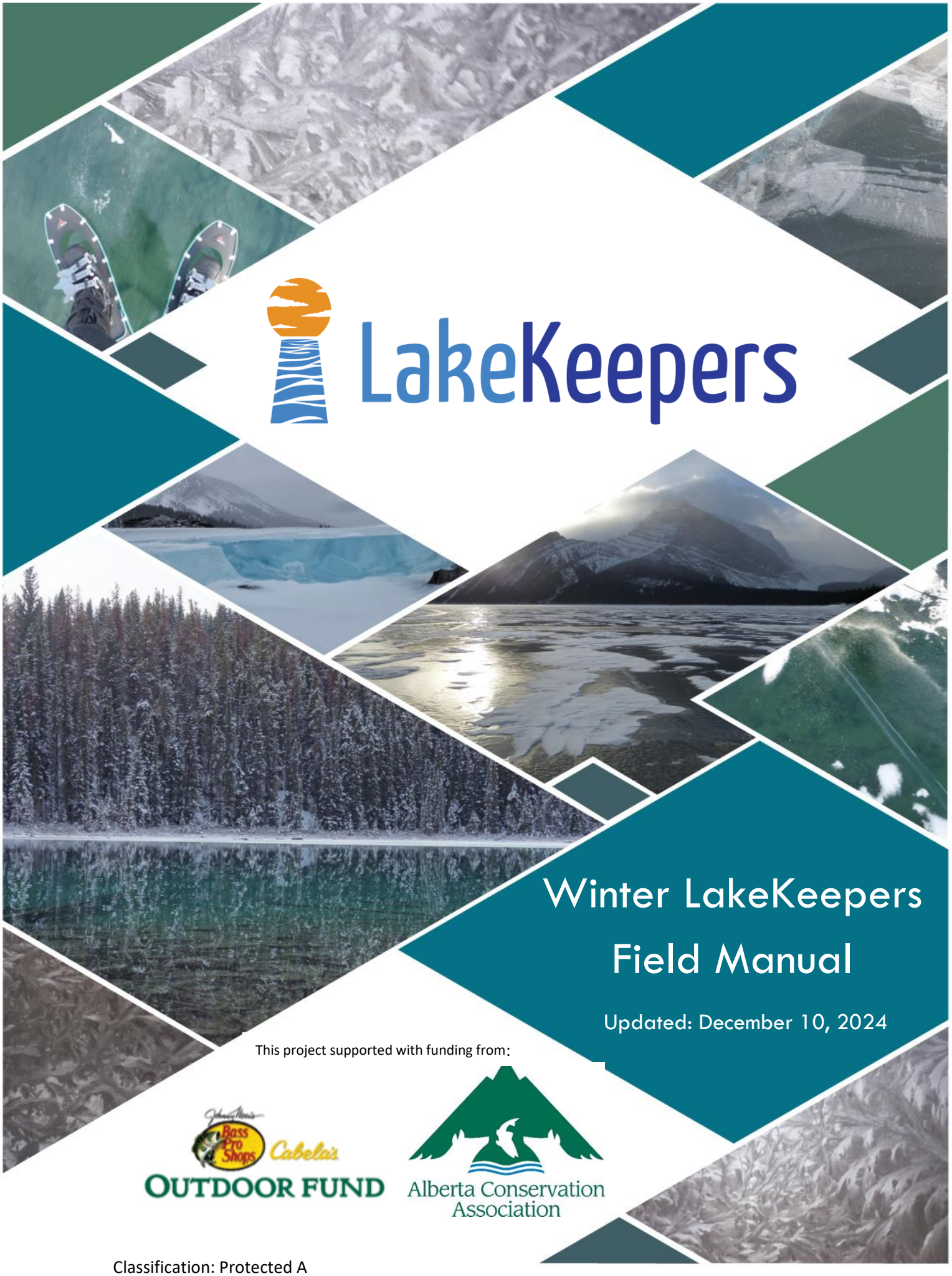

LakeKeepers

Winter LakeKeepers Field Manual

Updated: December 10, 2024

This project supported with funding from:

Bass Pro Shops Cabela's OUTDOOR FUND

Alberta Conservation Association

Classification: Protected A

ALBERTA LAKE MANAGEMENT SOCIETY'S LAKEKEEPERS PROGRAM

Welcome to Winter LakeKeepers!

Thank you for expressing interest in Alberta's aquatic environments and for participating in the Winter LakeKeepers program. You have proven that ecological apathy can be overcome and give us hope that our water resources will not be the limiting factor in the health of our environment. Throughout this process, you will be involved in the collection and preparation of scientific data critical for assessing the health of your lake of interest. This manual is meant to be a reference for Winter LakeKeepers sampling protocol.

LakeKeepers has several important objectives, one of which is to address the gap of winter lake water quality data for lakes in Alberta. At ALMS, our mission is to promote the understanding and comprehensive management of lakes and reservoirs and their watersheds. With Winter LakeKeepers, we hope to expand the breadth of lake monitoring, education, and management in Alberta.

For field sheets, safety training, and the ice safety quiz, visit:

https://alms.ca/winter-lakekeepers/

This manual was prepared by Brittany Onysyk, Kurstyn Perrin and Kirsten Letendre. For more information, please contact lakekeepers@alms.ca

Manual last updated: December 10th, 2024

This project supported with funding from
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Bass Pro Shops Cabela's OUTDOOR FUND
Alberta Conservation Association

1) BEFORE YOU HEAD OUT:

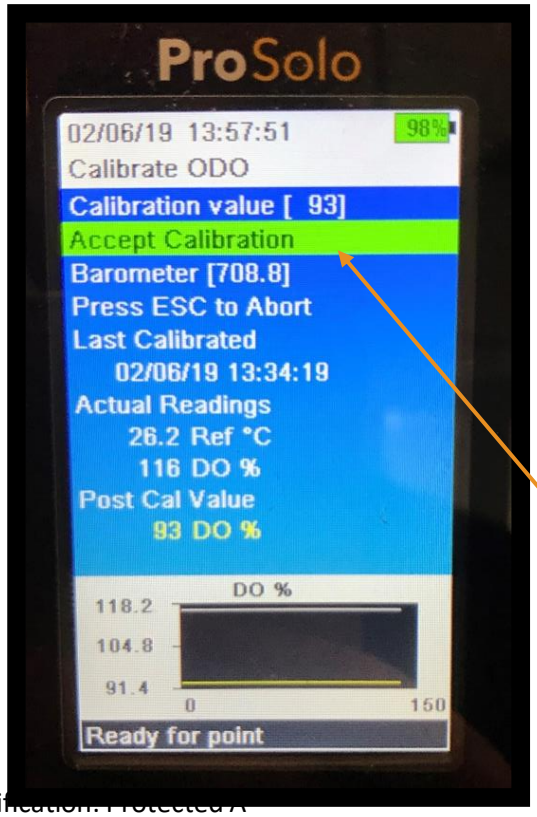
a) **Complete the online safety quiz and informed consent form at** www.alms.ca/winter-lakekeepers/

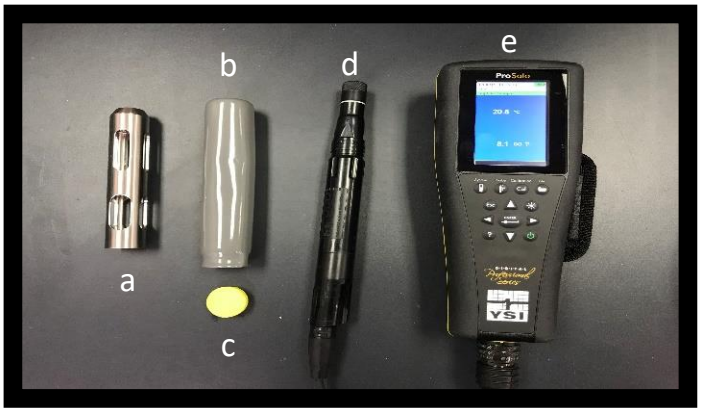
b) Confirm with ALMS (lakekeepers@alms.ca) whether you're following **P1 or P2 protocols**; look for P1 or P2 in the step name to know which steps to follow. Check the materials list on Page 13 (Appendix section A2) to make sure you have all applicable materials. Also, **plan a timeline for sample return with ALMS**, depending on filtering for chlorophyll-a.

c) Make sure your probe is charged (see the battery on the top right of the probe screen).

d) **Fill your hot water bottle** and place it in your YSI kit. This will protect the probe from freezing.

e) If you need help finding your GPS coordinates, follow the steps on Page 12 (Appendix section A1). If you are sampling the same location at a lake more than once, refer to your initial GPS in **Table 2** on Page 12 (Appendix section A1) to aid in navigating to the same site location.





