake Windermere Ambassadors, and Ecoscape Environmental Consultants Ltd. developed a Lake Suitability Index for powerboating (Table 8; Table 9; Appendix 5: Lake Suitability Index Criteria). This index is intended to identify lakes suitable and unsuitable for wake-surfing. The index was developed with all available peer-reviewed lake wake research to 2024 and uses recent and well supported limnological research. BC Lake Stewardship Society reports on Wasa Lake, Living Lake Canada's Wasa Lake Foreshore Inventory and Mapping, and this study were used to calculate a Lake Suitability Index for Wasa Lake.

Wasa Lake received a rating of 44/60 corresponding to "High Risk/unsuitable for powerboating – Powerboating is highly likely to have rapid and significant negative consequences on lake values". This rating recommends implementation of a permit system and pre-registration for daily permits to operate powerboats. A permit system is likely not feasible in Wasa Lake but this index highlights Wasa Lake's unsuitability for wake surfing and power boating.

Table 8: Wasa Lake's Lake Suitability Index

Category	Criteria	Wasa Lake's Rating
Limnology	Mean depth	5
	Trophic condition	2
	Percent littoral shallows < 8 m deep	5
	Litteral fine sediments	5
	Shoreline erosion/riparian condition	3
Safety	Swimmer/paddler safety	5
	Powerboat safety	2
Habitat	Vulnerable riparian habitats	4
	Aquatic/riparian species at risk	3
	Vulnerability to invasive mussel	4
Water Quality	Degraded water quality potential	3
	Harmful algae bloom potential	3
	Total	**44/60**

Note: Appendix 5: Lake Suitability Index Criteria provides definitions for rating values

Table 9: Lake Suitability Index Final Score Values

Lake score /60	Suitability to power boating	Suggested Actions (cumulative)
Negligible Risk (0-15)	suitable	preserve ecological values/services
Very Low Risk (16-23)	suitable	assess ecological resilience
Low Risk (24-32)	suitable - education advised	active >150m from shore >8 m water depth
Moderate Risk (33-39)	suitable - restrictions advised	code of boating behavior in place
High Risk (40-49)	unsuitable - permit system advised	pre-registration for daily permit to operate
Extreme (50-60)	unsuitable - prohibitions advised	power craft should be excluded

Conclusions

Water quality results indicated that Wasa Lake is suitable for aquatic non-motorized recreation. Water quality in Wasa Lake is threatened by powerboating. Wide-spread petroleum contamination in the sediment and extensive sediment scouring highlighted boating's negative influence on lake health. Sediment is easily resuspended in Wasa Lake when power boating occurs in shallow water. Resuspended sediment erodes water quality by increasing turbidity, releasing contaminants from the sediment, and re-introducing *E. coli* from the sediment back to the water column. In addition, watercraft are the primary transporters of invasive mussels. The introduction of Invasive mussels would devastate the ecological integrity, aquatic infrastructure, and recreational values of Wasa Lake.

Wasa Lake was rated as unsuitable for powerboating when considering bathymetry, lake width, lake substrates, human safety, and lake health. Only 13 % of Wasa Lake contained the minimum depth and distance from shore suitable for powerboating. The rest of Wasa Lake is at risk of ecological and water quality degradation caused by powerboating.

Wasa Lake's carrying capacity was estimated at 2 powerboats/wake surfing boats at one time when ecological and water quality factors are considered. This number increases to 13 powerboats/wake surfing boats at one time when considering surface area alone.

Looking Forward

The items below are potential options for WLLID, BC, and RDEK to collaborate on:

- Sample Wasa Lake for nutrients
  - Lab analyses of nitrogen and phosphorous concentrations can increase understanding of how algal communities are influenced by nutrients in Wasa Lake

- Sample Wasa Lake sediment in 5 years to monitor hydrocarbon concentrations
  - Some hydrocarbons can naturally degrade through benficial bacteria in the sediment
  - Reduced motorized recreation can decrease hydrocarbon accumulation in the sediment over time

- Review 2008 FIM and continue implementation of Foreshore Protection and Restoration

- Look at existing wake management campaigns to provide education to recreators
  - "I'm a Wake" – Regional District of North Okanagan
  - "Own your Wake For Everyone's Sake" – Michigan State

