Technical description of the proposed research:

a) Objectives: short-term and long-term objectives for the project

The overarching goal of this proposed work is to improve our basic understanding of physical oceanography in inner Frobisher Bay for the purpose of spill preparedness and response under the auspices of the Department of Fisheries and Oceans (DFO) Integrated Marine Response Planning Program (IMRP).

Targeted objectives of this proposed work include:

1. Observe the full-depth ocean currents and the tidal cycle at one point along the sea lane in inner Frobisher Bay annually; observe ocean temperature and salinity at depth (below the summer mixed layer) at the same point in inner Frobisher Bay annually.

2. Observed sea ice thickness and motion at the same point along the sea lane in inner Frobisher Bay annually.

3. Use the full-depth current observations, observed tides, and observed temperature and salinity below the summer mixed layer to:

(a) improve our understanding of the physical oceanographic environment in inner Frobisher Bay to aid in the determination of the fate and behavior of ship-source and mystery-source spills in the Iqaluit region,

(b) create, inform, and test a high spatial resolution physical oceanographic model of Frobisher Bay using the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM) environment developed at the Virginia Institute of Marine Science for the purpose of advancing oceanographic process knowledge of the Bay, and

(c) begin to interrogate if recently observed increased water temperature in the North Atlantic (Liu et al., 2024) might be making it into inner Frobisher Bay at point(s) in the annual cycle.

b) Background and Rationale: the state of knowledge and research related to the problem or question(s) being investigated. Explain the history and development of the research questions and justify the significance of and need for the project.

Comparatively few observations of the physical oceanography of Frobisher Bay exist, dating back to the Calanus expeditions of 1949-1955 (Dunbar, 1958). After those cruises, four oceanographic stations in Frobisher Bay were profiled for temperature and salinity in 1978, six stations were profiled in 1979 (Lovrity, 1981) and two stations were profiled in 1980 by teams from the Department of Fisheries and Oceans, Arctic Biological Station (Lovrity, 1982).

More recently, the Government of Canada's Oceans Protection Plan established the Coastal Environmental Baseline Program (CEBP) initiative (2018-2023) at six key coastal sites, including Iqaluit, Nunavut (https://www.dfo-mpo.gc.ca/science/partnerships-partenariats/research-recherche/cebp-pdecr/projects-projets/iqaluit-eng.html). The CEBP supports the collection of physical, chemical, and biological data to describe the current

state of the ecosystem. At the Iqaluit site, at least 24 projects were funded for various durations between 2018-2023, resulting in six open data records (e.g. Daoust, 2024, Dhifallah et al., 2023), at least eight publications (e.g. Dhifallah et al., 2022, Hilgendag et al., 2022, Rauf et al., 2025, Saab et al., 2023, Schaefer et al., 2022, Stroski et al., 2020, Sudlovenick et al., 2023), and a thesis (Schaefer, 2020). However, none of these works present data or interpretations of the physical oceanography of Frobisher Bay.

The Centre for Oil, Gas, and Energy Research (COOGER) at the Department of Fisheries and Oceans Bedford Institute of Oceanography produced a report (McIsaac et al., 2023) outlining factors that may influence the oil fate, behaviour, and response for Iqaluit, Nunavut. McIsaac et al. (2023) contains a cursory description of the shorelines, bathymetry, tides, circulation and currents, noting: *"Little previous work has been published focused on Frobisher Bay and recent circulation studies largely focus around Iqaluit in Koojesse Inlet. Field research seasons are short and typically occur during warmer months, making it challenging to observe seasonal changes in circulation and determine how those changes may impact oil spill fate and behaviour at different times of the year.".*

In terms of temperature and salinity, apart from the profiles published by Lovrity (1981, 1982), Arctic charr works by Spares et al. (2012, 2015) contain description of temperature layers that formed in the inner Bay, and Oceans Network Canada conducts CEBP-funded oceanographic work with community fishers who collect CTD data which is then displayed on the web: https://data.oceannetworks.ca/GeospatialMap. There were also CEBP CTD profiles collected between 2018-2023 that are presented in Lewis et al. (submitted), but obviously those data are not yet published. MacIsaac et al. (2023) also contains overview paragraphs pertaining to wind, and surface waves in Frobisher Bay, noting that there is little research focused on the wave climate in Frobisher Bay. MacIsaac et al. (2023) point only the work of Hatcher et al., (2014) who were doing coastal geoscience work in Koojesse Inlet to glean wave information.

Finally, in their treatise of modelling work on Frobisher Bay, MacIsaac et al. (2023) note specifically that the Nunavut Impact Review Board (NIRB, 2019) identified a gap in chemical and physical oceanographic knowledge in Frobisher Bay and in Davis Strait that makes it challenging to create reliable circulation models for the region necessary to determine oil spill trajectories. This dearth of observed data leaves incident planning and recovery work largely unsupported by the necessary environmental context.