2) CALIBRATE PROBE AT THE LAKE (P1 & P2):

a) Calibrate your probe in your vehicle to avoid freezing.

b) If not done already, connect your probe to your **handheld unit** (e).

c) Remove the **grey sleeve** (b) from your **probe** (d).

d) Remove the **metal probe guard** (a) and gently wipe any water droplets from the probe with a Kimwipe (supplied tissue).

e) Carefully place the metal guard back over your probe.

f) There is a yellow sponge inside the grey calibration sleeve. Using water from the calibration bottle, wet the **yellow sponge** (c) with a few millilitres of water (a few drops is all you need).

g) Place the grey sleeve (with yellow sponge inside) over the metal guard.

h) Wait **five minutes** to allow the air in the probe to become saturated with moisture from the sponge.

i) Connect your probe to your **handheld unit** (e).

j) Press the green power button on your handheld unit.

k) Press '**Cal.**' Cal

l) Choose '**ODO**' or '**DO**' by pressing Enter.

m) Choose '**DO %**' by pressing Enter.

n) Wait one minute.

o) Record the **Barometer value** on the front of your field sheet.

p) Choose '**Accept Calibration**' by pressing Enter.

q) Press escape until you see the '**log one sample** ' screen.

r) Keep the probe in its grey sleeve and in the sampling kit until you are ready to collect data.

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3) CALIBRATE PROBE FOR CONDUCTIVITY:

a) Calibrate your probe in your vehicle to avoid freezing.

b) Remove the **grey sleeve** (b) from your **probe** (d) and place inside the graduated cylinder.

c) Fill the graduated cylinder with the conductivity calibration solution so that the conductivity sensor on the probe (see below) is submerged. Let sit for 5 minutes.

d) If not done already, connect your probe to your **handheld unit** (e).

e) Turn on the handheld unit, and navigate to the conductivity calibration window: Press '**Cal.**' 

f) Choose '**Conductivity**' by pressing Enter.

g) Choose '**Sp. Conductance**' by pressing Enter.

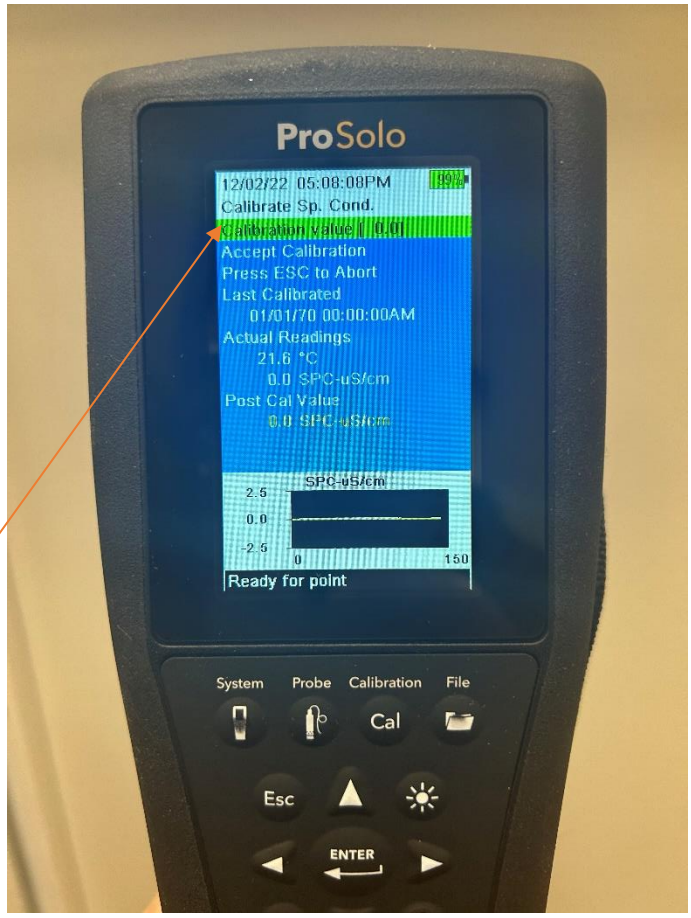
h) Change the 'Calibration value' to the conductivity calibration solution used (this will be marked on the bottle, units are in µS/cm).

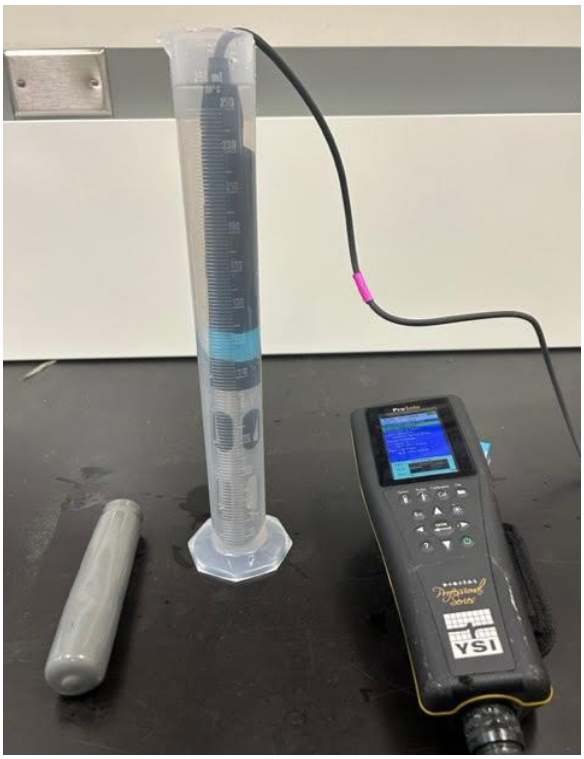
i) Watch the lines on the graph and wait 1 minute, or until the line stabilizes. Press '**Accept Calibration**'.

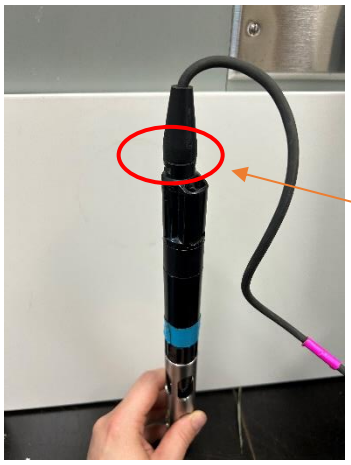
j) Calibration is now complete. Rinse the probe with water before putting the grey sleeve back on the probe.

k) Press 'ESC' until back at the home screen. Power down the handheld.

Do not reuse the conductivity solution.
Conductivity solution can be dumped down the drain or outside.