- Lobby province and RDEK to:
  - enforce clean, drain, dry practices for tourists and implement boat inspections to prevent invasive mussel introduction to Wasa Lake (see appendix 2)
  - remove unregulated boat launches

- Lobby Ministry of Transportation to implement speed restrictions and enforce carry capacities on Wasa Lake

- Apply for grants and funding to support additional studies of Wasa Lake including:
  - measured Boat Trial to determine water depths suitable for motorized recreation
  - update bathymetry data at high water level
  - carrying capacity study specific to Wasa Lake
  - re-do Wasa Lake Usage study by Living Lakes Canada outside of long weekends to reflect typical lake usage
  - literary review to understand research to date on Wasa Lake, summarize findings, and act on relevant recommendations

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Appendices:

Appendix 1: Methods conducted by LAC

Water Quality

Chemistry samples were collected by hand directly below the surface into bottles provided by CARO Analytical Services, Kelowna, BC (Table 1). Filled sample bottles were placed on chipped ice and delivered within 24 hours of collection to CARO Analytical Services. Samples were analysed for *E. coli*, total calcium and dissolved calcium according to current Standard Methods. Lake profiles recording temperature, oxygen, TDS, conductivity, and turbidity were collected with an AquaTroll 500 Multi-parameter Sonde.

Algae

Samples were collected directly below the surface and stored in a plastic 1 L bottle (Table 1). These samples were stored in a dark, iced cooler until analyzed by LAC. Lab protocols can be found by emailing Jamie@larratt.ca.

Sediment

Sediment samples were obtained by an Ekman grab, composed of stainless silver. The top sediment layer was collected to identify potential water quality impairment by sediment resuspension. Three sediment samples were combined to create a composite sample. Sediment was placed in a glass jar and stored in a dark, iced cooler until analyzed by Caro Labs. Samples were analyzed according to current Standard Methods for total metals and EPHs.

Sediment traps were composed of sediment catch basins on the sediment's surface. Samples were carefully removed to prevent sediment disturbance and analyzed for total weight and total volatile solids.

Sediment traps were deployed in the North, South and Central basins of Wasa Lake. Traps were placed directly on the sediment and left until they were removed at the end of the boating season.

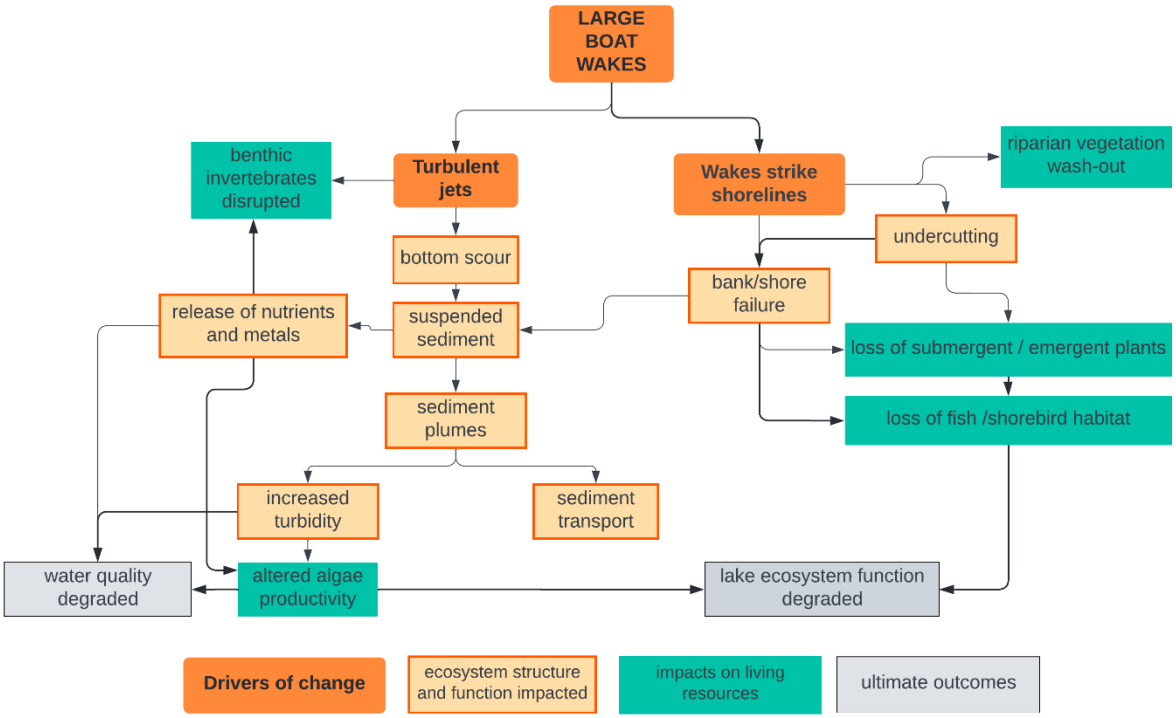
Appendix 2: Documents Regarding Invasive Mussel Information