So, the research questions we propose to address were developed in a clear, straightforward way to use our overarching and targeted objectives to begin to produce oceanographic data in Frobisher Bay for improved ecosystem understanding, and spill preparedness and response, including model development. There are almost no data, we propose to create some, highlight its utility, and then improve our observational capacity in time and space over years. Justification of the significance of this work is also straightforward, using for example the container spill by NEAS Inc. near the Port of Iqaluit in 2023. At least five containers are still unaccounted for and so far have not been found despite the efforts of NEAS Inc. and their contractors. Without physical oceanographic understanding of the temperature and salinity, and therefore density, as well as full-depth currents in Frobisher Bay, the location of those containers cannot be reliably forecast. This project will provide basic oceanographic data which will improve ecosystem understanding and enable ocean model development for spill preparedness and response in Frobisher Bay as vessel traffic is expected to increase in the region due in part to the newly opened Port of Iqaluit.

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c) Progress to Date: Describe the results of any work completed to date on the project. Include information on progress in the areas of capacity building, communications, and integration of Inuit knowledge.

Dr. Galley (DFO-IMRP planning coordinator) is a co-author on the work of Lewis et al. (submitted), having processed the CTD profile data therein for Chris Lewis and his other co-authors. Lewis et al. (submitted) should be considered ancillary to the proposed research.

To date, the proposed new research work has been presented in writing and orally to the Board of the Amaruq Hunters and Trappers Association (HTA) in Iqaluit, Nunavut. Fruitful discussion has occurred about the proposed work and its scientific and practical merits at HTA board meetings. The Amaruq HTA Board voted to support the work proposed, and the Amaruq HTA chair, Jimmy Akavak, has written a letter to Dr. Galley in support of the proposed work. Concurrent to this Nunavut Research Institute (NRI) licensing proposal, Dr. Galley is also pursuing authorization of the work by the Nunavut Planning Commission (NPC).

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d) Recruitment: How will each type of participant be recruited, who will recruit each type of participant, and what materials will be used for or during recruitment.

Recruitment of participants for this work is not anticipated. DFO-IMRP intends to meaningful and fruitfully continue to engage the Amaruq HTA and the community of Iqaluit in an ongoing partnerships in this research work upon retrieval of the first years' data.

e) Methodology: Describe and justify the research design, research methodology, data analysis techniques, and the ethical research protocols to be followed (e.g. protocols to secure informed consent, community engagement). Explain where and when the work will be carried out and justify the selection of research locations.

An oceanographic mooring (Figure 1) will be deployed in inner Frobisher Bay along the sea lane between Pike-Resor Channel and the Port of Iqaluit using a ship-of-opportunity in autumn 2025 in coordination with the Canadian Coast Guard (CCG), Bedford Institute of Oceanography, and the Canadian Hydrographic Service (CHS).

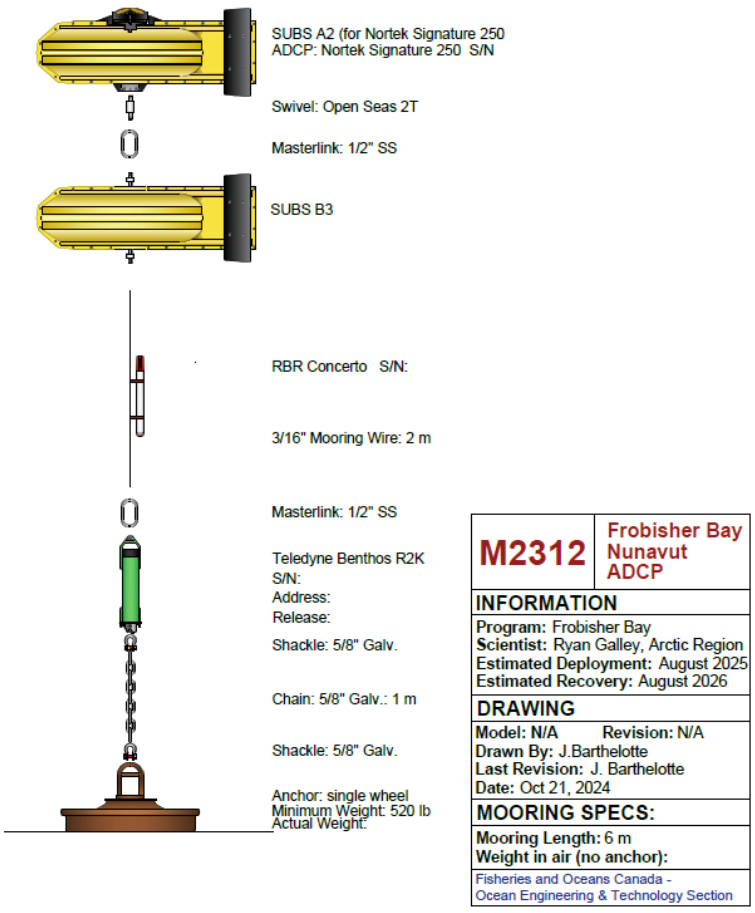

Figure 1: Draft design for a mooring setup using floats, a Nortek Signature 250 ADCP, an RBR Concerto CTD and a Teledyne Benthos release held to the bottom by a single train wheel anchor.