Conductivity sensor

4) RECORD BOTTOM DEPTH AND PROFILE MEASUREMENTS:

a) Fill in the '**Environmental Observations**' portion of your field sheet. See Appendix (A5) for **white ice** identification tips. For '**Ice & White Ice Thickness**' measurements, use the ice measuring stick included in the kit.

b) Auger **two separate holes** (one for the probe work and one for collecting bottles).

c) Use the '**tape and weight**' to determine the bottom depth and record the depth in the '**Approximate Bottom Depth**' box on the back of the field sheet.

d) With your probe turned on to the '**Log One Sample**' screen, remove the grey sleeve, keep the metal guard on, and lower the probe into the water until the 0.1 m marker is at the surface of the water. **The cable is already marked in meters, please don't measure in feet.**

e) If your backlight turns off during sampling, press any key to reactivate it.

f) Record the **temperature, dissolved oxygen,** and **conductivity** (if applicable) measurements on your field sheet following the depths indicated in the 'Depth (m)' row (see Appendix: step A3 on Page 14 for guide on cord depth markings).

g) You may need to wait 30-60 seconds for your dissolved oxygen readings to stabilize at each depth.

h) Continue this process until you have hit the bottom of the lake.

i) Hold the **Power Button** to turn off your probe.

j) Place the grey sleeve with wet sponge inside back over the metal guard. Return the probe to the warm sampling kit.

NEXT STEPS: FILLING BOTTLES WITH LAKE WATER

Any bottle with a **GREEN** sticker on the lid CAN be submerged into the lake.

Any bottle with a **RED** sticker on the lid CANNOT be submerged into the lake.

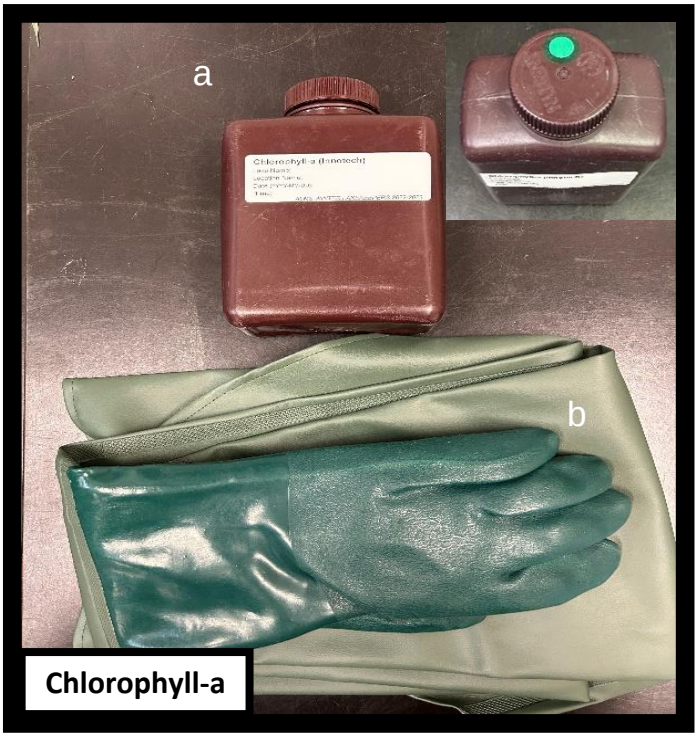
5) COLLECT WATER SAMPLE WITH CHLOROPHYLL-A BOTTLE (P2 ONLY):

a) Using a Sharpie, label your **Chlorophyll-a Bottle** (a) with the Lake Name, Location Name, Date, and Time.
THIS BOTTLE HAS A GREEN STICKER, IT CAN BE SUBMERGED INTO LAKE.

b) Wearing the **sampling glove** (b), fill your **Chlorophyll-a Bottle** with water from below the surface, as deep as you can reach down.

c) Place the sample into your cooler.

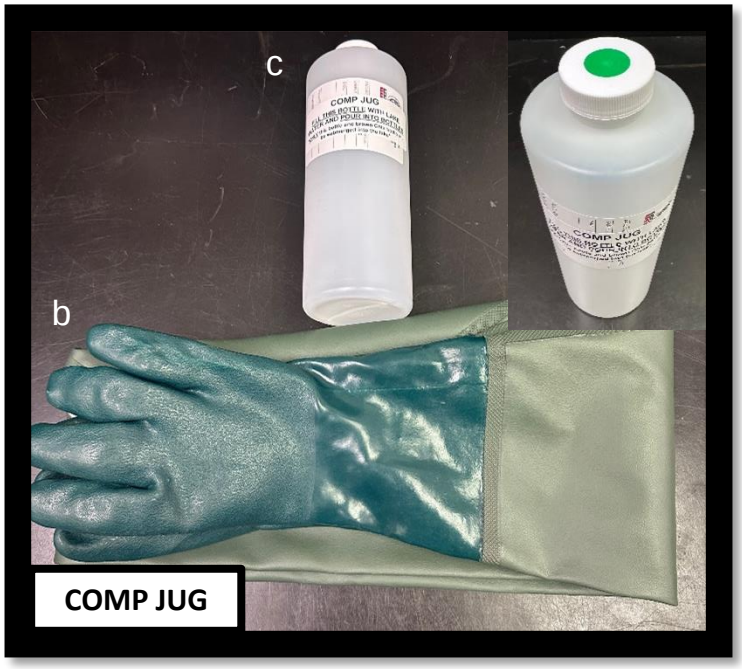
d) FOR FILTERING WATER FROM CHLOROPHYLL-A BOTTLES, PROCEED TO STEP 12.



6) COLLECT WATER SAMPLE WITH COMP JUG BOTTLE (P1 & P2):

a) Wearing the **sampling glove** (b), fill your **Comp Jug Bottle** (c) with water from below the surface, as deep as you can reach down.
THIS BOTTLE HAS A GREEN STICKER, IT CAN BE SUBMERGED INTO LAKE.

b) Use the water collected with the **COMP JUG** to fill **EVERY bottle with a red sticker on the lid.**



Preservative MSDS information can be found on the ALMS website at: https://alms.ca/winter-lakekeepers/

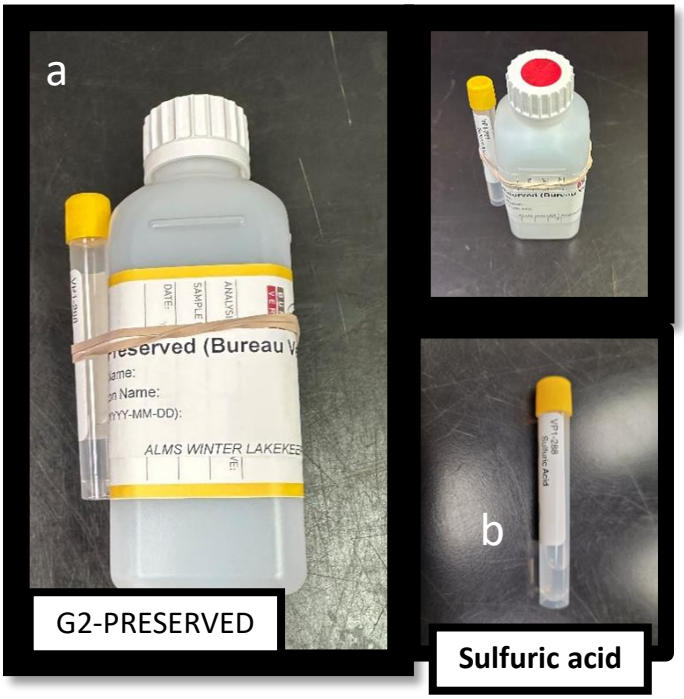
7) FILL G2-PRESERVED BOTTLE FROM THE COMP JUG BOTTLE (P1 & P2):

a) Using a Sharpie, label your **G2-PRESERVED Bottle** (a) with the Lake Name, Location Name, Date, and Time. **THIS BOTTLE HAS A RED STICKER, DO NOT SUBMERGE INTO LAKE.**

b) Using the **COMP JUG,** fill the **G2-PRESERVED** bottle until it reaches the neck.

c) Add one **yellow capped preservative** (b) to your **G2-PRESERVED bottle**. Wear disposable gloves and goggles as this preservative contains **sulfuric acid.**

d) Place the sample into your cooler.