- British Columbia Invasive Mussel Lake Monitoring Field Protocol
- BC Invasive Mussel Information Portal
- BC Invasive Mussel Defense Program
- Zebra, quagga and golden mussel facts
- Clean Drain Dry Information
- Central Kootenay Invasive Species Society Aquatic Invasive Page
- OBWB – Preparing for Invasive Mussels

Appendix 3: Drone Footage

Contact Bailey Repp or Larratt Aquatic Consulting Ltd. for footage.

Appendix 4: Summary of Large Boat Wake Impacts



Appendix 5: Lake Suitability Index Criteria

LAC Ranking of Lake Suitability to Power Boating

	Boating Impact	very highly vulnerable lakes (5)	high vulnerability lakes (4)	moderate vulnerability lakes (3)	low vulnerability lakes (2)	lakes at very low risk (1)	Data sources
LIMNOLOGY	mean depth	<10m	10-25 m	>25m	>60 m	> 80m	bathymetry
	trophic condition	eutrophic/ hyper eutrophic	eutrophic-mesotrophic	mesotrophic	oligotrophic	ultra oligotrophic	lake studies
	percent of littoral shallows (<8 m deep)	>15%	10-15%	5-10%	2-5%	<2%	bathymetry
	littoral fine sediments (clay silt sand)	common throughout lake	common in bays and fans	only in isolated shallow areas	rare	do not occur	lake surveys
	shoreline erosion /riparian condition	>20% of shorelines eroding	20-10% of shoreline eroding	>10% -small eroding patches	erosion isolated and rare	no measurable erosion	FIM
SAFETY	swimmer/paddlecraft safety	often unsafe in majority of lake	often unsafe in high traffic areas	Peak use unsafe in high traffic areas	generally safe	safe throughout lake	resident surveys
	power boat safety (summer, key areas)	boat density >1/ha	boat density >0.75/ha	boat density >0.375/ha	boat density >0.125/ha	boat density <1 boat/10 ha	lake studies
HABITAT	vulnerable riparian-littoral habitats	>10% of littoral/shoreline	7-10% of littoral/shoreline	5-7% of littoral/shoreline	2-5% of littoral/shoreline	<2% of littoral/shoreline	FIM + AHI
	aquatic/riparian species at risk	reproduction threatened	seasonal use threatened	occasional use threatened	SARA sp. seldom encountered	SARA sp. not evident	FIM SARA
	vulnerability to invasive mussels	suitable & connected to infestation	all suitability parameters met	most suitability parameters met	Ca suitability met (Ca > 15 mg/L)	Ca <12 mg/L or salinity >10	
WATER QUALITY	degraded water quality potential	exceedances throughout lake	localized exceedances/impacts	episodic local exceedances	impacts detected, no exceedan	impacts not detected	SWP plan
	harmful algae bloom potential	significant and frequent	significant and occasional	moderate and occasional	low potential and rare	not detected at any time	lake studies
				SUM	44		

Description of risk rating scale for power boating impacts

Risk Level	Numeric rating	Description
Very Low Risk	1	Power boating should not have a detectable effect on lake values.
Low Risk	2	Power boating could impact lake values but both the likelihood and scale of impact are expected to be low.
Moderate Risk	3	Power boating could impair lake values with either a high likelihood of occurring or high impact potential.
High Risk	4	Power boating is highly likely to have rapid and significant negative consequences on lake values.
Very High Risk	5	Power boating has the potential to cause rapid and catastrophic impacts to lake values.

----------END OF REPORT----------