The mooring will be composed of one Nortek Signature 250 ADCP to measure ocean currents, tides, wave height and direction, and an RBR Concerto CTD to measure ocean temperature, and salinity below the surface mixed layer. Moorings require an anchor to hold them to the bottom, and a release (e.g. Teledyne Benthos R2K) to allow the setup to float to the surface upon their intended retrieval (Figure 1).

The proposed location, as discussed with the Amaruq HTA, is in approximately 115 m of water (Figure 2), allowing for the surface wave height and direction to be potentially measured by the Nortek Signature 250 instrument, in addition to full-depth currents.

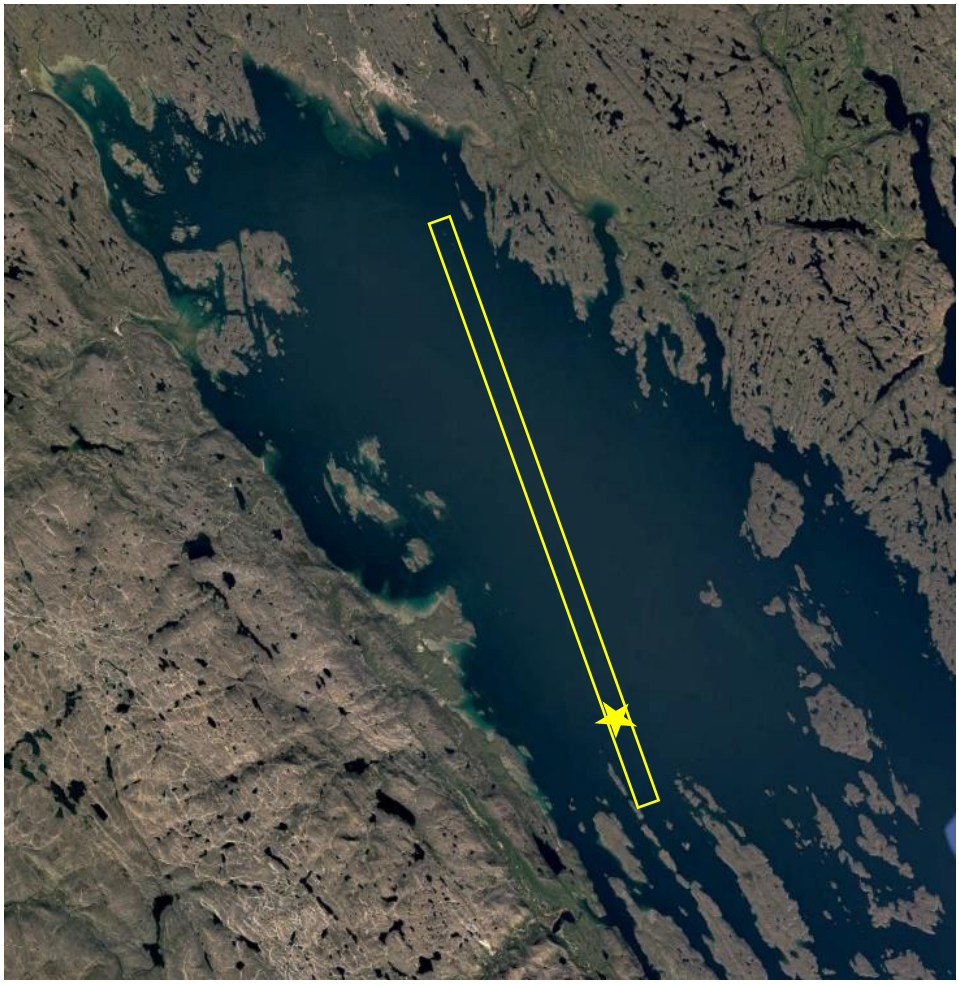

Figure 2: Mooring location (yellow star) in the shipping lane (yellow rectangle) in inner Frobisher Bay as proposed by the Arctic Region IMRP Team, Fisheries and Oceans Canada.