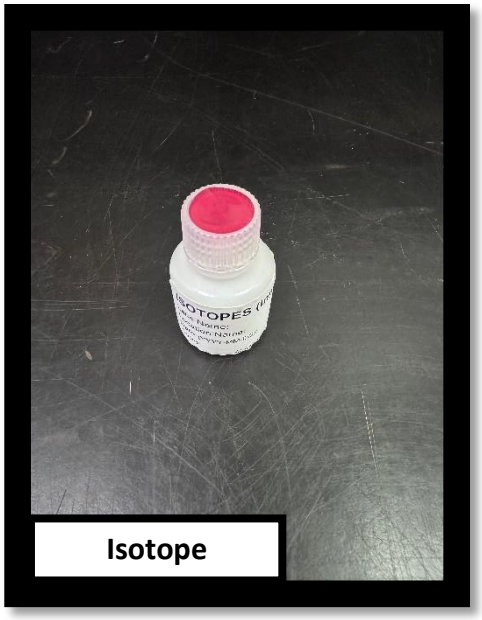


8) FILL ISOTOPE BOTTLE FROM THE COMP JUG BOTTLE (P1 & P2):

a) Using a Sharpie, label your **Isotope bottle** with the Lake Name, Location Name, Date, and Time. **THIS BOTTLE HAS A RED STICKER, DO NOT SUBMERGE INTO LAKE.**

b) Using the **COMP JUG,** fill the **Isotope** bottle until it reaches the neck.

c) Place the sample into your cooler.



Preservative MSDS information can be found on the ALMS website at: https://alms.ca/winter-lakekeepers/

9) FILL PHYTOPLANKTON BOTTLE FROM THE COMP JUG BOTTLE (P1 & P2):

a) Using a Sharpie, label your **Phytoplankton bottle** (a) with the Lake Name, Location Name, Date, and Time. **THIS BOTTLE HAS A RED STICKER, DO NOT SUBMERGE INTO LAKE.**

b) Using the **COMP JUG,** fill the **Phytoplankton** bottle until it reaches the neck.

c) Add one **green capped preservative** (b) to your **Phytoplankton Bottle.** Wear gloves and safety glasses as this preservative contains iodine and glacial acetic acid and easily stains.

d) Place the sample into your cooler.

e) IF FOLLOWING **P1**, SKIP AHEAD TO **STEP 13.**

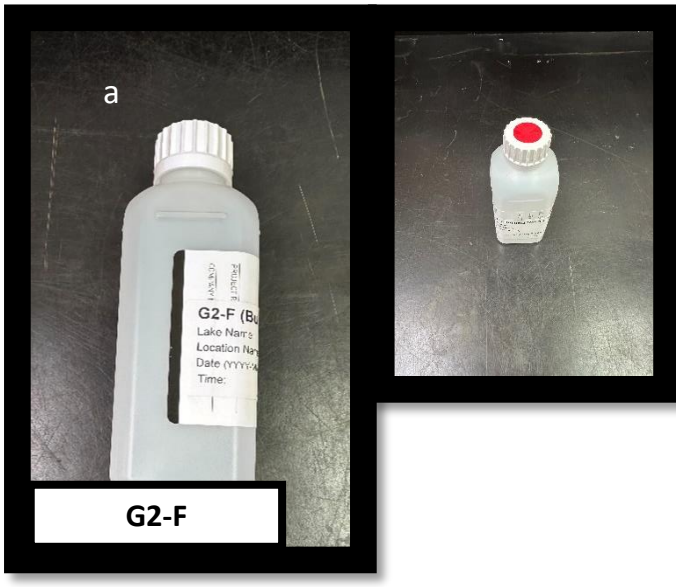
f) IF FOLLOWING **P2**, PROCEED TO **STEP 10.**

10) FILL G2-F BOTTLE FROM THE COMP JUG BOTTLE (P2 ONLY):

a) Using a Sharpie, label your **G2-F Bottle** (a) with the Lake Name, Location Name, Date, and Time. **THIS BOTTLE HAS A RED STICKER, DO NOT SUBMERGE INTO LAKE.**

b) Using the **COMP JUG,** fill the **G2-F** bottle until it reaches the neck.

c) Place the sample into your cooler.



Preservative MSDS information can be found on the ALMS website at: https://alms.ca/winter-lakekeepers/

11) FILL TOTAL AMMONIA BOTTLE FROM THE COMP JUG BOTTLE (P2 ONLY):

a) Using a Sharpie, label your **Total Ammonia Bottle** (a) with the Lake Name, Location Name, Date, and Time. **IMPORTANT NOTE: This bottle is pre-charged - meaning the preservative is already in the bottle. DO NOT triple rinse this bottle as the preservative will spill into the water body.**

THIS BOTTLE HAS A RED STICKER, DO NOT SUBMERGE INTO LAKE.

Total Ammonia

a) Using the **COMP JUG,** carefully fill the **Total Ammonia** bottle until it reaches the neck. Leave a little head space to prevent the preservative from spilling out.

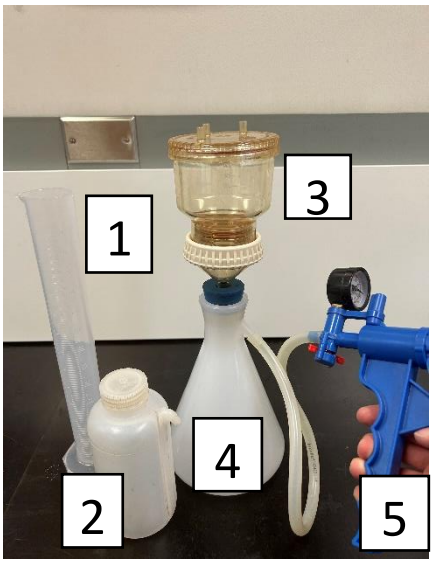
b) Place the sample into your cooler.

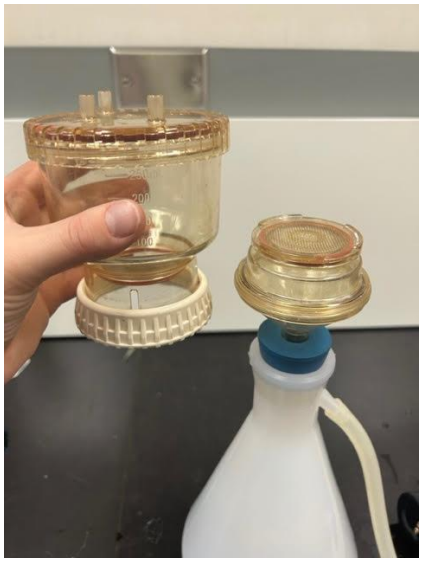
This bottle is pre-charged with the preservative.

Do not dip into the lake!

Preservative MSDS information can be found on the ALMS website at: https://alms.ca/winter-lakekeepers/

12a) CHLOROPHYLL-A FILTERING SET UP (P2+ChlA):





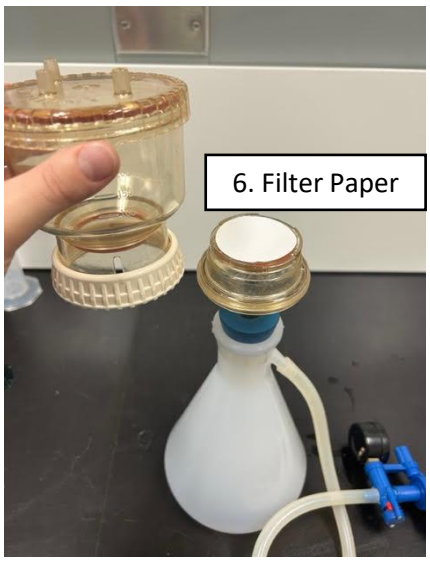


Figure 1. OPTION #1 SET UP: Filtration system including:

1. Graduated cylinder
2. Squirt bottle
3. Filter apparatus with rubber stop
4. 1000 mL Erlenmeyer flask
5. Hand vacuum/pump
6. Filter paper

You may receive one of two filter systems, depending on availability. Follow **Option #1** if you have a flask and stopper, or **Option #2** if you have a full apparatus

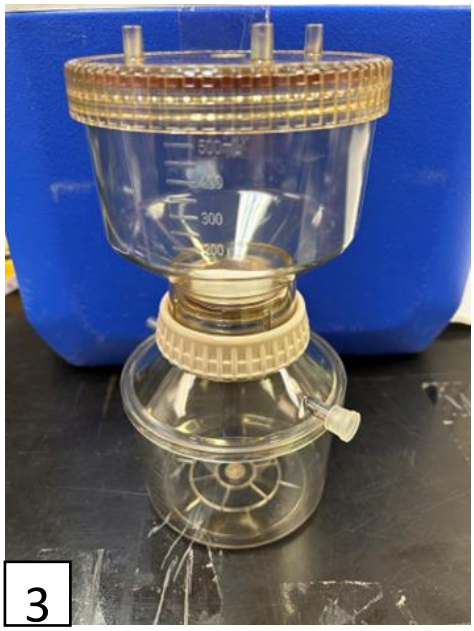


Figure 2. OPTION #2 SET UP: Screw-on filter set.

12b) FILTER WATER FROM CHLOROPHYLL-A BOTTLES (P2+ChlA):

a) Filtering must be done away from direct light and on a level surface **within 24 hours of collecting the water sample**. **If filtering is delayed because the location is too cold, refrigerate the sample at home but do not let it freeze.**

b) Put on disposable nitrile gloves to avoid contamination.

c) Set up the chlorophyll filtering apparatus as per your filter system (refer to page 8):

d) Unscrew the top piece of the filter apparatus and place one filter paper on the funnel using tweezers making sure to **cover all the holes**. Screw the top back on.

e) Wet the filter paper with **pure water** from your squirt bottle.

f) **Shake the Chlorophyll-a bottle** and measure 50 mL of lake water with the graduated cylinder. Pour it onto the filter paper. Keep track of how much you filter each time.

g) Use the hand pump to gently increase pressure and allow the water to filter through. Repeat this step, adding more lake water, until a slight green or brown color is visible on the filter paper. **Do not filter more than 300 mL.** If there is no colour at 300 mL, that is okay, you can stop.

h) If unsure about the paper's color, unscrew the top to lift the paper carefully around the edges with tweezers to check.

i) Triple-rinse the graduated cylinder and the inside of the filter apparatus with pure water, ensuring all rinses pass through the filter paper.

j) If the filter flask fills up, **discard the water back into the lake or outside (NEVER down the drain)**. Ensure the lake water does not reach the pump tubing.

k) **Record the total volume** of filtered sample water on the field sheet under the ChlA filter section (Filter #1, #2, or #3). Also record the filter paper colour in this section.

l) Add **three** drops of magnesium carbonate **($MgCO_3$)** onto the filter paper, pumping as you go.

m) Using tweezers, fold the filter paper in half twice, avoiding contact with the Chlorophyll-a sample.

n) Place the folded filter paper into a petri dish. Wrap the dish in aluminum foil to protect it from light.

o) Use the **given Filter Labels** and record the lake name, location, date, and **total volume of lake water** filtered. **STICK** filter label over the aluminum foil wrapped petri dish.

p) Repeat steps (d)–(o) **two more times to obtain three filter papers in total.**

q) Discard any excess water back into the lake or outside **(NEVER down the drain).**

r) Store the wrapped petri dishes in a Ziploc bag in the **freezer** until shipping them with other bottles.

13) WHAT TO DO AFTER SAMPLING

Shipping Samples

1. Pack all your bottles, including the *frozen* chlorophyll filters from the freezer, into a cooler.
2. Make sure to include a frozen ice pack or two depending on the size of your cooler.
3. Place the field sheet sealed in a Ziploc bag into the cooler. Email or text a photo of the field sheet to lakekeepers@alms.ca.
4. Tape the cooler shut.
5. Refer to the **'ALMS Shipping Slip'** included with your Chlorophyll kit when filling out the courier information. Please use ALMS' Purolator account number, which will be included on the slip.
6. Please send a picture of the **tracking number** to lakekeepers@alms.ca or by text message.

ALMS SHIPPING SLIP

ALMS Purolator Account #

Alberta Lake Management Society

4816 89 St

Edmonton, AB T6E 5K1

Please choose Overnight or Express shipping

PLEASE HOLD ONTO THIS SLIP AS A REFERENCE FOR THE SAMPLING SEASON

Important Reminders:

- Check with your courier for the daily cutoff times for overnight shipments. Samples must be submitted before these times if they are to arrive at our office the next day.
- Sampling any day between **Sunday-Wednesday** is ideal and will ensure samples are received before hold times. Thursday mornings can work if samples can be shipped by the afternoon and before the courier cutoff time.
- Our office will be closed for holidays from **December 21st to January 1st and February 17th**. We cannot receive samples during these times.

13) WHAT TO DO AFTER SAMPLING

Please follow the table below to know depending on your protocol steps, how quickly samples need to be returned to ALMS, and how to ship/deliver them.

Table 1. Shipment timing & process for Winter LakeKeepers 2024-2025

Protocol	Return Within:	How to ship:
P1	2 weeks	Keep **G2-Preserved** cold in fridge. **Phytoplankton & Isotopes** are okay on the shelf or counters until shipment
P2	24hrs	Keep **G2-Preserved, G2-F, and Total Ammonia.** **Chlorophyll-A** bottles cold in fridge until you filter or ship. **Phytoplankton & Isotopes** are okay on the shelf or counters until shipment
P2 + Chlorophyll-A Filtering	3 days	Keep **G2-Preserved, G2-F, Isotopes, and Total Ammonia** bottles cold in the fridge. Keep **Chlorophyll-a filters FROZEN.**

RETURNING YOUR SAMPLES & KIT IN PERSON:

- If you are returning your sampling kit in person to the ALMS office – please contact ALMS at 780-702-2567 or lakekeepers@alms.ca to arrange delivery timing.
- The ALMS office is located at **4816-89 St. Edmonton, AB. T6E-5K1**
- When returning the kit, park anywhere you like in the parking lot and buzz at the front door when you arrive.

RETURNING YOUR SAMPLES & KIT IN THE MAIL:

- Please use Purolator to ship your kit back to ALMS. Ensure the contents of the kit are secure, and that the pelican case has been taped closed with packing tape.
- To ship, use the ALMS Purolator Account Number (included on the shipping slip) and choose **Receiver Pays**.
- If shipping, arrange with ALMS prior to sampling to have them provide a cooler for shipping samples.
- For information on how to fill out your Shipping Form, see the ALMS Winter LakeKeepers page at www.alms.ca/winter-lakekeepers/

KEEPING YOUR KIT FOR FURTHER SAMPLING:

- If you plan on using this probe in another waterbody, ensure it has been cleaned with tap water. It is best if the tap water used to clean the probe is discarded outside and not down your drain.
- Do not use any cleaners on your probe – when storing the probe, ensure the yellow sponge is wet and the grey sleeve is over the probe.
- If you plan on using this probe again in the same waterbody, no cleaning is required.
- Even though you plan to continue sampling, your samples must be sent back to ALMS – see the 'in person' or 'in mail' options on Page 10, and make sure you process and ship your samples according to the timeline and processes outlined in Table 1 on Page 11.

APPENDIX

A1) GPS Coordinates Instructions & Documentation

1. **Go to https://www.googlemaps.com/maps, and find your lake (search its name).**
2. **Using your mouse, right click on the location of the lake where you collected your sample.**
3. **Choose "*What's Here?*"**
4. **The GPS coordinates will appear at the bottom of your screen in the format of: 55.217876, -113.252806. Record these coordinates on your field sheet.**

IF YOU PLAN ON SAMPLING THE SAME SITE MORE THAN ONCE IN THE WINTER, USE THE TABLE BELOW TO RECORD YOUR SITE GPS FROM THE FIRST SAMPLING EVENT TO BE USED FOR THE NEXT SAMPLING EVENTS. USE BOTTOM DEPTH AS ANOTHER REFERENCE FOR LOCATING SAME APPROXIMATE SITE LOCATION.