The proposed mooring location (Figure 2, yellow star) seems like a good spot for a number of reasons:

- It's in the shipping lane;
- Canadian Hydrographic Service would like surface current information for their navigational charts in the area;
- It's relatively deep, while the whole water column can be measured from the bottom;

- It will capture the ocean currents in the inner bay which may be more important, useful to the HTA and the people of Iqaluit, while hopefully observing the interaction between the inner and outer portions of Frobisher Bay;
- We have heard accounts of thin ice in this area during discussion with community members, and would like to try to explain those oceanographically;

The data collected will be employed by IMRP collaborator Dr. Yonngsheng Wu (Bedford Institute of Oceanography) for ocean, sea ice and oil spill modelling using the SCHISM (Semi-Implicit Cross-scale Hydroscience Integrated System Model) environment developed at the Virginia Institute of Marine Science (https://ccrm.vims.edu/schismweb/). The SCHISM includes ocean, sea-ice, and oil spill modules. Dr. Wu is currently running this model for the Atlantic Ocean, Labrador Sea, Davis Strait and Baffin Bay (see Figure 3 (top panel) for the models' spatial domain).

Dr. Wu has agreed to build a nested, high resolution physical model of Frobisher Bay based on the data we will generate using SCHISM so that sea ice, ocean, and oil dynamics are accurately understood in the region.

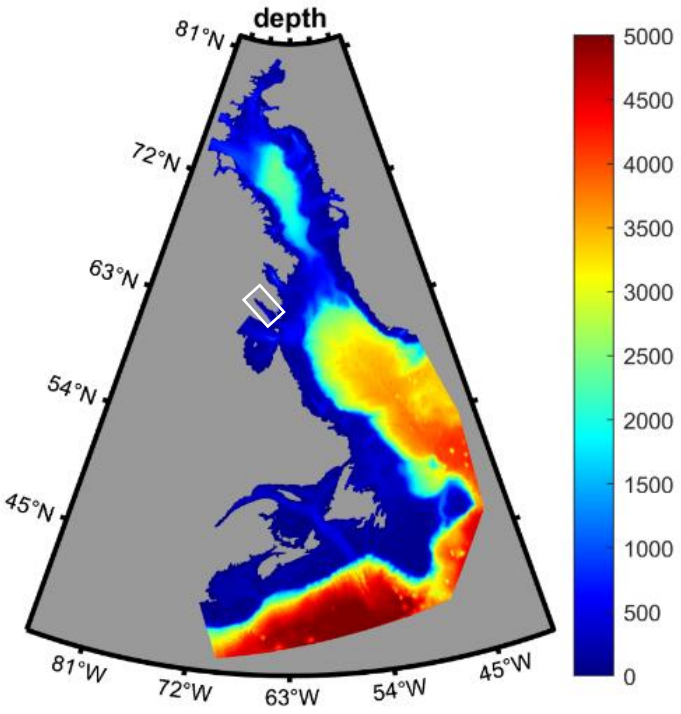

Figure 3: (left) Spatial domain with bathymetry (meters) of the ocean model currently run by Yongsheng Wu at Bedford Institute of Oceanography. Proposed high resolution Frobisher Bay model domain approximated by the white rectangle.

f) Data management: Describe your data management plan, and explain the principles and protocols for collecting, sharing, storing, and using data and information collected from or about Inuit and/or Nunavut.

Digital data will be collected from the Nortek ADCP and the RBR CTD upon mooring retrieval in autumn 2026. These data will undergo quality assurance/quality control and processing to create derived oceanographic variables and oceanographic information. Data will be stored on waterproperties.ca, an open and accessible online data repository run by the Water Properties Group at the DFO Institute of Ocean Sciences. Metadata records will also be submitted to the Polar Data Catalogue (polardata.ca) to further facilitate its discovery, sharing. Finally, all the data generated by this proposed work will be made available on the Nunavut Research Institute's research portal, isirvik.ca. The data will also be stored locally by DFO-IMRP in their Arctic spill response geodatabase.

g) Research outputs: Describe the major research outputs to be generated through the project (academic theses, publications, presentations, reports, etc.); describe specifically how and when research results will be validated with and communicated to research participants and impacted organizations in Nunavut.

The research output from this proposed project include open data records on the temperature, salinity and full-depth currents in inner Frobisher Bay. The data from this mooring will be published annually in the DFO Technical Report Series, making the information publicly available. Each year, DFO- IMRP will make presentations on the findings of this proposed research to the Amaruq HTA, either in writing, orally, or both depending on the availability of the HTA board, where DFO-IMRP will discuss the ongoing nature of this work for the benefit of all involved.

This proposed research will generate surface current information in inner Frobisher Bay that may be placed on Canadian Hydrographic Service charts for improved navigational safety. In collaboration with Dr. Wu at BIO, this work will result in the creation, information, and testing of a high spatial resolution physical oceanographic model of Frobisher Bay using the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM) environment.

Finally, placing the project on isirvik.ca will enable searchability, comparability, and availability to Nunavummiut, allowing easy identification and engagement with this research in Nunavut.