Table 2. Site GPS log (reference for subsequent sampling events)

SITE (Lake, Location Name) Eg. Moose Lake, Vezeau Bay	Latitude	Longitude	Bottom Depth (m)

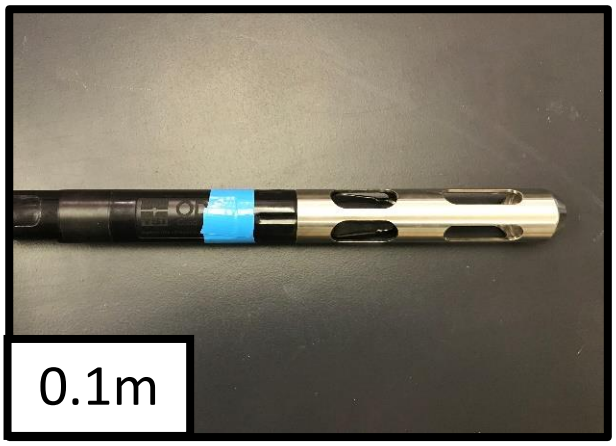
[1]Degree Minutes Seconds example: 53°29'06.5"N 113°27'54.6"W
[2]Decimal Degrees example: 53.485127, -113.465178
[3]Degree Decimal Minutes example: 53°29.1076'N, 113°27.9107'W

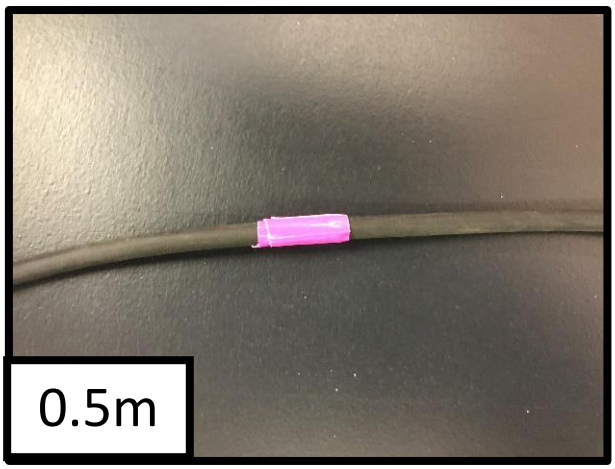
A2) USE THIS TABLE TO MAKE SURE YOU HAVE EVERYTHING YOU NEED FOR SAMPLING

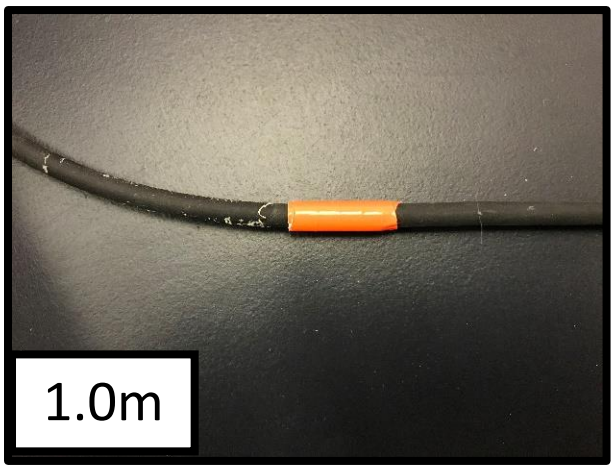
Table 3. Equipment & Material List

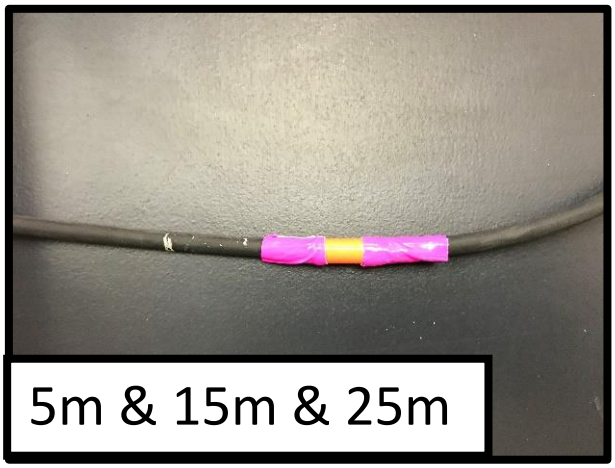
P1	P2	P2 + Chlorophyll-a Filtering
YSI Solo Probe	*Same as P1 plus…	*Same as P1 & P2
Long yellow or green gloves	**G2-F Bottle**	Buchner funnel & black plastic weight
G2-Preserved Bottle + yellow cap preservative (2mL sulfuric acid)	***Total Ammonia Bottle* (DO NOT fill in the lake, already has preservative)**	Rubber stopper
Isotope Bottle	**One 1L Chlorophyll-a bottle**	Hand pump & tube
Phytoplankton Bottle + green cap preservative (3mL Lugol's Solution)		Filter flask
Comp Bottle (fill in lake, pour off water from here into rest of bottles)		Graduated cylinder
Hot water bottle		Squirt bottle & pure water
Field Sheets on Clipboard		Tweezers
Probe charger		Filter paper
Extra disposable gloves, safety glasses		Magnesium Carbonate
Kimwipes (tissues)		Aluminum foil
Tape and Weight		Petri dishes & baggies
Pure water for calibration		Chlorophyll-a filter & bottle labels
Pencils/pens/Sharpies		Disposable gloves

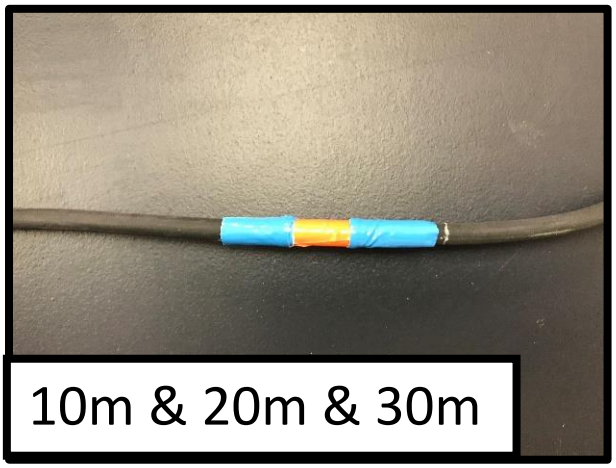
A3) YSI PROBE DEPTH MEASUREMENT MARKING GUIDE











A4) DATA COLLECTION BACKGROUND

Below are descriptions of what the data and samples collected through Winter LakeKeepers will be used for, and how they relate to better understandings lakes in the winter. Also provided is where the data will eventually be used and reported.

- **Environmental Observations:** 'Total Ice Thickness,' White Ice Thickness,' 'Snow Coverage,' 'Snow and/or Slush Thickness,' 'Air Temperature,' 'Water Colour,' 'Odour Present,' and 'Water Clarity' are all collected to put the data collected in context of the winter environment in which they were collected. Ice thickness and snow thickness (if present) can be used to understand how much light may be penetrating the ice. See Appendix section A5 on Page 17 for further description about white ice and clear ice. Recording water colour and the general water clarity can identify algae or cyanobacteria growth, and even the type of algae or cyanobacteria. Seeing how these parameters change may also help contextualize trends in other data collected through Winter LakeKeepers. Reported on in the ALMS Winter LakeKeepers reports.
- **GPS Coordinates:** Very important to collect, since the particular location on the lake where the sample is collected is used to contextualize all other data collected. Used to make maps for presentations and reporting about Winter LakeKeepers.
- **Probe Calibration:** Used to ensure probes are reading accurately given local environmental conditions.
- **Lake Measurements:** Temperature readings from the top to bottom of the lake (lake profile) are used to understand lake mixing, dissolved oxygen levels, and for evaluating habitat for plants and animals. Dissolved oxygen readings are also taken through the lake profile to understand fish habitat. Winter can often be a stressful time for fish, as low oxygen levels often present at the end of winter can cause die-offs of certain species of fish. Determining the rate at which oxygen decreases through the winter season can also be used to understand the impact of summer algae and cyanobacteria growth, as greater growth will cause oxygen to be depleted more quickly as the algae and cyanobacteria decompose. Low oxygen levels can impact nutrient levels, as lake sediments will release phosphorus into the lake if oxygen is absent – seasonal oxygen levels may contextualize seasonal nutrient changes. Reported on in the ALMS Winter LakeKeepers reports.
- **G2-Preserved:** Water from this bottle is used to determine total phosphorus and total nitrogen levels, which are important nutrients for algae, cyanobacteria, and aquatic plant growth. High levels of these nutrients may indicate pollution, and contextualize the amount and type of algae and cyanobacteria present. Reported on in the ALMS Winter LakeKeepers reports.

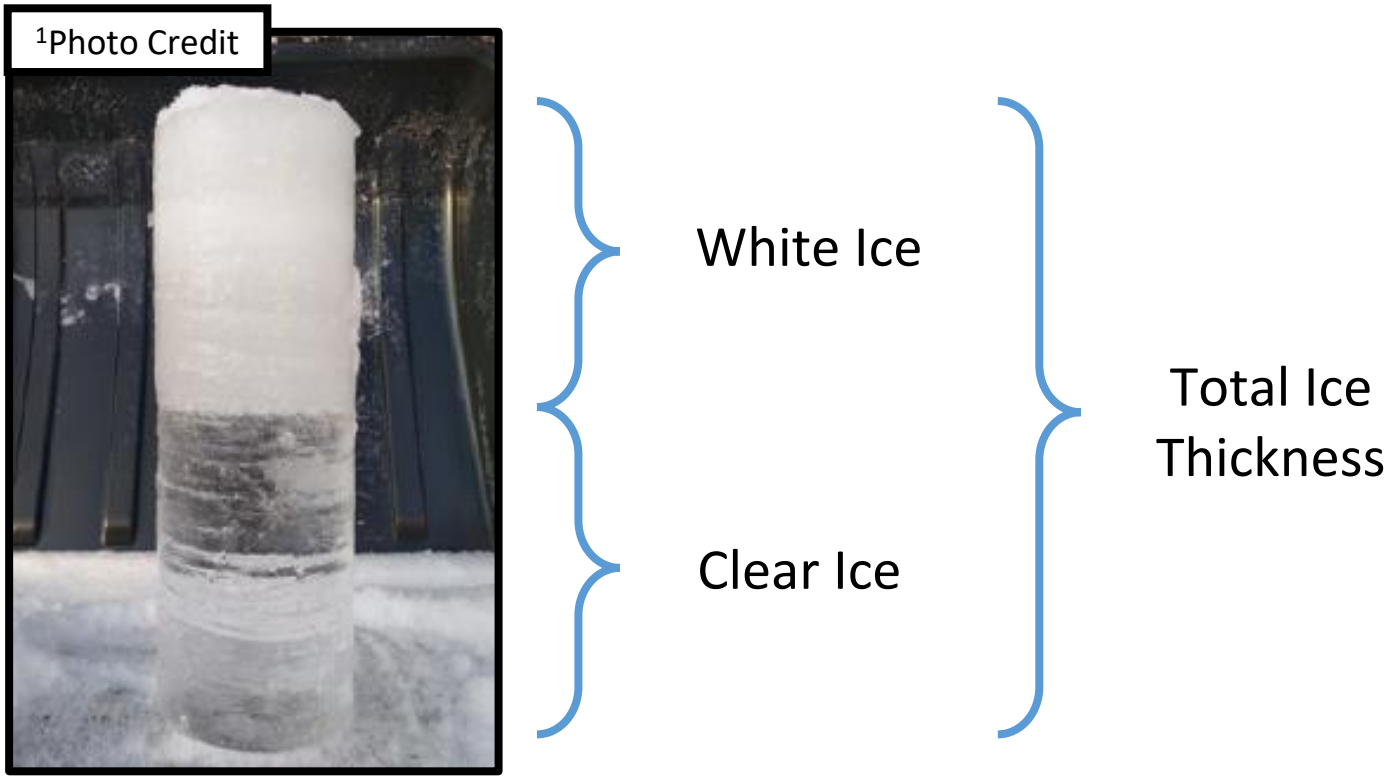
- **Isotopes:** Isotopes of hydrogen and oxygen are used to help understand water balance in lakes including sources (precipitation, inflow, groundwater), losses (e.g. evaporation, outflow), and residency time.
- **Phytoplankton:** This bottle preserves the cyanobacteria and algae species that are present just below the ice, where their levels will be the highest. Knowing which species are present, and in what amounts, will help to understand the biodiversity of algae and cyanobacteria, and their contribution to the winter lake food web. Information will also be used to understand how nutrient levels impact algae and cyanobacteria in the winter. These samples will be archived and may be analyzed at a later date if chlorophyll-a levels are high.
- **G2-F:** Water from this bottle is used to determine total dissolved phosphorus and dissolved organic carbon levels, which are important nutrients for algae, cyanobacteria, and aquatic plant growth. High levels of these nutrients may indicate pollution, and contextualize the amount and type of algae and cyanobacteria present.
- **Ammonia:** A nitrogen compound found naturally in water, often resulting from the breakdown of organic matter or human activities like agriculture and wastewater discharge. In lakes, elevated ammonia levels can be toxic to aquatic life, especially in fish, and can contribute to eutrophication, promoting excessive algae growth that depletes oxygen and harms overall water quality.
- **Chlorophyll-a:** Water from this bottle is used to determine the levels of chlorophyll-a in lake water. Chlorophyll-a is a green pigment found in all algae and cyanobacteria, and is used in photosynthesis. Chlorophyll-a levels are used to understand the amount of algae and cyanobacteria in lake water. Higher levels, in conjunction with high nutrient levels, may indicate nutrient pollution, or reflect the lake's natural ability to support high levels of algal and cyanobacterial growth. Chlorophyll-a levels compared with ice conditions will also improve the understanding of what influences algae and cyanobacteria growth in Alberta Lakes in the winter. Reported on in the ALMS Winter LakeKeepers reports.

A5) SNOW, SLUSH, WHITE ICE, AND CLEAR ICE

The quality, or characteristics of the snow and ice that covers lakes in the winter can be extremely variable. One of the major ways that snow and ice can vary on a lake is vertically, where snow, slush, white ice and clear ice can be identified. Snow and slush will be loose, while both white ice and clear ice will be hard. After auguring the hole in the ice, looking down the hole you should see up to two distinct layers of ice. On the top will be opaque or 'white' ice, and below will be clear, transparent 'clear' ice (also known as black ice). If you are sampling early in the season, there is a good chance that there will be little or no white ice, but later in the season, the layer of white ice may grow substantially. White ice is formed when snow melts and refreezes, which can happen during warm spells, rain events, or if the snow layer is heavy enough to force water up through cracks in the ice.[1]

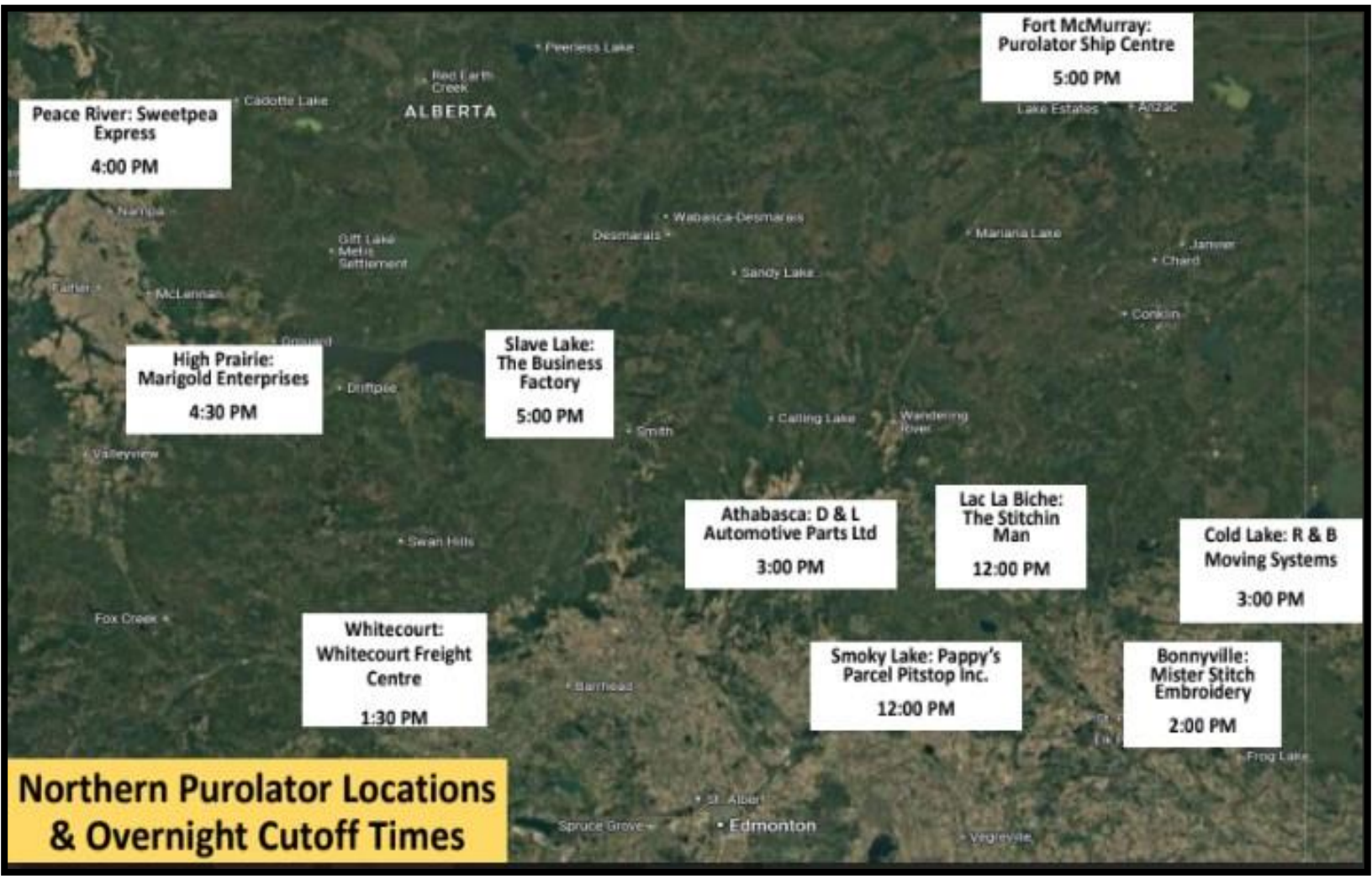
How to measure snow, slush, white ice, and clear ice: Before you clear your auger site, measure the snow and/or slush depth, or nearby the auger hole where you have not altered the snow. Next, clear the site where you will auger your hole. Make sure you clear all the way down to the hard layer of ice, if possible. After you auger your hole, measure the total ice thickness. Next, measure the thickness of the white ice layer, which will be from the surface of the ice down to the line where white ice transitions into clear ice. The thickness of clear ice is the difference of total ice thickness and white ice, which is why only total and white ice thickness are required on the field sheet.

[1]Photo Credit



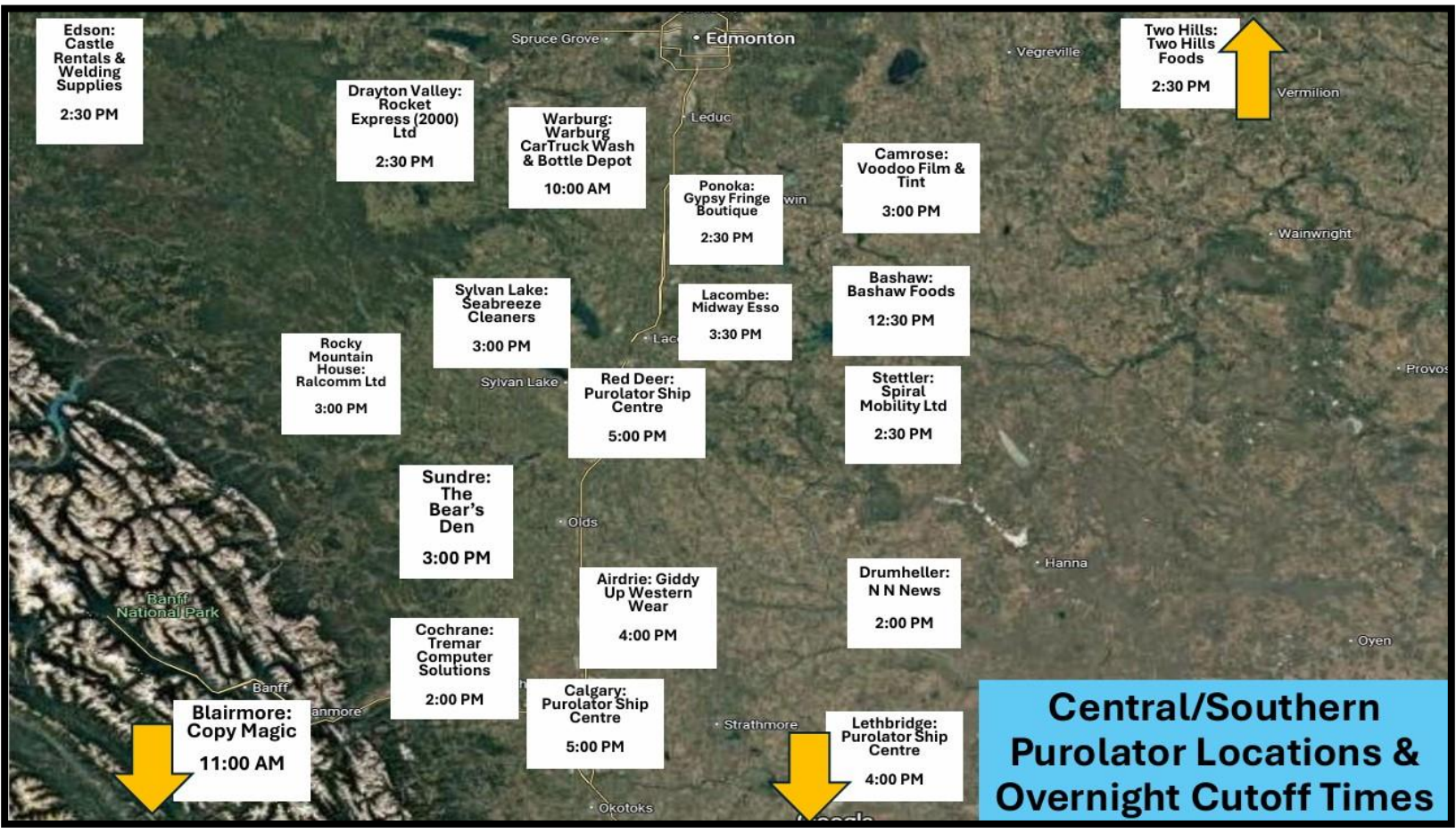
[1]Weyhenmeyer, G.A., Obertegger, U., Rudebeck, H. *et al.* Towards critical white ice conditions in lakes under global warming. *Nat Commun* **13**, 4974 (2022). https://doi.org/10.1038/s41467-022-32633-1

A6) PUROLATOR LOCATIONS & OVERNIGHT CUTOFF TIMES



***All these locations offer full Purolator services ***

A7) PUROLATOR LOCATIONS & OVERNIGHT CUTOFF TIMES



***All these locations offer full Purolator services ***